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ACTION

Pilot Area characterization

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Alma Mater Studiorum Università di Bologna | Department of Biological, Geological, and Environmental Sciences

Istituto Delta Ecologia Applicata

Vransko Jezero Park prirode • Nature Park

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Parco Naturale Regionale Dune Costiere da Torre Canne a Torre San Leonardo

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Abstract

The pilot action conducted by Public Institution Nature Park Vransko Jezero (PP5) focuses on developing a habitat restoration plan for the Jasen area, part of the Natura 2000 site "Vransko Jezero i Jasen." This initiative aims to restore valuable wetland habitats, including floodplain grasslands, Mediterranean temporary ponds, reedbeds, and shallow banks, to improve biodiversity conservation and water management. The restoration plan builds upon a conceptual design from the CHANGE WE CARE project, emphasizing regenerative agriculture and floodwater retention to mitigate climate change impacts.
The pilot area encompasses four Natura 2000 sites in northern Dalmatia, Croatia, characterized by diverse geological formations, hydrological systems, and fertile agricultural land. Lake Vrana, Croatia's largest natural lake, is a shallow cryptodepression influenced by karst aquifers and saline intrusion. The ecological status of the lake is under pressure from agricultural runoff and climate change effects such as rising temperatures and altered precipitation patterns.
Socio-economic analyses reveal that agriculture remains the dominant economic activity in Ravni Kotari, complemented by emerging tourism initiatives. However, challenges such as depopulation, aging demographics, and water scarcity necessitate sustainable land use strategies. Stakeholder surveys highlight awareness of climate change impacts on habitats, public health, and economic activities.
The restoration plan aims to address these challenges through habitat restoration, adaptive water management practices, stakeholder collaboration, and nature-based solutions. Future research will monitor seasonal variations in ecological indicators to refine conservation strategies. By integrating ecological restoration with socio-economic resilience measures, this project seeks to enhance the long-term sustainability of the Vransko Jezero region amidst climate change pressures.

Introduction

The pilot action of the PP5 Public institution nature park Vransko jezero is the preparation of the habitat restoration plan for the Jasen, the area of valuable floodplain wet grasslands / pastures and meadows in part of the Natura 2000 site Vransko jezero i Jasen. The management objective in this area is to increase the spatial distribution, establish and preserve the favorable condition of various types of wetland habitats, including the target habitat types of wet grasslands (6420 and 6540) and Mediterranean temporary ponds (3170), but also other wetland habitats important for numerous target species, primarily reedbeds, ponds and shallow gravel-muddy banks. The restoration would have a significant positive impact on the conservation status and distribution of rare and endangered habitat types and related target species, and would also have a significant function in regulating the water regime, as well as in purifying water that flows from agricultural areas in the basin into the lake.

A part of the Climate change adaptation plan, produced as the pilot action of the Interreg project CHANGE WE CARE, was a conceptual design that was developed for the restoration of wetlands and the establishment of regenerative agriculture in the Jasen area (Bišćević, 2021). The aim of the conceptual design was a greater retention of flood waters in the Jasen area supporting the revitalization of existing

wet grasslands (in the northern part of the Jasen area) and their restoration in a larger or smaller part of the area. In order to maintain a higher water level in the lake for a longer period of time, without increasing the risk of flooding, it is necessary to ensure and improve the ability to quickly evacuate large waters from the lake, by increasing the capacity to retain water in the basin and slow its flow into the lake, by returning part of the current agricultural areas back to the natural water regime. In seeking an optimal solution, it is extremely important to approach the problem in an integrated manner, while simultaneously trying to address and optimize all the set goals. Habitat restoration plan would build on a previously developed conceptual design.

Habitat restauration plan is an important tool for developing direction and identifying key values/assets, threats and potential solutions for restoring wetland habitats. A cohesive plan will guide the area management and will increase the effectiveness of restoration efforts. This involves identifying a "goal state" for the restored habitat. The aspirational qualities for restored habitats are that they are:
• adequate to meet target species' requirements over time (Natura 2000 bird species)
• ecologically 'functional' and self-sustaining
• resilient to disturbance in the shorter term
• adaptive to change (e.g. climate change) over the longer term

The plan will define the components desired at the site and in the landscape which will help recognize the types of species and interactions that are important in the basic functioning of a wetland ecosystem. The purpose of the activity is wetland rehabilitation with improved water quality and flood control.
A restoration plan will:

- Define aspirational restoration goals and target species.
- Understand what healthy habitat looks like for the target species of interest and how the habitat may naturally change over time.
- Define a desired goal state for the habitat.
- Identify the current state and threats to the habitat in the landscape and site of interest
- Identify general restoration actions that can be undertaken to reach the desired state.
- Summarize actions in a draft implementation plan, prepare draft budget and work plan.
- Redefine specific, measurable, agreed-upon, realistic and timebound restoration goal(s) for the system after feasibility review and set achievable milestones.
- Implement other stages of restoration actions and manage the site(s) adaptively (as informed by monitoring results). Appropriate stakeholder consultation should be carried out at each step that requires key decisions to be made (Clarke, 2010).

Also, as a part of the ACTION project some of the additional research of habitats and species of the pilot site is going to be conducted and, since all seasons have to be included in the research, the results will not be available until September 2025. Here is the abstract of the results of the previous research.

Pilot area description

Geographic and territorial characterization

The area of the pilot site includes four Natura 2000 sites: Vrana Lake Nature Park and the adjacent Jasen area representing the Natura 2000 sites Vransko jezero i Jasen (SPA HR1000025 and SAC HR5000025), as well as Natura 2000 sites Ravni kotari (SPA HR1000024 and SAC HR2001361), which overlaps the catchment area of the Vransko lake (Figure 1.).

The Natura 2000 sites are administratively located in Zadar and Šibenik-Knin counties, between the cities of Zadar and Šibenik, in the area of 20 local governments (towns of Benkovac, Biograd na Moru, Nin and Skradin and the municipalities of Škabrnja, Galovac, Sukošan, Sveti Filip i Jakov, Polača, Pakoštane, Stankovci, Vrsi, Ražanac, Posedarje, Poličnik, Zemunik Donji, Lišane Ostrovičke, Pirovac, Tribunj i Vodice). It is located in a coastal lowland area of northern Dalmatia, and extends at the foot of Velebit, from the hinterland of Zadar in the west to the hinterland of Skradin in the east. The pilot site belongs to the Mediterranean biogeographic region.

The Vransko jezero i Jasen site covers the area of 5,912.98 ha, of which 5,748.99 ha is the Nature Park, and the remaining 163.99 ha is the Jasen area, while the Ravni kotari site covers much broader area of 65.114,76 ha.

Lake Vrana is the largest natural lake in Croatia by surface area. The area is one of the most important wetlands in Croatia and one of only two large wetlands in the Mediterranean part of Croatia.

The lake extends 13.6 km in length, in the NW-SE direction, is 1.4-3.4 km wide and is relatively shallow, with a depth that varies from only 0.5-1 m in its NW part, to 4-6 m in the SE part. Formed in a shallow cryptodepression, with the lake bottom at -3.47 m above sea level, it is the lowest area in terms of relief, into which approximately half of the surface flows of Ravni kotari flow. The lake is separated from the sea only by a narrow and relatively low limestone ridge, but it is also connected to the sea by natural karst cracks in the ridge and the Prosika channel dug in the 18th century in its SE part. The lake's water level is highest in winter and spring, and lowest in summer and autumn, with a difference between the extremes of almost 2.5 m. The mean water level of the lake is 0.82 m above sea level. Along its NE side, the lake is bordered by a ridge that is much higher than the one along the opposite shore, part of which is the highest peak of Ravni kotari, the 303 m high Štandarac peak. In the NW the lake is continued onto the Vrana Field, a fertile agricultural area of about 45 km^2, which was also largely a wetland before the digging of the Prosika and land reclamation.

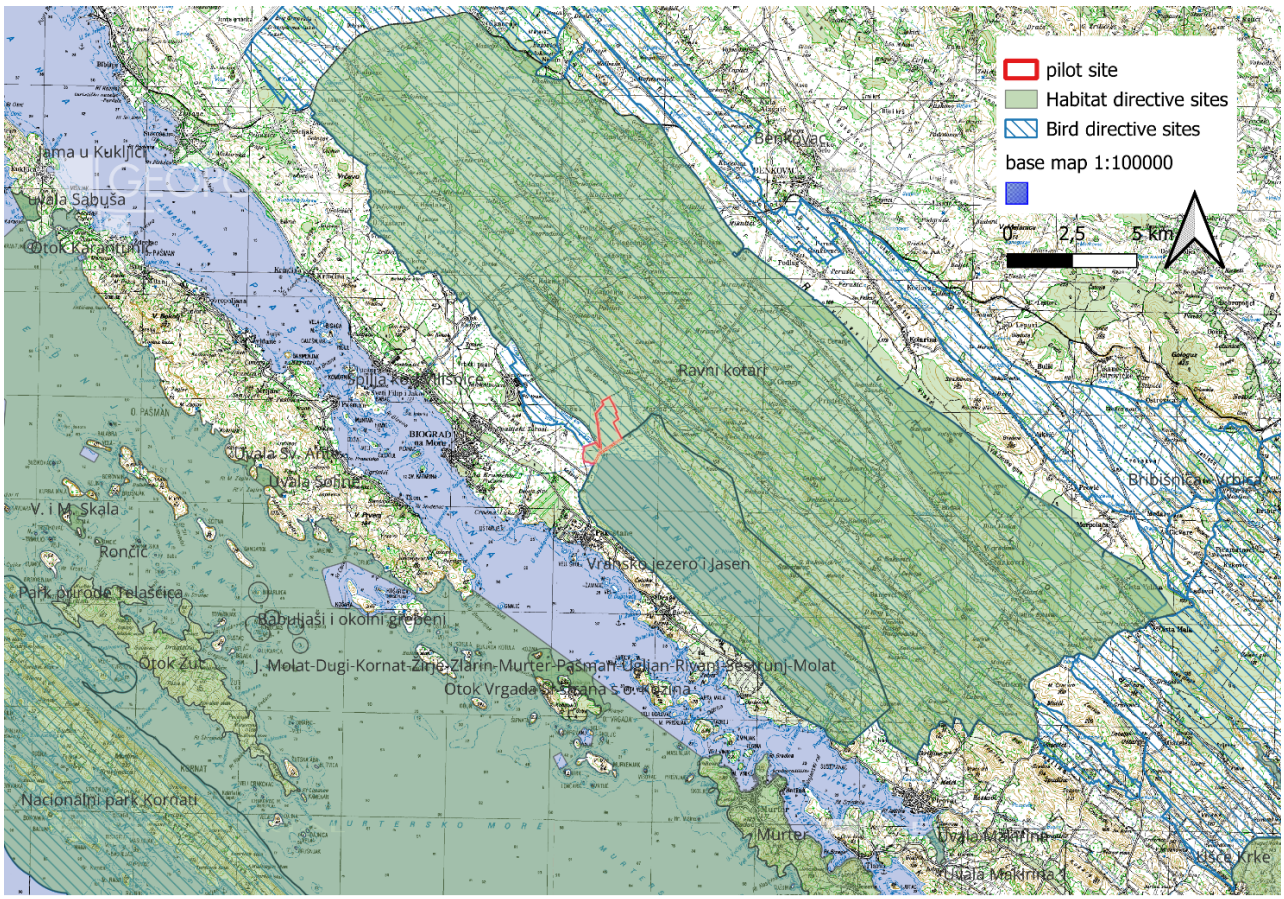


Figure 1. The location of the pilot site and the Natura 2000 sites (Source: Bioportal, https://bioportal.hr/o-sustavu/)

Geology and geomorphology

The rocks of the area can be geochronologically divided into Upper Cretaceous (from 100 million years ago to 66 million years ago), Eocene (from 56 million years ago to 34 million years ago) and Quaternary rocks (from 2.5 million years ago to the present). The deposits extend in a direction parallel to the extension of the Dinarides (NW-SE) (Mamužić, 1971, 1975) (Figure 2).

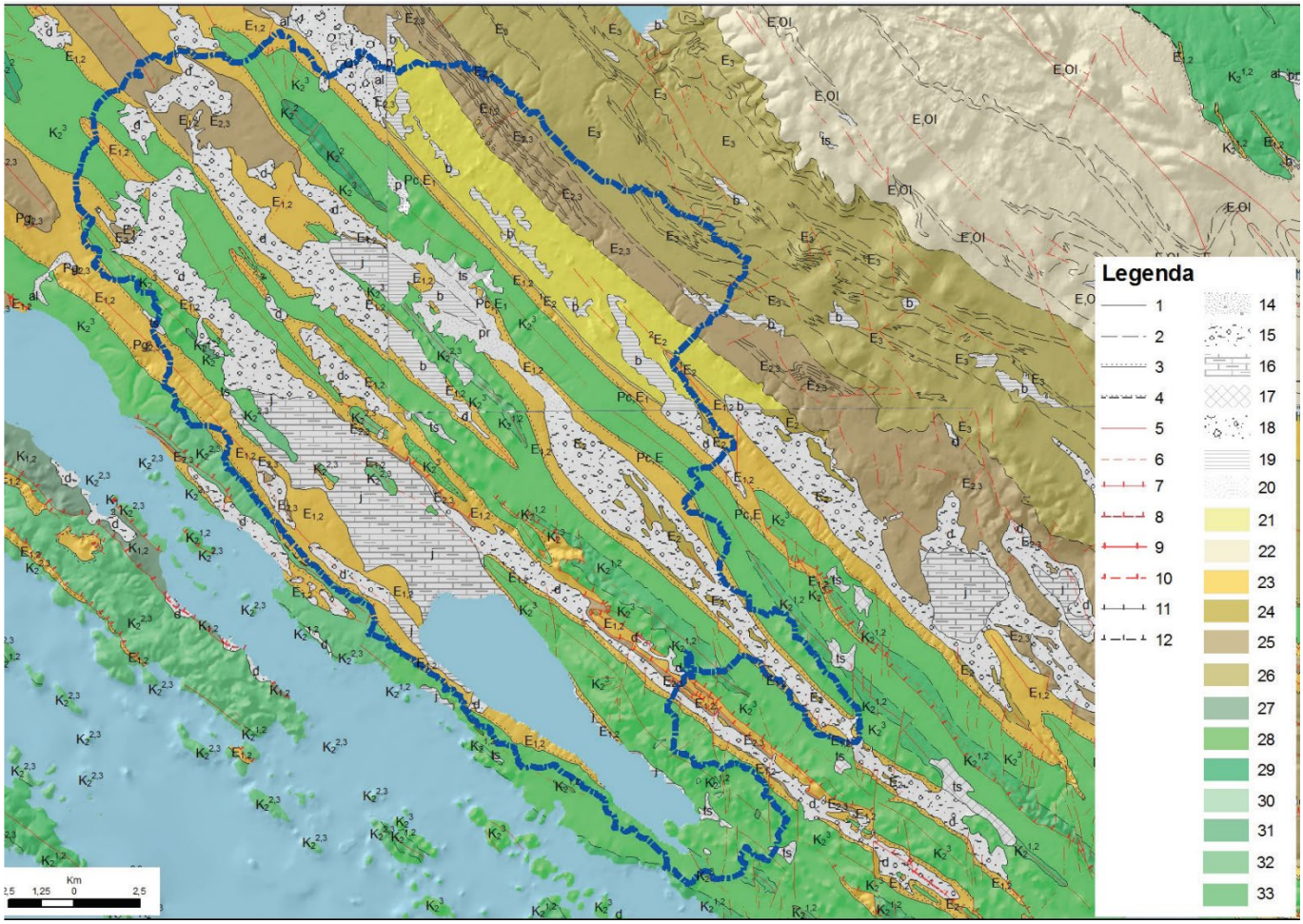


Figure 2. Geological map of Lake Vrana and its catchment (Mamužić & Nedela-Devide, 1971; Mamužić & Nedela-Devide, 1973; Mamužić, 1966; Mamužić, 1975; Majcen et al., 1970; Majcen & Korolija, 1973).

The oldest are Cretaceous carbonate rocks made of alternating limestones and dolomites, from the geological period Turonian (from 94 million years ago to 90 million years ago), which cover small areas of the terrain along the axes of the anticlines west, east and south of Vrana Lake. They are overlain by Upper Cretaceous rocks from the Senonian period (90 million years ago to 66 million years ago), made of light, thick-bedded limestone, which cover the hilly areas along the southwestern and eastern borders of the park, the areas south of Lake Vrana, and part of the surface below the bottom of Lake Vrana (Mamužić, 1971, 1975). Lower Eocene Paleogene rocks made of light gray and well-bedded foraminiferal limestones were transgressively deposited on the Cretaceous limestones, which cover part of the terrain west and east of the central area of Lake Vrana, and part of the surface below the bottom of Lake Vrana. A small part of the surface along the very axis of the syncline below the lake deposits of Lake Vrana is covered by flysch deposits, made of marl, sandstone and conglomerate, formed during the Middle Eocene (Mamužić, 1971, 1975). Quaternary sediments deposited in the area under consideration include lake, marsh and diluvial sediments, as well as red soil. Lake and marsh sediments, made up of predominantly fine-grained sand and clay, cover the bottom of Lake Vrana and the northern, northwestern and eastern parts of the

terrain along the lake's edge. They contain the remains of ostracods and gastropods, which indicates that these sediments are still being formed today. Diluvial (slope) deposits, which are formed by the weathering of carbonate and flysch rocks on higher terrain, the transport of weathered particles and their deposition in valleys, build up parts of the terrain along the eastern and western shores of the lake. In the southeastern part of the wider area of Lake Vrana, thicker red soil deposits have been deposited as part of morphological depressions (Mamužić, 1971, 1975).

The wider area of Lake Vrana is folded and tectonically deformed due to the subduction of the Adriatic tectonic microplate under the Eurasian tectonic plate. The deposits are folded in the NE-SW direction, and the folds are narrow and long, vertical, oblique and flat. The Vrana Field depression was formed in the area of a syncline bounded by anticlines to the northeast and southwest. The faults in the area in question are transverse to the direction of the deposits and create small displacements of the fold wings. The anticline to the northeast has been displaced several times by transverse faults (Mamužić, 1971, 1975).

