za zaštitu prirode i okoliša
Prilaz baruna Filipovića 21
10000 Zagreb
OIB: 84310268229

Strategic study on the environmental impact of the plan for the development of the geothermal potential of the Republic of Croatia until 2030

Zagreb, April 2023.

Funded by the European Union
NextGenerationEU

The name of the document:	Strategic study on the environmental impact of the plan for the development of the geothermal potential of the Republic of Croatia until 2030
The holder of the procedure	Ministarstvo gospodarstva i održivog razvoja, Uprava za energetiku Radnička cesta 80, 10 000 Zagreb
Creator of the Study:	IRES EKOLOGIJA d.o.o. za zaštitu prirode i okoliša Prilaz baruna Filipovića 21 10 000 Zagreb OIB: 84310268229

Lead of the Strategic study: Mario Mesarić, mag. ing. agr.

Experts		
Author	**Signature**	**Chapter**
Mario Mesarić, mag. ing. agr.		Soil and agricultural land, Agriculture, Cooperation on all chapters
Josip Stojak, mag. ing. silv.		Forests and forestry, Game and hunting
Employees		
Author	**Signature**	**Chapter**
Igor Ivanek, prof. biol.		Biodiversity, Protected nature areas, Invasive species
Monika Veljković, mag. oecol. et prot.nat.		
Antonela Mandić, mag. oecol.		
Paula Bucić, mag. ing. oecoing		Air and Climate, Water, Industry, Mineral Resources, Energy, Relationship of the Plan with other appropriate strategies, plans and programs at the national and county level, Environmental protection goals established by the conclusion of international treaties and agreements, which refer to the Plan
Helena Selić, mag. geogr.		
Filip Lasan, mag. geogr.		

Employees		
Author	**Signature**	**Chapter**
Martina Kušan, mag. geogr.		Introduction, Geological features and geodiversity, Population and human health, Tourism, Noise, Light pollution, Impact assessment methodology, Impact in the event of an uncontrolled event, Transboundary impacts, Reasonable alternative, Environmental monitoring, Study conclusions
Marko Blažić, mag. ing. prosp. arh.		Landscape characteristics, Traffic

Appropriate assessment	
Team lead: Mario Mesarić, mag. ing. agr.	
Experts:	
Josip Stojak, mag. ing. silv.	Mirko Mesarić, dipl. ing. biol.
Employees:	
Igor Ivanek, prof. biol.	Monika Veljković, mag. oecol. et prot.nat.
Antonela Mandić, mag. oecol.	

External collaborators		
Author	**Signature**	**Chapter**
Nediljka Gaurina-Međimurec, prof.dr.sc.		Technical aspects of making geothermal wells during exploration and exploitation
Darko Mayer, prof. emeritus		Water
Berislav Botinčan, dipl. ing. stroj.		Use of geothermal energy
Milan Mesić, prof. dr. sc.		Soil and agricultural land

External collaborators		
Author	**Signature**	**Chapter**
Danko Fundurulja, dipl. ing. građ.		Waste and wastewater
Amelio Vekić, dipl. arheolog		Cultural and historical heritage
Sonja Vidič, dipl. ing. fizike		Air and climate

RESPONSIBLE PERSON

IRES EKOLOGIJA d.o.o. za zaštitu prirode i okoliša

Mario Mesarić, mag. ing. agr.

Zagreb, April 2023

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1 Introduction

A strategic environmental impact assessment (hereinafter: SEA) is a procedure that assesses likely significant impacts on the environment and human health that may result from the implementation of a strategy, plan or program. The implementation of the SEA procedure creates a basis for promoting sustainable development through the unification of conditions for environmental protection in the strategies, plans and programs of a particular area. This enables authoritative decisions on the acceptance of strategies, plans and programs to be made with knowledge of possible significant impacts that the implementation of the strategy, plan and program could have on the environment, and the operators are provided with frameworks for action and are given the opportunity to include essential elements of environmental protection in decision-making (Law on Environmental Protection (OG 80/13, 153/13, 78/15, 12/18, 118/18)).

In the SEA procedure, a Strategic Environmental Impact Study (abbreviated: Study) is prepared, an expert basis for determining, describing and evaluating likely significant impacts on the environment and human health that may arise from the implementation of a strategy, plan or program. The study must include all the necessary data, explanations and descriptions in textual and graphic form and is attached to the strategy, plan or program, and it is prepared by a legal entity that has permission to perform professional work in the field of environmental protection (hereinafter: Authorized). The purpose of the SEA procedure is to ensure that the consequences for the environment and human health are evaluated during the preparation of the strategy, plan or program, before determining the final proposal and referring it to the adoption procedure.

The process of implementation of the SEA also provides an opportunity for stakeholders to participate in the process, and information and participation of the public during the decision-making process is ensured. Directive 2001/42/EC of the European Parliament and the Council on the assessment of the effects of certain plans and programs on the environment (SEA Directive) has been in force since 2001. In the Republic of Croatia (hereinafter: the Republic of Croatia), the legal framework for the preparation of strategic studies is harmonized with the SEA Directive, and is also in accordance with the Convention on Environmental Impact Assessment across State Borders (Espoo, 1991), which obliges states to inform and consult in with all large projects that could have an impact on the environment across state borders and with the Protocol on Strategic Environmental Assessment (Kiev, 2003).

The subject of this Study is the assessment of likely significant impacts on the environment and human health that could arise from the implementation of the Plan for the Development of the Geothermal Potential of the Republic of Croatia until 2030 (hereinafter referred to as: the Plan), which is a fundamental strategic planning document that determines the area where the to research, develop and exploit geothermal potential, methods of obtaining geothermal water for energy purposes, technique and technology of extraction, method of use by the end user and directing the energy development of the Republic of Croatia in the direction of green energy.

The SEA procedure for the Plan is carried out based on the provisions of the Environmental Protection Act, the Regulation on strategic assessment of the impact of strategies, plans and programs on the environment (Official Gazette 3/17, hereinafter: the Regulation) and the Regulation on information and participation of the public and interested public in matters of protection of the environment (OG 64/08). The SEA procedure consists of the steps listed in the following table.

The competent authority issued the Decision on starting the process of strategic assessment of the environmental impact of the Geothermal Potential Development Plan of the Republic of Croatia until 2030 on September 8, 2021 (Class: 310-01/21-03/67, Registration number: 517-07-1- 1-21-2) which is in the Annex 13.1.

Table1.1Steps in the implementation of the SEA procedure

Step	Purpose
Obtaining the opinion of the authority responsible for the protection of the environment and nature	Analytical review - Determine whether a strategic assessment is mandatory under the provisions of the Environmental Protection Act
Opinion of the authority responsible for nature protection	Conducting a preliminary acceptance assessment for the ecological network and determining whether it is necessary to create a Main Acceptance Assessment for the ecological network
Decision on initiating the SEA procedure	The decision on the implementation of the SEA procedure is made by the competent authority
Determination of the content of the Study	Defining the scope and level of detail to be covered in the Study
Opinion of public law bodies	Obtaining the opinion of the authorities responsible for the protection of individual components and factors in the environment on a strategic assessment
Information and participation of the public and interested public	Adoption of opinions, remarks and proposals
Making a Decision on the content of the Study	Determining the content and level of coverage of the data that must be processed in the Study
Preparation of the Study and assessment of its completeness and professional foundation	Assessment of likely significant impacts on the environment as a result of the implementation of the Plan
Work of the Commission	Advisory expert body that evaluates the likely significant impact of the Plan on the environment, including reasonable alternatives, by issuing the Commission's Opinion
Public Hearing	Discussion (public inspection and public presentation) on the draft Plan and Study
Obtaining the opinion of public law bodies	Obtaining the opinion of the authorities responsible for the protection of individual components of the environment on the draft of the Study
Statement on comments on the draft Plan by the Developer and the Study by the Authorized Person	Consideration of received opinions, proposals, alternative solutions, reasons for choosing a variant
Preparation of the final Plan proposal	The competent authority prepares the final proposal of the Plan and submits it to the competent authority for adoption
Obtaining the opinion of the competent body for nature protection on the acceptability for the ecological network	Issuance of a final opinion on the acceptability of the Strategy for the Ecological Network
Obtaining the opinion of the competent authority on the procedure carried out	Supervision of the implementation of the strategic assessment procedure by the authority responsible for environmental protection.
Adoption of the Plan	Discussion at the session and acceptance by the representative body
Report on the conducted strategic environmental impact assessment	Presentation of the manner in which environmental protection issues and ecological networks are integrated into the Plan Presentation of the way in which the results of the Study, the opinions of bodies and/or persons, as well as remarks, suggestions and opinions of the public were taken into account, that is, considered when making the decision on the adoption of the Plan Explanation of the reasons for accepting the selected reasonable alternative of the Plan, in relation to the other considered reasonable alternatives The method of monitoring the implementation of the measures that have become the content of the Plan The method of monitoring significant environmental impacts adopted by the Plan The report on the procedure carried out and the decisions made are submitted to the competent Ministry by March 31 of the current year for the previous calendar year.

For the Plan, a preliminary assessment of acceptability for the ecological network was carried out in accordance with the Law on Nature Protection (Official Gazette 80/13, 15/18, 14/19, 127/19). On September 3, 2021, the Ministry of Economy and Sustainable Development issued a Decision that the Plan needs to be subjected to a Main Assessment of Acceptability for the Ecological Network, given that the previous assessment of the acceptability of the Plan for the Ecological Network could not rule out the possibility of significant negative impacts on conservation goals and integrity of the area of the ecological network (Class: UP/I-612-07/21-37/243, Registration number: 517-10-2-3-21-2).

The authorized person for this Study is the company IRES EKOLOGIJA doo, which has the approval of the Ministry of Economy and Sustainable Development to carry out expert work in the protection of the environment and nature. The solutions can be found in the Appendices.

The competent authority carried out the procedure for determining the content of the Study, in accordance with Article 68, Paragraph 3 of the Environmental Protection Act (Official Gazette 80/13, 153/13, 78/15, 12/18 and 118/18) and the provisions of Articles 7 to 11. Regulation on the strategic assessment of the impact of strategies, plans and programs on the environment (Official Gazette 03/17), in such a way that it obtained the opinions of bodies determined by special regulations on the content of the Study and the level of coverage of the data that must be processed in the Study, related to the scope of that body. Public participation in the process was ensured by the publication of Information on the initiation of the strategic assessment procedure and the preparation of a strategic study - determining the content of the strategic study on the environmental impact of the Geothermal Potential Development Plan of the Republic of Croatia until 2030 (Class: 310-01/21-03/67 Registration number: 517-07-1-2-21-7) from September 8, 2021. on the official website of the Ministry. The decision on the content of the strategic environmental impact study of the Geothermal Potential Development Plan of the Republic of Croatia until 2030 was adopted on December 22, 2021 (Class: 310-01/21 -03/67, Registration number: 517-07-1-2-21 -28) and is in the Attachments.

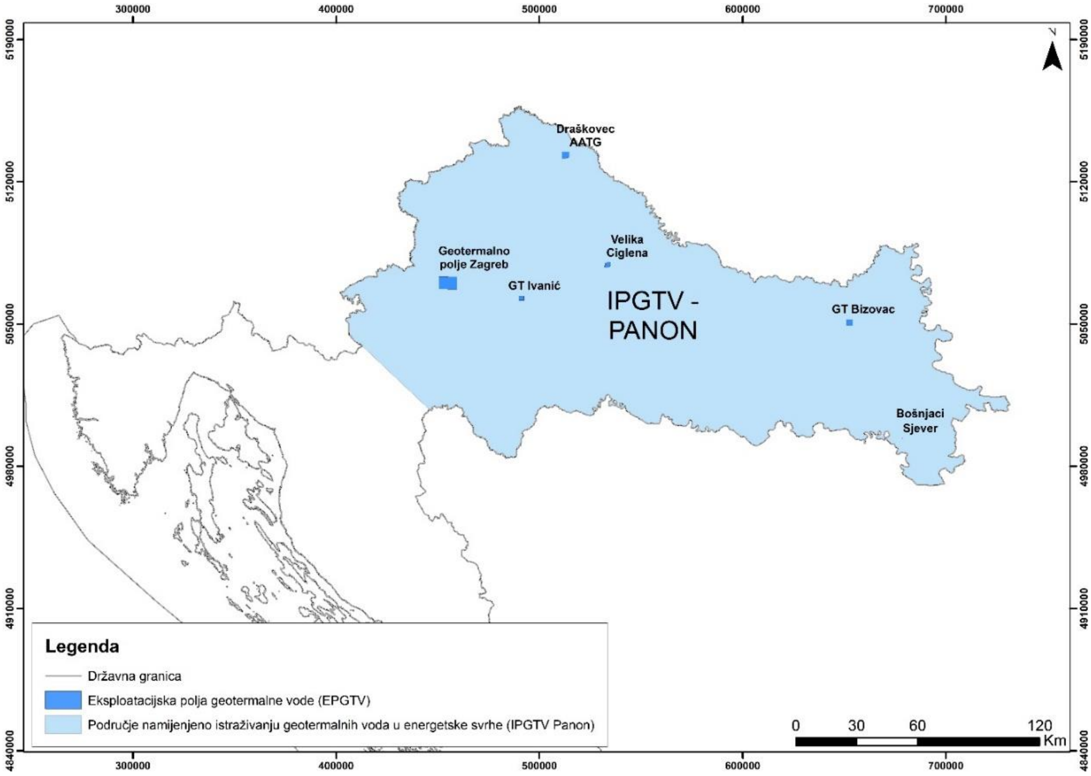
1.1 Scope of the Plan

The plan determines the area where geothermal potential will be explored, developed and exploited, the methods of obtaining geothermal water for energy purposes, the technique and technology of extraction, the method of use by the end user, and the direction of the energy development of the Republic of Croatia (hereinafter: the Republic of Croatia) in the direction green energy.

The plan considers the area of the Pannonian Basin of the Republic of Croatia and includes the following counties: Karlovac County, City of Zagreb, Zagreb County, Međimurje County, Krapina - Zagorje County, Varaždin County, Koprivnica - Križevačka County, Sisak - Moslavina County, Bjelovar - Bilogor County, Virovitica - Podravina County, Brod - Posavina County, Osijek - Baranja County, Požega - Slavonia County and Vukovar - Srijem County (hereinafter: counties in question/area covered by the Plan)

Geothermal waters are one of the renewable sources of energy whose contribution is included in achieving the goals of the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (NN 25/20) and the transition to a low-carbon economy. Geothermal energy contains all the key elements of shaping the national green policy contained in the five dimensions of the energy union, namely: decarbonization, energy efficiency, energy security, internal energy market and research, innovation and competitiveness.

The area intended for geothermal water research with existing geothermal water exploitation fields is shown on Picture1.1.



Picture1.1. Area intended for geothermal water research for energy purposes with existing geothermal water exploitation fields (Source: Plan)

1.2 The current state of research and exploitation of geothermal water for energy purposes

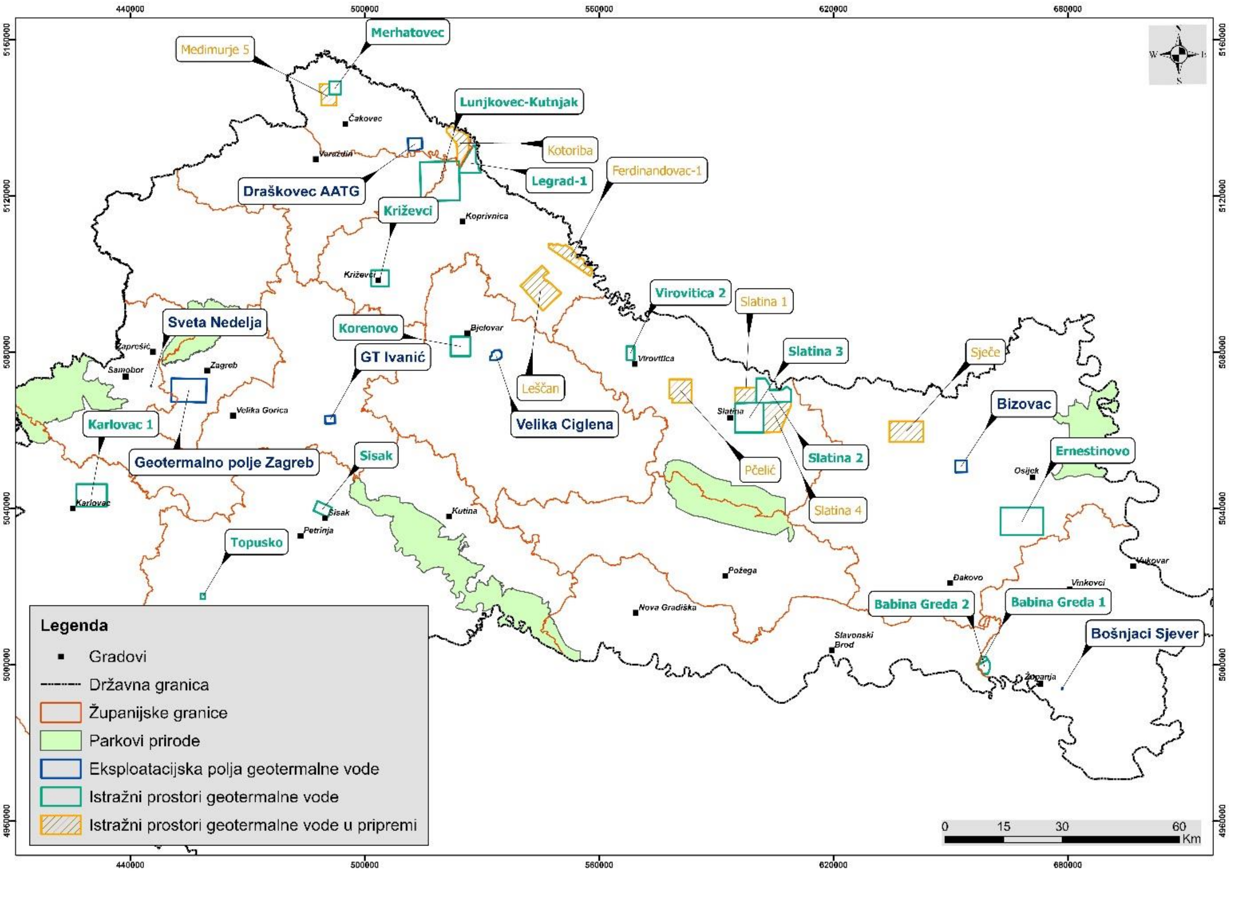
In the Republic of Croatia, there are currently 7 active areas where geothermal water is exploited for energy purposes (Table1.2) whose purpose is the production of electricity and thermal energy. Also, currently 14 research permits have been granted in 14 research areas (Table1.3,Picture1.2)

Table1.2. Currently active areas where the economic activity of geothermal water exploitation for energy purposes is carried out in the Republic of Croatia (Source: Plan)

SERIAL NO.	NAME OF EXPLOITATION FIELD (EPGTV)	AREA km2	COMMISSIONER OF THE EXPLOITATION FIELD
1	Bošnjaci Sjever	0,05	RURIS d.o.o. Županja
2	Draškovec AATG	11,18	AAT GEOTHERMAE d.o.o.
3	Geotermalno polje Zagreb	54,00	GPC Instrumentation Process d.o.o.
4	GT Bizovac	9,00	INA INDUSTRIJA NAFTE d.d.
5	GT Ivanić	5,00	INA INDUSTRIJA NAFTE d.d.
6	Velika Ciglena	5,94	GEOEN d.o.o.
7	Bošnjaci Sjever	0,05	RURIS d.o.o. Županja

Table1.3. Current areas where research activities are carried out with the aim of exploiting geothermal water for energy purposes in the Republic of Croatia (Source: Plan)

SERIAL NO.	NAME OF THE SPACE (IPGTV)	AREA km²	OFFICER OF THE INVESTIGATION AREA
1	Babina Greda 1	2,64	GEJZIR d.d.o.
2	Babina Greda 2	7,70	GEOTERMALNI IZVORI d.o.o.
3	Ernestinovo	76,66	Ensolx d.o.o.
4	Karlovac 1	44,98	GeotermiKA d.o.o.
5	Korenovo	25,00	Terme Bjelovar d.o.o.
6	Križevci	18,45	KOMUNALNO PODUZEĆE d.o.o.
7	Legrad-1	20,89	Terra Energy Generation Company d.o.o.
8	Lunjkovec-Kutnjak	99,97	Bukotermal d.o.o.
9	Merhatovec	9,59	Ensolx d.o.o.
10	Slatina 2	38,77	Geo Power Zagocha d.o.o
11	Slatina 3	55,26	Dravacel d.o.o.
12	Sveta Nedelja	0,01	Eko plodovi d.o.o.
13	Virovitica 2	7,00	POSLOVNI PARK VIROVITICA d.o.o.
14	Babina Greda 1	2,64	GEJZIR d.d.o.



Picture1.2. Currently active areas where the economic activity of exploitation and research of geothermal water for energy purposes is carried out in the Republic of Croatia (Source: Plan)

1.3 Reasons for creating the Plan

The reasons for adopting the Plan are the need to ensure the further development and use of geothermal energy as a domestic renewable potential that should be used more widely in energy transformations for the production of electricity, ie for heating and cooling.

By using energy from renewable energy sources, the interests of the Republic of Croatia in the field of energy are realized in terms of achieving the national goal of at least 36.6% of renewable energy sources in the final energy consumption by 2030 in the Republic of Croatia.

In accordance with the Strategy, it is necessary to encourage the use of geothermal energy through new exploration activities and exploitation, and in order to increase the share of renewable energy sources for the needs of electricity production and especially for heating and cooling, that is, the development of the heating industry.

Following these guidelines, the Strategy and the Integrated National Energy and Climate Plan encourage research and exploitation of geothermal waters, in accordance with the geothermal potential of each individual area.

Activities carried out for the purposes of research and exploitation of geothermal waters for energy purposes are carried out on the basis of the Law on Research and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19, 30/21)

The law encourages investments in geothermal sources, which currently represent one of the least utilized energy potentials in the Republic of Croatia. A unique database of geological and geophysical data, as well as data on wells with hydrocarbon, geological and, for the first time, geothermal potentials, has been established. In this way, Croatia's energy resources are united in one place, which increases the efficiency of the administration in introducing potential investors to investment opportunities.

The change in the economic environment in the period of energy transition and the growing interest of investors who, in order to invest in the exploration and exploitation of geothermal waters, needed to enable a higher degree of legal certainty and flexibility in the realization of projects, pointed to the need to regulate the procedures of exploration and exploitation of geothermal waters on a way that is defined and accepted in world practice. Also, the new amendments to the Law eased administrative barriers that primarily relate to spatial planning procedures (inclusion of areas with geothermal potential in spatial plans) as well as the possibility of determining geothermal potential before bidding.

In accordance with the provisions of the Law on Energy Efficiency (Official Gazette 127/14, 116/18, 25/20, 32/21, 41/21), the Geothermal Potential Development Plan of the Republic of Croatia implements the principles prescribed by law, and in order for geothermal energy to be used to achieve the goals. The Law on Energy Efficiency transposed into Croatian legislation the provisions of Directive 2012/27/EU of the European Parliament and the Council of October 25, 2012 on energy efficiency. Among other things, the law aims to establish mechanisms that will achieve energy savings in direct energy consumption in the manner prescribed by Directive 2012/27/EU. Directive 2012/27/EU itself was adopted in order to eliminate deficiencies in the energy market and to establish clear mechanisms for achieving energy and environmental goals such as reducing dependence on energy imports, improving air quality and public health and reducing greenhouse gas emissions. The principle of energy efficiency requires that all economic activities and future projects be viewed through the contribution to measures to improve energy efficiency, and aims to support the framework for facilitating sustainable investments in the energy, transport, construction, industry and other sectors, in terms of more efficient use of energy in all phases of the energy chain, from production to final consumption.

Directive 2018/2002 of December 11, 2018, which amended Directive 2012/27/EU on energy efficiency, establishes a common legal framework for the promotion of energy efficiency within the European Union, in order to ensure the achievement of the main energy efficiency goals of the European Union from 20 % reduction of energy consumption compared to the projected consumption in 2020 and at least 32.5% reduction of energy consumption in 2030, and the direction for further improvements in the field of energy efficiency after 2030 is also determined. Progress achieved in achieving the goals of the European Union for 2030 will be regularly evaluated in accordance with Regulation (EU) 2018/1999 of the European Parliament and the Council. It is important to emphasize the obligations that are transferred from this directive to units of regional and local administration and self-government, in order to solve more efficient heating and cooling in their area. In this sense, the Agency was given the authority to carry out works for the assessment of geothermal potential, for the needs of the Republic of Croatia, before the announcement of tenders for geothermal water for energy purposes. In this way, with its expertise and available data, the Agency is actively involved in encouraging the development of geothermal potential, and it is expected that in such a synergy, with the help of EU funds, projects will be investigated until 2026, and during the Program period 2021-2027, some of the most promising projects and finish. It is important to bear in mind that the planning of the renovation of public buildings at the level of local or regional self-government should also include a component of increasing RES in heating and cooling, and that new buildings must be built according to the nZEB standard.

The geothermal potential development plan of the Republic of Croatia is also harmonized with the Law on renewable energy sources and efficient cogeneration (Official Gazette 100/15, 123/16, 131/17, 111/18), through which the existing high share of renewable sources in heating and cooling, in accordance with the Directive (EU) 2018/2001, should be increased in the coming decade, in such a way that each member state strives to increase the share of renewable energy in that sector by approximately 1.1% for the Republic of Croatia as an annual average calculated for the periods from 2021 to 2025 and from 2026 to 2030, starting from the share of renewable energy in the heating and cooling sector in 2020.

A fundamental document adopted at the level of the European Union, which defines the way of efficient use of natural resources, because the European Green Plan (COM/2019/640). As a precondition for the realization of the mentioned plan, a reconsideration of the policy for the supply of clean energy in the economy, industry, production and consumption, large infrastructure, transport, agriculture and the food sector, construction, the tax sector and the social welfare sector was set. The main goal is to achieve climate neutrality of the European Union by 2050. Renewable energy sources, including geothermal energy, will play a central role in the transition to clean energy, and in this way it will be possible to achieve the goal of reducing greenhouse gas emissions in 2030 by more than 50% compared to 1990. By supporting the stronger introduction of renewable energy sources in all sectors of society and the economy, the decarbonization of the energy sector would be encouraged. In doing so, it is important to take advantage of the reduction in prices of energy obtained from renewable sources and to develop support policies to make this form of energy affordable for private users.

Directive 2018/2001 of the European Parliament and the European Council of December 11, 2018 on the promotion of the use of energy from renewable sources defines the concept of geothermal energy and the basic conditions for its use. According to the aforementioned directive, geothermal energy is an important local renewable energy source that has significantly less emissions than fossil fuels, and certain power plants based on geothermal energy generate almost zero emissions of harmful gases. However, it should be noted that, depending on the geological features of the area, some forms of geothermal energy production are not acceptable, because greenhouse gases and other substances can be released from underground fluids and other geological formations that have a harmful effect on nature and the environment. The European Commission does not support the use of such forms of geothermal energy, rather, it encourages the use of only those forms that have a low impact on the environment and generate lower greenhouse gas emissions compared to non-renewable energy sources. In that directive, the ways and possibilities of building heat pumps that would use geothermal energy were also determined, as well as the conditions for certification of persons who implement systems for the use of geothermal energy on built objects. The Plan for the Development of the Geothermal Potential of the Republic of Croatia implements the given guidelines and encourages the use of geothermal water for energy purposes without harmful greenhouse gas emissions through geological prospecting and technological solutions. In that directive, the ways and possibilities of building heat pumps that would use geothermal energy were also determined, as well as the conditions for certification of persons who implement systems for the use of geothermal energy on built objects. The Plan for the Development of the Geothermal Potential of the Republic of Croatia implements the given guidelines and encourages the use of geothermal water for energy purposes without harmful greenhouse gas emissions through geological prospecting and technological solutions. In that directive, the ways and possibilities of building heat pumps that would use geothermal energy were also determined, as well as the conditions for certification of persons who implement systems for the use of geothermal energy on built objects. The Plan for the Development of the Geothermal Potential of the Republic of Croatia implements the given guidelines and encourages the use of geothermal water for energy purposes without harmful greenhouse gas emissions through geological prospecting and technological solutions.

In addition to the above-mentioned directives, the European Union, as part of its research and development initiatives, finances geothermal technology research projects and projects that deal with research into models of direct use of heat obtained from geothermal sources, as well as indirect use of geothermal energy, whereby the heat obtained from a geothermal source is used for obtaining electricity. The goals of the aforementioned projects are research into the impact of using geothermal energy on the environment and society, and the creation of prerequisites for the expansion and financial efficiency of the geothermal energy use system. As part of the aforementioned programs, the reduction of costs in research and drilling during the extraction of geothermal energy is also encouraged, since the cost of building infrastructure for geothermal energy is very high.

1.4 Technical aspects of making geothermal wells during exploration and exploitation

1.4.1 Geothermal drilling technology on land during the exploration period

Locating the well

Research and analysis with 2D and 3D seismic imaging

Seismic exploration is the search for commercially economic underground deposits of crude oil, natural gas and minerals by recording, processing and interpreting artificially induced shock waves in the earth. Artificial seismic energy is generated on land using vibration mechanisms mounted on specialized trucks. Seismic waves are reflected and refracted by underground rock formations and travel back to acoustic receivers called geophones. The travel times (measured in milliseconds) of the returned seismic energy, integrated with existing borehole information, provide valuable information used in evaluating the structure (folding and faulting) and stratigraphy (rock type, depositional environment, and fluid content) of subsurface formations, in order to determined the location of potential drilling targets.

The recording of 2D and 3D reflective seismic data defines the geological subsoil in the most detailed way, both in the structural and tectonic sense, as well as in the interpretation of individual lithological units up to a depth of max. 10 km. This additionally helps seismologists in defining fault surfaces, their slopes and types (reverse, normal and lateral) as accurately as possible. The lengths of the fault surfaces can also be calculated, and the age of the fault can be indirectly calculated, which contributes to the understanding of the mechanism of the earthquake.

In a two-dimensional (2D) reflection seismic survey, both the sound source (the explosion) and the sound detectors (up to a hundred or more per shot) move along a straight line. The same line contains the recording cables and geophones as well as the origin points. The resulting product can be considered a vertical sonic section of the subsurface below the survey line. It is constructed by summing many reflections of compression (pressure) waves from different locations of sound sources and sound detectors at the central points of the sound path below each location (joint stacking of depth points).

In a three-dimensional (3D) reflection seismic survey, sound detectors (numbering up to a thousand or more) are spread over an area, and the sound source is moved from location to location through the area. 3D seismic programs are generally a uniform and evenly spaced grid of lines. Receiver lines containing recording devices (geophones) usually, but not always, run in a direction perpendicular or diagonal to the source lines. The resulting product can be thought of as a cube of stacked reflections of common depth points. Advantages over 2D include the added dimension, the fact that many more reflections are available for stacking at each point, providing greatly improved resolution of subsurface features, and the elimination of "clutter" or "lateral"

It is also important to mention that unlike other seismic research, for example when researching underground hydrocarbon tanks, smaller amounts of explosives are used in geothermal water research.

The integral steps of the recording process are therefore:

- Determining the line in 2D or the recording surface in 3D recording
- Delivery of recording equipment (generator/sound source), geophone, network
- Placement of equipment (insertion of geophone) on the ground
- Generating a sound wave that passes through the ground
- Reading the resulting image

When locating an exploration/development well, i.e. determining the microlocation of the well, in addition to the results of 2D or 3D seismic interpretation and other measurements, the following parameters are taken into account:

- relief characteristics of the area,
- boundaries of protected areas, including protected areas according to the Water Act (Official Gazette 66/19),
- placement of existing and future residential, infrastructural and commercial buildings,
- possible impact on cultural and historical heritage
- protected landscape and natural values
- possible impact on plant and animal species.

After the collection and analysis of the available data, a tour of the potential location follows and, based on the assessment, a decision is made to locate the new well.

The investor makes a decision on locating the exploration/development well on the field. A Record of the location of the well is maintained and kept.

Once the location has been completed, the Conceptual Project is created.

Pursuant to Art. 132 paragraph (1) of the Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19 and 30/21) "The conceptual project for oil and mining facilities and facilities is prepared as an expert basis for the preliminary assessment of acceptability to the ecological network, for the preparation documentation on the basis of which the assessment of the impact of the intervention on the environment is carried out or the assessment of the need to assess the impact of the intervention on the environment, for the creation of a conceptual project for obtaining a location permit, as applicable".

Excerpts from the spatial planning documentation confirm the planning basis of the intervention at the county level and at the level of municipal or city plans. Apart from excerpts from graphic sheets, Municipal or City Plans determine the possibility of encroachment in space and based on their general implementation provisions for planning categories that are not shown graphically (unclassified roads and paths, local utility network and lines).

Any planned operation in the area must be in compliance with the Ordinance on technical norms for the exploration and exploitation of oil, natural gas and stratified waters ("Official Gazette" No. 43/79, 41/81, 15/82 and "Narodne novine" No. 53 /91) which states these provisions regarding spatial determinations or restrictions:

Article 53.

The distance of the axis of the well from the protective zone of the navigable channel, railway, general-purpose power lines, public facilities and residential buildings must be at least equal to the height of the tower increased by 10%.

From the edge of the highway belt and first and second class roads, the distance of the axis of the well must be at least 30 m, and from other public roads and industrial, forest and field roads - at least 15 m.

The distance of the axis of the well from the forest is determined depending on the climate, the area, the configuration of the terrain and the type of forest.

Drilling an exploratory well is a procedure that is included in the list of procedures in Annex II. The list of interventions for which an assessment is carried out on the need to assess the impact of interventions on the environment, and for which the Ministry is responsible under point 10.12. Exploratory and other deep boreholes, with the exception of boreholes used for testing soil stability/geotechnical exploratory boreholes of the Regulation on environmental impact assessment (Official Gazette 61/14 and 3/17).

The request for an Assessment on the need to assess the impact of the intervention (construction of an exploratory well with a well working area for housing the drilling rig) on the environment and the outcome of the Decision is a prerequisite for submitting an application for the issuance of a location permit.

The Environmental Protection Elaborate for the assessment of the need to assess the impact of the intervention on the environment is attached to the Request for Assessment.

The expert basis for the preparation of the Environmental Protection Elaborate for the assessment of the need to assess the impact of the intervention on the environment and the obtaining of the location permit is the Conceptual Project for the preparation of an exploratory well with a well working area for the location of a drilling facility, which is approved by the Ministry of Economy and Sustainable Development.

After ejaculation:

Decisions that it is not necessary to carry out the environmental impact assessment procedure and the main acceptability assessment for the ecological network for the intended project (in accordance with the provisions of the Environmental Protection Act, the Nature Protection Act and the Decree on environmental impact assessment of projects (Official Gazette 61/14 and 3/17)) and

Location permits (in accordance with the provisions of the Spatial Planning Act)

the Project for making an exploratory well is being prepared.

To access the location of the planned exploratory well, an existing access road is arranged or a new access road is built, which further connects to the existing traffic infrastructure (local, county or state road). The access road must be of adequate width and subgrade strength to be able to transport heavy equipment to the location of the well.

Site preparation, earthworks and piezometer drilling are carried out in accordance with the construction project.

Project for making an exploratory well

For the purposes of performing oil-mining works, exploration and exploitation of geothermal waters, oil-mining projects are prepared in accordance with the Law on Exploration and Exploitation of Hydrocarbons and the regulations adopted on the basis of this Law.

During the exploration and exploitation of geothermal waters, oil-mining facilities and facilities are used, whereby this term includes all facilities, facilities, equipment, tools, devices and installations that are used in the process.

An exploratory well, as an oil-mining facility, from the aspect of geothermal potential research, means a well whose purpose is to determine the existence, position and shape of geothermal water deposits and their quantity and quality.

Pursuant to Article 135 paragraph (1) point 1 of the Law on Exploration and Exploitation of Hydrocarbons ("Official Gazette" No. 52/18, 52/19 and 30/21) "for the production of an exploratory well in the exploratory period that includes a rehabilitation plan and, when it is applicable, trial exploitation for the needs of laboratory tests and hydrodynamic and other measurements for the needs of determining the characteristics of the reservoir, the Well Project is drawn up". The previously mentioned acts are an integral part of the Well Project.

For the construction of an exploratory well in the exploration period, an exploratory well construction project is drawn up, which in accordance with Art. 26 of the Ordinance on oil-mining projects and the procedure for verifying oil-mining projects ("Official Gazette" No. 95/18) must contain the following chapters: (1) Geological and geophysical survey of the exploratory well and the surrounding area where the exploratory well is located, (2) Technological and technical design of the borehole, (3) Rehabilitation plan of the exploratory borehole and (4) Safety measures and environmental protection.

The Ministry, on the basis of the request of the investor with an attached oil-mining project that is subject to verification, with the expert assistance of the committee for the verification of oil-mining projects, issues a decision on the verification of oil-mining projects, which must also contain the obligations established in the Decision that the intended operation does not need to be carried out environmental impact assessment procedure and the main acceptability assessment for the ecological network and in the Location Permit.

Therefore, the oil-mining works covered by the verified exploratory well construction project and the location permit at the site begin only after the results of the "Declaration of completed verification of the oil-mining project" for the execution of oil-mining works issued by the Ministry of Economy and Sustainable Development (the competent ministry for exploration and exploitation of geothermal energy), and according to the verified Project for making an exploratory well.

Drilling area

The construction of the well itself is preceded by the arrangement of the well working area (BRP) for housing the drilling rig and the pit (lagoon) for receiving geothermal water during production testing (examination) of the well.

The borehole working area (BRP) is the plateau where all the activities of production and production testing of the exploratory geothermal well take place. The size of the BRP for housing the drilling rig with associated equipment depends on the selected drilling rig and the depth of the wells, and for example, for the National-402 drilling rig, which is intended for drilling wells up to 4,000 m deep, it is 15,000 m2 (for the dimensions of the BRP of 100 x 150 m). Construction works during the construction of the borehole work area are carried out in accordance with the verified borehole construction project. The plateau is made of stone material embankment on a previously leveled ground. The layer of stone material has a minimum thickness of 0.5 m, and the stone material itself is compacted to the prescribed compaction modulus.

The well work area contains the following construction facilities that are necessary for the normal development of the technological process of making and testing an exploratory geothermal well:

The mouth of the well – reinforced concrete open pool (so-called kela), internal dimensions 3.0 x 2.5 meters, depth approx. 2.0 meters. From the bottom of the mentioned pool, a conductor steel pipe (conductor column) of the appropriate diameter (according to the planned construction of the well) is installed to a depth of 25 m (measured from the ground level) and cemented to the top.

The foundation of the substructure of the tower - according to the specification for the selected drilling rig, reinforced concrete slabs measuring 3.0 x 1.0 x 0.14 m, stacked next to each other, are placed on the prescribed compacted base around the wellhead. The tower of the drilling rig is placed on this surface.

The foundations of the drilling rig - the area where the entire drilling rig is set up, reinforced concrete slabs are laid on the entire area, stacked next to each other on a base of prescribed compaction. Between the plates, a drainage system made of concrete channels is constructed, which ends in a reinforced concrete pool - "sand trap".

"Sand-trap" – an open buried reinforced concrete tank of appropriate volume (e.g. 60 - 70 m3), in which a system of concrete channels ends covering the paved area of the plant. The pool is divided into two unequal parts. The larger part is used to receive solid particles from the swollen material, while the smaller one is designed to receive liquids from the drainage channel system and part of the liquids from the larger pool via the overflow. The smaller pool is connected by a concrete channel with a temporary disposal site for the overburdened material (preventing spillage from the pool onto the work area).

Space for placing containers - area within the work area for placing storage containers and containers for work and accommodation of workers.

Temporary disposal site for inflated material - a space separated from the work area. At the site of the temporary disposal site for leaching material (leaching pit), the soil layer is removed to a depth of about 3 m from the level of the rest of the site. A 0.5 m high earth embankment with a slope of 1:1 is formed around the perimeter of the landfill. A waterproof PEHD film is placed on the bottom and sides of the landfill. A protective fence is placed on top of the landfill embankment.

Space for accommodation of fuel tanks - area within the work space for temporary accommodation of fuel tanks. Reinforced concrete slabs (slabs) are placed next to each other on the prescribed compacted base. On the surface prepared in this way, 2 steel lattice supports are placed, on which 2 portable double-sided tanks for diesel fuel, volume 20 m^3, are placed crosswise. Lattice supports and reservoirs are part of the drilling rig.

Two well test pits (flares) - serve to place two horizontal flares on which the possibly obtained quantities of gas obtained during the test of the exploratory well are burned.

Two piezometers - serve to define the zero state of groundwater quality, take samples for chemical analysis, determine the geomechanical characteristics of the soil, and monitor the quality of groundwater during the construction of an exploratory well.

A collection pit with a capacity of 5 m3 - for the collection of waste water from mobile containers for the accommodation and work of employees.

Area for disposal of humus and soil - on this part of the BRP, humus and soil, removed from the surface of the plateau during the development of the BRP, are deposited on this part, which are used after the construction of the well during the rehabilitation of the well working area.

A pit (lagoon) for the reception of geothermal water during production testing of the well. At the pit construction site, the soil layer is removed to a depth of 3.5 m from the level of the rest of the site. An earth embankment of 0.5 m height with a slope of 1:1 is formed around the perimeter of the pit. A waterproof PEHD film is placed on the bottom and sides of the pit. A protective fence is placed on top of the embankment of the pit. The volume of the pit depends on the expected flow of geothermal water and the test time (up to 10 days) and can vary between 12,000 m3 and 20,000 m3. For example, a pit measuring 50 mx 90 mx 3.5 m has a volume of 15,750 m3 and is sufficient in most cases.

If it is planned to make several wells, the mouths of which are only a few tens of meters apart, it is possible to do this from the same BRP, which reduces the coverage of the intervention in the area.

Drilling rig

For the purposes of making a well, there is a typical drilling rig in the well working area, which is intended for work on land (Picture1.3). The choice of plant depends on the planned depth of the well. OnPicture1.3different drilling rigs are shown, and the depth of the well that can be achieved with them is indicated next to their name. As a rule, a drilling rig consists of a supporting structure - a drilling tower, pulley system, crane, drive motors, transmission, top drive, drilling table, mud pumps, mud head, mud preparation and purification system, preventer assembly (eng. Blowout preventer, BOP), pipe tools (work rod, drill rods, heavy drill rods, heavy rods) and chisels and other tools.

IDECO 301 (3 000 m)

EMSCO 401 (4 000 m)

EMSCO 605 (6 000 m)

NATIONAL 801 (8 000 m)

Picture1.3Examples of drilling facilities (Source: http://www.crosco.com/index.php/drilling-services.html))

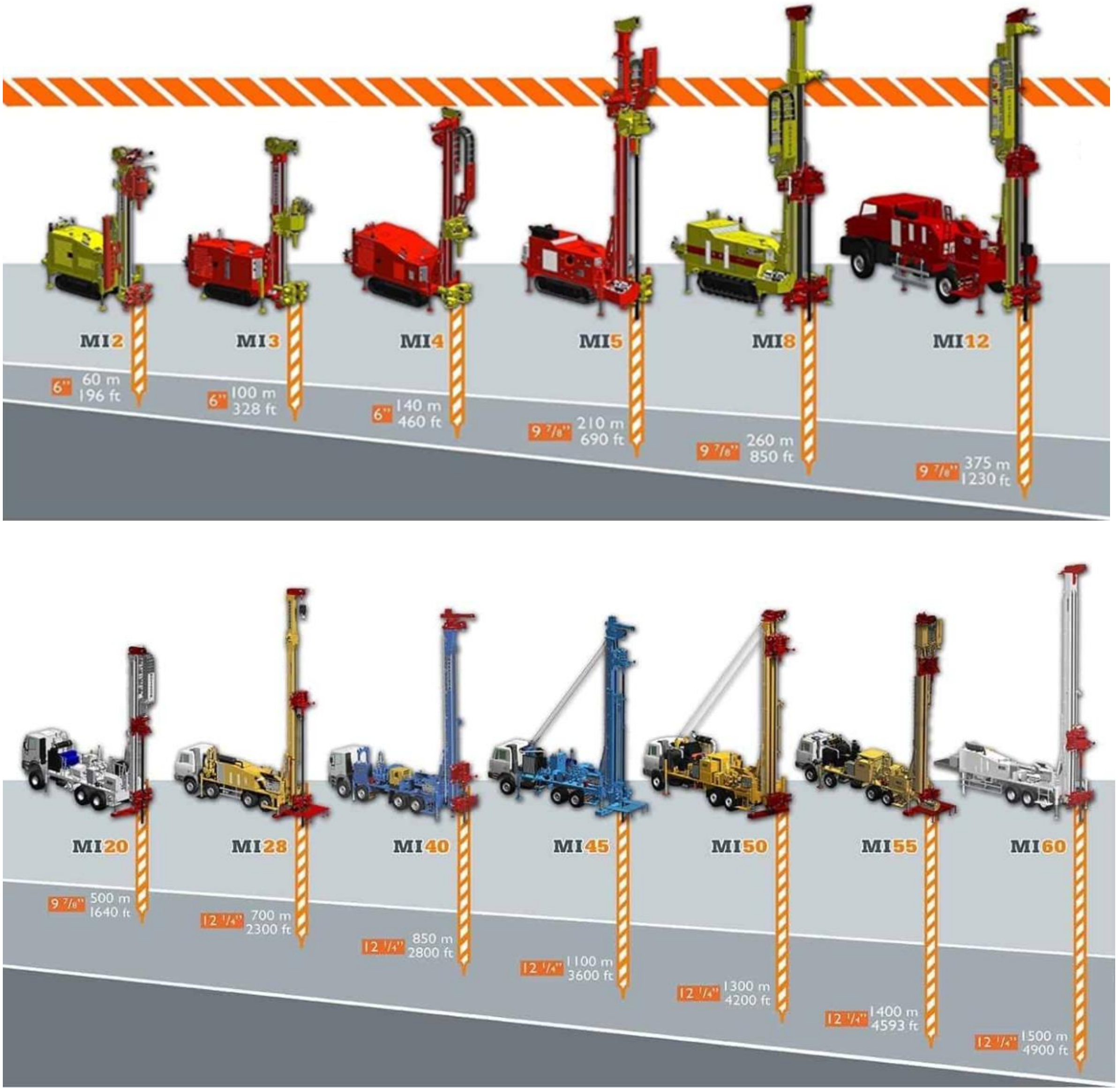
For example, the National-402 drilling rig, which can be applied to make wells up to 4000 m deep, has the following characteristics: working capacity of the tower about 2.8 MN (280 t) (on hook) with 12 ropes, rig power 750 kW (drilling cranes), height of the LC Moore tower: 44.5 m + substructure 7.6 m, which is a total of 52.1 m (top of the tower), dimensions of the tower base approx. 20 x 10 m (tower substructure - plant) and storage space in the tower for 4000 m of drill rods with a diameter of 127 mm (5"). The drilling rig is assembled/dismantled on site. Mobilization and installation of the drilling rig takes 10 to 13 days, depending on the distance the rig is transported.

The drilling rig is installed at the location of the new well according to the typical arrangement that is in accordance with the verified design of the drilling well and the design of the exploratory well (Picture1.4).

Picture1.4An example of the appearance of the borehole working area of an exploratory geothermal well (Source: EZO-Draškovec)

Drilling facilities for the production of shallow geothermal wells

Apart from the drilling facilities shown in Figure 1.3. for the creation of shallower geothermal wells (eng. Geothermal Drill Rig), and for the purpose of using geothermal water for the production of thermal energy and for agricultural purposes, smaller drilling facilities can also be used. Examples of such plants and drilling depths (using direct circulation) are shown in Figures 1.5 and 1.6. Such facilities require a smaller surface area of the well working area, and the construction of a well takes less time than the construction of deep geothermal wells.



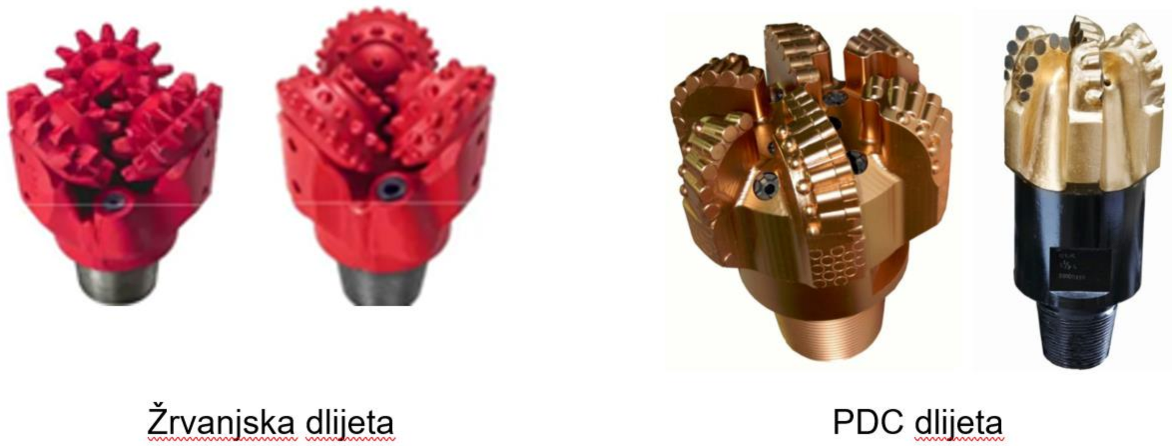
Picture1.5Examples of drilling rigs for making geothermal wells up to 1500 m deep (Source:https://www.massenzarigs.com/geothermal-drilling-rigs/)

Picture1.6Geo-Max drilling rig for making geothermal wells (Source: https://drillingsupply.info/geothermal-drilling-rigs/geothermal-drilling-track-rig-gm840-dd.html)

A series of drilling tools

A series of drilling tools (chisel, heavy rods and drill rods) is used to create the borehole channel, which is suspended from the derrick hook.

As a rule, ground and PDC chisels are used for making geothermal wells (Picture1.7). During the destruction of the rock at the bottom of the well channel, the chisel wears out, reducing the mechanical drilling speed, so it needs to be replaced with a new chisel. Replacing a worn bit requires pulling the entire string of drilling tools to the surface, replacing the old bit with a new one, and re-lowering the string of drilling tools to the bottom of the well to continue drilling. This has a significant impact, especially in deep wells, on the drilling time and the overall costs of the drilling.



Picture1.7Examples of grinding and PDC chisels for drilling hard and fractured rocks (Gaurina, 2022)

Drill rods and heavy rods connect the bit to the surface, conduct the mud and allow rotation to be transferred from the surface to the bit. Part of the weight of the heavy rods, which have thicker walls than the drill rods, provides the load on the chisel necessary to destroy the rock at the bottom of the well channel. As the well deepens, new drill rod is added. Therefore, with the increase in the length of the well channel, the length of the series of drilling tools also increases, so there should be a sufficient amount of them at the location of the well to meet the needs of drilling up to the designed final depth (Picture1.8).

Picture1.8Example of drilling and heavy rods (Gaurina, 2022)

Detailed data on the components of a series of drilling tools (diameters, quality of materials, threaded connections, stress resistance) are an integral part of the verified Project for making an exploratory well.

During drilling or rock destruction, the chisel is in constant contact with the bottom of the well, or with the rock it is destroying. In order for the chisel to advance and deepen the borehole channel, it is necessary to simultaneously achieve the rotation of the chisel, a certain load on the chisel and the continuous removal of fragments of destroyed rocks from the bottom of the borehole.

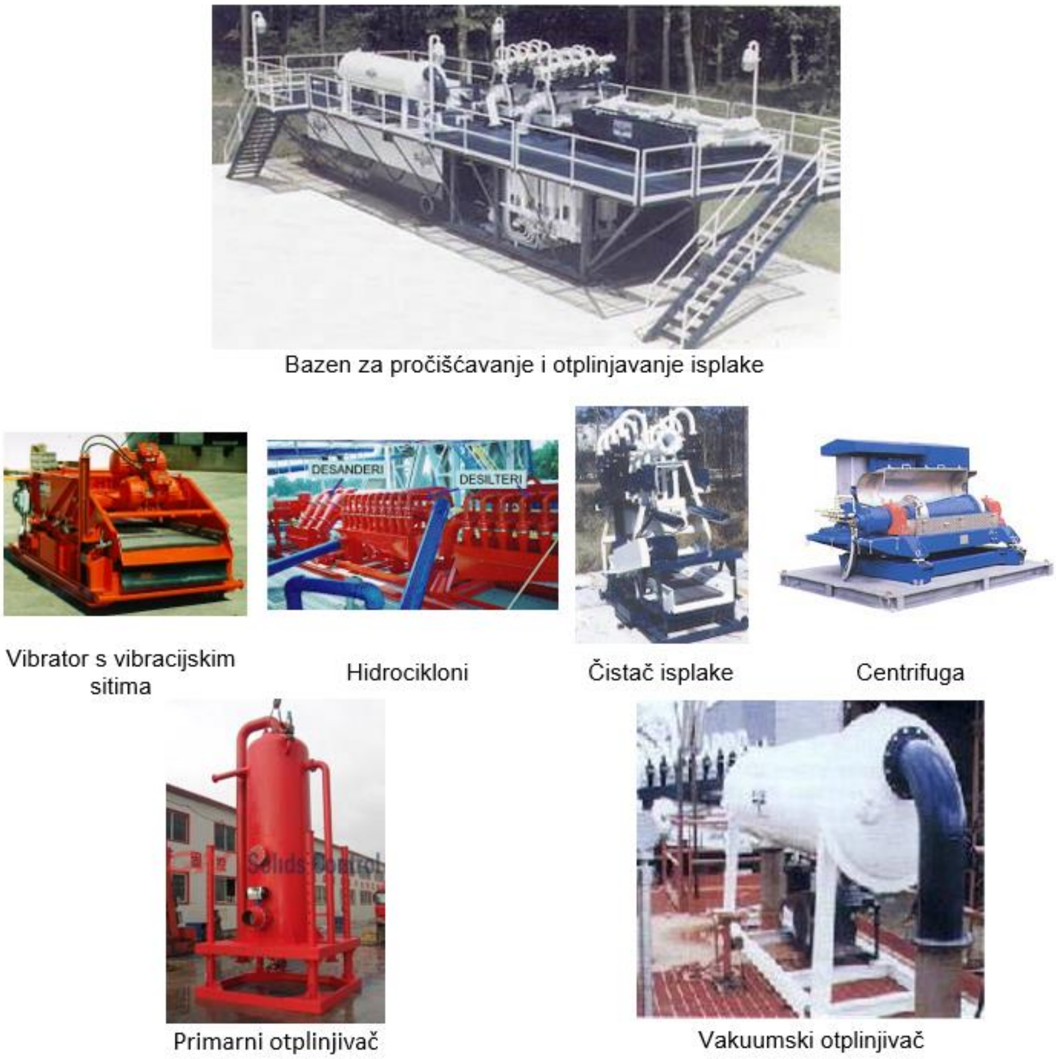
Chisel rotation can be achieved from the surface with a rotary table or top drive or directly with a downhole mud motor (Positive displacement mud motor - PDM), which is installed in a series of drilling tools directly above the chisel (Picture1.9). In practice, various steerable rotary systems (Rotary Steerable Systems - RSS) are increasingly used when making vertical, and especially when making horizontal wells and directional wells with a large reach (Extended Reach Drilling - ERD) (Gaurina-Međimurec et al. 2017; Hudoletnjak and Gaurina-Međimurec, 2019).

Picture1.9Examples of drilling table, top drive and deep engine (Gaurina, 2022)

Surface drainage system

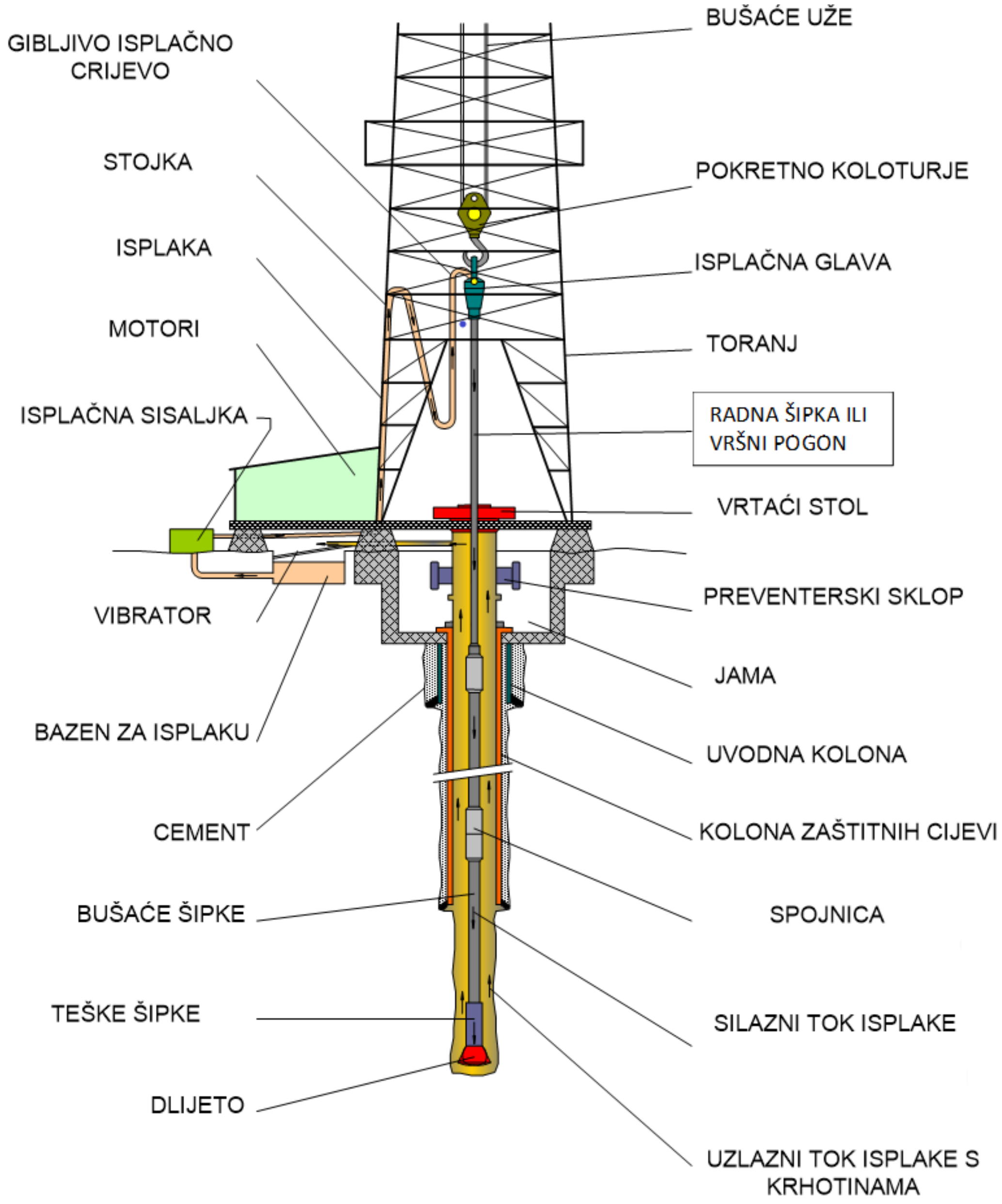
Continuous flushing of the borehole channel during drilling is achieved by mud circulation, whereby the surface mud system enables the preparation, pressing and purification of the mud. In the drilling area, there are steel pools of appropriate volume (e.g. 40 m3) which, depending on the purpose and equipment of the surface devices, are called: a pool for making and finishing mud, a pool for purification and degassing of mud, a suction pool from which the mud pump is supplied with mud , and a pool for reserve water and mud.

Prepared mud is sucked from the suction basin and pushed through the pressure line, stand, discharge hose, discharge head, working rod, drilling and heavy rods to the chisel using mud pumps. The mud comes out through the holes on the chisel - nozzles, where the jet of mud cleans the bottom of the well channel and the working surface of the chisel. After exiting the chisel, the mud flows through the annular space between the walls of the channel and the row of rods and carries the fragments of the destroyed rocks (swelled material) from the bottom of the borehole to the surface. After exiting the well (through the discharge tube), the mud passes through surface devices (Picture1.10) (vibrator with vibrating sieves, hydrocyclones, mud cleaner, centrifuge) by means of which fragments of destroyed rocks (solid particles) are separated from it and, if necessary, through gas separators (primary and vacuum degasser), in order to separate any gas present, and it is cooled, cleaned of rock fragments and degassed, leads to the suction drainage basin.



Picture1.10Examples of surface system components for removing rock debris and mud gas (Gaurina, 2022)

The mud is sucked from the suction pool using a mud pump and again pushed through the pressure line, stand, mud hose, mud head, working rod, drill and heavy rods to the chisel. This ensures a continuous circular flow of mud and the removal of fragments of destroyed rocks (Picture1.11).



Picture1.11Schematic representation of the circular mud flow (Gaurina-Međimurec, 2009)

Fragments of broken rocks that are separated from the mud are deposited in a concrete pool ("Sand trap"), and then on a temporary disposal site at the very location of the well. The gas extracted from the mud is burned in a flare.

Mud circulation (circular flow) is necessary during the drilling process, and it is interrupted by turning off the mud pumps, only when it is necessary to carry out certain works in the well (e.g. adding a new rod, pulling out and lowering the drilling tools, EK measurements, installing a series of protective pipes etc.).

In addition to bringing out fragments of destroyed rocks, the mud also performs a whole series of other functions important for the drilling process. The mud density is adjusted according to the expected layer pressures. A mud column of appropriate density exerts a pressure on exposed rock deposits that is greater than the layer pressure. In this way, the inflow of formation fluid into the well channel is prevented during well construction (primary pressure control). If the density of the mud is not adequate and there is an inflow of formation fluid into the borehole channel, its further flow towards the surface is stopped by closing the preventer - a device at the mouth of the borehole (secondary pressure control). Only in the event of an accident, i.e. loss of both primary and secondary pressure control, can an uncontrolled ejection of formation fluids to the surface (eruption) occur.

Muds for geothermal wells

Today, there are numerous (over a hundred) muds for different purposes and drilling conditions, but the main task of all muds (fluid for washing) (English Mud, Drilling fluid, Drilling system) is the successful creation of well channels. Which type of mud will be used in a specific case depends on the composition of the rocks through which the well channel is made and the phenomena expected during the construction of the well channel (inflow of formation fluid, mud contamination, high temperatures, etc.).

Although in rotary drilling, all muds have the same tasks, their properties can be changed as needed in order to achieve fast, safe and successful construction of the borehole channel. The selection, preparation and appropriate processing of the mud and the application of the appropriate washing regime play a key role in the construction of horizontal wells.

In terms of basic properties, the type of mud with which a vertical and/or curved well channel was successfully created in the same or similar rocks is the most suitable. Mud is a special liquid that is forced into the well through a series of drilling tools. It exits through the nozzles on the chisel and returns to the surface through the annular space.

When flowing through the well, the mud performs a number of tasks important for an efficient and safe well production process. The mud is designed so that its composition and properties correspond to the conditions in the well channel, the composition and properties of the rocks through which it is drilled, while being economically and environmentally acceptable.

The tasks performed by the mud during the construction of the borehole channel are (Gaurina-Međimurec, 2009): (1) removal of broken rock fragments from the borehole channel, (2) realization of appropriate back pressure on the walls of the borehole channel, (3) maintenance of the stability of the borehole channel, (4)) lubrication and cooling of drilling tools in the well, (5) retention of debris in a floating state during the interruption of mud circulation, (6) enabling measurements and other work in the well, (7) reducing the weight of a series of drilling tools, (8) reducing damage to bedrock .

The mud consists of a continuous liquid phase to which various additives are added in order to adjust its properties in accordance with the requirements of the drilling process. The composition of the mud can be simple (eg mud for initial drilling; bentonite suspension), but also very complex depending on well conditions such as pressure, temperature, composition of the rocks through which drilling is being done, etc.

Types of crying

In the process of creating a well channel, different muds can be used, which according to the continuous phase are divided into: (1) water-based muds, (2) oil-based muds, (3) synthetic muds and (4) gaseous media (gasified mud, air , foam).

Which type of mud will be selected and applied in practice depends on:

a) purpose (drilling for an introductory, technical or production column; equipment method, type of production),
b) rocks and rock properties (shales, sandstones, anhydrites, rock permeability, etc.),
c) water for mud preparation (water type, chloride concentration, water hardness),
d) possible or expected problems (problematic shales, sticking of chisel/hard tool, grip, depleted sandstones, loss zones),
e) drilling rig/equipment (remote location, limited area, mixing possibilities, mud pumps, equipment for removing solid particles),
f) possibilities of mud contamination (pollutants: solid particles, cement, salt, anhydrite/gypsum, CO2, H2S) and
g) drilling data (channel diameter, channel slope, torsion/tension, mechanical drilling speed, mud density, maximum temperature).

It is almost common for several different types of mud to be used during the production of each well.

The main tasks of geothermal drilling fluids are:

- maintain well stability and ensure pressure,
- enable cooling of channels and drilling tools,
- to clean the channel from the debris of the destroyed rocks.

When choosing mud for geothermal wells, one should bear in mind the high temperature at the bottom, low reservoir pressure, and naturally fractured reservoir rocks. During drilling, the loss of mud into the perforated bed rock is very common, which causes other problems related to the integrity of the well. The cost of remediating (closing) loss zones (material + time) can be 10 to 20% of the total cost of well construction, which can threaten the economics of the entire project, so in many cases, geothermal wells are abandoned due to loss of mud circulation (Saleh et al., 2020). .

Currently, water-based muds (bentonite and polymer), only water, aerated mud or aerated water and air and foam are used during the construction of geothermal wells. For this reason, oil and synthetic muds will not be described in detail.

Water-based muds

Water-based fluids (WBF or Water-based muds - WBM) are muds in which the continuous phase is water. They mainly consist of four basic components: fresh or salt water (> 90%), active colloidal particles (bentonite and polymers), inert solid particles and water-soluble additives (chemicals). Additives are used to adjust the properties of the mud in order for the drilling process to take place effectively. The proportions of individual components and the interactions between them give different types and different properties of water-based muds. By adjusting the composition of each type of mud, its properties can be adjusted.

In water-based muds, the active, solid, colloidal particles are clays. By adding clay to water or mud, there is an increase in density, viscosity, start-up stress and a decrease in filtration. Clays present in water-based muds come from two different sources. These are: clays that are added specifically to ensure rheological properties and reduce filtration (commercial clays: bentonite and attapulgite) and natural clays encountered during drilling through various rocks, so they can be incorporated into the mud.

Inert particles in mud can be classified either as aggregates or as loose rock particles. The density of the bentonite suspension is usually not sufficient to control the layer pressure, and hardeners must be added to it in order to achieve the desired mud density. Hardeners (barite, hematite, galena, calcium carbonate) are chemically inert solid particles. They have a density that is sufficient to ensure the necessary hydrostatic pressure at the bottom of the well.

Additives added to mud can be divided into groups based on their specific functions: viscosifiers (biopolymers: XC, welan, diutan, guar gum); dispersants (polyphosphates, tannins, lignins, lignosulfonates); additives to reduce filtration (starch, resins, polyanionic cellulose - PAC, Na-CMC, Na polyacrylate); lubricants, detergents, emulsifiers, surface-active substances (PAT), materials for closing the place of loss of mud (English. Lost Circulation Materials - LCM), corrosion inhibitors, etc. Materials for closing the place of loss of mud can be granular, fibrous and sheet-like (e.g. ground walnut shells, mica, dry beet noodles, cellophane sheets, ground CaCO3 and others). In addition to barite and clay, mud additives are used in small quantities (Gaurina-Međimurec, 2009). Water-based muds are mostly used in drilling practice (> 80% of cases) due to their low price, ease of preparation and reduced harmful impact on the environment. For initial drilling, simple muds are mainly used - slightly processed bentonite suspensions (Table1.4).

Table1.4Typical mud composition for initial drilling

Komponenta	Koncentracija	Funkcija
Voda	1 m^3*	Bazni fluid
Bentonit	70 kg/m^3	Viskoznost i filtracija
Ekstender bentonita	0,3 kg/m^3	Izdašnost bentonita
NaOH	1 – 2 kg/m^3	Kontrola pH vrijednosti
Polianionska celuloza	1 kg/m^3	Viskoznost
Na_2CO_3	1 kg/m^3	Kontrola tvrdoće vode

*količina

As the depth of the well increases, the areas of higher temperatures and higher pressures are reached, which requires treatment of the basic mud by adding appropriate additives. In this way, muds with a more complex composition are created, which are often named after an additive that is important for their behavior. Water-based muds can be divided according to their composition into: (1) chemically untreated muds (water and bentonite suspension) and (2) chemically treated muds (phosphate, tannic, lignite, lignosulfonate, lime, gypsum, potassium, magnesium, mud based on seawater, saline or partially saline, saturated saline, silicate, glycolic, MMH, polymer, formate, afron-based mud, mud with nano particles, etc.) (Gaurina-Međimurec et al., 2008; Gaurina-Međimurec and Pašić, 2009):

Different types of water-based muds can be used to flush the well channel when drilling through non-reservoir rocks. As an example of water-based mud, in the table (Table1.5) shows the initial composition of gypsum mud.

Table1.5Initial composition of 1 m3 of gypsum mud

Komponenta	Koncentracija za gustoću isplake		Funkcija
	1200 kg/m³	1400 kg/m³	
Voda	0,92 m³*	0,86 m³*	Bazni fluid
Barit	237 kg/m³	502 kg/m³	Povećanje gustoće
Gips	14 kg/m³		Sprječavanje hidratacije šejla
Viskozifer	5,7 kg/m³		Podešavanje reoloških svojstava isplake
Polianionska celuloza (PAC)	2,9 kg/m³		Smanjenje filtracije i postizanje viskoznosti
Polimer	11 kg/m³		Neviskozna forma polianionske celuloze, sekundarno djeluje kao dispergator otežane isplake
Biocid	0,7 kg/m³		Sprječavanje fermentacije prirodnih polimera
Vapno	2,0 kg/m³		Podešavanje pH vrijednosti i kontrola koncentacije topivih karbonata i bikarbonata
Natrijev karbonat (Na_2CO_3)	2,9 kg/m³		Podešavanje pH vrijednosti i kontrola razine topivog kalcija u isplaci

*količina

Polymeric muds are used to flush the borehole channel that passes through the bedrock. The typical composition of polymer mud for a sandstone deposit is shown in the table (Table1.6). The components are selected to minimize damage to the bedrock.

Table1.6Initial composition of 1 m3 of polymer mud with a density of 1150 kg/m3

Komponenta	Koncentracija	Funkcija
Voda	0,89 m³*	Bazni fluid
$CaCO_3$	191 kg/m³	Povećanje gustoće (topiv u kiselini)
NaCl	50 kg/m³	Sprječavanje hidratacije šejla
Viskozifer	2,9 kg/m³	Podešavanje reoloških svojstava isplake (npr. ksantan smola)
Polimer	10 kg/m³	Smanjanjenje filtracije
Biocid	0,7 kg/m³	Sprečavanje fermentacije prirodnih polimera
Vapno	2,0 kg/m³	Podešavanje pH vrijednosti i kontrola koncentracije topivih karbonata i bikarbonata
Na_2CO_3	2,9 kg/m³	Podešavanje pH vrijednosti i kontrola razine topivog kalcija u isplaci

* količina

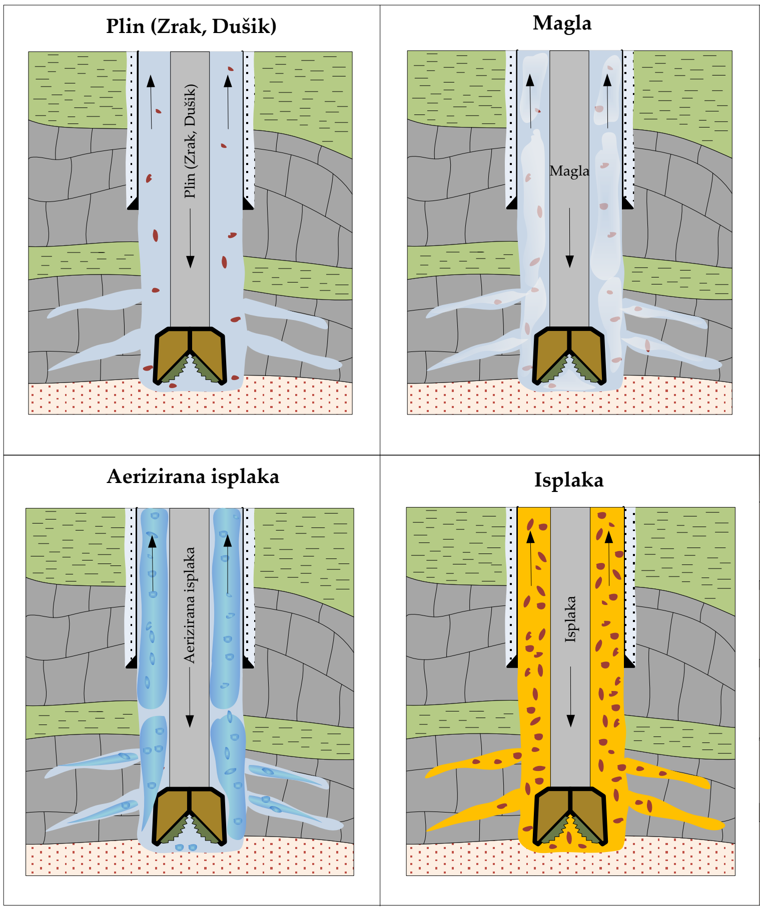
In addition to liquids, gases (e.g. air, nitrogen, etc.), mists, foams and gasified (aerated) muds are used when performing various works in the well (Pavić, 1991; Gaurina-Međimurec and Simon, 1993; Gaurina-Međimurec and Matanović, 1996; Lyons, 2009).

Their application in certain geological and technical conditions ensures the most effective drilling through zones of mud loss (fractured rock), enabling not only to minimize the total loss of time (downtime) and material and technical means, but also to significantly increase the mechanical speed of drilling and to improve the quality of exposing, cementing and conquering reservoir rocks (Picture1.12) (Gaurina-Međimurec et al., 2021).

There are different procedures for creating a well channel with the use of gaseous substances, however, the most widespread area of application is drilling with flushing with gasified mud. The reason for this is less restrictions imposed by geological and hydrogeological conditions and deposits and fewer problems during channel construction than when drilling with gas (air) blowing is applied.

Drilling wells with gasified muds is used in areas of mud loss (when the formation pressure is lower than the hydrostatic pressure and the rock fracturing pressure is slightly higher than the formation pressure), cavernous and fractured rocks (e.g. Dinarides, Pannonian basin) and oil deposits with low formation pressure (eg the Pannonian basin).

Construction of borehole channels in the mentioned areas is possible with (Gaurina-Međimurec and Pašić, 2009 and 2014): (1) restoration of losses (additions for plugging zones of mud loss, DOB and DOBC plugs, cement bridge, etc.), (2)) tolerating losses, i.e. blind drilling without return flow of mud to the surface and (3) drilling with the use of gas (air or nitrogen) (Air drilling or Dust drilling, Drilling with nitrogen), fog Mist drilling), foam drilling or aerated muds (Aerated drilling) in order to achieve hydrodynamic balance in the area of exposed rocks.



Gustoća isplake (kg/m³)	
Plin	0 – 2.4
Magla	24 - 72
Pjena	72 - 600
Aerizirana isplaka	540 - 899
Isplaka	827 i više

Picture1.12Schematic representation of channel cleaning during drilling under negative pressure conditions (gas, fog, foam, aerated mud) and classic drilling with the application of mud (Gaurina-Međimurec et al., 2021)

In the event of mud losses during drilling or circulation, it is very important to repair the losses immediately in order to reduce costs and prevent rock damage, i.e. reduction of their natural permeability, if it is a potential geothermal water reservoir (Gaurina-Međimurec and Pašić, 2009). . Therefore, if mud losses are expected, you should have a pre-prepared basin containing mud containing material for closing the place of mud loss (Lost circulation materials - LCM) (eg calcium carbonate of different granulations and fibrous material). The amount of material to close the loss site, which is added to the mud or just a small volume of mud, depends on the intensity of the mud loss.

Air drilling is used in areas where the rocks are consolidated, hard and dry, i.e. where there is very little or no water flow from the drilled rocks into the borehole channel (only very small amounts of water can be tolerated). It enables the construction of channels through mud loss zones and low pressure zones, while maintaining mud circulation. Large amounts of compressed air are used instead of the classic mud to remove the fragments of the destroyed rocks. The amount of air required depends on the diameter of the channel, the presence of water, and to a lesser extent on the depth of the channel.

Drilling with the application of fog is used when, during drilling with the application of air, small amounts of water (1.2 to 12 m3/h) begin to flow from the rocks into the borehole channel. Air volumes are increased (typically 30% more than required for air drilling). Small amounts of foaming agent and corrosion inhibitor solution are injected into the air stream. A foaming agent prevents rock debris from sticking together, and a corrosion inhibitor must be added to prevent the corrosive action of the water/air mixture on the drilling tools.

Drilling with the use of foam is particularly suitable for drilling channels with large diameters in rocks that are prone to loss of circulation. Foam is a dispersion of gas and liquid in which the liquid is the continuous phase and the gas is the discontinuous phase. The low density and viscosity values of the foam at low shear rates make the foam an extremely useful medium in low pressure reservoirs. The consistency of the foam is similar to shaving foam. The mentioned properties minimize the loss of fluid in the rock and reduce the required ascending speed, while ensuring a high ability to carry debris (better than liquid) at minimum pressures in the circulation. By applying foam, it is possible to achieve a pressure on the bottom of the well channel that is equivalent to the circulating density in the range of 200 to 800 kg/m3.

Air drilling is a technology in which air or nitrogen is injected into an unweighted water-based mud in order to reduce its density and thus the hydrostatic pressure at the bottom of the well. The density of gasified mud is usually in the range of 480 to 830 kg/m3. Aerated muds are often used as a flushing fluid during underbalanced drilling (underbalanced drilling - UBD) (Gaurina-Međimurec et al., 2006; Andersen et al., 2009). Nitrogen is used if there is any possibility of hydrocarbons being present to reduce the likelihood of an underground fire or explosion. Natural gas can also be used when available.

The creation of the well channel that will be flushed with gasified mud is designed with regard to the method and depth of drilling, the characteristics of the rocks through which it is drilled and possible problems associated with the existence of mud loss zones and formation water inflow zones, unstable deposits and rock deposits saturated with hydrocarbons. The application of such mud significantly changes the technology of making the well channel. The specifics of this technology are primarily determined by the conditions that arise in the well (Pavić, 1991). When making a well channel with gasified mud, the mud is mixed with compressed gas and forced through a series of drilling tools. After passing through the chisel, it flows through the annular space where the gas begins to expand due to the decrease in hydrostatic pressure. At the same time, the flow rate of gasified mud increases. In the upward flow of the gasified mud, fragments of broken rocks form the liquid phase of the gasified mud, while the gas is injected for better cleaning of the bottom of the well channel and reduction of hydrodynamic pressure on the bottom of the well channel. In order to fulfill these requirements, it is necessary, in accordance with the specific geological and technical conditions, to properly adjust the supply of mud or gas. The circulation regime of the gasified mud is changed by changing the gasification coefficient or by creating back pressure at the wellhead by damping on the surface nozzle. The use of nitrogen to reduce mud density has a number of advantages compared to air, such as: significantly lower costs, elimination of the possibility of corrosion of drilling tools, great adaptability of the plant for working with liquid nitrogen and the possibility of precise dosing of the gas phase, increase in safety at work (there is no possibility of creating explosive mixtures), great mobility of the plant, the possibility of occasional use in the process of creating a well. Nitrogen is a non-toxic, inert gas without color, taste or smell. It is not flammable and slightly soluble in most liquids. When producing and equipping wells, it is delivered in a liquid state. By injecting nitrogen into the mud, its density is reduced to a value that enables the achievement of hydrodynamic balance in the area of mud loss or exposed rocks. It is recommended to use high-quality bentonite muds that contain corrosion inhibitors (eg lime, sodium bichromate, etc.), and have low density and viscosity values and low filtration to reduce the possibility of shedding and collapsing the unstable walls of the borehole channel. high mobility of the plant, the possibility of occasional use in the process of creating a well. Nitrogen is a non-toxic, inert gas without color, taste or smell. It is not flammable and slightly soluble in most liquids. When producing and equipping wells, it is delivered in a liquid state. By injecting nitrogen into the mud, its density is reduced to a value that enables the achievement of hydrodynamic balance in the area of mud loss or exposed rocks. 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In our country, flushing with aerated fluids (water-based mud (or water) + air) began in 1971 in the Dinarides, at the Premuda-1 well, and was later applied at other locations (e.g. Nin-1, Brač-1, Poljica-1). Gasified mud (water-based mud + nitrogen) was first used in 1990 during the construction of the Velika Ciglena-1 geothermal well (Pannonian Basin) (Stojanac, 1990).

Gasified muds are used in drilling wells all over the world. In our country, their application is interesting when drilling wells in the area of the Dinarides (cavernous and fractured rocks) and the Pannonian Basin (existing oil deposits with low reservoir pressure and geothermal reservoirs with low reservoir pressure).

In accordance with the above, it is to be expected that during the construction of exploratory/exploratory geothermal wells in the Croatian part of the Pannonian Basin, water-based muds will mainly be used, and gasified muds only when well conditions require it. It is not expected to use oil-based muds, nor synthetic muds.

During the drilling of well channels through overpressure zones, where channel collapse (collapse of the formation) is expected and where there are high temperature gradients, bentonite mud (water based bentonite mud) (water + bentonite + NaOH) is mainly used. Depending on well conditions and required properties, dispersants, filtration reducers, hardeners, LCM, corrosion inhibitors and other mud additives can be added to them (Hole, 2008). However, after exposure to temperatures in the range of 150 and 200°C (Otte et al. 1990), the viscosity of these muds increases sharply, which can lead to stuck pipes, and thus to an increase in non-productive time (and total costs) (Pašić et al., 2007; Gaurina-Međimurec et al., 2012; Gaurina-Međimurec and Pašić, 2014).

Another option is polymer muds (polymer-based drilling fluids), which will ensure the stability of the borehole channel and allow debris to be brought to the surface. Polymer mud additives currently available on the market are temperature stable up to a circulation temperature of approximately 90°C (Kruszewski and Wittig, 2018). For this reason, during drilling in conditions of such high temperatures, it is customary to use mud coolers or cooling towers to lower the temperature of the mud before it is re-injected into the well. For example, in Iceland, during the construction of geothermal wells in conditions of very high temperatures, a cooling tower is usually used.

Preventer assembly

In order to ensure well pressure control (secondary pressure control), each onshore drilling facility is equipped with a suitable preventer assembly with associated equipment and devices (Picture1.13). The blowout preventer assembly (BOP) is selected according to the highest expected pressure in the continuation of drilling, and its composition is changed after the installation and cementation of an individual column of protective pipes. As a rule, it consists of a ring preventer, a jaw preventer that closes the full profile or a double jaw preventer (the upper jaws are used to seal around drill rods with an outer diameter of 127.0 mm (5"), and the lower jaws are for closing the full profile or cutting rods), drilling flanges and lines for suffocation and throttling with associated mechanical and hydraulic valves.If necessary, a rotary preventer is also used, which ensures the sealing of the annular space with the simultaneous rotation and longitudinal movement of a series of drilling tools.

All associated equipment (choking and throttling line with mechanical and hydraulic valves, adjustable and/or mechanical nozzle, distributors, etc.) have the same working pressures as the preventers.

The work starts, is carried out and/or continues only after the preventer assembly with the associated equipment has been functionally and pressure tested. Functional testing is performed after each assembly of the preventer assembly.

A pressure test of the preventer assembly, lasting 15 minutes, is performed: (a) after the installation and cementation of a series of protective pipes, (b) after any repair or service of any preventer device, (c) at least once every 15 days, (d) before drilling layers with increased pressures, and (e) whenever requested by an authorized professional. During the test period, the pressure drop is not allowed.

Picture1.13Example of a typical preventer assembly (BOP) (Potter, 2018)

To activate (put into operation) selected components of the preventer assembly, a control system (remote panel/board) is used, which must ensure the closing of the ring (annular) preventer for a maximum of 30 seconds (for a diameter of up to 508 mm (20 inches)), or for a maximum of 45 seconds (for a diameter of 508 mm (20 inches) and more), and the closing of the jaw (ram) preventers, regardless of the diameter and type of installed jaws, in a maximum of 30 seconds. An accumulator unit with a working pressure of at least 206.84 bar (3000 psi) is used to control the preventer assembly.

The control panel is located in at least two places: on the working platform of the drilling tower, that is, on the workplace of the shift leader, and in a safe place, far enough away from the well channel. Internal preventers are used to prevent the uncontrolled ejection of formation fluid (oil and/or gas and/or water) through a series of drilling tools, if necessary, in all stages of making the well channel (drilling).

At the working platform of the drilling rig, during each maneuver with the drilling tool (removal and/or lowering and/or addition), a selected internal preventer (functionally correct, serviced and pressure tested) of the appropriate threaded connection (or with additional equipment - transitions) is always available), so that it could be used and put into operation at any time. Nozzles and manifolds enable the controlled flow of mud and/or working fluid and/or formation fluid from the well channel (in case of inflow). The closing and suffocation of the well (after the inflow of formation fluid) is performed according to the prescribed procedures and instructions of the holder of the authorization for the exploration of geothermal water and/or the investor and the contractor.

The drilling part of the crew is trained in well shut-in exercises, which are carried out at prescribed intervals at the drilling rig and well shut-in and suffocation courses (well pressure control), which are held in authorized training centers according to internationally recognized programs, to quickly closing the well.

Construction of the geothermal well and protective pipe

The development of geothermal wells is conceptually no different from the development of oil/gas wells. However, there are certain differences that are specific to the construction of geothermal wells. It is primarily the high temperature that affects the equipment used and the design of the drill string. The high temperature also determines pressure control methods in geothermal wells to prevent uncontrolled discharge of fluids from the well, which are very different from those used in the production of oil wells. Geothermal wells are generally larger in diameter to enable the extraction of larger quantities of geothermal water, and thus more thermal energy.

The well is made by drilling rocks with a chisel from the surface to the final depth (the bottom of the channel), verified by the exploratory well construction project.

Drilling begins with a chisel of the largest diameter, and chisels of smaller diameter are used to continue drilling at each subsequent interval. Therefore, with an increase in depth, the diameter of the chisel, i.e. the well channel, and the diameter of the protective pipes (casing) decrease (Picture1.14). Protective pipes are connected to each other in a series (column).

Picture1.14Example of protective pipes (Gaurina, 2022)

After reaching the intended depth, individual sections of the channel, a column of steel protective pipes is installed in the newly created channel and cemented by pushing cement slurry into the sealing ring space.

Most geothermal wells have two to five casing strings, with deeper wells typically having multiple casing strings.

The construction of a geothermal well includes the installation of several columns of protective pipes (conductor, inlet, technical, production), which after installation are cemented from the bottom to the mouth.

The column conductor is installed as part of construction works for the construction of the well working area (up to a depth of 25 m). In this way, the surface deposits are stabilized and the well mouth is prepared for the start of drilling the well channel to the depth provided for the installation of the introduction column.

The introduction column is installed in order to cover the surface deposits, to secure possibly pierced aquifers, to enable the installation of the preventer assembly and the smooth and safe continuation of the drilling of the well channel, through the preventer assembly, to the depth provided for the installation of the technical column.

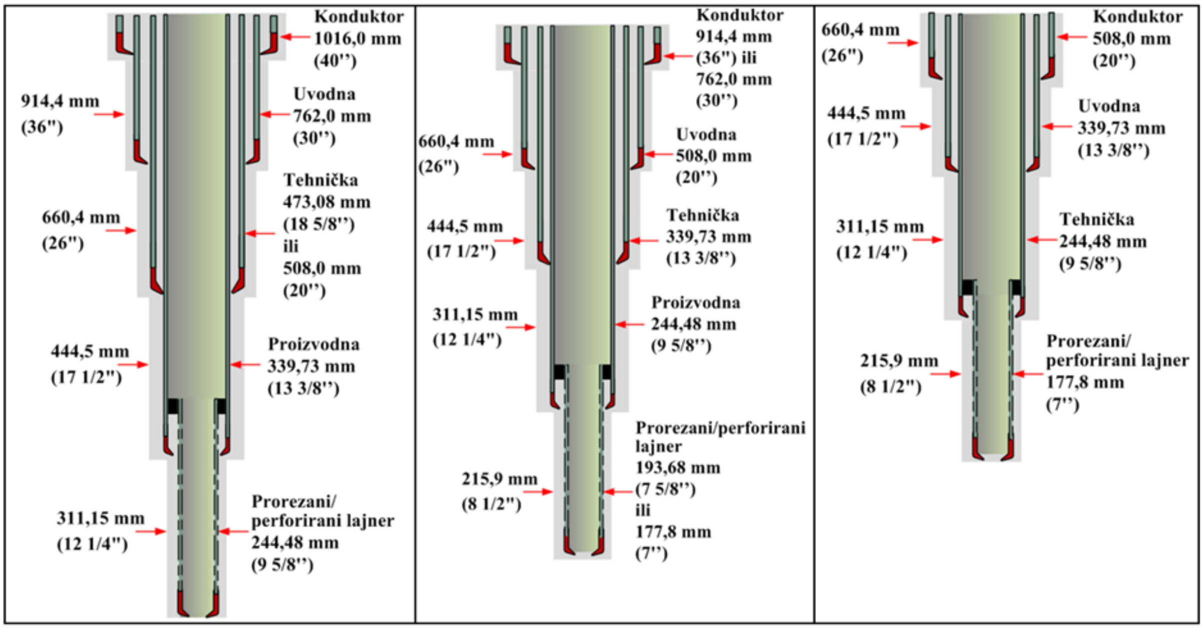
The technical column is installed in order to seal the open channel and solve various well problems. The technical column should be embedded deep enough to allow the well to be choked during drilling up to the depth of the installation of the production column. After its installation and cementation, the drilling of the well channel continues, through the preventer assembly, to the depth provided for the installation of the production column or production liner.

The production column is installed to isolate the production zones and ensure the control of the reservoir fluid. It is chosen based on the expected depth of the deposit and the temperature of the geothermal water. Through the production column, geothermal water and steam are extracted to the surface. If the installation of a production column is planned, after its installation and cementation, drilling continues through the geothermal reservoir to the designed final depth of the well, and a slotted liner is installed in that channel.

A production liner is the name for a series of protective casings that do not extend from the bottom of the channel to the surface, but are suspended using a liner hanger within a previously installed production (or technical) column. It can have slots (eng. slotted liner) or perforations (eng. perforated liner) through which geothermal water from the reservoir flows into the well.

Types of liners are: production liner, drilling liner, and tie back liner.

Various constructions of geothermal wells are possible, and examples of some common constructions are shown in Figure 1.15.

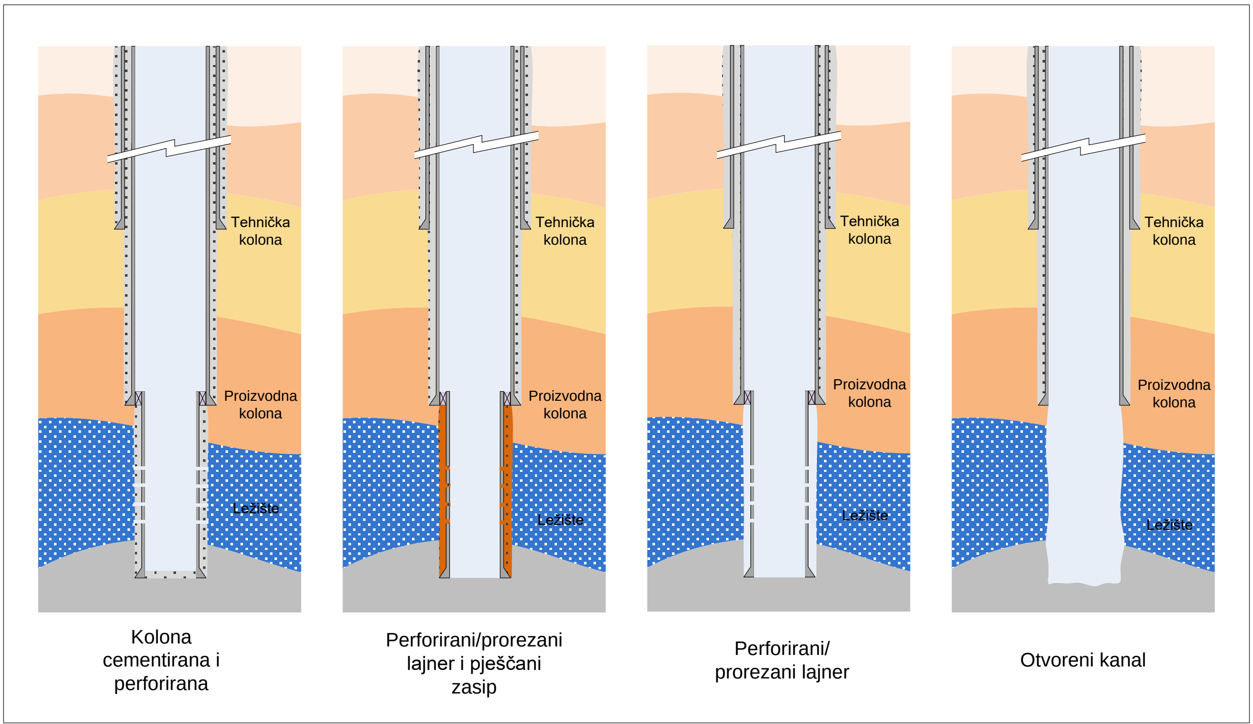


Picture1.15Examples of geothermal well constructions (Gaurina, 2022)

A steel perforated liner or slotted liner is usually installed in the part of the borehole channel that passes through the geothermal reservoir. The installation of the liner protects the open channel from collapsing. Liner is the name for a column that does not extend from the bottom to the mouth of the well but is suspended in a previously installed production column. In some shallow wells from which water will be extracted for direct use (eng. shallow direct-use wells), it is common for the channel in the area of the geothermal reservoir to remain unsealed (eng. open hole).

However, the part of the channel passing through the geothermal reservoir can be equipped in different ways depending on the reservoir rocks (Picture1.16).

In the case of weakly bound rocks, it is possible to equip that part of the well channel: (1) by installing and cementing a liner and subsequent perforation of the liner and cement stone in order to re-establish communication with the deposit or (2) by installing a perforated/slotted liner and placing a sand backfill to prevent the inflow of unbound sand into the well channel.



Picture1.16Examples of equipping the part of the well channel that passes through the reservoir (Gaurina, 2022)

In the case of compact, fractured rocks that can withstand stresses without deformation of the channel walls and reduction of its diameter (channel collapse), it is possible to equip that part of the channel with the installation of a perforated/slotted liner or to leave the channel open or unsealed.

The selection and installation depth of protective pipe columns and their cementation are based on the geological profile, layer pressure gradient and rock fracturing pressure, layer fluid, safety coefficients, stress calculations, programmed technological requirements in the most unfavorable well conditions and the location and properties of the geothermal water deposit. For each concrete well, detailed information about the columns of protective pipes (number of columns, diameters, depth of installation, quality of materials, etc.) is contained in the verified Project for the construction of an exploratory well.

Protective pipes, regardless of the type of well, must withstand combined stresses (longitudinal stresses and crushing and bursting pressures).

When choosing protective pipes for geothermal wells, the high temperature of the geothermal water, which causes thermal stresses in the column of protective pipes, should be taken into account. High temperature causes excessive axial stress and a decrease in yield strength, which leads to a decrease in the resistance of protective tubes to crushing and spalling. In addition, the compressive and tensile stresses that protective pipes can withstand without being plastically deformed are reduced (Torres, 2014). In addition to the choice of protective pipes, the correct selection of threaded connections is also important, as they must maintain strength and seal at high temperatures.

The quality of steel that will be used for an individual column of protective pipes depends on bursting pressure, crushing pressure, tensile and compressive strength, thermal stress and corrosion resistance. Protective tubes made of steel quality K-55 are made of low-carbon steel that is resistant to the combined action of tensile stress and corrosion in the presence of water and hydrogen sulfide (sulphide cracking) at all operating temperatures. K-55 quality steel is recommended for the introduction column and for the production perforated liner (Torres, 2014). Protective pipes made of L-80 quality steel are pipes with limited strength at the yield point and are of high hardness and can withstand high temperatures. They are resistant to sulphide stress cracking and can be used in wells where high concentrations of H_2S are present at all temperatures (Torres, 2014). Protective pipes made of T-95 quality steel are installed from the top of the liner to the mouth of the well when the temperature at the mouth is expected to be higher than 315 °C. When the final part of the casing string is placed in the wellhead, it is recommended to use a single coupling made of alloy steel to ensure the integrity of the wellbore (Torres, 2014).

Deep EGS wells (Engl. enhanced geothermal system) (>4000 m) are usually drilled vertically (and have a construction similar to the third construction in Figure 1.13.), whereby in the upper part of the channel with a diameter of 215.9 mm (8

1/2") installs and cements a 177.8 mm (7") diameter production column, and the lower part of that channel remains open (Hodson-Clarke et al., 2016).

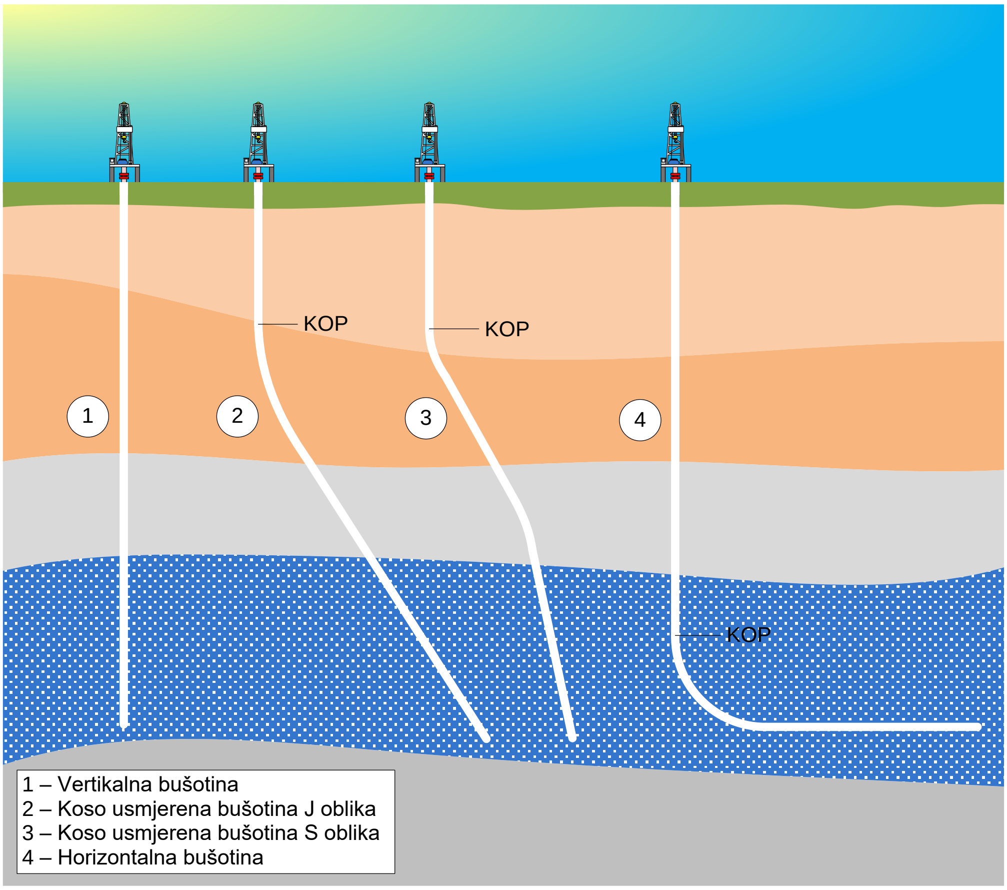
Division of wells according to the type of trajectory (path) of the well channel

Wells can be drilled as vertical or directional (oblique or horizontal wells) (Picture1.17). With vertical wells, the length and depth of the channel are equal, and with directional wells, the length of the well channel (measured depth) (English Measured Depth, MD) is greater than the actual vertical depth of the channel (English Thrue Vertical Depth, TVD). Construction of vertical geothermal wells is cheaper and simpler than construction of directional wells.

The creation of a directional geothermal well allows cutting multiple target deposits with one well channel and drilling multiple wells from the same well working area. The path (trajectory) of the channel of an obliquely directed borehole in the underground can be different, but the usual obliquely directed boreholes are J- and S-shaped.

Construction of a deviated well begins with the construction of a vertical channel from the surface to the depth of the channel's kick of point (KOP). After the installation and cementation of the column of protective pipes, drilling continues in the desired direction and at a certain angle of deflection from the vertical to the final depth of the well channel.

J-shaped drills maintain this angle until the final depth, while S-shaped drills can change the angle or direction if necessary. Changing the borehole direction (azimuth) requires the use of a downhole motor, while reducing the deflection angle can be achieved by changing the bottom-hole assembly (BHA).



Picture1.17Schematic representation of the channel path of a vertical, obliquely directed and horizontal well (Gaurina, 2022)

The production of horizontal wells is common in sedimentary formations in the oil industry, but it is not used in conventional two-phase systems with fractured igneous rocks due to the risk of losing the stability of the well channel. However, it could be an option for drilling through the warm and hot water system in sedimentary formations if it is economically viable (Zarrouk and McLean, 2019).

Therefore, the construction of horizontal geothermal wells is technologically demanding and not economically justified, so their application in the Pannonian Basin is not expected.

Cementation of protective pipe columns

The method of installation and cementing of protective pipes and the quantity and quality (properties and composition) of the cement slurry are defined in detail in the Exploration Well Development Project. After installation to the intended depth, the column of protective pipes is cemented by pushing cement slurry, through the column or through the drill rods, into the sealing ring space.

In geothermal wells, all columns (input, technical and production) of protective pipes must be cemented from the bottom (installation depth) to the mouth. Cementation achieves the strengthening of the installed column of protective pipes, the stability of the borehole channel and prevents the communication of reservoir fluids between the drilled rocks and their migration towards the surface.

When cementing wells, a special place belongs to the design of cement slurry. A complete understanding of borehole parameters, the behavior of cement slurry (especially at high temperatures) and the application of proven cementing technologies are the biggest guarantee for achieving quality cementation (Gaurina-Međimurec et al., 1994). The temperature conditions of cementing are important because the temperatures in the circulation at the bottom of the borehole affect the thickening time, rheological properties, the setting time of the cement slurry and the development of the compressive strength of the cement stone. Knowing the actual temperature, i.e. the one to which the cement slurry will be exposed during the cementing process, enables the selection of appropriate cement and cement additives and the design of cement slurry for specific applications. Most Portland cements can be used in geothermal wells.

As a rule, the lead string is cemented by pushing the cement slurry through the drill rods (eng. inner string) by raising the column of cement slurry to the mouth of the well. After cementation and hardening of the cement slurry into cement stone, and before continuing to drill the next interval of the well channel with a chisel of smaller diameter, on the lead preventer assembly (BOP) is installed in the column.

The technical and production column of protective pipes are cemented by pushing the cement slurry through the column itself (with the previous and incidental plug) in one or two stages and by raising the column of cement slurry through the annular space from the bottom to the mouth of the well.

Cementing of deeply embedded columns requires cementing in two stages when the rocks cannot withstand the pressure exerted by a long column of cement slurry or when the borehole channel crosses low pressure zones where cement slurry can be lost. Due to the different pressure and temperature conditions along the borehole channel, the string can be cemented in one stage by pushing the top and tail cement slurry. These two slurries differ in composition and properties, and are designed so that they harden into high-quality cement stone under different conditions of pressure and temperature.

The production liner (slotted or perforated) is not cemented.

Pressing of the cement slurry is carried out with a cementing aggregate equipped with a device for showing the pressure value and its record on the diagram. After the cement slurry hardens into cement stone, the tightness (hermeticity) of a series of protective pipes is tested for the pressure value prescribed in the verified Project for making an exploratory well. The leak test time should be 15 minutes, and the leak test result is satisfactory if the pressure drop does not deviate more than 10% from the prescribed value. The test results are recorded in the record (journal) to which the corresponding test diagram is attached. After installation, each column of protective pipes at the wellhead is wedged into its flange in the wellhead assembly.

In the case of geothermal wells, special attention should be paid to the quality of the cementation of the protective pipe columns. The problem is the possible presence of water in the annular space between the two columns of protective pipes that remained after cementation.

During the exploitation of geothermal water, the volume of this residual water increases due to the increase in temperature and creates significant pressure on the walls of the protective pipes, which can result in the crushing of the inner column or the bursting of the outer column of the protective pipes (Torres, 2014).

The duration of the construction of a new well depends on the final depth of the well, i.e. on the depths of the targeted geothermal water deposits, problems that may arise during drilling and the scope of technological tests during the construction of the wells. For example, the drilling of a well with a depth of about 2,200 m takes about 65 days. After making the well, the drilling rig is moved to a new location. The dismantling of the drilling rig takes several days (about 4 days).

On the part of the work area of the drilling rig, there is a shift leader's workplace equipped with a system and devices that manage the drilling rig, devices and equipment that control the operation of the drilling rig, and devices and equipment for monitoring drilling parameters with a mandatory record of drilling parameters on the associated diagram.

Surface equipment of the well

After the installation of the introductory column of protective pipes and the installation of the base flange at the mouth of the well, the preventer assembly consisting of jaw preventers and an annular preventer is mounted. The assembly also contains a drilling flange with choke and choke lines and mechanical and hydraulic valves on the choke and choke lines.

In the following, the procedures are described in the event that the construction of the well, in addition to the introduction, includes only the technical column and the slotted liner.

After installing the technical column, the preventer assembly is dismantled, a tubing flange is mounted on the base flange (Tubing spool), and the preventer assembly is returned to the tubing flange, followed by drilling of channels for installation of the slotted liner.

After installing the slotted liner, the preventer assembly is dismantled, and a cover flange (tubing head adapter) and an eruption device (Xmas tree) are mounted on the tubing flange.

The eruption device enables the safe operation of the well and the opening and closing of the flow of geothermal water from the well. The eruption device consists of a cross piece and shut-off valves.

The construction of the well, wellhead and eruption device is carried out according to the Verified project for the construction of an exploratory well.

Other works in the well

During well construction, in addition to drilling, installing and cementing protective pipes, work is also carried out in the well channel that enables obtaining information about the drilled rocks, such as: debris sampling, hydrocarbon detection, measurements in the well channel, coring (taking rock samples - cores). , logging measurements, testing of the deposit and work on the rehabilitation of any unforeseen breakdowns in the well (e.g. breakage or acceptance of tools). and production testing of the well.

The purpose of the production test of the well or deposit is to determine the presence of geothermal waters and the economic profitability of their exploitation. During the test, data on flow, pressure and temperature are measured and recorded, and a sample of reservoir fluid is obtained, whose properties and composition are determined in the laboratory.

The collected data are used to determine the reservoir characteristics and based on them, decisions are made about the choice of geothermal water extraction method, the choice of well production equipment and the construction of development/exploitation wells.

During production testing, the obtained geothermal water is accepted in a pit (lagoon) for production testing of the well with a volume of 12,000 m^3 to 20,000 m^3. The test lasts only as long as it is necessary to obtain the necessary data (up to 10 days).

Works after the completion of the well construction

After the drilling of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working area (BRP) is reduced to the optimal size for the extraction of geothermal water (plateau measuring 50 m x 80 m).

After the completion of the well, the preventer assembly is dismantled and the wellhead (base flange, tubing flange, tubing hanger) and eruption device are installed.

In the case of a positive outcome of the production test of the well and the commercial discovery of geothermal waters, it will be temporarily abandoned, and the working space of the well will be reduced to the optimal size for the extraction of geothermal water, in accordance with the verified Project for the creation of an exploratory well.

Exploration well remediation plan

If, during the test, it is determined that the well is negative because it has not established a reservoir of geothermal water, it will not be equipped, but the well will be abandoned (liquidated) in accordance with legal regulations. Upon completion of all permanent abandonment works, an agro-ecological analysis of the soil will be performed and a condition study will be prepared with a proposal for soil reclamation. Abandonment (liquidation) of a well involves the following procedures:

- placing two or three cement plugs (filling part of the protective pipes with cement slurry that will harden into cement stone);
- cutting all protective pipes at a depth of 1.5 to 2 m from the surface i
- removal of the well head.

Rehabilitation of the exploratory well is carried out in accordance with the exploratory well rehabilitation plan from the exploratory well construction project.

The exploratory well remediation plan must contain a description of the permanent abandonment of the well in case of negativity and a description of the arrangement of the area affected by the oil-mining works during and after the completion of the oil-mining works and the cost of renovating the exploratory well.

If the Project for creating an exploratory well does not include a Remediation Plan for the permanent abandonment of the well during the research period, a Project for permanent abandonment of the well is drawn up, which in accordance with Article 40 of the Ordinance on oil-mining projects and the procedure for verifying oil-mining projects ("Official Gazette" No. 95/18) contains the following chapters: (1) Introduction, (2) Technological and technical well abandonment project, (3) Well rehabilitation plan, (4) Cost of permanent well abandonment and (5) Health, safety and environmental protection measures.

The chapter Technological and technical well abandonment project contains, including, but not limited to: (1) Description of the existing equipment in the well, (2) Measurements that will be performed in the well before abandonment and (3) Description of permanent abandonment with an accurate description of the isolation method of individual deposits, using the working fluid and removing the above-ground part of the well equipment.

After the completion of the oil-mining works on the permanent abandonment of the well channel, the arrangement of the work area will be started.

The well remediation plan chapter contains a description of the arrangement of the well working area after the abandonment of the well, with the costs of permanent abandonment of the well.

Pursuant to Article 185 of the Law on Exploration and Exploitation of Hydrocarbons ("Official Gazette" No. 52/18, 52/19 and 30/21), after the completion of oil and mining works, the investor is obliged to rehabilitate the exploration area or exploitation field, i.e. rehabilitate the area where oil and mining facilities and plants are located.

Remediation is carried out in accordance with this Law, special regulations related to the protection of the environment and nature, the safety of people and property, the protection of human health, as well as international good practice in oil and mining operations.

The investor is obliged to report the rehabilitation to the energy inspection in the field of oil mining and the environmental protection inspection of the State Inspectorate. If the energy inspection in the area of oil mining and the environmental protection inspection of the State Inspectorate determine that the remediation has been carried out and that the security measures, nature and environmental protection measures, as well as the remediation carried out are sufficient, they will issue the investor a certificate to that effect, otherwise they will order the investor to within a specified period, no longer than six months, remove the identified deficiencies, and, if necessary, implement other security measures and notify the Ministry and the Agency accordingly.

If the investor does not comply with the order of the energy inspection in the field of oil mining and the environmental protection inspection of the State Inspectorate, they will inform the Ministry and the Agency about it, and the Agency will implement the necessary insurance measures and remediation at the expense of the investor.

1.4.2 Technology of making and equipping wells during the exploitation period

Development/exploitation well development project

Pursuant to Article 133 of the Law on the Exploration and Exploitation of Hydrocarbons, a Development and Exploitation Project is drawn up for the execution of oil-mining works, i.e. for the construction of oil-mining facilities and facilities. The development and exploitation project is subject to verification.

Pursuant to Art. 5 of the Ordinance on oil-mining projects and the procedure for verifying oil-mining projects ("Official Gazette" No. 95/18) The elaboration and exploitation project must contain the following chapters: 1. General part, 2. Introduction, 3. Geophysical survey of the exploitation field . , 11. Technical-technological solutions of oil-mining equipment installed in the well, 12. Technical-technological solutions for the construction of oil-mining facilities and facilities, 13. Rehabilitation plan, 14. Protection and safety measures, 15. Project timeline and project risks , 16. Economic evaluation and 17. Conclusion.

For the exploitation of geothermal water, it is mandatory to carry out the assessment procedure on the need for an environmental impact assessment based on point 10.3. Exploitation of mineral and geothermal waters from which accumulated heat can be used for energy purposes of Annex II. Decree on environmental impact assessment (Official Gazette 61/14 and 3/17).

Pursuant to Art. 135, paragraph (1) item 3 of the Act on Exploration and Exploitation of Hydrocarbons ("Official Gazette" No. 52/18, 52/19 and 30/21) for the construction of a development/exploitation well during the exploitation period, which is designed in accordance with with the technology processed by the development and exploitation project or the supplementary development and exploitation project, the Well Project is created". Previously issued acts: Decisions that it is not necessary to carry out the environmental impact assessment procedure and the main acceptability assessment for the ecological network for the intended operation and the Location permit are an integral part of the Well Project that is subject to verification.

This drilling of the well during the period of exploitation, the Project for the construction of the development/exploitation well is drawn up, which in accordance with Article 32 of the Ordinance on oil-mining projects and the procedure for the verification of oil-mining projects ("Official Gazette" No. 95/18), which must contain, including, but not exclusively, the following chapters: 1. Geological and geophysical survey of the development/exploitation well and the surrounding area where the development/exploitation well is located, 2. Technological and technical design of the well, 3. Hydrodynamic measurements, 4. Equipping the well for exploitation, 5. Well equipping and maintenance, 6. Well rehabilitation plan, 7. Health, safety and environmental protection measures.

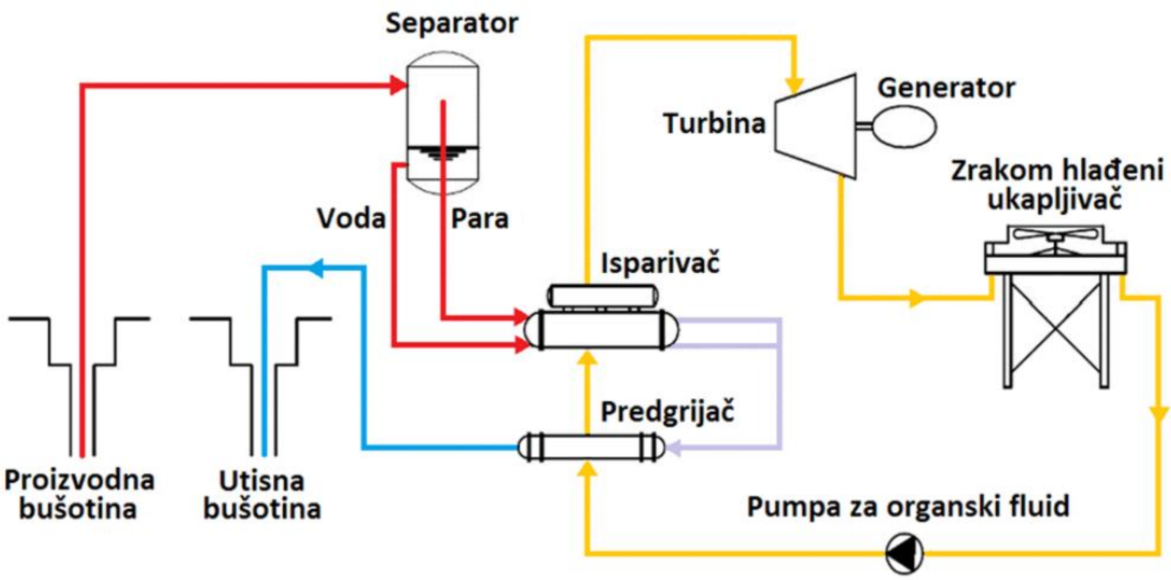
The technology of producing a development/exploitation well does not differ from the production of an exploratory well, so the production of a well will not be described again in this part.

Program of drilling works by stages of execution - transport, assembly and dismantling of the oil-mining drilling rig, description of the stages by diameter of the well channel, composition of tools for making the well in each stage, logging measurements, description of the installation of protective pipes with quality and basic calculation of the stress of the protective pipes, the type of well heads, the type, quantity and quality of the working fluids used in the construction of well channels, the method of installing and cementing protective pipes, the hydraulic calculation of flushing and cementing are an integral part of the chapter "Technological-technical project for the development/exploitation well".

For the exploitation of geothermal water, depending on the intended use of geothermal water, the following is required:

- in the case of direct use, at least one production well, a
- in the case of a geothermal power plant, at least one pair of wells, one of which is a production well and is used to extract geothermal water, and the other well is an injection well and serves to inject geothermal water after the heat from it has been used.

In Figure 1.18. a schematic representation of the production of electricity by exploiting geothermal water and using its heat in an ORC plant (English Organic Rankine Cycle; Rankine's thermodynamic cycle with the use of an organic working fluid) is given.



Picture1.18Schematic representation of electricity production in the ORC plant (Source: EZO Kotoriba)

From the diagram shown, it is evident that there are two closed and separate systems: (1) system of geothermal water as a source of thermal energy, and (2) system of organic working fluid (e.g. isobutane) which is evaporated in heat exchangers by heating with geothermal water (preheater , evaporator), expands in a turbine that drives an electric generator and cools (and liquefies again) giving the rest of the heat to the atmosphere.

Equipping a geothermal well for exploitation

After the development/exploitation well and the positive outcome of the geothermal water reservoir test, the well is equipped and the well working area (BRP) is reduced to the optimal size for the extraction of geothermal water (plateau measuring 50 x 80 m).

Well equipping generally includes a series of procedures such as: (1) revealing and separating selected intervals, (2) testing and equipping wells, (3) calculation and selection of underground and above-ground well equipment and (4) accompanying works during well equipping.

Development/exploitation wells are equipped for the exploitation of geothermal water in accordance with the approved oil-mining Project for the development/exploitation well.

Underground equipment of production geothermal wells

The equipment of the geothermal well depends on the conditions for obtaining geothermal water. According to the method of obtaining geothermal water, production geothermal wells can be: eruptive, with a deep pump, with air lifting and with a deep heat exchanger.

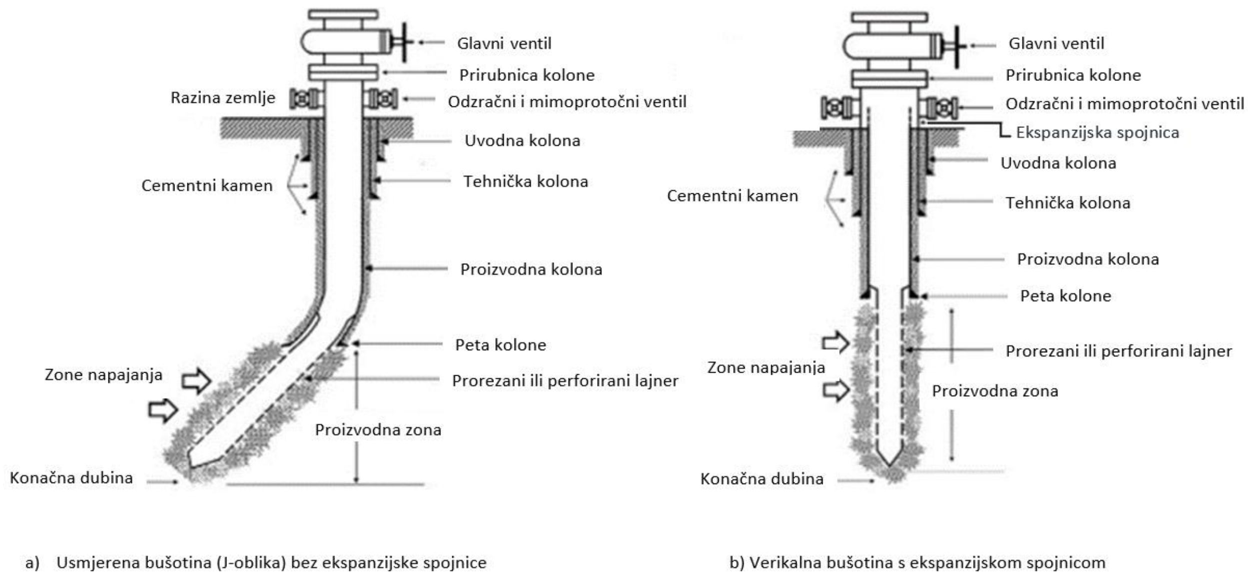
Eruptive geothermal well

An eruptive well (self-discharging well) is a production well with a pressure at the mouth of more than 3 bar, which eruptively produces geothermal water through a built-in liner and a production column. The ability of a geothermal well to erupt mainly depends on the reservoir pressure, the permeability of the reservoir rocks and the depth of the feed zone.

An eruptive well achieves a greater mass flow of geothermal water and generates more energy than other production wells, so it is desirable that all production geothermal wells be eruptive. Eruptive geothermal wells are all vapor-dominated wells, as well as most wells in which two phases (water and steam) are present (two-phase wells).

Good permeability of reservoir rocks and relatively high reservoir pressure will result in good exploitation of geothermal water of high temperature and enthalpy. It is a common misconception that geothermal wells erupt due to high reservoir pressure because geothermal eruptive wells generally have a reservoir pressure less than the hydrostatic pressure of the cold water column. Instead, the separation ("flashing") of the geothermal fluid into steam and water in the reservoir or in the casing string causes a decrease in its density and an increase in volume, which allows the geothermal fluid to flow toward the surface. Of course, the higher the reservoir pressure, the higher the pressure at the wellhead will be. Higher dynamic pressure at the wellhead enables the application of different technologies/processes for the use of geothermal water (double and triple flash) and provides greater operational flexibility.

Eruptive wells are designed according to the design of protective pipe columns shown in Figure 1.13. They are mainly drilled to a depth of about 1000 - 2500 m. In some geothermal fields, deeper wells are drilled, but it is not usual to drill over 3000 m. A schematic representation of the design of a geothermal eruptive well is shown in Figure 1.19.



Picture1.19Schematic representation of the design of a geothermal eruptive well (Zarrouk and McLean, 2019)

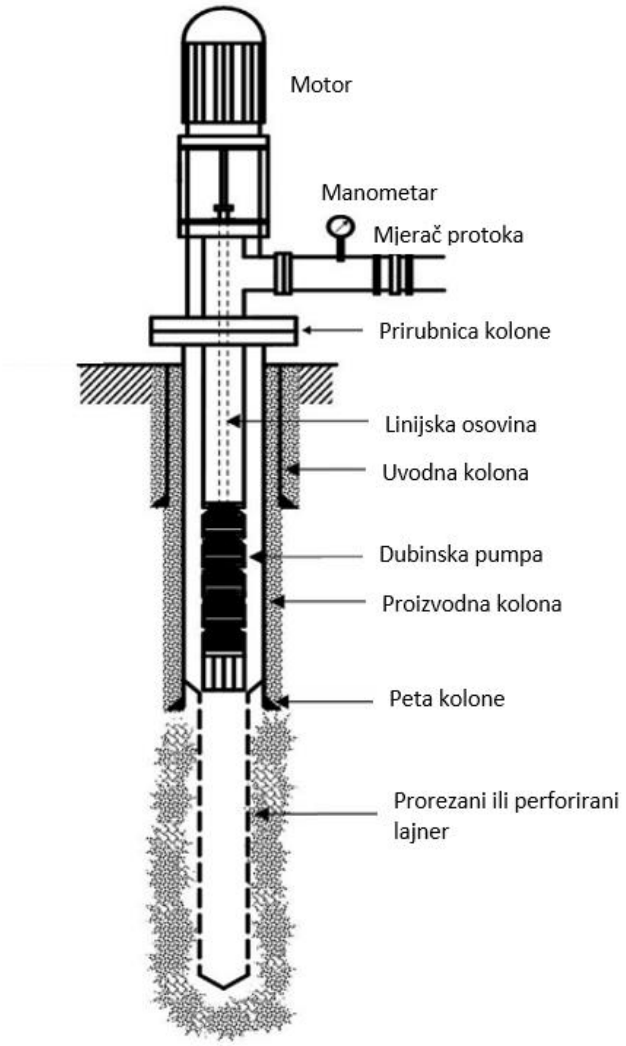
Geothermal well with deep pump

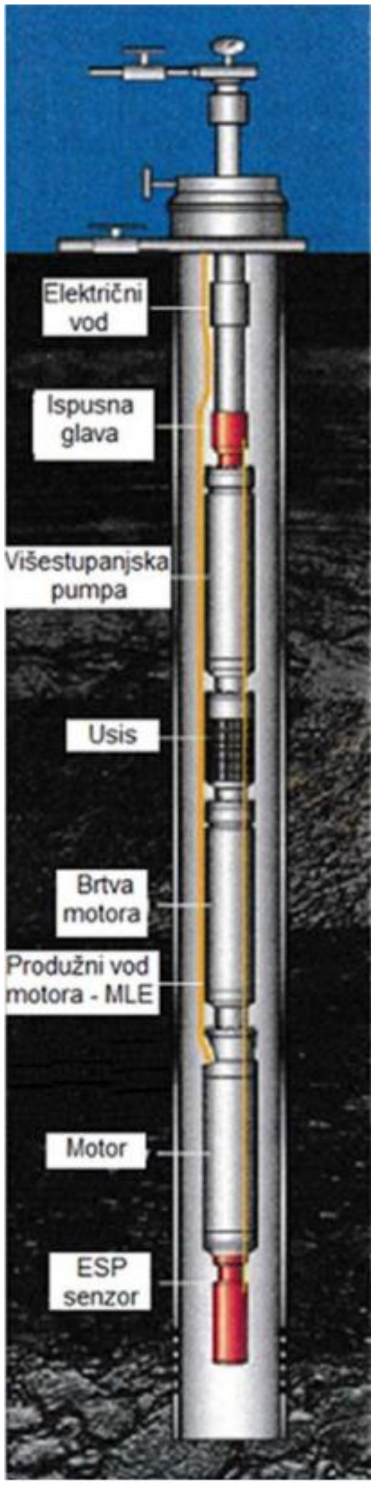
If the reservoir pressure is not sufficient to overcome the resistance to the flow of geothermal water from the reservoir to the mouth, the geothermal water can be exploited by installing a down-hole pump in the well.

Pumped wells are generally less commercially attractive than geothermal eruptive wells due to additional investment and maintenance costs (Hochwimmer et al., 2015), and the most critical factor is the relatively short lifetime of the pump (Held et al., 2014).

Geothermal wells with a built-in deep pump are used in cases of direct use of geothermal water and for the needs of a geothermal power plant with an organic Rankine cycle (ORC). The obtained geothermal fluid passes through heat exchangers and is then pumped back into the reservoir. It should be emphasized that it is not common to have geothermal wells with a built-in deep pump and geothermal eruptive wells serving the same ORC geothermal power plant, and definitely not the same steam flash plant.

An electrical submersible pump driven by a submersible motor (the term "electrical submersible (or submersible) pump" is also used) can be installed in a production geothermal well (Electrical Submersible Pump, ESP) (Picture1.20) or a submersible pump driven by an engine that is on the surface (peak drive) (Figure 3.5) (up to a depth of about 700 m) and tubing (rising pipes). Tubing is hung in the tubing flange of the eruption device using a tubing hanger.

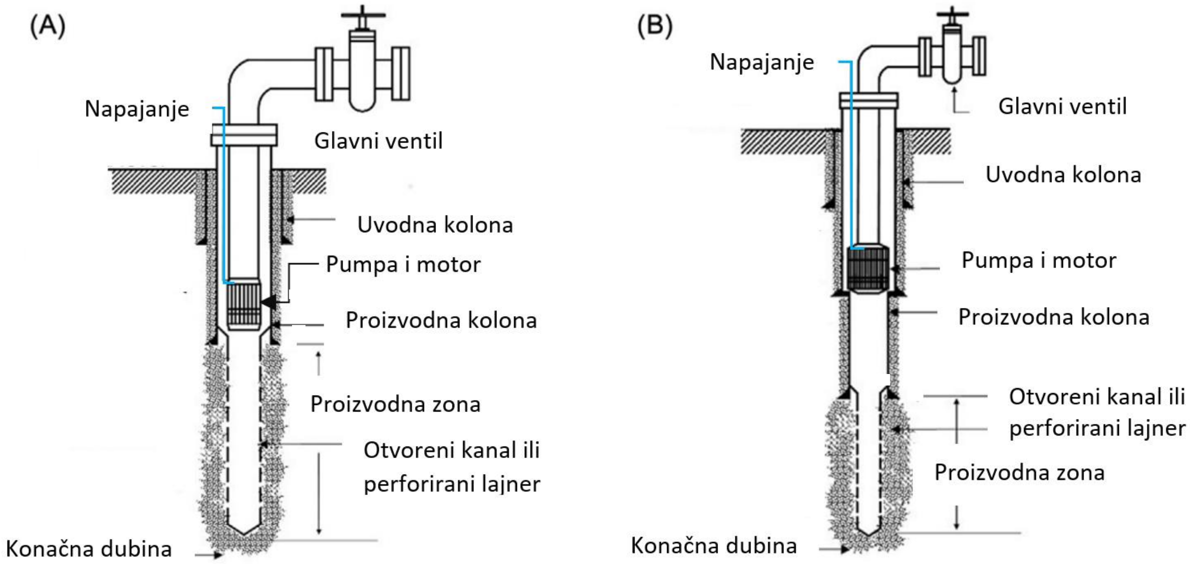




Picture1.20Schematic representation of a production geothermal well with a deep pump (Gaurina, 2022)

Geothermal submersible pumps can operate at temperatures up to 240 ºC (Hochwimmer et al., 2015), and the selection and installation of these pumps depends on well design, fluid chemical composition, geothermal water flow, reservoir pressure (water level) and permeability. Submersible pumps with an engine on the surface (with peak drive) and a line shaft (Line-shaft pumps) (Picture1.21a) require continuous lubrication of the bearings that hold the shaft in the center of the pipe (rising pipe) and prevent mechanical erosion.

It is possible to install a submersible pump inside existing wells that were originally designed to produce eruptively (Figure 3.4A) and inside wells that were specifically designed to install a submersible pump (Picture1.21b). Production geothermal wells that are specifically designed for the installation of a submersible pump allow the installation of larger diameter pumps to achieve a higher flow of geothermal water.

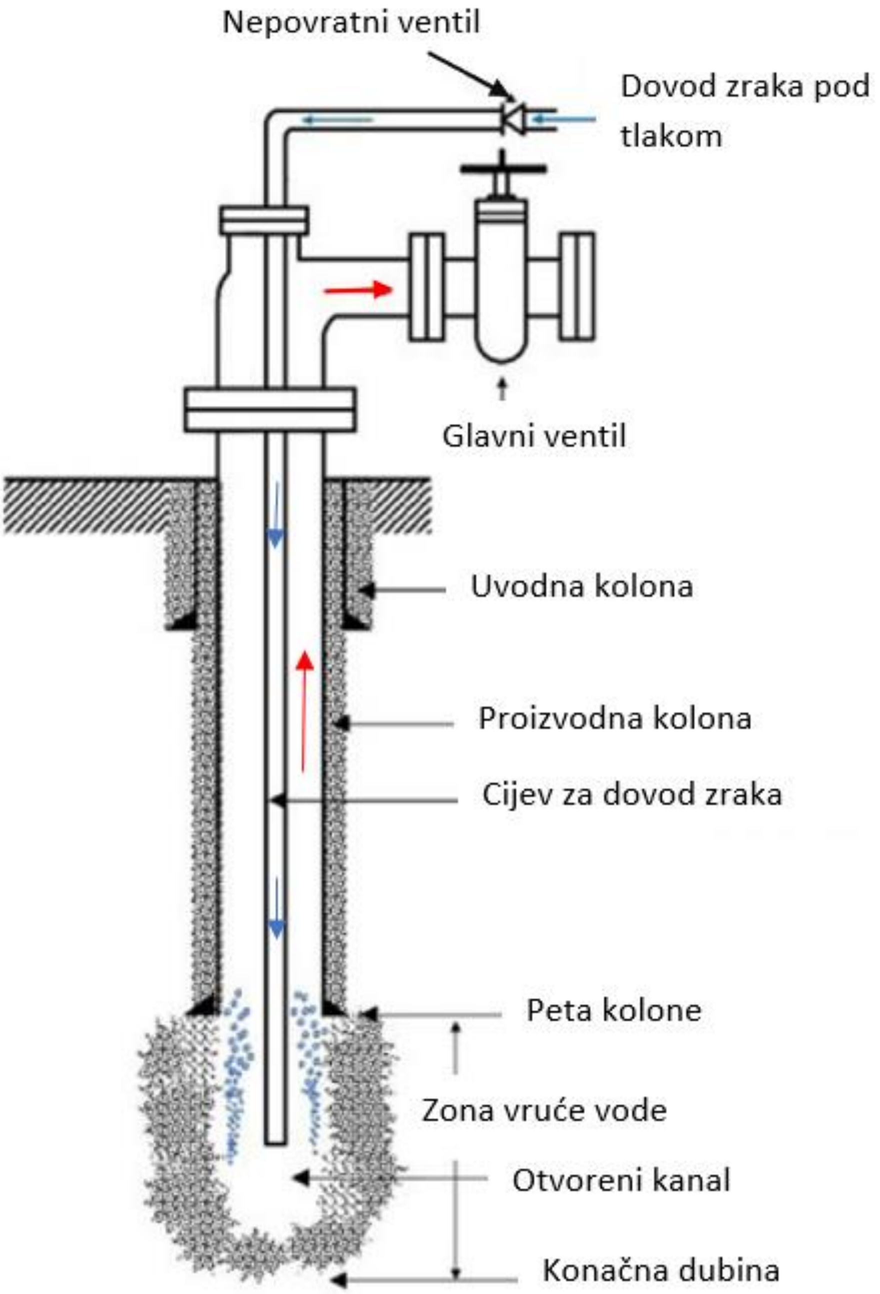


Picture1.21Schematic drawing of a geothermal well with a built-in submersible pump and motor: (A) standard design, (B) dedicated design (Zarrouk and McLean, 2019)

Geothermal well with air lift

Airlifted wells work by blowing air into a shallow well from a compressor (Picture1.22). The warm water and air mix below the water level in the well, consequently reducing the density of the mixed water-air fluid, which allows it to be lifted from the well to the surface for use.

Airlift geothermal wells are not used in electricity generation because they have a relatively lower power output of 1-4 MWth compared to eruptive or pumped wells and are generally more suitable for applications that do not require large flows of geothermal water (eg bathing, mineral water pools, space heating) (Thain et al., 2006).



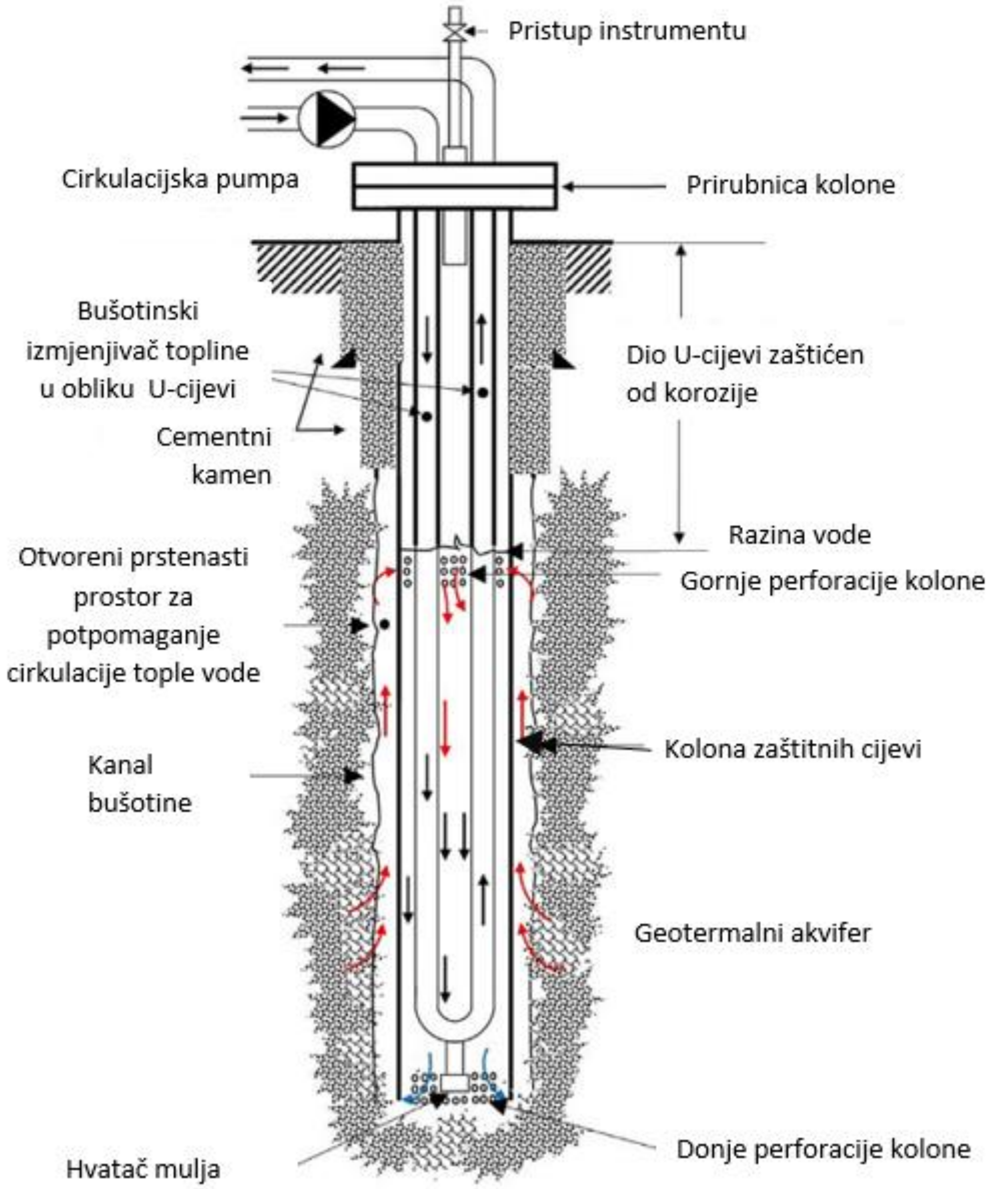
Picture1.22Schematic representation of a production geothermal well with air lift (Thain et al., 2006)

Common problems with air-lift geothermal wells are mineral deposition and corrosion due to air being forced into the well (oxygen corrosion). This will cause deposits in the inner surface tube and later in the surface heat exchangers. The corrosion problem can be reduced by reducing the air-to-water ratio (increasing the geothermal water flow) or by using nitrogen to lift the geothermal water which increases the final cost of the project (Drew, 1988). Gas lifting is normally used in the oil industry to increase oil recovery.

Deep (borehole) heat exchangers

Down-hole heat exchangers (DHE) or bottom-hole heat exchangers (bottom-hole exchangers) are an environmentally friendly method of extracting thermal energy from shallow geothermal wells, as their use can eliminate the extraction and disposal of geothermal water, since that only heat is extracted from the well (Lund, 2003). Deep heat exchangers are extensively used in the world for heating domestic hot water in apartments and institutional buildings (Dunstall, 1992).

The depth heat exchanger consists of a U-tube (English U-tube) (Picture1.23) or pipes laid inside a geothermal production well. Clean (fresh) water circulates inside a U-pipe or pipe laid inside the well, and heat is extracted from the geothermal well by forced convection, while heat from the reservoir is brought into the well by natural convection and conduction.



Picture1.23Schematic representation of a geothermal well with a deep (well) heat exchanger (Thain et al., 2006)

Improved geothermal systems - EGS wells

In some countries of the world, an enhanced geothermal system (EGS) is used to exploit geothermal energy. EGS is a technology based on the high temperature of the reservoir, which requires the construction of deep wells and the stimulation of the reservoir in order to increase the permeability of the rocks, which results in a better flow of the working fluid through the reservoir and a larger contact surface between the working fluid and the rock (Louis et al, 2008). In this way, heat transfer from the rock to the produced fluid is improved. EGS wells (hot and hot water systems) are usually drilled deeper (>3000 m) and therefore in some cases a well construction is used that includes smaller diameters of casing strings which means that the well ends up with an open channel with a diameter of 139,

In addition to production wells, there may be pressure and measurement wells in the exploitation field of geothermal water, so their purpose is described below.

Press boreholes

Reinjection wells are used to inject geothermal water back into the geothermal reservoir after the heat has been used. The reasons for re-injection of geothermal water into the reservoir are: (1) environmental protection, as surface disposal of geothermal wastewater is prohibited in most countries, and (2) maintenance of reservoir pressure (Kaya et al., 2011).

Geothermal injection wells are generally designed and drilled to the same standards as geothermal production wells. One of the reasons is that during the drilling of an injection well, it is possible to unexpectedly come across a good geothermal deposit, so in some fields injection wells have been repurposed into production wells and vice versa (Diaz et al., 2016).

If possible, the preferred option is that geothermal water injection takes place under gravity (Kaya et al., 2011). However, pumps are often used to re-inject geothermal water in order to increase the pressure at the mouth and facilitate the injection of cooled geothermal water into the well. The injection pressures and temperatures are monitored by measuring instruments on the injection/connection lines on the eruption device.

Measuring wells

Monitoring wells are used to measure/monitor changes in pressure, water level, temperature and chemical composition of the reservoir fluid. These are usually dedicated shallow (<100 m) groundwater monitoring wells (101.6 mm (4") – 177.8 mm (7") diameter), usually drilled from the same wellbore used for drilling of deeper wells (production or injection wells).

Monitoring wells serve as a first warning system for any unusual migration of deep water (eg re-injection of water or steam) into groundwater aquifers.

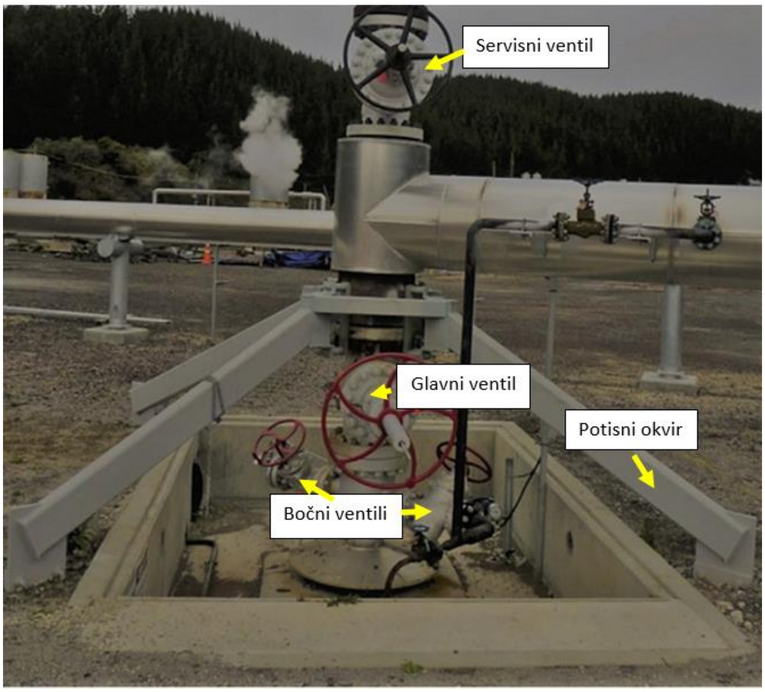
Deep measurement wells are usually production or injection wells that are no longer used or have become redundant for some reason because it is not common to purposefully drill deep measurement wells due to the high cost. They are used for long-term monitoring of reservoir pressure changes due to exploitation.

In rare cases, dedicated deep measurement wells (400-1500 m) are drilled to ensure that there is no communication between different fields (Boseley et al., 2012). Dedicated deep measurement wells have the same general casing string design as production wells, but are generally smaller in diameter to reduce costs. The high temperatures in the borehole and the chemical composition of the geothermal water limit the installation of electronic devices for long-term monitoring.

Above-ground equipment of a geothermal well

Upon completion of the well, the preventer assembly is dismantled and the wellhead assembly (base flange, tubing flange, tubing hanger) and eruption device (Xmas tree) are installed. The eruption device enables the safe operation of the well and the opening and closing of the flow of geothermal water from the well. The eruption device consists of a cross piece and shut-off valves.

A wellhead for a geothermal well of standard design usually includes two side valves at least 76.2 mm (3") in diameter and one master valve, which is usually 254 mm (10") in diameter (Picture1.24). The main valve is only for opening or closing the well and must not be used for flow control (throttling). An additional valve is installed to control the flow. The service valve at the top of the assembly is used to install measuring tools in the wellbore. The main valve is connected to the casing head flange (CHF) with the column of protective pipes. The material and diameter of the flange are selected depending on the expected operating temperature, pressure and conditions in the well.



Picture1.24Wellhead of a production geothermal well (Zarrouk and McLean, 2019)

There are two types of drill heads. In the past, the well head and the master valve were directly connected to the production column of protective pipes, while currently most geothermal wells have an extended (expansion spool) coupling that enables the free movement of the production column of protective pipes without moving the wellbore heads.

There are several side valves on the wellhead and the extended coupling that are used for testing the pressure in the annular space and for suffocating the well. These valves can often cause leaks that are difficult to stop. This is the reason why most high-temperature geothermal wells do not have side valves below the main valve, and the well suffocation takes place through a valve located between the main valve and the work valve. Usually, the flow of geothermal water is controlled through a fixed choke or through a control valve on the wellhead.

In order to enable the sufficient flow of geothermal water required by the electricity production plant, a control valve is most often used. There is usually a bypass around the valve that allows flow from the well when it is closed. For the same reason, there is a pipe that goes from the well to the separator to keep the well head warm when the well is closed. There are also valves on the wellhead that are used to take samples and place pressure gauges (Thorhallsson, 2003). Examples of the appearance of above-ground equipment of geothermal wells are shown in Figure 1.25.

Picture1.25Examples of the appearance of above-ground equipment of geothermal wells (Gaurina, 2022)

Stimulation works in geothermal wells

After testing the well, a decision is made on possibly necessary stimulation works. Stimulation works can be carried out in production geothermal wells to increase the flow of geothermal fluid from the reservoir or in injection wells to increase the injectivity of the well. Stimulation works are carried out for two reasons: (a) removal of damage to reservoir rocks with good permeability that occurred during the drilling process, during work on preparing the well for exploitation or during exploitation and (b) naturally low permeability of reservoir rocks. In accordance with the results of the test/probe of the well acceptance and the decision on the type of stimulation, a program is drawn up to prepare the well for stimulation, and to carry out the stimulation itself, and according to the Simplified Project for carrying out overhaul works with reservoir stimulation.

Occurrence of radioactivity during exploration and exploitation of geothermal water

Recently, in the scientific and professional literature, newer, more modern approaches have appeared - both from a technical and technological point of view, as well as from a legislative point of view - in relation to the problems caused by NORM (Naturally Occurring Radioactive Materials), i.e. natural radioactive material. This is how the European NORM Association was founded under the name ENA (European NORM Association), a platform for cooperation in the field of research and industry in which natural radionuclides appear.

Natural radioactive materials (NORM) are widespread in the environment. In many geological formations, larger and smaller (trace) amounts of radionuclides are encountered: uranium-238 (U-238), thorium-232 (Th-232) and potassium--4Q (K-40) and numerous products of their radioactive decay. Many mineral waters, especially thermal and geothermal waters in northern Croatia, contain the noble gas radon.

Radionuclides may be present in reservoir rocks, which are generally poorly soluble in reservoir fluids (water), but traces of NORM can be found during the production of fluids (water). In such cases, radionuclides can be found dissolved in the fluid (water), in the form of gas, in swollen particles and spent mud, and during exploitation in underground and above-ground equipment in the form of settled scale or sludge.

On the basis of the Law on Radiological and Nuclear Safety (Official Gazette 14/13, 39/15, 130/17), regulations were adopted: the Ordinance on monitoring the state of radioactivity in the environment (Official Gazette 40/18) and the Ordinance on the disposal of radioactive waste and used sources (Official Gazette 12/18). Annex 2 of the Rulebook on monitoring the state of radioactivity in the environment (Official Gazette 40/18) contains a list of activities that may increase the exposure of workers and residents from natural sources of ionizing radiation, including the production of geothermal energy.

In the 90s of the 20th century, radioactivity studies were carried out at the Velika Ciglena -1A (VC-1A) geothermal well. Tests and analyzes have established the presence of natural radionuclides in water and deposited scale. The results of the analyzes showed that the radioactivity of the geothermal water from VC-1A exceeds the previously published data on the radioactivity of mineral and thermal waters in Croatia and Slovenia. Radium - 226 (Ra-226) is classified in the first group of radiotoxicity due to its harmfulness. Considering the half-life (T1/2= 1622 years), it is necessary to monitor the concentration of this radionuclide in geothermal waters in order to prevent unwanted consequences caused by radiation. However, it should be emphasized that the conclusion of the aforementioned research is that although the exploitation of geothermal water at the Velika Ciglena geothermal well leads to an increase in radioactivity.

1.5 Use of geothermal energy

Introduction

Depending on the depth of geothermal resources, geothermal energy can be divided into three types:

Geothermal energy with a very low temperature at a depth of 5 m to 500 m. The average temperature at a depth of 10 to 150 m is between 2 oC and 21 °C.

Geothermal energy with a low temperature at a depth of 500 m to 5,000 m where the average temperature is between 40 oC and 200 °C.

Geothermal energy with a high temperature at a depth of 2,000 m to 6,000 m where the average temperature is between 80 oC and 400 °C.

Geothermal energy with a very low temperature requires the use of heat pumps. Geothermal energy with low temperature can be used directly, especially for heating swimming pools, greenhouses and applications in heating networks. Medium and high temperature geothermal water can be used to produce electricity.

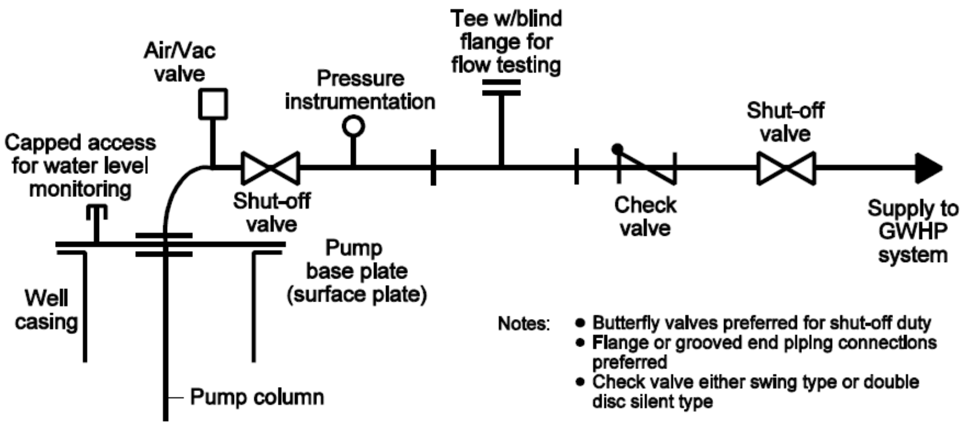
In principle, the field of use of geothermal energy is very wide. It can be used practically everywhere where thermal energy is needed, either independently or in combination with heat from another source, such as for example:

- space heating,
- greenhouse heating and covered ground heating,
- heating of pools and canals for aquaculture,
- drying of agricultural products,
- thermal energy for industrial processes,
- bathing and swimming,
- melting of snow and ice,
- space cooling,
- animal husbandry,
- spirulina cultivation,
- desalination,
- sterilization of bottles,
- frost protection,
- cooking,
- preparation of sanitary hot water.

The performance of the geothermal system essentially depends on the capacity, temperature and pressure of the geothermal source. However, the use of geothermal energy also depends on other factors such as the total potential of the source, the impact on equipment and materials, the impact on the environment and others.

According to the method of using geothermal energy, we distinguish between direct and indirect use. Direct use of geothermal energy refers to the immediate use of thermal energy, and not to its conversion into another form such as electricity. Primary forms of direct use include swimming pool heating and balneological needs, space heating and cooling including district heating, agriculture (mainly greenhouse heating, crop drying and in some cases animal husbandry), aquaculture (mainly pond heating), industrial processes and heat pumps (for heating and cooling). In general, geothermal fluid temperatures required for direct heat use are lower than those required for indirect uses such as electricity generation.

The following figure shows the key components of a geothermal production well (Picture1.26).

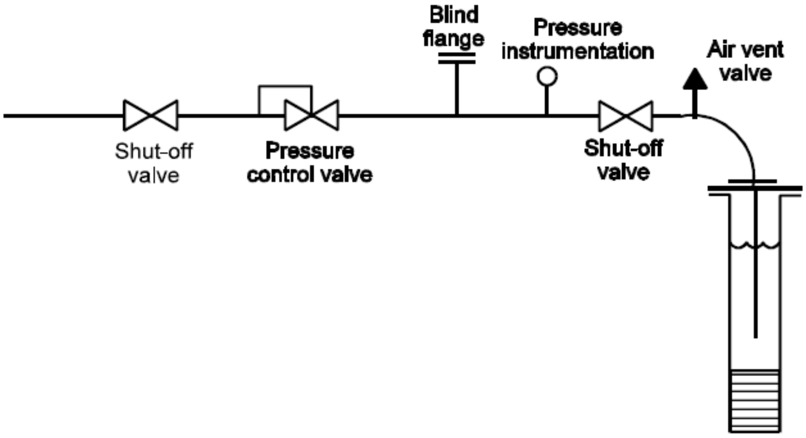


Picture1.26Presentation of the key components of a geothermal production well

Legend: Pump column, Capped access for water level monitoring, Well casing, Air/Vac valve, Pressure instrumentation, Tee w/blind flange for testing - T blind flange for testing, Check valve, Shut-off valve, Supply to GWHP (groundwater heat pump) system

In addition to the equipment shown in the diagram, a non-return valve is placed at the bottom of the riser pipe to prevent backflow through the submersible pump, but it is also important to regulate the pump.

The following figure shows the key components of the injection well (Picture1.27).

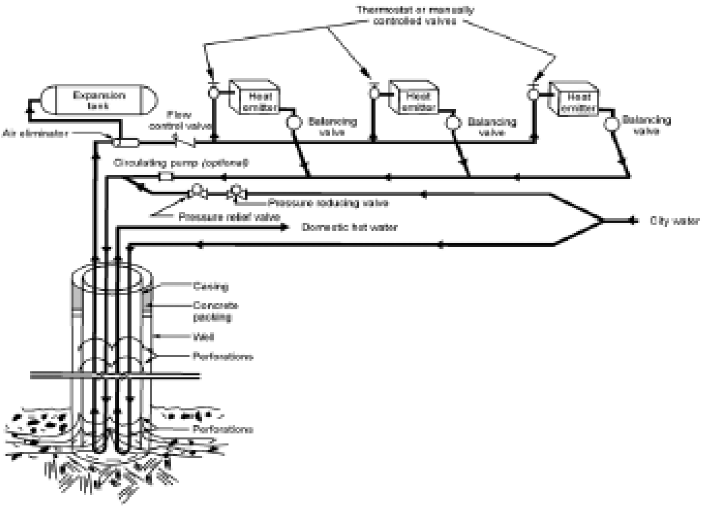


Picture1.27Presentation of the key components of a geothermal injection well

Legend: Shut-off valve, Pressure control valve, Blind flange, Pressure instrumentation, Air vent valve

The return piping to the injection well should be made so that the fluid inlet is well below the water level to minimize the formation of air bubbles that can prevent outflow. This is also helped by the vent valve that is mounted at the entrance to the injection well. It should be noted that the quality of the fluid significantly affects the performance of the injection well. In conditions of insufficient purification of the fluid at the production well, deposition of particles in the injection well may occur.

Using a downhole heat exchanger (DHE - downhole heat exchanger) can eliminate environmental problems related to the physical and chemical composition of the geothermal fluid. Such a heat exchanger consists of U-tubes that extend to the bottom of the well, as shown in the following figure (Picture1.28).

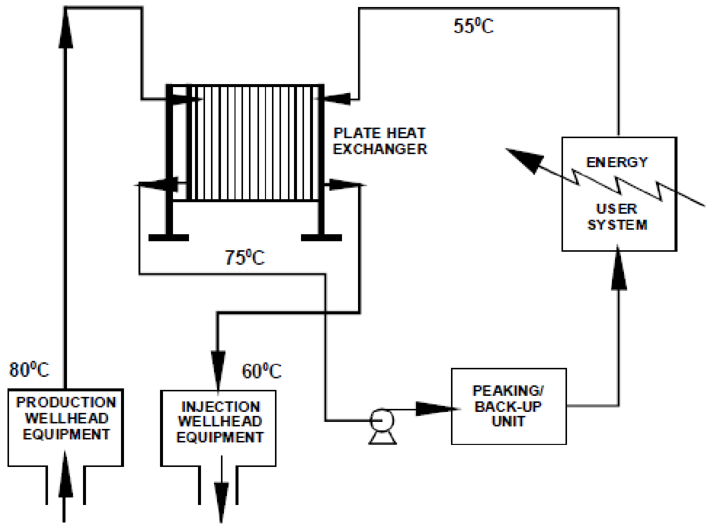


Picture1.28Scheme of the heat exchanger in the borehole

Legend: Perforations, Well, Source, Concrete Packing, Casing, City water, Domestic hot water, Pressure relief valve, Pressure reducing valve, Circulating pump, Air eliminator, Expansion tank, Flow control valve, Heat emitter, Balancing valve

Through such a heat exchanger, clean water is maintained in circulation, either by forced circulation (using a pump) or natural circulation (convection). Such systems do not exceed a thermal output of more than 1 MW. They are usually carried out to a depth of 150 m, and in some cases they can be economical to a depth of 500 m.

An example of a simple direct use of geothermal energy is shown in the following figure (Picture1.29).

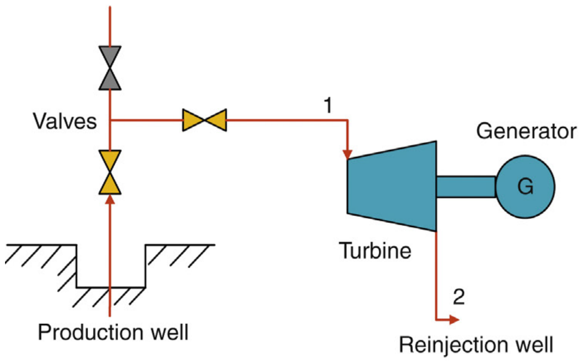


Picture1.29An example of direct use of geothermal energy

Legend: Production Wellhead Equipment, Plate Heat Exchanger, Energy User System, Peaking/Backup Unit, Injection Wellhead Equipment

From the production well, the geothermal water is fed into the plate heat exchanger where it transfers heat to the heating medium that flows on the other side of the heat exchanger. The heated heating medium is brought to the consumer of heat energy in a closed circulation circuit by means of a circulation pump through a unit for peak feeding, in which reheating is carried out depending on the needs.

In the following picture (Picture1.30) presented an example of a simple indirect use of geothermal energy for the production of electricity.

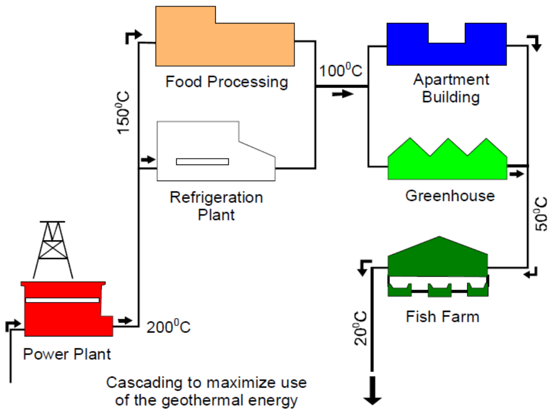


Picture1.30An example of indirect use of geothermal energy

Legend: Production well, Valves, Turbine, Generator, Reinjection Well

Geothermal fluid (steam) is fed into the turbine by stream 1, where it expands and turns the turbine blades. The mechanical work produced in the turbine is transmitted via the shaft to the generator that produces electricity. The output stream 2 from the turbine returns to the injection well.

In order to increase the degree of utilization of geothermal energy, cascade use of enthalpy is applied, as shown in the following figure (Picture1.31).



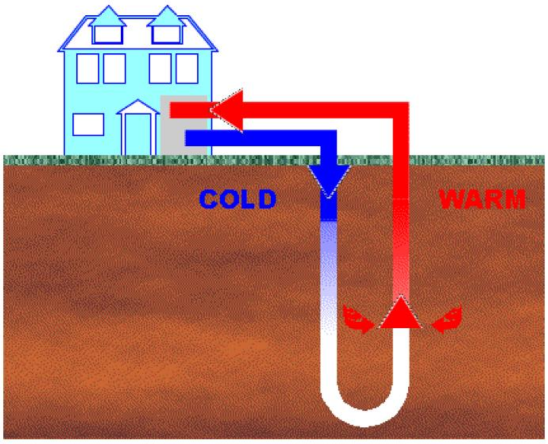
Picture1.31Example of cascading use of geothermal energy

Legend: Power Plant - Geothermal power station, Refrigeration Plant - Refrigeration plant, Food Processing - Food production, Apartment Building - Residential building, Greenhouse - Greenhouse, Fish Farm - Fish farm

The geothermal medium from the source enters the power plant, giving part of the enthalpy for the production of electricity. It is then taken to an absorption cooling plant and to a food production plant, where another part of the enthalpy is taken from the geothermal medium, which is at a temperature level of about 150o C, so that at the outlet the temperature level of the medium is about 100o C. This geothermal the fluid can be used for heating buildings and greenhouses. The remaining usable part of the enthalpy with a temperature level of about 50o C can be used for heating the fish farm, after which the geothermal water is injected into the injection well.

The most widespread way of using geothermal energy is realized by using heat pumps (heat pumps). Geothermal energy is used both for space heating and cooling, whereby the geothermal well has a dual role: as a source of thermal energy (in winter) and as a sink of thermal energy (in summer). It should be noted here that the use of heat pumps is not considered a 100% renewable source of energy due to the fact that of the total thermal energy delivered to the space being heated, about 25% is wasted on electricity (compressor heat pumps). The eventual use of absorption geothermal heat pumps is limited by the temperature of the geothermal source and is not widespread.

The following picture shows the operation scheme of the heat pump in winter for heating buildings (Picture1.32).

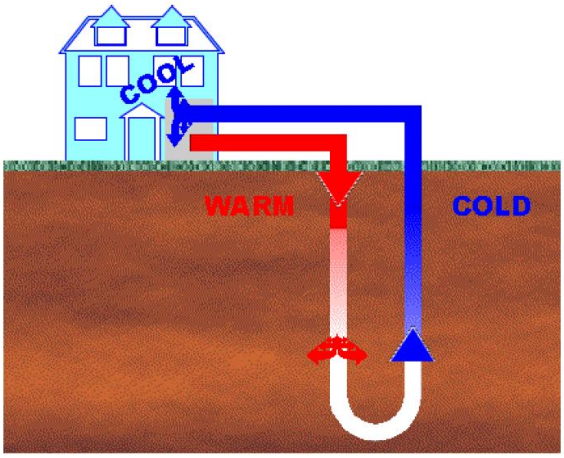


Picture1.32Schematic representation of the flow of heat during operation of a geothermal heat pump in winter

Legend: Cold – Cooled medium, Warm – Heated medium

The cooled medium from the heat pump in heating mode takes geothermal heat and heats up. The heated medium is then returned to the heat pump, from which, transferring heat to the heat pump evaporator, it cools down and returns to the well to absorb the heat of the geothermal source.