Ravni Kotari is a flat area with an average altitude of 100 - 150 m. On the surface of the area of 1261 km^2, there are small differences in altitudes, which are manifested as changes in lowland landscapes made of flysch and Quaternary deposits and carbonate hilly landscapes. Such landscape changes are more pronounced in the southern and southeastern parts of Ravni Kotari, while the northern part is almost completely flat, with average altitudes lower than 100 m. The lowest part of the terrain is equal to sea level in the vicinity of the city of Nin, while the highest elevation of the terrain, Velika Gradina, is located at 329 m above sea level, near the municipality of Stankovci. Among the other higher elevations in the southern part of the area, the Crnogorka hill near Vransko Lake, with an elevation of Štandarac (303 m), a hill near the settlement of Donji Kraj, with an elevation of Debeljak (284 m), a hill near the settlement of Crljenik, with an elevation of Gorivuk (267 m) and a hill near the settlement of Radošinovci with an elevation of Zmijevača (264 m). The highest elevations in the northern part of Ravni kotar are Debelo brdo (166 m) and Pekotin brig (164 m) near the settlement of Radovin (DGU, 2022).

Karst relief forms are characteristic of parts of the terrain built of carbonates. The largest karst form in the area is the submerged karst field of Vrana Lake, which is covered with Eocene flysch and Quaternary sediments. Several sinkholes stand out in the area, and in the largest, in the extreme southeastern part of the area, the Benča pond has formed. Other surface karst forms include cracks, grooves and scarp formations that are formed by the dissolution (corrosion) of carbonates by precipitation. These cracks are present on Senonian limestones, and their maximum development is present in the area of the Babin Škoj ridge. Biocorrosion depressions are formed by the action of bacteria, lichens, mosses or plant roots on Cretaceous limestone rocks. Among the speleological objects, the Banđen Cave on Crnogorka Hill stands out (Andlar et al., 2020). Crnogorka Hill is characterized by the appearance of ravines and dry valleys, of which the ravine between Prisoja and Osridak, the ravine at the foot of the Trstenice area and the dry valley of Mernjača stand out. Through ravines, the material was carried to the lower parts, where deluvial deposits and proluvial fans were formed in places (Punta, Velika njiva and Pod Gradinom). On rare very steep slopes, the process of collapse and formation of colluvial deposits occurs (Andlar et al., 2020).

Hydrogeology

With an average surface area of about 31.1 km^2, a length of about 13.6 km and a width that varies from about 1.4 to 3.4 km, Lake Vrana is the largest natural lake in Croatia by surface area. The lake is a cryptodepression because the lake bottom is below sea level, at a depth of -3.47 m. The lake is relatively shallow, with a depth that varies from only 0.5-1 m in its NW part, to 4-6 m in the SE part (Figure 3).

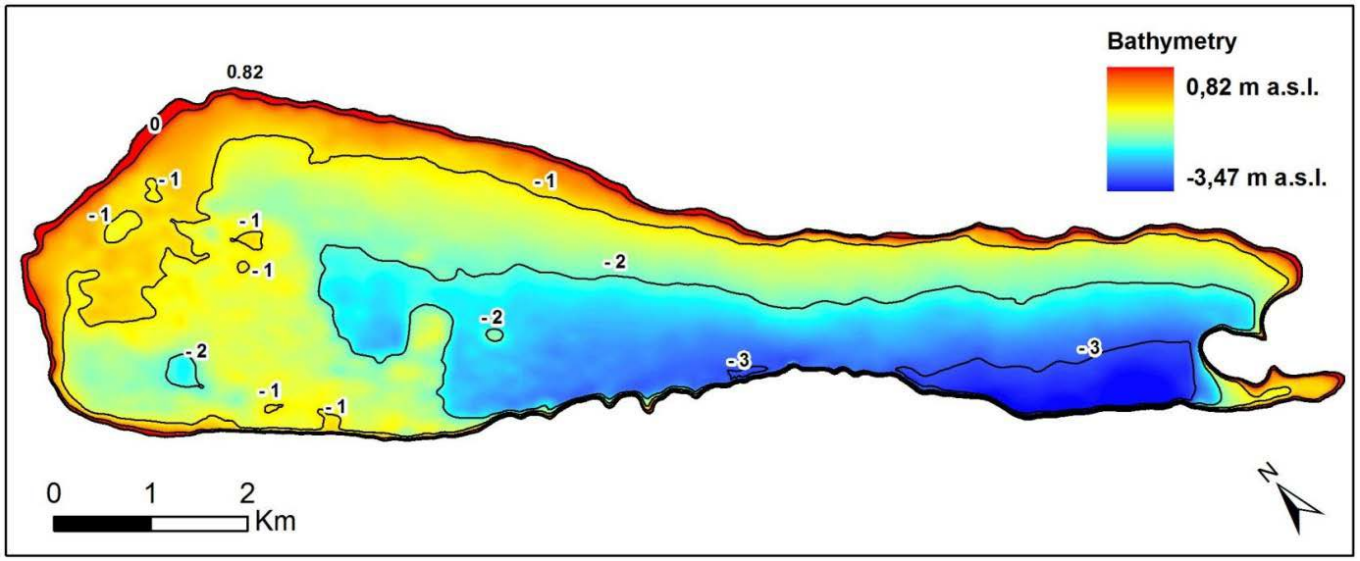


Figure 3. Bathymetric image of the bottom of Lake Vrana (according to measurements by the Teodolit company, Zadar, 2012).

The lake was formed by the gradual submergence of a karst field caused by the rise in sea level after the last ice age. It is separated from the Adriatic Sea by a narrow permeable limestone ridge 10 km long and less than 1 km wide in some places. Sediment analysis shows that the lake's salinity has been present for more than 4,000 years (IGH, 2020).

Rocks in the wider area of Lake Vrana are divided according to permeability into: permeable, partially permeable, impermeable, partially impermeable and rocks of alternating properties. Permeable rocks are limestone rocks of the Upper Cretaceous and Lower Eocene. Partially permeable rocks consist of plate-like marly Lower Eocene limestones with foraminifers and locally fractured plate-like limestones of the Upper Cretaceous. Partially impermeable rocks are thinly bedded to plate-like, and partly locally clayey foraminiferal limestones of the Lower Eocene and sandstones within the complex of Middle Eocene flysch deposits. Impermeable rocks are Middle Eocene flysch deposits that function as hydrogeological barriers. Rocks of alternating properties are clastic Quaternary rocks of lake, marsh and slope sediments whose permeability depends on the proportion of clasts of different sizes (sand, silt, clay) (Ilijanić, 2018). The direction of groundwater flow is in the direction of the deposits from northwest to southeast through karst limestone rocks.
The water level in the lake depends in a complex way on the inflow of water into the lake by surface and underground means, including springs in the lake itself, the outflow of water through underground karst fissures and the Prosika channel, and on evaporation. The surface level of the lake varies by almost 2.5 m,

between -0.16 m above sea level and 2.24 m above sea level, with an average water level of 0.82 m above sea level. The water level of the lake is highest in winter and spring, and lowest in summer and autumn (Figure 4).

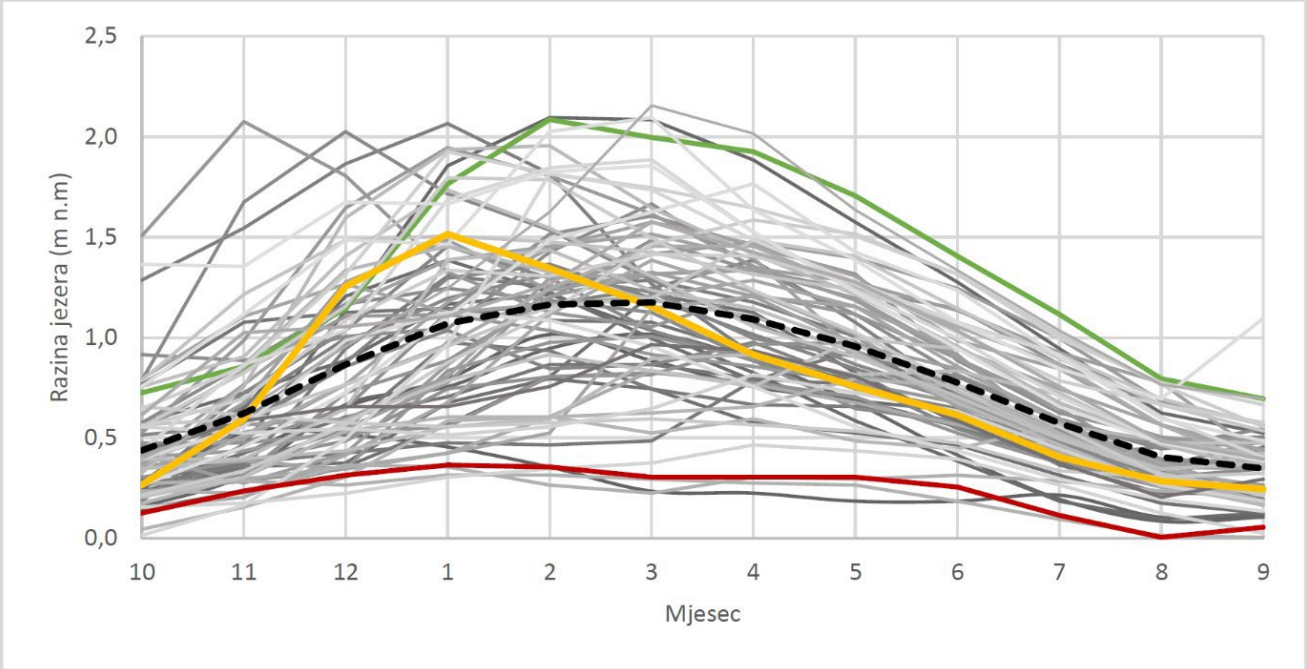


Figure 4. Intra-annual distribution of mean monthly water levels at the Pakoštanski most hydrological station over the Kotarka in the period 1947–2020, with the mean value highlighted (dashed black line), an extremely dry year (2011/2012, red line), an extremely wet year (2000/2001, green line) and 2019/2020 (yellow line) (taken from Rubinić et al., 2022)

The area of the flood zone is about 3 km^2, of which about 90% is in the ornithological reserve, and a smaller part in the Jasen area, in the Jezerine part. The average volume of water in the lake is about 75 million m^3, and depending on the water level it varies from 45 to 120 million m^3.
The Vrana Lake basin, with an area of about 515 km^2 (484.5 km^2 of the surrounding area and 31.1 km^2 of the lake itself), includes a large part of Ravni Kotari (to the northwest, approximately to D. Zemunik and Smilčić, and inland approximately all the way to Benkovac and Korlat) (Figure 5.), with approximately half of the surface flows of Ravni Kotari. Of the larger rivers that make up the basin, the Kotarka River and the Škorobić and Kličevica streams stand out.

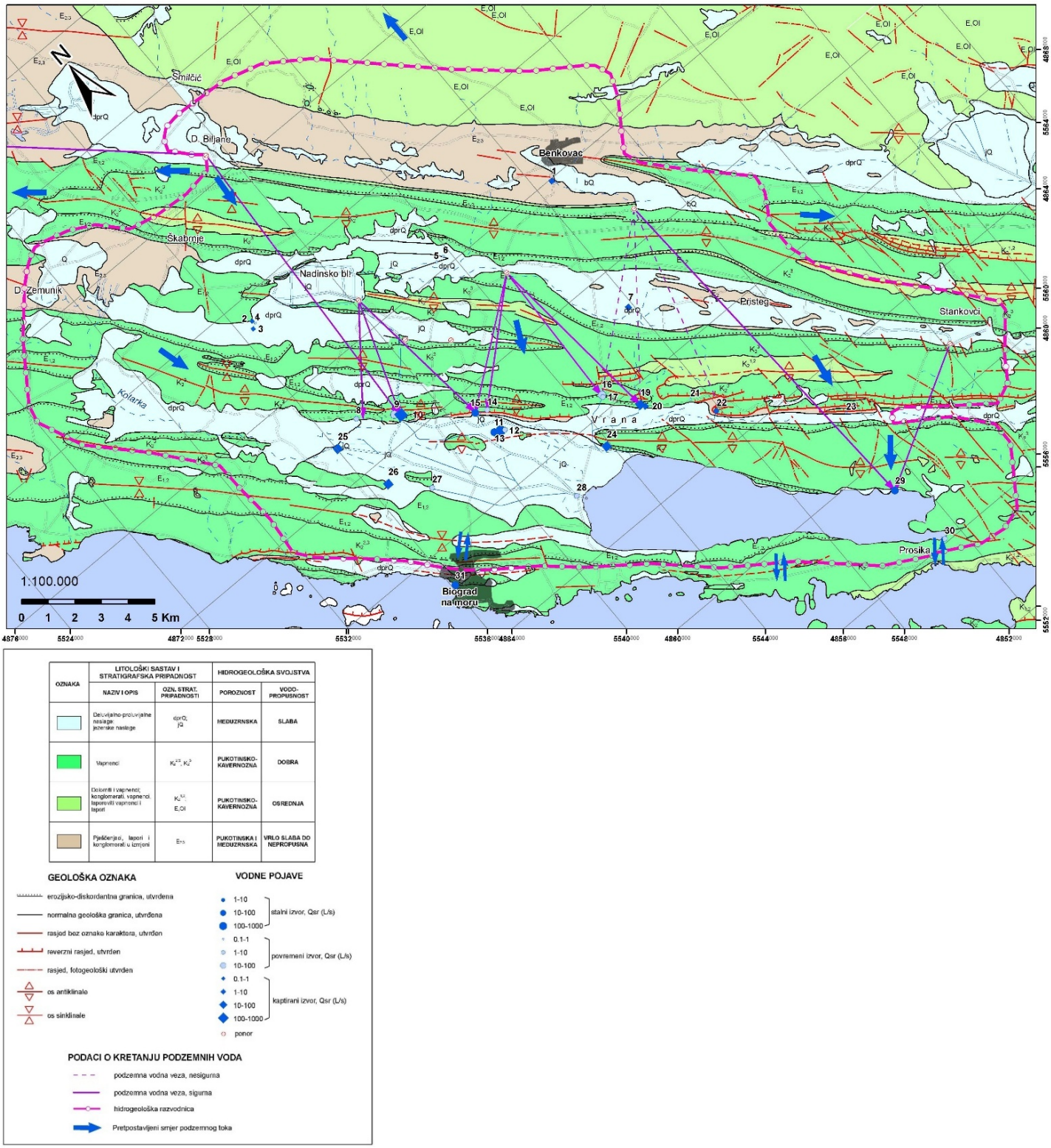


Figure 5. Hydrogeological map of the Vransko lake catchment (red dashed line) (Stroj, 2012)

The Kotarka River in Vrana Field has been regulated and transformed into the Main Canal, which is part of the canal network system that serves for the hydromelioration of the Vrana Field area. The Škorobić Stream flows into the Lateral Canal, which flows into Vrana Lake. Along the Lateral and Main Canals, embankments have been built for flood protection. The northern part of the lake, between the Main and Lateral Canals, is a shallow marshy area. The area east of the Lateral Canal has the highest risk of flooding (Hrvatske vode, 2020).

Brackish water springs and vruljas are located along the western and northern shores of the lake, and in the south along the Prosika Canal. The most prominent springs are the Begovača, Procip and Prizidina springs along the northern shore of the lake. The Živača spring is located on the southeastern edge of Vrana Lake. (Ilijanić, 2018; Mrakovčić et al. 2017).

The Prosika Channel, about 900 m long and 8 m wide, connects the southernmost part of the lake with the Adriatic Sea. The channel, which was subsequently widened and deepened, was drilled in its original form in 1770, after which the water level in the lake dropped significantly. In addition to the channel, the lake is connected to the sea by an aquifer. For most of the year, the water flows from the lake to the sea, but during hot and dry summer periods, the direction of water movement can be the opposite (Andlar et al., 2020; Ilijanić, 2018; Stipanić et al., 2021). Due to the connection to the sea underground and through the channel, the lake water is slightly saline, i.e. brackish. Its salinity is below 1‰ for most of the time, but as the intrusion of salt water varies depending on hydrological conditions throughout the year, there are also significant fluctuations in salinity, which in extreme conditions can reach extremely high values, unusual for freshwater systems (Vuković et al., 2020). As expected, a greater inflow of freshwater into the lake reduces salinity because it gradually “dilutes” the lake water and, due to the rise in the water level in the lake, also displaces saline groundwater in the fracture systems through which the sea naturally penetrates the lake. This is a sensitive system in dynamic equilibrium, which also naturally, due to climate variability, significantly changes ecological conditions. In addition, the system has already been significantly anthropogenically influenced, primarily by the creation of canals with the aim of improving the Vrana Field, which as a wetland naturally dampened natural oscillations in the lake system, and by reducing the inflow of freshwater into the lake by pumping it and using it for agriculture in the basin area. Climate change and the associated predicted changes in sea level, precipitation amount and distribution, evaporation intensity, and even the growing pressure to use water for human needs will certainly create additional pressures.

Although large, the lake is shallow, and currents and waves, which can be up to 1 m high in windy weather, cause mixing of the entire water column and the resulting uniform temperature and distribution of nutrients in the lake. Due to its shallow depth, the lake water heats and cools quickly, depending on the air temperature.

According to chemical and biological indicators, the lake is on the border between oligotrophic and mesotrophic, with a trend towards eutrophication. The shallowness of the lake allows light to penetrate to the very bottom in sufficient quantities for plant development, but makes it sensitive to dry periods, when the water level can drop significantly, during which the concentration of dissolved substances in the water increases, which, among other things, reduces water transparency and increases salinity. Also, due to the shallow depth, only in the deepest parts do the processes of decomposition of organic matter take

place, which accelerates the processes of increasing the concentration of nutrients and filling the lake (Žutinić et al., 2020).

Pedology

In the Ravni Kotari area, soils characteristic of areas with carbonate rocks in the substrate have been developed. According to data from the basic pedological map at a scale of 1:50,000 (Čolak, 1982, 1983; Adam and Čolak, 1984), around 20 pedological units have been mapped within the area, consisting of several different soil types (Figure 6.). These soils are divided into lower pedosystematic units at the level of subtypes, varieties and forms, and their development depends on pedogenetic factors and processes in this area.

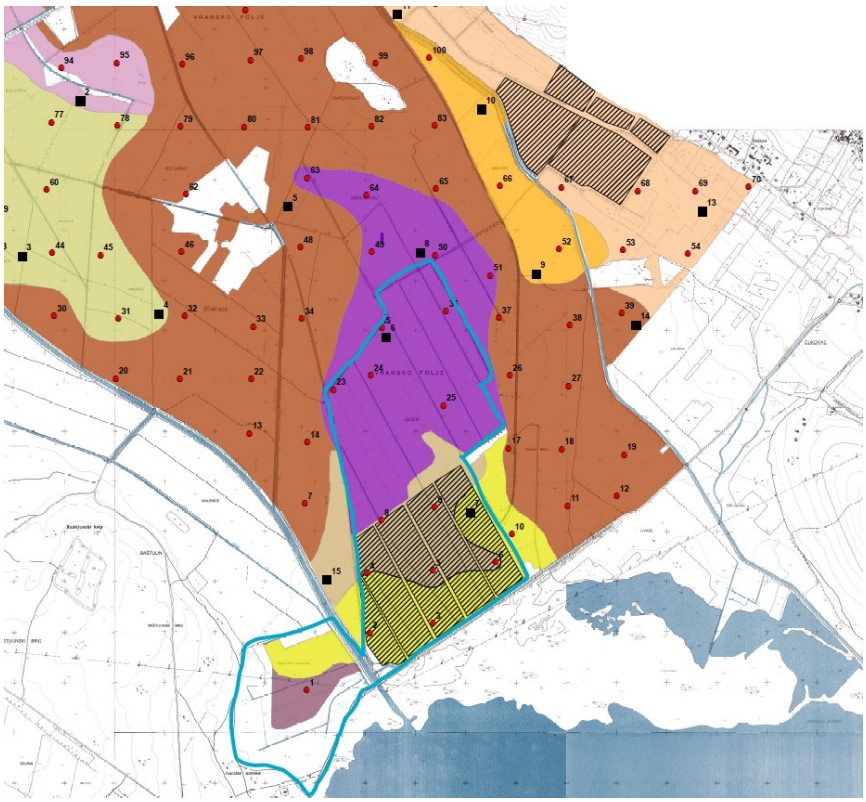


Figure 6. Pedological map of the area (Poljoprivredni fakultet Osijek, 2015.)

The most common soils in the Ravni Kotari area are rendzina, red soil, anthropogenic (rigola and hydromeliorated) soils, limestone-dolomite black soil (calcomelansol), eutric brown soil and brown soil on limestone and dolomite (calcocambisol). The spread of these soils, or rather their fertility, has enabled the Ravni Kotari region to become, along with the Neretva Valley, the most important agricultural region of coastal Croatia (Bogunović et al., 1997).
In the northern part of Ravni Kotari, rendzines and calcareous-dolomite black soil predominate. Black soil and brown soil occupy higher positions, while rendzines have developed in vast karst fields on marl, flysch

and soft limestone. Due to their favorable characteristics, extensive agriculture is carried out on rendzines. In addition to the fact that black soil and brown soil represent the dominant member in the mapped pedological units in the described areas, these soils are also common in association with other soil types, forming diverse pedological units in this area. In the lowest parts of the karst fields, along the courses of permanent or occasional watercourses, marshy gleyic, partially hydromeliorated soils have developed. In the northwest of this area, in the hinterland of Zadar, red soil occurs. In the central part, along with rendzine and black soil, the occurrence of eutric brown soil (eutric cambisol) is more common. In the southern part, red soil and anthropogenic (rigolano) soil of flysch and karst synclines and colluvium dominate (Bogunović et al., 1997).

Of the other soils in this area, vertisol has been mapped on Pristeg field. A smaller area of humus-silicate soil (ranker) is developed on higher and steeper positions (Pekotin brig, Debelo brdo, Gradina) near the village of Radovin in the north. In the area of Bokanjac and Nadin muds, and Vrana and Žažvić field, there are significant areas of arable land on which hydromeliorated soils are now located (peat hydromeliorated and peat-humus hydromeliorated). These are soils under strong anthropogenic influence, the characteristics of which have been influenced by land reclamation interventions in the past. The basic characteristics depend on the characteristics of the original alluvial soil. They are characterized by a very high clay content, which results in longer water retention on the surface. In the hinterland of Vrana Lake, there is an area dominated by rocky ground (Bogunović et al., 1997).

In the flood zone and on the edges of the ornithological reserve, we find swampy alluvial carbonate and alluvial meadow (hydro-reclamation) soils. They are characterized by great depth, good natural drainage and moderate absorption capacity. Intensive agricultural (horticultural) production has recently been carried out on alluvial meadow and hydromeliorated soils, which exposes these soils to pollution by artificial fertilizers, pesticides and herbicides. The last group consists of peat hydromeliorated and peat humus hydromeliorated soils found in the Jasen area. They are characterized by a very high clay content, which results in longer water retention on the surface. The soils have poor permeability and natural drainage with a lot of humus. In the area of these soils, intensive production of forage plants is currently taking place, and they are partly used as pastures.

Land use

Ravni Kotari belongs to the most fertile region of northern Dalmatia, so it is not surprising that agriculture is the main activity of this region, as can be seen from the land cover map, according to which 59% of the area is covered by various types of agricultural land, and about 25% by grasslands and transitional forest areas (HAOP, 2018) (Figure 7.).

According to the land cover map, only about 6% of the area of Ravni Kotari is covered by forest, where the forest is often not fully developed but is in various stages of degradation such as garrigue and macchia or low forests. Built-up areas (settlements, roads, etc.) also occupy only about 6% of the area. In terms of ownership, most of the land is privately owned.

The exceptional richness of the agrobiodiversity of Ravni Kotari is part of the historical tradition and cultural heritage, but also the most important tool for preserving existing landscapes, habitats and

associated biodiversity. Due to the favorable conditions, vegetables and cereals have been grown and consumed in the Ravni Kotari area from ancient times.

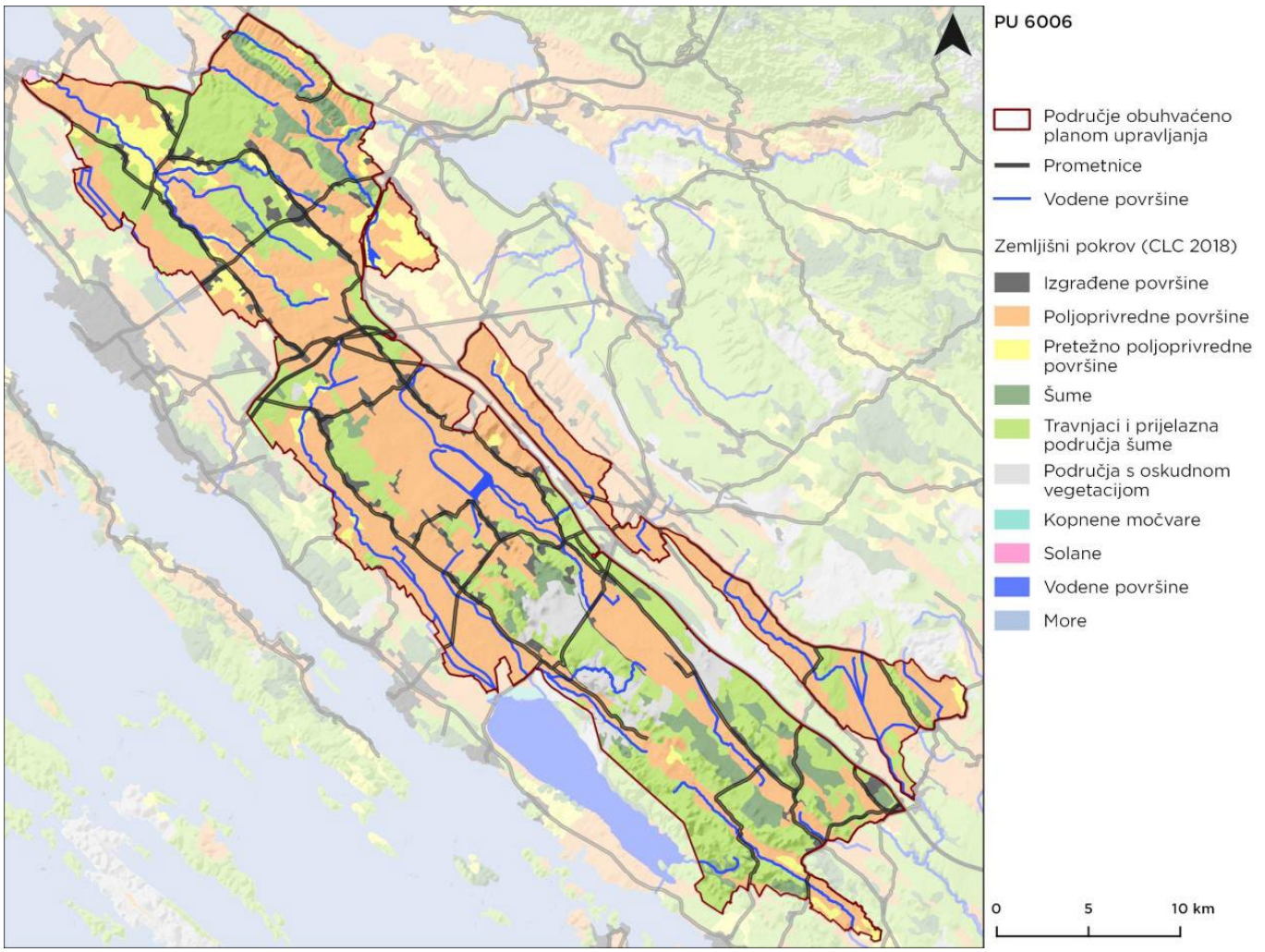


Figure 7. Land cover in the area covered by the Plan (HAOP, 2018)

Typical vegetables traditionally grown in Ravni Kotari are domestic onions (scallions), garlic, legumes (especially broad beans, chickpeas and field beans), Swiss chard, domestic melons and watermelons. The cultivation of cereals and old varieties of legumes is gradually being abandoned, and crops such as corn, tomatoes or potatoes are becoming dominant (Kremenić and Ozimec, 2014). On the other hand, olive and viticulture, as well as the cultivation of Marasca cherries, continue to develop, and today Ravni Kotari boasts precisely these leaders of its agriculture. Olive farming, as an element of the old agricultural tradition, developed in the southern parts of Ravni Kotari. Along the coast, and also below the mountain ranges, the olive tree is a typical Mediterranean plant, on its border and at its best. The most typical fruit tree for Ravni Kotari is the Maraska cherry, or as it is called here, Maraška, which has almost disappeared in other areas of Dalmatia, while new plantations are still being established in Ravni Kotari. Also, a typical

species of Ravni Kotari is the almond (bajam), with numerous original but unexplored varieties. One of the recognizable products of Ravni Kotari is dried figs and fresh fruit, mostly peaches (Kremenić and Ozimec, 2014). Medicinal and aromatic herbs in the Ravni Kotari area have been used since ancient times, but mostly from wild populations, and far less from cultivation. In addition to rosemary, the most commonly used are: oregano (Origanum vulgare), wild mint (Calamintha nepetrides), sage (Salvia officinalis), lavender (Lavandula sp.), bay leaf (Laurus nobilis), myrtle (Myrtus communis), immortelle (Helichrysum italicum), wormwood (Artemisia absintium), savory (Satureja sp.) and juniper (Juniperus oxycedrus) (Kremenić and Ozimec, 2014). According to stakeholders, agricultural production in Ravni kotari is mostly conventional, but there are already successful examples of developed organic production, mostly olives, figs, grapevines and garlic. The products are sold at markets in Zadar or directly on the farm and to a lesser extent through purchase stations.

In terms of livestock farming, according to agricultural agency's data (2022), sheep are the most widely raised livestock in the Ravni Kotari settlements (41,995 head), followed by goats (6,207 head) and cattle (2,788 head). Currently, the main livestock breeders in Ravni Kotari are Vrana d.o.o., which, in addition to livestock, also grows vegetables outdoors and in greenhouses, has a vineyard and is engaged in crop farming, a cattle farm owned by Vigens d.o.o. in the Bokanjačko blato area, and the Dar-Mar farm, a small family farm near Nin that has been producing and selling donkey milk for over 30 years, and in addition to donkeys, they also raise sheep and goats.

Within the municipalities in the area of Ravni kotari 2,223 active family farms are registered. Among them, 55 farms are also engaged in honey production, with a total of 2,541 registered beehives, most of which are located in the area of the city of Benkovac (APPRRR, 2022). A new and much more detailed land use map would be provided until the September 2025.

Ecological analyses

Surface water quality and quantity

Croatian Waters, as part of its regular supervisory and operational monitoring, monitor the ecological status of waters in the area, which integrally includes biological, physico-chemical and hydromorphological quality indicators. The results show that the lake is under obvious significant pressure from pollution coming from its main tributaries. The ecological status in Kotarka and the Lateral Channel is assessed as very poor (lowest score 5) or poor (4), while the ecological status in the lake itself is somewhat more favorable and is assessed with an overall score of moderate (score 3), or good (score 2) for physico-chemical indicators, and moderate (score 3) with regard to biological indicators and the presence of specific pollutants. Such assessments of the state result in the obligation to implement management measures that will ensure the fulfillment of one of the objectives of water management, which is "achieving and maintaining good water status", among other things "for the protection of aquatic and water-dependent ecosystems".

High measured levels of total nitrogen and nitrate in the waters of the main tributaries confirm that the leaching of artificial fertilizers from intensively cultivated agricultural areas in the basin represents

significant pressure on the lake ecosystem. The recorded elevated levels of adsorbable organic halogens (AOX) in the lake can also be linked to agricultural production. Given that maintaining low phosphate levels is one of the requirements for maintaining favorable habitat conditions for the target habitat type 3140, it is favorable that phosphate levels in the tributaries are not too high. The large difference between the nutrient load of the water in the tributaries and in the Vransko lake itself is a consequence of the fortunate circumstance that the tributaries flow into the lake in an area with reeds, which act as a natural filter (using nutrients from the tributaries) to purify the water that ends up in the lake.
In addition to chemical pollution of the lake waters, pollution by larger waste is also significant, which mainly ends up in the lake flooded through the main and lateral channels. Most of the flooded waste can also be linked to irresponsible behavior with waste on cultivated agricultural areas in the wider basin area in Vrana Field.
The situation is also not favorable in relation to the hydrological regime in the lake. The existing system, which consists of the network of canals in the Vrana field, the embankments and the Prosika canal, already does not allow for optimal water management, either to preserve the favorable state of the water resources of the lake ecosystem or to meet water needs. The expected consequences of climate change will only worsen the problems. Hot and dry summers will increase the need for irrigation of agricultural areas in conditions of lower available water quantities. Lower water inflows from the basin to the lake and increased evaporation from the lake due to rising temperatures will result in a decrease in the minimum water levels in the lake. Combined with the expected rise in sea level, this will result in an increase in the intensity and frequency of episodes of salinization of the lake water, which represent a shock for numerous target habitat types and associated species.
New data on the quantity an quality of groundwater and surface water will be available in September 2025.

Methodology

The sampling is done at two sampling points in the pilot area in the lake and in the tributary for biological indicators (chlorophyll concentration, transparency (secchi depth), number of coliform bacteria, number of fecal coliform bacteria, number of aerobic bacteria, P-B saprobacity index, IS – macrozoobenthos, IS – phytoplankton, trophic level), physico-chemical indicators (alkality, conductivity, turbidity, pH, salinity, total suspended substances, temperature, color, odor, waste products, total hardness, calcium hardness, oxidation/reduction potential, total dry suspended solids), oxygen regime (dissolved oxygen (DO), oxygen saturation, BPK5, KPK – Mn), nutrients (organic carbon, nitrogen compounds, phosphorus compounds), ions (fluorides, calcium, potassium, chlorides, magnesium, sodium, silicates, dissolved sulfates), metals (dissolved arsenic, dissolved copper, dissolved zinc, zinc, dissolved cadmium, dissolved chromium, dissolved nickel, dissolved lead, dissolved mercury, dissolved iron, iron, manganese), organic compounds (alkyl phenols, aromatic hydrocarbons, dioxins, furans, biphenyls, dodecanes, halogenated hydrocarbons, polybrominated diphenylaters (PBDE), pesticides, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs)) by Hrvatske vode (Croatian waters).
There are also three sampling points in the lake (P2, P4, P6) analyzed by multiparametric probes for physico-chemical indicators (conductivity, turbidity, pH, salinity, temperature, oxygen concentration) done by Public institution Nature Park Vransko jezero (Figure 8.).

At eight sampling points water levels of the lake, water extraction for consumption and water discharge on tributaries is being monitored by Državni hidrometeorološki zavod (DHMZ – Croatian hydrometeorological institute) (Figure 9.).

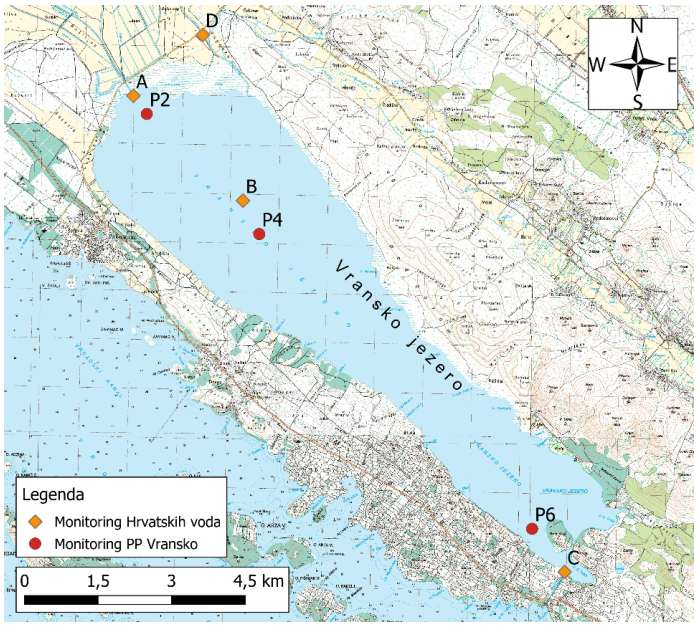


Figure 8. The map of sampling points in the Vransko lake (B) in the lake and (A) in the tributary done by Hrvatske vode and P2, P4, P6 done by PI.