The following picture shows the operation scheme of the heat pump in the summer for cooling buildings (Picture1.33).

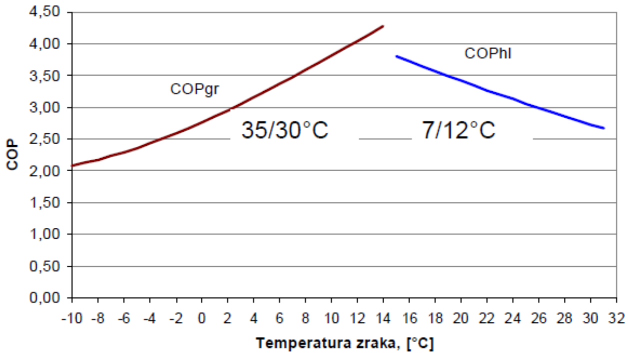


Picture1.33Schematic representation of heat flow during operation of a geothermal heat pump in summer

Legend: Cool – Cooling, Warm – Heated medium, Cold – Cooled medium

The heated medium from the heat pump in the cooling mode transfers the heat to the geothermal source and cools down. The cooled medium is then re-fed to the heat pump, from which, taking heat energy from the heat pump condenser, it is heated and returned to the well in order to transfer heat to the heat sink.

The advantage of using heat pumps is best expressed through the coefficient of performance (COP - coefficient of performance), which is the ratio of the heat supplied to the space being heated, that is, the heat removed from the space being cooled and the required work (energy).

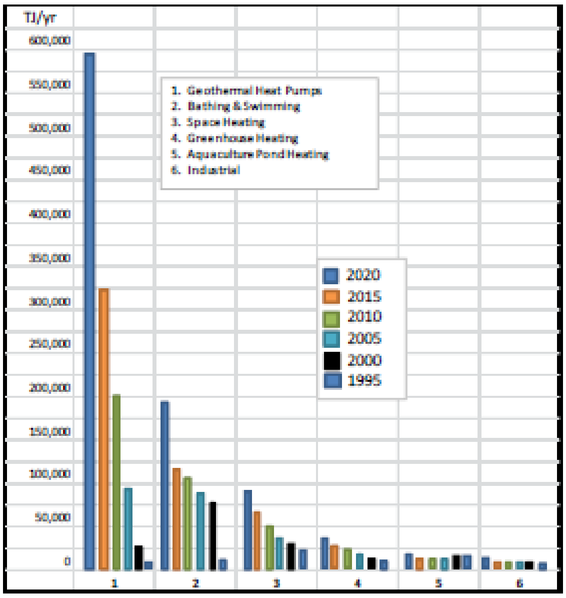


Picture1.34Efficiency coefficient diagram for heating and cooling of a compressor heat pump

Legend: COPgr – Coefficient of efficiency for heating, COPhl – Coefficient of efficiency for cooling

Thus, for the heating mode, it can be said that with the consumed work of 1 kWh, a thermal effect of 2.1 to 4.3 kWh can be achieved, and for the cooling mode, a thermal effect of 2.7 to 3.8 kWh, depending on the outside air temperature . The above is valid for a water temperature of 35 oC / 30 oC in the heating mode and for a water temperature of 7 oC / 12 oC in the cooling mode.

In the following diagram (Picture1.35) shows the development of capacities for the direct use of geothermal energy in the world.

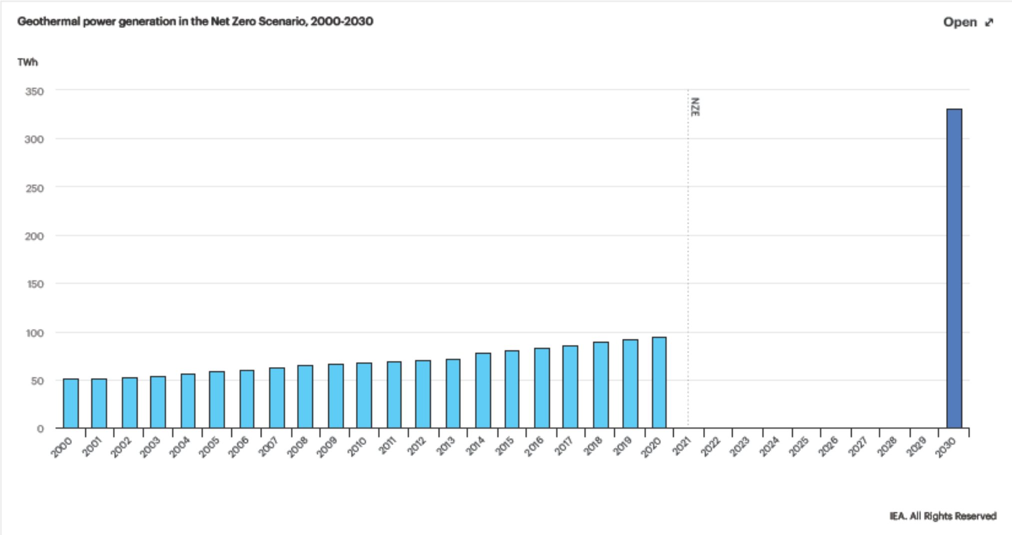


Picture1.35Comparison of the direct use of geothermal energy in the world

Legend: Geothermal Heat Pumps, Bathing & Swimming, Space Heating, Greenhouse Heating, Aquaculture Pond Heating, Industrial

It is evident from the diagram that the largest share of direct use of geothermal energy falls on heat pumps, which can be used to usefully use low-temperature geothermal energy, which in 2020 reaches about 590,000 TJ (about 160 TWh). The next place is the use of geothermal energy for heating swimming pools, followed by the use of geothermal energy for heating living spaces, then for heating greenhouses, and after that comes the use of geothermal energy for aquaculture and industrial needs.

In the picture below (Picture1.36) diagram shows the total world production of electricity in geothermal power plants (indirect use of geothermal energy) with an estimate for the year 2030.



Picture1.36Production of geothermal electricity in the world

It is evident from the diagram that the production of geothermal electricity also records constant growth, so that in 2020 it reaches over 90 TWh. For the year 2030, production of around 330 TWh is predicted.

The industrial application of geothermal energy, as well as the application to aquaculture and agricultural activities (except for heating greenhouses), as stated, has not yet been widely used, despite the fact that there are great potentials for its use in the mentioned branches of the economy.

For industrial applications, it can be used in basic processes for preheating, washing, peeling and blanching, evaporation and distillation, sterilization, drying and cooling.

For preheating, geothermal energy can be effectively used in a wide range of industries (eg for preheating additional demineralized water and feedwater for boiler units and other process waters). Namely, it is known that process condensate is not returned in a large number of industrial plants. This requires thermal energy to heat additional demineralized water, whose temperature is typically from 10 ºC to 16 ºC, and which should be heated (depending on the system) to a temperature of around 100 ºC. The use of geothermal resources relieves the preheating system of the boiler plant and other industrial processes for a wide range of industries.

Washing and cleaning at low temperatures (35 ºC – 90 ºC) in many industries consume large amounts of energy. One of the typical representatives is the food processing industry, with a large presence in meat processing for, in the production of soft drinks for washing dishes and returnable bottles, in food canning and other food processes. In the textile industry, in the finishing plants, large amounts of washing water at 90 ºC are also consumed. Likewise, smaller amounts of water are used for washing in plastic production (85 ºC – 90 ºC) and leather production (50 ºC). Significant amounts of hot water at a temperature of up to 90 ºC are used in some metal processing industries for washing machines and transport equipment and other parts.

When peeling, the product is briefly introduced into a hot bath, and after softening, the skin is mechanically rubbed or washed. Peeling equipment can be by continuously bringing the product into contact with a hot medium, in which case steam or hot water is applied directly to the product or indirectly by heating the product bath.

In the blanching process, the product is introduced into the blancher in order to inhibit the action of enzymes. It can be run as a continuous process or in batches. Due to the need for blanching fluids to have controlled properties, it is not possible to use geothermal water directly in blanchers, but geothermal fluids are used through heat exchangers.

For most peeling and blanching systems, the temperature range is 77 ºC - 104 ºC.

Evaporation and distillation are operations that are present in many industrial plants to increase the concentration of the product or to separate the product by distillation. Operating temperatures vary, depending on the products, but in most processes for processing agricultural products, typical operating temperatures are 82 ºC - 120 ºC (in some cases, evaporators work at reduced pressures, so the temperatures are lower).

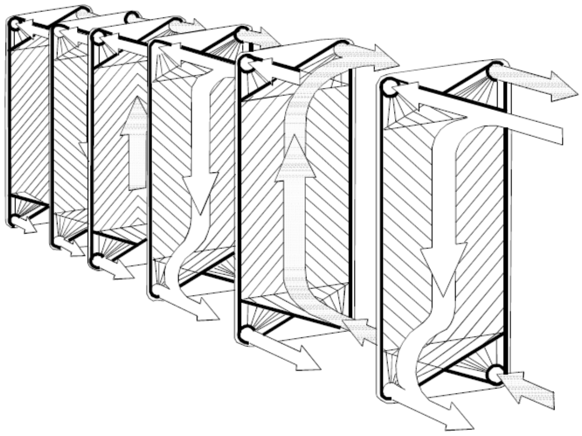
Industries where vaporizers are used are sugar processing, mint distillation, and the production of alcoholic beverages. In many cases, evaporators can be easily adapted to use geothermal energy as the primary heat source.

Sterilizers are used in many industries including sterilizing equipment for the canning and bottling industries. Most sterilizers work at temperatures of 104 ºC - 120 ºC and are able to use geothermal energy through a heat exchanger.

Different types of heat exchangers are used in geothermal plants for the exploitation of geothermal energy, which often come into contact with corrosive liquids at high temperatures. Therefore, the application of heat exchangers made of new materials is mentioned as a key factor for the efficient use of geothermal energy. In recent times, plate heat exchangers are most often used, which have favorable characteristics for use in geothermal systems, such as:

- thermal performance (small temperature difference between media, high heat transfer coefficient),
- corrosion resistance (use of thin stainless steel plates),
- ease of maintenance (after disassembly, all heat transfer surfaces are available for inspection and cleaning),
- possibility of expansion in case of need to increase performance (two or more heat exchangers can be placed in one frame),
- compact design.

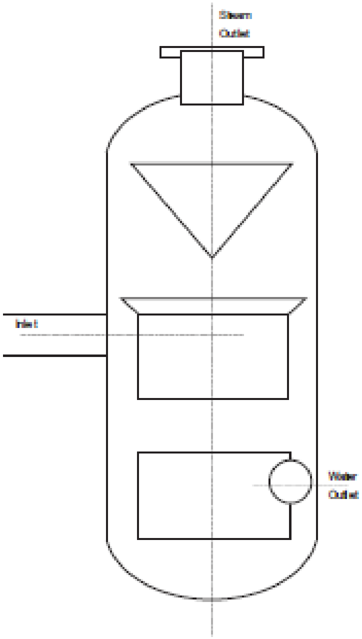
The following picture shows the layout of the plate heat exchanger (Picture1.37).



Picture1.37Schematic representation of the operation of the plate heat exchanger

As can be seen from the picture, a plate heat exchanger is basically a series of individual plates that are separated from each other by a gasket and clamped with screws over the end rigid plates.

An important element in geothermal systems is the expansion vessel (separator) in which steam and water are separated. A representation of one such container is given in the following picture (Picture1.38).



Picture1.38Scheme of the expansion vessel with cyclone separation

Legend: Inlet, Steam outlet, Water outlet

The cyclone separator (shown in the picture) is currently the most popular design of the separator and is found in many geothermal power plants. Separation of the steam and water phases is performed on the principle of centrifugal force using a tangential or spiral inlet to the cyclone. Due to the rotation of the inlet fluid, the phase of higher density moves outwards and downwards (water), and the phase of lower density moves inwards and upwards (steam). This type of separator has gone through a number of design improvements to maximize its efficiency.

Geothermal steam often contains gases that cannot be condensed (eg in power plant condensers). The main representatives of such gases are carbon dioxide (CO_2) and hydrogen sulfide (H_2S). Ammonia (NH_4) rarely appears, but small amounts of H_2, N_2, Ar, CH_4, CO and Hg may exist among the gases released.

Of the mentioned gases, H_2S is the most important because of its toxicity, so it is necessary to pay special attention to its reduction or removal. There are several technologies for H_2S removal, and the choice of technology depends on the amount and composition of the gas and the required level of H_2S removal. A brief description of typical H_2S removal processes follows.

The Klaus process (other gas-phase oxidation processes are similar) is the standard technology for removing large amounts of H_2S. In this technological process, the gas mixture is led to a special burner where enough air is added to burn only a third of the H_2S, while other flammable substances (eg H_2, CH_4) burn completely. The resulting SO_2 then catalytically reacts with the remaining H_2S from the gas phase to form elemental sulfur.

The Stretford redox process (reduction and oxidation reaction) is a technology based on an aqueous solution containing vanadium (as sodium vanadate). It is an older technology from 1990. Due to the residual content of vanadium in the produced sulfur, today this process is being replaced with an iron-based redox process.

The iron-based redox process is based on an aqueous solution of iron chelate. The technology is widely used for gas mixtures containing moderate amounts of H_2S. There are several iron-based technologies, but two (licensed) are the most common: LO-CAT and SulFerox.

The basis of the burning/purification process (Burn/Scrub Process) is the burning of the gas mixture (oxidation of H_2S to SO_2, with the formation of a small amount of SO_3), where hydrogen and methane are also burned. The burned gases are then introduced into the quench vessel, and then directed to the scrubber to remove SO_2. Purification is done with a dilute solution of sodium hydroxide by forming sodium sulfite salt.

Shell-Paqxues/THIOPAQ™ is a technology for H_2S removal by selective biological conversion of H_2S to elemental sulfur. Due to its hydrophilic nature, the produced sulfur has a significantly lower chance of contaminating or blocking equipment. In addition, this product is suitable for use in agriculture as a fertilizer.

There are also impurities in geothermal water, so before entering the geothermal system, the water is filtered to remove sand and other impurities it contains. This prevents the erosive effect of geothermal water on the equipment used in geothermal systems such as valves, expansion vessels, heat exchangers, pumps and others.

A big problem in using geothermal water is the formation of scale. In the underground, the fluid is in mineral balance with the rocks in the deposits. When the liquid comes to the surface, its pressure drops, so it is important to maintain as high a fluid pressure as possible when entering the heat exchanger, in order to prevent CO_2 from coming out of the liquid. A decrease in CO_2 in the fluid shifts the mineral balance to the left leading to calcite scale formation in pipes and pumps. In the event that maintaining high pressure is not feasible, a small amount of acid is added to the fluid to reduce the pH, which prevents the formation of calcite on the equipment. However, after the fluid enters the heat exchanger, by transferring heat to another medium, the fluid cools, which creates conditions for insufficient calcite saturation and calcite deposition decreases. On the other side,

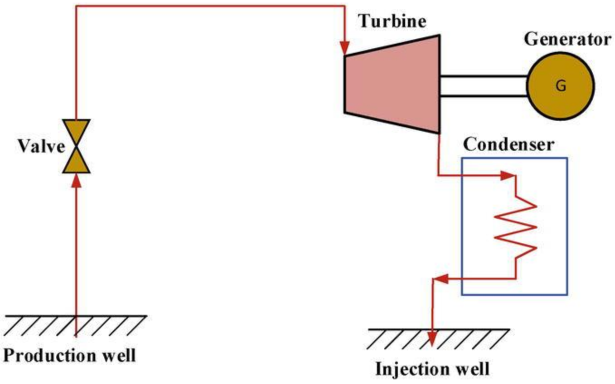
Production of electricity

There are three basic types of geothermal power plants:

- Dry steam plants.
- Dry saturated steam plants ("flash" plants).
- Plants with binary cycle.

A dry steam plant is a simple plant that works like a classic thermal power plant, however, they are poorly available since there are few geothermal sources in the world dominated by steam.

The schematic representation of the operation of the dry steam power plant is shown in the following figure (Picture1.39).



Picture1.39Scheme of the plant for the production of electricity using dry steam

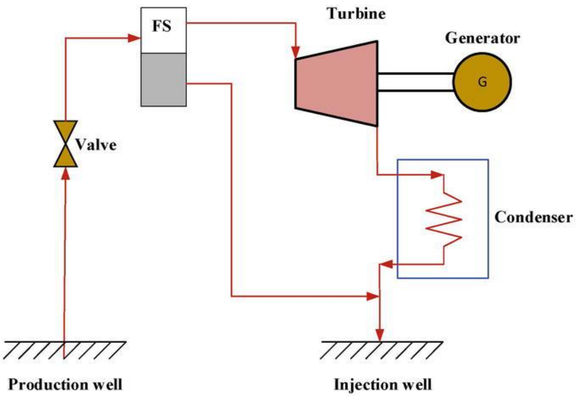
Legend: Production well, Valve, Turbine, Generator, Condenser, Injection well

Dry water vapor from the production well enters the turbine through the valve, where, through polytropic expansion, it converts the thermal and kinetic energy of the steam into useful work on the generator shaft, i.e. electrical energy. The steam then goes to the condenser where it liquefies and is pressed into the injection well. To ensure acceptable plant efficiency, the production capacity should be greater than 1 MW of electrical power.

There are two types of dry saturated steam geothermal plants:

- Dry saturated steam geothermal plant with one separator (expansion vessel)
- Dry saturated steam geothermal plant with two separators (expansion vessels)

A steam geothermal plant with one separator is shown schematically in the following figure (Picture1.40).

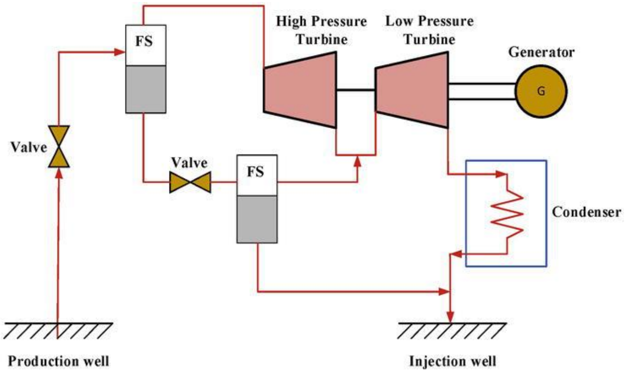


Picture1.40Plant for the production of electricity on dry saturated steam with one separator

Legend: Production well, Valve, Flash separator (FS), Separator (expansion vessel), Turbine, Generator, Condenser, Injection well

The hot water is fed from the production well through the valve to the separator where, due to the drop in pressure, the steam is separated from the water and fed into the steam turbine where, through polytropic expansion, it converts the heat and kinetic energy of the steam into useful work on the generator shaft, i.e. electricity. The cooled steam is liquefied in the condenser and pressed into the injection well together with part of the liquid from the lower part of the separator.

A steam geothermal plant with two separators is shown schematically in the following figure (Picture1.41).



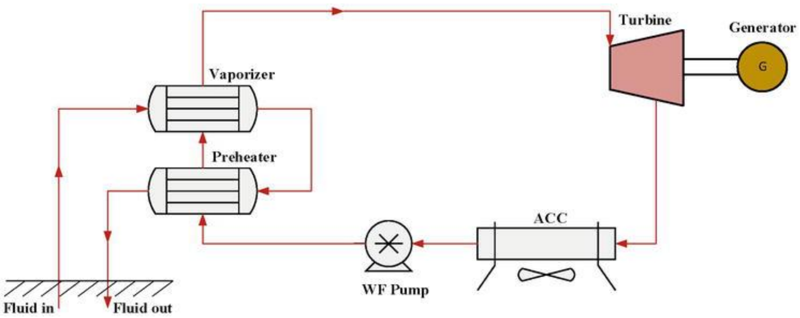
Picture1.41Plant for the production of electricity on dry saturated steam with two separators

Legend: Production well, Valve, Flash separator (FS), Separator (expansion vessel), High pressure turbine, Low pressure turbine, Generator, Condenser, Injection well – Pressing well

Hot water is fed from the production well via a valve to a high-pressure separator where the vapor phase is separated from the liquid. From the top of the separator, the steam is then fed into the high-pressure turbine. The liquid from the bottom of the high-pressure separator is fed through the valve to the low-pressure separator, in which the steam part is drained from the top of the separator into the low-pressure part of the turbine, and the liquid from the bottom of the low-pressure separator is drained into the injection well. The mechanical work released on the high-pressure and low-pressure turbines is converted into electrical energy in the generator. The wet steam at the exit from the low-pressure turbine is led to the condenser, where the heat of condensation is transferred to the cooling medium. The liquid from the condenser together with the liquid from the low-pressure separator is led into the injection well.

Although plants with two separators are more investment-intensive and more expensive to maintain than plants with one separator, they generate 15-25% more electricity.

A binary cycle power plant, in which a high-temperature fluid circuit (geothermal water) is separated from a low-temperature fluid (working substance), is suitable for geothermal sources with a lower temperature level. The following diagram shows a binary cycle known as an organic Rankine cycle (ORC) in which an organic substance (e.g. isopentane) is used as the working fluid.

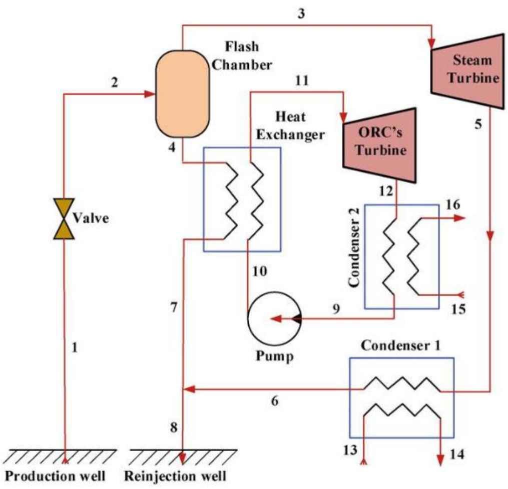


Picture1.42A plant for the production of electricity with a binary ORC cycle

Legend: Fluid in - Fluid inlet to the plant, Vaporizer - Evaporator, Turbine - Turbine, Generator - Generator, Air cooled condenser (ACC) - Air cooled condenser, Woking fluid pump (WF pump) - Pump for working fluid, Preaheater - Preheater, Fluid out – Fluid exit from the plant

In a binary ORC power plant, the geothermal fluid passes through an evaporator where it transfers heat to a working medium with a low boiling point, e.g. isopentane, which evaporates and the resulting dry saturated steam of the working medium drives the turbine. The mechanical energy of the turbine drives a generator in which the mechanical energy is converted into electrical energy. The low-pressure vapor of the working fluid coming out of the turbine condenses in the air-cooled condenser and is pumped back to the evaporator via the pre-heater of the working fluid. In this way, the loop system is closed and the process is continuously repeated.

The following figure shows a schematic diagram of a binary plant with one steam separator and an ORC cycle.



Picture1.43Binary plant with one steam separator and ORC cycle

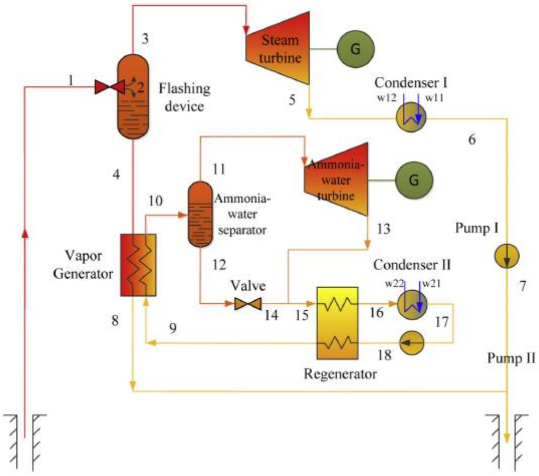
Legend: Production well, Valve, Flash chamber, Separator (expansion vessel), Heat exchanger, Steam turbine, ORC turbine, Condenser 1, Condenser 2 , Pump, Injection well

Hot geothermal water enters through line 1 to the valve and continues through line 2 to the expansion vessel. The steam phase is led by line 3 from the top of the expansion vessel into the steam turbine. After part of the enthalpy of water vapor in the steam turbine is converted into mechanical work, an electric generator (not shown in the diagram) which is mechanically connected to the steam turbine, converts the mechanical work into electrical energy. Wet water vapor leaves the steam turbine through line 5 and enters the condenser (condenser 1) where the heat of condensation is transferred to the cooling system or can be transferred to heat energy consumers. Cold water from the heat consumer enters the condenser through line 13, and hot water leaves the condenser through line 14 to the consumers. The liquid phase from the bottom of the expansion vessel is led by line 4 to the heat exchanger, which actually has the role of a steam generator, since the working fluid of the ORC process flows on the other side. The dry saturated steam of the working medium enters the OCR turbine through line 11, where the thermal and kinetic energy of the steam is converted into mechanical work that is used to drive the generator (not shown in the diagram), where the mechanical energy is converted into electrical energy.

The output steam from the ORC turbine (line 12) is introduced into the condenser (condenser 2) in which the heat of condensation is transferred to the cooling system or can be transferred to thermal energy consumers. Cold water from the heat consumer enters the condenser through line 15, and hot water leaves the condenser through line 16 to the consumers.

The selection of the working medium plays an important role in the performance of the configuration of the binary plant and the efficiency and economy of the system. In addition to the thermodynamic characteristics of geothermal water and the working fluid, when choosing the working medium, one should also take into account the safety of use, the impact on health and the impact on the environment.

The following figure shows the principle diagram of a binary plant for the production of electricity with one steam separator and a Kalina cycle in which a mixture of two working fluids with different boiling point temperatures is used; ammonia and water.



Picture1.44Binary plant with one steam separator and Kalina cycle

Legend: Flashing device, Steam turbine, Condenser 1, Vapor generator, Ammonia-water separator, Ammonia-water turbine, Ammonia and water turbine, Condenser 2 Condenser 2, Regenerator - Regenerator, Valve - valve, Pump I - Pumpa I, Pump II - Pumpa II

Geothermal water of high temperature and high pressure enters the separator (expansion device) through line 1, where it is transformed into a two-phase fluid by lowering the pressure (expansion); steam and water. The steam from the top of the separator is introduced into the steam turbine (line 3) to drive the generator for the production of electricity.

The liquid phase from the bottom of the separator (stream 4) enters the steam generator to heat the working fluid. The working fluid, a mixture of ammonia and water, enters the generator through line 9, where the ammonia-water mixture partially evaporates by absorbing the heat supplied by the geothermal water. From the steam generator, the two-phase mixture of ammonia and water enters the ammonia-water separator through line 10, where the ammonia-rich steam is separated from the ammonia-poor liquid. Ammonia-rich steam is introduced through line 11 into the ammonia and water turbine. In the turbine, steam rich in ammonia expands and releases mechanical energy. This mechanical energy drives an electric generator that is mechanically connected to the turbine.

The ammonia-poor liquid, which is drained from the bottom of the separator via line 12, is first throttled to low pressure by a valve (line 14), and then mixed with the exit phase 13 from the ammonia and water turbine. In this way, the basic mixture of ammonia and water is re-formed, which is introduced into the regenerator by stream 15. In the regenerator, heat is removed from the basic mixture of ammonia and water, and then the cooled current (16) is introduced into the condenser. In the condenser, heat is removed from the working substance, which is dissipated to the environment or to heat energy consumers. From the regenerator, the working substance comes to the suction of pump II (stream 17), where its pressure is raised (stream 18). Passing through the regenerator, the basic mixture of liquid ammonia and water is preheated and re-enters the steam generator (stream 9).

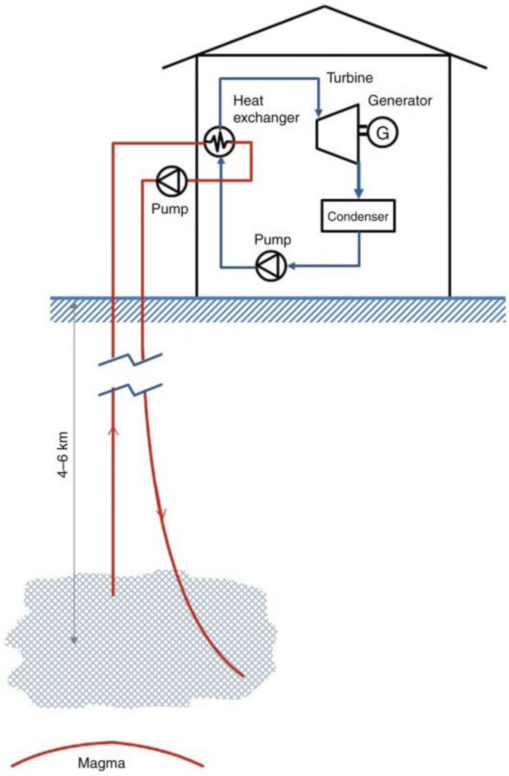
In the condenser I, the absorbed heat is carried away by the warm stream W12 towards the thermal energy consumers or to the environment, and the cold stream W11 enters the condenser. The cold current W21 enters the condenser II, and the warm current W22, which contains heat, goes to the heat energy consumers or to the environment. Plants with the simultaneous production of electricity and thermal energy in which the heat of condensation is beneficially used are called cogeneration plants (Combined Heat and Power – CHP).

A binary plant with one steam separator and the Kalina cycle can achieve high geothermal energy conversion efficiency since the geothermal water heat recovery from the separator, which still contains a large amount of energy, is exploited. In addition to the above, the Kalina cycle achieves good thermodynamic compatibility during the heat exchange process. Due to the variable evaporation temperature of the working substance, the temperature differences between the heat source and the working fluid are smaller, which leads to a reduction in irreversible heat losses. Cogeneration plants are an efficient technology that produces both electricity and heat with significantly higher efficiency than systems that produce only electricity or only heat.

Although about 20 types of working substances have been investigated, it has been shown that the binary ORC plant with isopentane gives the best results. For small domestic cogeneration (small CHP installations) working substances such as R123, R141b and ethanol are most suitable.

In addition to standard binary geothermal energy systems, hybrid energy systems are applied in which geothermal plants are integrated with biomass, fuel cells, wind, solar systems or waste disposal technologies. This type of synergy offers cost competitiveness, higher overall efficiency and a higher capacity and availability factor compared to single source power. For example, a hybrid geothermal system in combination with a system for concentrating solar power (Concentrated solar power - CSP) can eliminate the problem of rising ambient temperature during the day, in which case the hourly production of an independent geothermal plant decreases. With co-generation from the CSP system, the effect of which increases with the rise in ambient temperature,

The following picture shows a diagram of a geothermal power plant based on heat from hot dry rock (HDR - hot dry rock) (Picture1.45).



Picture1.45Geothermal power plant based on heat from hot dry rocks

Legend: Heat exchanger, Turbine, Generator, Condenser, Magma

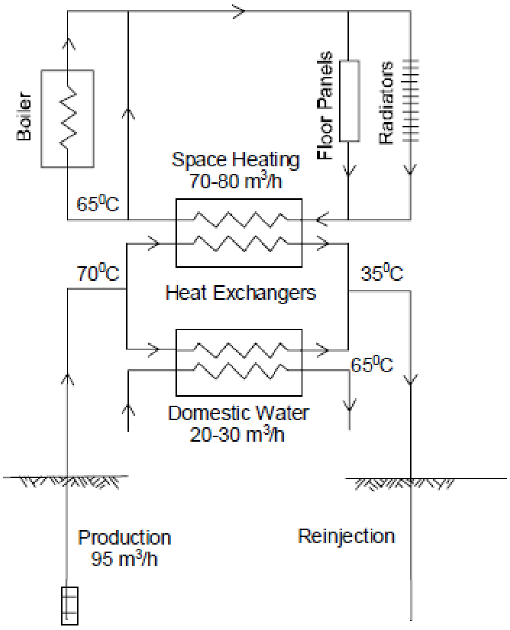
A geothermal system based on hot dry rocks is also known as an enhanced geothermal system (EGS). In such a geothermal system, water is not naturally present at the site. Water from the surface is used to extract heat from the dry rock, which requires two boreholes in the rock at a depth of 4 to 6 km. One borehole is used to supply water from the surface to the hot magma-heated rock, and the other to supply hot water/steam to the surface to be fed to the turbine. Further configurations of the HDR geothermal plant are the same as the aforementioned types of power plants: dry steam plant, dry saturated steam plant with separator, binary or hybrid plant.

The HDR system was first used experimentally in Los Alamos, New Mexico, USA in 1970. The experiment was then followed by similar projects in Australia, France, Germany, Japan and the United Kingdom. It is theoretically possible to build an HDR geothermal power plant in almost any location, but due to high drilling costs, they are not widely used.

It should be noted that when evaluating a geothermal power plant, a problem arises when defining the efficiency of the complete plant, since the analogy with a classic thermal power plant is not correct. In a geothermal power plant, the steam generator (steam boiler) is the Earth itself, so another definition of efficiency must be used.

Heating and cooling systems

In the following picture (Picture1.46) shows the scheme of using geothermal energy for heating buildings and preparing sanitary hot water.

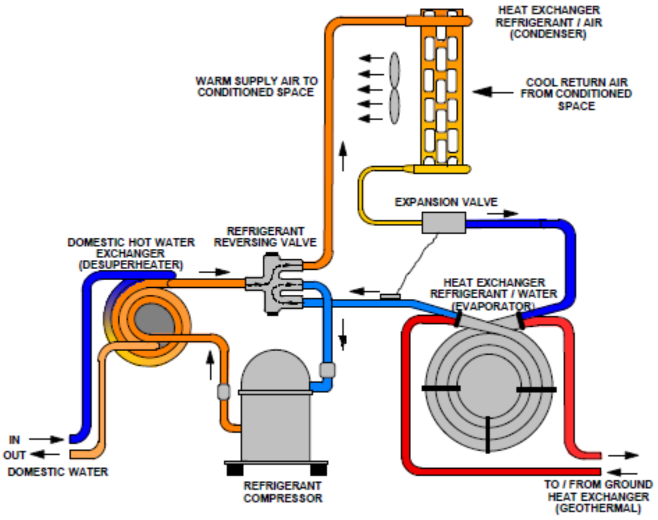


Picture1.46Scheme of using geothermal energy for heating buildings and preparation of sanitary hot water

Legend: Production, Boiler, Floor Panels, Radiators, Space Heating, Heat Exchanger, Domestic Water, Reinjection

Geothermal water with a temperature of 70 oC is drained from the production well to heat exchangers for space heating and preparation of sanitary hot water, where it transfers its heat to the heating medium and returns to the injection well with a temperature of 35 oC. In the geothermal heat exchanger for space heating, the water is heated to a temperature of 65 oC. The heated water is introduced into the hot water boiler, where it is heated to the required temperature for heating, and then it is drained to the heating elements (heat exchangers for floor and radiator heating). Domestic sanitary water is heated in a geothermal heat exchanger to a temperature of 65 oC.

In the following picture (Picture1.47) schematically shows the operation of a geothermal system with a heat exchanger in a borehole in combination with a heat pump in space heating mode.

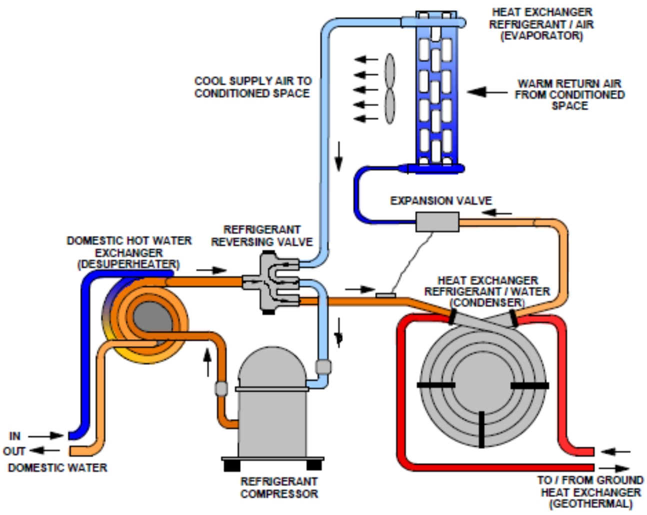


Picture1.47Schematic representation of the geothermal pump in heating mode

Legend: To/from ground heat exchanger (geothermal), Heat exchanger refrigerant/water (evaporator), Expansion valve, Refrigerant compressor working substances, Domestic hot water heat exchanger (desuperheater) – Heat exchanger for preparing consumable sanitary water (cooler), Refrigerant reversing valve – Reverse valve for reverse flow of working substance, Heat exchanger refrigerant/air (condenser) – Heat exchanger refrigerant/air (condenser), Cool return air from conditioned space, Warm supply air to conditioned space, In out domestic water, In out domestic water

The heat from the geothermal source is fed to the evaporator (coolant/geothermal water heat exchanger) where the working medium is heated after expansion behind the throttle valve. The heated working substance is then led to the compressor via the reverse valve. The compressed and heated working substance is then introduced into the heat exchanger for the preparation of sanitary hot water, where it transfers part of the heat to sanitary hot water, and is then fed into the condenser. In the condenser, the second part of the heat contained in the working substance is transferred to the cooled air that is blown into the heated room. Forced circulation of the air flowing over the condenser is maintained by a fan.

In the following picture (Picture1.48) schematically shows the operation of a geothermal system with a heat exchanger in a borehole in combination with a heat pump in the space cooling mode.

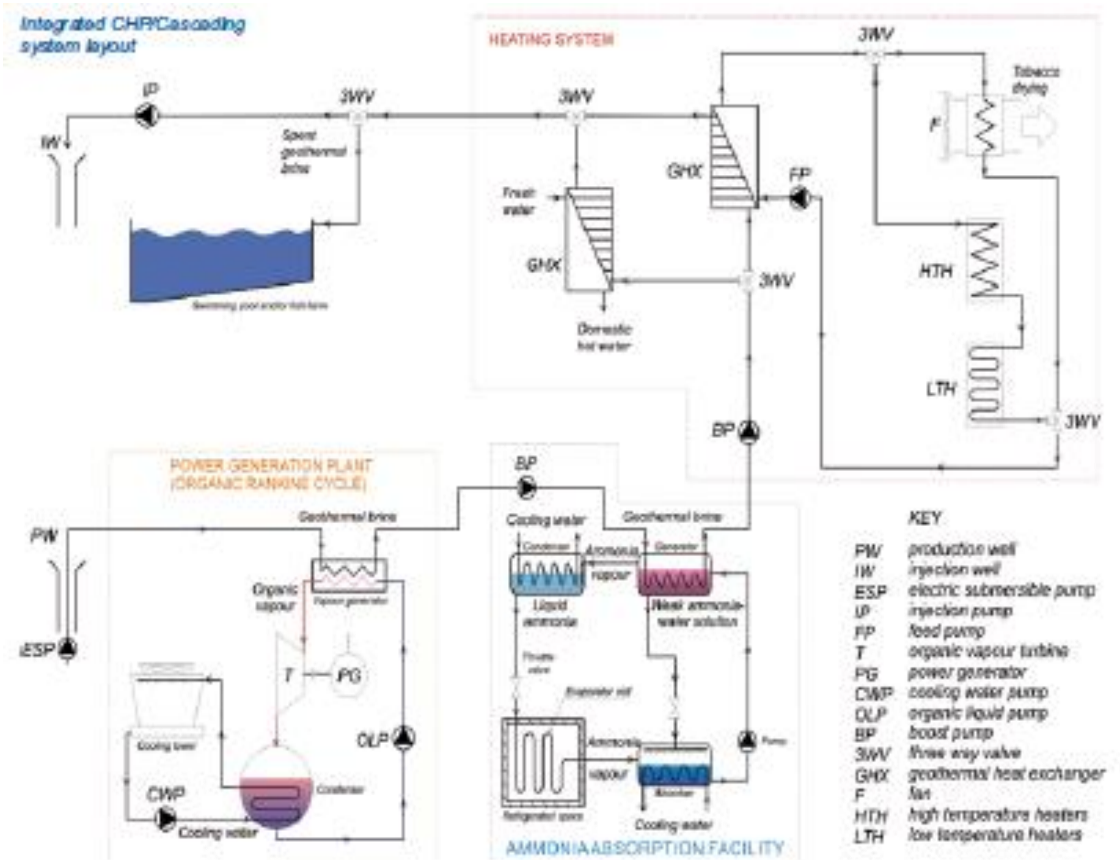


Picture1.48Schematic representation of the geothermal pump in heating mode

Legend: To/from ground heat exchanger (geothermal), Heat exchanger refrigerant/water (condenser), Expansion valve, Refrigerant compressor working substances, Domestic hot water heat exchanger (desuperheater) – Heat exchanger for preparing consumable sanitary water (cooler), Refrigerant reversing valve – Reverse valve for reverse flow of working substance, Heat exchanger refrigerant/air (evaporator) – Heat exchanger refrigerant/air (evaporator), Warm return air from conditioned space - Cool supply air to conditioned space - In out domestic water

After the evaporator (coolant/air heat exchanger) takes the heat from the heated air, which after cooling by means of a fan is introduced into the space being cooled, the working substance is fed via the reverse valve to the suction side of the compressor where the working substance is compressed and due to the supplied work from the compressor heats up. The heated working substance transfers part of the thermal energy to the heat exchanger for the preparation of consumable sanitary water, and then it is led to the condenser through the reverse valve, where the other part of the heat contained in the working medium is transferred to the geothermal exchanger in the well. The working medium is then fed into the evaporator through the throttle valve, where it evaporates due to the reduced pressure, taking heat from the heated air flowing through the evaporator.

In the following picture (Picture1.49) presented a geothermal integrated cascade heating and cooling system with the application of a cogeneration system.



Picture1.49Scheme of the integrated cascade cogeneration system for heating and cooling

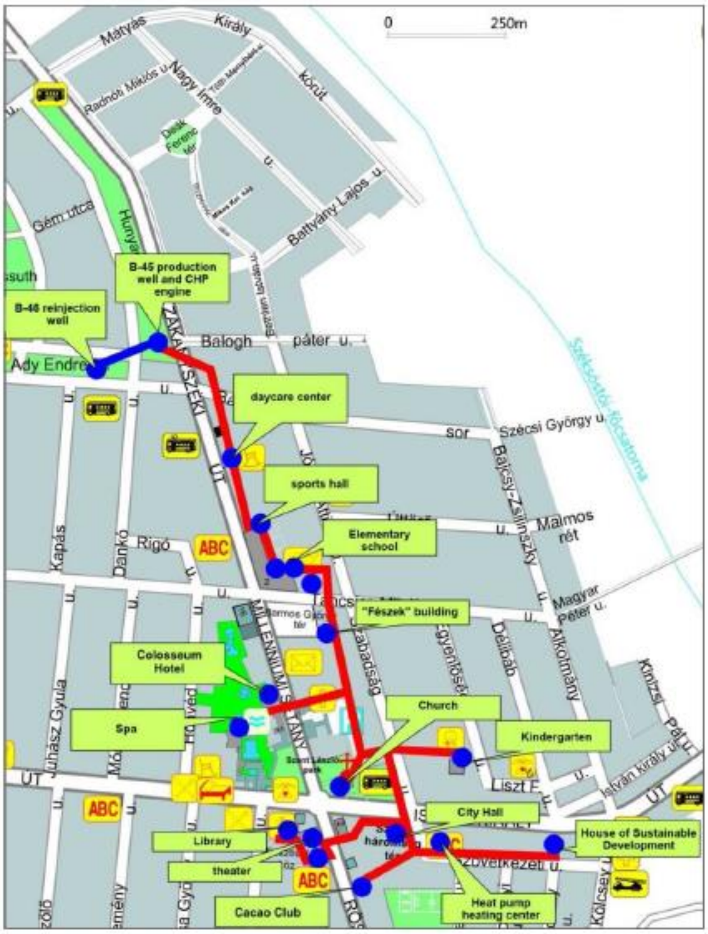
Legend: Production well, Injection well, Electric submersible pump, Feed pump, Organic vapor turbine, Power generator, Cooling water pump Cooling water pump, Organic liquid pump, Boost pump, Booster pump, Three way valve, Geothermal heat exchanger, Fan, High temperature heater , Low temperature heater, Power generation plant (Organic Rankine Cycle), Ammonia absorption facility, Heating system,Swimming and/or fish farm, Spent geothermal brine, Fresh water, Domestic hot water, Tobacco drying, Fan, Geothermal brine Geothermal brine, Organic vapor, Cooling tower, Cooling water, Vapor generator, Condeser, Condenser, Ammonia vapor, Liquid ammonia, Weak ammonia-water solution Lean ammonia-water solution, Throttle valve, Evaporator coil, Refrigerated space, Generator, Absorber, PumpFresh water, Domestic hot water, Sanitary hot water, Tobacco drying, Fan, Geothermal brine, Organic vapor, Cooling tower, Cooling water, Vapour generator – Steam generator, Condeser – Condenser, Ammonia vapor – Ammonia vapor, Liquid ammonia – Liquid ammonia, Weak ammonia-water solution – Poor ammonia-water solution, Throtle valve – throttle valve, Evaporator coil – Evaporator coil, Refrigerated space – Refrigeration space , Generator - Generator, Absorber - Absorber, Pump - PumpFresh water, Domestic hot water, Sanitary hot water, Tobacco drying, Fan, Geothermal brine, Organic vapor, Cooling tower, Cooling water, Vapour generator – Steam generator, Condeser – Condenser, Ammonia vapor – Ammonia vapor, Liquid ammonia – Liquid ammonia, Weak ammonia-water solution – Poor ammonia-water solution, Throtle valve – throttle valve, Evaporator coil – Evaporator coil, Refrigerated space – Refrigeration space , Generator - Generator, Absorber - Absorber, Pump - PumpCooling water, Vapor generator, Condeser, Condenser, Ammonia vapor, Liquid ammonia, Weak ammonia-water solution, Throttle valve, Evaporator coil evaporator, Refrigerated space, Generator, Absorber, PumpCooling water, Vapor generator, Condeser, Condenser, Ammonia vapor, Liquid ammonia, Weak ammonia-water solution, Throttle valve, Evaporator coil evaporator, Refrigerated space, Generator, Absorber, Pump

Geothermal water is supplied by means of a submersible pump (ESP) and is first introduced into a steam generator in which, on the other hand, in a closed cycle, an organic working substance flows, which evaporates in the generator, depriving part of the enthalpy of the geothermal water. The produced organic steam is introduced into the turbine (T) where it expands and produces mechanical work which is transmitted via the shaft to the generator for the production of electricity (PG). The output from the turbine is introduced into the condenser where the organic vapors are liquefied using cooling water. The resulting condensate of the organic working substance is fed back to the steam generator with the help of a pump (OLP).

After leaving the steam generator, the geothermal water is introduced into the generator of the ammonia absorption plant using a booster pump, where ammonia steam is produced from a poor ammonia solution. Ammonia vapor is introduced into a condenser that is cooled with cooling water and in which ammonia vapor condenses. Liquid ammonia is fed through the throttle valve into the coil of the evaporator, where the working substance evaporates using the heat of the cooled space for evaporation. After performing the cooling function, the ammonia vapor is brought to the absorber where it is cooled by cooling water and mixed with a lean solution of ammonia and water from the generator and delivered to the generator using a pressure pump.

On the other side of the generator, geothermal water is supplied to the heating system using a booster pump. Using a three-way valve (3MW), one part of the geothermal water is fed to the heat exchanger for the production of sanitary hot water (GHX), and the other part to the heat exchanger in the heating system circuit (GHX). One part of the heat taken in the geothermal heat exchanger (GX) is led to tobacco drying, and the other part to the low-temperature and high-temperature heat exchangers for other needs. Water circulation in the heating system is maintained by means of a feed pump (FP). The geothermal water that comes out of the heat exchanger for heating and preparation of sanitary hot water is drained into an injection well, and one part is used for a swimming pool, i.e. for a fish farm.

In the following picture (Picture1.50) a cartographic representation of remote cascade heating of buildings with a geothermal cogeneration unit is given.



Picture1.50An example of remote cascade heating of buildings with a geothermal cogeneration unit

Legend: B-45 Production Well and CHP Engine – B-45 production well and cogeneration unit, B-45 Reinjection Well – B-45 injection well

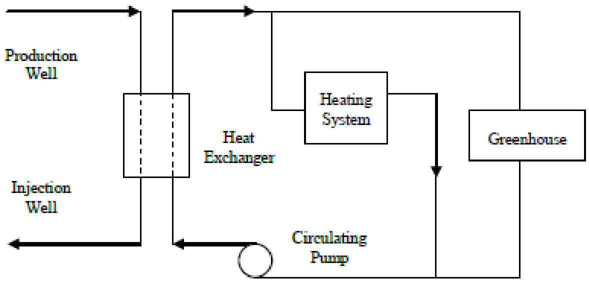
From the production well B-45, the geothermal fluid is led to the cogeneration unit, where part of the heat is converted into mechanical work to drive the generator for electricity production. Wet steam at the exit from the turbine plant is condensed and led to the heat consumers. After the geothermal medium has transferred part of the heating heat to the heat consumers, the cooled fluid is injected into the injection well B-45.

Geothermal systems of this type are extremely efficient and there are numerous examples, where conditions allow, of their implementation.

Greenhouse heating

The following picture (Picture1.51) schematically shows the greenhouse heating system. Two heating circuits are visible in the picture:

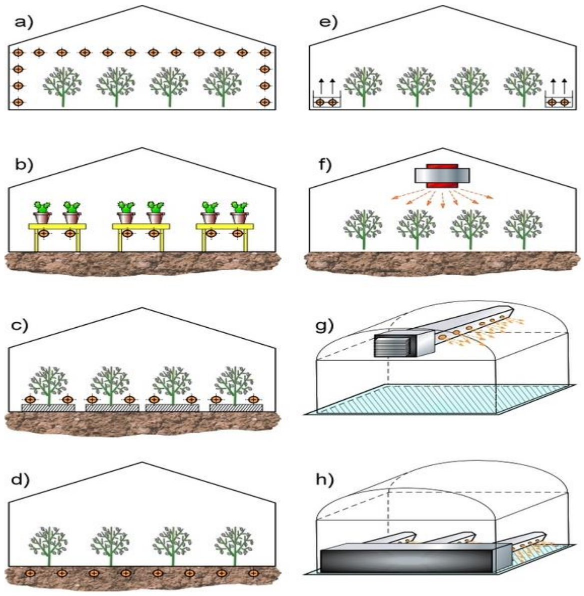
- geothermal water circulation circuit,
- water circulation circuit that has been taken over from the geothermal circuit via the heat exchanger.



Picture1.51Schematic representation of geothermal heating of the greenhouse

Legend: Production Well, Injection Well, Heat Exchanger, Heating System, Greenhouse, Circulating Pump

The system shown in the picture enables the heating of the greenhouse through the ground and by heating the space. Different heating versions are shown in the following picture (Picture1.52)

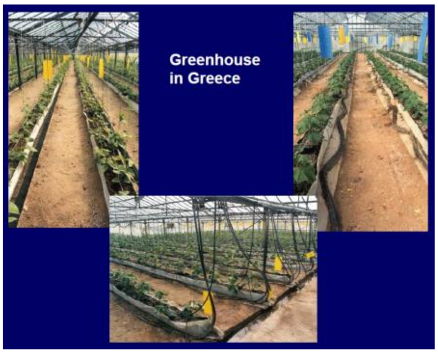


Picture1.52Presentation of geothermal heating of the greenhouse

Legend: Heating installations with natural convection – Installation of heating with natural convection: (a) aerial pipe heating – air pipes for heating; (b) bench heating – heating pipes on the bench; (c) low-position heating pipes for aerial heating – low-position pipes for aerial heating; (d) Soil heating. Heating installations with forced forced convection - Heating installation with forced convection: (e) lateral position – lateral position; (f) aerial fan - air fan; (g) high-position ducts – high-position ducts; (h) low-position ducts.

Figures A, B and C show the performance of heating by natural convection of heat to the surrounding air in the greenhouse. Figure D shows a greenhouse heating system in which heat is transferred from the ground to the surrounding space, which is in contact with warm pipes through which water circulates. Figure E shows a forced air circulation system that flows over laterally laid hot water pipes. Pictures F, G and H show a system with the flow of heated air into the greenhouse.

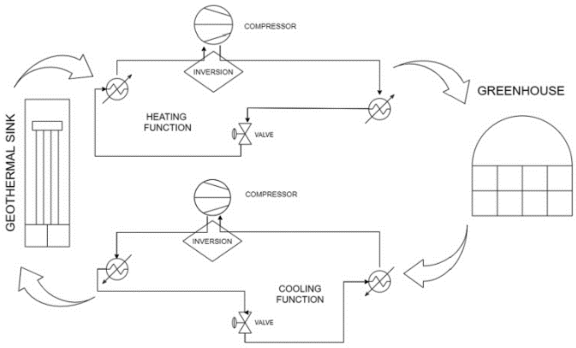
The following picture shows an example of a greenhouse with low-lying pipes for convective heating (Picture1.53).



Picture1.53An example of a greenhouse with geothermal heating with low-lying pipes

Legend: Greenhouse in Greece

The aforementioned geothermal systems for heating greenhouses are a good solution for heating greenhouses at low outside temperatures, however, this does not solve the problem of high temperatures under which conditions it is necessary to ensure cooling of the greenhouse. Using a geothermal heat pump, as shown in the following figure (Picture1.54), cooling is ensured, that is, the optimal temperature for plant growth.



Picture1.54Schematic representation of the operation of the geothermal system for heating and cooling the greenhouse

Legend: Geothermal sink, Heating function, Compressor, Valve, Greenhouse, Inversion

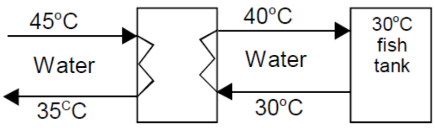
In the heating mode (clockwise process), the thermal energy from the geothermal sink passes through the heat exchanger (in the heating mode it plays the role of the evaporator) to the circulation circuit of the working medium. The heated working medium is compressed by the compressor and through the heat exchanger (in the heating mode it acts as a condenser) transfers thermal energy for heating the greenhouse. The cooled working medium is dampened via the valve and fed back into the heat exchanger (evaporator) where it takes over the thermal energy of the geothermal sink.

In the cooling mode (counter-clockwise process), the thermal energy from the greenhouse is transferred to the circuit of the working medium through the heat exchanger (in the cooling mode, it acts as an evaporator). The heated working medium is compressed by the compressor and through the heat exchanger (in the cooling mode it acts as a condenser) transfers the heat energy to the geothermal sink. The cooled working medium is dampened via the valve and fed back into the heat exchanger (evaporator) where it receives heat energy from the greenhouse.

By applying an advanced regulation system, in addition to stable air and soil temperature, optimal humidity in the greenhouse is ensured. This advanced system can dehumidify the interior of the greenhouse by up to 40%, and the condensed moisture can be used for irrigation, and for the reasons mentioned, such systems show a high degree of energy efficiency.

Aquaculture

Geothermal hot water is often used to heat fish farms in such a way that fresh water is heated in heat exchangers as shown schematically in the following picture (Picture1.55).

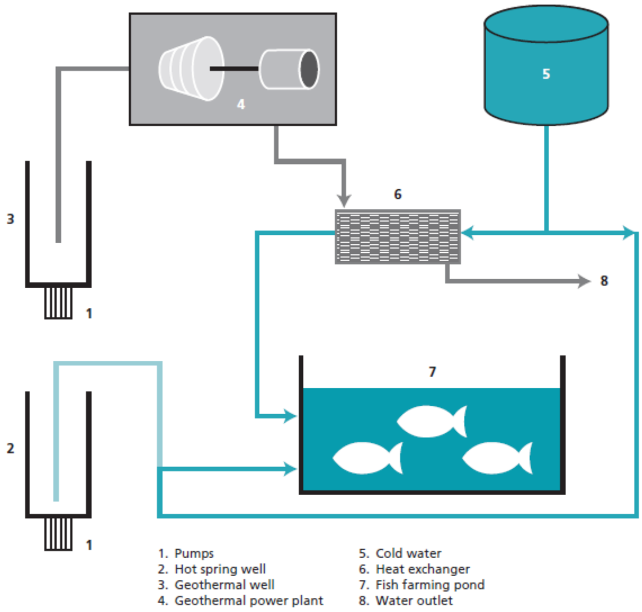


Picture1.55Scheme for heating fish farms with geothermal water

Legend: Water, Fish tank - Fish farm

Pond heating in order to achieve suitable temperatures for fish breeding can also be done by direct mixing of geothermal and fresh water. In colder climates or where other heating sources are not economical, heating fishways is among the most common applications of geothermal energy in aquaculture. Using geothermal energy in fish farming protects the fish stock in cold weather and increases fish production, especially in the spawning phase, and the economic aspects are not negligible either, since such production is cheap and profitable throughout the year.

The use of geothermal energy in fish farming is illustrated in the following picture (Picture1.56).



Picture1.56Scheme of using geothermal energy for fish farming

Legend: Pumps, Hot spring well, Geothermal well, Gerothermal power plant, Cold water, Heat exchanger, Fish farming pond, Water outlet

Geothermal water from the production well is first fed to the geothermal power plant

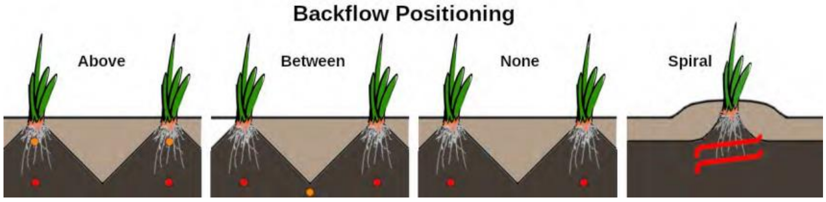
in which part of the thermal energy contained in the geothermal medium is converted into mechanical work that drives a generator for the production of electricity. The outgoing wet steam from the turbine of the geothermal power plant is introduced into the heat exchanger where the steam is condensed and the heat of condensation is transferred to the cold water heating circulation circuit. Cold water is also led from the tank through a heat exchanger, where it takes the heat of steam condensation, after which it is mixed with water from a hot spring and introduced into the pond. In order to maintain the required temperature in the pond, cold water from the tank is also added.

The water temperature in the pond generally ranges between 20 °C – 30 °C. The temperature of the water pumped into the pond depends on heat losses and the required temperature for individual fish species.

In addition to fish farming, spirulina and other algae can be grown in ponds, which are sold as health food and medical drugs around the world. Spirulina is grown in shallow mixed culture ponds at an optimal temperature between 35 ºC and 37 ºC, with strong sun and high alkaline conditions.

Ground heating

Ground heating with geothermal energy can be done outdoors or in a greenhouse. The following figure schematically shows four versions of ground heating with geothermal energy outdoors (Picture1.57).

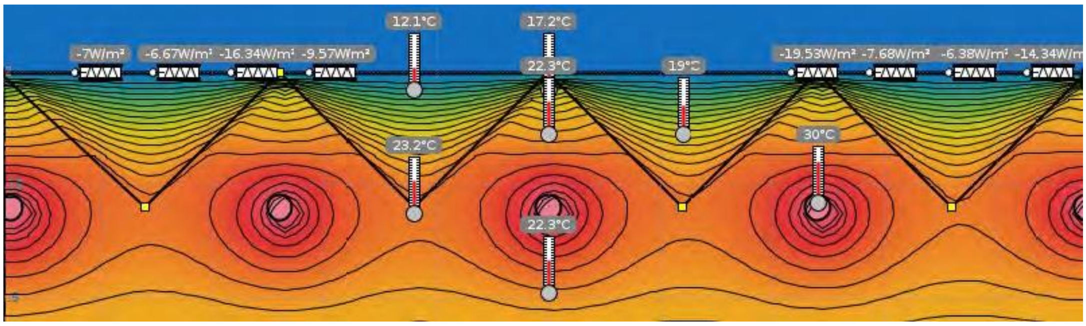


Picture1.57Schematic representation of the performance of soil heating with geothermal energy

Legend: Backflow positioning, Above, Between, None, Spiral

In the left part of the picture, the supply pipe for hot water is on the lower side, while the drain pipe is on the upper side. In this way, it is ensured that the colder medium is in contact with the higher layer of the soil, which is colder on the surface than under the surface, and the warmer media is in contact with the deeper layer of the soil, which is warmer. On the left side of the picture towards the middle, the hot water supply is shown from the bottom, and the drain is in the middle, between the two supply pipes. On the right side, in the middle of the picture, the supply pipe is shown in a variant in which there is no return of hot water. On the far right side of the picture is shown the spiral construction of the pipe around the root of the tree.

In order to reduce heat losses, the insulation of the heated soil is performed, which is shown schematically in the following figure (Picture1.58).



Picture1.58Schematic representation of the section of the ground heated by geothermal energy with the application of insulating material (Gaurina, 2022)

The insulating material is distributed in alternating rows through the arable soil in order to achieve as little heat loss as possible. Wood mulch can be used as an insulating material, but inorganic materials that have a lower heat conduction coefficient (eg crushed porous rocks) can also be used.

Irrigation

Geothermal water can be used for irrigation and heating of winter crops in open agriculture and in greenhouses. Geothermal water with a temperature between 40 ºC and 75 ºC is used for such purposes. Surface pipes are used for irrigation, and pipelines buried under the ground are used for heating.

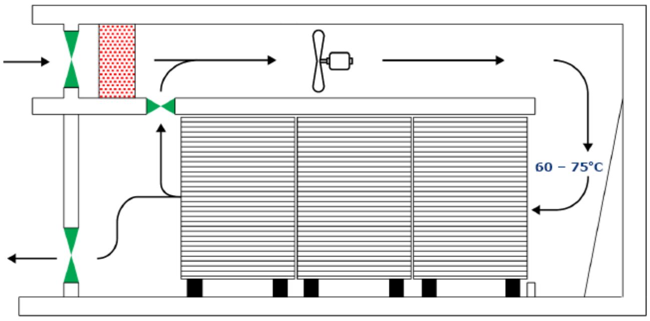
When using geothermal water for irrigation, the chemical composition and salinity of the water must be carefully monitored to prevent plant damage.

Food / crop drying

In order to preserve the greatest possible range of food for consumption, various thermal drying processes are used in food and agricultural production. In industrially developed countries, drying processes account for about 7% to 15% of the total industrial energy consumption. However, the thermal efficiency of the consumed energy is relatively low and amounts to about 25% to 50%. Since in some industrially highly developed countries more than a third of the primary waste is spent on drying processes

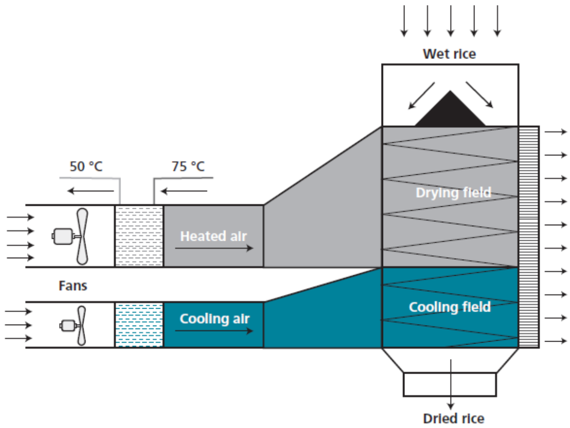
energy consumption, it is necessary to reduce energy consumption by applying effective procedures. Low to medium enthalpy energy resources are the best option for drying agricultural products, and for this you can use recovered heat or heat from geothermal sources.

One of the most important devices in geothermal drying systems is the heat exchanger. Heat exchangers made of lamellar steel or copper pipes, which have a large surface for heat transfer, are common. Geothermal hot water or steam circulates inside the pipe, and on the outside, air is blown onto the heat exchanger by means of a fan. The heated air then enters the chamber for the drying process as shown in the following figure (Picture1.59).



Picture1.59Geothermal chamber for drying fruit

The following picture shows a geothermal convection rice dryer (Picture1.60).

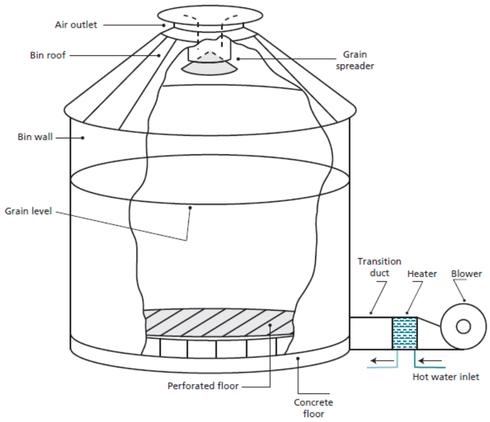


Picture1.60Geothermal convection rice dryer

Legend: Fans, Heated air, Cooling air, Drying field, Cooling field, Wet rice, Dried rice

Wet rice is put into the drying field through which warm air is blown, which evaporates the moisture. The rice then enters the cooling field where cold air is blown, after which we have cooled and dried rice at the exit. In addition to rice, this kind of dryer can, with minor adjustments, also be used for some other grains.

The following picture shows a geothermal batch grain dryer (Picture1.61).

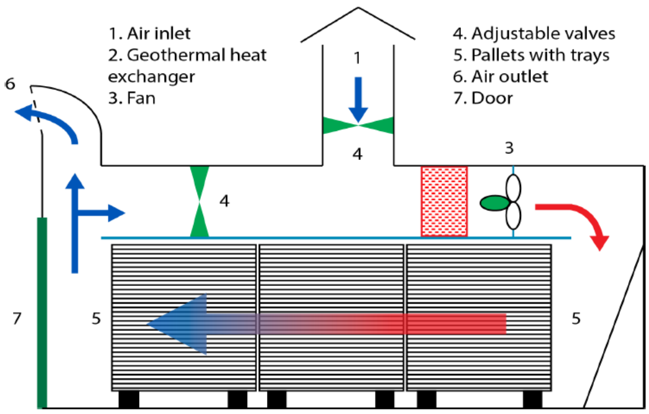


Picture1.61Geothermal batch grain dryer

Legend: Air outlet, Bin roof, Grain spreader, Bin wall, Grain level, Perforated floor, Concrete floor, Transition duct, Heater, Hot water inlet, Blower

The wet grain is fed into the drying container via a conical spreader. Heated air is introduced into the container by means of a blower from the bottom side through the perforated floor, and passing through the grain layer, it picks up moisture. Air saturated with moisture from the top of the container leaves the atmosphere.

The following picture shows a tunnel geothermal device for drying fish (Picture1.62).

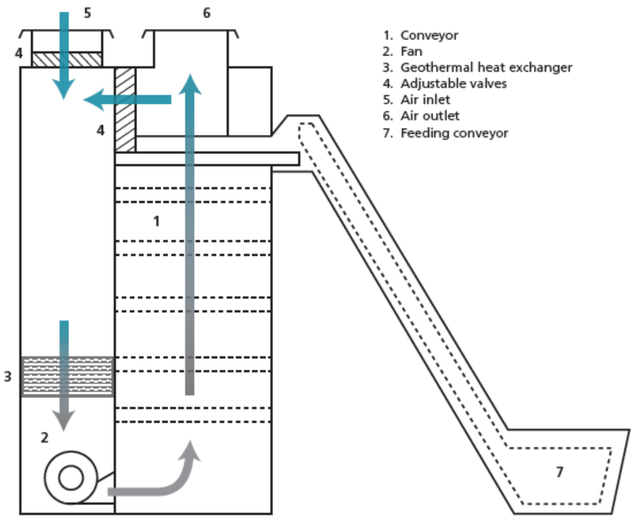


Picture1.62Tunnel geothermal device for drying fish

Legend: Air inlet, Geothermal heat exchanger, Fan, Adjustable valves, Pallets with trays, Air outlet, Door

The pallets with trays, on which the fish are arranged, are fed heated air using a fan. Part of the air saturated with moisture is released into the atmosphere, and the other part is recirculated through the regulating valve and reheats and resumes the drying process.

The following picture shows a vertical transport geothermal device for drying fish (Picture1.63).



Picture1.63Vertical transport geothermal device for drying fish

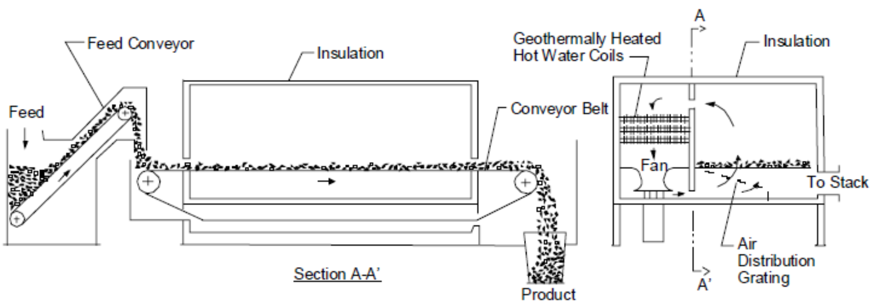
Legend: Conveyor – Transporter, Fan – Ventilator, Geothermal heat exchanger, Adjustable valves, Air inlet, Air outlet, Feeding conveyer

The fish for drying is supplied to the drying conveyor by means of a filling conveyor and is lowered through the dryer in a stream of warm air. Air is sucked into the fresh air duct by a fan, where it is heated by a geothermal heat exchanger. The heated air is fed into the dryer by means of the same fan, where it passes through the fish conveyor in a vertical flow and takes the moisture with it. With the help of the regulating valve, part of the air is recycled and reintroduced into the fresh air channel, while the other part of the moisture-saturated air is released into the atmosphere.

The following picture shows a geothermal tomato dryer (Picture1.64).

Picture1.64Geothermal tomato dryer

The following picture shows a horizontal conveyor for drying agricultural products using geothermal energy (Picture1.65).



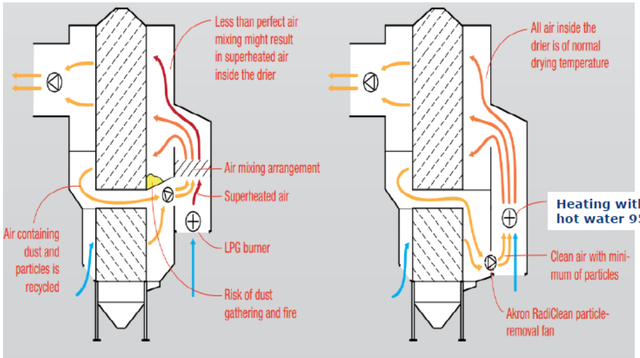
Picture1.65Horizontal conveyor for drying on geothermal energy

Legend: Feed - Filling, Feed conveyor - Conveyor for filling, Insulation - Isolation, Geothermally heated hot water coils - Tubular coils of geothermal hot water heaters, Fan - Ventilator, Conveyor - Conveyor belt, Product - Proizvod, Air distribution grating - Grid for distribution air, To stack - In the chimney

The wet product is brought to the conveyor belt for drying the product by means of a filling conveyor. The conveyor belt for drying passes through an insulated chamber where drying takes place, and upon exiting the chamber, the dried product is disposed of. Air circulation in the chamber is done using a fan, and air heating is done using a geothermal heat exchanger. The heated air is directed via the air distribution grid over the conveyor belt, and the saturated air with moisture is led into the chimney.

In food and agricultural production, in addition to thermal drying systems, drying systems with a freezing process are used, in which the conditions are created for the solid substance (ice) to change to a vaporous state by sublimation. The use of geothermal energy in such technological procedures is not significantly represented.

In technological procedures in which fossil energy is replaced by geothermal energy, economic and ecological reasons are cited as the main advantage of using geothermal energy. There are, however, technological procedures that, in addition to the application of geothermal energy, also show a significant technological improvement, as shown for the drying system in the following picture.



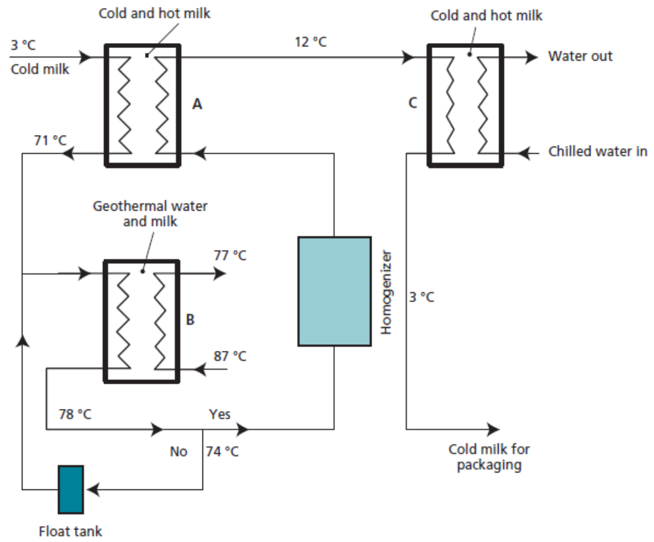
Picture1.66Schematic representation of the transition from fossil fuel to geothermal heating of the dryer

Legend: Air contain dust and particles is recycled - Less than perfect air mixing might result in superheated air inside the dryer - Air mixing arrangement - Construction for air mixing, Superheated air, LPG burner, Risk of Dust gathering and fire, All air inside the dryer drying temperature, Heating with geo hot water 95 oC - Heating with geothermal water temperature 95 oC, Clean air with minimum of particles, Acron RadiClean particle removal fan - Fan for removing particles

Pasteurization of milk

Milk is an important foodstuff, but the quality of milk in its natural state changes quickly due to the action of enzymes and microorganisms, especially if it is kept at ambient temperature. In order to prevent the activity of enzymes and the growth of microbes, milk is processed at high temperature using the pasteurization process or the process of applying ultra high temperature (UHT).

The following picture shows the milk pasteurization scheme using geothermal water (Picture1.67).



Picture1.67Milk pasteurization scheme using geothermal water

Legend: Cold milk - Cold and hot milk - Cold and hot milk, Geothermal water and milk - Geothermal water and milk, Float tank - Balancing vessel, Homogenizer - Homogenizer, Chilled water in - Cold water inlet, Water out - Water outlet, Cold milk for packing - Cold milk for packing

In the pasteurization process, they use three heat exchange sections using plate heat exchangers; one plate heat exchanger geothermal water / milk and two plate heat exchangers warm milk / cold milk.

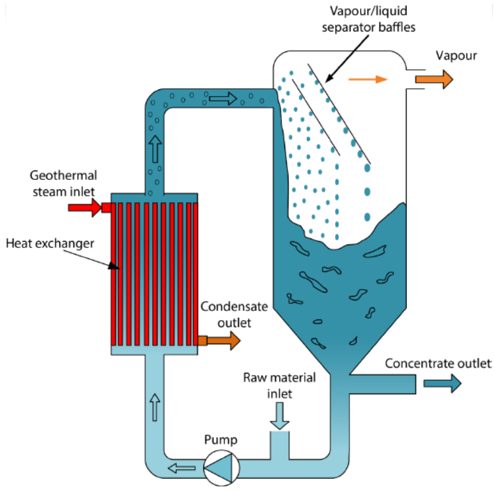
Raw milk is preheated with the milk coming from the homogenizer. After preheating, the milk passes through the second section of the heat exchanger, where it is briefly heated for 15 seconds using geothermal water to a temperature of at least 78 oC (so-called short-term pasteurization). If the milk temperature drops below 74 oC, the short-term pasteurizer automatically recirculates the milk to reheat it to the required temperature. After the milk reaches the required temperature, it passes through the homogenizer, after which it is pumped through a plate heat exchanger where it cools with the incoming milk. Finally, the milk is cooled in the third section with cold water, after which the milk is sent for packaging.

Evaporation and distillation

Evaporation and distillation are processes that are used in many food industries, such as sugar processing, mint distillation and processes for obtaining alcoholic beverages, i.e. as auxiliary processes in the concentration of some food products. Evaporation can be carried out as a batch process or as a continuous process. Although the evaporation temperature varies depending on the type of product, we can say that the most common temperature ranges between 80 oC and 120 oC. Precisely for such temperature levels, geothermal hot water appears as a suitable source of energy that can be used in evaporation and distillation processes.

In order to increase energy efficiency, two or three evaporators can be interconnected. In such a configuration, geothermal water is first fed into the first evaporator, steam from the first evaporator is introduced into the second evaporator, which then provides steam for the third evaporator, from which the steam is released into the air or used for some purpose. It is analogous to the liquid phase, which, passing through the evaporators, is condensed and finally collected from the last evaporator.

The following figure shows the principle diagram of a geothermal evaporator for continuous operation (Picture1.68).



Picture1.68Principle diagram of a geothermal evaporator

Legend: Heat exchanger, Geothermal steam inlet, Condensat outlet, Raw material inlet, Pump, Vapour / liquid separator baffles, Vapour - Steam, Concentrate outlet - Concentrate outlet

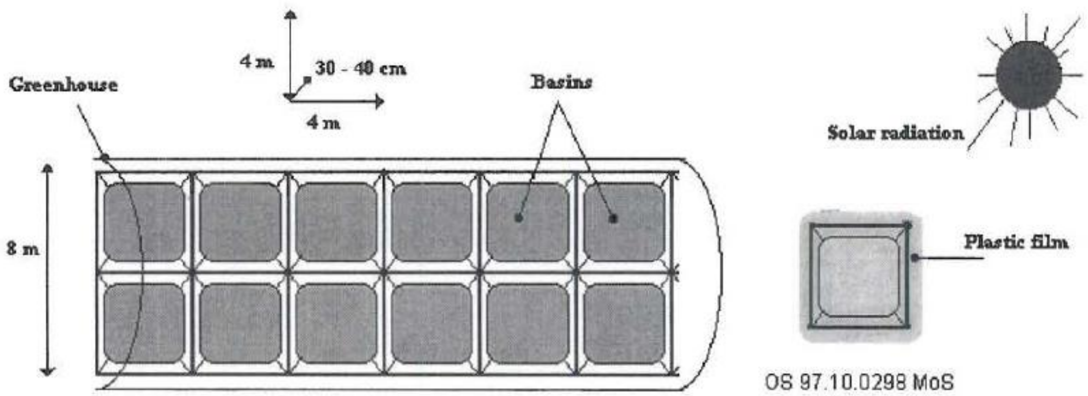
By means of a circulation pump, the product enters the geothermal heat exchanger, where it is heated and partially vaporized. The product is then fed into a container where steam and liquid are separated using separation partitions. The steam is drained from the upper side of the vessel, and the concentrated liquid from the bottom of the vessel. The amount of substance that is removed as a vapor and liquid phase is replaced by an additional amount of raw material that is added to the process. By transferring heat to the product, the geothermal steam condenses. The resulting condensate can be used for other purposes, i.e. it can be returned to the injection well.

Sterilization

Sterilization processes are widespread in the meat and fish processing industry, canning, bottling, sterilization of production equipment and others with the aim of stopping the growth of bacteria. Considering the temperature requirements for sterilization processes, geothermal steam or geothermal water can be successfully used.

Thermal energy from the geothermal source can also be used in agricultural production to sterilize the soil. This is especially true in intensive cultivation of crops where there is a high risk of nematode infection.

The presentation of soil disinfection with geothermal water in combination with solar radiation is shown in the following picture (Picture1.69).



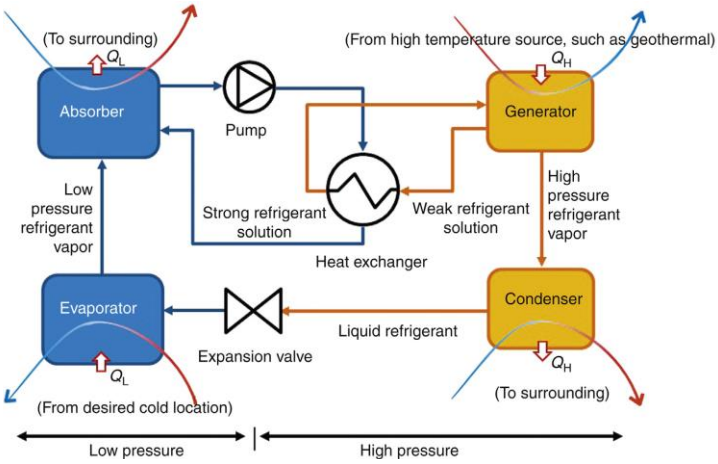
Picture1.69Presentation of soil sterilization with geothermal water

First, the soil is moistened by irrigating the entire surface with geothermal water to encourage the development of larvae from nematode eggs. The effect of geothermal water heat on nematodes is strongest when in active form. In doing so, the greenhouse must be divided into smaller, square-shaped basins, as shown in the picture, in order to ensure an equal supply of geothermal water for the entire area of the greenhouse. It is important to ensure that the pools are completely submerged with geothermal water. In order to increase the effect, the pools are covered with a plastic film that lets in sunlight and prevents heat loss. The process of soaking with hot geothermal water and covering the surface with plastic film and exposing it to solar radiation should be applied twice. The goal is to reach a temperature above 50°C in the soil at a depth of 40 to 60 cm.

A similar technology can be used to sterilize the substrate for growing mushrooms.

Cooling

The geothermal medium for the cooling process must have a temperature higher than 120 °C, and is suitable for applications where temperatures below 0 °C are required. The following figure shows the principle of operation of an absorption chiller with geothermal water, in which a solution of ammonia and water is used as the working medium (Picture1.70).



Picture1.70Schematic representation of an absorption cooling cycle with geothermal water as a heat source

Legend: To surrounding, Absorber, Low pressure refrigerant vapor, Evaporator, From desired cold location, Pump, Strong refrigerant solution, Expansion valve, From high temperatures source, such as geothermal, Generator, Weak refrigerant solution, High pressure refrigerant vapor, Condenser, Liquid refrigerant, To surrounding, Low pressure, High pressure

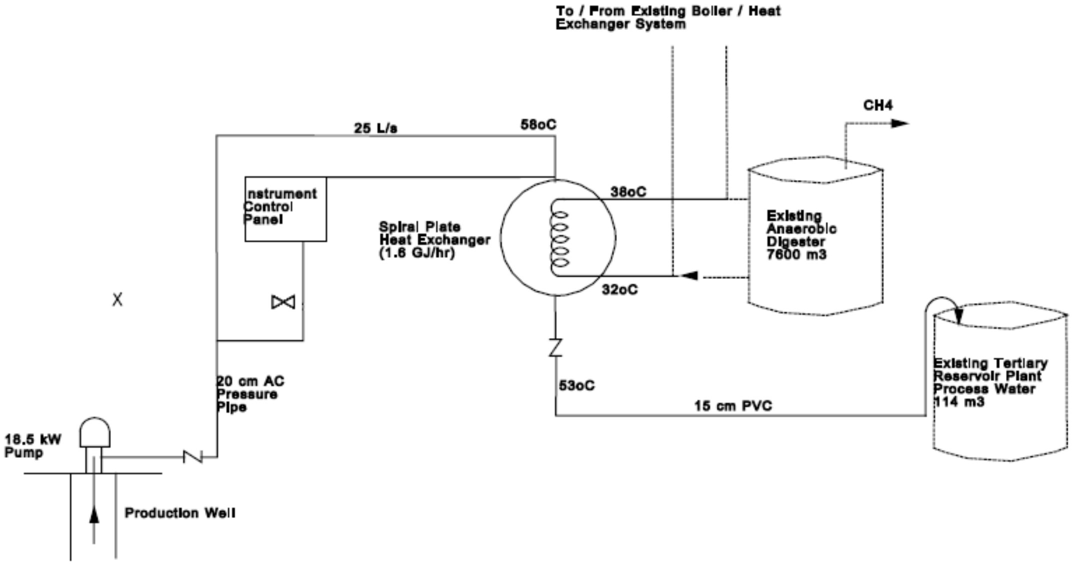
The evaporator absorbs heat from the space being cooled, the absorber and condenser transfer low-temperature heat to the environment, and the generator absorbs high-temperature heat from the geothermal source. The working medium, after taking the heat in the evaporator from the space being cooled, enters the absorber. In the absorber, it is mixed with a strong solution of the working substance that has been preheated on a heat exchanger that has taken heat from a generator heated by geothermal water. In the absorber, part of the heat is transferred to the environment. From the generator, the high-pressure steam of the working medium is taken to the condenser where it is condensed and the heat of condensation is transferred to the environment. The liquid working medium from the condenser is led, via the throttle valve, to the evaporator, where it reabsorbs the heat from the space being cooled.

Application for the operation of the anaerobic process

In order to protect the environment, biological processes are often used for the treatment of waste water, among which the anaerobic process occupies a significant place. In addition to wastewater treatment, the anaerobic process is used in bioelectric plants for the production of green electricity, in which manure, slurry, waste from the food industry, certain agricultural crops and other organic substances are used as raw materials for the production of biogas.

Anaerobic digestion is a biological process that uses microorganisms to produce methane. In order to maintain the quality of the process, it is necessary to add heat and mix the substrate in order to convert the molecules of complex organic materials into methane and digestate. Methane is collected at the top of the digester and is used as fuel to drive machines or produce electricity and thermal energy, and digestate is collected from the bottom of the digester and, if it meets certain criteria, can be used as organic fuel in agriculture.

The following picture shows the principle diagram of digester reheating of an existing biological device for the treatment of waste water with an anaerobic process.



Picture1.71Scheme of geothermal heating of the anaerobic reactor

Legend: Production well, Pump, Pressure pipe, Instrument control panel, Spiral plate heat exchanger, To / from existing boiler / heat exchanger system - To / from existing boiler / of the heat exchange system, Existing anaerobic digester, Existing tertiary reservoir plant process water - Existing tertiary reservoir in the plant for process water

Geothermal water from the production well is pumped to the spiral plate heat exchanger, where it is reheated in an anaerobic digester, ensuring an optimal temperature of around 35 oC.

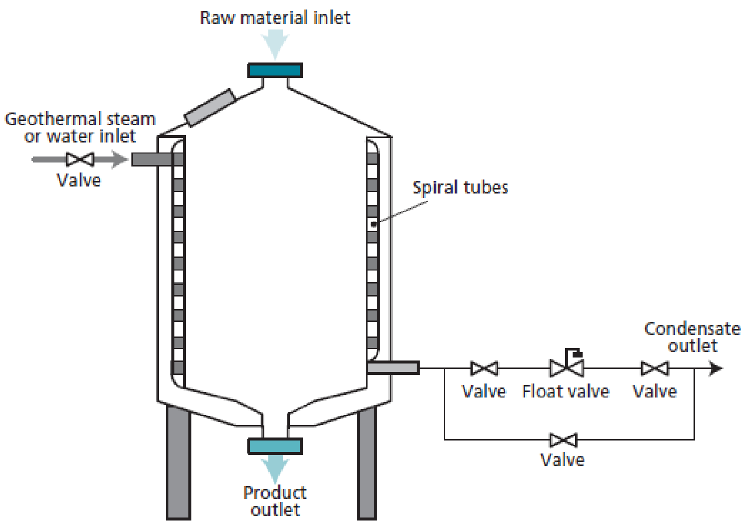
Heating process media in the food industry

It has already been mentioned that geothermal energy can be effectively used for heating processes in the food industry, where either steam or hot water can be used. In addition to heating process media, tanks for heating auxiliary media (for example water) are most often used in industry. There are two types of containers:

- double jacketed tank with spiral tubes between the two jackets and
- tank with internal spiral or zigzag pipes.

In a tank with a double jacket, the heat from geothermal hot water or steam, which circulates through spiral tubes between the two jackets, is transferred through the inner jacket to the substance being heated, while in a tank with internal tubes, the heat is transferred directly from the tube to the substance being heated. .

The following picture shows a section of a double jacketed heating tank with associated equipment (Picture1.72).



Picture1.72Geothermal tank heating

Legend: Geothermal steam or water inlet, Valve, Raw material inlet, Product outlet, Spiral tubes, Float valve, Condensate outlet

2 Relationship of the Plan with other relevant strategies, plans and programs

In continuation (Table2.1) presents a presentation of strategies, plans and programs at the national level, the purpose and goals of these documents, and a comparison of their goals with the goals of the Plan.

Table2.1List of analyzed strategies, plans and programs at the national level and comparison of their goals with the goals related to the Plan

Main objectives of the document	Relationship between the Plan and the document
National Development Strategy of the Republic of Croatia until 2030 (Official Gazette 13/21)	
The National Development Strategy of the Republic of Croatia is an umbrella document and a comprehensive act of strategic planning that directs the long-term development of society and the economy in all important issues for Croatia. The document is based on the competitive economic potential of Croatia and recognized development challenges at the regional, national, European and global levels. The elements of the strategic framework are the vision of Croatia in 2030, development directions and strategic goals. Within the framework of four development directions, strategic goals have been defined that will contribute to the realization of the vision of Croatia in 2030: Sustainable economy and society 1.1.A competitive and innovative economy 1.2. Educated and employed people 1.3.Effective and efficient judiciary, public administration and management of state assets 1..4. Global recognition and strengthening of Croatia's international position and role 2. Strengthening resistance to crises 2.1.A healthy, active and quality life 2.2.Demographic revitalization and better position of the family 2.3. Security for stable development 3. Green and digital transition 3.1. Ecological and energy transition for climate neutrality 3.2. Self-sufficiency in food and the development of the bioeconomy 3.3. Sustainable mobility 3.4. Digital transition of society and economy 4. Balanced regional development 4.1. Development of assisted areas and areas with special development characteristics 4.2. Strengthening regional competitiveness.	Geothermal potentials in the form of heat or electricity will contribute to objectives 3.1 Ecological and energy transition to climate neutrality. Raising electricity from renewable sources will provide a resource that can be connected to the energy system and the transport network. It will also contribute to the liquidity of the Croatian Electricity Exchange and the satisfaction of peak loads in the use of energy, as well as the stabilization of the price of electricity. The extraction and formation of new sources of electricity will potentially further popularize and speed up the aspirations for the development and application of new technologies as a necessary prerequisite for the decarbonization of the energy sector. In addition to the above, research and the formation of new locations within the network of geothermal exploitation and electricity production from the resource in question will additionally contribute and provide a resource in the pursuit of encouraging comprehensive, primarily energy renovation of buildings. Depending on the placement and location of the plant and the number and amount of future energy obtained from the resource in question, it is potentially possible to mitigate energy poverty in endangered localities that are threatened by the same. Geothermal sources and their use also have the potential to contribute to strategic objective 3.3. Sustainable mobility. By providing new sources of electricity and reducing its price and greater availability, further and more efficient efforts to promote transport with zero emission of pollutants are facilitated and enabled. Also, by raising the energy efficiency of the industry through the use and adaptation of thermal and electric energy infrastructure solutions, the potential of geothermal energy is realized and the basic and applied research, technology, capacity and infrastructure of industrial production that can potentially utilize this energy are accelerated, thus achieving the goals of the double transition in terms of climate neutrality and digitization. It follows from the above that the Plan is in accordance with the development plan directions and strategic goals of the National Development strategy of the Republic of Croatia until 2030.

Spatial Development Strategy of the Republic of Croatia (OG 106/17)	
Based on the established core values of the Croatian space and the spatial development management system, as well as the established state and process in the space, the strategy established the general goal (vision) of spatial development until 2030 with development starting points and priorities, directions and a framework for implementation. Following the findings of the analysis of the state and processes in the space and the concept settings, the priorities of spatial development and strategic directions for their realization were determined: 1. Sustainability of spatial organization 1.1. Optimizing the settlement system 1.2. Coordination of the development of cities and their functional regions 1.3. Developing pleasant and orderly cities 1.4. Improving the vitality and attractiveness of rural areas 1.5. Sustainable development and use of the coastal area 1.7. Improving the availability of infrastructure systems 1.8. Moderate use of space 2. Preservation of the identity of the space 2.1. Sustainable development of protected nature areas and ecological network areas 2.2 Preservation and sustainable use of cultural heritage 2.3. Improving the quality of construction and space design 2.4. Affirmation of landscape features and values 3. Traffic availability 3.1. Developing the transport system 4. Development of the energy system of the Republic of Croatia and connection with the European one 4.1. Increasing and improving the security of energy supply 4.2. Development of energy production, transmission, transport, storage, distribution and supply 4.3. Increasing the share of renewable energy sources 4.4. Further connection to the EU and international energy networks 5. Resistance to change 5.1. Adaptation to climate change 5.2. Strengthening natural capital by planning the development of green infrastructure 5.3. Increasing energy efficiency 5.4. Sustainable waste management 5.5. Sustainable management of mineral raw materials 5.6. Adapting to changes in business conditions 5.7. Developing sustainable tourism	The strategy aims to achieve economic growth with low greenhouse gas emissions. It opens up opportunities to stimulate economic growth through innovation, transfer of advanced technologies and structural changes while mitigating the consequences of climate change. The general goal of the 4th Strategy "Increasing the security of energy supply, sustainability of energy supply, increasing energy availability and reducing energy dependence" is directly achievable through the development of the potential of geothermal energy as a step towards its more frequent use. Developing the potential of geothermal energy brings closer and leads to the realization of several priority goals of the Strategy in question. The development of this resource is defined as the possibility of solving the problem of energy efficiency, strengthening the priority and importance of renewable energy sources in industry, heat and electricity production, reducing greenhouse gas emissions and using fossil non-renewable energy sources whose products are other forms of environmental pollutants, as well as the development of new knowledge and business opportunities in areas affected by economic and demographic degradation processes. Through the above, it contributes to the overall or realization of the segments and is aligned with the priorities: 1.3, 1.6, 1.8, 4.1, 4.2, 4.3, 5.1, 5.3. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Spatial Development Strategy of the Republic of Croatia.
Transport Development Strategy of the Republic of Croatia for the period from 2017 to 2030 (Official Gazette 84/17)	
The strategy represents the starting point in the new process of planning the transport development of the Republic of Croatia. The general goal of the Transport Development Strategy of the Republic of Croatia is to achieve an efficient and sustainable transport system on the territory of the Republic of Croatia. When defining the key indicators of the success of the Transport Development Strategy, which will follow the implementation plan, the goals determined by European guidelines in the areas of mobility and transport infrastructure, operability and sustainability were followed.	By considering and finally using the potential of geothermal energy, it is possible to contribute to the goals of the Strategy in question, which are based on energy efficiency and reducing the impact and pressure of transport infrastructure on the environment. By producing a greater share of electricity from renewable sources, the need for its production by other less environmentally acceptable methods is reduced in order to satisfy the upcoming and existing needs for electricity in the transport infrastructure. Greater and more sustainable

	availability of electricity through the use of geothermal potential, also potentially a greater share of the use of electric vehicles and category L vehicles due to greater accessibility, which has a positive effect on environmental protection, climate change and air quality. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Transport Development Strategy of the Republic of Croatia for the period 2017 - 2030.
Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 25/20)	
The goal of the Strategy is to build a system of balanced development of the relationship between security of energy supply, competitiveness and environmental protection, which will provide Croatian citizens and the economy with quality, safe, affordable and sufficient energy supply. The development guideline for the renewable energy sector is greater use of renewable energy sources. The Republic of Croatia adopts the goal that in 2030 the share of renewable energy sources in gross direct energy consumption will amount to 36%. The achievement of this goal will be achieved by the achievement of sectoral goals, one of which is: in the total production of electricity, the share of electricity from renewable energy sources will be 61%.	In accordance with the provisions of the existing Law on the Exploration and Exploitation of Hydrocarbons and the adopted Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050, the exceptional importance and key role of geothermal energy as one of the leading world trends in further strengthening the domestic and more competitive economy, developing technology is recognized and decarbonization of the energy sector. Geothermal energy is self-sustaining and the only basic renewable energy with the highest energy efficiency coefficient compared to other renewable energy sources. The implementation of geothermal projects of wide application (electricity production and/or heating and greenhouse production) will contribute to strengthening the independence and energy independence of local and regional self-government units and will enable the sustainable development of society and the transition to low-carbon activity. Underutilized geothermal potential represents an energy milestone in achieving a faster transformation into a green and sustainable economy, reducing greenhouse gas emissions and achieving a greater share of energy obtained from renewable energy sources in accordance with the goals of national legislation and the acquis of the European Union. From the above, it is possible to conclude that the subject Plan and aspirations towards the establishment of infrastructure for the use of geothermal resources will enable the achievement of the goals of the energy transition and contribute to the achievement of the comprehensive general goal of the subject Strategy. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050.
Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21)	

The focus of the low-carbon strategy is to reduce greenhouse gas emissions and prevent an increase in their concentration in the atmosphere and consequently limit global temperature rise. The strategy paves the way for a transition towards a sustainable competitive economy, in which economic growth is achieved with low greenhouse gas emissions. The goals of reducing greenhouse gas emissions until 2030 and 2050 will be implemented in the Republic of Croatia (hereinafter: the Republic of Croatia) within the framework of the political framework adopted by the European Union (hereinafter: the EU). The general objectives of the Strategy are: • Achieving sustainable knowledge-based development and a competitive, low-carbon and resource-efficient economy • Increasing security of energy supply, sustainability of energy supply, increasing energy availability and reducing energy dependence • Solidarity by fulfilling the obligations of the Republic of Croatia according to international agreements, within the framework of EU policy, as part of our historical responsibility and contribution to global goals. • Reduction of air pollution and impact on health.	Geothermal energy as a permanent and safe source of renewable electricity and thermal energy can provide a concrete contribution to achieving low-carbon goals. The reconstruction and expansion of the heat system network of large cities will enable the connection of new customers, the integration of high-power heat pumps and geothermal sources while reducing technical losses, the creation of prerequisites for low-temperature operation of heat systems, and the wider use of remote systems for heating and cooling needs. Also, geothermal power plants are considered extremely competitive within the framework of the Strategy. According to estimates of existing geothermal sources, the potential of the Republic of Croatia is over 1GW from geothermal energy. From the above, it follows that the Plan is in accordance with the development directions and strategic goals of the Low Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050.
Integrated national energy and climate plan for the Republic of Croatia (for the period from 2021 to 2030)	
The key goals presented in the Integrated Energy and Climate Plan are the goal of reducing greenhouse gas emissions for the Republic of Croatia in 2030, the share of RES in gross direct energy consumption and energy efficiency, expressed as primary energy consumption and direct energy consumption. The goal of reducing greenhouse gas emissions for the Republic of Croatia for the year 2030 is set by Directive (EU) 2018/410 of the European Parliament and the Council of March 14, 2018. The main dimensions that lead to the stated goal are listed in the Plan as the main national goals: Dimension: decarbonization Dimension: energy efficiency Dimension: energy security Dimension: internal energy market Dimension: research, innovation and competitiveness	Using geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a positive impact on the environment. In this way, geothermal water for energy purposes contributes to the goals of the Integrated National Energy and Climate Plan through the measure of increasing the efficiency of the heating system. Geothermal waters are one of the renewable energy sources whose contribution is incorporated in the achievement of the goals of the Strategy and the transition to a low-carbon economy. Geothermal energy contains all the key elements of shaping the national green policy contained in the five dimensions of the energy union listed as goals within the Plan in question. Also, with geothermal water of high enthalpy, it is possible to use cascading energy, and in addition to the production of electricity, it is possible to use cascading the remaining thermal energy of geothermal water for different purposes (heating, space heating, dryers, aquaculture, etc.). Such systems increase the efficiency of geothermal plants, and thus the economy of the entire geothermal project. By using energy from renewable energy sources, the interests of the Republic of Croatia in the field of energy are realized in terms of achieving the national goal of at least 36.6% of renewable energy sources in the final energy consumption by 2030 in the Republic of Croatia. According to the Strategy, it is necessary to encourage the use of geothermal energy through new exploration activities and exploitation, and in order to increase the share of renewable energy sources for the needs of electricity production and especially for heating and cooling, that is, the development of the heating industry. What the Plan in question also potentially contributes to. It follows from the above that the Plan is in accordance with the development directions and strategic goals of

	the Integrated National Energy and Climate Plan for the Republic of Croatia (2021-2030).
Waste management plan of the Republic of Croatia for the period 2017-2022 (Official Gazette 3/17, 1/22)	
The basic task of the Plan in the mentioned period is to organize the implementation of the main goals of the Strategy set for the period 2005 to 2025 in the field of waste management in the Republic of Croatia, namely: • establishment of a complete waste management system, • rehabilitation and closure of existing landfills, • rehabilitation of "black spots", location in an environment heavily burdened with waste, • development and establishment of regional and county centers for waste management, with waste pre-treatment before final disposal or disposal and • establishment of complete computerization of the waste management system.	The development of the potential of geothermal sources in the Republic of Croatia contributes to the reduction of waste by reducing the need for energy production in alternative, less environmentally acceptable ways that generate waste material such as nuclear waste, waste from thermal power plants, etc. Also, the establishment of a high-quality and wide network of geothermal energy use enables an alternative and a modern way of heating households, which reduces the amount of packaging waste and accompanying contents of firewood by burning. The establishment of modern and sustainable and renewable sources for the production of electricity favors the goal of the plan in question to reduce emissions of waste substances into the environment. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Waste Management Plan of the Republic of Croatia for the period 2017-2022. years
National forestry policy and strategy (OG 120/03)	
The general goal of the policy and strategy is to increase the contribution to the national economy through sustainable management, use and comprehensive protection of forest resources and biodiversity, applying research results, respecting international norms and resolutions, and respecting the rights of local communities. The national forestry policy and strategy is divided into the following areas: A. Management of forest ecological systems; B. Forest administration and legislation; C. Non-timber products – tourism, hunting and other products of forests and forest land; D. Wood industry; E. Environment and spatial planning; F. Education, research and international cooperation; G. Public relations and publicity. Each of these areas is presented with a general introduction and policy considerations. In addition, within the strategy, policy goals and specific strategic activities necessary for their realization are elaborated.	Nowadays, especially in parts of Croatia with a lower degree of economic and spatial development, firewood still accounts for a high proportion of primary energy production. Given that the mentioned form of obtaining heat energy is classified as one of the economically and cost-effective ones, consideration of energy potentials and integration and implementation of modern technologies for obtaining heat energy from geothermal water, primarily in larger urban areas, would facilitate housing and mitigate climate change , led to less occupation of forest areas and sustainability of production (timber industry - dryers). It follows from the above that the Plan is in accordance with the development directions and strategic goals of the National Forestry Policy and Strategy.
Climate change adaptation strategy of the Republic of Croatia until 2040 with a view to 2070.	
The subject strategy states as facts of priority importance the initiation of the social process of accepting the concept of adaptation to climate change, determining the effect of climate change on the Republic of Croatia, determining the degree of vulnerability and determining priority action measures. In other words, it is necessary to strategically approach the process of adapting to the reality of climate change and take advantage of the opportunities they present through the development and application of innovative solutions for sustainable development. Through the European Green Plan (2019), a strategic approach is set in solving the problem of the impact of climate change through the adoption of a new EU	The consideration and formation of the infrastructure for the use of geothermal sources directly fits with the answers to the questions and challenges of the causes of climate change in the energy sector through: - Ensuring an encouraging legal framework for the use of renewable energy sources with the aim of diversifying sources and increasing the decentralized production of electricity and thermal energy - Strengthening model predictive technologies for the assessment of resource bases for renewable energy sources

strategy for adaptation to climate change. It is important to ensure that adaptation measures to climate change also contribute to the reduction of greenhouse gas emissions. The adaptation strategy sets a vision: Croatia is resistant to climate change. In order to achieve this, the following goals were set: (a) reduce the vulnerability of natural systems and society to the negative impacts of climate change, (b) increase the capacity to recover from the effects of climate change and (c) take advantage of potential positive effects, which may also result from climate change. The adaptation strategy determines priority measures and coordinated action through short-term action plans and monitoring the implementation of measures.	- Consideration of integration and the possibility of using renewable energy sources in rural areas, such as micro-installations in agriculture and production Due to the change in the annual amount of precipitation, the problem of less electricity production appears. of energy in hydroelectric power plants, therefore the Plan in question moves towards the integration of alternative sources of electricity and insurance against energy poverty in the future. The formation of new sources of electricity provides a new source and a catalyst for the further development of switching to electricity as a means of driving vehicles, which directly reduces the impact of motor vehicles on climate change. Also, by switching to modern and sustainable forms of obtaining electricity, such as geothermal power plants, the need for plants that affect the environment by emitting fossil fuel combustion products, i.e. greenhouse gases, is reduced. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Climate Change Adaptation Strategy of the Republic of Croatia until 2040 with a view to 2070.
National Recovery and Resilience Plan 2021-2026	
The National Recovery and Resilience Plan contributes to and strives to achieve four general goals: promoting economic, social and territorial cohesion in the Union, strengthening economic and social resilience, reducing the social and economic effects of the crisis and encouraging the green and digital transition. Within Component 1 of the Plan entitled Economy, among the main general objectives are the following objectives: 2. Reduce the environmental footprint of energy production and consumption, reduce air pollution in cities, improve and digitize the energy infrastructure and objective 5. Create preconditions for a more sustainable use of natural resources and more competitive production in agriculture.	As part of NPOO, component 1. Economy, sub-component Energy transition for a sustainable economy, a reform of the decarbonization of the energy sector is planned. Geothermal energy and its potential enable the implementation of renewable energy projects for end users, especially those in private households, and an active approach to removing obstacles to the further implementation of high-efficiency heating systems based on renewable energy sources. This also requires a strong sectoral connection. By utilizing the potential of geothermal energy, it is possible to achieve the set goals related to reducing CO2, increasing the share of RES in total energy consumption, and increasing energy efficiency, which was committed to in the National Energy and Climate Plan. By setting up and introducing a new electric power infrastructure at the transport and distribution level, which enables the reception of a large amount of energy from renewable sources, the stability of the system is enabled. With further construction and investment in energy efficiency, the effect of the use of geothermal energy is further strengthened and thus turns to renewable sources and sustainable heating, which indirectly achieves economic savings both in industry and in housing. With the mentioned investments and complementary goals of the subject National Plan and the subject Study Plan in energy-efficient production processes and industry, small and micro cogeneration, heat pumps, strengthening the potential for the use of geothermal energy in heating, the potential for commercialization of the use of

	thermal energy obtained from renewable sources is increased in full scope. By additionally connecting the above with infrastructure programs for energy efficiency in buildings, the full economic potential is realized. By switching small consumers from fossil fuels to renewable energy sources and encouraging the construction of heating systems that will replace individual, often less profitable heating and cooling solutions. The aforementioned enables saving of energy and resources, accelerated development of a sustainable economy and reduction of energy poverty. It is also possible to reduce the import of energy into Croatia and the EU and to make better and more appropriate use of the internal energy potential. It follows from the above that the Plan is in line with the development directions and strategic goals of the National Recovery and Resilience Plan 2021-2026.
National strategic plan for the development of aquaculture for the period 2014 to 2020	
The National Strategic Aquaculture Development Plan (abbreviated as: NSPA) establishes the objectives and priorities of aquaculture development for the period in question. Among the general objectives of the document are: strengthening the social, business and administrative environment for the development of aquaculture, improving the perception and increasing the national consumption of aquaculture products, as well as increasing employment in aquaculture while contributing to the development of local communities. simplifying administrative procedures, ensuring sustainable development and growth through coordinated spatial planning and securing the necessary locations for cultivation, strengthening competitiveness, especially through connecting science and the sector and ensuring equal market competition.	The plan indirectly promotes and enables the achievement of the goals of the National Strategic Aquaculture Development Plan for the period 2014 to 2020. By strengthening the competitiveness and independence of the Republic of Croatia in terms of electricity and by making it easier and more accessible to switch and use means of transport based on sustainable and cleaner forms of energy, the burden of pollution of water bodies in the Republic of Croatia is reduced. The risk of accidental spills of polluting substances into waterways and environmental disasters is reduced. Also, by producing electricity in more sustainable ways, the generation of CO2 is reduced, and thus the pressure on the sea, which, for example, mitigates the acidification of the sea. In addition, the achievement of the objectives of the Plan in question directly affects the mitigation and slowing down of climate change, the rise in sea temperature and the impact on aquaculture and ichthyofauna are stopped. It follows from the above that the plan is in accordance with the development directions and strategic goals of the National Strategic Plan for the Development of Aquaculture for the period 2014 to 2020.
Strategy and action plan for nature protection of the Republic of Croatia for the period from 2017 to 2025	
Preservation of nature and human environment represents the highest values of the constitutional order of the Republic of Croatia and is the basis for the interpretation of the Constitution. The strategy is a fundamental document of nature protection, which determines long-term goals and guidelines for the preservation of biodiversity and geodiversity, as well as the manner of its implementation. It has five strategic goals that are aligned with the European Union Biodiversity Strategy until 2020: Increase the effectiveness of the basic mechanisms of nature protection Reduce direct pressure on nature and encourage sustainable use of natural resources Strengthen the capacities of the nature protection system Increase knowledge and availability of information about nature Raise the level of public knowledge, understanding and support for nature protection	About 62% of all threats to the vascular flora in the Republic of Croatia relate to the loss and/or degradation of habitats due to anthropogenic influences, and wetland habitats, such as bogs, are especially threatened. Underground habitats and species are extremely sensitive and threatened by external influences. Renewable energy sources (RES), due to their almost neutral CO2 balance, are key to overcoming and mitigating climate change, which represents one of the greatest threats to biodiversity on a global scale. Renewable energy sources such as geothermal waters greatly contribute to the decarbonation of energy sources and thereby contribute to economic development on the one hand, while on the other hand they mitigate the warming of the Earth's atmosphere. In addition to the above, plants using geothermal potential

The second strategic goal is achieved by maintaining their potential in order to meet the needs to fulfill, now and in the future, appropriate ecological, economic and social functions at the local, national and global levels.	as a substitute for fossil fuel power plants or other more environmentally acceptable forms of power plants occupy a smaller space and are not necessarily directly related to localities where endangered species live. Through the above, it is evident that the Plan directly contributes to the strategic objective of the 2nd strategy in question. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Strategy and Action Plan for Nature Protection of the Republic of Croatia for the period from 2017 to 2025.
Energy renovation programs	
Program for energy renovation of family houses for the period 2021-2030. The goal of the Program is to increase the energy efficiency of existing houses, reduce energy consumption and CO2 emissions into the atmosphere, and reduce monthly costs for energy sources, with an overall improvement in the quality of life. At the same time, the planning of such operations implies the involvement of local companies and experts, that is, it encourages economic activity. Program of energy renovation of public sector buildings for the period 2021-2030. Energy renovation program of buildings with the status of protected cultural property for the period 2021-2030. Program for energy renovation of multi-apartment buildings for the period 2021-2030. The goal of the program is to direct the segment of multi-apartment buildings, buildings with the status of protected cultural property and energy renovation of buildings within the housing stock and other purposes to more modern systems for thermal needs, i.e. for heating and cooling the space and preparation for hot water consumption and more efficient use of thermal energy.	The subject plan and the potential of geothermal energy in achieving the goals of the energy renovation program of family houses have the potential to contribute to a significant reduction in the use of fossil fuels and to achieve energy self-sufficiency. The mentioned potential can be realized through the encouragement of individual projects and the emphasis on locally available energy sources. Using geothermal energy in households significantly reduces the cost of space heating, reduces the use of fossil fuels and other forms of space heating. The benefits of building renovation, including multi-apartment buildings, are multiple. In addition to the direct energy (reduction of energy consumption, reduction of energy imports, increase in the use of renewable energy sources and decarbonization of energy systems), climate (reduction of CO2 emissions), economic (construction and production activity, employment) and budget effects, it is certainly worth highlighting the reduction of risks from harming health and poverty and increasing the value of real estate and protection against future increases in energy prices. For the aforementioned, geothermal potential and the possibility of using geothermal water as an innovative solution in heating residential and public buildings play a potentially large role. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Energy Renewal Program
Agriculture strategy for the period from 2020 to 2030	
The Agriculture Strategy provides a vision and implementation plan for the strategic transformation of agriculture and rural areas in Croatia for the period 2020-2030. The agriculture strategy shows the opportunities, goals, needs and targeted interventions for the transformation of the agricultural and food sector in Croatia. The strategy is focused on exploiting key development opportunities for the Croatian agri-food sector and establishing a results-based management framework in which goals, needs and interventions are explicit and evidence-based.	The subject strategy within the strategic objective 1. Increasing the productivity and resistance of agricultural production to climate change defines the key need 2. to improve the environmental sustainability of agricultural practices. In order to achieve the stated goal, the need to encourage and develop new models of transfer and adoption of the best knowledge, practices, technologies and innovations in agriculture is stated. These models include, among other things, agricultural practices adapted to climate change and reduction of greenhouse gas emissions, efficient use of renewable energy sources. The Plan in question and the implementation of a further lower hierarchy of related plans will ensure Croatia's greater competence on the EU scale in terms of productivity and the use of natural resources and

	renewable energy sources for the purpose of agriculture. The need for and dependence on fossil fuels during production at lower temperatures will decrease and the sustainability of production will increase. The potentials of geothermal energy for agriculture and their appropriate exploitation will enable survival and production in an increasingly strict regulatory framework in the agricultural sector. Also within Horizontal Objective IV. Encouraging innovation in the agri-food sector as a key need for the achievement of the 14th goal is the encouragement of investment in technology and innovation. By establishing stronger ties between scientific institutions and the agricultural and food sector, and directing larger private investments in applied research, a better picture of technological development and innovation in Croatia is ensured at the EU level. It is easy to calculate that the use of geothermal energy can significantly reduce space heating costs and indirectly increase the competitiveness of producers on the market, especially in the case of intensive cultivation of classic agricultural crops where heating makes up a high proportion of total costs. "Maintenance of the geothermal heating system is not complex, and the economic advantages are great. Geothermal energy represents a huge potential for the agricultural sector and its further development, especially because numerous deposits of lower temperatures where it would not be worthwhile to build geothermal power plants can be used for heating projects. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Agriculture Strategy for the period from 2020 to 2030.
The water area management plan (2016-2021) was created on the basis of the Water Act (Official Gazette 153/09, 63/11, 130/11, 56/13 and 14/14), which prescribes: Water management planning documents, Plan water area management and flood risk management plan. The document is a continuation of the first Water Area Management Plan (OG 82/13) adopted by the Government of the Republic of Croatia for the planning period from 2013 to 2015. Water area management plan 2016-2021. consists of two components of water area management: − water condition management − flood risk management. In the period from 2016 to 2021, it is planned to implement 269 different measures with the aim of achieving at least a good water condition.	As part of the Plan, it is stated that it is necessary to prevent the possibility of thermal pollution of surface streams by chemical and thermal adaptation of water when it is discharged into them. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems. The quality of such waters meets the conditions prescribed by the Water Act (Official Gazette 66/19). In addition to the aforementioned potential of transition to sustainable forms of heat and electricity generation, represented by geothermal waters, consequently, by reducing the use of fossil fuels in industry, housing, transport, etc., it can reduce water pollution, reduce the proportion of acid rain, and stop the discharge of waste into surface streams. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Water Area Management Plan 2016-2021.
Tourism development strategy of the Republic of Croatia until 2020	

The strategy is a document that strives to ensure the integration of the Republic of Croatia into the consolidated policy of the European Union, and represents a complete conceptual framework that enables: Coordinated action of tourism policy holders and systematic harmonization of tourism policy measures. Comprehensive understanding of the key directions of development of Croatian tourism as a prerequisite for attracting the interest of potential domestic and foreign investors Targeted guidance of the development-investment process and efficient withdrawal of EU funds The strategy also states that the EU sees the Republic of Croatia as a tourist destination with potential, and the task of the Republic of Croatia is to make the most of this status through development using the values of the sustainable development system. Measure 14 of the Strategy, entitled Action Plan for the Development of Health Tourism, states that it is necessary to develop forms of health tourism, which can be achieved through geothermal sources. Also, as an important step, he cites changes to the existing legal regulations related to the equal approval of concessions for the use of geothermal sources and other natural healing agents to all interested public and private investors.	The objectives of the Plan and its further elaboration directly affect the change in legal regulations and the easier and more efficient use of geothermal sources for energy purposes as well as for tourism purposes. "Waste" water, which is a product of the production of heat or electricity from geothermal sources, has the potential to be repurposed or used for the purpose of establishing a form of health tourism (spa with geothermal heated water). Thermal energy made possible by geothermal sources has the potential to establish a wider range of forms of health tourism in the research area. Also, through the Plan and its implementation, the potential for decentralization of tourism within the Republic of Croatia is formed by raising the competitiveness of the northern Republic of Croatia through the establishment of the aforementioned forms of tourist offer. Geothermal sources also offer the potential of supplying tourist facilities with electricity and thermal energy with almost no greenhouse gas emissions. The mentioned opportunities provided by geothermal potential are directly related to the aspirations of building a tourist offer based on the principles of sustainable development. It follows from the above that the Plan is in accordance with the development directions and strategic goals of the Tourism Development Strategy of the Republic of Croatia until 2020.

2.1 Spatial plans

Pursuant to the provisions of Article 67, Paragraph 1, Point 4 of the Spatial Planning Act (Official Gazette, No. 153/13, 65/17, 114/18, 39/19 and 98/19), the basic document defining the zones intended for the exploration and exploitation of mineral raw materials is the State Spatial Development Plan. The process of drafting and adopting the said plan and the process of strategic assessment of its impact on the environment is underway. Until its adoption, the exploration areas and exploitation fields of geothermal water, as well as the criteria for the implementation of interventions for the purpose in question, are determined by regional and local spatial plans. In the case when the spatial plan of the county stipulates immediate application of these interventions, it becomes implementing.

Spatial plans of counties are the basic documents of the spatial organization of regional self-government units. They work out the goals of spatial planning and determine the rational use of space in accordance and to the greatest extent possible with neighboring counties, spatial development and protection of space.

The spatial plan of the county, according to the Spatial Planning Act (OG 153/13, 65/17, 114/18, 39/19, 98/19), prescribes:

- the conditions for implementation of interventions in the space for public, social and other buildings of local (regional) significance,
- the conditions for the implementation of interventions in the area of regional (regional) importance, which according to the special regulations governing construction are not considered construction,
- guidelines for the creation of urban development plans on separate construction areas outside settlements for economic and public purposes of regional (regional) significance.

Pursuant to the provisions of Articles 8 and 44 of the Law on Exploration and Exploitation of Hydrocarbons, and for the purpose of effective implementation of the Plan, it is necessary to ensure spatial planning basis, in terms of clear and unambiguous spatial planning provisions at the local and regional level. Also, it is important to achieve their mutual coordination, as well as the uniformity of the plans of the same levels, in such a way that in every planned change and/or addition to any spatial plan, one actively participates, or initiates the change of the plan for the purpose in question.

Bjelovar-Bilogora County (County Gazette of the Bjelovar-Bilogora County No. 2/01, 13/04, 07/09, 06/15, 05/16 and 01/19, 10/21-refined text
Article 47 The plan established the Velika Ciglena thermal water exploitation field. Various forms of resource use are possible - geothermal power plant, heating plant or for recreational purposes, with a prior assessment of the impact on the environment and a detailed elaboration of the way of using the space, respecting the basic guidelines and recommendations of this Plan. Article 60. (1) Mining in the Bjelovar-Bilogora County uses mineral resources (stone, gravel, sand, quartz sand, hydrocarbons, geothermal water, etc.), which are still not sufficiently explored and properly utilized for the development of the County. Exploitation and expansion of existing and future sites, as well as remediation of abandoned ones, is carried out according to the legal provisions and the provisions of this Plan: - the formation of new exploitation fields, at the locations determined by this Plan, will be realized on the basis of legal regulations, and in accordance with the principles of environmental protection, - exceptionally, PPUO/G can also plan new exploitation fields even if their location is not determined by this Plan, but only within the exploration areas determined by this Plan (only one exploitation field up to 10.0 ha in size per exploration area), - the area or part of the area of exploitation fields that are abandoned and closed must be rehabilitated, revitalized or repurposed in accordance with the prepared documentation based on the principles of environmental protection. (2) The facilities of economic activities (contents) related to the location of natural resources (mineral and non-mineral raw materials-energetics) should be located on the smallest possible construction areas (areas) while determining the rational size of the exploitation field.

Brod-Posavina County (Official Gazette of Brod-Posavina County No. 04/01, 06/05, 11/08, 14/08 - revised text, 05/10, 09/12, 39/20 and 45/20 - revised text)

Article 170.

The Spatial Plan of Brod-Posavina County enables the construction of facilities for the use of renewable energy sources. Within the construction areas of the settlement and the separated construction area, the Spatial Plan of the Brod-Posavina County allows the construction of facilities for the use of renewable energy sources and cogeneration, with an installed power of up to and including 3 MW. Power plants up to and including 3 MW are:

(…)

- geothermal power plants

and they can be built in zones of economic use defined in PPUO/G and marked as I or I1 or exceptionally K3. The Spatial Plan of Brod-Posavina County, and within the construction areas of settlements or separated construction areas, allows the construction of facilities for the use of renewable energy sources, with an installed power of 3 MW-15 MW, if they are marked and planned on the maps of PPUO/Gova.

Power plants from 3 MW-15 MW are:

(…)

- geothermal power plants

and the exact locations and location conditions for the mentioned facilities are defined in the cartographic representations and provisions for the implementation of PPUO/G.

The Spatial Plan of the Brod-Posavina County, and outside the construction area of the settlement, also allows the construction of facilities for the use of renewable sources, with an installed power of up to and including 3 MW, if they are marked and planned on the maps of PPUO/Gs. Power plants up to and including 3 MW. Plants with a power of 3 MW are:

- geothermal power plants, with a mandatory preliminary study of the potential of geothermal sources, and with the consent of Hrvatske vode

City of Zagreb (Official Gazette of the City of Zagreb 8/01, 16/02, 11/03, 2/06, 1/09, 8/09, 21/14, 23/14, 22/17 - purified text)

3.4. Exploitation of mineral raw materials

Medium-temperature water deposits of limited capacity have been identified in the City area, which can be used for heating buildings, and geothermal resources will continue to be explored and used in the City of Zagreb area (which can contribute to a better supply of the City with thermal energy).

Article 12.

Geothermal waters

The spatial plan enables the use of geothermal waters for energy purposes and balneological purposes from the exploitation field "Geothermal waters Zagreb" (Mladost, Clinical Hospital Novi Zagreb - KBNZ, i.e. the Blato and Lučko localities), based on the Study on the environmental impact of the intervention in the area (analyses meteorological, geological, hydrogeological, seismological, pedological, hydrological, bioecological and sociological parameters in order to determine the impact on biodiversity, geodiversity, impact on water, impact on soil, impact on air quality, impact on landscape, impact on cultural heritage, noise, waste, impact on economic features, impact on the population, and determining the risk of environmental accidents).

Karlovac County (Gazette of Karlovac County, number 26/01, 33/01 - correction, 36/08 - revised text, 56/13, 07/14 - correction, 50b/14, 6c/17, 29c/17 - revised text, 8a/18, 19/18 – refined text)
Article 5. 5.5. Exploitation of mineral raw materials is an activity related to the research and exploitation of organic and inorganic mineral raw materials, which presupposes that the location of the activity is most often related to the sites. (…) 5.5.3. Areas for the exploitation of mineral raw materials (exploitation fields of geothermal water, stone, clay, etc.) will be arranged in accordance with concession decisions and spatial planning plans of municipalities and cities with strict supervision of remediation of the impact of these activities.

Koprivnica-Križevačka County (Official Gazette of Koprivnica-Križevačka County" number 8/01., 5/04.-correction, 9/04.-credible interpretation, 8/07., 13/12., 5/14.,3/ 21. and 6/21-refined text)
Article 4. 2.3.2. Energy buildings (…) Planned power buildings: ...Geothermal power plants in Antolovac, Legrad and Zablatje (…) 2.4.1. Exploration and exploitation of mineral raw materials - exploration areas of geothermal water for energy purposes, for which tenders were held, Lunjkovec-Kutnjak, Legrad-1 and Križevci, can be converted into exploitation fields without changing this Plan - areas that are planned for exploration and exploitation of geothermal water for energy purposes, but tenders have not been carried out are: Slanje, Križevci Vratno, Leščan, Dravka and Ferdinandovac-1 - existing exploitation fields of hydrocarbons within which tenders for exploration and exploitation of geothermal waters for energy purposes can be conducted - the potential area intended for the exploration and exploitation of geothermal water is the entire area of Koprivnica-Križevačka County (…)

2.4.2. Buildings for exploitation of hydrocarbons and geothermal water for energy purposes

- exploitation wells of hydrocarbons and geothermal water within the limits of approved exploitation fields of hydrocarbons and/or geothermal water

Article 5.

3.3.1. ...Mineral raw materials are a non-renewable resource, important for the Republic of Croatia, and in the area of Koprivnica-Križevačka County there are rich deposits of: - energy mineral raw materials: hydrocarbons - oil and gas, and geothermal water.

3.3.1.2. Geothermal water research

Research works and activities aimed at determining the state of geothermal water reserves can be carried out in the entire area of Koprivnica-Križevačka County. Tenders were held for the established exploration areas, Lunjkovec-Kutnjak, Legrad-1 and Križevci, and the most favorable bidders were selected and issued exploration permits. By analyzing the existing well data of old oil and gas wells (Križevci Vratno-1, Dravka 1, Ferdinandovac-1D and Ferdinandovac 8, MOL-32, Leščan-1, Gotalovo and others), areas planned for exploration and exploitation of geothermal water have been identified for energy purposes, but tenders were not carried out, namely: Slanje, Križevci, Vratno, Leščan, Dravka and Ferdinandovac-1. Tenders for the exploration and exploitation of geothermal water for energy purposes can be held for areas within the existing exploitation fields of hydrocarbons or after the cessation of exploitation of hydrocarbons, that is, they can be considered as potential exploitation fields of geothermal water for energy purposes. Exploration areas and parts of exploration areas of geothermal water for energy purposes and existing exploitation fields of hydrocarbons, or their parts, may, without amending this Plan, be converted into exploitation fields of geothermal water for energy purposes, if the said areas meet the corresponding prescribed requirements, provided that in accordance with the regulations on exploration and exploitation of geothermal waters and the basic guidelines from this Plan. Exploitation fields of geothermal water can be equal to or smaller than the specified areas. Additional environmental protection measures and ecological networks for preventing, reducing and mitigating potential negative impacts are determined for the areas where investigation works are planned:

- Carry out biological recultivation of well working areas and areas affected by oil and mining operations in accordance with verified oil and mining documentation.

- Geothermal water research should be directed so that a "closed system" is used during exploitation, i.e. that the used geothermal water is not discharged into a recipient on the surface but returned to the deposit.

- If a "closed system" is not used, it is necessary to ensure that the temperature of the released used geothermal water does not deviate from the temperature of the recipient, and the water quality corresponds to the values determined by the relevant regulations.

3.6. The development of tourism is based on the document "Strategic Marketing Plan of Tourism of Koprivnica-Križevačka County", and from the point of view of the use of space and planning of content in the space, it is related to: ... areas suitable for rest, sports and recreation: ... - geothermal waters: Ferdinandovac (Dravka 1, F1D, F8), Repaš (MOL-32), Đurđevac (Leščan), Kutnjak-Lunjkovec, Legrad, Gotalovo, Križevci (Križevčanka 1), Đurđevac Podravina fields.

Article 8.

6. Conditions (functional, spatial, ecological) for establishing traffic and other infrastructure systems in the area

6.2.14. Renewable energy sources

The plan envisages the use of renewable energy sources depending on the natural and economic potential of the county. Renewable energy sources mean solar energy, energy from biomass, energy from bioliquid, hydro energy, geothermal energy, gas energy from waste landfills, gas energy from waste water treatment plants and biogas, biodegradable part of certified waste for energy production in an economically appropriate way , in accordance with environmental and nature protection regulations.

Buildings for the use of energy from geothermal sources are recommended to be built in locations where the existence of reserves has been determined through investigation, and are located near major consumers of thermal energy, and it is possible to meet the necessary criteria for connection to the power grid. The locations of these buildings will be planned using spatial plans of a lower order.

Article 13.

11.3. Areas and localities for research and monitoring of phenomena and processes in space

(...)

11.3.2. Deposits (deposits) of geothermal water - it is necessary to carry out further research and possibilities of use.

Krapina-Zagorje County (Official Gazette of Krapina-Zagorje County" number 04/02, 06/10 and 8/15)
The water of Krapinske Toplice is found in Torton limestone, and its temperature ranges from 40-45o C. Mineralization is about 320 mg/l of water. For the purpose of treatment, geothermal water in Krapinske Toplice has been used since the 18th century. 1.1.3.1. Obligations from the Spatial Planning Program of the Republic of Croatia (...) Geothermal waters represent an extremely important natural resource to which much more attention should be paid and optimal forms of use in the economy, energy, health and tourism should be found. Water management system Regarding the energy use of water, it should be noted that in the area of the Krapina - Zagorje County, i.e. in the basin of the Krapina and Sutla rivers, there are no hydropower steps that would be used for the production of electricity, and there are no development plans for such a form of water use. However, it should be noted that it is necessary to carry out research on the use of geothermal waters for energy purposes as well. 2.2.3.3. Development of transport and other infrastructure (...) Water use In the area of Krapina - Zagorje County, the exploitation of thermal-mineral waters, which are now used exclusively as medicinal baths and for the purpose of health-recreational tourism, plays a more significant role. For the area of Krapina - Zagorje County, it would be expedient to study the geothermal water potential and its wider use for thermo-energy purposes and agricultural purposes (growing vegetable crops, flowers, etc.). 3.6.3. Energy system The planned energy consumption in the Republic of Croatia, foreseen by the Energy Development Strategy (PROHES), can be met by using conventional energy sources until 2015. Until then, research necessary to make

decisions on the justification and suitability of building alternative energy sources in Croatia (geothermal, solar, wind, tidal, bioenergy, etc.) should be continued.

(…)

The Zagorje region, which covers the territory of the County, is rich in natural geothermal sources, and in this regard, it would be necessary to carry out additional investigative work to find out about the cost-effectiveness of using geothermal energy.

Conditions for determining the area of buildings of importance to the State

B.3. Buildings for the exploitation of mineral raw materials

(…)

- buildings for the exploitation of geothermal waters

10.13. Environmental impact assessment

The obligation to carry out the environmental impact assessment procedure is also prescribed for the following buildings and operations:

(…)

buildings for the exploitation of geothermal and thermomineral waters for energy, medicinal, tourist - recreational and catering purposes

11.3. Areas and locations for research and monitoring of phenomena and processes in space

(…)

Sources of geothermal water - it is necessary to carry out further research and possibilities of use.

Međimurje County (Official Gazette of Međimurje County" number 7/01, 8/01, 23/10 and 7/19)

Article 16.

Existing buildings:

(...)

Exploitation fields and research areas of energy mineral raw materials and mining facilities and facilities in the function of research and exploitation

- exploitation fields of geothermal water "Lunjkovec - Kutnjak" and "Draškovec AATG"

Article 17

Exploitation fields of energy mineral raw materials and buildings in the function of exploitation

- research area of geothermal water "Kotoriba"

- hydrocarbon exploration area "Drava 2"

Article 18.

Exploitation fields of energy mineral raw materials

- planned possible exploitation field of Kotoriba and Merhatovec geothermal waters

Article 80.

Construction can be planned outside the construction area:

(...)

5) mining facilities and facilities in the function of exploration and exploitation of mineral raw materials (E3, E4), energy mineral raw materials (E1), and geothermal waters (E2) - conditions for accommodation are determined by Article 44 of these Provisions for Implementation

Conditions for planning buildings of a family farm and buildings in the function of rural tourism (on property 2.0 ha and more)

- interventions can be planned in areas of lesser natural value, outside the established localities of habitat types and habitats important for target species within the ecological network - "Natura 2000",

- interventions cannot be planned on agricultural land P1 and forest land

- for the planned intervention, a building plot must be formed, with the condition that it is possible to connect to the public traffic area and to infrastructure of a minimum scope

Article 44.

(...)

Exploitation of energy mineral raw materials and geothermal waters (E2)

Research work on hydrocarbon deposits in the area of Međimurje County resulted in the newly determined boundaries of already existing exploitation fields. In addition to the established exploitation fields of hydrocarbons,

in Međimurje County there are the exploitation fields of geothermal water "Lunjkovec - Kutnjak" and "Draškovec AATG", as well as the exploration areas of hydrocarbons "Drava 02" and geothermal water "Kotoriba". Exploitation of energy mineral raw materials E1 and geothermal waters E2 In order to protect endangered habitats that significantly contribute to the preservation of biodiversity in the area of Međimurje County, and are part of the European ecological network Natura 2000, it is necessary to prescribe conditions for the performance of mining operations in the function of research and exploitation of hydrocarbons and geothermal waters. 3.5.5. Construction outside the construction area (...) 2. Buildings in the function of exploitation of mineral raw materials (E3 and E4), mining facilities and plants in the function of research and exploitation of energy mineral raw materials (E1) and geothermal waters (E2) can be built outside the boundaries of the construction area of the settlement and areas exempted from construction. When choosing the location of mining facilities and facilities, it is necessary to avoid areas of forests and forest land as much as possible, and if they are located within the "Natura 2000" area, interventions must be planned in such a way as to avoid or reduce the permanent occupation of the habitats of endangered and rare species. It is not possible to plan the aforementioned interventions within the recorded protected archaeological zones. A mining procedure for the exploitation of geothermal waters that serves a specific purpose related to the use of thermal waters, Exploitation of geothermal waters (E2) is carried out for tourist purposes in the locality of Vučkovec, while in the locality of Draškovec it is planned to be used for several purposes. Investigative works at the sites of Merhatovec and Kotoriba have established the great potential of geothermal waters that can be used for multiple purposes. The extent of the excavation where the mining excavation is located in the area in the function of exploration and exploitation of hydrocarbons - wells for the exploration and exploitation of energy mineral raw materials, can be located within the exploitation field, and outside the construction area of the settlement and areas exempted from construction at distances of at least: - 70 m from a residential building, sports and recreation zone, tourist zone, cemetery, protected or registered cultural property, - 100 m from protected areas - 50 m from categorized roads - 250 m from watercourses that flow into the Mura river The scope of the intervention in the space in the function of hydrocarbon research and exploitation can be located in such a way as to avoid forest land as much as possible, and to avoid or reduce the permanent occupation of threatened and rare habitat types and habitats important for the target species within the ecological network - Natura 2000, and it must not be located within registered and protected archaeological zones. Mining operations in the area for the purpose of exploration and exploitation of geothermal water can be approved subject to the restrictions specified in paragraphs 2 and 3 of this article, and exceptionally it can be approved within the construction area of the settlement or a separate construction area outside the settlement, if the exploitation of geothermal water is in operation the zone in which it is located. The noise that can occur in the environment of residential and work buildings during the exploitation process must not exceed the limit values prescribed by a special law. Research works and activities aimed at determining the state of hydrocarbon reserves and geothermal waters can be carried out within the scope of the zones designated for carrying out research works.

Osijek-Baranja County (County Gazette of Osijek-Baranja County" number 1/02., 4/10., 3/16., 5/16., 6/16.-refined text, 5/20., 7/20 .-refined text, 1/21 and 3/21-refined text)
Article 50.

3.4. Areas and buildings for exploitation of mineral raw materials

(1) The use of mineral resources in the county area refers to valuable deposits of natural gas and oil and the exploitation of river sand and gravel, quartz sand, clay, cement marl, geothermal water and technical stone.

Article 51

Research areas and areas for exploitation of mineral raw materials cannot be established in: construction areas of settlements, nature areas protected according to a special regulation, unless such activities are permitted by the protection act, on particularly valuable agricultural land, except for energy mineral raw materials.

Article 52.

(1) All exploitation conditions must be subordinated to the rational use of the land and, in particular, environmental protection and rehabilitation measures must be implemented, both during use and after completion of use according to special regulations.
(2) It is necessary to avoid deforestation, and as a rule, existing roads and roads should be used for access.
(3) To transport raw materials, it is necessary to avoid using roads in the construction area of the settlement.
(4) The existing fields for exploitation of mineral raw materials within the construction areas of the settlement cannot be increased to the space within the construction areas of the settlement.
(5) At the end of the exploitation, it is necessary to carry out technical and biological rehabilitation of the area according to the mining project, that is, in accordance with the decision of the competent body for assessing the impact of the intervention on the environment if an assessment has been made for the exploitation field. If rehabilitation is not specified in the above-mentioned documents, the space must be rehabilitated and brought back to the purpose it was before exploitation. It is possible to determine the new purpose even in the plans of narrower areas.
(6) For the exploitation of mineral raw materials, apply a technological procedure that will prevent erosion of soil and river banks, harmful effects of water, as well as pollution of the surrounding soil, water and the environment in general.
(7) Abandoned areas of exploitation fields must be rehabilitated, and remediation must include ensuring the stability of the slopes and the surrounding terrain, as well as greening or other procedures for adaptation to the landscape and repurposing the areas for other uses (forests, meadows, water bodies, sports and recreational facilities, etc.).
(8) New areas for the exploitation of mineral raw materials can be formed within the framework of exploration areas based on projects according to a special regulation.

Article 146.

(4) Geothermal water, as a renewable source, has a great potential in the county and it is necessary to start using it as much as possible and as soon as possible for various purposes. When exploiting the geothermal potential of underground water, it is necessary to monitor the safety of the system from the aspect of water and soil pollution, and to use the potential sustainably.

(5) It is recommended to use geothermal energy for economic complexes and buildings in the function of agriculture, which, based on this plan, can be built outside the boundaries of construction areas, where the possibility of energy supply is difficult, and the proximity of a geothermal well is certain. In addition, geothermal wells are possible and recommended to be included in existing heating systems wherever the investment of inclusion is profitable in a realistic time frame.

Požega-Slavonia County (Official Gazette of Požega-Slavonia, number 05/02, 05A/02, 04/11, 04/15 and 05/19) and 2.2. Buildings of importance for the State and buildings of importance for the County

(…)

C. Energy buildings:

(…)

Power plants (plants) from renewable energy sources (wind, sun, biomass, geothermal energy, cogeneration, etc.) with a capacity of more than 20 MW

(…)

3.4. Exploitation of mineral raw materials:

(85.) The exploitation of mineral raw materials is related to the use of natural resources and these activities are located next to the deposits of raw materials. The utilization of geothermal water and mineral raw materials (peat, metals, non-metals, stone) is related to areas where the degree of potentiality of certain underground structures containing economically usable quantities is determined.

Existing exploitation fields of geothermal water:

JLS Lipik: EP Bolnica and EP Korita, JLS Pakrac: EP Bolnica, JLS Velika: EP Dubočanka

(…)

On the entire territory of the Požega-Slavonska County, it is possible to carry out investigative work and activities for the purpose of determining the possibility of exploitation of hydrocarbons or geothermal waters for energy purposes.

6.2.4. Renewable energy sources

(195c.) Geothermal energy can be used locally, because it is used mainly at production sites and for beneological purposes, for sports and recreation, agriculture, electricity production and heating. It can be used more widely if there is interest and the economic justification of such use is demonstrated, all the more so, because it does not require unknown technical and technological solutions, and is an ecologically clean process that has no negative impact on the environment. For this purpose, this Plan ensures the possibility of planning wells, heat pumps, pipelines, heating pipes and all other necessary facilities for the exploitation of geothermal energy.

(195f.) Buildings for the use of renewable energy sources that can be built outside the boundaries of the construction area are buildings for the use of wind energy, geothermal energy, created from wood plant waste or biomass processing. Buildings for the use of renewable sources of wind and solar energy can be built in locations that have natural predispositions for optimal use, and buildings for the use of geothermal energy sources in locations where the existence of reserves has been confirmed by research - in accordance with the conditions and criteria prescribed in this Plan and the cartographic representation no. 3B. "Conditions for use and protection of space - Areas of special restrictions on use and Areas of application of special land development measures".

Sisak-Moslavina County (Official Gazette of Sisak-Moslavina County" number 4/01, 12/10, 10/17, 12/19 and 23/19) - (refined text)

The geological potential of geothermal waters exists throughout the County, and the Plan envisages the possibility of planning geothermal water research in all areas where there are no obstacles for this in the spatial plans.

GEOTERMALNE VODE - utvrđena ležišta na području Sisačko-moslavačke županije

Redni broj	Sirovina	Ležište	E	N	Grad/Općina
1	GTV-001	TOPUSKO I	458783	5017313	TOPUSKO
2	GTV-002	SISAK	491613	5038946	SISAK
3	GTV-003	TOPUSKO II	458347	5017850	TOPUSKO
4	GTV-004	TOPUSKO III	458707	5017672	TOPUSKO
5	GTV-005	TOPUSKO IV	458522	5017393	TOPUSKO
6	GTV-006	TOPUSKO V	458577	5017089	TOPUSKO
7	GTV-007	TOPUSKO VI	458072	5016955	TOPUSKO
8	GTV-008	TOPUSKO VII	458469	5017291	TOPUSKO
9	GTV-009	DB-5	491562	5038541	SISAK
10	GTV-010	DB-3	492802	5039675	SISAK
11	GTV-011	SITER-1	490381	5038497	SISAK
12	GTV-012	SISAK-1	487895	5040126	SISAK
13	GTV-013	PETRINJA-1	485350	5031862	PETRINJA

Geološki potencijal geotermalnih voda postoji na cijelom prostoru Županije te se Planom predviđa mogućnost planiranja istraživanja geotermalne vode na svim prostorima na kojima za to u prostornim planovima ne postoji zapreka.

1. for accommodation of commercial facilities in the space

1.1. Mining and exploitation of mineral raw materials

new fields for exploitation that are planned to be opened, at the level of planning - guiding determination, are exploration fields of hydrocarbons, geothermal water, building stone, etc.

6.3.4. Possibilities of using renewable energy sources

In the area of Sisak-Moslavina County, it is possible, according to local conditions and needs: to use the following renewable energy sources:

(...)

geothermal energy (thermomineral water in the Topusko health resort - the possibility of using it for heating the health resort, catering buildings and apartments, greenhouse production of food and herbs; geothermal aquifers in Petrinja, Sisak, etc.)

6.3.4.6. Use of geothermal energy

The County of Sisak-Moslavina has a significant potential of geothermal energy that can be used in addition to health-recreational purposes and for heating systems of health-tourism complexes, for heating part of the settlement, and also for heating greenhouses, especially in areas where intensive agricultural production is already developed for the production of ecological food. In the territory of the Sisak-Moslavina County, there are three areas with confirmed deposits of energy raw material geothermal water: Topusko, the area of the City of Sisak and its immediate surroundings, and the surroundings of the City of Petrinja. The research of geothermal waters is carried out in the area of the City of Glina. The locations of established geothermal water deposits are shown on map 1. Use and purpose of space. Exploration of geothermal water in the area of Sisak-Moslavina County can be planned in all areas where there are no obstacles for this in the spatial plans. In the event that material traces of the cultural layer are encountered during earthworks, said works must be stopped and the competent Conservation Department of the Ministry of Culture of the Republic of Croatia informed of the finding.

11.3. Areas and localities for research and monitoring of phenomena and processes in space

Reports on the situation in the area of counties and local self-government units should include an assessment of the situation and monitoring of phenomena in the area, especially for:

(…)

geothermal water deposits - further research into the possibility and economy of use is planned (Topusko, Sisak, Petrinja, Glina)

Virovitica-Podravine County (Official Gazette Virovitica-Podravine County Official Gazette No. 7a/00, 1/04, 5/07, 1/10, 2/12, 4/12, 2/13, 3/13, 11/18, 2/19 and 2/21)

Article 24

(1) The existing and planned exploitation fields (wells) of hydrocarbons (oil and gas) and geothermal waters are shown in map 1. Use and purpose of the space of this Plan, namely: ... exploitation field of geothermal water EPGV Slatina 2 within JLS Čađavica, Sopje area in ha approx. 3881.65 under the designation Ep-29
(2) In the existing exploitation fields, the exploration and exploitation of mineral raw materials - hydrocarbons and geothermal waters is allowed in accordance with the reached decision approving the exploitation field and the Concession Agreement on the exploitation field.
(3) In the planned exploitation field, exploration and exploitation of mineral raw materials - hydrocarbons and geothermal waters is permitted after obtaining all necessary permits.

(4) The research areas, "Drava 02", "Drava-03", "SA-08" and "Slatina" and "Virovitica" are marked in Map 3. Conditions of use and protection of areas and 3.1.3. Mineral and energy raw materials and renewable energy sources.

Slatina, Čađavica, Sopje	Slatina	geotermalne vode	21.973,01	Ex-8
Virovitica	Virovitica	geotermalne vode	700,00	Ex-9

* approximate area in the area of VPŽ - the area of only the exploration area without the area of the approved exploitation field

(5) Exploration areas or parts of exploration areas from the previous paragraph of this article may, without amending this Plan, be repurposed into exploitation fields if the exploration area meets the corresponding prescribed requirements, provided that it complies with the mining regulations, the basic guidelines from this Plan on the protection of the environment and landscape values of the area, with the condition that this is planned in PPUO/G.

(6) In the entire area of Virovitica-Podravine County, it is possible to carry out investigative work and activities for the purpose of determining the possibility of exploitation of hydrocarbons or geothermal waters for energy purposes, except in the area of protective forests, especially valuable arable land and in infrastructure corridors.

(7) Within the area for the exploration of energy and mineral raw materials marked in the cartographic representations 3. Conditions of use and protection of the area and 3.1.3. exploitation fields can be formed in the PPUO/G without amending this Plan, provided that they meet the correspondingly prescribed requirements and that

they comply with the laws related to mining, hydrocarbons, geothermal waters and other special laws, and that they comply with the basic guidelines from of this Plan on environmental protection and landscape values.

(8) New exploitation fields of oil and gas must be planned through the Amendment of this Plan, with the exception of those within the exploration area "Dravica" (Ex-4) and "Drava 02" (Ex-4).

Article 25

(1) Activities of exploitation of mineral (peat, metals, non-metals, stone) and energy raw materials and geothermal waters are important for the State and the County.
(2) Activities of exploitation of mineral (peat, metals, non-metals, stone) and energy raw materials and geothermal waters are located in areas where the degree of potentiality of raw materials whose exploitation is economically justified is determined.
(3) The exploitation of raw materials must be based on a detailed elaboration of the way of using the space.

Article 45 The development of tourism from the point of view of the use of space and the planning of content in the space is related to:

(…)

multi-purpose recreation center with geothermal springs

Article 90

In the scope of this Plan, the possibility of building facilities for the production and use of alternative energy sources (solar energy, wind energy, geothermal energy, energy generated from the waste of the wood processing industry, as well as other types of wood, plant and municipal waste) is allowed, where particularly important emphasizes the renewable nature of the source and the environmental acceptability and reduction of pollution (especially the emission of CO_2 and other greenhouse gases).

Buildings for the use of renewable energy sources of wind and sun can be built in locations that have natural predispositions for optimal use, and buildings for the use of geothermal energy sources in locations where the existence of reserves has been confirmed by research, in accordance with the conditions and criteria prescribed in this Plan.

Buildings for the use of renewable energy sources of wind and sun can be built in locations that have natural predispositions for optimal use, and buildings for the use of geothermal energy sources in locations where the existence of reserves has been confirmed by research, in accordance with the conditions and criteria prescribed in this Plan.

11.5. Conditions for the immediate implementation of interventions in the space

Article 161 Implementation conditions and location conditions for the immediate implementation of this Plan are established for the following interventions in the area of national significance:

(…)

- for the extraction of the exploitation field of geothermal water Slatina 2 (hereinafter: EPGV) from art. 24 of these Provisions of Regional Significance.

Vukovar-Srijem County (Official Gazette of Vukovar-Srijem County 07/02, 08/07, 09/07, 09/11, 19/14, 14/20)

Article 31

After point (8.14), point (8.15) is added, which reads: "(8.15) Constructions and buildings of state importance are:

- exploration and exploitation of mineral raw materials,

- research and exploitation of hydrocarbons, research and exploitation of geothermal waters from which accumulated heat can be used for energy purposes, storage of natural gas and permanent disposal of carbon dioxide

- buildings in the exploitation field of mineral raw materials

Article 42.

In point (13.1.), paragraph (3) is added. which reads: "(3) Within spatially determined exploitation fields outside construction areas, the construction of: asphalt bases, concrete plants and other buildings in the function of processing mineral raw materials can be planned. The exploration of hydrocarbons and geothermal water can be planned in all areas for which spatial plans there are no obstacles."

Article 43.

- E2 geothermal waters: individual wells in Bošnjaci, Babina Greda, Vinkovci, Gradište, Otok and in the area between the settlements of Otok and Bošnjaci (wells called "Lešić") and Vukovar (zone south of the settlement with three wells), Bogdanovci (three wells) and Negoslavci (one well).

Article 44.

(3.) It is possible to carry out investigative works and activities in the entire area of the County for the purpose of determining the possibility of exploitation of geothermal waters for energy purposes. Exploration areas or parts of exploration areas can, without amending this Plan, be converted into exploitation fields of geothermal waters for energy purposes if the exploration area meets the corresponding prescribed requirements, provided that it complies with the regulations on exploration and exploitation of hydrocarbons and the basic guidelines from this Plan ."

(13.4) Research areas and areas for exploitation of mineral raw materials cannot be established in:

- construction areas of the settlement (except for geothermal water for energy purposes, spas, tourist purposes, etc.)

- natural areas protected according to a special regulation, unless such activities are permitted by a protection act or subsequent permission of a public institution with special powers,

- on particularly valuable agricultural land, except for energy mineral raw materials (hydrocarbons and geothermal waters).

(13.6.) In further planning (PPUO/G), investigation areas for the exploitation of geothermal water may include areas of the ecological network.

In further planning (PPUO/G), do not plan facilities for the exploitation of geothermal water (including boreholes and exploratory boreholes) in EM areas:

1. HR2001045 Trpinja

2. HR2001088 Mala Dubrava – Vučedol

3. HR2001500 Steppe habitats near Bapska

4. HR2001501 Steppe habitats near Opatovac

5. HR2001502 Steppe habitats near Šarengrad

In the further planning (PPUO/G) of facilities for the exploitation of geothermal water (including boreholes and exploratory boreholes), avoid the location of target habitat types, i.e. habitats necessary for the survival of the target species of the EM area:

1. HR2000372 Danube – Vukovar

2. HR2001311 Sava downstream from Hrušćica

3. HR2001414 Spačvanski pool

4. HR2001415 Spačva SW.

(7) New areas for the exploitation of mineral raw materials and the exploitation of hydrocarbons and geothermal waters for energy purposes can be formed within the framework of exploration areas based on projects under a special regulation.

(8) In separate construction areas outside settlements for economic purposes (production, business and agriculture), all renewable energy sources can be used as resources, while in separate construction areas outside settlements for other purposes (hospitality-tourism, sports-recreation, etc.) only renewable energy sources such as sun, wind and geothermal energy can be used as a resource.

Article 76.

(28.3b.) "(1) Geothermal water is planned to be used in the County at the following locations: 1. Bosniaks 2. Babina Greda 3. Vinkovci 4. Gradište 5. Otok 6. Lešić 7. Vukovar (zone with 7 wells)

(2) Planned geothermal fields smaller than 25 ha are shown with a symbol, and the boundaries are shown in detail in PPUO/G. New geothermal fields can be established through the preparation of PPUO/G.

(3) Geothermal water research area is considered to be the area of the entire county, except for the parts that are protected by special regulations prohibiting the research and use of geothermal water.

(4) On the basis of the results obtained by preliminary investigative measurements in the further professional documentation for areas for the exploitation of mineral raw materials - geothermal water, estimate the amount of greenhouse gases that could be released into the atmosphere.

Article 105.

The borders of the Economic Zone of Krčevina are defined by the Spatial Plan of the Municipality of Babina Greda (SL.GL.VSŽ number 07/04, 13/08, 16/11, 20/14, 21/14, 09/16, 02/17). In the area of the Krčevina Economic Zone, apart from the construction of buildings for the purpose of using geothermal water as a primary purpose, it is possible to accommodate production, business, hospitality-tourism, and agricultural purposes, as well as infrastructure, auxiliary and other buildings in the function of using geothermal energy/water.

Article 106.

Geothermal water is a great potential in the area of the County, and it is necessary to start using it as much as possible and as soon as possible for various purposes. When exploiting the geothermal potential of underground water, it is necessary to monitor the safety of the system from the aspect of water and soil pollution, and to use the potential sustainably. It is recommended to use geothermal energy for economic complexes and buildings in the function of agriculture, which, based on this Plan, can be built outside the boundaries of construction areas, where the possibility of energy supply is difficult, and the proximity of a geothermal well is certain. In addition, geothermal wells are possible and recommended to be included in existing heating systems wherever the investment of inclusion is profitable in a realistic time frame.

DECISION on the sanitary protection zones of the source of "Banovina" - Tovarnik, location "Mlaka"

Article 9.

PROTECTION MEASURES IN ZONE III - GENERAL PROVISIONS

In zone III, the following is prohibited:

(…)

• underground and surface exploitation of mineral raw materials, except for geothermal and mineral waters.

Varaždin County (Official Gazette of Varaždin County No. 08/00, 29/06, 16/09 and 96/21)

Article 4.

1. Terms of demarcation of space according to characteristics, use and purpose

(…)

1.7. Under certain conditions, construction can be planned outside the construction area:

(…)

buildings intended for the exploration and exploitation of mineral raw materials (which are located in the ground or on its surface, on the bottom of rivers, lakes or under it), and buildings intended for the exploration and exploitation of hydrocarbons, exploration and exploitation of geothermal waters from which accumulated heat can be used for energy purposes, storage of natural gas and permanent disposal of carbon dioxide.

1.14.3.2. Structures outside the construction area of national and county significance

4.1. Exploration and exploitation of hydrocarbons, exploration and exploitation of geothermal waters from which accumulated heat can be used for energy purposes, storage of natural gas and permanent disposal of carbon dioxide (E1)

4.2. Geothermal waters for medicinal and recreational purposes - (marked at K3b)

4.	GOSPODARSKA NAMJENA - POVRŠINE ZA ISKORIŠTAVANJE MINERALNIH SIROVINA (EKSPLOATACIJSKO POLJE)	E					
4.1.	Istraživanje i eksploatacija ugljikovodika, istraživanje i eksploatacija geotermalnih voda iz kojih se može koristiti akumulirana toplina u energetske svrhe, skladištenje prirodnog plina i trajno zbrinjavanje ugljikova dioksida	E1	-	-	-	-	**Neposredna provedba PPŽ-om** (11.1.4.1., točka 3.3.2. Odredbi)
4.2.	Geotermalne vode za ljekovite i rekreacijske svrhe*	-	-	-	-	-	**Neposredna provedba PPŽ-om om** (11.1.4.1., točka 3.3.3. Odredbi)

B In the area of Varaždin County, encroachments in the area and surface of state significance that are not considered construction refer to the exploration and exploitation of mineral resources with buildings for exploitation in the exploitation field of mineral resources, and mineral resource dumps. The following locations - areas for exploitation of mineral raw materials - are planned:

B1. exploration and exploitation of hydrocarbons, exploration and exploitation of geothermal waters from which accumulated heat can be used for energy purposes, storage of natural gas and permanent disposal of carbon dioxide:

B1.2. Geothermal waters from which accumulated heat can be used for energy purposes - marked with the symbol I2, i.e. Ex in the graphic part of the Plan:

- Proposed IP "Lunjkovec-Kutnjak" (in the extreme eastern part of Varaždin County
- Municipality of Mali Bukovec, Municipality of Veliki Bukovec and City of Ludbreg) IP proposal "Mali Bukovec" (in the eastern part of Varaždin County
- Municipality of Mali Bukovec, Municipality of Veliki Bukovec, Municipality of Sveti Đurđ and City of Ludbreg) other areas if they are determined as exploration areas, i.e. exploitation fields of geothermal water from which accumulated heat can be used for energy purposes

B1.3. Mineral raw materials - geothermal water for medicinal, tourist and recreational purposes and other purposes - marked with a triangle symbol in the graphic part of the Plan:

- Geothermal source/spring »Varaždinske Toplice« (City of Varaždinske Toplice) thermal mineral water

- Geothermal source/spring "Topličica" (City of Novi Marof)

- Geothermal source/spring "Podevčevo" (City of Novi Marof)

- Geothermal source/spring "Belec" (Town of Ivanec)

3.3.1. Mineral raw materials are a non-renewable resource of importance for the Republic of Croatia. Research and exploitation of mineral raw materials is related to the use of natural resources, and the location of these activities depends on the deposits of raw materials. On the basis of strategic documents and regulations from the field of mining and the field of exploration and exploitation of hydrocarbons and the field of spatial planning, as well as the Mining Geological Study of Varaždin County (hereinafter: RGS), this Plan plans areas for the exploitation of mineral resources, which include areas intended for exploration and exploitation and individual locations of geothermal water sources:

- Energy mineral raw materials:

- hydrocarbons (oil, natural gas and gas condensate)

- geothermal waters from which accumulated heat can be used for energy purposes Mineral raw materials for medicinal, tourist and recreational purposes and other uses:

- geothermal waters

Mineralna sirovina - GEOTERMALNE VODE za ljekovite, turističke i rekreativne svrhe i druge namjene			
R. br.	Lokacija	JLS	Obuhvat
1.	VARAŽDINSKE TOPLICE	Grad Varaždinske Toplice	-
2.	TOPLIČICA	Grad Novi Marof	-
3.	PODEVČEVO	Grad Novi Marof	-
4.	BELEC	Grad Ivanec	-

Mineralna sirovina - energetska - GEOTERMALNE VODE iz kojih se može koristiti akumulirana toplina u energetske svrhe			
R. br.	Lokacija	JLS	Obuhvat
1.	LUNJKOVEC - KUTNJAK	dijelovi područja Općine Mali Bukovec i Veliki Bukovec i Grada Ludbrega	obuhvaća prijedlog IP na području Varaždinske županije (ranije EP)
2.	MALI BUKOVEC	dijelovi područja Općina Mali Bukovec, Veliki Bukovec i Sveti Đurđ i Grada Ludbrega	obuhvaća prijedlog IP na području Varaždinske županije (raniji IP)

3.3.2. Research and exploitation of energy mineral raw materials - hydrocarbons and geothermal waters from which the accumulated heat can be used for energy purposes (in the graphic representations, including the cartogram, hydrocarbons are marked with E1 - exploitation field, Ex possible exploration area and I1 - exploration area/exploration proposal area, and geothermal waters from which the accumulated heat can be used for energy purposes are labeled Ex possible investigation area and I2 - proposal of investigation area)

Research works and activities aimed at determining the state of hydrocarbon reserves (oil, natural gas, gas condensate) and geothermal waters from which accumulated heat can be used for energy purposes can be carried out in principle in the entire area of Varaždin County, subject to the conditions prescribed by this Plan, and special regulations.

3.3.2.2. This Plan plans the following areas for the exploration of hydrocarbons in accordance with the Framework Plan and Program for the Exploration and Exploitation of Hydrocarbons on Land, and under the conditions prescribed by these Provisions for Implementation and the provisions of the applicable special regulations:

- the area of the approved research area Drava 02 ("Drava-02")

- the area of approved exploration area Northwest Croatia - 01 ("SZH-01")

- the area proposed for the exploration area Northwest Croatia - 05 ("SZH-05"), with the prior implementation of all prescribed procedures and the determination of the hydrocarbon exploration area.

Exploration of geothermal waters from which the accumulated heat can be used for energy purposes (including the formation of research areas) is allowed in the area of Varaždin County based on and in accordance with the geothermal potential established by the Mining and Geological Study of Varaždin County (identified zones of potential according to structural-tectonic units, but total the geological potential of the mineral raw material of hydro-geothermal deposits of high and low enthalpy has been determined in almost the entire area of Varaždin County and as such is entirely interesting for research and use). For the exploration and exploitation of geothermal water, from which the accumulated heat can be used for energy purposes, this Plan particularly highlights and proposes the area of the earlier research area Mali Bukovec,

3.3.2.4. The activities that are carried out for the purposes of geothermal water research for energy purposes are identical to the activities that are carried out for hydrocarbon research, and are carried out based on the current regulation. As a result of the above, the conditions for carrying out mining operations in the area in the function of exploration and exploitation of geothermal waters from which the accumulated heat can be used for energy purposes (locating a well for research/exploitation and construction of the necessary buildings and other facilities and plants) are identical to the conditions for carrying out mining works for hydrocarbons , as defined in point 3.3.2.7. of these Provisions for implementation.

3.3.2.5. According to the results of research, in the case of a commercial discovery of hydrocarbons, i.e. geothermal water from which the accumulated heat can be used for energy purposes, it is possible based on this Plan and in accordance with it, and in accordance with the prescribed conditions from the valid special regulations and the conditions and requirements of the authorities public law bodies, determination and formation of exploitation fields of hydrocarbons, i.e. geothermal waters from which accumulated heat can be used for energy purposes. Exploitation fields of hydrocarbons, i.e. geothermal water from which accumulated heat can be used for energy purposes, can only be formed within defined and approved exploration areas, and their surface area can be the same or smaller than the exploration areas,

3.3.2.6. Within the limits of the existing approved exploitation fields of hydrocarbons and geothermal water from which the accumulated heat can be used for energy purposes, and future exploitation fields if they are determined/approved by the competent public law bodies based on the implemented prescribed procedures in accordance with the special regulations and conditions from this Plan (especially the conditions of certain points 3.3.2.7 and 3.3.2.8), oil-mining works for the purpose of exploitation/acquisition of hydrocarbons, i.e. geothermal waters from which accumulated heat can be used for energy purposes, are allowed, which include all works and activities that are considered exploitation in accordance with prescribed by the regulation on the exploration and exploitation of hydrocarbons, and the construction and/or reconstruction of mining buildings, structures and facilities,

Before the start of exploration work and work on the exploitation of hydrocarbons and geothermal waters for energy purposes, i.e. the construction of the necessary buildings and facilities, it is necessary to obtain prescribed documentation and acts in accordance with valid regulations in the field of exploration and exploitation of hydrocarbons, mining, environmental and nature protection, spatial planning , construction, transport, other infrastructure and from other areas as necessary, respecting the provisions of this Plan and the spatial plans of the municipalities and cities in the area of which interventions will be carried out.

Exploitation of hydrocarbons, i.e. geothermal water, from which accumulated heat can be used for energy purposes, must be carried out with the prescribed measures for comprehensive protection of nature and the environment, health and safety of people and property, as well as measures for the protection of other goods and elements of restrictions if they are established, and in accordance issued acts (permits, decisions, solutions, contracts, assessments, approvals of competent public law bodies, etc.), oil-mining projects and hydrocarbon exploitation programs, i.e. geothermal water from which accumulated heat can be used for energy purposes, and other documents prepared in accordance with regulations , relevant legislation and provisions of this Plan.

3.3.2.7. Mining interventions in the area in the function of exploration and exploitation of hydrocarbons and geothermal waters from which the accumulated heat can be used for energy purposes (wells for exploration/exploitation and construction of the necessary buildings and other facilities and plants), which are carried out within approved exploration areas, i.e. exploitation areas fields, must be located:

- outside the built-up areas of the settlement and separate parts of the built-up areas of the settlement defined by the spatial plans of municipalities and cities and the perimeter belt in addition to the specified areas with a width of at least 500 m

- outside the separate construction areas outside the settlements defined by this Plan and the plans of the municipalities and cities and the belt in addition to the specified areas with a width of at least 500 m (for areas of public and social, sports-recreational and tourist-hospitality purposes), or 250 m (for areas of economic production and business purposes and waste management purposes, and cemeteries)

- outside the built and planned structures outside the construction area defined by this Plan and the plans of municipalities and cities and belts along the specified areas with a width of at least 70 m

- outside protected cultural assets (areas or individual monuments of cultural heritage, protected and potential archaeological areas shown in map 3a. Conditions of use, arrangement and protection of spaces Conditions of use - Areas of special conditions of use), and possibly at a distance from them if they require it competent public law bodies, and on the condition that damage or destruction of cultural assets is avoided, as well as that in the event of encountering unrecorded localities and cultural heritage sites during investigation and exploitation activities, work is suspended and the competent public law body is notified

- outside protected parts of nature and parts planned for protection shown in map 3a. Conditions of use, arrangement and protection of space Conditions of use - Areas of special conditions of use, and possibly also at a distance from them if required by competent public law bodies

- outside the area of the ecological network - »Natura 2000«, which are smaller than 100 km2, and outside the habitat type »Caves and pits closed to the public« and the perimeter belt adjacent to the areas of the specified habitat type with a width of at least 500 m (areas shown in map representation 3a. Conditions of use, arrangement and protection of space Conditions of use - Areas of special conditions of use)

- in addition to restrictions and measures of environmental protection and protection in established localities of habitat types and habitats important for target species within the ecological network - »Natura 2000« in order to prevent, reduce and mitigate potential negative impacts on the environment and ecological network, and in accordance with the provisions in point 3.3. 2.8.

- outside the rare habitats of exceptional value ("Internationally important areas for bats, bats, caves and pits") and the peripheral zone next to the areas of the specified habitat type, i.e. speleological facilities with a width of at least 500 m

- outside the particularly valuable natural and cultivated landscapes shown on map 3b. Terms of use, arrangement and protection of space Terms of use - Areas of special restrictions on use), except exceptionally, with the approval of public law bodies responsible for cultural heritage protection and nature protection of the area

- outside the watercourses and lakes of the Danube basin, and their inundation areas, i.e. a zone of 250 m along watercourses and lakes, and a zone of 1000 m along the large rivers of the Danube basin

- beyond the planned retentions and accumulations

- outside zone I of sanitary protection of drinking water sources, and with restrictions in zone II. and III. in the zone of sanitary protection of the sources shown on map 3b. Terms of use, arrangement and protection of space Terms of use - Areas of special restrictions on use with the capture of water from aquifers with intergranular porosity, and depending on microzoning, as well as outside the 500 m wide zone from the principle location of the potential source in Hrženica

- outside protective forests and special purpose forests, and as a rule outside commercial forests and forest land, and valuable agricultural land, except exceptionally, with the consent of the competent public law body

- outside existing roads, railways and airports, and their protective corridors in accordance with special regulations, as well as outside planned traffic corridors

- outside existing and planned locations and corridors of other infrastructure, and at distances from them in accordance with special regulations and conditions of competent public law bodies

- outside the special purpose (military) zones and the construction ban areas adjacent to these zones, and according to the special conditions of the competent public law body in the restriction zones

- outside the area for exploration and exploitation of other mineral raw materials (non-energy) determined by this Plan

- outside all other areas where research and exploitation are not allowed according to special regulations.

As an exception to the stated conditions, mining operations in the area for the purpose of research and exploitation of geothermal waters, from which accumulated heat can be used for energy purposes, may exceptionally be approved within the construction area of the settlement or a separate construction area outside the settlement, if the exploitation of geothermal water would be or is in the function of supplying energy to a certain zone in the construction area.

In doing so, it is particularly important to take care that any noise that may occur in the environment of residential and work buildings/spaces in the process of exploitation does not exceed the limit values prescribed by special regulations for individual uses of space. It is necessary to provide an access road to the locations of wells for the exploration/exploitation of energy mineral raw materials (hydrocarbons and geothermal waters from which the accumulated heat can be used for energy purposes) (as a rule, use the existing public or unclassified road if there is one or build a new road for this purpose). , and other infrastructure (electricity, water, etc.) as needed.

The conditions defined in point 3.3.4.5 apply to securing the access road and other infrastructure. Implementation provisions. Well locations must be fenced off in accordance with regulations. In connection with the exploration and exploitation of hydrocarbons and geothermal waters, from which the accumulated heat can be used for energy purposes, the necessary pipelines and buildings for their transport, as well as other necessary and accompanying buildings, can be built, and appropriate equipment can be installed, and in accordance with special regulations and the conditions of competent public law bodies.

3.3.2.8. The following measures are established to prevent, reduce and mitigate potential negative impacts of the exploitation of energy mineral raw materials (hydrocarbons and geothermal water from which accumulated heat can be used for energy purposes) on the environment, that is, on the ecological network:

- Before starting the exploitation of geothermal water, from which the accumulated heat can be used for energy purposes, it is necessary to carry out water sampling from the reservoir in order to determine the values of pollutants before releasing the cooled water into the recipient.

- The temperature of chilled water from geothermal deposits must not deviate from the temperature of the recipient. Before the start of exploitation, the potential of the well should be defined in order to match the use with the possible supply.

- On the exploration areas Northwestern Croatia 01 and Drava 02, and the proposed exploration area Mali Bukovec, as well as future exploitation fields of energy raw materials (hydrocarbons and geothermal water from which accumulated heat can be used for energy purposes), works (including works of drilling facilities) within areas of conservation important for birds (POP) HR1000008 Bilogora and Kalnica Mountains (areas shown on map 3a. Conditions of use, arrangement and protection of space Conditions of use - Areas of special conditions of use) should be carried out outside the period of nesting of forest bird species and care for young (from 01 August to 01 February), and respect the areas of distribution of nesting populations.When exploiting energy mineral raw materials (hydrocarbons and geothermal water from which accumulated heat can be used for energy purposes), it is necessary to respect the restrictions and protection measures from the Strategic Environmental Impact Study of the Framework Plan and Program for the Exploration and Exploitation of Hydrocarbons on Land (2015.)

3.3.2.9. Exploitation of geothermal waters, from which the accumulated heat can be used for energy purposes, implies exploitation for the purpose of energy production, and in connection with that, the construction of geothermal power plants for the production of electricity and/or thermal energy and the possibility of using the energy thus obtained for the needs of agricultural production (greenhouses, greenhouses). , industrial processing of agricultural products (dryers), fish farming (ponds), for heating buildings for residential and other purposes in the construction areas of surrounding settlements, as well as for other forms of using geothermal water (for tourist, recreational, health, scientific and other purposes - spas , spas, recreation areas, tourist resorts and accompanying facilities, etc.), which is dealt with in point 3.3.3. of these Provisions for implementation.

Before exploiting geothermal water, from which the accumulated heat can be used for energy purposes, it is necessary to assess the profitability of the operation and the impact on the environment, and create a more detailed elaboration of the way to use the space, and depending on the selected solutions, change the spatial plans as necessary. The possibilities of building smaller geothermal power plants (capacity up to 10 MW) and related forms of energy use and geothermal water from which the accumulated heat can be used for energy purposes, and possibly other purposes, are planned in the spatial plans of municipalities and cities, and in accordance with the guidelines from this Plan (point 6.3.3.6. Provisions for implementation).

3.3.2.10. Renovation of the area after the completion of research and exploitation of energy mineral raw materials - hydrocarbons and geothermal water for energy purposes

After the completion of oil-mining works (exploration, i.e. exploitation), the investor is obliged to rehabilitate the exploration area, i.e. the exploitation field, in accordance with the regulation relating to the exploration and exploitation of hydrocarbons (which also relates to the exploration and exploitation of geothermal water from which accumulated heat can be used for energy purposes), and special regulations in the field of environmental and nature protection, safety of people and property, protection of human health, as well as international good practice in oil and mining operations.

It is mandatory to remove and dispose of all objects, plants and installations from the investigation area/exploitation field and clean the area. Rehabilitation must be carried out in accordance with the prescribed documentation (detailed rehabilitation plan). As a rule, it is necessary to rehabilitate the area of wells by returning the area to its original purpose, and it is possible to bring the area to another purpose that does not contradict the spatial plans of the local level.

3.3.3. Research and exploitation of mineral raw materials - geothermal water for medicinal, touristic and recreational purposes and other purposes (in the graphic representations of the principle location marked with a dot - symbol)

3.3.3.1. The utilization of mineral raw materials - geothermal water for balneological - medicinal and recreational purposes, and related to that for touristic and other purposes is carried out in the localities in Varaždinske Toplice (City of Varaždinske Toplice) and in the locality of Topličica (City of Novi Marof).

On the basis of the RGS of Varaždin County, further use of existing locations is planned, and the possibility of researching and using the locations of geothermal sources/springs Podevčevo (City of Novi Marof) and Belec (City of Ivanec) for balneological - medicinal and recreational purposes, and related to that for tourism and other purposes.

When planning the use of the location of the Belec geothermal source/spring, define and ensure the ecologically acceptable flow needed to preserve habitats suitable for the target species of the conservation area of importance for species and habitat types (POVS) HR2000371 Upper part of Ivančica related to water ecosystems. Exploration and exploitation, i.e. the use of geothermal water for the stated purposes is also possible in other locations in accordance with the geothermal potential determined by the Regional State Administration of Varaždin County.

As a rule, research and exploitation/use of geothermal water for the stated purposes and purposes is carried out outside the construction area, and depending on the location of the source, it can be approved within the construction area of the settlement or a separate construction area outside the settlement, if such exploitation/use of geothermal water is in operation the zone in which it is located (or the corresponding purpose zones are planned and formed in accordance with the point 3.3.3.2.).

(…)

3.3.3.3. Before starting the activity of exploitation of geothermal water, it is necessary to carry out water sampling from the deposit in order to determine the values of pollutants before releasing the cooled water into the recipient. The temperature of the chilled water from geothermal deposits must not deviate from the temperature of the recipient. Before the start of exploitation, the potential of the well should be defined in order to match the use with the possible supply.

6.3.3. Possibilities of using renewable energy sources

6.3.3.1. The plan envisages the rational use of energy using renewable energy sources and cogeneration, depending on the energy and economic potential of individual areas of the County. Renewable energy sources in the area of the County include: solar energy, hydro energy, geothermal energy, energy from biomass, wind energy, and unspecified and other renewable energy sources. For the area of Varaždin County, it is proposed to conduct a study that would assess the areas where it is possible to place biomass power plants and geothermal power plants, which, according to the conclusions of the publication on the potential of renewable energy sources, stand out as potential, as well as power plants that use other renewable energy sources.

- energy plants for the exploitation of geothermal sources can be planned in locations where the existence of reserves is confirmed by research, i.e. that it is commercially profitable

6.4.1.10. The use of geothermal water is possible for the purpose of heating buildings/facilities (including those for the purpose of agricultural production), electricity production and other economic purposes, as well as for health, tourist and sports-recreational purposes. The possibilities of using geothermal waters are determined by chapter 3. Economic activities, point 3.3.2 of these Implementation Provisions.

11.3.2. Deposits (deposits) of geothermal water - it is necessary to carry out further research and possibilities of use.

Zagreb County (Zagreb County Gazette 3/02, 6/02 (correction), 8/05, 8/07, 4/10, 10/11, 14/12 (corrected text), 27/15, 31/15 (corrected text), 43/20, 46/20 (correction of the Decision) and 2/21 (refined text))

1.3.3. areas for exploitation of mineral raw materials

Article 22.

Areas for the exploitation of mineral raw materials are shown in the Plan with a symbol, except for the areas for the exploitation of hydrocarbons and geothermal fields, which are shown by surface area. The sizes of exploitation fields, the conditions of use and the method of remediation should be determined by the spatial planning plans of large cities, towns and municipalities, and according to the criteria from this Plan.

8. Encroachments in space, that is, surfaces of state significance, which according to special regulations governing construction are not considered construction 8.1. Exploration and exploitation of mineral raw materials a) Exploration and exploitation of hydrocarbons and geothermal waters for energy purposes – exploitation fields of hydrocarbons: Bunjani (Ivanić-Grad, Križ), Dugo Selo (Dugo Selo), Ivanić (Ivanić-Grad), Ježevo (Ivanić-Grad , Rugvica), Kloštar (Ivanić-Grad, Brckovljani, Kloštar Ivanić), Lupoglav (Brckovljani, Kloštar Ivanić), Okoli (Križ), Šumečani (Ivanić-Grad, Križ), Vezišće (Križ), Žutica (Ivanić-Grad, Križ) and PSP Okoli (Križ), – exploitation fields of geothermal waters: Geothermal field Zagreb (Stupnik) and GT Ivanić (Ivanić Grad) – assigned hydrocarbon exploration area DR-02,

Article 63.

The exploitation of mineral resources according to this Plan is planned on the existing legal exploitation fields. In these fields, it is possible to plan the exploitation of several types of mineral raw materials with spatial planning plans for large cities, towns and municipalities. The locations of exploitation fields are marked in the Plan with symbols, except for the exploitation fields of hydrocarbons and geothermal waters for energy purposes (Geothermal field Zagreb and GT Ivanić), which are marked with surfaces. The exact location, size and shape of exploitation fields marked with symbols is determined by the spatial planning plans of large cities, towns and municipalities.

Exploitation fields of hydrocarbons and geothermal waters for energy purposes are shown on map no. 1. "Usage and purpose of space", and exploration areas for hydrocarbons and geothermal waters for energy purposes are shown on map 3.2. "Terms of use and protection of space II". The immediate implementation of this Plan enables the determination of the shown exploitation fields and exploration areas of hydrocarbons and geothermal waters for energy purposes, as well as the issuance of acts for the implementation of the spatial plan and the construction and/or reconstruction of interventions in the area in the function of performing oil-mining works, exploration and exploitation, storage and transport of hydrocarbons and geothermal waters for energy purposes according to the provisions of the article. 66.a.

Article 66.

The exploitation of certain types of mineral raw materials at the newly planned locations (except for hydrocarbons, mineral and geothermal waters for energy purposes) can only be approved after 70% of the exploitation stocks of those types of raw materials on the existing legal exploitation fields from this Plan have been used, with the prior approval of the County assembly and the city or municipal council of the city or municipality on whose territory the location is located. Exploration areas or parts of exploration areas for hydrocarbons and geothermal waters for energy purposes may, without amendments to this Plan, be converted into exploitation fields if the exploration area meets the corresponding prescribed requirements, provided that it is in accordance with the regulations on exploration and exploitation of hydrocarbons and provisions of this Plan.

It is not allowed to plan new locations for the exploration and exploitation of non-energy mineral raw materials and the construction of new wells and mining facilities and facilities for the exploration and exploitation of hydrocarbons and geothermal waters for energy purposes in the following areas: - within I., II. and III. the sanitary protection zone of the source, the area reserved for the first sanitary protection zone of the water pumping station, as well as the potential water protection area of Črnkovec, - within the Franjo Tuđman Airport Development Area, - within the Contact Area next to the Franjo Tuđman Airport Development Area, - within the construction area of the settlement and separated construction areas of cemeteries, catering-tourist purposes and sports-recreational purposes outside the settlement, - in the area of particularly valuable arable land (P1), except exceptionally, with the consent of the competent public law body,

The following environmental protection measures and ecological networks for the exploration and exploitation of hydrocarbons and geothermal waters for energy purposes are established in the proposed exploration areas: - When installing the same wells, it is necessary, wherever possible, to avoid areas of valuable arable soil (P2) in order to reduced the negative impact on a very important natural resource.

- It is necessary to avoid carrying out exploration works for the exploitation of hydrocarbons and geothermal waters for energy purposes in the area of rare and endangered habitats. Work for the exploration and exploitation of hydrocarbons and geothermal waters for energy purposes can be carried out in the area of rare and endangered habitats only with the consent of the competent public law bodies.

- Surfaces for the exploitation of geothermal water for energy purposes should be moved from the forest area to the greatest extent possible, and the removal of trees, other vegetation, and disturbance of animals should be minimized. Plan the project in such a way that existing forest roads are used as access roads and avoid solutions that will have an impact on the objectives of preserving the ecological network.

Article 66a.

Acts for the implementation of the spatial plan and for the construction and/or reconstruction of interventions in the area for the purpose of performing oil-mining works, exploration and exploitation, storage and transportation of hydrocarbons and geothermal waters for energy purposes, storage of natural gas and permanent disposal of carbon dioxide in geological structures, in entirely within the scope of this Plan, may be issued based on the immediate implementation of this Plan in accordance with the provisions, guidelines and criteria of special regulations and the requirements of competent public law bodies, namely:

- for buildings - mining facilities and facilities and the execution of procedures that are not considered construction:

- well working areas with drilling and repair facilities for making wells and performing oil-mining works,

- well working areas with associated oil and mining facilities and facilities in the function of exploitation, which includes, but is not limited to:

- connecting pipelines, submersible pumps and other necessary equipment (liquid tanks, distribution control units, lighting poles, separators, tank truck filling stations, flares...)

,– access roads,

– high-voltage 10 kV and low-voltage power lines, including substations,

– signal cables,

- fences,

- oil-mining facilities and facilities for processing and refining and preparation for transport within the exploitation fields, as well as oil-mining facilities and facilities outside the exploitation fields, which are in direct connection with the exploitation fields,

- other infrastructural, auxiliary and supporting buildings

Article 110.

The locations of facilities for the use of renewable energy sources and cogeneration will be determined by the spatial planning plans of large cities, towns and municipalities.

An inspection of the spatial planning documentation of the county level in the research area provided for in the subject Plan established that all spatial plans of the county level enable the research and potential use of geothermal energy. Certain spatial plans determine in more detail the parameters and frameworks of potential actions during the integration of interventions for the examination and exploitation of geothermal potentials, by setting the conditions for the prior exploitation of existing exploitation fields and determining the localities where the actions in question are limited. Through certain plans, it is possible to build facilities for the use of renewable energy sources within the construction areas of the settlement and ona separate construction area outside the settlement with an installed capacity of up to and including 3 MW; such as: geothermal power plants (in economic use zones I, I1and K3 and IGPIN, and power is enabled in GPNfrom 3 to 15 MW if they are marked and planned on the PPUO/Gova maps.)In order to build them, it is necessary to carry out a preliminary study of the potential of geothermal sources, with the consent of Hrvatske vode.Certain plans, on the other hand, do not have detailed detailed conditions, but they also enable research and exploitation of geothermal energy. It is also necessary to emphasize that some of the plans are currently in the process of making amendments and additions, and the tendency is certainly further harmonization of all spatial plans of the counties in question in the part of research and exploitation of geothermal energy.

3 Existing state of the environment and possible development of the environment without implementation of the Plan

The approach to creating the document is based on the internationally accepted framework for reporting on the state of the environment - the DPSIR (driver, pressure, state, impact, response) methodology. This framework assumes cause-and-effect relationships between interconnected components of social and economic systems and the environment. He recognizes the chain of driving systems and processes of individual pressures on the environment, the consequences of these pressures, i.e. environmental conditions that generate various problems and impacts on the environment. The aforementioned pressures and impacts of human activities on components and factors in the environment result in the response of society, which acts on all links of the chain through a series of measures. In accordance with the mentioned methodology, the current state of the environment is analyzed through the chapters drivers of changes in the environment, environmental burdens, and environmental components and factors in the environment.

3.1 Drivers of environmental change

Drivers of changes in the environment can be represented by any human activity that endangers or could endanger the components and factors in the environment, that is, cause changes in the environment in a certain area and increase loads or pressures in the environment.

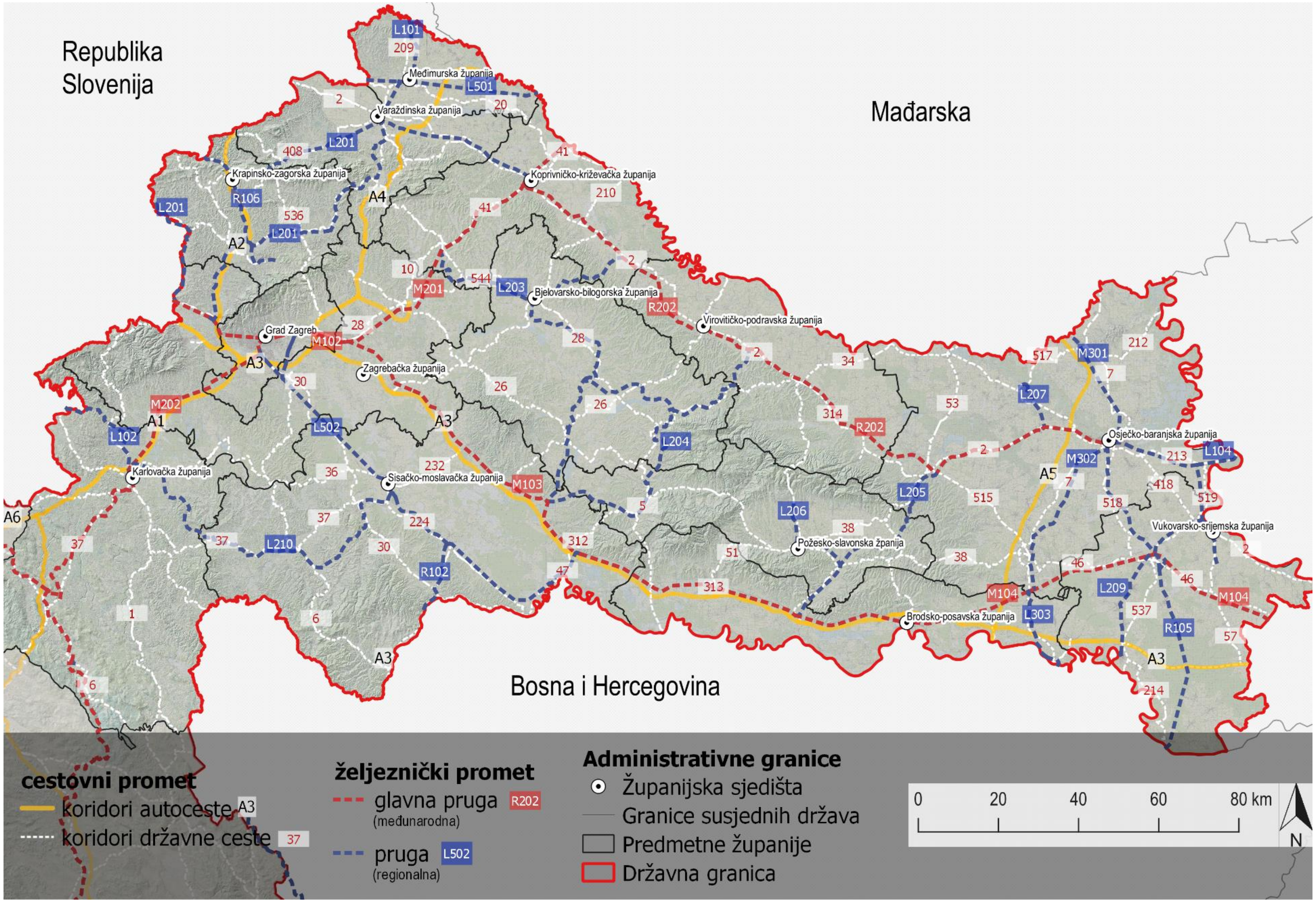
3.1.1 Traffic

According to the section of the National Strategy for the Development of Transport Infrastructure, the coverage envisaged by the Plan extends over two functional transport regions of the Republic of Croatia; Eastern Croatia and Central Croatia.

Due to its geographical location, the functional region of Central Croatia occupies a prominent role in the transport network of the Republic of Croatia and the whole of Central and Eastern Europe. It borders and joins Hungary in the north, Slovenia in the west and Bosnia and Herzegovina in the south. Towards the southwest, the transport infrastructure passes into the region of the northern Adriatic. Within the region of central Croatia is the City of Zagreb as the main economic center of Croatia and a network of other important cities such as Varaždin, Čakovec, Koprivnica, Bjelovar, Sisak and Karlovac, which in places form new functional sub-regions.

The transport functional region of Eastern Croatia borders Hungary, Serbia to the east, and Bosnia and Herzegovina to the south, while the national transport region of Central Croatia is located to the west. This transport region is characterized by polycentricity and the uniform importance of urban centers in terms of the dominance of traffic fluctuation and gravity, but Osijek and Slavonski brod can stand out as important cities at the level of the international network as economic and transport hubs.

The following documents related to transport infrastructure are in force within the counties in question, which are included in the scope of the area planned for the exploration of geothermal potentials: Transport master plan of the functional region of Eastern Croatia (Virovitica-Podravska, Brod-Posavska, Osijek-Baranjska, Požega-Slavonska, Vukovar-Srijem), Masterplan of integrated passenger transport of the northern counties of Croatia (Međimurje, Varaždin and Koprivnica-Križevačka), Traffic Development Study of Karlovac County, Masterplan of the Transport System - City of Zagreb, Zagreb County and Krapina-Zagorje County, Masterplan of the Transport System of Bjelovar-Bilogor County, Masterplan of the Transport System development of the city of Osijek and the Osijek-Baranja County, the Master Plan for the transport development of the Sisak-Moslavina County. In addition to those mentioned in the area in question, there are also other documents related to the transport infrastructure of lower levels.



Picture3.1The main transport infrastructure in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Geoportal DGU, Regulation on classification of railways, Transport Development Strategy of the Republic of Croatia, Business Plan HŽ infrastruktura doo 2021-2024.)

3.1.2 Tourism

Croatia is characterized by two important characteristics of its position, which are crucial for the development of tourism: its position in relation to important communication and tourist flows, and its position in relation to attractive neighboring areas and leading European emission markets (Bešker, 2005). Croatia is located at the geographical, cultural, historical and political intersection of East and West Europe, and as such, attracts numerous visitors with its historical, ethnic, cultural, economic, urban-ad ministrative and other peculiarities. In addition to the natural resource-attraction basis, the wealth of Croatian cultural and historical heritage is also an important factor in the development of tourism activities in Croatia. This is evidenced by a large number of cultural assets under the protection of UNESCO, and a larger number of individual buildings in the well-preserved historical parts of Zagreb and numerous other Croatian cities/towns (Tourism Development Strategy of the Republic of Croatia, until 2020, 2013). For these reasons, the area covered by the Plan is naturally destined for the development of tourism of special interests, such as religious tourism, congress tourism, spa tourism, cycle tourism, rural, eno-gastro, excursion tourism, etc.

Of the natural values, the following nature parks stand out: Žumberak - Samoborsko gorje, Kopački rit, Lonjsko polje, Medvednica and Papuk, and regional parks Moslavačka gora and Mura - Drava. Other categories of protected areas are represented: forest park, special reserve, monument of park architecture, monument of nature and significant landscape (more on this in the chapter3.3.7Protected areas of nature).

The area covered by the Plan is rich in cultural and historical heritage (more on that in the chapter**Error! Reference source n ot found.**3.3.11 Cultural and historical heritage). Some of the most famous monuments of different historical times and cultures are the Old Town of Varaždin, the Zagreb Cathedral, the castles of Hrvatski Zagorje, etc. In addition to material heritage (museums, galleries, historical sites, etc.), the intangible (customs, traditions, manifestations) is also very important. however, it has not yet been used to the maximum extent.

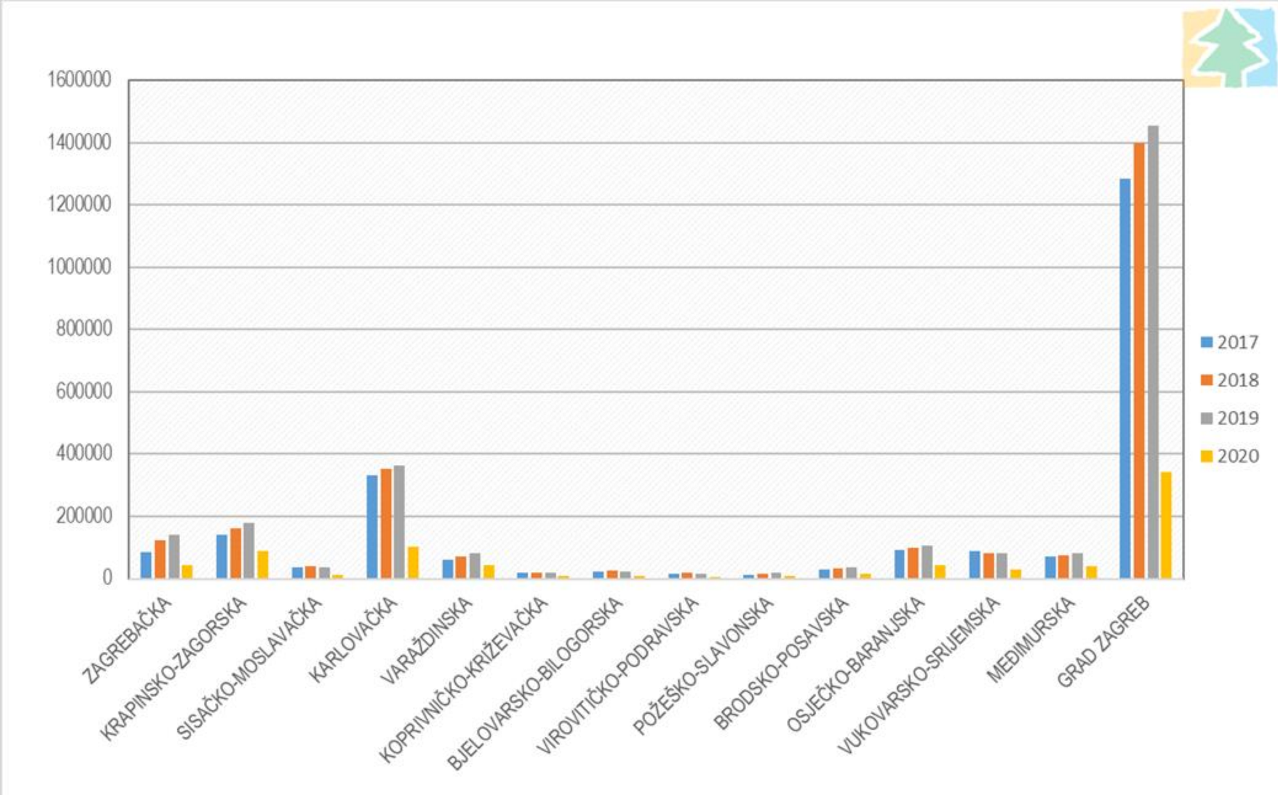
Local tourist boards, cities and municipalities organize numerous events with the aim of attracting domestic and foreign tourists. One of the most important is Advent in Zagreb, which, according to the voters of the "European Best Destinations" portal, was declared the best destination for the Christmas holidays in Europe three times, in 2016, 2017 and 2018. In addition, among the famous events are the Špancirfest in Varaždin, the Vinkovac Autumn Festival, the Porciunkolovo in Čakovec, the Boat Round in Slavonski Brod, "Kaj su jeli naši stari?", Karlovac Beer Days, the Ogulin Fairy Tale Festival, ZagrebDox, Tabor Film Festival, etc.

According to the statistical reports of the CBS for Tourism, in 2020, Croatia had 1,049,109 permanent beds in registered commercial accommodation facilities, most of which were in resorts and similar facilities for short vacations (rooms, apartments) and hotels. The largest number of registered permanent beds is found in Adriatic Croatia (94.85%), while continental Croatia (scope of the Plan) accounts for only 5.15%. The largest share in the total number of permanent beds in the area covered by the Plan is held by the City of Zagreb (40.88%), followed by Karlovačka (15.93%) and Osijek-Baranja County (6.48%).

In 2020, the year of the pandemic caused by the coronavirus, the number of tourist arrivals and overnight stays returned to the level of 20 years ago. Travel restrictions, border closures, quarantine regulations and the implementation of epidemiological measures in the Republic of Croatia and the world, in order to prevent the spread of infection, directly affected the drop in tourist arrivals and overnight stays.

There were 7,001,128 arrivals and 40,794,455 tourist overnight stays in commercial accommodation facilities in 2020, which is 64.2% fewer tourist arrivals and 55.3% fewer tourist overnight stays compared to 2019. In 2020, only 11.35% of arrivals and 4.2% of overnight stays by tourists fell within the area covered by the Plan.

The largest number of arrivals in the area covered by the Plan from 2017 to 2020 was recorded by the City of Zagreb and the County of Karlovac, while the lowest number of arrivals was recorded by the Virovitica-Podravine County (Picture3.2).

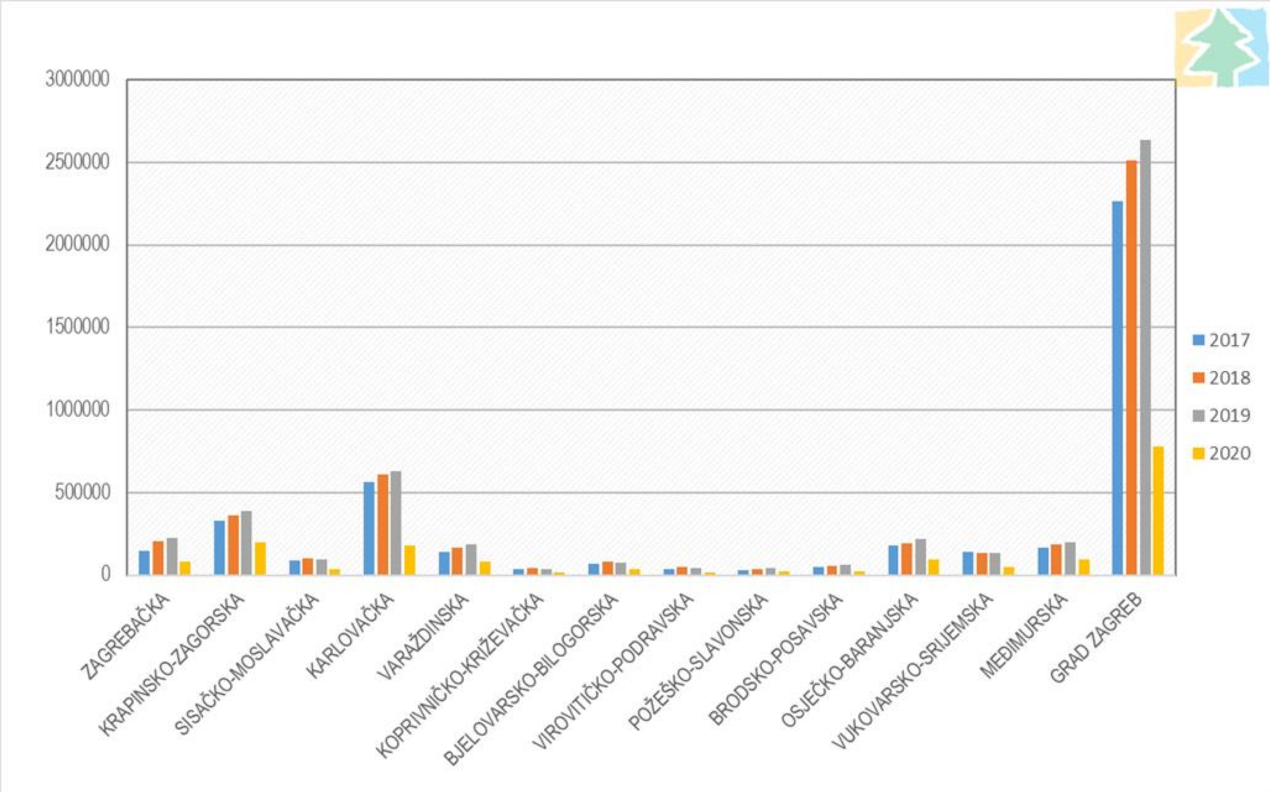


Picture3.2Number of tourist arrivals by county in the area covered by the Plan from 2017 to 2020 (Source: State Bureau of Statistics)

The ratio of the total number of tourist arrivals per km^2 indicates the pressure that the arrival of tourists represents for a certain county during the peak season. Tourist pressure on space in Croatia in 2019 was 345.73 tourists/ km^2, while in continental Croatia it was 82.85 tourists/ km^2. The same indicator in Croatia in 2020 was 123.71 tourists/ km^2 and in continental Croatia it was 24.93 tourists/ km^2.

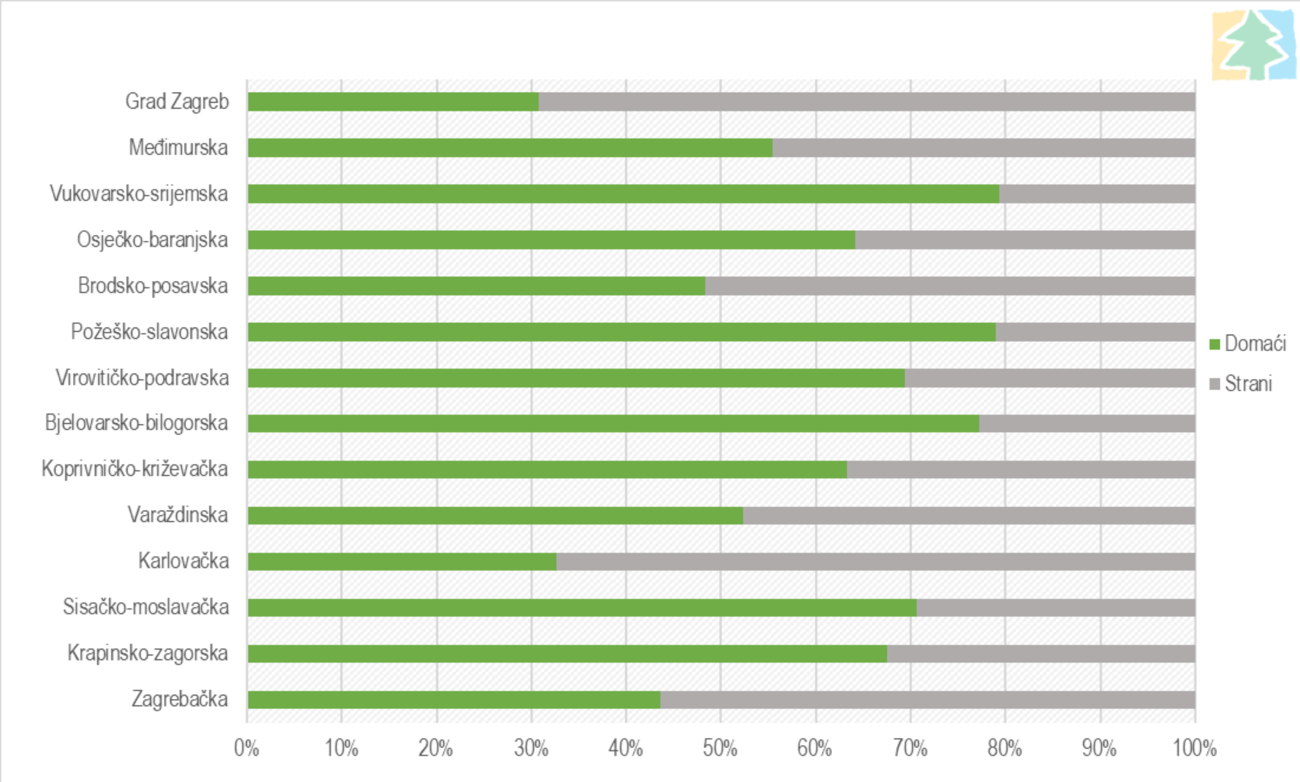
Analyzing the data by respective counties, it is concluded that the City of Zagreb had the greatest pressure, 2,268.36 tourists/km2 in 2019, and a pressure of 534.28 tourists/ km^2 in 2020. Virovitica-Podravine County (8.26 tourists/ km^2) in 2019 and Sisak-Moslavina County (2.91 tourists/ km^2) in 2020 had the lowest tourist pressure on the area.

In accordance with the number of arrivals, a decrease in the number of overnight stays by tourists was also recorded in Croatia. The largest number of overnight stays, in the analyzed period from 2017 to 2020, was recorded by the City of Zagreb and Karlovac County, while the lowest number of overnight stays was achieved by the Virovitica-Podravine County (Picture3.3).



Picture3.3Number of overnight stays by county in the area covered by the Plan from 2017 to 2020 (Source: State Bureau of Statistics)

The number of overnight stays per inhabitant by county reflects the density of tourist traffic. In Croatia, the number of overnight stays per inhabitant is 10.49, which indicates that in 2020, about 10 times more guests stayed overnight in Croatia than the officially registered number of inhabitants in 2021. Krapina-Zagorje County (1.66) and Karlovac County (1.6) had the highest number of overnight stays in continental Croatia per inhabitant. Koprivnica-Križevačka County has the lowest number of overnight stays per inhabitant (0.18). In the vast majority of Croatian counties in 2020, foreign guests stayed overnight (86.73%). In continental Croatia, the share of domestic guests prevails in most counties, but the total number of overnight stays is also dominated by foreign guests, 55.18%.



Picture3.4Share of domestic and foreign guests in the total number of overnight stays by county in the area covered by the Plan, 2020 (Source: State Bureau of Statistics)

According to the statistical reports of the CBS for Tourism for 2020, the majority of foreign tourists to the area covered by the Plan came from Germany, Italy, Slovenia, the USA, Bosnia and Herzegovina, France and Austria.

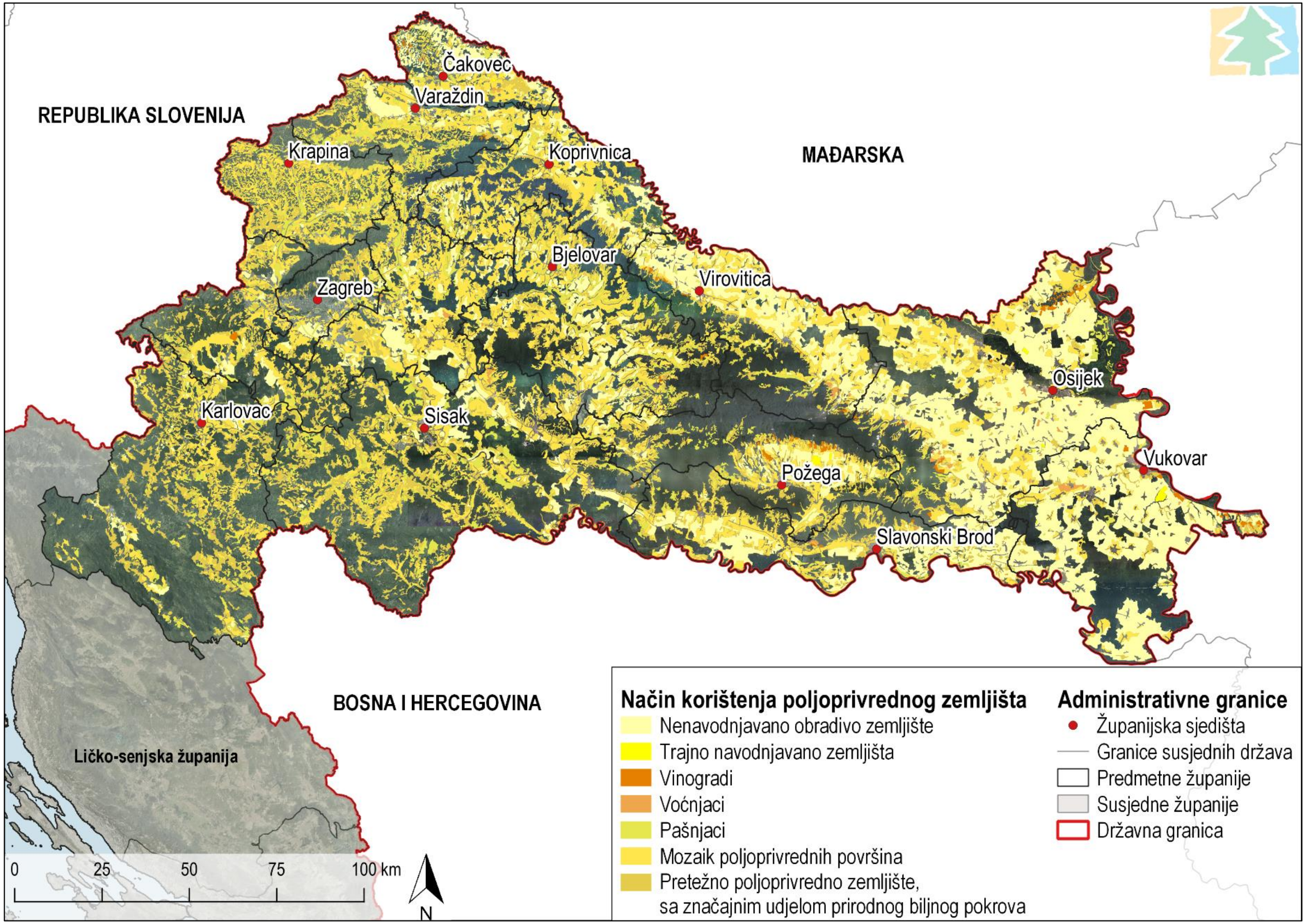
3.1.3 Agriculture

The latest available data from the year 2018 of the CORINE (Coordination of Information on the Environment) Land Cover program (hereinafter: CLC database) was used to analyze the way agricultural land is used, which makes up a digital database on the condition, ways of use and changes in land cover. . The CLC Croatia database is consistent and homogenized with land cover data from the entire EU and is used as a basic reference data set for spatial and territorial analyses.

According to the CLC database, there are 1,649,583.81 ha of agricultural land divided into 7 categories in the area of the counties in question, and the most represented categories are the mosaic of agricultural land and non-irrigated arable land (Table3.1). The counties in question with the largest share of agricultural land are Osijek-Baranja County (16%) and Sisak-Moslavina County (11%).

Table3.1The way agricultural land is used in the counties in question (Source: CLC 2018)

Method of using agricultural land	Area (ha)
Non-irrigated arable land	595,075.24
Irrigated arable land	2110.93
Vineyards	8551.88
Orchards	6753.82
Pastures	158 330.38
Mosaic of agricultural areas	609 602.96
Predominantly agricultural land, with a significant proportion of natural plant cover	269 158.60



Picture3.5The way agricultural land is used in the counties in question (Source: IRES EKOLOGIJA doo according to CLC 2018 and Geoportal DGU)

In contrast to the previously mentioned data, the ARKOD database for the year 2021 records a significantly smaller area of agricultural land of 967,340.5 ha (Table3.2). The reason for this is that according to the Ordinance on agricultural land use records (Official Gazette 54/19, 126/19, 147/20), it is necessary to register in the Register of Farmers only if incentives for agricultural production are claimed, which means that this database covers only a part farmers. The number of agricultural holdings (hereinafter: PG) by type for the year 2021 according to the data of the Agency for Payments in Agriculture, Fisheries and Rural Development (hereinafter: APPRRR) shows that the largest number of registered entities in the area of the counties in question operate as family agricultural holdings (96,859), followed by self-sufficient family farms (17,437), trading companies (2,367), trades (1,862), cooperatives (217) and other legal entities (172).

Most of the agricultural land in the respective counties is occupied by arable land, as much as 85%, followed by meadows and orchards. The basic characteristics of agricultural land are fragmentation and fragmentation, as evidenced by the fact that 54% of agricultural holdings have less than three hectares of agricultural land, and 39% have three to 20 hectares of agricultural land. Also, the previously mentioned area of agricultural land according to ARKOD - u of 967,340.5 ha is fragmented into as many as 1,017,223 plots, which means that the average plot size is 0.95 ha. Osijek-Baranjska (22%), Vukovar-Srijemska (16%) and Bjelovar-Bilogorska counties (10%) have the largest share of arable land (according to ARKOD in 2021).

Table3.2Agricultural areas registered in the ARKOD database in the area of the respective counties (Source: APPRRR, 2021)

County	Total area of ARKOD plots (ha)	Total number of ARKOD plots	Total number of PGs
Bjelovarsko-bilogorska	92 966.15	96 208	11 124
Brodsko-posavska	67 339.52	52 060	7329
Grad Zagreb	7729,10	18 141	6508
Karlovačka	32 415.02	61 781	6845
Koprivničko-križevačka	70 482.77	123 192	9682
Krapinsko-zagorska	21 754.53	84 668	9039
Međimurska	29,694.35	57 162	4738
Osječko-baranjska	21 2105.3	85,998	12 634
Požeško-slavonska	45,354.71	45 055	5115
Sisačko-moslavačka	71 294.05	68 436	9376
Varaždinska	30,600.09	81 434	8160
Virovitičko-podravska	84 128.33	56 934	6504
Vukovarsko-srijemska	131 032.4	64 462	7600
Zagrebačka	70 444.22	121 692	14 260
In total	**967 340.5**	**1 017 223**	**118 914**

Ecological agriculture

Organic production is a comprehensive management system of agricultural holdings and food production that unites the best practices regarding the environment and climate, a high level of biological diversity, the conservation of natural resources, the application of high standards of animal welfare and production standards that are in line with the demand of an increasing number of consumers for products produced using natural substances and processes. Adherence to high standards in the field of health, environment and animal welfare in the production of ecological products is inherent in the high quality of these products.

The area of ecologically used agricultural land in the area of the counties in question in 2020 was 70,434 ha, which is 21.9% more than in 2016, when it was 57,783 ha (Table3.3). Osijek-Baranja and Virovitica-Podravine counties have the largest areas of ecologically used agricultural land. There is also organic livestock farming, and according to data for 2020, the most organically farmed sheep - 26,468 and cattle - 11,903, while Sisak-Moslavina and Karlovac counties are leading in organic livestock farming.

Table3.3The area of ecologically used agricultural land and the number of organically raised livestock in the area of the counties in question (Source: State Bureau of Statistics)

County	Area of ecological used agricultural land (ha)		Number of organically raised livestock	
	2016	in 2020	2016	in 2020
Bjelovarsko-bilogorska	3038	5955	3178	5383
Brodsko-posavska	5684	7320	3164	3503
Grad Zagreb	1683	316	514	365
Karlovačka	3148	4525	5330	6382
Koprivničko-križevačka	469	724	72	307
Krapinsko-zagorska	254	173	59	3287
Međimurska	1119	1481	77	269
Osječko-baranjska	17 219	19 107	6844	5668
Požeško-slavonska	3228	3184	3347	4314
Sisačko-moslavačka	7258	9445	10 278	12 901
Varaždinska	302	665	1060	351
Virovitičko-podravska	9078	11 021	2358	1906
Vukovarsko-srijemska	3215	4416	407	1235
Zagrebačka	2088	2102	2941	1558
In total	**57 783**	**70 434**	**39 629**	**47 429**

Cattle breeding

According to the data of the Croatian Agricultural Agency, 31.12.2020. in the area of the counties in question, there were a total of 2,072,765 head of cattle registered on 101,389 agricultural holdings, and according to the number of heads, Osijek-Baranja, Vukovar-Srijem and Bjelovar-Bilogor counties are leading (Table3.4). If we compare these data with those from 2016, when there were a total of 2,238,560 head of cattle on 135,106 farms in the area of the counties in question, we see that in the five-year period, the number of farms decreased by 25%, while the number of head decreased by 7 .4%.

Table3.4Numerous state of domestic animals in the area of the counties in question in 2020 (Source: Single register of domestic animals)

	Cattle	Horses	Donkeys	Pigs	Sheep	Goats
Number of farms	15 255	4078	315	67,200	12 008	2533
Number of animals	366 045	19 478	1431	1 303 225	351 412	31 174

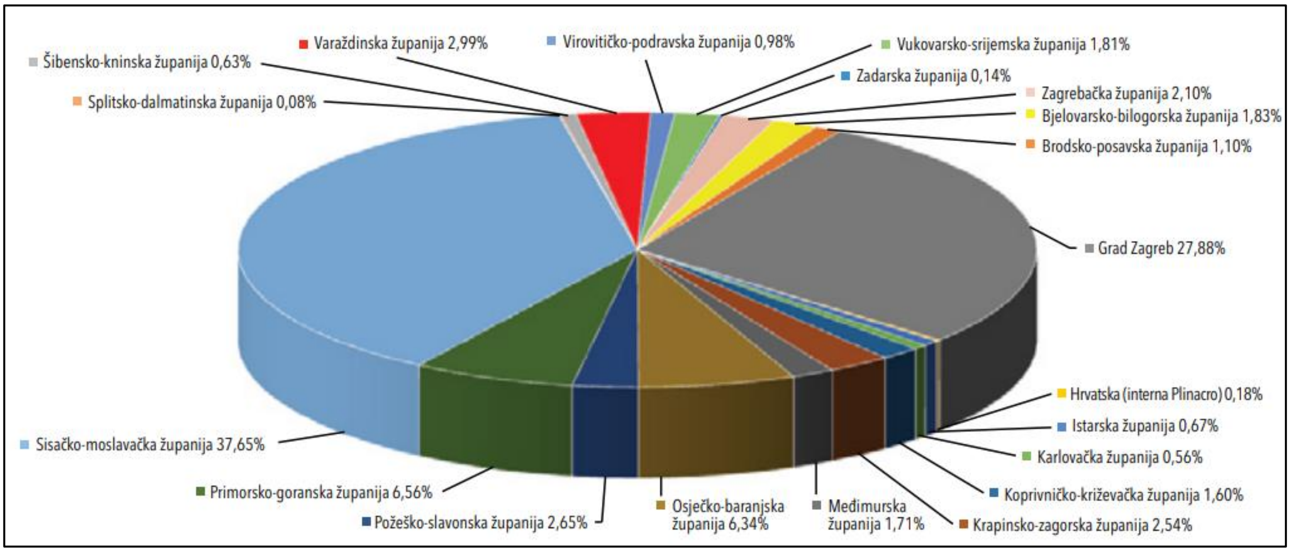
Animal husbandry in Croatia, including in the area of the counties in question, is underdeveloped compared to agriculturally developed countries, with a tendency to further decline. The consequences of this are the increasing representation of imported products in domestic consumption, the abandonment of production by smaller producers, the irrational use or abandonment of agricultural land, the reduction of employment and income in agriculture.

3.1.4 Energetics

Energy production

According to the data from the Annual Energy Review "Energy in Croatia 2020" (MINGOR, 2020), the total production of primary energy in the Republic of Croatia in 2020 was 196.06 PJ (petajoule), of which 32.8% was firewood and biomass. 26.3% energy from hydropower, 15.3% natural gas, 13.8% crude oil, while 11.9% are other renewable energy sources and ambient heat. The total production of primary energy in 2020 was reduced by 2.3% compared to the previous year. The production of energy from other renewable sources (wind energy, solar energy, biogas, liquid biofuels and geothermal energy) increased by 16.0%, energy from firewood and biomass by 2.4%, thermal energy from heat pumps by 1.4% and the energy of used water power by 0.2%. The decrease in natural gas production was 17.3%,

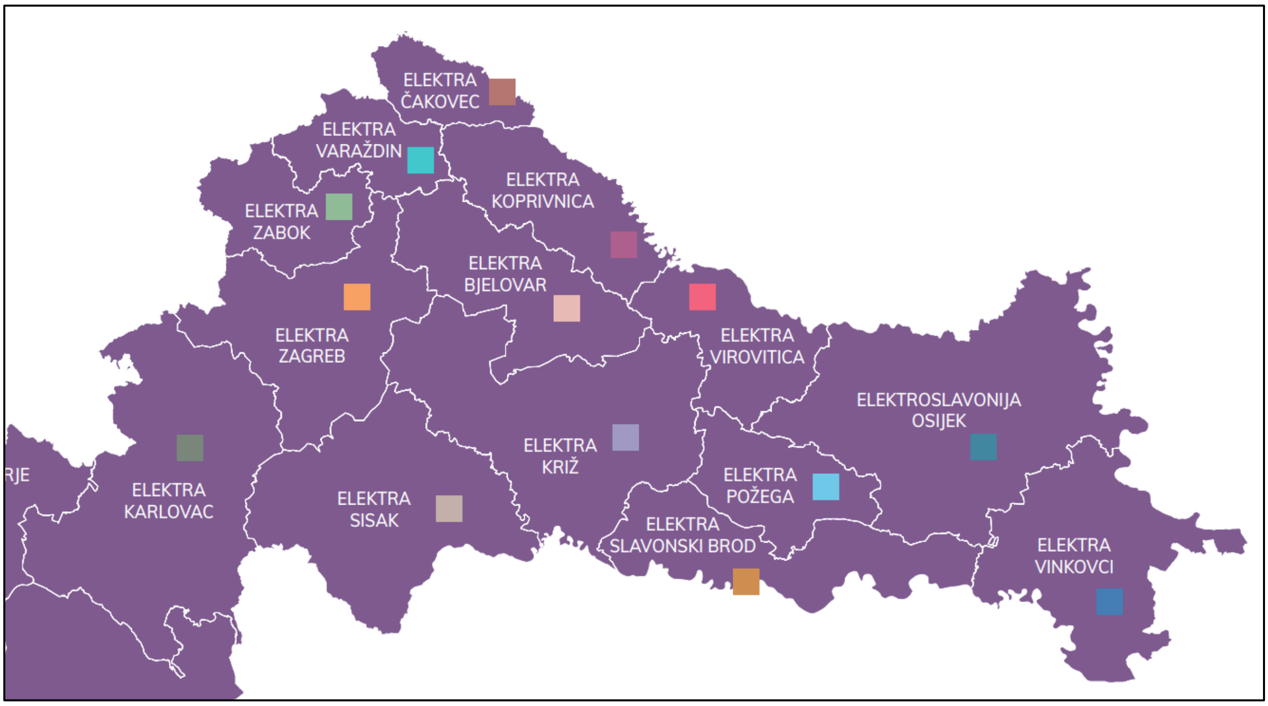
Natural gas is produced in 54 exploitation fields on the mainland and three exploitation fields in the Adriatic, which in 2020 met around 30 percent of domestic needs for natural gas and around 20 percent of domestic needs for oil. The production of gas from Pannonian Croatia is higher than the production from the Adriatic Sea and amounted to 67%. The largest part of natural gas production is related to the deposits of Duboka Podravina and Međimurje (Molve, Gola dubka, Kalinovac, Vučkovec, Vukanovec and Zebanec deposits). In the exploitation fields of Posavina, the most significant production of natural gas and oil was realized in the fields of Žutica, Okoli and Stružec. The total length of gas pipelines in the transport system of the Republic of Croatia is 2,549 km, of which 1,579 km are gas pipelines with a working pressure of 50 bar, 952 km are gas pipelines with a working pressure 75 bar, and 18 km of gas pipeline with a working pressure of 100 bar. The delivery of gas from the transport system took place through 199 connections to 156 output metering and reduction stations. The transport gas system enables the delivery of gas in the territory of 19 counties (including all counties in question), and during 2020, the largest share in the structure of the transported quantities of natural gas by county was held by the County of Sisak-Moslavina (37.65%) and the City of Zagreb (27.88 %), (Picture3.6). In 2020, the length of the gas distribution network in the Republic of Croatia was 18,429 km (excluding household connections), (MINGOR, 2020). According to the Register of Licenses for Performing Energy Activities of the Croatian Energy Regulatory Agency, 40 companies have a license to perform the energy activity of gas supply in the area of the counties in question, and 29 companies have a license to perform the energy activity of gas distribution.



Picture3.6The structure of transported quantities of natural gas by county in 2020 (Source: IRES EKOLOGIJA doo according to data from MINGOR (2020) and Plinacro)

Thermal energy is produced in cogeneration plants in Zagreb, Osijek and Sisak or in mini heating plants, block and home boilers for individual settlements and is distributed by hot water pipes/heat pipes/steam pipes of a total length of about 443 km to facilities where it is handed over to consumers via thermal stations. In Zagreb, Osijek and Sisak, technological steam is also produced and delivered for the needs of industry, and partly also for the needs of space heating. In 2020, about 2.00 TWh of thermal energy was delivered in the area of the counties in question through a distribution network with a length of about 427 km (MINGOR, 2020).

Out of a total of 72 companies that have a license to produce electricity in the Republic of Croatia, 60 of them are located in the respective counties (HERA, 2022). The majority owner of large production capacities is the HEP group (a company owned by the Republic of Croatia), and private producers mainly own power plants based on renewable energy sources (MINGOR, 2020). At the state level, including the counties in question, the license for the transmission of electricity is held by the Croatian transmission system operator doo, Zagreb, and for the distribution of electricity by HEP-Operator distribucijno sustava doo (HEP ODS doo), Zagreb. The distribution network of HEP ODS in the Republic of Croatia is organized within 21 distribution areas divided into 129 field units and four groups of areas: North, East, West and South.Picture3.7). The length of the network is greatest in the distribution areas of Elektra Zagreb (17,994.1 km) andElectroslavonia Osijek(8,364.5 km), and the smallest in the distribution areas of Elektra Požega (2,073.1 km) and Elektra Virovitica (2,567.3 km). In the area of the counties in question, 11 companies have licenses for electricity supply (HERA, 2022).



Picture3.7Map of distribution areas of HEP ODS in the Subject Counties (Source: HEP ODS doo 2021)

Renewable energy sources

Renewable energy sources are becoming increasingly important in the overall energy supply of the Republic of Croatia. The increase in installed capacities for the production of electricity from renewable sources is also followed by its production, so in 2020, almost 3,000 GWh of electricity from renewable sources were produced, and this production accounted for 22.3% of the total production, with the exception of large hydropower plants (Annual Energy Review "Energy in Croatia 2020"). In the following table (Table3.5) contains an overview of electricity production from renewable energy sources in Croatia in 2020.

Table3.5Production of electricity from renewable energy sources in Croatia in 2020 (Source: MINGOR's Annual Energy Review "Energy in Croatia 2020")

Type of source	Electricity production (GWh)
Sun	95.5
Wind	1720.7
Biomass	558.9
Biogas	419.3
Small hydropower plants	102.0
Geothermal	93.7
In total	**2990.1**

Energy from biomass

Biomass obtained from the forestry sector (woods, etc.) and the wood-processing industry sector (bark, sawdust, wood chips, etc.) is a significant potential renewable energy source, especially in the area of Osijek-Baranja, Vukovar-Srijem and Virovitica-Podravine counties. which, according to the Register of Renewable Energy Sources and Cogeneration and Privileged Producers (hereinafter: OIEKPP Register), are leading in the number of registered biomass power plants. The potential for the use of biomass is also great in most of the other counties in question that are covered to a significant extent by forests, such as Bjelovar-Bilogorska, Sisak-Moslavina, etc.

The following table contains an overview of registered biomass power plants in the area of the relevant counties (Table3.6), according to data from the OIEKPP Register.

Table3.6Overview of registered biomass power plants in the area of the Counties in question (Source: IRES EKOLOGIJA doo according to data from the OIEKPP Registry)

County	Number of biomass power plants	Electric power (MW)
Bjelovarsko-bilogorska	7	7.85
Brodsko-posavska	5	12.62
Grad Zagreb	0	/
Karlovačka	8	17,23
Koprivničko-križevačka	8	22.62
Krapinsko-zagorska	3	2.89
Međimurska	0	/
Osječko-baranjska	18	17.41
Požeško-slavonska	1	1.53
Sisačko-moslavačka	9	22.20
Varaždinska	7	9.22
Virovitičko-podravska	10	23,36
Vukovarsko-srijemska	13	26,33
Zagrebačka	8	11.09

The energy of the sun

The average annual irradiance of the horizontal surface by total solar radiation in most of the subject area amounts to 1.25 - 1.30 MWh/m², while in part of the Požega-Slavonia County it is even higher and amounts to 1.30 - 1.35 MWh/m² (Matić, 2007) which indicates a significant potential that can be used by passive solar systems for the preparation of domestic hot water and space heating as well as photovoltaic systems for the production of electricity. According to data from the OIEKPP Register, in the area of the counties in question, the most solar power plants are registered in Osijek-Baranja and Vukovar-Srijem counties (Table3.7).

Table3.7Overview of registered solar power plants in the area of the respective counties (Source: IRES EKOLOGIJA doo according to data from the OIEKPP Registry)

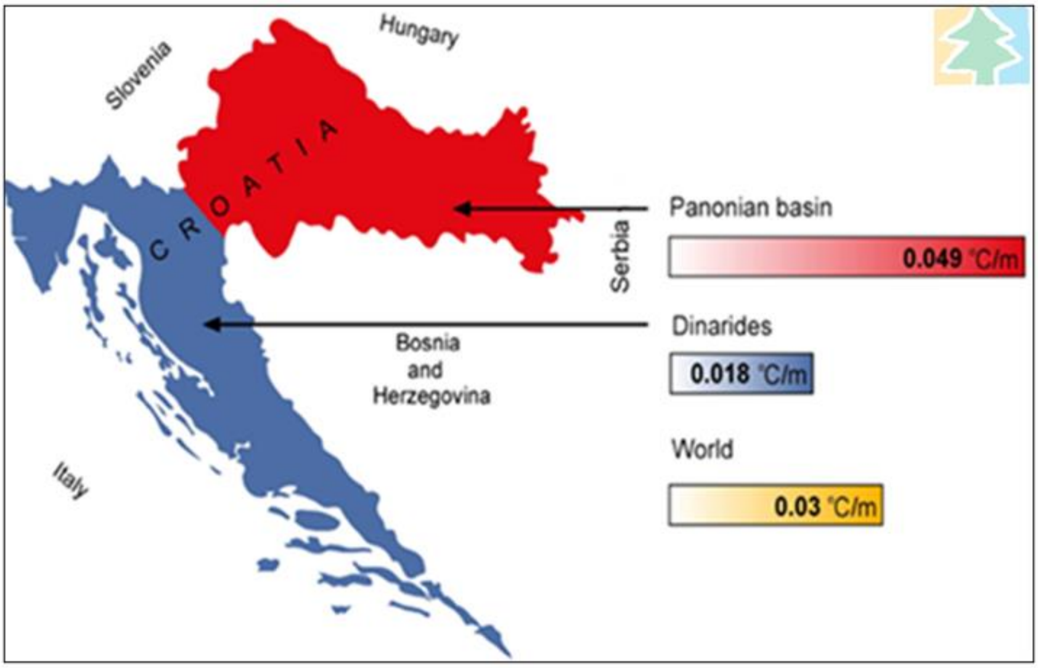
County	Number of solar power plants	Electric power (MW)
Bjelovarsko-bilogorska	117	4.82
Brodsko-posavska	224	4.01
Grad Zagreb	28	0.91
Karlovačka	66	0.96
Koprivničko-križevačka	97	11.75
Krapinsko-zagorska	92	29,13
Međimurska	270	12.36
Osječko-baranjska	664	17.63
Požeško-slavonska	53	0.67
Sisačko-moslavačka	90	5.57
Varaždinska	277	18:00
Virovitičko-podravska	102	4.51
Vukovarsko-srijemska	405	9.55
Zagrebačka	176	2.80

Wind energy

According to data from the OIEKPP Registry, there are no registered electricity producers in the area of the counties in question that use wind energy for production.

Geothermal energy

The average geothermal gradient of the Croatian part of the Pannonian Basin of 0.049 ºC/m is even 60% higher than the European average (Picture3.8). The geothermal potential of the Republic of Croatia was identified in numerous wells made in the second half of the twentieth century for the purposes of exploration and exploitation of oil and gas. Data collected from drilled wells are used as a basis for designing and planning geothermal projects in the territory of the Republic of Croatia. The highest geothermal potential is found in carbonates (dolomites, limestones and their varieties of Mesozoic age (under Neogene)) and in limestone-dolomite breccias/breccia conglomerates of Neogene and Mesozoic age (under Neogene). Carbonate deposits appear in the Pannonian part as large bodies of water, i.e. massive deposits.



Picture3.8Geothermal gradient of the Republic of Croatia (Source: Plan)

Geothermal power plants can operate with a capacity factor of up to 95%, continuously for 24 hours, without depending on weather conditions. Also, they can replace energy production in the absence of other renewable energy sources, and for this reason, the term base renewable energy is associated with geothermal energy. It is ecologically clean, uses heat from underground and reduces the emission of greenhouse gases (CO2). In addition to the production of electricity, geothermal energy also has great potential in heating - from heating residential buildings, business premises and swimming pools to agriculture where geothermal water is used for heating greenhouses, drying fruits and vegetables, aquaculture farms, etc. Geothermal systems have significant advantages in relation to to other renewable energy systems and are one of the rare sources that provide cooling and heating from the same installation. Geothermal energy in the agri-food sector can be used to heat greenhouses and sterilize soil, creating a growing environment suitable for food production in places where natural conditions would not allow it. In addition, protection against disease and extreme weather conditions increase the productivity and availability of agricultural products in the off-season. Geothermal energy can also be used for drying, which helps preserve a wide range of foods.

The Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19 and 30/21) regulates the exploration and exploitation of geothermal waters, from which accumulated heat can be used for energy purposes, and issues of protection of geothermal waters when they are used for energy purposes purposes that are not regulated by this Act, the provisions of regulations governing water shall apply. Pursuant to Art. 5, paragraph 1 of the aforementioned Act, the basic act of planning which determines the management of geothermal waters and the planning of oil-mining economic activity at the state level is the Energy Development Strategy of the Republic of Croatia, adopted by the Croatian Parliament in accordance with the regulations regulating energy. Pursuant to Art. 5, paragraph 5.

In the Republic of Croatia, there are currently 7 active areas where geothermal water is exploited for energy purposes, the purpose of which is the production of electricity and thermal energy. According to data from the OIEKPP Registry, a geothermal power plant with an electrical power of 10 MW is registered in the area of Bjelovarsko-Bilogorska, while there are no registered geothermal power plants in the area of the other counties in question. According to data from the website of the Agency for Hydrocarbons (AZU), in addition to the mentioned power plant, the economic activity of exploitation of geothermal water for energy purposes is also carried out in the area of exploitation fields Bizovac in Osijek-Baranja County (thermal energy), Bošnjaci-Sjever in Vukovar-Srijem County (thermal energy for the needs of agriculture),Table3.8). Also, currently 14 research permits have been granted in 14 research areas in Pannonian Croatia (Table3.9), and there is also the possibility that the exploitation fields of geothermal water for energy purposes are formed on the exploitation fields of hydrocarbons in Pannonian Croatia after the cessation of exploitation of hydrocarbons (Table3.10).

Table3.8Currently active exploitation fields where the economic activity of exploitation of geothermal water for energy purposes is carried out in the Republic of Croatia (Source: IRES EKOLOGIJA doo according to the Plan)

Serial no.	Name of the exploitation field	Area km2	The authorized person of the exploitation field
1	Bošnjaci Sjever	0.05	RURIS doo Županja
2	Draškovec AATG	11,18	AAT GEOTHERMAE doo
3	Geotermalno polje Zagreb	54.00	GPC Instrumentation Process doo
4	GT Bizovac	9.00	INA INDUSTRIJA NAFTE dd
5	GT Ivanić	5.00	INA INDUSTRIJA NAFTE dd
6	Bošnjaci Sjever	5.94	GEOEN doo
7	Holy Sunday	0.01	Eko plodvi doo

Table3.9Current areas where exploration activities are carried out with the aim of exploiting geothermal water for energy purposes in the Republic of Croatia (Source: IRES EKOLOGIJA doo according to the Plan for the Development of the Geothermal Potential of the Republic of Croatia until 2030)

Serial no.	The name of the space	Area km2	The authorized representative of the investigation area
1	Babina Greda 1	2.64	GEJZIR ddo
2	Babina Greda 2	7.70	GEOTHERMAL SPRINGS doo
3	Ernestinovo	76,66	Ensolx doo
4	Karlovac 1	44.98	GeotermiKA doo
5	Korenovo	25.00	Terme Bjelovar doo
6	Križevci	18.45	MUNICIPALITY COMPANY doo
7	Legrad-1	20.89	Terra Energy Generation Company doo
8	Lunjkovec-Kutnjak	99.97	Bukothermal doo
9	Merhatovec	9.59	Ensolx doo
10	Slatina 2	38.77	Geo Power Zagocha doo
11	Slatina 3	55,26	Dravacel doo
12	Sveta Nedelja	0.01	Eko plodvi doo
13	Babina Greda 1	7.00	BUSINESS PARK VIROVITICA doo
14	Topusko	1.42	TOP-TERME doo

Table3.10Potential exploitation fields of geothermal water for energy purposes formed on exploitation fields of hydrocarbons after the cessation of exploitation of hydrocarbons (Source: IRES EKOLOGIJA doo according to the Plan for the Development of the Geothermal Potential of the Republic of Croatia until 2030)

Serial no.	Potential exploitation fields of geothermal water for energy purposes formed on exploitation fields of hydrocarbons after the cessation of exploitation of hydrocarbons	Area km2
1	Bačkovica	3.10
2	Beničanci	38.26
3	Bilogora	65.48
4	Bizovac	11.96
5	Bokšić - klokočevci	91.67
6	Bunjani	13.62
7	Cabuna	4.50
8	Crnac	38.15
9	Cvetkovec	4.23
10	Čepelovac - hampovica	20.20
11	Dugo selo	2.69
12	Đeletovci	33.06

13	Ferdinandovac	18.67
14	Gakovo	8.71
15	Galovac pavljani	4.82
16	Gola	40.95
17	Ilača	4.47
18	Ivanić	19.15
19	Jagnjedovac	8.45
20	Jamarica	42.23
21	Janja lipa	4.90
22	Ježevo	3.21
23	Kalinovac	92.77
24	Kloštar	30.51
25	Kozarica	22.52
26	Kučanci - kapelna	61.64
27	Kutnjak - đelekovec	41.53
28	Legrad	17.89
29	Lepavina	1.44
30	Letičani	14.23
31	Lipovljani	14.07
32	Lupoglav	21.42
33	Mihovljan	12.66
34	Molve	72.56
35	Mosti	42.02

Water flow energy

According to the OIEKPP Register data, in the area of the counties in question, hydropower is used mostly in Karlovac and Požeško-Slavonska counties, and to a lesser extent in the area of Sisak-Moslavina, Međimurje, Varaždin and Zagreb counties, while there are no registered power plants in the area of the other counties in question. water flow energy.

Table3.11Overview of registered water power plants in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from the OIEKPP Registry)

County	Number of hydroelectric power plants	Electric power (MW)
Bjelovarsko-bilogorska	0	/
Brodsko-posavska	0	/
Grad Zagreb	0	/
Karlovačka županija	11	7.87
Koprivničko-križevačka	0	/
Krapinsko-zagorska	0	/
Međimurska	1	79.00
Osječko-baranjska	0	/
Požeško-slavonska	7	0.94
Sisačko-moslavačka	4	0.86
Varaždinska	3	0.86
Virovitičko-podravska	0	/
Vukovarsko-srijemska	0	/
Zagrebačka	1	0.05

Biogas energy

According to the OIEKPP Registry data, in the area of the counties in question, biogas energy is mostly used in Osijek-Baranja, Vukovar-Srijem and Bjelovar-Bilogor counties, while there are no registered biogas power plants in Brod-Posavina, Karlovac and Krapina-Zagorje counties.

Table3.12Overview of registered biogas power plants in the area of the Counties in question (Source: IRES EKOLOGIJA doo according to data from the OIEKPP Registry)

County	Number of biogas power plants	Electric power (MW)
Bjelovarsko-bilogorska	10	9.35
Brodsko-posavska	0	/
Grad Zagreb	1	2.00
Karlovačka županija	0	/
Koprivničko-križevačka	7	8.80
Krapinsko-zagorska	0	/
Međimurska	3	1.16
Osječko-baranjska	22	23.58
Požeško-slavonska	2	4.00
Sisačko-moslavačka	1	0.14
Varaždinska	3	1.61
Virovitičko-podravska	6	8.00
Vukovarsko-srijemska	11	12:30
Zagrebačka	5	7.20

Also, according to data from the OIEKPP Register, in the area of the City of Zagreb and Osijek-Baranja County, landfill gas and gas from wastewater treatment plants are registered. 3 such power plants with an electrical power of 6.70 MW are registered in the area of the City of Zagreb, while 1 such power plant with an electrical power of 0.50 MW is registered in the area of the Osijek-Baranja County. In the territory of the other counties in question, there are no registered landfill gas and gas from waste water treatment plants.

Energy from cogeneration

According to the data of the OIEKPP Registry, cogenerations are registered in the area of the counties in question in the City of Zagreb, Međimurje, Sisak-Moslavina, Varaždin and Vukovar-Srijem counties, while there are no registered cogenerations in the area of the other counties in question.

Table3.13Overview of registered cogeneration in the area of the Subject Counties (Source: IRES EKOLOGIJA doo according to data from the OIEKPP Registry)

County	Number of cogeneration plants in the subject counties	Electric power (MW)
Bjelovarsko-bilogorska	0	/
Brodsko-posavska	0	/
Grad Zagreb	1	112.00
Karlovačka županija	0	/
Koprivničko-križevačka	0	/
Krapinsko-zagorska	0	/
Međimurska	1	0.30
Osječko-baranjska	0	/
Požeško-slavonska	0	/
Sisačko-moslavačka	1	3.20
Varaždinska	1	0.03
Virovitičko-podravska	0	/
Vukovarsko-srijemska	2	11.00
Zagrebačka	0	/

According to data from the OIEKPP Registry, a kinetic power plant with an electrical capacity of 1.00 MW is registered in the Brod-Posavina County.

3.1.5 Industry

According to data from the Croatian Chamber of Commerce, in 2020, 10,829 industrial business entities were registered in the area covered by the Plan.[1]. As many as 93.5% of subjects were recorded in the activity C - Manufacturing, followed by activities D - Supply of electricity, gas, steam and air conditioning with 5.65% and B - Mining and extraction with 0.85%. If we compare these data with the data for the first ten limited liability companies and joint-stock companies in the area covered by the Plan according to income, we see that in addition to activities C and D, activity G also predominates - Wholesale and retail trade; repair of motor vehicles and motorcycles and items for personal use and household (Table 3.).

Table 3.3.14Leading companies in the area covered by the Plan according to income (Source: Croatian Chamber of Commerce)

Company name	Core activity (NKD)	Company name	Core activity (NKD)
INA-INDUSTRIJA NAFTE, dd	C1920 - Manufacture of refined petroleum products	Hrvatski Telekom dd	J6110 - Activities of wired telecommunications
KONZUM plus doo for trade	G4711 - Retail sale in non-specialized stores mainly of food, beverages and tobacco products	SPAR Hrvatska doo for trade	G4711 - Retail sale in non-specialized stores mainly of food, beverages and tobacco products
PRVO PLINARSKO DRUŠTVO doo for import, supply and trade of gas	D3522 - Distribution of gaseous fuels through the distribution network	PLIVA HRVATSKA doo for the development, production and sale of medicines and pharmaceutical products	C2120 - Manufacture of pharmaceutical preparations
HRVATSKA ELEKTROPRIVREDA dd	D3513 - Distribution of electricity	HEP-Proizvodnja doo for the production of electricity and thermal energy	D3511 - Production of electricity
LIDL HRVATSKA d.o.o. for trade limited partnership for trade	G4711 - Retail sale in non-specialized stores mainly of food, beverages and tobacco products	KAUFLAND CROATIA limited partnership for trade	G4711 - Retail sale in non-specialized stores mainly of food, beverages and tobacco products

One of the problems is represented by facilities with hazardous substances present, which represent a potential source of accidents. In 2020, in the area covered by the Plan, 479 persons subject to the Register of Environmental Pollution (hereinafter: ROO) who discharge industrial wastewater and 1,972 persons liable to transfer industrial wastewater were recorded.

Gases such as carbon dioxide (CO2), sulfur dioxide (SO2), nitrogen dioxide (NO2), carbon monoxide (CO) and particles in the air (PM10) contribute the most to air pollution. In the area covered by the Plan in 2020, there were 318 air emissions obligees. The largest amounts of carbon dioxide (CO2), carbon monoxide (CO) and nitrogen dioxide (NO2) are generated by electricity supply activities, while the processing industry, specifically metal casting, generates the largest amounts of particles in the air (PM10).

Production waste is waste generated in the production process in industry, trade and other processes, and its composition and properties differ from municipal waste. Residues from the production process that are used in the production process of the same manufacturer are not considered production waste. According to ROO data for 2020, 2,742,334.8 t of non-hazardous waste and 49,306.4 t of hazardous waste were generated in the area covered by the Plan.

Not all legal entities are registered in the ROO. Namely, if a legal entity produces waste that does not exceed limit values, does not release pollutants into the air, water and soil, and does not perform waste management activities, it is not obliged to submit data to the ROO. If, according to the amount of produced waste, the limit value threshold for the next reporting period is exceeded, the data must be submitted to the ROO.

[1]The term "industry" is used as a synonym for the industrial sector of the economy, and it is defined by the activities of areas B, C and D according to the NKD 2007. This definition of the industry sector is mostly harmonized with the EU industry definition for business statistics.

3.1.6 Mining, hydrocarbons and geothermal waters for energy purposes

Mineral raw materials, in terms of the Law on Mining (Official Gazette 56/13, 14/14, 52/18, 115/18, 98/19), are considered to be mineral raw materials for industrial processing, mineral raw materials for the production of building materials, architectural and building stone and mineral raw materials of metals. The term energy mineral raw materials previously contained in the aforementioned law has ceased to be valid, and at the time of the creation of this Plan, the exploration and exploitation of hydrocarbons and geothermal water, which are understood by that term, is regulated by the Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19, 30 /21).

In the area covered by the Plan, mineral raw materials are exploited with exclusive use in construction. Their use depends on market needs, and production depends on natural potential. According to the data of the Unified Information System of Mineral Resources of the Republic of Croatia (hereinafter: JISMS), there are a total of 127 active exploitation fields of mineral resources within the scope of the Plan. All these locations are accompanied by the same problems of disturbance of soil, air and landscape characteristics and noise generation. In the following table (Table3.15) shows the first ten active exploitation fields of mineral raw materials in the area covered by the Plan by area.

Table3.15Exploitation fields of mineral raw materials in the area covered by the Plan (Source: JISMS)

Number	Mark in the registry	Name of the exploitation field	JLS	Type of mineral raw material	Area (ha)
1.	E2 94	BUKOVA GLAVA-VRANOVIĆ	City of Našice	Mineral raw materials for cement production	249.69
2.	E11 6	IVANOVEC	City of Čakovec	Construction sand and gravel	92.02
3.	E11 43	LAMB 2	Municipality of Legrad	Construction sand and gravel	87,48
4.	E11 80	TRESTENIK	Municipality of Rugvica	Construction sand and gravel	76.63
5.	E11 72	NEW UNCLE	City of Velika Gorica	Construction sand and gravel	76.2
6.	E11 23	OAK	Municipality of Donji Martijanec	Construction sand and gravel	69.73
7.	E6 46	VETO	The city of Kutjevo	Technical construction stone	68.33
8.	E9 28	A WORD	City of Karlovac	Brick clay	62.95
9.	E9 6	GRABOVAC	The city of Đakovo	Brick clay	56,55
10.	E9 26	DONJA ČEMERNICA	Municipality of Topusko	Brick clay	55.75

According to the Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19, 30/21), oil mining includes all activities related to the exploration and exploitation of hydrocarbons, geothermal waters used for energy purposes, natural gas storage and permanent disposal of hydrocarbons. dioxide. In the table (Table3.16) shows the first ten exploitation fields of hydrocarbons in the area covered by the Plan by surface area.

Table3.16Exploitation fields of hydrocarbons and their surface in the area covered by the Plan (Source: GEOPORTAL of the National Infrastructure of Spatial Data)

Number	Name of the exploitation field	Area (ha)
1.	Kalinovac	92.77
2.	Bokšić - Klokočevci	91.67
3.	Plums	72.56
4.	Bilogora	65,48
5.	Kučanci - Chapel	61,64
6.	Jaundice	55.89
7.	Stari Gradac	45,41
8.	Jamarica	42,23
9.	Relics	42.02
10.	Kutnjak - Đelekovec	41.53

In the Republic of Croatia, there are currently 7 active areas where geothermal water is exploited for energy purposes (Table1.2Table1.2) whose purpose is the production of electricity and thermal energy (more on that in the chapter1.2 The current state of research and exploitation of geothermal water for energy purposes).

3.1.7 Freshwater fisheries and aquaculture

The legislation governing fisheries and aquaculture in the Republic of Croatia is the Freshwater Fisheries Act (Official Gazette 63/19), which defines freshwater fisheries as the management of fish in fresh (terrestrial) waters, and includes fishing, stocking, aquaculture, protection of fish and their habitats. Also, the Rulebook on the Control System of Organic Agriculture (Official Gazette 110 /22) prescribes the methods of fish farming if it is an organic production.

According to the Ministry of Agriculture, the cultivation of freshwater fish species is carried out in accordance with natural conditions in two ways, as the cultivation of cold-water (salmonid or trout) and warm-water (cyprinid or carp) species.

Aquaculture in the Republic of Croatia is, in accordance with the legal framework, a strategic branch of the economy and as such part of other development strategies. This economic activity produces nutritionally high-value products that are used for food and that make up for the lack of supply of fishery products that come from direct catches due to increasing restrictions on fishing. Aquaculture significantly contributes to the survival of sensitive island and rural communities, as it provides permanent employment throughout the year. It also contributes to the development of supporting activities that positively influence the retention of the working-age population on the islands, and at the same time contributes to the development of the tourist offer.

Freshwater aquaculture is engaged in by a total of 40 authorized persons, i.e. license holders in 2023 (cultivation of freshwater and cold-water species) who are registered as individuals or natural persons for the performance of freshwater aquaculture activities. In the total production of freshwater fish, about 70% goes to the production of warm-water species, and the remaining share refers to the cultivation of cold-water species. The number of aquaculture licenses is subject to change on an annual basis. With the adoption of the Law on Aquaculture (Official Gazette 130/17, 111/18, 144/20), privileges for aquaculture were replaced by permits for aquaculture, and the same have been issued since then.

The most important species in freshwater farming are carp (Cyprinus carpio), white carp (Ctenopharyngodon idella), tench (Tinca tinca), catfish (Silurus glanis), perch (Stizostedion lucioperca), pike (Esox lucius) and rainbow trout (Oncorhynchus mykiss.

Pursuant to Article 10, Paragraph 4 of the Aquaculture Act (Official Gazette 130/17, 111/18 and 144/20), the Ministry of Agriculture maintains the Register of Aquaculture Permits. According to the latest extract from the register of aquaculture permits, the situation within the respective counties is as follows:

Table3.17Permits in aquaculture (source: Register of permits in aquaculture of the Ministry of Agriculture)

County	Number of licenses for performing activities in aquaculture:	Localities
Vukovar-Srijemska	0	/
Sisak-Moslavina	1	pond in the municipality of Lipovljani in Piljenice, Lipovljani and Kraljeva Velika
Osijek-Baranja	5	pond in the territory of the municipality of Feričanci in the municipality of Feričanci at no. 2 pond in the area of the town of Našice in the district of Breznica Našička pond in the area of Municipality of Bilje, in Vardarac district pond in the area of the town of Donji Miholjac, in the municipality of Donji Miholjac pond in the area of Popovac municipality on cadastral parcels in Popovac municipality
Požega-Slavonia	3	pond in the area of the town of Lipik in the district of Marino Selo and the town of Garesnica in the district of Uljanik pond on cadastral plot number 413/5 in Šeovci district pond on cadastral parcels number 530/1, 530/2 and 531 in Čaglin district

Brodsko Posavina	4	pond in the area of Brodski Stupnik, Bebrina and Sibinj municipalities pond Vrbovljani in the municipality of Stara Gradiška in the municipality of Gređani and the municipality of Okučani in the municipality of Vrbovljani and the municipality of Čovac pond Old pond Jasinje in the municipality of Oriovac in the municipality of Radovanje and municipality of Oriovac and the municipality of Brodski Stupnik in the municipality of Brodski Stupnik pond in the area of Brodski Stupnik, Bebrina and Sibinj municipalities
Virovitica-Podravska	1	Grudnjak pond in the area of Zdenci municipality in Zdenci and Kutovi municipalities and Đurđenovac municipality in Bokšić municipality
Bjelovar-Bilogorska	9	pond in the area of Končanica municipality in Končanica district, Brestovac district and Vukovje district the pond 'Sišćani' in the area of the town of Čazma, in the district of Sišćani pond "Blagorovac" in the territory of the municipality of Dežanovac in the district Blagorodovac, district Kreštelovac and district Sokolovac pond in the area of the town of Lipik in the district of Marino Selo and the town of Garesnica in the district of Uljanik the Narta pond in the area of the Ivanska municipality in the district of Đurđic and the district of Narta and in the area of the Štefanje municipality in the district of Narta part of the pond owned by the Republic of Croatia in the area of the Municipality of Farkaševac in Ko Kabel and the Municipality of Dubrava Štefanje pond on cadastral parcels number 27/5, 55, 184/1, 187/5, 208, 343, 381 and 815 in Štefanje municipality and on cadastral parcels number 20 and 459 in Blatnica municipality, Dubrava municipality, Vukšinac municipality and Novaki municipality, and Grada Boots in ko Sišćani farm in aquaculture on cadastral plot number 374 in the municipality of Bjelovar Sredice the pond 'Garešnica' in the area of the town of Garešnica
Varaždinska	3	pond in the immediate vicinity of Bela settlement (town of Novi Marof), on cadastral lot number 43/3 in Bela district pond in the immediate vicinity of Bela settlement (town of Novi Marof), on cadastral parcel number 63 in Bela district pond Topličica, on cadastral lot number 1805 in the municipality of Donje Makojišće
Koprivnica-Križevačka	0	/
Međimurska	2	pond in the area of the municipality of Nedelišće, district Črečan, c.č. no. 885 and 886/1 pond in the area of the Balogovec reservoir, in Mačkovec and Šenkovec districts, on cadastral parcels in accordance with Article I of the Concession Agreement for the use of inland waters for the purpose of fish farming for market purposes, CLASS: 034-02/07-01/00097, UR NO: 525- 10/1-2-48-07/0007, dated October 16, 2007.
Krapina-Zagorje	0	/
City of Zagreb	1	Gračanski pond in the area of the City of Zagreb in the village of Gračani at c.č. no. 590/5
Zagreb County	7	the Crna Mlaka pond in the area of the Municipality of Klinča Sela in the district of Zdenčina Pisarovina pond in the territory of the Municipality of Pisarovina in the area of Pisarovina I, Pisarovina II, Donja Kupčina and Velika Jamnička part of the pond owned by the Republic of Croatia in the area of the Municipality of Farkaševac in Kabel district and the Municipality of Dubrava in Vukšinac district and Novaki district and the town of Čazma in Sišćani district

		part of a pond in private ownership in the area of the Municipality of Dubrava in the district of Vukšinac pond in Zagreb County on cadastral parcels number 1750 and 1751/1 in the district of Žumberak pond in Jagodno, town of Velika Gorica, on cadastral lot 251/1 in Ribnica district aquaculture farm Jaševnica, in the territory of the municipality of Kostanjevac, on cadastral parcel number 2319 in the municipality of Kostanjevac aquaculture farm "Ribnjaci Vrabac" in Kostanjevac, Žumberak municipality
Karlovačka	4	pond in Karlovac County on cadastral parcels number 67, 960/1 and 5038/3, Ko Plaški pond on cadastral parcels number 269/2, 269/5, 277, 282, 283/1, 283/2, 286 and 288 in the municipality of Vitunj aquaculture farm Vitunj in the town of Ogulin, ID no. 2754 in the district of Vitunj aquaculture farm Kunić in the municipality of Plaški, on cadastral parcel no. 78 in Ko Kunić pond in Karlovac County on cadastral parcels number 67, 960/1 and 5038/3, Ko Plaški pond in the territory of the Draganić municipality in the Draganić district

As a rule, aquaculture has a positive impact on the environment. As large water reservoirs, lowland ponds have a positive effect on the groundwater regime and the microclimate of the area and represent biological water purifiers. The impact on biodiversity is also positive.Carp farms play the role of artificial wetland habitats and represent important habitats for numerous protected species, among which birds that use the farms as resting, nesting or wintering grounds for easily available food stand out.

Aquaculture production according to the National Aquaculture Development Plan for the period up to 2027 has been in decline in recent years. In 2015, 4,832.41 t of fish were produced in the continental parts of Croatia, that is, from freshwater ponds, while in 2020, only 2,779.14 t were produced. However, according to the latest available data (Source: Ministry of Agriculture), production in freshwater aquaculture in 2021 amounted to 4,143 t, which indicates positive trends in this segment of aquaculture. In the continental part, i.e. in the area of the subject Plan, the cultivation of warm-water species predominates, while cold-water species are less represented and their more intensive cultivation begins with the beginning of the karst relief, i.e. from the Lika-Senj County to the south.

3.2 Environmental burdens

According to the Environmental Protection Act, loads are emissions of substances and their preparations, physical and biological factors (energy, noise, heat, light, etc.) and activities that endanger or could endanger environmental components (eg air and road traffic). Environmental burden is any activity or consequence of the impact of an activity on the environment, or the impact of a certain activity on the environment, which alone or in connection with other activities, can cause a decrease in the quality of the environment, a risk to the environment or the use of the environment.

In the following text, the most significant environmental burdens that will be generated by the implementation of the Plan are analyzed - waste and wastewater, noise, light pollution and invasive species.

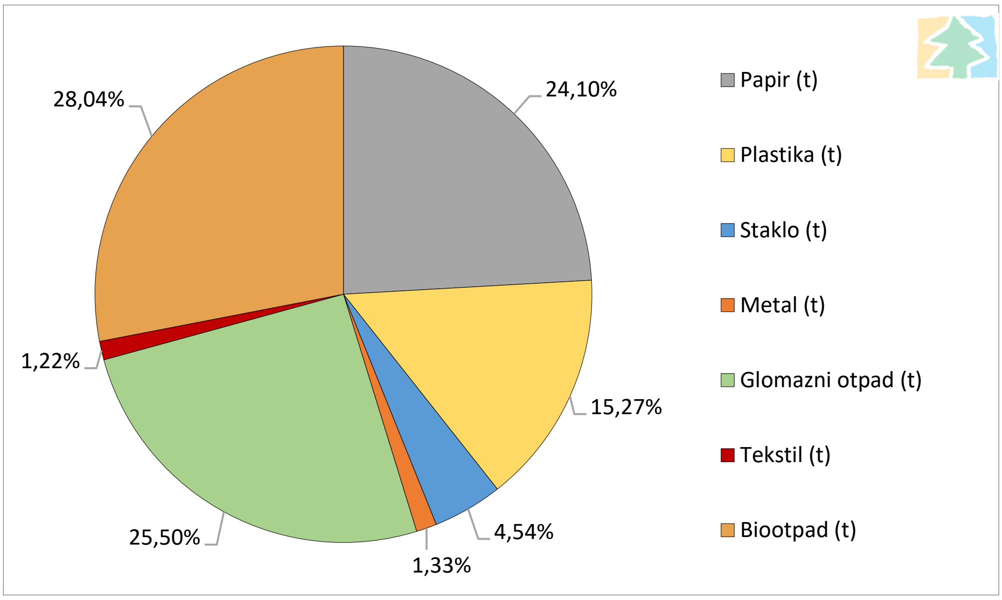
3.2.1 Waste and wastewater

The data on waste presented in this chapter are taken from the Municipal Waste Report for 2020. According to MINGOR data for the year 2020, in the area of the Counties in question, 103 companies performed the activity of the public service of the collection of mixed municipal waste (MKO), while 89 of them have a valid permit for the collection of mixed municipal waste. Waste was disposed of in 49 locations. In the area of the subject counties in 2020, the total amount of municipal waste generated amounted to 932,605 t, which is 324.62 kg of waste per inhabitant, and all the Subject Counties except the City of Zagreb produced less kg of waste per inhabitant compared to the average of the Republic of Croatia (annual the amount of municipal waste per inhabitant in the territory of the Republic of Croatia in 2020 was 418 kg) (Table3.18).

Table3.18Overview of the amount of total generated and collected municipal waste by respective counties (Source: Report on municipal waste)

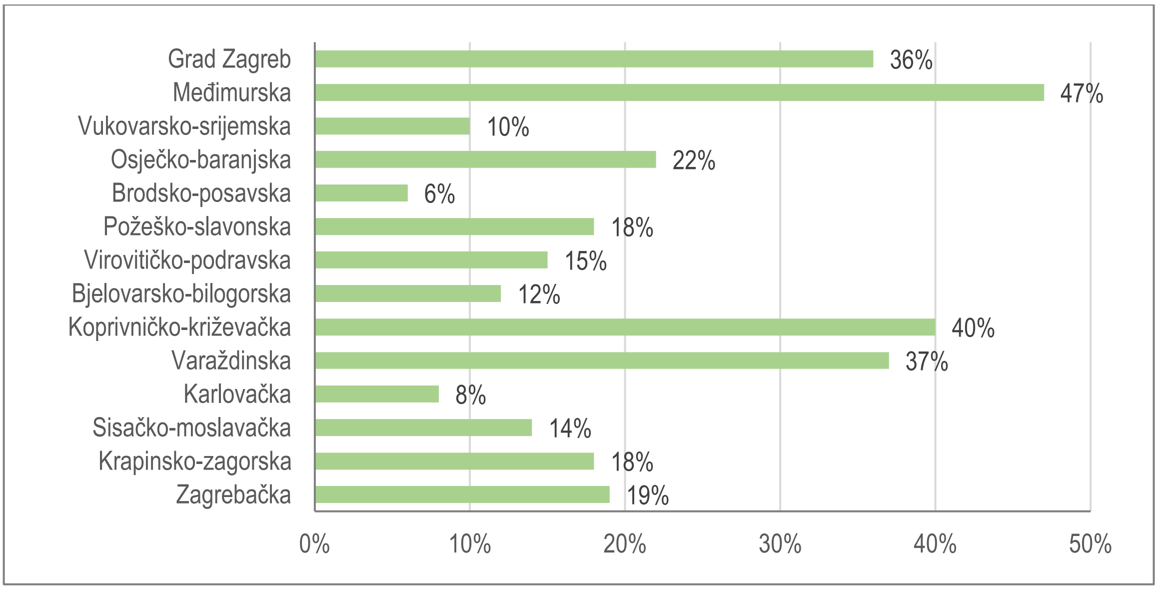
County	Total amounts of generated municipal waste (t)	Amount of waste per inhabitant (kg/apartment)	Total collected KO in the organization of LGUs (t)	Collected MKO (t)	The share of MKO in the collected municipal waste of the county
Zagrebačka	108 186	341	83 418	61 954	74%
Krapina-Zagorje	30 753	231	23 420	18 034	77%
Sisak-Moslavina	42 484	246	32 869	27 219	83%
Karlovačka	45 228	351	33 528	27 568	82%
Varaždinska	42 678	243	29 320	18 018	61%
Koprivnica-Križevačka	30 214	261	23 143	12 195	53%
Bjelovar-Bilogorska	25 704	215	19,558	16 721	85%
Virovitica-Podravska	22 786	269	17,928	14 813	83%
Požega-Slavonia	16,853	216	13 262	10,790	81%
Brod-Posavina	38 138	241	29 571	23 578	80%
Osijek-Baranja	83 694	274	64 549	47 057	73%
Vukovar-Srijemska	48 737	271	38,000	33,500	88%
Međimurska	41 511	365	29 724	14 156	48%
City of Zagreb	355 639	450	267 217	172 225	64%

The rate of separate collection of municipal waste (CO) organized by LGUs (all types except MKO) is a total of 30%, with the highest rate in Međimurje County (52%) and Koprivnica-Križevačka County (47%). The amounts of separate types of waste from municipal waste in 2020, for all 14 counties, are shown in the following graphic (Picture3.9). From the data presented, it is evident that in the largest quantities, mainly biowaste (28.04%) and bulky waste (25.50%) are collected separately.



Picture3.9Distribution of separate types of municipal waste in the relevant counties in 2020 (Source: IRES EKOLOGIJA doo according to the Municipal Waste Report for 2020, HAOP)

The county with the highest recovery rate in the organization of LGUs is Međimurje County (47%), followed by Koprivnica-Križevačka County (40%), Varaždin County (37%) and the City of Zagreb (36%) (Picture3.10).



Picture3.10The share of MSW sent for recovery in the counties in question (Source: IRES EKOLOGIJA doo according to the Municipal Waste Report for 2020, HAOP)

According to the Ordinance on the Register of Environmental Pollution (Official Gazette 80/13, 78/15, 03/22), an organizational unit that produces and/or transfers from the location hazardous waste in a total amount greater than or equal to 0.5 tons per year and/or non-hazardous waste in a total amount greater than or equal to 20 tons per year is required to submit data on waste production to the ROO. According to the Report on data from the Register of Environmental Pollution for the year 2020, the total reported amount of non-hazardous waste produced in the area of the Subject Counties is 1,584,355 t, and hazardous 64,830 t. Krapina-Zagorje (20%) and Bjelovar-Bilogorje (17%) have the largest share of hazardous waste in the total waste of individual counties.

In the territory of the Republic of Croatia, including the counties in question, there are problems related to illegal waste disposal sites. Namely, inadequate disposal of waste leads to contamination of the soil and other components of the environment. As part of the Waste Management Information System, an Application for Records of Locations of Discarded Waste (hereinafter: ELOO) was established, which enables the recording of locations of discarded waste. On 21.2.2022. of the total number of applications processed, there are 2779 confirmed active locations of discarded waste (these are locations that the municipal warden has confirmed, but there is still discarded waste there) and 2729 confirmed inactive locations (these are waste locations that the communal warden has confirmed and marked that the waste has been removed).

According to the Water Act (Official Gazette 66/19, 84/21), waste water is all potentially polluted technological, sanitary, storm water and other water. The law stipulates that responsible natural or legal persons who introduce, discharge or dispose of dangerous or other polluting substances in water during the performance of their business activities are obliged to remove these substances from water before connecting to public drainage in accordance with the water law permit, while local self-government units are obliged to ensure the collection and purification of municipal waste water, before its direct or indirect discharge into natural waters. The wastewater collection and drainage system is part of the public drainage system that collects and drains municipal wastewater. In addition to public drainage facilities, waste water can also be collected by individual drainage systems such as septic tanks and collection pits.

Legal and physical persons who discharge during the performance of their activities[2]or transmit[3]polluting substances in waste water, they are obliged to partially or completely purify these substances before discharging them into public drainage structures or natural receivers in accordance with the issued water law permits for the discharge of waste water, i.e. binding water law opinions. In 2020, a total of 13,423,494.67 kg/year of waste water discharged from the locations of taxpayers was reported, and of the total number of discharges, 84.34% refers to the discharge into the public drainage system. The total municipal water discharged from the public drainage system in 2020 amounted to 40,988,935.24 kg/year,

[2]The term "discharge" refers to the direct discharge of wastewater from the obligee's location into a natural receiver
[3]The term "transfer" of pollutants in waste water refers to the indirect discharge of waste water, i.e. when it is not discharged into a natural receiver but into the public drainage system.

and the most waste discharges occurred in the City of Zagreb and Osijek-Baranja County. An overview of discharges by individual counties is given in the following table (Table3.19).

Table3.19Discharge of waste water from the public drainage system and from the location of the taxpayer in the area of the counties in question in 2020 (Source: ROO Report)

County	Wastewater discharges from the public drainage system (kg/year)	Discharge and transfer of waste water from the obligee's location		
		Directly (in natural receiver) (kg/year)	Indirectly (into the public drainage system) (kg/year)	Total (kg/year)
Zagrebačka	5,867,488.36	452,852.44	262,904.62	715 757.07
Krapina-Zagorje	1 456 762.9	139 103.32	50 168.5	189,271.83
Sisak-Moslavina	456,040.76	12 770.24	573 563.38	586 333.64
Karlovačka	434,865.59	23 184.35	796 556.0	819 740.29
Varaždinska	1 015 666.36	138 395.11	554 580.22	692 975.34
Koprivnica-Križevačka	456 954.14	28 177.65	533 241.65	561 419.29
Bjelovar-Bilogorska	630 310.84	8127.67	350 235.11	358 362.77
Virovitica-Podravska	599 384.73	811 384.1	84 656.82	896 040.97
Požega-Slavonia	336 122.55	8619.92	98 135.25	106 755.16
Brod-Posavina	1 554 625.08	17 446.0	69,636.98	87,082.98
Osijek-Baranja	11 956 940.62	219 127.27	1 450 652.68	1 669 779.95
Vukovar-Srijemska	1 337 332.24	220,854.82	92 952.52	313 807.33
Međimurska	411 360.64	4630.72	609 313.59	613,944.34
City of Zagreb	14 475 080.43	17 396.36	5 794 827.31	5,812,223.71

Local self-government units are obliged, through the water service provider, to ensure the collection and treatment of municipal waste water, before its direct or indirect discharge into the water, in accordance with the issued water law permit for the discharge of waste water. According to data from the ROO for 2020, a total of 139 municipal wastewater discharges and 1121 wastewater discharges from the taxpayer's location were reported in the area of the counties in question. The total amount of municipal water discharged in the area of the Counties in question in 2020 was 248,852,634 m^3/year, and almost 70% of the discharge was reported in the City of Zagreb (Table3.19).

Table3.20Amounts of municipal water discharged and the number of discharges in the area of the counties in question in 2020 (Source: Report of the ROO)

County	Discharged municipal water (m^3/year)	Number of municipal water outlets
Zagrebačka	7 572 829	15
Krapina-Zagorje	2 956 828	43
Sisak-Moslavina	5 325 709	2
Karlovačka	7 023 532	7
Varaždinska	7 692 197	8
Koprivnica-Križevačka	4 052 493	8
Bjelovar-Bilogorska	4 870 734	10
Virovitica-Podravska	2 315 958	9
Požega-Slavonia	2 943 423	11
Brod-Posavina	7 719 530	2
Osijek-Baranja	14 885 444	10
Vukovar-Srijemska	7 628 699	9
Međimurska	4 135 659	4
City of Zagreb	169 729 599	1
In total	**248 852 634**	**139**

The following table shows the number of discharges and the amount of discharged municipal water according to the method of purification (Table3.21). In the area of the counties in question, in 2020, 96% of municipal water was subjected to some kind of pre-purification procedure. The largest amount of discharged municipal water was purified by combined physico-chemical procedures, and at the largest number of outlets, 69 of them, waste water was discharged without prior purification. Krapina-Zagorje County (28%) and Zagreb County (11%) have the largest share of discharged water without treatment.

Table3.21The number of discharges and the amount of municipal water discharged in the area of the counties in question in 2022 (Source: Report of the ROO)

Method of purification	Amount of municipal water discharged (m3/s)	Number of outlets
Without purification	9 512 703	69
Biological procedures	5 155 825	21
Physical procedures	22 507 075	12
Combined with physical-biological procedures	57 094	1
Combined with physico-chemical procedures	192 864 100	25
Combined physical-chemical-biological procedures	15 957 483	7
Combined on chemical-biological procedures	798 354	4

3.2.2 Noise

Noise is any unwanted sound caused by human activity and is one of the main causes of reducing the quality of life, especially in urban areas where it is constantly present and affects many aspects of everyday life, among other things, on human health. The most common adverse effects of noise on quality of life and health are fatigue, reduction of work energy and concentration, and hearing damage. In urban areas, traffic noise plays a significant role in polluting the human environment and is a serious environmental problem, and its occurrence is related to technical progress, urbanization and increased traffic volume. The main sources of noise in the outdoor space are traffic, industry, construction and public works, recreation, sports and entertainment, and in the closed living space service devices, household machines and noise from the neighborhood. The harmful impact of noise has an accumulative character,

Pursuant to the Law on Noise Protection (Official Gazette 30/09, 55/13, 153/13, 41/16, 114/18 and 14/21), settlements with more than 100,000 inhabitants in Croatia have drawn up a strategic noise map (Zagreb, Split, Rijeka and Osijek) and highways A1, A2, A3, A4, A6, A8 and A9. Obligation to create a strategic map and create and adopt action plans for main roads with more than 3,000,000 vehicle passages per year

The basic law establishing measures aimed at avoiding, preventing or reducing harmful effects on human health caused by noise in the environment is the Law on Protection from Noise (Official Gazette 30/09, 55/13, 153/13, 41/16, 114/18 and 14/21). This Act establishes the areas for which the production of strategic noise maps and corresponding action plans is mandatory, including the concessionaires of industrial areas, cities with more than 100,000 inhabitants, roads with more than 3,000,000 vehicle passages per year, main railway lines with more than 30,000 of trains per year and the main airport with more than 50,000 operations (takeoffs and landings) per year, etc.

The cities of Zagreb and Osijek and the highways A1, A2, A3 A4, A6, A8 and A9 have prepared a strategic noise map in the area covered by the Plan. The A3 highway runs entirely through the Plan area and connects Slavonia longitudinally from east to west. Croatian highways have installed barriers to protect against noise in places where noise directly threatens the population, however, with the development of cities, there may be a need for additional measures.

. The noise of tram traffic and industrial plants causes disturbance only in micro locations in the immediate vicinity of the noise source. The general quality of the railway infrastructure in Croatia is at a rather low level. In addition, the rolling stock and all railway equipment are on average older than 30 years, which means that they cause the somewhat renewed infrastructure to wear out faster than expected. The most prominent consequence of poor contact between the wheels of railway vehicles and the track is the high level of noise generated by trains, especially in urban areas.

The maximum permissible noise levels are defined by the Ordinance on the highest permissible noise levels with regard to the type of noise source, time and place of occurrence (Official Gazette 14372021) as shown in the following table (Table3.22). Acceptable noise levels in all zones are up to 50 dB for the day period, and up to 40 dB for the night period.

Table3.22The highest permissible rated levels of noise immission in an open space (Source: Ordinance on the highest permissible noise levels with regard to the type of noise source, time and place of origin (Official Gazette 14372021)

Noise zone	Purpose of space	The maximum permissible rating level of immission noise LRAeq in dB(A)			
		for the day (Lday)	evening (Levening)	night (Lnight)	(Lden)
1.	A zone of protected quiet areas intended for rest and recovery, including a national park, special reserve, nature park, regional park, natural monument, significant landscape, park-forest, monument of park architecture, quiet areas outside the populated area	50	45	40	50
2.	A zone intended for permanent residence and/or residence, quiet areas within a populated area	55	55	40	56
3.	Zone of mixed, predominantly residential use	55	55	45	57
4.	Zone of mixed, predominantly business use with temporary housing, predominantly agricultural holdings	65	65	50	66
5.	Zone of economic purpose, predominantly craft. Zone of business, mainly service, trade and commerce or utility and service purposes. Hospitality tourism zone including hotels, tourist village, camp, individual catering facilities with accompanying facilities. Zones for sports and recreation purposes on land, including a golf course, equestrian center, hippodrome, winter sports center, tennis center, sports center - swimming pools. Zones for sports and recreation on the sea and rivers, including organized swimming pools, water sports centers. Port zones of nautical tourism including anchorage, disposal of vessels, dry marina, marina.	65	65	55	67
5.	A zone of economic use, predominantly manufacturing industrial activities. Zones of seaports of national importance for essential activities, zones of seaports of special international economic importance, zones of seaports of county importance. Zones of river ports of national and county significance.	The noise level originating from noise sources within this zone and at the border with the nearest zone 1, 2, 3 or 4 where the highest immission noise levels are expected, the noise must not exceed the permitted noise levels at the border of zone 1, 2, 3 or 4.			

3.2.3 Light pollution

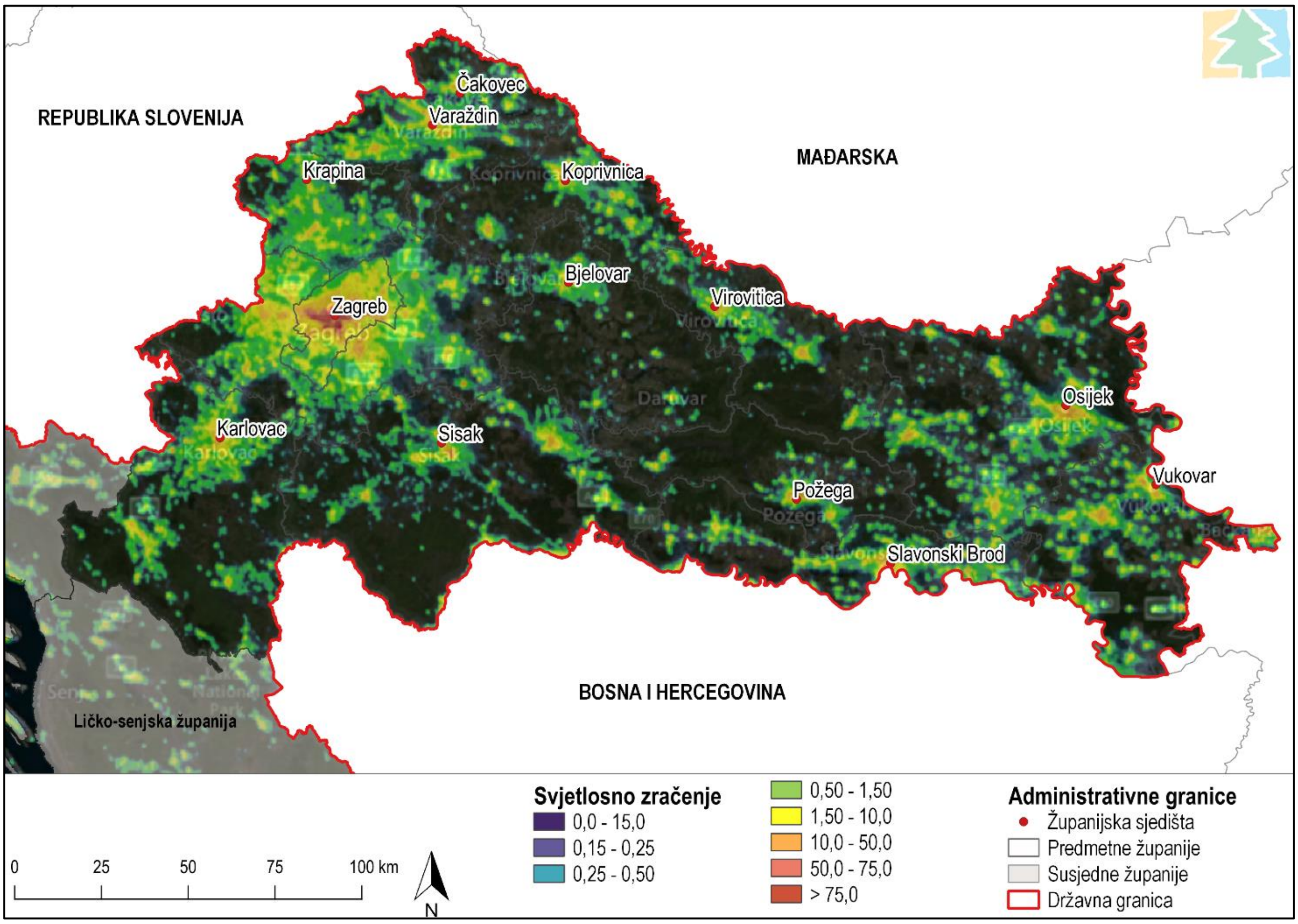
Light pollution is a change in the level of natural light in night conditions caused by the introduction of light produced by human activity. The International Dark Sky Association (IDA) defines light pollution as any harmful effect of artificial light, including an increase in the brightness of the night sky, glare, illumination outside the area that needs to be illuminated, excessive illumination, reduced visibility at night and the dissipation of light energy.

Light pollution of the environment is the emission of light from artificial sources that has a harmful effect on human health and causes a sensation of glare, endangers traffic safety due to glare, due to direct or indirect radiation of light towards the sky, disrupts the life and/or migration of birds, bats, insects and other animals, and it disturbs the growth of plants, endangers the natural balance in protected areas, distorts the image of the night landscape, and by radiating light towards the sky, electricity is wasted unnecessarily. A harmful effect is an impermissible effect of lighting that causes a measurable change in natural lighting in night conditions or a disruption in the functioning of natural resources and other components of the environment and human health.

In view of the growing problem of light pollution, the Republic of Croatia passed a special law, the Law on Protection from Light Pollution (Official Gazette 14/19). It regulates protection against light pollution, which includes those liable for protection against light pollution, measures to protect against light pollution, the method of determining the maximum permissible lighting values, restrictions and prohibitions of lighting, conditions for planning, construction, maintenance and reconstruction of outdoor lighting, measurement and method of monitoring lighting environment and other issues in order to reduce light pollution of the environment and the consequences of light pollution.

The Ordinance on lighting zones, permissible lighting values and methods of managing lighting systems (Official Gazette 128/2020) prescribes mandatory lighting management methods and conditions, lighting and protection zones, maximum permissible lighting values, conditions for selecting and installing lamps, energy efficiency criteria, conditions and the highest permissible values of the correlated color temperature of the light source, the obligations of local self-government units regarding the prescribed standards, as well as other related issues.

According to the light pollution map (Light pollution map dated February 24, 2021), it is evident that light pollution is most pronounced in the larger city centers, of which the wider urban areas of Zagreb, Varaždin, Karlovac, and Osijek. In rural areas, the intensity of light pollution is significantly lower (Picture3.11). The red color indicates the areas affected by the strongest light radiation (value greater than 75 10-9 W/cm2 * sr), while the dark blue color indicates the weakest (up to 0.15 10-9 W/cm2 * sr).



Picture3.11Light pollution of the environment in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Light pollution map and Geoportal DGU)

3.2.4 Invasive species

Invasive species are species that have been introduced to a territory that is not part of their natural range and that threaten native species and human health. They generally spread or reproduce very easily, and often have no natural enemies in the area where they were introduced. They can be introduced into a new area accidentally or intentionally; they were most often deliberately introduced for certain economic benefits, for example for cultivation for the purpose of food or raw materials (timber), while some were introduced for the specific purpose of regulating the number of certain autochthonous species of some areas (for example, gambusia (Gambusia holbrooki) to control the number of mosquitoes, mongooses (Herpestes auropunctatus) to reduce the population of snakes, and others.). In addition to intentional introduction, species with invasive potential can reach new habitats unintentionally, most often through trade and transport of people and goods.

Invasive species represent a significant threat to ecosystem integrity, biological diversity, global economy and human health. They can change the chemical composition of the soil, obstruct waterways, destroy construction facilities, and in other ways negatively affect the ecological system and people's well-being (Nikolić et al. 2014). Invasive plant species usually first inhabit degraded habitats and abandoned agricultural lands and are very difficult to control or remove once they spread in an area. One of the most common plant invasive species in Croatia is ragweed, Ambrosia artemisiifolia. In addition to endangering native plant species, the spread of ragweed is a major health problem, as ragweed pollen is one of the strongest natural allergens. In the following table, except for plant invasive species,Table3.23). The counties located in the area covered by the Plan are divided into the following regions of Croatia: Northern (Međimurje, Varaždin, Krapina-Zagorje and Koprivničko-Križevačka), Central (Karlovačka, Sisak-Moslavina, Bjelovar-Bilogorska, Zagrebačka and the City of Zagreb) and Eastern (Vukovar-Srijem, Osijek-Baranja, Brod-Posavina, Požega-Slavonia and Virovitica-Podravina). Karlovac County was not analyzed in its entirety, but only the area of Karlovac County that is within the scope of the Plan was taken into account.

In addition to the aforementioned ragweed, the following plant invasive species are also widespread in the Plan's area: acacia (Ailanthus altissima), amorpha (Amorpha fruticosa) and acacia (Robinia pseudoacacia). All three species are woody and have a very wide range of conditions that they tolerate, which is the reason for their wide spread. Of the listed species in the table, the gypsy feather (Asclepias syriaca) stands out, which due to its invasive characteristics is on the list of invasive species that are significant for the entire area of the European Union. It was grown for its fiber, and today it is a common ornamental plant or is grown for beekeeping. It is most often spread on lawns or in river valleys.

Invasive animal species recorded in the area covered by the Plan are often associated with watercourses. Dreissena polymorpha (Dreissena polymorpha) is a widespread invasive species and is a major problem as it forms dense mats on living and non-living surfaces in slow flows. The invasive snail Potamopyrgus antipodarum also grows on different surfaces in the water, and they are best suited to slow-flowing or stagnant water with a lot of nutrients and a constant temperature. Nevertheless, like most invasive species, they can tolerate a wide range of nutrient concentrations, temperature and other factors. Of the invasive crustaceans, the crustaceans Dikerogammarus villosus and Chelicoropichum curvispinum, and the decapod crustacean Orconectes limosus stand out. A common invasive species is the turtle Trachemys scripta, which poses a threat to the native pond turtle (Emys orbicularis). Among the invasive fish, some of the ones present are black catfish (Ameiurus melas), babushka (Carassius gibelio), sunfish (Lepomis gibbosus) and bream (Pseudorasbora parva).

Table3.23. List of invasive species in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to the Observation Map of invasive foreign species, Flora Croatica Database and Nikolić et al. 2014)

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
*Abutilon theophrasti*Medic.	Theophrastus' Darkness	X	X	X
*Acer negundo*L.	a non-Gundov	X	X	X
*Aedes albopictus*Skuse, 1894	Asian tiger mosquito		X	X
Ailanthus altissima(Mill.) Swingle	glandular girdle	X	X	X
*Amaranthus albus*L.	white stork	X	X	X
*Amaranthus blitoides*S. Watson	western american squirrel	X		X
*Amaranthus deflexus*L.	to swoop down		X	X
*Amaranthus hybridus*L.	crossed stork	X	X	X
*Amaranthus retroflexus*L.	sharp-haired stork	X	X	X
*Ambrosia artemisiifolia*L.	ambrosia	X	X	X
Ameiurus melas(Rafinesque, 1820)	black American pygmy catfish	X	X	X
*Amorpha fruticosa*L.	amorphous	X	X	X
Antheraea yamamai (Guerin-Meneville, 1861)	Japanese oak bridge	X	X	
Aphis gossypii(Glover, 1877)	-		X	
Apiognomonia veneta(Sacc. & Speg.) Höhn	nomony		X	
Appendiseta robiniae(Gillette, 1907)	-		X	
Aproceros leucopoda(Takeuchi, 1939)	elm leaf wasp	X	X	
Argyresthia thuiella(Packard, 1871)	juniper leaf screwer		X	
*Arion vulgaris*Moquin-Tandon, 1855	Spanish slug		X	
*Artemisia verlotiorum*Lamotte	Chinese wormwood	X	X	X
*Asclepias syriaca*L.	gypsy feathers	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
Grandma gymnotrachelus(Kessler, 1857)	head runner			X
*Bidens frondosa*L.	bicuspid	X	X	X
Broussonetia papyrifera(L.) Vent.	Japanese mulberry		X	X
*Bruchus pissorum*Linnaeus, 1758	pea weevil	X	X	X
*Buddleja davidii*French.	summer lilac	X	X	
Caloptilia roscipennella(Hübner, 1796)	-		X	
*Cameraria ohridella*Deschka & Dimic, 1986	chestnut moth miner	X	X	X
Carassius died(Bloch, 1782)	babushka	X	X	X
Carpobrotus acinaciformis(L.) L. Bolus	sabre-headed carpobrot		X	
Chamomilla suaveolens(Pursh) Rydb.	yellow chamomile	X	X	X
Chelicorophium curvispinum(GOSars, 1895)	-	X	X	X
Chelicorophium robustum(GO Sars, 1895)	-	X		X
Chelicorophium sowinskyi(Martynov, 1924)	-		X	X
*Chelicorophium*sp.	-	X		X
*Chenopodium ambrosioides*L.	fragrant swan	X	X	
Chymomyza amoena(Loew, 1862)	vinegar fly	X	X	
Conyza bonariensis(L.) Cronquist	curly haired harlot	X	X	
Conyza canadensis(L.) Cronquist	Canadian idol	X	X	X
Corbicula fluminea(OF Müller, 1774).	large-ribbed cat	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
Cortaderia selloana(Schult. & Schult.f.) Asch. & Graebn.	pampas grass		X	
Corythucha arcuata(Say, 1832)	oak web bug	X	X	X
Corythucha ciliata(Say, 1832)	sycamore net bug		X	X
*Cronartium ribicola*JCFisch.	-	X	X	
Cryphonectria parasitica(Murrill) MEBarr	-	X	X	X
Ctenopharyngodon idella(Valenciennes, 1844)	white grass carp	X	X	X
*Cuscuta campestris*Yuncker	Polish fairy hair		X	X
Cydalima perspectalis(Walker, 1859)	boxwood moth	X	X	X
Dasineura gleditchiae(Osten Sacken, 1866)	-		X	
Dasineura oxycoccana(Johnson, 1899)	blueberry fruit fly		X	
*Datura innoxia*Mill.	Polish fairy hair	X	X	X
*Datura stramonium*L.	white dog	X	X	X
*Diabrotica virgifera virgifera*LeConte, 1868	sweet corn	X	X	X
*Dikerogammarus bispinosus*Martynov, 1925	-			X
Dikerogammarus haemobaphes(Eichwald, 1841)	ruckus demon		X	X
*Dikerogammarus*sp.	-	X		
Dikerogammarus villosus(Sowinsky, 1894)	rascal killer	X	X	X
Diuraphis noxia(Kurdyumov, 1913)	Russian wheat aphid			X
Dreissena polymorpha(Pallas, 1771)	a varied triangle	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
*Drosophila busckii*Coquillett, 1901	-		X	
*Drosophila hydei*Sturtevant, 1921	-		X	
*Drosophila immigrans*Sturtevant, 1921	-	X		
*Drosophila melanogaster*Meigen, 1830	vine fly	X	X	
Drosophila suzukii(Matsumura, 1931)	fruit fly	X	X	
*Dryocosmus kuriphilus*Yasumatsu, 1951	chestnut pine cone wasp	X	X	X
Duchesnea indica(Andrews) Focke	Indian strawberry	X	X	X
Echinocystis lobata(Michx.) Torr. & A. Gray	oil dumbbell	X	X	X
Echinogammarus ischnus(Stebbing, 1899)	-			X
Eleusine indica(L.) Gaertn.	Eleusinian	X	X	X
*Elodea canadensis*Michx.	canadian dropsy	X	X	X
*Epilobium ciliatum*Raf.	recruitment	X	X	
Erigeron annuus(L.) Pers.	one-year-old beautiful	X	X	X
Erigeron annuus(L.) Pers. coll. annuus	beautiful	X	X	X
Erigeron annuus(L.) Pers. coll. septentrionalis (Fernald et Wiegand) Wagenitz	beautiful	X		
Erysiphe flexuosa(Peck) U. Braun & S. Takam.	-		X	
Erysiphe planati(Howe) U. Braun & S. Takam.	-		X	
*Euphorbia maculata*L.	spotted milkweed	X	X	X
*Euphorbia prostrata*Aiton	lay down milkweed	X	X	X
*Eutypella parasitica*RWDavidson & RCLorenz	-	X	X	

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
Frankliniella occidentalis(Pergande, 1895)	california trips		X	X
Galinsoga ciliata(Raf.) SFBlake	ciliated tip	X	X	X
*Galinsoga parviflora*Cav.	small tip	X	X	X
*Gambusia holbrooki*Girard, 1859	gambusia		X	
Glischrochilus quadrisignatus(Say, 1835)	-		X	X
Globodera rostochiensis(Wollenweber, 1923)	golden potato cyst nematode	X		
Graptemys pseudogeographica(Gray, 1831)	false geographic tortoise		X	
Halyomorpha halys(Stål, 1855)	brown marbled bug		X	
Harmonia axyridis(Pallas, 1773)	Asiatic sheep of God	X	X	X
*Helianthus tuberosus*L.	thistle	X	X	X
*Hymenoscyphus fraxineus*Baral et al. (2014)	-	X	X	X
Hyphantria cunea(Drury, 1773)	bagpiper			X
Hypophthalmichthys molitrix(Valenciennes, 1844)	white head			X
Illinoia liriodendri(Monell, 1879)	liriodendron aphid		X	
*Impatiens balfourii*Hook.f.	Balfour's touch	X	X	
*Impatiens glandulifera*Royle	glandular tumor	X	X	X
*Impatiens parviflora*DC.	small-flowered sedum	X	X	X
*Jaera istri Veuille,*in 1979	-	X	X	X
*Juncus tenuis*Willd.	gentle satiety	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
*Kabatina thujae*R. Schneid. & Arx (1966)	-			X
*Katamysis warpachowskyi*GOSars, 1893	-			X
*Koelreuteria paniculata*Laxm.	kelreuterium	X	X	X
*Lepidium virginicum*L.	virginia humpback	X	X	X
Lepomis gibbosus(Linnaeus, 1758)	sunstroke	X	X	X
Leptinotarsa decemlineata(Say, 1824)	potato beetle	X	X	X
*Leptoglossus occidentalis*Heidemann, 1910	North American bed bug	X	X	
*Limnomysis benedeni*Czerniavsky, 1882	-			X
*Lupinus polyphyllus*Lindl.	wolf		X	
Metcalfa pruinosa(Say, 1830)	honey cricket		X	
Micropterus salmoides(Lacepede, 1802)	trout perch	X	X	X
*Mycosphaerella pini*roster	-	X	X	
Myocastor coypus(Molina, 1782)	pond nutria	X	X	
Neogobius fluviatilis(Pallas, 1814)	river head	X	X	X
Neogobius melanostomus(Pallas, 1814)	round head		X	X
Obesogammarus obesus(GOSars, 1894)	-			X
Obolodiplosis robiniae(Haldeman, 1847)	acacia pine cone fly	X	X	
*Oenothera biennis*L.	two-year bud	X	X	X
Muskrat zibethicus(Linnaeus, 1766)	Bizam rat	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
Ophiostoma ulmi(Buisman) Nannf.	-	X	X	X
Orconectes limosus(Rafinesque, 1817)	spiny crab			X
Ostrinia palustralis(Hübner, 1796)	-		X	
Pacifastacus leniusculus(Dana, 1852)	signal cancer	X	X	X
*Panicum capillare*L.	hairy millet	X	X	X
*Panicum dichotomiflorum*Michx.	forked millet	X	X	X
Paramysis lacustris(Czerniavsky, 1882)	-			X
*Parectopa robiniella*Clemens, 1863	acacia moth miner	X	X	
Parthenocissus quinquefolia(L.) Planch.	five-part logic	X	X	X
Pelodiscus sinensis(Wiegmann, 1835)	Chinese soft-shelled turtle		X	
Pelophylax kurtmuelleri(Gayda, 1940)	big green frog		X	
*Perccottus glenii*Dybowski, 1877	rotten			X
Phyllonorycter issikii(Kumata, 1963)	linden moth miner		X	
Phyllonorycter leucographella(Zeller, 1850)	fire thorn miner		X	
Phyllonorycter robiniella(Clemens, 1859)	acacia moth miner	X	X	
*Phyllosticta paviae*Desm.	-		X	
Physella acuta(Draparnaud, 1805)	-	X	X	
*Phytolacca americana*L.	American kermes	X	X	X
Phytophthora cambivora(Petri) Buisman	-		X	X
Pineus strobi(Hartig, 1839)	-			X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
*Platygaster robiniae*Buhl & Duso, 2008	-	X	X	
Ponticola kessleri(Günther, 1861)	round head	X		X
Potamopyrgus antipodarum(Gray, 1843)	-	X		
*Procambarus virginalis*Lyko 2017	marble crab	X		
*Prunus serotina*Ehrh.	late rush	X		
Pseudaulacaspis cockerelli(Cooley, 1897)	-		X	
Pseudorasbora parva(Temminck & Schlegel, 1846)	fishless	X	X	X
*Pulvinaria hydrangeas*Steinweden, 1946	-		X	X
*Reynoutria × bohemica*Chrtek & Chrtková	Czech courtier	X	X	X
*Reynoutria japonica*Houtt.	Japanese courtier	X	X	X
*Reynoutria*spp.	invasive courtiers		X	X
Rhagoletis cingulata(Loew, 1862)	North American cherry fly	X		
*Rhagoletis completa*Cresson, 1929	nut fly	X	X	
*Robinia pseudoacacia*L.	acacia	X	X	X
*Rudbeckia laciniata*L.	tattered budgie	X	X	X
*Scaphoideus titanus*Ball, 1932	American cricket	X	X	X
Synanodont woodiana(I. Lea, 1834)	East Asian toothless	X	X	X
*Sitophilus oryzae*Linnaeus	rice weevil		X	X
Sitotroga cerealella(Olivier, 1789)	grain moth	X	X	
*Solidago canadensis*L.	densely flowered gold coin	X	X	X

Scientific name	Croatian name	northern Croatia	central Croatia	Eastern Croatia
*Solidago gigantea*Aiton	a large gold coin	X	X	X
*Solidago*sp.	gold coins	X	X	X
Sorghum halepense(L.) Pers.	pyramidal sorghum	X	X	X
*Torymus sinensis*Kamijo, 1982	-	X	X	
Trachemys scripta(Thunberg In Schoepff, 1792)	yellow-eared turtle	X	X	X
*Tribolium confusum*Jaqueline Du Val, 1868	small mealworm		X	X
*Veronica persica*Poir.	persian often-slavic	X	X	X
Viteus vitifoliae(Fitch, 1855)	cane louse	X	X	
*Xanthium spinosum*L.	thorny dike		X	X
*Xanthium strumarium*subsp. italicum - (Moretti) D. Löve	coastal dike	X	X	X
*Xiphinema index*Thorne & Allen, 1950	california spear nematode			X
Zygogramma suturalis(Fabricius, 1775)	goldfish		X	

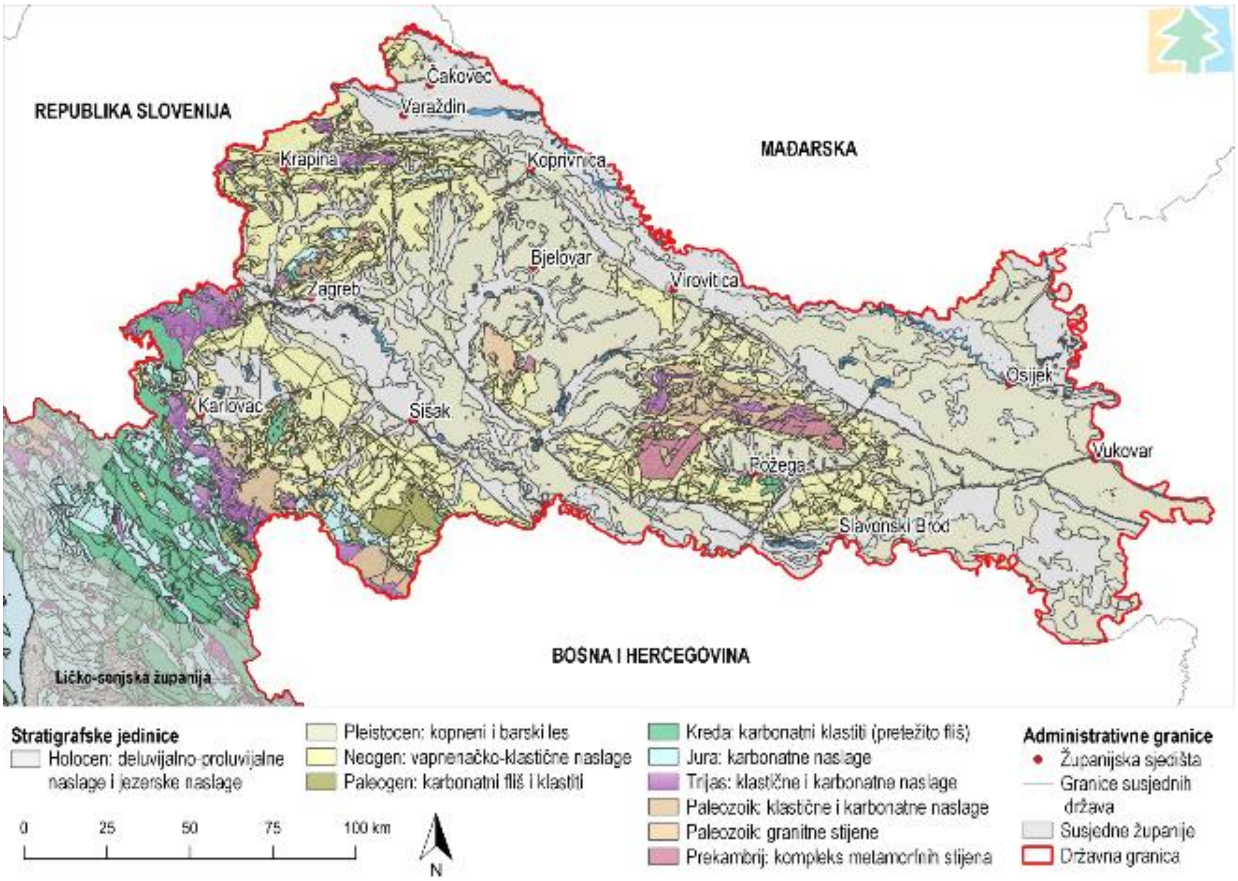
3.3 Description of the state of environmental components and factors in the environment

The state of the environment is analyzed using the relevant features of the environmental component or factors in the environment that clearly show the trends of environmental development and changes. The availability of data, i.e. the possibility of quantitative and qualitative presentation of environmental features, which will be the subject of the environmental impact assessment, was also a criterion for the analysis of the situation.

3.3.1 Geological features and geodiversity

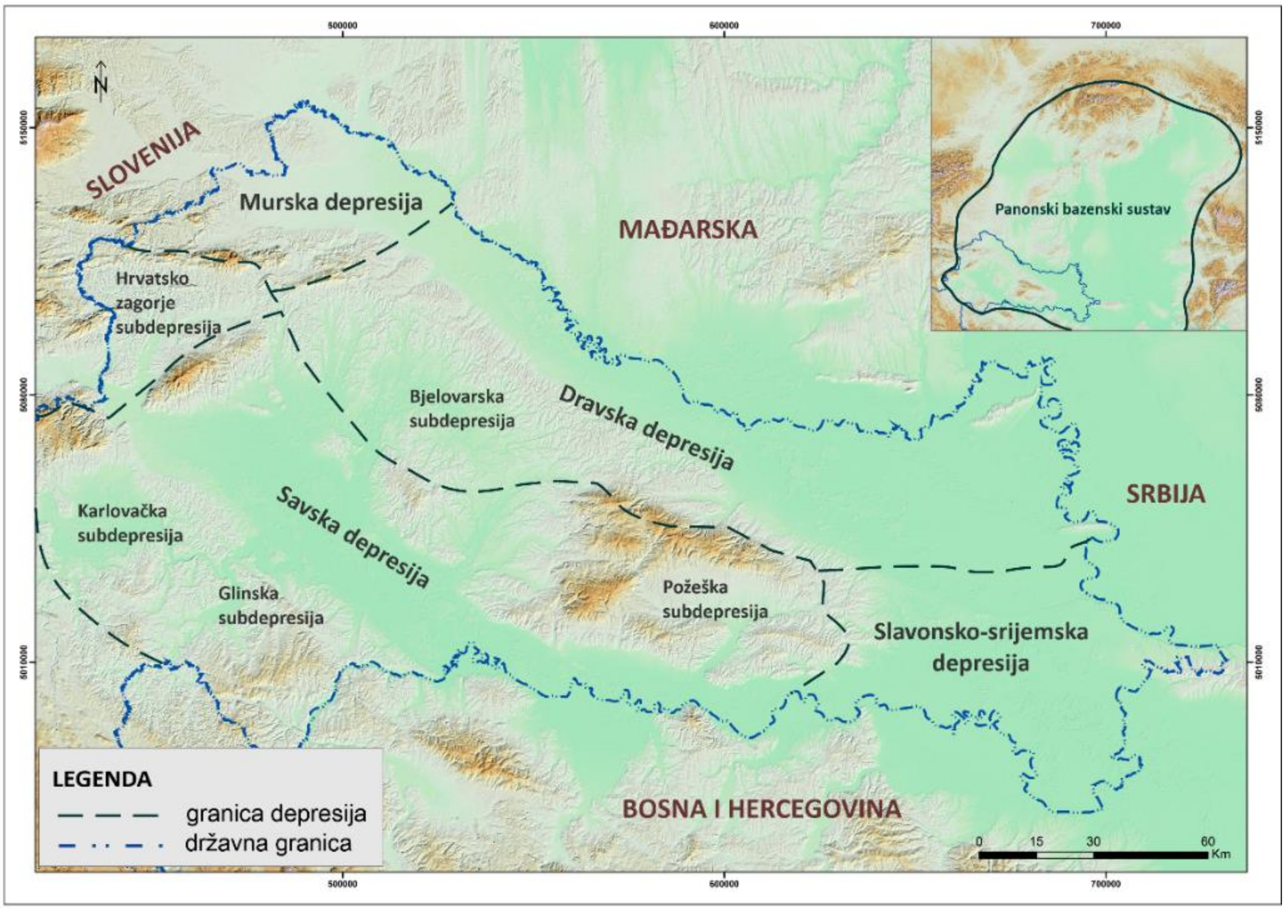
The geological features of the Plan are described based on the data of the Geological Map of the Republic of Croatia 1:300,000, prepared by the Croatian Geological Institute, Institute of Geology, and the Plan.

Parts of two large sedimentary areas belong to the Republic of Croatia: the Pannonian Basin and the Adriatic Sea, and the elevated karst area of the Dinaride that lies between them. The geological structure of the Pannonian basin contains the oldest and youngest deposits on land. The most widespread on the surface are the younger, Quaternary and Neogene deposits, which surround the Pannonian and marginal mountains built from older deposits and rocks ranging from the Precambrian to the Neogene (Picture3.12). On the other hand, Mesozoic and Paleogene, less Paleozoic and Neogene deposits and Quaternary sediments predominate in the Dinarides. The border between the Pannonian Basin and the Dinarides stretches along the Kupa River from Vivodina to Karlovac, then south-southeast towards Cetingrad and further along the Korana Valley to the border with Bosnia and Herzegovina (Croatian Geological Institute, 2009).



Picture3.12Spatial distribution of stratigraphic units in the area covered by the Plan (Source: Geological map of the Republic of Croatia 1:300,000)

There are 4 main depressions within the Pannonian basin system: Murska, Drava, Sava and Slavonia-Srijemska with associated subdepressions (Picture3.13). The division into four geothermal plays is made according to different types of rocks and different stages of development of the Pannonian basin. The division of geothermal potential in this way is confirmed by the fact that geothermal water for energy purposes is already being extracted from all four geothermal plays in the existing exploitation fields of geothermal water.



Picture3.13Depressions of the Croatian part of the Pannonian Basin (Source: Plan)

Mur depression

The Mura depression is morphologically divided into three smaller formations oriented north-west. The younger neotectonic anticline Ormož - Selnica and the older Čakovec plateau separate the formations from each other.

The first and oldest Mursko-Sobot formation is limited by the tectonic-erosion discordance of Pt/Tg in the basement and the EK-marker Rs5 in the roof. It is characterized by a heterogeneous lithological composition, and chronostratigraphically, it includes the older, middle Miocene and the oldest part of the younger Miocene (part of the lower Pannonian). The formation lithologically consists of: conglomerate, breccia, marly sandstones, calcitic sandstones, lithotamnian limestones (lithovites), calcitic marls, argillaceous marls and their varieties.

The Lendavska formation is bounded by EK-markers Rs5 and ib and represents an approximate equivalent to deposits of Pannonian and lowermost part of Upper Pontian age. The formation is characterized by sandy and clayey marls and sandstones.

The last and youngest Mura formation includes deposits of the uppermost part of the Miocene (Upper Pontus), Pliocene and Quaternary. The deposits are characterized by a heterogeneous composition and are dominated by sandstones and sands, sandy and clayey marls, gravels and clays with occasional occurrences of coal layers. The floor of the formation is determined by EK-marker b, while the roof of the formation is defined by the terrain surface.

Drava depression

The Drava depression, which is also the largest in the region, covers most of the area. The depression has a northwest-northeast orientation and an asymmetric contour with a slight northeast slope and a steep southwest border that follows the slopes of the Bilogora mountain. The basin fill sediments of Neogene-Quaternary age within the Drava Depression are divided into five formations.

The first and oldest Moslavačka gora formation is limited by the tectonic-erosion discordance of Pt/Tg in the basement and the EK-marker Rs5 in the roof. It is characterized by a heterogeneous lithological composition, and chronostratigraphically it includes the older and middle Miocene and the oldest part of the younger Miocene (part of the lower Pannonian). The formation lithologically consists of: conglomerates, breccias, marly sandstones, calcitic sandstones, lithotamnian limestones (Lithovites), calcitic marls, argillaceous marls and their varieties.

The Ivanić-Grad formation is bounded by EK-markers Rs5 and Z' and represents an approximate equivalent to deposits of Pannonian and Upper Pontian age. The formation is characterized by sandy, clayey and siltous marls and sandstones. The appearance of calcitic marls often occurs in the lower part of the formation.

The Kloštar Ivanić formation is limited by EK-markers Z' and Δ, and lithologically it is characterized by sandy and clayey marls and sandstones of Lower Pontian age.

The Bilogora Formation includes a sequence of deposits of Upper Pontic age, which is delimited by EK-markers Δ and α'. The formation is lithologically defined by the occurrence of sands to loosely bound sandstones, marly clays, clayey or sandy marls with occasional layers of coal.

The last and youngest Lonja formation includes Pliocene and Quaternary deposits. The deposits are characterized by a heterogeneous composition and are dominated by sand, gravel and sandy and marly clays with occasional occurrences of coal seams. The floor of the formation is determined by the EK-marker α', while the roof of the formation is defined by the terrain surface.

Sava depression

The Sava Depression is oriented NW-SE and includes most of the research area. It has an asymmetrical shape with a gentle slope in the NW direction and a very steep NE wing.

The basin fill sediments of Neogene-Quaternary age within the Sava Depression are divided into six formations.

The first and oldest Prečec formation is limited by the tectonic-erosion discordance of Pt/Tg in the basement and the EK-marker Rs7 in the roof. It is characterized by a heterogeneous lithological composition, and chronostratigraphically, it includes the older and middle Miocene. The most common rocks are: conglomerates, breccias, marly sandstones, sandy sandstones, calcitic sandstones, limestones and lithotamnian limestones.

The Prkos formation includes deposits of Lower Pannonian age, and they refer to the so-called "white marls". Their lithological composition gradually changes from calcareous marls to sandstones of arkosic and subarkosic type. The formation is delimited by EK-markers Rs7 and Rs5.

The Ivanić-Grad Formation is bounded by EK-markers Rs5 and Z' and represents the approximate equivalent of deposits of Upper Pannonian age. The formation is characterized by sandy and clayey marls, which in the deeper parts contain thin interlayers of sandstone and silt.

The Kloštar-Ivanić formation is limited by EK-markers Z' and Rφ, and lithologically it is characterized by marls with numerous varieties and sands/sandstones of Lower Pontic age.

The Široko Polje formation comprises the sequence of deposits of the uppermost part of the lower pontoon and the upper pontoon. They lie concordantly on older deposits, and consist of sandstone and sand, as well as sandy and clayey marls with layers of coal. The bottom of the formation is determined by the EK-marker Rφ, while the roof is defined by the EK-marker α'.

The Lonja Formation represents the last and youngest formation and includes Pliocene and Quaternary deposits. The deposits are characterized by a heterogeneous composition and are dominated by sand, gravel and sandy and marly clays with occasional occurrences of coal seams. The floor of the formation is determined by the EK-marker α', and the roof of the formation is determined by the terrain surface.

Slavonsko - Srijem depression

Eastern Slavonia is represented by the Slavonian - Srijem depression, and it has the same orientation (northwest - southeast and southwest - southeast). The basin fill sediments of Neogene-Quaternary age within the Slavonia-Srijem depression are divided into five lithostratigraphic units or formations.

The first and oldest Vukovar formation is limited by the tectonic-erosion discordance of Pt/Tg in the basement and EC-marker H in the roof. It is characterized by a heterogeneous lithological composition, and chronostratigraphically, it includes the older and larger part of the Middle Miocene. The most common rocks are: conglomerates, breccias, marly sandstones, sandy sandstones, calcitic sandstones, limestones and lithotamnian limestones.

The Valpovac formation includes a sequence of deposits of Sarmatian and Pannonian age between EK-marker H in the subsoil and EK-marker G in the roof. The lithological composition is quite homogeneous, and it mainly refers to calcitic marls with less abundant biocalcarenite quartz sandstones and siltous marls.

The Vinkovac Formation is limited by EK-marker G (or H) in the subsoil and EK-marker B in the roof. The formation is built by a thick sequence of marl deposits with occasional presence of sandstones of the upper part of the Pannon and the lower Pontus.

The Vera formation is characterized by the alternation of sandy and marly layers of Upper Pontic age. The formation is delimited by EK-markers B and A.

The Vuka formation is the last and shallowest formation in the depression, which includes a sequence of deposits of Pliocene and Quaternary age. The formation is characterized by a heterogeneous composition of deposits, which includes sand, gravel, sandy and marly clays with occasional layers of coal. The floor of the formation is determined by EK-marker A, while the roof of the formation is defined by the surface of the terrain.

Tectonic - stratigraphic overview

The tectonics of the area is given on the basis of the geological survey of the land by the Hydrocarbons Agency.

Seven units have been identified in the Pannonian basin. The oldest unit is pre-Permian and represents the basic highlands. It is composed of igneous and metamorphic and less often sedimentary rocks, with granites, gneisses, slates and metamorphic rocks of different lower degrees of metamorphosis. These units were influenced by the Caledonian and Hercynian orogenies (unit 7).

Within the shallow depressions, along the margins of the basin and in the central part of the basin, an angular discordance separates the underlying highlands in the basin from the overlying sediments and carbonates deposited on platforms and deep troughs that were formed during the Upper Permian, Triassic and Jurassic. The basal sediments (unit 6) are composed of shallow-water carbonates, dolomitic limestones and breccias that were deposited until the middle Triassic when volcanic activity indicates the fragmentation of the western Tethys. Younger basal sediments largely give way to carbonates that were deposited under conditions of a gradually deepening basin and submarine uplifts. The end of the phase is marked by the Late Jurassic obduction of the ophiolite. Local uplift and erosion follow. The collision of Apitus and Rhodope began during the period from the Upper Cretaceous to the Paleocene.

In the deeper parts of the depression, especially in Savska and Drava, the sediments of unit 5 - Miocene age discordantly rest on the underlying highlands. In other depressions, they are in anomalous contact with the Mesozoic and Paleogene layers. The formation of these units is related to the Miocene "wrench pull apart" extension that appears as a result of the rotation of the Apulian Plate. It seems that "wrench" faults are formed in weakened zones that were formed during previous tensile processes. In this way, the fault-bounded basins (Sava and Drava) of the Dinaric orientation were formed. These strong movements induced rapid subsidence and fault-controlled marine and non-marine sedimentation that lasted until the end of the Sarmatian. At the beginning, large amounts of breccia, conglomerate and various sandstones were deposited in alluvial fans, interlaced rivers and coastal area. At the same time, significant amounts of lava and pyroclastite appear, which are related to the activities of the "wrench" fault along the newly grown edge of the basin. Later, some parts of the carbonates were redeposited as thick deposits of carbonate breccias. The initial subsidence related to the faults was slowed down in the Carpathians, and limestone back-reefs, reefs and fore-reefs are formed in the marginal marine areas.

The period of mild subsidence at the beginning of Baden (unit 4) was stimulated by the migration of the ridges towards the marginal parts of the basin and the formation of thick packages of marls rich in organic matter in the central areas. At the end of this phase during the Sarmatians, slow thermal uplift and heavy erosion of the marginal parts of the depressions led to the formation of a regional discordance.

Sinking occurred immediately after uplift due to cooling of the lithosphere with relatively rapid filling of newly formed basins that had the characteristics of lakes. The regression that was dominant in the period from the end of the middle Miocene to the present facilitated the progression of deltaic and turbidite depositional systems (unit 3) and the filling of depressions. This cycle begins with the deposition of Lower Pannonian dark, organically rich and anoxic marls in the deeper parts of the basin. Light gray marls were simultaneously deposited in the marginal parts.

After that, the upper Pannonian and lower Pontic sandstones of turbidite origin are deposited, which were deposited only in the deepest parts of the depression. After that, the deposition of lower Pontic marly limestones and siltites formed on the slopes of the delta and sandstones formed at the head of the delta alternate. Oil generation began in the upper Plio-Quaternary sands and clays of the alluvial plains with frequent coal intercalations (unit 2).

The last tectonic phase began at the end of the Pliocene with the formation of a strong transgressive regime. The marginal faults of the basin were transferred into reverse faults with the frequent appearance of positive floral structures and associated anticlinal forms. As long as this tectonic phase coincides with the main phase of oil and gas generation, it is assumed that newly formed anticlinal traps are immediately filled with hydrocarbons. Unit 1 lies on the previously mentioned sequence and represents recent sediments.

Geothermal potential

Geothermal potential is written according to the Delineation and Characterization of Geothermal Groundwater Bodies in the Republic of Croatia (Marković et al., 2020).

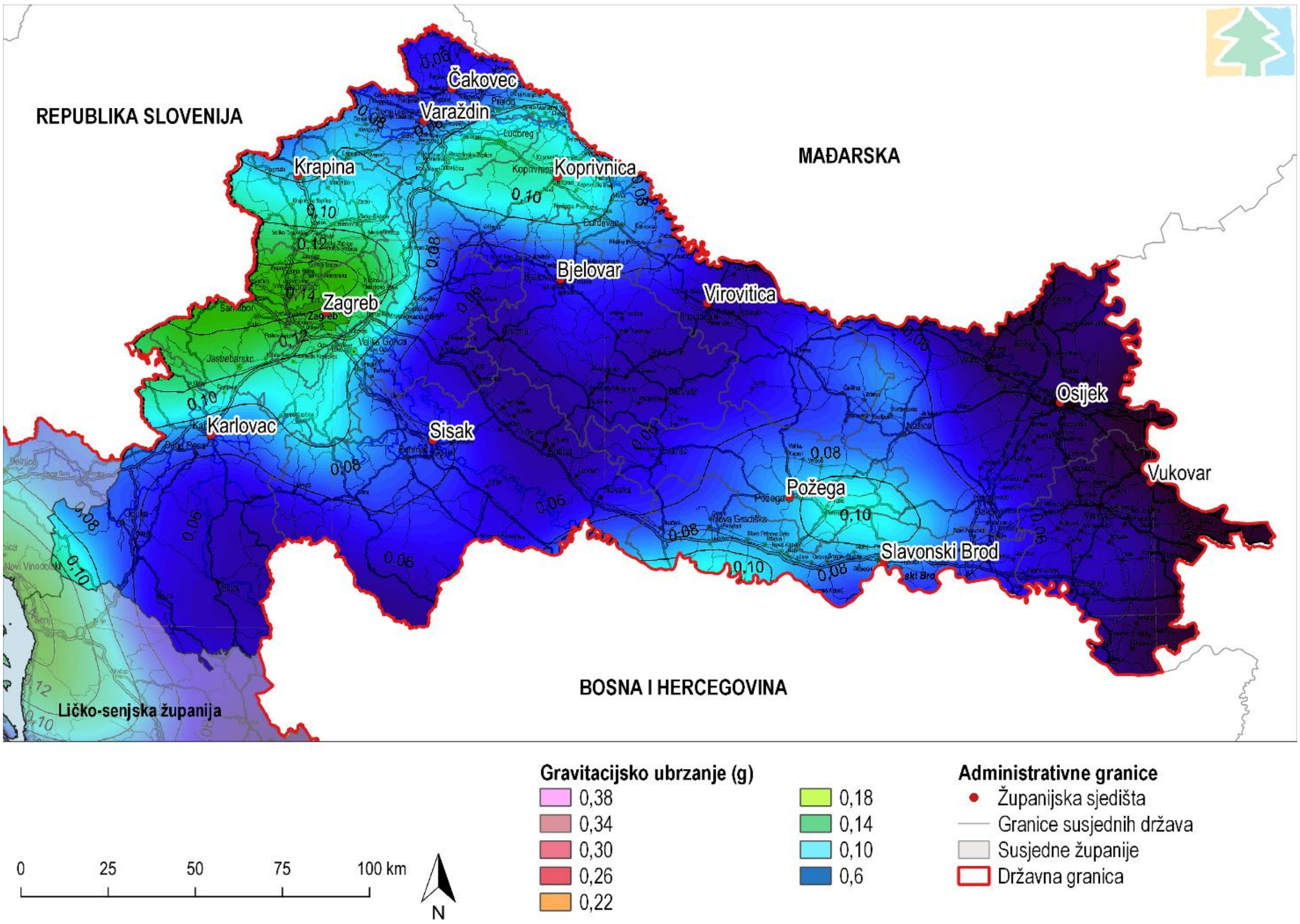
The Pannonian Basin is characterized by a high geothermal gradient - an average of 0.049°C/m and a high surface heat flux of 76 mW/m². The Dinarides area has a low geothermal gradient averaging 0.025°C/m and an average surface heat flux of 29 mW/m² (EIHP, 2018). The difference is due to the depth to the Mohorovičić discontinuity (Moho), the boundary between the Earth's crust and mantle. In the area of the Dinarides, the depth to the Moho varies from 32 to 46 km, and in the area of the Pannonian basin from 22 to 27 km (Šumanovac, 2016). Given that convection transports heat from the mantle more efficiently than in the crust, areas where the mantle is closer to the surface will have a higher heat flow, which is the main reason that the Pannonian part of the Republic of Croatia has the highest geothermal potential. In addition, the generation of heat inside the rocks is also affected by the radioactive decay of uranium, thorium and potassium (238U, 232Th and 40K). They most often occur inside granite, in which, due to research into the potential of the HDR system (Hot Dry Rock), the average amount of heat released by the said process was measured to be 2.7 μW/m3 (Goldstein et al., 2009). However, it should be emphasized that heat production within individual granite masses varies greatly: 1.4 - 4.9 μW/m3 (Fritschle et al., 2014). Since igneous and metamorphic rocks (grabbites, gneisses, etc.) are present in the Pannonian Basin, they also contribute to underground heating. Likewise, the flow of underground water can contribute to the rapid and efficient transfer of heat by convection, especially in deep fault zones along which, if it is a permeable fault zone, high-temperature water rises to the surface. If such zones reach the surface of the terrain, then they enable the emergence of geothermal sources.varieties of Mesozoic age (in the Neogene substrate)) and in limestone-dolomite breccias/breccia conglomerates of Neogene and Mesozoic age (in the Neogene substrate). Lower geothermal potential was determined in sandstones and lithotamnic limestones of Neogene age, since these deposits are not characterized by high permeability, so the inflow of geothermal water is somewhat lower.

The Pannonian basin has a 60% higher geothermal gradient than the European average, and in this area, in addition to the already discovered geothermal deposits, new geothermal deposits can be expected to be found. Geothermal potential in Croatiacan be divided into three groups - medium temperature reservoirs 100 - 200 °C, low temperature reservoirs 65 to 100 °C and geothermal sources with water temperature below 65 °C.

Seismological features

The seismological features of the land area of the Republic of Croatia are shown in the map of earthquake areas of the Republic of Croatia (Herak et al., 2011). The map is made in an approximate scale of 1:800,000. The values shown on the map correspond to the horizontal peak ground accelerations of type A (agR) which are exceeded on average during the return period of 95 and 475 years. Accelerations are expressed in units of gravitational acceleration g (1 g = 9.81 m/s2). The amounts of comparative peak accelerations on the map are shown by isolines with a resolution of 0.02 g. Numerically stated values refer to the space between two adjacent isolines.

Return periods are used to estimate the total number of earthquakes that can be expected over a longer period. The value of comparative peak accelerations of the foundation soil agR (for foundation soil type A) for the County is shown in the following figures (Picture3.14,Picture3.15).



Picture3.14Map of horizontal peak ground accelerations of type A with a probability of exceeding 10% in 10 years for a return period of 95 years for the area covered by the Plan (Source: Herak et al., 2011)

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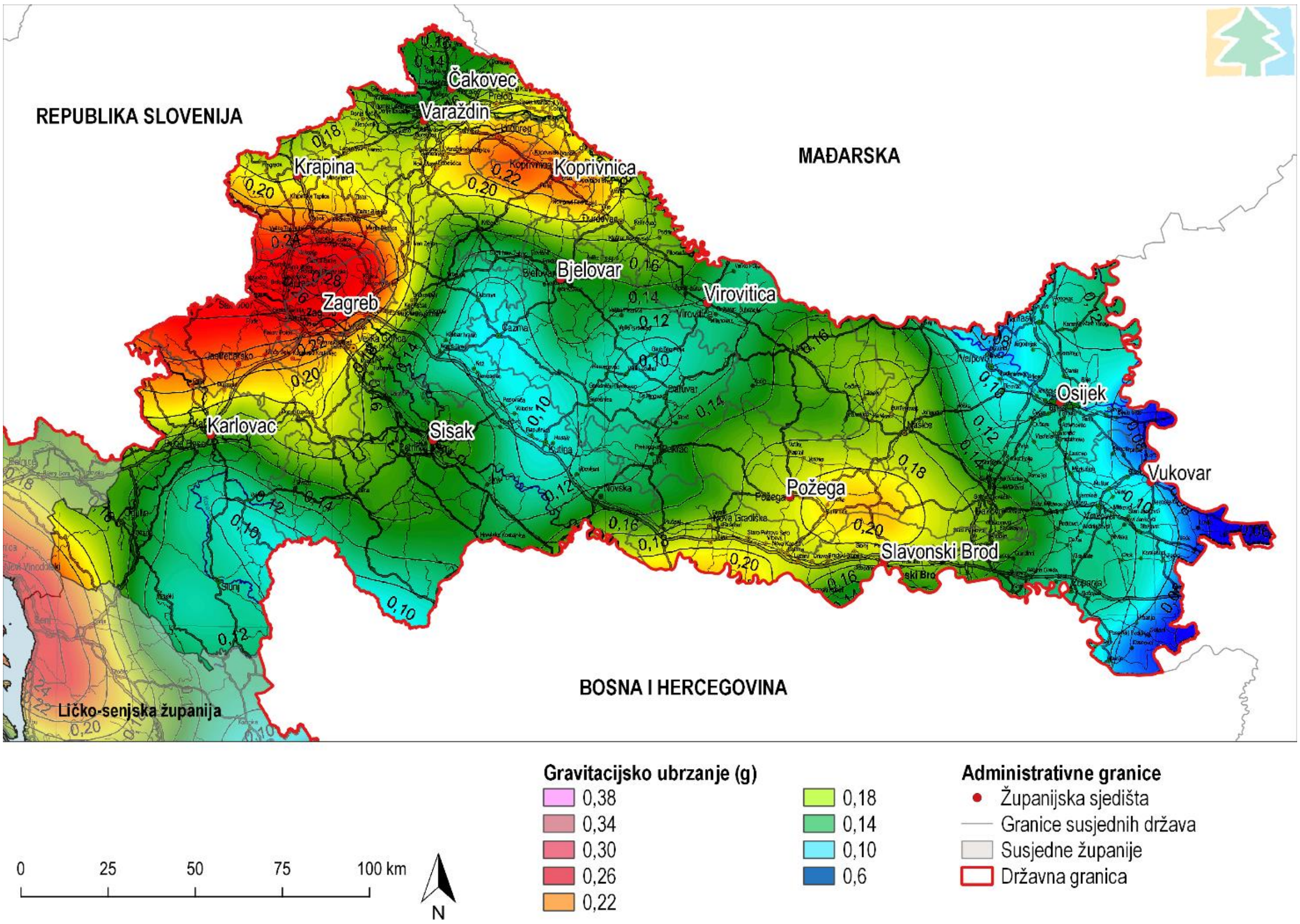


Picture3.15Map of comparative peak ground accelerations of type A with a probability of exceeding 10% in 50 years for a return period of 475 years for the area covered by the Plan (Source: Herak et al., 2011)

The first figure shows peak accelerations with a probability of exceeding 10% in 10 years for a comparative return period of 95 years, while the second figure shows peak accelerations with a probability of exceeding 10% in 50 years for a comparative return period of 475 years. The peak probability acceleration of 10% in 10 years for a comparative return period of 95 years in the County varies from 0.04 g in the center to 0.14 g in the northwestern part and the extreme southeastern part. For a probability of 10% in 50 years for a comparative return period of 475 years in the County, it varies from 0.08 g to 0.28 g.