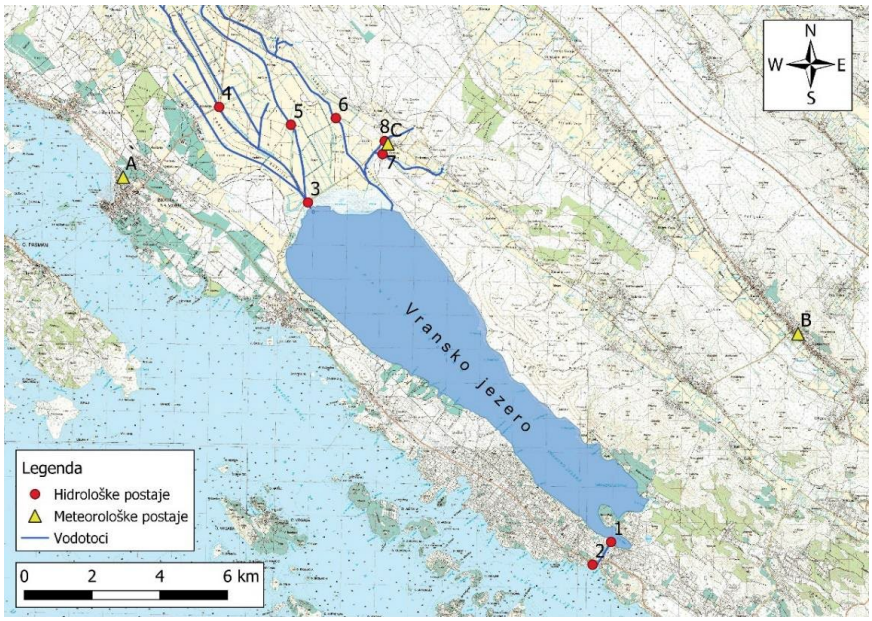


Figure 9. The map of water level monitoring points (DHMZ)

Results

From the monitoring results presented in Figure 10., 11. and 12., it can be confirmed that Lake Vrana is a coastal hydrological system that has a very pronounced dynamics and interaction with the sea.
With the onset of expected climate change / variation, the sea level would rise and the equilibrium between the lake and the sea would be established at slightly higher water levels in the lake. However, such an altitude shift of the entire lake-sea system would not be problematic in itself if the estimated climate changes did not result in an increase in air temperature (and thus increased evapotranspiration in the basin and evaporation from the lake surface) and a decrease in precipitation. All this would have the effect of significantly reducing the inflow into the lake system. This generally reduces the water level in the lake, and prolongs the periods with negative gradients - the penetration of saline sea water into the lake system.
The analysis of climatological characteristics by Rubinić (2014.) shows the presence of a global trend of increasing air temperatures, which in the area of influence is about 0.03 °C / year, or even about 2.9 °C / 100 years. with a simultaneous decrease in annual precipitation from 2.0 to 5.9 mm / year, depending on the location in the analysed regional area. Thus, the presence of global trends of increasing sea level was confirmed in the coastal area of Vransko Lake, where it is shown with a growing trend of 5.8 mm / year. All this affects the amount of water inflow into the lake, its level, but also the quality of water in the lake, ie the increase in the share of saline sea water in the lake. The average annual water level in the lake does not have a declining trend, but, depending on the observation period, stagnation or a slight increase. The reason for this is the replenishment mechanism of Vransko Lake, which in conditions of lower water levels in the lake in relation to the sea replenishes the lake with groundwater with large amounts of saline sea water.
Despite the decreasing trend of average annual flows, the average annual water levels in Vransko Lake have an increasing trend. If you look at it in a simplified way, it is completely illogical. But there is also a very plausible explanation for the possible cause of such a trend, which is related to the trend of fluctuations in mean annual sea levels, which is also on the rise. Precisely due to the trend of rising sea levels, the entire karst aquifer system, and even Vransko Lake itself, is gradually rising and a new equilibrium is being established between the lake, karst aquifer and the sea. It is a model of the action of coastal karst aquifers in response to climate change / variation and the resulting sea level rise. It should be noted that in the area of Croatian karst, this is a unique example, and even the most direct evidence of the presence and effects of climate change / variation on coastal water resources.
The recorded extremes have the character of very low probabilities of occurrence, below 2%, ie that the return period of their occurrence was less frequent than the 50-year return period. However, given the presence of a trend of increasing levels of the Adriatic Sea, and thus raising the level of water oscillations in the lake and its karst aquifer, it is expected that in the future high levels, but also extreme droughts with low water levels in the lake, will be even more frequent.
In order to establish a comprehensive system of monitoring the state of the lake, now and in the conditions of the expected construction of the movable gate and the easing of the Prosika canal as well as the irrigation system of the Vrana field, it is necessary to improve monitoring/re-establish continuous monitoring of the lake's inflow on all tributaries (Lateral Canal and Kotarka), as well as control of the state of salinity in the Prosika area and at the Jugovir spring.

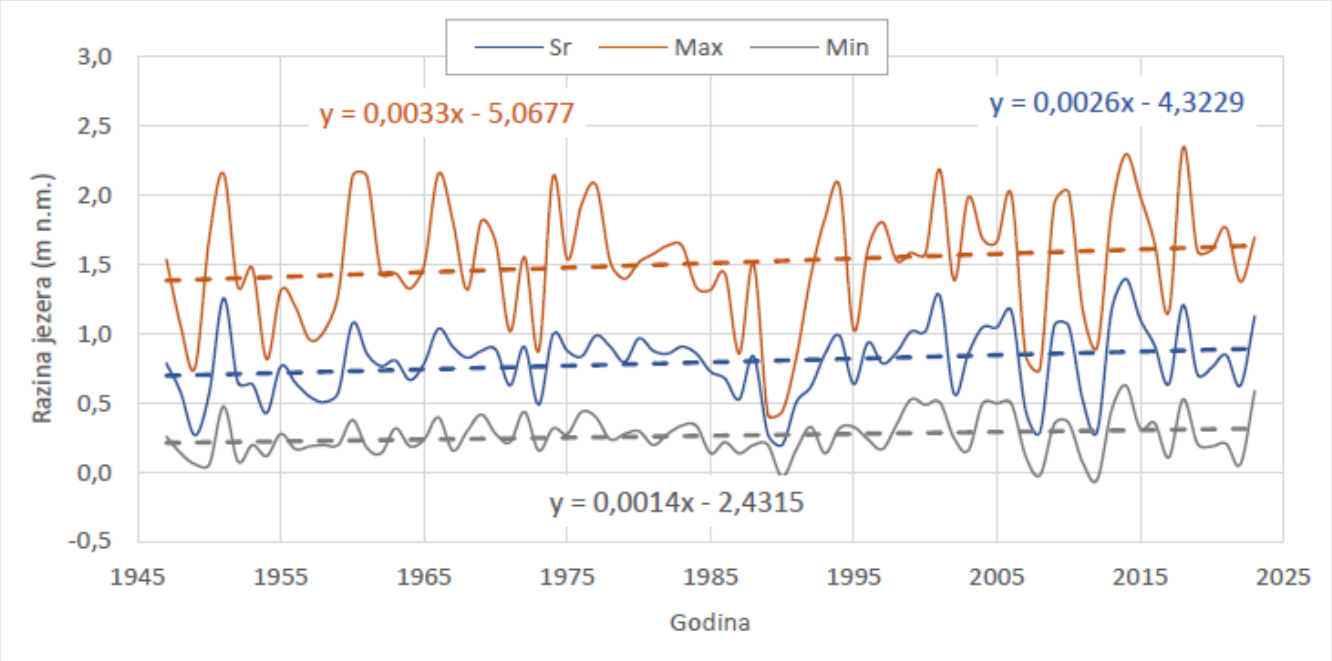


Figure 10. Course of characteristic annual values of mean, maximum and minimum water levels in Lake Vrana recorded at the Pakoštanski most station (1947 - 2023) and their trend

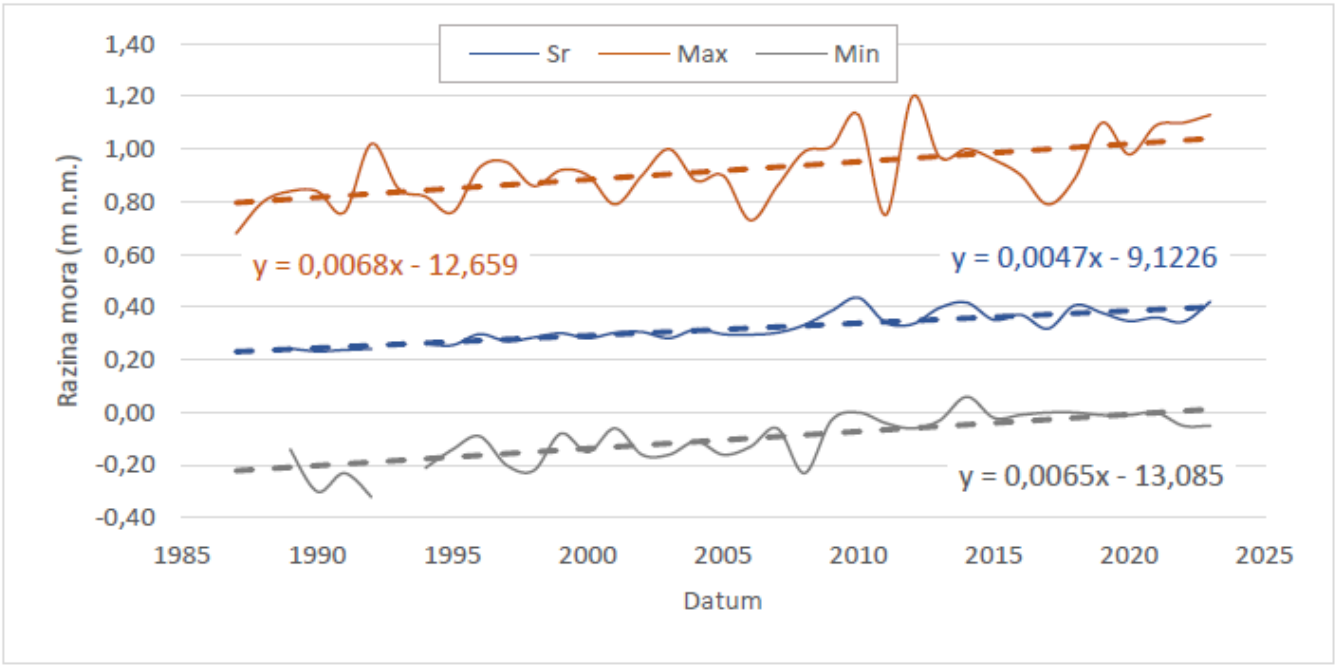


Figure 11. Course of characteristic annual values of mean, maximum and minimum sea levels recorded at the Prosika-Adriatic Sea station (1987-2023) and their trend

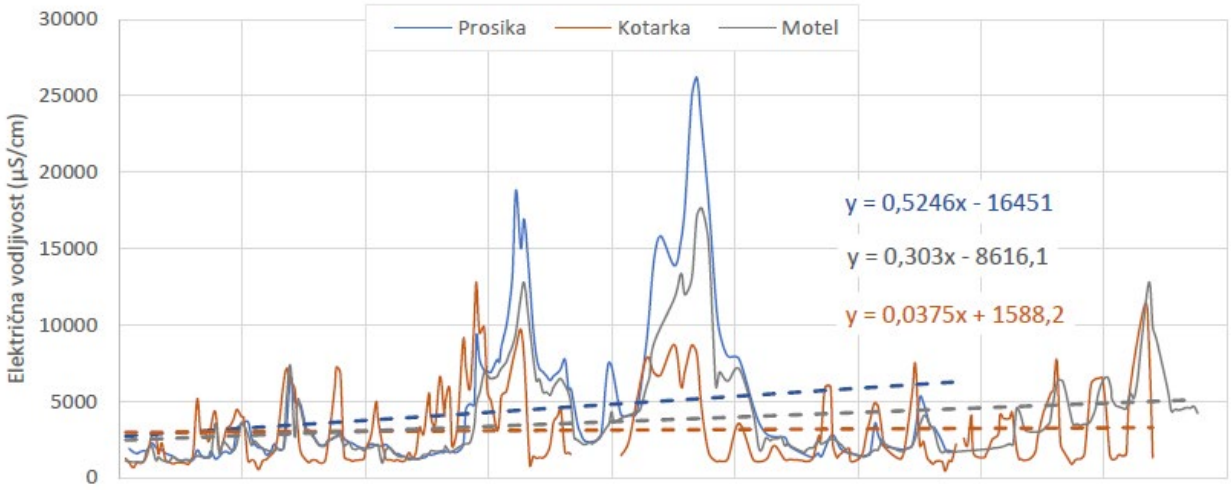


Figure 12. Fluctuations in electrical conductivity at three state monitoring stations in Lake Vrana with a trend - Motel (2000-2023), Kotarka (2000-2022) and Prosika (2000-2018)

Groundwater quality; Groundwater salinity; water table

The data will be available in September 2025 after installation of piezometer and analysis of the results of data collected.

Soil composition, quality and salinity

Within the framework of the development of the pedological-hydropedological basis of the preliminary design of the Vrana Field irrigation system, field and laboratory soil research was carried out, after which the data was processed. Field pedological research were carried out in accordance with the criteria and norms for the development of pedological maps at a scale of 1:10,000. Identification of the pedosystematic affiliation and description of the morphological characteristics of pedological profiles were carried out using the soil classification system (Škorić et al. 1985) (Figure 13.).
During the field research, terrain sounding was carried out (185 soil sounding samples), opening of 28 pedological profiles, soil sampling for laboratory analyses, and infiltration measurement with infiltrometers at representative locations. The research was carried out during October 2013 and May 2014. Laboratory soil research included the determination of physical and chemical properties of the soil. The following physical soil properties were determined: soil water capacity, current soil moisture, laboratory soil water permeability, soil and solids bulk density, packing density, total porosity, soil air and water capacity, soil mechanical composition, stability of microstructural aggregates and soil moisture retention at 0.33, 6.25 and 15 bar. The following chemical soil properties were determined: soil reaction (pH), total carbonate content, humus content, physiologically active nutrients, phosphorus and potassium content and soil electrical conductivity (EC 1:5), anion and cation concentration, heavy metal content at representative locations. All of the above laboratory investigations of physical and chemical soil properties

were carried out based on standard methods according to the manual for pedological soil research (Škorić, 1985) and HRN ISO standards (Poljoprivredni fakultet Osijek, 2015).

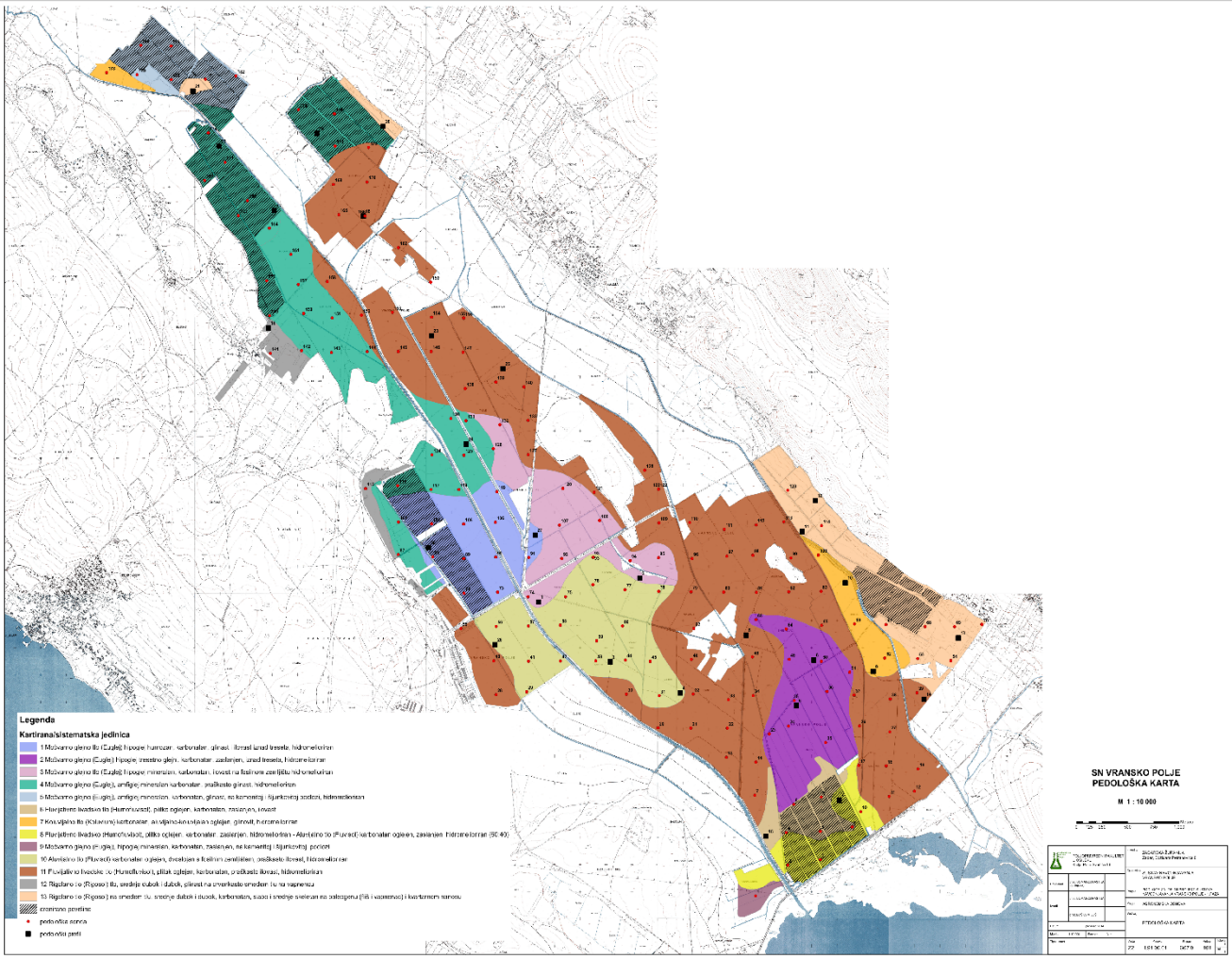


Figure 13. Pedological map of the Vrana field.