On March 22, 2020, Zagreb and the wider Zagreb area were hit by a strong earthquake of magnitude 5.5 on the Richter scale at 6 hours and 24 minutes. The main earthquake was followed by a series of numerous aftershocks (by the end of 2021, around 3,500 earthquakes were recorded, of which around 3,200 were recorded in the first year). The highest intensity of the Zagreb earthquake is level VII on the European macroseismic scale. Considering the intensity value, the main earthquake of the Zagreb series can be considered a very strong earthquake.

On December 29, 2020, central Croatia was hit by a devastating earthquake of magnitude 6.4 on the Richter scale, with an epicenter 3 km southwest of the town of Petrinja. The maximum intensity of feeling was estimated at VIII. (very harmful) to IX. (devastating) degree on the EMS scale. This event was preceded by three major earthquakes, the strongest of which had a magnitude of 5.2. After that, a series of several hundred earthquakes followed, the strongest of which was magnitude 5.0.

Geodiversity

Geodiversity, according to the Nature Protection Act (Official Gazette 80/13, 15/18, 14/19, 127/19), is the diversity of non-living nature, and it consists of the diversity of soil, rocks, minerals, fossils, landforms, underground objects and structures, and natural phenomena and processes that created them through geological periods, and are still creating them today. Geodiversity therefore includes geological, geomorphological and pedological diversity.

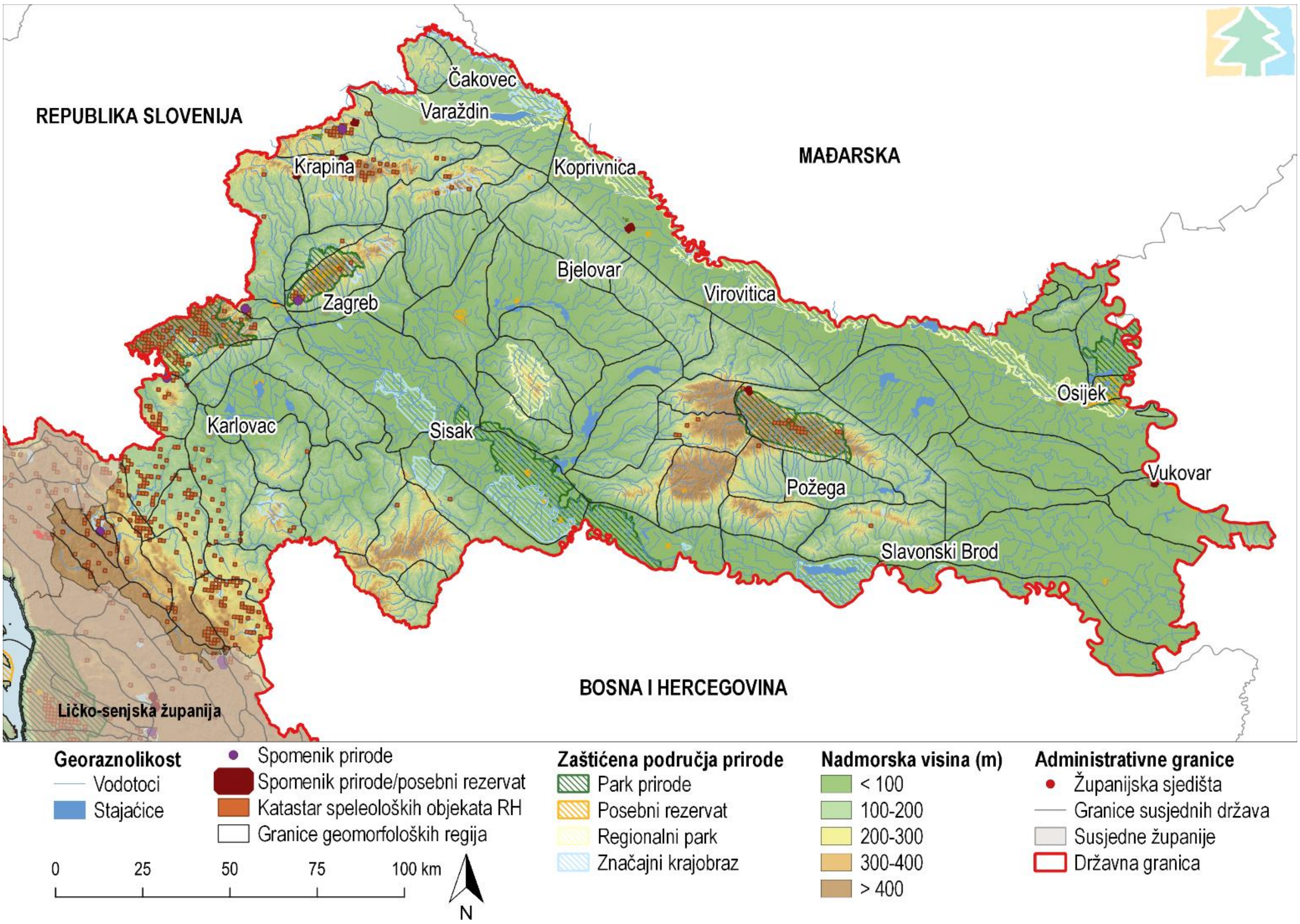
The geomorphological position of a certain area represents its position in the geomorphological regionalization of Croatia (Bognar, 2001). According to this regionalization, the area covered by the Plan belongs to the megamacrogeomorphological regions of the Pannonian basin and the Dinaric mountain system. Furthermore; It includes 5 macrogeomorphological regions: Mountain Croatia, the mountain-valley area of NW Croatia, the Zavala of NW Croatia, the Slavonian rocky highlands with the Požega Zaval and the Sava lowlands, and the Eastern Croatian plain with Gornja Podravina, as well as several mesogeomorphological and subgeomorphological regions (Picture3.16).

Scope of the Planoccupies the southwestern part of the Pannonian Plain, which is the successor of the Pannonian Basin. In a geological sense, northern Croatia is the southern edge of the former Pannonian Sea, which is closed by Žumberak and Petrova gora from the south, and Medvednica and the Slavonian mountains (Papuk, Psunj, etc.) are actually the Pannonian island archipelago. Today, the Pannonian lowland is an open plain region where slightly undulating flagstone or loess plains, sandbars, wet alluvial plains along watercourses and the aforementioned mountains stand out. The area has a well-developed network of watercourses and is dominated by milder fluvial relief.

A review of the Register of Protected Areas revealed that there are several sites of protected geoheritage in the area covered by the Plan. The geological monuments of nature are Gaveznica - Kameni vrh in Lepoglava, Majdan Rupnica near Voćin and Gorjanović's banner profile in Vukovar. The geomorphological natural monuments are the solitary rock of Visibaba, Otruševačka cave, Vrlovka cave in Brlog-grad and Veternica cave. Recorded paleontological natural monuments are Mačkova (Velika) cave, Polupećina Hušnjakovo near Krapina and Vindija Cave near Donja Voća. The only geographically and botanically special reserve is Đurđevački pijesci in Podravina. More about other localities of protected nature areas in the area covered by the Plan is written in the Chapter*3.3.7 Protected areas of nature*, and their position is shown on the attached map (Picture3.45).

According to the Nature Protection Act, speleological objects are naturally formed underground cavities (caves, pits, sinkholes, etc.). A cadastre is created for speleological objects and is available as part of the nature protection information system - Bioportal. According to the Cadastre, there are 658 speleological objects on the territory of the counties in question, of which: 393 caves, 5 cave systems, 254 pits, 1 cave system, 4 complex speleological objects and 1 cavern. In continental Croatia, most of the aforementioned buildings are located in the western part of the Dinaric mountain system, where karst relief predominates.

The aforementioned geomorphological regionalization, altitude categories, locations of geomorphological elements and locations of protected areas are shown onPicture3.16.



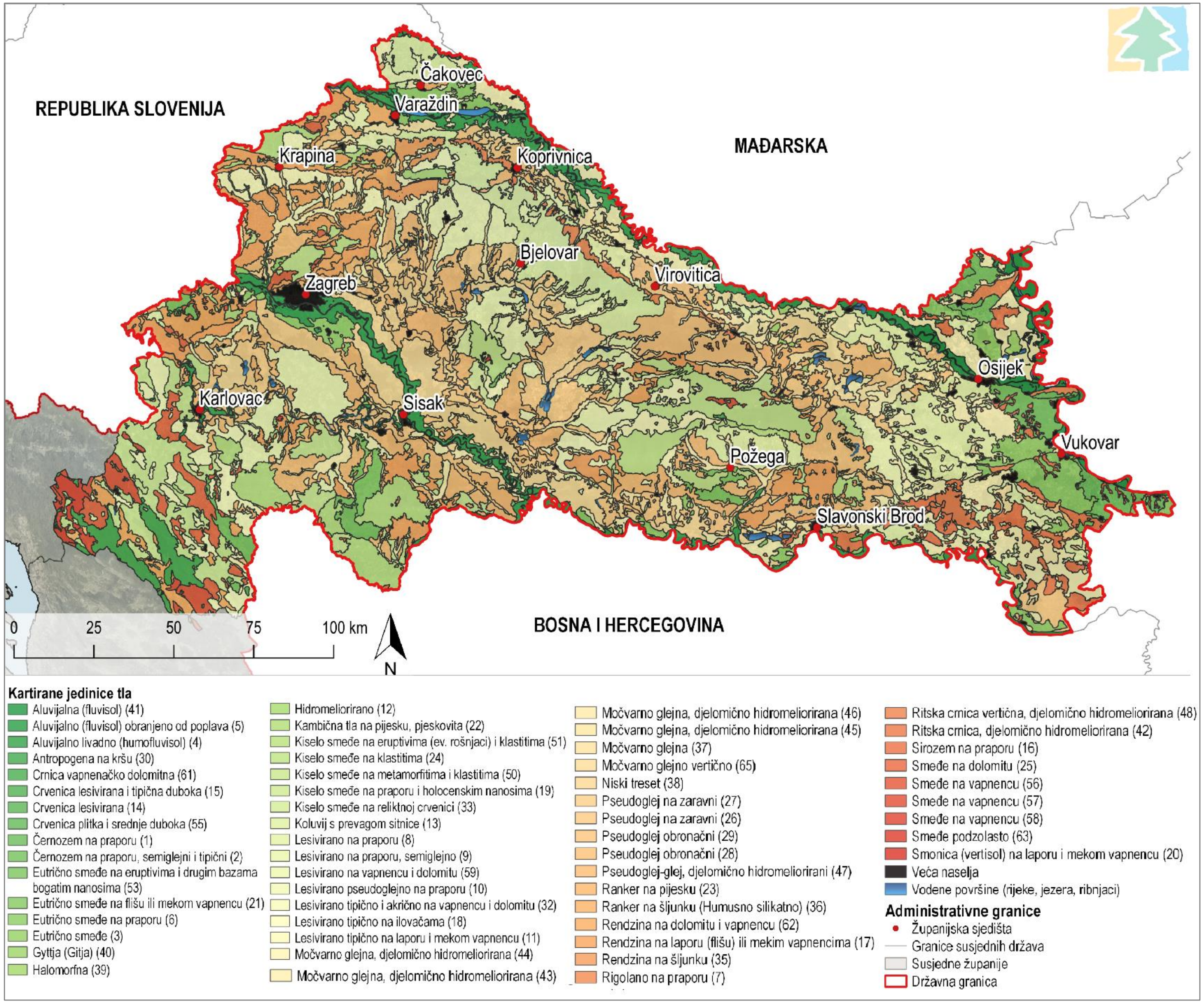
Picture3.16Geomorphological regionalization, locations of protected areas and altitude in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Bioportal)

3.3.2 Soil and agricultural land

Pedological features

The pedological features of the area were determined on the basis of the Dedicated Pedological Map (Bogunović et al. 1996) and the associated scientific article The Dedicated Pedological Map of the Republic of Croatia and its Use (Bogunović et al. 1997). According to the mentioned sources, there are 58 systematic soil units in the territory of the counties in question, the spatial distribution of which is shown in the following figure (Picture3.17). The mapped units are characterized by soil types that belong to the order of terrestrial, semiterrestrial and hydromorphic, halomorphic and subaquatic soils.

The largest number of mapped soil units, which cover about 50% of the area of the counties in question, belong to the order of terrestrial soils. They are characterized by an automorphic mode of wetting exclusively by rainwater up to a depth of 1 m, whereby the excess water is freely filtered through the soil solum without long retention. In some soil types of this order, wetting by underground water may occur that does not reach the upper 1.0 m of soil depth, i.e. it remains exclusively in the parent substrate zone. The semi-terrestic soils include pseudogley soils, the dominant mode of wetting of which is rainwater, which, due to the presence of a poorly permeable horizon that prevents its percolation, stays longer or shorter in the soil horizon itself, resulting in its partial or complete saturation. With a coverage of about 28%, hydromorphic soils are the second most represented type of soil within the spatial scope of the counties in question, and these are mostly marshy clayey, partially hydromeliorated soils. The dominant form of wetting of this order is wetting by underground water within a zone of 1.0 m soil depth. In addition to the aforementioned basic, supplementary wetting by long-term stagnant surface water may occur, which may be of precipitation, flooding or runoff from higher ground. Halomorphic and subaquatic soils are the least represented in the area of the counties in question. Halomorphic soils are classified as soils whose origin and development are dominantly characterized by wetting by salinity and alkalized waters, and soils that form and develop under a shallow water layer of stagnant water are classified as subaqueous soils. The dominant form of wetting of this order is wetting by underground water within a zone of 1.0 m soil depth. In addition to the aforementioned basic, supplementary wetting by long-term stagnant surface water may occur, which may be of precipitation, flooding or runoff from higher ground. Halomorphic and subaquatic soils are the least represented in the area of the counties in question. Halomorphic soils are classified as soils whose origin and development are dominantly characterized by wetting by salinity and alkalized waters, and soils that form and develop under a shallow water layer of stagnant water are classified as subaqueous soils. The dominant form of wetting of this order is wetting by underground water within a zone of 1.0 m soil depth. In addition to the aforementioned basic, supplementary wetting by long-term stagnant surface water may occur, which may be of precipitation, flooding or runoff from higher ground. Halomorphic and subaquatic soils are the least represented in the area of the counties in question. Halomorphic soils are classified as soils whose origin and development are dominantly characterized by wetting by salinity and alkalized waters, and soils that form and develop under a shallow water layer of stagnant water are classified as subaqueous soils. Halomorphic and subaquatic soils are the least represented in the area of the counties in question. Halomorphic soils are classified as soils whose origin and development are dominantly characterized by wetting by salinity and alkalized waters, and soils that form and develop under a shallow water layer of stagnant water are classified as subaqueous soils. Halomorphic and subaquatic soils are the least represented in the area of the counties in question. Halomorphic soils are classified as soils whose origin and development are dominantly characterized by wetting by salinity and alkalized waters, and soils that form and develop under a shallow water layer of stagnant water are classified as subaqueous soils.



Picture3.17Mapped soil units in the area of the counties in question (Source: IRES EKOLOGIJA doo according to the Special Pedological Map of the Republic of Croatia and the Geoportal of the DGU)

Mapped units are composed of two to seven systematic units, including inclusions, and represent complex land combinations. The following table shows the areas of pedogeographic units (dominant units and systematic units together) as well as their shares in the total area of the counties in question (Table3.24). The most common types of soil are pseudogley on the slopes (28), swampy gley, partially hydromeliorated (44), leached pseudogley on the flag (10) and leached on the flag (8). With regard to the suitability of the soil for agricultural cultivation, Pseudogley obronačni is classified as a soil of limited suitability (P-3), Swampy gley, partially hydromeliorated as temporarily unsuitable for cultivation (N-1), and Leached pseudoglay on the banner (10) and Leached on banner (8) as moderately limited arable land (P-2).

Table3.24Mapped soil units, their area and share in the area of the respective counties (Source: Dedicated pedological map of the Republic of Croatia and its use, Bogunović et al. 1997)

Mapped soil unit		Share in the area of the mapped unit (%)1	Suitability of the soil for cultivation	Sensitivity to chemical pollutants	Area (ha)	Share (%)
Number	Composition and structure					
1	**Chernozem on the banner**	80	P-1	*	19,657.83	0.62
	Eutric brown	15				
	Silicate carbonate silt soil	5				
2	**Black soil on the banner, semigley and typical**	75	P-1	*	34 068.26	1.07
	Rit black, hydromeliorated	10				
	Eutric brown	10				
	Rigolano	5				
3	**Eutric brown**	50	P-1	*	71 077.04	2.23
	Leucized	30				
	Alluvial meadow (semiglay)	10				
	Swamp clay, hydromeliorated	10				
4	Alluvial meadow (humofluvisol)	70	P-1	*	33 710.06	1.06
	Swamp clay	20				
	Alluvial	10				
5	**Alluvial (fluvisol) protected from floods**	40	P-1	*	96 466.74	3.03
	Alluvial meadow	30				
	Alluvial flood	20				
	Swamp clay	10				
6	**Eutric brown on flagellum**	60	P-2	*	33 563.64	1.05
	Chernozem on the banner	30				
	Leucized on the banner	10				
7	**Rigolano on the banner**	60	P-2	**	25,466.49	0.80
	Silicate carbonate silt soil	20				
	Eutric brown on flagellum	20				
8	**Leucized on the banner**	55	P-2	*	20 0197.2	6.29
	Pseudoglea	15				
	Eutric brown	15				
	Swamp clay	10				
	Colluvium	5				
9	**Leucized on the banner, semi-glazed**	70	P-2	*	110 119.7	3.46
	Pseudoglea on the plain	10				
	Marsh clay mineral	10				
	Pseudogley-gley	5				
	Eutric brown on flagellum	5				
10	**Leucized pseudogley on the banner**	45	P-2	**	205 754.3	6.46
	Leached typical	20				
	Pseudoglea	20				
	Swamp clay	10				
	Acid brown on flag	5				
11	**Leached typically on marl and soft limestone**	40	P-2	***	62,838.54	1.97
	Carbonate grater	20				

	Pseudoglea obroganice	10				
	Eutric brown	10				
	Silicate carbonate cirrhosis	10				
	Colluvion with a predominance of trifles	5				
	Swamp clay	5				
12	**Hydromeliorated**	90	P-2	*	6142.40	0.19
	Alluvial (fluvisol)	10				
13	**Colluvion with a predominance of trifles**	65	P-2	**	3406.30	0.11
	Swamp clay	20				
	Alluvial meadow	10				
	Pseudoglea	5				
14	**Cvernica lysed**	40	P-2	*	613.75	0.02
	Acid brown on relict red	30				
	Brown on limestone	15				
	Leached acrylic	10				
	Black dolomite limestone	5				
15	**Red blood lysed and typical deep**	80	P-2	*	343,18	0.01
	Brown on limestone	15				
	Black dolomite limestone	5				
16	**I'm poor on the banner**	30	P-3	*	3860.29	0.12
	Colluvion with a predominance of trifles	30				
	Swamp clay	20				
	Eutric brown	10				
	Chernozem	10				
17	**Rendzina on marl (flysch) or soft limestone**	35	P-3	*	170 553.3	5.36
	Rigolana soils of the vineyard	30				
	Silicate carbonate silt soil	15				
	Leucized on marl or flagstone	10				
	Swamp clay	5				
	Eutric brown	5				
18	**Leached typically on loam**	4	P-3	**	51 665.94	1.62
	Sour brown	25				
	Pseudoglea obroganice	20				
	Ranker	10				
	Rendzina on limestone or marl	5				
19	**Acid brown on banner and Holocene deposits**	50	P-3	***	65,858.35	2.07
	Leucized	20				
	Pseudoglea	10				
	Rendzina	10				
	Swamp clay	5				
	Eutric brown	5				
20	**Smonica (vertisol) on marl and soft limestone**	55	P-3	*	228.02	0.01
	Anthropogenic soils	20				
	Rendzina on flash	10				
	Silicate carbonate silt soil	10				
	Brown on limestone	5				
21	**Eutric brown on flysch or soft limestone**	40	P-3	*	26,339.67	0.83
	Rendzina on marl	30				
	Leucized	20				
	Brown on limestone and dolomite	5				
	Silicate carbonate silt soil	5				
22	**Cambic soils on sand, sandy**	30	P-3	***	2661.84	0.08
	Ranker regolithic	20				
	Leucized on sand	20				

	Arenosol	20				
	Pseudoglea on the plain	10				
23	**Ranker on the sand**	30	P-3	***	584,21	0.02
	Sour brown	30				
	Leucized	20				
	Poor soil on the sand	10				
	Pseudoglea on the plain	10				
24	**Acid brown on clastites**	40	P-3	***	100 209.6	3.15
	Ranker regolithic	30				
	Leucized	10				
	Pseudoglea	17				
	Yellowish brown	3				
25	**Brown on dolomite**	50	P-3	*	45,555.82	1.43
	Rendzina on dolomite	20				
	Leached on dolomite	20				
	Brown on relict red	10				
26	**Pseudoglea on the plain**	55	P-3	***	145,939.90	4.58
	Pseudogley-gley	20				
	Leucized on the banner	10				
	Swamp clay	10				
	Rit black woman	5				
27	**Pseudoglea on the plain**	65	P-3	***	133,993.30	4.21
	Pseudoglea obroganice	10				
	Acid brown on flag	10				
	Leached brown	10				
	Swamp clay	5				
28	**Pseudoglea obroganice**	65	P-3	***	230,633.00	7.24
	Pseudoglea on the plain	10				
	Leucized on the banner	10				
	Sour brown	5				
	Swamp clay	5				
	Colluvium	5				
29	**Pseudoglea obroganice**	60	P-3	***	82,018.39	2.58
	Sour brown	15				
	Leucized on the banner	10				
	Rendzina on marl	5				
	Eutric brown	5				
	Swamp clay	5				
30	**Anthropogenic on the karst**	50	P-3	**	105,36	0.003
	Brown soils on limestone and dolomite	25				
	Redheads	10				
	Black limestone-dolomite	10				
	Colluvium	5				
32	**Leached typically and acrylic on limestone and dolomite**	60	P-3	**	38,409.96	1.21
	Acid brown on relict red	30				
	Crvenica typical and leached	10				
	Rendzina on dolomite	10				
33	Acid brown on relict red	50	P-3	***	69,699.98	2,19
	Leached acrylic and typically on limestone and dolomite	20				
	Redhead	10				
	Rendzina on dolomite	10				
	Brown on limestone and dolomite	10				

35	**Rendzina on gravel**	50	N-1	*	0.67	0.00
	Cambic soils	20				
	Anthropogenic soils	20				
	Stoneman	5				
	Colluvium	5				
36	**Ranker on gravel (humus silicate)**	70	N-1	***	8111.98	0.25
	Acid brown soil	28				
	Yellowish brown	2				
37	**Swamp clay**	80	N-1	***	243.22	0.01
	Peat	10				
	Subaquatic	10				
38	**Low peat**	70	N-1	***	1354.75	0.04
	Swamp clay	20				
	Rit black woman	10				
39	**Halomorphic**	50	N-1	***	470.51	0.01
	Pseudogley-gley	20				
	Rit black woman	20				
	Swamp clay	10				
40	**Gyttja**	80	N-1		254,22	0.01
	Alluvial	20				
41	**Alluvial (Fluvisol)**	90	N-1	**	45,620.78	1.43
	Swamp clay	10				
42	**Rit black, partially hydromeliorated**	55	N-1	***	57 363.28	1.80
	Swamp clay	35				
	Pseudoglea on the plain	10				
43	**Swamp clay, partially hydromeliorated**	50	N-1	***	119 633.10	3.76
	Colluvion with a predominance of trifles	25				
	Rendzina on proluvija	2				
	Pseudoglea on the plain	10				
	Pseudogley-gley	10				
44	**Swamp clay, partially hydromeliorated**	70	N-1	***	215,649.10	6.77
	Alluvial meadow	10				
	Rit black woman	10				
	Alluvial	10				
45	**Swamp clay, partially hydromeliorated**	60	N-1	***	62,888.70	1.98
	Pseudogley-gley	20				
	Pseudoglea on the plain	10				
	Rit black verticle	5				
	Leucized on a pre-precipitated banner	5				
46	**Swamp clay, partially hydromeliorated**	70	N-1	***	27,664.65	0.87
	Swamp gley vertic	25				
	Alluvial meadow	5				
47	**Pseudogley-gley, partially hydromeliorated**	55	N-1	***	58,200.72	1.83
	Pseudoglea on the plain	20				
	Swamp clay	10				
	Leucized on the banner	5				
	Rit black woman	5				
	Alluvial meadow (humofluvisol)	5				
48	**Vertical, partially hydromeliorated Rite black forest**	45	N-1	***	12 787.98	0.40
	Rit black woman	25				
	Swamp clay	25				
	Pseudogley-gley	5				
50	**Acid brown on metamorphites and clastites**	70	N-2	***	106 454.6	3.34

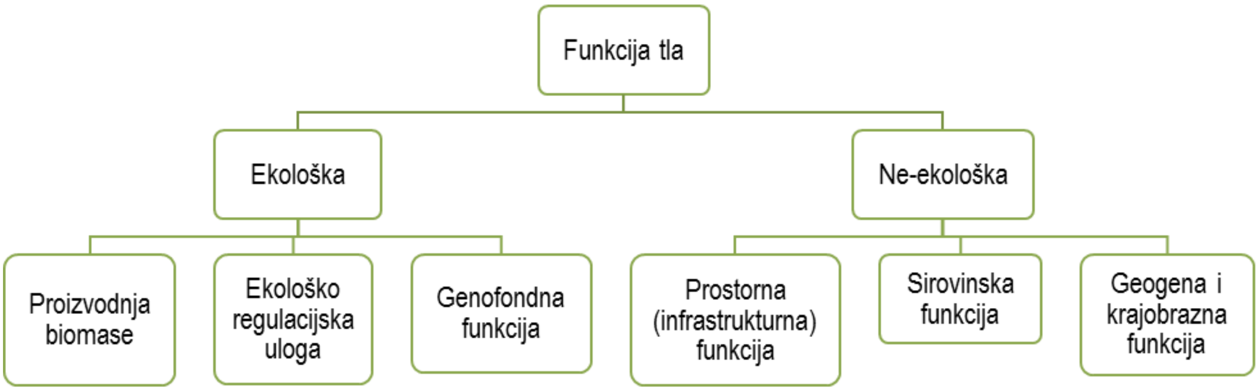
	Ranker	20				
	Leucized on a silicate deposit	10				
51	**Acid brown on eruptives (probably rošnjaci) and clastites**	80	N-2	***	4923.72	0.15
	Leucized on a silicate deposit	10				
	Ranker on andesite	10				
53	**Eutric brown on eruptive and other sediment-rich bases**	40	N-2	*	18,672.12	0.59
	Ranker eutric	25				
	Sour brown	20				
	Leucized	10				
	Rendzina	5				
55	**Shallow and medium deep redness**	50	N-2	*	186.35	0.01
	Brown on limestone	30				
	Calcareous-dolomite chert	15				
	Anthropogenic	5				
56	**Brown on limestone**	40	N-2	*	20 498.27	0.64
	Black limestone-dolomite	25				
	Rendzina	10				
	Leached on limestone	10				
	Redhead	5				
	Rigolana karst soils	5				
	Eutric brown	3				
	Poor soil on marl	2				
57	**Brown on limestone**	35	N-2	*	3092.35	0.10
	Crvenica typical and leached	20				
	Black limestone-dolomite	15				
	Rendzina on the consumption of limestone	10				
	Leached on limestone	10				
	Stoneman	5				
	Rigolano	5				
58	**Brown on limestone**	45	N-2	*	10,791.97	0.34
	Leached on limestone	20				
	Black limestone-dolomite	20				
	Rendzina	10				
	Colluvium	5				
59	**Leached on limestone and dolomite**	50	N-2	**	3679.50	0.12
	Brown on limestone	30				
	Rendzina on limestone	10				
	Black limestone-dolomite	10				
61	**Black limestone-dolomite**	45	N-2	*	35,711.66	1.12
	Brown on limestone and dolomite	40				
	Rendzina on the consumption of limestone	10				
	Leached on limestone and dolomite	5				
62	**Rendzina on dolomite and limestone**	60	N-2	*	72 339.15	2.27
	Brown soil on limestone	20				
	Luvisol on limestone	10				
	Calcareous-dolomite chert	10				
63	**Yellowish brown**	50	N-2	***	447.42	0.01
	District brown	20				
	Podzol	20				
	Ranker regolithic	10				
65	**Swamp gley vertic**	70	N-2	***	152 457.20	4.79
	Gleina	28				

	Peat clay	2				
66	Water surfaces		/	/	39,806.36	1.25
67	Larger settlements		/	/	32,977.89	1.04

* weak sensitivity, ** moderate sensitivity, *** strong sensitivity
[1]the representation of a particular systematic soil unit in the mapped unit refers to data for the entire Republic of Croatia

Soil functions

Soil is a natural, conditionally renewable resource in which very rapid degradation is possible, and whose formation and regeneration is very slow, which the user of the soil should take care of regardless of the way the soil is used (Sofilić, 2014). Blum (2005) divided soil functions into two categories: ecological and non-ecological (Picture3.18).



Picture3.18Functions of soil (Source: Functions of soil for society and the environment, 2005)

The productive function of the soil is the primary and most important role in which the soil is an irreplaceable factor in the maintenance of natural and cultural vegetation, i.e. agriculture and forestry - economic branches that are the basis of sustainable development and the satisfaction of human food and non-food needs.

Ecological regulatory role includes climate-regulatory, receptor-accumulation, transformer, buffer and filter role. Soil is an important part of the cycle of biogenic elements in nature, especially the carbon that builds organic matter. Also, it receives and accumulates harmful substances such as residues of fertilizers and pesticides or heavy metals, and some of these substances can be transformed thanks to chemical, physical and biological processes that take place in the soil. The filtering role refers primarily to rainwater that the soil can purify and thus protect the groundwater from pollution, while the buffering role of the soil is responsible for preventing sudden stress changes that can have harmful consequences on the pedoflora and pedofauna in the soil.

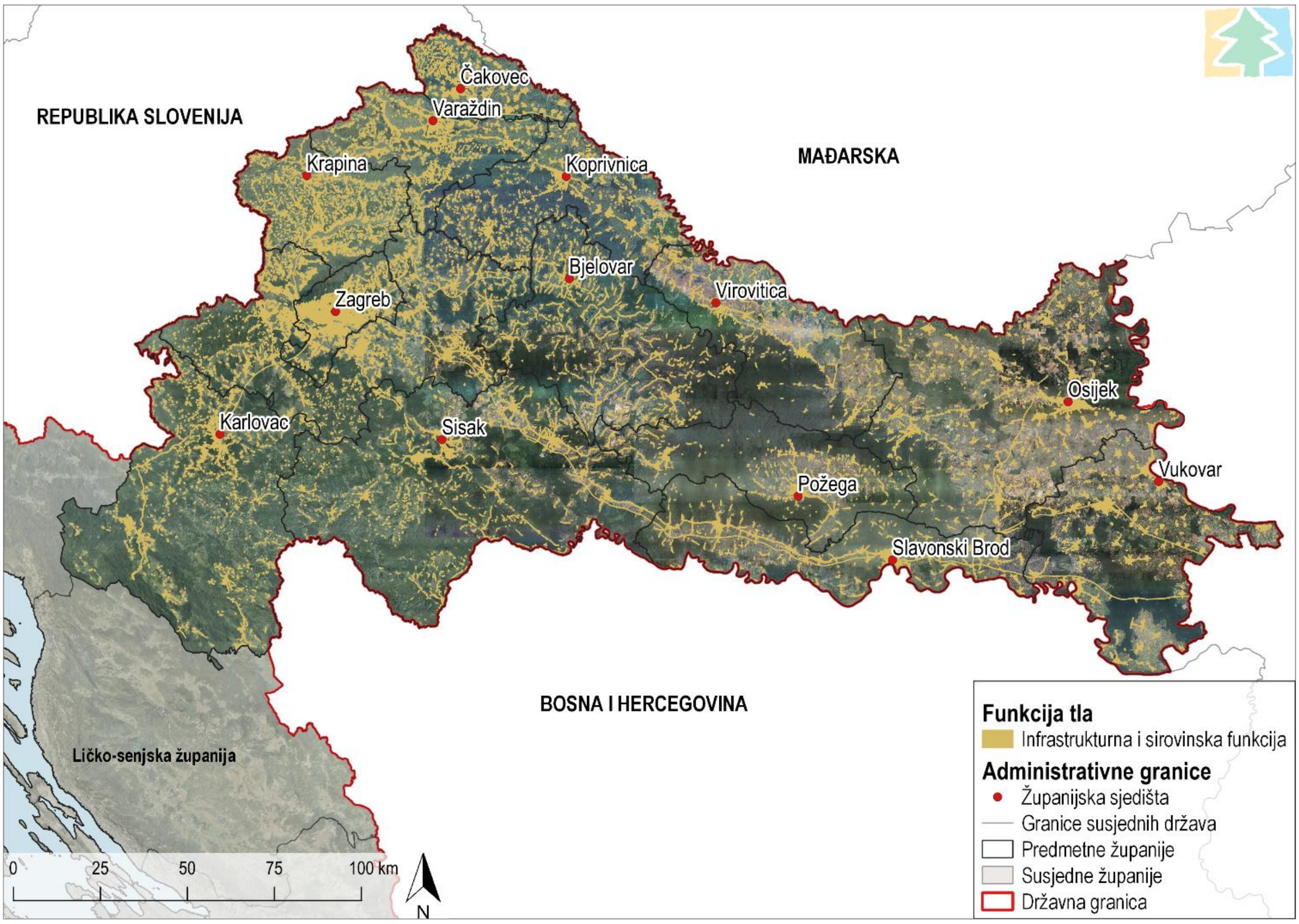
The gene pool function of the soil refers to the soil as a habitat for a large number of organisms and represents the basis of biodiversity. As a rule, soil that is not polluted supports the development of a greater number of organisms that lead to more fertile soil.

The infrastructural function of the soil refers to the soil as the foundation of urban areas, roads, sports-recreational areas, landfills, etc. Such surfaces are permanently lost for primary organic production and are treated as a permanent loss of the productive function of the soil.

The raw material function of the soil implies the soil as a source of raw materials, especially in construction (excavation of stone, gravel, sand, peat, etc.).

The geogenic and landscape function of the soil refers to the importance of the soil for the geogenic and cultural heritage as well as in the formation of the landscape.

In the territory of the counties in question, ecological functions of the soil prevail: gene pool, ecological regulation and production, while infrastructure and raw materials, according to the Map of non-forest habitats, occupy 142,061.56 ha or 4.46% of the area (Picture3.19).



Picture3.19Presentation of the infrastructural and raw material functions of the soil in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Bioportal and Geoportal DGU)

Soil erosion

Erosion is an exogenous process that includes the separation, movement and transport of the surface part of the soil under the influence of various agents such as water, wind or the force of gravity, and can be increased due to human activities such as soil cultivation and clearing of vegetation. According to the classification of soil damage (Bašić, 1994), erosion processes cause III. degree of soil damage, i.e. severe and non-renewable (irreversible) soil damage that manifests itself as soil movement. The consequences are the loss of part of the soil or the entire profile, changes in the stratigraphy of the profile, reduction or loss of production areas, disturbances in processing, increased heterogeneity of the cover, increased production costs, reduced yield and endangerment of other ecosystems.

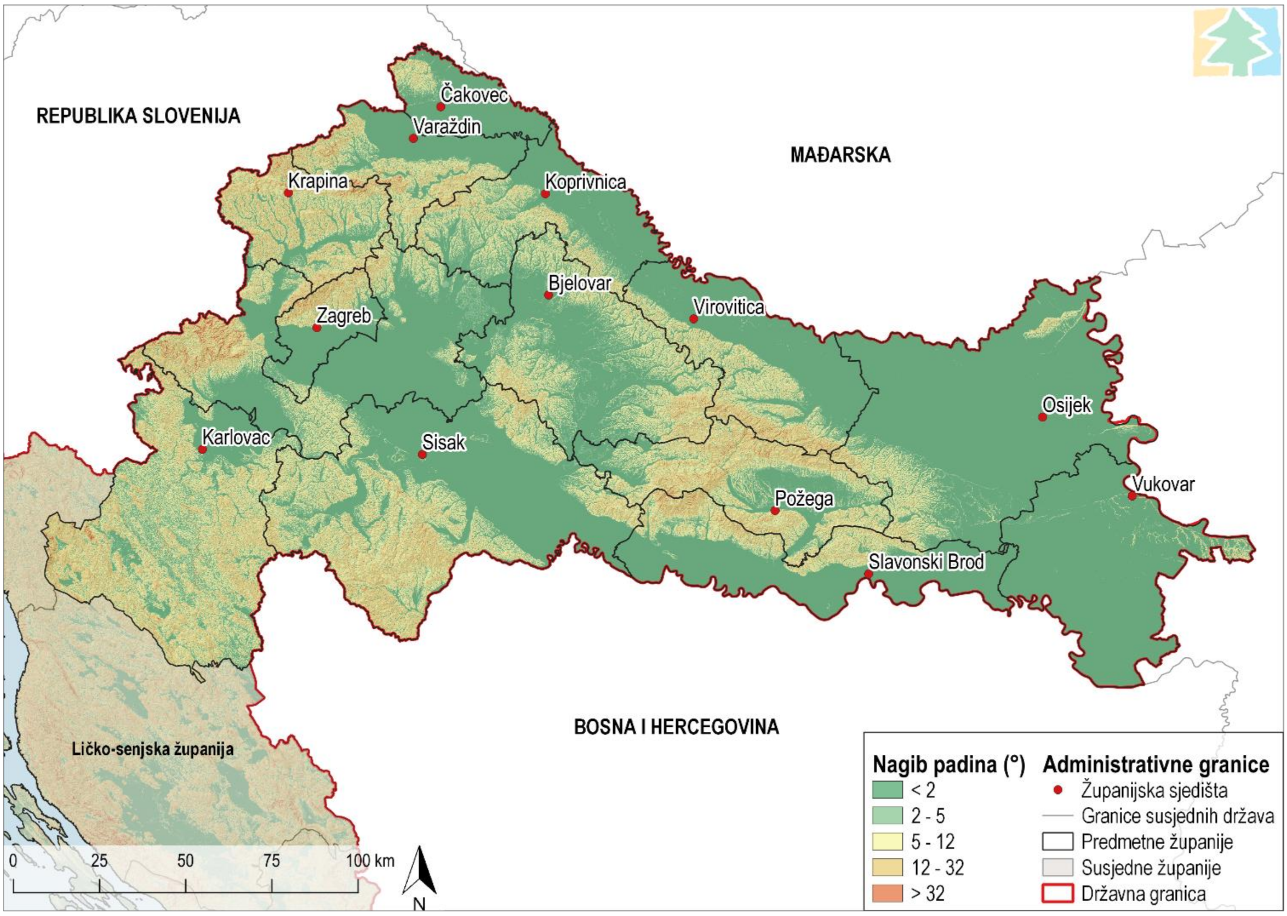
In order to analyze the risk of erosion of an area, the geomorphological classification of slopes (IGU, 1968) with the processes that characterize it was used. The following table lists the slope categories and their brief description (Table3.25).

Table3.25Geomorphological classification of terrain slopes (Source: IGU, 1968))

Slope (°)	Description
0-2	Plain, mass movement is not observed
2-5	Slightly sloping terrain, slight washout
5-12	Inclined terrain, increased washing and movement of masses
12-32	Strongly sloping terrain, strong erosion and significant movement of masses

Slope (°)	Description
32-55	Very steep terrain, dominated by destruction
>55	Cliffs (cliffs, escarpments); collapse

According to the slope map (Picture3.20) with a representation of almost 60% in the total area of the subject area, the plain is dominated by slopes of less than 2°. These are mainly river terraces, flood plains such as Kopački rit and Lonjsko polje, and loess plains of Eastern Croatia. In terms of representation, it is followed by sloping terrain with a slope of 5-12°, which is characterized by the processes of increased washing and movement of masses, and strongly sloping terrain with a slope of 12-32°, where erosion processes dominate. These slope categories prevail in the area of hills (Bilogora, Moslavačka gora, Vukomeričke gorica, Hrvatsko zagorje hills) and old rocky mountains (Žumberak - Samoborsko gorje, Medvednica, Papuk, Petrova gora, Zrinska gora, Psunj and others) and in the area of Karlovac County on transition towards Gorska Hrvatska. Very steep terrain is represented in a percentage of less than 1% in the total area of the area covered by the Plan.



Picture3.20The slope of the slopes in the area of the counties in question (Source: IRES EKOLOGIJA doo according to IGU, 1968 and Geoportal DGU)

Soil pollution

According to the Croatian Permanent Soil Monitoring Program, soil pollution is defined as the introduction of substances, biological organisms or energy into the soil, which results in a change in the quality of the soil and affects the normal use of the soil or the health of people and other organisms. The appearance of polluted soils is a consequence of anthropogenic action, so the sources of soil pollution are usually found in industry, agriculture, transport, urbanization, processing and disposal of waste, military activities, etc.

Intensive agriculture promotes high yields through the use of fertilizers and agrochemicals. When using fertilizers, the focus is on plant nutrition, and the soil microorganisms responsible for its fertility and biological balance are neglected. Chemical pesticides are introduced into the soil with the aim of controlling and suppressing pests, and they remain in the soil for many years after their application. They can cause the appearance of "super weeds" since organisms become resistant to the active substance if it is introduced into the soil in excessive quantities. Heavy metals are common impurities in mineral fertilizers. Most often, phosphate fertilizers are used, which contain elevated concentrations of cadmium and may contain fluorine and chlorine. Copper, zinc and iron are mostly introduced into the soil through the use of plant protection products. According to Lončarić et al. (2012),

In addition to heavy metals, the danger of soil pollution is represented by organic pollutants that mostly remain in the soil after the intensive application of mineral fertilizers and various plant protection agents. They are persistent, toxic and can be transported by air over long distances and thereby cause pollution of spatially distant soil. In addition to being attached to particles, they can dissolve in the liquid phase of the soil and thus be washed away by rainwater or migrate into deeper underground layers. The Rulebook on the Protection of Agricultural Land from Pollution (Official Gazette 71/19) prescribes the maximum permitted concentration of pollutants on agricultural land (Table3.26).

Table3.26Maximum permissible concentrations of pollutants on agricultural land (Source: Ordinance on protection of agricultural land from pollution)

Element	Soil pH in 1 M KCl solution		
	5	5-6	> 6
CD	1	1.5	2
Cr	40	80	120
Cu	60	90	120
Hg	0.5	1	1.5
Nor	30	50	75
Pb	50	100	150
Zn	60	150	200
Mo	15	15	15
As	15	25	30
Co	30	50	60

Also, agrochemicals lower the pH value of the soil in such a way that sulfur and nitrogen compounds accumulate in it, which causes acidification or acidification of the soil. Acidified soil disrupts the biological activity and diversity of the pedosphere because the acidic environment favors the mobility of heavy metals, hindering the availability of essential micro- and macroelements crucial for plant development.

Agricultural practices are not the only source of land and soil pollution. Poor waste management, municipal and industrial, is the cause of more than a third of local pollution at the global level, followed by pollution from industrial activity. Some pollutants break down in the soil over time, but others remain present forever. In many cases, soils are the final destination where various pollutants end up and accumulate over time. The full extent of the risk from these chemicals and their various mixtures is not fully known. However, based on the sampling locations, it is known that land and soil pollution can have serious effects on human health and on soil biodiversity and ecosystem health.

According to physical and chemical indicators, the sensitivity of dominant systematic soil units to chemical pollutants was evaluated. According to the table (Table3.24) more than 50% of the soil surface in the area of the counties in question is very sensitive to pollutants.

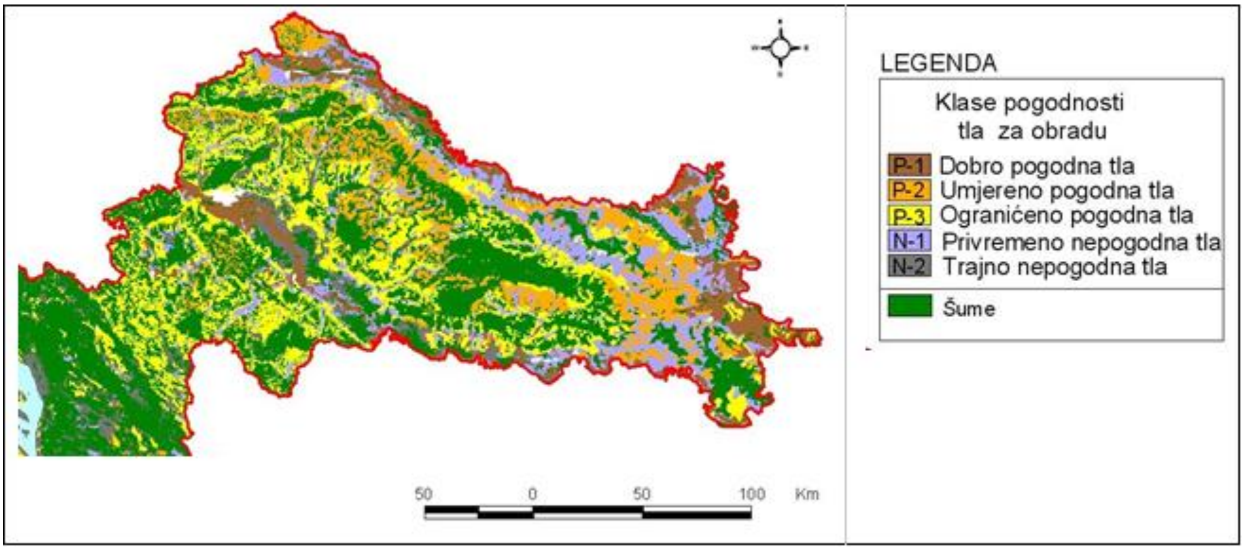
In the area of the counties in question in 2020, as in previous years, there were no registered ROO payers emitting pollutants into the soil.

Credit value of the land

The creditworthiness of the land means the natural productive capacity of the land and it defines the productive potential of the soil. The creditworthiness of the land is determined based on the creditworthiness of the soil, relief, climate and other correction factors. With regard to creditworthiness, land is classified into one of four categories of land use and protection: P1 – particularly valuable arable agricultural land (hereinafter: P1 agricultural land), P2 – valuable arable agricultural land (hereinafter: P2 agricultural land) , P3 – other arable land (hereinafter: P3 agricultural land) and PŠ – other agricultural land, forests and forest land. Law on Agricultural Land (OG 20/18, 115/18, 98/19, 57/22) defines particularly valuable (P1) and valuable (P2) agricultural land as the highest quality agricultural areas intended for agricultural production, which shape, position and size enable the most efficient application of agricultural technology. Land of such quality is intended exclusively for agricultural production, but there are exceptions in which it is possible to use it for non-agricultural purposes, and these are determined by legal regulations.

In view of the fact that in Croatia there is no adequate data on the distribution and area of individual spatial categories of land use, i.e. the fact that in the spatial plans of the counties different methods were used for credit evaluation of land and that such data on the area of spatial categories are not comparable, below the distribution of spatial categories of land use and their area is shown on the basis of the soil suitability map for cultivation (Bogunović et al., 1996, Bogunović et al., 1997) (Picture3.21). The FAO method (FAO, 1976) of land assessment was used in the assessment of soil suitability for cultivation and the creation of the aforementioned map. Based on the established dominant limitations, the soils were classified into the following classes of benefits:

- class P-1: suitable soils without significant restrictions or with restrictions that will not significantly affect the productivity and profit of agricultural production,
- class P-2: moderately suitable soils, with restrictions that moderately threaten the productivity and profit of agricultural production,
- class P-3: limited suitable soils, with restrictions that significantly threaten the productivity and profit of agricultural production,
- class N-1: temporarily unsuitable soils, with restrictions that in their current state exclude technologically and/or economically justified agricultural production,
- class N-2: permanently unsuitable soils, with restrictions that exclude any possibility of technologically and/or economically justified agricultural production.



Picture3.21Suitability of soil for cultivation in the area of the counties in question (Source: Husnjak and Bogunović, 2002)

By inventorying the areas of individual soil suitability classes for cultivation and the above criteria in terms of correlation with spatial categories of land use, their representation was determined, which for Pannonian Croatia is shown in the following table (Table3.27).

Table3.27The area of individual soil suitability classes for cultivation/spatial categories of land use in the area of agricultural land in Pannonian Croatia

Soil suitability class for cultivation	Estimated spatial category of use	Surface	
		Ha	%
Well-suited soils of P-1 convenience class	Very valuable P1 category arable soil	258 443.0	14.2
Moderately suitable soils P-2 class benefits	Valuable arable soil of category P2	410 864.1	22.6
Limited suitable soils of P-3 convenience class	Other arable soils of category P3	1 036 896.7	57.0
Temporarily unsuitable soils of N-1 convenience class			
Permanently unsuitable soils N-2 classes of benefits	Other agricultural soils of the PS category	112,755.5	6.2
Total agricultural land in the Republic of Croatia		1 818 959.3	100.0

Based on the above data for the area of Pannonian Croatia, it can be stated that in the area of land, excluding forests, that is, land that can be considered agricultural, P3 agricultural land dominates, considering that they occupy about 57% of the total agricultural land, followed by P2 agricultural land which occupy about 14.2% and P1 agricultural land which occupies only 14.2% of the total agricultural land. The fact that there are relatively few very valuable and valuable arable soils in the area of Pannonian Croatia indicates the need for their maximum protection, in accordance with legal regulations.

3.3.3 Air

The Air Protection Act (Official Gazette 127/19, 57/22) and corresponding by-laws regulate the area of air quality monitoring and management in the territory of the Republic of Croatia. An assessment of the state of air quality, in accordance with the Air Protection Act, is made every five years based on the results of air quality parameter measurements and modeling. In this way, it is determined whether in the current five-year period there has been a deterioration or improvement in air quality compared to the previous period, and appropriate policies and air protection measures are adopted. The introduction of zones and agglomerations as territorial units (Decree on the determination of zones and agglomerations according to air pollution levels in the territory of the Republic of Croatia (Official Gazette 1/14)) enables the operational monitoring of air quality and the adoption of appropriate measures and policies where necessary, that is, in areas where a potential problem has been identified, which does not necessarily cover the entire territory of the Republic of Croatia. Thus, with regard to air quality indicators, five zones and four agglomerations were determined. The counties in question include two agglomerations (HR ZG and HR OS) and 3 zones (fully zone HR 1 and HR 2 and partially zone HR 3), which is shown in the following table (Table3.28,Picture3.22).

Table3.28Coverage of zones and agglomerations on the territory of the counties in question (Source: Regulation on the determination of zones and agglomerations according to air pollution levels in the territory of the Republic of Croatia)

Zone designation	Zone name	Zone coverage
HR 1	continental Croatia	Bjelovar-Bilogora County Koprivnica-Križevac County Krapina-Zagorje County Međimurje County Osijek-Baranja County (excluding the HR OS agglomeration) Požega-Slavonia County Varazdin county Virovitica-Podravka County Vukovar-Srijem County Zagreb County (excluding the HR ZG agglomeration)
HR 2	Industrial zone	Brod-Posavina County Sisak-Moslavina County
HR 3	Lika, Gorski kotar and Primorje	Karlovac County
Sign of agglomeration	Name of agglomeration	Coverage of the agglomeration
HR ZG	Zagreb	City of Zagreb, City of Dugo Selo, City of Samobor, City of Sveta Nedjelja, City of Velika Gorica, City of Zaprešić
HR OS	Osijek	City of Osijek

So far, five-year air quality assessments have been adopted for the periods 2006-2010, 2011-2015 and 2016-2020 (to be adopted). In addition, reports on the state of air quality in the previous year are published every year, and in this way the state and quality of the air quality management system is continuously monitored.

On the basis of available information and conducted analyses, the Government, at the suggestion of MINGOR, in September 2019, passed the Decision on the adoption of the Air Pollution Control Program for the period from 2020 to 2029 (Official Gazette 90/19). The goal of this Program is to fulfill obligations to reduce emissions of pollutants in the air, namely: sulfur dioxide, nitrogen oxides, non-methane volatile organic compounds, ammonia and fine floating particles in the period 2020 - 2029, but also after 2030. By limiting anthropogenic emissions of certain pollutants in the air, progress would be made in achieving air quality levels that do not lead to significant negative effects and risks for human health and the environment.

Picture3.22The territory of Croatia is divided into zones and agglomerations - air quality management areas that have similar characteristics

In the Republic of Croatia, based on the Air Protection Act and the Ordinance on Air Quality Monitoring (Official Gazette 72/20), air pollutants are measured in the state network for permanent air quality monitoring, which is managed by the State Hydrometeorological Institute (hereinafter: DHMZ) and in local networks (in the jurisdiction of counties and cities). At the same time, in the vicinity of the source of air pollution, polluters are obliged to ensure air quality monitoring according to the decision on the acceptability of interventions on the environment or the decision on unified environmental protection conditions, i.e. environmental permit, and these special purpose measurements are an integral part of local air quality monitoring networks. The legal obligation of DHMZ for the state network and the obligation of the competent administrative body of the units for the local network is to submit reports and validated data on air quality to MINGOR by 30 April of the current year for the previous calendar year. Pursuant to the Air Protection Act and the Ordinance on Air Quality Monitoring, MINGOR's obligation is to prepare the Annual Report on Air Quality Monitoring on the territory of the Republic of Croatia (hereinafter: Air Quality Report).

Based on the measurement of pollution levels, and with regard to the environmental protection goals set (prescribed limit target values), air quality categories (categories I and II) are determined at air quality monitoring stations for each zone and agglomeration of the Republic of Croatia.

According to the Air Protection Act:

- the first category of air quality means clean or slightly polluted air: limit values (GV), target values (CV) and target values for ground-level ozone are not exceeded
- the second category of air quality means polluted air: limit values (GV), target values and target values for ground-level ozone are exceeded.

Air quality in a certain zone or agglomeration is determined on an annual basis, once a year for the past calendar year and for each pollutant separately. If there are several measuring points for the same pollutant in a zone or agglomeration, the assessment of the zone or agglomeration is given according to the measuring point with the worst state of air quality, i.e. according to the measuring point where the environmental goals are exceeded. Table (Table3.29) shows zones and agglomerations that are inconsistent with the environmental goals (GV and CV) in 2020, i.e. measurement sites where the air quality of the second II category.

According to the Air Quality Report for 2020, all zones and agglomerations in the area of the concerned counties comply with the limit values for concentrations of SO2, NO2, O3, CO and benzene with regard to the protection of human health (I air quality category).

As for the ratings for floating particles PM10 and PM2.5, the limit values were exceeded. Thus, the Industrial zone does not comply with the limit value for the average annual value of PM2.5 with regard to the protection of human health (air quality category II), while all other zones and agglomerations (with the exception of the Osijek agglomeration, where due to the lack of measurements and the impossibility of applying an objective assessment conformity assessment) compliant with the limit value for the mean annual value of PM2.5 with regard to the protection of human health. For floating PM10 particles, the agglomeration of Zagreb, the agglomeration of Osijek and the Industrial Zone do not comply with the limit value for 24-hour concentrations and the limit value for the average annual value of PM10 concentrations with regard to the protection of human health.

Table3.29Assessment of air quality (compliance with environmental goals) with regard to the protection of human health by pollutants for the year 2020 (Source: Report on air quality)

Zone/ Agglomeration	SO2	NO2	PM10	PM2.5	O3	CO	Benzene	Pb, Cd, As, Ni*	Benzo(a)pyrene (B(a)P)*
HR 1									
HR 2									
HR 3									
HR ZG									
HR OS									

The gray color indicates the absence of measurement and the impossibility of applying the method of objective assessment
*Analyzed in suspended particles PM10

For all zones and agglomerations, conformity with the limit and target values for the average annual values of concentrations of Pb in PM10, Cd in PM10, As in PM10 and Ni in PM10 was assessed with regard to the protection of human health.

According to the assessment for benzo(a)pyrene in PM10 (B(a)P in PM10), the agglomeration of Zagreb and the Industrial Zone (Sisak) are inconsistent with the target value for the average annual value of B(a)P in PM10 with regard to the protection of human health, and for all other agglomerations and zones, no assessment of compliance with the target value of B(a)P in PM10 was given due to the absence of measurements or due to insufficient coverage of data due to malfunctions of measuring instruments.

Annual reports on air quality provide an informative assessment of the state of air quality, but the final assessment is made on the basis of reports for the past five-year period (e.g. 2016-2020), since the non-compliance of an individual zone or agglomeration with the set environmental protection goals is declared in the event that during for at least 3 years in the considered period, individual goals were exceeded.

Analysis of the five-year period 2016-2020 (Table3.30)shows that floating particles are still critical parameters for agglomerations Zagreb (PM10, PM2.5, benzopyrene in PM10) and Osijek (PM10) and zone HR02 (PM10, PM2.5, benzopyrene in PM10). In all zones and agglomerations, the long-term goals of human health protection with respect to ozone have not been achieved. The influence of traffic, industry and households (monitoring via the NO2 parameter) is still excessive in the Zagreb agglomeration (highest traffic pressure), so that in the past five-year period, as well as in earlier periods, there is non-compliance with the goal of protecting people's health with regard to nitrogen dioxide in air.

The analysis of the levels of pollution with sulfur and nitrogen compounds with regard to the prescribed critical values for vegetation in the period from 2016 to 2020 shows that these values were not exceeded and that the ecosystems are not under the excessive influence of acidification and nutrification, which occurs either due to the emission of these compounds into the atmosphere either through cross-border transport. However, the pressure due to the increased values of the AOT40 parameter during the vegetative period continues to be a problem (the objectives of vegetation protection with regard to this parameter were not achieved even in this period).

Table3.30Assessment of the level of pollution with regard to the goals of environmental protection for human health in the period from 2016 to 2020 in the zones and agglomerations of the Republic of Croatia

Zone and agglomeration designation	The level of air pollution by pollutants with regard to the protection of human health									
	SO2	NO2	PM10	PM2.5	Benzene	BaP*	Pb,As Cd,Ni*	CO	O3	Hg
HR ZG	green	red	red	red	green	red	green	green	red	green
HR OS	green	green	red	gray	green	green	green	green	red	green
HR RI	green	green	green	green	green	green	green	green	red	green
HR ST	green	green	green	green	green	green	green	green	red	green
HR 01	green	green	green	green	green	green	green	green	red	green
HR 02	green	green	red	red	green	red	green	green	red	green
HR 03	green	green	green	green	green	green	green	green	red	green
HR 04	green	green	green	green	green	green	green	green	red	green
HR 05	green	green	green	green	green	green	green	green	red	green

green - legally prescribed environmental protection goals achieved, red - legally prescribed environmental protection goals not achieved, gray - no measurement data
* Analyzed in suspended particles PM10

In order to gain an insight into the potential pressures on air quality, i.e. the presentation of pollutant emissions into the air, the Report on data from the Environmental Pollution Register (hereinafter referred to as the Environmental Pollution Register) was used, which is prepared according to the data from the Environmental Pollution Register database. in accordance with the Ordinance on the Register of Environmental Pollution (Official Gazette 80/13, 78/15, 03/22). ROO represents a database on the sources, type, quantity, method and place of discharge, transfer and disposal of pollutants and waste into the environment. Those operators who discharge pollutants whose annual quantity does not exceed the discharge threshold are not obliged to register them in the ROO database. Also, those taxpayers who exceed the discharge threshold for at least one polluting substance in the reporting year are only required to report quantities for that substance, while the other polluting substances only need to be stated. In accordance with the aforementioned regulation, polluters are obliged to submit data in the current year for the period of the previous calendar year

In the following table (Table3.31) shows the amount of polluting substances released into the air in the area of the relevant counties by pollutant. Sisak-Moslavina County (18%), City of Zagreb (13%) and Osijek-Baranja County (12%) have the largest share in the amount of discharged pollutants. Carbon dioxide (CO2) emissions account for 99.7% of the emitted pollutants.

Table3.31Annual quantities of pollutant discharges in the area of the respective counties in 2020 (Source: Report of the ROO)

County	SO2	NO2	CO	CO2	NH3	PM_{10}	Other inorganic and organic substances and metals*
	t/yr						
Zagrebačka	53,59	136.64	189.87	190 845.99	/	12.63	44.67
Krapina-Zagorje	161.36	374,36	9.46	117 415.11	/	6.02	116,17
Sisak-Moslavina	351.68	1783,41	925.55	1 571 257.02	2170,61	191.85	275.70
Karlovačka	138,23	56.70	74,23	73 446.47	/	17,29	/
Varaždinska	228.43	170.70	100.62	178,029.00	57,36	89.85	1.45
Koprivnica-Križevačka	111.08	193.44	59.49	315,082.71	/	12.91	/
Bjelovar-Bilogorska	147.53	242.35	356.60	276,038.68	/	172,33	/
Virovitica-Podravska	9.41	96.59	48,38	66 959.76	/	51,18	/
Požega-Slavonia	12,17	35.95	11,12	40,747.60	/	9.25	/
Brod-Posavina	0.00	11.66	10.70	18,225.43	/	/	/
Osijek-Baranja	733,13	1246.52	4743.99	1 072 266.89	49.34	81.59	334.07

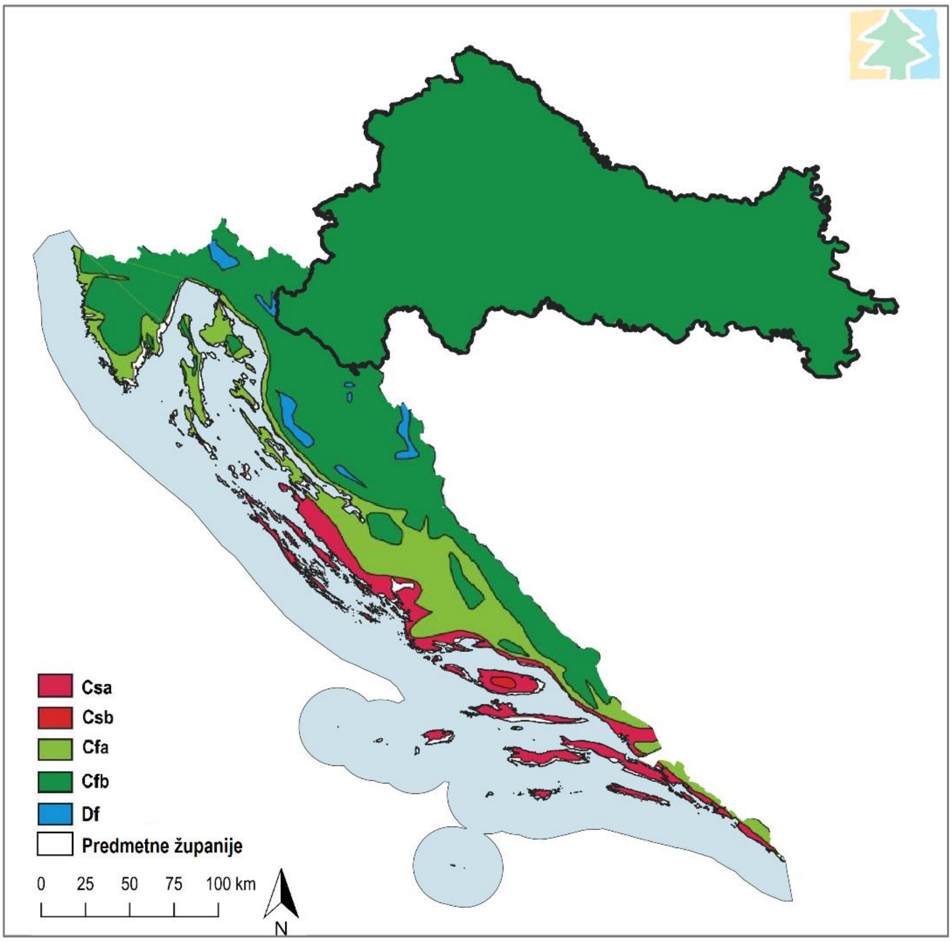
Vukovar-Srijemska	63.90	293.31	200.15	247 889.15	/	89.78	364.53
Međimurska	/	9,18	3,13	22 386.34	/	2.49	/
City of Zagreb	38,37	862.79	137.72	1 100 663.40	/	12.01	127.82
In total	**3294.77**	**9454.73**	**10,059.09**	**8 706 856.76**	**2480.18**	**1084.20**	**1264.41**

/ - the release of polluting substances was not reported or they were below the threshold for reporting data to the ROO
* inorganic substances – HCL, HF, H2S, N2O; organic substances – CH4, NMHOS; metals – As, Cd, Tl, V, Hg, Ni

3.3.4 Climate

According to the Köppen climate classification (Picture3.23) defined according to the average annual trend of air temperature and amount of precipitation, the area of the counties in question belongs to the climate type Cfb, i.e. a moderately warm humid climate with hot summer. The basic characteristics of this climate type are the mean monthly temperature of the coldest month higher than -3 °C and lower than 18 °C. The hottest month of the year has a mean temperature lower than 22 °C, and more than four months of the year have a mean monthly temperature higher than 10 °C.

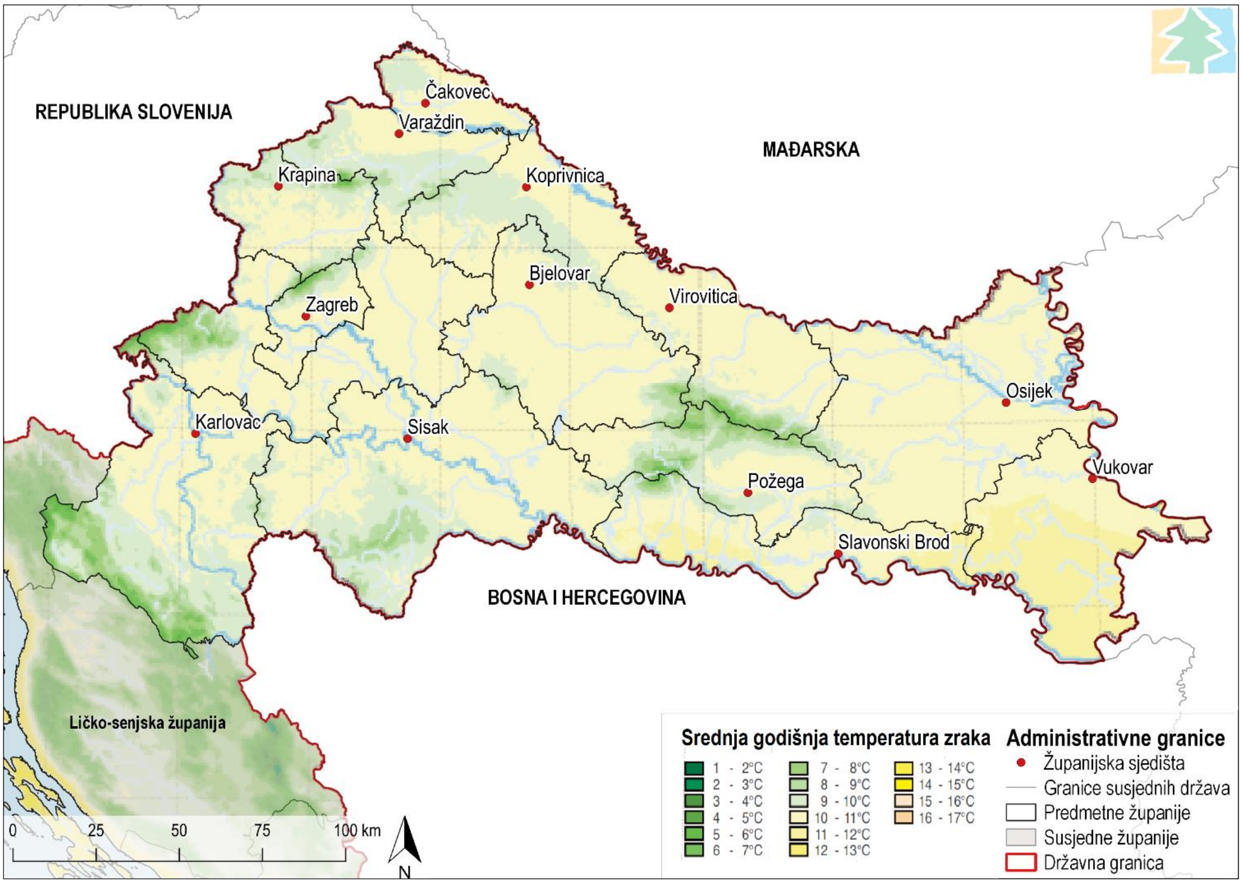
Due to its location, continental Croatia is in the circulation belt of moderate latitudes all year round, where the state of the atmosphere is very variable, and it is characterized by a variety of weather situations with frequent and intense changes throughout the year. These changes are caused by traveling systems of high or low pressure, often similar to vortices with a diameter of hundreds and thousands of kilometers. The climate of the continental part of Croatia is modified by the maritime influence from the Mediterranean, which is more pronounced in the area south of the Sava than in the north and becomes weaker towards the east. A significant climate modifier is the orography, which can intensify short-term heavy precipitation on the windward side or create rain shadows in the leeward side.



Picture3.23Geographical distribution of climate types according to W. Köppen in Croatia in the standard period from 1961 to 1990 (Source: IRES Ekologija doo according to Šegota and Filipčić, 2003)

3.3.4.1 Climatic features

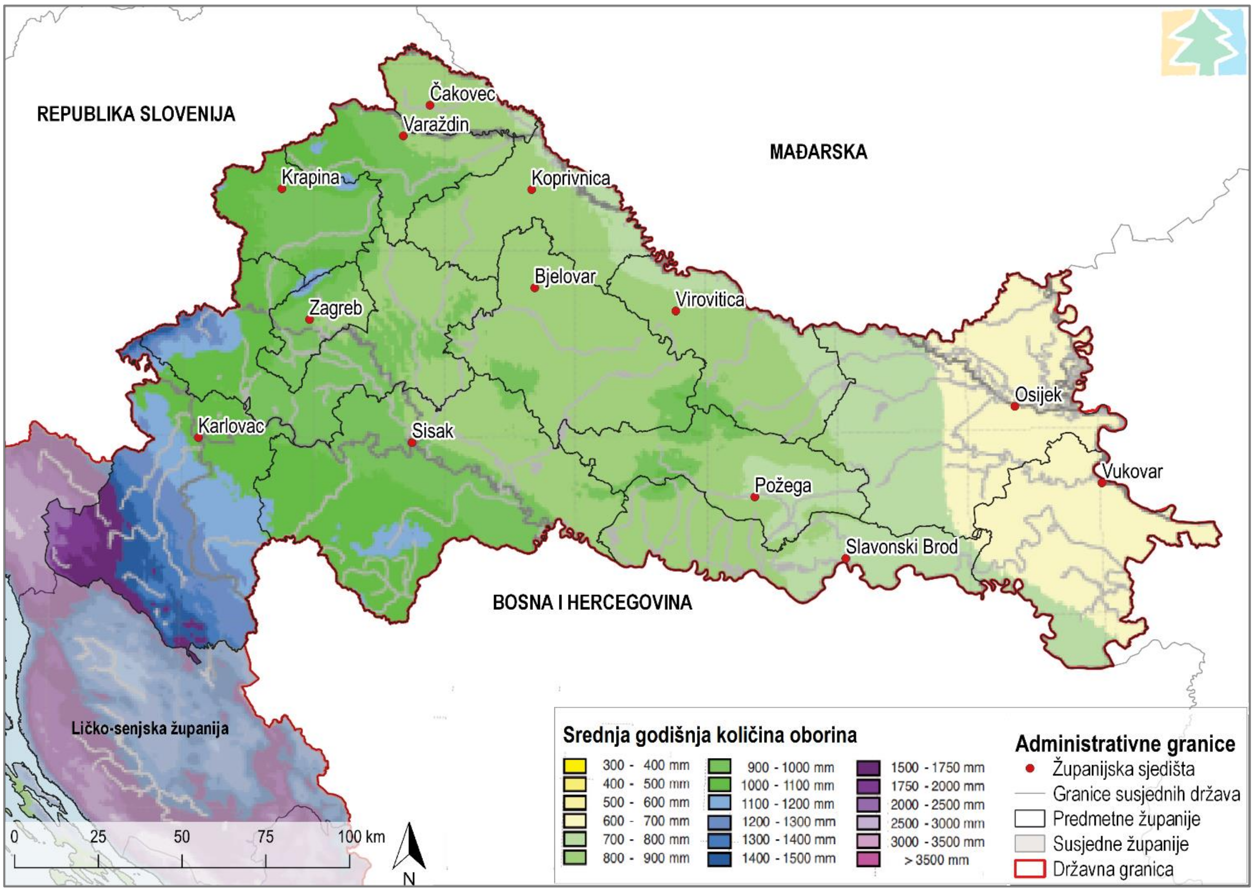
The plain part of continental Croatia has slight differences in the average annual air temperature with the prevailing air temperature up to about 11 °C (Picture3.24). Higher mean annual air temperatures are observed only in the easternmost regions as a result of very hot summers and in the Zagreb area due to the influence of the city's heat island. Lower mean air temperatures (8 °C - 11 °C) occur at higher altitudes in the highlands of western Slavonia and northwestern Croatia. The lowest average annual air temperatures of 6 °C occur at the top parts of Žumberačka gora and the transition to Gorska Hrvatska. South of the Sava, average annual air temperatures range between 7 °C and 11 °C, with the lowest values at the peaks of Zrinska and Petrova gora.



Picture3.24Mean annual air temperature in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from the Climatic Atlas of Croatia and Geoportal DGU)

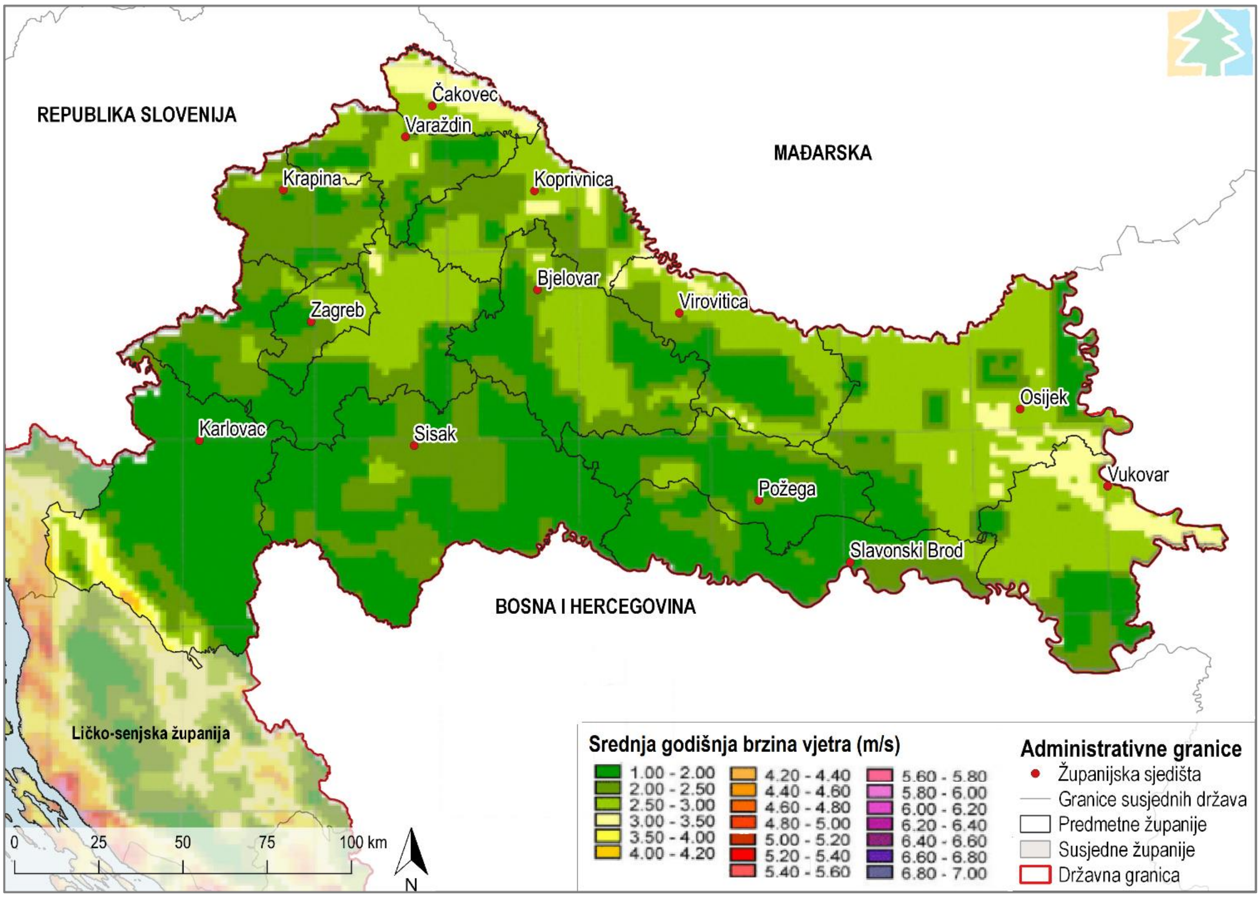
In the continental part of Croatia, the average annual precipitation decreases from west to east (Picture3.25). The reason for this is the air masses, because those coming from the southwest and west gradually lose moisture, and those coming from the northeast (from the interior of the continent) are dry, so there are no abundant precipitations. For this reason, on average, 600 mm to 700 mm of precipitation falls in the far east of Croatia, while somewhat larger amounts of precipitation can only be expected in a narrow part on the slopes of Fruška Gora and in the area along the Sava (700 to 800 mm). In northwestern Croatia, the highest mean annual precipitation is in the area of Medvednica, Kalnik and the Žumberački and Samoborski mountains, where about 1,200 mm of precipitation falls annually on the peak parts. The increase in precipitation occurs in the area of Karlovac County, that is, at the transition to mountainous Croatia, where the average annual precipitation ranges from 1100 mm to 1500 mm.

As a rule, the annual course of precipitation is continental, that is, the minimum precipitation occurs in the cold part of the year. In the Ogulin and Karlovac areas, the main maximum occurs in November, and the main minimum occurs in late winter (January or February). Moving away to the east, two equal maxima appear in November and June, and the main minimum at the end of winter. Deeper in the continent, the maritime influence is weaker and weaker, so in the northwestern land area the summer maximum becomes the main one, and the one in November becomes secondary. The main minimum occurs at the end of winter, and the secondary minimum occurs in October. The region of Slavonia has a similar annual trend, with the fact that the differences between the minimum at the end of winter and the one in October decrease as we move eastward.



Picture3.25Average annual precipitation in the area of the counties in question (Source: IRES EKOLOGIJA doo according to the data of the Climatic Atlas of Croatia and the Geoportal of the DGU)

In the continental part of Croatia, weak to moderate winds prevail, the direction of which is variable, and the average annual wind speed is between 1.00 and 3.50 m/s (Picture3.26). Therefore, the prevailing wind direction in the interior of Croatia depends significantly on the openness and shape of the surrounding terrain. Strong wind is very rare, and is associated with the penetration of cold air from the polar or Siberian regions in the cold part of the year or occurs during summer storms.



Picture3.26Mean annual wind speed (m/s) at a height of 10 m above the ground in the area of the counties in question (Source: IRES EKOLOGIJA doo according to the data of the Climate Atlas of Croatia and Geoportal DGU)

3.3.4.2 Climate changes

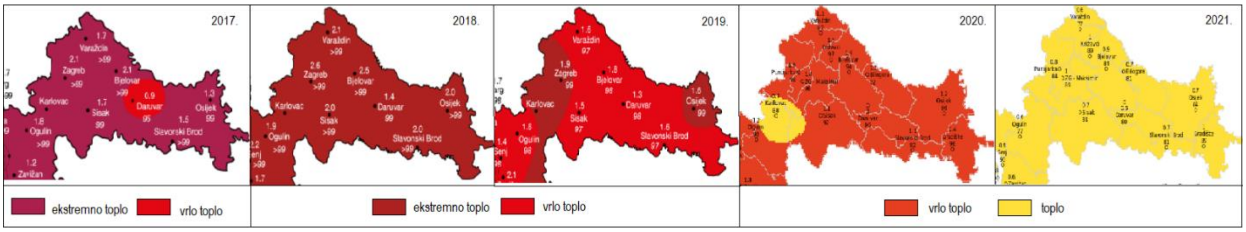
In April 2020, the Republic of Croatia adopted the Climate Change Adaptation Strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 (Official Gazette 46/20) (hereinafter: Adaptation Strategy of the Republic of Croatia), according to which there is increasing evidence that the Republic of Croatia is under the influence of climate change, and given that it is largely part of the Mediterranean region, it will grow and the vulnerability to climate change is assessed as high. According to the report of the European Environment Agency (EEA), the Republic of Croatia belongs to the group of three European countries with the highest cumulative share of damages from extreme weather and climate events in relation to the gross national product (GNP). The degree of vulnerability of Croatia can already be assessed by the fact that the share of agriculture and tourism alone in the total GDP in 2018 was one quarter of the total GDP. Consequently, the exceptional vulnerability of the economy to the effects of climate change can have a negative impact on overall social development, especially on vulnerable groups of society. That is why societies that do not start implementing measures to adapt to the reality of climate change in time may face catastrophic consequences for the environment and the economy, thereby jeopardizing its sustainable development.

For the purposes of the Adaptation Strategy of the Republic of Croatia, adaptation to climate change is defined as a process that "includes the assessment of the harmful effects of climate change and taking appropriate measures with the aim of preventing or reducing the potential damage they may cause".

Mitigation of climate change refers to procedures for reducing greenhouse gas emissions, which contribute to climate change. It includes, for example, the implementation of measures to reduce greenhouse gas emissions, but also to increase carbon storage.

In addition to the above, the increasingly significant impact of climate change is highlighted in the document Disaster risk assessment for the Republic of Croatia, where the impact of climate change on risk is taken into account when processing each of the scenarios, not only in order to emphasize changes in the environment resulting from climate change and for which concrete values were determined when calculating the risk, but especially in order to emphasize the importance and connection of climate change and the risk of disasters and in this sense to define adaptations to climate change through concrete public policies to reduce the risk of disasters.

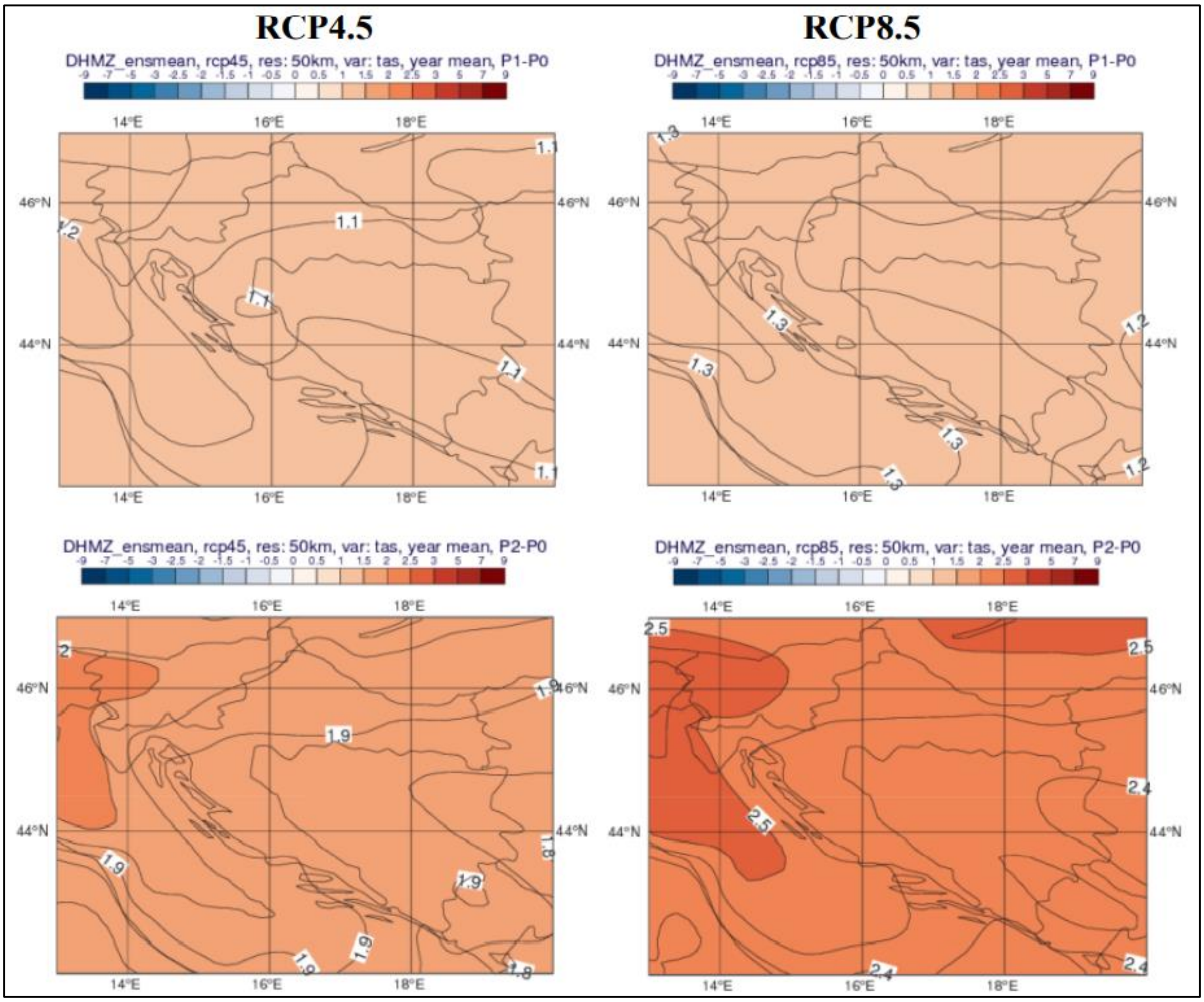
Data on the increase in mean air temperature, as one of the most important climate indicators, were taken from the official website of DHMZ. The following images show the mean annual air temperature (Picture3.27) on the subject counties in the period 2017-2021. compared to the multi-year average. For the period 2017-2018. in relation to the period 1961-1990, and for the period 2019-2021. compared to the period 1990-2010. From what is shown, it is evident that according to the distribution of percentiles, the thermal conditions in the specified period in the observed area are described by the dominant category extremely warm, very warm and warm, and a look at the website of DHMZ shows that the same has been present since 2011, from when DHMZ monitors the climate in this way.



Picture3.27Deviation of the mean air temperature in the period 2017-2021 in the area of the Subject Counties (Source: DHMZ)

As part of the project "Strengthening the capacity of the Ministry of Environmental Protection and Energy for adaptation to climate change and preparation of the Draft Strategy for Adaptation to Climate Change", climate simulations and projections of the future climate for the territory of the Republic of Croatia were made. The regional atmospheric climate model RegCM (English Regional Climate Model) was used for climate simulations. Defining and selecting greenhouse gas concentration scenarios is very important for creating simulations. Scenarios of greenhouse gas concentrations RCP (eng. Representative Concentration Pathways) are trajectories of greenhouse gas concentrations (not emissions) that describe four possible future climates, depending on how many greenhouse gases will be in the atmosphere in the coming years (Moss et al., 2010) . The four scenarios, RCP2.6, RCP4.5, RCP6 and RCP8.5, give the range of values of possible radiation forcing (in W/m²) in 2100 compared to pre-industrial values (+2.6, +4.5, +6.0 and +8.5 W/m²). RCP2.6 presents relatively small future concentrations of greenhouse gases at the end of the 21st century, while RCP8.5 gives significantly higher concentrations. The results of the aforementioned modeling are presented in the document Results of climate modeling on the HPC Velebit system for the purposes of drafting the Climate Change Adaptation Strategy of the Republic of Croatia until 2040 with a view to 2070 and the Action Plan (Subactivity 2.2.1) (hereinafter: Results of climate modeling) .

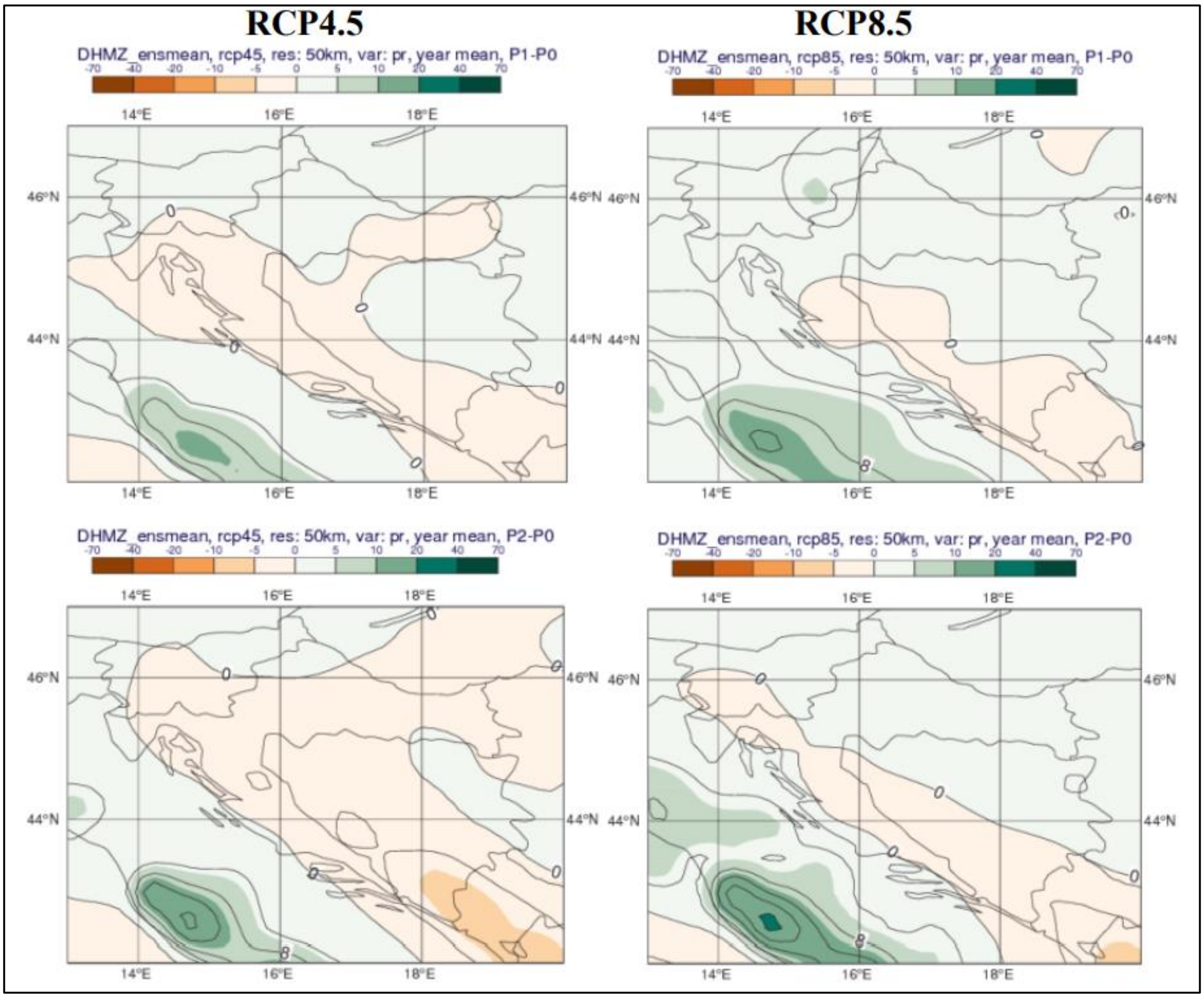
Along with simulations of the current ("historical") climate covering the period 1971-2000. (P0, reference period), the expected changes (projections) for the future climate in two periods, 2011-2040, are presented. (P1, immediate future) and 2041-2070. (P2, mid-21st century climate) assuming IPCC scenarios RCP4.5 and RCP8.5. Climate changes are defined as differences in the values of climate variables between the period 2011-2040. and 1971-2000. (P1 -P0), and the period 2041-2070. and 1971-2000. (P2 - P0).



Picture3.28Change in mean annual air temperature (°C) in relation to the reference period 1971-2000 in the mean of the ensemble from four integrations by the RegCM model. Above: for the period 2011-2040; below: for the period 2041-2070. Left: RCP4.5 scenario; right: scenario RCP8.5 (Source: Climate modeling results)

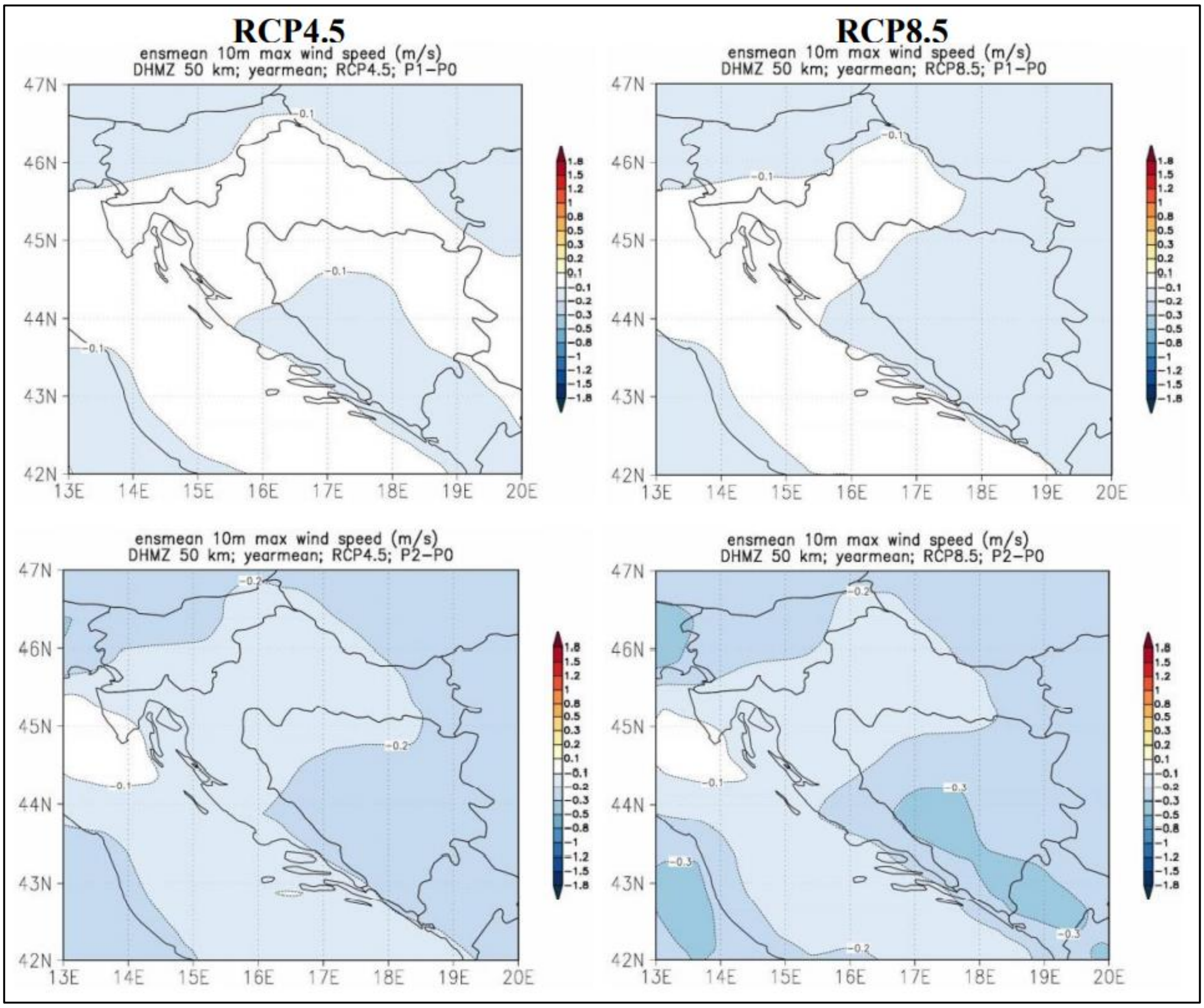
Compared to the reference period, the expected annual increase for the mean maximum temperature until 2040 is about 1.1°C for the RCP4.5 scenario (Picture3.28, top left), and 1.3°C for RCP8.5 (Picture3.28, up right). In the period 2041-2070. the projected increase is for RCP4.5 from 1.9 to 2.0°C (Picture3.28, bottom left), and for RCP8.5 from 2.4 to 2.5°C (Picture3.28, bottom right). It is important to note that the greatest increase in the maximum temperature is in summer, when the reference climate is the warmest, and the greatest increase in the minimum temperature is in the winter, when the reference climate is the coldest.

Measurement data at the main meteorological stations of DHMZ in the last 30 years confirm these predictions, showing a very pronounced trend of increasing both the mean and maximum air temperature throughout the year and in summer, as well as a significant trend of increasing the minimum air temperature in the winter period. The measurement data also show trends of increasing the number of warm and hot days in summer and the number of days with warm nights. At the same time, the number of cold and winter days is decreasing.



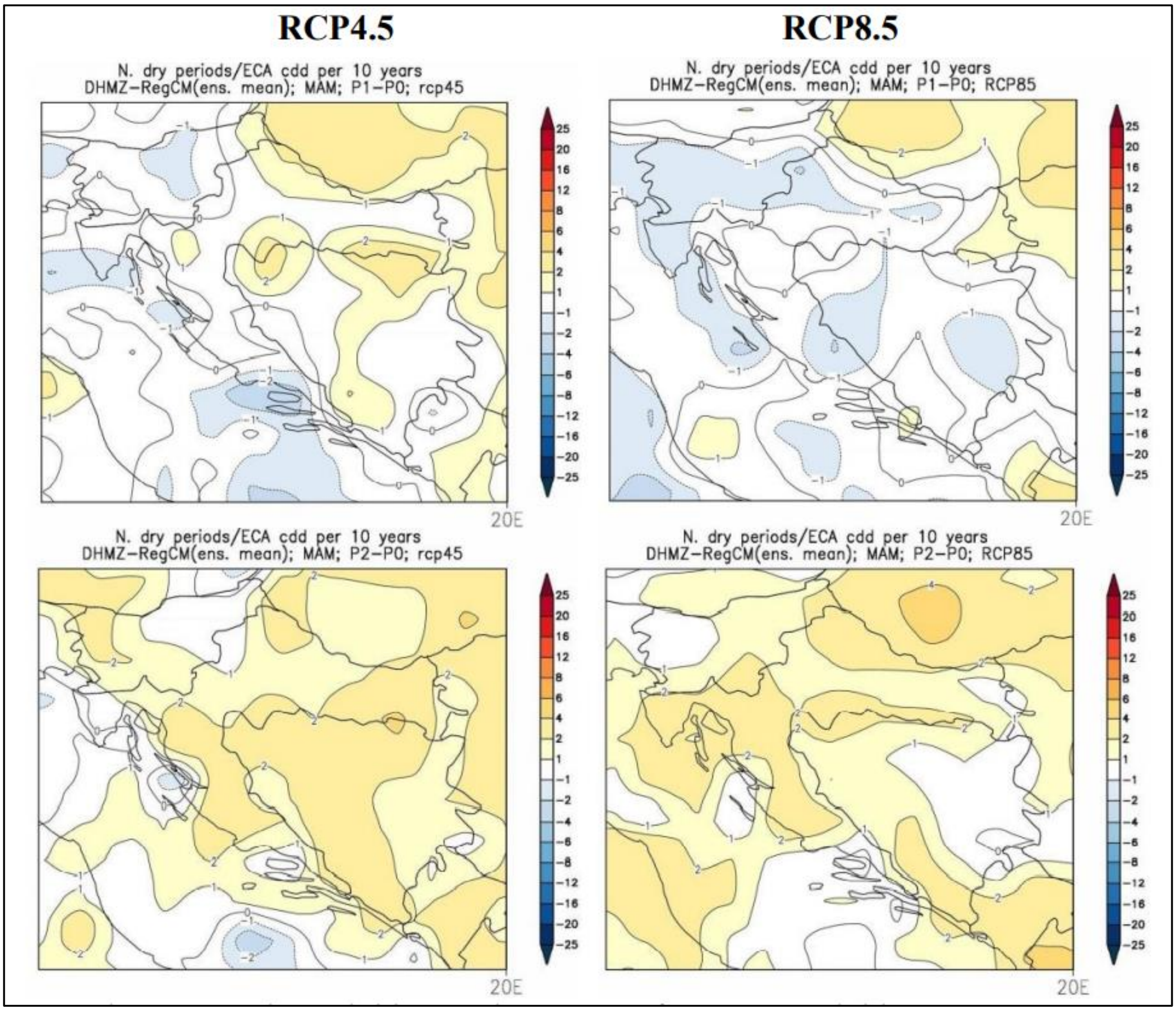
Picture3.29Change in the mean annual total amount of precipitation (%) compared to the reference period 1971-2000. in the mean of the ensemble from four integrations with the RegCM model. Above: for the period 2011-2040; below: for the period 2041-2070. Left: RCP4.5 scenario; right: scenario RCP8.5 (Source: Climate modeling results)

By 2040, under the RCP4.5 scenario, a very small decrease in the total amount of precipitation (less than 5%) is expected in most of the country, which will not have a significant impact on the total annual amount (Picture3.29, top left). With RCP8.5, the decrease in precipitation would be limited to central and southern Dalmatia, while a slight increase in precipitation is expected in the rest of Croatia, also up to a maximum of 5% (Picture3.29, up right). In the period 2041-2070. it is expected for RCP4.5 a decrease in the total amount of precipitation almost in the entire country also up to about 5% (Picture3.29, bottom left). For RCP8.5, the decrease in precipitation was limited only to the greater part of mountainous Croatia and the coastal hinterland, and in other regions a smaller increase in the total amount of precipitation is expected (less than 5%) (Picture3.29, bottom right). Thus, in the annual mean, the expected changes in the total amount of precipitation do not exceed ±5% in relation to the reference climate, but the spatial distribution of these changes depends on the scenario and the observed future climate period.



Picture3.30Change in mean annual maximum wind speed of 10 m (m/s) compared to the reference period 1971-2000. in the mean of the ensemble from four integrations with the RegCM model. Above: for the period 2011-2040; below: for the period 2041-2070. Left: RCP4.5 scenario; right: scenario RCP8.5 (Source: Climate modeling results)

The projected change in the mean annual maximum wind speed at 10 m indicates a decrease in wind speed (Picture3.30). This reduction is in the period 2011-2040. relatively little for both observed scenarios. In the period 2041-2070. a somewhat stronger decrease in maximum wind speed is expected, somewhat more pronounced in central and southern Dalmatia.



Picture3.31Change in the number of dry periods compared to the reference period 1971-2000. in the mean of the ensemble from four integrations with the RegCM model. Above: for the period 2011-2040; below: for the period 2041-2070. Left: RCP4.5 scenario; right: scenario RCP8.5 (Source: Climate modeling results)

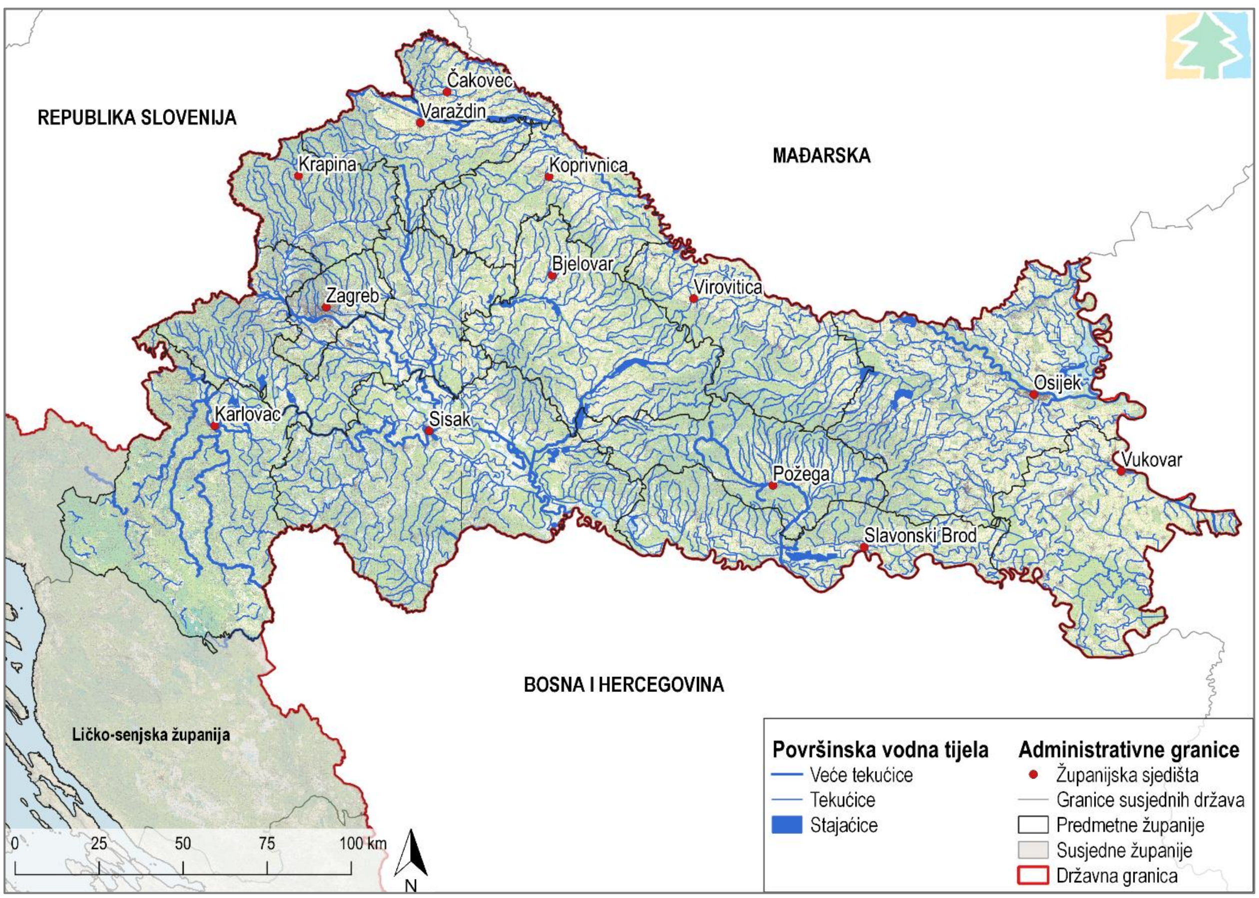
Until 2040, no significant change in the number of dry periods is expected for the RCP4.5 scenario (Picture3.31, top left) while according to the RCP8.5 scenario, the number of dry periods could decrease by 1-2 in the part of central Croatia and the Adriatic (Picture3.31, up right). In the period 2041-2070. an increase in the number of dry periods by 1-4 is expected for RCP4.5 (Picture3.31, bottom left). For RCP8.5, the number of dry spells 1-4 is expected to increase across the country (Picture3.31, bottom right).

3.3.5 Water

The state of water is analyzed at the level of water bodies. Water bodies are the basic units for analyzing the characteristics and management of water quality. In order to fulfill their purpose, water bodies must be determined in such a way as to enable an appropriate, sufficiently unambiguous description of the ecological and chemical state of surface waters, or the quantitative and chemical state of underground waters. The state of water bodies is described separately for surface water bodies, and separately for underground water bodies, considering the different methodology of assessing the state of these waters.

3.3.5.1 Surface waters

The territory of the Republic of Croatia hydrographically belongs to the basin of the Adriatic and Black seas and according to the Water Act (Official Gazette 66/19, 84/21) it is divided into the water area of the Danube River and the Adriatic water area. The area of the counties in question belongs to the water area of the Danube River, i.e. the sub-basin of the Drava and Danube rivers and the water area of the Sava sub-basin, which is characterized by a large concentration of surface water and a branched network of streams. According to data from Croatian Waters, there are 1,071 bodies of surface water in the area of the counties in question, of which 1,040 are flowing water bodies and 31 are stagnant water bodies (Picture3.32).

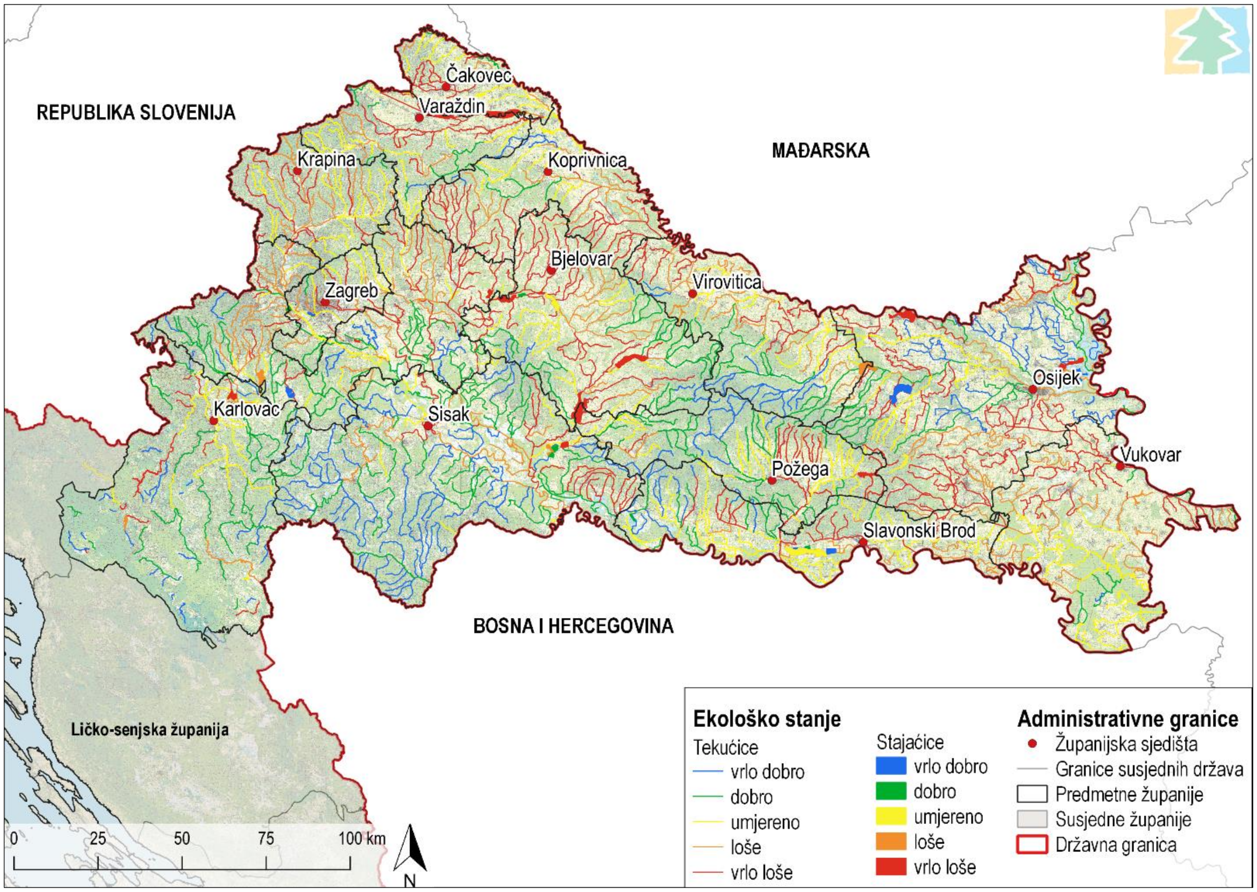


Picture3.32Display of water bodies of surface waters in the area of the concerned counties (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

In accordance with the Water Framework Directive (hereinafter: WFD), member states are obliged to establish monitoring programs for the state of water bodies in order to obtain a clear and comprehensive overview of the state of water in each water area. The analysis of the characteristics of surface waters includes streams with a catchment area of more than 10 km2 and stagnant waters with a water surface area of more than 0.5 km2. For other small water bodies, there is no typification or evaluation according to the provisions of the ODV, but, where necessary, they are evaluated according to the standards that apply to the larger water body with which they are in surface contact or, if there is no such contact, to the nearest or most appropriate larger water body.

The status of a surface water body is determined by its ecological status/potential and its chemical status, depending on which of the two ratings is worse.

The ecological condition of surface water bodies expresses the quality of the structure and functioning of aquatic ecosystems and is determined on the basis of individual evaluations of relevant biological and basic physico-chemical and chemical and hydromorphological elements of quality that support biological elements. Depending on the individual assessments of relevant quality elements, water bodies are classified into five classes of ecological status: very good, good, moderate, bad and very bad. The decree on the water quality standard (Official Gazette 73/13, 151/14, 78/15, 61/16, 80/18, 96/19) stipulates that biological elements of quality, whose values are decisive for classification into one of the classes. To be classified in a very good ecological condition, in addition to biological standards, all basic physico-chemical and chemical and hydromorphological standards prescribed for very good condition must be met. Belonging to a good ecological condition is decided on the basis of biological and basic physico-chemical and chemical elements of quality. The ecological state of surface water bodies in the area of the counties in question is shown in the following figure (Picture3.33).



Picture3.33Ecological condition of water bodies in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

All categories of the ecological state of water bodies are represented in the area of the counties in question (Table3.32,Table3.33). Out of a total of 1040 bodies of water, 382 of them were assessed as having a very good or good ecological condition, which represents 36.73% of bodies of water. The largest number of water bodies of liquid water was rated as in very poor condition due to an unsatisfactory rating of biological, physico-chemical or hydromorphological elements. As for stagnant water bodies, out of a total of 31 water bodies, 14 of them were rated as having a very good or good ecological condition, or 45.16%, while 41.94% of stagnant water bodies were rated as very bad.

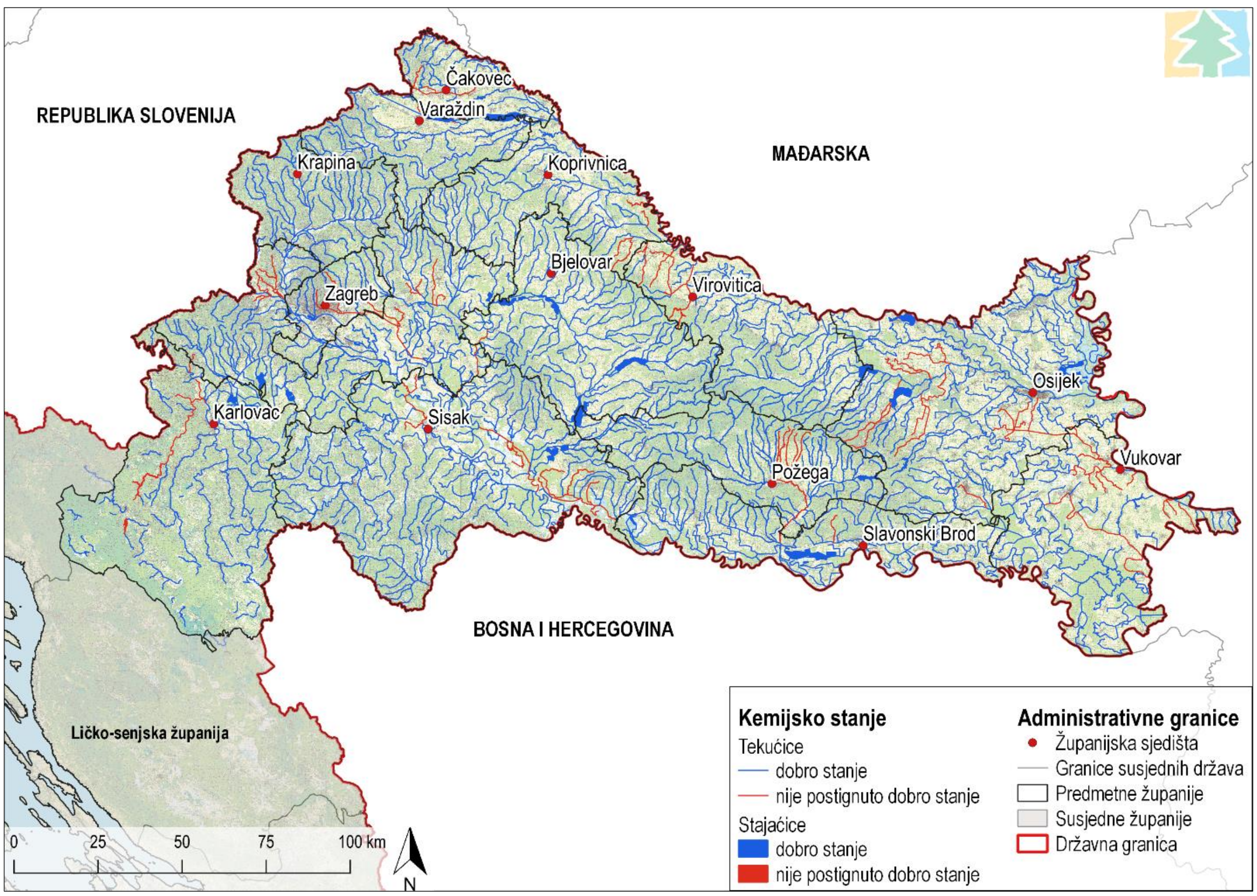
Table3.32Ecological condition of surface water bodies of liquid water (Source: Hrvatske vode)

Ecological condition	Number of water bodies	Share (%)
Very good	177	17.02
Good	205	19.71
Moderately	204	19,62
Bad	177	17.02
Very bad	277	26.63

Table3.33Ecological condition of surface water bodies of standing water (Source: Hrvatske vode)

Ecological condition	Number of water bodies	Share (%)
Very good	8	25.81
Good	6	7:35 p.m
Moderately	2	6.45
Bad	2	6.45
Very bad	13	41.94

The chemical state of the surface water body expresses the presence of priority substances in the surface water, sediment and biota. According to the concentration of individual priority substances, surface waters are classified into two classes of chemical status: good status and good status not achieved. A surface water body is in good chemical condition if the average and maximum annual concentration of each priority substance does not exceed the prescribed quality standards. The chemical state of water bodies in the area of the counties in question is shown below (Picture3.34).



Picture3.34Chemical state of water bodies in the area of the concerned counties (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

The chemical state of water bodies was rated much better than the ecological state, and 92.69% of surface water bodies met the conditions for the assessment of good chemical state, while all stagnant water bodies were rated as having good chemical state (Table3.34). In the case of water bodies that have not achieved a good condition, it is most often a matter of contamination by metals and their compounds (mercury, lead and nickel). From the group of pesticide active substances, endosulfan appears most often, and from the group of hydrocarbons, polycyclic aromatic hydrocarbons are present, most often fluoranthene.

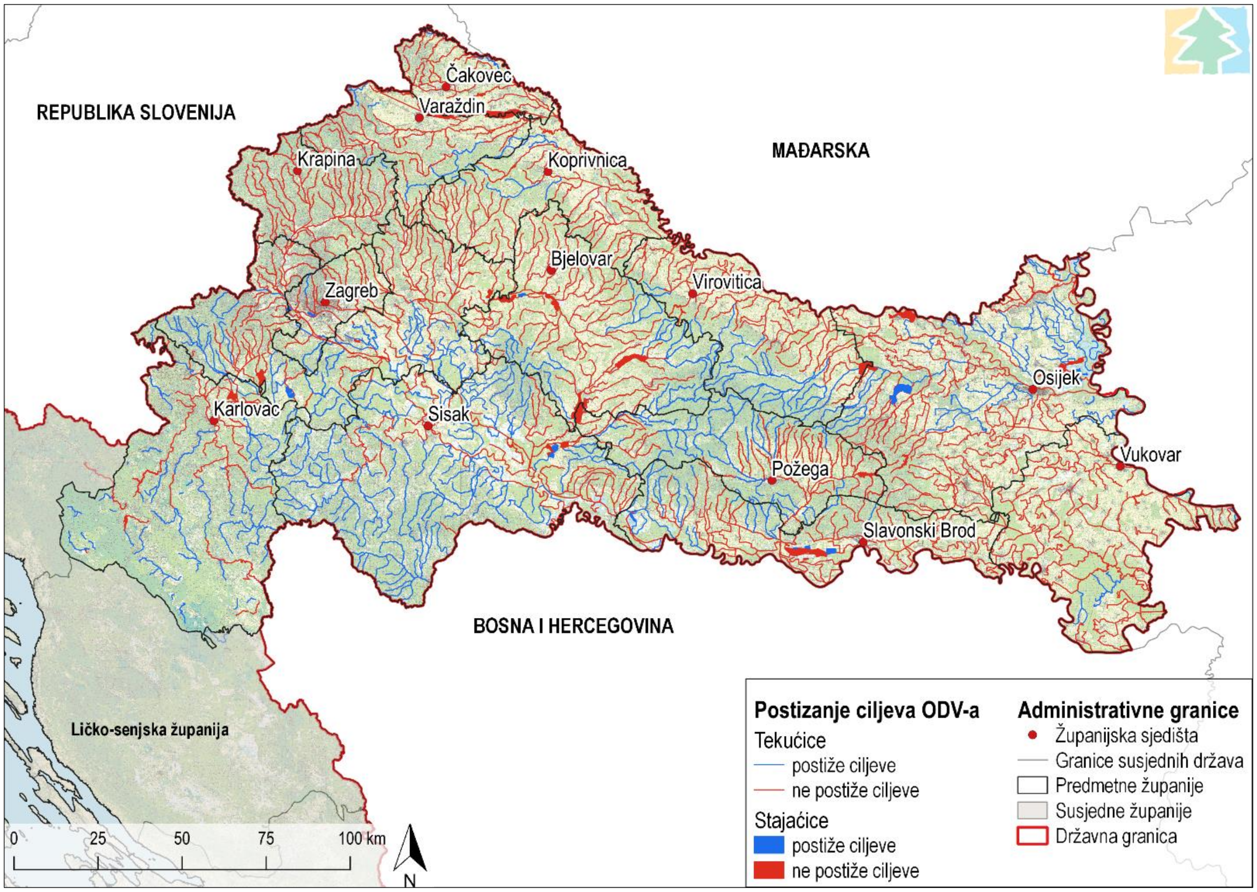
Table3.34Chemical state of surface water bodies of liquid water (Source: Hrvatske vode)

Chemical state	Number of water bodies	Share (%)
Good	964	92.69
Not good	76	7.31

With regard to the ecological and chemical condition of water bodies of surface waters, an overall assessment of the condition is also given, which is determined in such a way that the worse of the two assessments is taken. As with the ecological condition, the overall condition of the water body is classified into five categories of overall condition: very good, good, moderate, bad and very bad. In the case when the water body receives an assessment of its chemical condition - not good condition has been achieved, the overall condition of the water body is assessed in the lowest possible category, very poor. Taking into account the overall state of water bodies of surface waters, it is possible to determine which are in a satisfactory state, that is, which achieve the goals of water protection, and which are not in a satisfactory state, that is, do not achieve the goals of water protection. Pursuant to the Water Area Management Plan 2016-2021 (Official Gazette 66/16) and the Decree on Water Quality Standards, water protection objectives are achieved by surface water bodies that are in good or very good overall condition (that is, water bodies that are in very good or good ecological condition and good chemical condition). In the area of the counties in question, 63.94% of flowing water bodies and 54.84% of stagnant water bodies do not achieve the water protection goals prescribed by the ODV (Table3.35,Picture3.35).

Table3.35Water bodies of surface waters with regard to the achievement of ODV goals (Source: Hrvatske vode)

Achieving water protection goals	Liquids		Stands	
	Number of water bodies	Share (%)	Number of water bodies	Share (%)
Achieves goals	375	36.06	14	45,16
It doesn't achieve goals	665	63.94	17	54.84



Picture3.35Water bodies of surface waters with regard to the achievement of the goals of the Water Framework Directive
(Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

The largest number of water bodies do not achieve water protection goals due to poor evaluations of physicochemical indicators, in which the biological consumption of oxygen, total nitrogen and total phosphorus was considered. Human activities have an extremely significant impact on the state of water in terms of pollution by organic substances, expressed by the indicator BPK5, biological oxygen consumption in 5 days, which shows how much organic waste is in waste water. Also, the source of phosphorus in the water is waste water, so it can be concluded that the excessive concentration of BOD5 and total phosphorus is the result of the discharge of untreated waste water. Mineral fertilizers from agriculture are a significant source of phosphorus and nitrogen in water bodies. Pollution of surface and underground water with these substances occurs due to excessive and unprofessional use of nitrogen and phosphorus fertilizers. When these fertilizers are used, they end up on agricultural land, and by seeping through the soil, they can end up in groundwater. If they get into the underground water that is used for drinking, they can affect its quality, which directly endangers people's health. Although the presence of these substances in normal concentrations in waters has no direct impact on organisms, their increased concentrations can lead to the occurrence of eutrophication processes that can have a significant negative impact on aquatic organisms.

Among the hydromorphological indicators, the most common cause of a low rating is the changed hydrological regime and morphological conditions of water bodies, and the unsatisfactory hydromorphological condition of water bodies is mostly a consequence of using the hydrological potential of the river for the purpose of electricity production or changing the hydromorphological elements of watercourses for the purpose of flood defense.

The primary cause of the poor assessment of biological quality elements was the indicator for macrozoobenthos and, to a lesser extent, the indicator for macrophytes. However, it should be noted that the assessment of biological elements was given for only about 15% of water bodies of surface waters due to poor coverage of biological monitoring in the whole of Croatia. The causes of unsatisfactory assessments of the biological condition are difficult to determine at this level of assessment, since they can be diverse and complex, but this assessment often depends on the assessment of other categories of the state of water bodies.

3.3.5.2 Hydrogeological features

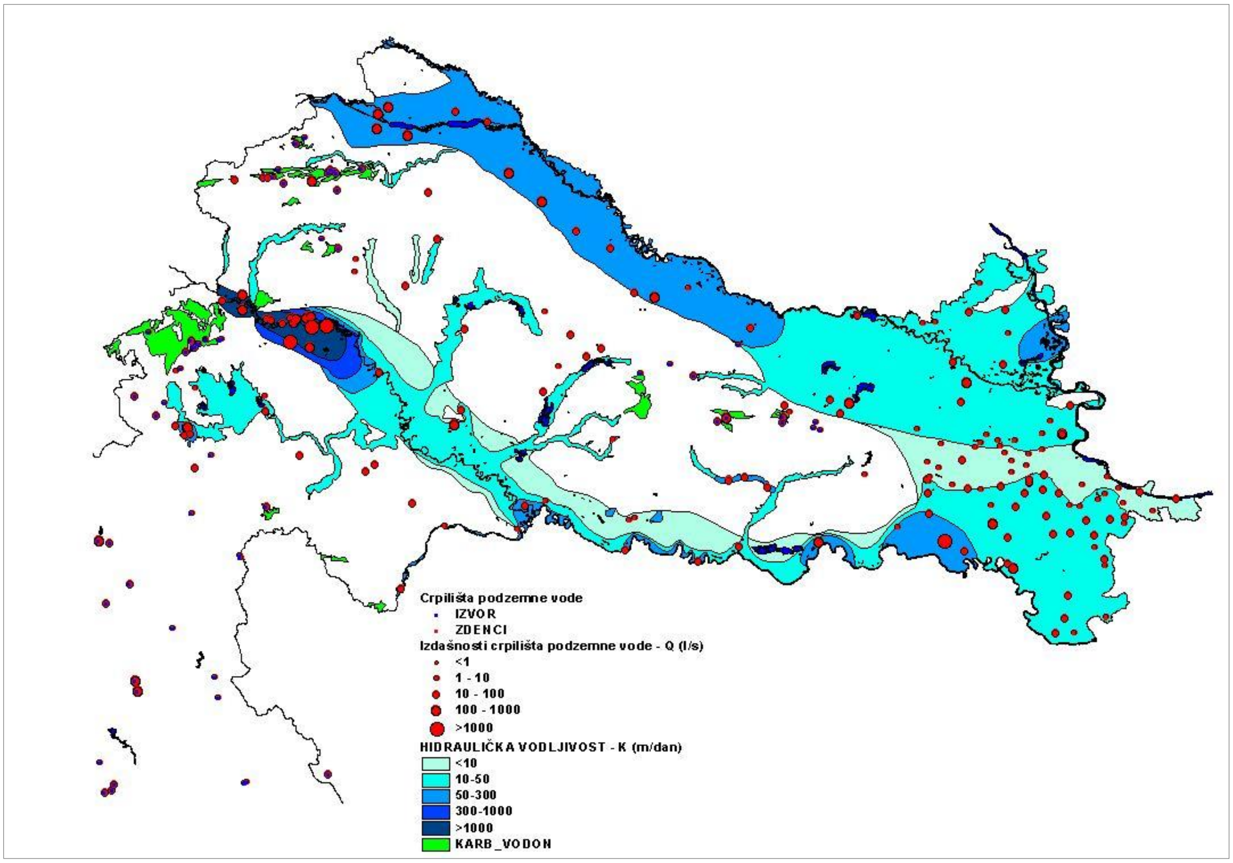
The amount and distribution of groundwater in Croatia is conditioned by the geological structure, climatic and hydrological conditions and hydrogeological features of certain areas. According to the geological structure and hydrogeological features, the entire territory of the Republic of Croatia can be divided into two completely different parts. These are, on the one hand, the area of northern and eastern Croatia, which is mostly built of clastic sedimentary rocks of different granulometric composition and different degree of consolidation, and on the other hand, western and southern Croatia, where the terrain structure is dominated by carbonate solid rocks of different degrees damages and collisions.

Primarily due to geological structure, but also large differences in relief and climatic features, these two parts of Croatia differ significantly in terms of the way groundwater accumulates, their dynamics, the possibility of capturing and being threatened by anthropogenic influences. Because of this, the possibilities of using groundwater and the possible impacts on the quality of groundwater in those two areas are significantly different.

The counties in question are located almost entirely in the territory of northern and eastern Croatia, which includes the Drava valley, the Sava valley and the valleys of their tributaries, as well as the hilly and hilly area between them. A gradual increase in water temperature and salinity with depth is characteristic of the entire area of northern Croatia. Considering these two indicators, the area is divided into two hydrogeological zones in a vertical section. The first hydrogeological zone consists of sediments up to an approximate depth of 200 m, and the quality of underground water in its natural state (directly or with clastic processing methods) corresponds to the norms prescribed for drinking water. The second hydrogeological zone consists of deposits saturated with groundwater, which has higher mineralization and a higher temperature than the so-called drinking water. With regard to the use of water for water supply, only the first hydrogeological zone is interesting,

The first hydrogeological zone

The most important parts of the first hydrogeological zone extend through the Drava valley, the Sava valley and its left tributaries, and the area of eastern Croatia (Picture3.36).



Picture3.36Aquifers of the first hydrogeological zone and more important water intakes for public water supply in the area of the counties in question (Source: Water area management plan 2016-2021)

Going from west to east, in the valley of the Drava and its tributaries, the following can be distinguished as special hydrogeological units: the plain part of Međimurje, upstream Podravina, central Podravina, downstream Podravina, Baranja and the plateau of eastern Slavonia and Srijem.

<u>Plain part of Međimurje</u>it is located between the Drava and Mura, east and south of the road Mursko Središće - Čakovec - Središće ob Drava. The surface part of the terrain is made up of fine-grained sediments that represent the fine-grained cover of the aquifer (sands, dusty sands, dust, clays). The thickness of the roof is between 0.5 m and 4.5 m. It is followed by an aquifer layer saturated with underground water. It is built of gravel and sand with interlayers of fine-grained materials. The thickness of the aquifer varies and varies between 140 m (near Prelog) and below 20 m in the west, north and east. The intensive hydraulic connection of the aquifer with the Mura and Drava rivers, which represent the main source of the aquifer's supply, is evident. The construction of hydropower facilities on the Drava River has changed the natural regime of underground water, so the reservoir lakes cause constant percolation of water into the aquifer,

<u>The area of upstream Podravina</u>occupies the space between the Drava River in the north and the slopes of Ivanščica and Kalnik in the south. The western border is the state border with Slovenia, and the eastern road is Koprivnica - Legrad. The structure of the terrain is dominated by an aquifer layer consisting of well-granulated gravel with varying amounts of sand. In the peripheral parts and east of Ludbreg, the number and amount of lenses of sand and dusty clay increases. The thickness of the deposit increases from the west (5-10 m) to the east and near Hrženica (south of Prelog) it reaches 150 m. Further towards Legrad, it sharply decreases to 15 m, and between Legrad and Koprivnica it is about 70 m. dusty-sandy and clayey deposits with a thickness between 0 and 4 m. A thickness greater than 4 m is registered only locally on the edges of the valley. The Drava has cut a bed in its own alluvium and is in direct hydraulic connection with underground water, and is the main source of water supply for the aquifer. Today, the natural relationship between the river and the underground water has been significantly changed due to the regulation of its

flow and the construction of hydropower facilities. The old bed has ceased to be an area of intensive water supply, and its drainage effect is mainly felt, along with the lowering of the underground water level. The main and permanent supply areas have become storage lakes, from which water seeps into the underground. Going east, there is a slight increase in the iron concentration in the water. The old bed has ceased to be an area of intensive water supply, and its drainage effect is mainly felt, along with the lowering of the underground water level. The main and permanent supply areas have become storage lakes, from which water seeps into the underground. Going east, there is a slight increase in the iron concentration in the water. The old bed has ceased to be an area of intensive water supply, and its drainage effect is mainly felt, along with the lowering of the underground water level. The main and permanent supply areas have become storage lakes, from which water seeps into the underground. Going east, there is a slight increase in the iron concentration in the water.

Central Podravinaextends from the line Koprivnica - Legrad to the line Podravska Slatina - Sopje. The northern border is formed by the state border with the Republic of Hungary, and the southern by the northern slopes of Bilogora and Papuk. There are several aquifers in that area. The most important is the first Quaternary aquifer, whose thickness in the southern part is up to 30 m, but in some parts it reaches up to 70 m. Hydraulic conductivity coefficients have values up to 300 m/day. The roof of the aquifer consists of dust, sand and clay, with the characteristic occurrence of quicksands, and mostly swampy flags in the southern and eastern parts of the area. To the west of Virovitica, the thickness of the roof is less than 10 m, but near Virovitica the roof suddenly thickens and further east regularly reaches more than 20 m. There is no unique hydrogeological regime in the water area. The influence of the Drava on the water level and the direction of the groundwater flow is clearly visible from Legrad to Pitomača, where in the zone 2-3 km from the Drava the groundwater levels change during the year depending on the water levels of the Drava. The underground water in this aquifer is renewed by the infiltration of rainwater through the poorly permeable cover and percolation from the Drava riverbed in the upstream part of the area.

Downstream Podravinaoccupies part of the Drava Plain from Podravska Slatina to the Danube. The southern border consists of the slopes of Papuk and Krndije, that is, further to the east, the positive structure of Eastern Slavonia and Srijem. The area is characterized by tectonic depressions, in which the thickness of the deposits of the first hydrogeological zone is almost regularly greater than 150 m, and in some places it reaches up to 300 m. The deepest recesses are near Crnec and near Madarinec. The lithological composition of the deposits of the Quaternary aquifer complex is dominated by layers of sand and, less often, gravel, which are separated from each other by thinner layers of dust and clay. The thickness of the permeable layers is greatest in the most labile parts of the area. An increased proportion of clayey-dusty layers is found in the marginal zones and on the rise south of Osijek. There are many permeable layers of different thickness and extent. The deposits of the first hydrogeological zone can be represented schematically by a series of permeable and semi-permeable layers of different thicknesses, which lie on the impervious floor of the marked relief. Groundwater communication is possible between all adjacent aquifers by "flowing" through semi-permeable clayey-dusty layers. The connection with the waters on the surface takes place via the shallowest striking aquifer and its dusty-sandy cover, the thickness of which can reach more than 30 m.

Baranja areaoccupies an area bounded by the Drava River in the south and southwest, the Danube in the east and the state border with Hungary in the north and northwest. There are two types of aquifer deposits in Baranja. Thus, in the area of Baranjska greda, significant aquifer deposits are lithotamnian limestones - rocks with fissure porosity. Given the limited possibility of power supply, underground water reserves in them have no greater significance except for local water supply. Replenishment of underground water supplies in lithotamnian limestones takes place by percolation of precipitation through the flagstone cover in the area of Baranjska greda. In the inundation area, the alluvial plain and the river accumulation terrace, a unique first aquifer layer built of clastic sediments was formed. Its characteristics change depending on the granulometric composition of the deposits. The average thickness of the aquifer in the area of the accumulation terrace ranges from 10-20 m, in the area of the alluvial plain 30-40 m, and in the inundation area 40-60 m. The aquifer protrudes along the edge of the Baranjska greda and the lake terrace. In the bottom of the first aquifer there are clays, dust and sand, which alternate vertically and laterally. In some places, the sand forms deeper layers with water under pressure, of very uneven thickness and extent. The first water-bearing layer of the plain part of the area is fed by precipitation infiltration through the poorly permeable surface cover, and in the vicinity of the Drava and Danube by percolation from the riverbeds. In deeper layers with water under pressure, the renewal of underground water supplies is extremely weak. The aquifer protrudes along the edge of Baranjska greda and the lake terrace. In the bottom of the first aquifer there are clays, dust and sand, which alternate vertically and laterally. In some places, the sand forms deeper layers with water under pressure, of very uneven thickness and distribution. The first water-bearing layer of the plain part of the area is fed by precipitation infiltration through the poorly permeable surface cover, and in the vicinity of the Drava and Danube by percolation from the riverbeds. In deeper layers with water under pressure, the renewal of underground water supplies is extremely weak. The aquifer protrudes along the edge of Baranjska greda and the lake terrace. In the bottom of the first aquifer there are clays, dust and sand, which alternate vertically and laterally. In some places, the sand forms deeper layers with water under pressure, of very uneven thickness and extent. The first water-bearing layer of the plain part of the area is fed by precipitation infiltration through the poorly permeable surface cover, and in the vicinity of the Drava and Danube by percolation from the riverbeds. In deeper layers with water under pressure, the renewal of underground water supplies is extremely weak. The first water-bearing layer of the plain part of the area is fed by precipitation infiltration through the poorly permeable surface cover, and in the vicinity of the Drava and Danube by percolation from the riverbeds. In deeper layers with water under pressure, the renewal of underground water supplies is extremely weak. The first water-bearing layer of the plain part of the area is fed by precipitation infiltration through the poorly permeable surface cover, and in the vicinity of the Drava and Danube by percolation from the riverbeds. In deeper layers with water under pressure, the renewal of underground water supplies is extremely weak.

Plateau of eastern Slavonia and Srijemextends over the so-called positive structures of eastern Slavonia and Srijem, which means the northernmost part of the Đakovo-Vinkovac flag plain and the Vukovar and Dalj flag plains. In the south, the area is limited by the watershed with the Sava basin. The entire area is characterized by a flagellated surface covering up to twenty meters thick. Next comes the first aquifer layer built from medium-grained to fine-grained sand (mainly in the area of the Đakovo and Vukovar flag plains), and its thickness does not exceed 10 m. Continuity of lateral extension has not been proven. This is followed by an exchange of poorly permeable to impermeable dusty and clayey deposits with layers of fine-grained dusty sand of modest permeability. In some places, several such aquifers (5-6) containing water under pressure have been recorded.

In the Sava valley and the valleys of its tributaries, the hydrogeological situation is somewhat different. There, according to hydrogeological features, the Sutla river basin area, the Krapina river basin area, the basin area of the right tributaries of the Sava from the mouth of the Kupa to the mouth of the Una and, most importantly, the lowland area of the Sava basin are distinguished.

The Sutla basinit is mostly located in the territory of Slovenia, and in Croatia it is defined by the watershed towards the Krapina river and the state border with Slovenia, and covers an area of 120 km2. The average annual amount of precipitation is about 800-900 mm. In terms of water capacity, the dolomites and limestones of the Upper Triassic are important, and to a lesser extent the Oligocene, Tortonian and Pontic deposits.

Krapina basin areait is bounded by the mountains of Zagorje - Medvednica, Ivanščica and Maceljska gora and the hilly part of Kostelj. It covers an area of 1349 km2. The average annual precipitation is in the range of 1000-1250 mm. Poorly permeable and impermeable sediments predominate in the area, which, in addition to the morphological characteristics of the terrain, results in surface runoff and weak infiltration of rainwater into the subsoil. Numerous watercourses of predominantly torrential character are formed. Considering the hydrogeological features, solid rocks with fissure porosity and loosely bound and unbound sediments of intergranular porosity are found in that area. The most important aquifer consists of tectonically disturbed and fractured limestones and dolomites of the Middle and Upper Triassic and crumbling and tectonically disturbed lithotamnian limestones.

The basin area of the right tributaries of the Sava from the mouth of the Kupa to the mouth of the Unait belongs to the Sunje basin, which is the largest watercourse. The area is mostly hilly, and is defined by the watershed with Glina and Una and the Sunja-Dubica railway line. It covers an area of about 609 km2. The average annual precipitation amounts to 900-1000 mm. From a hydrogeological point of view, the carbonate Neogene deposits (lithotamnian limestones) are more interesting in the part of the area where they are tectonically disturbed and eroded. The alluvial deposit is not significantly developed, and the amount of groundwater in this area is not large.

Ravničar part of the Sava basinit occupies a relatively narrow strip of the valley part of the Sava River and extends from Zaprešić in the west and further follows the course of the Sava River, which for the most part also represents the southern border of the area. It covers an area of 5420 km^2. The average annual precipitation amounts to 900 mm in the western part of the basin, or 600-700 mm in the eastern part of the Sava basin. From a hydrogeological point of view, clastic sediments of the Tertiary and Quaternary periods are significant. In the upstream part, the water is dominated by very rich alluvial deposits of the Sava.

Thus, in the wider area of Samobor, there is a significant alluvium of the Sava, rich in water, but relatively thin, which grows from west to east. The thickness ranges between 7-8 m near Bregana and 12-15 m north of Samobor. A sudden increase in thickness was observed between Medsave and Domaslovec, and further towards the sub-neighboring threshold, the gravel layer suddenly thins again. The greatest thicknesses of Sava deposits were registered in the area of Strmac (over 50 m) and between Sv. Nedelje and Domaslovac (over 50 m). There is also sand with weaker hydrogeological characteristics in the area of Medsave at a depth of over 130 m, and its bottom has not been reached. The quantities of underground water are large, because there is a possibility of recovery from the Sava. Pumping station capacities can reach 1000 l/s and there is a possibility of 2-3 pumping stations on each coast. This assessment was made based on the results of mathematical models for Šibice and Strmec pumping stations. The capacities of individual wells constructed to date range from 30 to over 200 l/s.

In the area of Zagreb, the main aquifer consists of gravel, sand, dust and clay, and to a lesser extent conglomerate. The roof of the aquifer consists of sand, dusty sand, dust and clay. The greatest roof thicknesses are registered north of the Sava, and are greater in the east (17 m) than in the west. The smallest thicknesses are closer to the Sava and south of the Sava. The aquifer in the western part of the area has a thickness of 5-10 m. In the section Sašnjak - Mala Mlaka, the thickness of the aquifer increases sharply to 20-40 m and further increases, so that in the area of Obrezin - Črnkovac the aquifer reaches a thickness of over 100 m. They are often vertical and lateral changes in the granulation of larger clastic sediments, and in connection with this, changes in hydrogeological characteristics. The bottom of the horizon consists of gray-blue and gray-green clays. Considering the hydrogeological parameters, the aquifer is of high quality, and the hydraulic connection with the Sava is very good. In the area of Črnkovac and Velika Gorica, drainage from the Sava causes relatively rapid changes in the level of underground water in the horizon.

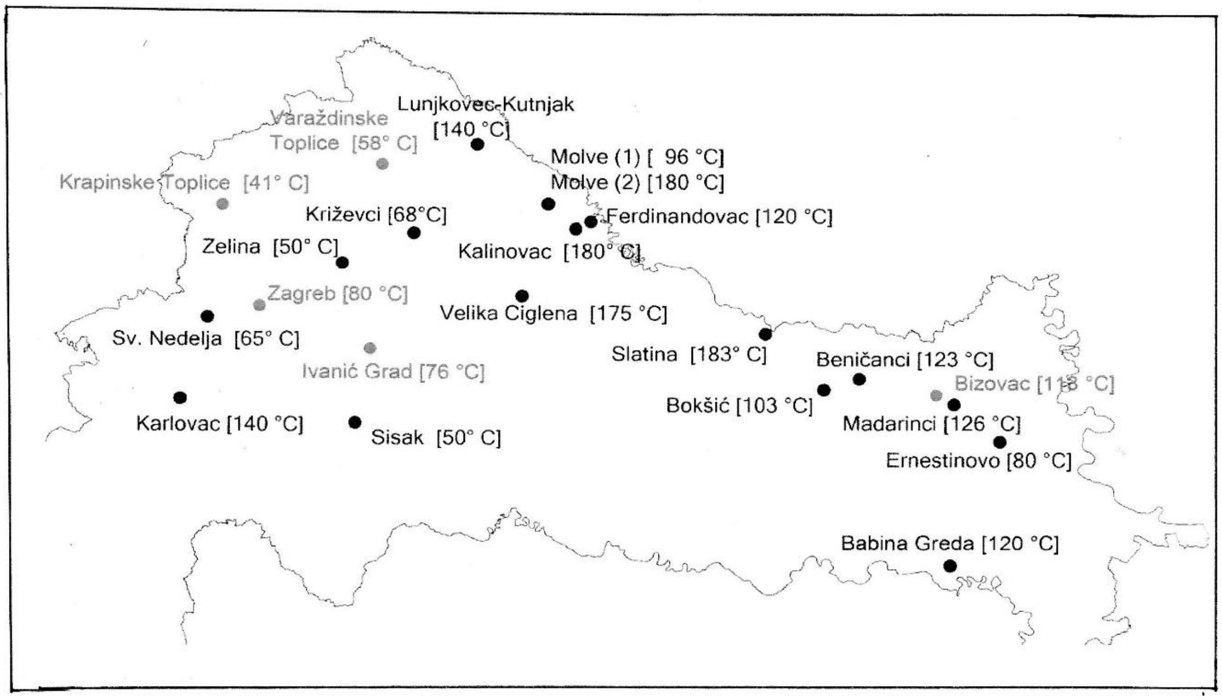
From Ivanje Reka to Slavonski Brod, fluvial and lake-marsh sediments dominate, which were formed by the sedimentation of material deposited by the left and right tributaries of the Sava. With regard to underground water supplies, clastic deposits of Pliopleistocene and Quaternary age are significant. They are characterized by a rhythmic and monotonous alternation of permeable and relatively impermeable deposits. The most hydrogeologically suitable parts of the area are the "cones" formed in the confluence zones of the right tributaries of the Sava. The first hydrogeological zone with underground water, which according to temperature and mineralization corresponds to the criteria for drinking water, reaches a depth of about 200 m. There are differences between "shallow" and "deeper" aquifers. About 70% of all wells capture water from aquifers shallower than 80 m, but there are also wells deeper than 250 m.

East of Slavonski Broddominated by lake and fluvial sediments, the formation of which was decisively influenced by material from the right tributaries of the Sava. There are great differences in the hydrogeological features of the deposits located in the southern part compared to those located in the northern and eastern parts of the area. In the south, along the Sava, in the area between Gundinaci, Gradište and Županja, there is the most hydrogeologically favorable area in the whole of Eastern Slavonia. There is a gravelly-sandy aquifer whose thickness reaches over 100 m.

The mountainous and hilly area between the Sava and Drava riversit is mainly built of weakly permeable and impermeable rocks, which, in addition to the morphological characteristics of the terrain, results in surface runoff and weak infiltration of rainwater into the subsoil. Because of this, numerous watercourses are formed, predominantly of torrential nature. According to the type of water permeability in that part of Croatia, consolidated rocks with fissure porosity and weakly bound and unbound rocks with intergranular porosity are distinguished. The most significant aquifer consists of tectonically disturbed and fractured carbonates of the Middle and Upper Triassic.

Second hydrogeological zone

The second hydrogeological zone consists of deep aquifers saturated with underground water of higher temperature (thermal water) and sometimes with water of higher mineralization (more than 1000 mg/l). Geothermal potential is, among other things, significantly related to the thickness of the continental crust, that is, the depth of the Mohorovičić discontinuity, which represents the boundary between the Earth's crust and mantle. In the Pannonian area, the Mohorovičić discontinuity is also found at depths of less than 20 km. Geothermal potential is most often expressed using the value of the geothermal gradient and/or heat flow density. The area of northern and eastern Croatia is characterized by high values of heat flow density and a high geothermal gradient of over 4°C per 100 m. There are two main types of geothermal aquifers. The first type refers to aquifers with intergranular porosity that are present in clastic Mesozoic and Tertiary deposits, while the second type refers to secondary porosity present in fractured Mesozoic and Miocene carbonates. Deposits of Mesozoic massive carbonates with highly developed secondary porosity may contain geothermal fluid with a much higher flow rate and higher temperatures, such as those at the locations of Velika Ciglena (175°C), Slatina (190°C), Lunjkovec-Kutnjak (140°C), etc. (Škrlec, M., Kolbah, S., Živković, S. & Tumara, D., 2019).



Picture3.37 Geothermal sites in the area of the counties in question according to data from 2013 (Source: Golub, M., Križ, J. & Cazin, V., 2016)

Such aquifers can support economically very profitable electricity production. In addition to locations suitable for electricity production, a significant part of the Croatian Pannonian Basin System (HPBS) has favorable characteristics such as acceptable yield and temperatures for direct use of thermal energy. For this purpose, it is possible to use aquifers located at shallower depths, such as the Bošnjaci and Sv. A week where geothermal energy is used in greenhouse vegetable production. In addition, the potential of exploiting shallow geothermal energy should not be forgotten.

3.3.5.3 Underground water

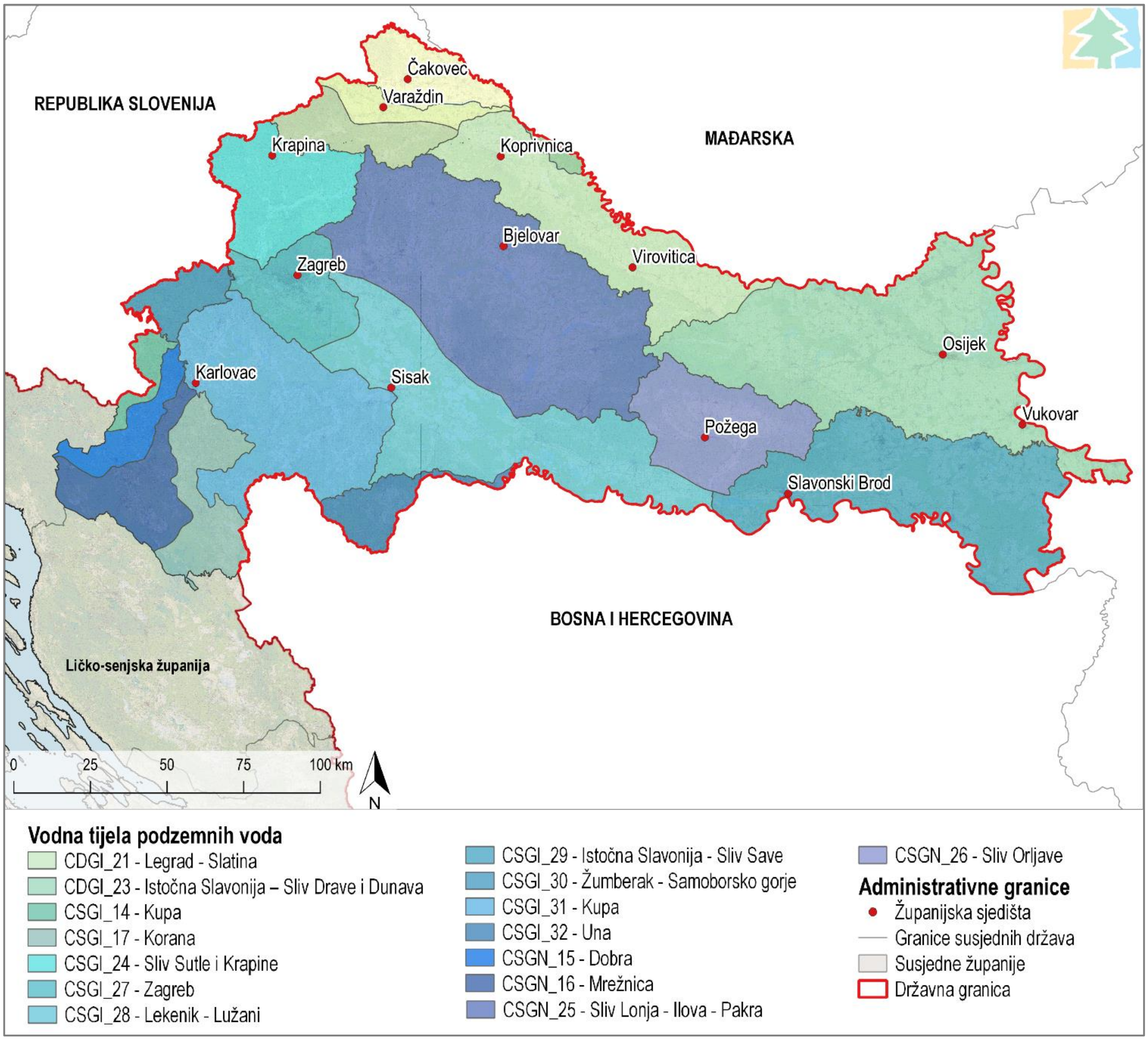
For the purpose of monitoring and protection, underground waters in the territory of the Republic of Croatia are separated into separate units. By applying the criteria determined in accordance with the ODV, a total of 461 basic bodies of groundwater (hereinafter referred to as: TPV) were identified, which were subsequently grouped into 20 TPV in the water area of the Danube River (15 in the Pannonian part and 5 in the karst part). In this way, all water bodies of groundwater that are used, or could be used in the future for capturing water intended for human consumption, and which provide more than 10 m3/day, have been isolated. The grouping was performed on the basis of the similarity of the hydrogeological characteristics of the aquifer. In the area of the counties in question, there are 19 TPVs whose basic characteristics are shown in the following table (Table3.36).

Table3.36Basic data on groundwater bodies in the area of the counties in question
(Source: Water Area Management Plan 2016-2021)

Code	Name of the groundwater body	Porosity	Area (km2)	Renewable underground water supplies (*106 m3/year)	Natural vulnerability
CDGI_18	Međimurje	intergranular	747	113	62% of areas of high and very high vulnerability
CDGI_19	Varaždin area	intergranular	402	88	Almost entirely high and very high vulnerability
CDGI_20	Bednja basin	dominantly intergranular	724	52	74% of areas of low and very low vulnerability
CDGI_21	Legrad - Slatina	intergranular	2370	362	23% of areas of high and very high vulnerability
CDGI_22	Novo Virje	intergranular	97	18	51% of areas of high and very high vulnerability
CDGI_23	Eastern Slavonia - Drava and Danube Basin	intergranular	5009	421	84% of areas of moderate to high vulnerability
CSGI_24	Sutla and Krapina basin	dominantly intergranular	1405	82	70% of areas of low to very low vulnerability
CSGN_25	Basin Lonja - Ilova - Pakra	dominantly intergranular	5186	219	73% moderate to elevated vulnerability
CSGN_26	The Orljava basin	dominantly intergranular	1575	134	57% of areas of low to very low vulnerability
CSGI_27	Zagreb	intergranular	988	273	40% of high and very high areas, and 44% of moderate to elevated vulnerability
CSGI_28	Lekenik - Lužani	intergranular	3444	366	53% of areas of moderate to high vulnerability
CSGI_29	Eastern Slavonia - Sava Basin	intergranular	3328	379	76% moderate to elevated vulnerability
CSGI_30	Žumberak - Samoborsko gorje	fissured to fissured-cavernous	443	139	60% very low to low vulnerability
CSGI_31	Cup	dominantly intergranular	2870	287	58% of moderate to elevated vulnerability
CSGI_32	Una	dominantly intergranular	541	54	90% very low to low vulnerability
CSGI_14	Cup	fissure-cavernous	1027	1429	medium 26.8%, high 28.4%, very high 16.7%
CSGN_15	Good	fissured to fissured-cavernous	755	758	medium 19.7%, high 27.7%, very high 32.8%
CSGN_16	Retina	fissure-cavernous	1372	1324	medium 28.4 %, high 33.4 %, very high 25.9 %
CSGI_17	Koran	fissure-cavernous	1227	870	medium 20.5%, high 27.4%, very high 21.1%

The area of the counties in question includes 15 TPV of the Pannonian part and 4 TPV of the Karst part. The largest number of groundwater bodies contain aquifers of intergranular porosity, and a smaller number of fissure-caverous porosity. Most TPVs have a cross-border character, i.e. they extend into the neighboring countries of Slovenia, Hungary, Serbia and Bosnia and Herzegovina.

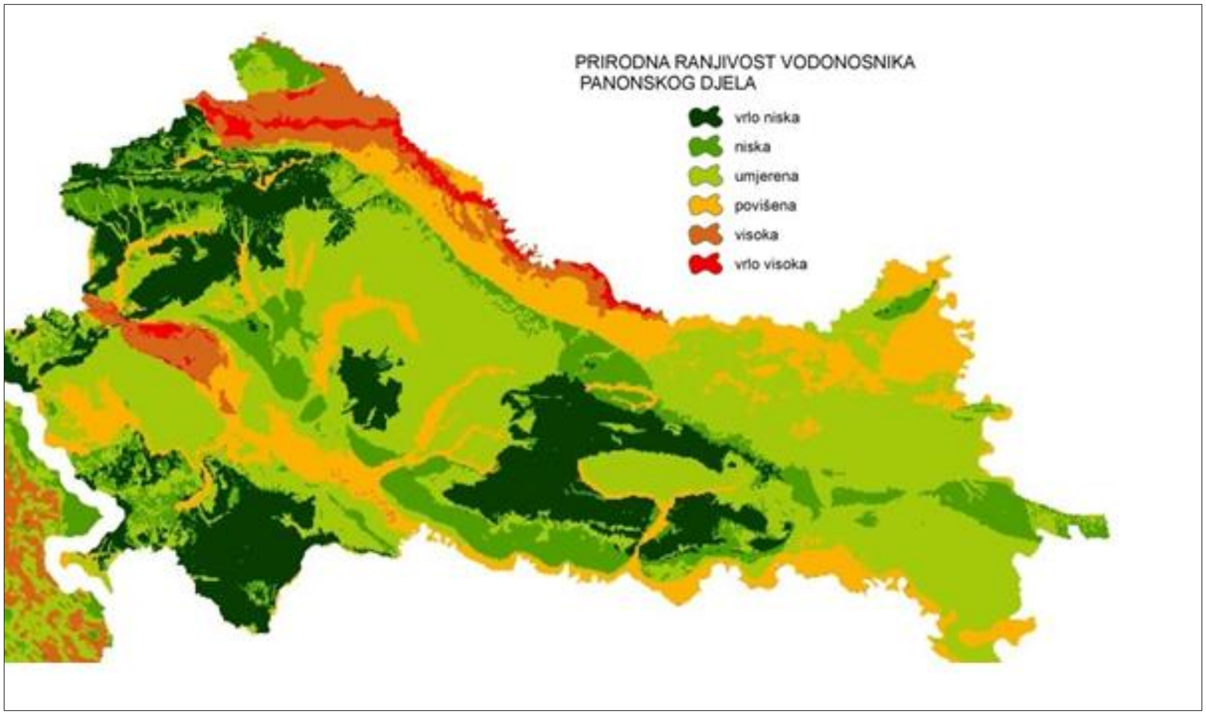
The following figure shows the distribution of groundwater bodies in the area of the respective counties (Picture3.38).



Picture3.38Groundwater bodies in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

Considering the hydrogeological characteristics of individual areas within the framework of the initial characterization, the aquifers are classified into the categories of primary, secondary and non-productive aquifers. Primary aquifers are defined as quaternary aquifers with intergranular porosity and high hydraulic properties, from which the majority of public water supply in northern Croatia takes place or are planned for water supply. Secondary aquifers are Quaternary aquifers of intergranular porosity with lower hydraulic properties that are used for water supply and carbonate (Triassic) aquifers of fissure and fissure-cavernous porosity and moderate permeability. Non-productive rocks are mainly limited to Neogene deposits, Quaternary deposits with low hydraulic properties and/or small thicknesses and metamorphic rocks (permeable only shallowly below the terrain surface).

According to the Water Area Management Plan 2016-2021. the area of the concerned counties is divided into six categories of natural vulnerability of aquifers, ranging from very high to very low (Table3.36,Picture3.39).



Picture3.39Natural vulnerability of aquifers in the area of the counties in question (Source: Water Area Management Plan 2016-2021)

Very high and high vulnerability are characteristic of alluvial aquifers with very good hydraulic properties, with a relatively small depth to the groundwater and a weak protective function of the unsaturated zone and soil.

Increased vulnerability was achieved for alluvial aquifers in places where the protective role of the soil is more pronounced or the thickness of the roof exceeds 5 m, for smaller alluvial aquifers with weaker hydraulic properties and for some carbonate aquifers.

The moderate vulnerability of aquifers is characteristic for alluvial aquifers with relatively good hydraulic properties, but with a significant protective function of the roof deposits of the aquifer and soil, for aquifers with mainly weak hydraulic properties, but with a relatively small depth to the water and weak protective properties of the unsaturated zone and soil, as well as for the majority of carbonate aquifers in the mountainous regions of Pannonian Croatia.

Low and very low vulnerability is mostly achieved in mountain areas built from rocks with weak to very weak hydraulic properties, as well as for alluvial aquifers with a favorable soil protection function and a roof thickness greater than 30 m.

Condition of groundwater bodies

The state of groundwater bodies is evaluated from the point of view of the quantity and quality of groundwater, which can be good or bad. Good status is based on meeting the requirements of the Water Framework Directive and the Groundwater Protection Directive (DPV). Classification tests are carried out to assess the satisfaction of these conditions. The worst result of all the mentioned tests is adopted for the overall assessment of the condition of the underground water body. Assessments of the chemical, quantitative and overall state of TPV within the relevant counties are shown in the following table (Table3.37).