Additional data on Electrical conductivity of the soil (dS/m; soil:water 1:5), ECe (approximate conductivity of saturation extract), soil salinity rating and soil ionic composition will be available in September 2025 after the field sampling campaign. Previously available data is listed in the table (Figure 14. – P6 and P7 sampling points are at the location of the pilot site)

Profil	Dubina cm	EC 1:5	Ece korigirani	Ocjena zaslanjenosti	Cl^-	HCO_3^-	Ca^{+2}	Mg^{+2}	K^+	Na^+
					mg/kg					
P1	0-45	0.20	1.80	Nezaslanjeno	46.7	650.0	296300.0	2235.5	1802.5	311.5
	45-60	0.26	2.34	Blago zaslanjeno	35.0	500.0	306200.0	1712.5	1277.0	252.5
	60-88	0.29	2.61	Blago zaslanjeno	23.4	500.0	325200.0	1086.5	340.0	219.5
	88-100	0.33	2.97	Blago zaslanjeno	81.8	816.7	230200.0	2615.0	2619.0	345.5
	100-120	0.31	2.79	Blago zaslanjeno	81.8	666.7	277100.0	2164.5	1557.0	231.5
P2	0-42	0.44	3.96	Blago zaslanjeno	186.9	616.7	319200.0	1339.5	342.0	388.0
	42-58	0.52	4.68	Umjereno zaslanjeno	397.2	633.3	309650.0	1011.0	145.0	462.0
	58-100	0.70	6.30	Umjereno zaslanjeno	607.4	616.7	282050.0	1307.0	159.5	613.0
P3	0-15	0.19	1.71	Nezaslanjeno	70.1	416.7	281250.0	1446.0	636.0	282.0
	15-40	0.22	1.98	Nezaslanjeno	46.7	733.3	217800.0	2515.5	2324.0	325.0
	40-60	0.34	3.06	Blago zaslanjeno	163.5	716.7	220150.0	2139.0	1587.0	347.0
	60-95	0.53	4.77	Umjereno zaslanjeno	70.1	433.3	302700.0	1129.5	39.5	241.5
P4	0-40	0.52	4.68	Umjereno zaslanjeno	537.3	500.0	288700.0	1716.5	841.0	467.0
	40-70	0.43	3.87	Blago zaslanjeno	257.0	483.3	300400.0	1736.5	965.5	469.5
	70-80	0.69	6.21	Umjereno zaslanjeno	490.6	800.0	232350.0	1847.0	964.5	628.0
	80-95	0.65	5.85	Umjereno zaslanjeno	537.3	650.0	247200.0	1612.0	428.0	566.0
	95-160	1.11	9.99	Jako zaslanjeno	1238.2	366.7	343050.0	1321.5	81.5	786.5
P5	0-20	0.27	2.43	Blago zaslanjeno	186.9	516.7	340350.0	1821.5	288.0	409.0
	20-100	0.18	1.62	Nezaslanjeno						
	100-120	0.85	7.65	Jako zaslanjeno	864.4	583.3	308600.0	2039.0	254.5	998.0
P6	0-40	2.19	19.71	Vrlo jako zaslanjeno	2192.3	627.3	184250.0	2652.5	1904.0	1256.5
	40-55	3.67	36.70	Vrlo jako zaslanjeno	2721.4	366.7	52250.0	2725.0	2296.5	1819.5
P7	0-35	0.45	4.05	Umjereno zaslanjeno	70.1	633.3	270100.0	1607.5	1307.5	258.5
	35-100	0.64	5.76	Umjereno zaslanjeno	70.1	1183.3	269600.0	1073.5	619.0	248.5
	100-153	0.75	6.75	Umjereno zaslanjeno	93.5	900.0	120400.0	2819.5	3286.5	287.5
P8	0-35	0.51	5.10	Umjereno zaslanjeno	467.2	366.7	92361.0	3267.0	72.8	490.1
	35-50	0.62	6.20	Umjereno zaslanjeno						
P15	0-40	0.37	3.33	Blago zaslanjeno	210.3	666.7	214800.0	3097.0	2697.5	464.0
	40-96	0.20	1.80	Nezaslanjeno	233.6	333.3	318100.0	1407.0	53.5	337.0
	96-130	0.30	2.70	Blago zaslanjeno						
P27	0-35	0.22	1.98	Nezaslanjeno	70.1	633.3	270100.0	1607.5	1307.5	258.5
	35-60	0.35	3.15	Blago zaslanjeno	70.1	1183.3	269600.0	1073.5	619.0	248.5
	60-80	0.65	5.20	Umjereno zaslanjeno	93.5	900.0	120400.0	2819.5	3286.5	287.5

Figure 14. Electrical conductivity (dS/m; soil:water 1:5), ECe (approximate conductivity of saturation extract), soil salinity rating and soil ionic composition (P6 and P7 pilot site)

Sediment quality

Additional data on sediment quality will be available in September 2025 after the field sampling campaign.

Habitats

Dataset

The mosaic landscape in which agricultural areas, grasslands, forests and aquatic habitats alternate is the main feature of Ravni Kotari, important for the preservation of endangered and/or rare plant and animal species, especially birds.

The Ravni Kotari area represents one of the most fertile areas of the Croatian coast with great potential for agricultural production, and as such is today considered one of the most important agricultural areas of Adriatic Croatia (Peričić and Babić, 2016). However, a good part of the agricultural areas still consists of small plots cultivated in the traditional way. Thanks to this, the agricultural habitats of Ravni Kotari largely consist of a diverse mosaic of arable land, fallow plots, overgrown plots, hayfields and pastures, orchards, vineyards and olive groves separated from each other by edge habitats, hedges and tree lines, and drainage channels (Barišić et al., 2019). This mosaic of agricultural habitats is not singled out as a target habitat type, but it is a habitat for numerous target bird species.

After the impact of water on the natural habitats of Ravni Kotari was reduced by drainage, aquatic habitats were reduced to a few small permanent ponds and occasional watercourses, as well as artificially created drainage channels that are subject to regular maintenance by machinery. Vegetation that develops in shallow water or in areas of high groundwater levels is present, such as reed beds, bulrushes, tall sedges and sedges.

Aquatic habitats are important for all target species as watering places, and drainage channels and the vegetation that develops alongside them are an essential component of agricultural mosaics to which many target bird species are associated. Aquatic habitats are also important for target bat species as hunting grounds.

Grassland habitats are most often developed as a result of human influence on the environment and contribute significantly to the biodiversity and recognisability of the area. In addition to being a habitat where numerous plant species and groups of invertebrates spend their entire lives, grassland habitats also serve as foraging area for species that have shelters or nesting grounds in forest or rocky habitats, and together with them and agricultural areas, they form a unique mosaic that is crucial for many rare and endangered species. As a semi-natural habitat, grasslands depend on maintenance in the form of mowing and/or grazing, and are closely linked to livestock farming.

While in the past, large areas of Ravni kotari were periodically flooded and thus under greater water influence, the construction of drainage canals drained them to enable agricultural production (Barišić et al., 2019). Wet Mediterranean grasslands are included in the target habitat type Mediterranean tall wet grasslands Molinio-Holoschoenion (6420). These grasslands, made up of tall grasses and common cowslip (Holoschoenus vulgaris), are used as pastures and are rare in Croatia (Topić and Vukelić, 2009), and in the Ravni kotari area they have been recorded only in places, although they are well represented on the gentler slopes of the nearby Vrana Lake and the surrounding flat areas of the Vrana basin (MINGOR, 2021). A habitat map of Natura 2000 site Ravni kotari with the scale of 1:10000 will be available in September 2025.

Biological communities

According to the results of regularly conducted research on the species composition and distribution of stoneworts (algae of the Characeae family), which are also an indicator of good water status, as a key component of the good status of the entire lake ecosystem, the status of the target habitat type 3140 (Hard oligo-mesotrophic waters with bottom covered with Characeae) varies significantly from year to year (Stanković, 2010, 2011, 2013, 2014; Alegro et al., 2014, 2018, 2019, 2020, 2021). Over the past ten

years, coverage has varied from around 80% in 2010 and 90% in 2011, to around 10% in 2012, with a recovery to around 70% as early as 2014, a further increase to 90-80% in 2018 and 2019, and then a further drop to 5% in 2020 and worrying 0% in 2021. The decline in coverage is accompanied by a decline in the number of recorded species of algae from the Characeae family (from 5 recorded species in 2018 and 2019 to 2 species in 2020 and no species in 2021). Analysis of the correlation between the state of macrophytes in the lake and various monitored lake water parameters indicates that the key factors negatively affecting the target habitat type are longer periods with significantly increased water salinity (such as in the case of 2012, when the salinity of the lake water increased to 17‰, and otherwise it is mostly below 1‰) and reduced transparency due to increased phytoplankton development and higher amounts of suspended particles, due to increased trophism (which is the presumed cause of the latest collapse of macrophyte populations in the years 2020 and 2021, during which the lake water was permanently turbid). Considering the significant variations described, as well as the existing threats (water salinization due to low freshwater inflows and low water levels, and increased eutrophication caused by the supply of nutrients from arable areas in the catchment area), as well as the tentatively determined ideal state of macrophytic vegetation in Lake Vrana, the fact that no Characeae species were recorded at all from 2021, the state of preservation can be assessed as "reduced", and even alarming. Lake Vrana, although large in area, is a very vulnerable system due to its shallow depth, silty substrate, connection to the sea and the large area of arable land in its basin. A shallow lake can hardly compensate for significant negative pressures from external factors (Alegro et al., 2021). Consequently, a good conservation status of the target habitat type is only possible if external pressures are effectively reduced, by mitigating salinization and reducing nutrient inputs from the basin.

The state of lake macrophyte abundance influences also the composition and abundance of bird populations. Since 2021, a significant decline has been recorded in the numbers of wintering birds feeding on the submerged macrophytes.

The wetland bird community in this area is particularly notable for its richness, diversity and importance for nature protection. In general, the area encompassing Lake Vrana and Jasen is one of the most important areas for birds in Croatia (Tutiš et al., 2013), with reedbeds and wet meadows being the most important. So far, 265 bird species have been recorded in the area, of which 102 species are nesting in the area, while the rest use it as a wintering or resting place during migration. Precisely because of the 87 wintering sites with more than 100,000 individuals, this area is one of the most important European wintering sites for wetland birds. In addition, more than 140 migratory (migratory) species from Central and Eastern Europe rest in this significant area, so the daily bird population in the Vrana Lake area during autumn migration can reach as many as one million individuals (or 170 birds per hectare of area). Of the 265 bird species, as many as 55 are at high risk (14 critically endangered (CR), 22 endangered (EN) and 19 vulnerable (VU)), and another 30 are near threatened according to the Croatian Red Lists. Fifteen species are at high risk at the European level, and 4 at the global level (PI archive). Due to all of the above, the Vrana Lake area has been listed as an Important Bird Area (IBA), and the entire Park was declared a RAMSAR site in 2013.

Both freshwater and marine fish species are present in the lake, and research has confirmed 20 species (Mrakovčić et al., 2017). Of these, only 4 are autochthonous for the Dalmatian freshwater ichthyofauna: two endemics of the Adriatic basin, the target species is the common goby (*Knipowitschia panizzae*), a

small fish that inhabits brackish waters, i.e. lagoons, river mouths, parts of rivers and lakes influenced by the sea (Kovačić and Zanella, 2014), which is considered endangered due to its patchy distribution; the near-endangered species *Scardinius dergle*; the Mediterranean endemic and sensitive species of river blenny (*Salaria fluviatilis*); and the European eel (*Anguilla anguilla*), which is strictly protected and critically endangered at the European level.
The six represented marine species of fish that can live in brackish water, and which can enter the lake through the Prosika channel, are 5 species of mullet – *Chelon labrosus, Liza ramada*, *Liza aurata*, *Mugil cephalus* and *Mugil saliens* – and *Atherina boyeri*.
The remaining 10 species were introduced to the area and are considered non-native. These are: catfish (*Silurus glanis*); pike (*Esox lucius*); 6 species from the carp family (*Cyprinus carpio*, *Carassius gibelio, Squalius cephalus, Tinca tinca, Rutilus aula, Pseudorasbora parva*); and *Gambusia hoolbroki* and Sunfish (*Lepomis gibbosus*). Gambusia was probably introduced in the first half of the 20th century with the intention of biocontrol of mosquitoes, while the others were introduced starting from the middle of the 20th century, some intentionally for breeding and/or fishing (e.g. carp, catfish, pike), and some probably accidentally (e.g. Sunfish, Prussian carp).
All recorded species are fish of lentic areas, calm waters with macrophytes, i.e. inhabitants of lakes and side streams, and according to the type of reproduction and the substrate on which they lay their eggs, phytophiles predominate.
Of the molluscs, a total of 15 species of snails and 6 species of bivalves were recorded in the lake, main and lateral channels, in the Benča pond and the Jasen area (Lajtner&Crnčan, 2015). The Benča pond is one of only three areas in Croatia where the target snail species Anisus vorticulus has been found, a rare and endangered species that lives in clean, stagnant or slowly flowing waters, with a lot of aquatic vegetation, where it is most often found.
Further research and monitoring will be implemented during this project to define the birds and fish population status.

Socio-economic analyses

Aim of the activity
The A.1.2 “Pilot areas characterization” activity aims to also describe the socio-economic context of the four pilot areas: Po Delta, Neretva Delta, Vransko Lake, and Coastal Dune Parks. Although these areas have different territorial contexts, they share common climate-related threats, including saline intrusion, reduced freshwater inflows, sea level rise, and increased coastal erosion, which directly affect environmental balances and human activities. In this document we report the socio-economic analysis for the pilot area Vransko jezero.

The structure of the activity
The socio-economic analysis has been addressed to collect and systematize data on land use, local and regional statistics, technical reports, and specific studies. Key indicators were defined to evaluate the socio-economic dynamics of the pilot areas, with surveys also distributed to the local population and to

key target groups to gather direct information and analyze their perception on the impacts of climate change. The collected data, included and commented in this report (and in the reports of the other pilot areas), will serve as the foundation for developing the Joint Strategy of WP4. This activity provides essential knowledge for developing adaptation and sustainable management strategies, contributing to strengthening the resilience of pilot areas in response to climate change challenges. The analysis included in this report has been coordinated by PP4 IDECO and carried out by the main reference partner for the pilot area, being PP5.

The context of the analysis

A comparative analysis enables the evaluation of environmental, demographic, social, and economic factors influencing coastal resilience in Italy and Croatia, allowing for the identification of vulnerabilities, administrative framework is also key to assessing available public policies, funding opportunities, and the potential for local stakeholder engagement. Understanding the socio-economic dynamics of affected areas, such as employment shifts, economic dependencies, and community strengths, and targeted strategies to mitigate climate change impacts.

To conduct a comprehensive socio-economic analysis, it is essential to first define the area of study, ensuring a clear understanding of its geographical, environmental, and administrative characteristics. This includes providing a detailed description of the territory and its context, specifying key socio-economic features that influence local development and resilience. Special attention has been given to the presence of Natura 2000 sites or other protected areas, as these zones are crucial for biodiversity conservation and may influence land use policies, tourism activities, and ecosystem services. Understanding the engagement, provides a foundation for informed decision-making. Public awareness and stakeholder involvement are key to fostering adaptive behaviors and promoting sustainable practices. Conducting a thorough analysis requires collecting data across environmental (see section Ecological analyses above), infrastructural, demographic, and economic dimensions. In the next section (Analysis of indicators) the macro areas identified, and the key socio-economic indicators collected for the pilot site Vransko lake are gathered and analyzed.

For the pilot site Vransko lake the geographical area under investigation for the socio-economic study has been the area of Ravni kotari and Vransko lake.

Analysis of indicators

For the purpose of socio-economic impact assessment, the following indicators have been collected, which can be grouped according to the respective macro-area of reference:

Macro Area	Indicator	Unit of Measure	Scale	Source	Value
Demographics	Municipalities: Number of population	Number	**Municipality**	https://podaci.dzs.hr/media/rqybclnx/popis_2021-stanovnistvo_po_naseljima.xlsx	**In the Table 01.**
Demographics	Provinces: Number of population	Number	**County**	https://podaci.dzs.hr/media/rqybclnx/popis_2021-stanovnistvo_po_naseljima.xlsx	**159766 (Zadar) 96381 (Sibenik-Knin)**
Demographics	Population Density	People per km²	**Municipality**	https://podaci.dzs.hr/media/rqybclnx/popis_2021-stanovnistvo_po_naseljima.xlsx	**In the Table 01.**
Economical	Share of GDP generated by tourism	Number	**National**	https://www.hnb.hr/	**19,60 %**
Economical	Share of GDP generated by agriculture	Number	**National**	https://gospodarski.hr/	**2,10 %**
Economical	Share of GDP generated by fisheries/aquaculture	Number	**National**	https://narodne-novine.nn.hr/clanci/sluzbeni/full/2014_03_38_670.html	**0,2-0,7 %**
Economical	Gross Domestic Product (GDP)	Euro	**National**	https://poljoprivreda.gov.hr/UserDocsImages/dokumenti/poljoprivredna_politika/zeleno_izvjesce/2024_08_21%20Zeleno%20izvje%C5%A1%C4%87e%202023_3.pdf	**76,5 billion**
Economical	Investment in the tourism sector compared to GDP (2022 - 2025)	% and €	**National**	https://podaci.dzs.hr/2024/hr/76973	**0,095 %, 729.519.141**
Economical	Investment in the agriculture sector compared to GDP (2022 - 2025)	% and €	**National**		
Economical	Investment in the fisheries/aquaculture sector compared to GDP (2022 - 2025)	% and €	**National**	https://podaci.dzs.hr/2024/hr/76973 https://podaci.dzs.hr/2023/hr/58261 State Institute of Statistics	**306.110.242 EUR (2022. – 2023.)**
Economical	Expenditure to maintain/restore habitats/protect species, linked to climate change impacts, time series (10 years)	Euro	**Pilot site**	Nature Park's annual reports 2015-2024 https://www.pp-vransko-jezero.hr/planovi-upravljanja/	**690,00 EUR**
Economical	Expenditure to maintain/restore tourism facilities, linked to climate change impacts, time series (10 years)	Euro	**Pilot site**	Nature Park's annual reports 2015-2024 https://www.pp-vransko-jezero.hr/planovi-upravljanja/	**80.581,89 EUR**
Economical	Expenditure to maintain/restore public, cultural and historical heritage, linked to climate change impacts, time series (10 years)	Euro	**Pilot site**		