The overall state, i.e. both the chemical and quantitative state of water bodies in the area of the counties in question, was assessed as good for 18 out of 19 groundwater bodies. Chemical condition of the water body of groundwater CDGI_19 The Varaždin area was assessed as bad due to the average nitrate values at the level of the groundwater body, which in a significant number exceed the limit values, which is why its overall condition is also bad. The largest share in the total area of the counties in question is TPV CSGN_25 Basin Lonja - Ilova - Pakra (16.28%), followed by

TPV CDGI_23 East Slavonija - Basin Drava and Danube (15.72%), CSGI_28 Lekenik - Lužani (10.81%)) and CSGI_29 East Slavonia – Sava Basin (10.44 %). TPV CDGI_19 The Varaždin area covers 1.26% of the area.

Table3.37State of groundwater bodies in the area of the respective counties (Source: Water area management plan 2016-2021)

Code	Name of the groundwater body	Chemical state	Quantitative condition	Total condition
CDGI_18	Međimurje	good	good	good
CDGI_19	Varaždin area	bad	good	bad
CDGI_20	Bednja basin	good	good	good
CDGI_21	Legrad - Slatina	good	good	good
CDGI_22	Novo Virje	good	good	good
CDGI_23	Eastern Slavonia - Drava and Danube Basin	good	good	good
CSGI_24	Sutla and Krapina basin	good	good	good
CSGN_25	Basin Lonja - Ilova - Pakra	good	good	good
CSGN_26	The Orljava basin	good	good	good
CSGI_27	Zagreb	good	good	good
CSGI_28	Lekenik - Lužani	good	good	good
CSGI_29	Eastern Slavonia - Sava Basin	good	good	good
CSGI_30	Žumberak - Samoborsko gorje	good	good	good
CSGI_31	Cup	good	good	good
CSGI_32	Una	good	good	good
CSGI_14	Cup	good	good	good
CSGN_15	Good	good	good	good
CSGN_16	Retina	good	good	good
CSGI_17	Koran	good	good	good

Groundwater supplies

Due to complex hydrogeological relationships and insufficient and uneven exploration of aquifers, the determination of underground water supplies is based on estimates. Due to the importance of water management, the most important are the so-called renewable underground water supplies.Namely, renewable or seasonal underground water supplies are the amount of water that is "stored" in the pore space of the aquifer between the lowest and highest level of the water surface registered in a certain period. It is the amount of water that is renewed by infiltration and can theoretically be exploited and used for water supply and/or irrigation (Table3.38).

Table3.38Renewable underground water supplies in 106 m3/year (Source: Water Management Strategy)

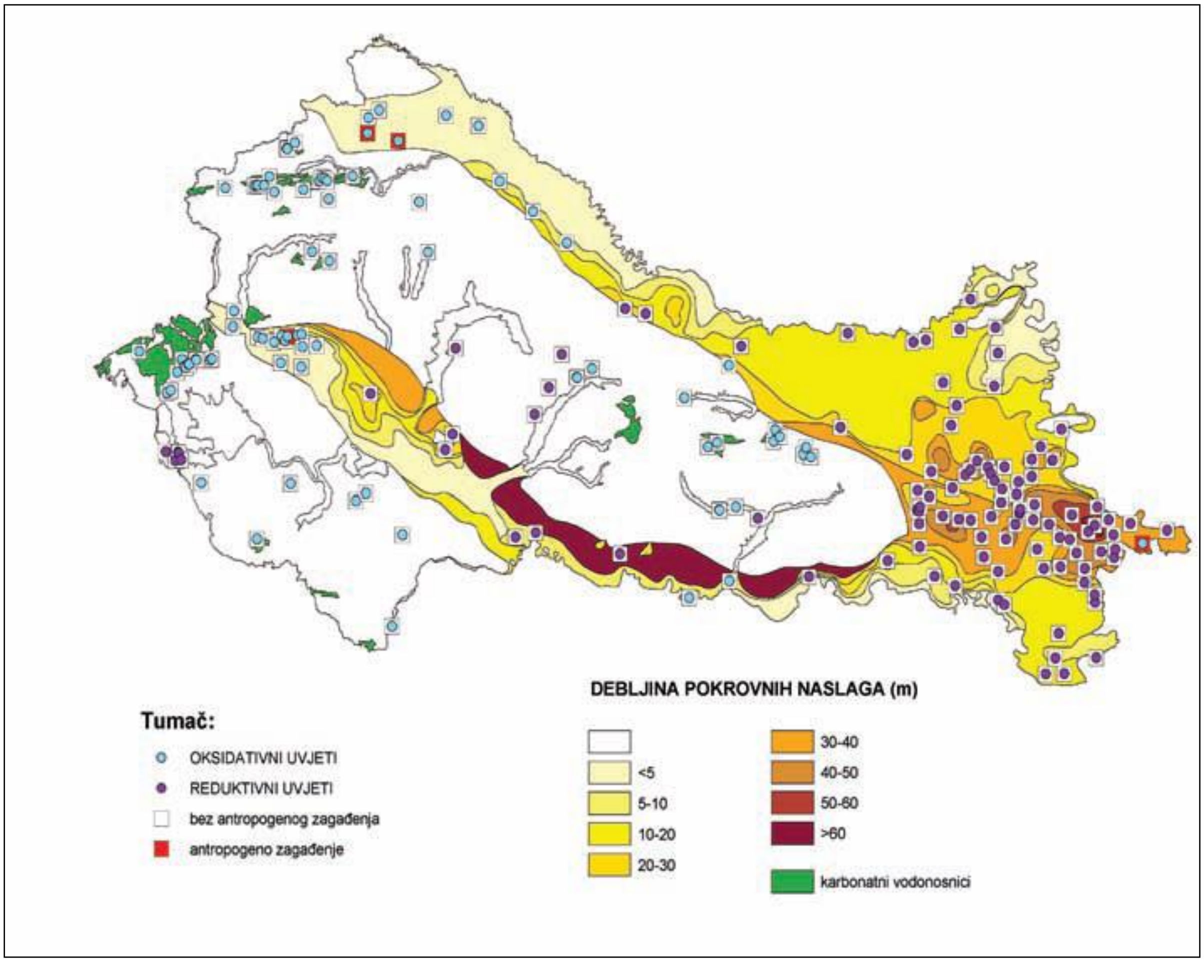
Territory	Alluvial aquifers	Carbonate aquifers	In total
Sava basin	1198,3	653.8	1852, 1
Drava and Danube basin	802.6	7,8	810.4
In total	2000.9	661.6	2662.5

Renewable underground water supplies in shallow alluvial aquifers are determined as a product of the spread area of aquifers, the amplitude of piezometric level fluctuations and effective porosity. For deep aquifers, the values of the storage coefficient were taken instead of the effective porosity.

Due to the peculiarities of karst aquifers, complex structural-tectonic relationships and multiple springs and sinks of water at different horizons within the same basin, in many cases it is unreliable to separate surface and underground waters, and especially to determine underground water supplies. For this reason, the renewable reserves are determined based on the minimum yields of the sources, the capacity of the water catchment facilities, the estimated effective porosities and retention capacities of the aquifers.

Groundwater quality

Groundwater is primarily used for public water supply, and its quality is generally assessed according to the indicators defined in the Ordinance on the Healthiness of Drinking Water (Official Gazette 47/08). The general state of groundwater quality in the area of the counties in question is determined by the genesis of aquifers and the thickness of poorly permeable cover deposits above the aquifer (Picture3.40).



Picture3.40Protection of aquifers and groundwater quality in northern and eastern Croatia (Source: Water Management Strategy)

In the extreme west of the Drava valley, the aquifer is covered with relatively thin dusty-clay deposits, which is why the concentration of nitrates in the first aquifer, in certain areas, has increased as a result of anthropogenic influence. Groundwater from another aquifer is of relatively good quality. In the central and eastern part of the Drava basin, due to the considerable thickness of the cover deposits, the possibility of aquifer pollution is significantly lower, but as a rule, aquifer deposits deposited in reductive conditions prevail, so the underground water naturally contains high concentrations of iron and accompanying ingredients (manganese, ammonia). The basic chemical composition of groundwater in the Danube basin is mainly calcium-hydrocarbonate type. Due to the considerable thickness of poorly permeable cover deposits, the vulnerability of the aquifer is low, but reductive conditions prevailed during the deposition of the aquifer, so the underground water is characterized by naturally increased concentrations of iron, manganese, arsenic and fossil ammonia. The highest concentrations of iron were registered in the groundwater of shallower aquifers (up to 50 m deep). Groundwater from the Gore and Prigorje carbonate aquifers is characterized by high quality, and since their water supply areas are mostly uninhabited and overgrown with forest, there is practically no danger of anthropogenic pollution. Depending on the lithology, that is, the chemical composition of the aquifer, the groundwater from these areas is calcium or calcium-magnesium-hydrocarbonate. The highest concentrations of iron were registered in the groundwater of shallower aquifers (up to 50 m deep). Groundwater from the Gore and Prigorje carbonate aquifers is characterized by high quality, and since their water supply areas are mostly uninhabited and overgrown with forest, there is practically no danger of anthropogenic pollution. Depending on the lithology, that is, the chemical composition of the aquifer, the groundwater from these areas is calcium or calcium-magnesium-hydrocarbonate. The highest concentrations of iron were registered in the groundwater of shallower aquifers (up to 50 m deep). Groundwater from the Gore and Prigorje carbonate aquifers is characterized by high quality, and since their water supply areas are mostly uninhabited and overgrown with forest, there is practically no danger of anthropogenic pollution. Depending on the lithology, that is, the chemical composition of the aquifer, the groundwater from these areas is calcium or calcium-magnesium-hydrocarbonate.

In the immediate basin of the Sava River from the Slovenian border to Sisak in the western part of the area, groundwater is naturally of good quality, but due to the thin surface cover and the large number of pollutants on the surface, in places they have elevated concentrations of indicators of anthropogenic pollution. Going east, the concentration of natural iron and manganese content in the groundwater increases, and due to the greater thickness of the surface cover, the possibility of pollution from the surface decreases.

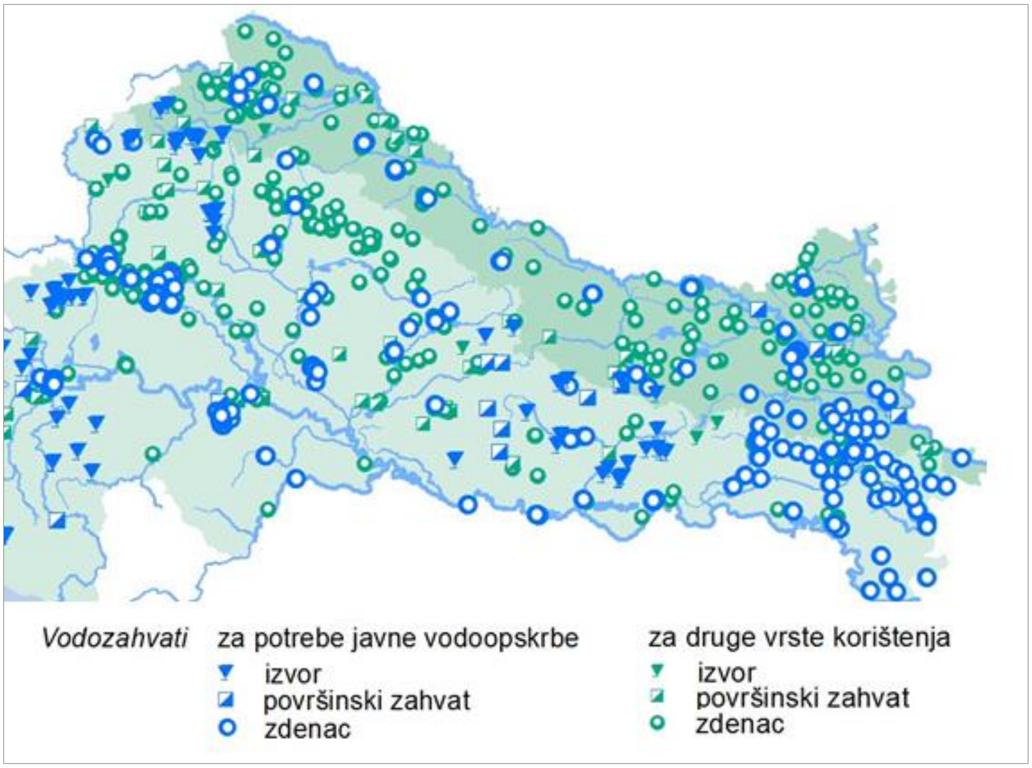
The quality of the underground water in the part of the Sava basin from the mouth of the Kupa to the mouth of the Orljava is mainly a reflection of the change in oxidative and reductive conditions, which is why the water in places contains increased concentrations of iron, manganese and accompanying ingredients. In the area from the Orljava mouth to the border with Serbia, reductive conditions dominate in the aquifers, and iron, manganese, arsenic, ammonia, phosphates and increased values of chemical oxygen consumption were found to be natural quality indicators. The highest recorded value of these indicators is in the area of Slavonski Brod.

In the basin of the Lonja, Česma, Ilova and Pakra rivers, reductive conditions prevail in the alluvial aquifers, with the best water quality in the Lonjsko polje area. In the Orljava river basin, the groundwater quality is mostly satisfactory, except for occasionally increased manganese content in places, and in the Kupa river basin, the groundwater quality from the alluvial aquifer in the Karlovac basin is also a reflection of reductive conditions.

The underground water quality of the mountain aquifers in the Pannonian area of the Sava basin is excellent. The exception is groundwater from part of the carbonate aquifers in the Krapina river basin, in the Samobor Mountains and in the Kupa basin, which may contain microbiological contamination only occasionally and in places. Depending on the source rock, according to the chemical composition, these are calcium to calcium-magnesium hydrocarbonate waters. Groundwater from the karst area of the Sava basin belongs to the calcium-hydrogen carbonate, calcium-magnesium to magnesium-calcium geochemical type of water. In terms of chemical composition, the water is of good quality, but constant microbiological pollution of fecal origin is already present at some sources. The springs in the catchment area of Paleozoic and Upper Triassic clasts are naturally characterized by somewhat elevated concentrations of some heavy metals.

Water supply

In the area of the counties in question, the population's water supply is based on the exploitation of underground water from the first hydrogeological zone. According to the Water Area Management Plan of the Republic of Croatia 2016-2021. 70% of the total population is connected to public water supply systems in that area. The public water supply is mostly based on the pumping of underground water from drilled wells, and significantly less in the hilly and hilly area between the Drava and Sava rivers, on spring catchments. Surface water intakes are rare and, with the exception of Sisak, of little importance (Picture3.41).



Picture3.41 Water intakes for the needs of public water supply and other types of use, situation in 2012 (Source: Water area management plan 2016 - 2021)

A large part of the population without public water supply is supplied with water from the so-called local waterworks, of which there are several hundred in Croatia, mostly in the area of the Black Sea basin. Local waterworks are managed by the direct users who financed their construction. Water is captured from springs that are not registered in the water use system (there is no water permit and concession). Local water supply systems do not have a water quality control system in place, but it is implemented according to the need and assessment of the user.

3.3.5.4 Areas of special water protection

Protected areas are all areas established on the basis of the Law on Water and other regulations for the purpose of special protection of surface water, underground water and unique and valuable ecosystems that depend on water.

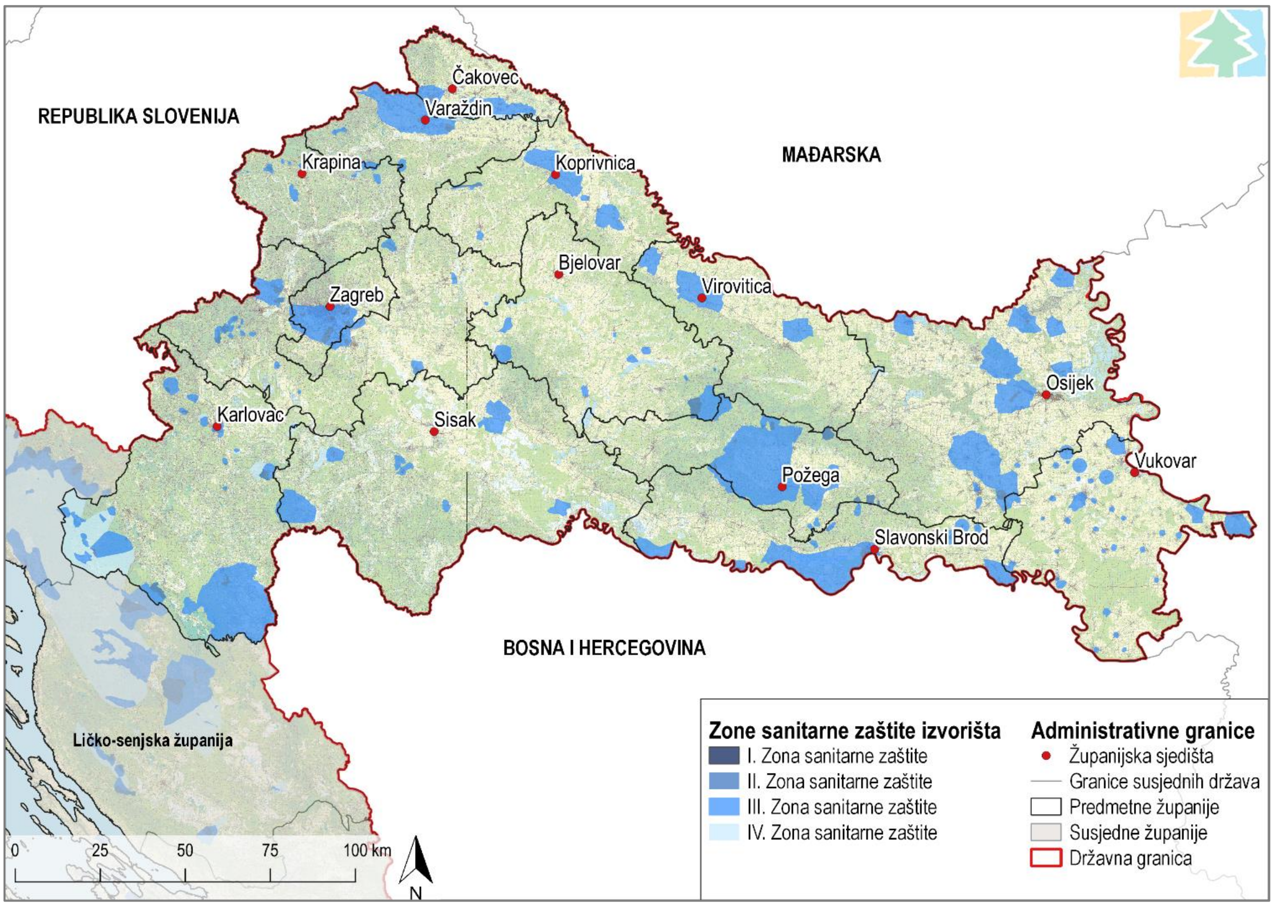
According to the Water Area Management Plan 2016-2021, areas of special water protection are divided into the following categories:

- water intended for human consumption or reserved for such purposes in the future
- waters suitable for the life of freshwater fish
- waters suitable for shellfish
- areas for swimming and recreation
- sensitive areas and associated watersheds of sensitive areas
- areas subject to nitrate pollution and associated vulnerable areas
- areas intended for the protection of birds where maintenance or improvement of water conditions is an essential element of their protection
- areas intended for the protection of habitats or species (except for birds) where maintenance or improvement of water conditions is an essential element of their protection
- other protected areas of nature.

<u>Water intended for human consumption or reserved for such purposes in the future</u>

This category of protection includes all waters intended for human consumption that provide an average of more than 10 m3 of water per day or supply more than 50 people, as well as all water bodies reserved for these purposes in the future. In order to protect the area of the spring or other reservoir of water that is used or reserved for public water supply, zones of sanitary protection of the spring are established. They are determined by the Ordinance on the conditions for establishing sanitary protection zones of springs (Official Gazette 66/11, 47/13) and, depending on the type of aquifer from which water for human consumption is drawn, three or four sanitary protection zones are determined. Since aquifers of intergranular porosity predominate in the area of the counties in question, they are a zone of restriction and supervision (Zone III), a zone of strict restriction and supervision (Zone II) and a zone of strict regime of protection and supervision (Zone I).

The extent of zones of sanitary protection of water sources in the area of the concerned counties is shown in the following figure (Picture3.42). III. the largest area is protected by the zone of sanitary protection of the source, while IV. the sanitary protection zone of the source was declared only in the extreme western, karst part of Karlovac County.



Picture3.42Zones of sanitary protection of water sources in the area of the concerned counties (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

Within each of the sanitary protection zones of the source, certain activities are prohibited, as follows:

- within the zone of restriction and supervision (Zone III) the discharge of untreated wastewater, the storage and disposal of waste, the construction of a waste disposal site except for the rehabilitation of the existing one with the aim of its closure, buildings for waste disposal including waste incinerators and facilities for the processing, recovery and disposal of hazardous waste are prohibited, construction of chemical industrial plants of hazardous and polluting substances for water and the aquatic environment, construction of gas stations without double-walled tanks, devices for automatic detection and reporting of leaks and protective structures (tank tanks), underground and surface exploitation of mineral raw materials except for geothermal and mineral waters, construction roads, airports,parking lots and other traffic and manipulative surfaces without controlled drainage and adequate purification of stormwater polluted water before discharge into a natural receiver

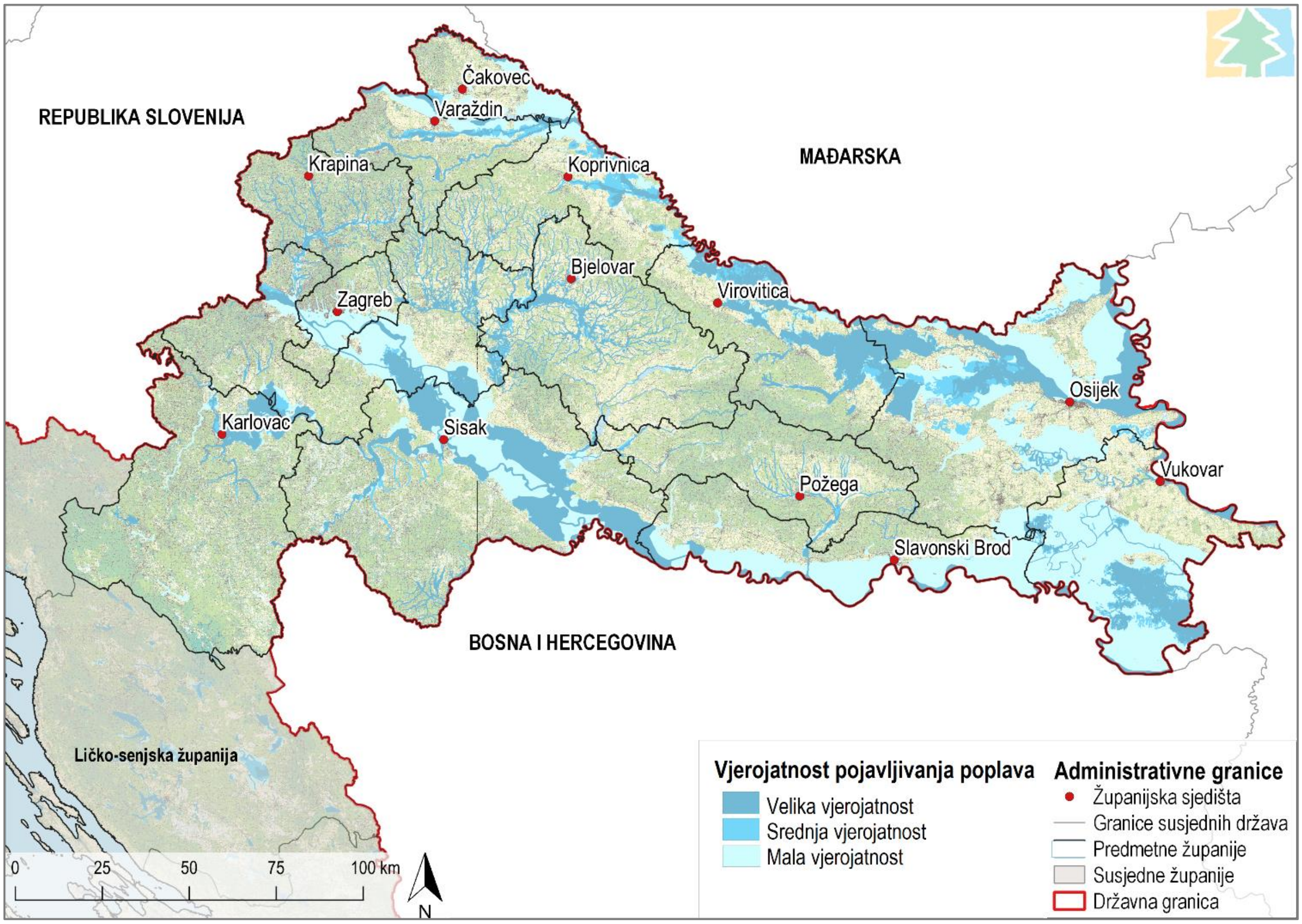
- withinzones of strict restriction and surveillance (Zone II)everything that is also prohibited within III is prohibited. zone and additionally agricultural production, except for ecological production with the application of permitted fertilizers and plant protection agents according to a special regulation, livestock production, except for agricultural holdings, i.e. farms up to 20 conditional heads with the implementation of water protection measures prescribed by the appropriate water protection program against pollution caused by nitrates of agricultural origin and principles of good agricultural practice, discharge of purified and untreated wastewater from roads, formation of new cemeteries and expansion of existing ones, storage and disposal of waste, construction of waste disposal sites except rehabilitation of existing ones with the aim of closing them, buildings for waste disposal including waste incinerators, regional and county waste management centers,
- within the zones of strict regime and supervision (Zone I), all activities are prohibited, except those related to capturing, conditioning and transporting water into the water supply system.

3.3.5.5 Danger of flooding

Floods are natural phenomena that rarely occur and whose occurrences cannot be avoided, but by taking various preventive construction and non-construction measures, the risks of flooding can be reduced to an acceptable level. Due to extensive hilly and mountainous areas with high rainfall intensities, wide valleys of lowland watercourses, large cities and valuable assets on potentially endangered surfaces, and due to insufficiently built protection systems, Croatia is quite exposed to floods. Also, climate models point to the increasingly frequent occurrence of climatic extremes, and for this reason, in the future, extreme values of air temperature and precipitation intensity, as well as extremely dry periods, along with occurrences of storms, can be expected.

According to the Water Area Management Plan 2016 - 2021, flood management is carried out through the concept of flood risk management. Flood risk is defined as a combination of the probability of a flood event and the potential adverse consequences of a flood event for human health, the environment, cultural heritage and economic activities. For the purpose of implementing the same, and during the activities on the creation of the Flood Risk Management Plan, a preliminary flood risk assessment was initially carried out, and hazard maps and flood risk maps were subsequently created. Hazard maps and flood risk maps are created for low, medium and high probability of occurrence.

The water area of the Danube River, to which the area of the counties in question belongs, is at a significantly greater risk of flooding than the Adriatic water area. The analysis of areas under flood risk has determined that approximately 25% of the area of the counties in question is under low-probability flood risk, 11% under medium probability, and 8% under high probability (Picture3.43).



Picture3.43Flood risk map of low, medium and high probability for the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Hrvatske vode and Geoportal DGU)

3.3.6 Biodiversity

3.3.6.1 Habitats

According to data from the Flora Croatica Database, the area covered by the Plan includes the following communities climatically: Genisto-Quercetum roboris s. lat., Luzulo albidae-Fagetum s. lat., Carpino-Quercetum roboris, Quercetum petraeae s. lat., Salici - Populetum s. lat. ., Leucoio-Fraxinetum angustifoliae, Ulmo-Quercetum roboris, Querco-Carpinetum s. lat., Fagetum montanum s. lat., Aceri tatarici-Quercetum s. lat., Luzulo albidae-Abietetum, Ostryo-Fagetum s. lat.

The Map of Terrestrial Non-Forest Habitats from 2016 (hereinafter: Map of Non-Forest Habitats) was used for the analysis of habitat types. Considering that there is a large representation of forest habitats, and the Map of non-forest habitats does not classify forest habitats into lower categories, data from the Habitat Map from 2004 (hereinafter: Habitat Map) were also used for a more detailed classification of forest habitats. Habitats characterized by the Map of non-forest habitats as E. Forests are overlapped with the Map of Habitats, and forest habitats that do not overlap with the layers of forest habitats of the Map of Habitats, are assigned the category "Forests - unclassified". When calculating the exact areas, a map obtained by combining the layers Map of non-forest habitats and Map of habitats was used.

The present habitat types of polygonal and point localities are shown in the tables (Table3.40,Table3.40) Habitat types are also shown cartographically (Picture3.44), and the habitat types that are rare and endangered according to the Ordinance on the list of habitat types and habitat map (Official Gazette 27/2021) are in bold in the table.

Table3.39List of habitat types of polygon sites in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Bioportal data)

NKS code	NKS habitat name	BBŽ	BPŽ	GZ	KŽ1	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
		Area (ha)													
		Area share in the county (%)													
Terrestrial habitats – polygon localities															
A.1.1.*	Constant stalls	2362.4	1497.3	290.3	359.2	691.9	65.6	1789.0	3075.5	816.2	1120.3	1536.0	602.9	385.5	1192.5
		0.772	0.738	0.453	0.199	0.396	0.053	2,454	0.741	0.448	0.251	1,218	0.298	0.157	0.390
A.1.2.	Occasional stalls	1.0	458.7	0.5	35.2	22.5	1,2	35.7	798.7	-	483.5	13.9	486.5	85.6	38.3
		0.0004	0.226	0.0008	0.020	0.013	0.001	0.049	0.192	-	0.108	0.011	0.241	0.035	0.013
A.1.3.	**Unvegetated and sparsely vegetated shores of the banks**	-	-	40.6	2.1	-	-	-	-	-	12.3	-	-	-	25.4
		-	-	0.063	0.001	-	-	-	-	-	0.003	-	-	-	0.008
A.2.2.	Occasional streams	-	23.0	1,1	39.3	30.7	3.1	45.9	27.8	2.8	223.0	86.1	18.3	7,7	46.5
		-	0.011	0.0017	0.022	0.018	0.003	0.063	0.007	0.002	0.050	0.068	0.009	0.003	0.015
A.2.3.	Permanent watercourses	557.8	2476.8	408.6	1783.5	1315,6	1279.2	685.7	5593.4	1745.6	5477.4	1076,1	1892.5	3535.4	1498.8
		0.211	1,222	0.637	0.989	0.753	1,041	0.941	1,348	0.958	1,226	0.853	0.936	1,443	0.490
A.2.4.	Channels	1016,2	2411,2	229.9	176.3	851.4	246.3	487.5	3398.3	419.9	883.4	397.9	1430.7	1469.1	1371.9
		0.385	1,189	0.359	0.098	0.487	0.200	0.669	0.819	0.230	0.198	0.316	0.707	0.600	0.448
A.2.7.	**Unvegetated and sparsely vegetated riverbanks**	-	7,4	10.0	1.0	101.5	-	46.7	18,1	31.3	44.9	61.4	12.2	17.2	41.9
		-	0.004	0.016	0.001	0.058	-	0.064	0.004	0.017	0.010	0.049	0.006	0.007	0.014
A.3.2.	**Free-swimming floating and submerged hydrophytes**	14.1	-	2.1	3.7	-	-	0.7	324.3	-	13.9	-	-	-	69.8
		0.005	-	0.0033	0.002	-	-	0.0010	0.078	-	0.003	-	-	-	0.023
A.3.3.*	Rooted aquatic vegetation	376.7	-	3.1	24.3	9.3	-	4.3	2.1	110.7	53.1	-	20.0	-	159.1
		0.143	-	0.005	0.013	0.005	-	0.006	0.001	0.061	0.012	-	-	-	0.052
A.4.1.	**Reeds, rushes, tall sedges and tall sedges**	1113.9	1183.4	67.0	1487.8	373.1	260.9	672.8	13078.8	502.3	3153.0	499.6	816.3	1477.4	1669,3
		0.422	0.584	0.104	0.825	0.213	0.212	0.923	3,152	0.276	0.706	0.396	0.404	0.603	0.546
A.4.2.*	Amphibian communities	-	-	-	-	-	-	-	-	-	-	-	-	-	1.5
		-	-	-	-	-	-	-	-	-	-	-	-	-	0.000
A.4.2.1.*	Low spikes	-	1,4	-	-	22.1	-	-	-	-	8.0	-	8.3	-	-
		-	0.001	-	-	0.013	-	-	-	-	0.002	-	0.004	-	-
B.1.1.	Unvegetated sections of steep rocks	-	-	-	-	-	-	-	-	-	5.5	2.8	-	-	-
		-	-	-	-	-	-	-	-	-	0.001	0.002	-	-	-

B.1.3.	**Alpine-Carpathian-Balkan limestone rocks**	-	-	-	-	3.9	0.7	-	-	-	2.9	-	-	-	-
		-	-	-	-	0.002	0.0006	-	-	-	0.001	-	-	-	-
B.3.1.	Fire stations	-	7.3	-	-	3,3	3.7	-	-	-	1.6	-	-	-	10.0
		-	0.004	-	-	0.002	0.003	-	-	-	0.000	-	-	-	0.003
C.1.1.1.	**Basophilic crets (low crets)**	-	-	-	-	-	-	-	-	-	-	-	-	-	2.0
		-	-	-	-	-	-	-	-	-	-	-	-	-	0.001
C.2.2.1.	**Osaka flood meadows**	-	-	-	-	-	-	-	725.1	-	-	-	-	-	-
		-	-	-	-	-	-	-	0.175	-	-	-	-	-	-
C.2.2.2.	**Permanently wet meadows of Central Europe**	8.2	3,6	-	6.3	45.2	7.6	1,4	46.2	-	12.6	11.5	112.8	-	-
		0.003	0.002	-	0.003	0.026	0.006	0.002	0.011	-	0.003	0.009	0.056	-	-
C.2.2.2.3.	**Meadows of lungworts and coastal invertebrates**	-	-	-	-	-	-	-	-	6.1	-	-	-	-	-
		-	-	-	-	-	-	-	-	0.003	-	-	-	-	-
C.2.2.3.	**Communities of hygrophilous greens**	-	1.9	-	22.1	63.4	27.5	10.1	29.0	2.7	-	74.8	25.7	-	123.2
		-	0.001	-	0.012	0.036	0.022	0.014	0.007	0.001	-	0.059	0.013	-	0.040
C.2.2.4.	**Periodically wet meadows**	716.1	28.8	293.5	252.5	84.4	78.5	-	9.3	-	1098,2	-	10.2	-	5068.7
		0.271	0.014	0.458	0.140	0.048	0.064	-	0.002	-	0.246	-	0.005	-	1,656
C.2.2.5.	**Communities with pale clover**	-	10.7	-	-	-	-	-	15.2	49.2	-	-	1,1	-	-
		-	0.005	-	-	-	-	-	0.004	0.027	-	-	0.0005	-	-
C.2.3.2.	**Mesophilic meadows of Central European meadows**	26863.4	5612.2	6850.8	20225,4	14915,6	14467,1	2642.5	5115.8	8077.5	27108,2	6937.3	5987.4	1295.4	37076,2
		10,180	2,768	10,683	11,214	8,535	11,770	3,625	1,233	4,434	6,070	5,501	2,960	0.529	12,117
C.2.3.2.1.	**Central European meadows of early pohovka**	2050.0	78.8	1117.8	503.6	3761.7	7584.5	1390,4	97.1	103.5	563.7	3523,1	587.5	-	2579.9
		0.777	0.039	1,743	0.279	2,153	6,170	1,907	0.023	0.057	0.126	2,794	0.290	-	0.843
C.2.3.2.12.	**Meadows of sedges and yellow sables**	-	-	-	-	-	-	-	-	-	-	-	-	-	2.5
		-	-	-	-	-	-	-	-	-	-	-	-	-	0.001
C.2.3.2.2.	**Hare's thorn meadows and early pohovka**	83.6	19,4	-	-	5,8	32.2	-	60.1	124.8	-	13.3	57.7	-	78.9
		0.032	0.010	-	-	0.003	0.026	-	0.014	0.069	-	0.011	0.029	-	0.026
C.2.3.2.3.	**Meadows of mountain hare and early pahovka**	-	-	-	-	-	5.5	-	-	-	-	-	-	-	-
		-	-	-	-	-	0.004	-	-	-	-	-	-	-	-

C.2.3.2.4.	**Meadows of tuberous cones and early sedges**	7,8	0.8	12.7	-	213.4	189.3	54.3	0.6	20.9	-	42.4	-	7.5	6.5
		0.003	0.0004	0.020	-	0.122	0.154	0.074	0.0001	0.011	-	0.034	-	0.003	0.002
C.2.3.2.5.	**Meadows of russet and reeds**	-	52.5	-	-	-	-	-	-	-	-	-	-	-	-
		-	0.026	-	-	-	-	-	-	-	-	-	-	-	-
C.2.3.2.7.	**Lowland haystacks with medicinal blood**	23.2	3,3	-	-	203.0	9.5	64.4	0.6	8,9	-	209.0	2,3	-	-
		0.009	0.002	-	-	0.116	0.008	0.088	0.0001	0.005	-	0.166	0.001	-	-
C.2.4.1.	**Nitrophilic pastures of the lowland vegetation belt**	1821,3	1959,6	-	257.3	191.7	-	15.0	3011.8	507.1	8505,2	19.6	715.7	975.4	966.0
		0.690	0.966	-	0.143	0.110	-	0.021	0.726	0.278	1,904	0.016	0.354	0.398	0.316
C.2.6.1.	Tread surfaces of forest roads	-	-	-	-	-	1.8	-	-	-	-	2,4	0.9	-	-
		-	-	-	-	-	0.001	-	-	-	-	0.002	0.0004	-	-
C.3.1.1.	**Subpannonian fescue grasslands**	-	-	-	-	-	-	-	283.4	-	-	-	3.1	51.0	-
		-	-	-	-	-	-	-	0.068	-	-	-	0.002	0.021	-
C.3.2.1.	**Pannonian open grasslands on the sands**	-	-	-	-	42.2	-	-	-	-	-	-	-	-	-
		-	-	-	-	0.024	-	-	-	-	-	-	-	-	-
C.3.3.1.	**Mountain meadows of upright oats on a carbonate substrate**	2,2	425.8	400.4	4783.3	10.3	1122.8	14.4	128.0	584.8	106.3	515.0	29.8	-	2316.5
		0.001	0.210	0.624	2,652	0.006	0.913	0.020	0.031	0.321	0.024	0.408	0.015	-	0.757
C.3.4.3.3.	**Lika heath**	-	-	-	1,4	-	-	-	-	-	-	36.6	-	-	-
		-	-	-	0.001	-	-	-	-	-	-	0.029	-	-	-
C.3.4.3.4.	Bujadnica	24.4	1,1	1,1	6931.0	216.3	46.5	4,6	-	40.8	2486.0	-	16.7	-	309.9
		0.009	0.001	0.002	3,843	0.124	0.038	0.006	-	0.022	0.557	-	0.008	-	0.101
C.5.2.1.	Forest clearings of nightingales and narrow-leaved cypress	3,4	-	-	-	-		-	-	5.0	6,7	1,2	11.9	-	3,4
		0.001	-	-	-	-	0.000	-	-	0.003	0.002	0.001	0.006	-	0.001
C.5.4.1.1.	**Tall green with a real cone**	-	-	-	12.1	-	269.7	3,4	2.5	-	-	310.9	4.1	-	19,4
		-	-	-	0.007	-	0.219	0.005	0.001	-	-	0.247	0.002	-	0.006
D.1.1.1.	**Willows of gravelly and sandy river banks**	-	-	-	-	32.4	-	3.9	-	-	-	-	-	-	73.7
		-	-	-	-	0.019	-	0.005	-	-	-	-	-	-	0.024
D.1.1.2.	Ash and eared willow willows	240.8	43.5	87.1	350.2	3.7	-	-	9.0	67.4	322.3	-	3.1	-	845.6
		0.091	0.021	0.136	0.194	0.002	-	-	0.002	0.037	0.072	-	0.002	-	0.276
D.1.2.1.	Mesophilic hedges and	5970.3	10239.5	3132.6	7393.0	2157,2	3924.9	531.6	6198.0	8178.5	30985.4	1890,9	5243.8	828.5	12544.9
		2,262	5,050	4,885	4,099	1,234	3,193	0.729	1,494	4,489	6,938	1,499	2,593	0.338	4,100

	thickets of continental, especially coastal regions														
D.2.5.	**Pine trees**	-	-	-	26.3	-	-	-	-	2.1	-	-	-	-	-
		-	-	-	0.015	-	-	-	-	0.001	-	-	-	-	-
D.4.1.	Thickets of foreign bushes	-	-	-	-	-	-	-	2.0	-	-	-	-	-	-
		-	-	-	-	-	-	-	0.0005	-	-	-	-	-	-
D.4.1.1.	Constituents of the living organism	142.3	4608,1	-	144.0	8.0	-	-	33.4	-	15555.4	3,6	-	432.5	1229.9
		0.054	2,273	-	0.080	0.005	-	-	0.008	-	3,483	0.003	-	0.177	0.402
E.1.1./E.1.2.	**Willow floodplain forests / Poplar floodplain forests**	63.9	28.9	19.8	18.4	1731.4	-	1478.0	21858.5	9.2	1121.6	2343.2	799.5	971.0	458.1
		0.024	0.014	0.031	0.010	0.991	-	2,027	5,268	0.005	0.251	1,858	0.395	0.396	0.150
E.2.1.	**Flood forests of black alder and field ash**	325.5	2305,6	150.8	1173.4	2427.5	-	-	1216.8	33.5	11181.6	-	1023,1	1390,4	2726.9
		0.123	1,137	0.235	0.651	1,389	-	-	0.293	0.018	2,504	-	0.506	0.568	0.891
E.2.2.	**Floodplain oak forests**	3200.9	13402.0	107.2	2665.7	847.3	-	60.2	6936.6	81.9	23664,3	-	675.5	33183.9	11115,4
		1,213	6,610	0.167	1,478	0.485	-	0.083	1,672	0.045	5,299	-	0.334	13,548	3,633
E.3.1.	**Mixed oak-hornbeam and pure hornbeam forests**	34405,7	20575,4	8784.8	55132.7	20428.9	23292.8	6521.8	42498.0	13605.9	72349.6	13680.1	32730.3	27049,4	59903.0
		13,038	10,148	13,699	30,568	11,690	18,950	8,946	10,242	7,468	16,200	10,847	16,183	11,043	19,577
E.3.1./C.2.2.	**Mixed oak-hornbeam and pure hornbeam forests / Wet meadows of Central Europe**	190.9	-	-	-	58.0	-	-	-	8,8	2,4	-	39.3	-	-
		0.072	-	-	-	0.033	-	-	-	0.005	0.001	-	0.019	-	-
E.3.2.	**Central European acidophilic forests of oak and common birch**	7549.0	14749.8	1038.5	6281.3	5943.9	3546.9	-	7822.9	28382.7	53514,6	9880.0	7916,1	-	1065.4
		2,861	7,274	1,619	3,483	3,401	2,886	-	1,885	15,579	11,982	7,834	3,914	-	0.348
E.3.4.	**Central European thermophilic oak forests**	86.7	-	-	-	546.1	-	-	-	-	-	234.0	-	-	628.5
		0.033	-	-	-	0.312	-	-	-	-	-	0.186	-	-	0.205
E.3.5./C.3.3.	**Coastal, thermophilic**	-	-	-	6,9	-	-	-	-	-	-	-	-	-	-
		-	-	-	0.004	-	-	-	-	-	-	-	-	-	-

	forests and honeysuckle thickets / Sub-Atlantic mesophilic grasslands and mountain meadows on carbonate soils														
E.4.1.	**Central European neutrophilic to weakly acidophilic, mesophilic beech forests**	23513.7	311.9	-	-	21351.7	-	-	-	809.2	38.8	2012,3	5622.6	-	-
		8,911	0.154	-	-	12,218	-	-	-	0.444	0.009	1,596	2,780	-	-
E.4.2.	**Central European, acidophilic beech forests**	301.2	-	-	-	-	-	-	-	-	1565.6	18.8	-	-	1448.7
		0.114	-	-	-	-	-	-	-	-	0.351	0.015	-	-	0.473
E.4.5.	**Mesophilic and neutrophilic pure beech forests**	26734.9	9403.9	6759.1	23269.7	1626.4	13025.5	626.2	4756.1	41530.0	43801.0	12159.6	16432.4	-	30480.1
		10,131	4,638	10,540	12,902	0.931	10,597	0.859	1,146	22,795	9,807	9,642	8,125	-	9,961
E.5.1.	**Pannonian beech-fir forests**	1762.8	-	870.4	-	-	4247.8	-	-	3627.4	-	1300.1	4959.1	-	796.5
		0.668	-	1,357	-	-	3,456	-	-	1,991	-	1,031	2,452	-	0.260
E.9.2.	Conifer plantations	115.7	-	34.3	71.0	316.9	639.2	43.0	9.3	-	79.2	713.7	63.1	-	960.9
		0.044	-	0.053	0.039	0.181	0.520	0.059	0.002	-	0.018	0.566	0.031	-	0.314
E.9.3.	Plantations of broad-leaved trees	336.7	852.2	28.8	-	1603,3	-	829.0	973.9	-	912.0	300.6	182.0	3109,2	257.0
		0.128	0.420	0.045	-	0.917	-	1,137	0.235	-	0.204	0.238	0.090	1,269	0.084
E.*	**Forests - unclassified**	19223,3	17486.5	5402.4	10705,4	10029.2	10648.4	5748.1	27244,3	15334.7	37327.9	7860.4	11638.5	9330.9	19188,2
		7,285	8,624	8,425	5,935	5,739	8,663	7,885	6,566	8,417	8,358	6,233	5,755	3,810	6,271
I.1.3.	Utrines of continental, less often coastal regions	-	7,7	-	0.8	-	-	-	6,8	-	5,4	1.9	-	10.4	2.6
		-	0.004	-	0.0004	-	-	-	0.002	-	0.001	0.002	-	0.004	0.001
I.1.4.	Ruderal communities of continental regions	18.6	57.4	115.8	43.7	17.9	48.2	60.7	189.6	294.5	182.9	24.9	136.4	28.3	133.6
		0.007	0.028	0.181	0.024	0.010	0.039	0.083	0.046	0.162	0.041	0.020	0.067	0.012	0.044
I.1.5.*	Nitrophilic, scyophilic ruderal vegetation	104.6	9.2	-	-	135.1	12.7	52.4	123.0	125.8	15.6	102.4	261.3	24.2	3,3
		0.040	0.005	-	-	0.077	0.010	0.072	0.030	0.069	0.003	0.081	0.129	0.010	0.001

I.1.6.	Weeds of Central Europe	1,2	6.3	-	-	-	48.4	-	-	-	-	5,4	23.6	2.6	-
		0.0005	0.003	-	-	-	0.039	-	-	-	-	0.004	0.012	0.001	-
I.1.7.*	Communities of nitrophilic, hygrophilic and schiophilic habitats	1692.7	313,1	477.0	1905, 1	38.9	15.7	2.8	255.5	238.1	4510.8	39.9	135.4	3-	1615,3
		0.641	0.154	0.744	1,056	0.022	0.013	0.004	0.062	0.131	1,010	0.032	0.067	-	0.528
I.1.8.	Neglected agricultural areas	3554.0	4718.4	2291.0	5648.7	2443.6	5944.3	2866.6	6915.8	3291.6	16982.9	5455.7	3311.6	1541.4	11117,6
		1,347	2,327	3,573	3,132	1,398	4,836	3,932	1,667	1,807	3,803	4,326	1,637	0.629	3,633
I.2.1.	Mosaics of cultivated areas	85435.5	75818.1	8065.9	20841.5	67483.7	19364.4	37198.9	228363.7	44591.1	64305,6	39465.6	88477.3	143940.1	71032,3
		32,377	37,393	12,578	11,555	38,616	15,754	51,027	55,038	24,476	14,399	31,293	43,747	58,766	23,214
I.5.1.	Orchards	1962.5	3038.6	768.2	878.1	1069.4	1111.6	1054.0	4708,3	2056.5	4271.4	769.4	1522.0	1848,6	2427.7
		0.744	1,499	1,198	0.487	0.612	0.904	1,446	1,135	1,129	0.956	0.610	0.753	0.755	0.793
I.5.3.	Vineyards	935.2	286.6	614,1	405.7	2324.8	2786.8	1126.3	2800.2	1789.0	1132.6	3156,1	1373.9	1955,0	2910.3
		0.354	0.141	0.958	0.225	1,330	2,267	1,545	0.675	0.982	0.254	2,503	0.679	0.798	0.951
J.	Built and industrial habitats	9009.7	8217,3	15658.7	6198.8	8971.9	8513.4	6617.9	15858.7	4971.5	11277.4	9277.8	6806.5	9642.3	18322.5
		3,414	4,053	24,419	3,437	5,134	6,926	9,078	3,822	2,729	2,525	7,357	3,365	3,937	5,988

BBŽ - Bjelovar-Bilogor County, BPŽ - Brod-Posavina County, GZ - City of Zagreb, KŽ - Karlovac County, KKŽ - Koprivnica-Križevačka County, KZŽ - Krapina-Zagorje County, MŽ - Međimurje County, OBŽ - Osijek-Baranja County, PSŽ - Požega-Slavonia County, SMŽ - Sisak-Moslavina County, VŽ - Varaždin County, VPŽ - Virovitica-Podravska County, VSŽ - Vukovar-Srijem County, ZŽ - Zagreb County

[1]The part of Karlovac County that is included in the Plan

* within the class there are rare and endangered communities

Table3.40List of habitat types of point localities in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Bioportal data)

NKS code	NKS habitat name	BBŽ	BPŽ	GZ	KŽ1	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Terrestrial habitats - point locations															
A.3.1.	**Underwater vegetation of antlers**										X				
A.3.3.1.5.	**Large spawning grounds**		X								X				X
A.3.3.2.	**Rooted submerged communities of liquid water**				X							X			X
A.3.4.	**Carbonate spring**												X		X
A.3.5.	**Travertine river communities**				X										
A.3.6.	**Travertine vegetation on waterfalls**				X								X		
A.4.2.1.*	Low spikes		X					X	X		X	X		X	X
A.4.2.1.3.	**The community of the egg-shaped lake bream and the three-veined leubor**														X
B.2.4.	**Pioneer communities on carbonate outcrops**					X	X								
C.1.1.1.	**Basophilic crets (low crets)**						X								X
C.1.1.1.2.	**Dinaric basophilic crets of dry skin**														X
C.1.1.1.7.	**Cret five-flower pond**														X
C.1.2.1.1.	**Cret white spikes**										X				

NKS code	NKS habitat name	BBŽ	BPŽ	GZ	KŽ1	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
C.1.2.1.2.	**Cret of star sedge and dew**										X				X
C.1.2.2.1.	**Mountain peat cret**										X				
C.2.2.1.	**Osaka flood meadows**								X						
C.2.2.2.1.	**Common invertebrates of Central European meadows**				X										
C.2.2.3.	**Communities of hygrophilous greens**	X	X		X	X	X	X	X	X		X	X		X
C.2.2.4.	**Periodically wet meadows**	X			X	X	X		X	X	X	X			X
C.2.2.5.	**Communities with pale clover**								X	X			X		
C.2.3.2.1.	**Central European meadows of early pohovka**	X	X	X	X	X		X	X	X	X	X	X		X
C.2.3.2.2.	**Hare's thorn meadows and early pohovka**					X				X		X			X
C.2.3.2.4.	**Meadows of tuberous cones and early sedges**		X			X		X		X	X	X			
C.2.3.2.5.	**Meadows of russet and reeds**		X												
C.2.3.2.7.	**Lowland haystacks with medicinal blood**		X			X		X	X	X		X	X		
C.3.4.2.	**Hardy grass lawns**				X		X								
C.3.7.1.	**Community of one-year kafranka**													X	
C.5.4.1.2.	**Shady communities of common burdock**	X	X	X					X	X	X	X	X		X
D.1.1.1.	**Willows of gravelly and sandy river banks**									X					
D.1.1.1.1.	**Pre-alpine willows with sedge**											X			
D.1.1.3.	Shrubs				X										
I.1.5.4.5.	**Prickly licorice community**		X											X	
I.1.7.*	Communities of nitrophilic, hygrophilic and schiophilic habitats										X				

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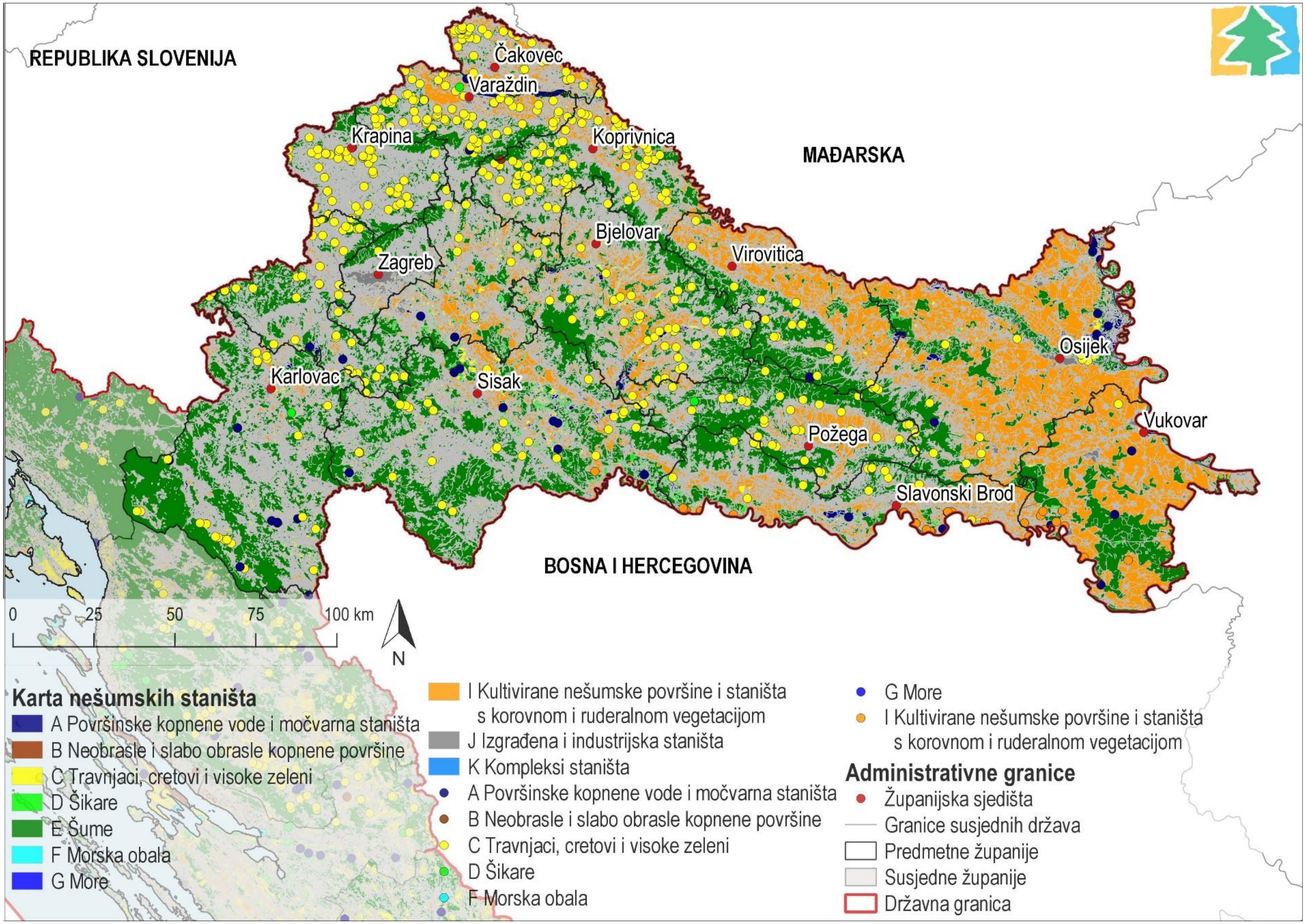
[1]The part of Karlovac County that is included in the Plan

* within the class there are rare and endangered communities



Picture3.44Habitat types in the area of the counties in question (Source: IRES EKOLOGIJA doo according to Bioportal data)

According to the data from the previous tables and the picture above (Table3.39,Table3.40,Picture3.44) it is evident that the largest part of the area within the scope of the Plan is under habitat type E. Forests (41.8%), and the most represented class within habitat type E. are E.3.1. Mixed oak-hornbeam and pure hornbeam forests (14.3%). Apart from forests, habitat type I prevails in the area within the scope. Cultivated non-forest areas and habitats with weedy and ruderal vegetation (37.8%), and the most represented class within habitat type I. are I.2.1. Mosaics of cultivated areas (33.1%).

The habitat types that are rare and endangered at the European level, as well as in Croatia, and which are found in the area covered by the Plan, are briefly described in the table below (Table3.41). Of the above types of habitats, the most sensitive are water and wet habitats, the preservation of which is extremely important in order to protect endangered wild species, especially birds for which wetlands and water habitats represent important areas for reproduction and/or feeding, as well as for resting during migrations.

Table3.41Description of rare and endangered habitat types in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to the National Classification of Habitats - Version V, 2018)

NKS code	NKS name	Habitat description
A.1.1.*	Constant stalls	Freshwater lakes, ponds or parts of such bodies of water of natural or anthropogenic origin in which water is permanently retained, although its level may fluctuate, together with present pelagic and benthic communities.
A.1.3.	Unvegetated and sparsely vegetated shores of the banks	Unvegetated and sparsely vegetated shores of permanent freshwater lakes and ponds or parts of such bodies of water in which water is permanently retained, occasionally dry due to artificial or natural fluctuation of the water surface, including unvegetated lake beds created by wind or waves. Often important habitats for feeding some migratory bird species.
A.2.7.	Unvegetated and sparsely vegetated riverbanks	Unvegetated and sparsely vegetated banks are dry as a result of artificial or natural fluctuation of the water surface. It includes shores with soft and mobile sediments (banks) and stony and rocky shores. Often important habitats for feeding some migratory bird species.
A.3.1.	Underwater vegetation of antlers	Vegetation of cormoid-shaped algae of the genera Chara and Nitella, which fouls the bottom of mostly shallow water pools with oligotrophic to mesotrophic water with a neutral to weakly basic reaction.
A.3.2.	Free-swimming floating and submerged hydrophytes	The plants that make up the vegetation of this biotope complex do not take root at the bottom of the pool, but swim freely on the surface of the water or are submerged (completely immersed in water).
A.3.3.*	Rooted aquatic vegetation	Aquatic communities of calm, relatively deep pools of water and streams of varying speed, built of plants that root to the bottom of the pool or stream.
A.3.3.1.5.	Large spawning grounds	Populations of large spawners are found in lakes, gravel pits, marshes, canals and rivers. Often, only one of the mentioned types of spawners prevails.
A.3.3.2.	Rooted submerged communities of liquid water	Communities of vascular plants rooted at the bottom of flowing water. The variability of the habitat within this group is manifested primarily in the speed of the flow and the physical and chemical characteristics of the water medium.
A.3.4.	Carbonate spring	Carbonate hot Palaearctic with specialized communities usually dominated by Cratoneurion commutati mosses. Characteristic species are the mosses Cratoneuron filicinum, Cratoneuron commutatum, Cratoneuron commutatum var. falcatum, Catoscopium nigritum, Eucladium verticillatum, Gymnostomum recurvirostrae, and horsetails Equisetum telmateia and Equisetum variegatum.
A.3.5.	Travertine river communities	Euhydrophytic communities of Palaearctic watercourses that are poor in nutrients, but rich in limestone and in which travertine is formed.
A.3.6.	Travertine vegetation on waterfalls	Euhydrophytic communities of mosses and algae accompanied by the grass Polypogon viridis, in Palearctic watercourses that are poor in nutrients and rich in limestone. This community forms large structured deposits of tufa, with a complex arrangement of lower syntaxonomic units, characteristic especially for the karst area of the eastern Adriatic coast.
A.4.1.	Reeds, rushes, tall sedges and tall sedges	Communities of the edges of lakes, rivers, streams, eutrophic ponds and swamps, but also shallow floodplains or areas with a high level of lower (underground) water in which marshy, tall monocotyledons and dicotyledons, mainly helophytes, predominate
A.4.2.*	Amphibian communities	This group mainly includes therophytic vegetation adapted to the alternation of submerged and dry phases of the substrate (soil). It inhabits the bottoms and shores of shallow lakes and ponds, in the Littoral of ponds that are periodically or temporarily flooded, and they

NKS code	NKS name	Habitat description
		develop on muddy, sandy or stony soil. This includes communities of annual plants that develop during the "dry phase" during the summer, and communities of perennial plants that tolerate occasional flooding.
A.4.2.1.*	Low spikes	Vegetation that develops on the banks of ponds that remain dry in one part of the year, and on the bottoms of occasional ponds, such as puddles and ponds.
A.4.2.1.3.	The community of the egg-shaped lake bream and the three-veined leubor	The association includes those stands that Horvatić (1963) labeled with the name "Eleocharetum ovatae Hayek 1923". Along with Eleocharis ovata, there are species of Lindernia dubia / L. procumbens, Limosella aquatica, Marsilea quadrifolia, and other species of amphibian communities.
B.1.3.	Alpine-Carpathian-Balkan limestone rocks	A group of chasmophytic communities of rock plants developed in the cracks of carbonate rocks of foothills and mountains, less often hilly and mountain vegetation zones.
B.2.4.	Pioneer communities on carbonate outcrops	Communities appear in natural as well as artificial habitats, most often on a dolomite substrate. They represent the initial phase of vegetation succession.
C.1.1.1.	Basophilic crets (low crets)	The vegetation of basophilic low (flat) crets is found in places where calcareous waters erupt on an impermeable substrate. They develop on soils that are constantly saturated with water, often rich in limestone and bases, but poor in nutrients. Water is retained directly on the ground, slightly above or below ground level. Calciphilous small sedges and other species from the Cyperaceae family usually dominate these communities. A carpet of brown mosses is also common on them. In these communities, there may be mixed elements of wet grasslands, tall sedges, reeds, heather, amphibian and aquatic communities, etc. On permeable karst terrain, the conditions for the development of this vegetation are not particularly favorable.
C.1.1.1.2.	Dinaric basophilic crets of dry skin	Basophyllin crets from the Dinarides developed in small stands with the species Carex panicea, Eriophorum latifolium, Succisa pratensis, Carex echinata (=Carex stellulata), Carex serotina, Parnassia palustris, Valeriana dioica, Potentilla erecta, Briza media, Vicia cracca and others.
C.1.1.1.7.	Cret five-flower pond	Cretaceous community that develops in the summer in small shallow depressions with an unvegetated substrate. They are usually very small stands, often built by only one species, Eleocharis quinqueflora. Sometimes another type of basophilic crets is also found, eg Carex flava agg.
C.1.2.1.1.	Cret white spikes	The significant Central European community in Croatia is relict and very rare. Today it is known from a small number of sites where it was fragmentarily developed, and in most localities it has already disappeared. Characteristic species are Rhynchospora alba, Agrostis canina and Sphagnum spp.
C.1.2.1.2.	Cret of star sedge and dew	It develops on a shallower peat substrate, on alluvial grounds. Today, there are only very small, often with an area of only a few m2, fragmentarily developed and highly endangered stands in which there are Drosera rotundifolia, Carex echinata (=Carex stellulata), Carex flava, Eriophorum angustifolium, Eriophorum latifolium.
C.1.2.2.1.	Mountain peat cret	In the past, fragmentary vegetation of raised (high) crets existed in several places in Croatia, and today the only remnant is on Trstenik. Characteristic species of peat mosses (Sphagnum rubellum, S. acutifolium, S. medium) are represented, but nowhere are there any flowering plants specific to the tall peat mosses of the northern regions of Europe. In addition to peat mosses and Polytrichum strictum, heather (Calluna vulgaris) and sedge (Molinia caerulea) dominate the community, which is the dominant species in these stands today. The abundant occurrence of invertebrates, in some places enhanced by anthropogenic influence, caused a succession in the direction of moist acidocline grasslands, so that today it is the only locality in Trstenik that still retains some characteristics of the high Cretaceous. Other species include Eriophorum angustifolium, Vaccinium vitisidaea, Carex flava,
C.2.2.	Wet meadows of Central Europe	The hygrophilous meadows of Central Europe are spread from the lowland to the mountain vegetation belt.
C.2.2.1.	Osaka flood meadows	Flood alluvial meadows of continental Europe, which do not require fertilization for their survival, but in the absence of mowing, they are threatened with healing. According to *Mucina et al. connection Cnidion venosi Bal.-Tul. 1965 is considered a synonym of the association Deschampsion cespitosae Horvatić 1930. This approach was not applied when creating this classification, so the association Deschampsion cespitosae Horvatić 1930 is excluded from the communities associated with the association Cnidion venosi Bal.-Tul. 1965 is under the code C.2.2.4..
C.2.2.2.	Permanently wet meadows of Central Europe	The community represents permanently wet meadows of Central Europe with a high level of groundwater during the growing season.

NKS code	NKS name	Habitat description
C.2.2.2.1.	Common invertebrates of Central European meadows	The community is significant primarily for the mountainous area of Central Europe, where it develops on moderately moist soils, especially during spring. In Croatia, this name covers different stands dominated by Molinia caerulea with a different flora composition.
C.2.2.2.3.	Meadows of lungworts and coastal invertebrates	A meadow community dominated by Molinia litoralis (Molinia caerulea subsp. arundinacea), which indicates the variability of soil moisture, where an extremely wet phase alternates with a relatively dry phase during the growing season. In addition to the invertebrates, Gentiana pneumonanthe, Succisa pratensis, Juncus effusus, Selinum carvifolia are also important in the floristic composition.
C.2.2.3.	Communities of hygrophilous greens	Communities that develop in meadows where water often remains year-round.
C.2.2.4.	Periodically wet meadows	Communities develop on meadows for which the alternation of wet and dry phases is significant. Since the approach applied in *Mucina et al. was not used during the creation of this classification. communities of the Cnidion venosi Bal.-Tul association are not included within this association. in 1965
C.2.2.5.	Communities with pale clover	Wet meadows developed on heavy, poorly permeable soils.
C.2.3.2.	Mesophilic meadows of Central European meadows	The community represents the mesophilic meadows of Central European meadows spread from the lowland to the mountain belt.
C.2.3.2.1.	Central European meadows of early pohovka	The community represents the most important meadow-mower of the Atlantic part of Central Europe. It reaches its eastern border in Croatia. It develops, as a rule, beyond the reach of flood waters. In the floristic composition, Arrhenatherum elatius, Trisetum flavescens, Crepis biennis, Tragopogon pratensis, Knautia pratensis, Heracleum sphondilium and a number of others stand out. It is one of the most floristically rich meadow communities. Apart from the typical, subas is also known in Croatia. salvietosum pratensis in drier habitats, and subas. convolvuletosum arvensis in more or less ruderal habitats.
C.2.3.2.12.	Meadows of sedges and yellow sables	It is a significant meadow community in the mountainous parts of western Croatia. It is widespread in Gorski kotar, mostly above 1000 meters above sea level. The largest stands are located in the area of Begovo Razdolje. The floristic composition is dominated by Trisetum flavescens, and is joined by several apomictic species of the genus Alchemilla, along with a number of species of the order ARRHENATHERETALIA. In the previous (fourth) version of the NKS, this community was marked with the code C.2.3.3.1..
C.2.3.2.2.	Hare's thorn meadows and early pohovka	The meadow meadow community is significant for the sub-Pannonian part of Podravina, where it has been studied in more detail. In addition to the species just mentioned, Ononis arvensis plays a significant role in the floristic composition.
C.2.3.2.3.	Meadows of mountain hare and early pahovka	The community is significant for the mountainous parts of Lika, from where it was described. So far, it is known from Krasansko polje in northern Velebit and Oštarijsko polje in central Velebit. In the floristic composition, in addition to the arenateretal species, Centaurea fritschii and several brometal species regularly appear.
C.2.3.2.4.	Meadows of tuberous cones and early sedges	The meadow community described from the sub-Pannonian part of Austria in the wider vicinity of Vienna was discovered in Croatia only recently in the area of Sveta Nedjelja and Samobor and phytocenologically analyzed there. In the floristic composition, Filipendula vulgaris and Galium verum stand out in addition to the general arenateretal species.
C.2.3.2.5.	Meadows of russet and reeds	The meadow community of the lowland part of eastern Croatia. It develops on areas beyond the reach of flood water, and in the floristic composition, Rhynanthus rumelicus, Filipendula vulgaris and Fragaria viridis stand out.
C.2.3.2.7.	Lowland haystacks with medicinal blood	Mowers on weakly to moderately fertilized soil of the lowlands belonging to the order Arrhenatherion. These grasslands are rich in species, and on some of them, in addition to those from the order Arrhenatherion, some "molinietal" species also grow there. The habitat is known for large blue butterflies, whose larvae feed exclusively on large bloodsucker (Sanguisorba officinalis). Plant species for habitat identification are: Arrhenatherum elatius, Trisetum flavescens, Pimpinella major, Centaurea jacea, Crepis biennis, Knautia arvensis, Tragopogon pratensis, Daucus carota, Leucanthemum vulgare, Alopecurus pratensis, Sanguisorba officinalis, Campanula patula, Leontodon hispidus. Dianthus deltoides. Lawns are mowed once or twice a year, and intensive fertilization sharply reduces the otherwise large number of species in the habitat.
C.2.4.1.	Nitrophilic pastures of the lowland vegetation belt	Communities that develop on moist soils rich in nitrates.
C.3.1.1.	Subpannonian fescue grasslands	Dry grasslands of the eastern continental part of Croatia in the Pannonian area. Due to intensive agriculture, these grasslands have mostly disappeared and only a few small stands or stripy areas along roads and embankments have been preserved.

NKS code	NKS name	Habitat description
C.3.2.1.	Pannonian open grasslands on the sands	Grasslands on the Pannonian sands, which used to be mobile, but today are stilled by human activity. They are maintained by special protection measures, which consist of preventing the spread, they are often very invasive, non-sand species. In addition to undesirable species, the surface layer of humus is also removed.
C.3.3.	Sub-Atlantic mesophilic grasslands and mountain meadows on carbonate soils	They belong to the class FESTUCO-BROMETEA Br.-Bl. et Tx. ex Soó 1947. More or less mesophilic communities created in the processes of anthropogenic degradation, dominated by perennial sedge grasses and to a lesser extent by sedges.
C.3.3.1.	Mountain meadows of upright oats on a carbonate substrate	Mesophilic communities formed in the processes of anthropogenic degradation dominated by perennial sod grasses. They mostly serve as mowing meadows and as pastures, and they are significant for the sub-Atlantic parts of Europe in terms of climate. They inhabit shallower or deeper, brown carbonate soils, usually on steep slopes, unsuitable for agriculture. They are significant habitats due to the abundance of orchids.
C.3.4.2.	Hardy grass lawns	Dry or more or less mesophilic grasslands on acidic soils dominated by Nardus stricta.
C.3.4.3.3.	Lika heath	The most important species that builds this type of habitat is the heather ("heath") - Calluna vulgaris - from where the folk name "heath" originates. Calluna vulgaris is a Western European (Atlantic) species and reaches the easternmost limit of its range (Fukarek 1963) precisely in Croatia (Lika). Chamaespartium sagittale (=Genista sagittalis), Festuca tenuifolia (=Festuca filiformis), Genista pilosa, Viola canina, Potentilla erecta, Luzula campestris also stand out in the floristic composition. This community also includes very small stands of the Festucetum capillatae Horvat 1962 community, large areas of which in Lika have grown into sedges, and some of them have been burned in order to obtain better quality pastures. In the previous version (fourth) of the NKS, this habitat type was recorded with the code C.3.4.1.1..
C.3.7.1.	Community of one-year kafranka	The community was developed only on parts of the salted pasture in the village of Trpinji. Camphorosma annua predominates in the composition, while Puccinellia distans subsp. limosa, Aster tripolium subsp. pannonicum, Plantago tenuiflora and Scorzonera cana. Unfortunately, the species Pholiurus pannonicus, which was present a few decades ago, has not been confirmed by new research.
C.5.4.1.1.	Tall green with a real cone	Communities of tall greens that develop along rivers, in wet depressions and in abandoned meadows in the western deciduous forest region, and are dominated by the true coneflower (Filipendula ulmaria).
C.5.4.1.2.	Shady communities of common burdock	Communities of alluvial banks along small streams, characteristic of the lower mountain positions of the Alpine system and the Hercynian chain of Western and Central Europe. The dominant species is Petasites hybridus (syn. Petasites officinalis), sometimes Chaerophyllum hirsutum or Equisetum telmateia, along with which tall green Cirsium oleraceum or ferns are common. In the previous (fourth) version of the NKS, this community was marked with the code I.1.5.5.
D.1.1.1.	Willows of gravelly and sandy river banks	A set of habitats and associated plant communities of deciduous thickets (willows) that form in the upper and middle reaches of rivers that flow from the Alpine area in Central Europe. In Croatia, this group of habitats includes willows with gray willow (Salix eleagnos) and/or willow (Salix purpurea).
D.1.1.1.1.	Pre-alpine willows with sedge	A typical community of pebbly riverbanks in the upper reaches of alpine rivers. It was studied on the banks of the Drava near Varaždin, but it was mostly destroyed there by the construction of the hydroelectric power plant system. In the floristic composition, the most significant are Salix eleagnos and Myricaria germanica, and Salix purpurea and Calamagrostis epigejos, while the other species are not permanent.
D.2.5.	Pine trees	Stands develop on abandoned grasslands of hills and hills, and often occupy large areas in Lika, Kordun and Gorski kotar.
E.*	Forests	The entire forest vegetation, managed or unmanaged, natural or anthropogenic (including forest plantations), together with those development stages that do not differ in flora composition from the stages of mature forests, and physiognomically belong to "shrubs" in the broader sense
E.1.1.	Flooded willow forests	The community belongs to the order SALICETALIA PURPUREAE Moor 1958 within the class SALICETEA PURPUREAE Moor 1958. The community includes shrubby stands of rickets and almond willows and forest stands built by white willow, black and white poplar.
E.1.2.	Flooded poplar forests	The association Salicion albae Soó 1951 consists of low open willow and poplar forests that develop in lowlands or sub-mountainous river valleys in the temperate climate zone and at higher altitudes in the Mediterranean region. The association Populion albae consists of floodplain forests of the sub-Mediterranean region.

NKS code	NKS name	Habitat description
E.2.1.	Flood forests of black alder and field ash	Floodplain forests of low-lying Central European and North Pyrenean watercourses, on soils that are periodically flooded during the annual high water level of rivers, but are otherwise well drained and aerated during low water levels.
E.2.2.	Floodplain oak forests	They belong to the order ALNETALIA GLUTINOSAE Tx. 1937. Mixed flood forests of the Pannonian and sub-Mediterranean parts of Southeast Europe dominated by the species Quercus robur, Fraxinus angustifolia, Ulmus minor, Ulmus laevis, Alnus glutinosa, Acer campestre, Carpinus betulus. They develop on pseudoglea, and are flooded for a relatively short time.
E.3.1.	Mixed oak-hornbeam and pure hornbeam forests	They belong to the order FAGETALIA SYLVATICAE Pawl. in Pawl. et al. 1928. Mesophilic and neutrophilic forests of planar and barren (colline) areas, regularly out of reach of floodwaters, in which the upper forest floor is dominated by sedge or sedge, and in the lower floor by hornbeam (which in the degradation stages can be the dominant tree species). These forests form an altitudinal transition between lowland flood forests and mountain beech forests.
E.3.4.	Central European thermophilic oak forests	They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order QUERCETALIA PUBESCENTIS Klika 1933.
E.3.5.	Coastal, thermophilic forests and honeysuckle thickets	They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order QUERCETALIA PUBESCENTIS Klika 1933.
E.4.1.	Central European neutrophilic to weakly acidophilic, mesophilic beech forests	They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order FAGETALIA SYLVATICAE Pawl. in Pawl. et al. in 1928
E.4.2.	Central European, acidophilic beech forests	They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order FAGETALIA SYLVATICAE Pawl. in Pawl. et al. in 1928
E.4.5.	Mesophilic and neutrophilic pure beech forests	They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order FAGETALIA SYLVATICAE Pawl. in Pawl. et al. 1928 by Aremonio-Fagion (Horvat 1950) Borhidi in Török et al. in 1989
E.5.1.	Pannonian beech-fir forests	It is located on a silicate substrate and district brown soils. They belong to the class QUERCO-FAGETEA Br.-Bl. et Vlieger 1937 order FAGETALIA SYLVATICAE Pawl. in Pawl. et al. 1928 by Aremonio-Fagion (Horvat 19508) Borhidi in Török et al. in 1989
I.1.5.*	Nitrophilic, scyophilic ruderal vegetation	The group includes various shady, nitrophilous communities, developed along the edges and in small clearings within moist and flooded forests.
I.1.5.4.5.	Prickly licorice community	The community develops in the Croatian part of Posavina in the belt of floodplain forests or thickets of willows and poplars, especially on their cuttings, on sandy or sandy-loamy alluvial soil, which is periodically flooded for a short time. So far, it has been studied near Galdov near Sisak, Bročice, Jasenovac, Slavonski Kobaš and Gunja. The floristic composition is dominated by Glycyrrhiza echinata, joined by Althaea officinalis, Senecio erraticus, Calystegia sepium, Asclepias syriaca, Euphorbia lucida, Urtica dioica and others. floristic composition have not been published.
I.1.7.*	Communities of nitrophilic, hygrophilic and schiophilic habitats	They belong to the BIDENTETEA Tx class. et al. ex von Rochow 1951. A set of schiophilic and weakly nitrophilic communities that develop in rare forests, along forest roads and averages, along the edges of forest roads in the lowland vegetation belt, and secondarily on river banks for low water levels.
* within the class there are rare and endangered communities		

3.3.6.2 Flora

The scope of the Plan is within the 14 counties of the Republic of Croatia, with the fact that it does not cover the area of the entire Karlovac County. A significant number of threatened and strictly protected plant taxa, most commonly associated with wet and grassland habitats, was recorded on that area. Based on the available data of the Flora Croatica Database portal, 2589 plant species were recorded in the area covered by the Plan. According to the Ordinance on Strictly Protected Species (Official Gazette 144/13, 73/16), among the recorded species there are 165 strictly protected plant species that belong to the IUCN higher threat categories of the Law on Nature Protection (Official Gazette 80/13, 15/18, 14/19, 127/19): 6 regionally extinct (RE), 63 critically endangered (CR), 45 endangered (EN) and 51 vulnerable (VU) species (Table3.42).

Table3.42List of high-risk and strictly protected flora in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to the Flora Croatica Database portal and the Ordinance on Strictly Protected Species)

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
regionally extinct (RE)															
Caldesia parnassifolia(L.) Parl.	RE/NW								X		X				X
*Cuscuta epilinum*Weihe	RE/NW					X	X					X			X
*Cyperus glaber*L.	RE/NW								X					X	
*Drosera intermedia*Hayne	RE/NW														X
*Eryngium planum*L.	RE/NW										X				
*Hippophae rhamnoides*L.	RE/NW					X		X				X			X
critically endangered (CR)															
Agropyron cristatum(L.) Gaertn. coll. pectinatum (M. Bieb.) Tzvelev	CR/NW								X			X			
*Alyssum montanum*L. ssp. pluscanescens (Raim. ex Baumgartner) Trpin	CR/NW														X
*Anemone sylvestris*L.	CR/NW			X	X		X		X			X			X
*Aster tripolium*L. ssp. pannonicus (Jacq.) Soó	CR/NW														X
Baldellia ranunculoides(L.) Parl.	CR/NW										X				
Bassia laniflora(SGGmel.) AJ Scott	CR/NW			X		X									X
*Betula pubescens*Ehrh.	CR/NW	X		X	X	X	X			X	X	X	X		X
Botrychium matricariifolium(Retz .) A. No. ex Koch	CR/NW			X											
*Calla palustris*L.	CR/NW						X		X	X		X			X
*Camphorsma annua*Pallas	CR/NW							X					X		
*Carex bohemica*Schreb.	CR/NW					X			X		X	X			
Catabrosa aquatica(L.) P. Beauv.	CR/NW	X				X	X		X	X		X		X	X

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Chamaecytisus ratisbonensis(Schaeff.) Rothm.	CR/NW					X							X		
Consolida ajacis(L.) Schur	CR/NW			X					X					X	X
Consolida orientalis(Gay) Schrödinger	CR/NW													X	
Corynephorus canescens(L.) P. Beauv.	CR/NW	X		X		X				X		X	X		X
*Cyperus capitatus*Vand.	CR/NW											X			X
*Delphinium halteratum*Sm. in Sibth. et Sm.	CR/NW											X			
*Digitalis lanata*Ehrh.	CR/NW								X	X			X	X	
*Doronicum hungaricum*Rchb.f.	CR/NW								X						
*Drosera rotundifolia*L.	CR/NW				X		X	X			X	X			X
Eleocharis uniglumis(Link) Schult.	CR/NW								X			X			X
*Eriophorum angustifolium*Honck.	CR/NW	X			X	X	X			X	X	X			X
*Festuca vaginata*Waldst. et Kit. ex Willd.	CR/NW					X				X			X		X
*Gallium rubioides*L.	CR/NW			X			X		X						X
*Gallium uliginosum*L.	CR/NW			X	X	X		X	X					X	X
*Heliotropium supinum*L.	CR/NW		X												
*Hieracium echioides*Lumn.	CR/NW					X									
*Hydrocotyle vulgaris*L.	CR/NW										X	X			
*Kitaibela vitifolia*Willd.	CR/NW								X					X	
Koeleria glauca(Schrad.) DC.	CR/NW			X		X									X
*Limosella aquatica*L.	CR/NW					X		X	X		X			X	
Lycopodiella inundata(L.) Pigeon	CR/NW					X	X				X				
*Lythrum tribracteatum*Salzm. ex Spreng.	CR/NW		X												
*Myosurus minimus*L.	CR/NW					X							X		X
Myricaria germanica(L.) Desv.	CR/NW			X		X		X				X			X

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
*Osmunda regalis*L.	CR/NW				X						X				X
*Papaver argemone*L.	CR/NW					X				X			X		
*Papaver hybridum*L.	CR/NW												X		
Pholiurus pannonicus (Host) Trin.	CR/NW							X						X	
*Pinguicula vulgaris*L.	CR/NW				X										X
*Plantago indica*L.	CR/NW			X		X		X	X				X		
*Plantago tenuiflora*Waldst. et Kit.	CR/NW													X	
*Polygonum arenarium*Waldst. et Kit.	CR/NW					X		X		X		X			
Potentilla palustris(L.) Scop.	CR/NW				X										
*Prunus tenella*Batsch	CR/NW								X						
Puccinellia distans(L.) Parl.	CR/NW											X			
Pulsatilla pratensis(L.) Miller ssp. nigricans (Störck) Zam.	CR/NW				X	X			X			X		X	X
*Reseda inodora*Rchb.	CR/NW								X				X		
Rhynchospora alba(L.) Vahl	CR/NW				X						X				X
*Scirpus cespitosus*L.	CR/NW			X						X					X
*Scirpus mucronatus*L.	CR/NW		X		X			X				X			X
*Scirpus setaceus*L.	CR/NW					X		X			X				
*Scirpus supinus*L.	CR/NW		X					X							
Tofieldia calyculata(L.) Wahlenb.	CR/NW				X							X			X
*Trifolium michelianum*Sava	CR/NW		X							X	X		X		
*Triglochin maritimum*L.	CR/NW											X			
*Triglochin palustris*L.	CR/NW							X			X	X			X
*Typha laxmannii*Lepech.	CR/NW								X						

Scientific name	Threat category / level of protection	BB Ž	BP Ž	G Z	KŽ *	KK Ž	KZ Ž	M Ž	OB J	PS G	SM Ž	V Ž	VP Ž	VS Ž	Z Ž
*Typha minima*Funk	CR/NW					X		X	X			X			
Vaccaria hispanica(Miller) Rauschert	CR/NW			X	X	X						X			
Ventenata dubia(Leers) Coss.	CR/NW	X		X		X			X	X	X	X	X		
*Veronica dillenii*Crantz	CR/NW					X			X						
*Adonis aestivalis*L.	EN/SZ			X	X	X				X		X			X
*Adonis annua*L. amend. Hoods.	EN/SZ											X			
*Alisma gramineum*Lay.	EN/SZ								X						
*Allium angulosum*L.	EN/SZ					X			X	X		X	X	X	X
Blackstonia perfoliata(L.) Huds. coll. serotina (Kochex Rchb.) Vollm.	EN/SZ			X					X						X
Blysmus compressus(L.) Panz. ex Link	EN/SZ				X	X	X				X				X
*Carex davalliana*Sm.	EN/SZ						X	X				X			
*Carex divisa*Hoods.	EN/SZ									X		X			
*Carex echinata*Murray	EN/SZ	X		X	X		X		X	X	X	X			X
*Carex flava*L.	EN/SZ			X	X	X	X	X		X	X	X	X		X
*Carex hostiana*DC.	EN/SZ			X		X				X	X				X
*Carex lepidocarpa*Tausch	EN/SZ				X		X								X
Carex nigra(L.) Reichard	EN/SZ	X			X	X	X		X	X	X	X			X
*Carex serotina*Merat	EN/SZ			X	X		X	X		X	X	X			X
*Cynanchum acutum*L.	EN/SZ	X									X				
*Cypripedium calceolus*L.	EN/SZ					X						X			X
Dactylorhiza incarnata(L.) Soó	EN/SZ			X						X	X		X		X
Dactylorhiza majalis (Rchb.) PFHunt et Summerh.	EN/SZ			X		X	X		X	X		X	X		X
*Daphne cneorum*L.	EN/SZ									X	X		X		X

*Eleocharis carniolica*Koch	EN/SZ				X										X
Eleocharis ovata(Roth) Roem. et Schult.	EN/SZ				X					X			X		
*Eriophorum latifolium*Hopp	EN/SZ	X		X	X		X	X		X	X	X	X		X
*Gentiana pneumonantha*L.	EN/SZ	X	X	X	X	X	X		X	X	X		X		X
*Glaucium flavum*Crantz	EN/SZ			X											
*Hibiscus trionum*L.	EN/SZ		X	X	X	X	X		X	X	X	X	X	X	X
*Hippuris vulgaris*L.	EN/SZ			X	X		X		X	X		X	X	X	
*Hordeum secalinum*Schreb.	EN/SZ		X	X		X				X			X		X
*Hottonia palustris*L.	EN/SZ			X	X	X	X	X	X		X		X	X	X
*Solder gibba*L.	EN/SZ	X		X	X				X		X				X
*Malva parviflora*L.	EN/SZ									X			X		
*Marrubium peregrinum*L.	EN/SZ	X		X	X				X						X
*Marsilea quadrifolia*L.	EN/SZ	X	X	X	X	X	X		X	X	X	X			X
*Menyanthes trifoliata*L.	EN/SZ			X	X					X	X			X	X
*Ophrys apifera*Hoods.	EN/SZ			X	X	X	X			X			X		X
*Orchis lactea*Poir.	EN/SZ														X
*Orchis spitzelii*Saut. ex Koch	EN/SZ														X
*Pedicularis hoermanniana*K. Malý	EN/SZ				X										X
*Periploca graeca*L.	EN/SZ			X		X					X	X			
*Ranunculus lingua*L.	EN/SZ								X		X			X	
*Ranunculus ophioglossifolius*Vill.	EN/SZ					X					X				X
*Rhinanthus rumelicus*Velen.	EN/SZ		X	X						X				X	
*Salvia nemorosa*L.	EN/SZ			X		X			X	X			X	X	X
Selaginella helvetica(L.) Spring.	EN/SZ						X								
*Vicia onobrychioides*L.	EN/SZ			X											X
*Xeranthemum annuum*L.	EN/SZ					X			X	X		X	X		
*Alopecurus aequalis*Sable.	VU/NZ		X	X	X	X		X	X	X	X		X	X	X
*Alopecurus geniculatus*L.	VU/NZ		X	X	X		X	X	X	X	X	X	X	X	X
*Alopecurus rendlei*Eig	VU/NZ		X	X	X		X			X	X	X	X		X
*Arnica montana*L.	VU/NZ				X										X
Cardaminopsis halleri(L.) Hayek	VU/NZ						X								X
*Carex panicea*L.	VU/NZ		X	X	X		X	X	X	X	X	X	X		X
*Carex riparia*Curtis	VU/NZ		X	X	X	X	X		X	X	X	X	X	X	X

*Carex rostrata*Stokes ex With.	VU/NZ				X				X	X	X	X		X	X
*Carex vesicaria*L.	VU/NZ		X	X	X	X	X		X	X	X	X	X	X	X
*Clematis integrifolia*L.	VU/NZ		X	X					X	X	X		X	X	X
*Cyperus flavescens*L.	VU/NZ			X	X		X	X		X	X	X	X		X
*Cyperus fuscus*L.	VU/NZ		X	X	X	X	X	X	X	X	X	X	X	X	X
*Cyperus glomeratus*L.	VU/NZ		X	X		X			X					X	X
*Cyperus longus*L.	VU/NZ				X		X		X		X				X
Cyperus michelianus(L.) Link	VU/NZ			X					X		X	X			X
*Cyperus serotinus*Rottb.	VU/NZ	X		X		X		X				X			
*Daphne blagayana*Freyer	VU/NZ														X
*Dianthus giganteus*D' Urv ssp. croaticus (Borbás) Tutin	VU/NZ			X	X		X	X	X	X	X	X			X
*Digitalis ferruginea*L.	VU/NZ		X	X	X				X	X			X		
*Equisetum hyemale*L.	VU/NZ	X		X	X	X	X		X	X		X	X		X
*Fritillaria meleagris*L.	VU/NZ	X	X	X	X	X	X		X	X	X	X	X	X	X
Glyceria fluitans(L.) R.No.	VU/NZ		X	X	X	X	X		X	X	X	X	X	X	X
Glyceria plicata(Fr.) Fr.	VU/NZ			X	X	X	X		X	X	X		X		X
*Hordeum marinum*Hoods.	VU/NZ										X				
*Ilex aquifolium*L.	VU/NZ	X	X	X	X	X	X			X		X	X		X
*Iris croatica*Horvat et MDHorvat	VU/NZ			X			X			X			X		X
*Lilium bulbiferum*L.	VU/NZ				X						X				X
*Lilium carniolicum*Bernh. ex Koch	VU/NZ			X	X		X					X	X		X
*Lilium martagon*L.	VU/NZ		X	X	X	X	X		X	X		X	X	X	X
Lindernia procumbens(Krock.) Philcox	VU/NZ		X	X					X	X	X		X		X
Lythrum portula(L.) DAWebb	VU/NZ		X	X	X					X	X		X		X
Ophrys fuciflora(FWSchmidt) Moench	VU/NZ			X		X	X			X		X	X		X
*Ophrys fusca*Link	VU/NZ			X											
*Ophrys insectifera*L.	VU/NZ			X	X	X	X			X		X	X		X
*Ophrys sphegodes*Mill.	VU/NZ			X	X	X	X		X	X			X		X
*Orchis coriophora*L.	VU/NZ	X		X	X	X	X		X	X	X		X	X	X
*Orchis militaris*L.	VU/NZ	X	X	X	X	X	X		X	X		X	X		X

*Orchis pallens*L.	VU/NZ			X	X	X	X			X		X	X		X
*Orchis purpurea*Hoods.	VU/NZ		X	X	X	X	X		X	X	X	X	X		X
*Orchis simia*Lam.	VU/NZ			X						X		X	X		X
*Orchis tridentata*Scop.	VU/NZ		X	X	X	X	X			X	X	X	X		X
*Orchis ustulata*L.	VU/NZ	X		X	X	X	X			X					X
Platanthera bifolia(L.) Rich.	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Polygonatum latifolium(Jacq.) Desf.	VU/NZ	X		X		X			X	X				X	
*Salsola kali*L.	VU/NZ					X									
*Stratiotes aloides*L.	VU/NZ								X		X		X	X	
*Suaeda faith*JF Gmelin in L.	VU/NZ													X	
*Taxus baccata*L.	VU/NZ	X		X		X	X			X		X	X	X	X
*Trifolium pannonicum*Jack.	VU/NZ			X	X	X	X			X		X	X	X	X
*Trifolium resupinatum*L.	VU/NZ			X											
Wolffia arrhiza(L.) Horkel ex Wimm.	VU/NZ	X	X	X	X	X			X	X	X				X

3.3.6.3 Fauna

Invertebrates

The scope of the Plan is within the 14 counties of the Republic of Croatia, with the fact that it does not cover the area of the entire Karlovac County. According to MINGOR data, a significant number of endangered and strictly protected species, i.e. 134 species of invertebrates, were recorded in the area. 4 regionally extinct (RE), 31 critically endangered (CR), 48 endangered (EN) and 51 vulnerable (VU) species of invertebrates were recorded, and most species are also strictly protected (SZ). In the following table there is a list of them and it is indicated in which county they were recorded (Table3.43).

Table3.43List of high-risk and strictly protected species of invertebrates in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to data from MINGOR, Regulations on Strictly Protected Species and Red Books)

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Machaerites croaticus	CR/NW				X										
Typhlotrechus bilimekii croaticus	EN/SZ				X										
Chthonius exarmatus	CR/NW										X				
Chthonius magnificus	EN										X				
Chthonius born	EN/SZ										X				
Chthonius trebinjensis	CR/NW										X				
Insulocreagris regina	VU/NZ										X				
Microchthonius karamani	EN/SZ										X				
Microchthonius rogatus	VU/NZ										X				
Neobisium gentile flavum	VU/NZ										X				
Neobisium gentile giganteum	CR/NW										X				
Neobisium hadzii	VU/NZ										X				
Neobisium heros	VU/NZ										X				
Neobisium insulare	EN/SZ	X									X				
Neobisium lethaeum superbum	CR/NW										X				
Neobisium spelunkarium	EN/SZ										X				
Roncus trojanicus	CR/NW										X				
Troglochthonius doratodactylus	VU/NZ										X				
Troglochthonius mirabilis	VU/NZ										X				
Abasola troglodytes	CR/NW										X				
Cyphophthalmus noctiphilus	EN/SZ										X				
Cyphophthalmus silhavyi	EN/SZ										X				
Hadzinia Karamani	VU/NZ										X				
Travunia jandai Kratochv	VU/NZ										X				
Apatura metis	VU/NZ		X			X		X	X				X		
Colias myrmidone	CR/NW	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Leptidea morsei major	VU/NZ	X		X	X	X	X	X		X	X	X	X		X
Nymphalis vaualbum	CR/NW	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Nymphalis xanthomelas	EN/SZ		X	X	X	X	X			X		X	X		X
Phengaris alcon alcon	CR/NW	X								X		X			
Phengaris alcon rebeli	VU/NZ		X		X		X		X	X		X	X		X
Phengaris Arion	VU/NZ	X	X	X		X			X	X	X	X	X		X
Phengaris nausithous	CR/NW					X		X				X			
Phengaris teleius	CR/NW					X		X				X	X		
Delay bureschi	EN				X										

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Besdolus imhoffi	VU/NZ														X
Brachyptera monilicornis	EN/SZ	X			X					X	X		X		
Isogenus nubecula	RE				X							X			
Marthamea vitripennis	RE/NW										X				
Nemoura dubitans	EN/SZ											X			
Perla burmeisteriana	EN/SZ									X	X	X	X		
Perla carantana	VU/NZ														X
Perla illiesi	VU/NZ										X				
Pearl margin	VU/NZ	X													
Perla pallida	VU/NZ	X	X	X	X		X			X	X		X		X
Siphonoperla neglecta	VU/NZ			X						X		X	X		
Siphonoperla torrentium	VU/NZ		X							X					
Taeniopteryx auberti	VU/NZ				X										
Taeniopteryx schoenemundi	VU/NZ				X										X
Xanthoperla apicalis	CR/NW					X		X	X						
Barusia corculana	EN/SZ										X				
Folkia Boudewijni	CR/NW										X				
Folkia haasi	VU/NZ										X				
Hadites tegenarioides	VU/NZ										X				
Mesostalita comottii	VU/NZ										X				
Palliduphantes brignolii	CR/NW										X				
Stalita hadzii	VU/NZ				X										X
Stalita pretneri	EN/SZ										X				
Sulcia inferna Kratochv	CR/NW										X				
Troglohyphantes liburnicus	VU/NZ										X				
Troglohyphantes roberti dalmatensis	CR/NW										X				
Typhlonyphia reimoseri	VU/NZ										X				
Agathylla strigillata strigillata	VU/NZ										X				
Cepaea hortensis	CR/NW			X		X					X				X
Chilostoma crinita	EN/SZ										X				
Chondrina avenacea avenacea	EN/SZ			X		X	X				X				X
Clausilia pumila swordfish	CR/NW			X		X					X				
Cochlodina laminate laminate	EN/SZ	X		X	X	X	X		X		X	X	X		X
Cochlostoma stossichi	EN/SZ										X				X
Delima blanda blanda	VU/NZ										X				
Delima latilabris tenebrosa	EN/SZ										X				
Delima pachystoma pachystoma	CR/NW										X				

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Delima vidovichii leucostoma	CR/NW										X				
Hadziella thermalis	CR/NW			X											X
Hauffenia media	CR/NW				X										X
Helicella vukotinovici	EN/SZ										X				X
Nesovitrea hammonis	VU/NZ					X									
Perforatella bidentata	EN/SZ			X		X			X		X				
Pomatias rivularis	EN/SZ								X						
Vertigo moulinsiana	EN/SZ	X	X		X	X	X	X	X	X	X	X	X	X	X
Xeropicta derbentina littoralis	EN/SZ										X				
Zospeum lycanum	VU/NZ				X										
Zospeum spelaeum schmidti	VU/NZ				X										X
Acanthocyclops petkovskii	CR/NW			X											X
Astacus astacus	VU/NZ	X	X		X	X	X	X	X	X	X	X	X		X
Austropotamobius pallipes	EN/SZ		X		X					X	X	X	X		X
Austropotamobius torrentium	VU/NZ	X	X	X	X		X			X	X	X	X		X
Balkanostenasellus skopljensis croaticus	EN/SZ			X											X
Cyzicus tetracerus	VU										X				
Echinogammarus cari	EN/SZ				X										
Eoleptestheria ticinensis	EN/SZ										X		X		
Lepidurus apus	EN					X			X		X				
Leptestheria dahalacensis	VU								X		X		X		
Leptodora kindtii	VU			X											
Monolistra caeca meridionalis	EN/SZ				X										
Monolistra racovitzai pseudoberica	VU/NZ														X
Monolistra velkovrhi	EN/SZ				X										X
Niphargus hrabei	EN/SZ														X
Niphargus jalzici	EN/SZ				X										
Niphargus kenki	VU						X								
Niphargus labacensis	EN/SZ			X				X				X			X
Niphargus lattingerae	EN/SZ			X											X
Niphargus longidactylus	EN/SZ			X				X			X	X			X
Niphargus medvednicae	VU			X			X								X
Niphargus microcerberus	EN/SZ											X			
Niphargus pannonicus	EN		X							X			X		
Niphargus parapupetta	EN/SZ			X											X
Niphargus petrosani	EN			X			X								X

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Niphargus zagrebensis	EN/SZ			X			X								X
Protelsonia hungarica thermalis	EN/SZ			X											X
Triops cancriformis	VU										X				
Troglocaris anophthalmus	EN/SZ				X										
Onychiuroides paucituberculatus	VU/NZ										X				
Pseudosinella dallaii	CR/NW			X							X				X
Typhlogastrura hot	EN/SZ										X				
Brachydesmus croaticus	CR/NW				X										X
Chaetopteryx gonospina	VU										X				
Drusus schmidi	VU									X					
Hydropsyche guttata	VU		X												
Rhyacophila palmeni	VU				X										X
Aeshna grandis	EN/SZ					X		X			X	X			X
Aeshna viridis	CR/NW					X									
Epitheca bimaculata	EN/SZ			X		X		X	X	X	X		X	X	X
Hemianax ephippiger	VU/NZ								X		X		X	X	
Lestes macrostigma	CR/NW				X				X						
Lestes virens	VU/NZ		X		X	X	X	X	X	X	X	X	X	X	X
Leucorrhinia caudalis	CR/NW					X					X	X			
Leucorrhinia pectoralis	EN/SZ		X		X	X			X	X	X	X	X	X	X
Ophiogomphus cecilia	VU/NZ		X	X		X		X	X	X	X	X	X		X
Somatochlora metallica	RE/NW		X							X	X				
Sympetrum danae	RE/NW			X					X						
Sympetrum depressiusculum	CR/NW			X				X	X		X	X			
Sympetrum flaveolum	VU/NZ								X			X	X		X
Sympetrum pedemontanum	CR/NW							X				X			

Vertebral bones

The scope of the Plan is within the 14 counties of the Republic of Croatia, with the fact that it does not cover the area of the entire Karlovac County. According to MINGOR data, a significant number of endangered and strictly protected species, i.e. 102 species of vertebrates, were recorded in the area. 10 regionally extinct (RE), 15 critically endangered (CR), 35 endangered (EN) and 42 vulnerable (VU) vertebrate species have been recorded, and the majority of endangered vertebrate species are also strictly protected (SZ). In the following table there is a list of them and it is indicated in which county they were recorded (Table3.44).

Table3.44List of high-risk and strictly protected species of vertebrates in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to data from MINGOR, Rulebook on Strictly Protected Species and Red Books)

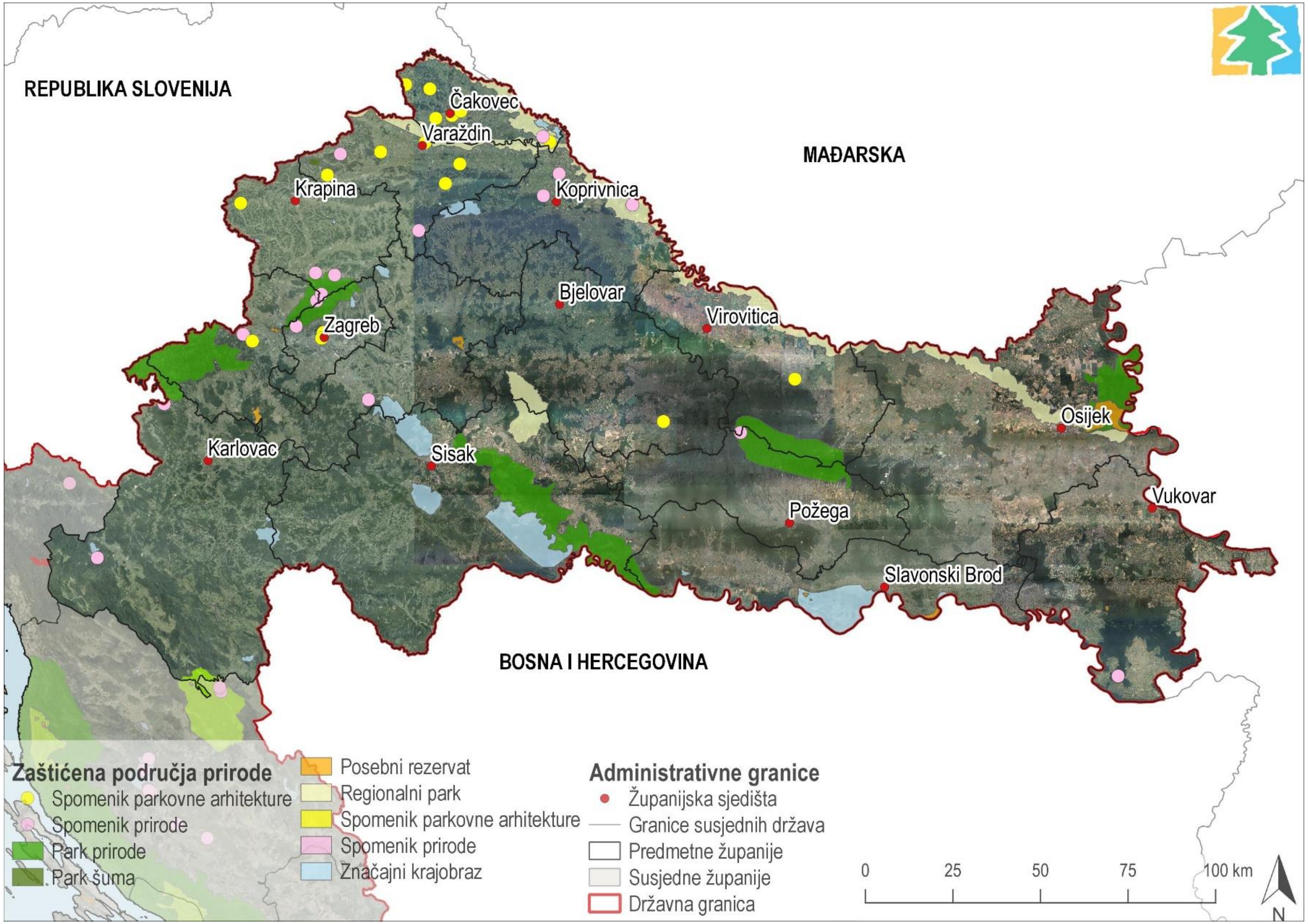
Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Acipenser gueldenstaedtii	RE/NW		X					X	X						
Acipenser naccarii	CR (EN)/NW		X								X				X
Acipenser nudiventris	RE/NW		X			X		X	X		X	X	X		X
Acipenser ruthenus	VU	X	X	X	X	X		X	X	X	X	X	X	X	X
Acipenser stellatus	RE/NW		X					X	X		X				
Acipenser sturio	RE/NW		X			X			X		X			X	
Alburnus sarmaticus	VU/NZ							X	X			X			
Aulopyge huegelii	EN/SZ										X				
Barbus balcanicus	VU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Carassius carassius	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Cobitis elongata	VU/NZ	X	X	X	X		X			X	X			X	X
Cyprinus carpio	EN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Gasterosteus aculeatus	EN/SZ	X						X	X						
Gymnocephalus balloni┬á	VU/NZ	X	X			X		X	X		X	X	X	X	X
Gymnocephalus schraetser┬á	CR/NW	X	X		X	X		X	X	X	X	X	X	X	
Hucho hucho	EN	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hoo hoo	RE/NW	X	X	X	X			X	X		X			X	X
Leucaspius delineatus	VU/NZ	X	X		X	X		X	X		X	X	X	X	X
Leuciscus idus	VU	X	X	X	X	X		X	X	X	X	X	X	X	X
Lotta lotta	VU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Misgurnus fossilis	VU/NZ	X	X		X	X	X	X	X	X	X	X	X	X	X
Sabaneje's balcanica	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X		X
Salaria fluviatilis	VU/NZ										X				
Salmo trutta	VU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Squalius illyricus	VU										X				
Telestes croaticus	EN/SZ										X				
Telestes polylepis	CR/NW				X						X				
Telestes souffia	VU/CR	X	X		X	X	X	X	X		X	X			X
Telestes is crying	CR/NW										X				
Thymallus thymallus	VU	X	X	X	X	X		X	X		X	X	X		X
Umbra traders	EN/SZ	X				X		X	X	X	X	X	X	X	X
Boom boom	VU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Zingel nerd	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Zingel zingel	VU/NZ	X	X	X	X	X		X	X	X	X	X	X	X	
Barbus meridionalis	VU	X	X	X	X	X	X		X	X	X	X	X	X	X
Chalcalburnus chalcoides	VU	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Misgurnus fossilis	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Sabanaje's balcanica	VU/NZ		X		X				X	X	X		X		X
Proteus anguinus	EN/SZ				X										X
Ablepharus kitaibelii	EN/SZ									X			X	X	
Dolichophis caspius	EN/SZ								X					X	
Zootoca vivipara pannonica	EN		X						X					X	
Acrocephalus melanopogon	CR/NW gp								X						
Actitis hypoleucos	VU/SZ gp	X	X		X	X	X	X	X	X	X	X	X		X
Anas acuta	RE/SW gp				X				X	X					
Anas clypeata	RE/SW gp	X	X		X					X					X
Anas strepera	EN/SZ gp, VU/SZ zp	X	X		X				X	X	X		X		X
Anser anser	VU/SZ gp	X	X		X	X			X	X	X		X		X
Aquila pomarina	EN/NW gp										X				X
Ardea purpurea	EN/NW gp	X	X		X	X			X	X	X		X	X	X
Ardeola ralloides	EN/NW gp	X	X		X				X	X	X		X		X
Botaurus stellaris	EN/NW gp	X			X		X		X	X	X		X	X	X
Burhinus oedicnemus	EN/NW gp						X								X
Calandrella brachydactyla	VU/SZ gp													X	
Calidris alpina	EN/SZ zp									X					
Casmerodius albus	EN/NW gp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Ciconia nigra	VU/SZ gp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Circus aeruginosus	EN/NW gp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Circus pygargus	EN/NW gp	X	X	X					X		X		X	X	X
Columba oenas	VU/SZ gp	X	X		X	X	X	X	X	X	X	X	X		
Coracias garrulus	CR/NW gp										X				
Crex crex	VU/SZ gp	X	X	X	X		X	X		X	X	X	X		X
Egretta garzetta	VU/SZ gp	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Falco cherrug	CR/NW gp								X					X	
Falco columbarius	VU/SZ pp								X						
Falco peregrinus	VU/SZ gp	X		X		X	X					X			X
Gallinago gallinago	CR/NW gp	X				X			X	X	X				
Glaucidium passerinum	VU/SZ gp	X	X				X			X	X	X			
Haliaeetus albicilla	VU/SZ gp	X	X		X	X		X	X	X	X	X	X	X	X
Hieraaetus pennatus	CR/NW gp						X			X			X		
Himantopus himantopus	VU/SZ gp	X							X				X	X	
Saint Luscinia	EN/NW gp			X					X			X			
Lymnocryptes minimus	VU/SZ pp										X				
Melanocorypha calandra	VU/SZ gp													X	
Mergus merganser	CR/NW gp	X			X	X				X					
Milvus migrans	EN/NW gp	X	X		X	X	X		X	X	X		X	X	X

Scientific name	Threat category / level of protection	BBŽ	BPŽ	GZ	KŽ*	KKŽ	KZŽ	MŽ	OBJ	PSG	SMŽ	VŽ	VPŽ	VSŽ	ZŽ
Milvus milvus	RE/SW gp								X						
Netta rufina	VU/SZ gp		X	X	X				X	X			X		
Numenius arquata	EN/SZ zp, VU/SZ gp	X								X	X				
Numenius phaeopus	VU/SZ pp														X
Pandion haliaetus	RE/SW gp	X				X				X				X	X
Panurus biarmicus	EN/NW gp	X			X				X	X			X		
Phalacrocorax pygmeus	CR/NW gp		X			X					X			X	
Platalea leucorodia	EN/NW gp	X	X						X	X	X		X		X
Plegadis falcinellus	EN/SZ pp		X								X				
Pluvialis squatarola	EN/SZ zp									X					X
Podiceps nigricollis	EN/NW gp		X		X					X	X				X
Porzana parva	EN/NW gp	X	X		X				X	X	X		X	X	X
Porzana porzana	EN/NW gp						X				X				X
Porzana pusilla	CR/NW gp										X				X
Riparia riparia	VU/SZ gp	X	X	X		X		X	X	X		X	X	X	X
Scolopax rusticola	CR/NW gp	X		X											
Sterna albifrons	EN/NW gp			X		X							X		X
Sterna caspia	EN/SZ pp									X					
Tringa totanus	CR/NW gp	X							X	X					X
Miniopterus schreibersii	EN/SZ	X	X	X	X	X	X		X	X	X	X	X	X	X
Myotis bechsteinii	VU/NZ	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Myotis capaccinii	EN/SZ				X										X
Plecotus austriacus	EN/SZ	X	X	X		X	X	X	X	X	X	X	X	X	X
Rhinolophus euryale	VU/NZ	X		X	X		X			X	X				X
Spermophilus citellus	RE/NW								X					X	
Lynx lynx	CR/NW	X	X	X	X	X	X		X	X	X	X	X	X	X

3.3.7 Protected areas of nature

In the area covered by the Plan, there are 197 protected areas in the categories of nature park, forest park, special reserve, regional park, monument of park architecture, monument of nature and significant landscape. In the following picture (Picture3.45) are cartographically shown protected areas within the scope of the Plan by county, while in the table (Table3.45) listed basic information about them. The largest area is occupied by nature parks: Žumberak - Samoborsko gorje, Kopački rit, Lonjsko polje, Medvednica and Papuk, regional parks Moslavačka gora and Mura - Drava, and important landscapes of Mura and Sunjsko polje.



Picture3.45Protected nature areas in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Bioportal and Geoportal DGU)

Table3.45Protected nature areas in the area covered by the Plan and basic information about them (Source: Bioportal)

Protection category	Area name	Proclamation year	Area (ha)
Nature park	Kopački rit	in 1977	23 142.81
	Lonjsko polje	1990	51 173.29
	Medvednica	in 1981	17,936.19
	The heel	in 1999	34 306.81
	Žumberak - Samobor mountains	in 1999	34 235.98
Forest park	Boric	in 1995	117.76
	Grandfather hill	2000	27.59
	Drava forest	2001	85.74
	Jankovac	in 1955	629.76
	Kanovci	in 2003	16.69
	Okić-grad	1970	6.58
	Ozalj-grad	1970	4.92
	Guard	1970	23,31
	Tepec - Palačnik	1970	308.45
	Trakošćan	in 1955	487.19
	Priestess	in 1983	39,24
Special reserve	Grandmother's tooth - Ponikve	in 1963	151.81
	Bara Dvorina	in 1987	738.28
	Bliznec - The Forester's Grave	in 1963	175.56
	Brežuljak near Smerovišće	in 1963	3.04
	Fountain	in 1982	50.84
	Cret Banski Moravci	in 1967	1.81
	Cret Đon swamp	in 1964	17.42
	Cret Dubravica	in 1966	8.49
	Black Mlaka	1980	693.96
	Black Bright	in 1965	72.55
	Đol Dražiblato	in 1969	78,59
	Long Hill	in 1973	10.76
	Đurđevac sands	in 1963	19.33
	Gračec - Lukovica - Rebar	in 1963	28.45
	Japetić	in 1975	26,27
	Jastrebarski lugovi	in 1967	62.50
	Jelas ponds - part	in 1995	132.48
	Kopački rit - Reserve	in 1967	6065.72
	Krapje Đol	in 1963	26,18
	Lodges	in 1975	109.01
	Mali Kalnik	in 1985	5.37
	Markovčak - Bistra	in 1963	250.58
	Mikulić stream - Vrabečka gora	in 1963	101.72
	Male well	in 1963	48.02
	Rookie	in 1982	1.95
	Subpanj	in 1998	90,22
	Stamen	in 1965	54,46
	Pušinjak - Gorščica	in 1963	192,29
	Radishevo	in 1975	4,17
	Osier	in 1969	148.63
	Rauchova lugarnica - Desna Trnava	in 1963	103.84
	Sava - Strmec	in 1971	269.92
	Sekulinac mountains	in 1966	11,20
	Stupnica lye	in 1964	16,27
	Tusti peak – Kremenjak	in 1963	7:45 p.m
	Varoški Lug	in 1982	897.03
	Varoški Lug - Forest	in 1988	62.49
	Veliki Pažut	in 1983	513.68
	Vukovar Danube Ades	in 1989	113.68
Regional park	Moslavačka gora	2011	15 107.61
	Mura - Drava	2011	87 448.70
A monument of park architecture	Arboretum Opeka	in 1947	50,43
	Banski dvori - park	in 1968	10.63
	Bedekovčina Gornja - Park around the castle	in 1965	6.51
	Bednja - Two linden trees	in 1969	-
	Bežanec - Park and tree line next to the castle	in 1965	3.21

	Plants - Park around the castle	in 1975	8.83
	Bosiljevo - Park next to the old town	in 1974	8.95
	Botanical Garden of the Faculty of Pharmacy and Biochemistry	in 1969	2.41
	Botanical garden of the Faculty of Science and Mathematics	in 1971	4.77
	Božjakovina - park around the castle	in 1965	7.39
	Čakovec - Two wisteria	in 1995	-
	Čakovec - Perivoj Zrinski	in 1975	13.87
	Čalinec - Yew	in 1963	-
	Čepin - Park around the castle	in 1975	2,18
	Đakovo - Small park	1970	1.04
	Đakovo - Strossmayer's Perivoj	in 1968	8.02
	Dalj - Patriarch's Park	in 1973	1.22
	Daruvar - Ginko	in 1967	-
	Desinic - Lipa	2012	-
	Donja Dubrava - Ginko	in 1995	-
	Gornja Bistra - Park around the castle	in 1971	7.55
	Ilok - Park around the old town	in 1973	4.84
	Jalkovec - Park near the castle	in 1972	2.68
	Jalžabet - Platana	in 1963	-
	Jastrebarsko - Park by the castle	in 1964	10,10
	Karlovac - Marmontova aleja	in 1968	1.89
	Karlovac - Vrbanić perivoj	1970	4.58
	Klenovnik - Park around the castle	in 1963	11.34
	Klokovec - Park around the castle	1970	4.78
	Kneževo - Park Around the Castle	in 1976	14.35
	Križevci - Park near Elementary School "Vladimir Nazor"	in 1971	1.33
	Križevci - Park near the agricultural school	in 1971	1.46
	Križovljangrad - Park next to the castle	in 1952	22.97
	Kutjevo - Park around the castle	in 1967	1.79
	Lipik - Spa park	in 1965	10,28
	Lug Samoborski - Park around the castle	in 1964	6.46
	Lužnica - Park around the castle	in 2019	11.65
	Marija Bistrica - Park next to the castle	1950	1.91
	Martijanec - Park around the castle	in 1969	6.27
	Miljana - Park around the castle	in 1973	1.75
	Mirkovec - Park by the castle	in 1965	5.21
	Našice - Park around the castle	in 1949	53.94
	Nedelišće - Platana	in 1963	-
	Noskovačka Dubrava - Group of trees	in 1969	1.24
	Novi Marof - Hospital Park	in 1962	12.65
	Nuštar - Park around the castle	in 1971	13.25
	Oroslavje Donje - Park around the castle	in 1965	5.43
	Osijek - King Petar Krešimir IV Park.	in 1973	2.44
	Osijek - Perivoj of King Tomislav	in 1973	18,28
	Park in Donji Miholjac	in 1958	14.36
	Petrinja - Strossmayer's promenade	in 1969	1.51
	Pribislavec - Magnolia	2001	-
	Samobor - Park Bistrac	in 1969	2,13
	Samobor - Park Mojmir	in 1976	1.02
	Samobor - Park at Langova 39	in 1962	0.61
	Samobor - Tisa	in 1963	-
	Šaulovec - Park around the castle	1970	5.74
	Selnica - Park around the castle	in 1969	12.08
	Slatina - Mamutovac	in 1967	-
	Slatina - Park behind the Assembly building	in 1968	1.27
	Stubički Golubovec - Park by the castle	in 1952	21.97
	Suhopolje - Park around the castle	in 1958	7.99
	Saint Urban - Two plane trees	in 1995	-
	Tenja - Park around the castle	in 1973	2.94
	Trenkovo - Park around the castle	in 1964	7.82
	Valpovo - Park around the castle	in 1958	28.97
	Varaždin - Platana	in 1975	-
	Varaždin spa - Lipe	in 1963	-
	Varaždinske Toplice - Spa Park	in 1963	15.33
	Varaždin Cemetery	in 1966	6,19

	Veliki Bukovec - Park by the castle	in 1963	11.58
	Vidovec - Park around the castle	in 1972	1.46
	Virovitica - Park around the castle	in 1967	5.01
	Vučetinec - Tulipanovac	in 1995	-
	Zagreb - Leustekov park	in 1963	0.47
	Zagreb - Mallin Park	1960	1.69
	Zagreb - Mamutovac II	in 1998	-
	Zagreb - Josip Juraj Strossmayer Park	1970	1.43
	Zagreb - King Petar Krešimir IV Park.	2001	2.43
	Zagreb - King Petar Svačić Park	2001	0.63
	Zagreb - King Tomislav Park	1970	2.16
	Zagreb - Park Maksimir	in 1964	356,21
	Zagreb - Park Opatovina	2001	0.85
	Zagreb - Park Ribnjak	1970	4.67
	Zagreb - Park at Jurjevska 27	in 1948	0.86
	Zagreb - Park at Jurjevska 30	1970	0.17
	Zagreb - Park next to Junković Castle	in 1971	1.75
	Zagreb - Park Zrinjevac	1970	2.03
	Zagreb - The procession of July victims	2000	2.04
	Zagreb - Garden in the driveway of Gjura Deželić	in 1998	-
Monument of nature	Bedeković's grabs	in 2002	13,11
	Belina Lipa	in 1966	-
	Plant cemetery - Travnjak	2001	0.61
	Gaveznica - Kameni vrh	in 1998	5.79
	Gorjanović's banner profile in Vukovar	in 2017	0.70
	Grgosova cave	in 1974	-
	Gupča linden	in 1957	-
	Galženjak oak	2012	-
	Oak in Donji Vidovac	in 1995	-
	Oak in Rakitovac	2001	-
	Oaks near the Repaš Forestry	in 1998	-
	Oaks in Djedovica	in 2004	-
	Oaks in Drenovci	in 1961	-
	Hušnjakovo	in 1948	2.44
	Chestnut in Koprivnica	2001	-
	Meadows of Zovje	2000	-
	The cat's cave	in 1966	-
	Hole	in 1948	0.50
	Yew habitat on Papuk	in 2005	0.08
	Yew tree on Horvat's steps	in 1964	-
	Yew in Supljak	in 1964	-
	Poplars in the Drava Forest	2001	1.51
	Windmill	in 1979	-
	Vindia	in 1964	1.14
	Vrlovka	in 1962	-
A significant landscape	Chambina	in 1999	50,21
	Širinski Island	2001	105.65
	Landmark	in 1969	194.46
	Erdut	in 1974	160.34
	Gajna	1990	399.89
	Goranec	in 1977	477.38
	Clear field	in 1995	19,526.35
	Jelkush	in 2021	291.60
	Mudguard	in 1985	4045.66
	Kotar - Old grove	in 1975	5378.55
	Crossroads	2001	802.57
	Lipa on Medvednica	in 1975	266.64
	Mura	2001	14 437.52
	Odran field	in 2006	9399.47
	Pasnjak Iva	2010	268,11
	Peter's Hill	in 1969	2734.91
	Savica	in 1991	79.54
	Slapnica	in 1964	259.38
	Sov lake	in 1989	71.39
	Sunny field	in 2013	20,270.25

	Sutin spa	1980	117.42
	Turopolj lye	in 2003	3343.56
	Source	2001	1.15
	Zelenjak - Risvička and Cesarska gora	2011	287.30
	Vegetable head	in 1992	1003.94

3.3.8 Forests and forestry

With regard to geographical features, the area covered by the Plan is located in the Pannonian-Peripannonian area (55% of the area of the Republic of Croatia), consisting of the true Pannonian area, which is identified with the East Croatian Plain, i.e. the Croatian Danube, and the Peripannonian area, which is divided into two sub-units, the western and the eastern Peripannon area. The western Peripannonian area occupies the western Croatian interriver with the transitional Kordun area towards Gorska Hrvatska. The relief alternates between mountainous and hilly areas and hills with lowland and plain regions. In the relief of the Eastern Peripannonian area, the old massifs of the Slavonian highlands stand out, separated by river valleys that frame the Požega basin. The Eastern Croatian Plain is the most distinctive lowland region of Croatia (high connection to the Danube), and it is part of the real Pannonian area, and that is in the extreme eastern part of the state territory, and represents the most important agricultural, primarily grain-producing area. There are flag flats, drained flag terraces and moist alluvial plains of the Drava and Sava rivers. Younger, lower and underwater alluvial plains are used for wetter crops and grasslands, while the lowest parts are periodically flooded terrains, overgrown with oak, willow and poplar forests.

Taking the orographic conditions into account, the area of Plano can be classified as a megamorphological region of the Pannonian Basin. The distribution of relief according to height (hypsometry) shows that Croatia is predominantly a lowland area, since as much as 53.42% of its surface is occupied by areas with an altitude of up to 200 m. These are mainly plains and loess plains of the Pannonian basin (Erdut, Vukovar, Đakovac, Ilov , Čazmanska), created by the accumulation of various crushed material. The relief of altitude zones from 200 to 500 m also prevails in the Pannonian-Peripannonian area and occupies about 25.61% of the surface of the Republic of Croatia. Weak vertical breakdown of the relief (5-30 m/km2) dominates the Pannonian area, and includes areas of loess plains, river terraces and lower parts of the Podgorje steps, such as the Prigorje and Baranja zones, while weakly to moderately dissected relief is characteristic of hills, higher parts of foothill steps and lower mountains. An important morphometric feature is the information about the slope of the slopes, and in the Pannonian area there is a predominance of flat terrains - plains on which the movement of masses is not observed and gently sloping terrains on which gentle washing prevails. According to the slope map (Picture3.20) with a representation of almost 60% in the total area of the subject area, the plain is characterized by slopes of less than 2o. More details about the slope of the terrain in the subject area are written in Chapter3.3.2.

In the geological structure of the Pannonian Basin, there are the oldest and youngest deposits on land, and the younger, Quaternary and Neogene deposits (Holocene, Pleistocene, Pliocene and Miocene) are the most widespread on the surface. It should be noted that the sediments of the Pleistocene and Holocene are particularly significant from a pedological point of view because they provide a basis for the cultivation of forest crops.

Phytogeographically, the area covered by the Plan is located within the Euro-Siberian-North American forest region (European subregion), which in a vertical sense includes: European-planar (lowland), European-kolin (hilly), European-montane (hilly) and European-altimontane vegetation belt (mountain). In each of them there are several vegetation zones (Vukelić and Raus, 1998).

Lowland vegetation belt– forms the backbone of the forest vegetation of the Sava-Drava confluence. It extends at an altitude of 80 - 150 m. The belt is characterized primarily by forests of larch oak (Genisto elatae-Quercetum roboris Horvat 1938; Carpino betuli-Quercetum roboris (Anić 1959) Raus 1971), Polish ash (Leucojo aestivi-Fraxinetum angustifoliae Glavač 1959) , black alder (Frangulo-Alnetum glutinosae Raus (1971) 1973), willow and poplar (Salici – Populetum nigrae (R. Tx. 1931) Meyer Drees 1936) whose origin and survival is more or less related to surface and underground water, whether it is flood water, as in the case of poplar and willow forests, underground water (alder oak forests) or both water is very important, as in forests where the predominant species are black alder and field ash. The forest vegetation is characterized by some peculiarities,

Hilly vegetation belt– continues in the lowlands and extends between 150 and 500 m above sea level. It has a very favorable climate and edaphic conditions for the growth of forest vegetation, which is why the forest communities are lush in appearance and rich in flora. This ring-like belt surrounds higher mountains such as the Slavonian Mountains, occupying all the marginal areas below the mountain belt of beech forests. The main type of trees is undisputedly the oak (Epimedio-Carpinetum betuli (Ht. 1938) Borhidi 1963; Betulo-Quercetum petraeae Tx. (1929) 1937). It occurs in acidophilic, neurophilic-mesophilic and thermophilic basophilic communities, on different geological substrates and soils. Of the other types of trees, the following are significant: common hornbeam and beech, as well as more tame chestnut, birch, cherry, honeysuckle, chub, cherry and other species.

Mountain vegetation belt– occupies a significant place in the forest vegetation, especially because of the main species of that belt, common beech (Luzulo luzuloidis-Fagetum sylvaticae Meusel 1937; Blechno-Fagetum (Horvat 1950) Tx. Et Oberd. 1958 corr. Rivas-Martinez 1962; Galio odorati-Fagetum Sougnez et Thill 1959). In the Pannonian part, it extends from 350 m above sea level. The beech forests of the mountain belt contain a large number of plant species and belong to the richest and most lush beech forests in Europe. Apart from the synecological conditions, the reasons also lie in the historical-genetic development of the beech and its flora from the postglacial to the present day.

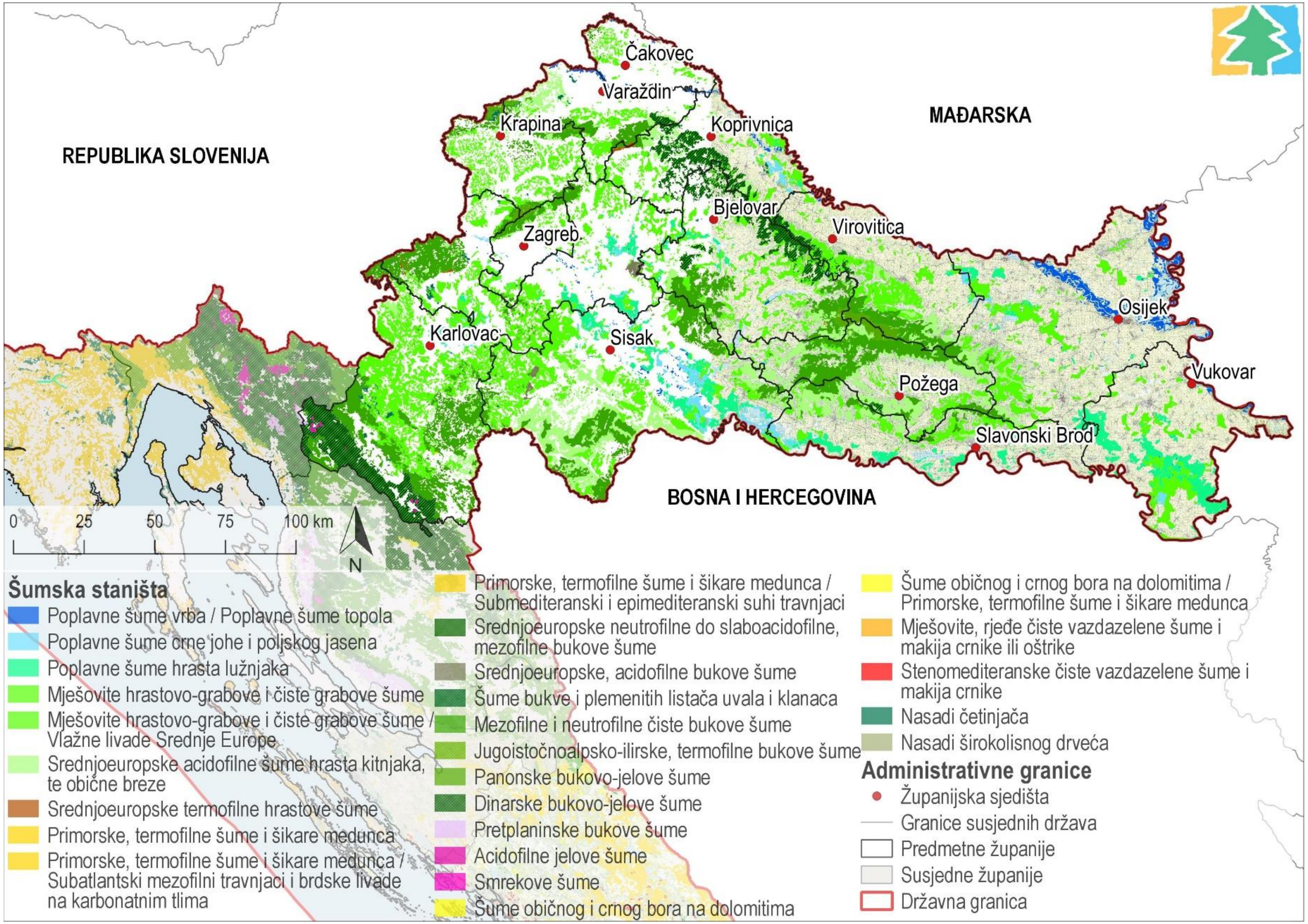
Mountain vegetation belt– it is expressed in the Pannonian mountains at a height of 600 to 1100 m, while on the northern slopes of Papuk it descends even lower. The fundamental characteristic of this belt is the greater or lesser degree of preservation from anthropogenic influence and the prevalence of large forest complexes. The main forest community is the Pannonian beech-fir forest (Festuco drymeiae-Abietetum Vukelić et Baričević 2007).

The following figure shows the spatial arrangement of prominent forest habitats in the area covered by the Plan (Picture3.46). In most of the counties in question, according to the Habitat Map, mixed oak-hornbeam and pure hornbeam forests predominate, followed by mesophilic and neutrophilic pure beech forests, and Central European acidophilic forests of white oak and common birch.

According to the CLC methodology of visual interpretation of satellite images, the total forest area within the scope of the Plan amounts to 1,204,451.69 ha. In the surface structure, coniferous forests predominate with 76.25%, followed by succession of forests (recovery land) with 21.59%, mixed forests with 1.73% and coniferous forests with 0.42% (Table3.46)**.**Sisak-Moslavina County has the largest forest area, followed by Zagreb, Osijek-Baranja and Bjelovar-Bilogor counties. From the presented total share of forests, a significant economic, but also many times more valuable general utility aspect can be seen, in terms of the ecological and, lately, increasing social function of forests. The forests are characterized by a natural composition and a high level of biodiversity, which is indicated by the small presence of forest crops (mainly Euro-American poplars), which were mostly planted in the last century in the flood plains in the habitats of willow-poplar forests and which nowadays through substitution procedures , are again replaced by autochthonous vegetation.

Table3.46Forests in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to data from Corine Land Cover)

Name of the County	Land cover category (ha)				Total (ha)	Share (%)
	Forest succession (recovering land)	Belogorica forest	Montenegrin forest	Mixed forest		
Bjelovar-Bilogorska	19,705.86	87 339.62	346,781	2008,74	109 401	9.08
Brod-Posavina	17 508,637	57 851,435	148,434	549,161	76 057.67	6.31
City of Zagreb	2795,573	17 634,068	-	531,579	20,961.22	1.74
Karlovac*	21 107,692	72 261,437	1185,444	1492,26	96,046.83	7.97
Koprivnica-Križevačka	12 570,136	50 748,703	329,235	463,141	64 111.22	5.32
Krapina-Zagorje	9721,022	37 471,617	643,339	3031,697	50,867.68	4.22
Međimurska	2341,549	11 318,719	33,23	118,106	13,811.6	1.15
Osijek-Baranja	28 529,583	81 812.21	-	-	110 341.8	9,16
Požega-Slavonia	13 995,221	81 397,008	468,971	3511,513	99 372.71	8.25
Sisak-Moslavina	72 213,327	165 124,493	180,553	3382,728	240 901.1	20.00
Varaždinska	4035,499	40 403,961	713,999	1924,929	47,078.39	3.91
Virovitica-Podravska	14 146,632	63 108,089	861,892	1491,413	79 608.03	6.61
Vukovar-Srijemska	18,057,037	55 007,905	119,398	0.213	73 184.55	6.08
Zagrebačka	23 375,227	96 910.39	60,697	2361,587	122,707.9	10,19
*The area of Karlovac County that is included in the Plan						



Picture3.46Forest habitats represented in the area of the counties in question (Source: IRES EKOLOGIJA doo according to data from Bioportal and Geoportal DGU)

Forest areas in the area covered by the Plan are mostly state-owned, under the authority of the public forest owner - Hrvatske šume doo. The organizational area is divided into 11 Forest Management branches: Bjelovar, Karlovac, Koprivnica, Našice, Nova Gradiška, Osijek, Požega, Sisak, Slatina, Vinkovci and Zagreb (Table3.47) that supervise the performance of all professional and technical tasks in forest management by 106 foresters. A more detailed table is shown in the Annex**Error! Reference source not found.**and shows the total and overgrown forest areas and the validity of management programs in 277 economic units according to the forests to which they belong. The total area of state forests and forest land according to the UŠP within the scope of the Plan amounts to 865,102.85 ha, of which 807,281.30 ha are vegetated areas, or 93.30%. Furthermore, according to the data in the table, it can be seen that the largest area of forests and forest land is located in the Bjelovar Provincial Park, followed by the Sisak Provincial Park, the Osijek Provincial Park and then the Nova Gradiška Provincial Park.

Table3.47The condition of the areas of state forests and forest land according to UŠP that are located in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to Hrvatski šume)

UŠP	Total area (ha)	Covered area (ha)
Bjelovar	151 941.7	136,002.78
Karlovac*	77 044.14	75,284.84
Koprivnica	59,808.91	57 072.22
Našice	39,732.52	37,884.24
Nova Gradiška	85,626.35	80 895.99
Osijek	88 908.7	58,778.76
It burns	62 235.26	54,028.73
Mad dog	93 085.26	88 246.4
Slatina	51 526.87	48 231.87
Vinkovci	75,693.62	72 111.4
Zagreb	79 499.52	75 517.69
*area of UŠP Karlovac located in the area included in the Plan		

Privately owned forests are managed by private forest owners/owners, with expert and advisory assistance from the Ministry of Agriculture, at the owner's/owner's request. They are organizationally divided into 235 economic units, of which 210 are organized. In the table (Table3.48) shows the areas of the forest owners according to the arrangement and the county where they are located. The total area of managed private forests and forest land is 306,409.60 ha, and the total area of unmanaged private forests and forest land, according to the estimated areas from the Forest Management Base of the area, is 35,911.33 ha, which is a total of 342,320.93 ha. In accordance with the provisions of the Law on Forests (Official Gazette 68/18, 115/18, 98/19, 32/20 and 145/20), all forests must be regulated. The largest total area of managed forests of forest owners is in Zagreb County, followed by Sisak-Moslavina County. While the largest total area of unmanaged forests of forest owners is in Varaždinska, followed by Sisak-Moslavina County.

When looking at the areas of state and private forests and forest land, they occupy an area of 1,207,423.78 ha within the scope of the Plan, of which 71.60% are state and 28.40% are private forests and forest land. These data are very similar to the data obtained from the CLC analysis, and the difference is due to the different methodology of data collection. Given that the total area of forests and forest land, according to the Forest Management Basis of the Area (2016 - 2025), is 2,759,039.05 ha, it turns out that the area covered by the Plan constitutes 43.76% of the forest management area. If it is taken into account that the total wood stock at the level of the Republic of Croatia is 418,618,277 m3, i.e. the average for the Republic of Croatia is 242 m3/ha, it can be concluded that the average wood stock of the subject area is higher than the stated 242 m3/ha, since it is a valuable forest fund consisting of forests with a high growth form, made up mainly of economically significant tree species (predominantly stands of holm oak and common beech), in contrast to the Mediterranean area of the Republic of Croatia (low karst), where scrub and maquis stands predominate and other stands with a low average wood supply. The above can be supported by the fact that out of 1,393,816,

Regarding the design, construction and maintenance of forest infrastructure, the programs and principles of management of economic units of forest owners prescribe the maintenance of existing forest roads and, according to management needs, the construction of new forest roads.

Table3.48State of the forest areas of private forest owners within the counties located in the area covered by the Plan (Source: Croatian Forests and Forest Management Base of the Republic of Croatia (2016 - 2025))

The name of the county	Edited		Messy
	Total area (ha)	Vegetation (ha)	Total area (ha)
Bjelovar-Bilogorska	18,529.55	17 736.83	1933,57
Brod-Posavina	11 411.73	11,393.97	862.96
City of Zagreb	11,961.19	11,927.55	-
Karlovac*	42 538.83	41 496.46	2177.4
Koprivnica-Križevačka	18 743.38	18,529.92	5031.68
Krapina-Zagorje	33 382.74	33 255.48	3559.45
Međimurska	7899.65	7886.35	-
Osijek-Baranja	22,308.87	21,840.95	2704.67
Požega-Slavonia	20,746.99	20,643.24	-
Sisak-Moslavina	40,906.21	40,826.06	8900.98
Varaždinska	21 759.57	21 641	10,906.45
Virovitica-Podravska	5753.81	5729.52	486.83
Vukovar-Srijemska	626.33	625.61	1280.91
Zagrebačka	49,840.75	49,615.22	-
*The part of Karlovac County that is located in the area covered by the Plan			

According to their purpose, forests can be economic, protective and forests with a special purpose. Commercial forests, which cover the largest surface area covered by the Plan, are primarily used for the production of wood and other forest products. Protective forests, which are much less common, serve to protect watercourses, settlements and other economic facilities from erosion and other weather disasters. Forests with a special purpose are forest areas that are registered as facilities for the production of forest seeds, then forests intended for scientific research, teaching and defense needs, protected forests (on the basis of nature protection regulations) and urban forests (rest and recreation of visitors, forests within the scope of camps and golf courses and other sports and recreational areas), Article 22 of the Forest Act.

Based on the report of the Croatian Forestry Institute (2021), on the damage to the forest ecosystems of the Republic of Croatia for the year 2020, a very small reduction in the significant absence of both for all species (from 30.33% to 29.34%) and for deciduous trees (from 26 .38% to 25.95%) compared to 2019. The largest number of trees is still found in classes of absence 0 and 1, that is, in classes with no absence or little absence. The most damaged deciduous tree is still the field ash, although since 2018 the number of significantly dead ash trees has been decreasing. The absence of mulberry oak significantly increased compared to 2019 and approached the absence of Polish ash (from 45.73% to 54.27%). On the other hand, in comparison to 2019, the absence of holm oaks has somewhat decreased. With absence unchanged compared to 2019, black pine is our most damaged tree species.

From the data of the Ministry of the Interior (2022), it is evident that the total area of mine-suspected areas in the Republic of Croatia is 204,400 ha, of which 98.7% refers to forests and forest land. During 2022, demining of those economic units, i.e. economic divisions and departments, whose demining will enable the exploitation of wood mass, as well as the maintenance of valuable forest assets and forest roads, will continue and will contribute to increasing the safety of the work of employees related to forest management. In the area covered by the Plan, the planned demining works include forests and forest areas in Karlovac County (Josipdol Municipality), Osijek-Baranja (Valpovo Town), Požega-Slavonia (Pakrac Town) and Sisak-Moslavina County (Novska and Sisak Towns and Dvor Municipality). In addition to the economic value,

3.3.9 Game and hunting

In the area covered by the Plan, 698 open hunting grounds and 18 breeding grounds were recorded on an area of 3,085,918 ha (Table3.49). The area is dominated by open-type hunting grounds, which are characterized by the unhindered daily and seasonal migrations of hairy game, while breeding grounds are represented to a lesser extent. The county with the most open hunting grounds is Osijek-Baranjska with 105 open hunting grounds, and the least is the City of Zagreb with 12 open hunting grounds, while Bjelovar-Bilogor County has the most breeding grounds, 5 of them. Sisak-Moslavina County has the largest total area of hunting grounds, followed by Osijek- Baranja and Karlovac counties.

Pursuant to the Law on Hunting (Official Gazette 99/18, 32/19, 32/20), hunting licensees are obliged to take care of all types of game, as well as other animal species, in accordance with positive legal acts and signed international conventions. The goal of hunting grounds management is to preserve ecosystem stability, progressive and permanent hunting management in such a way as to maintain their biodiversity, ability to reproduce, production, vitality, potential and fulfillment of ecological, economic and social functions, without harming other ecosystems.

Table3.49Data on hunting grounds in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to data from the Ministry of Agriculture)

Name of the County	Number of open hunting grounds	Number of farms	Property			Total area of hunting grounds in the County (ha)
			Area of own state hunting grounds (ha)	Area of own private hunting grounds (ha)	Area of county (common) hunting grounds (ha)	
Bjelovar-Bilogorska	58	5	113 419	-	160 929	274 348
Brod-Posavina	38	3	70 739	-	121 566	192 305
City of Zagreb	12	-	2282	-	32 740	35 022
Karlovačka	74	1	112 743	-	228 179	340 922
Koprivnica-Križevačka	35	-	53 274	-	114 426	167,700
Krapina-Zagorje	31	-	2679	-	120,960	123 639
Međimurska	21	-	3561	-	71 202	74 763
Osijek-Baranja	105	2	110 277	1723	304 952	416 952
Požega-Slavonia	42	1	55 748	-	100 256	156 004
Sisak-Moslavina	65	1	186 487	-	245 580	432 067
Varaždinska	32	-	11 263	-	116 476	127 739
Virovitica-Podravska	33	1	79 773	-	118 493	198 266
Vukovar-Srijemska	71	2	83 190	-	164 769	247 959
Zagrebačka	81	2	46 386	306	251 540	298 232

The area covered by the Plan stands out for its high-quality hunting grounds with a rich tradition. The hunting of large game, i.e. red deer, wild boar, roe deer and brown bear in open hunting grounds, as well as fallow deer and mouflon in fenced hunting grounds, is particularly noteworthy. Of the small game, the following are important: pheasant, hare, wild duck, wild goose, grouse, quail and snipe. In addition to the mentioned species, the following game also lives in certain hunting grounds: badger, wild cat, white marten, golden marten, fox, jackdaw, ferret, wild pigeon, gray crow, magpie, screeching jay and others.

For the preservation of game stocks, especially large game, the areas of complete forest complexes and forest areas and moors along rivers, which support high-quality hunting productive areas of good quality classes, are very important, which is manifested through the vitality of populations and increased biodiversity, i.e. the ecological balance of natural habitat, which ensures peace in the habitat, hiding places, availability of water and food, and daily and seasonal migrations of large game.

3.3.10 Landscape characteristics

The scope of the Plan represents the area for exploration and exploitation of geothermal water. The mentioned area is located within the Croatian part of the former Pannonian basin, that is, within one of the two areas of Croatia with a higher geothermal gradient called the Pannonian part. In the broadest view, the natural component of the landscape of the mentioned part was formed throughout history as the bottom of the Pannonian basin at the junction of the Mediterranean and Indian oceans. The northern part of Croatia is the southern edge of the former Pannonian Sea, which in that part was once closed by relief dynamics, i.e. today's mountains Žumberka and Petrova Gora. Other elevated orographic forms, Medvednica and the Slavonian mountains, also known as the island highlands, formed the archipelago of this part of the mentioned sea.

The issue of landscape is additionally covered by the guidelines of the European Convention on Landscapes, within which the main objectives are the recognition of the landscape for the purpose of its optimal preservation, management and planning. Certain parts of the area in question are covered by pilot documents of this type, within which the processes of landscape analysis, inventory and typology have been started to different levels of detail and from different professional points of view. In the given area, the landscape foundations of the Zagreb and Sisak-Moslavina Counties can be highlighted, as well as the increasingly numerous studies of green infrastructure and landscape foundations of urban areas and surrounding rural landscapes.

In a general sense, the landscape of the central part of the designated area for researching the potential of geothermal waters is marked by the characteristic landscape of the Bilogora-Moslavina region. This area is dominated by an agrarian landscape on a slightly indented hilly terrain. Altitudes do not reach above 300m. Despite the moderate and mild elevation of the terrain, the area of the highlands is characterized by a mostly continuous forest belt, which forms a picturesque relationship with the agricultural areas that the area abounds in due to its flatness.

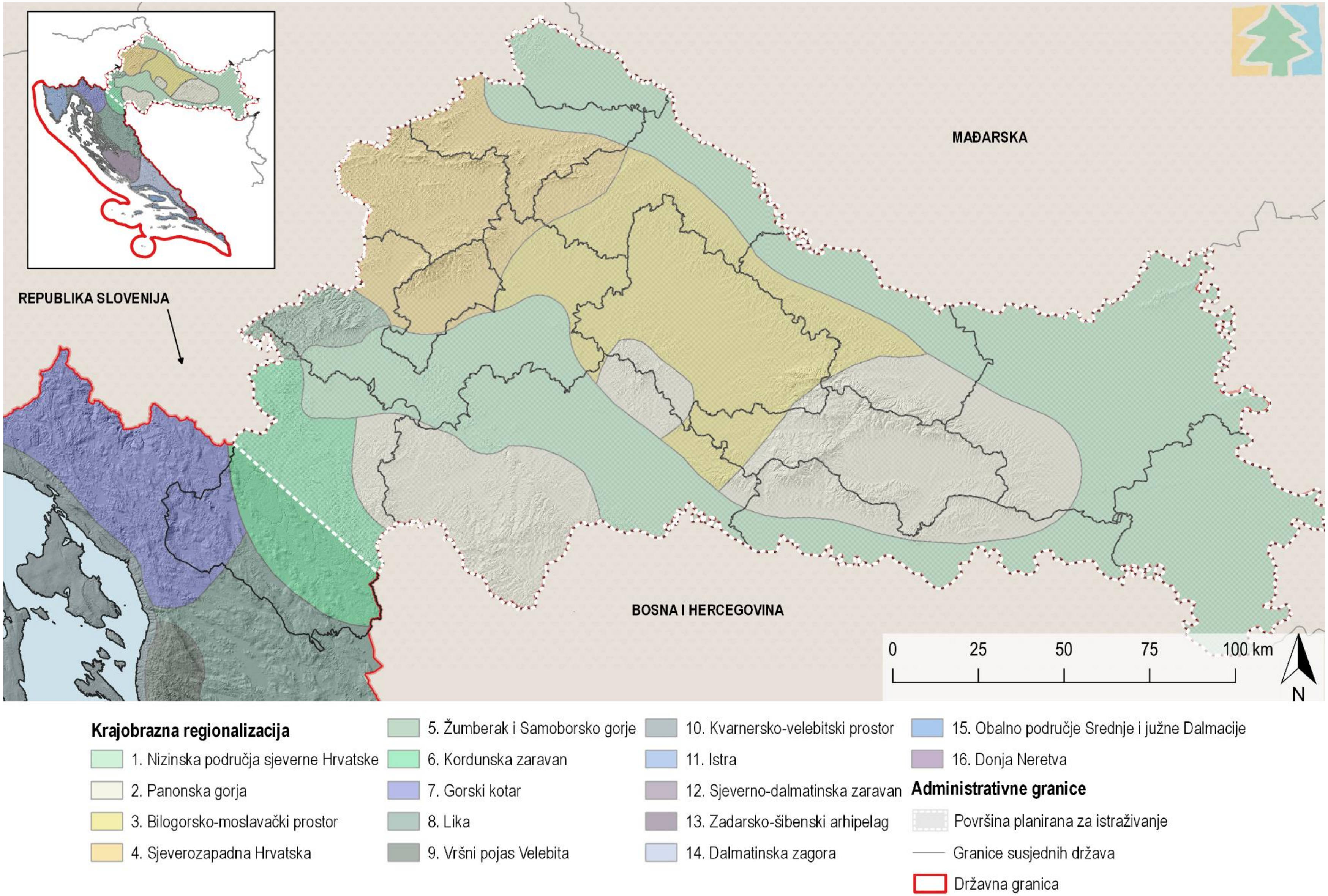
The aforementioned central part of northern Croatia is surrounded by mountain ranges in the area of Žumberk and Samoborski Gori and the Pannonian Gori and lowland areas. It is these lowland areas of northern Croatia that are characterized by the largest share of potential and existing geothermal sources. This area that frames northern Croatia is characterized by plains of an agrarian landscape with forest complexes stretching through it. Also, due to the flat terrain, some of the largest and most significant floodplains are formed here (Kopački rit, Lonjsko polje, Spačvanske šume).

The third group of geothermal potential sites is located in northwestern Croatia in the plain between the Medvednica ridge, Vukomerička gora and the Žumberačka gora massif. The mentioned area is characterized by a diverse landscape dominated by the hills of Prigorje and Zagorje on the north side of Medvednica, which surround the orographic forms of the Peripannon hills Kalnika, Ivančica and Medvednica).

The scope of the Plan, i.e. the area planned for the exploration and exploitation of geothermal water can be placed in the following landscape regions according to landscape regionalization with regard to natural features (Bralić 1995) as part of the spatial planning strategy of the Republic of Croatia:

- Bilogora Moslavina area
- Lowland areas of northern Croatia
- Northwest Croatia

In addition to them, the landscape region of the Pannonian Mountains, the landscape region of the Kordun Plain, as well as the region of Žumberk and the Samobor Mountains are also covered by the Plan. However, due to their relief predispositions and geomorphological structure, the mentioned regions do not contain existing and planned geothermal interventions, but the implementation of exploration works is not excluded.



Picture3.47Existing and planned areas for research and use of geothermal potential in relation to the landscape regions of the Republic of Croatia (Source: IRES EKOLOGIJA doo according to Bralić 1995 and the Plan)

Landscape region of the lowland areas of northern Croatia

The area stretches along the border of northern Croatia with neighboring countries in the very north, Slovenia and Hungary, in the east with Serbia, and in the south with Bosnia and Herzegovina. The northern part of the area is defined by a rich river landscape permeated by the hydrographic system of the Mura and Drava rivers, whose meandering form is also reflected on the administrative border of the state. The internationally recognized biosphere reserve Mura-Drava Regional Park stretches along this part. The Eastern and Southern parts of the region are characterized by the rivers Sava and Danube. Both parts contain accompanying tributaries, lakes, meanders, river backwaters and backwaters. On the inner side, closer to the central part, the region is defined by relief dynamics starting from Ravna Gora in the very north over the Ivanščica and Strahinjčica mountain ridges, then along the Bilogora hills, the Papuk, Požeška and Donje Gora mountain groups, the Psunja mountain massif, Moslavačke gora all the way to Medvednica. In the mentioned area, which is located between the mentioned belts of rivers and mountain massifs, there is plain terrain. Less soil porosity and terrain features are the result of the generation of extensive and most valuable wetland and water habitats in the continental part of Croatia, where exceptional natural landscapes and one of the richest areas in terms of flora and fauna diversity are created. The forest cover of the landscape area is characterized by larger patches of forest located mostly centrally along the belt that forms the landscape region. Higher vegetation also appears as an amorphous form, that is, a group "eroded" by agricultural areas and pastures. Vegetation moves also form an organic curvilinear form that follows the backwaters and meanders of rivers, and with straight lines it indicates the former courses of canalized tributaries. In addition to the above, the overgrown plots and pastures sometimes form linear stretches of vegetation that in some cases separate agricultural areas. Linear vegetation lines, hedges, "clumps[4]" significantly contribute to the naturalness of the landscape by maintaining the habitats and migration routes of the fauna that inhabits the area.

Anthropogenic factors within the landscape area are primarily agricultural areas. The aforementioned stretch of leveled terrain is extremely important in terms of the rural landscape and is very significant in the overall share of agricultural land in the Republic of Croatia. The space is dominated by areas of diverse agricultural areas consolidated in places through the aspirations towards the intensification of agriculture and the maintenance of agricultural production in the given area. The urban network develops mainly along the rivers with Varaždin, Prelog, Osijek, Vukovar, Slavonski Brod, Sisak and Petrinja as the main centers. In some places larger urban centers like Čakovec and Vinkovci are distanced from the river courses by a belt of agricultural land. Throughout history, the railway corridors Rijeka-Zagreb-Budapest and Ploče-Sarajevo-Budapest have played a major role in the formation and grouping of urban areas within the landscape area. Although the subject area can be defined as relatively large and predominantly rural, parameters such as the economic base, pedological and geological predispositions, religious influences, tradition, geographical location create a spectrum of specific details in traditional construction. The diversity of traditional construction as a whole and details related to historical ways of life closely connected with the environment enrich the subject landscape area. geographic location create a spectrum of specific details in traditional construction. The diversity of traditional construction as a whole and details related to historical ways of life closely connected with the environment enrich the subject landscape area. geographic location create a spectrum of specific details in traditional construction. The diversity of traditional construction as a whole and details related to historical ways of life closely connected with the environment enrich the subject landscape area.

The main element that makes up the identity of the landscape of this area are the vast agricultural areas on the flat terrain that open uninterrupted views towards the contrasting mountain massifs. An additional special feature of the area is given by the slight relief indentation and historical subdivision with hedges that form a contrasting grid within the agricultural landscape. The space and long vistas are emphasized by the edges of scattered oak forests and other higher vegetation in succession along canals and neglected fields. The low historic construction of traditional villages and settlements also contributes to the ambience and image and identity of the landscape. The accompanying infrastructure of rural buildings and the buildings themselves emphasize the space and create a rural atmosphere in terms of form and material. Richness and dynamism in the ambience of the landscape are also brought by unique and experience-rich fluvial localities.

Landscape region of the Bilogora-Moslavina region

The landscape area is located in the central part of northern Croatia. It is defined in relief by mountain massifs, namely Kalnik from the northwest, Bilogora and Slatinsko Voćinsko pobrđe from the northeast, Moslavačka gora from the south and the Papuka mountain group from the southeast. The aforementioned mountains frame the valley of the Česma and Lonja rivers, within which potential areas for the exploitation of geothermal sources are formed. The mountain belt or ring that surrounds the area is characterized by uniformity without prominent peaks and dominance over the central lowland area. In the forest cover that covers them, the dynamics of the heights caused by the gentle cuts of streams and springs that reach towards the

[4]A small group of trees that forms a circular forest edge, and is often in a visually contrasting relationship with the surrounding space.

valley are visible. The highest peaks are formed in the southeast, where the Papuk hills reach heights of up to 869 meters above sea level. The vegetation cover of the area, moving from the peaks towards the lowlands, consists of the white mountain forests, which are gradually more and more "eroded" and merge and turn into agricultural areas as the terrain transitions into the lowlands. A significant natural factor of the lowland part of the area is also the large areas of lakes or ponds located in places within the entire area. These elements greatly enrich the share of naturalness in the overall impression and identity of the given landscape.

The lowland area is characterized by linear agricultural areas related to the subdivision of settlements, which are developed linearly along roads in one row. Forest cover is reduced to linear stretches along agricultural plots, vegetation along melioration canals and groups of "clump" vegetation that stand out in the surrounding landscape. The network of settlements in the subject area was developed partly along rivers and the edges of mountain massifs such as Čazma, Pakrac and Đakovo, while some larger centers such as Vrbovac and Bjelovar are located in the lowlands. Linear settlements along the highways conurbate in places with larger centers, while they themselves are slowly expanding radially, mostly due to upcoming industrial and economic uses.

The visually exciting character of this region is marked by mostly smaller agricultural areas of a linear shape located in the background of plots and houses along roads. Larger consolidated agricultural areas appear in places. In the leveled parts, long vistas extend across the fields to the mountain massifs, whose white-gray vegetation forms a contrasting mass in the background in the summer. The traditional construction of the area is manifested in elongated one-story houses stretched transversely through the plot, sequentially divided into sections according to purpose. Some buildings are oriented to the road with their front longitudinal and some with their shorter transverse frontage towards the road. When moving through the space, the views open up to agricultural areas and spacious ponds from parts of roads that are not connected to settlements and from the surrounding glades.

The landscape region of northwestern Croatia

The landscape of this region is characterized by diversity with the dominance of hills in the area of Prigorje and Zagorje, which surround the forest-covered Peripannon hills. The main relief elements within the mentioned area are Kalnik, Ivančica, which enclose the landscape area from the north, and Medvednica, which crosses the area at the extreme southern part. The area between Medvednica from the south and Ivančica from the north is defined by smaller hills, the lower parts of which have been turned into agricultural areas.

This hilly agricultural landscape stretches across the entire northern part of the area, where vineyards are located in places with greater solar exposure. The background of the mentioned vineyards is the higher forest vegetation of the top parts of the hills. The landscape region also includes the area south of the most dominant relief element of Medvednica up to the slopes of the Žumberački Mountains. In this area, the hills of Medvednica gradually transition to the plains and the plains of the Sava River in the area of the City of Zagreb. The forest cover of the highlands varies from white-leaved to traces of evergreen vegetation that appear at higher altitudes.

The area on the northern side of Medvednica is characterized by an agricultural landscape that is intrinsically related to the terrain and sun exposure. The hilly ribbed landscape formed in the lowlands of the northern part of the landscape region, seen from the air as a whole, resembles fans or the organic form of growing plants. Within the vascular network formed by the mentioned hills, there are road networks whose hierarchical importance decreases proportionally with branching.

From the roads, the views open up to the hillsides overgrown with vineyards and other agricultural forms, the background of which is formed by the massifs of contrasting mixed alpine vegetation. The relief features of the terrain enable rich short to moderately long views of the complex morphology of the landscape formed by terraces, solitary trees, traditional and contemporary main and supporting single-family buildings and forests. Compacted surfaces are still less common in these areas due to the slope of the terrain and the inaccessibility of larger machinery. The area is also characterized by smaller settlements located along straighter stretches through the hilly terrain, as well as hidden within smaller undulating areas between the hills. This area of the edge of the Pannonian cultural zone is characterized by traditional buildings, of which a three-room Pannonian house stands out, locally characteristic for its extremely white facade coated with milk of lime with a wooden roof. In addition to it, other traditional elements of the former way of life contribute to the ambience, such as the barn, chamber, stables, barns, cellars, etc. The anthropogenic factors of the landscape of the given landscape region on the south side of Medvednica are primarily manifested in the predominantly urbanized but environmentally diverse environment. The form, experience and spirit of the urban environment can be divided according to the period of creation. Thus, visually and ambiently, the oldest core of the city stands out, to which the construction on the hill is added to the north, while to the south, the hierarchy continues through the block-like atrium construction towards the one that is less regulated in places.

These traffic corridors are one of the factors that have historically determined the development of diverse building styles, and therefore, for example, the railway forms the end of block construction towards the south. Most of the arms of the slopes that extend towards the Sava river are today built urban infrastructure, which has largely cut into the profile of the mountain itself. The urban matrix also extends to the very course of the Sava River, which is completely channelized and separated by an inundation zone and embankment. To the south of the river corridor there is also a somewhat sparser, but in some places higher and more massive urban matrix. After that, the southern landscape is increasingly transformed again and transformed into rural forms.

The perception of the environment and landscape varies with the changes of the seasons, on which the formation of a rich chromatic spectrum depends, which is the product of the varying coloration of individuals individually as well as the overall collage. The landscape of the lowland on the southern side of Medvednica can be experientially described as an urban living center of intense daily migrations in several focal points. The atmosphere of the city is dynamic and depends on the preservation and condition of the structures that make it up and the share of modern trends of quality urban life. It also depends on the sociological, political, economic, social and environmental components of the city.

3.3.11 Cultural and historical heritage

Historical overview

The planned coverage for exploration and exploitation of geothermal waters mainly covers the surface of Pannonian Croatia. This area, which was once covered by the Pannonian Sea, has been inhabited by many peoples since prehistoric times. Romans, 35 BC. they begin to penetrate the area of Pannonia inhabited by Pannonians mixed with Celtic tribes. Emperor Diocletian at the end of the 3rd century changed the previous division into Upper and Lower Pannonia and divided Pannonia into four areas: Sava Pannonia with its center in Siscia (Sisak), First Pannonia, Lower Pannonia with its center in Sremska Mitrovica and Pannonia Valerija with its center in Pécs.

After the rule of Rome and the division of the Roman Empire in the area of Pannonia, the Goths and Lombards alternated. At the beginning of the Middle Ages, the nomadic people of the Eurasian Avars established a large state in the area of Pannonia with its center in the Pannonian plain (khaganate). The Persians, Avars and Slavs put pressure on Byzantium and Constantinople from the area of the Pannonian Plain. Constantinople survives, but Byzantine rule in Pannonia is then only a formality on paper. Avars and Slavs occupied a large part of the area until the end of the 8th century. when Charlemagne destroys the state of the Avars, leaving only the Slavs in Pannonia. In the 9th century The Hungarians penetrate into the Danube plain and suppress the Slavs, occupying the northern parts under the names Pannonia Valeria and First Pannonia. The northwestern part of Pannonia belongs to German rule, while Sava and Second Pannonia remain in the possession of the Slavs.

The penetration and formation of the Croatian people in this area was further strengthened during the reign of King Tomislav. The two main Slavic provinces within the remaining areas of Pannonia were in the area of Sisak and Srijem until the beginning of the rule of the Avars when we talk about Posavska Croatia. After that, the name Pannonia was lost and the area began to be called Slavonia (the land inhabited by Slavs). The mixing of peoples and the influence of Croats from the coastal area after the victory over the Hungarians and Avars cause the abandonment of pagan customs among the Pannonian Croats and the acceptance of Christianity. The proof of this event is best shown by archaeological finds of old Croatian graves, in which objects buried together with the deceased no longer appear from that period. The independent history of the Pannonian principality thus ends in the 10th century.

The area of former first Pannonia and part of Sava Pannonia today make up central Croatia, while parts of Pannonia Valerija and second Pannonia make up Slavonia. In the 10th century, the prefects were replaced by the king's supporters who became lords and Croatia acquired a feudal society. The area of the former Pannonia later came under the rule and alliance with the Hungarians until the invasion and conquest of the Turks, from whom the area of Slavonia and Banovina was liberated at the end of the 17th century. Due to the influence of Austria and Hungary, the area of central Croatia is poorly developed, therefore the network of cities is very poor. The stronger development of urban centers only encouraged the ever-increasing influx of population from rural areas through the stronger development of industry.

Today, as a result of the above, parts of central Croatia are counted among the most urbanized areas of the country, among which Zagreb, Velika Gorica, Varaždin, Karlovac and in Slavonia Osijek and Slavonski Brod stand out. The development of the railway and the construction of the first railway in the territory of today's Republic of Croatia in the second half of the 19th century also greatly contributed to the development of cities in this area, after which some of them rapidly expanded beyond their historical borders. The war events of the 19th and 20th centuries also resulted in a large number of memorial cultural assets in certain parts of the subject area, such as the area along the southern border of the Republic of Croatia. A greater concentration of cultural assets is consequently linked to areas of greater anthropogenic activity throughout history, thus areas around larger centers such as Zagreb, Osijek, Vukovar, Varaždin and others.


Picture3.48. Left: Ruins of the Medvedgrad Fort (source: Register of Cultural Properties of the Republic of Croatia), Image3.49.Right: Dvor Trakoščan (source: Register of Cultural Properties of the Republic of Croatia)

An exceptionally rich spectrum of historical events and changes of government and changes in the ethnicity of the people, cultures and religious beliefs in the area in question have resulted in a rich share of cultural assets and exceptional heritage dating back to the Neanderthal era, such as the excavations of prehistoric people from the cave on Hušnjak's hill near Krapina. The archeological excavation at Vučedol, which is one of the most famous symbols of the city of Vukovar, also dates from prehistory. Turbulent events during the Middle Ages left their mark on the area through a network of forts from the period of the principality and later lordly and noble castles and estates such as the Medvedgrad fortress, the ruins of the old city of Novigrad on the Dobra or Veliki Tabor manor and Trakošćan manor or later baroque period castles such as Eltz manor in Vukovar and the manor. Ways of life, social structure and diverse culture also leave traces of architectural and construction heritage on the area in question. But the above is also reflected in the rich intangible heritage.

According to the register of cultural assets of the Republic of Croatia, there are 3,121 cultural assets in the area covered by the Plan, which includes 14 county spatial units, including preventively protected and intangible cultural assets.

Picture3.50. Eltz manor complex (Source: register of cultural assets of the Republic of Croatia)

Inventory

Cultural heritage consists of all movable and immovable cultural assets of artistic, historical, paleontological, archaeological, anthropological and scientific significance, which are legally regulated by the Law on the Protection and Preservation of

Cultural Assets (Official Gazette 69/99, 151/03, 157/03, 100/ 04, 87/09, 88/10, 161/11, 25/12, 136/12, 157/13, 152/14, 44/17, 90/18, 32/20, 62/20) and is under supervision Conservation department. The following authorities are responsible for the subject area: conservation department in Karlovac, conservation department in Sisak, conservation department in Zagreb, conservation department in Krapina, conservation department in Varaždin, conservation department in Bjelovar, conservation department in Požega, conservation department in Osijek, conservation department in Slavonski Brodu and the conservation department in Vukovar. Numerous and diverse cultural heritage is categorized according to the basic division into tangible (immovable and movable) and intangible heritage. As the most numerous type of immovable cultural heritage, which is to the greatest extent exposed to the effects of changes in purposes and methods of use, architectural heritage stands out (individual buildings and complexes. In addition to them in the subject area, there are also cultural and historical units of the settlement, elements of the historical equipment of the settlement, historical civil engineering buildings, technical facilities with devices and other similar facilities), cultural landscapes (planned: gardens, orchards and parks; organically developed and associative landscapes: memorial areas, places of historical events) and archaeological sites and archaeological areas, including underwater sites and zones.Table3.50, and a more detailed view can be found atPicture3.51.

Table3.50

Type and number of cultural assets in the area of counties in the investigation area of geothermal potential (source: Register of Cultural Assets of the Republic of Croatia)

County	Immovable cultural property		Intangible cultural assets	Cultural landscape	In total
	Individually	Cultural - historical entity			
KŽ	192	11	14	-	219
SMŽ	210	20	12	-	260
ZŽ	257	20	23	1	306
GZG	576	35	13	1	628
KZŽ	170	12	15	-	214
VŽ	171	6	17	1	223
MŽ	49	1	14	-	65
KKŽ	111	3	17	-	138
BBŽ	99	2	9	-	120
VPŽ	38	2	12	1	103
PSG	103	3	15	-	166
OBJ	239	10	24	-	424
BPŽ	58	2	24	-	131
VSŽ	125	9	23	-	240

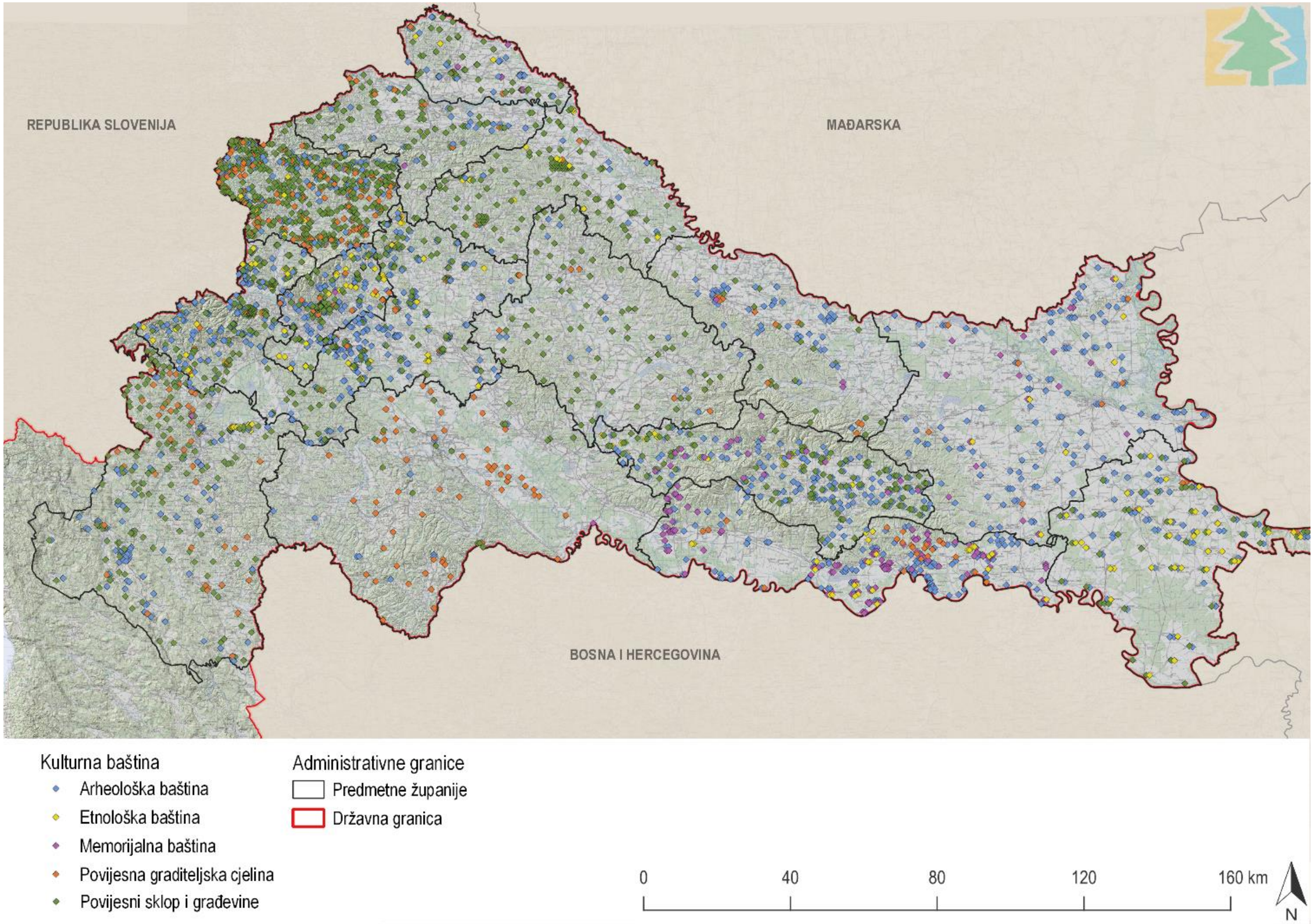
In addition to cultural assets protected under the Register of Cultural Assets, numerous examples of cultural heritage of regional value are recorded in spatial planning documentation. The aforementioned heritage is protected by the implementing provisions of the county spatial plans and prescribed protection measures. The relation to cultural and historical heritage and its record in the Spatial Plan differs from county to county in the detail of the graphic representation, symbols, class nomenclature.

According to the graphic appendices of the spatial plans of the counties located on the area planned for the exploration and exploitation of geothermal water, there is a total of cultural assets in the given area, of which 86 are in VPŽ, 159 in PSŽ, 445 in BPŽ, 1347 in VSŽ, 1567 in OBŽ, 88 in BBŽ, 135 in KKŽ, 83 in MŽ, 99 in VŽ, 569 in KZŽ, 230 in GZG, 567 in ZŽ, 87 in SMŽ, 400 in KŽ.

Table3.51Cultural assets recorded in the spatial plans of the respective counties (Source: IRES EKOLOGIJA doo according to the county spatial plans)

Type of cultural property/County	VPŽ	PSG	BPŽ	VSŽ	OBJ	BBŽ	KKŽ	MŽ	VŽ	KZŽ	GZG	ZŽ	SMŽ	KŽ
Archaeological heritage														
Archaeological site	47	37	122	673	287	14	222	22	17	106	106	5	11	168
Historical building complex														
Urban settlement	1	3	1	3	5	3	3	3	4	7	16	4	4	5
Rural settlement	-	-	21	9	1	1	20		3	76		52	52	1
Historical structure and buildings														
Residential buildings	-[5]	35	36	338	449	1	71	10	-	144	80	115	-	-
Construction complex, complex	1	5	7	-	5	-	-	2	21	6			3	36
Sacred buildings	19	30	97	123	181	58	212	32	38	152		269	12	143
Residential and commercial buildings	6	50	-	-	-	1	-	7	-	-		-	-	-
Old cities	4	4	-	-	-	-	-	-	-	12		6	-	-
Memorial heritage														
Memorial object	-	-	104	182	279	-	9	3	1	16		107	-	1
Cemetery	1	1	1	-	-	-	11	-	-	?		-	-	-
Memorial area	6	8	-	-	7	-	-	1	-	-	1	-	1	-
Ethnological heritage														
Ethnological area	-	-	2	-	9	-	-	3	-	6	26	-	-	18
Ethnological building	-	16	24	19	318	-	-	-	-	-		-	-	-
Cultural and historical landscape														
Cultural and historical area.	1	-	-	-	-	-	-	-	1	47	1	1	-	1
In total	86	159	415	1347	1567	88	135	83	99	569	230	567	87	400

[5](-) – Spatial planning documentation does not provide information on the number of the specified category of cultural property



Picture3.51. Protected cultural assets in the area of the counties in question (Source: IRES EKOLOGIJA doo according to county spatial plans)

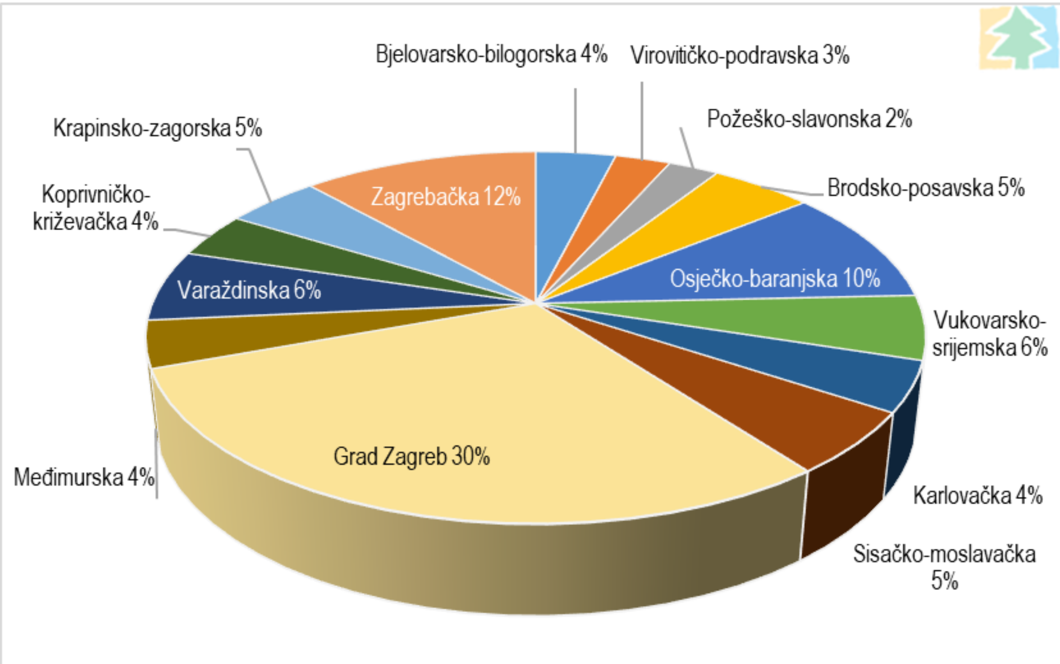
3.3.12 Population and human health

Demographic picture of the Republic of Croatia

Population is one of the main resources of an area and an important determinant of socio-economic development. Its movement and composition significantly reflect on the current processes in the space and largely determine its future development. According to the first, unofficial information from the 2021 census, there are 3,888,529 inhabitants in the territory of the Republic of Croatia. Pannonian Croatia has 1,025,221 inhabitants, the City of Zagreb 769,944, Northern Croatia 789,936, which makes a total of 2,585,101 inhabitants in the area covered by the Plan. Looking at the respective counties, the city of Zagreb has the largest number of inhabitants (769,944 people, which is 30% of the population in the area covered by the Plan), and the Požega-Slavonia County has the smallest (64,420 people, which is about 2% of the population in the area covered by the Plan). (Table3.52,Picture3.52).

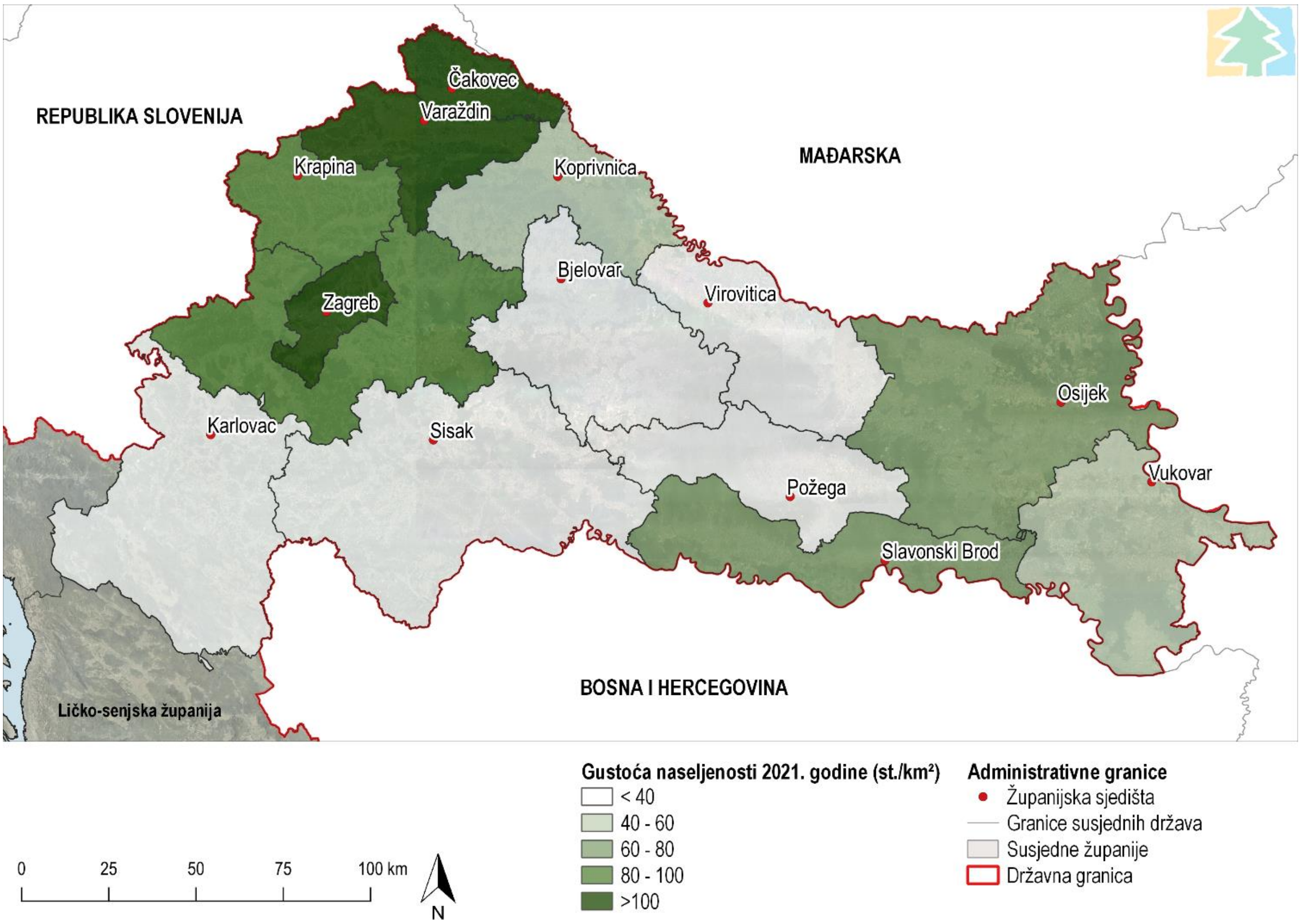
Table3.52Population movement in the period 1991–2021. on the territory of the counties in question (Source: IRES EKOLOGIJA doo according to the data of the State Bureau of Statistics)

County	in 1991	2001	2011	in 2021
Zagrebačka	282,989	309,696	317.606	301.206
Krapina-Zagorje	148,779	142,432	132,892	120,942
Sisak-Moslavina	251.332	185,387	172,439	140,549
Karlovačka	184,577	141,787	128,899	112,596
Varaždinska	187,853	184,769	175,951	160.264
Koprivnica-Križevačka	129,397	124,467	115,584	101.661
Bjelovar-Bilogorska	144.042	133.084	119,764	102.295
Virovitica-Podravska	104,625	93,389	84,836	70,660
Požega-Slavonia	99,334	85,831	78,034	64,420
Brod-Posavina	174,998	176,765	158,575	130,782
Osijek-Baranja	367.193	330.506	305.032	259,481
Vukovar-Srijemska	231,241	204,768	179,521	144,438
Međimurska	119,866	118,426	113,804	105,863
City of Zagreb	777,826	779.145	790.017	769,944
In total	3.204.052	3.010.452	2,872,954	2,585,101



Picture3.52Shares of counties in the total number of inhabitants in the area covered by the 2021 Plan (Source: IRES EKOLOGIJA doo according to the data of the Central Bureau of Statistics)

The city of Zagreb has the highest population density (1200.69 people/km2), followed by Međimurje (145.22 people/km2) and Varaždin County (127.08 people/km2). Five counties, in relation to the population density of the Republic of Croatia (68.71 persons/km2), have an above-average population density. Karlovac County (31.05 people/km2) and Sisak-Moslavina County (31.47 people/km2) have the lowest population density (Picture3.53).



Picture3.53Population density in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to data from the State Statistics Office and Geoportal DGU)

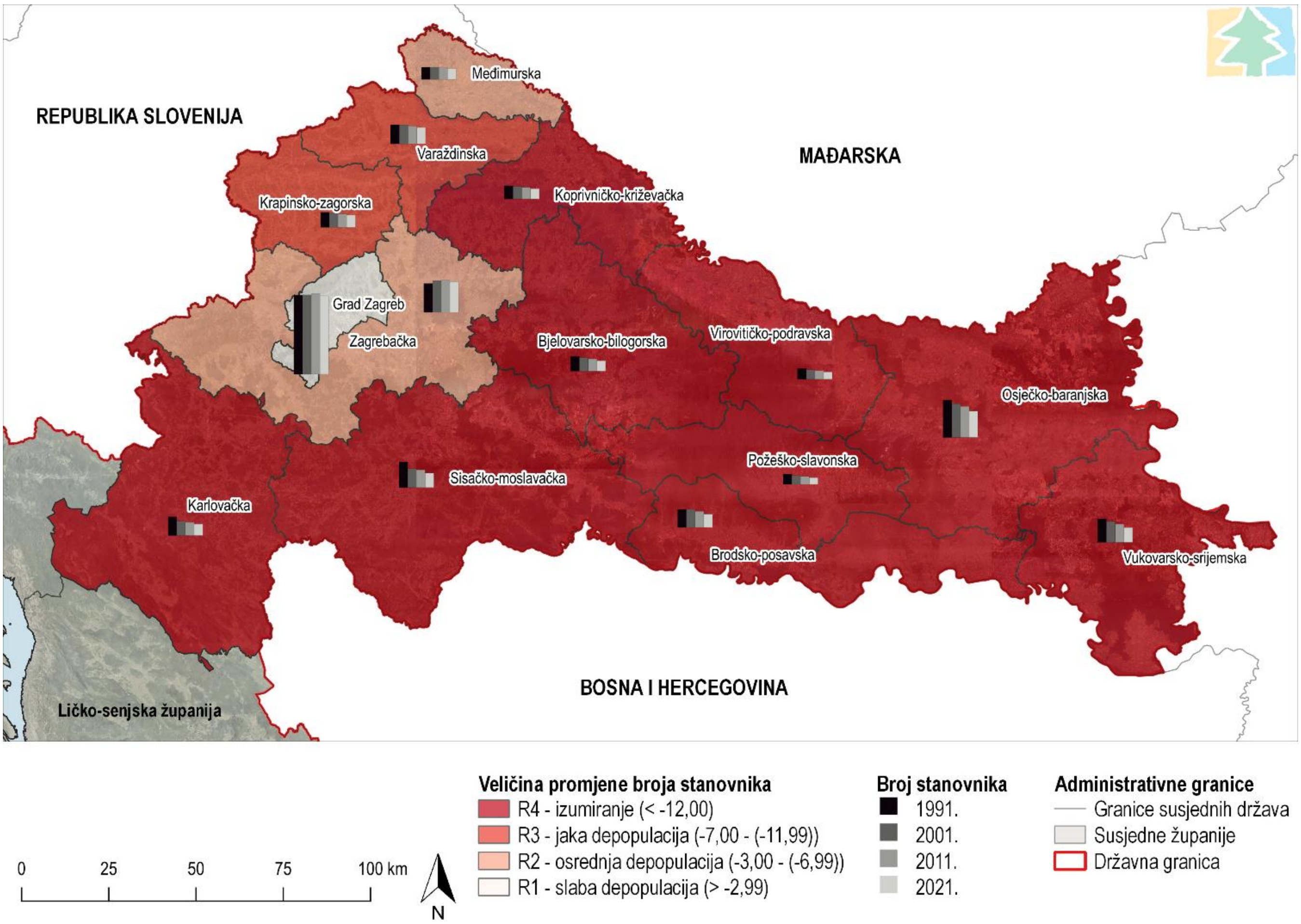
Total (general) population movement

In most counties, the decline in the number of inhabitants has been recorded since 1991 (Table3.52) (the rate of the total change in the number of inhabitants was -18.72%), while in the area covered by the Plan, Zagreb County, which recorded an increase in the number of inhabitants of 6.44% in the period from 1991 to 2021, and Sisak- Moslavina County, which at that time had a population decline of 44.1%.

Compared to the 2001 Census, the number of inhabitants of the counties in question decreased in 2011 by 137,498 inhabitants or by -4.57%. In the last inter-census period (2011-2021), the counties in question experienced a total decrease of 287,853 inhabitants or by -10.02%. The analysis of the population shows that not a single county recorded population growth. The smallest decline in the area covered by the Plan was recorded by: City of Zagreb (-2.54), Zagreb County (-5.16 %) and Međimurje County (-6.98). The largest decrease in population was recorded in Vukovar-Srijem County (-19.54%), Sisak-Moslavina County (-18.49) and Brod-Posavina County (-17.53%). Changes in the number of inhabitants per county can be observed through auxiliary type criterion[6]general movement (Picture3.54). In the period from 2011 to

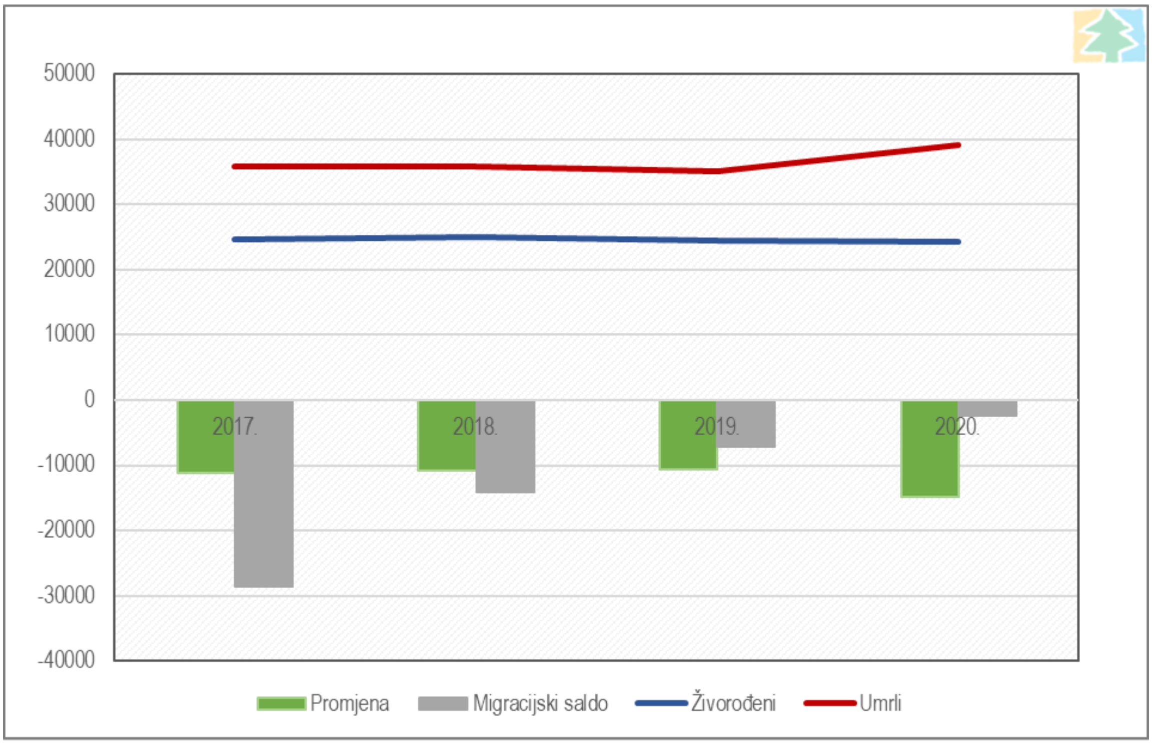
[6]When determining the general type of movement, an auxiliary criterion is also used - the size of the change in the number of inhabitants between the two censuses. Depending on the values of the change, the space can be affected by progression or regression, where each is divided into types. Progression (P): very strong progression (>12.00 %), strong progression (7.00-11.99 %), moderate progression (3.00-6.99 %), weak progression (1.00-2 .99 %) and stagnation (-0.99 – 0.99). Regression (R): weak depopulation (-1.00 – (-2.99) %), medium depopulation (-3.00 – (-6.99) %), strong depopulation (-7.00 – (-11 .99) %) and extinction (< -12.00 %)

2021, as many as nine counties (KŽ, SMŽ, BBŽ, KKŽ, VPŽ, PSŽ, BPŽ, OBŽ and VSŽ) recorded the most unfavorable R4 type - extinction.



Picture3.54The magnitude of the change in the number of inhabitants between the 2011 and 2021 Census and the population movement in the period 1991–2021. by county in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to the Central Bureau of Statistics)

The next graphic shows the natural change (difference between live births and deaths) and the migration balance for the respective counties (Picture3.55). Data for the four-year period 2017-2020. show extremely unfavorable trends since the natural change and migration balance were negative in all years. The most unfavorable year was 2017, when the counties in question recorded a total loss of 39,696 people. Emigration intensified with Croatia's entry into the European Union in 2013. Accordingly, the most common destinations of emigrants are other EU states such as Germany, Austria, Ireland, etc. In 2020, the most unfavorable migration balance was recorded by VSŽ (-1,324) and OBŽ (-948), while OBŽ recorded the largest natural decline (-2,108) and the City of Zagreb (-2,073).



Picture3.55Natural change in the number of inhabitants and migration balance in the counties in question for the period from 2017 to 2020 (Source: IRES EKOLOGIJA doo according to data from the State Bureau of Statistics)

The problem of demographic aging should also be highlighted. The average age of the total population of the Republic of Croatia in 2019 was 43.6 years (men 41.8, women 45.3), which ranks it among the oldest nations in Europe. The aging process is largely contributed by the multi-year decline in the share of the young population (0-19 years) in the total population. The mentioned share at the state level in 2019 was 19.3%. The share of the young population is the highest in Međimurje County (21.9%).

Development index of the Republic of Croatia

The development index is a composite indicator that is calculated as an adjusted average of standardized values of socio-economic indicators (unemployment rate, income per inhabitant, budget revenues of local or regional self-government units per inhabitant, general population movement, education rate and aging index) for the purpose of measurement level of development of local and regional self-government units in a certain period. Based on the deviation of the indicator value from the national average, local and regional self-government units are classified into development groups. The development index is used to determine the intensity of development promotion through state measures and aid programs.

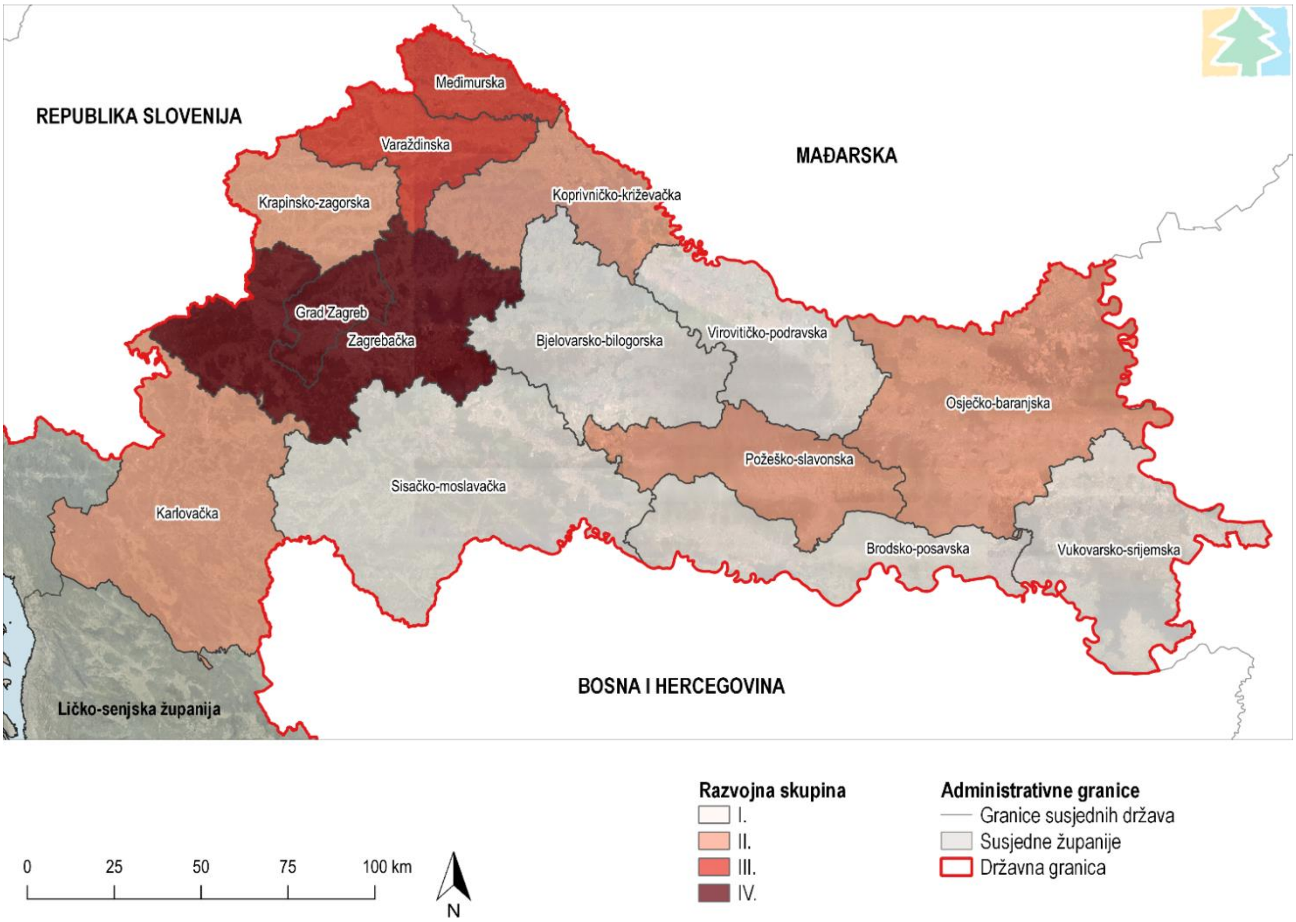
The basis for calculating the development index is represented by: the Law on Regional Development of the Republic of Croatia (Official Gazette 147/14 and 123/17) and the Decree on the Development Index (Official Gazette 131/17). Amendments to the Law from 2017 changed the way units are classified into groups according to the development index. Thus, instead of five, local self-government units are now divided into eight groups, and regional self-government units into four groups. Local self-government units with a development index lower than the average value (100%) are divided into four equal groups or quarters, thus forming I., II., III. and IV. group. Those with an index value above 100% are also divided into four equal groups and thus V., VI., VII. and the last VIII. the most developed group. Units of local (regional) self-government with below-average index values (less than 100%) are divided into two equal groups - I. and II. Those with values above the average are also divided into two groups: III. and IV. The development index is interpreted so that units of local, or regional (regional) self-government that have an index value greater than 100 fall into the area of above-average development, while units of local, or regional (regional) self-government that have an index value of less than 100 fall into the area of below-average development .

Counties in northwestern Croatia have the highest index of regional development, while the index in other counties is significantly lower. The highest index of regional development is recorded by the City of Zagreb (117,758), followed by Zagreb County (105,890). The lowest values of the development index were recorded in Virovitica-Podravska (90,666), Sisak-Moslavina (91,701), Vukovar-Srijemska (91,992) and Bjelovar-Bilogora County (92,576) (Table3.53andPicture3.56).

More developed counties have a greater concentration of infrastructure for economic activities (transport, energy, communication systems, communal services) and non-economic activities (education, health, science, culture, social protection and administration), which caused the concentration of jobs and labor strength of a higher level of professional education, immigration and, in general, better economic indicators.

Table3.53Development groups of local (regional) self-government according to the index of development in the area covered by the Plan (Source: Croatian Chamber of Commerce, 2017)

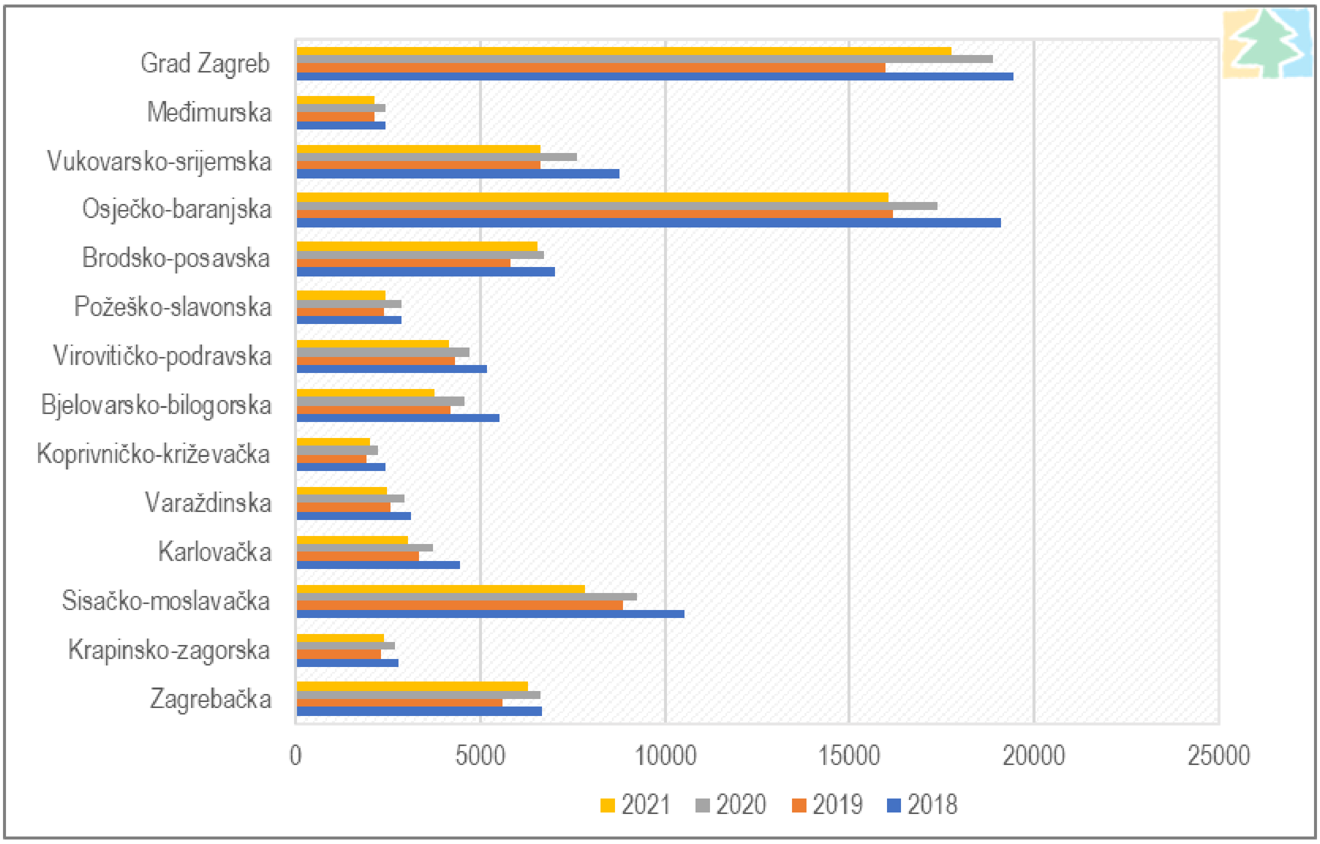
County	Index of development	Development group
Virovitica-Podravska	90,666	AND.
Sisak-Moslavina	91,701	AND.
Vukovar-Srijemska	91,992	AND.
Bjelovar-Bilogorska	92,576	AND.
Brod-Posavina	93,449	AND.
Požega-Slavonia	93,947	II.
Karlovačka	95,191	II.
Osijek-Baranja	96,009	II.
Koprivnica-Križevačka	98,493	II.
Krapina-Zagorje	98,976	II.
Međimurska	100,502	III.
Varaždinska	101,713	III.
Zagrebačka	105,890	IV.
City of Zagreb	117,758	IV.



Picture3.56Development groups of local (regional) self-government according to the index of development in the area covered by the Plan (Source: IRES EKOLOGIJA doo according to the data of the Croatian Chamber of Commerce)

Economic activity

According to the Croatian Employment Service, data on registered unemployment in the area of the respective counties in the last four years were analysed. The decrease in registered unemployment is related to migration trends and the decreasing number of the young population, which generates a decreasing number of the working age population. Also, the number of unemployed people in all the counties in question will decrease in 2021 after in 2020 due to the pandemic of the new respiratory disease COVID-19 (Coronavirus) and the measures taken to stop its spread (reduced working hours, closed more facilities), increased number of unemployed (Picture3.57).



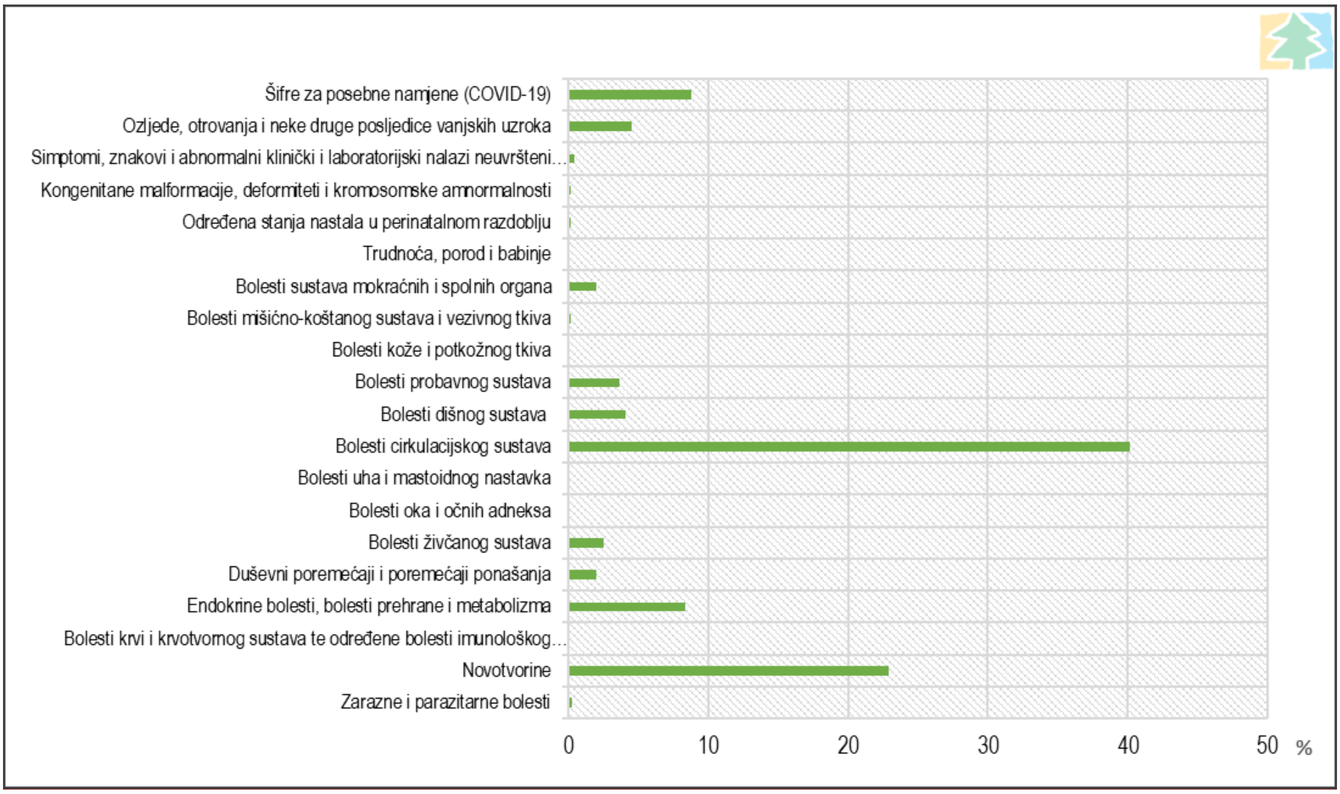
Picture3.57Registered unemployment of the population in the counties in question, in the period 2018 - 2021 (Source: data from the Croatian Employment Service)

According to the data of the Croatian Chamber of Commerce for the year 2020, the three leading companies in terms of the number of employees in the area of the respective counties were: KONZUM plus doo za trugnuje (10,863), HP - Hrvatska pošta dd (9,680) and HRVATSKE ŠUME doo (8,104). The companies belong to the following activities: G4711 - Retail trade in non-specialized stores mainly of food, beverages and tobacco products, H5310 - Activities of providing universal postal services and A0210 - Forestry and other related forestry activities.

People's health

According to tabular data of the Croatian Health and Statistical Yearbook for 2020, the two dominant causes of death in the area covered by the Plan are diseases of the circulatory system (40.13%) and neoplasms (22.87%).

In the same year, the respiratory disease COVID-19 (Coronavirus) was the dominant cause of 8.78% of deaths in the area covered by the Plan (Picture3.58). As of April 21, 2022, 1,115,442 cases of coronavirus infection were recorded in Croatia, and 15,765 people with diagnosed infection died. The virus spread to all Croatian counties, and a total of 708,971 cases of infection and 11,704 deaths were recorded in the area covered by the Plan.



Picture3.58Dominant causes of death in the area covered by the Plan in 2020 (Source: IRES EKOLOGIJA doo according to the Croatian Health and Statistical Yearbook for 2020 - tabular data)

3.4 Possible development of the environment without implementation of the Plan

Air

In the area of the counties in question, the problem of pollution with floating particles PM10 and PM2.5 and benzo(a)pyrene in PM10 was recorded, considering which the air quality is II. category, while for other pollutants the air quality is category I. In the settlements of continental Croatia, the problem of particle pollution (PM10) is particularly pronounced during the heating season, and the most significant local source of particle air pollution in winter is home fireplaces where biomass is burned (firewood). The increase in particle concentrations in winter is particularly favored by unfavorable weather conditions, which lead to the retention of polluted air in cities. The development of the environment in the area of air quality will go in the direction of a slow but continuous reduction of the concentration of pollutants in the air that can have a harmful effect on the environment and human health.

Climate and climate change

Since the problem of climate change is global in both its causes and its consequences, long-term comprehensive international cooperation is needed to master this problem. Global climate change is related to changes in the global energy balance of the Earth, so it is understandable to conclude that even without the implementation of the Plan, the annual temperature increase is expected to continue, a slight decrease in the amount of precipitation, an increase in the number of dry periods, an increase in the frequency and intensity of precipitation in a short period, etc. which will have an impact on the environment, infrastructure and people. Without the application of adaptation measures and vulnerability reduction in all sectors, the continuation and intensification of previous negative trends can be expected due to the new conditions.

By joining the European Union, Croatia assumed obligations related, among other things, to the reduction of greenhouse gas emissions. Without the implementation of the Plan, and in accordance with the set goals of increasing the share of renewable energy sources in the production of electricity and thermal energy and reducing the production of energy from fossil sources, there will be a gradual reduction of greenhouse gas emissions into the atmosphere due to the implementation of environmental and nature protection measures and the mitigation of climate change that are defined by other relevant documents at the national or international level. However, the implementation of the Plan will contribute to additional mitigation of climate change.

Water

Data from the Extract from the Register of Water Bodies obtained by Hrvatske vode, among other things, assess the expected state of water bodies after 2021. By setting more ambitious goals and implementing certain measures in the area of surface and underground water protection, there will potentially be an improvement in the ecological and chemical condition of certain water bodies and a reduction in the water load in the future, while some water bodies will not achieve at least a good overall condition due to a poor assessment of physical -chemical, hydromorphological, biological or chemical quality elements. The above data do not include an assessment of the state of groundwater bodies, but it is to be expected that pressure on the quantity and chemical state of groundwater will continue in the future.

Geological features and geodiversity

Without the implementation of the Plan, the geological features of the area could change only if certain interventions would encroach into the deeper layers of the Earth's crust. Geodiversity in the area covered by the Plan is the most affected by anthropogenic pressure. Any intervention in the area that involves the occupation of new areas or generates pollution of the surrounding area, depending on the location, can have a negative impact on a particular form of geodiversity to a greater or lesser extent. In particular, this refers to potential damage, impairment of characteristics, impact on natural processes or pollution within protected natural areas. Failure to implement the Plan would prevent the exploitation of the immense geothermal potential of the Pannonian Basin and the transition to a low-carbon economy.

Soil and agricultural land

Soil, as one of the most important and irreplaceable natural resources, is under constant stress in the form of pollution from various sources (traffic, agriculture, industry) and conversion, i.e. loss of natural and desirable soil functions such as production, gene pool and ecological regulation. Insufficient investments in the development of agriculture, especially in organic farming, and the problems of fragmented agricultural plots are the reason for the uncompetitiveness of agriculture as an economic branch. The vulnerability of agriculture to climate change is very high due to increasing temperatures and less precipitation, which consequently leads to lower yields and more frequent occurrence of plant diseases. Without the implementation of the Plan, there would be no potential benefits from the use of geothermal energy in agricultural production (in greenhouse production of fruits and vegetables, in aquaculture...), but there would be no additional land degradation in the area of exploration works and areas of construction of geothermal plants in the future. As for agricultural policy, it will continue in the direction of increasing the percentage of recorded used agricultural land in ARKOD and increasing the area under ecologically used agricultural land.

Biodiversity and protected areas of nature

Failure to implement the Plan reduces the risk of potential occupation of habitats and the loss of part of rare and endangered habitat types, as well as the risk of potential disruption of the stability of the population of endangered flora and fauna through the reduction of living space, disturbance due to noise and vibration, and casualties due to collisions with vehicles on newly constructed roads, casualties in pits and suffering as a result of a collision with the accompanying electric power infrastructure. Also, failure to implement the Plan reduces the risk of short-term or long-term conversion of habitats and the potential destruction or reduction of natural values due to which the protected nature area acquired the status of protection, as well as the risk of potential disruption of the population stability of the flora and fauna of protected nature areas by reducing the living space, harassment due to noise and vibration and injuries due to collisions with vehicles on newly built roads, injuries in pits and injuries due to collisions with the accompanying electric power infrastructure. Failure to implement the Plan also reduces the risk of pollution, release of heated geothermal water into surface water bodies (streams, lakes, etc.) or changing the water regime, i.e. the risk of changing the conditions and quality of water and wetland habitats inside and outside protected nature areas. Also, by not acting on the implementation of the Plan, the indirect benefits that its implementation can have on the total reduction of greenhouse gas emissions in the atmosphere and the mitigation of climate change are missing, because the use of geothermal energy reduces the consumption of conventional energy sources (e.g. fossil fuels).

Landscape

The landscape of the subject area is the result of the interaction of natural and anthropogenic factors over time. It forms and is an integral part of the residential, biological, ecological, health, psychological, cultural, touristic, economic and infrastructural aspects and parameters of the locality. The current landscape processes in the subject area are diverse.

Processes triggered by deagrarianization and depopulation operate within most agricultural landscapes. These existing economic and sociological trends will certainly continue regardless of the implementation of the Plan. However, the economic benefit that certain procedures can have for society would potentially enable investments in programs to preserve the cultural and natural landscape of the area in question. Also by delaying and delaying the integration of more environmentally suitable and efficient energy generation variants, the emphasis and direction of development will remain on existing electricity generation solutions. The conversion of rural landscape and wooded areas into infrastructural and construction land changes the already threatened state of the landscape, which is recognizable in the area in question. Without the implementation of the Plan, the risk of disrupting the elements of the landscape and their mutual relationships that make up its identity would be reduced. Geothermal sources with a slightly lower water flow are suitable for agricultural purposes, therefore, the integration of the drainage infrastructure opens up the potential for the implementation of new picturesque elements in the space. However, the traditional methods of agriculture, which make most of the area in question unique, as well as the forms of agricultural areas themselves, are less suitable for integration with the principles of drainage through geothermal sources, which are predominantly used for more intensive, monotonous forms of agriculture. It can be concluded that by not implementing the Plan in the area, the existing marking trends in the landscape would be maintained, while its potential additional degradation would also be avoided.

Forests and forestry

The dynamics of the development of the forest ecosystem would primarily be conditioned by natural processes and recorded environmental problems, as well as by regulations on the basis of management of the relevant economic units, i.e. annual and operational plans of an executive nature, which have an immediate effect on the state and structure of forests.

Game and hunting

The structure and condition of game populations and the quality of habitats where game has natural conditions for development will continue to be interrelated with the economic activities of this area (forestry, agriculture, water management), but also with recognized environmental problems, which synergistically affect the design and characteristics of the space on the area covered by the Plan. The main influence on the number and age and gender structure of hunting game is expected from the prescribed activities of hunting management bases (killing quotas, hunting of game, etc.).

Population and human health

The demographic picture of the area covered by the Plan in the last decade is marked by natural depopulation, population aging, a continuous increase in life expectancy at birth, a negative migration balance and a continuous decline in the number of inhabitants. The aforementioned trends will consequently affect the economic structure of the population and socio-economic development. Without the implementation of the Plan, the planned activities aimed at encouraging sustainable energy development would not be realized, which can have a multiplier effect on the economy and improve the quality of life of the population, for example in the form of increasing the employability of the local population. Accordingly, without the implementation of the Plan, the suboptimal use of the comparative advantages of the area and the lack of economic specialization of the area would continue.

Cultural and historical heritage

The cultural-historical heritage in the area in question is the result of a wide range of historical, social, natural, cultural, religious and other parameters that determine the morphology of the heritage. The lack of implementation of the Plan is not expected to change the current state of the cultural-historical heritage as an underutilized potential that is subject to degradation processes. Non-implementation of the Plan reduces the risk of potential destruction and degradation of undiscovered archaeological sites and direct impact on existing cultural assets by the process of preparation of interventions that imply further steps of the topic in question. Stopping potential exploratory drilling also reduces the risk of degradation of valuable undiscovered cultural heritage. On the contrary, the lack of implementation of the Plan negates the potential for the discovery of new sites.

4 Existing environmental problems that are important to the Plan

The analysis of the current state and trends of drivers of changes in the environment, environmental load and components and factors in the environment resulted in the separation of existing environmental problems of all components and factors in the environment from the aspect of the area of application of the Plan. In this chapter, their importance, locations, causes and links with drivers of change and environmental burdens are highlighted. Mitigation of environmental problems is considered and analyzed within the framework of this strategic assessment, with measures to improve the environment.

Table4.1Existing environmental problems that are important to the Plan

Component/factor in the environment	Existing environmental problems
Air	• In the area of zone HR02 Industrial zone the air is II. quality with regard to floating particles PM10 and PM2.5, and benzo(a)pyrene in PM10 • In the area of the Zagreb agglomeration, the air in certain areas is II. quality with regard to suspended particles PM10 and benzo(a)pyrene in PM10 • In the area of the Osijek agglomeration, the air is II. quality with regard to suspended particles PM10
Climate changes	• The trend of the increase in the mean annual air temperature compared to the multi-year average • Increasing number of dry periods • Increasingly frequent storms accompanied by strong winds
Geological features and geodiversity	• Disruption of geodiversity due to the removal of soil, rocks, minerals and fossils through the exploitation of mineral raw materials • Disruption of fluvial and fluviokarst forms of geodiversity by anthropogenic interventions in the vicinity or directly on watercourses • Contamination of speleological facilities by improper disposal of waste
Soil and agricultural land	• Loss of soil ecological functions as a result of land conversion for infrastructure needs • Soil erosion present in the area of the hilly-mountain belt • Lack of data on soil pollution • Fragmentation and excessive fragmentation of plots (average size 0.95 ha) that are not suitable for the application of modern technology and profitable agricultural production • In the last five-year period, the number of agricultural holdings (-25%) and the number of cattle (-7.4%) decreased
Water	• Non-achievement of ODV goals for 64.68% of surface water bodies (liquid and stagnant) mostly due to failure to achieve a satisfactory assessment of physico-chemical and hydromorphological indicators • Non-implementation of monitoring of biological quality elements in more than 80% of water bodies of surface waters and, consequently, lack of data on the biological state of waters • Pollution of water bodies due to agricultural production and wastewater
Biodiversity	• Degradation, loss and conversion of habitats, especially endangered habitats • Fragmentation of the habitat, which negatively affects the population of flora and fauna • Water pollution • Suffering of wild species on roads • The lack of a database for autochthonous, non-native and invasive species, and innose and the spread of non-native species threaten the survival of autochthonous flora and fauna • Anthropogenic pressure on aquatic habitats
Protected areas of nature	• Pollution of surface and underground water • Intensification of agriculture • Lowering the water level • Poaching • Active or untreated quarries

Component/factor in the environment	Existing environmental problems
	• Absence of a Management Plan for all protected areas
Forests and forestry	• Slowed growth, drying and decay of trees due to climate changes and due to changes in habitat conditions in floodplain forests, i.e. a decrease in the level of underground water and the absence of floods • The need for wood raw material, intensive agricultural production and various infrastructural interventions cause conversion and fragmentation and fragmentation of the forest biotope. • The general poor state of private forests, the absence of biological forest regeneration, the disorganization of forests (not all management programs have been adopted), fragmented and fragmented areas, unsettled land registers and property legal relations, illegal logging, lack of interest of the owners in caring for the forest, etc.) • Conversion of forests and forest land, which reduces the utilization of wood stock and the value of general utility functions • Forest fires and non-implementation of the necessary fire protection measures in terms of building fire prevention averages, protecting forests and carrying out cultivation works in the function of fire protection • Mining of forests and forest land • Forest pests • Spread of plant invasive species
Game and hunting	• Fragmentation caused by infrastructural interventions, which is especially pronounced on the edge of the habitat due to changes in habitat conditions • Reduction of hunting productive area • Suffering of wild animals on roads • Poaching and the lack of data on poaching • Diseases and reduction of population vitality (e.g. American fluke) • Pressure on the productive capacity of the habitat and biological diversity due to biotic and abiotic factors within the game habitat (e.g. impact on water sources)
Landscape characteristics	• Development of urban infrastructure without contextual spatial and form integration • Depopulation and deagrarianization and the inability to maintain the complexity and structure of the agricultural landscape • Degradation and deterioration of urban and rural cores due to depopulation and abandonment and neglect of traditional forms of construction • Change and disappearance of valuable linear landscape elements (parcellation with hedges, organic form of streams) as a result of agro-melioration interventions and geometrization of the hydrographic system • The area of Eastern Slavonia is permanently burdened by the problem of the lack of forest areas that have disappeared due to historical logging, which indirectly affects the naturalness of the landscape as well as the aesthetic complexity. • A reflection of changing economic trends and aspirations on the structure of the landscape: for example, the intensification of agriculture • "Erosion" and the creation of rectilinear forest edges due to the expansion of human activities • Construction on visually or landscape exposed locations • The canalization of streams in the urban environment, and the degradation and unused potential of the green and blue infrastructure
Population and human health	• According to the first unofficial results of the 2021 Population Census, a decrease of 287,853 inhabitants or by -10.02% in the area covered by the Plan • None of the counties in question recorded population growth • Nine counties (KŽ, SMŽ, BBŽ, KKŽ, VPŽ, PSŽ, BPŽ, OBŽ and VSŽ) record the most unfavorable R4 type – extinction. • Unfavorable demographic trends – negative migration balance and natural change in the last four-year period (2018 – 2021) • Loss of population caused by emigration, especially the young, the most productive and able-bodied age groups

Component/factor in the environment	Existing environmental problems
	• Uneven spatial distribution of the population • Uneven spatial development and economic progress • Declining quality of life under the influence of the coronavirus pandemic
Cultural and historical heritage	• Unsatisfactory construction condition of the architectural heritage, neglect, lack of maintenance, dilapidation. • The issue of property legal relations regarding cadastre and land documents of cultural property. • Insufficient spectrum of interdisciplinarity and professional capacities for the preparation of documentation necessary for rehabilitation and preparation of an economic use plan in the network of institutions responsible for cultural heritage. • Degradation and devastation of cultural assets due to war destruction. • The lack of a development document on cultural heritage issues (cultural heritage management model), which causes inadequate systematic maintenance and use. • Existing and threatening irreversible devastation of cultural assets, especially archeological ones, during the integration of infrastructure networks. • The decline of the local population's interest in spatial identity factors due to their degradation and depopulation of the settlements in the area in question.

5 Environmental features of the area that may be significantly affected by the implementation of the Plan

The environmental features of the area that may be significantly affected by the implementation of the Plan are described in the Chapter3.3Description of the components and factors in the environment, and in this chapter they are separated and presented in accordance with the preliminarily recognized influences that can be more significantly influenced by the implementation of the Plan.

Table5.1Environmental features that may be significantly affected by the implementation of the Plan by environmental components and environmental factors

Component/factor in the environment	An environmental feature	Influence
Water	Condition of surface and underground waters	If there was an uncontrolled release of technological waste water or extracted geothermal water from wells into the environment, surface and underground water would be polluted, and due to the change in biological potential, the functions of water streams would be lost.
Soil and agricultural land	P1 and P2 land	Negative changes due to the implementation of research and infrastructural interventions due to the conversion of P1 and P2 agricultural land, if the mentioned activities will be located on such lands and thus their production value and function will be permanently lost.
Biodiversity Protected areas of nature	Rare and endangered habitats Endangered flora Endangered fauna Protected areas of nature	The construction of the infrastructural facilities provided for in the Plan may lead to the occupation of habitats and the loss of part of rare and endangered habitat types, as well as the potential disruption of the population stability of endangered flora and fauna through the reduction of living space, including emigration due to noise and vibration and injuries due to collisions with vehicles on newly constructed roads, injuries in pits and injuries due to collisions with accompanying electric power infrastructure. Furthermore, if there is pollution, the release of heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.) or a change in the water regime, this results in a change in the conditions and quality of water and wetland habitats. Realization of research and infrastructural interventions is possible for short-term or long-term repurposing of the habitat and potential destruction or reduction of the natural values due to which the protected nature area acquired the status of protection. Also, it is possible to potentially disrupt the stability of the population of flora and fauna of protected nature areas by reducing the living space, disturbance due to noise and vibration, and casualties due to collisions with vehicles on newly built roads, casualties in pits and casualties due to collisions with the accompanying electric power infrastructure. Furthermore, if there is pollution, the release of heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.) or a change in the water regime, this results in changes in the conditions and quality of water and wet habitats of protected nature areas.
Landscape characteristics	A valuable and unstable element of forest areas in the lowland agricultural landscape Integrity and structurality of the landscape Visual identity of the landscape	Actions that imply further development of the matter of the Plan envisages space for the implementation of geothermal power plants, exploration and exploitation wells as well as other forms of using geothermal energy. The life cycle of such a plant, after the research process, which includes the implementation of analyzes and test wells, enters the process of "deployment". It turns into an exploitation site and is abandoned after a certain period, and the landscape is restored to its "ante-operam" state. The landscape of the subject territory is the result of a complex relationship of natural and anthropogenic factors that form a spatial identity throughout history. The construction and implementation of the structure negatively changes the morphological elements that form the landscape: open agricultural areas, linear elements (streams, hedges), relationships between volumes (forests) and areas, spatial edges,

		sequence, continuity and integrity of the landscape. The visual identity and image are changed, and the existing views within the landscape are interrupted by the introduction of new accent elements, thereby disrupting its naturalness, balance and complexity in a literal and perceptual sense.
Forests and forestry	General utility functions of forests Stability of the forest ecosystem	As a result of the construction of the infrastructure provided for in the Plan, valuable forest areas are lost and the stability of forest stands is disrupted, as well as a reduction in the general useful functions of the forest and the amount of wood stock.
Game and hunting	Hunting productive area Wild animals	As a result of the construction of the infrastructure foreseen in the Plan, the habitat conditions change and the fragmentation of the productive hunting area increases and prevents the migration of the game present, and the possibility of collision of the game with vehicles on the newly built roads and death in the pits is increased.
Cultural Heritage	Degradation of properties of cultural assets	During the implementation of primarily investigative works, and later depending on the results of exploitation works, it is possible to influence the physical and visual integrity of cultural assets in the immediate and intermediate distance from the operations in question. It is also possible to influence newly discovered archaeological sites. Therefore, archaeological sites are subject to possible impacts of future research and exploitation interventions
Population and human health	Noise Pollutants in the air	Due to the implementation of exploration and exploitation works, a significant negative impact on the population is possible if the levels of noise and pollutants in the air exceed the legally permitted limit values, and thus endanger the health of the population living near the locations of the said works.

6 Environmental protection goals established by the conclusion of international treaties and agreements, which refer to the Plan

Conventions and protocols are international agreements, the provisions of which the signatories of the documents must respect. By ratifying them, the states are formally committed to implementing the provisions, both by law and in practice.

Below is a description of the environmental protection goals established by the conclusion of international treaties and agreements, the purpose and goals of these documents, and a comparison of their goals with the goals of the Plan.

Table6.1A list of analyzed international treaties and agreements and a comparison of their goals with the goals related to the Plan

International document	Relationship with the Plan
Convention on access to information, public participation in decision-making and access to justice in environmental matters Aarhus (1998) (NN – MU 10/01).	
The goal of the convention is that: "... in order to contribute to the protection of the right of every person of the present and future generations to live in an environment suitable for his or her health and well-being, each party guarantees the right of access to information, public participation in environmental decision-making and access to justice in matters environment in accordance with the provisions of this Convention".	The Subject Study and subsequent studies, as well as documentation related to the project level, are the basic prerequisites for the implementation of the Plan's tendencies. The entire hierarchy of documents related to the further development of the matter of the Plan will be subject to environmental impact assessment documents. One of the tasks of the same is the public perception of the possible impacts of the Plan on the environment through public inspection and public discussions of both the study in question and future studies related to the interventions necessary to realize the objectives of the Plan in question. Through the above, we strive to improve the quality of life, ensure a greater degree of environmental protection and sustainable development.
Protocol on Strategic Environmental Assessment, Kyiv (2003) (NN-MU 3/10.)	
The goal of the Protocol is to ensure a high level of environmental protection, including health, through: • ensuring that environmental issues, including health, are fully taken into account in the development of plans and programmes; • contributing to the consideration of environmental requirements, including health, in the development of policies and legislation; • establishment of clear, transparent and efficient procedures for strategic environmental assessment; • ensuring public participation in strategic environmental assessment; and • inclusion in these ways of environmental requirements, including health, in measures and instruments intended to promote sustainable development	The Study in question and the further, more detailed hierarchy of documents whose task is the implementation of environmental protection measures are in accordance with the goals of the protocol. The strategic study is a tool and a step by which environmental and nature issues are brought into the process of adopting plans and programs. All documents of this nature are available to the public with the aim of involving them in their creation with the aim of improving the condition and protection of individual components of the environment as well as their interrelationships and the balance they create in order to steer towards sustainable development. In addition to the above, one of the main goals of the Plan is the decarbonization of the energy sector, as well as sustainable management of resources and energy independence, which also achieves the goals of environmental protection and preservation.
Convention on Environmental Impact Assessment across State Borders (Espoo, 1991) (NN-MU 6/96, 07/08)	
The signatories of the Convention will individually or jointly take all appropriate and effective measures to prevent, reduce and control significant negative impacts of planned activities on the environment across state borders. Also**r, the country of origin should ensure that an environmental impact assessment is carried out in accordance with the provisions of this Convention before making a decision to approve or carry out the planned activity. The signatories should pay special attention to the creation or intensification of special research programs aimed at:**	The study presents an environmental impact assessment of the Plan in question, as part of which, among other things, the possible cross-border impacts of activities that are necessary for further elaboration of the plan's tendencies were assessed. The study and legal regulations determine the distance of the minimum distance of future activities related to the Plan from water bodies. Almost the entire state border in the area designated for the development of the plan is bordered by river watercourses, which in this case

International document	Relationship with the Plan
− improve existing qualitative and quantitative methods for assessing the impact of planned activities − achieve a better understanding of cause-and-effect relationships and their role in comprehensive environmental management − analyze and monitor the effective implementation of decisions on planned activities with the intention of minimizing or preventing the consequences − create methods for stimulating a creative approach in the search for environmentally acceptable alternatives for planned activities, production and consumption methods, create a methodology for applying the principles of environmental impact assessment at the macro-economic level.	serve as a kind of shield. Therefore, with the mitigation measures prescribed by the Study, the possibility of cross-border impacts is significantly reduced. Placing future activities near the state border and implementing more detailed protective environmental documents creates an opportunity for international cooperation, strengthening cohesion and mutual improvement of qualitative and quantitative methods for assessing the impact of planned activities. Through the aforementioned, the Plan in question and the Study conducted for it directly achieve the goal of the Convention on the analysis and monitoring of the effective implementation of decisions on planned activities with the intention of minimizing or completely preventing the consequences.
European Green Plan	
The European Green Plan represents a way to make Europe the first climate-neutral continent by 2050, strengthening the economy, improving people's health and quality of life, taking care of nature and leaving no one behind. It is a roadmap for achieving a sustainable EU economy by turning climate and environmental challenges into opportunities in all policy areas and a transition that is fair and inclusive for all. The goal is to increase the efficient use of resources by moving to a clean, circular economy and stop climate change, reverse the loss of biodiversity and reduce pollution by covering all sectors of the economy, especially transport, energy, agriculture, construction and industries such as steel, cement, ICT, textiles and chemicals. In addition, The European Green Plan emphasizes the importance and necessity of adapting to climate change and how strengthening efforts in climate resilience, building resilience, prevention and preparedness is crucial. It will be important to ensure that across the EU, investors, insurers, companies, cities and citizens can access data and develop tools to integrate climate change into their risk.	A fundamental document adopted at the level of the European Union, which defines the way of efficient use of natural resources, because the European Green Plan (COM/2019/640). As a precondition for the realization of the mentioned plan, a reconsideration of the policy for the supply of clean energy in the economy, industry, production and consumption, large infrastructure, transport, agriculture and the food sector, construction, the tax sector and the social welfare sector was set. The main goal is to achieve climate neutrality of the European Union by 2050. Renewable energy sources, including geothermal energy, will play a central role in the transition to clean energy, and in this way it will be possible to achieve the goal of reducing greenhouse gas emissions in 2030 by more than 50% compared to 1990.
UN Framework Convention on Climate Change (UNFCCC, 1992) (NN-MU 02/96)	
The goal of the UN framework convention on climate change is to stabilize the concentration of greenhouse gases in the atmosphere in a way that does not endanger food production and to enable the continuation of economic development in a sustainable manner. It is necessary to limit the impact of all activities (traffic, certain technologies, etc.) that in some way cause the emission of greenhouse gases, that is, influence climate change. The principles of this Convention state that the parties in their activities to achieve the goal of the Convention should, among other things, take precautionary measures in order to prevent, prevent or minimize the causes of climate change and mitigate its negative consequences. The Republic of Croatia, as a Party to the UN Framework Convention on Climate Change UNFCCC, is obliged to prepare and submit a national report on climate change every four years, which reports on the implementation of the obligations of the Convention. In 2018, the Ministry of Environmental Protection and Energy issued the Seventh National Report of the Republic of Croatia according to the United Nations Framework Convention on Climate Change.	With the further development and implementation of the Plan's content, the goals of the UN framework convention on climate change are realized through a direct reduction of the concentration of greenhouse gases in the atmosphere by switching to cleaner forms of electricity generation. Also, the potential of geothermal energy can potentially be integrated in several forms in the sectors of transport, production technology in industry, agriculture, and housing. Within each of the mentioned greenhouse gas generators, it is possible to achieve their reduction by further developing the potential of geothermal energy.
Paris Agreement on Climate Change (2015) (NN-MU 3/17)	

International document	Relationship with the Plan
The Paris Agreement on Climate Change (part of the UNFCCC) is a global climate agreement that aims to limit the increase in global average air temperature to "well below" 2 °C compared to pre-industrial levels and to continue efforts to limit the increase in global temperature to 1.5 °C, ensuring food supply, but also strengthening the capacity of countries to fight the consequences of climate change, developing new "green" technologies and helping weaker, less economically developed members to achieve their national plans to reduce emissions. The targets for reducing greenhouse gas emissions are determined by their own planning, so that each party to the Paris Agreement (or a group of countries) determines the planned nationally determined contribution until 2030.	Adopting and further developing the substance of the Plan achieves the aspirations of the Paris Agreement on climate change through the direct extension of the period of agricultural cultivation on an annual level with technologies made possible by geothermal energy, also through decarbonization and the transition to sustainable forms of energy, an indirect reduction in temperature growth is realized. By acting on the issue of further development of the aspirations of the Plan, energy independence is achieved, which strengthens the competitiveness of the Republic of Croatia and facilitates the realization of national plans on reducing emissions. By adopting the plan for the development of the geothermal potential of the Republic of Croatia, it directly approaches the plan's aspirations and the achievement of the goals of the Paris Agreement on climate change.
EU Strategy for Adaptation to Climate Change	
The new strategy sets out how the European Union can adapt to the inevitable impacts of climate change and become resilient to the coming changes by 2050. The impact of climate change is so widespread that our response to it must be systematic. Therefore, the European Commission will actively include aspects of resilience to climate change in all relevant policy areas related to both the public and private sectors. Basic goals: • make adaptation smarter by encouraging action based on reliable data and risk assessment tools available to all • make adaptation more systematic, because climate change has an impact on all sectors • to make adaptation faster, because we are already feeling the consequences of climate change • strengthen action at the international level, because adaptation is a cross-sectoral element of external action of the EU and member states that includes international cooperation, migration, trade, agriculture and security.	By adopting the Plan and achieving the goals of better utilization of geothermal potential, a more systematic and faster realization of the benefits that geothermal energy can achieve in reducing climate change is achieved. Also, through the achievement of goals for the easier realization of all forms of use of geothermal potential, the process of adaptation to climate change is accelerated, given that geothermal energy is considered a climate-sustainable source of energy. The development of a new source for the production of electricity creates the possibility of supply at the national and international level, and the efficient and adequate establishment of the use of the resource in question can, by its example, stimulate the international development of infrastructure that affects the slowing down and reduction of the impact of climate change.
Convention on Biological Diversity, Rio de Janeiro (1992) (NN-MU 6/96)	
The Convention on Biological Diversity establishes the preservation of biological diversity as a fundamental international principle in the protection of nature and a common obligation of humanity. The three main objectives of the Convention are: • preservation of overall biological diversity • sustainable use of biological diversity components • fair and equal distribution of benefits resulting from the use of genetic resources. In 2020, the EU Biodiversity Strategy until 2030 was adopted, and it represents a comprehensive, ambitious and long-term plan to protect nature and stop ecosystem degradation. The strategy aims to enable European biodiversity to start recovering by 2030.	Through the goals of the Plan, which include the incorporation of underutilized geothermal potential into the energy infrastructure of the Republic of Croatia, an energy milestone is achieved through a faster transformation into a green and sustainable economy, reduced greenhouse gas emissions and the achievement of a greater share of energy obtained from renewable sources. The aforementioned has a positive effect on biological diversity by directly reducing the negative effects of fossil fuels, waste water, and the degradation effects of other forms of electricity generation through a lower need for them. The study in question also regulates and determines measures in order to maximally protect the components of biological diversity and overall biological diversity from possible degradation by achieving the objectives of the Plan in question.
Convention on the Protection of European Wild Species and Natural Habitats - Bern Convention, Bern (1979) (NN-MU 6/2000)	

International document	Relationship with the Plan
The main objectives of the Convention are to ensure the preservation and protection of wild plant and animal species and their natural habitats, to increase cooperation between the contracting parties, as well as to regulate the exploitation of these species (including migratory species).	The Study in question protects through measures localities of existential importance for wild species, among which are migratory ones, which is carried out by protecting them from the degradation of their habitats. Also, further development of the Plan and the establishment of a network for the use of geothermal potential reduce the pressure of pollutants on wild species and habitats by reducing the use of less environmentally acceptable sources of heat and electricity.
Convention on European Landscapes Firenze (2000) (NN-MU 12/02)	
The Convention aims to promote the protection of the landscape, its management and planning, and the organization of European cooperation in the field of landscape. Also, the convention prescribes special measures related to raising awareness, training and education, identification and evaluation, and implementation of landscape policies.	The plan does not have direct objectives related to the protection, management and planning of landscapes, but its implementation creates new opportunities for the objectives of the Convention in question. By protecting the natural factors of the landscape by establishing a sustainable and more environmentally friendly way of generating heat and electricity, the morphology of the landscape is directly protected from the present pollutants. With the measures of the Study, the subject Plan is directed towards actions and forms of use that can have a positive effect on the further development and management of landscapes through its positive transformation and slowing down of other existing degradation processes of the landscape.
Convention on the Protection of World Cultural and Natural Heritage, UNESCO (1972) (NN-MU 12/93)	
The goal of establishing this convention is the efficient protection and preservation of cultural and natural heritage on the territory of the signatory countries, as well as the popularization of said heritage.	Within the set goals, the Plan has no direct links with the goals of the Convention in question. However, the goals of preserving and popularizing natural and cultural heritage are potentially realized through the discovery of new cultural heritage sites during the implementation of activities that imply further steps of the Plan. Also, by establishing a sustainable and more environmentally friendly way of generating electricity and thermal energy, the degradation effect of fossil fuels and other pollutants of the existing energy infrastructure on the natural heritage is reduced.

7 Impacts of the Plan on the environment

7.1 Impact assessment methodology

The assessment of the impact of the implementation of the Plan analyzes the change or the consequence that the implementation of research and exploitation of geothermal waters will have on the environmental characteristics of components and factors in the environment.

The impacts of the Plan on the components of the environment and other factors in the environment are assessed using the method of expert judgment based on available existing data on the characteristics of the Plan's activities and available national and international scientific and professional literature on the possible impacts of certain characteristics of the planned activities or elements.

When analyzing the impact assessment on environmental components and other factors in the environment, the following impact categories are used to define the type and scope of individual impacts in more detail:

- according to importance:

Name	Description
POSITIVE INFLUENCE	The activity of the Plan improves the state of environmental components and other factors in the environment in relation to the existing state or trend by solving one of the existing environmental problems or by positively changing the existing negative trend.
NEUTRAL INFLUENCE	The activity of the Plan does not generate an impact on the components of the environment and other factors in the environment.
NEGLIGIBLE IMPACT	The impact is defined when the implementation of the Plan will generate small, local and temporary consequences in the form of changes in the environment within the existing limits of natural variations. The natural environment is completely self-sustaining because the receptors are characterized by low sensitivity or value.
MODERATELY NEGATIVE IMPACT	The impact is moderately negative if it is estimated that the implementation of the Plan will slightly worsen the state of the environmental features compared to the current state, and it is characterized by a wide range that starts from a threshold that slightly exceeds the negligible level of impact and ends at a level that almost exceeds the limits prescribed by law. Changes in the environment exceed the existing limits of natural variations and lead to the deterioration of the environmental characteristics of components and factors in the environment. The natural environment remains self-sustaining. In this category are the impacts that occur as a result of the release of pollutants within the limits prescribed by law, the occupation of smaller parts of more numerous or less valuable habitats, the risk of suffering a smaller number of individuals of species that are not in the protection regime, etc. Protection measures are defined for this category of impacts. environment that can exclude/reduce the possibility of negative impact.
SIGNIFICANTLY NEGATIVE IMPACT	The impact is significantly negative if, during the assessment, it is determined that there is a risk that, as a result of the implementation of the Plan, the condition of the environmental features will deteriorate to the extent that the limits prescribed by the legislation may be exceeded or valuable and sensitive natural receptors may be damaged. Changes in the environment result in significant disruption of individual environmental features of components and factors in the environment. Certain environmental features lose their ability to self-heal. For this impact, it is necessary to prescribe a protection measure that would reduce the significant impact to the level of moderate or eliminate it, and if this is not possible, it is necessary to consider changing the proposed activities of the Plan (find other suitable solutions) or reject the Plan, i.e. individual activities proposed by it as unacceptable.

- according to the course of action:

Name	Description
IMMEDIATE IMPACT	The implementation of the activities of the Plan represents a direct source of influence.
INDIRECT INFLUENCE	The implementation of the activities of the Plan generates a change that is a source of future influence.

- according to time duration:

Name	Description
SHORT-TERM IMPACT	The influence of the implementation of the activities of the Plan on the environment/nature ceases within 5 years.

MEDIUM-TERM IMPACT	The influence of the implementation of the activities of the Plan on the environment/nature ceases between the 5th and 10th year from the beginning of the development of the impact.
LONG-TERM IMPACT	The effect of the implementation of the activities of the Plan would have permanent consequences for the environment/nature and would not end even after 10 years.

- by reach area:

Name	Description
LOCAL INFLUENCE	Influence on the characteristics of the environmental features of components and factors in the environment that occurs in the area of implementation of the Plan, that is, in the counties in question.
REGIONAL INFLUENCE	Impact on the characteristics of environmental features of components and factors in the environment that may occur outside the area of implementation of the Plan, i.e. the counties in question.
CROSS-BORDER INFLUENCE	The impact is transboundary if the implementation of the planned activities can affect the environment of another country.

- according to the total effect:

Name	Description
CUMULATIVE IMPACT	The impact is cumulative when the Plan, together with the possible realization of other planned activities in the vicinity, generates equal but increased impacts on the components of the environment and factors in the environment that are affected by the activities themselves. In addition, cumulative impacts of planned activities with existing pressures in the space are possible.
SYNERGIC INFLUENCE	The impact is synergistic if the implementation of the Plan generates different impacts that together act on the component of the environment in such a way as to create a new collective impact that is stronger than the sum of the individual impacts on the component or factor in the environment.

When assessing the impact of the Plan on the environment, the starting point is the fact that the implementation of the Plan will comply with all legal provisions. Likewise, for all environmental components and factors in the environment, the worst possible impact scenario was assessed as a precaution, given that it is a strategic assessment that does not specify the methods of performance, nor the exact locations of the research and exploitation of geothermal waters. Therefore, such an assessment should help when defining the project level when the planned activities will be defined in the form of interventions for which an assessment or assessment of the need for an environmental impact assessment and/or assessment of acceptability for the ecological network will be carried out.

Possible loads introduced or intensified by the implementation of the Plan were also assessed, the change of which was identified through the process of assessing the impact on environmental components and factors in the environment in which it is generated and which may be significantly affected.

The impact assessment as well as the prescribed environmental protection measures is divided into two sections that refer to two main phases: the research phase and the exploitation phase, which are described in detail in Chapter1.4.

The impact of the implementation of the activities of the Plan on the environment includes the chapter on the assessment of the impact of the creationwaste (Chapter0, assessments of the impact of climate change on the implementation of Plan activities (Chapter7.2.2.1), impact assessments in case of an uncontrolled event (Chap1.4), cross-border impacts (Chap1.5) and the cumulative and synergistic assessment of the impact of the implementation of the Plan on the environment (Chap1.6).

7.1.1 The method of assessing the impact on environmental components and factors in the environment

Each component of the environment and factor in the environment uses a specific impact assessment methodology with regard to its characteristic elements and features, as follows:

Geological features and geodiversity

The assessment of the impact of the Plan on the geological features considers possible changes in the rock structure of the stratigraphic units that may occur as a result of the implementation of the planned activities. The impact assessment on geodiversity analyzes the activities of the Plan that, due to their location and operation, can potentially threaten valuable forms of geodiversity. Possible encroachment on valuable forms of geodiversity that could potentially be discovered during the works was considered. The analyzed impacts are divided into (Gray, 2013 according to Butorac et al., 2017): complete loss of geodiversity element, partial loss or physical damage, loss of access, interruption of natural processes and pollution. The chapter considers the influence on fluvial and karst landforms, while the influence on the morphological elements of the watercourse (bed, valley sides) is considered in Chapter7.2.5 Water, and the impact on Protected Nature Areas in Chapter7.2.7.

Soil and agricultural land

The impact on the soil is assessed taking into account the functions performed by the soil, i.e. their change, which can be productive, gene pool, ecological-regulatory, raw material, infrastructural, geogenic and landscape. Desirable soil functions are natural ones (production, gene pool and ecological-regulatory) that are lost when they are converted into infrastructure or raw materials. Also, the structure of the soil, which will be damaged due to encroachment into the soil, was taken into account. The impact on agricultural land is assessed with regard to its conversion, which would directly result in the loss of agricultural soil, and thus in the loss of the productive function of the soil. According to the Law on Agricultural Land, the most important agricultural soils are those with P1 and P2 creditworthiness values, and the emphasis is placed precisely on the protection of these soils from conversion to some other, non-agricultural purpose. Since the planned activities are not spatially located, only the potential risk of erosion in the recorded problem areas is considered. Also, a potential increase in soil pollution through the implementation of some activities of the Plan is being considered.

The impact is especially interpreted for the phase of exploratory works, 2d and 3d seismic, and especially for exploratory and exploitation drilling, which includes the construction of roads, the construction and arrangement of the drilling circuit, the placement of tanks for raw materials and waste during the drilling process. Impacts are also assessed due to the definition and procedures essential for the preservation of soil functions after exploratory drilling and rehabilitation of the borehole circuit of negative wells, as well as previous work for production wells, construction of supporting infrastructure and pipelines, as well as procedures after the completion of well exploitation work.

Air

The assessment of the Plan's impact on air quality and changes in air quality is considered through the analysis of the pressures that can be generated by the increase in pollutant emissions over time and the analysis of air quality indicators and changes in pollutant concentrations over time.

Climate and climate change

The impact of the Plan on the climate and climate change is considered through the analysis of the pressures that can be generated by the increase of greenhouse gas emissions over time and the analysis of the mutual cause-and-effect relationship between the activity in question and the trends/projections of climate indicators over time.

Water

When assessing the impact on surface and underground water, all possible activities and events that occur during the process of exploration and exploitation work and finally the operation of the geothermal power plant were taken into account. The impact on water was assessed with regard to possible changes in the ecological and chemical state of surface waters and the chemical and quantitative state of underground waters, and the possibility of contamination of the sanitary protection zones of the source was also taken into account.

Biodiversity

When assessing the impact on biodiversity, the databases of MINGOR, FCD, Bioportal, Red Books, and data from the Map of non-forest habitats (2016) and Map of habitats of the Republic of Croatia (2004) were used. The greatest attention was paid to endangered and rare habitats, as well as to high-risk endangered and strictly protected flora and fauna. The assessment of the impact on the habitats is determined with regard to the quality of the habitat conditions.

Impacts on flora and fauna were determined according to the national status of endangered and protected species potentially present in the Plan area, taking into account the possibility of direct suffering of individuals, reduction of the quality of suitable habitats, and taking into account other ecological requirements of groups/species by occupying habitats and disrupting habitat conditions in them .

Protected areas of nature

The impact of the Plan on protected nature areas was assessed with regard to the relationship between the category of protected nature areas and the potential location of the planned activities. The assessment, in addition, included a probable change in the features of the protected area (geomorphological, landscape characteristics, etc.), as well as the deterioration of the quality of rare and endangered habitat types, and the possible realization of the ecological requirements of potentially endangered flora and fauna.

Landscape characteristics

Cabinet research included consideration of the state of the broader picture of compiled landscape factors of isolated landscape areas whose boundaries are defined by macrological natural features. An analysis was carried out in the GIS program interface, a review of the literature of individual components of the landscape and spatial characteristics of the given area, as well as a review of map bases and digital ortho-photographs from different time periods. In addition to the above, the genesis processes of the current state of penetration of anthropogenic and natural factors that form the landscape were discussed. The preliminary assessment of the activities that are listed as necessary and possible for the implementation of the development of the Plan and the way of exploiting geothermal potential has been singled out and described those actions and spatial interventions that, by their nature, i.e. the planned activities: (new construction, occupying surfaces, visual exposure and dominance within the field of view, renovation and reconstruction of existing elements, process actions, etc.) affect the change of landscape characteristics. After that, the relevant activities that certain stages of implementation entail are reviewed, and their impact on the landscape is described.

Forests and forestry

The assessment of the impact on the forest ecosystem is based on the analysis of the Plan and possible changes that may generate an impact on the forest ecosystem. The impacts were analyzed through the potential conflicts of the Plan with forests and forest land, which manifest themselves as the occupation or loss of forests and forest land, the reduction of the generally useful functions of forests, the disruption of the stability of forest ecosystems, and the impact on forest management.

Game and hunting

During the impact assessment, the potential impact of the implementation of the Plan on hunting productive areas, that is, the condition and structure of the game species present, was primarily considered. The hunting productive area represents the parts of the hunting ground where a specific game species has all the natural conditions for living, feeding (nutrition) and feeding, breeding and sheltering. The impact was analyzed through the possible loss of productive hunting areas or through their degradation, i.e. potential pressures on the hunting sector.

Population and human health

The impact on the population and people's health is assessed by considering the activities planned by the Plan and taking into account their potential to improve the quality of life and the health and safety of people, taking into account changes in indicators of the quality of life of the inhabitants (eg changes in demographic trends, social picture or economic indicators). It is based on the assumption that improving the quality of life and health of people is a prerequisite for stopping the negative and starting a positive demographic trend. Also, the negative impacts due to the research and exploitation phase are considered (reduction of air quality due to increase in dust and exhaust gases, impacts of increased threat from noise and light pollution, etc.).

Cultural and historical heritage

The methodology for assessing the impact on cultural heritage follows the international approaches and guidelines of ICOMOS (2011), Guidance on Heritage Impact Assessment for World Heritage Properties (2011), and Sustainability Appraisal and the Historic Envinronmet. The general starting point for the strategic assessment of the impact on cultural heritage in all forms of upcoming development tendencies includes the main task, which is to preserve and improve the historical environment, cultural heritage of all kinds and its surroundings. In accordance with the above, the impact of potential upcoming spatial interventions hinted at by the Plan in question was assessed, with possible direct and indirect impacts depending on the placement of cultural assets in relation to the upcoming interventions in the space. The immediate impact leads to a possible change in the physical and spatial characteristics of the cultural property,

7.2 Assessment of the impact of the Plan on components and factors in the environment

The overall significance, course of action and time duration of the impact that would occur as a result of the implementation of the activities and projects of the Plan were analyzed and described based on the results of data on the current state of environmental components and factors in the environment and the characteristics of future activities.

7.2.1 Air

Research phase

From the perspective of possible impacts on air quality, the sources of emissions are stationary sources and incineration flares and, to a lesser extent, the products of diesel fuel combustion in work machines and vehicles. In the phase of investigative works, the influence of the considered activities has a character of limited duration and is reflected in the increased pressure of emissions due to the increased traffic and realization of construction works. Once these jobs are completed, the influence ends. In rural areas, where oil-mining activities take place, the capacity of the atmosphere and atmospheric processes allows good mixing of the air and effective dilution of the resulting emissions, so that this type of influence does not have the potential to increase ground concentrations to the limit of exceedance prescribed by the Regulation on the levels of pollutants in the air (OG 77/20).

During the investigation works, there will be emissions of total suspended matter and emissions of particles smaller than 10µm (PM10) and smaller than 2.5µm (PM2.5) due to construction works, i.e. the construction of the plateau of the working areas of the wells and the arrangement of access roads. There will also be emissions of NOx, SO2, CO, CO2, VOCs, PM10, PM2.5, heavy metals in PM10 from vehicle exhaust gases, as a product of diesel fuel combustion in work machines and vehicles, and their emission will depend on the type of vehicle and driving engine and fuel consumption. Considering the time-limited duration of the investigation work and the small increase in the concentration of pollutants in the air, the impact is estimated as immediate, short-term and negligible.

Exploitation phase

In the exploitation phase, emissions appear as a continuous pressure from part of the stationary sources that are necessary for managing the process technology. The emissions of these sources, although they are not significant compared to the contribution of, for example, the transport sector, the energy sector, etc., need to be reviewed and monitored so that their impact can be controlled and gradually reduced by applying appropriate measures.

During the exploitation phase, there will be an increase in the concentration of pollutants in the air. Emission of NOx, SO2, CO, CO2, VOC, PM10, PM2.5 and heavy metals in PM10 is possible from stationary sources such as gas engines and hot water boilers. In addition to emissions from stationary and mobile sources, flares for burning excess gases appear as an occasional source of emissions in the exploitation area. Considering that they occur occasionally, according to the amount of substances released into the atmosphere by burning, they can be considered a small pressure on the environment, and since the flares are installed in a rural area, atmospheric processes greatly contribute to the dilution of emissions and good ventilation so that this influence can also be considered small. The size of the impact will depend on the dynamics of exploitation.

In general, the impacts that occur in the event of an accident are measurable and significant considering most of the aspects and consequences they can cause. In principle, the interventions and remediation of the consequences that can be expected are quick and effective, so it is expected that the accident, even if it occurs, will not last long as a rule. In these circumstances, the effects on the air may be increased for a short time, but without long-term consequences for the environment and the surrounding population (increased concentrations of chemical compounds and particles).

Accordingly, the impacts on the air in the form of increased emissions of NOx, SO2, CO, CO2, VOCs, PM10, PM2.5 and heavy metals in PM10 and increased emissions of pollutants into the air during the exploitation phase are assessed as immediate, long-term and negligible.

7.2.2 Climate and climate change

Research phase

In the research phase, the impact on climate change is possible due to the increase in greenhouse gas emissions. In a geothermal water reservoir, at high pressure and temperature, there may be gases dissolved in the water, the concentration of which varies from one reservoir to another. The geothermal water that is exploited from the underground reservoir during the well test is temporarily stored in a watertight pit for the reception of geothermal water, and due to the drop in pressure to atmospheric pressure, which happens when the geothermal water is discharged into the pit, dissolved gases are released from geothermal water into the air.Due to the small amounts of gases potentially released during exploration works, the impact on increasing greenhouse gas emissions is estimated to be immediate and negligible. Since the activities in the research phase are limited in time (several months), a short-term increase in greenhouse gas emissions cannot generate climate change. Variations in climate and climate indicators in that period move within the existing limits of natural variations, therefore the impact on changes in climate indicators and their extremes (air temperature, precipitation, currents, clouds, solar radiation) is assessed as neutral, intermediate and short-term.

Exploitation phase

Exploitation of geothermal water for electricity generation generates much lower greenhouse gas emissions than most other technologies. In comparison, it is important to take into account the entire production cycle, i.e. all phases before, during and after the operation of the power plant. Geothermal power plants have low greenhouse gas emissions compared to other technologies, so when it comes to global emissions reduction, they are a better option than coal, oil or gas power generation.

In open geothermal plants, approximately 10% of air emissions are carbon dioxide, and a smaller amount is methane. Estimates of greenhouse gas emissions for open systems are approximately 0.0453592 kg CO2-eq/kWh (IPCC, 2011). In closed geothermal plants, these gases are not released into the atmosphere, but there are still certain emissions associated with the construction of the plant and the supporting infrastructure. In comparison, life-cycle emissions estimates for electricity generated using natural gas are between 0.272155 kg and 0.907185 kg CO2-eq/kWh, and estimates for electricity generated from coal are between 0.635029 kg and 1.63293 kg CO2-eq/kWh (IPCC, 2011).

According to all of the above, the impact on the increase in greenhouse gas emissions during the exploitation phase is estimated as long-term, but negligible, while the impact on climate change indicators and their extremes (air temperature, precipitation, currents, clouds,solar radiation) is evaluated as neutral, intermediate and long-term.

The use of geothermal energy is one of the activities that cannot be attributed to direct impacts on the climate and climate changes. Greenhouse gas emissions generated by this activity are generally small. Their contribution to total emissions (regionally and globally) is practically negligible, so this activity can be considered climate neutral. However, since it is a cumulative contribution to all other activities, it is necessary to monitor the amount of greenhouse gas emissions and other gases produced in the exploitation processes, keep them within the prescribed values and continuously reduce them.

7.2.2.1 The impact of climate change on the implementation of the Plan

The change of climate and climate indicators manifests itself on a local, regional and global scale and includes large systems and human activities (seas, oceans, plant cover, management and management of natural resources). The cumulative impact of all these activities leads to an imbalance in nature and phenomena that can be dramatic and negative in some areas of the planet, and mild and acceptable in others.

According to regional climate projections, changes are expected in our area due to an increase in temperature stress and extreme events (droughts, floods, storms, etc.) everyday life. These phenomena were recorded on the territory of Croatia and they happen more often, as a rule, unexpectedly and with a stronger intensity than was recorded in earlier periods. Violent weather phenomena linked to climate change affect all human activities, can cause great damage (locally and regionally) and threaten human lives. As a result, the activity of utilizing geothermal energy is under the influence of weather phenomena that can cause damage and temporary stoppage of production processes. However, as in all other activities, the re-establishment of the production process is possible since the installation itself is largely of the underground type.

In general, the impact of climate change on the implementation of all human activities, including these, is possible and should be expected. However, it is not limiting and should be included as a possible risk in both planning and implementation.

7.2.2.2 Consolidated documentation on review/preparation for climate change

In order to encourage the shift to environmentally friendly investments, the EU has introduced rules defining what green or sustainable activities are. Within the framework of Regulation (EU) 2020/852 of the European Parliament and of the Council on the establishment of a framework for facilitating sustainable investments and amending Regulation (EU) 2019/2088 (the so-called Taxonomy Regulation), six environmental objectives are established on the basis of which it is determined whether a certain economic the activity is environmentally sustainable, and in order to be considered environmentally sustainable, it must significantly contribute to at least one environmental goal, without causing significant damage to any other environmental goal.

The established environmental goals are:

1. mitigating climate change (avoiding/reducing greenhouse gas emissions or increasing greenhouse gas removal)
2. adaptation to climate change (reducing or preventing a negative impact on the current or expected future climate or the risk of such a negative impact)
3. sustainable use and protection of water and marine resources
4. transition to a circular economy (with an emphasis on reuse and recycling of resources)
5. pollution prevention and control
6. protection and restoration of biological diversity and ecosystems

As part of this Study, an assessment of the sustainability of the Plan was carried out for the first two environmental goals - mitigation of climate change and adaptation to climate change. In that context:

- a significant contribution of economic activities or measures to mitigating climate change means that the activity significantly contributes to the stabilization of greenhouse gas concentrations in the atmosphere in accordance with the long-term goal of the Paris Agreement regarding temperature by avoiding or reducing greenhouse gas emissions or increasing the removal of greenhouse gases, among others by means of innovations in the field process or product;
- significant contribution of economic activities or measures to adapt to climate change means that the risk of the adverse effect of the current climate and the expected future climate on that economic activity is significantly reduced or that adverse effect is significantly reduced, without increasing the risk of adverse effects on people, nature or property.

The principle of "do no significant harm" (Do no significant harm, DNSH) implies that economic activities that cause significant harm to any of the listed environmental goals are not supported or carried out. Article 17 of the Taxonomy Ordinance defines what constitutes "significant damage" for a particular environmental objective:

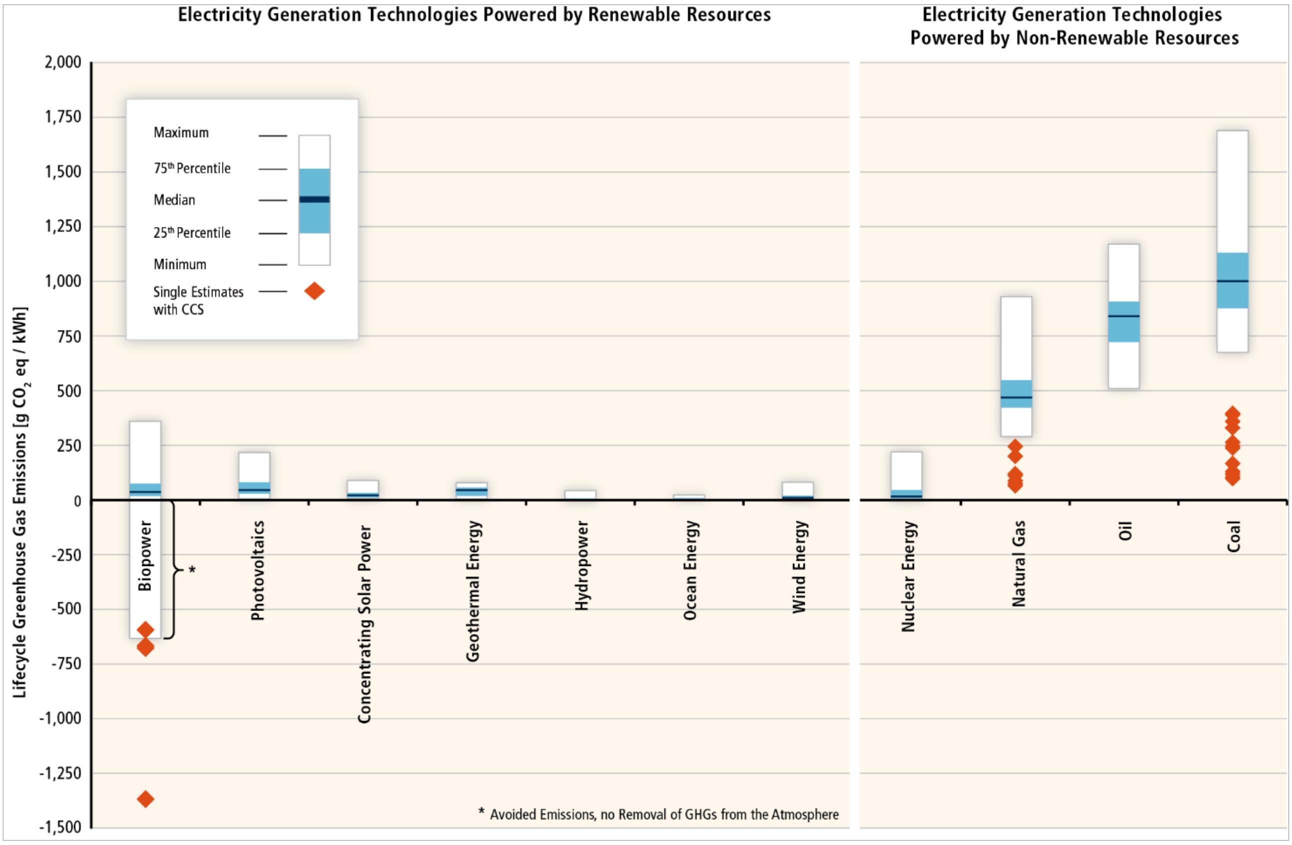
1. it is considered that the activity significantly harms the mitigation of climate change if it leads to significant emissions of greenhouse gases
2. an activity is considered to significantly harm adaptation to climate change if it leads to an increased adverse effect of the current climate and the expected future climate on the activity itself or on people, nature or property.

The first delegated act, currently adopted by the EC, sets criteria for economic activities in sectors that are most important for achieving climate neutrality and achieving adaptation to climate change - sectors such as energy, forestry, production, transport, construction. Within that document, the criteria for mitigating and adapting to climate change are prescribed, and it includes activities that are most significant for reducing greenhouse gas emissions and improving resilience to climate change.

Conclusion

Geothermal energy is one of the renewable sources of energy, and its extraction, especially energy production, can lead to greenhouse gas emissions. These emissions are generally very small compared to the emissions produced by the production of energy from conventional sources such as oil and gas. Estimates of greenhouse gas emissions for different electricity generation systems during their life cycle show that all renewable energy sources, including geothermal energy, emit significantly lower amounts of greenhouse gases compared to those from non-renewable energy sources. Thus, the median value of greenhouse gas emissions of renewable energy sources is between 4 and 46 g CO2-eq/kWh (for geothermal energy 45.36 g CO2-eq/kWh), and for fossil fuels between 469 and 1001 g CO2-eq/kWh (Picture7.1).

According to the above, the implementation of the Plan significantly contributes to the environmental goal of mitigating climate change, without causing significant damage to other environmental goals.



Picture7.1Greenhouse gas emissions for different electricity generation systems during their life cycle (Source: IPCC, 2012)

Adaptation to climate change implies undertaking a certain set of activities with the aim of reducing the vulnerability of natural and social systems to climate change, increasing their ability to recover from the effects of climate change, but also exploiting potential positive effects that may also be a consequence of climate change.

Climatic parameters directly affect the energy sector in the form of increased or decreased need for energy resources in certain periods of time, and climatic extremes and natural disasters can disrupt the safe supply of energy. The geothermal potential development plan contributes to adaptation to climate change in the form of increased security of energy supply, sustainability of energy supply and reduction of energy dependence due to expected intensification of weather events that can affect production, but also transmission and distribution of energy. The implementation of the Plan includes activities that do not represent a source of negative impact on people, nature or property, but should act to mitigate climate change and thereby reduce the potential adverse effects of the climate.

It was not possible to carry out a detailed assessment of compliance with the principle of "doing no significant damage" at the strategic level, which is why the Study prescribes a measure for the implementation of an assessment of compliance with the DNSH principle at the project level, which ensures that all infrastructure built within the framework of the implementation of the Plan is resistant to climatic changes. For this reason, since the Plan includes the construction of infrastructure in an area that is subject to thermal stress and temperature variability, and that the expected lifetime of the property is mostly longer than 10 years (if it is about the exploitation of geothermal energy), during the construction of the planned infrastructure, the Study prescribes an obligation conducting a vulnerability analysis in accordance with the Technical Guidelines for preparing infrastructure for climate change in the period 2021-2027. in order to apply physical and non-physical solutions during construction, which significantly reduce the most important physical climate risks. By complying with the measures prescribed by the Study, it does not expect that the implementation of the Plan will lead to an increase in the harmful effect of the current or future climate on people, nature or property, which is why it is concluded that the Plan complies with the principle of "not causing significant damage" for the environmental goal of adaptation to climate change.

According to all of the above, in compliance with the prescribed measures with the aim of reducing possible negative impacts on mitigation and adaptation to climate change to the lowest possible level, it is estimated that the Plan will not have a negative impact on mitigation and adaptation to climate change.

7.2.3 Geological features and geodiversity

Research phase

The highest geothermal potential is found in carbonates (dolomites, limestones and their varieties of Mesozoic age (under Neogene)) and in limestone-dolomite breccias/breccia conglomerates of Neogene and Mesozoic age (under Neogene). Carbonate deposits are characterized, apart from a high geothermal gradient and high permeability, and it is possible to realize large inflows of geothermal water from them. In addition to the temperature, in order to estimate the geothermal potential, it was also necessary to estimate the flow of geothermal water, which tells us how much water can be extracted per second and converted into thermal or electrical energy. Carbonate deposits appear in the Pannonian part as large bodies of water, i.e. massive deposits.

For the purposes of performing oil-mining works, exploration and exploitation of geothermal waters, oil-mining projects are prepared in accordance with the Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19 and 30/21) and the regulations adopted on the basis of this Law. Pursuant to the Law, geothermal water research includes all exploration works that are proposed in the tender offer, the purpose of which is to determine the existence, position and shape of geothermal water deposits, the quantity and quality of reserves and the conditions of exploitation, including, but not limited to:

• Geophysical surveys - gravimetric, magnetometric, seismic, magnetotelluric and other geophysical surveys, interpretation of data thus collected and their study processing,

• Construction of exploratory wells - construction, deepening, diversion, equipping, testing, temporary abandonment or liquidation of exploratory geothermal wells,

Drilling works are short-term, lasting up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the scope of technological tests during drilling. The impact is local in nature, mostly limited to the well working area of about 1.5 ha or less.

During the research phase, there may be potentially negative impacts on geodiversity if exploration wells are built near speleological objects, fluvial forms of geodiversity, protected geoheritage sites or other valuable geodiversity elements. In order to prevent the impact of total or partial loss, loss of access, interruption of natural processes and/or pollution due to the construction of exploratory wells, it is necessary to determine a protective zone 250 m away from the mentioned localities in which activities will not be carried out. In the case of speleological facilities, the protection zone does not only apply to the entrance, but also to the underground extension channel. Also, if hitherto undiscovered speleological objects are discovered, it is necessary to act in accordance with Article 101 of the Law on Nature Protection.As it is assumed that a certain number of new elements of geodiversity will be discovered during the geophysical surveys, a neutral impact on the component is expected in compliance with the applicable regulations.

Exploitation phase

If there is no possibility of using previously made exploratory wells for exploitation purposes, it is necessary to make new wells. Measurements in already existing boreholes do not lead to physical damage to geological structures and additional encroachment into the space than that found at each individual borehole. If the geological-geophysical studies indicate the existence of deep aquifers, the location and construction of new exploratory wells is approached, and since the process of making wells in this phase is the same as the exploratory wells described earlier, the potential impacts are also the same, which are local in nature and limited to well working area.

Depending on the purpose of using the energy contained in the geothermal fluid (amount of geothermal water flow and temperature), the main activities in the exploitation period include the construction of geothermal wells (exploitation, one of which is exploitation/pressurization), the construction of above-ground energy facilities and plants, and the construction of the necessary surface infrastructure.

During the exploitation of geothermal waters, the cooled geothermal water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. Also, this avoids changes in the underground water regime, which can potentially lead to the interruption of natural processes and changes in the morphology of surface water bodies, as well as ground subsidence, which can be caused by the extraction of large amounts of geothermal water from geothermal deposits.

The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems. In this case, it is geothermal water that is mainly used for the purpose of heat energy production, for agricultural purposes, etc. therefore, the amount of geothermal water required is smaller. When releasing geothermal water into a natural receiver, it is necessary that it meets the values prescribed by the Ordinance on Limiting Values of Wastewater Emissions (Official Gazette 26/20) in order to avoid potential pollution. If satisfactory water quality is achieved, it is discharged into a natural receiver, but if the aforementioned is not achieved,

Seismicity usually occurs naturally, due to the movement of faults in tectonically active areas, but sometimes it can be caused by human activity. The extraction and reinjection of geothermal waters can trigger or increase the frequency of low-magnitude earthquakes known as "microquakes" that occur in the region of the injection zone. Microquakes that are sometimes associated with geothermal development are not considered a hazard to geothermal power plants or surrounding communities and will usually go unnoticed unless sensitive seismometers are nearby. The probability of a major seismic event is very low because it has never been documented. In populated areas, the consequences of these earthquakes are relatively small (Berrizbeitia, 2014; Gaurina-Međimurec, 2022). In case of application of EGS (engl.*hot dry rock*) local stresses in the rocks increase, which can cause earthquakes up to magnitudes M=2.0–3.0 (Rybach, 2002; Gaurina-Međimurec, 2022). Induced seismicity is associated with the application of EGS technology, because by injecting water (working fluid) under high pressure, cracks are intentionally created in dry hot rocks. For this reason, it is important that, in the case of applying EGS technology, a seismometer network is set up to monitor local seismicity (Rybach, 2003; Gaurina-Međimurec, 2022).

7.2.4 Soil and agricultural land

Research phase

The 3D seismic research itself has an impact primarily on the physical condition of the soil. Depending on the mechanical composition of the soil, trampling in the wet state can lead to soil compaction, which improves over the years, and this impact needs to be eliminated so that agrotechnical soil rehabilitation measures do not have to be implemented later. Trampling the soil leads to the destruction of the soil structure and thus to a significant reduction in the soil's water and air capacity and vertical water permeability. Also, the normal growth of the roots is prevented and the microbiological activity of the soil is reduced. On sandy loamy, loamy, powdery loamy, powdery, clayey loamy and powdery clayey loamy soils, the duration of the negative impact due to the passage of heavy vehicles is medium-term, while on soils of other textures the duration is short-term. The negative impact of the passage of heavy vehicles will be significantly smaller if the trampling is done when the soil is dry (soil moisture below the moisture of the lower limit of plasticity) and then the impact can be estimated as negligible to moderately negative. If the soil is wetter, the impact will be moderately to significantly negative.

On sloping terrains, as a result of compaction, paths for soil erosion by water can be opened, which should be taken into account. Likewise, although not in the context of soil protection, but rather the protection of farmers, investigative work on agricultural land should be carried out when the soil is dry, and preferably without crops. In that case, there will be a minimal impact on the soil condition, which could be described as negligible. If it is a matter of trampling heavy soil in a wet state, and if there is a crop in the field, then the impact will be moderately negative to significantly negative.

The phase of investigation includes the detailed determination of the location of the well, the construction of roads, the temporary repurposing of the soil around the well, and the earthworks necessary to locate the facilities necessary for drilling. In each specific case, it will be necessary to carry out minimal investigative pedological works, in order to determine the so-called "zero state" of the soil before the start of work.

When the location of the exploratory well is determined, access roads will be built for the purposes of exploratory work, during which soil and potentially agricultural land will be occupied, which will generate a moderately negative impact. Trampling the soil during the road construction phase leads to soil compaction and destruction of the soil structure, reduces the soil capacity for air and microbiological activity. In addition, there is pollution of the surrounding soil with dust from the roads, but these impacts are short-term and limited to the time of investigation works.

On sloping terrain, soil erosion by water along the route of the road is possible, which on slopes with a slope of > 8% leads to a decrease in soil fertility and productivity.

For the purpose of building a circle of exploratory wells, land will be occupied and agricultural land will be temporarily converted, which will generate negative impacts on the soil. Therefore, when determining the exact location of the exploration well and the associated circle, it is necessary to avoid P1 and P2 agricultural lands and give priority to other soils. During the preparation of the well working area for the creation of an exploratory well, about 1.5 ha of the area is temporarily repurposed, while in the case of a positive outcome and bringing it into production, this area is reduced to the size of 0.4 ha, and the remaining area is rehabilitated. Each exploratory drilling should be preceded by a study of the initial state of the soil, before the start of work, on the surface of the expected impact. Due to the conversion of land with higher credit values, the impact will be significantly negative,

During the research phase, works on the arrangement of the well work area include soil excavation and removal of the humus-accumulative soil layer, which is deposited on the designated part of the well work area, and is returned after the end of the well work.

If the test results of the geothermal deposit are negative, the location will be rehabilitated to a state close to the original, the impacts will be short-term, and if the test results are positive, there will be permanent soil occupation and the impact will be significantly negative.The construction of access roads for the needs of exploration works will result in the temporary occupation of the surface, and in the case of a positive result of the geothermal field test and its exploitation, there will be a long-term conversion of soil and agricultural land. The goal of rehabilitation should be to bring the soil to a state as close as possible to the state before the work began. After the completion of the rehabilitation process, it is necessary to prepare an appropriate agro-ecological study, which aims to check the quality of the works.

Exploitation phase

Impacts on the soil during the exploitation phase include the occupation of the soil for the purpose of creating the well space and the construction of the necessary infrastructure of the geothermal power plant and access roads. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent conversions and fragmentation of around 0.4 ha. The operational period can last 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If exploration is successful and exploration wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The construction of a geothermal power plant will lead to the permanent conversion of soil and its fragmentation for infrastructural purposes and the loss of its ecological functions. It is also possible to damage the soil on the route of the newly installed pipelines, due to the excavation of the land, the installation of the pipeline and the backfilling of the trench. Due to the expansion and/or construction of access roads, there will be a permanent conversion of land for infrastructure purposes. Land conversion refers to new roads that were not built during the exploratory drilling phase. Also, during the use of roads, there may be an increased traffic of vehicles with internal combustion engines, and accordingly, possible impacts in the form of emissions of pollutants that are deposited on the surrounding soil. 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During the exploitation phase, soil contamination may occur during accidental situations or contamination from waste production and disposal, but since the well working area is designed as watertight in accordance with the prescribed measures, the possibility of contamination is reduced and the impacts will be negligible.

7.2.5 Water

Research phase

Impacts on water in the research phase refer to construction works and the creation of exploratory wells, during which there may be pollution of underground and surface waters, i.e. disruption of their chemical, ecological and quantitative state.

On the well working area there are a number of construction facilities that are necessary for the exploration of the well, among other things a collection pit for waste/sanitary water and a pit (lagoon) for the reception of geothermal water. Continuous flushing of the borehole channel during drilling is achieved by using mud, which, by its circulation through the borehole, collects rock fragments and carries them to the designated, watertight, pool on the surface.

During research and well maintenance work, due to extreme rainfall, precipitation water may drain from the well area. Also, there may be losses of mud and other pollutants in rock fracture systems, with possible local and short-term impairment of groundwater quality. Since the mentioned objects/spaces are designed as watertight in accordance with the prescribed measures, the possibility of pollution is reduced. All water that spills over the well working area (mud, geothermal water, sanitary or rainwater) during the exploration of the well is collected in a reinforced concrete basin by the system of drainage concrete channels, and is drained from it to a temporary landfill, i.e. a leach pit, and later handed over to an authorized company.

When drilling an exploratory well, it is possible to damage individual aquifers, which may result in their contamination or mixing. In order to prevent this, the production and injection wells are fenced off with protective pipes and cement, which physically separates them from possibly pierced aquifers so that the penetration of geothermal water into shallower permeable layers with groundwater or its spilling onto the surface of the terrain cannot occur. their potential pollution, therefore this impact is assessed as neutral.

Geothermal water obtained during exploration work on the well is stored in a pit (lagoon) for the reception of geothermal water. If the project envisages its return to the deposit, it is chemically processed after cooling and pressed back underground. In rare cases, the project will plan its release into a natural receiver (watercourse).Therefore, if it is a shallow reservoir with natural water supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the criteria for discharge into surface watercourses prescribed by the Rulebook on limit values of waste water emissions (Official Gazette 26/20), it is possible to discharge the extracted geothermal water cooled geothermal water into a natural receiver instead of returning it to the reservoir. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). If the mentioned criteria are not achieved, additional processing with physico-chemical methods and its additional purification is required. Based on the above and in compliance with the measures prescribed by the Study, this impact is assessed as negligible.

Before starting the construction of the borehole channel, two piezometers, or shallow control wells, are made in order to take groundwater samples for analysis. The locations of the piezometers are defined by the Conceptual Project on the basis of which the Location Permit is obtained, and most often they are within the well working area. Samples are taken before and after the completion of well construction and once during well construction (Gaurina-Međimurec, 2022).

Since exploratory works are carried out over a period of up to five years, in accordance with the methodology, all the mentioned impacts are short-term and limited to the time of making and testing exploratory wells. If there is a failure in the organization of the construction site, incorrect manipulation of work machines or in case of accidents, there is a possibility of groundwater pollution. However, such impacts can be avoided by following the applicable regulations during construction, since preventive measures are taken into account in the planning phase of the project and accordingly incorporated into the oil and mining project.

After the completion of the works, the well working area is renovated, and the terrain is brought back to its original state. After the completion of all work on the rehabilitation of the well working area (to abandon the well or to reduce the area of the well working area to an area sufficient for the installation of surface equipment for bringing the geothermal well into operation), water samples are taken, and again after six months. If, by comparing the results of the analysis of groundwater samples, it is determined that there are no changes, further water analyzes are not carried out.

<u>Exploitation phase</u>

Impacts on water in the exploitation phase relate to the creation of exploitation wells, the construction of energy facilities, i.e. the necessary infrastructure for the production and transmission of energy, and the long-term pumping of geothermal waters, during which groundwater and surface waters may be polluted, i.e. their chemical and ecological state may be impaired.

If there is no possibility of using previously made exploratory wells for exploitation purposes, it is necessary to make new wells, in which case, depending on the technology, one well (production) or at least one pair of wells, production (for extracting geothermal water) and injection (for pressing in geothermal water) is needed water back into the reservoir after its thermal potential has been exploited). Since the process of creating wells in this phase is the same as the exploratory wells described earlier, the potential impacts on surface and underground water are also the same, which are assessed as short-term and negligible, if the prescribed measures are followed.

The construction of the planned energy facilities and accompanying infrastructure will create sanitary and stormwater wastewater, as well as extracted geothermal water from wells. If there is no built-in public drainage system at the location of the intervention, in accordance with the measures, a watertight collection pit will be built to prevent the outflow of waste water into the environment, while storm water from buildings, internal roads and parking lots will be purified in a separator before discharge.

Negative impacts on underground and surface water are possible in case of placement of exploitation wells and geothermal power plants in areas with the possibility of flooding, which may lead to pollution of water bodies. It is not suitable to build in areas with a high probability of flooding, where the payback period is 25 years, primarily because of the high risk of damage, and large investments in preventing it. Also, in the area of medium probability, where the return period is 100 years, it is assumed that at least one flood will occur during the lifetime of the power plant, which is why such areas are also less suitable for construction. The above is limited by measures, which is why this impact is assessed as negligible.

During the use of geothermal water for the production of electricity, in accordance with the Plan, the use of binary geothermal power plants is foreseen, which form a closed system, in which the geothermal water is not consumed, and after the utilization of its heat, it is pressed back into the geothermal reservoir. In the case of exceptional situations when it is not possible to return them, it is necessary to provide a watertight pool for the temporary storage of geothermal water until it is possible to return it to the deposit. In accordance with the above, since in the described case there is no possibility of contamination of underground and surface water, provided that the system is implemented in accordance with the regulations, this impact is assessed as neutral.

During the use of geothermal waters for the production of thermal energy, the impacts are in principle the same as for the production of electricity. However, taking into account that the different phases of direct use of geothermal fluid are smaller in volume, the amount of geothermal fluid obtained from the underground is significantly smaller, so the potential ecological effects of direct use of geothermal fluid are also smaller compared to the use of geothermal fluid for the production of electricity.

During the use of geothermal water for agricultural purposes, it is possible to release geothermal water into nearby surface watercourses, which represents a moderately negative impact of disrupting the chemical and ecological state of water bodies, since geothermal water contains different concentrations of toxic substances that can potentially be harmful to the environment. In order to minimize negative impacts, it is necessary to carry out pretreatment of geothermal waters before their release into watercourses, after which the analysis of their chemical state must meet the values prescribed by the Rulebook on Limiting Values of Wastewater Emissions (Official Gazette 26/20). If satisfactory water quality has been achieved, it is released into the watercourse, but if the aforementioned has not been achieved, additional treatment with physico-chemical methods and additional purification is required.

7.2.6 Biodiversity

Research phase

The geothermal potential research phase includes 2D and 3D seismic recording, arrangement of existing or construction of new access roads, and arrangement of the well work area to accommodate the drilling rig with associated equipment and construction facilities required for production testing of the exploratory geothermal well. The mentioned activities can be sources of significantly negative impact on rare and endangered habitat types, primarily through long-term or short-term loss (conversion), habitat degradation and fragmentation, and on strictly protected species due to habitat loss and fragmentation, harassment and suffering. According to Gaurina-Međimurec (2022), the drilling rig is installed at the location of the new well according to the typical arrangement that is in accordance with the verified project for the construction of the well and the project for the construction of the exploratory well.

Short-term conversion of the habitat will occur in the case of negative test results of an exploratory well when no geothermal water deposit has been identified, therefore such a well is abandoned (liquidated) in accordance with legal regulations, and the occupied well working area is rehabilitated and restored to a state close to its original state. With the construction of new access roads and in the case of a positive test result of the geothermal deposit and bringing it into exploitation, there will be a long-term conversion of the habitat. During the preparation of the well working area for the creation of an exploratory well, around 1.5 hectares of mostly agricultural or forest land is temporarily repurposed, while in the case of a positive outcome and bringing it into production, this area is reduced to a size of 50 mx 80 m (0.4 ha), and the remaining surface is being rehabilitated. The implementation of the mentioned activities can result in significant losses of endangered and rare habitats, and due to their sensitivity to changes, water and wet habitats are the most endangered, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened.

Changes in habitats caused by fragmentation and short-term or long-term repurposing of habitats during the installation of research facilities and the construction of access roads have a moderately negative effect on the species that inhabit them, considering that a part of the area of native plant and animal species is lost. The main negative impact of fragmentation is the edge effect, where the conditions of the habitat change (temperature, wind, lighting, changes in the composition of the vegetation, etc.), which can lead to the avoidance of such a habitat by the species that inhabited it until then. Also, habitat fragmentation leads to the separation of species, i.e. the loss of genetic diversity (Hein, 2012), and by reducing the integrity of the habitat, the interactions between individuals of the population and the availability of feeding grounds and prey become difficult. A moderately negative impact of habitat degradation can also occur on the route of movement of heavy machinery for the purposes of 2D and 3D seismic recording and land clearing for the purposes of arranging the well work area, the destruction of autochthonous plant communities in that area, and the reduction of habitat stability, which can facilitate the spread of invasive species. species, in case the newly created habitat conditions are suitable for them. Construction machinery can spread invasive flora by transporting plant parts (vegetative and generative parts) with wheels and other vehicle parts over potentially long distances and new habitats that invasive flora can occupy. During spawning, amphibians are extremely sensitive, and construction in areas suitable for spawning, such as puddles and wetlands, could have a moderately negative impact. The conversion of habitats important for bird migration and nesting can have a negative impact on birds, such as wading birds in wetland habitats and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and for maternity colonies of bats, therefore the conversion/damage of such a habitat can have significantly negative impact on bats.

In the process of researching geothermal potential, there is an increased level of noise and vibration due to the operation of machines and the presence of people. The activities planned by the Plan, which refer to seismic surveys and arrangement of the well work area for housing the drilling rig, may have a negative impact on species and habitats in the immediate vicinity. Research activities will take place for the first 5 years, with the possibility of an extension of up to 1 year, and mainly include the acquisition of 2D and 3D seismic data and exploratory drilling, as well as numerous other analytical studies. The influence of the process of creating an exploratory well is up to two months for deep wells, and several weeks for shallow ones. During the investigation period in which activities such as seismic surveys are carried out, a negative impact on all animal species in the vicinity is possible. The negative impact comes from noise and vibrations that are created due to the operation of machines (vibrators, etc.) that are used to perform seismic surveys. The periods of animal migration, reproduction and nesting are particularly sensitive to this influence. Underground habitats and species are extremely sensitive to surface and underground changes caused by natural and anthropogenic factors. Although there is no exact information on the places where the planned operations will be carried out, it is to be expected that the impact on caves and cave fauna would be significantly negative if seismic tests and exploratory drilling were carried out in the immediate vicinity of such facilities. In addition to being vulnerable to the destruction of their habitats, bats are also vulnerable to disturbance while they reside in them (Armstrong, 2010). Noise represents a potentially significant negative impact on bats, especially during the period of searching for food and finding shelter for hibernation and raising young. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats. These impacts can be mitigated by planning research activities outside habitats suitable for endangered and protected species of fauna, by performing 2D and 3D seismic recording and vegetation removal works outside the reproductive period of the target species of birds and bats, and according to Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats. 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These impacts can be mitigated by planning research activities outside habitats suitable for endangered and protected species of fauna, by performing 2D and 3D seismic recording and vegetation removal works outside the reproductive period of the target species of birds and bats, and according toKagel et al. (2005) and GEL (2022) using techniques and equipment for dampening noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, etc.), level control noise directly at its source and prescribing additional mitigation measures in case of need.

Continuous drilling involves the use of powerful lamps to illuminate the work site at night (Gaurina-Međimurec, 2022), which can lead to a moderate impact of disturbing the fauna of the area. The most endangered groups of animal species are those that are active at night, such as bats, some types of birds (eg owls), saproxylic beetles (eg deer) and the like.

The movement of vehicles (vibrators, etc.) during seismic recording, as well as the movement of machinery during land clearing for the purposes of arranging the well work area and during the construction and use of new access roads, may cause harm to animal species (especially individuals with reduced mobility) that live in that area. Also, the suffering of animal species is possible if they enter the temporary disposal site for the filled material (sand pit), the "sand trap", the pit for the reception of geothermal water and the collection pit. Although the mentioned facilities are mostly fenced, smaller animals can potentially enter them, depending on the type of fence. This impact is assessed as moderately negative.

During seismic recording, the construction of the drilling platform, the arrangement of existing or the construction of new access roads, there may be emissions of fine particles (dust) and exhaust gases due to the combustion of diesel fuel in work machines and vehicles and in the diesel engines of the drilling rig. As these actions are performed only during seismic recording, construction of plateaus and access roads, the impact resulting from them will be short-term and negligible. In a geothermal water reservoir, at high pressure and temperature, there may be dissolved gases in the water to a certain extent, for example carbon dioxide (CO2) and hydrogen sulfide (H2S). The concentration of dissolved gases varies from reservoir to reservoir. Geothermal water that is exploited from the underground reservoir during well testing is temporarily stored in a watertight pit (lagoon) for the reception of geothermal water, where the dissolved gases from the geothermal water are released into the air. The testing (testing) of the well is very limited in time, therefore the possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant negative impact and is considered short-term and negligible. therefore, eventual emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant negative impact and is considered short-term and negligible. therefore, eventual emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant negative impact and is considered short-term and negligible.

Water and soil pollution can occur as a result of liquid substances (propellant fuel, motor oil) being spilled during seismic surveys, construction works during the arrangement of the well work area and accompanying facilities, arrangement of existing or construction of new access roads, as well as due to the spilling of waste water on the surface of the well work area. space; due to the migration of geothermal fluids towards the surface; due to the absence of a drainage system for surface (rain) water on manipulative surfaces; the absence of an adequate solution for sanitary waste water generated on the construction site; incorrect handling and storage of petroleum products, oils and lubricants or storage in inappropriate containers; filling transport means and work machines with fuel; increased amounts of construction, communal and hazardous waste, the washing of which can contaminate underground water; breakdown of construction machines and tools used; intentional or accidental release or disposal of excess hazardous construction materials and chemicals into waterways. All the water that spills over the well working area during drilling is collected in a reinforced concrete basin for the separation of rock fragments (solid particles) from the mud by a system of drainage concrete channels, and is drained from it to a temporary landfill for the drilled material, i.e. a mud pit. Geothermal water obtained during hydrodynamic testing of the well is accepted in a pit (lagoon) for receiving geothermal water. During the performance of mining works in the borehole working area, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain (Gaurina-Međimurec, 2022).

For the preparation of mud and cement slurry for cementing the columns of protective pipes and for sanitary purposes, technological water is used, which is delivered by the vehicles of the fire department and is accepted in reservoirs that are an integral part of the equipment at the drilling plant. However, in some cases, water requirements can be met by using surface water, which can affect the change in the water regime of surface waters, and thus lead to a significant negative impact on the habitat conditions of aquatic habitats. Excessive pumping of water from natural streams and lakes can lead to disruption of the natural hydrological regime and, consequently, to disruption of conditions in habitats related to aquatic ecosystems. By pumping water, surface and underground water regimes change, which is a consequence of the redistribution of part of the water balance. The lowering of the level of surface and underground water in the area of the intervention can be reflected in the species that inhabit watercourses and lakes in the form of a change in the conditions in the habitats, which would be reflected in the lowering of the water level in the lakes and in the bed of the watercourse downstream of the planned interventions, the consequent reduction of the flow, the drying of the surrounding wet and aquatic habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. which would be reflected in the lowering of the water level in the lakes and in the river bed downstream from the planned operations, the consequent reduction of the flow, drying up of the surrounding wet and water habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. which would be reflected in the lowering of the water level in the lakes and in the river bed downstream from the planned operations, the consequent reduction of the flow, drying up of the surrounding wet and water habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies.

Various types of non-hazardous and hazardous waste are generated during the arrangement of the well working area and the construction of the well, which are handled in accordance with the legal regulations, therefore no significant negative impact of waste management during the research phase on the area's biodiversity is expected.

Exploitation phase

The exploitation phase, depending on the intended use of energy, includes the creation of geothermal wells (exploitation, one of which is exploitation-pressurization), the construction of above-ground energy facilities and plants, and the creation of the necessary surface infrastructure. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent repurposing and fragmentation of about 0.4 hectares of vegetation. The operational period can last 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If the research is successful, and exploratory wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, due to sensitivity to changes, water and wet habitats are the most threatened, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, due to sensitivity to changes, water and wet habitats are the most threatened, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, due to sensitivity to changes, water and wet habitats are the most threatened, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened. the most endangered are water and wet habitats, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened. the most endangered are water and wet habitats, and an environmental protection measure has been prescribed accordingly. Also, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are also particularly threatened.

The negative impact of fragmentation will occur as a result of vehicle traffic on roads built for the purposes of exploration and exploitation of geothermal water, i.e. by interrupting the migration routes of individuals in that area. No significant negative impact of fragmentation due to the construction of a plateau with an exploitation well is expected since the initial well working area for setting up a drilling facility for testing the geothermal water reservoir in the exploitation phase is reduced to a plateau of around 0.4 ha. Also, due to the potential introduction of invasive species by construction machinery, there will be a moderate negative impact on the autochthonous flora and fauna due to the spread of invasive species that could be better adapted to the changed habitat conditions. During spawning, amphibians are extremely sensitive, and construction in areas suitable for spawning, such as puddles and wetlands, could have a moderately negative impact. The conversion of habitats important for bird migration and nesting can have a negative impact on birds, such as wading birds in wetland habitats and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and maternity colonies of bats, therefore the conversion/damage of such a habitat can have a significant negative impact on bats. The conversion of habitats important for bird migration and nesting can have a negative impact on birds, such as wading birds in wetland habitats and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and maternity colonies of bats, therefore the conversion/damage of such a habitat can have a significant negative impact on bats. The conversion of habitats important for bird migration and nesting can have a negative impact on birds, such as wading birds in wetland habitats and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and maternity colonies of bats, therefore the conversion/damage of such a habitat can have a significant negative impact on bats.

In the process of making a production/injection well or drilling additional wells for the purpose of exploitation, there is an increased level of noise and vibrations due to the operation of machines and the presence of people, which can have a negative impact on fauna in the immediate vicinity. In the process of exploiting geothermal energy, that is, during the drilling of wells and the construction of plants for converting geothermal energy into electricity, the noise level ranges from 45 to 120 dB and is not constant, and the noise level of a geothermal power plant during electricity production corresponds to most plants that use motorized plants (Pravica et al., 2006). Animal species are particularly sensitive to this influence during periods of migration, reproduction and nesting. Underground habitats and species are extremely sensitive to surface and underground changes caused by natural and anthropogenic factors, therefore it is to be expected that the impact on caves and cave fauna (including bats) would be significantly negative if the construction of a production/injection well or the drilling of additional wells were carried out in the immediate vicinity of such facilities. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds and leaving suitable nesting habitats. Also, making a production/injection well or drilling additional wells in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats.Kagel et al., 2005; GEL, 2022).

Drilling a production/injection well or additional wells for exploitation also involves the use of powerful lamps to illuminate the work site at night which may disturb the fauna of the area as well as during the exploration phase. Also, the geothermal power plant will be illuminated during the exploitation of geothermal water, which can also have a moderately negative impact on animal species in its vicinity, especially bats, birds, saproxylic beetles, etc., which are active at night.

During the operation of the geothermal power plant, it is possible to induce earthquakes, especially with the application of EGS technology, where large amounts of water are injected under high pressure to deliberately create cracks in dry hot rocks, which can induce earthquakes up to magnitude M = 2.0 - 3.0 (Rybach, 2002; Gaurina-Međimurec, 2022). However, these are microseismic events (microquakes) that can only be detected by instruments and that do not cause damage to infrastructure. This would potentially have a moderate negative impact by disturbing the fauna of the area. At the same time, underground habitats and the species that live in them (especially bats), as well as the fauna of the wider area, are particularly sensitive. The impact can be avoided by favoring technologies that will not cause local stress in rocks that can trigger earthquakes. Significant (damaging) earthquakes are not expected because they can only occur at depths greater than 5 km and only if the following conditions are met: (1) there must be a fault system large enough to allow significant slip, (2) there must be forces that cause this slip along the fault and (3) the forces that cause the slip must be greater than the forces that hold the fault together (Majer et al., 2007).

During the operation of the geothermal power plant, a potentially significant negative impact is possible due to the death of birds due to landing on air condensers and due to the death of birds and bats due to a collision with the infrastructure built for the needs of the geothermal power plant (power lines, etc.). During the movement of vehicles on newly built roads, the movement of machinery due to the potential clearing of land and the construction of additional roads for the exploitation of geothermal water may lead to the death of animal species that live in that area. Also, the suffering of animal species is possible if they enter the temporary disposal site for the filled material (sand pit), the "sand trap", the pit for the reception of geothermal water and the collection pit. The impact on other species is assessed as moderately negative.

During the construction of a production/injection well or the drilling of additional wells for the purpose of exploitation, the emission of fine particles (dust) and exhaust gases may occur due to the combustion of diesel fuel in work machines, vehicles and in the diesel engines of the drilling plant. As these actions are performed only during the production/injection well or the drilling of additional wells, the impact resulting from them will be short-term and negligible. During the operation of the geothermal power plant, there may be emissions of exhaust gases due to the combustion of diesel fuel in the diesel electric generator used in the event of an impossibility of electricity supply, but this is a short-term and negligible impact. Also, during the construction of a production/injection well or the drilling of additional wells, there may be emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), which can occur in exceptional situations when geothermal water is temporarily stored in a watertight pool. Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level.

During the construction of a production/injection well or the drilling of additional wells, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain. In accidental situations, a significant negative impact of pollution on rare and endangered habitats is possible, and the most endangered are water and wet habitats. All possible negative impacts on surface and underground water during research can be avoided by proper organization of the construction site and compliance with construction regulations and conditions.

Land subsidence can sometimes be caused by the extraction of large amounts of geothermal water from geothermal deposits. Long-term pumping of geothermal water without re-pressing it into the reservoir leads to greater ground subsidence in some areas near the exploitation field, and less subsidence in a much wider area (Gaurina-Međimurec, 2022). Land subsidence can lead to submergence of pieces of land in nearby water bodies (William & Glassley, 2010; Gašparić, 2021) and to a change in the regime of water bodies connected to an underground reservoir from which a large amount of geothermal water was squeezed out, which would have a negative impact on species related to aquatic habitats. Since it is a phenomenon that is not frequent, by adhering to the usual practice of operating a geothermal power plant, i.e. re-injecting geothermal water back into the geothermal reservoir from which it was obtained after its heat has been used, from the beginning to the end of the operation of the geothermal power plant, this impact can be reduced to a negligible level. In the case of direct use of geothermal energy (for agricultural purposes, for heat production, etc.) accumulated in shallow reservoirs of geothermal water, the probability of land subsidence is small because it is a matter of shallow reservoirs and pumping of smaller amounts of geothermal water.

During the exploitation of geothermal waters, the cooled ("waste") geothermal water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow reservoirs of geothermal water, which are fed by fresh surface water through naturally fractured fissure systems (Gaurina-Međimurec, 2022).. In this case, it is geothermal water that is mainly used for the purpose of heat energy production, for agricultural purposes, etc. therefore, the amount of geothermal water required is smaller. Therefore, if it is a shallow reservoir with a natural supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21), it is possible to discharge the cooled geothermal water into the natural receiver instead of returning it to the tray. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). In case of discharge of extracted geothermal water into a natural receiver, it is, if necessary, can be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person (Gaurina-Međimurec, 2022). Considering the stated, no significant negative impact of the release of recovered cooled geothermal water that meets the parameters prescribed by the aforementioned Ordinance on the habitat conditions of the natural receiver is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed protection measures, no significant impact of geothermal water exploitation on habitats, surface and underground water is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed protection measures, no significant impact of geothermal water exploitation on habitats, surface and underground water is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed protection measures, no significant impact of geothermal water exploitation on habitats, surface and underground water is expected.

Other working fluids used during oil-mining operations in the well (e.g. fluids for equipping and maintaining the well, stimulation fluids), after returning to the surface are not released uncontrolled into the environment, but are accepted in closed metal containers, prepared for removal (e.g. by neutralization) and handed over to an authorized collector (Gaurina-Međimurec, 2022). Significantly negative impacts on the quality of aquatic habitats and species related to such habitats would occur by releasing heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.). Increased temperatures result in an increase in the amount of dissolved oxygen and an acceleration of the metabolism of aquatic organisms (Kristmannsdottir & Armannsson, 2003; Shortall et al., 2015a; Davidsdottir & Axelsson, 2022).at a depth of 500 m to 5000 m between 40 ºC and 200 ºC, and at a depth of 2000 m to 6000 m between 80 ºC and 400 ºC. Taking into account that the average temperature of geothermal water obtained from shallow deposits is lower (at a depth of 10 - 150 m the average temperature of geothermal water is between 2 ºC and 21 ºC) than the average temperature of geothermal water from deeper deposits and that the obtained geothermal water is cooled before discharge into surface water bodies (mainly discharged in winter when it cools down faster), no significant impact on the quality of aquatic habitats and species related to such habitats is expected.

The implementation of the Plan will lead to an overall reduction of greenhouse gas emissions in the atmosphere and mitigation of climate change, because the use of geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a long-term positive impact on biodiversity.

7.2.7 Protected areas of nature

Research phase

The geothermal potential research phase includes 2D and 3D seismic recording, arrangement of existing or construction of new access roads, and arrangement of the well work area to accommodate the drilling rig with associated equipment and construction facilities required for production testing of the exploratory geothermal well. The aforementioned activities can be sources of negative impact on protected nature areas, primarily through long-term or short-term loss (conversion), degradation and fragmentation of habitats. According to Gaurina-Međimurec (2022), the drilling rig is installed at the location of the new well according to the typical arrangement that is in accordance with the verified well project and the project for the creation of the exploratory well. On the well working area, which is made of rock material embankment,

The short-term conversion of the habitat within the protected nature area will occur in the case of negative test results of the exploratory well when no geothermal water deposit has been determined, therefore such a well is abandoned (liquidated) in accordance with legal regulations, and the occupied well working area is rehabilitated and restored to a state close to its original state. With the construction of new access roads and in the case of a positive test result of the geothermal deposit and bringing it into exploitation, there will be a long-term conversion of the habitat. During the preparation of the well working area for the creation of an exploratory well, around 1.5 hectares of mostly agricultural or forest land is temporarily repurposed, while in the case of a positive outcome and bringing it into production, this area is reduced to a size of 50 mx 80 m (0.4 ha), and the remaining surface is being rehabilitated. Protected areas of nature are extremely valuable areas that represent fundamental value with their beauty, diversity and wealth, which must be protected from negative anthropogenic influence because they are one of the most important natural assets of the Republic of Croatia. The above-mentioned activities would have a significant negative impact because they would potentially destroy or reduce the natural values due to which the protected nature area acquired the status of protection, and the long-term or short-term conversion of the land would lead to a disruption of habitat functions, therefore special reserves, park forests, monuments of park architecture and natural monuments as a protection measure exclude from the implementation of the activities provided for in the Plan from the research phase, and therefore from the exploitation phase. diversity and wealth that must be protected from negative anthropogenic influence because they are one of the most important natural assets of the Republic of Croatia. The above-mentioned activities would have a significant negative impact because they would potentially destroy or reduce the natural values due to which the protected nature area acquired the status of protection, and the long-term or short-term conversion of the land would lead to a disruption of habitat functions, therefore special reserves, park forests, monuments of park architecture and natural monuments as a protection measure exclude from the implementation of the activities provided for in the Plan from the research phase, and therefore from the exploitation phase. diversity and wealth that must be protected from negative anthropogenic influence because they are one of the most important natural assets of the Republic of Croatia. The above-mentioned activities would have a significant negative impact because they would potentially destroy or reduce the natural values due to which the protected nature area acquired the status of protection, and the long-term or short-term conversion of the land would lead to a disruption of habitat functions, therefore special reserves, park forests, monuments of park architecture and natural monuments as a protection measure exclude from the implementation of the activities provided for in the Plan from the research phase, and therefore from the exploitation phase.the economic use of natural resources is easily allowed in areas that are protected in the nature park category, these are areas of exceptional natural value (biodiversity, geodiversity). Placement of exploratory wells should be directed to areas next to settlements, which are already partially or fully urbanized and in their immediate vicinity (eg in business zones). Therefore, a protective measure has been prescribed.

Changes in habitats caused by fragmentation and short-term or long-term repurposing of habitats during the installation of research facilities and the construction of access roads have a moderately negative effect on the species that inhabit protected nature areas, considering that a part of the area of indigenous plant and animal species is lost. The main negative impact of fragmentation is the edge effect, where the conditions of the habitat change (temperature, wind, lighting, changes in the composition of the vegetation, etc.), which can lead to the avoidance of such a habitat by the species that inhabited it until then. Also, habitat fragmentation leads to the separation of species, i.e. the loss of genetic diversity (Hein, 2012), and by reducing the integrity of the habitat in the protected nature area, the interactions between individuals of the population and the availability of feeding grounds and prey become difficult. A moderately negative impact of habitat degradation can also occur on the route of heavy machinery for the purposes of 2D and 3D seismic recording and clearing of land for the purposes of arranging the well work area, the destruction of autochthonous plant communities of the protected area, and the reduction of habitat stability, which can facilitate the spread of invasive species , in case the new habitat conditions are suitable for them. Construction machinery can spread invasive flora by transporting plant parts (vegetative and generative parts) with wheels and other vehicle parts over potentially long distances and new habitats that invasive flora can occupy. During spawning, amphibians in the protected area are extremely sensitive, and construction in areas suitable for spawning, such as puddles and wetlands, could have a moderately negative impact. Conversion of habitats important for bird migration and nesting in protected areas can have a negative impact on birds, such as wading birds in wetland habitats, for example in nature parks Kopački rit and Lonjsko polje, and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities that they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and raising young bats.

In the process of researching geothermal potential, there is an increased level of noise and vibration due to the operation of machines and the presence of people. The activities planned by the Plan, which refer to seismic surveys and arrangement of the well work area for the accommodation of the drilling rig, may have a negative impact on the species and habitats of the protected area in the immediate vicinity. Research activities will take place for the first 5 years, with the possibility of an extension of up to 1 year, and mainly include the acquisition of 2D and 3D seismic data and exploratory drilling, as well as numerous other analytical studies. The influence of the process of creating an exploratory well is up to two months for deep wells, and several weeks for shallow ones. During the investigation period in which activities such as seismic surveys are carried out, a negative impact on all animal species in the vicinity is possible. The negative impact comes from noise and vibrations that are created due to the operation of machines (vibrators, etc.) that are used to perform seismic surveys. The periods of migration, breeding and nesting of animals in the protected area are particularly sensitive to this influence. Underground habitats and species are extremely sensitive to surface and underground changes caused by natural and anthropogenic factors. Although there is no exact information on the places where the planned operations will be carried out, it is to be expected that the impact on the caves and cave fauna of protected areas would be significantly negative if seismic tests and exploratory drilling were carried out in the immediate vicinity of such facilities. In addition to being vulnerable to the destruction of their habitats, bats are also vulnerable to disturbance while they reside in them (Armstrong, 2010). Noise represents a potentially significant negative impact on bats, especially during the period of searching for food and finding shelters for hibernation and maternity colonies. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats of protected areas. The impact can be reduced by performing 2D and 3D seismic recording and vegetation removal outside the reproductive period of the target species of birds and bats, and according especially during the period of searching for food and finding shelter for hibernation and maternity colonies. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats of protected areas. The impact can be reduced by performing 2D and 3D seismic recording and vegetation removal outside the reproductive period of the target species of birds and bats, and according especially during the period of searching for food and finding shelter for hibernation and maternity colonies. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. 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(2005) and GEL (2022) using techniques and equipment for dampening noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, etc.), level control noise directly at its source and prescribing additional mitigation measures in case of need.

Continuous drilling involves the use of powerful lamps to illuminate the work site at night (Gaurina-Međimurec, 2022), which can disturb the fauna of that protected area. The most endangered groups of animal species are those that are active at night, such as bats, some types of birds (eg owls), saproxylic beetles (eg deer) and the like.

The movement of vehicles (vibrators, etc.) during seismic recording, as well as the movement of machinery during land clearing for the purposes of arranging the well work area and during the construction and use of new access roads, may cause harm to animal species (especially individuals with reduced mobility) that live in that area of the protected area. areas of nature. Also, the suffering of animal species is possible if they enter the temporary disposal site for the filled material (sand pit), the "sand trap", the pit for the reception of geothermal water and the collection pit. Although the mentioned facilities are mostly fenced, smaller animals can potentially enter them, depending on the type of fence.

During seismic recording, the construction of the drilling platform, the arrangement of existing or the construction of new access roads, there may be emissions of fine particles (dust) and exhaust gases due to the combustion of diesel fuel in work machines and vehicles and in the diesel engines of the drilling rig. As these actions are performed only during seismic recording, construction of plateaus and access roads, the impact resulting from them will be short-term and negligible. In a geothermal water reservoir, at high pressure and temperature, there may be dissolved gases in the water to a certain extent, for example carbon dioxide (CO2) and hydrogen sulfide (H2S). The concentration of dissolved gases varies from reservoir to reservoir. Geothermal water that is exploited from the underground reservoir during well testing is temporarily stored in a watertight pit (lagoon) for the reception of geothermal water, where the dissolved gases from the geothermal water are released into the air. The testing (testing) of the well is very limited in time, therefore the possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of testing the well,

Water and soil pollution in a protected nature area can occur due to the spilling of liquid substances (propellant fuels, motor oils) during seismic surveys, construction works during the arrangement of the well work area and accompanying facilities, arrangement of existing or construction of new access roads, as well as due to the spillage of waste water by the surface of the well working space; due to the migration of geothermal fluids towards the surface; due to the absence of a drainage system for surface (rain) water on manipulative surfaces; the absence of an adequate solution for sanitary waste water generated on the construction site; incorrect handling and storage of petroleum products, oils and lubricants or storage in inappropriate containers; filling transport means and work machines with fuel; increased amounts of construction, communal and hazardous waste, the washing of which can contaminate underground water; breakdown of construction machines and tools used; intentional or accidental release or disposal of excess hazardous construction materials and chemicals into waterways. All the water that spills over the well working area during drilling is collected in a reinforced concrete basin for the separation of rock fragments (solid particles) from the mud by a system of drainage concrete channels, and is drained from it to a temporary landfill for the drilled material, i.e. a mud pit. Geothermal water obtained during hydrodynamic testing of the well is accepted in a pit (lagoon) for receiving geothermal water. During the performance of mining works in the borehole working area, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain (Gaurina-Međimurec, 2022).

For the preparation of mud and cement slurry for cementing the columns of protective pipes and for sanitary purposes, technological water is used, which is delivered by the vehicles of the fire department and is accepted in reservoirs that are an integral part of the equipment at the drilling plant. However, in some cases, water requirements can be met by using surface water, which can affect the change in the water regime of surface waters in a protected nature area, and thus lead to a significant negative impact on the habitat conditions of aquatic habitats. Excessive pumping of water from natural streams and lakes can lead to disruption of the natural hydrological regime and, consequently, to disruption of conditions in habitats related to aquatic ecosystems. By pumping water, surface and underground water regimes change, which is a consequence of the redistribution of part of the water balance. The lowering of the level of surface and underground water in the area of the intervention can be reflected in the species that inhabit watercourses and lakes in the form of a change in the conditions in the habitats, which would be reflected in the lowering of the water level in the lakes and in the bed of the watercourse downstream of the planned interventions, the consequent reduction of the flow, the drying of the surrounding wet and aquatic habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during the exploration of geothermal deposits instead of water from surface water bodies in the protected nature area. consequent reduction in flow, drying out of the surrounding wet and water habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during the exploration of geothermal deposits instead of water from surface water bodies in the protected nature area. consequent reduction in flow, drying out of the surrounding wet and water habitats. Suffering of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during the exploration of geothermal deposits instead of water from surface water bodies in the protected nature area. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during the exploration of geothermal deposits instead of water from surface water bodies in the protected nature area. The suction power will potentially cause the death of aquatic organisms, for example, fish fry. This potentially significant negative impact can be avoided by using process water during the exploration of geothermal deposits instead of water from surface water bodies in the protected nature area.

Various types of non-hazardous and hazardous waste are generated during the arrangement of the well working area and the construction of the well, which are handled in accordance with the legal regulations, therefore no significant negative impact of waste management during the research phase on the biodiversity of the protected area is expected.

<u>Exploitation phase</u>

The exploitation phase, depending on the intended use of energy, includes the creation of geothermal wells (exploitation, one of which is exploitation-pressurization), the construction of above-ground energy facilities and plants, and the creation of the necessary surface infrastructure. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent repurposing and fragmentation of about 0.4 hectares of vegetation. The operational period can last 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If the research is successful, and exploratory wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, the mentioned activity would produce a significant negative impact because it would potentially destroy or reduce the natural values due to which the protected nature area acquired the status of protection, and the long-term or short-term conversion of the land would lead to a disruption of habitat functions, therefore special reserves, forest parks ,the economic use of natural resources is easily allowed in areas that are protected in the nature park category, these are areas of exceptional natural value (biodiversity, geodiversity). The placement of exploitation wells should be directed to areas next to settlements, which are already partially or fully urbanized and in their immediate vicinity (eg in business zones). Therefore, a protective measure has been prescribed.

The negative impact of fragmentation will occur as a result of vehicle traffic on roads built for the purposes of exploration and exploitation of geothermal water, that is, due to the interruption of migration routes of the individuals of that protected area. No significant negative impact of fragmentation due to the construction of a plateau with an exploitation well is expected since the initial well working area for setting up a drilling facility for testing the geothermal water reservoir in the exploitation phase is reduced to a plateau of around 0.4 ha. Also, due to the potential introduction of invasive species by construction machinery, there may be a moderately negative impact on the native flora and fauna of the protected area due to the spread of invasive species that could be better adapted to the changed habitat conditions. During spawning, amphibians are extremely sensitive, and construction in areas suitable for spawning, such as puddles and wetlands, could have a moderately negative impact. The conversion of habitats important for bird migration and nesting can have a negative impact on birds, such as wading birds in wetland habitats, e.g. in the Kopački rit and Lonjsko polje nature parks, and burrowing birds in forest habitats. Bats are sensitive to changes in the abiotic conditions of the habitat and changes in the structure of the plant communities they feed on, and the speleological objects in which they live have special microclimatic conditions, the change of which reduces the suitability of that habitat for hibernation and raising young bats, therefore the conversion/damage of such a habitat in a protected area nature can have a significant negative impact on bats.

In the process of creating a production/injection well or drilling additional wells for the purpose of exploitation, there is an increased level of noise and vibrations due to the operation of machines and the presence of people, which can have a negative impact on the fauna of the protected area in the immediate vicinity. In the process of exploiting geothermal energy, that is, during the drilling of wells and the construction of plants for converting geothermal energy into electricity, the noise level ranges from 45 to 120 dB and is not constant, and the noise level of a geothermal power plant during electricity production corresponds to most plants that use motorized plants (Pravica et al., 2006). Animal species are particularly sensitive to this influence during periods of migration, reproduction and nesting. Underground habitats and species in the protected nature area are extremely sensitive to surface and underground changes conditioned by natural and anthropogenic factors, therefore it is to be expected that the impact on caves and cave fauna (including bats) would be significantly negative if the construction of a production/injection well or drilling of additional wells was carried out in the immediate vicinity of such facilities. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds and leaving suitable nesting habitats. Also, making a production/injection well or drilling additional wells in the immediate vicinity can have a moderately negative impact on other animal species that live in other habitats of the protected area.Kagel et al., 2005; GEL, 2022).

Drilling a production/injection well or additional wells for exploitation also involves the use of powerful lamps to illuminate the work site at night which may disturb the fauna of that protected area as well as during the exploration phase. Also, the geothermal power plant will be illuminated during the exploitation of geothermal water, which may also have a moderately negative impact on the animal species of the protected area in its vicinity, especially bats, birds, saproxylic beetles, etc., which are active at night.

During the operation of the geothermal power plant, it is possible to induce earthquakes in the protected natural area, especially with the application of EGS technology, whereby by injecting large amounts of water under high pressure, cracks are intentionally created in dry hot rocks, which can induce earthquakes up to magnitude M = 2.0 - 3.0 (Rybach, 2002; Gaurina-Međimurec, 2022). This would potentially have a moderately negative impact by disturbing the fauna of that protected area. At the same time, underground habitats and the species that live in them (especially bats), as well as the fauna of the wider area, are particularly sensitive. The impact can be avoided by giving preference to technologies that are not based on the fracturing of dry hot rocks, ie that will not cause local stress in the rocks that can cause earthquakes.

During the operation of the geothermal power plant, a potentially significant negative impact is possible due to the death of birds due to landing on air condensers and due to the death of birds and bats located in the protected area due to a collision with the infrastructure built for the needs of the geothermal power plant (power lines, etc.). During the movement of vehicles on newly built roads, the movement of machinery due to the potential clearing of land and the construction of additional roads for the exploitation of geothermal water may lead to the suffering of animal species that live in that protected area. Also, the suffering of animal species of the protected nature area is possible if they enter the temporary disposal site for the filled-up material (sand pit), "sand trap", pit for the reception of geothermal water and collection pit.

During the construction of a production/injection well or the drilling of additional wells for the purpose of exploitation, the emission of fine particles (dust) and exhaust gases may occur due to the combustion of diesel fuel in work machines, vehicles and in the diesel engines of the drilling plant. As these actions are performed only during the production/injection well or the drilling of additional wells, the impact that will result from them will be short-term and negligible for protected nature areas. During the operation of the geothermal power plant, there may be emissions of exhaust gases due to the combustion of diesel fuel in the diesel electric generator, which is used in the event of power failure, but this is a short-term and negligible impact on protected areas. Also, during the construction of a production/injection well or the drilling of additional wells, emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), may occur, which may occur in exceptional situations when geothermal water is temporarily stored in a watertight basin . Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level.

During the construction of a production/injection well or the drilling of additional wells, except in accidental situations, there is no outflow of polluted wastewater into the surrounding terrain of the protected nature area. In accidental situations, a significantly negative impact of habitat pollution is possible, and the most endangered are water and wet habitats in protected nature areas. All possible negative impacts on surface and underground water during research can be avoided by proper organization of the construction site and compliance with construction regulations and conditions.

Land subsidence in the protected nature area can sometimes be caused by the extraction of large amounts of geothermal water from geothermal deposits. Long-term pumping of geothermal water without re-pressing it into the reservoir leads to greater ground subsidence in some areas near the exploitation field, and less subsidence in a much wider area (Gaurina-Međimurec, 2022). Land subsidence can lead to submergence of pieces of land in nearby water bodies (William & Glassley, 2010; Gašparić, 2021) and to a change in the regime of water bodies connected to an underground reservoir from which a large amount of geothermal water was squeezed out, which would have a negative impact on species related to aquatic habitats. Since it is a phenomenon that is not frequent, by adhering to the usual practice of operating a geothermal power plant, i.e. re-injecting geothermal water back into the geothermal reservoir from which it was obtained after its heat has been used, from the beginning to the end of the operation of the geothermal power plant, this impact on protected natural areas can be reduced to a negligible level. In the case of direct use of geothermal energy (for agricultural purposes, for heat production, etc.) accumulated in shallow reservoirs of geothermal water, the probability of land subsidence is small because it is a matter of shallow reservoirs and pumping of smaller amounts of geothermal water.

During the exploitation of geothermal waters, the cooled ("waste") geothermal water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems (Gaurina-Međimurec, 2022). In this case, it is geothermal water that is mainly usedfor the purpose of producing thermal energy, for agricultural purposes, etc. therefore, the amount of geothermal water required is also smaller. Therefore, if it is a shallow reservoir with a natural supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21), it is possible to discharge the cooled geothermal water into the natural receiver instead of returning it to the tray. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). In case of discharge of extracted geothermal water into a natural receiver, it is, if necessary, can be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person (Gaurina-Međimurec, 2022). Considering the stated, no significant negative impact of the release of recovered cooled geothermal water that meets the parameters prescribed by the aforementioned Ordinance on the habitat conditions of the natural receiver is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With the proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water exploitation on habitats, surface and underground water in the protected nature area is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With the proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water exploitation on habitats, surface and underground water in the protected nature area is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With the proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water exploitation on habitats, surface and underground water in the protected nature area is expected.

Other working fluids used during oil-mining operations in the well (e.g. fluids for equipping and maintaining the well, stimulation fluids), after returning to the surface are not released uncontrolled into the environment, but are accepted in closed metal containers, prepared for removal (e.g. by neutralization) and handed over to an authorized collector (Gaurina-Međimurec, 2022). Significantly negative impacts on the quality of aquatic habitats and species related to such habitats in the area of the protected nature area would be caused by the release of heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.). Increased temperatures result in an increase in the amount of dissolved oxygen and an acceleration of the metabolism of aquatic organisms (Kristmannsdottir & Armannsson, 2003; Shortall et al., 2015a; Davidsdottir & Axelsson, 2022).at a depth of 500 m to 5000 m between 40 ºC and 200 ºC, and at a depth of 2000 m to 6000 m between 80 ºC and 400 ºC. Taking into account that the average temperature of geothermal water obtained from shallow deposits is lower (at a depth of 10 - 150 m the average temperature of geothermal water is between 2 ºC and 21 ºC) than the average temperature of geothermal water from deeper deposits and that the obtained geothermal water is cooled before discharge into surface water bodies (mainly discharged in winter when it cools down faster), no significant impact on the quality of aquatic habitats and species related to such habitats is expected.

The implementation of the Plan will lead to a total reduction of greenhouse gas emissions in the atmosphere and mitigation of climate change, because the use of geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a long-term positive impact on protected nature areas.

1.1.1 Forests and forestry

Research phase

The geothermal potential research phase includes 2D and 3D seismic recording, arrangement of existing or construction of new access roads, and arrangement of the well work area to accommodate the drilling rig with associated equipment and construction facilities required for production testing of the exploratory geothermal well. The mentioned activities can be sources of significantly negative impact on forests and forest land, especially if they are located in protective forests, special purpose forests and valuable economic forests, primarily due to long-term or short-term loss of forest areas, their degradation and fragmentation, and reduction of general useful functions sum. According to Gaurina-Međimurec (2022) the drilling rig is set up at the location of the new well according to the typical layout that is in accordance with the verified well construction project and the exploratory well construction project. On the borehole working area, which is made of stone material embankment, construction objects necessary for the technological process of making and testing the borehole are placed, such as the mouth of the borehole (reinforced concrete open pool), foundations of the substructure of the tower, foundations of the drilling rig, "sand-trap -a" (open buried reinforced concrete tank), space for placing containers, a temporary disposal site for overburdened material (weeping pit), space for placing fuel tanks, two well test pits (flares), two piezometers, collection pits and space for disposal of humus and soil and pits (lagoons) for receiving geothermal water.