Macro Area	Indicator	Unit of Measure	Scale	Source	Value
Economical	Expenditure linked to public defense, linked to climate change impacts, time series (10 years)	Euro	**Pilot site**	Nature Park's annual reports 2015-2024 https://www.pp-vransko-jezero.hr/planovi-upravljanja/	**1.750.000,00 EUR**
Economical	Damage claims, linked to climate change impacts, time series	Euro	**National**	Annual report on the assessment of damages and the expenditure of aid funds for the mitigation and partial elimination of the consequences of natural disasters	**427.834.907,21 EUR (2022.)** **589.104.814,86 EUR (2023.)**
Economical	Variation in crop yield, time series	ton/y	**National**	https://poljoprivreda.gov.hr/UserDocsImages/dokumenti/poljoprivredna_politika/zeleno_izvjesce/2024_08_21%20Zeleno%20izvje%C5%A1%C4%87e%202023_3.pdf	**2023:** **cereals 3.177.373 t/y on 539.628 ha;** **oil seeds 415.339 t/y on 154.352 ha;** **vegetables 209.282 t/y on 9.674 ha;** **potato 126.281 t /y on 7.230 ha;** **fruits 127.441 t/y on 37.939 ha;** **olive 29.851 t/y on 20.787 ha;** **grapes 94.905 t/y on 19.826 ha;** **tobacco 4.154 t/y on 2.283 ha;** **sugar beet 499.911 t/y on 8.010 ha;** **legumes 6.693 t/y on 4.058 ha;** **roughage 2.000.000 t/y on 644.050 ha;**
Land use	Areas used for specific leisure activities, eg: marinas, bathing establishments etc. in sensible areas, time series	Hectares	**National**	Croatian Bureau of Statics https://podaci.dzs.hr/hr/podaci/turizam/	**Nautical tourism ports: 224 (2023.)**

Macro Area	Indicator	Unit of Measure	Scale	Source	Value
Economical	Number of touristic assets located in sensible areas, time series	Number	**National**	https://www.zadarska-zupanija.hr/images/dokumenti/planski_dokumenti/Plan_razvoja_Zadarske_%C5%BEupanije_2021.pdf	**Zadar County 37.432 (2019.)**
Land use	Protected land and water areas (% of land area in the study area), time series	Percentage (%)	**Pilot site**	Pilot site is a Natura 2000 area https://bioportal.hr/gis/	**100 %**
Sustainable	Areas covered by N2000 habitats at risk, linked to climate change (%), time series	Percentage (%)	**Pilot site**	Aquatic and wetland habitats https://bioportal.hr/gis/	**3000 ha**
Land use	Type of crops cover, in sensible areas, time series	Hectares/crop	**National**		
Sustainable	Existence of land use or development planning processes, specifically referring to nature protection	Yes/No	**Pilot site**	https://bioportal.hr/gis/	**Yes**
Sustainable	Existence of land use or development planning processes, specifically referring to agriculture activities	Yes/No	**Pilot site**	https://bioportal.hr/gis/	**Yes**
Sustainable	Existence of land use or development planning processes, specifically referring to tourism activities	Yes/No	**Pilot site**	https://bioportal.hr/gis/	**No**
Sustainable	Existence of land use or development planning processes, specifically referring to fisheries/aquaculture-related activities	Yes/No	**Pilot site**	https://bioportal.hr/gis/	**No**
Occupational	Fisheries/aquaculture-related employment (% of total employment)	Percentage (%)	**National**	https://podaci.dzs.hr/hr/	**0,0016 %**
Occupational	Tourism-related employment (% of total employment)	Percentage (%)	**National**	https://www.htz.hr/sites/default/files/2024-08/HTZ%20TUB%20HR_%202023_1.pdf	**0,0125 %**
Occupational	Agriculture-related employment (% of total employment)	Percentage (%)	**National**	https://poljoprivreda.gov.hr/UserDocsImages/dokumenti/poljoprivredna_politika/zeleno_izvjesce/2024_08_21%20Zeleno%20izvje%C5%A1%C4%87e%202023_3.pdf	**2,40 %**
Occupational	Green jobs-related employment (% of total employment)	Percentage (%)	**National**	not available	**-**

The purpose of the pilot action of the PP5 Public institution Nature Park Vransko jezero, which is the restoration plan for the pilot site, is to restore the degraded wetland area. The humid grasslands that were once covering the area is currently being used as a ploughland. This caused the degradation of soils by oxidation and erosion, while, artificial lowering of groundwater level by pumping station and amelioration channels, led to the soil salinization from the groundwater. The change of the land use to pastures would support the restoration of target habitats and target species that use those habitats, while, the active keeping of higher water levels in the soil should contribute to the nutrient remediation and salinization minimizing. As the agriculture and agricultural water use is one of the main pressures to the sensitive lake ecosystem, together with the climate change impact, the purpose of the analysis is to define trends in the agricultural land use and also to offer sustainable solutions and adaptations of current use.

Demographic data

Demographic analysis is the starting point for understanding the structure and evolution of the population in each area. Relevant indicators are:

- **Number of inhabitants by municipality and province/county**: This data makes it possible to observe the distribution of the population in the various administrative units, identifying any territorial disparities and trends of depopulation or growth. The distinction between provinces and municipalities makes it possible to highlight population dynamics on different territorial scales.
- **Population density**: A high value indicates a high concentration of inhabitants and may imply pressures on infrastructure and environmental resources. Conversely, low density may suggest problems related to housing dispersion, such as difficulty in accessing services and lower attractiveness for economic investment.

These indicators are crucial for assessing the sustainability of population growth, the needs of the population in terms of public services and infrastructure, and for guiding urban and spatial development policies.

According to the 2021 census (CBS, 2021), the area of Ravni Kotari covered by the Management Plan has a population of just over 16 thousand. If we look at the total number of inhabitants living within cities and municipalities, i.e. all 22 municipalities covered by the Management Plan, it can be said that the Ravni Kotari area has over 100 thousand inhabitants, most of whom live in the coastal area. Settlements within Ravni Kotari with more inhabitants are located mainly in the northern part (the hinterland of Zadar) (Figure 15.), and the largest number of inhabitants live in the settlements of Zemunik Donji (1,557 inhabitants), Škabrnja (1,320), Poličnik (1,023), Polača (993) and Murvica (855). In the central and southern parts there are settlements with a smaller number of inhabitants (up to 250), and the smallest number of inhabitants lives in the settlements of Žažvić (29 inhabitants), Donje Ceranje (42), Gorica (61), Putičanje (68), Lišane Tinjske (70) and Dobra Voda (79), of which Žažvić and Putičanje are located within the Šibenik-Knin County.
Within the boundaries of the Vrana Lake Nature Park, only about 15 families currently live in the Majdan area within the settlement of Vrana, one on the Babin škoj peninsula and several in the Prosika area and

on the lake side of Pakoštane, while the central areas of all the aforementioned settlements – Pakoštane, Draga, Betina, Vrana, Radašinovci, Banjevci and Kašić – are located 1-3 km outside the boundaries of the Park. According to the latest census, in 2021, this innermost circle of settlements had 5,346 inhabitants, of which 72% lived in 3 coastal settlements (Pakoštane, Drage and Betina), and 28% in coastal settlements (Vrana, Radašinovci, Banjevci and Kašić). In an even wider circle – which includes other settlements within the cities and municipalities where the Park is located, and the City of Biograd n/m, from whose border the Park is about 25 m away – 25,800 inhabitants lived in 2021.

Municipality	Number of inhabitants	Population density number of inhabitant per km2
Benkovac	9680	19
Biograd na Moru	5601	151
Nin	2705	51
Skradin	3349	18
Škabrnja	1661	73
Galovac	1258	118
Sukošan	4665	84
Sveti Filip i Jakov	4461	94
Polača	1389	46
Pakoštane	4100	49
Stankovci	1831	27
Pirovac	1606	41
Tribunj	1594	104
Vodice	8649	93
Vrsi	2045	55
Ražanac	2746	40
Posedarje	3430	44
Poličnik	4676	57
Zemunik Donji	2159	39
Lišane Ostrovačke	593	12

Table 01. Number of inhabitants and population density for the municipalities of the pilot site

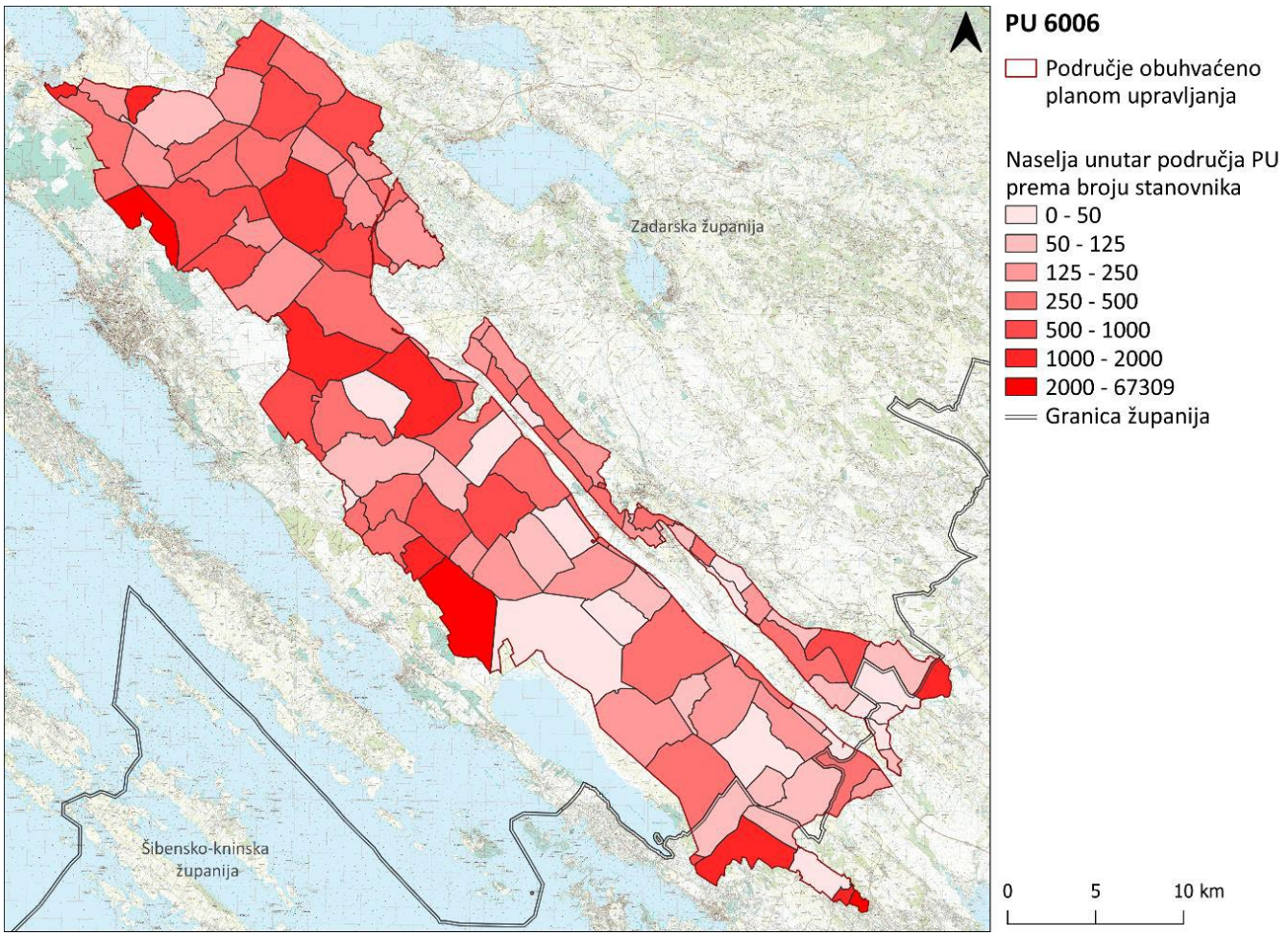


Figure 15. Number of inhabitants by settlements within the pilot area (DZS, 2021)

Economic data

The economic analysis focuses on the area's production structure, GDP composition and investment in strategic sectors. Key indicators include:

- **Share of GDP generated by tourism, agriculture, and fisheries/aquaculture**: These data make it possible to identify the leading sectors of the local economy and assess their relative importance to the overall production system. An economy heavily dependent on a single sector may be more vulnerable to sectoral crises, while greater economic diversification promotes resilience.
- **Total GDP**: Measuring the total GDP of the area provides insight into the economic size of the area analyzed and its weight relative to neighboring or national regions.
- **Investment in key sectors (2022-2025)**: Observing investments in tourism, agriculture, and fisheries/aquaculture relative to GDP provides insights into the development priorities and economic strategies adopted. A high level of investment suggests a desire to strengthen a sector, while a reduction could indicate a change of direction or a crisis in the sector.

- **Environmental and cultural protection expenditures**: Expenditures on maintaining habitats, tourism facilities and cultural heritage provide insight into policies adopted to mitigate the effects of climate change and preserve local heritage. Substantial financial commitment in these areas can promote more sustainable tourism and an economy with less impact on the environment.
- **Change in agricultural yield over time**: This indicator provides information on production trends in the agricultural sector and the effects of external factors, such as climate change or agricultural policies.
- **Number of tourism assets located in sensitive areas**: The distribution of tourism assets in vulnerable areas provides an assessment of potential environmental impacts and the need to regulate the sector to ensure balanced development.

These indicators help to understand the economic strength of the area, its ability to attract investment, and challenges related to the sustainability of development.

The development of the Ravni Kotari economy was influenced, to a large extent, by historical events, but also by its location in the fertile areas of the Dalmatian hinterland, which is why this area is traditionally an agricultural and livestock-raising region. Even today, the main economic branch in Ravni Kotari is still agriculture - crop farming, fruit growing, olive growing, viticulture and livestock farming. The wide range of agricultural products makes the Ravni Kotari area recognizable on the food market.
Recently, there has been a growing interest in the production of organic wines as well as other organic agricultural products, for which the entire county has very good preconditions. Organic agricultural production is an additional element that raises the level of attractiveness of this area and represents a valuable resource for the development of organic rural-tourism products.
A large number of rural households are engaged in animal husbandry in addition to agriculture. Most domestic animals are bred for own needs, and the most intensive branches of animal husbandry are sheep and goat breeding. The pastures of Ravni Kotar, which are regularly used for grazing sheep and goats, create an atmosphere of rural life and represent a special visual attractiveness. That agriculture and livestock farming are one of the backbones of the economy is also evidenced by the fact that the town holds a livestock agricultural fair every month, attracting an increasing number of sellers, buyers and, more recently, more and more curious people. The Ravni Kotari area is located in the hinterland of two significant urban and tourist centres, Zadar and Šibenik, which, with their tourist surroundings, are areas of exceptional tourist activity during the summer months. This traditionally rural area is today facing the challenges of revitalising its economic base, where in addition to encouraging agricultural production, it sees the solution in the development of tourism. It is an area of intensive tourist activity during the summer months. Such a traffic position offers Ravni Kotari a distinct advantage because it is simultaneously "near and far". That is, it is close to the hot spots of tourist demand and far enough from the usual heat and bustle that prevails in tourist destinations on the coast (Razović, 2022.).

Land use data

Land use is a key aspect of the balance between economic development, environmental conservation and quality of life. Relevant indicators include:

- **Recreation areas in sensitive areas**: This measure helps assess the burden of tourism and recreation in sensitive natural areas. Uncontrolled expansion of recreational infrastructure could compromise biodiversity and alter ecosystems.
- **Protected area**: A high level of protected areas indicates a strong commitment to biodiversity conservation. The balance between environmental protection and economic development is a crucial aspect to consider.
- **Type of crops grown in sensitive areas**: Analyzing which crops are grown in fragile areas provides insight into their impact on the environment and assesses the need for specific regulations.

Well-planned land use is essential to ensure sustainable development and minimize the negative impacts of human activities.

Ravni Kotari belongs to the most fertile region of northern Dalmatia, so it is not surprising that agriculture is the main activity of this region, as can be seen from the land cover map, according to which 59% of the area is covered by various types of agricultural land, and about 25% by grasslands and transitional forest areas (HAOP, 2018) (Figure 29). According to the land cover map, only about 6% of the area of Ravni Kotari is covered by forest, where the forest is often not fully developed but is in various stages of degradation such as garrigue and macchia or low forests. Built-up areas (settlements, roads, etc.) also occupy only about 6% of the area. In terms of ownership, most of the land is privately owned. The exceptional wealth of agrobiodiversity of Ravni Kotari is part of the historical tradition and cultural heritage, but also the most important tool for preserving existing landscapes, habitats and accompanying biodiversity.
Within the pilot area 2,223 active family farms are registered. Among them, 55 farms are also engaged in honey production, with a total of 2,541 registered beehives, most of which are located in the area of the city of Benkovac (APPRRR, 2022). In November 2019, a Beekeeping Center (Center for Development and Education Poličnik) was opened in Poličnik, which includes a honey filling plant, a laboratory, a wax processing plant, and tasting rooms, but has not yet started operating.
State-owned forests and forest land in the Ravni Kotari area are managed by Croatian Forests. Forests are managed in accordance with the Forest Management Plans that are located within 21 state management units in the area. In the same area, there are also five management units of private forest owners, which are managed based on the Forest Management Program of Private Forest Owners.
Waters in the Ravni Kotari area are managed by Croatian Waters in accordance with the water management plans.
There are a total of 22 hunting grounds in the pilot area, of which 6 are state and 16 are joint county hunting grounds. A total of 15 hunting licensees manage all hunting grounds. Hunting grounds are managed in accordance with hunting management plans issued for a ten-year period. The most common small game is the common hare (*Lepus europaeus*) and birds are the rock partridge (*Alectoris graeca*), pheasant (*Phasianus colchicus*), partridge (*Perdix perdix* L.) and quail (*Coturnix coturnix*). Of the large game, the wild boar (*Sus scrofa*) is represented (Hunting Association of the Zadar County, 2022).

There are no wind farms in the area, but there are four wind farms in its immediate vicinity: Korlat wind farm (capacity 58 MW), Zelengrad – Obrovac wind farm (42 MW), ZD2 wind farm (18 MW) and ZD3 wind farm (18 MW). Korlat wind farm, located in the settlement of the same name, is the closest to the area covered by the Plan and is the newest Croatian wind farm, and was commissioned in 2021. It contains 18 wind turbines with towers 114 m high and a rotor diameter of 131 m (Brezovec, 2021).
There are four exploitation fields of mineral raw materials within the area. There are three exploitation fields in the Municipality of Polača, EP Zapužane (area 41.66 ha) for the exploitation of carbonate mineral raw materials for industrial processing, EP Grabovača (30 ha) and EP Zapužane – Zdrug (17.77 ha) for the exploitation of technical and construction stone. In the Municipality of Zemunik Donji there is one exploitation field, EP Sječa (14.06 ha), also for the exploitation of technical and construction stone. Outside the pilot area, but in its immediate vicinity, there is a larger complex of seven exploitation fields with a total area of 128.16 ha, for the exploitation of technical and construction stone (HAOP, 2018).
The entire area is interconnected by a series of roads, from the motorway (A1), through state (D106, D8, D422, D424, D56, D502, D503, D27), county and local roads to the railway line Zadar - Knin (Decision on the Classification of Public Roads, NN 41/2022).
Tourism does not have a long tradition in the pilot area, but recently more and more households have turned to this activity. In 2016, around 850,000 tourists visited the settlements in the Ravni Kotari region, mostly in coastal towns, while the central part of Ravni Kotari does not see a large number of tourists. At the traditional site near the Benkovac village, every 10th day of the month, the Benkovac Livestock Fair is held, which attracts a large number of participants and visitors from almost the entire country (Grad Benkovac, 2022). Among the handicrafts that have been preserved are woodcarving (making of bukars, chairs) and the making of musical instruments (svirala, dipla) and wool products, while the making of opanaks is still only demonstratively shown at folklore festivals (Kremenić and Ozimec, 2014).