Short-term conversion/loss of forest areas will occur in the case of negative test results of an exploratory well when no geothermal water deposit has been identified, therefore such a well is abandoned (liquidated) in accordance with legal regulations, and the occupied well working area is rehabilitated and restored to a state close to its original state. In order to achieve the aforementioned, a protection measure has been prescribed. The construction of new access roads and in the case of a positive test result of the geothermal deposit and bringing it into exploitation will lead to a long-term loss of forests and forest land. Namely, during the preparation of the well working area for the construction of an exploratory well, around 1.5 hectares of mostly agricultural or forest land is temporarily repurposed. while in the case of a positive outcome and bringing it into production, that space is reduced to a size of 50 mx 80 m (0.4 ha), and the remaining area is rehabilitated. The implementation of the aforementioned activities would lead to a short-term or long-term loss of forests and forest land, and would potentially have a significant negative impact if they are located in protective forests, special-purpose forests, and commercial forests with a high degree of cultivation (the distribution of which is concentrated in the areas of Pannonian Croatia), which is especially manifested through the disruption of the stability of the forest ecosystem (reduction in the vitality of forest stands and increase in sensitivity to biotic and abiotic factors, such as diseases and pests and climatic extremes), disruption of the features of protective forests (increased erosion and soil slippage, especially pronounced on slopes above 12°) and special-purpose forests (especially pronounced in forest seed facilities), reduction of generally useful functions of forests (protection against erosion, protection of water resources, mitigating the consequences of climate change, preservation of biodiversity, social functions, etc.), and reduction of the economic functions of forests (loss of wood stock and potential felling force and leads to pressure on the implementation of forest and forest land management measures). By implementing protective measures, these impacts can be reduced to an acceptable level. Also, it is necessary to take into consideration the relative facts related to the geological foundations, natural features, valorization of the space in research, that is, the possibility of rational use of the natural asset and financial profitability, in the previous procedures for spatial planning.

The main negative impact of forest fragmentation is the creation of an edge effect, where the microclimatic conditions of forest habitats change (temperature, wind, lighting, changes in the composition of vegetation, etc.). This reduces the integrity of forest complexes and the vitality of forest stands along the newly formed forest edge, which leads to an additional opening of the forest complex, i.e. a reduction in the general and economic functions of forests (timber damage). Also, the danger of forest fires is increasing. Given that these impacts are mostly limited to the forest edge zone and taking into account the prescribed protection measures, the impacts are not expected to be significant. Degradation of forests can also occur on the route of movement of heavy machinery for the purposes of recording 2D and 3D seismic, i.e. by destroying the forest vegetation of that area, which, in addition to the reduction of general and economic functions, it can facilitate the spread of invasive species and change the composition of the forest community. Construction machinery can spread invasive flora by transporting parts of plants (vegetative and generative parts) with wheels and other parts of vehicles over potentially long distances and new forest areas that invasive flora can occupy, especially endangered forest stands of the first age class and stands in the stage of felling. . Also, during the research phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure. Construction machinery can spread invasive flora by transporting parts of plants (vegetative and generative parts) with wheels and other parts of vehicles over potentially long distances and new forest areas that invasive flora can occupy, especially endangered forest stands of the first age class and stands in the stage of felling. . Also, during the research phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure. Construction machinery can spread invasive flora by transporting parts of plants (vegetative and generative parts) with wheels and other parts of vehicles over potentially long distances and new forest areas that invasive flora can occupy, especially endangered forest stands of the first age class and stands in the stage of felling. . Also, during the research phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure. age class of that stand in the stage of fertilization cuttings. Also, during the research phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure. age class of that stand in the stage of fertilization cuttings. Also, during the research phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure.

The arrangement of existing or the construction of new access roads, the arrangement of the well working area and the inadequate drainage of surface (precipitation) water on manipulative surfaces can lead to increased erosion and movement of masses on forests and forest land, especially if it concerns forest stands on steep terrain slopes and/ or to parts of stands of disturbed structure. The impact of erosion can be reduced to the smallest possible extent by the prescribed protection measure.

During seismic recording, the construction of the drilling platform, the arrangement of existing or the construction of new access roads, there may be emissions of fine particles (dust) and exhaust gases due to the combustion of diesel fuel in work machines and vehicles and in the diesel engines of the drilling rig. An increase in the concentration of pollutants in the air can lead to a decrease in the vitality of forest stands. However, as these actions are performed only during seismic recording, construction of plateaus and access roads, the impact that will result from them will be short-term and negligible. The increased generation of dust carried by the wind can also cause pollution in the surrounding forests near the project, however, this depends on weather conditions, is short-term and negligible. In a geothermal water reservoir, at high pressure and temperature, there may be dissolved gases in the water to a certain extent, for example carbon dioxide (CO2) and hydrogen sulfide (H2S). The concentration of dissolved gases varies from reservoir to reservoir. Geothermal water that is exploited from the underground reservoir during well testing is temporarily stored in a watertight pit (lagoon) for the reception of geothermal water, where the dissolved gases from the geothermal water are released into the air. The testing (testing) of the well is very limited in time, therefore the possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare.

Pollution of forests and forest land, i.e. damage to forest vegetation and disruption of the vitality of forest stands can occur as a result of water and soil pollution, spillage of liquid substances (propellant fuels, motor oils) during seismic surveys, construction works during the arrangement of the well work area and accompanying facilities, arrangement existing or construction of new access roads, as well as due to spillage of waste water on the surface of the well working area; due to the migration of geothermal fluids towards the surface; due to the absence of a drainage system for surface (rain) water on manipulative surfaces; the absence of an adequate solution for sanitary waste water generated on the construction site; incorrect handling and storage of petroleum products, oils and lubricants or storage in inappropriate containers; filling transport means and work machines with fuel; increased amounts of construction, municipal and hazardous waste, the washing of which can pollute groundwater; breakdown of construction machines and tools used; intentional or accidental release or disposal of excess hazardous construction materials and chemicals into waterways. All the water that spills over the well working area during drilling is collected in a reinforced concrete basin for the separation of rock fragments (solid particles) from the mud by a system of drainage concrete channels, and is drained from it to a temporary landfill for the drilled material, i.e. a mud pit. Geothermal water obtained during hydrodynamic testing of the well is accepted in a pit (lagoon) for receiving geothermal water. During the performance of mining works in the well working area,

The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems (Gaurina-Međimurec, 2022). Therefore, if it is a shallow reservoir with a natural supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21), it is possible to discharge the cooled geothermal water into the natural receiver instead of returning it to the tray. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). In the case of discharge of extracted geothermal water into a natural receiver, it can, if necessary, be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person (Gaurina-Međimurec, 2022).

For the preparation of mud and cement slurry for cementing the columns of protective pipes and for sanitary purposes, technological water is used, which is delivered by the vehicles of the fire department and is accepted in reservoirs that are an integral part of the equipment at the drilling plant. However, in some cases water requirements can be met by using surface water, which can affect the change in the water regime of surface waters, and thus lead to a significant negative impact on the habitat conditions of aquatic habitats and consequently on forests and forest land in the vicinity (primarily floodplains forests). Excessive pumping of water from natural watercourses and lakes can lead to the disruption of the natural hydrological regime and, consequently, to the disruption of conditions in forest habitats related to water ecosystems. By pumping water, surface and underground water regimes change, which is a consequence of the redistribution of part of the water balance. There is a potential lowering of the water level in the lakes and in the river bed downstream from the planned interventions, resulting in a reduction of the flow, drying up of the surrounding wet and water habitats. The most endangered are willow and poplar flood forests (depending on the flood water regime), field ash and black alder forests (depending on the flood and groundwater regime), and flood oak forests (depending on the groundwater regime). This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. drying out the surrounding wet and watery habitats. The most endangered are willow and poplar flood forests (depending on the flood water regime), field ash and black alder forests (depending on the flood and groundwater regime), and flood oak forests (depending on the groundwater regime). This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies. drying out the surrounding wet and watery habitats. The most endangered are willow and poplar flood forests (depending on the flood water regime), field ash and black alder forests (depending on the flood and groundwater regime), and flood oak forests (depending on the groundwater regime). This potentially significant negative impact can be avoided by using process water during geothermal field testing instead of water from surface water bodies.

Various types of non-hazardous and hazardous waste are generated during the arrangement of the well working area and the construction of the well, which are handled in accordance with the legal regulations, therefore no significant negative impact of waste management during the research phase on the forests and forest land of the area is expected.

Also, it should be noted that in the area covered by the Plan there are mine-suspected forest areas in Karlovac County (Municipality of Josipdol), Osijek-Baranja County (City of Valpovo), Požega-Slavonia County (City of Pakrac) and Sisak-Moslavina County (towns of Novska and Sisak and the Municipality of Dvor), which needs to be taken into account during the phase of investigative works for the exploitation of geothermal water.

Exploitation phase

The exploitation phase, depending on the intended use of energy, includes the creation of geothermal wells (exploitation, one of which is exploitation-pressurization), the construction of above-ground energy facilities and plants, and the creation of the necessary surface infrastructure. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent repurposing and fragmentation of about 0.4 hectares of vegetation. The operational period can last 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If the research is successful, and exploratory wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). In the exploitation phase, similar to the previous phase, the planned activities can be sources of significantly negative impact if they are located in protective forests, special purpose forests and commercial forests with a high degree of cultivation, which is especially manifested through the disruption of the stability of the forest ecosystem (reduction in the vitality of forest stands and increasing sensitivity to biotic and abiotic factors, such as diseases and pests and climatic extremes), impairment of the characteristics of protective forests and special-purpose forests, reduction of the generally useful functions of forests (protection against erosion, protection of water resources, mitigation of the consequences of climate change, preservation of biodiversity, social functions, etc.), and reduction of economic functions forest (loss of wood stock and potential felling force and leads to pressure on the implementation of forest and forest land management measures). In this phase, additional loss of forests and forest land may occur and the reduction of the economic functions of forests (loss of wood stock and potential felling force, which leads to pressure on the implementation of forest and forest land management measures). In this phase, additional loss of forests and forest land may occur and the reduction of the economic functions of forests (loss of wood stock and potential felling force, which leads to pressure on the implementation of forest and forest land management measures). In this phase, additional loss of forests and forest land may occurby building the necessary infrastructure for the use of geothermal water (construction of hot water systems, transmission lines, etc.). By implementing protective measures, these impacts can be reduced to an acceptable level.

No significant negative impact of forest fragmentation and the creation of a new forest edge due to the construction of a plateau with an exploitation well is expected, since the original well working area for setting up a drilling facility for testing geothermal water deposits in the exploitation phase is reduced to a plateau of about 0.4 ha. Also, due to the potential introduction of invasive species by construction machinery, there may be a moderately negative impact on the forest vegetation due to the potential change in the composition of natural forest communities. During the exploitation phase, forest roads may be cut and damaged, which leads to difficult access to the forest, i.e. the implementation of activities prescribed by the management programs. It is possible to avoid the impact with the prescribed protection measure.

The construction of geothermal wells, above-ground energy facilities and facilities, and the construction of other surface infrastructure can lead to increased erosion and movement of masses on forests and forest land, especially if it concerns forest stands on larger terrain slopes and/or parts of stands with a disturbed structure. The impact of erosion can be reduced to the smallest possible extent by the prescribed protection measure.

During the construction of a production/injection well or the drilling of additional wells for the purpose of exploitation, the emission of fine particles (dust) and exhaust gases may occur due to the combustion of diesel fuel in work machines, vehicles and in the diesel engines of the drilling plant. An increase in the concentration of pollutants in the air leads to damage to forest stands, i.e. an impact on the vitality of forest stands. However, as these actions are performed only during the production/injection well or drilling of additional wells, the impact resulting from them will be short-term and negligible. The increased generation of dust carried by the wind can also cause pollution in the surrounding forests near the project, however, this depends on weather conditions, is short-term and negligible. During the operation of the geothermal power plant, there may be emissions of exhaust gases due to the combustion of diesel fuel in the diesel electric generator, which is used in the event of power failure, but this is a short-term and negligible impact on forests and forest lands. Also, during the construction of a production/injection well or the drilling of additional wells, there may be emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), which may occur in exceptional situations when geothermal water is temporarily stored in waterproof pool. Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level. during the construction of a production/injection well or the drilling of additional wells, emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), may occur, which may occur in exceptional situations when geothermal water is temporarily stored in a watertight basin . Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level. during the construction of a production/injection well or the drilling of additional wells, emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), may occur, which may occur in exceptional situations when geothermal water is temporarily stored in a watertight basin . Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level.

During the construction of a production/injection well or the drilling of additional wells, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain. In accidental situations, a moderately negative impact of water pollution on forest and forest lands is possible, and flood forests are the most threatened, however, all possible negative impacts on surface and underground water during research can be avoided by proper organization of the construction site and compliance with construction regulations and conditions.

Land subsidence can sometimes be caused by the extraction of large amounts of geothermal water from geothermal deposits. Long-term pumping of geothermal water without re-pressing it into the reservoir leads to greater ground subsidence in some areas near the exploitation field, and less subsidence in a much wider area (Gaurina-Međimurec, 2022). Land subsidence can lead to submergence of pieces of land in nearby water bodies (William & Glassley, 2010; Gašparić, 2021) and to a change in the regime of water bodies connected to an underground reservoir from which a large amount of geothermal water was squeezed out, which would have a negative impact on forests and forest land located next to these water bodies. Since it is a phenomenon that is not frequent, by adhering to the usual practice of operating a geothermal power plant, i.e. re-injecting geothermal water back into the geothermal reservoir from which it was obtained after its heat has been used, from the beginning to the end of the operation of the geothermal power plant, this impact can be reduced to a negligible level. In the case of direct use of geothermal energy (for agricultural purposes, for heat production, etc.) accumulated in shallow reservoirs of geothermal water, the probability of land subsidence is small because it is a matter of shallow reservoirs and pumping of smaller amounts of geothermal water.

During the exploitation of geothermal waters, the cooled ("waste") water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems. In this case, it is geothermal water that is mainly usedfor the purpose of producing thermal energy, for agricultural purposes, etc. therefore, the amount of geothermal water required is also smaller. The quality of such waters meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21). In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With the proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water utilization on forests and forest lands is expected. In case of discharge of extracted geothermal water into a natural receiver, it is, if necessary, can be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person. Other working fluids used during oil-mining operations in the well (e.g. fluids during well equipment and maintenance, stimulation fluids),

Given that the impact of possible ground subsidence and the release of geothermal water relate to locations near water bodies, taking into account the distribution of floodplain forests in the area in question, it can be concluded that the aforementioned impacts are mostly related to willow and poplar floodplain forests, forests field ash and black alder and floodplain oak forests.

The implementation of the Plan will result in a total reduction of greenhouse gas emissions in the atmosphere and mitigation of climate change, because the use of geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a long-term positive impact on forests and forest land.

1.1.2 Game and hunting

Research phase

The geothermal potential research phase includes 2D and 3D seismic recording, arrangement of existing or construction of new access roads, and arrangement of the well work area to accommodate the drilling rig with associated equipment and construction facilities required for production testing of the exploratory geothermal well. The mentioned activities can be sources of moderately negative impact on game and hunting, primarily through long-term or short-term loss (conversion), degradation and fragmentation of the productive hunting area. According to Gaurina-Međimurec (2022), the drilling rig is installed at the location of the new well according to the typical arrangement that is in accordance with the verified project for the construction of the well and the project for the construction of the exploratory well. On the well working area, which is made of rock material embankment,

The short-term conversion/loss of hunting productive area will occur in case of negative test results of an exploration well when no geothermal water deposit has been determined, therefore such a well is abandoned (liquidated) in accordance with legal regulations, and the occupied well working area is rehabilitated and restored to a state close to its original state. The construction of new access roads and in the case of a positive test result of the geothermal deposit and bringing it into exploitation will lead to a long-term loss of the productive hunting area. During the preparation of the well working area for the creation of an exploratory well, around 1.5 hectares of mostly agricultural or forest land is temporarily repurposed, while in the case of a positive outcome and bringing it into production, this area is reduced to a size of 50 mx 80 m (0.4 ha), and the remaining surface is being rehabilitated. The implementation of the mentioned activities would lead to short-term or long-term loss of productive hunting areas, i.e. to the loss of areas where game animals have the conditions for living, feeding, feeding, breeding and sheltering. In this way, the quality of the productive hunting areas is reduced, and there may be a violation of the ratings of the hunting grounds, depending on the size of the area under the intervention. The loss of forests and forest land would have a greater impact on large game (primarily brown bear and red deer), while the loss of agricultural land would have a greater impact on small game (pheasant, hare, etc.). The aforementioned is manifested through the destruction of complete forest complexes, areas of forests and ridges along rivers and forest complexes that enable the vitality and stability of populations in finding peace and food, that is, they ensure the productive capacity of the habitat and biological diversity. In addition, there may be a loss of sources for feeding game and disturbance of habitat conditions by regulation of natural flows.

When setting up research facilities and building access roads, there may be a moderately negative impact of fragmentation of the habitat and difficulty in the movement of game along well-established migration routes, which leads to the separation of species, i.e. the loss of genetic diversity, and the reduction of the integrity of the habitat in the hunting ground hinders the interactions between individuals of the population and the availability of feeding grounds . Degradation of the productive hunting area can also occur on the route of heavy machinery for the purposes of 2D and 3D seismic recording and clearing of land for the purposes of arranging the well work area, destroying autochthonous plant communities.

During the recording of 2D and 3D seismic, the arrangement of existing or construction of new access roads and the arrangement of the well working area, there may be a moderately negative impact, which is manifested by the difficulty of carrying out activities prescribed by hunting management principles, which is particularly reflected in hunting tourism and in the violation of safety during the conduct of hunting.

In the process of researching geothermal potential, there is an increased level of noise and vibration due to the operation of machines and the presence of people. Activities during the research phase related to seismic surveys and arrangement of the well work area to accommodate the drilling rig can have a negative impact on game and hunting grounds in the immediate vicinity. Research activities will take place for the first 5 years, with the possibility of an extension of up to 1 year, and mainly include the acquisition of 2D and 3D seismic data and exploratory drilling, as well as numerous other analytical studies. The influence of the process of creating an exploratory well is up to two months for deep wells, and several weeks for shallow ones. During the investigation period in which activities such as seismic surveys are carried out, a negative impact on all animal species in the vicinity is possible. A moderately negative short-term impact results from noise and vibrations that are created due to the operation of machines (vibrators, etc.) used to perform seismic surveys. Given that one of the criteria for determining the quality of hunting productive areas is peace in the hunting grounds, its disturbance will affect the reduction of the quality of hunting productive areas. The periods of migration, breeding and nesting of game animals are particularly sensitive to this influence. The impact can be reduced, among other things, by using techniques and equipment for dampening noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, etc.), by controlling the noise level directly at its source and prescribing additional mitigation measures in case of need. Also,

The movement of vehicles (vibrators, etc.) during seismic recording, as well as the movement of machinery during land clearing for the purposes of arranging the well work area and during the construction and use of new access roads, may cause injury to game animals (especially young individuals with reduced mobility) that live in that area of the hunting grounds. . Also, it is possible for wild animals to suffer if they enter the temporary disposal site for the filled material (sand pit), "sand trap", pit for the reception of geothermal water and collection pit. Since the area around the dumping pit and the geothermal water receiving pit are fenced off for safety reasons, and the steel sand trap is raised at least 1.5 m from the surface of the field, the possibility of wild game entering is minimal, and the impact of wildlife suffering is estimated to be negligible.

Contamination of water and soil on the hunting productive surface, which negatively affects game that consumes that water, can occur as a result of liquid substances (propellant fuels, motor oils) being spilled during seismic surveys, construction works during the arrangement of the well work area and accompanying facilities, arrangement of existing or construction of new access roads, as well as due to spillage of waste water on the surface of the well working area; due to the migration of geothermal fluids towards the surface; due to the absence of a drainage system for surface (rain) water on manipulative surfaces; the absence of an adequate solution for sanitary waste water generated on the construction site; incorrect handling and storage of petroleum products, oils and lubricants or storage in inappropriate containers; filling transport means and work machines with fuel; increased amounts of construction, municipal and hazardous waste, the washing of which can pollute groundwater; breakdown of construction machines and tools used; intentional or accidental release or disposal of excess hazardous construction materials and chemicals into waterways. All the water that spills over the well working area during drilling is collected in a reinforced concrete basin for the separation of rock fragments (solid particles) from the mud by a system of drainage concrete channels, and is drained from it to a temporary landfill for the drilled material, i.e. a mud pit. Geothermal water obtained during hydrodynamic testing of the well is accepted in a pit (lagoon) for receiving geothermal water. During the performance of mining works in the well working area, except in accidental situations,

The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems (Gaurina-Međimurec, 2022). Therefore, if it is a shallow reservoir with a natural supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21), it is possible to discharge the cooled geothermal water into the natural receiver instead of returning it to the tray. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). In the case of discharge of extracted geothermal water into a natural receiver, it can, if necessary, be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person (Gaurina-Međimurec, 2022). Possible impacts of the release of cooled geothermal water into a natural receiver on the health of wild game are manifested by a change in the quality of water for feeding wild game. However, no significant negative impact of the release of cooled geothermal water that meets the parameters prescribed by the said Ordinance is expected on game that consumes that water.

Various types of non-hazardous and hazardous waste are generated during the arrangement of the well working area and the construction of the well, which are handled in accordance with the legal regulations, therefore no significant negative impact of waste management during the research phase on game and hunting is expected.

Exploitation phase

The exploitation phase, depending on the intended use of energy, includes the creation of geothermal wells (exploitation, one of which is exploitation-pressurization), the construction of above-ground energy facilities and plants, and the creation of the necessary surface infrastructure. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent repurposing and fragmentation of about 0.4 hectares of vegetation. The operational period can last 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If the research is successful, and exploratory wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, the aforementioned activities would lead to a short-term or long-term loss of productive hunting areas, i.e. to the loss of areas where game animals have conditions for living, feeding, feeding, breeding and sheltering. In this way, the quality of the productive hunting areas is reduced, and there may be a violation of the ratings of the hunting grounds, depending on the size of the area under the intervention. The loss of forests and forest land would have a greater impact on large game (primarily brown bear and red deer), while the loss of agricultural land would have a greater impact on small game (pheasant, hare, etc.). The aforementioned is also manifested through the destruction of complete forest complexes, areas of forests and moors along rivers and forest complexes that enable the vitality and stability of populations in finding peace and food, i.e. ensure the productive capacity of habitats and biological diversity.

The moderately negative impact of fragmentation and difficulty in the movement of game along well-established migration routes will occur as a result of vehicle traffic on roads built for the purposes of exploration and exploitation of geothermal water. No significant negative impact of fragmentation due to the construction of a plateau with an exploitation well is expected since the initial well working area for setting up a drilling facility for testing the geothermal water reservoir in the exploitation phase is reduced to a plateau of around 0.4 ha.

During the construction of geothermal wells, above-ground energy facilities and facilities, the construction of the necessary surface infrastructure, and the exploitation of geothermal water, there may be a moderately negative impact, which is manifested by the difficulty of carrying out activities prescribed by hunting management principles, which is particularly reflected in hunting tourism and in the violation of safety during hunting .

In the process of making a production/injection well or drilling additional wells for the purpose of exploitation, there is an increased level of noise and vibrations due to the operation of machines and the presence of people, which can have a negative impact on the game hunting grounds in the immediate vicinity. In the process of exploiting geothermal energy, that is, during the drilling of wells and the construction of plants for converting geothermal energy into electricity, the noise level ranges from 45 to 120 dB and is not constant, and the noise level of a geothermal power plant during electricity production corresponds to most plants that use motorized plants (Pravica et al., 2006). Game is particularly sensitive to this influence during periods of migration, reproduction and nesting. Given that one of the criteria for determining the solvency of a productive hunting area is exactly peace in the hunting grounds, its violation will have a moderately negative effect on the quality of hunting productive areas. The impact can be reduced, among other things, by using techniques and equipment for dampening noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, geothermal power plants with internal noise-absorbing walls etc.), by controlling the noise level directly at its source and prescribing additional mitigation measures in case of need (Kagel et al., 2005; GEL, 2022).

Drilling a production/injection well or additional wells for exploitation also involves the use of powerful lamps to illuminate the work site at night which may disturb the game of that hunting ground as well as during the exploration phase. Also, the geothermal power plant will be illuminated during the exploitation of geothermal water, which may also have a moderately negative impact on wildlife in its vicinity, especially those that are active at night.

During the movement of vehicles on newly built roads, the movement of machinery due to the potential clearing of land and the construction of additional roads for the exploitation of geothermal water may lead to the death of game animals that live on that hunting ground. Also, it is possible for wild animals to suffer if they enter the temporary disposal site for the filled material (sand pit), "sand trap", pit for the reception of geothermal water and collection pit.

During the construction of a production/injection well or the drilling of additional wells, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain of hunting-productive areas. All possible negative impacts on surface and underground water during research can be avoided by proper organization of the construction site and compliance with construction regulations and conditions.

During the exploitation of geothermal waters, the cooled ("waste") water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems. In this case, it is geothermal water that is mainly usedfor the purpose of producing thermal energy, for agricultural purposes, etc. therefore, the amount of geothermal water required is also smaller. The quality of such waters meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21). In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With the proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water utilization on habitats, surface and underground water in the hunting area is expected. In case of discharge of extracted geothermal water into a natural receiver, it is, if necessary, can be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person. Other working fluids used during oil-mining operations in the well (e.g. fluids during well equipment and maintenance, stimulation fluids), after returning to the surface, they are not released uncontrolled into the environment, but are accepted in closed metal containers, prepared for removal (e.g. by neutralization) and handed over to an authorized collector (Gaurina-Međimurec, 2022). Moderately negative impacts on the quality of aquatic habitats and game related to such habitats in the area of the hunting grounds would be caused by the release of heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.). This impact can be prevented by prioritizing the return of extracted geothermal water through injection wells back into the deposit, especially in the case of deeper deposits where the average temperature of geothermal water at a depth of 500 m to 5000 m is between 40 ºC and 200 ºC, and at a depth of 2000 m to 6000 m between 80 ºC and 400 ºC.

The implementation of the Plan will lead to an overall reduction of greenhouse gas emissions in the atmosphere and mitigation of climate change, because the use of geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a long-term positive impact on the quality of productive hunting areas.

1.1.3 Landscape characteristics

Research phase

The above-mentioned factors of the geothermal water research site can generate different influences on the visual/aesthetic data as well as on the physical structure and quality of the landscape. In the case of the implementation of new or adaptation of existing access roads to potential localities suitable for the exploitation of geothermal water, the landscape is fragmented in a natural and visually structural sense, which results in smaller units, which changes their perception but also disrupts the existing morphology of the landscape itself. The strength of the potential immediate, short-term to long-term impact depends on the existing landscape data at the locality, the length and number of introduced linear elements, therefore the impact ranges from negligible to moderately negative. Considering that the Plan covers a large part of Croatia, where large areas of predominantly natural and/or agricultural space predominate, and in its large parts within the landscape there is no significant proportion of anthropogenic constructions, there is a possibility of a potential negligible to moderate impact on the landscape by removing the surface layer (vegetation cover and/or agricultural natural areas) which changes its visual-experiential and natural characteristics. The greatest share of impact is potential in areas of forest habitats and high vegetation and recognized valuable natural and pre-natural landscape qualities. and in its large parts within the landscape there is no significant proportion of anthropogenic constructions, there is a possibility of a potential negligible to moderate impact on the landscape by removing the surface layer (vegetation cover and/or agricultural natural areas), which changes its visual-experiential and natural characteristics. The greatest share of impact is potential in areas of forest habitats and high vegetation and recognized valuable natural and pre-natural landscape qualities. and in its large parts within the landscape there is no significant proportion of anthropogenic constructions, there is a possibility of a potential negligible to moderate impact on the landscape by removing the surface layer (vegetation cover and/or agricultural natural areas), which changes its visual-experiential and natural characteristics. The greatest share of impact is potential in areas of forest habitats and high vegetation and recognized valuable natural and pre-natural landscape qualities.

With regard to the legally regulated distances for the placement of boreholes from existing roads, the formation of new roads during which, if any, vegetation is removed, and the passage of machinery on them potentially generates dust, polluting particles from motor vehicles and other anthropogenic traffic pressures on the ecological system as a factor in the naturalness of the landscape , which potentially causes a short-term negligible impact if the impact is not continued by converting the site into an exploitation plant. During exploratory works on the surface of the various borehole areas (hereinafter referred to as BRP) of a size proportional to the depth of the borehole, together with access roads, it can amount to several hectares, which potentially generates a short-term to long-term moderately negative local impact on agricultural, meadow and or natural forest landscapes by their removal. The paved surface in combination with disposal pits, machinery, materials, auxiliary equipment and necessary infrastructure forms an anthropogenic contrasting patch and changes the visual identity of the space, which causes a short-term, local, negligible impact considering the fact that the drilling rig is present on the site for a relatively short time. The placement of exploratory boreholes in the areas of the forest edge has a short-term to long-term, local and moderately negative impact on the natural component of the landscape, especially in parts of the Plan, where the existing problem of the landscape is a scarce share of forest vegetation within large spatial areas. By implementing borehole working surfaces in the space, short-term to long-term, negligible impact on the morphological characteristics of the terrain, by leveling, cutting accompanying pits and basins with regard to the nature and predispositions of the intervention. The vertical breakdown of the drilling rig tower causes its visual exposure within a wide spatial band regardless of the relief elevation. The visual exposure of the mentioned element generates a short-term moderately negative limited impact on the visual structure and perception of the landscape, and creates an anthropogenic spatial accent in a potentially natural environment. The aforementioned impact is additionally expressed by the construction of several boreholes in a relatively small locality and is also present during the construction of a pressure borehole, which causes a local, immediate, negligible to moderately negative impact on the visual identity and image of the landscape. Given the short duration and the possibility of manipulating the visors, the previously mentioned impact can be significantly mitigated. During the investigation work, the well work area is illuminated at night with powerful reflectors, which has an impact on the night landscape, however, due to the short-term period of action of this impact, it is assessed as negligible. If the results of the exploratory wells prove to be negative, the liquidation of the exploratory well is carried out, i.e. it is abandoned and the affected area is rehabilitated according to the plan for the rehabilitation of the exploratory well. By implementing the above-mentioned plan, the landscape characteristics of the area are restored to their ante-opera state through reclamation and rehabilitation. During the investigation work, the well work area is illuminated at night with powerful reflectors, which has an impact on the night landscape, however, due to the short-term period of action of this impact, it is assessed as negligible. If the results of the exploratory wells prove to be negative, the liquidation of the exploratory well is carried out, i.e. it is abandoned and the affected area is rehabilitated according to the plan for the rehabilitation of the exploratory well. By implementing the above-mentioned plan, the landscape characteristics of the area are restored to their ante-opera state through reclamation and rehabilitation. During the investigation work, the well work area is illuminated at night with powerful reflectors, which has an impact on the night landscape, however, due to the short-term period of action of this impact, it is assessed as negligible. If the results of the exploratory wells prove to be negative, the liquidation of the exploratory well is carried out, i.e. it is abandoned and the affected area is rehabilitated according to the plan for the rehabilitation of the exploratory well. By implementing the above-mentioned plan, the landscape characteristics of the area are restored to their ante-opera state through reclamation and rehabilitation.

<u>Exploitation phase</u>

In the case of positive research results, the integration of exploitation infrastructure and the potential construction of a geothermal power plant will be started. Geothermal water exploitation can be spatially defined as point elements connected by a network of line elements. Upon discovery and commissioning of a new exploitation well, it is necessary to connect it to the site of the geothermal power plant with pipelines for the transfer of geothermal water. Depending on the distance of the exploitation well from the power plant/turbine and the conditions of the surrounding area, the aforementioned network of pipelines passes through the landscape. A new anthropogenic linear element is formed, which is visually exposed in open lowland localities and in chromatic contrast with the environment, which potentially forms a long-term, local to regional,

In addition to the above, passing through the area of the forest cover fragments the volumes in the space, which also disrupts the structure but also the perception of the naturalness of the landscape. The operation of the power plant itself forms a visual spatial patch of a larger area, the size of which is proportional to the power of the power plant, which potentially has a long-term, local and moderate negative impact on the experience, perception and visual/aesthetic characteristics of the landscape, especially in the localities of recognized complex landscapes of high natural and aesthetic value. During the functioning of geothermal plants, the cooling chimneys form imposing tall columns of water vapor whose intensity depends on the outside temperature. The above can cause an occasional, negligible, local impact on the visual and aesthetic characteristics and values of the landscape, as well as a change in the experience of the entire space. In the case of expansion of the geothermal plant by drilling additional exploitation wells due to an increase in the need for electricity or geothermal water, the network of the geothermal power plant expands within the landscape, forming "arms" that lead to satellite wells. The above is also possible when geothermal wells are overexploited, which causes a drop in productivity. Radial expansion in space is also possible by repurposing the planned injection well into an exploitation well. The aforementioned expansion of the intervention increases the negative impacts on the area, thus creating an additional long-term, moderately negative impact on the integrity and continuity, naturalness and visual identity of the landscape. Long-term exploitation from one or more exploitation wells in a certain area can lead to a change in the underground water regime, which consequently potentially leads to a change in the formations of surface water bodies (swamps, formations of new streams, springs). Such an outcome potentially generates a moderately negative to significant, long-term impact on the natural factors of the landscape. Also, the exploitation of geothermal waters can potentially lead to land subsidence in certain areas due to the change and lowering of the water level in the underground basins. The above can cause less induced seismic activity. As a result of the aforementioned, degradation is possible through potential, long-term, moderately negative impact on anthropogenic features and factors of the landscape in case of possible abandonment of certain areas.

1.1.4 Cultural and historical heritage

Research phase

Depending on the spatial placement, ie the choice of space for conducting research works that include 2D and 3D recording of the underground, there is a potential local, long-term and negligible to moderately negative impact on the possible unrecorded archaeological legacy. Also, exploratory works with an emphasis on the creation of exploratory wells depending on the distance from primarily construction and archaeological but also other cultural assets can potentially cause their structural and consequently visual degradation through vibrations. The construction of the necessary infrastructure (roads, well working area, drilling tower) can also produce vibrations and emissions of dust and particles from motor vehicles that reflect a negative impact on immediate cultural assets.

If BRPs are placed in their vicinity, negligible to moderately negative impacts on archaeological, architectural, memorial, ethnological heritage and all other forms of cultural assets that are manifested in physical immovable form are possible. Through the above, the spatial and visual integrity is changed, the authenticity of cultural assets and historical settings are violated. In addition, positive impacts through the potential for finding new archaeological sites are also possible through the execution of investigative works. A long-term, moderately negative impact through damage to the structure of cultural assets is potentially possible due to induced seismic activity due to the exploitation and/or reinjection of geothermal waters. However, these are microseismic events that can only be detected using instruments,

Exploitation phase

In the case of positive results during the research phase and the transition to the exploitation phase, the aforementioned influence on the authenticity and visual integrity of the cultural assets located within the influential boundaries of the exploitation site will be reduced due to the significantly lower visual appearance of the spatial elements of the exploitation well work area. The constructed access roads also, as in the research phase, potentially have a long-term, negligible impact on cultural assets due to the vibration of machinery and the emission of particles from motor vehicles, considering the reduced share of use during the exploitation process.

In the case of the implementation of the operation of the geothermal power plant, a long-term, moderately negative impact on the authenticity, significance and visual image of the cultural assets located nearby is potentially generated. Plant construction and operation, as well as the movement of machinery during the construction of a geothermal power plant, can also cause negligible to moderately negative impacts on the authenticity and structure and perception of cultural assets. Forms of using geothermal water, such as a geothermal power plant, have a far-reaching visual impact in the space, primarily due to the columns of water vapor, which can degrade the authenticity, perception and ambience of certain cultural heritage structures and localities, and have a negligible to moderately negative impact depending on the importance and proximity of the cultural asset.

1.1.5 Population and human health

Research phase

Negative impacts on the population during the research phase were caused by construction works. During the construction, the daily life of the population may be disrupted by machines and vehicles that will move through the affected areas. The negative impact will be manifested in the reduced possibility of unhindered use of roads during the transport of materials and equipment. Mechanization aids and machines that will occasionally move through the settlements will slow down and disrupt the flow of traffic and create certain noise and traffic jams. Also, they could damage the quality of the public local road infrastructure - damage the pavement and apply soil residues and unwashed construction material residues on the same. The mentioned impacts will be temporary, will last until the completion of the works and will not be expressed. During the construction of construction facilities, which are necessary for the normal development of the technological process of making a well, a temporary change in the visual qualities of the space can be expected, which may affect the quality of life of the inhabitants to a lesser extent. There is a smaller possibility of a negative impact of the intervention on residents who live at the closest distance from the location of the wells, which can be manifested in a decrease in air quality due to an increase in dust and exhaust gases from working machines and an increase in the risk of noise and light pollution due to construction work. The noise of trucks and backhoes varies depending on their age, condition, load and the characteristics of the roads they travel on. On average, a truck creates noise of 84 dB, and a backhoe 75 dB. During drilling, the noise in the working area around the axis of the well is 54 dB and decreases with the distance from the axis of the well. After the construction of the well, in the case of bringing it into operation, the noise will be even less. Given that workers will be exposed to noise, the permissible exposure of workers to noise regardless of the purpose of the space during the day is 65 dB, and in the period from 08:00 to 18:00 hours it is allowed to exceed the equivalent noise level by an additional 5 dB (Regulation on the highest permissible noise levels in environment where people work and live NN 145/04). Exceeding the permitted noise levels by 10 dB is exceptionally permitted, in the event that this is required by the technological process for a maximum of one night or two days during a period of thirty days. Also, in the drilling area, lighting is used, which is an integral part of the drilling rig. so that the workers during the execution of the works have sufficient light intensity for safe work, which is prescribed by the Law on Safety at Work (Official Gazette 71/14, 118/14, 154/14, 94/18, 96/18) and the Ordinance on Testing the Working Environment (NN 16/16). Continuous drilling involves the use of powerful lamps to illuminate the work site at night, which can disturb local residents. However, considering the previously mentioned legally regulated distances of drilling wells from existing roads and residential buildings, the aforementioned impacts will not significantly affect the quality of life of the local population and are estimated to be of negligible importance. The duration of construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, therefore the impact is estimated as short-term. Also, the Law on Protection from Light Pollution (Official Gazette 14/19) does not apply to oil-mining works in the function of drilling a well, which is clarified in Art. 3 of the Act, because the work with the drilling rig lasts several weeks and represents a negligible impact.

After drilling the exploratory well, and in case of negative test results, the well is permanently abandoned. The occupied forest and/or agricultural area is rehabilitated and brought back to its original purpose, which enables reconstruction at the location of the intervention. The aforementioned works will be carried out in accordance with the Rulebook on technical norms for the exploration and exploitation of oil, natural gas and stratified waters (Official Gazette No. 43/79; 41/81; 15/82 and NN No. 53/91) and the Design Project wells. In this way, the remediation of the well working area does not cause damage or permanent consequences for the environment. In the case of commercial discovery of geothermal waters, there is a long-term loss of surface area, but the working space is reduced.

If the local population of the concerned counties is engaged in the phase of preparation and construction of the plant, the intervention will generate a positive impact of increasing the employment rate. The above applies mostly to jobs in construction and assembly, transportation, and project management and management.

The increase in radioactivity that has been confirmed in the literature during the development of geothermal potential can in theory generate negative impacts on human health. However, since the entire technological process of exploration and exploitation of geothermal water is planned as closed, it is determined that there will be no negative effects of the increase in natural radioactivity (NORM) on human health.

Exploitation phase

Geothermal energy is a renewable base-type energy source, which means that energy production is possible 24/7 throughout the year, which contributes to the high efficiency of geothermal energy plants. Using geothermal energy reduces the consumption of conventional energy sources (fossil fuels), which results in a positive impact on the environment. In addition to the production of electricity, geothermal energy also has great potential in heating - from heating residential buildings, business premises and swimming pools to agriculture where geothermal waterit can be used to heat greenhouses and sterilize soil, creating a growing environment suitable for food production in places where natural conditions would not allow it. In addition, protection against disease and extreme weather conditions increase the productivity and availability of agricultural products in the off-season.Geothermal systems have significant advantages over other renewable energy systems and are one of the few sources that provide cooling and heating from the same installation. The implementation of geothermal projects of wide application (electricity production and/or heating and greenhouse production) will contribute to strengthening the independence and energy independence of local and regional self-government units, which will enable the sustainable development of society, the transition to low-carbon activity. The stated goals will lead to an improvement in people's quality of life, which may indirectly contribute to reducing the negative demographic trend. Considering that the activities of the Plan will improve the situation compared to the existing ones, the impact is estimated to be positive.

As for the negative impacts, they are limited to accidental situations and given the relative isolation of the wells and the adequate distance from the settlements, they do not have the potential to cause large-scale damage in terms of human health.

1.2 Impact on freshwater fisheries and aquaculture

In terms of geothermal potential and the connection of the Plan with freshwater fisheries and aquaculture in the area of Continental Croatia, they can realize positive trends. Low-temperature geothermal sources that are not hot enough to generate electricity are very useful for aquaculture farmers. Animals reared in water at the appropriate temperature grow faster and are larger than those reared in cold or fluctuating water. They are also more resistant to disease and die less often. Aquaculture farmers who have access to geothermal water can use it to regulate the temperature in their ponds. The future food supply in the world depends more and more on the development of aquaculture, especially in those countries where the use of animal proteins (meat, eggs, milk and derivatives) is limited. While traditional fisheries have reached near-saturation, aquaculture could make an important breakthrough since its production can be planned in advance according to market conditions. Intensive aquaculture that can be developed using warm water (thermal aquaculture) is particularly interesting. In fact, there is a direct relationship between the biomass produced and the temperature, with each type of biomass having its own optimum temperature. Thermal aquaculture can double the growth of fish compared to the average values of natural waters, moreover it can make aquaculture almost independent of seasonal cycles. In fact, there is a direct relationship between the biomass produced and the temperature, with each type of biomass having its own optimum temperature. Thermal aquaculture can double the growth of fish compared to the average values of natural waters, moreover it can make aquaculture almost independent of seasonal cycles. In fact, there is a direct relationship between the biomass produced and the temperature, with each type of biomass having its own optimum temperature. Thermal aquaculture can double the growth of fish compared to the average values of natural waters, moreover it can make aquaculture almost independent of seasonal cycles.

Economically, using geothermal energy to heat water for aquaculture can have many advantages. Water that has already been used for heating or electricity generation can heat ponds almost for free. Also, a farm that uses geothermal water does not burn fossil fuels or other heat sources to regulate the temperature of the water and therefore emits no pollutants. Many geothermal aquaculture operations use water that has already been used by geothermal power plants or heating systems. Aquaculture itself reduces the pressure on commercial fisheries, many of which have been seriously overfished. However, in order to use geothermal water in aquaculture for temperature adaptation and optimization of biomass growth, it is necessary to realize other factors such as: proximity to the source/outlet of geothermal water, preparation of geothermal water, On the other hand, the potential discharge of heated waste water used in other processes in which it is possible to exploit geothermal extracts, can cause a moderately negative, immediate, local impact on cold and warm water farms. Due to excessive temperature fluctuations, certain biotopes change and localities become unsuitable for fish farming and commercial fishing. In addition to the above, cooled geothermal water that potentially reaches waterways or aquaculture farms can contain dangerous dissolved substances if it is not purified, which can also generate a moderately negative impact on the survival of aquaculture.

The pumping of geothermal waters changes the underground water regime, if aquaculture activities are formed on existing water bodies or on ponds, these water bodies are potentially replenished by underground capillary flows and/or retain a certain level of water due to water saturation of the soil. By changing the regime of groundwater, changes are possible in the regime and water filling of surface streams, which directly affects the activity of aquaculture, but also the ability of water bodies to support freshwater fishing and fishing. However, since we are talking about a closed system of pumping geothermal water from great depths, this impact is unlikely and is estimated to be negligible.

1.3 The impact of waste generation

Research phase

In the process of making geothermal wells, different materials (additives) are used and different types of waste are generated.

During the process of making, equipping and maintaining wells, three basic types of waste are generated, namely:

- waste consisting of broken rock fragments,
- waste created from possible waste materials used during the construction of the well channel (mud),
- waste created from possibly discarded materials used for equipping and maintaining wells.

The primary way the drilling process can affect the environment is through the broken rock debris and mud used to carry the debris out of the well. Such waste is called primary waste. Water-based muds are mainly used. Appropriate physical or chemical properties of the fluid are achieved by adding different additives. Oil-based muds also contain various additives and chemicals that maintain emulsion stability. Diesel oil is most often used as a base for oil muds. Diesel oil contains aromatics, and more recently mineral and synthetic oils are also used. These muds have a greater harmful impact on the environment than water-based muds. Oil-based muds will not be used for geothermal water research.

Many additives used in muds can be dangerous. Grease for thread lubrication often contains metals Pb, Zn, Cu, Cd that can be leached into the mud.

During the process of equipping and maintaining wells (repair work), aqueous salt solutions ("hardened water"), various acids and alkalis, diesel oil, crude oil, and various additives (corrosion inhibitors, viscosifiers, etc.) are also used. Such waste is called secondary waste. The main contaminants in muds can be heavy metals, salts and hydrocarbons and all are potentially harmful to the environment, depending on the quantity.

According to the Ordinance on the catalog of waste (Official Gazette 90/15), the categories of waste generated in the process of exploration and exploitation of geothermal waters (and hydrocarbons) are shown inTable7.1

Table7.1Categories of waste generated in the process of exploration and exploitation of geothermal waters

Key number	Name
01 05	muds and other drilling waste
01 05 04	drilling muds and other wastes from drilling, which contain fresh water
01 05 07	muds and other drilling waste, containing barite and not specified under 01 05 05 and 01 05 06
13 02 05*	non-chlorinated mineral-based motor, lubricant and machine oils
15 01	packaging
15 01 01	paper and cardboard packaging
15 01 02	plastic packaging

15 01 03	wooden packaging
15 01 10*	packaging that contains residues of dangerous substances or is contaminated with dangerous substances
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths and protective clothing, contaminated with hazardous substances
17 09 04	mixed construction waste and demolition waste, not listed under 17 09 01*, 17 09 02* and 17 09 03*
20 03 01	mixed municipal waste

<u>Exploitation phase</u>

Waste mud with fragments of destroyed rocks, along with layer water, represents the largest amount of waste generated in the process of exploration and exploitation of geothermal waters. During the construction of a typical borehole up to 4000 m deep (including channel extensions), about 500 m3 of broken rock debris is generated (Navaro, 1995). In this process, it is possible to generate larger amounts of construction waste. Namely, during drilling, cement slurry is used, which, if it remains after cementing the well, is disposed of as construction waste, that is, if possible, it is recycled.

Many additives that are purposely added to the mud to adjust its properties are dangerous (eg chromium-based additives used as deflocculants, dispersants, biocides, corrosion inhibitors; grease for thread lubrication, etc.). In general, all muds contain a certain number of undesirable components. These are most often heavy metals (barium from barite, mercury and cadmium from impurities in barite and rock fragments, lead from grease for thread lubrication, chromium from additives to reduce viscosity and corrosion inhibitors), salts and hydrocarbons (diesel from lubricants, release fluids accepted tools and oil-based mud debris) that are harmful to the environment (Reis, 1996).

In addition, smaller amounts of other types of waste are generated (eg waste from washing plants and equipment, empty packaging, etc.).

In part of the well working area, there is also a space for the disposal of humus and soil that will be used during the rehabilitation of the said area.

The types and amounts of waste expected during the construction of new exploratory wells and their exploitation are shown inTable7.2. The data was collected during the construction of the existing exploration wells. If, despite the special attention that will be paid to the supply of machinery with fuel, as well as during the manipulation of fresh and waste oils, there is a spillage of the same, such cases will be dealt with urgently and fall into an accident. This implies the removal and removal of contaminated soil and waste oil by an authorized collector of hazardous waste.

Table7.2Data on waste at new facilities

Quantities of waste in exploitation fields			
Key number	**Name of the waste**	**Processing/disposal**	
Waste during well construction			
01 05 04	muds and other waste from drilling, which contain fresh water and waste	2,000 t	temporarily on location
13 02 05*	non-chlorinated mineral-based motor, lubricant and machine oils	1 t	authorized collector
15 01 06	mixed packaging	2 t	authorized collector
15 01 10*	packaging that contains residues of dangerous substances or is contaminated with dangerous substances	1 t	authorized collector
15 02 02*	absorbents, filter materials (including oil filters not otherwise specified), wiping cloths and protective clothing, contaminated with hazardous substances	1 t	authorized collector
20 03 01	mixed packaging	1 t	authorized collector
Waste during construction works (construction of the access road, construction and rehabilitation of the well working area, ...)			
17 01 01	construction waste	500 t	temporarily on location

As you can see from the attachment, we work with small amounts of waste, where construction waste prevails.

During the exploitation of geothermal waters, small amounts of waste are generated, namely absorbents, filter materials (including oil filters that are not otherwise specified), fabrics and means for wiping and absorbing and protective clothing contaminated with dangerous substances (15 02 02*); metal packaging containing hazardous solid porous materials, including empty containers. A very small amount of mixed municipal waste is also generated.

Waste management is carried out in accordance with the Law on Waste Management (Official Gazette 84/2021) and the Ordinance on Waste Management (Official Gazette 81/2020). This Study does not refer to the handling of radioactive waste, wastewater and gaseous substances released into the atmosphere.

Waste substances are understood as all substances or objects determined by the categories of waste prescribed by a special rulebook, which the owner discards, intends or must discard. The producer of waste or the owner of waste bears the costs of waste management measures and is financially responsible for the implementation of remedial measures due to the damage caused or that could be caused by the waste, i.e. the "polluter pays principle" applies. The basic goals of dealing with waste are:

- avoiding and reducing the generation of waste and reducing the hazardous properties of waste that cannot be prevented
- prevention of uncontrolled handling of waste
- utilization of valuable properties of waste for material and energy purposes and its processing before disposal
- the priority order of waste management is:

1. preventing the generation of waste

2. preparation for reuse

3. recycling

4. other recovery procedures, eg energy recovery i

5. disposal.

When the priority order of waste management is applied and a decision is made between two or more options:

- preference must be given to the variant that gives the best overall outcome for the environment, which may include a deviation from the priority order of waste management for a certain waste stream if this is justified by the results of the life cycle analysis of the overall effects of the generation and management of that type of waste and
- general principles of environmental protection, precaution, sustainability, technological feasibility and economic viability, resource protection, and overall effects on the environment, human health, economy and society must be taken into account.

Waste materials should be handled in such a way as to avoid:

- danger to human health
- the risk of pollution of the sea, water, soil and air, as well as endangering biological diversity
- discomfort due to noise and unpleasant smells
- danger to flora and fauna
- uncontrolled disposal and burning
- explosion or fire
- the appearance and reproduction of harmful animals and plants and the development of pathogenic microorganisms

All employees during the drilling of geothermal wells are obliged to handle waste materials with extreme caution, and to protect people's health and contribute to the protection of the environment. The owner of the waste is obliged to categorize the waste in his possession so as to determine the origin and place of origin of the waste, the group, the subgroup and the key number of the waste and the properties of the waste in accordance with the Waste Catalog.

The mention of a specific substance or object in the Waste Catalog does not imply that this substance or object has the status of waste in all circumstances, but only a substance or object that meets the requirements of the definition of the term "waste" is considered waste (Article 4).

Waste that is not designated as hazardous waste in the Waste Catalog is considered hazardous waste if it is determined by testing that it has a hazardous property.

Waste can be:

- Non-hazardous waste
- Inert waste
- Hazardous waste

Non-hazardous waste is waste that does not possess any of the hazardous properties specified in the Waste Management Act.

Inert waste is waste that is not subject to significant physical, chemical or biological changes. Inert waste is not soluble, not flammable, does not react physically or chemically in any other way, and is not biodegradable. With the substances it comes into contact with, it does not act in a way that would affect the health of people, animal and plant life or increase permitted emissions into the environment. The water solubility, the content of pollutants in the aqueous extract and the ecotoxicity of the aqueous extract (eluate) of inert waste must be negligible and must not endanger the quality of surface or underground water in any of the prescribed parameters.

Hazardous waste is waste that possesses one or more dangerous properties, i.e. contains substances that have one of these properties: explosiveness, reactivity, flammability, corrosiveness, harmfulness, toxicity, infectivity, carcinogenicity, mutagenicity, teratogenicity, ecotoxicity and the property of releasing toxic gases through chemical reaction or biological decomposition.

The amount of waste that is considered insignificant in the waste trade is the amount of one or more apparently related shipments of waste that is considered not to be able to permanently or to a significant extent endanger the quality of the air, soil, subsoil, water or sea, or to a significant extent or in a wider area endanger animals, plants or fungi, or endanger the life or health of people. The amount of waste that is considered insignificant is up to 1,000 kg of hazardous waste or up to 10,000 kg of non-hazardous waste.

In dealing with waste at each location of geothermal wells, the contractor appears as:

- producer of waste materials (performs the activities within which they are generated)
- temporary waste collector (collects or temporarily stores)

Municipal waste is collected in containers located in a certain area (next to the container for employees). Recyclable waste is collected and disposed of separately from municipal waste. Hazardous waste is collected separately and taken away by an authorized company.

Secondary raw materials are waste substances that can be recycled or reused in their original state or after additional processing (special categories of waste). Recycling means the use of waste material in the same process in which it was created. Reuse means the use of waste material in any process where its valuable properties can be used.

Unfortunately, a significant reduction in the amount of waste generated during drilling and exploitation of geothermal waters is not possible. The largest part of the volume of waste is muds and waste from drilling. The volume of waste mud and debris depends primarily on the depth and number of drilled wells. For this type of waste, it is first necessary to create a general characterization of the waste, and depending on the test result, this type of waste is taken over by an authorized collector or it is possible to declare it as a by-product and then sell it on the market.

The waste generated in the process of drilling and exploitation includes many substances that can be used multiple times. These are: acids, amines, antifreeze, batteries, catalysts, alkalis, coolants, gases, glycols, metals, oils, plastics, solvents, water, paraffin, etc. Water has the greatest possibility of reuse (e.g. water from leach pits and from mud, cooling water, layer water).

By installing appropriate equipment (eg a closed system) the reuse of materials is encouraged and facilitated. Some types of waste can be used at another location (eg reconditioned mud), for some other purposes (waste mud, dereacted acids) or simply returned to the vendor (chemical bottles) for refilling.

Some types of waste material can be used as raw material for own production, in which case they do not represent waste but are reported as a by-product. In some cases, only part of the considered waste contains valuable substances that can be recovered and reused, thereby reducing the net volume of waste. Sand and debris can be washed and used in the cement and brick industry and in the construction of roads and other structures.

Hazardous waste is collected and disposed of in a safe and environmentally friendly way until it is handed over to an authorized collector.

Temporary disposal on the surface: Disposal of waste at the place of origin, in lagoons (pits), is the most common method of disposal of waste mud on land. After the liquid phase is purified and allowed to evaporate, all material is disposed of in the lagoon. Rainfall also reaches the pit, which in normal amounts the pit can accept. In order to prevent the flow of hazardous materials from the pit, it is necessary to take measures to protect the pit, i.e. build it in accordance with the rules that apply to waste disposal sites, in a way that completely prevents the flow of the liquid phase of the waste fluid into the surrounding terrain or underground water. The pit embankments and the bottom should be constructed in such a way as to ensure the stability and impermeability of the pit during the drilling process and after it, until the pit is closed and rehabilitated. When the need to use the cesspit ends or when the situation arises that the central waste pit can no longer receive new quantities of waste, rehabilitation and closing of the pit (lagoon) is started. The technological procedure of remediation of waste from the pit takes place in two phases, namely:

- separation of the liquid phase and permanent disposal underground (the printing of the technological fluid is done in pressure wells that are approved and registered for this purpose),
- mixing the remaining contents of the pit with CaO – solidification – permanent disposal of the solidified material in the pit – covering the solidified with earth.

During drilling on land, debris that is separated from the mud by surface devices (vibrating screens, hydrocyclones, mud cleaners, centrifuges) is deposited in a mud pit (lagoon) located next to the drilling rig. The volume of the leach pit depends on the type of plant, that is, the drilling depth and other technological parameters. Part of the condensed phase can be mixed with lime and solidified. After characterization of the waste, the solidified material (solidified) can be taken to a non-hazardous waste disposal site.

During the exploration and exploitation of geothermal waters at certain locations, relatively small amounts of non-hazardous waste will be generated, which will not represent an additional burden on the existing waste management system. As a rule, the largest amount of waste is inert waste (construction waste), which, in accordance with the Waste Management Act, must be recycled or declared a by-product, so that it will not end up in a landfill. Hazardous waste is collected and temporarily stored at the place of origin in special containers. Considering the very small annual amount, it does not represent a potentially negative impact on the environment. Hazardous waste is handed over to an authorized collector. Possible causes of extraordinary pollution are also evaluated, namely natural disasters of greater intensity (very strong and long-lasting precipitation, fire, earthquake), which can cause leakage of waste materials, and in the event of unprofessional and careless handling of waste and fuel, waste and fuel spillage on traffic-manipulative surfaces may occur; vehicle accidents within the circle of the investigation area.

1.4 Impact in case of uncontrolled events

Uncontrolled events are most often caused by natural disasters (storms, drought, hail, floods, earthquakes) or human carelessness (fires, spills of industrial wastewater and industrial chemicals, fuel spills in the case of traffic accidents, oil spills in the case of drilling accidents, etc.) , and they have in common the endangering of human lives, plant and animal life, and the environment.

Accidental situations that can be expected during the production of an exploratory well are events where the uncontrolled flow of gas, oil or other well fluids from the well (or measuring separator) can reach the environment. The probability of such an event is low due to primary and secondary well pressure control.

The flow of gas into the well channel is prevented by the application of mud of appropriate density, whose column achieves a pressure higher than the formation pressure. However, if an uncontrolled event does occur, it is not expected to have an impact outside the borehole working area, nor are permanent environmental consequences expected. For excessive amounts of gas from the main collector of separated gas, two horizontal flares will be installed on which the possibly obtained amounts of gas are burned. The sources of fire can also be fuel, oil and lubricant for machines, as well as faults in electrical installations. All such impacts are considered negligible, because they are already taken into account in the project planning phase, and incorporated into the oil-mining project.

A negative impact on water can occur in case of spillage of oil derivatives, technical oils and grease from machines and vehicles. This possibility of pollution is difficult to completely avoid, but it can be reduced to a large extent by regular maintenance of the machines, changing and topping up oil and fuel at the designated places. In case of accidental release of oil derivatives, technical oils and greases from machines and vehicles, means for absorbing oil derivatives (dry cleaning) will be provided. The contaminated part of the soil will be removed and stored separately in the prescribed manner until it is handed over to the authorized legal entity.

Natural and induced earthquakes can increase the risk of accidental situations. Induced seismicity is a consequence of the direct influence of oil and gas exploitation on the disruption of natural seismicity. Production facilities and wells can be damaged not only by local and nearby earthquakes, but also by strong earthquakes hundreds of kilometers away. Therefore, during design and construction, it is necessary to take into account the design seismic forces in accordance with the earthquake hazard and national anti-seismic norms. In addition, in the chapter on environmental protection measures (Chap9), in the component of geological features and geodiversity, a measure is prescribed to reduce the negative impact of induced seismicity.

The impact in case of uncontrolled events is also analyzed in the individual impact assessment for environmental components (Chapter7.2).

1.5 Cross-border influence

The activities provided for in the Plan do not have a significantly negative cross-border impact. An exception is the potential contamination of surface and underground water in the event of accidents. Since the borders of the Mura, Drava, Danube, Sava, etc. border rivers form the almost complete border of the Plan with neighboring countries, and taking into account the prescribed measure of the necessary distance of 250 m from water bodies when carrying out activities, the possibility of a negative cross-border impact is significantly reduced. Also, this Study prescribes other adequate environmental protection measures that reduce negative impacts on components/factors in the environment. Furthermore, given that the increase in emissions of floating particles is expected as a minor side effect of mechanization during exploratory drilling, it is not expected that this increase would have a negative effect on air quality in neighboring countries.

1.6 Cumulative and synergistic impact assessment

Air

Cumulative impact is associated with the expectation of a permanent, cumulative increase in the emissions of polluting substances generated in the production process. It is possible to monitor these emissions and gradually reduce them with technical and technological measures. A synergistic impact that would create new impacts with regard to changes in air quality is not expected.

Climate and climate change

Cumulative impact is associated with the expectation of a permanent, cumulative increase in greenhouse gas emissions generated in the production process. It is possible to monitor these emissions and gradually reduce them with technical and technological measures. Also, emission levels are prescribed by national quotas and must be within the allowed quotas. In this way, the total cumulative impact is controlled and kept within the agreed values. A synergistic impact that would create new impacts with regard to changes in climate indicators is not expected.

Geological features and geodiversity

Cumulative impacts on elements of geodiversity are expected if there are accidental situations and excessive exploitation of geothermal water without injecting it back into the deposit, as a result of which there may be negative impacts in the form of physical damage, pollution, loss of access or interruption of natural processes of individual elements of geodiversity. The impact will be more significant if prescribed measures are neglected in the area where we find the karst relief. A negative impact is expected if EGS technologies will be applied by injecting large amounts of water into hot dry rocks.

Soil and agricultural land

Cumulative impacts on soil and agricultural land are manifested in the concentrated occupation and degradation of soil and the loss of its ecological functions in a certain area if research and exploitation activities are located at a small spatial distance. In addition, cumulative impacts can be expected in the event that other existing or planned interventions are located in the nearby area, which needs to be determined in the further stages of development of separate projects, given that its spatial component is not known in the strategic phase of the Plan.

Water

Given that impacts in the phase of exploration and exploitation of geothermal waters are largely negligible, except in the case of accidental situations and non-compliance with prescribed measures, no significant cumulative impacts on surface and underground waters are expected. However, they are possible due to the exploitation of geothermal waters from several wells located at a small spatial distance from each other, when due to increased pumping of water from the same aquifer, there may be a potential disturbance in the underground water supplies, i.e. a violation of their quantitative state.

Biodiversity and protected areas of nature

The implementation of Plan activities during the research phase and the exploitation phase may have a cumulative impact on the biodiversity and characteristics of protected areas through habitat loss, degradation and fragmentation, which indirectly affects the flora and fauna present, especially if the activities are concentrated in a smaller area. The impact characteristics depend on a number of factors. If the mentioned activities include the occupation of rare and endangered habitats or are located next to the location of a significant diversity of fauna, the risk of cumulative suffering of species increases. In addition to the cumulative impacts caused by the implementation of the Plan itself, cumulative impacts can also be expected if other existing or planned interventions are located in the immediate vicinity and generate the same or similar impact, which needs to be determined in the further stages of the development of geothermal water research and exploitation projects, considering that its spatial component is not known in the strategic phase of the Plan. Also, the individual activities of the Plan together with the existing and planned interventions may lead to a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes due to which the specific habitats, fauna and flora of the area in question have developed. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on biodiversity and protected nature areas are expected at the strategic level. the individual activities of the Plan together with the existing and planned interventions may lead to a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes due to which the specific habitats, fauna and flora of the area in question have developed. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on biodiversity and protected nature areas are expected at the strategic level. the individual activities of the Plan together with the existing and planned interventions may lead to a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes due to which the specific habitats, fauna and flora of the area in question have developed. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on biodiversity and protected nature areas are expected at the strategic level.

Forests and forestry

During the research phase and the exploitation phase, there may be a cumulative impact on the forest ecosystem through the loss and degradation of forests, i.e. the creation of new forest edges, especially if the activities of the Plan are concentrated in a smaller area and if they are protected forests, special purpose forests or valuable commercial forests. In addition to the cumulative impacts caused by the implementation of the Plan itself, cumulative impacts can also be expected if other existing or planned interventions are located in the nearby or the same forest area and generate the same or similar impact, which needs to be determined in the further stages of the development of geothermal water exploration and exploitation projects, considering that in the strategic phase of the Plan, its spatial component is not known. It is certainly necessary to take into account the felling prescribed by management programs in nearby forest stands with the aim of harmonizing the dynamics of forest vegetation removal, so as not to put too much pressure on the forest ecosystem through increased erosion processes or mass movement. Also, the individual activities of the Plan, together with existing and planned interventions, may have a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes in floodplain forests, which largely depend on the water regime of floodwaters and/or groundwater. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on forests and forest land are expected at the strategic level so as not to put too much pressure on the forest ecosystem due to increased erosion processes or the movement of masses. Also, the individual activities of the Plan, together with existing and planned interventions, may have a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes in floodplain forests, which largely depend on the water regime of floodwaters and/or groundwater. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on forests and forest land are expected at the strategic level so as not to put too much pressure on the forest ecosystem due to increased erosion processes or the movement of masses. Also, the individual activities of the Plan, together with existing and planned interventions, may have a cumulative impact of changing the hydrological regime of watercourses and disrupting natural processes in floodplain forests, which largely depend on the water regime of floodwaters and/or groundwater. Taking into account the protection measures prescribed by the Study, no significant cumulative impacts on forests and forest land are expected at the strategic level

Game and hunting

During the research phase and the exploitation phase, there may be a cumulative impact on game and hunting through the loss of productive hunting areas, potential damage to the credit ratings of productive hunting areas, and disruption of peace in the hunting grounds, especially if the activities of the Plan are concentrated in a smaller area of the hunting grounds. In addition to the cumulative impacts resulting from the implementation of the Plan itself, cumulative impacts can also be expected if other existing or planned interventions are located in the immediate vicinity and generate the same or similar impact, which needs to be determined in the further stages of the development of geothermal water exploration and exploitation projects, considering that its spatial component is not known in the strategic phase of the Plan. Taking into account the protection measures prescribed by the Study,

Landscape characteristics

In the research phase, by creating more exploratory boreholes with accompanying boreholes within a smaller spatial scope with accompanying borehole towers, a cumulative impact on the visual and experiential characteristics of the landscape is generated. By forming new spatial anthropogenic patches caused by BRP and geothermal power plants, and the accompanying infrastructure in the landscape, with radial linear elements (pipelines, roads) together with existing interventions that occupy the space, potentially generate a cumulative impact of fragmentation of the visual identity, integrity and morphology of the landscape.

Cultural and historical heritage

Spatial interventions, the future occurrence of which is implied by the proposed Plan, cumulatively with other interventions in the space, can potentially interact with all types of cultural and natural heritage and on the cultural and historical features of the space that are currently existing and recorded by the subject study, as well as those added to the records in the future. The cumulative impacts of the interventions in the space will potentially reflect on the authenticity, structurality, and visual dominance, as well as the significance of the captured cultural heritage. Therefore, in the future planning and designing of spatial interventions of the Plan in question, the cultural assets in question must be considered and elaborated in detail in the hierarchy of protective environmental documents, especially during the preparation of the Environmental Impact Study.

Population and human health

Geothermal energy is self-sustaining and the only basic renewable energy with the highest energy efficiency coefficient compared to other renewable energy sources, whose contribution is incorporated into the achievement of the goals of the Strategy and the transition to a low-carbon economy. Geothermal energy contains all the key elements of shaping the national green policy contained in the five dimensions of the energy union, namely: decarbonization, energy efficiency, energy security, internal energy market and research, innovation and competitiveness. The implementation of geothermal projects of wide application (electricity production and/or heating and greenhouse production) will contribute to strengthening the independence and energy independence of local and regional self-government units and will enable the sustainable development of society and the transition to low-carbon activity. The implementation of the mentioned activities from the Plan is expected to have a positive synergistic impact of raising the quality of life of the local population, and consequently a possible reduction of negative demographic trends.

8 A reasonable alternative

The study does not deal with a reasonable alternative, since the Plan, as a starting document that is the subject of analysis, does not go into the details of the exploitation of geothermal potential and treats all potential locations and methods of performance in the research and exploitation phases as equivalent.

9 Environmental protection measures

Environmental protection measures are proposed based on the analysis of the existing situation and the analysis of possible impacts on the components and factors in the environment as a result of the implementation of the Plan in question, and include measures to prevent and reduce the impact of the implementation of the Plan on the components of the environment and factors in the environment, which are prescribed to reduce potential negative impacts on the environment during the implementation of activities from the measures of the Plan. The prescribed measures are divided into two groups: measures in the research phase and measures in the exploitation phase, and they need to be adequately implemented in the content of the Plan.

Air

Research phase

- Burning of any kind of waste is prohibited during construction and drilling.
- The emission sources must be built, equipped, used and maintained so that they do not emit pollutants into the air above emission limit values (NOx, SO2, CO, PM10 and PM2.5), i.e. they do not emit/introduce pollutants into the air in quantities that they can endanger people's health, quality of life and the environment.
- Continuously maintain documentation on emissions into the air and monitor the amount of compounds emitted into the air on all stationary sources of emissions, at wells and incineration flares

Exploitation phase

- The emission sources must be built, equipped, used and maintained in such a way that they do not release pollutants into the air above emission limit values (NOx, SO2, CO, PM10 and PM2.5), i.e. they do not release/introduce pollutants into the air in quantities which can endanger people's health, quality of life and the environment.

Climate changes

Research phase

- Plan the planned infrastructure in accordance with recorded and predicted climate changes and apply appropriate adaptation measures, if necessary.

Exploitation phase

- At the level of individual operations (through the EIA or OPUO), conduct a vulnerability analysis according to the Technical Guidelines for the preparation of infrastructure for climate change in the period 2021-2027. in order to apply physical and non-physical solutions during construction, which significantly reduce the most important physical climate risks.
- Plan the planned infrastructure in accordance with recorded and predicted climate changes and apply appropriate adaptation measures, if necessary.

Geological features and geodiversity

Research phase

- Determine a protective zone at a distance of 250 m from valuable elements of geodiversity. The mentioned measure also applies to the Landscape Characteristics component
- If a speleological object is encountered during the research phase, the person performing the work is obliged to stop the work at the location of the discovery and to notify the Ministry in writing without delay.

Exploitation phase

- At the level of individual procedures (through PUO or OPUO), determine and define the indicator parameters of induced seismicity (e.g. magnitude of induced earthquakes, earthquake intensities, accelerations and/or speeds of soil erosion caused by induced earthquakes) and their limit values, and reduce and/or suspend production in in case the selected indicator parameters exceed the set thresholds. The mentioned measure also applies to the component Population and human health

- Avoid EGS (engl.*enhanced or engineered geothermal system*) technology of injecting large amounts of water into hot dry rocks.

Soil and agricultural land

Research phase

- Avoid using heavy machinery on wet soil, especially on soil with excessive moisture. When planning the route for 2D and 3D seismic work, take into account the soundness value of the soil (maximally avoid trampling on surfaces P1 and P2 of the spatial category of use), mechanical composition and water holding capacity of the soil."
- Use the mechanization that degrades the soil the least at the time when the soil is dried to a greater depth.
- Avoid trampling the soil under agricultural crops
- When carrying out earthworks, the humus layer should be adequately deposited in the designated place and, according to possibilities and in accordance with the regulations, after the work is completed, return it back as a surface layer during the rehabilitation of the terrain
- Activities should be planned in such a way that the existing infrastructure is used to the greatest extent possible. The mentioned measure also applies to the Landscape Characteristics component
- If the intervention is planned in an area of moderate and high risk of erosion, use agrotechnical mitigation measures, in accordance with valid legal acts. The mentioned measure also applies to the component Geological features and geodiversity.
- When locating the drilling rig and associated infrastructure (access roads), avoid P1 and P2 agricultural land, and give priority in conversion to use categories: P3 - other arable land and PŠ - other agricultural land. On the surface of the drilling rig, determine the natural state in the context of the type of soil, physical and chemical characteristics of the soil before the start of exploration, based on a pedological map on a scale of 1:5,000. Show the natural state of the soil based on a representative number of soil samples, and consolidate all of the above in the Elaborate on the initial state of the soil at the chosen location of the drilling facility.
- In the event of a negative finding of the exploratory well, prepare a study on the condition of the soil after the completion of the remediation procedure, which aims to check the quality of the works based on valid legal acts, based on a representative number of soil samples.

Exploitation phase

- Except in exceptional situations, the installation of infrastructure should be planned in such a way as to avoid occupation and fragmentation of the P1 and P2 categories of agricultural land use.
- After the stoppage of the operation of the exploitation well, prepare a study on the condition of the soil after the completion of the rehabilitation procedure, which aims to check the quality of the works based on a representative number of soil samples.

Water

Research phase

- During the investigation work process water must be collected on a waterproof surface and properly disposed of.
- Precipitation waste water from the manipulative surfaces of the well working area should be purified on an oil and grease separator before discharge.
- All dangerous and harmful substances and hazardous waste, which are temporarily stored on site, should be stored on isolated watertight surfaces (covered if possible) with a separate drainage and purification system. This measure also applies to the component Population and human health.
- For the reception of geothermal waters during the production testing of the well, construct watertight basins.
- The wells must be lined with protective pipes and cemented, that is, watertight, except in the area of the geothermal reservoir when a production liner is installed that has slots or perforations through which the geothermal water from the reservoir flows into the well.
- Working machines (units, compressors and others) for testing wells must be placed on a watertight surface.
- When determining the locations of wells and the location of geothermal power plants, take into account the necessary distance of 250 m from water bodies.
- Geothermal energy research and exploitation activities should not be planned in areas with a high probability of occurrence (return period of approximately 25 years) of floods, except in exceptional cases with respect for the

construction conditions issued by the competent authorities and with respect for adequate measures to mitigate the negative impacts of floods at the project level

- Drilling wells, construction of facilities and exploitation of geothermal energy should not be planned in the first sanitary protection zone of the source, and avoid planning in areas of underground water bodies with poor chemical and quantitative status.
- At the project level, adopt an Operational Plan for water protection, which will define the measures to be taken in case of accidental situations, with the aim of preventing the spread and removal of the resulting pollution.

Exploitation phase

- In order to receive geothermal water during overhaul and stoppages in the operation of the geothermal power plant, make watertight basins.
- The watertightness of all waste water drainage systems must be determined by testing before the technical inspection of the plant and periodically checked by testing the watertightness every 8 years.
- Whenever possible, the used geothermal water is pumped back into the geothermal reservoir. The mentioned measure also applies to the component Biodiversity and the component Protected Nature Areas.
- In case of discharge of geothermal water into a natural receiver, if necessary, ensure water quality below the permitted limit values of waste water emissions by chemical pretreatment. The mentioned measure also applies to the component Biodiversity and the component Protected Nature Areas.
- In case of discharge of geothermal water into a natural receiver, regularly conduct analyzes of the chemical state of the water body. The mentioned measure also applies to the component Biodiversity and the component Protected Nature Areas.

Biodiversity

Research phase

- Define a protective zone of influence of 250 m from watercourses in which the movement of heavy machinery is not allowed for the purposes of 2D and 3D seismic recording (except on existing roads) and exploratory drilling and the use of water from natural watercourses and lakes, with the aim of protecting strictly protected and/or endangered plant and animal species and rare and endangered habitat types related to water and wet habitats.
- Exploratory drilling should be moved 500 m away from habitat type H. Underground. The protection zone of 500 m does not only refer to the entrance position of the habitat type (cave or pit opening), but also to its underground distribution. Before carrying out the works, determine the position and direction of the cave channels. For recording 2D and 3D seismic, within a zone of 500 m, do not use explosives, that is, reduce the intensity of vibrations to a level that will not affect the change in habitat conditions in caves and pits
- Avoid rare and endangered habitat types and habitats suitable for endangered and/or strictly protected species during 2D and 3D seismic recording and exploratory drilling, i.e. make maximum use of existing infrastructure corridors and habitats of lesser natural value (e.g. ruderal habitats, habitats overgrown with invasive species, anthropogenic habitats, etc.).
- If necessary, install suitable protective elements to prevent the entry of fauna (smaller fauna, eg amphibians) into the collection pit for the collection of waste water, the pit for the reception of geothermal water during production testing of the well, the "sand-trap" and into the leach pit.
- In accordance with good practice, use techniques and equipment for dampening noise from geothermal facilities (eg temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, etc.).This measure also applies to the component Game and hunting and Population and human health.
- Control the noise level directly at its source and, if necessary, prescribe additional noise mitigation measures at the project level. This measure also applies to the component Game and hunting and Population and human health..

Exploitation phase

- Define a protective zone of influence of 250 m from watercourses in which the exploitation of geothermal water and the use of water from natural watercourses and lakes will not be carried out, with the aim of protecting strictly protected and/or endangered plant and animal species and rare and endangered habitat types related to water and wetlands habitats.

- Exploitation of geothermal water should be moved 500 m away from habitat type H. Underground. The protection zone of 500 m does not only refer to the entrance position of the habitat type (cave or pit opening), but also to its underground distribution. Before carrying out the works, determine the position and direction of the cave channels.
- Avoid rare and endangered habitat types and habitats suitable for endangered and/or strictly protected species during the exploitation of geothermal water, i.e. make maximum use of existing infrastructure corridors and habitats of lesser natural value (e.g. ruderal habitats, habitats overgrown with invasive species, anthropogenic habitats, etc.) .
- If necessary, install suitable protective elements to prevent the entry of fauna (smaller fauna, eg amphibians) into the collection pit for the collection of waste water, the pit for the reception of geothermal water during production testing of the well, the "sand-trap" and into the leach pit.
- At the design level, if necessary, provide protection against bird casualties on air condensers (eg, place a physical barrier on top of air condensers to prevent birds from landing on them). The planned electric power systems related to the implementation of the Plan should be carried out in such a way as to protect birds and bats from collision and electrocution in accordance with the latest scientific and professional guidelines, recommendations and special conditions for the protection of the environment and nature. For lightning purpose use ecological lights with a beam of light directed towards the ground and minimal scattering in other directions.
- In accordance with good practice, use techniques and equipment to dampen noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, geothermal power plants with internal noise-absorbing walls, etc.) .This measure also applies to the component Game and hunting and Population and human health.
- Control the noise level directly at its source and, if necessary, prescribe additional noise mitigation measures at the project level. This measure also applies to the components Game and hunting and Population and human health.

Protected areas of nature

Research phase

- For special reserves, park forests, monuments of park architecture and monuments of nature, limit the implementation of the Plan in such a way that exploratory drilling and recording of 2D and 3D seismic are not carried out within these areas. Within the categories regional park and significant landscape, exploratory drilling and recording of 2D and 3D seismic should be maximally limited outside of rare and endangered habitat types. This measure also applies to the component *Geological features and geodiversity*.
- When planning the activities of the Plan, i.e. at the intervention level,in the area of the nature park, exploratory wells are excluded from the areas where there are endangered and rare habitat types and habitats of endangered and rare and strictly protected species and, depending on the zoning of the nature park, exclude areas that are located in zones of strict protection and zones of active protection and all , or most of the activities, to be directed to the zones of use. This measure also applies to the component Geological features and geodiversity.

Exploitation phase

- For special reserves, park forests, monuments of park architecture and monuments of nature, limit the implementation of the Plan in such a way that geothermal water exploitation is not carried out within these areas. Within the categories of regional park and significant landscape, the exploitation of geothermal water should be maximally limited outside of rare and endangered habitat types. This measure also applies to the component *Geological features and geodiversity.*
- When planning the activities of the Plan, i.e. at the intervention level, in the area of the nature park, exploitation wells are excluded from areas where there are endangered and rare habitat types and habitats of endangered and rare and strictly protected species and, depending on the zoning of the nature park, exclude areas that are located in zones of strict protection and zones of active protection and all, or most of the activities, to be directed to the zones of use. This measure also applies to the component Geological features and geodiversity.

Forests and forestry

Research phase

- In the process of final determination of areas for the purpose of developing geothermal potential, valorize the areas of forests and forest land for the purpose of preserving the stability and biodiversity of the forest ecosystem in such a way that the forest ecosystems are not fragmented, that is, the integrity of the forest complex is not violated. In this sense, try to plan the selection and formation of the drilling area outside the forest areas (especially outside the forests of high growth form), or, otherwise, make maximum use of existing infrastructure corridors, marginal parts of forest areas or unvegetated forest land.
- To the greatest extent, avoid exploratory drilling and 2D and 3D seismic recording in the area of protective forests, otherwise, in the protective forest, carry out categorization of slopes with regard to stability, and for all slopes characterized as conditionally stable, conditionally unstable and unstable, avoid exploratory drilling and recording 2D and 3D seismics.
- Exploratory drilling and recording of 2D and 3D seismic should be avoided to the greatest extent in special-purpose forests, in the forest seed object category, and otherwise determine the reasons that, due to technical or economic conditions, the construction of a building outside the forest seed object cannot be planned, and exploratory drilling should be avoided to the greatest extent and recording of 2D and 3D seismic in the area of other special purpose forest categories, otherwise, make maximum use of existing infrastructure corridors, marginal parts of forest areas or unvegetated forest land.
- Define a protective zone of influence of 250 m from the watercourse, in the immediate vicinity of which flood forests are located, in which no exploratory drilling will be carried out and in which heavy machinery may not move for the purposes of 2D and 3D seismic recording, except on existing roads.
- At the project level, ensure a favorable water regime of surface and underground waters in floodplains through harmonizing exploratory drilling and 2D and 3D seismic recording with the conditions for preserving forest habitats, in consultation with the relevant forestry services.
- To rehabilitate the well working area on forest areas, use native species of trees and shrubs listed in the program or management basis for the section in question. The mentioned measure also applies to the Protected Nature Areas component
- Determine the felling of trees with the competent forestry service and coordinate it with the dynamics of construction, and inform them about the start of works on the construction of the project.
- To establish permanent cooperation with the competent forestry services in order to define the access roads to exploratory boreholes and the use of existing and planned forest infrastructure, with the aim of rational use of space and ensuring undisturbed management of forests.
- If the activities of the Plan are carried out on forests and forest land, it is necessary to establish permanent cooperation with the competent forestry services with the aim of protecting forests from fires and forest pests and diseases.
- Restore the used forest roads close to their original condition.
- During the arrangement of existing or construction of new access roads, the arrangement of the well working area and the drainage of surface (precipitation) water on manipulative surfaces, provide technical solutions for the prevention of erosion on forests and forest land.
- Forest land and forests outside the project scope are not allowed to be used for the temporary disposal of construction materials, as well as for the disposal of surplus materials and waste.
- Control invasive plant species in the drilling area. The mentioned measure also applies to the Biodiversity and Protected Nature Areas components.
- Before starting the research phase, obtain a confirmation from the competent service on the exclusion of the demined forest area and forest land from the mine-suspected area.

<u>Exploitation phase</u>

- In the process of final determination of areas for the purpose of developing geothermal potential, valorize the areas of forests and forest land for the purpose of preserving the stability and biodiversity of the forest ecosystem in such a way that the forest ecosystems are not fragmented, that is, the integrity of the forest complex is not violated. In this sense, try to plan the selection and formation of the drilling area outside the forest areas (especially outside the forests of high cultivation form), or, otherwise, make maximum use of the existing infrastructure corridors, marginal parts of the forest areas, or unvegetated forest land.
- To the greatest extent, avoid the exploitation of geothermal water in the area of protective forests, otherwise, in the protective forest, carry out the categorization of slopes with regard to stability, and for all slopes that are characterized as conditionally stable, conditionally unstable and unstable, avoid the exploitation of geothermal water.

- Exploitation of geothermal water should be avoided to the greatest extent in special-purpose forests in the forest seed object category, and otherwise determine the reasons that, due to technical or economic conditions, construction of buildings outside the forest seed object cannot be planned. Also, to the greatest extent, avoid the exploitation of geothermal water in the area of other categories of special purpose forests, otherwise, make maximum use of the existing infrastructure, marginal parts of forest areas or unvegetated forest land.
- Define a protective zone of influence of 250 m from the watercourse in which the exploitation of geothermal water will not be carried out, with the aim of protecting flooded forests.
- At the project level, ensure a favorable water regime of surface and underground waters in floodplains through harmonizing the exploitation of geothermal water with the conditions for the preservation of forest habitats, in consultation with the competent forestry services.
- To rehabilitate the well working area on forest areas, use native species of trees and shrubs listed in the program or management basis for the section in question.
- Determine the felling of trees with the competent forestry service and coordinate it with the dynamics of construction, and inform them about the start of works on the construction of the project.
- To establish permanent cooperation with the competent forestry services in order to define access roads to exploitation wells and the use of existing and planned forest infrastructure, with the aim of rational use of space and ensuring undisturbed management of forests.
- If the activities of the Plan are carried out on forests and forest land, establish permanent cooperation with the competent forestry services with the aim of protecting forests from fires and forest pests and diseases.
- Restore the used forest roads to their original condition.
- During the construction of geothermal wells, above-ground energy facilities and plants, and the construction of other surface infrastructure, provide technical solutions for the prevention of erosion on forests and forest land.
- Forest land and forests outside the project scope are not allowed to be used for the temporary disposal of construction materials, as well as for the disposal of surplus materials and waste.
- Carry out control of plant invasive species within the scope of the intervention. The mentioned measure also applies to the Biodiversity and Protected Nature Areas components.
- Before starting the exploitation phase, obtain a certificate from the competent serviceon the exclusion of demined areas of forests and forest land from mine-suspected areas.

Game and hunting

Research phase

- In consultation with the hunting authorities of the hunting grounds where the activities of the Plan will take place in the research phase, agree on the time of implementation of the activities provided for in the Plan that could disturb the peace during mating/nesting of wild game in areas important for the reproduction of certain species.
- In the process of final determination of areas for the purpose of developing geothermal potential, valorize hunting productive areas in such a way as not to reduce the quality of game habitats, i.e. to preserve complete forest areas and areas of forests and moors along rivers, sources that serve to feed game and a favorable water regime in in the case of water flow regulation.
- For the purpose of preserving the stability and biodiversity of the forest ecosystem, the areas of forests and forest land should be preserved in such a way that the forest ecosystems are not fragmented, that is, the integrity of the forest complex is not disturbed. In this sense, try to plan the selection and formation of the drilling area outside the forest areas (especially outside the forests of high cultivation form), or, otherwise, make maximum use of the existing infrastructure corridors, marginal parts of the forest areas, or unvegetated forest land.

Exploitation phase

- In consultation with the hunting authorities of the hunting grounds where the activities of the Plan will take place in the exploitation phase, agree on the time of implementation of the activities provided for in the Plan that could disrupt the peace during mating/nesting of wild game in areas important for the reproduction of certain species.
- In the process of final determination of areas for the purpose of developing geothermal potential, valorize hunting productive areas in such a way as not to reduce the quality of game habitats, i.e. to preserve complete forest areas and areas of forests and moors along rivers, sources that serve to feed game and a favorable water regime in in the case of water flow regulation

Landscape characteristics

Research phase

- To the greatest extent possible, preserve existing vegetation, especially autochthonous species of trees and shrubs, especially in localities characterized by existing problems of lack of vegetation surface cover. This measure also applies to the components Biodiversity and Forests and forestry.
- On occasion defining the position of the spatial scopemeasures necessary to achieve the objectives of the plan, as well as the technology and angle of formation of exploration wells, to adapt them to the relief characteristics of the area in order to minimize the changes in terrain morphology.
- During the implementation of new spatial interventions that include investigative works, the existing traffic links with localities should be used as much as possible in order to avoid additional encroachment on the integrity of the landscape.
- If possible, future exploratory well work areas should be placed on existing localities of previously degraded and/or low value in terms of aesthetic and natural landscape quality.
- When defining future exploration and exploitation sites, avoid areas of landscape units based on natural, aesthetic and cultural values, as well as individual elements/factors that make a specific landscape recognizable. The above refers primarily to areas of valuable autochthonous vegetation, forest edges and valuable localities such as swamp landscapes.

Exploitation phase

- Visually fit future geothermal plants and infrastructure related to exploitation fields into the context of landsacpe through the implementation of landscaping and rehabilitation projects.
- If possible, future geothermal power plants should be located on existing sites that were previously degraded and/or of low value in terms of the aesthetic and natural quality of the landscape.

Cultural and historical heritage

Research phase

- Carry out a preliminary archaeological reconnaissance of the area within which the follow-up operations of the Plan in question will be planned, which include exploration and exploitation wells, as well as future facilities, traffic corridors and pipelines.
- As part of the hierarchically lower-ranked/more detailed environmental protection documents for the future defined localities of the intervention areas, conduct an analysis of the spatial, structural and visual integrity of spatially relevant cultural assets.
- For all forms of activity that include potential works in the immediate and indirect vicinity or on the cultural assets themselves, consult and obtain the opinion of the competent Conservation Department.
- If an archaeological site is encountered during construction or any other works carried out on the surface or under the surface of the ground, the works must be stopped and the central state authority responsible for cultural heritage protection, i.e. the competent Conservation Department, must be notified without delay.

Exploitation phase

- Exploitation/well work spaces, accompanying infrastructure and areas of operation of geothermal power plants, as well as other facilities related to the use of geothermal water, should be located at the greatest possible distance from registered cultural assets.

Population and human health

Research phase

- Move interventions as far as possible from the boundaries of construction areas or residential zones, with the exception of the use of geothermal energy for heating residential and commercial buildings.
- Protect the local population from the harmful effects of noise by regularly measuring the noise level.
- Inform the public about the benefits of geothermal energy and safety during exploitation compared to conventional energy sources.

Exploitation phase

- Protect the local population from the harmful effects of noise by regularly measuring the noise level

- In the process of final determination of areas for the purpose of developing geothermal potential, valorize geothermal potential in terms of users and purpose (wood industry, health, tourism, etc.) and contribution to the transition to clean energy. Ensure the involvement of all stakeholders in the process through research and data collection in the subject area and the development of a common database (agriculture, tourism, health, wood industry and others) with an emphasis on different target groups, energy efficiency and initiatives for geothermal energy.

10 Environmental monitoring

Through the estimated impacts, the Study did not determine the need to establish monitoring of the state of the environment in the area covered by the Plan as a result of the strategic environmental impact assessment procedure.

11 The main assessment of the acceptability of the Plan for the ecological network

11.1 Introduction

The Ministry of Economy and Sustainable Development issued a Decision (CLASS: UP/I 612-07/21-37/243 URBRO: 517-10-2-3-21-2, Zagreb, September 3, 2021) on the obligation to conduct the Main Assessment Plan for the development of the geothermal potential of the Republic of Croatia until 2030 for the ecological network. A copy of the Solution can be found in the chapter**Error! Reference source not found.**. The main acceptability assessment for the ecological network w as made in accordance with the Law on Nature Protection (80/13, 15/18, 14/19, 127/19) and the Decree on the Ecological Network and the Competencies of Public Institutions for the Management of Ecological Network Areas (Official Gazette 80/19) . According to Article 26 of the Law on Nature Protection for strategies, plans and programs for which a strategic assessment is required, the main assessment is carried out within the framework of the strategic assessment of the impact of strategies, plans and programs on the environment (SEA) and, accordingly, the relevant The study contains a chapter Main assessment of acceptability for the ecological network (hereinafter: Main assessment).

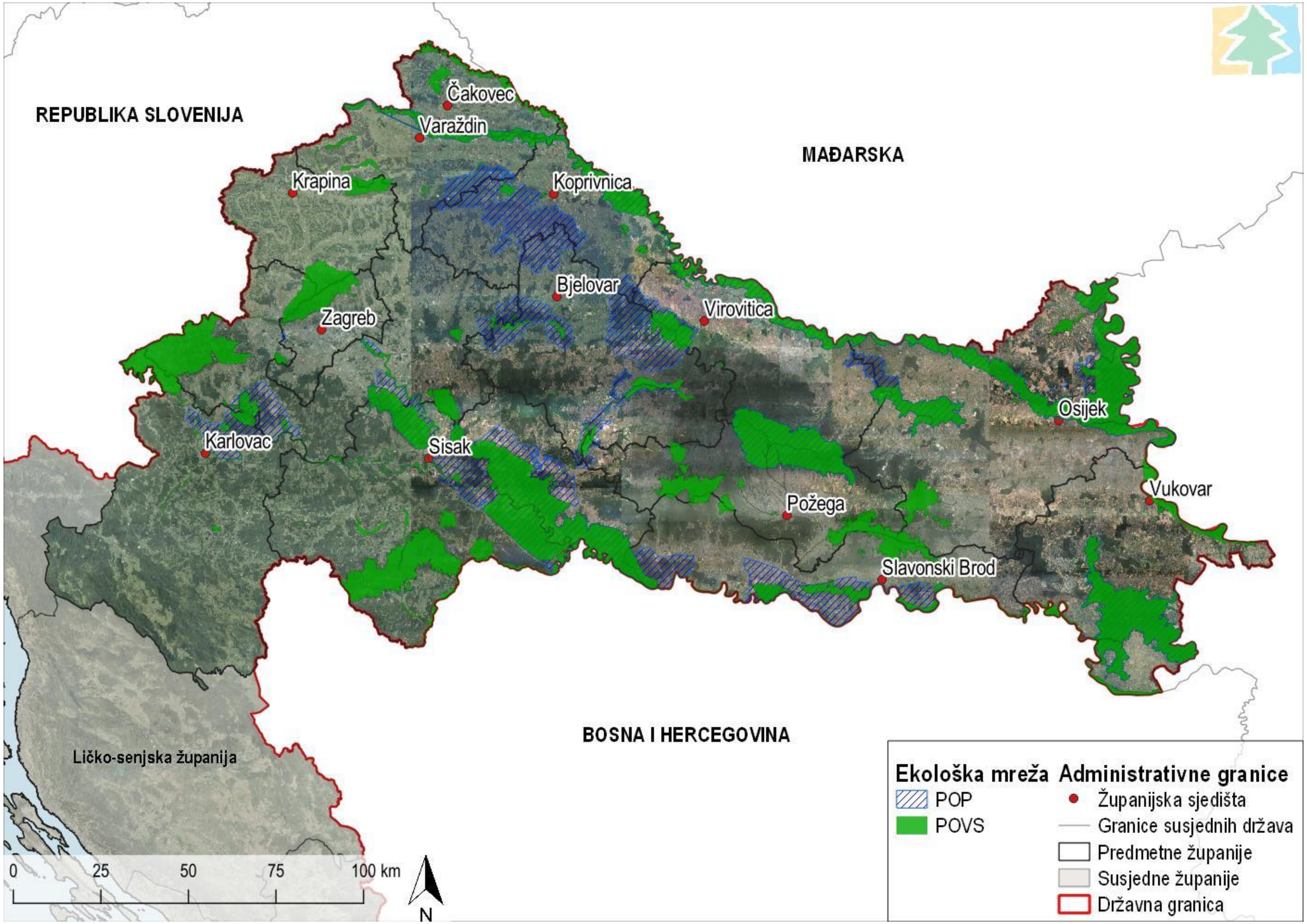
In the Main Assessment chapter, the Plan for the Development of the Geothermal Potential of the Republic of Croatia until 2030 (hereinafter referred to as the Plan) is analyzed.

The creator of the chapter The main assessment is the company IRES EKOLOGIJA doo with headquarters in Zagreb, Prilaz baruna Filipovića 21. A copy of the Decisions for carrying out professional work in the field of nature protection issued by the Ministry of Economy and Sustainable Development (formerly the Ministry of Environmental Protection and Energy) is in the Annex**Error! Reference source not found.**.

11.2 Description of the ecological network area

In the area covered by the Plan (the area planned for the exploration and exploitation of geothermal water) there are a total of 154 areas of the ecological network, of which 132 conservation areas are significant for species and habitat types (POVS), 5 probable conservation areas are significant for species and habitats types (vPOVS), 1 special conservation area important for species and habitat types (PPOVS) and 16 internationally important conservation areas important for birds (POP). Out of the total number of covered ecological network areas, 2 POVS areas are not fully covered by the plan (HR2000593 Mrežnica – Tounjčica and HR2001505 Korana downstream from Slunj). A quarter of the area covered by the Plan with 744,229 ha is under the ecological network.

The spatial distribution of these areas is shown in the following figure (Picture11.1), and all areas of the ecological network that are included in the Plan and that are the subject of this Main Assessment are attached**Error! Reference source not f ound.**. More detailed information on the areas of the ecological network can be found on the pages of the Nature Protection Information System (https://www.bioportal.hr/) and in the Regulation on the ecological network and the competences of public institutions for the management of ecological network areas.



Picture11.1Areas of the ecological network covered by the Plan

11.3 Characteristics of the impact of the Plan on the areas of the ecological network

11.3.1 Impact assessment methodology

The main evaluation analyzed the activities of the Plan in the areas of the ecological network. Considering that the activities of the Plan do not have a spatial component, the Main Evaluation was not able to precisely determine the intensity of the impact on the subject areas of the ecological network, but the description of the activities clearly shows that their implementation will very likely have an impact in space. Due to the lack of spatially defined data, the possible impacts of the implementation of the Plan on the ecological network cannot be factually assessed, therefore the key risks related to possible impacts on the ecological network have been highlighted, and refer to:

- ecological network areas smaller than 5000 ha,
- target habitats and habitats of target species which, according to the relevant databases, have less than 1000 ha (within the area of the ecological network larger than 5000 ha),
- underground habitats (caves and pits),
- water and wet habitats.

For the purpose of displaying the intensity of the impact, a standard scale was used, in accordance with the Guidelines for Evaluating the Acceptability of the Ecological Network for the Strategic Environmental Impact Assessment (SEA) (Table11.1).

Table11.1The applied scale for assessing the intensity of the impact of the implementation of the Plan (Source: Annex 1. Guidelines for the assessment of acceptability for the ecological network, 2014)

Value	Term	Description
-2	Probability of significant negative impact	**Significant negative impact** **It excludes the implementation of SPP** Significant disturbance or destructive impact on the habitat or population of species or a significant part of them, significant disturbance of the ecological requirements of the habitat or species, significant impact on the habitat or natural development of species. These impacts must be reduced by mitigation measures below the level of significance, and if this is not possible, the element with a rating of -2 must be removed from the SPP.
-1	Likelihood of moderate negative impact	Limited/moderate/negligible negative impact **Implementation**SPP is not excluded. Moderate problematic impact on the habitat or population of species, moderate disturbance of the ecological conditions necessary for the preservation of the habitat or species, marginal impact on the habitat or natural development of the species. It is possible to mitigate or eliminate it with appropriate mitigating measures, but their prescription is not mandatory related to the main assessment.
0	Probably no impact	SPP shows no visible impacts.
+1	Likelihood of moderate positive impact	Moderate beneficial impact on the habitat or species population, moderate improvement of the ecological requirements of the habitat or species, moderate beneficial impact on the habitat or natural development of the species.
+2	Likelihood of significant positive impact	Significant beneficial impact on the habitat or species population, significant improvement of the ecological requirements of the habitat or species, significant beneficial impact on the habitat or natural development of the species.

11.4 Description of the impact of the Plan on the ecological network

11.4.1 Possible individual impacts

Research phase

Loss and fragmentation of target habitats and habitats of target species

The geothermal potential research phase includes 2D and 3D seismic recording, arrangement of existing / construction of new access roads and arrangement of the well work area to accommodate the drilling rig with associated equipment and construction facilities required for production testing (examination) of the exploratory geothermal well. The mentioned activities can be sources of negative impact on the conservation goals of the ecological network, primarily through temporary or permanent loss (conversion), degradation and fragmentation of target habitats and habitats of target species of the ecological network. According to the data from the Plan, the common basis of recording 2D and 3D seismic refers to the initiation of the wave at the source at the point of ignition, observation of the movement and reflection/reflection of the seismic wave from reflectors - geological elements in the underground, and its registration on the receiver - geophone. 2D seismic measurements are recorded along individual lines of longitudinal and transverse profiles, along which ignition points and geophones are located that register the arrival of the seismic wave. 3D seismic measurements represent a more sophisticated type of measurement that refers to the creation and recording of a 3D network of lines of transverse and longitudinal profiles, and the wave source is induced from each point of ignition or vibration, when a vibrator is used as a wave energy source. The method provides multiple coverage and a clearer, high-resolution 3D image, that is, the volume of the geological subsoil. According to Gaurina-Međimurec (2022), the drilling rig is installed at the location of the new well according to the typical arrangement that is in accordance with the verified project for the construction of the well and the project for the construction of the exploratory well. On the well working area, which is made of rock material embankment, the construction facilities necessary for the technological process of making and testing the well are being installed. These are: well mouth (reinforced concrete open basin), tower substructure foundation, foundations of the drilling rig, "sand-trap" (an open buried reinforced concrete tank with a volume of about 70 m3), container accommodation, temporary disposal site for overburdened material (leaching pit), space for housing fuel tanks, two well test pits (flares), two piezometers, a collection pit with a volume of 5 m3, a place to dispose of humus and soil and a pit (lagoon) for receiving geothermal water. The dimensions of the well working area depend on the selected drilling rig and the depth of the wells and, for example, for the National-402 drilling rig, which is intended for drilling wells up to 4000 m deep, is 15,000 m2 (for dimensions of the well working area of 100 x 150 m), while drilling facilities for the creation of shallower geothermal wells (for the production of thermal energy and for agricultural purposes) require a smaller area of the well working area. In the area where the entire drilling rig is installed (the foundations of the drilling rig), reinforced concrete slabs are placed, stacked next to each other on a base of prescribed compaction, and a drainage system made of concrete channels is constructed between the slabs, which ends in a reinforced concrete pool - "sand". trap".

The temporary conversion of the habitat will occur in case of negative test results of the exploratory well when no geothermal water deposit has been determined, therefore such a well is abandoned (liquidated) in accordance with legal regulations, and the occupied well working area is rehabilitated and restored to a state close to its original state. With the construction of new access roads and in the case of a positive result of testing the geothermal reservoir and bringing it into exploitation, there will be a permanent conversion of the habitat. During the preparation of the well working area for the creation of an exploratory well, around 1.5 hectares of mainly agricultural or forest land is temporarily repurposed, while in the case of positive results and production, this area is reduced to a size of 50 mx 80 m (0.4 ha), and the remaining the surface is being rehabilitated.Table11.2), considering that due to their relatively small area, any encroachment into that area can result in significant losses of target habitats and habitats of target species and target habitats and habitats of target species in ecological network areas larger than 5000 ha, which in accordance with conservation goals or other relevant bases data (SDF, Map of non-forest habitats (2016), Corine land Cover (2018), i.e. if the conservation goal does not exist) has less than 1000 ha, and can potentially be influenced by the Plan's planned activities (Table11.3,**Error! Reference source not found.**,Table11.4). At the same time, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are especially threatened.

Changes in habitats caused by fragmentation and temporary or permanent conversion of habitats during the installation of research facilities and the construction of access roads have a negative effect on the species that inhabit them. The edge effect, as the main negative impact of fragmentation, changes habitat conditions (temperature, wind, lighting, changes in the composition of vegetation, etc.), which can lead to the avoidance of such a habitat by the species that inhabited it until then. Also, habitat fragmentation leads to the separation of species, i.e. the loss of genetic diversity (Hein, 2012). The negative impact of habitat degradation can also occur on the route of movement of heavy machinery (vibrators) for the purposes of 2D and 3D seismic recording and land clearing for the purposes of arranging the well work area, the destruction of autochthonous plant communities in that area and the spread of invasive species. Construction machinery can spread invasive flora by transporting plant parts (vegetative and generative parts) with wheels and other vehicle parts over potentially long distances and new habitats that invasive flora can occupy.

Harassment and suffering of target species

In the process of researching geothermal potential, there is an increased level of noise and vibration due to the operation of machines and the presence of people. The activities planned by the Plan related to seismic surveys and arrangement of the well work area for the accommodation of the drilling facility may have a negative impact on the species and habitat types in the immediate vicinity. Research activities will take place for the first 5 years, with the possibility of an extension of up to 1 year, and mainly include the acquisition of 2D and 3D seismic data and exploratory drilling, as well as numerous other analytical studies. The influence of the process of creating an exploratory well is up to two months for deep wells, and several weeks for shallow ones. During the investigation period in which activities such as seismic surveys are carried out, there is a possible negative impact on all animal species of the ecological network in the vicinity. The negative impact comes from noise and vibrations that are created due to the operation of machines (vibrators, etc.) that are used to perform seismic surveys. The periods of animal migration, reproduction and nesting are particularly sensitive to this influence. Underground habitats and species are extremely sensitive to surface and underground changes caused by natural and anthropogenic factors. Although there is no exact information on the places where the planned operations will be carried out, it is to be expected that the impact on caves and cave fauna would be significantly negative if seismic tests and exploratory drilling were carried out in the immediate vicinity of such facilities. In addition to being vulnerable to the destruction of their habitats, bats are also vulnerable to disturbance while they reside in them (Armstrong, 2010). Noise represents a potentially negative impact on bats, especially in the period of searching for food and finding shelter for hibernation and for maternity colonies. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a negative impact on other animal species that live in other habitats. The impact can be reduced by performing 2D and 3D seismic recording and vegetation removal outside the reproductive period of the target species of birds and bats, and according Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a negative impact on other animal species that live in other habitats. The impact can be reduced by performing 2D and 3D seismic recording and vegetation removal outside the reproductive period of the target species of birds and bats, and according Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds, which can lead to the abandonment of suitable nesting habitats and a reduction in the number of breeding pairs. Also, conducting seismic surveys and exploratory drilling in the immediate vicinity can have a negative impact on other animal species that live in other habitats. The impact can be reduced by performing 2D and 3D seismic recording and vegetation removal outside the reproductive period of the target species of birds and bats, and accordingKagel et al. (2005) and GEL (2022) using techniques and equipment for dampening noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, etc.), level control noise directly at its source and prescribing additional mitigation measures in case of need.

Continuous drilling involves the use of powerful lamps to illuminate the work site at night (Gaurina-Međimurec, 2022), which may disturb the target species of the ecological network area. The most endangered groups of animal species are those that are active at night, such as bats, some types of birds (eg owls), saproxylic beetles (eg deer) and the like.

The movement of vehicles (vibrators, etc.) during seismic recording, as well as the movement of machinery during land clearing for the purposes of arranging the well work area and during the construction and use of new access roads, may cause harm to animal species (especially individuals with reduced mobility) that live in that area, including target species. Also, the suffering of the target and other animal species is possible if they enter the temporary disposal site for the excavated material (flood pit), "sand trap", pit for receiving geothermal water and collection pit. Although the mentioned facilities are mostly fenced, smaller animals can potentially enter them, depending on the type of fence.

Pollution and change of water regime

During seismic recording, construction of the drilling platform, arrangement of existing / construction of new access roads, there may be emissions of fine particles (dust) and exhaust gases due to the combustion of diesel fuel in work machines and vehicles and in the diesel engines of the drilling rig. As these actions are performed only during seismic recording, construction of plateaus and access roads, the impact resulting from them will be short-term and negligible. In a geothermal water reservoir, at high pressure and temperature, there may be dissolved gases in the water to a certain extent, for example carbon dioxide (CO2) and hydrogen sulfide (H2S). The concentration of dissolved gases varies from reservoir to reservoir. Geothermal water that is exploited from the underground reservoir during well testing must be temporarily stored in a watertight pit (lagoon) for the reception of geothermal water, where the dissolved gases from the geothermal water are released into the air. The testing (testing) of the well is very limited in time, therefore the possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant impact and is considered short-term and negligible. therefore, eventual emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant impact and is considered short-term and negligible. therefore, eventual emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative. During the testing of the well, noxious gases are emitted due to the burning of gas on two torches. The amount and composition of harmful gases released at the flare, and thus the impact on the air, are directly related to the composition of the gas entering the flare. Considering the limited time of the well test, gas burning at the flare does not represent a significant impact and is considered short-term and negligible.

Water and soil pollution can occur as a result of liquid substances (propellant fuels, motor oils) being spilled during seismic surveys, construction works during the arrangement of the well work area and accompanying facilities, the arrangement of existing / construction of new access roads, as well as due to the spilling of waste water on the surface of the well work area. space; due to the migration of geothermal fluids towards the surface; due to the absence of a drainage system for surface (rain) water on manipulative surfaces; the absence of an adequate solution for sanitary waste water generated on the construction site; incorrect handling and storage of petroleum products, oils and lubricants or storage in inappropriate containers; filling transport means and work machines with fuel; increased amounts of construction, communal and hazardous waste, the washing of which can contaminate underground water; breakdown of construction machines and tools used; intentional or accidental release or disposal of excess hazardous construction materials and chemicals into waterways. All the water that spills over the well working area during drilling is collected in a reinforced concrete basin for the separation of rock fragments (solid particles) from the mud by a system of drainage concrete channels, and is drained from it to a temporary landfill for the drilled material, i.e. a mud pit. Geothermal water obtained during hydrodynamic testing of the well is accepted in a pit (lagoon) for receiving geothermal water. During the performance of mining works in the borehole working area, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain (Gaurina-Međimurec, 2022).

For the preparation of mud and cement slurry for cementing the columns of protective pipes and for sanitary purposes, technological water is used, which is delivered by the vehicles of the fire department and is accepted in reservoirs that are an integral part of the equipment at the drilling plant. However, in some cases, water requirements can be met by using surface water, which can affect the change in the water regime of surface waters, and thus lead to a negative impact on the habitat conditions of aquatic habitats. Excessive extraction of water from natural watercourses and lakes can lead to disruption of the natural hydrological regime and, consequently, to disruption of the habitat conditions of target species and habitats (target habitats and habitats suitable for target species) related to aquatic ecosystems. By pumping water, surface and underground water regimes change, which is a consequence of the redistribution of part of the water balance. The lowering of the level of surface and underground water in the area of the intervention can be reflected in the species that inhabit watercourses and lakes in the form of a change in the conditions in the habitats, which would be reflected in the lowering of the water level in the lakes and in the bed of the watercourse downstream of the planned interventions, the consequent reduction of the flow, the drying of the surrounding wet and aquatic habitats. Suffering of target species of fauna is possible due to potential occasional drying caused by changes in groundwater level and hydrological regime and during the use of catchment structures. The suction power will potentially cause the death of aquatic organisms, for example, fish fry of target species.

Various types of non-hazardous and hazardous waste are generated during the arrangement of the well working area and the construction of the well, which are handled in accordance with legal regulations, therefore no significant impact of waste management during the research phase on the conservation goals of the ecological network area is expected.

Exploitation phase

Loss and fragmentation of target habitats and habitats of target species

The exploitation phase, depending on the intended use of energy, includes the creation of geothermal wells (exploitation, one of which is exploitation-pressurization), the construction of above-ground energy facilities and plants, and the creation of the necessary surface infrastructure. After the creation of the exploratory well and the positive outcome of the geothermal water reservoir test, the well is equipped for exploitation and the well working space is reduced to the optimal size for the extraction of geothermal water (a plateau measuring 50 m x 80 m, while the remaining part of the well working space is rehabilitated) which leads to a permanent repurposing and fragmentation of about 0.4 hectares of vegetation. The operating period can last a maximum of 25 years with the possibility of extension. The technology of producing an exploration well is no different from the production of an exploratory well. If the research is successful and the exploratory wells cannot be used as production or injection wells, additional wells are drilled for the exploitation of geothermal waters. The duration of the construction of a new well and its equipment for exploitation is estimated to last up to 60 days per well channel, depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the construction of the wells (Gaurina-Međimurec, 2022). As in the research phase, the most threatened areas of the ecological network are smaller than 5000 ha (depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the drilling of wells (Gaurina-Međimurec, 2022). As in the research phase, the most threatened areas of the ecological network are smaller than 5000 ha (depending on the depths of the targeted geothermal water deposits and the extent of technological tests during the drilling of wells (Gaurina-Međimurec, 2022). As in the research phase, the most threatened areas of the ecological network are smaller than 5000 ha (Table11.2), considering that due to their relatively small area, any encroachment into that area can result in significant losses of target habitats and habitats of target species and target habitats and habitats of target species in ecological network areas larger than 5000 ha, which in accordance with conservation goals or other relevant bases data (SDF, Map of non-forest habitats (2016), Corine land Cover (2018), i.e. if the conservation goal does not exist) has less than 1000 ha, and can potentially be influenced by the Plan's planned activities (Table11.3,**Error! Reference source not found.**,Table11.4). At the same time, due to the specificity of planning activities (drilling and vibrations), underground habitats (caves and pits) are especially threatened.

The negative impact of fragmentation will occur as a result of vehicle traffic on roads built for the purposes of exploration and exploitation of geothermal water, i.e. by interrupting the migration routes of individuals in that area. No significant impact of fragmentation is expected due to the construction of a plateau with an exploitation well, since the original well working area for setting up a drilling facility for testing the geothermal water reservoir in the exploitation phase is reduced to a plateau of around 0.4 ha. Also, due to the potential introduction of invasive species by construction machinery, there will be a negative impact on the autochthonous flora and fauna due to the spread of invasive species that could be better adapted to the changed habitat conditions.

Harassment and suffering of target species

In the process of creating a production/injection well or drilling additional wells for the purpose of exploitation, there is an increased level of noise and vibration due to the operation of machines and the presence of people, which can have a negative impact on species and habitat types in the immediate vicinity. In the process of exploiting geothermal energy, that is, during the drilling of wells and the construction of plants for converting geothermal energy into electricity, the noise level ranges from 45 to 120 dB and is not constant, and the noise level of a geothermal power plant during electricity production corresponds to most plants that use motorized plants (Pravica et al., 2006). The periods of animal migration, reproduction and nesting are particularly sensitive to this influence. Underground habitats and species are extremely sensitive to surface and underground changes caused by natural and anthropogenic factors, therefore it is to be expected that the impact on caves and cave fauna (including bats) would be significantly negative if the construction of a production/injection well or the drilling of additional wells were carried out in the immediate vicinity of such facilities. Under the influence of noise and vibration, there can be a significant negative impact by disturbing nesting colonies of birds and leaving suitable nesting habitats. Also, making a production/injection well or drilling additional wells in the immediate vicinity can have a negative impact on other animal species that live in other habitats. The impact can be reduced by using techniques and equipment for dampening noise from geothermal facilities (e.g.Kagel et al., 2005; GEL, 2022).

Drilling a production/injection well or additional wells for exploitation also involves the use of powerful lamps to illuminate the work site at night which may disturb the target species of the ecological network area as well as during the exploration phase. Also, the geothermal power plant will be illuminated during the exploitation of geothermal water, which can also have a moderately negative impact on animal species in its vicinity, especially bats, birds, saproxylic beetles, etc., which are active at night.

During the operation of the geothermal power plant, it is possible to induce earthquakes, especially with the application of EGS technology, where large amounts of water are injected under high pressure to deliberately create cracks in dry hot rocks, which can induce earthquakes up to magnitude M = 2.0 - 3.0 (Rybach, 2002; Gaurina-Međimurec, 2022). This would potentially have a moderate negative impact by disturbing the fauna of the area. At the same time, underground habitats and the species that live in them (especially bats), as well as the fauna of the wider area, are particularly sensitive. The impact can be avoided by giving preference to technologies that are not based on the fracturing of dry hot rocks, ie that will not cause local stress in the rocks that can cause earthquakes.

During the operation of the geothermal power plant, a potentially significant negative impact is possible due to the death of birds due to landing on air condensers and the death of birds and bats due to a collision with the infrastructure built for the needs of the geothermal power plant (power lines, etc.). As a result of vehicle traffic on newly built roads, the movement of machinery due to potential land clearing and the construction of additional roads for the exploitation of geothermal water, animal species that live in that area, including target species, may suffer. Also, the suffering of the target and other animal species is possible if they enter the temporary disposal site for the excavated material (flood pit), "sand trap", pit for receiving geothermal water and collection pit.

Pollution and change of water regime

During the construction of a production/injection well or the drilling of additional wells for the purpose of exploitation, the emission of fine particles (dust) and exhaust gases may occur due to the combustion of diesel fuel in work machines, vehicles and in the diesel engines of the drilling plant. As these actions are performed only during the production/injection well or the drilling of additional wells, the impact resulting from them will be short-term and negligible. During the operation of the geothermal power plant, there may be emissions of exhaust gases due to the combustion of diesel fuel in the diesel electric generator used in the event of an impossibility of electricity supply, but this is a short-term and negligible impact. Also, during the construction of a production/injection well or the drilling of additional wells, there may be emissions of gases dissolved in geothermal water, such as carbon dioxide (CO2) and hydrogen sulfide (H2S), which can occur in exceptional situations when geothermal water is temporarily stored in a watertight pool. Possible emissions of carbon dioxide and hydrogen sulfide will be short-term and moderately negative, but by following the rules of operation of the power plant, the impact can be reduced to a negligible level.

During the construction of a production/injection well or the drilling of additional wells, except in accidental situations, there is no outflow of polluted waste water into the surrounding terrain. In accidental situations, a significantly negative impact of pollution on target habitats and habitats of target species is possible, and water and wetland habitats are the most threatened. All possible negative impacts on surface and underground water during research can be avoided by proper organization of the construction site and compliance with construction regulations and conditions.

Land subsidence can sometimes be caused by the extraction of large amounts of geothermal water from geothermal deposits. Long-term pumping of geothermal water without re-pressing it into the reservoir leads to greater ground subsidence in some areas near the exploitation field, and less subsidence in a much wider area (Gaurina-Međimurec, 2022). Land subsidence can lead to submergence of pieces of land in nearby water bodies (William & Glassley, 2010; Gašparić, 2021) and to a change in the regime of water bodies connected to an underground reservoir from which a large amount of geothermal water was squeezed out, which would have a negative impact on species related to aquatic habitats. Since it is a phenomenon that is not frequent, by adhering to the usual practice of operating a geothermal power plant, i.e. re-injecting geothermal water back into the geothermal reservoir from which it was obtained after its heat has been used, from the beginning to the end of the operation of the geothermal power plant, this impact can be reduced to a negligible level. In the case of direct use of geothermal energy (for agricultural purposes, for heat production, etc.) accumulated in shallow reservoirs of geothermal water, the probability of land subsidence is small because it is a matter of shallow reservoirs and pumping of smaller amounts of geothermal water.

During the exploitation of geothermal waters, the cooled ("waste") geothermal water is not released into the environment, but is pumped back into the deposit, into injection wells. In this way, the thermal renewability of the geothermal water is ensured, the reservoir pressure is maintained, and the geothermal water is brought into mechanical and thermal equilibrium with the environment. The release of cooled geothermal water into the environment is foreseen only in cases of direct use of geothermal energy accumulated in shallow geothermal water reservoirs, which are fed by fresh surface water through naturally fractured fissure systems (Gaurina-Međimurec, 2022). In this case, it is geothermal water that is mainly usedfor the purpose of producing thermal energy, for agricultural purposes, etc. therefore, the amount of geothermal water required is also smaller. Therefore, if it is a shallow reservoir with a natural supply where there is no drop in reservoir pressure during pumping, and the quality of the extracted geothermal water meets the conditions prescribed by the Water Act (Official Gazette 66/19, 84/21), it is possible to discharge the cooled geothermal water into the natural receiver instead of returning it to the tray. Since these are shallow deposits, the temperature of geothermal water obtained from these deposits is lower than from deeper deposits (for example, the average temperature at a depth of 10 - 150 m is between 2 ºC and 21 ºC). In case of discharge of extracted geothermal water into a natural receiver, it is, if necessary, can be mixed with water from the water supply or technological water in order to achieve a quality that meets the legally prescribed criteria for discharge into surface watercourses according to the Rulebook on limit values of waste water emissions (Official Gazette 26/20). If the pre-treatment achieves water quality that meets the parameters prescribed by the Ordinance, the obtained geothermal water can be discharged into a natural receiver. If pre-treatment does not meet the conditions prescribed by the Ordinance, the obtained geothermal water must be pre-treated at the place of origin using certain physico-chemical methods, before being taken to final purification. Removal and disposal is performed by an authorized person (Gaurina-Međimurec, 2022). Considering the stated, no significant negative impact of the release of recovered cooled geothermal water that meets the parameters prescribed by the aforementioned Ordinance on the habitat conditions of the natural receiver is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water utilization on habitats, surface and underground water is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water utilization on habitats, surface and underground water is expected. In the case where it is a closed system - through the exploitation geothermal well, geothermal water is pumped to the surface where, after exploitation, it is returned to the reservoir through the injection well (Gaurina-Međimurec, 2022). With proper organization of the construction site, compliance with construction regulations and conditions, and with prescribed mitigation measures, no significant impact of geothermal water utilization on habitats, surface and underground water is expected.

Other working fluids used during oil-mining operations in the well (e.g. fluids for equipping and maintaining the well, stimulation fluids), after returning to the surface are not released uncontrolled into the environment, but are accepted in closed metal containers, prepared for removal (e.g. by neutralization) and handed over to an authorized collector (Gaurina-Međimurec, 2022). Significantly negative impacts on the quality of aquatic habitats and species related to such habitats would occur by releasing heated extracted geothermal water into surface water bodies (watercourses, lakes, etc.). Increased temperatures result in an increase in the amount of dissolved oxygen and an acceleration of the metabolism of aquatic organisms (Kristmannsdottir & Armannsson, 2003; Shortall et al., 2015a; Davidsdottir & Axelsson, 2022).at a depth of 500 m to 5000 m between 40 ºC and 200 ºC, and at a depth of 2000 m to 6000 m between 80 ºC and 400 ºC. Taking into account that the average temperature of geothermal water obtained from shallow deposits is lower (at a depth of 10 - 150 m the average temperature of geothermal water is between 2 ºC and 21 ºC) than the average temperature of geothermal water from deeper deposits and that the obtained geothermal water is cooled before discharge into surface water bodies (mainly discharged in winter when it cools down faster), no significant impact on the quality of aquatic habitats and species related to such habitats is expected.

Research phase and exploitation phase (by areas of the ecological network)

INTable11.2the POP and POVS areas of the ecological network are listed, which are at the highest risk of significantly negative impact (-2) on the conservation objectives, since they are areas of the ecological network that are smaller in area (less than 5000 ha). Given that the Plan does not have a spatial component, only the final assessment after the application of mitigation measures is listed in the above table. At the same time, for individual areas smaller than 5000 ha, the impact rating after the application of mitigation measures is -1 due to the impact of potential disturbance of the target species of the specified POP and POVS areas during exploration and exploitation of geothermal water.

INTable11.3and**Error! Reference source not found.**listed POVS areas larger than 5000 ha on which the activities of the Plan may have a significant negative impact due to loss/fragmentation of habitats, changes in the water regime, disturbance/suffering of target species and/or habitat pollution, while inTable11.4the specified POVS areas larger than 5000 ha on which the activities of the Plan may have a significant negative impact due to the loss of target habitats, changes in the water regime, and/or pollution of target habitats. In the mentioned tables, only the final assessment after the application of the mitigation measures is also indicated. INTable11.3the impact rating after the application of mitigation measures is -1 due to the impact of potential disturbance of the target bird species of the mentioned POP areas during the exploration and exploitation of geothermal water, while in**Error! Reference source not found.**the impact rating after the application of mitigation measures is -1 due to the impact of potential disturbance/suffering of the target species of amphibians and reptiles and due to the potential disturbance of the target species of mammals in the mentioned POVS areas during the exploration and exploitation of geothermal water. The application of mitigation measures is not expected to affect the target habitat types of the mentioned POVS areas of the ecological network (Table11.4), therefore, for them, the impact rating after the application of mitigation measures is 0.

Table11.2A listPOP and POVS areas smaller than 5000 hain the area of the area planned for the exploration and exploitation of geothermal water (Source: IRES EKOLOGIJA doo according to Bioportal data, Regulation on ecological network and competences of public institutions for managing ecological network areas (Official Gazette 80/19), Amendment to the Rulebook on conservation objectives and conservation measures of target species birds in the areas of the ecological network (Official Gazette 38/20, working documents Conservation objectives of April 26, 2022 and Refined conservation objectives)

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
POP						
HR1000002	Sava near Hrušćica with Rakitje gravel pit	1453.51	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 6th, 7th, 10th, 11th, 12th.	Harassment	-1
HR1000012	The settling tanks of the Virovitica sugar factory	24,14	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 6th, 7th, 10th, 11th, 12th.	Harassment	-1
POVS						
HR2000094	Ozalj Cave	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2000108	Watercourse	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2000174	Abdomen – Rastik	2 005.39	Loss of habitat, disturbance/suffering of species, pollution of habitat	1st, 3rd, 6th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2000234	Draganićka šuma - Ješevica 1	65,88	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2000368	Peteranec	203.42	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2000369	The top part of Ravna Gora	764.05	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 3rd, 4th, 5th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2000426	The courtyard	1 490.89	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR2000427	Gajna	425.59	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2000437	Ponds Končanica	1 286.81	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000438	Poljana ponds	1 962.64	Loss of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000440	Ponds Siščani and Blatnica	732.25	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000441	Narta pond	648.55	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000444	Varoški Lug	866.67	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2000449	Ponds Crna Mlaka	675.76	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000450	Ribnjaci Draganići	390.97	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000451	Ponds Pisarovina	389.87	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000459	Petrinjčica	793.93	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR2000463	Una Valley	4 269.51	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 3rd, 4th, 5th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2000465	Jaundice	4,660.57	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000470	Cep - Nedelišće	82,82	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2000488	South Dilj	152.90	Habitat loss and pollution	1., 10.	-	0
HR2000570	Black bright	522,13	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2000571	Đurđevac peski	23.55	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2000572	Kloštarski (Kalinovački) peski	28,14	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2000573	The Petri family	125.39	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2000589	Stupnica lye	760.97	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 9th, 10th.	-	0
HR2000593	Mrežnica - Tounjčica	475.09 (43%)	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000642	Cup	3 737.18	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2000670	Cret Dubravica	5.51	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2000672	Calling	1.60	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2000728	Plant cemetery	2.85	Habitat loss and pollution	1., 10.	-	0
HR2000730	Bistrina	27,16	Habitat loss and pollution	1., 10.	-	0
HR2000780	The clincher of the village	32.92	Habitat loss and pollution	1., 10.	-	0
HR2000799	Gornji Hruševec - Kravarščica stream	2.75	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001001	Cret Blatuša	42,13	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001002	Cepelova meadows	35.87	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2001004	Stari Gradac - Lendava	28,33	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001005	Old Town Marof	189,14	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001006	County canal (Gornje Bazje - Zidina)	151.32	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001031	Odra near Jagodno	6.41	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR2001034	Mačkovec - pond	4.85	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001045	Patience	5.15	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001070	Sutla	141.38	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001086	Breznički Pond (Našice Pond)	1 408.82	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001088	Mala Dubrava - Vučedol	224.88	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001115	Scarecrow	1 358.77	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 9., 10., 11., 12.	Harassment	-1
HR2001162	Pub	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001178	Vugrin Cave	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001190	Jewish pits	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001191	Cerjanska cave	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001192	Zdenec near Ciglar	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001193	Cave near Šušnjar	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001195	Cave under Špica	0.78	Habitat loss and pollution	1st, 3rd, 10th.	-	0
HR2001216	Ilova	836.46	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001220	Meadows along the Injatica stream	37.79	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2001224	Malodapceva meadows	18,29	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2001228	Potok Dolje	5.22	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10., 11., 12.	Harassment	-1
HR2001243	Česma River	102.79	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001285	Gornja Garešnica	76.34	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001286	Orljavac	400.84	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001288	Pričac - Lužani	196.95	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001289	Davor - meadows	17.52	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001292	Meadows near Čaglin	199.79	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR2001293	Meadows near Grubišno Polje	2 936.89	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001298	Vejalnica and Krč	142.84	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001305	It rattles	12.25	Habitat loss and pollution	1., 10.	-	0
HR2001318	Kalnik - Vranilac	23.30	Habitat loss and pollution	1., 10.	-	0
HR2001319	Trim	916.70	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001320	Montenegro	145.26	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	1., 10.	-	0
HR2001323	Fountains - forests	124.77	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001326	Jelas field with ponds	4 747.04	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001327	Dubrava pond	342.96	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001328	Lonđa; Glogovica and Breznica	120.06	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001329	Streams around Papuk	486.26	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001330	Pakra and Bijela	144.22	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001331	Šaševa - cret	25,16	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001335	Jastrebarski lugovi	3 792.05	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 8., 10., 11., 12.	Harassment	-1
HR2001339	The area around the Jopić Cave	223.33	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001342	The area around the cave of Gradus	1 811.71	Loss of habitat, disturbance/suffering of species, pollution of habitat	1st, 3rd, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001347	Donje Medjimurje	218.93	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001348	Sutle Valley near Razvor	96.25	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001370	The area around Hrvatska Kostajnica	2,922.02	Loss of habitat, disturbance/suffering of species, pollution of habitat	1st, 3rd, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001372	The area around the Vrlovka cave	5,10	Loss of habitat, disturbance/suffering of species, pollution of habitat	1st, 3rd, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001378	Meadows near Hudinčec	13,28	Habitat loss and pollution	1., 10.	-	0
HR2001379	Vlakanac-Radinje	2,922.98	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR2001381	Vukmanić - cret	14.55	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001383	Class boys	1.43	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001385	Eagle	111.72	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001387	The area next to Maja and Brućina	997.32	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10., 11., 12.	Harassment	-1
HR2001389	Banićevac	6.38	Habitat loss and pollution	1., 10.	-	0
HR2001390	Brajak hill	11.07	Habitat loss and pollution	1., 10.	-	0
HR2001391	Brebornica	75.48	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10., 11., 12.	Harassment	-1
HR2001392	Sweetie	13.48	Habitat loss and pollution	1., 10.	-	0
HR2001393	Nurkovac	12.71	Habitat loss and pollution	1., 10.	-	0
HR2001404	Hawthorn tree	3.22	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001405	Lonja	4.36	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001407	Orljavica	22,26	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001408	Meadows along Bednja I	226.47	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001409	Meadows along Bednja II	1 145.13	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001410	Meadows along Bednja III	307.75	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001411	Meadows along Bednja IV	19.86	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001412	Meadows along Bednja V	112.81	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001416	Brezovica-Jelik	439.57	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001500	Steppe habitats near Bapska	77.95	Habitat loss and pollution	1., 10.	-	0
HR2001501	Steppe habitats near Opatovac	42,38	Habitat loss and pollution	1., 10.	-	0
HR2001502	Steppe habitats near Šarengrad	38.91	Habitat loss and pollution	1., 10.	-	0
HR2001505	Korana downstream from Slunj	440.47 (75%)	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 3rd, 4th, 5th, 6th, 7th, 8th, 9th, 10th, 11th, 12th.	Harassment	-1
HR2001506	Sava upstream from Zagreb	207.71	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0
HR2001509	Donji Emovci**	97.63	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1st, 4th, 5th, 10th.	-	0

Area code	Area name	Area area (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR2001510	Meadows near Pačica**	118,19	Habitat loss and pollution	1., 10.	-	0
HR2001511	Dry meadows near Sinli**	1 582.72	Habitat loss and pollution	1., 10.	-	0
HR2001512	Sov lake**	2.48	Loss of habitat, change in water regime, habitat pollution	1st, 4th, 5th, 10th.	-	0
HR2001513	Otman's height**	26.07	Habitat loss and pollution	1., 10.	-	0
HR2001346 Međimurje* **						
Scientific name of the target species	Croatian name of the target species	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Lycaena dispar	acid fire plume	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10.	-	0
Phengaris nausithous	extinguish the meadow plavac	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10.	-	0
Phengaris teleius	large meadow plavac	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	1., 4., 5., 10.	-	0
*Euplagia quadripunctaria**	daytime honeydew	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	1., 10.	-	0
Target habitat type code	Croatian name of the habitat type	The area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
6510	Lowland meadowsweet (Alopecurus pratensis, Sanguisorba officinalis)	**< 1000**	Habitat loss and pollution	1., 10.	-	0
91L0	Illyrian oak-hornbeam forests (Erythronio-Carpinion)	**< 1000**	Habitat loss and pollution	1., 10.	-	0

* priority wild species
** Probable Areas of Conservation Significant for Species and Habitat Types (vPOVS)
*** HR2001346 Međimurje is a POVS area of less than 5000 ha (2523.01 ha), but it was analyzed in more detail because the locations of two exploration areas with the potential for the exploitation of geothermal energy are known in that area.

Table11.3Overview of POP target species of ecological network areas larger than 5,000 ha in the area of the area planned for exploration and exploitation of geothermal water (Source: IRES EKOLOGIJA doo according to Bioportal data, Regulation on ecological network and competences of public institutions for managing ecological network areas (Official Gazette 80/19) , Amendment to the Ordinance on Conservation Objectives and Conservation Measures for Target Bird Species in Ecological Network Areas (Official Gazette 38/20 and Corine Land Cover)

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
HR1000001					
Saint Luscinia(blue vole, P) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Grus grus(crane, P) / 231, 242, 243, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Circus cyaneus(spurred harrier, Z, Circus pygargus (meadow harrier, G) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Crex crex(kosac, G) / 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Falco vespertinus(red-legged kestrel, P) / 231, 321, 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Lanius collurio(Russian magpie, G), Lanius minor (gray magpie, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker, G), Picus canus (gray woodpecker, G), Strix uralensis (goshawk, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2nd, 4th, 5th, 6th, 7th, 8th, 10th, 11th, 12th.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Alcedo atthis(kingfisher, G), Anas strepera (crackling duck, G), Aythya nyroca (snake duck, G), Aythya nyroca (snake duck, P), Casmerodius albus (great white heron, P, Z), Chlidonias hybrida (white-bearded tern , P), Egretta garzetta (Little White Heron, P), Netta rufina (Garden Duck, G), Philomachus pugnax (Pearfowl, P), Tringa glareola (Shrimp, P), significant non-breeding (migratory) bird populations (Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, wild goose Anser anser, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula , red-billed swan Cygnus olor, coot Fulica atra, hen snipe Gallinago gallinago, black-tailed sandpiper Limosa limosa,hen Rallus aquaticus, black wagtail Tringa erythropus, crook-billed wagtail Tringa nebularia, red-legged wagtail Tringa totanus, wagtail Vanellus vanellus) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Botaurus stellaris(Otter, G), Botaurus stellaris (Otter, P, Z), Acrocephalus melanopogon (Black-striped tern, P), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, P), Chlidonias hybrida (White-bearded tern, G), Chlidonias niger (black tern, P), Ciconia nigra (black stork, P), Ixobrychus minutus (little heron, G), Ixobrychus minutus (little heron, P), Nycticorax nycticorax (gaac, P), Pandion haliaetus , P), Platalea leucorodia (spoonfish, P), Porzana parva (grey hake, G), Porzana pusilla (small hake, P) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Porzana porzana(red pike, G) / 411, 512, 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000003					
Alcedo atthis(aquarius, G) / 411, 511, 512	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime,	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		disturbance/suffering of species, pollution of habitat			
Crex crex(kosac, G) / 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Lanius collurio(Russian magpie, G), Lanius minor (gray magpie, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Pernis apivorus (white-throated woodpecker, G), Picus canus (grey woodpecker, G), Strix uralensis (goshawk, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000004 Donja Posavina					
Aquila clanga(gulling eagle, Z) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Grus grus(crane, P) / 231, 242, 243, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Circus cyaneus(white harrier, Z), Circus pygargus (meadow harrier, G) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(stork, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Crex crex(kosac, G) / 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Falco vespertinus(red-legged kestrel, P) / 231, 321, 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Falco columbarius(small falcon, Z), Lanius collurio (Russian magpie, G), Lanius minor (grey magpie, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker, G), Picus canus (gray woodpecker, G), Strix uralensis (goshawk, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2nd, 4th, 5th, 6th, 7th, 8th, 10th, 11th, 12th.	Harassment	-1
Circus aeruginosus(marsh harrier, G), Gallinago gallinago (hen snipe, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (crackling duck, G), Aythya nyroca (snake duck, G), Aythya nyroca (snake duck, P, Z), Casmerodius albus (great white heron, G), Casmerodius albus (great white heron, P, Z), Chlidonias hybrida (white-bearded tern, P), Egretta garzetta (little white heron, P), Netta rufina (bark duck, G), Numenius arquata (great whistling, P), Philomachus pugnax (plover, P), Tringa glareola (P) significant non-breeding (migratory) populations of birds (snake Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, barred goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula,mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, snipe Gallinago gallinago, black-tailed sandpiper Limosa limosa, common duck Netta rufina, coot Rallus aquaticus, black stilt Tringa erythropus, crooked stilt Tringa nebularia, red-legged stilt Tringa totanus, vivax	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Vanellus vanellus, great whistler Numenius arquata) / 411, 511, 512					
Acrocephalus melanopogon(black-striped reed, P), Ardea purpurea (Danguba heron, G), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, G), Ardeola ralloides (Yellow heron, P), Chlidonias hybrida (White-bearded tern, G), Chlidonias niger (black tern, P), Ciconia nigra (black stork, P), Egretta garzetta (little white heron, G), Ixobrychus minutus (little egret, G), Ixobrychus minutus (little egret, P), Nycticorax nycticorax (gak, G), Nycticorax nycticorax (gak, P), Pandion haliaetus (wren, P), Phalacrocorax pygmaeus (little crow, G), Platalea leucorodia (spooner, G), Platalea leucorodia (spooner, P), Podiceps nigricollis (black-throated grebe, G), Porzana parva (grey pike, G), Porzana parva (gray pike, P), Porzana porzana (red pike, P), Porzana pusilla (small pike, P) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Porzana porzana(red pike, G) / 411, 512, 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Actitis hypoleucos(small bream, G), Riparia riparia (bregunica, G) / 511	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
HR1000005 Jelas polje					
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2nd, 4th, 5th, 6th, 7th, 8th, 10th, 11th, 12th.	Harassment	-1
Grus grus(crane, P, Z) / 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Lanius collurio(Russian magpie, G), Lanius minor (gray magpie, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker,	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
G), Picus canus (gray woodpecker, G) / 311					
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Egretta garzetta (little white heron, P), Netta rufina (bark duck, G), Numenius arquata (great whistling duck, P), Philomachus pugnax (plover, P) , Sterna hirundo (red-billed tern, G), Tringa glareola (tawny tern, P), significant non-breeding (migratory) populations of birds (tall duck Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, barred goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, woodcock hen Gallinago gallinago, black-tailed flycatcher Limosa limosa,Nudged duck Netta rufina, hen Rallus aquaticus, black plover Tringa erythropus, crooked plover Tringa nebularia, red-footed plover Tringa totanus, grebe Vanellus vanellus, great whistling Numenius arquata) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Egretta garzetta (little white heron, P), Netta rufina (bark duck, G), Numenius arquata (great whistling duck, P), Philomachus pugnax (plover, P) , Sterna hirundo (red-billed tern, G), Tringa glareola (tawny tern, P), significant non-breeding (migratory) populations of birds (tall duck Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Anas strepera, barred goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, woodcock hen Gallinago gallinago, black-tailed flycatcher Limosa limosa,Nudged duck Netta rufina, hen Rallus aquaticus, black plover Tringa erythropus, crooked plover Tringa nebularia, red-footed plover Tringa totanus, grebe Vanellus vanellus, great whistling Numenius arquata) / 411, 511, 512					
Acrocephalus melanopogon(black-striped reedeater, P), Anser anser (wild goose, G), Ardea purpurea (Danguba heron, G), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, G), Ardeola ralloides (Yellow heron, P), Aythya nyroca (Mider duck, G), Aythya nyroca (Mider duck, P, Z), Casmerodius albus (Great white heron, G), Casmerodius albus (Great white heron, P, Z), Chlidonias hybrida (White-bearded tern, G), Chlidonias hybrida (white-bearded tern, P), Chlidonias niger (black tern, P), Ciconia nigra (black stork, P), Egretta garzetta (little white heron, G), Ixobrychus minutus (little egret, G), Ixobrychus minutus (little heron, P), Nycticorax nycticorax (gak, G), Nycticorax nycticorax (gak, P), Pandion haliaetus (little heron, P), Phalacrocorax pygmeus (little crow, G), Phalacrocorax pygmeus (little crow, Z), Platalea leucorodia (spoon plant, G),Platalea leucorodia (spoonfish, P, Z), Plegadis falcinellus (shiny ibis, G), Podiceps nigricollis (black-throated grebe, G), Porzana parva (grey pike, G), Porzana porzana (red pike, P) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Riparia riparia(bregunica, G) / 511	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
HR1000006 Spačva pool					
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Pernis apivorus (white-throated woodpecker, G), Picus canus (gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000008 Bilogora and Kalničko gorje					
Bubo bubo(ushara, G) / 3.92 ha of habitat type B. Unvegetated and lightly vegetated land areas7	**< 1000**	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Circus cyaneus(stilt harrier, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(white stork, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Caprimulgus europaeus(lark magpie, G), Lanius collurio (Russian magpie, G), Lanius minor (gray magpie, G), Lullula arborea (lark's crown, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Columba oenas(woodpecker, G), Dendrocopos medius (red-headed woodpecker, G), Dryocopus martius (black wagtail, G), Ficedula albicollis (white-throated flycatcher, G), Ficedula parva (little flycatcher, G), Hieraaetus pennatus (dwarf eagle, G), Pernis apivorus (shrike, G), Picus canus (grey wagtail, G), Strix uralensis (goshawk, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 312, 313, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000009 Ponds by the Fountain					
Saint Luscinia(blue vole, P) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1

7 To maintain the nesting population of 2-3 p., it is important to preserve rocky areas that are not classified in the Corine Land Cover (CLC) database, therefore, the Map of terrestrial non-forest habitats of the Republic of Croatia from 2016 was used to calculate the area of suitable habitats for the egret.

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Lanius collurio(Russian magpie, G), Lanius minor (gray magpie, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker, G), Picus canus (gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Numenius arquata (great whistling duck, P), Philomachus pugnax (plover, P), Tringa glareola (shrike, P), significant non-breeding (migratory) populations of birds (duck teal Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, mallard Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, wild goose Anser anser, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, hen snipe Gallinago gallinago, black-tailed sandpiper Limosa limosa, mallard Netta rufina, hen Rallus aquaticus, black wagtail Tringa erythropus, crooked-billed wagtail Tringa nebularia, red-legged wagtail Tringa totanus, wagtail Vanellus vanellus,big whistler Numenius arquata) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Acrocephalus melanopogon(black-striped reed, P), Ardea purpurea (Danguba heron, G), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, P), Aythya nyroca (Mider duck, G), Aythya nyroca (Mider duck, P), Casmerodius albus (great white heron, P, Z), Chlidonias hybrida (white-bearded tern, P), Chlidonias niger (black tern, P), Ciconia nigra (black stork, P), Egretta garzetta (little white heron, P) .) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000010 Watershed with ponds					
Saint Luscinia(blue vole, P) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1
Circus cyaneus(white harrier, Z), Circus pygargus (meadow harrier, G) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Lanius collurio(Russian magpie, G), Lanius minor (gray magpie, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker, G), Picus canus (gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 313, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Aquila pomarina(clicker eagle, G) / 311, 411, 321, 231	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Numenius	> 1000	Loss/fragmentation of habitat, change of water regime,	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
arquata (great whistling duck, P), Philomachus pugnax (plover, P), Sterna hirundo (red-billed tern, G), Tringa glareola (shrike, P), significant non-breeding (migratory) populations of birds (tall duck Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, wild goose Anser anser, hawthorn goose Anser fabalis . trout Tringa nebularia,red-legged plover Tringa totanus, wagtail Vanellus vanellus, great whistling Numenius arquata) / 411, 511, 512		disturbance/suffering of species, pollution of habitat			
Acrocephalus melanopogon(black-striped reedeater, P), Ardea purpurea (danguba heron, P), Ardeola ralloides (yellow heron, P), Aythya nyroca (miner duck, G), Aythya nyroca (miner duck, P), Botaurus stellaris (otter, G) . ,Ciconia nigra (black stork, P), Egretta garzetta (little white heron, P), Ixobrychus minutus (little egret, G), Ixobrychus minutus (little egret, P), Nycticorax nycticorax (gak, P), Pandion haliaetus , P), Platalea leucorodia (spoonfish, P), Podiceps nigricollis (black-throated grebe, G), Porzana parva (grey pike, G), Porzana porzana (red pike, P) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000011 Ponds Grudnjak and Našice					
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	**< 1000**	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Panurus biarmicus (whiskered woodpecker, G), Philomachus pugnax (plover, P) , Picus canus (grey dogwood, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Egretta garzetta (little white heron, P), Netta rufina (bark duck, G), Numenius arquata (great whistling duck, P), Phalacrocorax pygmeus (little crow, G), Tringa glareola (P) significant non-breeding (migratory) populations of birds (snake Anas acuta, spoonbill Anas clypeata, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, barred goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, woodcock Gallinago gallinago, black-tailed sandpiper Limosa limosa , nudibranch Netta rufina,hen Rallus aquaticus, black wagtail Tringa erythropus, crook-billed wagtail Tringa nebularia, red-legged wagtail Tringa totanus, wagtail Vanellus vanellus, great whistling Numenius arquata) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Acrocephalus melanopogon(black-striped reedeater, P), Anas anser (wild goose, G), Ardea purpurea (Danguba heron, G), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, G), Ardeola ralloides (Yellow heron, P), Aythya nyroca (Mider duck, G), Aythya nyroca (Mider duck, P), Botaurus stellaris (Otter, G), Botaurus stellaris (Otter, P,Z), Casmerodius albus (Great white heron, G), Casmerodius albus (great white heron, P,Z), Chlidonias hybrida (white-bearded tern, G), Chlidonias hybrida (white-bearded tern, P), Chlidonias niger (black tern, P), Egretta garzetta (little white heron, G), Ixobrychus minutus (Little heron, G), Ixobrychus minutus (Little heron, P), Nycticorax nycticorax (Gak, G), Nycticorax nycticorax (Gak, P), Pandion haliaetus (Bukoč, P), Pernis apivorus (Shrike, G), Platalea leucorodia (spoon, G),Platalea leucorodia (spoonfish, P, Z), Porzana parva (grey pike, G) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000013 Drava reservoirs					
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	**< 1000**	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Falco columbarius(small falcon, Z) / 242	**< 1000**	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Actitis hypoleucos(little tern, G), Riparia riparia (stern, G), Sterna hirundo (red-billed tern, G) / 511	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 312, 313, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (crackling duck, G), Egretta garzetta (little white heron, G), Egretta garzetta (little white heron, P), significant non-breeding (migratory) populations of birds (the mallard Anas acuta, the mallard Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, leaf goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula , red-billed swan Cygnus olor, coot Fulica atra, mallard Netta rufina, hen Rallus aquaticus) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Casmerodius albus(great white heron, P, Z), Ixobrychus minutus (little heron, G), Ixobrychus minutus (little heron, P), Nycticorax nycticorax (gak, G), Nycticorax nycticorax (gak, P), Phalacrocorax pygmeus (little crow, Z) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000014 The upper course of the Drava					
Saint Luscinia(blueberry, G, Luscinia svecica (blueberry, P) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ardea purpurea(Danguba heron, P), Botaurus stellaris (Otter, G), Botaurus stellaris (Otter, P, Z), Casmerodius albus (Great white heron, P, Z), Ixobrychus minutus (Little heron, G), Ixobrychus minutus (Egret voljak, P), Nycticorax nycticorax (gak, P), Phalacrocorax pygmeus (little crow, Z) / 411, 512	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Falco columbarius(small falcon, Z), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Pernis apivorus (white-throated woodpecker, G), Picus canus (gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 312, 313, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Egretta garzetta (little white heron, P), significant non-breeding (migratory) populations of birds (tall duck Anas acuta, grebe Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos , navel duck Anas querquedula, cricket duck Anas strepera, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, common duck Netta rufina, hen Rallus aquaticus, merganser Vanellus vanellus) / 411 , 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Actitis hypoleucos(little tern, G), Riparia riparia (little tern, G), Sterna albifrons (little tern, G), Sterna hirundo (red-billed tern, G) / 511	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
HR1000015 Middle course of the Drava					
Saint Luscinia(blueberry, G), Luscinia svecica (blueberry, P) / 411	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ardea purpurea(Danguba heron, G), Ardea purpurea (Danguba heron, P), Casmerodius albus (Great white heron, P, Z), Ixobrychus minutus (Little heron, G), Ixobrychus minutus (Little heron, P), Nycticorax nycticorax , P), Phalacrocorax pygmeus (little crow, Z) / 411, 512	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Circus cyaneus(Eja Stnjarica, Z) / 231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Falco columbarius(small falcon, Z), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Ficedula albicollis (white-throated flycatcher, G), Milvus migrans (black harrier, G), Picus canus (grey wagtail, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Egretta garzetta (little white heron, P), significant non-breeding (migratory) populations of birds (tall duck Anas acuta, mallard Anas crecca, whistling Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula, red-billed swan Cygnus olor, coot Fulica atra, common duck Netta rufina, hen Rallus aquaticus, merganser Vanellus vanellus) / 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Actitis hypoleucos(small bream, G), Riparia riparia (bregunica, G) / 511	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
HR1000016 Danube and lower Podravlje					
Circus cyaneus(stilt harrier, Z)/231, 242, 321	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia ciconia(genus, G) / 231, 242, 321, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Grus grus(crane, P) / 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Falco vespertinus(red-legged kestrel, P) / 231, 321, 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 7., 8., 10., 11., 12.	Harassment	-1
Caprimulgus europaeus(leganj, G), Falco columbarius (peregrine falcon, Z), Lanius collurio (Russian magpie, G), Sylvia nisoria (spotted bush, G) / 242	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Dendrocopos syriacus(Syrian woodpecker, G) / 242, 222	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos medius(red-headed woodpecker, G), Dryocopus martius (black woodpecker, G), Ficedula albicollis (white-necked flycatcher, G), Milvus migrans (black harrier, G), Pernis apivorus (snake woodpecker, G), Picus canus (gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Haliaeetus albicilla(štekavac, G) / 311, 411, 511, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G)/311, 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Acrocephalus melanopogon(Black-striped Reed Warbler, G), Aquila clanga (Spurred Eagle, G), Aquila clanga (Spurred Eagle, Z), Luscinia svecica (Blue-bellied Warbler, G), Luscinia svecica (Blue-bellied Warbler, P) / 411	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Circus aeruginosus(marsh egret, G) / 411, 231, 321, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Alcedo atthis(kingfisher, G), Anas strepera (cracking duck, G), Egretta garzetta (little white heron, P), Netta rufina (bark duck, G), Numenius arquata (great whistling duck, P), Pandion haliaetus (whooper, P) , Philomachus pugnax (Pearfinch, P), Sterna hirundo (Red-billed Tern, G), Tringa glareola (Bright-billed Tern, P), significant non-breeding (migratory) populations of birds (Later Duck Anas acuta, Spoonbill Anas clypeata, Crested Anas crecca, Whistler Anas penelope, wild duck Anas plathyrhynchos, navel duck Anas querquedula, cricket duck Anas strepera, leaf-fronted goose Anser albifrons, wild goose Anser anser, hawthorn goose Anser fabalis, mallard Aythya ferina, crowned duck Aythya fuligula, mallard Bucephala clangula,	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
red-billed swan Cygnus olor, Coot Fulica atra, Hen Snipe Gallinago gallinago,black-tailed sandpiper Limosa limosa, mallard Netta rufina, hen Rallus aquaticus, black shrike Tringa erythropus, crook-billed shrike Tringa nebularia, red-legged shrike Tringa totanus, grebe Vanellus vanellus, great whistling Numenius arquata) / 411, 511, 512					
Acrocephalus melanopogon(black-striped reedeater, P), Anser anser (gray goose, G), Ardea purpurea (Danguba heron, G), Ardea purpurea (Danguba heron, P), Ardeola ralloides (Yellow heron, G), Ardeola ralloides (Yellow heron, P), Aythya nyroca (Mider duck, G), Aythya nyroca (Mider duck, P), Botaurus stellaris (Otter, G), Botaurus stellaris (Otter, P, Z), Casmerodius albus (Great white heron, G), Casmerodius albus (great white heron, P, Z), Chlidonias hybrida (white-bearded tern, G), Chlidonias hybrida (white-bearded tern, P), Chlidonias niger (black tern, P), Ciconia nigra (black stork, P), Egretta garzetta (little white heron, G), Himantopus himantopus (little heron, P), Ixobrychus minutus (little heron, G), Ixobrychus minutus (little heron, P), Nycticorax nycticorax (gak, G), Nycticorax nycticorax (gak, P), Panurus biarmicus (whiskered arbor, G),Phalacrocorax pygmeus (Little Crow, G), Phalacrocorax pygmeus (Little Crow, Z), Platalea leucorodia (Spooner, P, Z), Podiceps nigricollis (Black-throated Grebe, G), Porzana parva (Gray Pike, G), Porzana parva (Gray hake, P), Porzana porzana (red hake, P) / 411, 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Porzana porzana(red pike, G) / 411, 512, 231, 321	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Actitis hypoleucos(small bream, G), Riparia riparia (bregunica, G) / 511	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Himantopus himantopus(owner, G) / 512	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
HR1000040 Heel					

Scientific name of the target species (Croatian name of the target species, species status) / CLC (classes)	Area of suitable habitats of target species (ha)	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Crex crex(kosac, G) / 231, 321	**< 1000**	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Columba oenas(woodpecker, G), Dendrocopos medius (red-headed woodpecker, G), Dryocopus martius (black wagtail, G), Ficedula albicollis (white-throated flycatcher, G), Ficedula parva (little flycatcher, G), Hieraaetus pennatus (dwarf eagle, G), Pernis apivorus (Osas woodpecker, G), Picus canus (Gray woodpecker, G) / 311	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1
Ciconia nigra(black stork, G) / 311, 312, 313, 411	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 6., 7., 8., 10., 11., 12.	Harassment	-1
Dendrocopos leucotos(mountain woodpecker, G) / 311, 313	> 1000	Habitat loss/fragmentation, disturbance/suffering of species, habitat pollution	2., 6., 7., 8., 10., 11., 12.	Harassment	-1

according to Bioportal data, the Regulation on the ecological network and the competences of public institutions for the management of ecological network areas (Official Gazette 80/19), working documents Conservation objectives from 04.26.2022. and Refined Conservation Objectives)

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Plants							
Marsilea quadrifolia	four-leaf clover	HR2000394 Kopački rit	> 1000	Loss of habitat, change in water regime, loss of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	> 1000				
*Pulsatilla vulgaris*coll. grandis	blue hour	HR2000371 Top part of Ivančica	**< 1000**	Loss of habitat, loss of species, pollution of habitat	2., 10.	-	0
		HR2000580 Pakuk	**< 1000**				
Himantoglossum adriaticum	Adriatic codfoot	HR2000580 Pakuk	**< 1000**	Loss of habitat, loss of species, pollution of habitat	2., 10.	-	0
		HR2000583 Medvednica	**< 1000**				
		HR2000586 ŽumberakSamobor Mountains**	**< 1000**				
Mannia triandra	-	HR2000586 ŽumberakSamobor Mountains**	**< 1000**	Loss of habitat, loss of species, pollution of habitat	2., 10.	-	0
Invertebrates							
Anisus vorticulus	-	HR2000364 Mura	> 1000	Loss of habitat, change in water regime, loss of species, pollution of habitat	2., 4., 5., 10.	-	0
Arytrura musculus	Willow boss	HR2000416 Lonjsko polje	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
*Austropotamobius torrentium**	crayfish	HR2000583 Medvednica	**preserved watercourses**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000586 ŽumberakSamobor Mountains**	**preserved watercourses**				
Carabus nodulosus	knotty run	HR2000580 Pakuk	**< 1000 ha of suitable habitats and preserved watercourses**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
Cerambyx cerdo	oak sawfly	HR2000394 Kopački rit	**< 1000**		2., 4., 5., 9., 10.	-	0

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000415 Odran field	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat			
		HR2000416 Lonjsko polje	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
Coenagrion ornatum	eastern water maiden	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001309 Danube S from Kopački rit	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
Cordulegaster heros	mountain stream	HR2000371 Top part of Ivančica	**preserved watercourses**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000580 Pakuk	**preserved watercourses**				
		HR2000583 Medvednica	**preserved watercourses**				
		HR2000586 ŽumberakSamobor Mountains**	**preserved watercourses**				
		HR2000623 Forests on Dilj gora	**preserved watercourses**				
		HR2001356 Zrinska gora	**preserved watercourses**				
Cucujus cinnaberinus	-	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000372 Danube – Vukovar	> 1000				
		HR2000394 Kopački rit	> 1000				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000416 Lonjsko polje	> 1000				
		HR2000580 Pakuk	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2001307 Drava reservoirs	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
Euphydryas aurinia	swamp red	HR2000415 Odran field	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
Euphydryas maturna	little May ruddy	HR2000586 ŽumberakSamobor Mountains**	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
*Euplagia quadripunctaria**	daytime honeydew	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000394 Kopački rit	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2000623 Forests on Dilj gora	> 1000				
		HR2001281 Bilogora	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
Graphoderus bilineatus	two-striped Cossack	HR2000372 Danube – Vukovar	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	> 1000				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000415 Odran field	**< 1000**				
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	**< 1000**				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001309 Danube S from Kopački rit	> 1000				
Leptidea morsei	Grund's forest white man	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
Leptodirus hochenwarti	thin-necked underground	HR2000586 ŽumberakSamobor Mountains**	**6 speleological objects have been preserved**	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 3., 10.	-	0
Leucorhinia pectoralis	big peat bog	HR2000394 Kopački rit	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	**< 1000**				
		HR2001308 The lower course of the Drava	**< 1000**				
		HR2001309 Danube S from Kopački rit	**< 1000**				
		HR5000014 The upper course of the Drava	**< 1000**				
		HR5000015 Middle course of the Drava	**< 1000**				
Lucanus cervus	deer	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 9., 10.	-	0
		HR2000394 Kopački rit	> 1000				
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2000580 Pakuk	> 1000				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
Lycaena dispar	acid fire plume	HR2000371 Top part of Ivančica	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000372 Danube – Vukovar	**< 1000**				
		HR2000394 Kopački rit	**< 1000**				
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2000580 Pakuk	**< 1000**				
		HR2000583 Medvednica	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001309 Danube S from Kopački rit	**< 1000**				
		HR5000014 The upper course of the Drava	> 1000				
Morimus funereus	large four-spotted cvilidreta	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
*Nymphalis vaualbum**	white ginger	HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
Ophiogomphus cecilia	horned regoch	HR2000364 Mura	**< 1000**		2., 4., 5., 10.	-	0

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat			
		HR2000394 Kopački rit	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001311 Sava downstream from Hrušćica	**preserved water course and localities (Uštica and Rugvica)**				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	**< 1000**				
*Osmoderma Hermit**	fragrant recluse	HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
Rhysodes sulcatus	-	HR2000394 Kopački rit	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000580 Pakuk	> 1000				
*Rosalia alpina**	alpine sawfly	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10.	-	0
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
Entered by crassus	common licorice	HR2001311 Sava downstream from Hrušćica	**preserved watercourse**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR5000015 Middle course of the Drava	**preserved river flow and channel**				
Fish							
Aspius aspius	sick	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**< 1000 ha of suitable habitats and preserved river flow**				
		HR2001307 Drava reservoirs	**preserved river flow**				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Barbus balcanicus	river barbel	HR2000580 Pakuk	**preserved watercourse**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000583 Medvednica	**preserved river flow**				
		HR2000586 ŽumberakSamobor Mountains**	**preserved watercourse**				
Cobitis elongata	big curlew	HR2001311 Sava downstream from Hrušćica	**preserved watercourse**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
Cobitis elongatoides	turnip	HR2000364 Mura	**preserved river flow, backwaters and canals**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000416 Lonjsko polje	**< 1000**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Cottus gobio	lappet	HR2000580 Pakuk	**preserved watercourse**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000586 ŽumberakSamobor Mountains**	**preserved watercourse**				
Eudontomyzon mariae	Ukrainian paklara	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**preserved watercourse**				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2001308 The lower course of the Drava	**< 1000 ha of suitable habitats and preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
Eudontomyzon vladykovi	danube paklara	HR2001311 Sava downstream from Hrušćica	**preserved watercourse**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR5000015 Middle course of the Drava	**preserved river flow**				
Gymnocephalus balloons	Baloni's drool	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**< 1000 ha of suitable habitats and preserved river flow**				
		HR2001307 Drava reservoirs	**preserved river flow**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Gymnocephalus schraetser	striped drool	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**preserved water flow**				
		HR2001307 Drava reservoirs	**preserved river flow**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Misgurnus fossilis	pee	HR2000364 Mura	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**< 1000**				
		HR2000416 Lonjsko polje	**< 1000**				
		HR5000014 The upper course of the Drava	**< 1000**				
		HR5000015 Middle course of the Drava	**< 1000**				
Pelecus cultratus	swordfish	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**preserved water flow**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Rhodeus amarus	minnow	HR2000394 Kopački rit	**< 1000 ha of suitable habitats and preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000416 Lonjsko polje	**< 1000**				
		HR2001308 The lower course of the Drava	**< 1000 ha of suitable habitats and preserved river flow**				
		HR5000014 The upper course of the Drava	**< 1000 ha of suitable habitats and preserved river flow**				
		HR5000015 Middle course of the Drava	**< 1000 ha of suitable habitats and preserved river flow**				
Romanogobio kessleri	Kesler's neck	HR2000364 Mura	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
Romanogobio uranoscopus	thin-tailed grebe	HR2000364 Mura	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Romanogobio vladykovi	white-finned grebe	HR2000364 Mura	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**preserved water flow**				
		HR2001307 Drava reservoirs	**preserved river flow**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Rutilus virgo	roach	HR2001308 The lower course of the Drava	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved watercourse**				
		HR5000015 Middle course of the Drava	**preserved watercourse**				
Sabaneje's balcanica	golden curlew	HR2001307 Drava reservoirs	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Umbra traders	brunette	HR2000364 Mura	**< 1000**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR5000014 The upper course of the Drava	**< 1000**				
		HR5000015 Middle course of the Drava	**< 1000**				
Zingel nerd	small dragonfly	HR2000364 Mura	**preserved river flow**		2., 4., 5., 10.	-	0

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2001308 The lower course of the Drava	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat			
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Zingel zingel	big dragonfly	HR2000372 Danube – Vukovar	**preserved river flow**	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	**< 1000 ha of suitable habitats and preserved river flow**				
		HR2001307 Drava reservoirs	**preserved river flow**				
		HR2001308 The lower course of the Drava	**preserved river flow**				
		HR2001309 Danube S from Kopački rit	**preserved watercourse**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
		HR5000015 Middle course of the Drava	**preserved river flow**				
Amphibians							
Bomba bomba	red bully	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
		HR2000394 Kopački rit	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2001085 Pond Grudnjak with the surrounding forest complex	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR5000014 The upper course of the Drava	> 1000				
Bombina variegata	yellow muck	HR2000371 Top part of Ivančica	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2000623 Forests on Dilj gora	> 1000				
		HR2001281 Bilogora	> 1000				
		HR2001354 The area around Lake Borovik	> 1000				
		HR2001355 Punj	> 1000				
		HR2001356 Zrinska gora	> 1000				
Bombina bombina x Bombina variegata	hybrids of red and yellow muck8	HR2000415 Odran field	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
Triturus carnifex	a large pond	HR2000583 Medvednica	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
Triturus dobrogicus	the great Pannonian water pond	HR2000394 Kopački rit	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
		HR2001085 Pond Grudnjak with the surrounding forest complex	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR2000415 Odran field	> 1000			Harassment/suffering	-1

8In the Decree on the Ecological Network and the Competencies of Public Institutions for the Management of Ecological Network Areas (Official Gazette 80/19), both species are targeted, but considering that this is an area of species hybridization, the conservation goal is set for hybrids

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Triturus carnifex x Triturus dobrogicus	hybrids of the large and large Pannonian kingfisher	HR2000416 Lonjsko polje	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.		
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
Reptiles							
Emys orbicularis	terrapin	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment/suffering	-1
		HR2000394 Kopački rit	> 1000				
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
Mammals							
Barbastella barbastellus	wide-eared darkling	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
*Canis lupus**	wolf	HR2001356 Zrinska gora	> 1000	Loss/fragmentation of habitat, disturbance/suffering of species, pollution of habitat	2., 10., 11., 12.	Harassment	-1
Castor fiber	beaver	HR2000364 Mura	> 1000			Harassment	-1

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000415 Odran field	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.		
		HR2000416 Lonjsko polje	> 1000				
		HR2001307 Drava reservoirs	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
Lutra lutra	otter	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 4., 5., 8., 10., 11., 12.	Harassment	-1
		HR2000372 Danube – Vukovar	> 1000				
		HR2000394 Kopački rit	> 1000				
		HR2000415 Odran field	**< 1000**				
		HR2000416 Lonjsko polje	> 1000				
		HR2000420 Sunjsko polje	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	**< 1000**				
		HR2001085 Pond Grudnjak with the surrounding forest complex	> 1000				
		HR2001307 Drava reservoirs	**< 1000**				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001309 Danube S from Kopački rit	> 1000				
		HR2001414 Spačva pool	> 1000				
		HR2001415 Spačva JZ	**< 1000**				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
Miniopterus schreibersii		HR2000583 Medvednica	> 1000			Harassment	-1

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
	long-winged vertebrate	HR2001309 Danube S from Kopački rit	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.		
Myotis bechsteinii	big-eared bat	HR2000364 Mura	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000371 Top part of Ivančica	> 1000				
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2001309 Danube S from Kopački rit	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
Myotis blythii	sharp-eared bat	HR2001309 Danube S from Kopački rit	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Myotis dasycneme	swamp bat	HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
Myotis emarginatus	ginger bat	HR2000415 Odran field	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
Myotis myotis	a big bat	HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
Rhinolophus euryale	southern horseshoe	HR2000583 Medvednica	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
	a large horseshoe	HR2000415 Odran field	> 1000			Harassment	-1

Scientific name of the target species	Croatian name of the target species	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of suitable habitats in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
Rhinolophus ferrumequinum		HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.		
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
		HR2001309 Danube S from Kopački rit	> 1000				
Rhinolophus hipposideros	small horseshoe	HR2000580 Pakuk	> 1000	Loss/fragmentation of habitat, change of water regime, disturbance/suffering of species, pollution of habitat	2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12.	Harassment	-1
		HR2000583 Medvednica	> 1000				
		HR2000586 ŽumberakSamobor Mountains**	> 1000				
* priority target species ** PPOVS							

Table11.4Overview of the target habitat types of the POVS ecological network area larger than 5000 ha in the area of the area planned for the exploration and exploitation of geothermal water (Source: IRES EKOLOGIJA doo according to Bioportal data, the Regulation on the ecological network and the competences of public institutions for the management of ecological network areas (Official Gazette 80/19), of the working documents Conservation objectives from 04.11.2022 and Refined conservation objectives from 04.11.2022)

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
3130	Amphibian habitats of Isoëto-Nanojuncetea	HR2000394 Kopački rit	> 1000	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000415 Odran field	**< 1000**				
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	> 1000				
		HR2001085 Pond Grudnjak with the surrounding forest complex	> 1000				
		HR2001309 Danube S from Kopački rit[9]	> 1000				
		HR5000014 The upper course of the Drava	**< 1000**				
3150	Natural eutrophic waters with Hydrocharition or Magnopotamion vegetation	HR2000364 Mura	**< 1000**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000394 Kopački rit	> 1000				
		HR2000415 Odran field	**< 1000**				
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	**< 1000**				
		HR2001307 Drava reservoirs	**< 1000**				
		HR2001309 Danube S from Kopački rit	> 1000				
		HR2001311 Sava downstream from Hrušćica	**< 1000**				
		HR2001414 Spačva pool	**< 1000**				
		HR2001415 Spačva JZ	**< 1000**				
		HR5000014 The upper course of the Drava	**< 1000**				

9In the complex with housing type 3150Natural eutrophic waters with Hydrocharition or Magnopotamion vegetation.

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
3230	Banks of mountain rivers with Myricaria germanica	HR5000014 The upper course of the Drava	**preserved river flow**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
3260	Watercourses with Ranunculion fluitantis and Callitricho-Batrachion vegetation	HR2000580 Pakuk	**preserved watercourse**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
3270	Rivers with muddy banks overgrown with Chenopodion rubri pp and Bidention pp	HR2000372 Danube – Vukovar	**preserved river flow**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2001309 Danube S from Kopački rit	**< 1000**				
		HR2001311 Sava downstream from Hrušćica	**preserved watercourse**				
		HR5000014 The upper course of the Drava	**preserved river flow**				
4030	European dry heaths	HR2000586 Žumberak Samoborsko gorje**	**< 1000**	Habitat loss and pollution	2., 10.	-	0
6210*	Dry continental grasslands (Festuco-Brometalia) (*important localities for cacti)	HR2000371 Top part of Ivančica	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000580 Pakuk	**< 1000**				
		HR2000586 Žumberak Samoborsko gorje**	> 1000				
6230*	Nardus meadows rich in species	HR2000586 Žumberak Samoborsko gorje**	**< 1000**	Habitat loss and pollution	2., 10.	-	0
6240*	Subpannonian steppe grasslands (Festucion valesiacae)	HR2000372 Danube – Vukovar	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2001309 Danube S from Kopački rit	**< 1000**				
6250*	Pannonian steppe grasslands on the banner	HR2000372 Danube – Vukovar	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2001309 Danube S from Kopački rit	**< 1000**				
6410	Molinion caeruleae meadows	HR2000580 Pakuk	**< 1000**	Habitat loss and pollution	2., 10.	-	0
6430	Hydrophilic edges of tall greenery along rivers and forests (Convolvulion sepii,	HR2000416 Lonjsko polje	**< 1000**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000580 Pakuk	**< 1000**				
		HR2000583 Medvednica	**< 1000**				

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
	Filipendulion, Senecion fluviatilis)	HR2000586 Žumberak Samoborsko gorje**	**< 1000**				
		HR2001307 Drava reservoirs	> 1000				
6440	Cnidion dubii meadows	HR2000394 Kopački rit	**< 1000**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
6510	Lowland meadowsweet (Alopecurus pratensis, Sanguisorba officinalis)	HR2000364 Mura	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000415 Odran field	**< 1000**				
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	> 1000				
		HR2000586 Žumberak Samoborsko gorje**	> 1000				
		HR2001307 Drava reservoirs	**< 1000**				
		HR5000014 The upper course of the Drava	**< 1000**				
6520	Mountain mowers	HR2000586 Žumberak Samoborsko gorje**	**< 1000**	Habitat loss and pollution	2., 10.	-	0
7220*	Springs where travertine is deposited (Cratoneurion) - dot or ribbon formations dominated by mosses from the genus Cratoneurion commutati	HR2000586 Žumberak Samoborsko gorje**	**preserved carbonate springs**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
7230	Basophilic cells	HR2000586 Žumberak Samoborsko gorje**	**< 1000**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
8210	Carbonate rocks with chasmophytic vegetation	HR2000371 Top part of Ivančica	> 1000	Habitat loss and pollution	2., 10.	-	0
		HR2000583 Medvednica	**< 1000**				
8220	Silicate rocks with chasmophytic vegetation	HR2001356 Zrinska gora	**< 1000**	Habitat loss and pollution	2., 10.	-	0
8310	Caves and pits closed to the public	HR2000580 Pakuk	**three registered speleological objects**	Habitat loss and pollution	2., 3., 10.	-	0
		HR2000583 Medvednica	**five speleological facilities**				

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000586 Žumberak Samoborsko gorje**	**13 speleological objects have been preserved**				
9110	Luzulo-Fagetum beech forests	HR2000580 Pakuk	> 1000	Habitat loss and pollution	2., 10.	-	0
		HR2000583 Medvednica	**< 1000**				
		HR2000586 Žumberak Samoborsko gorje**	> 1000				
		HR2001355 Punj	**< 1000**				
9130	Asperulo-Fagetum beech forests	HR2000580 Pakuk	> 1000	Habitat loss and pollution	2., 10.	-	0
		HR2001281 Bilogora	> 1000				
		HR2001356 Zrinska gora	> 1000				
9160	Sub-Atlantic and Central European oak and oak-hornbeam forests Carpinion betuli	HR2000364 Mura	**< 1000**	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000415 Odran field	> 1000				
		HR2000416 Lonjsko polje	> 1000				
		HR2000420 Sunjsko polje	>1000				
		HR2001085 Pond Grudnjak with the surrounding forest complex	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	> 1000				
9180*	Forests of great slopes and Tilio-Acerion gorges	HR2000371 Top part of Ivančica	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000580 Pakuk	**< 1000**				
		HR2000583 Medvednica	**< 1000**				
91E0*	Alluvial forests (Alno-Padion, Alnion incanae, Salicion albae)	HR2000364 Mura	> 1000	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000372 Danube – Vukovar	> 1000				
		HR2000394 Kopački rit	> 1000				
		HR2000415 Odran field	**< 1000**				

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
		HR2000416 Lonjsko polje	**< 1000**				
		HR2000420 Sunjsko polje	**< 1000**				
		HR2000580 Pakuk	**< 1000**				
		HR2001085 Pond Grudnjak with the surrounding forest complex	**< 1000**				
		HR2001281 Bilogora	**< 1000**				
		HR2001307 Drava reservoirs	> 1000				
		HR2001308 The lower course of the Drava	> 1000				
		HR2001309 Danube S from Kopački rit	**< 1000**				
		HR2001311 Sava downstream from Hrušćica	> 1000				
		HR2001356 Zrinska gora	**< 1000**				
		HR2001414 Spačva pool	**< 1000**				
		HR2001415 Spačva JZ	**< 1000**				
		HR5000014 The upper course of the Drava	> 1000				
		HR5000015 Middle course of the Drava	> 1000				
91F0	Flooded mixed forests of Quercus robur, Ulmus laevis, Ulmus minor, Fraxinus excelsior or Fraxinus angustifolia	HR2000394 Kopački rit	> 1000	Loss of habitat, change in water regime, habitat pollution	2., 4., 5., 10.	-	0
		HR2000416 Lonjsko polje	> 1000				
		HR2001415 Spačva JZ	> 1000				
		HR5000014 The upper course of the Drava	**< 1000**				
91K0	Illyrian beech forests (Aremonio-Fagion)	HR2000371 Top part of Ivančica	> 1000	Habitat loss and pollution	2., 10.	-	0
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2000586 Žumberak Samoborsko gorje**	> 1000				

Target habitat type code	Croatian name of the habitat type	Conservation objective in the ecological network (code and name of the area of the ecological network)	Area of the target habitat in accordance with the conservation objective < or > of 1000 ha	Influence	Mitigation measure	Impact after mitigation measure	Final grade
91L0	Illyrian oak-hornbeam forests (Erythronio-Carpinion)	HR2000371 Top part of Ivančica	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000580 Pakuk	> 1000				
		HR2000583 Medvednica	> 1000				
		HR2000586 Žumberak Samoborsko gorje**	> 1000				
		HR2000623 Forests on Dilj gora	> 1000				
		HR2001281 Bilogora	**< 1000**				
		HR2001354 The area around Lake Borovik	> 1000				
		HR2001356 Zrinska gora	> 1000				
91H0*	Pannonian forests with Quercus pubescens	HR2000580 Pakuk	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000623 Forests on Dilj gora	**< 1000**				
91M0	Pannonian-Balkan forests of sorghum and malt	HR2000580 Pakuk	**< 1000**	Habitat loss and pollution	2., 10.	-	0
		HR2000586 Žumberak, Samoborsko gorje	**< 1000**				
9260	Chestnut forests (Castanea sativa)	HR2000583 Medvednica	> 1000	Habitat loss and pollution	2., 10.	-	0
		HR2000586 Žumberak Samoborsko gorje**	**< 1000**				
		HR2001356 Zrinska gora	> 1000				

* priority habitat type
** PPOVS

1.6.1 Possible cumulative impacts

Considering that it is not known how many activities of the Plan will be realized in the areas of the ecological network, it is not possible to factually determine the actual cumulative impact, but it is possible to show certain risks of the spatial location of the activities of the Plan within the areas of the ecological network. When assessing the individual impacts, it was determined that the activities of the Plan, if they are located within certain areas of the ecological network, represent a high risk of possible significant impacts on conservation goals. This risk increases in particular if several activities of the Plan are spatially located in the same area of the ecological network, and especially in the same habitats, so there may be cumulative impacts. Cumulative impacts can be manifested by additional losses/fragmentation of target habitats and habitats of target species, primarily through the arrangement of well working areas, by building geothermal power plants and supporting infrastructure. Cumulative degradation of habitats can also occur due to changes in the water regime of aquatic and wet habitats that can be generated by the activities of the Plan, i.e. due to the arrangement of well work areas and the potential exploitation of geothermal water, as well as due to the construction of transport infrastructure. The construction of transport infrastructure in the same areas of the ecological network can contribute to the cumulative impacts of habitat fragmentation and the loss of target species, as well as the impact on their populations. Also, the construction of energy infrastructure (transmission lines, etc.) in the same areas of the ecological network can contribute to the cumulative impacts of the suffering of target species (especially target species of birds and bats). Due to the implementation of the Plan, a cumulative increase in the number of pollution sources is also possible. Cumulative degradation of habitats can also occur due to changes in the water regime of aquatic and wet habitats that can be generated by the activities of the Plan, i.e. due to the arrangement of well work areas and the potential exploitation of geothermal water, as well as due to the construction of transport infrastructure. The construction of transport infrastructure in the same areas of the ecological network can contribute to the cumulative impacts of habitat fragmentation and the loss of target species, as well as the impact on their populations. 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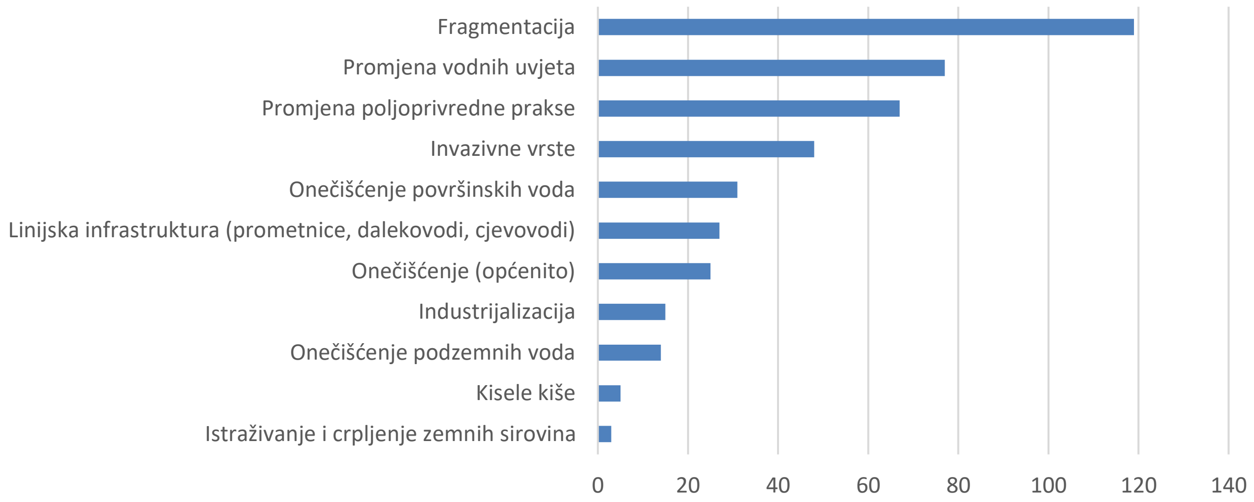
Potential cumulative impacts can also be seen through the existing pressures, that is, the sensitivity of the area of the ecological network to various activities and interventions in the space. Namely, the exploitation and use of geothermal energy can lead to various changes in natural environments, and the areas of the ecological network that are covered by the Plan include a large number of different target species and target habitats that have their own ecological requirements, on the basis of which the goals of their conservation are defined . The sensitivity of species and habitats to anthropogenic influences, and thus their conservation goals, varies between areas, and mostly depends on the structure of the target species and habitats, abiotic factors, the size of the area of the ecological network, and existing loads. Considering the scope of the Plan and the number of ecological network areas, for a more comprehensive overview of possible cumulative impacts, all areas of the ecological network are assigned sensitivity types. The types of sensitivity of the area are defined in the context of the changes that the implementation of the Plan and the activities associated with its implementation may lead to, while also taking into account the relevant existing loads in the area, which is shown in the table in the attachment0. When it comes to the implementation of new anthropogenic elements in natural ecosystems, one of the main and almost inevitable consequences is the cumulative loss of habitat, for which there is no exception when it comes to the sensitivity of target species and habitats, or their conservation goals. All areas of the ecological network are sensitive to this type of changes in space, so habitat loss was not singled out as a separate type, but was viewed as a ubiquitous sensitivity.

In the following picture (Picture11.2) shows the ratio of individual types of sensitivity in relation to all areas of the ecological network covered by the Plan. With the exception of habitat loss, the largest part of the area, taking into account the target species and habitats, i.e. their conservation goals, is sensitive to the consequences of fragmentation, and since it is an area in which a significant part of the target species and habitats is connected to surface waters, changes in water conditions it ranks high on the sensitivity scale. Exploration and extraction of earth's raw materials is the lowest on the scale, and its position is the result of observing existing loads.

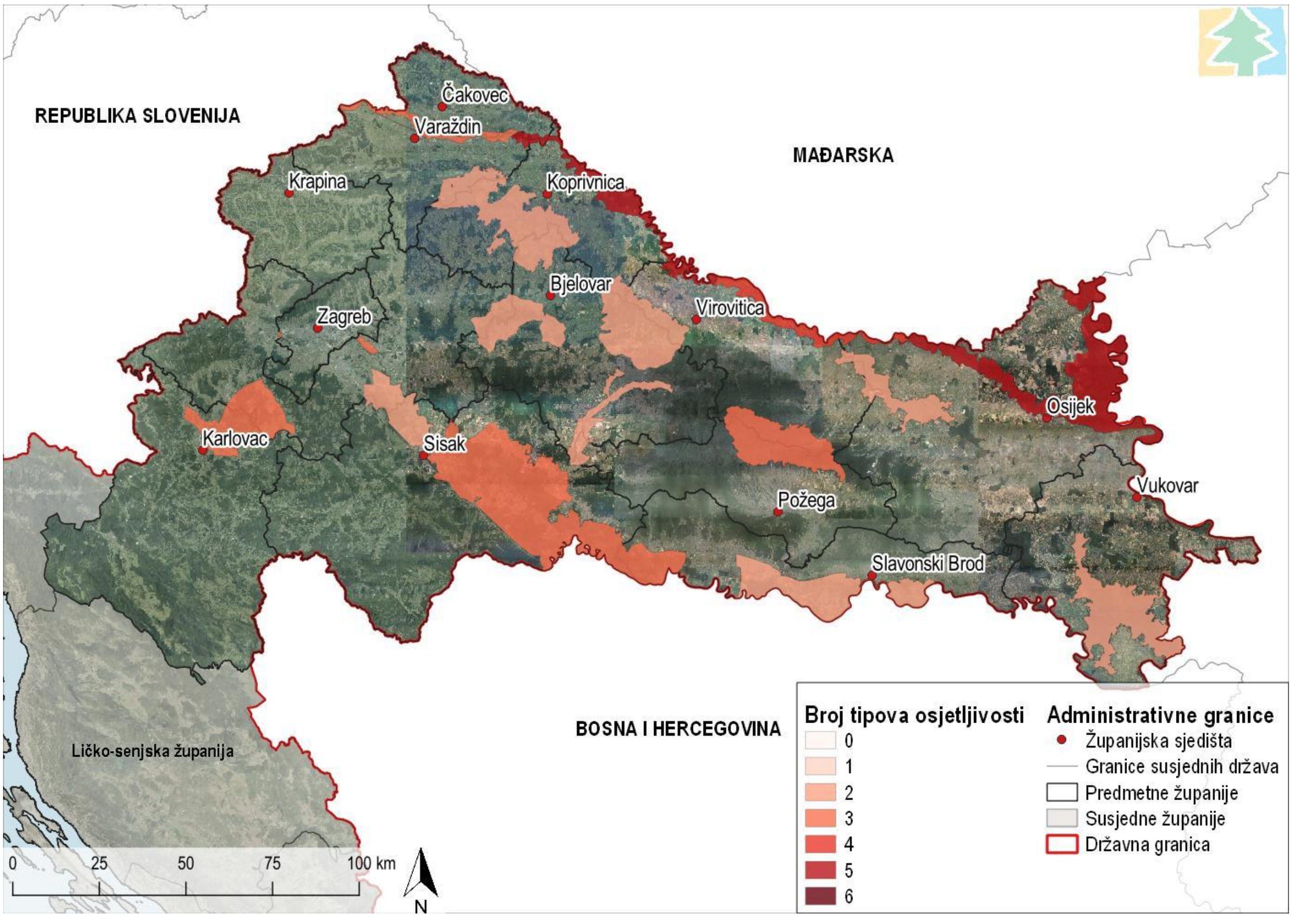


Picture11.2Sensitivities of the ecological network area (Source: Bioportal)

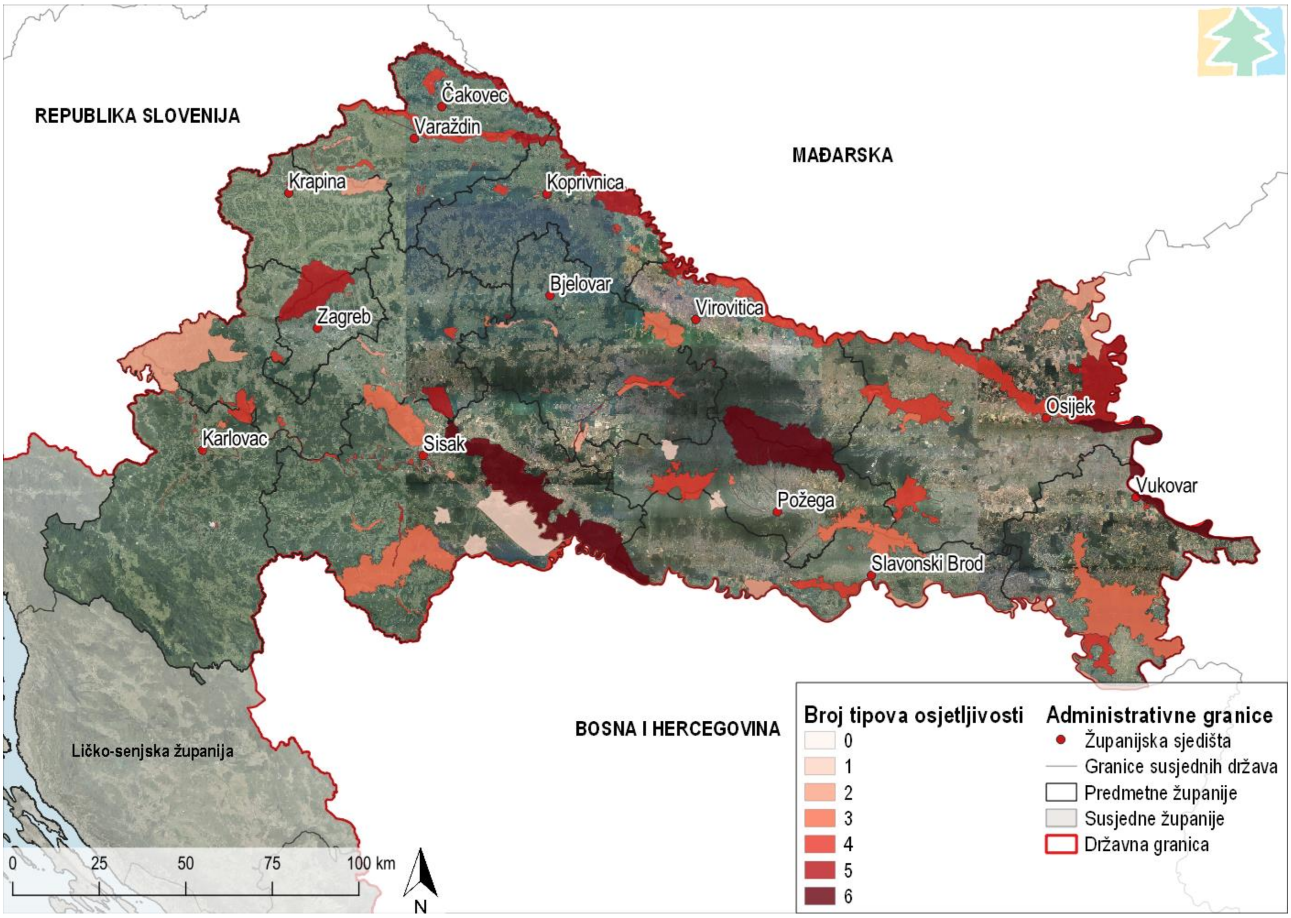
Onfollowing pictures (Picture11.3andPicture11.4) shows the number of determined types of sensitivity in certain areas of the ecological network within the scope of the Plan. What is important to point out is that a larger number of represented types does not necessarily mean a greater sensitivity of the area to changes. Hypothetically speaking, if grasslands occupying a relatively small area of several hectares are specified for the purpose of conservation for the target species of butterflies for an area, and if a smaller number of types of sensitivity are recognized in the area, the sensitivity of the area can be much higher compared to the sensitivity of another area with greater by the number of established sensitivity types, which are inhabited by the same target species, but with more suitable habitats.

Taking into account all the above, in the further stages of development of the Plan in question, it is necessary to take into account the potential cumulative impacts on the areas of the ecological network, in order to completely avoid or reduce them immediately in the initial stages. Furthermore, considering that measures have been prescribed for the identified individual impacts that maximally limit the activities of the Plan within the area of the ecological network, i.e. target habitats and habitats of target species, and measures have been prescribed to prevent the suffering of target species and preserve the water regime, no significant cumulative impacts of the implementation of the Plan on conservation goals and the integrity of the ecological network area.

On the other hand, the implementation of the Plan will lead to a total reduction of greenhouse gas emissions in the atmosphere and mitigation of climate change, because the use of geothermal energy reduces the consumption of conventional energy sources (eg fossil fuels), which results in a positive impact on the environment. Given that climate change and accompanying negative factors related to it, such as fire, drought, spread of invasive species, etc., represent a major threat to the stability and sustainability of the ecosystem, the implementation of the Plan will have a positive cumulative impact.



Picture11.3Number of sensitivity types in individual POP areas (Source: IRES EKOLOGIJA doo according to Bioportal)



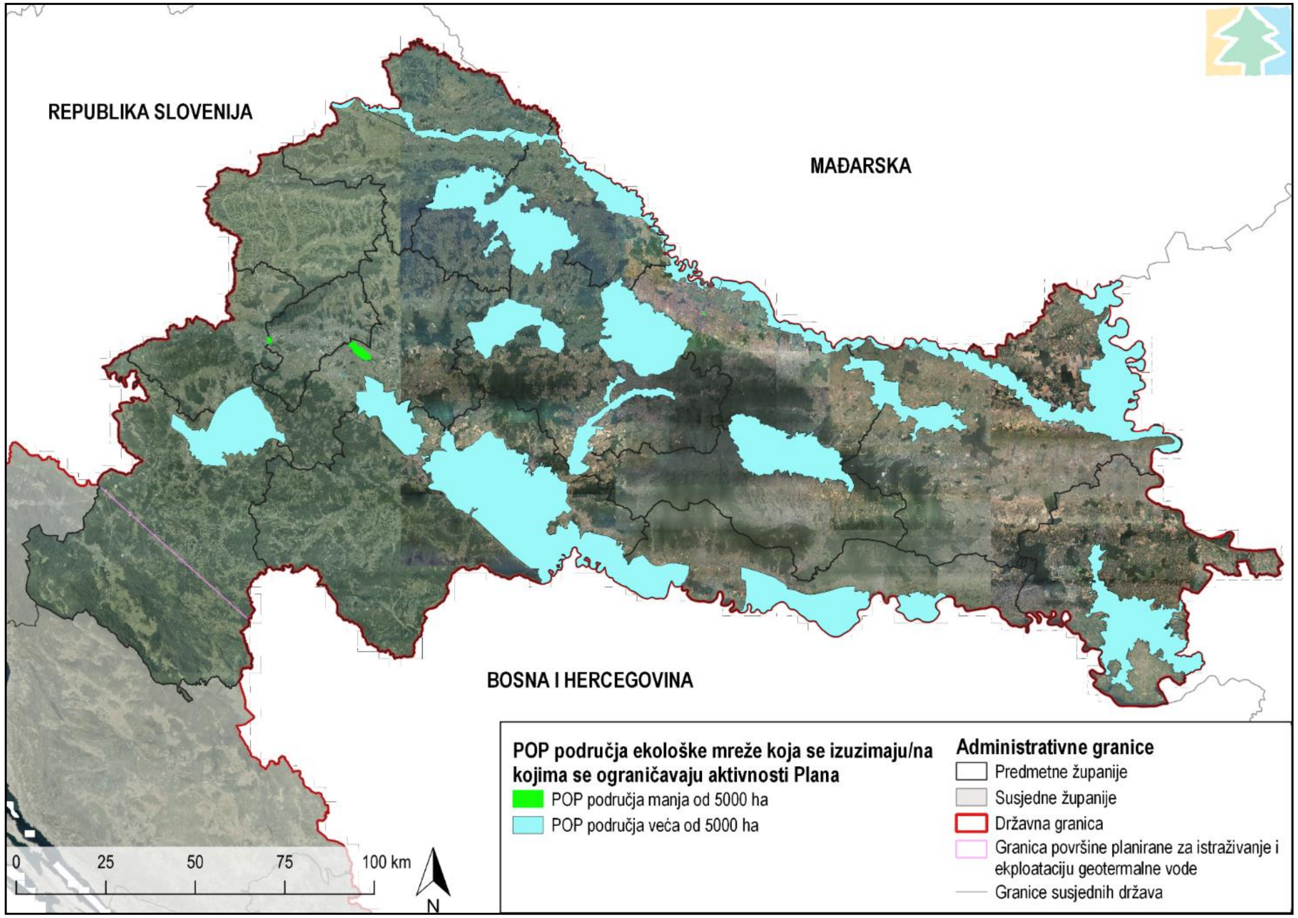
Picture11.4Number of sensitivity types in individual POVS areas (Source: IRES EKOLOGIJA doo according to Bioportal)

1.7 Measures to mitigate the negative impact of the planned activities on conservation goals and the integrity of the ecological network area

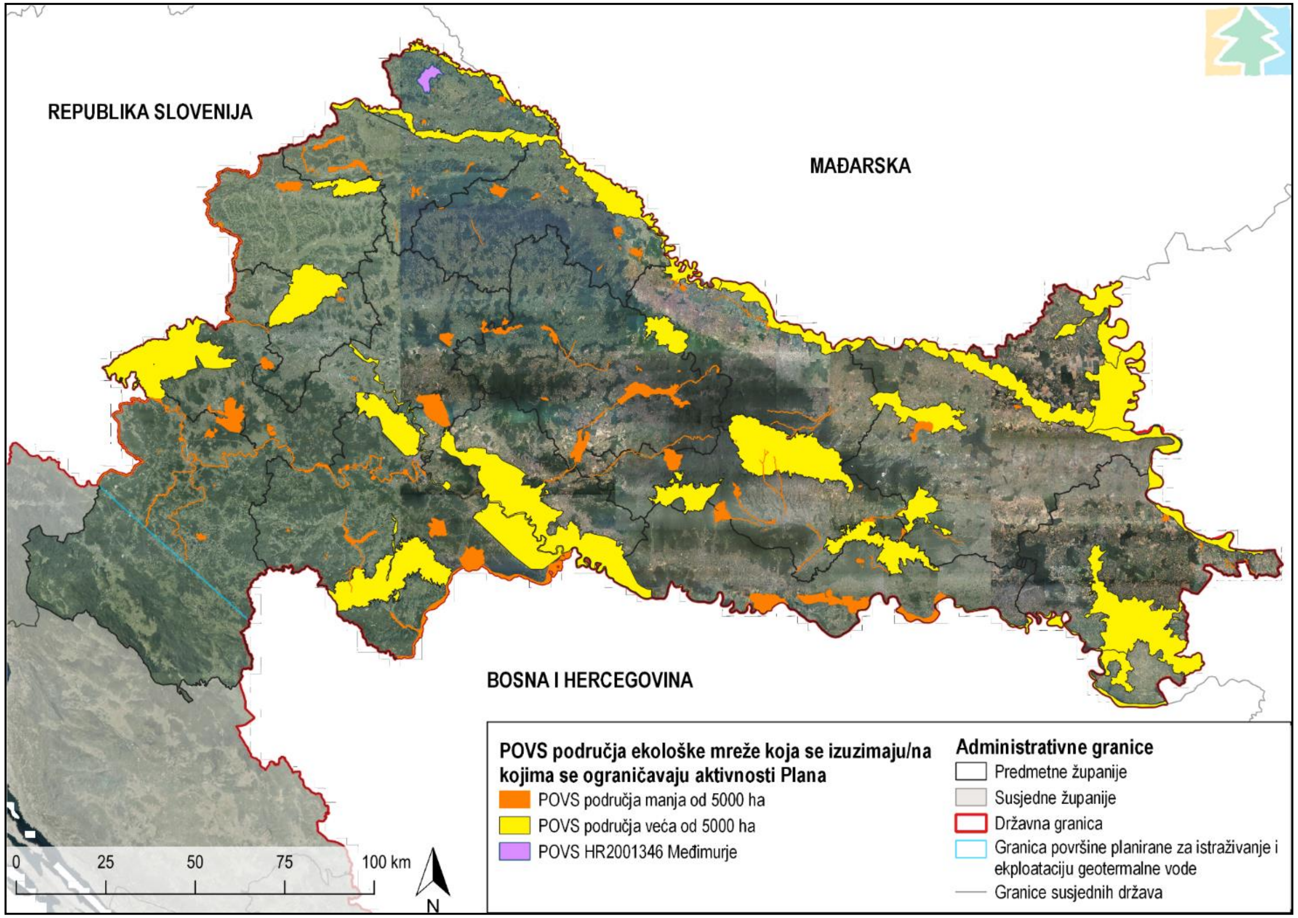
1. For ecological network areas smaller than 5000 ha (Table11.2,Picture11.5,Picture11.6) limit the implementation of the Plan in such a way that exploratory drilling and exploitation of geothermal water is not carried out within these areas, and 2D and 3D seismic recording in the areas of the ecological network is carried out only on existing roads. This mitigation measure does not apply to POVS HR2001346 Međimurje[10].
2. When planning the activities of the Plan, i.e. at the intervention level, collect data on the distribution of target species and habitat types in the area of the ecological network in the area and in the vicinity of the intervention and, in accordance with the data, plan exploratory drilling and exploitation of geothermal water and 2D and 3D seismic recording outside the area of distribution of the target habitats types and habitats suitable for the target species (Table11.3,**Error! Reference source not found.**andTable11.4,Picture11.5,Picture11.6).
3. Exploratory drilling and exploitation of geothermal water should be moved 500 m away from habitat type 8310 Caves and pits closed to the public. The protection zone of 500 m does not only refer to the entrance position of the habitat type (cave or pit opening), but also to its underground distribution. Before carrying out the works, determine the position and direction of the cave channels. For recording 2D and 3D seismic, within a zone of 500 m, do not use explosives, that is, reduce the intensity of vibrations to a level that will not affect the change in habitat conditions in caves and pits.
4. For areas of the ecological network that have been set aside for the purpose of preserving target habitat types and species related to aquatic ecosystems, exploratory drilling, exploitation of geothermal water and use of water from natural watercourses and lakes are not allowed in the watercourse and in the immediate vicinity of the watercourse (within 250 m of the watercourse), as and in areas of distribution of target habitat types and habitats of target species related to aquatic ecosystems. Heavy machinery is not allowed to move within 250 m of the watercourse for the purposes of 2D and 3D seismic recording, except on existing roads.
5. Adhere to the usual practices of using geothermal energy by re-injecting water, i.e. wherever possible return the extracted geothermal water through an injection well back into the deposit, in order to avoid changes in the water regime.
6. 2D and 3D seismic recording and vegetation removal work should be performed outside the reproductive period of the target species of birds and bats.
7. At the project level in POP areas, if necessary, provide protection against bird casualties on air condensers (eg place a physical barrier on top of air condensers to prevent birds from landing on them). Also, the planned electrical energy systems related to the implementation of the Plan should be carried out in such a way as to protect birds and bats from collision and electrocution in accordance with the latest scientific and professional guidelines, recommendations and special conditions for the protection of the environment and nature.
8. If necessary, install suitable protective elements to prevent the entry of fauna (smaller fauna, eg amphibians) into the collection pit for the collection of waste water, the pit for the reception of geothermal water during production testing of the well, the "sand-trap" and into the leach pit.
9. For lighting during the operation of the geothermal power plant, use environmentally friendly lamps, with a beam of light directed towards the ground and minimal scattering in other directions.
10. Proper organization of the work space and compliance with building regulations and conditions prevent accidental situations (such as the accidental release or disposal of excess hazardous construction materials and chemicals into inland waters, breakdowns of construction machinery and tools, and leakage of a large amount of geothermal water due to valve damage) and also prevent failures in the organization workplace, such as the absence of a surface water drainage system, the absence of an adequate solution for sanitary waste water from the workplace, improper handling and storage of petroleum products, oils and lubricants, and increased amounts of construction, communal and hazardous waste that can be leached into groundwater.

[10]HR2001346 Međimurje is a POVS area of less than 5000 ha,but it is not fully exempted because there are already two exploration fields in the area with the potential for geothermal energy exploitation, therefore the following mitigation measure applies to this area:When planning the activities of the Plan, that is, at the level of interventions in the area of POVS HR2001346 Međimurje, collect data on the distribution of target species and habitat types of the ecological network area in the area and in the vicinity of the intervention (according to the Decree on the Ecological Network and the Competencies of Public Institutions for the Management of Ecological Network Areas (Official Gazette 80/19) and, in accordance with the data, to plan exploratory drilling and exploitation of geothermal water and 2D and 3D seismic recording outside the area of distribution of the target habitat types and habitats suitable for the target species (Table11.2).

11. In accordance with good practice, use techniques and equipment to dampen noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, geothermal power plants with internal noise-absorbing walls, etc.) .
12. Control the noise level directly at its source and take additional noise mitigation measures at the project level if it is determined that there are excesses and/or negative impacts on fauna.
13. In the case when the technology with two wells (exploitation and injection) is not applied, the geothermal water discharged into the recipient should be processed in such a way that it does not with its physical-chemical prporeties change the physical-chemical properties of the recipient (temperature, chemical composition, etc.).



Picture11.5POP areas where the activities of the Plan are limited and which are exempted from exploratory drilling and exploitation of geothermal water (Source: IRES EKOLOGIJA dooaccording to Bioportal data)



Picture11.6POVS areas where the activities of the Plan are limited and which are exempted from exploratory drilling and exploitation of geothermal water (Source: IRES EKOLOGIJA doo according to Bioportal data)

1.8 Conclusion on the impact of the implementation of the Plan on the ecological network

In the area covered by the Plan (the area planned for the exploration and exploitation of geothermal water) there are a total of 154 areas of the ecological network, of which 132 conservation areas are significant for species and habitat types (POVS), 5 probable conservation areas are significant for species and habitats types (vPOVS), 1 special conservation area important for species and habitat types (PPOVS) and 16 internationally important conservation areas important for birds (POP).

Given that the activities of the Plan do not have a spatial component, the possible impacts of the implementation of the Plan on the ecological network cannot be factually evaluated, therefore key risks related to possible impacts on the ecological network are highlighted. During the phase of research and exploitation of geothermal potential, there may be negative impacts of loss and fragmentation of target habitats and habitats of target species, disturbance and suffering of target species, as well as habitat pollution and changes in the water regime.In the following table (Table11.5) the estimated negative impacts of the Plan on conservation goals and the integrity of the area of the ecological network, as well as the evaluation of the impact after the implementation of the mitigation measures in the Plan, are listed.

Table11.5Measures to mitigate the Plan's negative impacts on conservation goals and the integrity of the ecological network area

Influence	Mitigation measures	Final impact assessment
Loss and fragmentation of target habitats and habitats of target species	For areas of the ecological network smaller than 5000 ha (Table 5.2), limit the implementation of the Plan in such a way that exploratory drilling and exploitation of geothermal water are not carried out within these areas, and recording of 2D and 3D seismic in the areas of the ecological network is carried out only on existing roads.	0
	When planning the activities of the Plan, that is, at the intervention level, collect data on the distribution of target species and habitat types of the ecological network area in the area and in the vicinity of the intervention (according to the Decree on the Ecological Network and the Competencies of Public Institutions for the Management of Ecological Network Areas (Official Gazette 80/19) and in accordance with based on the data, exploratory drilling and exploitation of geothermal water and 2D and 3D seismic recording should be planned outside the area of distribution of the target habitat types and habitats suitable for the target species (Table 5.3, Table 5.4 and Table 5.5).	
	Exploratory drilling and exploitation of geothermal water should be moved 500 m away from habitat type 8310 Caves and pits closed to the public. The protection zone of 500 m does not only refer to the entrance position of the habitat type (cave or pit opening), but also to its underground distribution. Before carrying out the works, it is necessary to determine the position and direction of the cave channels.	
Harassment of target species	2D and 3D seismic recording and vegetation removal work should be performed outside the reproductive period of the target species of birds and bats.	-1
	In accordance with good practice, use techniques and equipment to dampen noise from geothermal facilities (e.g. temporary noise shields around part of the drilling equipment and around standard equipment and tools, mobile and fixed acoustic barriers, geothermal power plants with internal noise-absorbing walls, etc.) .	
	Control the noise level directly at its source.	
	For lighting during the operation of the geothermal power plant, use environmentally friendly lamps, with a beam of light directed towards the ground and minimal scattering in other directions.	
Suffering of target species	Also, the planned electrical energy systems related to the implementation of the Plan should be carried out in such a way as to protect birds and bats from collision and electrocution in accordance with the latest scientific and professional guidelines, recommendations and special conditions for the protection of the environment and nature.	0
	Install suitable protective elements to prevent the entry of fauna (smaller fauna, eg amphibians) into the collection pit for the collection of waste water, the pit for the	

	reception of geothermal water during production testing of the well, the "sand-trap" and into the leach pit.	
Changing the water regime	For areas of the ecological network that have been set aside for the purpose of preserving target habitat types and species related to aquatic ecosystems, exploratory drilling, exploitation of geothermal water, use of water from natural watercourses and lakes in the immediate vicinity of the watercourse (within 250 m of the watercourse), as well as in the areas where the target habitat types and habitats of target species related to aquatic ecosystems. Heavy machinery is not allowed to move within 250 m of the watercourse for the purposes of 2D and 3D seismic recording, except on existing roads.	0
	Adhere to the usual practices of working with geothermal energy by re-injecting water, that is, wherever possible, return the obtained geothermal water through an injection well back into the reservoir, in order to avoid changes in the water regime.	
Habitat pollution	Proper organization of the work space and compliance with building regulations and conditions prevent accidental situations (such as the accidental release or disposal of excess hazardous construction materials and chemicals into inland waters, breakdowns of construction machinery and tools, and leakage of a large amount of geothermal water due to valve damage) and also prevent failures in the organization workplace, such as the absence of a surface water drainage system, the absence of an adequate solution for sanitary waste water from the workplace, improper handling and storage of petroleum products, oils and lubricants, and increased amounts of construction, communal and hazardous waste that can be leached into groundwater.	0
	In the case when the technology with two wells (exploitation and injection) is not applied, the geothermal water that is discharged into the recipient should be processed in such a way that it does not change the physical-chemical properties of the recipient (temperature, chemical composition, etc.).	

The main assessment prescribes mitigation measures with the aim of mitigating possible negative impacts on conservation goals and the integrity of the ecological network area, and by implementing them in the Plan, the possibility of significantly negative impacts on the conservation goals and the integrity of the ecological network area can be excluded.

12 Data sources

1.9 Scientific papers

Armstrong, KN (2010): Assessing the short-term effect of minerals exploration drilling on colonies of bats of conservation significance: a case study near Marble Bar, Western Australia. Journal of the Royal Society of Western Australia, 93: 165-174.

Bašić F. (1994): Classification of soil damage in Croatia. Agronomic Gazette 3-4/94

Berrizbeitia, LD (2014). Environmental Impacts of Geothermal Energy Generation and Utilization, Volcanos of the Eastern Sierra Nevada – G190 Hamburger, June 16, 2014. Świątek, L., (2020) A case study of geothermal resources use for the innovative aquaculture from the perspective of syntropic development concept . International Journal of Energy Production and Management, 5(1), pp.60-69.

Blum WEH (2005): Functions of Soil for Society and the Environment. Reviews in Environmental Science and Bio/Technology 4 (3), 75–79.

Bognar A. (2001): Geomorphological regionalization of Croatia, Acta Geographica Croatica, 34, 7-29

Bogunović M., Vidaček Ž., Racz Z., Husnjak S., Sraka M. (1996): Dedicated pedological map of the Republic of Croatia, scale 1:300,000. University of Zagreb, Faculty of Agriculture, Department of Pedology

Bogunović M., Vidaček Ž., Racz Z., Husnjak S., Sraka M. (1997): Dedicated pedological map of the Republic of Croatia and its use. Agronomic Bulletin 59 (5-6), 363-39

Brkić, Ž., Biondić, B. (2000):The Sava aquifer and its hydrogeological features, Proceedings: Round table - Hydrology and water resources of the Sava in new conditions Croatian Hydrological Society, Croatian Society for Drainage and Irrigation, 217-227, Zagreb.

Brkić, Ž., Mayer, D. (2005):Investigation of fresh groundwater in the Republic of Croatia, Scientific and professional newsletter of the Croatian Association of Petroleum Engineers and Geologists, INA - Industrija nafte dd, 1-14, Zagreb

Čubrić, S. (2012): Basic features of the hydraulic model of the Velika Ciglena geothermal reservoir, Nafta 63 (5-6) 180-184 (2012)

Dzaja Grgicin V., Jericevic, A., Prtenjak MT, Vidic S., Bloeman H. (2014): Analyzes and Source identification of PM10 concentrations during episodes of air pollution in central and southeastern European areas. Proceedings form 9th Int. Conf. On Air Quality – Science and Application, Garmisch-Partenkirchen, Germany 24 – 28 March 2014, 249

Fritschle, T., Daly, S., Whitehouse, MJ, McConnell, B., Buhre, S. (2014): Geothermal potential of Caledonian granites from the Iapetus Suture Zone in Ireland and the Isle of Man. 5th European Geothermal PhD Day – Abstracts, 31 March – 2 April 2014, p. 37, Darmstadt.

Gaurina-Međimurec, N.; Pašić, B.; Mijić, P.; Medved, I. (2021): Drilling Fluid and Cement Slurry Design for Naturally Fractured Reservoirs. Applied Sciences-Basel, 11(2021), 2, 767, 1-31; doi:10.3390/app11020767

Goldstein, BA, Hill, AJ, Long, A., Budd, AR, Ayling, B., Malavazos, M. (2009): Hot rocks down under – evolution of a new energy industry, Geothermal Resources Council Transactions 33, 185 – 198.

Golub, M., Križ, J., Cazin, V. (2016): Geothermal energy, in: Croatian natural resources, Croatian Academy of Sciences and Arts, 15-27, Zagreb

Granić, G. (vp) (2018): Analyzes and basis for the development of the energy strategy of the Republic of Croatia, Green Book, Draft, Energy Institute Hrvoje Požar (EIHP), Zagreb

Held, S., Genter, A., Kohl, T., Kölbel, T., Sausse, J., Schoenball, M., (2014): Economic evaluation of geothermal reservoir performance through modeling the complexity of the operating EGS within : Soultz-sous-Forêts. Geothermics, 51, pp. 270-280.

Herak, M., Allegretti, I., Herak, D., Ivančić, I., Kuk, V., Marić, K., Markušić, S., Sović, I. (2011): Republic of Croatia. Map of earthquake areas

Jeričević, A., Džaja Grgičin, V., Telišman Prtenjak, M., Vidič S., Bloemen H. (2016): Analyzes of urban and rural particulate matter mass concentrations in Croatia in the period 2006-2014, Geofizika Vol. 33, No. 2, 2016, pp. 119-210

Jeričević, A., Ilyin, I, Vidič, S. (2011): Modeling of Heavy Metals: Study of Impacts Due to Climate Change, National Security and Human Health Implications of Climate Change, Ch. 15., NATO Science for Policy and Security Series-C. Environmental Security, Springer, ed. HJS Fernando et al., ISBN 978-94-007--2429-7, pp. 175-189.

Klemenčić, M. (1990): The process of evaluating the age composition of the population, Radovi, 25, 73-80

Marković, T., Sladović, Ž., Larva, O., Brkić, Ž. (2020): Delineation and characterization of geothermal groundwater bodies in the Republic of Croatia, Croatian Geological Institute, Institute of Hydrogeology and Engineering Geology (HGI), Zagreb

Mayer, D. (2012): Croatian underground waters, Proceedings of the round table: Forests, soil and water - invaluable natural resources of Croatia, HAZU - Scientific Council for Agriculture and Forestry and Scientific Council for Nature Protection, 91-108, Zagreb

Majer, EL; Baria, R.; Stark, M:; Oates, S.; Bommer, J.; Smith, B.; et al. (2007): Induced seismicity associated with Enhanced Geothermal Systems. Geothermics. 2007; 36: 185-222

Nejašmić, I. (2005): Demogeography: population in spatial relations and processes, Školska knjiga, Zagreb

Ostman, D., 2015. A New Approach for Assessing Landscape Impacts of Geothermal Power Plants: A Case Study of Hellisheiði (Doctoral Dissertation).

Pekaš, Ž., Brkić, Ž. (2007):Pumping station of the Eastern Slavonia Regional Waterworks - results of thirty years of research, Croatian waters and the European Union - challenges and opportunities, University Press, 787-796, Zagreb

Piljek M., Dzaja Grgicin V., Jericevic, A., Vidic S., Patarcic M., Srnec L., Guettler I., Brankovic C. (2014): Climate change effects on Urban Air Quality. Proceedings form 9th Int. Conf. On Air Quality – Science and Application, Garmisch-Partenkirchen, Germany 24 – 28 March 2014, 232

Pisoni, E., Guerreiro, C., Lopez-Aparicio, S., Guevara, M., Tarrason, L., Janssen, S., Thunis, P., Pfafflin, F., Piersanti, A., Briganti, G. ., Cappelletti, A., D'Elia, I., Mircea, M., Villani, G., Vitali, L., Matavž, L., Rus, M., Žabkar, R., Kauhaniemi, M., Karppinen , A., Kousa, A., Vakeva, O., Eneroth, K., Stortini, M., Delaney, K., Struzewskam, J., Durka, P., Kaminski, JW, Krmpotic, S., Vidic, S., Belavic, B., Brzoja, D., Milic, V., Assimakopoulos, VD, Fameli, KM, Polimerova, T., Stoyneva, E., Hristova, Y., Sokolovski, E., Cuvelier, C. (2019): Supporting the improvement of air quality management practices: The "FAIRMODE pilot" activity, Journal of Environmental Management, Volume 245, 1 September 2019, Pages 122-130

Potter, PA (2018): Making the Connection for Well Control on Floaters: Evolving Design Rationales for BOP Control Systems, Book Chapter, IntechOpen, htttp://dx.doi.org/10.5772/intechopen.77998

Rybach, L. (2002). Umweltaspekte der geothermishen Stromerzeugung (Ecological aspects of geothermal energy production). VDI-Berichte 1703, 127–138.

Rybach, L. (2003). Geothermal energy: sustainability and the environment, Geothermics 32 (2003) 463–470.

Šegota T., Filipčić A. (2003): Köppen climate division and Croatian nomenclature, Geoadria, vol. 8/1, 17–37, Zadar

Škrlec, M., Kolbah, S. Živković, S., Tumara, D. (2019): Use of geothermal energy resources in the Republic of Croatia, Nafta i Plin, Vol.39, 159-160, Zagreb

Šumanovac, F., Hegedus, E., Orešković, J., Kolar, S., Kovacs, AC, Dudjak, D. & Kovacs, I. (2016): Passive seismic experiment and receiver functions analysis to determine crustal structure at the contact of the northern Dinarides and southwestern Pannonian Basin, Geophys. J., 205, 1420–1436.

Vukelic, J., Raus, Đ. (1998): Forestry phytocenology and forest communities in Croatia, University of Zagreb, Faculty of Forestry, Zagreb.

1.10 Internet databases

Agency for Payments in Agriculture, Fisheries and Rural Development (APPRRR), Presentation of the number and area of ARKOD by settlements and type of agricultural land use for 2021, Accessed: January, 2022.

Agency for Payments in Agriculture, Fisheries and Rural Development (APPRRR), Presentation of the number and area of ARKOD and the number of PG with regard to the size and headquarters of PG for 2021, Accessed: January, 2022.

Agency for Payments in Agriculture, Fisheries and Rural Development (APPRRR), Register of farmers - PG number for 2021, Accessed: January, 2022.

Agency for Hydrocarbons (AZU), Geological survey of land, https://www.azu.hr/istraživanje-i-eksploatacija/geološki-pregled-kopna/, Accessed: March, 2022.

Agency for Hydrocarbons (AZU), Geoterme, https://www.azu.hr/geoterme/, Accessed: March, 2022.

ARKOD, http://preglednik.arkod.hr/, Accessed: January, 2022.

Environmental Atlas, http://envi-portal.azo.hr/atlas, accessed: January, 2022.

Bioportal, http://www.bioportal.hr/gis/, Accessed: January, 2022.

Corine Land Cover, https://land.copernicus.eu/pan-european/corine-land-cover, Accessed: January, 2022.

State Hydrometeorological Institute (DHMZ),https://meteo.hr/,Accessed: February, 2022.

State Bureau of Statistics (DZS), https://www.dzs.hr/, Accessed: January, 2022.

Records of discarded waste locations (ELOO), https://eloo.haop.hr/public/izvjestaji, Accessed: February, 2022.

Geoportal of the State Geodetic Administration (DGU), https://geoportal.dgu.hr/, Accessed: January, 2022.

FCD:https://hirc.botanic.hr/fcd/, Accessed: February, 2022.

City of Bjelovar, https://www.bjelovar.hr/u-bjelovaru-otvoreno-novo-kogeneracija-postrojenje-na-drvnu-biomasu/, Accessed: March 2022.

Geothermal Engineering Ltd. (GEL), https://geothermalengineering.co.uk/wp-content/uploads/2021/10/Noise-FAQ.pdf, Accessed: April 2022.

Croatian Environment and Nature Agency: Map of observations of invasive alien species,https://invasivnevrste.haop.hr/karta, Accessed: April, 2022.

Croatian Energy Regulatory Agency, https://www.hera.hr/hr/html/registar_dozvola_20.html, Accessed: April, 2022.

Croatian Chamber of Commerce (HGK), Evaluation and classification of local and regional (regional) self-government units according to the level of development, https://www.hgk.hr/documents/potpomognuta-podrucjapo-zupanijama5adf24a09fb4e.pdf, Accessed: February, 2022.

Croatian Agricultural Agency (HPA), https://hpa.mps.hr/jrdz-izvjestaji/broj-domacih-zivotinja/, Accessed: January, 2022.

Croatian Forests, http://javni-podaci.hrsume.hr/, Accessed: February, 2022.

Croatian Employment Service, Statistics online,https://statistika.hzz.hr/, Accessed: January, 2022.

Croatian Institute for Public Health, Croatian Health and Statistical Yearbook for 2020, https://www.hzjz.hr/hrvatski-zdravstveno-statisticki-ljetopis/hrvatski-zdravstveno-statisticki-ljetopis-za-2020-tablicni-podaci/ , Accessed: February, 2022.

Unique information system of mineral resources of the Republic of Croatia, https://jisms.gospodarstvo.gov.hr/#/maps, Accessed: February, 2022.

Ministry of Economy and Sustainable Development (MINGOR), Working documents Conservation objectives from 04/26/2022. and Refined Conservation Goals, https://www.dropbox.com/sh/3r4ozk30a21xzdz/AADuvuru1itHSGC_msqFFMAMa?dl=0 , Accessed: April 2022.

Register of Cultural Properties of the Republic of Croatia, https://registar.kulturnadobra.hr/#/, Accessed: January, 2022.

Register of Environmental Pollution (ROO), http://roo.azo.hr/rpt.html, Accessed: February, 2022.

Register of business entities, https://digitalnakomara.hr/hr, Accessed: January, 2022.

The Government's official website for timely and accurate information about the coronavirus, https://www.koronavirus.hr/, Accessed: April, 2022.

Central hunting records,https://sle.mps.hr/, Accessed: February, 2022.

Zagreb holding, Water supply and drainage branch, Price of water Republic of Croatia, Economy, www.vio.hr/default.aspx, Accessed: March, 2022.

Web application: Geological map of Croatia 1:300,000, http://webgis.hgi-cgs.hr/gk300/default.aspx, Accessed: January 2022.

What is the difference between 2D and 3D seismic?, Source: https://thelundingroup.com/lundin-group-of-companies/reports-from-the-field/what-is-the-difference-between-2d-and -3d-seismic/, Accessed: July, 2022.

1.11 Laws, decrees, regulations, decisions

Law on Environmental Protection (OG 80/13, 153/13, 78/15, 12/18, 118/18)

Law on Nature Protection (OG 80/13, 15/18, 14/19, 127/19)

Law on Waste Management (OG 84/21)

Law on Exploration and Exploitation of Hydrocarbons (Official Gazette 52/18, 52/19, 30/21)

Law on Hunting (OG 99/18, 32/19, 32/20)

Law on Agricultural Land (Official Gazette 20/18, 115/18, 98/19, 57/22)

Law on Regional Development of the Republic of Croatia (OG 147/14 and 123/17)

Law on Mining (OG 56/13, 14/14, 52/18, 115/18, 98/19)

Law on Forests (OG 68/18, 115/18, 98/19, 32/20, 145/20)

Law on Water (Official Gazette 66/19, 84/21)

Law on communal economy (Official Gazette 68/18, 110/18, 32/20)

Law on Aquaculture (OG 130/17, 111/18, 144/20)

Law on the Protection and Preservation of Cultural Property (Official Gazette 69/99, 151/03, 157/03, 100/04, 87/09, 88/10, 61/11, 25/12, 136/12, 157/13, 152 /14 , 98/15, 44/17, 90/18, 32/20, 62/20, 117/21)

Law on Protection from Noise (Official Gazette 30/09, 55/13, 153/13, 41/16, 114/18 and 14/21)

Law on protection against light pollution (OG 14/19)

Air Protection Act (OG 127/19, 57/22)

Regulation on the ecological network and the competences of public institutions for the management of ecological network areas (Official Gazette 80/19)

Regulation on the Development Index (Official Gazette 131/17)

Regulation on determining zones and agglomerations according to air pollution levels on the territory of the Republic of Croatia (Official Gazette 1/14)

Regulation on levels of pollutants in the air (Official Gazette 77/2020)

Regulation on determining the list of measuring points for monitoring the concentrations of certain pollutants in the air and the location of measuring stations in the state network for permanent monitoring of air quality (Official Gazette 107/22)

Regulation on water quality standards (Official Gazette 96/19)

Decree on Classification of Railways (Official Gazette 84/2021)

Rulebook on agricultural land use records (Official Gazette 54/19, 126/19, 147/20)

Rulebook on methodology for monitoring the state of agricultural land (Official Gazette 47/19)

Rulebook on criteria for determining particularly valuable arable (P1) and valuable arable (P2) agricultural land (Official Gazette 23/19)

Rulebook on agrotechnical measures (Official Gazette 22/19)

Rulebook on waste management (OG 81/20)

Rulebook on waste water emission limit values (Official Gazette 26/20)

Rulebook on the method of creating and content of noise maps and action plans and on the method of calculating permitted noise indicators (Official Gazette 117/2018)

Ordinance on the highest permissible noise levels with regard to the type of noise source, time and place of occurrence (Official Gazette 143/21)

Rulebook on the list of habitat types and habitat map (OG 27/21)

Rulebook on air quality monitoring (Official Gazette 72/20)

Rulebook on the Register of Environmental Pollution (Official Gazette 80/13, 78/15, 03/22)

Rulebook on the content, method of preparation and procedure for adoption, i.e. approval of the hunting management basis, game breeding program and game protection program (Official Gazette 40/06, 92/08, 39/11 and 41/13)

Ordinance on Strictly Protected Species (Official Gazette 144/2013, 73/16)

Rulebook on the conditions for establishing zones of sanitary protection of springs (Official Gazette 66/11, 47/13)

Rulebook on determination of reserves and exploitation of mineral resources (Official Gazette 46/18)

Rulebook on the protection of agricultural land from pollution (Official Gazette 71/19)

Rulebook on lighting zones, permissible lighting values and methods of managing lighting systems (Official Gazette 128/2020)

Rulebook on conservation goals and conservation measures of target bird species in ecological network areas (Official Gazette 25/20, 38/20)

Decision on the National Classification of Activities 2007 - NKD 2007 (OG 58/07)

Decision on Designation of Sensitive Areas (Official Gazette 81/10, 141/15)

Decision on determining the area of waters suitable for the life of freshwater fish (Official Gazette 33/11)

1.12 Conventions, charters, agreements and protocols

Convention on access to information, public participation in decision-making and access to justice in environmental matters Aarhus (1998) (NN – MU 10/01).

Protocol on Strategic Environmental Assessment, Kyiv (2003) (NN-MU 3/10.)

Convention on Environmental Impact Assessment across State Borders (Espoo, 1991) (NN-MU 6/96, 07/08)

European Green Plan

UN Framework Convention on Climate Change (UNFCCC, 1992) (NN-MU 02/96)

UN Framework Convention on Climate Change (UNFCCC, 1992) (NN-MU 02/96)

Paris Agreement on Climate Change (2015) (NN-MU 3/17)

EU Strategy for Adaptation to Climate Change

Convention on Biological Diversity, Rio de Janeiro (1992) (NN-MU 6/96)

Convention on the Protection of European Wild Species and Natural Habitats - Bern Convention, Bern (1979) (NN-MU 6/2000)

Convention on European Landscapes Firenze (2000) (NN-MU 12/02)

Convention on the Protection of World Cultural and Natural Heritage, UNESCO (1972) (NN-MU 12/93)

1.13 Strategies, plans and programs

Integrated national energy and climate plan for the Republic of Croatia (for the period from 2021 to 2030)

National Development Strategy of the Republic of Croatia until 2030 (Official Gazette 13/21)

National forestry policy and strategy (OG 120/03)

National Recovery and Resilience Plan 2021-2026

Waste management plan of the Republic of Croatia for the period 2017-2022 (Official Gazette 3/17)

Water area management plan 2016 - 2021 (OG 66/16)

Program for energy renovation of family houses for the period 2021-2030.

Program for energy renovation of multi-apartment buildings for the period 2021-2030.

Program of energy renovation of public sector buildings for the period 2021-2030.

Energy renovation program of buildings with the status of protected cultural property for the period 2021-2030.

Air pollution control program for the period from 2020 to 2029 (OG 90/19)

Program for measuring the level of pollution in the state network for permanent monitoring of air quality (Official Gazette 73/2016)

Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 25/20)

Strategy and action plan for nature protection of the Republic of Croatia for the period from 2017 to 2025 (Official Gazette 72/17)

Low-carbon development strategy of the Republic of Croatia until 2030 with a view to 2050 (Official Gazette 63/21)

Agriculture strategy for the period from 2020 to 2030

Climate change adaptation strategy in the Republic of Croatia for the period up to 2040 with a view to 2070 (Official Gazette 46/20)

Transport Development Strategy of the Republic of Croatia for the period from 2017 to 2030 (Official Gazette 84/17)

Spatial Development Strategy of the Republic of Croatia (OG 106/17)

Tourism Development Strategy of the Republic of Croatia until 2020 (Official Gazette 55/13)

Water management strategy, Zagreb, 2009.

Forest management basis of the territory of the Republic of Croatia (2016 – 2025)

1.14 Publications

Andersen, H., Vigrestad, A. and Kuru, E., 2009, February. Hydraulic optimization of aerated mud drilling for maximum drilling rate. In IADC/SPE Managed Pressure Drilling and Underbalanced Operations Conference & Exhibition. OnePetro.

Baseline, P. et.al., (2020): Proposal for a harmonized procedure on the Environmental Impact Assessment for geothermal development in Europe, GEOENVI, a publication published as a collection of works within the EU Horizon 2020 research and innovation program.

Bralić, I. (1999): Landscape differentiation and evaluation with regard to natural features, Landscape: Content and Methodological Basis of Landscape Basics of Croatia, Faculty of Agriculture, University of Zagreb - Department of Ornamental Plants and Landscape Architecture, Ministry of Spatial Planning, Construction and Housing – Institute for Spatial Planning, Zagreb, p. 101-109

DHMZ, Assessment of air quality in Croatia 2011-2015, Department for Air Quality, Zagreb, November 2017.

DHMZ, Assessment of air quality in the territory of the Republic of Croatia 2016-2020. (draft, under construction), 2022.

DHMZ, Assessment of air quality in the territory of the Republic of Croatia in the period 2006-2010. year, 2012

EC guidelines: The European Commission (2012): Non paper guidelines for project managers: making vulnerable investments climate resilient

Elaborate on environmental protection in the evaluation process on the need to assess the impact on the environment of geothermal water exploitation for energy purposes, (2016), Ecomission, Varaždin

Environmental protection report for the assessment of the need for an environmental impact assessment, exploratory well at the geothermal water exploration area "Kotoriba", municipality of Kotoriba and municipality of Donja Dubrava, (2018), Dvokut ecro, Zagreb

Elezović, I.; Škrlec, M.; Kolbah, S. (2018): Constructions of production geothermal wells in Croatia, Nafta i plin, Vol. 38, No. 155, 60-78.

Franković, M.; Belančić, A.; Bogdanović, T.; Ljuština, M.; Mihoković, N. & Vitas, B. (2008), Red Book of Dragonflies of Croatia, Ministry of Culture of the Republic of Croatia, State Institute for Nature Protection, Zagreb, Croatia.

Frolova, M., Centeri, C., Benediktsson, K., Hunziker, M., Kabai, R., Scognamiglio, A., Martinopoulos, G., Sismani, G., Brito, P., Muñoz-Cerón, E and Słupiński, M., 2019. Effects of renewable energy on landscape in Europe: Comparison of hydro, wind, solar, bio-, geothermal and infrastructure energy landscapes. Hungarian Geographical Bulletin, 68(4), pp.317-339.

Gaurina-Međimurec, N., Pašić, B. (2009): Aphron-Based Drilling Fluids: Solution for Low Pressure Reservoirs. Mining-Geological-Petroleum Engineering Bulletin, vol. 21, 65-72.

Gaurina-Međimurec, N., Pašić, B. (2009): Aphron-Based Drilling Fluids: Solution for Low Pressure Reservoirs. Mining-Geological-Petroleum Engineering Bulletin, vol. 21, 65-72.

Gaurina-Međimurec, N., Matanović, D., Krklec. G. (1994): Cement Slurries for Geothermal Wells Cementing, Mining-Geological-Petroleum Engineering Bulletin, vol. 6, 127-134.

Gaurina-Međimurec, N., Simon, K., Matanović, D., Pašić, B. (2006): Underbalanced Drilling Technology. Mining-Geological-Petroleum Engineering Bulletin, volume 18, 81-95.

Gottstein, S.; Hudina, S.; Lucić, A.; Maguire, I.; Ternjej, I. & Žganec, K. (2011), 'Red list of crustaceans (Crustacea) of fresh and brackish waters of Croatia', Technical report, State Institute for Nature Protection, Zagreb, Rooseveltov trg 6, Zagreb.

Hochwimmer, A., de Kretser, S., (2015) Safety by design processes for the engineering of geothermal facilities. Safety, 19, p.25.

Hole, H. (2008): Drilling Fluids for Drilling of Geothermal Wells, Petroleum Engineering Summer School, Dubrovnik, Croatia. Workshop #26 June 9-13, 1-8.

Matić, Z. (2007): Solar radiation in the territory of the Republic of Croatia, Manual for energy use of solar radiation. Energy Institute Hrvoje Požar, Zagreb, pp. 475.

Mekinić, S., Jelić, K. (2015): The Red Book of Amphibians and Reptiles of Croatia, State Institute for Nature Protection, Zagreb

Mrakovčić M., Brigić A., Buj I., Ćaleta M., Mustafić P., Zanella D. (editors) (2006). The Red Book of Freshwater Fishes of Croatia. Ministry of Culture, State Institute for Nature Protection, Zagreb
Nikolić T., Mitić B., Boršić I. (2014). Flora of Croatia - Invasive plants. Alfa dd, Zagreb

Niyazi, A. (2007): Optimization of downhole pump setting depths in liquid dominated geothermal systems: a case study on the Balcova-Narlidere field, Turkey. Geothermics 36, 436-458.

Otte C., Pye DS, Stefanides NJ (1990): The Applicability of Geothermal Drilling Experience to Super-Deep Drilling. In: Fuchs, K., Kozlovsky, YA, Krivtsov, AI, Zoback, MD (eds), Super-Deep Continental Drilling and Deep Geophysical Sounding, Exploration of the Deep Continental Crust, Springer, Berlin, Heidelberg.

Pašić, B., Gaurina-Međimurec, N., Matanović, D. (2007): Wellbore Instability: Causes and Consequences. Mining-Geological-Petroleum Engineering Bulletin (Rudarsko-geološko-naftni zbornik), volume 19, 87-98.

DHMZ publications: https://meteo.hr/proizvodi.php?section=publikacije¶m=publikacije_publikacije_dhmz

Pravica, Z., Kulenović, I., Golub, M. (2006): Ecological aspects of geothermal energy exploitation, Energy and Environment 2006 Vol. // / Franković, B. (ed.). Rijeka: Croatian Association for Solar Energy, 207-214.

Roth, M., Eiter, S., Röhner, S., Kruse, A., Schmitz, S., Frantal, B., Centeri, C., Frolova, M., Buchecker, M., Stober, D. and Karan, I., 2018. Renewable energy and landscape quality. Pan, 128, pp. 2-2.

Saleh, FK, Teodoriu, C., Ezeakacha, Ch. P., Salehi, S. (2020): Geothermal Drilling: A Review of Drilling Challenges with Mud Design and Lost Circulation Problem, Proceedings, 45th Workshop on Geothermal Reservoir Engineering Stanford University, Stanford, California, February 10-12, 2020 SGP- TR-214, 1-8

Sofilić T. (2014): Soil pollution and protection, University of Zagreb, Faculty of Metallurgy

Stojanac, D. (1990): Contribution to the technique of drilling wells using nitrogen-enriched drilling fluid with special reference to the VC-1 well, professional paper, INA-Naftaplin, Zagreb.

Šašić M., Mihoci I, Kučinić M. (editors) (2015). The Red Book of Day Butterflies of Croatia. Ministry of Environment and Nature Protection, State Institute for Nature Protection, Croatian Museum of Natural History, Zagreb

Thain, I., Reyes, AG, Hunt, T. (2006): A Practical Guide to Exploiting Low Temperature Geothermal Resources, GNS Science Report 2006/09. 76 p.

Torres, A. (2014): Challenges of Casing Design in Geothermal Wells. Asia Pacific Drilling Technology Conference held in Bangkok, Thailand, 25.-27. August 2014, IADC/SPE-170480-MS 13.

Tutiš, V., Kralj, J., Radović, D., Ćiković, D., Barišić, S. (ed.) (2013): Red book of the birds of Croatia. Ministry of Environment and Nature Protection, State Institute for Nature Protection, Zagreb

Tvrtković N. (editor) (2006). The Red Book of Mammals of Croatia. Ministry of Culture, State Institute for Nature Protection, Zagreb

Velić, I. and Vlahović, I. (eds.): Interpreter of the Geological Map of the Republic of Croatia 1:300,000, Croatian Geological Institute, Institute of Geology, Zagreb.

Zaninović, K., Gajić-Čapka, M., Perčec Tadić, M. et al, 2008: Klimatski atlas Hrvatske / Climate atlas of Croatia 1961–1990, 1971–2000. State Hydrometeorological Institute, Zagreb, 200 pages

Zarrouk Sadiq, J., Mclean, K. (2019): Geothermal Well Test Analysis: Fundamentals, Applications and Advanced Techniques. Academic Press, Elsevier

1.15 Reports

Annual report on air quality monitoring in the Republic of Croatia for 2016, HAOP, 2017.

Report on municipal waste for 2020, MINGOR 2021.

Report on data from the Environmental Pollution Register for 2020, MINGOR 2021.

Report on air quality monitoring in the Republic of Croatia for 2017, HAOP, 2018.

Report on air quality monitoring in the Republic of Croatia for 2018, MZOE, 2019.

Report on air quality monitoring in the Republic of Croatia for 2019, MINGOR, 2020.

Report on air quality monitoring in the Republic of Croatia for 2020, MINGOR, 2021.

Kagel, A., Bates, D., & Gawell, K. (2005): A guide to geothermal energy and the environment, United States. https://doi.org/10.2172/897425

The fifth national report of the Republic of Croatia according to the UN Framework Convention on Climate Change (UNFCCC)- selected chapters

Damage to the forest ecosystems of the Republic of Croatia, report for 2020, Croatian Forestry Institute, 2021.

Seventh national report of the Republic of Croatia according to the UN Framework Convention on Climate Change (UNFCCC) - selected chapters

Sixth national report of the Republic of Croatia according to the UN Framework Convention on Climate Change (UNFCCC) - selected chapters

1.16 The rest

Groundwater Directive - 2006/118/EC

EGPV – hydrogeological data base of the Faculty of Mining, Geology and Petroleum, University of Zagreb

Gaurina-Međimurec, N. (2022) Elaborate on the technology of making and equipping geothermal wells and the possible impacts of making wells on the environment (as part of the strategic environmental impact assessment of the Geothermal Potential Development Plan of the Republic of Croatia), Zagreb

Geological map of the Republic of Croatia 1:300,000, Croatian Geological Institute, Department of Geology

HEP Distribution System Operator doo (2021): Annual report for 2020.

Hrvatske vode - Data submitted through an official Request for Access to Information

IGU (1968): Project of a unique key for a detailed geomorphological map of the world

Ministry of Economy and Sustainable Development. 2020 Annual Energy Review "Energy in Croatia 2020", Zagreb

Water Framework Directive - 2000/60/EC

Sub-activity 2.3.1.: Report on estimated impacts and vulnerability to climate change by individual sectors, SAFU, 2017

Ministry of the Interior (2022): Proposal for a mine action plan for 2022

Results of climate modeling on the HPC Velebit system for the purposes of drafting the Climate Change Adaptation Strategy of the Republic of Croatia until 2040 with a view to 2070 and the Action Plan (Subactivity 2.2.1), SAFU, 2017.

Technical guidelines on the application of the principle of not causing significant damage within the framework of the Regulation on the Mechanism for Recovery and Resilience (2021/C 58/01)

Technical guidelines for preparing infrastructure for climate change in the period 2021-2027. (2021/C 373/01)

Regulation (EU) 2020/852 of the European Parliament and of the Council establishing a framework to facilitate sustainable investment and amending Regulation (EU) 2019/2088

13 Attachments

13.1 Decision on starting the strategic assessment procedure

Na temelju članka 63. Zakona o zaštiti okoliša (Narodne novine, br. 80/13, 153/13, 78/15, 12/18 i 118/18) i članka 5. stavka 2. Uredbe o strateškoj procjeni utjecaja strategije, plana i programa na okoliš (Narodne novine, br. 3/17) te Zakona o istraživanju i eksploataciji ugljikovodika (Narodne novine, br. 52/18, 52/19 i 30/21) i Odluke o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske (KLASA:310-01/21-03/67, 517-07-1-1-21-1 od 22. srpnja 2021. godine), Ministar donosi

O D L U K U

o započinjanju postupka strateške procjene utjecaja na okoliš

Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030 godine

Članak 1.

Donošenjem ove Odluke započinje postupak strateške procjene utjecaja na okoliš Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (u daljnjem tekstu: Plana).

Prema ovoj Odluci nositelj izrade Plana i nadležno tijelo za provođenje strateške procjene je Ministarstvo gospodarstva i održivog razvoja, dok je Agencija za ugljikovodike kao stručno tijelo, izrađivač Plana.

Članak 2.

Razlozi donošenja Plana iz članka 1. ove Odluke, kao i ciljevi, programska polazišta te obuhvat Plana navedeni su u Odluci o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske (KLASA 310-01/21-03/67, URBROJ 517-07-1-1-21-1).

Razlog izrade Plana je utvrđivanje geotermalnog potencijala Republike Hrvatske, a ciljevi su iskorištavanje obnovljivih izvora energije (geotermalna energija) te određivanje prostora, prihvatljivih tehnika istraživanja i eksploatacije, primjenjivih metoda u aktivnostima te način upotrebe geotermalne energije kod krajnjeg korisnika. U sadržajnom dijelu potrebno je definirati pojedine zahvate iz sadržajne strukture Plana, odrediti planske mjere, kriterije i uvjete za provedbu tih zahvata u prostoru te posvetiti u budućnosti veliku pažnju u racionalizaciji planskog i stvarnog korištenja u odnosu na stvarne potrebe i mogućnosti.

Područje obuhvata Plana su sljedeće županije: Karlovačka županija, Grad Zagreb, Zagrebačka županija, Međimurska županija, Krapinsko–zagorska županija, Varaždinska županija, Koprivničko–križevačka županija, Sisačko–moslavačka županija, Bjelovarsko–bilogorska županija, Virovitičko–podravska županija, Brodsko–posavska županija, Osječko–baranjska županija, Požeško–slavonska županija i Vukovarsko–srijemska županija.

Planom razvoja geotermalnog potencijala Republike Hrvatske osigurava se usklađenost sa strateškim opredjeljenjima i politikom Republike Hrvatske prema obnovljivim izvorima energije te smjernicama i ciljevima Europske Unije vezanim uz energetsku politiku te Europski zeleni plan.

S obzirom na to da navedeni Plan može imati određene utjecaje na sastavnice okoliša i okolišna opterećenja obuhvaćenog područja, a u svrhu sprječavanja pojave negativnih djelovanja, strateška procjena istih bit će izrađena integralnim i sustavnim pristupom obzirom na postojeće okolišne uvjete, poštujući nacionalni i europski zakonodavni okvir.

Članak 3.

Radnje koje će se provesti u postupku strateške procjene utjecaja Plana provode se sukladno odredbama Zakona o zaštiti okoliša (Narodne novine, 80/13, 153/13, 78/15, 12/18 i 118/18), Uredbe o strateškoj procjeni utjecaja strategije, plana i programa na okoliš (Narodne novine, 3/17), Uredbe o informiranju i sudjelovanju javnosti i zainteresirane javnosti u pitanjima zaštite okoliša (Narodne novine, 64/08) i odredbama posebnih propisa iz područja iz kojeg se Plan donosi (Prilog I).

Članak 4.

U okviru strateške procjene utjecaja Plana na okoliš provest će se glavna ocjena prihvatljivosti Plana za ekološku mrežu sukladno Rješenju Uprave za zaštitu prirode, Ministarstva gospodarstva i održivog razvoja (KLASA: UP/I-612-07/21-37/243, URBROJ: 517-10-2-3-21-2 od 3. rujna 2021. godine).

Članak 5.

U postupku strateške procjene prema ovoj Odluci sudjelovati će tijela i osobe koje su navedene u Prilogu II. ove Odluke.

Članak 6.

Nadležno tijelo je o ovoj Odluci dužno informirati javnost sukladno odredbama Zakona o zaštiti okoliša (Narodne novine, 80/13, 153/13, 78/15, 12/18 i 118/18) i odredbama Uredbe o informiranju i sudjelovanju javnosti i zainteresirane javnosti u pitanjima zaštite okoliša (Narodne novine, 64/08) kojima se uređuje informiranje javnosti i zainteresirane javnosti u pitanjima zaštite okoliša.

Članak 7.

Ova Odluka stupa na snagu danom donošenja, a objavit će se na službenim internetskim stranicama Ministarstva gospodarstva i održivog razvoja (https://mingor.gov.hr/) te Agencije za ugljikovodike (www.azu.hr).

KLASA: 310-01/21-03/67

URBROJ: 517-07-1-1-21-2

Zagreb, 8. rujna 2021. godine

REPUBLIKA HRVATSKA MINISTARSTVO GOSPODARSTVA I ODRŽIVOG RAZVOJA

MINISTAR

dr. sc. Tomislav Ćorić

13.2 Decision on content

Na temelju članka 68. stavka 3. Zakona o zaštiti okoliša („Narodne novine", br. 80/13, 153/13, 78/15 i 12/18) i članka 10. Uredbe o strateškoj procjeni utjecaja strategije, plana i programa na okoliš („Narodne novine", br. 3/17), ministar gospodarstva i održivog razvoja donosi

ODLUKU

o sadržaju strateške studije procjene utjecaja na okoliš za

Plan razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine

I.

Donošenjem ove Odluke utvrđuje se konačni sadržaj strateške studije utjecaja na okoliš za Plan razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (u daljnjem tekstu: Plan). Odluka se donosi u okviru postupka strateške procjene utjecaja na okoliš koji je započeo Odlukom o provođenju postupka strateške procjene utjecaja na okoliš za Plan razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (KLASA: 310-01/21-03/67, URBROJ: 517-07-1-1-21-2 od 8. rujna 2021. godine).

Polazišne osnove, razlozi i pravna osnova donošenja Plana

II.

Na temelju Strategije energetskog razvoja Republike Hrvatske do 2030. s pogledom na 2050. godinu („Narodne novine", broj 25/2020, a u vezi s člankom 5. stavkom 5. Zakona o istraživanju i eksploataciji ugljikovodika („Narodne novine", br. 52/18, 52/19 i 30/21), ministar gospodarstva i održivog razvoja donio je Odluku o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (KLASA:310-01/21-03/67, URBROJ: 517-07-1-1-21-1 od 22. srpnja 2021. godine).

Na temelju članka 63. Zakona o zaštiti okoliša („Narodne novine", br. 80/13, 153/13, 78/15, 12/18 i 118/18) i članka 5. stavka 2. Uredbe o strateškoj procjeni utjecaja strategije, plana i programa na okoliš („Narodne novine", br. 3/17) te Zakona o istraživanju i eksploataciji ugljikovodika („Narodne novine", br. 52/18, 52/19 i 30/21) i Odluke o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske (KLASA:310-01/21-03/67, URBROJ: 517-07-1-1-21-1 od 22. srpnja 2021. godine) ministar gospodarstva i održivog razvoja donio je Odluku o započinjanju postupka strateške procjene utjecaja na okoliš Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (KLASA: 310-01/21-03/67, URBROJ: 517-07-1-1-21-2 Zagreb od 8. rujna 2021. godine).

Razlozi donošenja su prvenstveno potreba za usklađivanjem sa Strategijom energetskog razvoja Republike Hrvatske do 2030. s pogledom na 2050. godinu i Zakonom o istraživanju i eksploataciji ugljikovodika.

Smjernice, ciljevi i mjere koji će se definirati Planom

III.

Ciljevi Plana su utvrđivanje geotermalnog potencijala Republike Hrvatske i iskorištavanje obnovljivih izvora energije (geotermalna energija) te određivanje prostora, prihvatljivih tehnika istraživanja i eksploatacije, primjenjivih metoda u aktivnostima te način upotrebe geotermalne energije kod krajnjeg korisnika. U sadržajnom dijelu potrebno je definirati pojedine zahvate iz sadržajne strukture Plana, odrediti planske mjere, kriterije i uvjete za provedbu tih zahvata u prostoru te posvetiti u budućnosti veliku pažnju u racionalizaciji planskog i stvarnog korištenja u odnosu na stvarne potrebe i mogućnosti.

Područje obuhvata Plana su sljedeće županije: Karlovačka županija, Grad Zagreb, Zagrebačka županija, Međimurska županija, Krapinsko–zagorska županija, Varaždinska županija, Koprivničko–križevačka županija, Sisačko–moslavačka županija, Bjelovarsko–bilogorska županija, Virovitičko–podravska županija, Brodsko–posavska županija, Osječko–baranjska županija, Požeško–slavonska županija i Vukovarsko–srijemska županija.

Planom razvoja geotermalnog potencijala Republike Hrvatske osigurava se usklađenost sa strateškim opredjeljenjima i politikom Republike Hrvatske prema obnovljivim izvorima energije te smjernicama i ciljevima Europske Unije vezanim uz energetsku politiku te Europski zeleni plan.

S obzirom na to da navedeni Plan može imati određene utjecaje na sastavnice okoliša i okolišna opterećenja obuhvaćenog područja, a u svrhu sprječavanja pojave negativnih djelovanja, strateška procjena istih bit će izrađena integralnim i sustavnim pristupom s obzirom na postojeće okolišne uvjete, poštujući nacionalni i europski zakonodavni okvir.

Konačno utvrđeni sadržaj strateške studije

IV.

Strateška studija treba sadržavati i poglavlje Glavne ocjene prihvatljivosti za ekološku mrežu, sukladno Rješenju Uprave za zaštitu prirode, Ministarstva gospodarstva i održivog razvoja (KLASA: UP/I-612-07/21-37/243, URBROJ: 517-10-2-3-21-2 od 3. rujna 2021. godine).

Strateška studija obvezno sadrži poglavlja:

1. kratki pregled sadržaja i glavnih ciljeva Plana razvoja geotermalnog potencijala Republike Hrvatske i odnosa s drugim odgovarajućim planovima i programima;
2. pregled postojećih podataka o stanju okoliša i moguć razvoj okoliša bez provedbe Plana razvoja geotermalnog potencijala Republike Hrvatske, koji mora sadržavati sljedeće:
    - geološke značajke i tlo - stratigrafija, tektonika, geofizika (potresi i geološki rizici), hidrogeologija, geomorfologija
    - kopnene vode (površinske, podzemne, vodonosnici) i more
    - klimatske značajke i kvaliteta zraka
    - vodna tijela vezana uz provedbu Plana

- bioekološke značajke - bioraznolikost, tipovi staništa, zaštićene i/ili ugrožene životinje i biljke, zaštićena područja
- stanovništvo i zdravlje
- materijalna dobra i ekonomske djelatnosti (npr. infrastruktura, poljoprivreda, lovstvo, šumarstvo, akvakultura, industrija, promet, turizam…)
- kulturna baština i krajobrazne značajke
- postojeća okolišna opterećenja;
- socioekonomske podatke

3. okolišne značajke područja na koja provedba Plana može značajno utjecati;
4. ciljeve zaštite okoliša i prirode uspostavljene po zaključivanju međunarodnih ugovora i sporazuma, koji se odnose na Plan, te način na koji su ti ciljevi i druga pitanja zaštite okoliša i prirode uzeti u obzir tijekom izrade Plana
5. postojeće okolišne probleme koji su važni za Plan, posebno uključujući one koji se odnose na područja posebnog ekološkog značaja, primjerice područja određena u skladu s posebnim propisima o zaštiti prirode;
6. opis i vrstu aktivnosti vezano uz istraživanje i eksploataciju geotermalnih voda koji se očekuju na predmetnom prostoru te njihov posljedični utjecaj na okoliš. Aktivnosti koje se očekuju tijekom istraživanja i eksploatacije uključuju istražno i eksploatacijsko bušenje, snimanje 2D i 3D seizmike, gradnja eksploatacijskih postrojenja i cjevovoda, proizvodnja otpada, izgradnja novih prometnica, održavanje, dekomisija (čišćenje i uklanjanje postrojenja). Ove aktivnosti mogu imati utjecaja na prirodu i širi okoliš na više načina: npr. buka koja se razvija tijekom snimanja seizmičkih mjerenja i bušenja, fizičko oštećenje tla i vegetacije te geoloških struktura, poremećaji u staništima te mogući gubitak staništa, povećana količina prašine uslijed povećanog transporta kamionima, zagađenje voda, tla i zraka i sl.;
7. opis postojećih mjera kontrole i zaštite, uključujući mjere sprječavanja, smanjivanja, ublažavanja i kompenzacije nepovoljnih utjecaja provedbe Plana razvoja geotermalnog potencijala Republike Hrvatske, te postojeće i predviđene mjere praćenja;
8. prepoznavanje vjerojatno značajnih utjecaja (sekundarni, kumulativni, sinergijski, kratkoročni, srednjoročni i dugoročni, stalni i privremeni, pozitivni i negativni) na okoliš, uključujući biološku raznolikost, ljude, biljni i životinjski svijet, tlo, vodu i upravljanje vodama, zrak, klimu, materijalnu imovinu, kulturno-povijesnu baštinu, krajobraz, uzimajući u obzir njihove međuodnose, a koje bi očekivane aktivnosti Plana mogle imati na okoliš te izdvajanje posebnih područja vezanih uz staništa programa Natura 2000;
9. procjena klimatskih promjena na području Plana, utjecaj na aktivnosti i procjena ranjivosti na klimatske promjene
10. predložene mjere kontrole, mjere prilagodbe, zaštite i praćenja stanja okoliša;
11. kratki prikaz razloga za odabir razmotrenih varijantnih rješenja, obrazloženje najprihvatljivijeg varijantnog rješenja Plana na okoliš i opis provedene procjene, uključujući i poteškoće (primjerice tehničke nedostatke ili nedostatke znanja i iskustva) pri prikupljanju potrebnih podataka;

12. Glavnu ocjenu prihvatljivosti za ekološku mrežu izrađenu sukladno Zakonu o zaštiti prirode koja sadrži sljedeća poglavlja:
    - podaci o ekološkoj mreži:
        - opis ekološke mreže na koje provedba strategije, plana ili programa može utjecati
        - kartografski prikaz područja ekološke mreže u odgovarajućem mjerilu sukladno mjerilu kartografskog prikaza strategije, plana ili programa
    - opis mogućih značajnih utjecaja provedbe strategije, plana ili programa na ekološku mrežu:
        - vjerojatnost, trajanje, učestalost, jačina i kumulativna priroda (procjena rizika) mogućih utjecaja provedbe strategije, plana ili programa na ekološku mrežu
    - prijedlog mjera ublažavanja negativnih utjecaja provedbe strategije, plana ili programa na ekološku mrežu
    - zaključak:
        - konačna ocjena prihvatljivosti strategije, plana ili programa za ekološku mrežu uz primjenu predloženih mjera ublažavanja
13. kratak sadržaj podataka iz gornjih navoda rječnikom prilagođen javnosti (ne-tehnički sažetak).

Pored navedenih obaveznih poglavlja, Strateška studija sadrži zahtjeve koji su utvrđeni prilikom određivanja sadržaja strateške studije u postupku prikupljanja mišljenja od tijela i/ili osoba određenih posebnim propisima i tijela jedinica područne (regionalne) samouprave.

Popis tijela i/ili osoba određenih posebnim propisima, koja su sudjelovala u postupku određivanja sadržaja strateške studije

V.

Na sadržaj strateške studije očitovalo se 14 od 20 tijela te su mišljenja odnosno prijedloge imala sljedeća tijela: Ministarstvo mora, prometa i infrastrukture, Ministarstvo regionalnog razvoja i fondova Europske unije, Ministarstvo poljoprivrede, Ministarstvo prostornoga uređenja, graditeljstva i državne imovine, Ministarstvo gospodarstva i održivog razvoja Uprava za zaštitu prirode, Ministarstvo gospodarstva i održivog razvoja Uprava za procjenu utjecaja na okoliš i održivo gospodarenje otpadom, Vukovarsko – srijemska županija, Zagrebačka županija, Sisačko – moslavačka županija, Virovitičko – podravska županija, Osječko – baranjska županija, Grad Zagreb, Požeško – slavonska županija, Varaždinska županija.

Popis tijela koja su sudjelovala u postupku određivanja sadržaja strateške studije:

1. Ministarstvo regionalnog razvoja i fondova Europske unije;
2. Ministarstvo gospodarstva i održivog razvoja, Uprava za zaštitu prirode
3. Ministarstvo gospodarstva i održivog razvoja, Uprava za procjenu utjecaja na okoliš i održivo gospodarenje otpadom;

4. Ministarstvo prostornoga uređenja, graditeljstva i državne imovine;
5. Ministarstvo mora, prometa i infrastrukture;
6. Ministarstvo poljoprivrede;
7. Grad Zagreb;
8. Zagrebačka županija;
9. Karlovačka županija;
10. Međimurska županija;
11. Krapinsko - zagorska županija;
12. Varaždinska županija;
13. Koprivničko – križevačka županija;
14. Sisačko – moslavačka županija;
15. Bjelovarsko – bilogorska županija;
16. Virovitičko – podravska županija;
17. Brodsko – posavska županija;
18. Osječko – baranjska županija;
19. Požeško – slavonska županija;
20. Vukovarsko – srijemska županija.

U svrhu utvrđivanja sadržaja studije provedena su usuglašavanja mišljenja o sadržaju strateške studije i utvrđivanja konačnog sadržaja strateške studije, te su 7. listopada 2021. godine, provedene konzultacije s predstavnicima tijela od kojih su dopisom zatražena mišljenja.

Osnovni podaci o izrađivaču strateške studije

VI.

Sukladno Odluci o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine (KLASA: 310-01/21-03/67, URBROJ: 517-07-1-1-21-1 od 22. srpnja 2021. godine), Ministarstvo gospodarstva i održivog razvoja nositelj je izrade Plana, te je i nadležno tijelo za donošenje Plana, dok je izrađivač Plana Agencija za ugljikovodike.

VII.

Sukladno Zakonu o zaštiti okoliša i Pravilniku o uvjetima za izdavanje suglasnosti pravnim osobama za obavljanje stručnih poslova zaštite okoliša („Narodne novine", br. 57/10) stratešku studiju izrađuje pravna osoba koja ima suglasnost Ministarstva gospodarstva i održivog razvoja za obavljanje stručnih poslova zaštite okoliša i poslova izrade studija o značajnom utjecaju strategija, plana i programa na okoliš.

Stratešku studiju Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine izradit će pravna osoba koja ima suglasnost za poslove izrade studija o značajnom utjecaju strategije, plana ili programa na okoliš, kao i izrade poglavlja i studija ocjene prihvatljivosti strategija, plana, programa ili zahvata za ekološku mrežu, po provedenom postupku javne nabave za predmetnu uslugu.

VIII.

U svrhu informiranja i sudjelovanja javnosti u pitanjima zaštite okoliša, informacija o pokretanju postupka strateške procjene i izradi strateške studije objavljena je na internetskoj stranici Ministarstva gospodarstva i održivog razvoja 27. rujna 2021. godine.

Tijekom proteklog razdoblja nisu zaprimljena mišljenja i/ili prijedlozi javnosti na sadržaj strateške studije.

IX.

Na temelju Uredbe, a sukladno Zakonu o zaštiti okoliša i odredbama članka 5. stavka 2. Uredbe o informiranju i sudjelovanju javnosti i zainteresirane javnosti u pitanjima zaštite okoliša („Narodne novine", br. 64/08), Ministarstvo gospodarstva i održivog razvoja objavit će ovu Odluku na svojoj internetskoj stranici.

X.

Ova Odluka stupa na snagu danom donošenja.

KLASA: 310-01/21-03/67

URBROJ: 517-07-1-2-21-28

Zagreb, 22. prosinca 2021. godine

MINISTAR

dr.sc. Tomislav Ćorić

Consent to perform professional environmental protection work

REPUBLIKA HRVATSKA
MINISTARSTVO GOSPODARSTVA
I ODRŽIVOG RAZVOJA
10000 Zagreb, Radnička cesta 80
Tel: 01/ 3717 111 fax: 01/ 3717 149

Uprava za procjenu utjecaja na okoliš i
održivo gospodarenje otpadom
Sektor za procjenu utjecaja na okoliš

KLASA: UP/I 351-02/15-08/100
URBROJ: 517-03-1-2-21-12
Zagreb, 25. siječnja 2021.

Ministarstvo gospodarstva i održivog razvoja, na temelju odredbe članka 42. Zakona o zaštiti okoliša („Narodne novine", broj 80/13, 153/13, 78/15 i 12/18), a u vezi s člankom 71. Izmjena i dopuna Zakona o zaštiti okoliša („Narodne novine", broj 118/18), u vezi s člankom 130. Zakona o općem upravnom postupku (Narodne novine, broj 47/09), rješavajući povodom zahtjeva ovlaštenika IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, radi utvrđivanja promjena u popisu zaposlenika ovlaštenika, donosi

R J E Š E N J E

I. Ovlašteniku IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, OIB: 84310268229, izdaje se suglasnost za obavljanje stručnih poslova zaštite okoliša:

1. Izrada studija o značajnom utjecaju strategije, plana ili programa na okoliš (strateška studija) uključujući i dokumentaciju potrebnu za ocjenu o potrebi strateške procjene te dokumentaciju za određivanje sadržaja strateške studije
2. Izrada studija o utjecaju zahvata na okoliš, uključujući i dokumentaciju za provedbu postupka ocjene o potrebi procjene utjecaja zahvata na okoliš te dokumentacije za određivanje sadržaja studije utjecaja na okoliš
3. Izrada programa zaštite okoliša
4. Izrada izvješća o stanju okoliša
5. Izrada elaborata o zaštiti okoliša koji se odnose na zahvate za koje nije propisana obveza procjene utjecaja na okoliš
6. Izrada projekcija emisija, izvješća o provedbi politike i mjera smanjenja emisija i nacionalnog izvješća o promjeni klime

1

7. Izrada i/ili verifikacija posebnih elaborata, proračuna i projekcija za potrebe sastavnica okoliša

8. Praćenje stanja okoliša

9. Obavljanje stručnih poslova za potrebe Registra onečišćavanja okoliša

10. Izrada elaborata o usklađenosti proizvoda s mjerilima u postupku ishođenja znaka zaštite okoliša "Prijatelj okoliša" i znaka EU Ecolabel

11. Izrada elaborata o utvrđivanju mjerila za određenu skupinu proizvoda za dodjelu znaka zaštite okoliša „Prijatelj okoliša"

II. Suglasnost iz točke I. ove izreke prestaje važiti u roku od godine dana od dana stupanja na snagu propisa iz članka 40. stavka 9. Zakona o zaštiti okoliša.

III. Ukida se rješenje Ministarstva gospodarstva i održivog razvoja KLASA: UP/I 351-02/15-08/100; URBROJ: 517-03-1-2-20-10 od 21. srpnja 2020. godine.

IV. Ovo rješenje upisuje se u očevidnik izdanih suglasnosti za obavljanje stručnih poslova zaštite okoliša koje vodi Ministarstvo gospodarstva i održivog razvoja.

V. Uz ovo rješenje prileži Popis zaposlenika ovlaštenika i sastavni je dio ovoga rješenja.

Obrazloženje

Ovlaštenik IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb (u daljnjem tekstu: ovlaštenik), podnio je zahtjev za izmjenom podataka u Rješenju KLASA: UP/I 351-02/15-08/100; URBROJ: 517-03-1-2-20-10 od 21. srpnja 2020. godine, izdanom od Ministarstva gospodarstva i održivog razvoja (u daljnjem tekstu: Ministarstvo), a vezano za popis zaposlenika ovlaštenika koji prileži uz navedeno rješenje. Ovlaštenik je zatražio izmjenu popisa zaposlenika jer djelatnice dr.sc. Maja Kljenak i Mateja Leljak, mag.ing.prosp.arch. više nisu njihove zaposlenice.

U provedenom postupku Ministarstvo je izvršilo uvid u zahtjev za promjenom podataka, te je utvrdilo da se iz popisa mogu izostaviti djelatnice dr.sc. Maja Kljenak i Mateja Leljak, mag.ing.prosp.arch.

Slijedom navedenoga, utvrđeno je kao u točkama od I. do V. izreke ovoga rješenja.

UPUTA O PRAVNOM LIJEKU:
Ovo rješenje je izvršno u upravnom postupku i protiv njega se ne može izjaviti žalba, ali se može pokrenuti upravni spor. Upravni spor pokreće se tužbom Upravnom sudu u Zagrebu, Avenija Dubrovnik 6, u roku 30 dana od dana dostave ovog rješenja. Tužba se predaje navedenom upravnom sudu neposredno u pisanom obliku, usmeno na zapisnik ili se šalje poštom, odnosno dostavlja elektronički.

2

Upravna pristojba na zahtjev i ovo rješenje naplaćena je državnim biljezima sukladno Zakonu o upravnim pristojbama („Narodne novine", broj 115/16) i Uredbi o tarifi upravnih pristojbi („Narodne novine", broj 8/17, 37/17, 129/17, 18/19, 97/19 i 128/19).

VIŠA STRUČNA SAVJETNICA

Davorka Maljak

DOSTAVITI:
1. IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, (**R!, s povratnicom!**)
2. EVIDENCIJA, ovdje
3. Državni inspektorat, Šubićeva 29, Zagreb

3

POPIS
zaposlenika ovlaštenika: IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, slijedom kojih je ovlaštenik ispunio propisane uvjete za izdavanje suglasnosti za obavljanje stručnih poslova zaštite okoliša sukladno rješenju Ministarstva KLASA: UP/I 351-02/15-08/100; URBROJ: 517-03-1-2-21-12 od 25. siječnja 2021.

STRUČNI POSLOVI ZAŠTITE OKOLIŠA prema članku 40. stavku 2. Zakona	*VODITELJ STRUČNIH POSLOVA*	*ZAPOSLENI STRUČNJACI*
1. Izrada studija o značajnom utjecaju strategije, plana ili programa na okoliš (strateška studija) uključujući i dokumentaciju potrebnu za ocjenu o potrebi strateške procjene te dokumentacije za određivanje sadržaja strateške stuudije.	Mirko Mesarić, dipl.ing.biol. Mario Mesarić, mag.ing.agr. Ivana Gudac, mag.ing.geol.	Martina Rupčić, mag.geogr. Josip Stojak, mag.ing.silv.
2. Izrada studija o utjecaju zahvata na okoliš, uključujući i dokumentaciju za provedbu postupka ocjene o potrebi procjene utjecaja zahvata na okoliš te dokumentacije za određivanje sadržaja studije utjecaja na okoliš.	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
9. Izrada programa zaštite okoliša	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
10. Izrada izvješća o stanju okoliša	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
12. Izrada elaborata o zaštiti okoliša koji se odnose na zahvate za koje nije propisana obveza procjene utjecaja na okoliš	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
15. Izrada projekcija emisija, izvješća o provedbi politike i mjera smanjenja emisija i nacionalnog izvješća o promjeni klime	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
20. Izrada i/ili verifikacija posebnih elaborata , proračuna i projekcija za potrebe sastavnica okoliša	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
22. Praćenje stanja okoliša	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
23. Obavljanje stručnih poslova za potrebe Registra onečišćavanja okoliša	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
25. Izrada elaborata o usklađenosti proizvoda s mjerilima u postupku ishođenja znaka zaštite okoliša "Prijatelj okoliša" i znaka EU Ecolabel	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)
26. Izrada elaborata o utvrđivanju mjerila za određenu skupinu proizvoda za dodjelu znaka zaštite okoliša „Prijatelj okoliša"	voditelji navedeni pod 1)	stručnjaci navedeni pod 1)

13.3 Consent to perform professional nature protection work

REPUBLIKA HRVATSKA
MINISTARSTVO GOSPODARSTVA
I ODRŽIVOG RAZVOJA
10000 Zagreb, Radnička cesta 80
Tel: 01/ 3717 111 fax: 01/ 3717 149

Uprava za procjenu utjecaja na okoliš i
održivo gospodarenje otpadom
Sektor za procjenu utjecaja na okoliš

KLASA: UP/I 351-02/16-08/25
URBROJ: 517-03-1-2-21-14
Zagreb, 25. siječnja 2021.

Ministarstvo gospodarstva i održivog razvoja, na temelju odredbe članka 43. Zakona o zaštiti okoliša („Narodne novine", brojevi 80/13, 153/13 78/15 i 12/18) i članka 71. Zakona o izmjenama i dopunama Zakona o zaštiti okoliša („Narodne novine", broj 118/18) u vezi s člankom 130. Zakona o općem upravnom postupku („Narodne novine", broj 47/09), rješavajući povodom zahtjeva ovlaštenika IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, radi utvrđivanja promjena u popisu zaposlenika ovlaštenika, donosi:

R J E Š E N J E

I. Ovlašteniku IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, OIB:84310268229, izdaje se suglasnost za obavljanje stručnih poslova zaštite prirode:

1. Izrada poglavlja i studija ocjene prihvatljivosti strategija, plana, programa ili zahvata za ekološku mrežu

II. Suglasnost iz točke I. ove izreke prestaje važiti u roku od godine dana od dana stupanja na snagu propisa iz članka 40. stavka 9. Zakona o zaštiti okoliša.

III. Ovo rješenje upisuje se u očevidnik izdanih suglasnosti za obavljanje stručnih poslova zaštite okoliša koje vodi Ministarstvo gospodarstva i održivog razvoja.

IV. Ukida se rješenje Ministarstva gospodarstva i održivog razvoja: KLASA: UP/I 351-02/16-08/25, URBROJ: 517-03-1-2-20-12 od 14. rujna 2020. godine kojim je ovlašteniku IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, dana suglasnost za obavljanje stručnih poslova iz područja zaštite prirode.

V. Uz ovo rješenje prileži Popis zaposlenika ovlaštenika i sastavni je dio ovoga rješenja.

O b r a z l o ž e n j e

Tvrtka IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb (u daljnjem tekstu: ovlaštenik), podnijela je zahtjev za izmjenom podataka u Rješenju: (KLASA: UP/I 351-02/16-

1

08/25, URBROJ: 517-03-1-2-20-12 od 14. rujna 2020. godine izdanom od Ministarstva gospodarstva i održivog razvoja (u daljnjem tekstu Ministarstvo), a vezano za popis zaposlenika ovlaštenika koji prileži uz navedeno rješenje. Ovlaštenik je zatražio izmjenu popisa zaposlenika jer djelatnice dr.sc. Maja Kljenak i Mateja Leljak, mag.ing.prosp.arch. više nisu njihove zaposlenice.

U provedenom postupku Ministarstvo je izvršilo uvid u zahtjev za promjenom podataka, te je utvrdilo da se iz popisa mogu izostaviti djelatnice dr.sc. Maja Kljenak i Mateja Leljak, mag.ing.prosp.arch.

Slijedom navedenoga, utvrđeno je kao u točkama od I. do V. izreke ovoga rješenja.

UPUTA O PRAVNOM LIJEKU:
Ovo rješenje je izvršno u upravnom postupku i protiv njega se ne može izjaviti žalba, ali se može pokrenuti upravni spor. Upravni spor pokreće se tužbom Upravnom sudu u Zagrebu, Avenija Dubrovnik 6, u roku 30 dana od dana dostave ovog rješenja. Tužba se predaje navedenom upravnom sudu neposredno u pisanom obliku, usmeno na zapisnik ili se šalje poštom, odnosno dostavlja elektronički.

Upravna pristojba na zahtjev i ovo rješenje naplaćena je državnim biljezima sukladno Zakonu o upravnim pristojbama („Narodne novine", broj 115/16) i Uredbi o tarifi upravnih pristojbi („Narodne novine", broj 8/17, 37/17, 129/17, 18/19, 97/19 i 128/19).

VIŠA STRUČNA SAVJETNICA

Davorka Maljak

REPUBLIKA HRVATSKA 3 MINISTARSTVO GOSPODARSTVA I ODRŽIVOG RAZVOJA ZAGREB

U prilogu: Popis zaposlenika ovlaštenika

DOSTAVITI:
1. IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, **(R!, s povratnicom!)**
2. Evidencija, ovdje
3. Državni inspektorat, Šubićeva 29, Zagreb

2

POPIS **zaposlenika ovlaštenika: IRES EKOLOGIJA d.o.o., Prilaz baruna Filipovića 21, Zagreb, slijedom kojih je ovlaštenik ispunio propisane uvjete za izdavanje suglasnosti za obavljanje stručnih poslova zaštite okoliša sukladno rješenju Ministarstva KLASA: UP/I 351-02/16-08/25; URBROJ: 517-03-1-2-21-14 od 25. siječnja 2021. godine**		
STRUČNI POSLOVI ZAŠTITE OKOLIŠA PREMA ČLANKU 40. STAVKU 2. ZAKONA	*VODITELJI STRUČNIH POSLOVA*	*ZAPOSLENI STRUČNJACI*
3. Izrada poglavlja i studija ocjena prihvatljivosti strategija, plana, programa ili zahvata za ekološku mrežu.	Mirko Mesarić, dipl. ing.biol. Mario Mesarić, mag.ing.agr.	Josip Stojak, mag.ing.silv. Martina Rupčić, mag.geog. Ivana Gudac, mag.ing.geol.

13.4 Areas of the ecological network

Tablica 13.1 Područja ekološke mreže u obuhvatu Plana s definiranim tipovima osjetljivosti (Izvor: IRES EKOLOGIJA d.o.o. prema Bioportal-u, Uredbi o ekološkoj mreži i nadležnostima javnih ustanova za upravljanje područjima ekološke mreže i EU SDF bazi podataka)

Kod područja	**Naziv područja**	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
POP													
HR1000001	Pokupski bazen	35 092,58	+	+								+	
HR1000002	Sava kod Hrušćice sa šljunčarom Rakitje	1 453,51	+	+			+						
HR1000003	Turopolje	20 002,85	+									+	
HR1000004	Donja Posavina	121 072,95	+	+								+	
HR1000005	Jelas polje	38 833,79	+									+	
HR1000006	Spačvanski bazen	43 518,93	+	+									
HR1000008	Bilogora i Kalničko gorje	95 086,64	+									+	
HR1000009	Ribnjaci uz Česmu	23 177,78	+									+	
HR1000010	Poilovlje s ribnjacima	13 543,26	+									+	
HR1000011	Ribnjaci Grudnjak i Našice	20 767,36	+	+									
HR1000012	Taložnice Virovitičke šećerane	24,14	+										
HR1000013	Dravske akumulacije	9 653,41	+					+	+				
HR1000014	Gornji tok Drave	22 894,84	+	+				+	+			+	
HR1000015	Srednji tok Drave	13 454,20	+					+	+			+	
HR1000016	Podunavlje i donje Podravlje	65 815,11	+	+				+	+			+	
HR1000040	Papuk	37 384,52	+							+	+		
POVS													
HR2000094	Ozaljska špilja	0,78							+				
HR2000108	Vodotečina	0,78							+				
HR2000174	Trbušnjak - Rastik	2 005,39	+										
HR2000234	Draganićka šuma - Ješevica 1	65,88	+	+							+		+

Kod područja	**Naziv područja**	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
HR2000364	Mura	6 082,92	+	+		+						+	+
HR2000368	Peteranec	203,42	+									+	
HR2000369	Vršni dio Ravne gore	764,05	+								+		
HR2000371	Vršni dio Ivančice	6 076,28	+							+			
HR2000372	Dunav - Vukovar	12 712,41	+	+		+		+		+		+	
HR2000394	Kopački rit	23 112,40	+	+				+				+	+
HR2000415	Odransko polje	13 739,22	+									+	+
HR2000416	Lonjsko polje	51 135,23	+	+	+	+					+		+
HR2000420	Sunjsko polje	19 574,97	+										
HR2000426	Dvorina	1 490,89	+										+
HR2000427	Gajna	425,59	+										+
HR2000437	Ribnjaci Končanica	1 286,81	+				+					+	
HR2000438	Ribnjaci Poljana	1 962,64	+					+					
HR2000440	Ribnjaci Siščani i Blatnica	732,25	+									+	
HR2000441	Ribnjaci Narta	648,55	+									+	
HR2000444	Varoški Lug	866,67	+	+							+		+
HR2000449	Ribnjaci Crna Mlaka	675,76	+					+	+		+		
HR2000450	Ribnjaci Draganići	390,97	+	+								+	
HR2000451	Ribnjaci Pisarovina	389,87	+	+				+				+	
HR2000459	Petrinjčica	793,93	+	+				+				+	+
HR2000463	Dolina Une	4 269,51	+	+								+	+
HR2000465	Žutica	4 660,57	+	+	+						+		+
HR2000470	Čep - Nedelišće	82,82	+	+									
HR2000488	Južni Dilj	152,90	+							+	+		
HR2000570	Crni jarki	522,13	+	+							+		
HR2000571	Đurđevački peski	23,55	+					+	+			+	+
HR2000572	Kloštarski (Kalinovački) peski	28,14	+					+	+			+	+

Kod područja	**Naziv područja**	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
HR2000573	Petrijevci	125,39									+	+	
HR2000580	Papuk	37 384,52	+	+	+	+					+	+	
HR2000583	Medvednica	18 532,85	+	+		+						+	+
HR2000586	Žumberak Samoborsko gorje**	34 193,10	+									+	
HR2000589	Stupnički lug	760,97	+	+							+		+
HR2000593	Mrežnica - Tounjčica	475,09 (43 %)	+	+									+
HR2000623	Šume na Dilj gori	15 461,47	+							+	+		
HR2000642	Kupa	3 737,18	+	+		+						+	
HR2000670	Cret Dubravica	5,51		+									
HR2000672	Zovje	1,60	+				+					+	
HR2000728	Biljsko groblje	2,85				+							
HR2000730	Bistrinci	27,16									+		
HR2000780	Klinča sela	32,92				+	+					+	
HR2000799	Gornji Hruševec - potok Kravarščica	2,75	+	+			+						+
HR2001001	Cret Blatuša	42,13	+										
HR2001002	Čepelovačke livade	35,87	+	+				+			+		
HR2001004	Stari Gradac - Lendava	28,33	+	+				+					
HR2001005	Starogradački Marof	189,14	+	+				+					
HR2001006	Županijski kanal (Gornje Bazje - Zidina)	151,32	+	+			+						+
HR2001031	Odra kod Jagodna	6,41		+				+					
HR2001034	Mačkovec - ribnjak	4,85		+								+	
HR2001045	Trpinja	5,15		+								+	
HR2001070	Sutla	141,38	+	+								+	
HR2001085	Ribnjak Grudnjak s okolnim šumskim kompleksom	12 432,09	+	+			+					+	
HR2001086	Breznički ribnjak (Ribnjak Našice)	1 408,82	+				+					+	
HR2001088	Mala Dubrava - Vučedol	224,88	+	+							+		+

Kod područja	Naziv područja	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
HR2001115	Strahinjčica	1 358,77	+			+	+				+	+	
HR2001162	Pivnica	0,78											
HR2001178	Vugrinova špilja	0,78											
HR2001190	Židovske jame	0,78											
HR2001191	Cerjanska špilja	0,78							+				
HR2001192	Zdenec pri Ciglaru	0,78							+				
HR2001193	Špilja kod Šušnjara	0,78											
HR2001195	Špilja pod Špicom	0,78											
HR2001216	Ilova	836,46	+			+		+	+			+	
HR2001220	Livade uz potok Injaticu	37,79	+									+	
HR2001224	Malodapčevačke livade	18,29	+	+								+	
HR2001228	Potok Dolje	5,22	+	+		+		+					
HR2001243	Rijeka Česma	102,79	+					+				+	+
HR2001281	Bilogora	7 496,56	+					+					+
HR2001285	Gornja Garešnica	76,34	+	+								+	+
HR2001286	Orljavac	400,84	+	+								+	
HR2001288	Pričac - Lužani	196,95	+	+				+				+	
HR2001289	Davor - livade	17,52	+	+			+					+	
HR2001292	Livade kod Čaglina	199,79	+	+								+	
HR2001293	Livade kod Grubišnog Polja	2 936,89	+	+								+	+
HR2001298	Vejalnica i Krč	142,84	+								+		+
HR2001305	Zvečevo	12,25		+									+
HR2001307	Dravske akumulacije	9 653,41	+	+			+					+	
HR2001308	Donji tok Drave	21 092,62	+	+				+				+	
HR2001309	Dunav S od Kopačkog rita	13 753,07	+										+
HR2001311	Sava nizvodno od Hrušćice	13 153,62	+				+						
HR2001318	Kalnik - Vranilac	23,30											

Kod područja	**Naziv područja**	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
HR2001319	Ris	916,70	+	+							+		+
HR2001320	Crna gora	145,26	+				+						
HR2001323	Česma - šume	124,77	+	+							+		+
HR2001326	Jelas polje s ribnjacima	4 747,04	+	+				+				+	
HR2001327	Ribnjak Dubrava	342,96	+	+								+	
HR2001328	Lonđa; Glogovica i Breznica	120,06	+			+		+				+	
HR2001329	Potoci oko Papuka	486,26	+			+							
HR2001330	Pakra i Bijela	144,22	+									+	
HR2001331	Šaševa - cret	25,16											
HR2001335	Jastrebarski lugovi	3 792,05	+	+							+		+
HR2001339	Područje oko Jopića špilje	223,33											
HR2001342	Područje oko špilje Gradusa	1 811,71	+										
HR2001346	Međimurje	2 523,51	+			+						+	+
HR2001347	Donje Medjimurje	218,93	+	+		+					+	+	+
HR2001348	Dolina Sutle kod Razvora	96,25	+										+
HR2001354	Područje oko jezera Borovik	7 230,97	+	+			+						+
HR2001355	Psunj	10 050,38	+	+								+	+
HR2001356	Zrinska gora	30 783,28	+								+		+
HR2001370	Područje oko Hrvatske Kostajnice	2 922,02	+										
HR2001372	Područje oko špilje Vrlovka	5,10	+										
HR2001378	Livade kod Hudinčeca	13,28	+				+						
HR2001379	Vlakanac-Radinje	2 922,98	+	+									
HR2001381	Vukmanić - cret	14,55											
HR2001383	Klasnići	1,43	+	+			+						+
HR2001385	Orljava	111,72		+				+				+	+
HR2001387	Područje uz Maju i Brućinu	997,32		+				+				+	
HR2001389	Banićevac	6,38	+	+							+		

Kod područja	**Naziv područja**	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste
HR2001390	Brajakovo brdo	11,07	+	+			+						
HR2001391	Brebornica	75,48	+	+								+	+
HR2001392	Ljubeščica	13,48	+				+					+	
HR2001393	Nurkovac	12,71	+									+	
HR2001404	Glogovnica	3,22						+				+	+
HR2001405	Lonja	4,36		+				+					
HR2001407	Orljavica	22,26		+			+						+
HR2001408	Livade uz Bednju I	226,47	+	+			+						+
HR2001409	Livade uz Bednju II	1 145,13	+	+			+						+
HR2001410	Livade uz Bednju III	307,75	+	+			+						+
HR2001411	Livade uz Bednju IV	19,86	+	+			+						+
HR2001412	Livade uz Bednju V	112,81	+	+			+						+
HR2001414	Spačvanski bazen	38 193,06	+	+								+	
HR2001415	Spačva JZ	5 325,86	+	+							+		+
HR2001416	Brezovica-Jelik	439,57	+	+							+		+
HR2001500	Stepska staništa kod Bapske	77,95									+	+	
HR2001501	Stepska staništa kod Opatovca	42,38		+									
HR2001502	Stepska staništa kod Šarengrada	38,91		+									
HR2001505	Korana nizvodno od Slunja	440,47 (75 %)	+										+
HR2001506	Sava uzvodno od Zagreba	207,71		+			+	+					
HR2001509	Donji Emovci*	97,63	+										
HR2001510	Livade uz Pačicu*	118,19											
HR2001511	Suhe livade kod Sinlija*	1 582,72										+	
HR2001512	Sovsko jezero*	2,48											
HR2001513	Otmanov vis*	26,07											
HR5000014	Gornji tok Drave	22 894,84	+	+				+	+			+	
HR5000015	Srednji tok Drave	13 454,20	+					+	+			+	

Kod područja	Naziv područja	Površina područja (ha)	Tipovi osjetljivosti										
			Fragmentacija	Promjena vodnih uvjeta	Istraživanje i crpljenje zemnih sirovina	Industrijalizacija	Onečišćenje (općenito)	Onečišćenje površinskih voda	Onečišćenje podzemnih voda	Kisele kiše	Linijska infrastruktura	Promjena poljoprivredne prakse	Invazivne vrste

*vPOVS
**PPOVS

13.5 Decision of the Ministry of Economy and Sustainable Development on the obligation to implement the Main Assessment of Acceptability for the Ecological Network

REPUBLIKA HRVATSKA
MINISTARSTVO GOSPODARSTVA
I ODRŽIVOG RAZVOJA
10000 Zagreb, Radnička cesta 80
Tel: 01/ 3717 111 fax: 01/ 3717 149

Uprava za zaštitu prirode
KLASA: UP/I-612-07/21-37/243
URBROJ: 517-10-2-3-21-2
Zagreb, 3. rujna 2021.

Ministarstvo gospodarstva i održivog razvoja, Uprava za zaštitu prirode, temeljem članka 48. stavak 6. i 7. Zakona o zaštiti prirode (Narodne novine, br. 80/13, 15/18, 14/19, 127/19), vezano uz članak 46. stavak 1. Zakona o zaštiti prirode, povodom zahtjeva Ministarstva gospodarstva i održivog razvoja, Uprave za energetiku, Radnička cesta 80, 10000 Zagreb, za provedbu prethodne ocjene prihvatljivosti za ekološku mrežu za Plan razvoja geotermalnog potencijala Republike Hrvatske za razdoblje do 2030. godine, nakon provedenog postupka donosi

R J E Š E NJ E

I. Da je za planirani Plan razvoja geotermalnog potencijala Republike Hrvatske za razdoblje do 2030. godine obavezna provedba glavne ocjene prihvatljivosti za ekološku mrežu.

II. Ovo Rješenje objavljuje se na internetskim stranicama Ministarstva gospodarstva i održivog razvoja.

Obrazloženje

Ministarstvo gospodarstva i održivog razvoja, Uprava za energetiku, (dalje u tekstu: MINGOR – Uprava za energetiku), podnijelo je aktom, KLASA: 310-01/21-03/67, URBROJ: 517-07-1-2-21-3 od 30. kolovoza 2021. godine, zahtjev za provedbu prethodne ocjene prihvatljivosti za ekološku mrežu za Plan razvoja geotermalnog potencijala Republike Hrvatske za razdoblje do 2030. godine (dalje u tekstu: Plan). U zahtjevu su sukladno članku 48. stavku 2. dostavljeni podaci o Planu, nositelju izrade, programskim polazištima i razlozima donošenja. Uz zahtjev su priloženi „Odluka o izradi Plana razvoja geotermalnog potencijala Republike Hrvatske“, KLASA: 310-01/21-03/67, URBROJ: 517-07-1-1-21-1 od 22. srpnja 2021. godine, Nacrt „Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine“ iz lipnja 2021. godine i Nacrt „Odluke o započinjanju postupka strateške

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procjene utjecaja na okoliš Plana razvoja geotermalnog potencijala Republike Hrvatske do 2030. godine".

Razmatranjem ranije navedenog zahtjeva, kojim je zatražena provedba postupka prethodne ocjene prihvatljivosti za ekološku mrežu, nakon uvida u dostavljene podatke i dostavljenu dokumentaciju te uvida u Uredbu o ekološkoj mreži i nadležnostima javnih ustanova za upravljanje područjima ekološke mreže (Narodne novine, broj 80/2019) utvrđeno je slijedeće.

Nositelj izrade Plana je Ministarstvo gospodarstva i održivog razvoja, Radnička cesta 80, 10000 Zagreb. Izrađivač Plana je Agencija za ugljikovodike, Miramarska 24, 10000 Zagreb.

Obuhvat Plana odnosi se na prostor panonskog bazena Republike Hrvatske, te obuhvaća sljedeće županije: Karlovačku županiju, Grad Zagreb, Zagrebačku županiju, Međimursku županiju, Krapinsko-zagorsku županiju, Varaždinsku županiju, Koprivničko-križevačku županiju, Sisačko-moslavačku županiju, Bjelovarsko-bilogorsku županiju, Virovitičko-podravsku županiju, Brodsko-posavsku županiju, Osječko-baranjsku županiju, Požeško-slavonsku županiju i Vukovarsko-srijemsku županiju.

Planom se osigurava usklađenost sa strateškim opredjeljenjima i politikom Republike Hrvatske prema obnovljivim izvorima energije te smjernicama i ciljevima Europske unije vezanim uz energetsku politiku i Europski zeleni plan.

Programska polazišta proizlaze iz članka 5. stavka 5. Zakona o istraživanju i eksploataciji ugljikovodika (Narodne novine, broj 52/18, 52/19 i 30/21) i biti će izrađen u skladu sa Strategijom energetskog razvoja Republike Hrvatske do 2030. s pogledom na 2050. godinu (Narodne novine, broj 25/20).

Razlozi donošenja Plana su potreba da se osigura daljnji razvoj i korištene geotermalne energije kao domaćeg obnovljivog potencijala koji se treba šire koristiti u energetskim transformacijama za proizvodnju električne energije odnosno za grijanje i hlađenje.

Planom se određuje prostor na kojem će se istraživati, razvijati i eksploatirati geotermalni potencijal, metode pridobivanja geotermalne vode u energetske svrhe, tehniku i tehnologiju pridobivanja, način upotrebe od strane krajnjeg korisnika te usmjeravanje energetskog razvoja Republike Hrvatske u smjeru zelene energije.

Planom će se između ostalog utvrditi geotermalni potencijal Republike Hrvatske kroz istraživanje geotermalne vode u energetska svrhe koje obuhvaća geofizička snimanja (gravimetrijska, magnetometrijska, seizmička, magnetotelurska i druga geofizička snimanja, interpretaciju tako prikupljenih podataka i njihovu studijsku obradu) te izradu istražnih bušotina (izradu, produbljivanje, skretanje, opremanje, ispitivanje, privremeno napuštanje ili likvidaciju istražnih geotermalnih bušotina) i mogućnost eksploatacije geotermalne vode u energetske svrhe odnosno utvrditi će se aktivnosti u fazi eksploatacije kod upotrebe geotermalne vode za proizvodnju električne energije i/ili toplinske energije i aktivnosti u fazi eksploatacije kod upotrebe geotermalne vode za poljoprivredne svrhe. Planom će se detaljnije prikazati i objasniti i geotermalni potencijal obzirom na geološku građu glavnih depresija (Murska depresija, Dravska depresija, Savska depresija, Slavonsko-srijemska depresija) te naftno-rudarski radovi i aktivnosti koje je potrebno realizirati u cilju pridobivanja geotermalnih voda za proizvodnju električne energije i/ili toplinske energije ili stakleničku proizvodnju (grijanje staklenika). Također, biti će opisan postupak nadmetanja, dodjele dozvola za istraživanje i eksploataciju geotermalnih voda u energetske svrhe te sklapanja ugovora za eksploataciju.

U zahtjevu MINGOR, Uprave za energetiku, navedeno je da će za Plan sukladno odredbama Zakona o zaštiti okoliša (Narodne novine, broj 80/13, 153/13, 78/15, 12/18,

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118/18) i Uredbe o strateškoj procjeni utjecaja strategije, plana i programa na okoliš (Narodne novine, broj 3/17) biti proveden postupak strateške procjene utjecaja na okoliš.

Područje obuhvata Plana preklapa se sa područjima ekološke mreže proglašene Uredbom o ekološkoj mreži i nadležnostima javnih ustanova za upravljanje područjima ekološke mreže i to sa područjima očuvanja značajnim za ptice (POP), područjima očuvanja značajnim za vrste i stanišne tipove (POVS), posebnim područjima očuvanja značajnim za vrste i stanišne tipove (PPOVS) i vjerojatnim područjima očuvanja značajnim za vrste i stanišne tipove (vPOVS). Detaljni podaci o područjima ekološke mreže dostupni su u sklopu informacijskog sustava zaštite prirode Bioportal (http://www.bioportal.hr).

Analizom mogućih utjecaja provedbe Plana, uzimajući u obzir sada poznate podatke o Planu, a to su obuhvat, ciljevi i aktivnosti koje se planiraju, uzimajući u obzir ekološke zahtjeve i rasprostranjenost ciljnih vrsta i rasprostranjenost ciljnih stanišnih tipova kao i ciljeve očuvanja područja ekološke mreže, ocijenjeno je da nije moguće isključiti značajne negativne utjecaje Plana. Provedbom plana može doći do značajnih utjecaja na ciljne vrste i stanišne tipove u vidu trajnog gubitka ciljnih stanišnih tipova i/ili stanišnih tipova neophodnih za ciljne vrste, degradacije ciljnih stanišnih tipova, pogoršanja stanišnih uvjeta za pojedine ciljne vrste, smanjenje brojnosti populacija ili nestanak ciljnih vrsta, stradavanje pojedinih ciljnih vrsta i dr.. Slijedom navedenog budući da u okviru postupka prethodne ocjene prihvatljivosti za ekološku mrežu nije moguće isključiti značajne negativne utjecaje na ciljeve očuvanja i cjelovitost područja ekološke mreže riješeno je kao u izreci te je za Plan obvezna provedba postupka glavne ocjene prihvatljivosti za ekološku mrežu.

Člankom 46. Zakona o zaštiti prirode propisano je da Ministarstvo gospodarstva i održivog razvoja, provodi prethodnu ocjenu i glavnu ocjenu za strategije, planove i programe koji se pripremaju i/ili donose na državnoj i područnoj (regionalnoj) razini, kao i za one koji se pripremaju i/ili donose na državnoj i područnoj (regionalnoj) razini, a za koje je posebnim propisom kojim se uređuje zaštita okoliša određena obveza strateške procjene ili ocjene o potrebi strateške procjene.

Nadalje člankom 48. stavkom 6. Zakona o zaštiti prirode propisano je da ako Ministarstvo ne isključi mogućnost značajnih negativnih utjecaja strategije, plana ili programa na ciljeve očuvanja i cjelovitost područja ekološke mreže, donosi rješenje da je za strategiju plan ili program obavezna glavna ocjena prihvatljivosti za ekološku mrežu.

Člankom 48. stavkom 7. Zakona o zaštiti prirode propisano je da rješenje iz stavka 5. i 6. tog članka sadrži podatke o strategiji, planu ili programu, podatke o ekološkoj mreži, obrazloženje razloga na temelju kojih je isključena mogućnost značajnih negativnih utjecaja na ciljeve očuvanja i cjelovitost područja ekološke mreže ili obrazloženje razloga na temelju kojih je utvrđena obveza provedbe glavne ocjene prihvatljivosti za ekološku mrežu.

Člankom 48. stavkom 8. Zakona o zaštiti prirode propisano je da rješenje iz stavka 5. i 6. tog članka sadrži i uvjete zaštite prirode ako se radi o strategiji, planu ili programu u čijem se obuhvatu nalaze zaštićena područja, strogo zaštićene vrste i/ili ugroženi i rijetki stanišni tipovi za koje nisu izdvojena područja ekološke mreže. Zbog nedostatka detaljnih podataka vezanih uz prostornu i vremensku raspodjelu budućih aktivnosti koje će se provoditi u okviru postupka prethodne ocjene prihvatljivosti za ekološku mrežu nije moguće utvrditi uvjete zaštite prirode koji se odnose na zaštićena područja, strogo zaštićene vrste i/ili ugrožene i rijetke stanišne tipove.

U skladu sa člankom 51. stavak 2. Zakona o zaštiti prirode ovo Rješenje objavljuje se na mrežnoj stranici Ministarstva gospodarstva i održivog razvoja.

Podnositelj zahtjeva oslobođen je plaćanja upravne pristojbe temeljem članka 8. stavka 1. točka 1. Zakona o upravnim pristojbama (Narodne novine, broj 115/2016).

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UPUTA O PRAVNOM LIJEKU

Ovo Rješenje je izvršno u upravnom postupku te se protiv njega ne može izjaviti žalba, ali se može pokrenuti upravni spor pred upravnim sudom na području kojeg tužitelj ima prebivalište, odnosno sjedište. Upravni spor pokreće se tužbom koja se podnosi u roku od 30 dana od dana dostave ovog Rješenja.

Tužba se predaje nadležnom upravnom sudu neposredno u pisanom obliku, usmeno na zapisnik ili se šalje poštom, odnosno dostavlja elektronički.

REPUBLIKA HRVATSKA – MINISTARSTVO GOSPODARSTVA I ODRŽIVOG RAZVOJA – ZAGREB

VODITELJICA SLUŽBE

Blaženka Randić Potkonjak

Dostaviti:

1. **Ministarstvo gospodarstva i održivog razvoja, Uprava za energetiku - ovdje**
2. **U spis predmeta, ovdje**

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13.6 Condition of forest areas and forest land of economic units of state forests that are spread within the scope of the Plan (Source: Hrvatske šume)

UŠP	Šumarija	broj	GJ	Važenje programa	Ukupna površina	Obrasla površina
BJELOVAR	Čazma	173	Čazmanske nizinske šume	2014. - 2023.	4030,52	3759,32
		174	Česma	2016. - 2025.	4181,11	678,41
		182	Garjevica – Čazma	2019. - 2028.	4538,74	4411,76
	Đulovac	167	Bastajske šume – Krivaja - Klisa	2020. - 2029.	2578,74	2559,73
		213	Vrani kamen	2015. - 2024.	7938,84	7684,95
	Bjelovar	168	Bedenik	2017. - 2026.	392,19	375,54
		169	Bjelovarska Bilogora	2013. - 2022.	7711,81	7483,51
		171	Bolčanski- Žabljački lug	2016. - 2025.	2650,6	2564,58
		174	Česma	2016. - 2025.	4181,11	1595,06
	Daruvar	175	Daruvarske prigorske šume	2014. - 2023.	3472,29	3387,22
		213	Vrani kamen	2015. - 2024.	7938,84	7684,95
	Garešnica	176	Dišnica-Zobikovac-Petkovača	2014. - 2023.	3489,98	3401,39
		191	Krnjača - Gradina - Sječa	2012. - 2021.	2990,56	2396,39
		193	Međuvođe – Ilovski lug	2019. - 2028.	1313,96	1295,38
		209	Trupinski-Pašijanski gaj	2012. - 2021.	1214,79	1163,89
		350	Garjevica – Garešnica	2019. - 2028.	3900,8	3744,78
	Grubišno Polje	184	Grubišnopoljska Bilogora	2018. - 2027.	7748,21	7499,32
		215	Zdenački gaj – Prespinjača	2013. - 2022.	2226,63	2129,17
	Ivanska	177	Dugački gaj – Jasenova – Drljež	2015. - 2024.	3429,84	3302,43
		185	Ivanske prigorske šume	2015. - 2024.	3589,09	3474,11
		349	Garjevica – Ivanska	2019. - 2028.	2739,27	2657,31
	Lipik	170	Blatuško brdo	2020. - 2029.	3237,78	3212,41
		192	Lugovi	2017. - 2026.	1407,01	1376,11
		195	Miletina rijeka	2011. - 2020.	2469,49	2364,99
		203	Rogoljica	2020. - 2029.	2932,14	2854,73
	Pakrac	198	Pakračka gora – Zapadni Papuk	2011. - 2020.	5474,06	5307,77

		205	Sjeverni Psunj – Javorovica	2015. - 2024.	8355,7	8144,19
	Sirač	186	Javornik	2017. - 2026.	10570,5	10286,67
	Velika Pisanica	177	Dugački gaj – Jasenova – Drljež	2015. - 2024.	3429,84	3302,43
		199	Pisanička Bilogora	2013. - 2022.	6071,37	5868,06
	Veliki Grđevac	177	Dugački gaj – Jasenova – Drljež	2015. - 2024.	3429,84	3302,43
		183	Grđevačka Bilogora	2018. - 2027.	5803,52	5574
		191	Krnjača - Gradina - Sječa	2012. - 2021.	2990,56	525,19
		209	Trupinski-Pašijanski gaj	2012. - 2021.	1214,79	1163,89
	Vrbovec	171	Bolčanski- Žabljački lug	2016. - 2025.	2650,6	2564,58
		172	Bukovac	2014. - 2023.	1661,18	1581,51
		174	Česma	2016. - 2025.	4181,11	1686,31
		196	Novakuša – Šikava	2014. - 2023.	2151,71	2059,16
		210	Varoški lug	2012. - 2021.	864,04	805,39
		214	Vrbovečke prigorske šume	2011. - 2020.	788,54	773,76
KARLOVAC	Cetingrad	447	Glinica – Otmić*	2015. - 2024.	1444,58	1423,96
		448	Strmačka*	2018. - 2027.	1110,51	1057,98
		449	Repušnjak-Duga kosa	2018. - 2027.	894,59	881,37
		450	Gredarska kosa – Begovac*	2018. - 2027.	1253,92	1238,18
		451	Komesarska kosa – Trnovi*	2015. - 2024.	742,75	733,94
	Draganić	421	Draganićki lugovi	2014. - 2023.	3465,97	3348,12
	Duga Resa	453	Dobra*	2011. - 2020.	3064,89	2932,69
		455	Bosiljevac*	2020. - 2029.	3381,66	3199
	Gvozd	438	Petrova gora - Bistra	2017. - 2026.	1404,71	1384,57
		439	Trepča	2016. - 2025.	2552,65	2503,03
		441	Kremešnica	2020. - 2029.	1348,61	1326,34
		442	Kozarac	2016. - 2025.	2314,9	2296,58
	Jastrebarsko	422	Jastrebarski lugovi	2014. - 2023.	2767,52	2635,62
		431	Jastrebarske prigorske šume	2018. - 2027.	1643,1	1614,45
		432	Plešivica	2012. - 2021.	1735,33	1702,25
	Karlovac	424	Rečički lugovi	2014. - 2023.	3134,6	3002,16
		425	Domačaj lug-kovačevački lug	2020. - 2029.	846,56	836,01

		435	Veliko brdo	2019. - 2028.	2803,78	2766,12
		464	Kozjača	2013. - 2022.	1466,02	1400,86
	Krašić	426	Blaževa gora	2013. - 2022.	1897,36	1861,74
		428	Slapnica	2013. - 2022.	2063,61	2023,84
		429	Kupčina – Žumberak	2019. - 2028.	3071,34	3042,19
		430	Jazbina vučjak	2013. - 2022.	577,3	564,07
	Krnjak	444	Loskunja	2018. - 2027.	1205,91	1186,06
		445	Debela kosa - markovac	2018. - 2027.	1659,52	1634,43
		456	Skradska gora	2012. - 2021.	1880,36	1786,51
	Ozalj	427	Sušica ozaljska	2019. - 2028.	1999,01	1985,84
		452	Stražnji vrh	2017. - 2026.	827,6	820,79
	Pisarovina	423	Pisarovinski lugovi	2014. - 2023.	2068,36	2013,4
		433	Gračec lučelnica	2014. - 2023.	989,37	981,57
		440	Crna draga	2011. - 2020.	1383	1366,53
	Slunj	446	Crno osovje – Veliki lisac*	2015. - 2024.	2670,31	2580,6
		457	Koranska Dubrava*	2019. - 2028.	3310,73	3285,23
	Topusko	434	Orlova	2011. - 2020.	1427,39	1412,42
		437	Petrova gora - Bublen	2017. - 2026.	5902,08	5801,91
		443	Topličke kose	2016. - 2025.	739,88	734,14
	Vojnić	436	Petrova gora - Petrovac	2017. - 2026.	5994,36	5920,34
KOPRIVNICA	Čakovec	264	Donje Međimurje	2012. - 2021.	3049,81	2722,76
		265	Gornje Međimurje	2020. - 2029.	734,37	729,19
	Đurđevac	179	Đurđevačka Bilogora	2019.- 2028.	3722,09	3630,03
		180	Đurevačke nizinske šume	2017. - 2026.	4145,31	3927,4
		181	Đurđevački Peski	2017. - 2026.	744,76	603,54
	Ivanec	266	Sjeverna Ivanščica	2019. - 2028.	700,82	678,67
		267	Ravna gora	2015. - 2024.	1009,08	998,71
		268	Trakoščan	2016. - 2025.	731,85	710,31
	Kloštar Podravski	204	Seča	2018. - 2027.	2802,22	2730,05
		208	Svibovica	2015. - 2024.	2944,79	2735,21
	Koprivnica	178	Dugačko brdo	2012. - 2021.	2130,6	2058,96

		189	Koprivničke nizinske šume	2014. - 2023.	1934,21	1857,87
		197	Novigradska planina	2016. - 2025.	2873,76	2814,73
	Križevci	187	Jazmak – Kosturač – Buk – Drobna	2015. - 2024.	4110,08	4014,17
		188	Kalnik-Kolačka	2013. - 2022.	4223,27	4073,49
		190	Križevačke prigorske šume	2020. - 2029.	1686,43	1661,02
	Ludbreg	270	Lijepa gorica	2019. - 2028.	1476,87	1469,18
		272	Ludbreške podravske šume - Križančija	2014. - 2023.	1481,74	1323,14
		273	Kalnik	2011. - 2020.	2394,37	2333,32
	Repaš	202	Repaš-gabajeva greda	2011. - 2020.	4218,47	3649,92
	Sokolovac	194	Mesarica-plavo	2013. - 2022.	2860,97	2795,44
		201	Polum - medenjak	2020. - 2029.	4749,13	4671,98
	Varaždin	269	Vinica-plitvica-željeznica	2018. - 2027.	1438,99	1428,74
		274	Varaždinbreg	2017. - 2026.	1674,49	1650,97
		276	Varaždinske podravske šume	2013. - 2022.	1589,55	1456,16
		978	Zelendvor	2014. - 2023.	380,88	347,26
NAŠICE	Orahovica	015	Pušinska planina	2019. - 2028.	3036,4	2955,57
	Đurđenovac	006	Đurđenovačke nizinske šume	2021. - 2030.	1970,72	1810,3
		007	Krndija gazijska	2017. - 2026.	1841,01	1778,01
	Donji Miholjac	001	Miholjačke podravske šume	2012. - 2021.	1030,02	998,53
		002	Čađavački lug – Jelas - Đol	2012. - 2021.	4346,05	4085,22
		003	Kapelački lug – Karaš	2013. - 2022.	6226,02	5944,28
	Koška	004	Lacić - Gložđe	2014. - 2023.	6037,86	5671,18
		005	Budigošće-Breza-Lugovi	2020. - 2029.	2659,19	2525,26
	Našice	008	Krndija našička	2015. - 2024.	2836,8	2715,38
		009	Krndija seonska	2020. - 2029.	555,6	529,93
	Orahovica	010	Duzlučka planina	2017. - 2026.	1713,59	1672,08
		011	Obradovačke nizinske šume	2018. - 2027.	651,39	641,32
		012	Pištanske prigorske šume	2018. - 2027.	2017,42	1971,58
		013	Kokočačka planina	2018. - 2027.	1783,57	1696,87
		014	Orahovačka planina	2015. - 2024.	3026,88	2888,73
NOVA GRADIŠKA	Jasenovac	136	Grede-Kamare	2016. - 2025.	4908,62	4237,1

		137	Krapje đol	2011. - 2020.	1664,6	1451,95
		138	Žabarski bok	2013. - 2022.	825	762,83
	Nova Gradiška	125	Južna Babja gora	2020. - 2029.	5668,74	5556,41
		126	Ključevi	2019. - 2028.	2502,28	2362,02
		127	Gradiška brda	2017. - 2026.	3820,19	3724,3
		128	Južni Psunj	2013. - 2022.	6590,28	6414,63
	Nova Kapela	123	Radinje	2011. - 2020.	2639,6	2283,92
		124	Ješevik-Briknjevača	2020. - 2029.	1311,31	1295,76
		125	Južna Babja gora	2020. - 2029.	5668,74	5556,41
	Novska	134	Novsko brdo	2018. - 2027.	3677,05	3473,05
		135	Trstika	2011. - 2020.	1909,52	1851,38
		151	Zelenika	2016. - 2025.	3687,92	3364,53
		152	Rajićko brdo	2018. - 2027.	4004,22	3711,79
	Okučani	129	Zapadni Psunj	2020. - 2029.	3714,32	3559,31
		133	Okučanska brda	2011. - 2020.	3513,39	3377,19
	Oriovac	038	Stupničko brdo-Cerje	2020. - 2029.	3586,08	3484,78
		039	Mlada vodica-Puavice	2015. - 2024.	2082,36	2033,71
		040	Mrsunjski lug - Migalovci	2014. - 2023.	2611,23	2429,14
	Slavonski Brod	040	Mrsunjski lug - Migalovci	2014. - 2023.	2611,23	2429,14
		041	Južni dilj	2017. - 2026.	5055,33	4899,8
	Stara Gradiška	130	Prašnik	2016. - 2025.	1436,42	1330,35
		131	Ljeskovača	2016. - 2025.	1552,91	1411,58
		132	Međustrugovi	2018. - 2027.	2770,71	2402,4
		156	Podložje	2019. - 2028.	1533,1	1410,43
	Trnjani	042	Bratljevci	2018. - 2027.	2214,31	2147,5
		043	Glovac – Renovica	2019. - 2028.	1665,62	1623,73
		044	Dolca	2018. - 2027.	826,78	796,38
		045	Ilijanska Jelas	2011. - 2020.	1574,49	1514,47
OSIJEK	Đakovo	023	Đakovački lugovi i gajevi	2018. - 2027.	2850,32	2785,4
		024	Vuka	2016. - 2025.	1309,15	1249,46
		027	Kujnjak – Rakovac – Mačkovac	2011. - 2020.	2361,07	2 039,66

	Baranjsko Petrovo Selo	084	Jagodnjačke šume	2011. - 2020.	3861,73	3106,09
		108	Torjanačke šume	2012. - 2021.	3161,22	2614,11
	Batina	085	Zmajevačke podunavske šume	2019. - 2028.	3832,25	3381,29
		107	Baranjska planina	2012. - 2021.	1660,06	1363,4
		976	Bačke šume	-	6048	4113
	Darda	088	Haljevo – Kozaračke šume	2011. - 2020.	2914,13	2684,13
		089	Darđanske šume	2011. - 2020.	2992,55	2110,49
		090	Kopačevske podunavske šume	2011. - 2020.	9020,61	3062,6
		976	Bačke šume	-	6048	4113
	Levanjska Varoš	025	Breznica	2013. - 2022.	2755,7	2352,93
		026	Sjeverni dilj	2012. - 2021.	1856,08	1802,84
	Osijek	020	Osječke podravske šume	2017. - 2026.	3047,37	2547,22
		021	Erdutske podunavske šume	2017. - 2026.	1878,34	1632,61
		022	Osječke nizinske šume	2018 - 2027.	3654,23	3483,65
	Tikveš-Bilje	086	Tikveške podunavske šume	2018. - 2027.	5204,7	1970,79
		087	Dvorac – Siget	2019. - 2028.	4016,69	2190,98
		090	Kopačevske podunavske šume	2011. - 2020.	9020,61	3062,6
		976	Bačke šume	-	6048	4113
	Valpovo	018	Valpovačke podravske šume	2014. - 2023.	3114,12	2869,7
		019	Valpovačke nizinske šume	2020. - 2029.	2253,77	2169,47
POŽEGA	Čaglin	054	Južna Krndija čaglinska	2018. - 2027.	3668,59	3613,44
		056	Sjeverni Dilj čaglinski	2013. - 2022.	4901,93	4842,23
	Kamenska	049	Zapadni Papuk kamenski	2015. - 2024.	4810,69	4749,47
		050	Zapadni Papuk zvečevački	2016. - 2025.	6051,2	5872,19
	Kutjevo	051	Južni Papuk	2014. - 2023.	7054,46	970,57
		053	Južna Krndija kutjevačka	2018. - 2027.	3994,6	3844,8
	Pleternica	055	Sjeverni Dilj pleternički	2012. - 2021.	3696,14	3632,2
		057	Požeška gora	2011. - 2020.	4677,39	4599,19
		059	Poljadijske šume	2019. - 2028.	3368,04	3338,5
		949	Orljava (vodoprivreda)	2011. - 2020.	127,01	35,74
	Požega	058	Sjeverna Babja gora	2020. - 2029.	4657	4579,9

		059	Poljadijske šume	2019. - 2028.	3368,04	3338,5
		060	Istočni Psunj	2020. - 2029.	2908,73	2855,48
	Velika	051	Južni Papuk	2014. - 2023.	7054,46	5889,06
		052	Poljanačke šume	2014. - 2023.	1896,98	1867,46
SISAK	Dvor	382	Javornik	2013. - 2022.	7058,86	6972,57
		401	Zrinska brda	2012. - 2021.	6787,97	6691,49
	Glina	391	Pogledić-Biljeg	2019. - 2028.	552,9	548,96
		392	Pokule-Pećine	2020. - 2029.	2406,35	2374,94
		394	Popov gaj	2020. - 2029.	3554,68	3509,51
		396	Prolom-Kobiljak-Šašava	2020. - 2029	5646,11	5544,08
	Hrvatska Dubica	403	Posavske šume-Dubica	2019. - 2028.	5294,89	5046,76
	Kostajnica	397	Šamarica I	2011. - 2020.	6102,91	6016,24
	Lekenik	383	Kalje	2018. - 2027.	2722,78	2670,3
		390	Pešćenica-Cerje	2015. - 2024.	4019,37	3941,97
	Petrinja	385	Kotar-Stari gaj	2013. - 2022.	3394,38	3279,08
		388	Petrinjčica	2016. - 2025.	4215,48	4183,1
		389	Petrinjski lug-Piškornjač	2013. - 2022.	803,49	743,56
		398	Šamarica II	2011. - 2020.	2891,42	2841,37
		400	Vučjak-Tješnjak	2013. - 2022.	3567,69	3499,77
	Pokupsko	384	Kljuka	2014. - 2023.	2075,23	799,82
		393	Pokupske šume	2015. - 2024	2227,27	2198,19
		399	Vinica-Kobiljača	2011. - 2020.	1155,06	1148,53
	Rujevac	381	Ćorkovača-Karlice	2012. - 2021.	10733,06	10650,1
	Sisak	379	Belčićev gaj-Šikara	2018. - 2027	1989,33	1778,51
		380	Brezovica	2017. - 2026.	4506,24	4113,64
		384	Kljuka	2014. - 2023.	2075,23	1254,3
		386	Letovanički lug	2015. - 2024.	1795,94	1763,71
		402	Leklan	2013. - 2022	566,99	547,25
	Sunja	387	Lonja	2018. - 2027	2077,53	1666,02
		395	Posavske šume-Sunja	2019. - 2028	4864,1	4462,63
SLATINA	Ćeralije	031	Ćeralijske prigorske šume	2020. - 2029.	2856,91	2792,7

		036	Kotline	2019. - 2028.	1522,2	1494,99
		037	Sekulinačka planina	2014. - 2023.	3891,73	3786,77
	Čačinci	016	Drenovačka planina	2018. - 2027.	3003,79	2913,99
		017	Gaj	2019. - 2028.	1845,64	1768,72
	Pitomača	166	Banov brod	2019. - 2028.	828,8	794,58
		200	Pitomačka bilogora	2018. - 2027.	1335,63	1306,78
	Slatina	028	Slatinske podravske šume	2017. - 2026.	894,61	812,82
		029	Slatinske nizinske šume	2019. - 2028.	2170,27	2081,55
		030	Slatinske prigorske šume	2011. - 2020.	6399,85	6206,58
	Suhopolje	206	Suhopoljska bilogora	2020. - 2029.	5702,17	5597,63
		207	Suhopoljsko – virovitičke nizinske šume	2012. - 2021.	1430,47	949,84
		212	Suhopoljske dravske šume	2013. - 2022.	444,72	304,21
	Virovitica	207	Suhopoljsko – virovitičke nizinske šume	2012. - 2021.	1430,47	401,95
		211	Virovitička Bilogora	2013. - 2022.	7255,08	6834,7
	Voćin	032	Medveđak-kusac	2019. - 2028.	2940,55	2866,97
		033	Jovanovica	2019. - 2028.	1965,52	1901,67
		034	Djedovica-trešnjevica	2017. - 2026.	2914,53	2795,16
		035	Jovac-Slana voda	2018. - 2027.	2693,93	2620,26
VINKOVCI	Županja	071	Kusare	2013. - 2022.	3050,38	2946,08
		072	Kragujna	2013. - 2022.	3818,18	3646,16
	Cerna	066	Ceranski lugovi	2020. - 2029.	2162,07	2095,92
		067	Krivski otok	2020 - 2029.	1464,55	1424,86
		068	Banov dol	2020. - 2029.	1878,71	1817,61
	Gunja	074	Desićevo	2017. - 2026.	2599,17	2493,85
		075	Trizlovi - Rastovo	2017. - 2026.	1995,32	1903,76
		076	Savski lugovi	2016. - 2025.	1520,24	1476,38
	Ilok	082	Jelaš	2019. - 2028.	1822,59	1769,49
		083	Vukovarske dunavske ade	2020. - 2029.	1810,03	1553,58
		091	Iločke šume	2012. - 2021.	1799,53	1672,22
	Lipovac	078	Dubovica	2012. - 2021.	1434,32	1385,09
		079	Narače	2013. - 2022.	1678,27	1611,01

		080	Topolovac	2012. - 2021.	3460,3	3279,92
	Mikanovci	061	Durgutovica	2018. - 2027.	721,84	695,95
		062	Muški otok	2018. - 2027.	3017,76	2919,65
	Otok	069	Otočke šume	2011. - 2020.	2590,61	2507,04
		070	Slavir	2014.-2023	8610,72	8251,25
	Strizivojna	046	Trstenik	2012. - 2021.	1547,24	1490,95
		047	Merolino	2013. - 2022.	1865,29	1809,4
		048	Orljak	2012. - 2021.	1024,97	987,46
	Strošinci	077	Debrinja	2017. - 2026.	5332,55	4990,24
	Vinkovci	063	Vrapčana	2018. - 2027.	1250,28	1205,85
		064	Dionica	2019. - 2028.	1693,75	1629,13
		065	Kunjevci	2012. - 2021.	3079,39	2911,17
	Vrbanja	073	Vrbanjske šume	2015. - 2024.	8281,41	7885,89
	Vukovar	081	Vukovarske dubrave	2019. - 2028.	2551,53	2428,42
		082	Jelaš	2019. - 2028.	1822,59	1769,49
		083	Vukovarske dunavske ade	2010. - 2019.	1810,03	1553,58
ZAGREB	Donja Stubica	301	Stubička gora	2018. - 2027.	1672,65	1655,76
		318	Stubičko podgorje	2014. - 2023.	758	750,25
	Dugo Selo	302	Duboki jarak	2019. - 2028.	677,95	647,8
		303	Črnovščak	2019. - 2028.	2712,24	2598,51
		313	Zelinske šume	2013. - 2022.	1139,5	1126,52
	Krapina	297	Macelj	2017. - 2026.	2698,89	2667,22
		310	Strahinjčica-Trnovec	2012. - 2021.	946,55	923,13
		317	Pregrada - Klanjec	2014. - 2023.	463,18	459,05
	Kutina	141	Kutinske nizinske šume	2011. - 2020.	3213,32	2528,81
		142	Kutinske prigorske šume	2012. - 2021.	3285,17	3176,69
		143	Kutinska Garjevica	2017. - 2026.	2667,3	2584,38
	Lipovljani	139	Josip Kozarac	2015. - 2024.	5802,32	5514,45
		140	Jamaričko brdo	2012. - 2021.	1429,25	1365,75
	Novoselec	146	Žutica	2018. - 2027.	6242,23	5742,63
		147	Veliki Jantak	2012. - 2021.	2158,74	1869,37

		148	Čret - Varoški lug	2011. - 2020.	1180,38	1099,83
		149	Marča	2012. - 2021.	2321,24	2141,22
	Popovača	144	Popovačke nizinske šume	2019. - 2028.	5072,83	4669,33
		145	Popovačke prigorske šume	2020. - 2029.	1184,03	1165,65
		157	Popovačka Garjevica	2017. - 2026.	2296,4	2247,11
	Remetinec	304	Obreški lug	2020. - 2029.	1416,3	1368,82
		316	Vukomeričke gorice-Horvati	2014. - 2023.	846,56	834,65
		324	Stupnički lug	2020. - 2029.	1707,65	1642,98
	Samobor	308	Kal - Javorac	2011. - 2020.	1433,02	1413,65
		312	Žumberak – Novoselska gora	2013. - 2022.	4867	4791,73
		321	Tepec-Palačnik-Stražnik	2015. - 2024.	340,99	337,77
	Velika Gorica	306	Savski vrbaci	2020-2029	269	242,75
		315	Šiljakovačka Dubrava II	2014. - 2023.	4225,05	3983,19
		319	Turopoljski lug	2015. - 2024.	4359,77	4099,87
		320	Vukomeričke gorice II	2015. - 2024.	2711,56	2660,07
	Zagreb	298	Sljeme – Medvedgradske šume	2018. - 2027.	2377,56	2345,37
		299	Markuševačka gora	2018. - 2027.	2071,46	2028,12
		300	Bistranska gora	2018. - 2027.	1451,34	1412,51
		309	Limbuš Sava	2011. - 2020.	565,3	554,99
	Zlatar	307	Južna Ivančica	2011. - 2020.	2049,92	2013,8
		311	Zlatarske prigorske šume	2012. - 2021.	489,79	484,22
	Hortikultura Zagreb	322	Park šume Grada Zagreba	2014. - 2023.	395,08	369,74
*Gospodarska jedinica se ne nalazi cijelom površinom u području obuhvata Plana						

13.7 The method of land use according to the Corine Land Cover database within the POP area covered by the Plan

CLC	POP												
	HR1000001	HR1000003	HR1000004	HR1000005	HR1000006	HR1000008	HR1000009	HR1000010	HR1000011	HR1000014	HR1000015	HR1000016	HR1000040
	ha												
	%												
111	-	-	-	1,15	-	-	-	-	-	-	-	-	-
	-	-	-	0,003	-	-	-	-	-	-	-	-	-
112	446,75	151,03	2003,78	551,48	6,31	374,92	423,04	252,22	3,05	216,25	47,78	113,63	21,91
	1,27	0,76	1,66	1,42	0,01	0,39	1,83	1,86	0,01	0,94	0,36	0,17	0,06
121	78,33	-	189,9	33,81	27,54	5,01	-	-	-	9,42	-	3,81	68,36
	0,22	-	0,16	0,09	0,06	0,01	-	-	-	0,04	-	0,01	0,18
122	89,14	-	664,39	-	155,23	-	-	-	-	-	-	-	-
	0,25	-	0,55	-	0,36	-	-	-	-	-	-	-	-
123	-	-	-	-	-	-	-	-	-	-	-	0,01	-
	-	-	-	-	-	-	-	-	-	-	-	0,000	-
131	-	-	-	-	-	41,07	-	-	-	117,33	-	31,57	233,41
	-	-	-	-	-	0,04	-	-	-	0,51	-	0,05	0,62
132	-	-	179,77	-	-	-	-	-	-	-	-	-	-
	-	-	0,15	-	-	-	-	-	-	-	-	-	-
133	-	-	101,36	-	-	-	-	-	-	-	-	48,81	-
	-	-	0,08	-	-	-	-	-	-	-	-	0,07	-
141	-	-	-	-	-	-	-	-	-	-	-	1,34	-
	-	-	-	-	-	-	-	-	-	-	-	0,002	-
142	-	-	-	0,49	-	-	-	-	-	34,31	-	3,01	-
	-	-	-	0,001	-	-	-	-	-	0,15	-	0,005	-
211	3076,73	1056,39	9894,86	12 916,41	223,09	1696,6	2230,34	1399,27	56,28	3837,4	5577,94	6289,05	13,85
	8,77	5,28	8,17	33,26	0,51	1,78	9,62	10,33	0,27	16,76	41,46	9,56	0,04
221	-	-	-	-	-	141,63	-	-	-	-	-	-	4,42
	-	-	-	-	-	0,15	-	-	-	-	-	-	0,01
222	-	-	-	-	-	36,52	-	-	-	-	-	0,79	0,69
	-	-	-	-	-	0,04	-	-	-	-	-	0,001	0,002
231	3277,06	3339,17	10 772,27	2424,45	0,28	4902,18	1405,14	1257,96	181,66	609,82	141,34	4387,18	490,17
	9,34	16,69	8,90	6,24	0,00	5,16	6,06	9,29	0,87	2,66	1,05	6,67	1,31
242	7482,14	4035,16	18 785	6132,08	34,13	17 744,54	7089,52	2375,63	12,62	5015,84	4014,26	1885,45	96,84
	21,32	20,17	15,52	15,79	0,08	18,66	30,59	17,54	0,06	21,91	29,84	2,86	0,26
243	1475,61	1540,02	7595,19	1824,85	1,26	8190,24	1181,09	298,83	0,87	451,44	382,96	2246,64	287,69

	4,20	7,70	6,27	4,70	0,003	8,61	5,10	2,21	0,004	1,97	2,85	3,41	0,77
311	10 640,65	7302,31	36 829,88	7702,3	32 836,65	50 889,43	6836	3204,05	14911,79	7156,97	1170,22	20 317,97	31 583,34
	30,32	36,51	30,42	19,83	75,45	53,52	29,49	23,66	71,80	31,26	8,70	30,87	84,48
312	-	-	-	-	-	77,6	-	-	-	1,03	-	-	270,96
						0,08	-	-	-	0,00	-	-	0,72
313	-	-	-	-	-	895,68	-	79,25	-	0,04	-	-	3064,07
						0,94	-	0,59	-	0,00	-	-	8,20
321	444,69	-	2972,08	-	-	-	-	-	-	-	-	316,29	-
	1,27	-	2,45	-	-	-	-	-	-	-	-	0,48	-
324	5749,22	2494,71	26 363,91	3507,38	10 187,67	9998,38	2304,11	1163,89	3125,15	2716,14	869,13	12 980,54	1248,8
	16,38	12,47	21,78	9,03	23,41	10,52	9,94	8,59	15,05	11,86	6,46	19,72	3,34
331	-	-	-	-	-	-	-	-	-	70,51	-	-	-
	-	-	-	-	-	-	-	-	-	0,31	-	-	-
411	365,51	73,06	822,07	834,54	-	-	81,65	46,76	167,23	397,98	217,64	10 584,8	-
	1,04	0,37	0,68	2,15	-	-	0,35	0,35	0,81	1,74	1,62	16,08	-
511	642,09	11	2169,23	1133,85	46,79	-	-	-	-	1929,93	1031,23	4877,16	-
	1,83	0,05	1,79	2,92	0,11	-	-	-	-	8,43	7,66	7,41	-
512	1324,67	-	1729,26	1771,01	-	92,84	1626,89	3465,42	2308,72	330,39	1,68	1726,76	-
	3,77	-	1,43	4,56	-	0,10	7,02	25,59	11,12	1,44	0,01	2,62	-
Ukupna površina	35 092,58	20 002,85	121 072,94	38 833,79	43 518,93	95 086,64	23 177,78	13 543,26	20 767,36	22 894,84	13 454,22	65 815,07	37 384,52
	100	100	100	100	100	100	100	100	100	100	100	100	100

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