Sustainability data

Sustainability analysis makes it possible to assess the degree of environmental protection and the area ability to cope with climate change challenges. The indicators identified are:

- **Area of Natura 2000 habitats at risk**: This figure highlights the level of threat to protected ecosystems and helps identify areas in need of more urgent conservation action.
- **Existence of development and land use plans for specific sectors**: The presence of master plans and land management strategies in the nature, agriculture, tourism and fisheries sectors is a sign of a willingness to govern development in a sustainable manner. An absence of such tools could encourage unregulated practices with long-term negative impacts.

The availability of integrated strategies and their implementation are essential to mitigate the negative impacts of human activities and ensure long-term sustainable growth. These data are critical to understanding the ability of the land to balance economic development and environmental protection, ensuring the conservation of natural resources for future generations.
Please include here comments/analysis on data collected.

Ravni Kotari are one of the most sparsely populated areas in Croatia, which presents a challenge in developing the local economy and sustaining communities. Since irrigation water is already the main limiting factor in the production of high and quality agricultural yields in the Vrana Basin, because the distribution of water resources throughout the year is such that in the summer there is not enough water for all irrigation needs, the construction of reservoirs is planned, which would retain part of the precipitation water in the winter period for irrigation needs throughout the summer period (IGH, 2013). The entire project would cover 4,449 ha of agricultural areas of the Vrana Plain with irrigation, and documentation has been prepared (Heček, 2017) and the Environmental Impact Assessment procedure has been carried out (Uzelac Obradović, 2017; MZOE, 2018) for the first of a total of 3 phases of the project, which would cover 1,625 ha of agricultural areas. The project has been assessed as acceptable for the environment and the ecological network, with the mandatory application of environmental protection measures and mitigation of impacts on conservation objectives, and the implementation of an environmental and ecological network monitoring program. The active involvement of the public authorities is of key importance for the implementation of the project and its subsequent operational use in a manner that respects the objectives of environmental and nature protection, including through efforts to make maximum use of so-called nature-friendly solutions in the project. Also, given that the project will enable the intensification of agricultural activities within the area of influence of Lake Vrana, it becomes additionally important to invest maximum effort in directing agricultural activities in the area in a direction that minimizes negative and maximizes positive impacts of agriculture on the environment and biodiversity. A likely positive consequence is that ensuring quality irrigation will reduce the current pressure from uncontrolled water abstraction from the basin (both from underground and surface flows), which would otherwise only increase in the future.

Occupational data

Employment is a central aspect of socio-economic analysis, reflecting the area's ability to provide opportunities and ensure the well-being of the population. Key indicators are:

- **Employment in strategic sectors**: The incidence of employment in tourism, agriculture and fisheries/aquaculture provides insight into the weight of these sectors in the local labor market. A high concentration in one sector may pose a risk in the event of sectoral economic crises.
- **Employment in green jobs**: This indicator measures the area's ability to move toward a sustainable development model, favoring jobs related to environmental protection, energy efficiency and the circular economy. An increase in this share suggests an increased focus on green transition and the creation of new professional opportunities.

Analyzing the employment structure allows us to identify any critical issues, such as the precariousness of seasonal work or the need for training policies to improve the competitiveness of the local workforce.

According to the 2011 census, only about 2.5% of the active population of Ravni Kotari worked in the primary sector, about 20% in the secondary sector, and 77.5% in the tertiary and quaternary sectors. These data show that, compared to the past, service industries have become dominant. The population on the coast of Ravni Kotari is mostly engaged in primary activities, while the central part has recorded a

decline in the number of people working in agricultural production. These data may not be entirely accurate, as part of the population is engaged in agriculture as a secondary activity (Blaće, 2014, 2015). The aging index for the Ravni Kotari region in 2011 was 85.71%, which is significantly higher than the 40% threshold for the population entering the aging process. Also, according to education in 2011, the most people had completed secondary school (47.29%), primary school (20.99%), then highly educated (15.08%), and a relatively small share of those who did not complete school (2.01%) (DZS, 2021).

Questionnaire analysis

To collect data relevant to socioeconomic analysis, specific questionnaires were set up and disseminated. Aim of these questionnaires was to understand stakeholders' perception related to climate change impacts in coastal areas. Specifically, a single questionnaire was prepared, translated in IT and in EN, divided then into different sections according to the categories of the respondent, as follows (see also **Annex 1**):

:

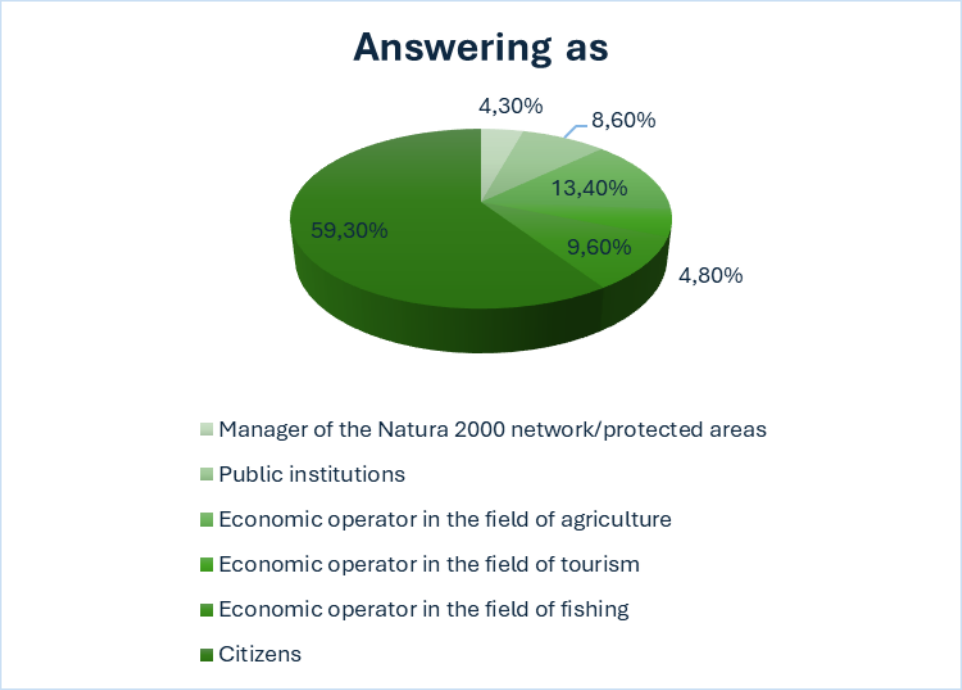
1. **Public Entities**: divided into two respective sections, **Nature 2000 Network Managers** and **other Public Entities**. These categories are asked to identify themselves and describe their perceptions of climate change issues related to nature protection, identifying threats and impacts/effects of climate change on their territory/community, and any obstacles to be overcome and solutions/strategies to be implemented to understand/mitigate its effects.
2. **Operators** in the relevant economic fields: **divided into three respective sections**, operators in the **field of agriculture/agricultural producers**, in the field of **fishing/commercial or recreational fishermen**, and in the field of **tourism/tourism facility managers**. These categories are asked to identify themselves and describe their perceptions of climate change issues related to their related socioeconomic activities, identifying negative impacts/consequences of climate change on their activities and implemented practices/obstacles to overcome to counter or adapt to these effects.
3. **Citizens**: who are asked to identify themselves (geographically and demographically) and then describe their perceptions of climate change issues related to nature protection and public health, again identifying threats and impacts/effects of climate change on their local area/community, and any security risks related to them.

All are also asked to assess the degree of information regarding the effects of climate change and which channels are considered most appropriate for this purpose.

Guidelines for PPS to compile this section (delete the following instructions in blue, when compiling your report)

A total of 209 respondents replied to the questionnaire between 7 February and 14 March 2025. 59.3% of respondents are citizens from the territory of the Republic of Croatia, primarily from the City of Ploče and the vicinity of Lake Vrana, which points to the fact that the results of the survey indicate the difficulties that citizens living in the vicinity of 2 pilot areas in the territory of the Republic of Croatia face on a daily basis, and based on the results of this survey guidelines for future action in the field of environmental

protection of the Adriatic Croatia can be created. This refers in particular to the creation of natural solutions that have the potential to create contributions to environmental protection.



Graph 1: Diversification of data subjects, representatives of protected area managers to which group they belong Source: Survey questionnaire results

Out of 209 subjects, 124 or 59.30% are citizens, which makes this group the most numerous group of subjects. 4.30% of respondents are managers of Natura 2000 areas or protected areas, 8.60% of respondents are public bodies (city (municipal), county or state), 13.40% of respondents are farmers, 4.80% are economic or recreational fishermen and 9.60% are economic or recreational fishermen. Based on the fact that the most numerous group of respondents are citizens who are often recreational farmers, and in the second place are persons engaged in professional agriculture, it can be concluded that the results of the survey will indicate the problems faced by citizens as well as farmers in their activities. Based on the analysis of collected responses, it will be possible to create recommendations for future actions in the field of environmental protection and creation of natural solutions (NBS) that will in the long term have an impact on elimination or mitigation of negative effects resulting from climate change.

SECTION 2 - managers of natural Areas and the Natura 2000 Network
Name of your institution/Park:

- Public institution nature of Sibenik-Knin County
- Public institution “Telascica nature Park”
- Public institution Paklenica National Park
- Public institution nature Park Vransko Lake
- Public institution nature Park Papuk

- Public institution for the management of protected nature areas of Dubrovnik-Neretva County
- Public institution National Park Risnjak
- Public institution Mljet National Park
- Public institution "Zumberak nature Park - Samobor Mountains"

A total of 9 public institutions from all over the Republic of Croatia replied to the questionnaire, of which 7 public institutions are located in the coastal part of the Republic of Croatia.

List the cities (municipalities)/counties within which the protected areas/ecological network areas you manage are located:

- Sibenik-Knin County;
- Municipality of Sali/Zadar County;
- Zadar and Lika-Senj counties;
- The towns of Benkovac, Biograd n/M, Nin and Zadar and the municipalities of Galovac, Lishan Ostrovička, Pakostane, Polača, Poličnik, Posedarje, Raznatac, Stankovci, Sukosan, Sveti Filip and Jakov, Skabrnja, Vrdo and Zemunik Donji in the area of Zadar County. The towns of Skradin and Vodice and the municipalities of Pirovac, Tisno and Tribunj in the area of Sibenik-Knin County;
- Municipalities of Brestovac, Velika, Kaptol, Cacinci, Vocin; the town of Kutjevo and Orahovica;
- Cities - Ploče, Opuzen, Metkovic, Municipality - Pojezerje, Toad, Tower of Norinska, catchment;
- Čabar, Delnice, Bakar, Lokve i Čavle;
- • Zagreb and Karlovac counties, City of Samobor, City of Jastrebarsko, City of Ozalj, Municipality of Zumberak, Municipality of Krasic.

All respondents replied that they were aware of the impact of climate areas on the area they manage. Taking into account the fact that data subjects manage protected areas throughout the Republic of Croatia, it is possible to conclude that climate change has a negative impact on the entire territory of the state, regardless of the characteristics of the individual area (whether it is a coastal or terrestrial part of the state).

Since respondents answered the question referred in the affirmative, they were asked to define on a linear scale to what extent they were informed about the impact of climate change in their territory. The scale is defined on a scale of 1-3 (1 – poorly informed, 2 – fairly well informed, 3 – very well informed). The average score of 2.89 indicates that respondents are very well informed about the impact of climate change on their area of activity.

Perception of Climate change issues linked to nature Protection

All respondents replied that they believe that habitats and species in the area they manage are already or will be affected by climate change, which leads to the conclusion that the negative impacts of climate change on habitats and flora and fauna are currently pronounced. It is expected to intensify in the future in the event that preventive measures are not taken to mitigate or eliminate negative climate change.

Below, respondents were asked to assess the impact of individual types of threats on habitats and species. For each threat, respondents assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know). In the types of threats where the response occurs, I don't know, in the calculation of the average score, subjects who responded with I don't know were excluded from the number of subjects. This is applicable in all tables below, where the answer option appears I do not know.

Threat types	1	2	3	4	5	I don't know.	Average rating
INCREASED Salt gear	4	1	2	0	2	0	2,44
Surface water Pollution	1	2	0	2	4	0	3,67
Groundwater Pollution	0	3	1	1	4	0	3,67
Agricolture ground Pollution	1	2	2	2	2	0	3,22
Eutrophication	2	1	2	1	3	0	3,22
Coastal erosion	0	1	5	1	2	0	3,44
Salinity changes in coastal lands	3	1	0	1	4	0	3,22
Over-exploitation of Freshwater	2	1	0	3	3	0	3,44
Sea level rise	2	1	1	1	4	0	3,44
Rising sea temperature	2	1	1	0	4	1	3,38
Droughts	0	0	0	1	8	0	4,89
Extreme climatic events	0	0	0	2	6	1	4,75
Rise temperatures	0	0	0	1	8	0	4,89
Invasive alien species	0	0	1	3	5	0	4,44

Table 02. Views of protected area managers on threats to the areas in which they operate Source: Survey questionnaire results

Based on the average scores from the above table, it is evident that the subjects consider the increase in temperature and drought to be the most pronounced risks affecting habitats, flora and fauna in the territory of the Republic of Croatia. It can be pointed out that these are risks that have a causal link, i.e. droughts are a direct consequence of rising temperatures, and it is expected that drought periods will be longer if the average temperature increases continue in the future. The area of Adriatic Croatia is specific as it is characterised by long, hot and dry summers and short, mild and rainy winters. These climatological characteristics have a direct impact on the flora and fauna of the site and it is expected that the negative effects of drought and rising temperatures will continue in the future.

One of the higher average scores was recorded in the case of a risk extreme climatic event. It is also possible to point out that this type of risk has a causal link with the increase of average temperatures, and even today it is evident that temperatures are increasing in summer, periods of drought are getting longer, etc. Most respondents noted that invasive alien species pose one of the biggest threats to habitats. Today, in the Adriatic coast, some of the most common invasive species are blue crab, zebra mussel and spider

fish. Although blue crab can be hunted for example and thus naturally regulated, the use of zebra mussels in gastronomy is not allowed due to the application of regulations regulating the cultivation, hunting and trade of bivalve molluscs. On the other hand, the spider fish is not only highly harmful to the flora and fauna of its locality, it is toxic to human consumption.

It is very interesting to note that most subjects do not perceive the negative impact of increased salinity in water and soil. This is due to the fact that not all areas of the Adriatic coast are equally affected by the negative impact of increased salinity levels. In doing so, the Neretva delta area can be distinguished as one of the areas strongly influenced by salinity growth, which is why numerous measures have been applied in recent years aimed at preventing sea penetration into the delta area.

Impacts of climate change observed by protected area managers in their territory:

- Loss of marine ecosystems – 2 subjects;
- Loss of terrestrial ecosystems – 5 subjects;
- Loss of the brackish/freshwater ecosystem – 5 subjects;
- Reduction of ecosystem services – 7 respondents;
- Loss of animal species – 5 subjects;
- Loss of plant species – 3 subjects;
- Increase in the presence of invasive species – 7 subjects; and
- Other: changes in the distribution of individual plant and animal species (1 subject) and extreme water levels, winds and extreme weather conditions (1 subject).

The answer to this question shows how respondents identified a reduction in ecosystem services and an increase in the presence of invasive species as the effects of climate change that have a pronounced impact on their territory. The smallest number of respondents identified the loss of plant species and the loss of marine ecosystems as the impact of climate change observed in their territory. In doing so, these claims should be taken with reservations because the identification of marine ecosystems is partly more difficult to identify than the loss of terrestrial ecosystems due to the limited visibility of the seabed itself.

Most respondents, i.e. 88.9%, think that they can contribute to climate change adaptation or mitigation through their work. On the other hand, 11.1% of respondents feel that they cannot contribute to climate change adaptation or mitigation through their work. While some respondents do not consider that their work can contribute to climate adaptation or mitigation, it is necessary to take into account the collective impact, not only the effects of the actions of individuals (and/or individual entities) that are most often insignificant.

Activities/strategies implemented by the institutions represented by the respondents to understand/mitigate the effects of climate change in their territory:

- Monitoring of key species and habitats – 9;
- Surface water monitoring — 6;
- Groundwater monitoring — 1;

- Coastal erosion monitoring – 2;
- Nature-based solutions – 4;
- Hydraulic water management models — 0;
- Installation of controllable locks -1;
- Active coastal dunes defence interventions – 1;
- Water management contracts with farmers — 2;
- Cooperation with local authorities – 6 and
- Dissemination of information material – 6.

It is possible to identify how all public institutions implement the strategy for monitoring key species and habitats, which is the basis for defining future activities in the field of nature protection. However, it is evident that very few institutions apply some of the other mentioned activities/strategies that can be implemented in order to understand/mitigate the effects of climate change in their territory.

It is worrying that only one institution follows groundwater, given that it violates a part of the Adriatic Croatia that is very rich in rivers of submersible waters, which are important for the supply of drinking water in this part of Croatia. In the event of an increase in salinity, reduction or pollution of groundwater, the long-term supply of drinking water to the population and businesses may be endangered, and thus, certainly, agricultural production using groundwater becomes questionable. Considering that the majority of public institutions cooperate with local authorities in the scope of their activities, it is recommended that the strategies of the institutions' activities be further adapted in the future through cooperation with local authorities, in order to prevent negative effects that may result from e.g. excessive use of drinking water, pollution of flows, etc.

4 respondents answered the question of what type of nature-based solution they adopted or would like to adopt in the future. They gave the following answers:

- Change of awareness among all state institutions to stakeholders;
- Restoration of buffer zones around watercourses, restoration of wetlands;
- In preparation of the project Resilience and adaptation of forest ecosystems to climate change in the Papuk nature Park, and
- Reduction of possible catastrophic events based on services of existing ecosystems; adaptation to climate change based on services of existing ecosystems. For example, 1) avoiding the identification of coasts and the channelling and Regulation of watercourses, 2) maintaining favourable dynamics and water regime, including the level of groundwater, for the preservation of diversity of aquatic and wetland habitats.

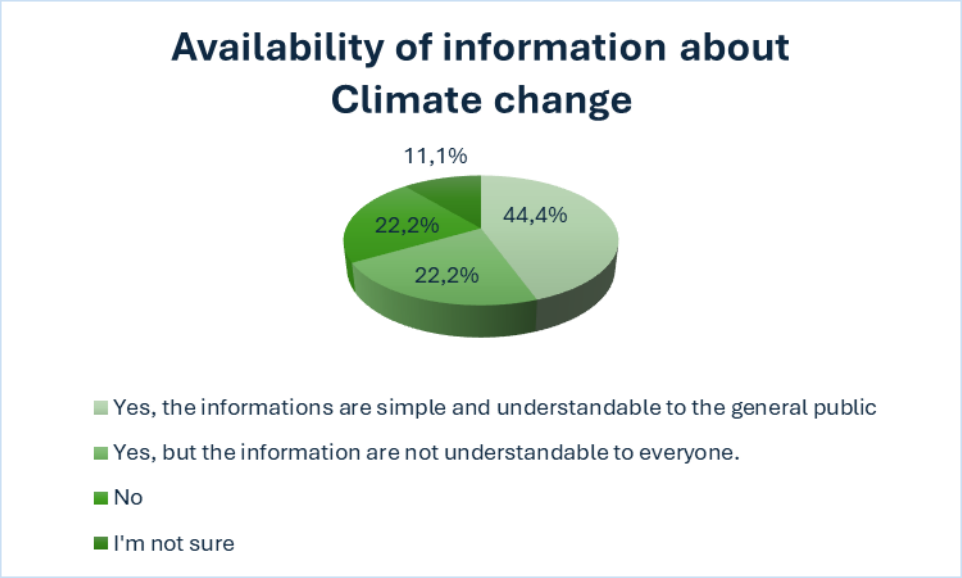
Below, respondents were asked to assess the impact of obstacles to the implementation of climate adaptation/mitigation practices. For each obstacle, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Obstacles	1	2	3	4	5	I don't know.	Average rating
Lack of financial resources	0	1	1	2	5	0	4,22
Lack of specific expertise	1	1	2	2	3	0	3,56
Lack of adequate programming/planning	1	0	3	3	2	0	3,56
Lack of appropriate policies/legislation	1	0	2	3	3	0	3,78
Lack of consciousness	0	0	3	2	4	0	4,11
Lack of authority	0	1	2	1	5	0	4,11
Fragmentation of responsibilities of competent authorities	0	1	2	1	5	0	4,11
Difficulties in dialogue with stakeholders	0	2	2	3	2	0	3,56

Table 03. Views of protected area managers on obstacles to implementation of climate adaptation/mitigation practices Source: Survey questionnaire results

Unfortunately, most respondents consider that the lack of financial resources is one of the fundamental obstacles to the implementation of climate adaptation or mitigation practices. For this reason, it is necessary to suggest an increase in future public expenditures related to environmental protection, investment in the development of green business practices, etc. In addition, the majority of respondents identified a lack of awareness (presumed to be equal to citizens, entrepreneurs, public authorities and other stakeholders), a lack of authority and a fragmentation of the responsibilities of competent authorities as some of the obstacles to the implementation of climate change adaptation practices.

It should be pointed out that if the average scores for each of these obstacles are considered, it is evident that the respondents consider that each of these obstacles is relevant, which leads to the conclusion that, in cooperation with relevant stakeholders (primarily public authorities), it is necessary to take measures aimed at mitigating or eliminating the obstacles that currently exist and preventing more effective action in the implementation of adaptation or mitigation practices.



Graph 02. Views of protected area managers on the availability of information related to the impacts of climate change Source: Survey questionnaire results

Nearly half of respondents think the information is simple and understandable to the public, on the other hand, 22.2% think the information is not clear to the general public. The same number of respondents also considered that the information was not available to the public. Based on these results, it is recommended to simplify information (presented through media releases, posters, articles or other forms of publications) in order to make it understandable to the public. It is also recommended to increase the number of posts, especially in digital media, in order to access this target group more effectively.

Views of protected area managers on the appropriateness of information on the impacts of climate change:

- Scientific articles/journals – 5 subjects;
- State organisations – 7 respondents;
- Konferencije/seminari/radionice – 8 subjects;
- Mandatory training – 5 respondents;
- Social networks and blogs – 9 respondents;
- TV/radio – 5 respondents;
- Information boards/local portals – 5 respondents; and
- Oral communication - 6 subjects.

All respondents consider that social media/blogs are the most appropriate to inform the public about the impacts of climate change. This can be directly linked to the fact that almost all individuals today use social networks (e.g. Facebook, Instagram, X, etc.). In doing so, it is necessary to select an appropriate social network, especially since the public is increasingly pointing out that Facebook is now used primarily by older people and Instagram by young people, for example. Other forms of information are appropriate in

certain situations and through these channels it is most often possible to access a limited social group, which underlines the need to carefully select channels of communication with the aim of ensuring effective access to a particular social group.

SECTION 3 - public institutions
A total of 18 respondents replied in this part of the questionnaire. As some of them, one can point out:

- Agency for Rural Development of Zadar County;
- Dubrovnik-Neretva County, Administrative Department for environmental Protection and Municipal Affairs;
- The city of Ploče;
- The city of Biograd at sea;
- Croatian waters – VGI Zadar;
- Source plate;
- Public Institute of Krka National Park;
- Public fire Brigade Ploče;
- Ministry of environmental Protection and Green Transition;
- Municipality of Fabre;
- Pora d.o.o.;
- Tourist Board of the City of Biograd na moru
- Municipality of Pakostane and
- Vladimir Nazor Ploče Elementary school.

Respondents operate in the following areas:

- Plaques/Dubrovnik-Neretva County;
- Zadar County;
- Municipality of Zablje/Dubrovnik-Neretva County;
- Boards, Tower of Norinska/Dubrovnik-Neretva County and Gradac/Split-Dalmatia County;
- Sibenik, Drnish, Knin, Ervenik, Promina, Skradin, Kistanje/Sibenik-Knin County;
- Municipality of Pakostane/Zadar County;
- Biograd na moru/Zadar County and
- The territory of the entire Republic of Croatia.

All respondents in this section stated that they are aware of climate change in their area. In the following question, respondents were asked to express on the 1-3 linear scale (1 – poorly informed, 2 – fairly well informed and 3 – very well informed) how well informed they are about the impacts of climate change. Average score 2.33 shows that respondents are fairly well informed about the impact of climate change on their territory, which is a very good basis for engaging with other stakeholders and creating public policies that could potentially direct all stakeholders' action towards environmental protection and long-term sustainable development.

Perception of Climate change issues linked to nature Protection

All respondents believe that habitats and species in their territory are already affected or will be affected by climate change in the future. These are stakeholders who are already taking a number of measures, within their mandate, aimed at preventing or mitigating the adverse effects of climate change. In order to make public bodies more efficient in the future, it is necessary to create improved, green strategies and implement them.

Below, respondents were asked to assess the impact of individual types of threats on habitats and species. For each threat, respondents assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Threat types	1	2	3	4	5	I don't know.	Average rating
INCREASED Salt gear	2	3	4	7	2	0	3,22
Surface water Pollution	1	1	5	9	1	1	3,47
Groundwater Pollution	0	3	4	10	1	0	3,50
Agricolture ground Pollution	2	1	5	8	1	1	3,29
Eutrophication	2	3	5	6	1	1	3,06
Coastal erosion	2	4	6	5	0	1	2,82
Salinity changes in coastal lands	3	3	1	7	3	1	3,24
Over-exploitation of Freshwater	4	1	6	5	1	1	2,88
Sea level rise	4	2	3	5	4	0	3,17
Rising sea temperature	1	4	2	7	4	0	3,50
Droughts	0	0	3	9	6	0	4,17
Extreme climatic events	1	2	3	7	5	0	3,72
Rise temperatures	1	0	2	7	8	0	4,17
Invasive alien species	1	0	4	7	5	1	3,88

Table 04. Views of representatives of public authorities on threats threatening the areas in which they operate Source: Survey questionnaire results

Based on the results presented in the table above, it is noted that representatives of public authorities consider drought and an increase in average temperature as the primary threats threatening habitats in their area. Again, it is pointed out that these are two threats that are causally linked, that is to say, it is assumed that the increase of average temperatures will lead to the emergence of more pronounced droughts in the future. The lowest average rating was recorded in case of coastal erosion, i.e. it can be pointed out that representatives of public authorities consider coastal erosion to be a threat of medium relevance, while other threats are more relevant.

It is also noted that representatives of public authorities give excessive use of drinking water medium relevance, on the basis of which it can be concluded that this group of respondents does not have a strong perception of the potential risk that may arise as a result of excessive use of drinking water. This can be

partly linked to the fact that Croatia abounds in drinking water, especially in the underworld, as well as to the fact that there are significant reserves of drinking water in the town of Ploče and Lake Vrana. For a number of threats per 1, the respondent stated that he/she did not know or could not assess the impact of a specific threat on habitats in their territory.

Climate change impacts observed by representatives of public authorities in their territory:

- Loss of marine ecosystems – 8 respondents;
- Loss of terrestrial ecosystems – 4 respondents;
- Loss of the brackish/freshwater ecosystem – 5 subjects;
- Reduction of ecosystem services – 6 respondents;
- Loss of animal species – 7 subjects;
- Loss of plant species – 7 subjects;
- Increase in the presence of invasive species – 12 subjects; and
- Other: disturbance in drinking water quality parameters (1 subject) and frequent floods (1 subject).

Based on the answer to this question, it can be concluded that the largest number of representatives of public authorities identified an increase in the presence of invasive species in their territory as a direct consequence of climate change. The lowest number of respondents identified the loss of terrestrial systems as a result of climate change. The answers to this question should be taken with reservations because respondents are primarily employees and/or representatives of public bodies that are most often not experts in the field of environmental protection and receive more information through the media that most often publish contributions related to the appearance of invasive species, and less frequently information about the negative impact of climate change on terrestrial ecosystems, etc.

Perception of Climate change issues linked to public Health

Representatives of public authorities generally agree on how climate change can affect public health. That is, 94.4% of respondents think climate change affects public health and 5.6% of respondents are uncertain. The answers to this question can be directly linked to the answers to the following question, in which 61.1% of respondents said they had identified health problems in the social community that they considered to be related to climate change. (e.g. heat waves, deterioration of air quality, emergence of new diseases, etc.). 38.9% of respondents said they were not safe.

While it is often assumed that climate change leads to negative effects on public health, especially for older people, children and chronic patients, some impacts are harder to relate to climate change. For example, it is evident that heat waves are the cause of negative effects on citizens' health, but it is more difficult to prove that climate change is directly linked to the emergence of new diseases in certain sites, other than diseases linked to their carriers (e.g. the appearance of mosquito-borne dengue fever, which is able to survive almost all year due to an increase in average temperature).

Below, respondents were asked to assess the impact of individual impacts of climate change on health and safety. For each impact of climate change, respondents assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Types of impacts of climate change	1	2	3	4	5	I don't know.	Average rating
Increased frequency of heat-related diseases	0	4	9	4	1	0	3,11
Increased frequency of respiratory diseases	1	4	5	6	2	0	3,22
Increased frequency of water quality related diseases	3	3	7	5	0	0	2,78
Increased frequency of pest-related diseases	5	2	7	2	0	2	2,38
Increasing personal security risks (accommodation, infrastructure, transport …)	3	3	9	2	0	1	2,59

Table 05. Views of representatives of public authorities on the impact of climate change on health and safety Source: Survey questionnaire results

Based on the results presented in the table above, it is noted that representatives of public authorities made relatively low evaluations in case of all impacts of climate change on health and safety. The highest average score was observed in case of increased incidence of respiratory diseases, while the lowest score was observed in case of increased pest-related diseases. This can be directly linked to the fact that a large number of citizens complain about respiratory difficulties during sudden changes in weather conditions, the influence of heat waves, etc. Since pest-related diseases are not common in the territory of Croatia, it is expected that most subjects do not have the perception of an increase in the incidence of pest-related diseases.

Perception of Climate change issues linked to socio-economic activities

All respondents believe that climate change can have an impact on economic activities in their area (e.g. tourism, fisheries, agriculture, etc.). Although it is possible to point out that long warm summers, i.e. extending the summer dry season, can have positive effects on the development of tourism in Croatia, these phenomena have a direct negative impact on agriculture, which in the long term can lead to the creation of negative effects on the economy of Croatia and a drop in GDP. For this reason, the impact of climate change on each activity needs to be analysed in more detail, and although at first glance it seems that climate change can have a positive impact on tourism, gastronomic tourism is developing more and more pronounced in Croatia, which is directly dependent on agriculture as an economic activity.

Below, respondents were asked to assess the potential to create adverse impacts of climate change on economic activities in their territory. For each effect, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Impacts of climate change with potential impact on economic activities	1	2	3	4	5	I don't know.	Average rating

Elevated temperatures	0	1	5	5	7	0	4,00
Increased coastal erosion	2	7	4	3	1	1	2,65
Increased Salting	2	2	5	5	4	0	3,39
Reduced availability of fresh water	0	3	7	4	4	0	3,50
Habitat degradation	1	1	7	4	4	1	3,53
Droughts	0	0	5	6	7	0	4,11
Extreme weather events (i.e. floods, extreme winds, …)	1	1	5	5	6	0	3,78

Table 06. Views of representatives of public authorities on the potential for adverse impacts of climate change on economic activities Source: Survey questionnaire results

Representatives of public authorities estimate that the drought could have a relevant impact on economic activities as a result of climate change. This applies primarily to agriculture, in particular taking into account the fact that extensive agriculture has been developed in the area of the town of Ploče and Lake Vrana, and there are a large number of persons engaged in this activity professionally or amateurish. Respondents consider that coastal erosion as a result of climate change is an impact that could potentially have the least pronounced impact on economic activities in their territory.

When asked whether they consider that their work can contribute to climate change adaptation or mitigation, 50% of respondents answered yes, while 50% of respondents are uncertain. Since the respondents were representatives of public authorities, it was assumed that there would be a higher percentage of respondents who thought they could create positive changes, whether through the creation of new public policies or actions that would have a positive impact on mitigation of the consequences of climate change.

Activities/strategies implemented by public authorities represented by respondents to understand/mitigate the effects of climate change in their territory:

- Surface water monitoring — 8;
- Groundwater monitoring — 3;
- Coastal erosion monitoring – 2;
- Nature-based solutions – 6;
- Hydraulic water management models — 4;
- Active coastal defence interventions – 3;
- Installation of controllable locks -2;
- Water management contracts with farmers — 1;
- Cooperation with local authorities – 13;
- Raising public awareness – 13;
- Dissemination of information material – 10 and
- Stakeholder round tables – 6.

The largest number of public authorities apply a strategy for cooperation with local authorities and raising public awareness because they identified the two strategies as the most effective for

understanding/mitigating the effects of climate change. Only one public authority implements a strategy for contracts with farmers on water management, which is actually worrying because the need for fresh water use in agriculture is increasing due to pronounced dry periods, whether permanent crops or one-year crops. More frequent contracting of water management with farmers and other stakeholders engaged in economic activity is recommended in order to monitor drinking water consumption and prevent potential loss of drinking water in the future. (especially if drought continues in the future).

In the following question, respondents stated what types of territorial agreements they had adopted or would like to adopt in the future. The following responses were recorded:

- The strategy for the development of the town of Ploče;
- An agreement on the participation of climate change mitigation costs in proportion to the profits achieved by farmers and businesses and by undertakings contributing to climate change through their activities;
- Reduction of pollution;
- Construction of irrigation systems;
- Cooperation with DVDs;
- Investments in the development of green and blue infrastructure and strengthening the capacity and operational readiness of civil protection and firefighting with a focus on the establishment and improvement of surveillance and monitoring systems to reduce fire and disaster risks;
- Alert the local authorities frequently about the problems encountered;
- None of those
- An agreement to increase green spaces.

Each of the public authorities has specific instruments that help them implement activities that can mitigate or eliminate the negative effects of climate change in the long term. For this reason, the implementation of activities and strategies that will eliminate the adverse effects of climate change in the long term should be encouraged at national or transnational level.

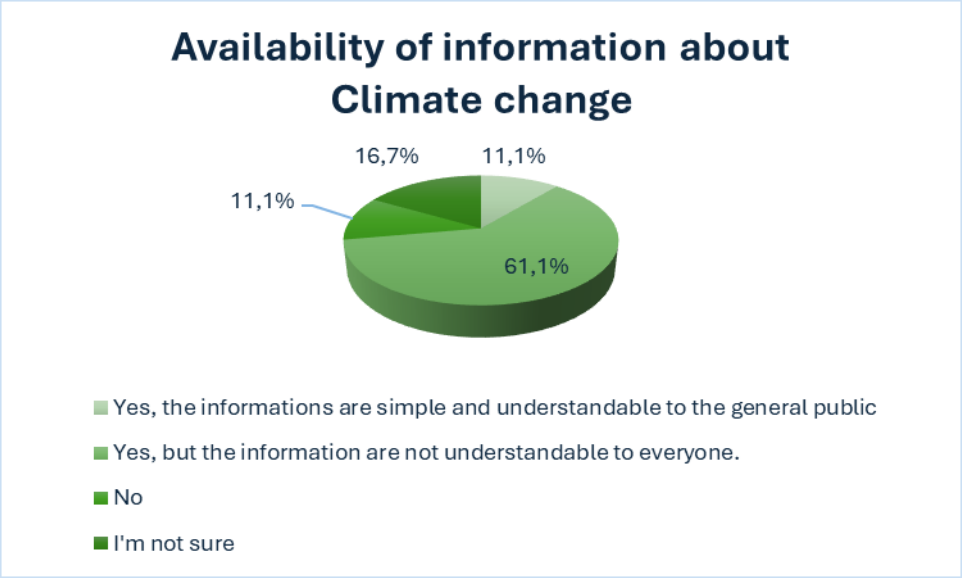
Below, respondents were asked to assess the relevance of individual obstacles to the implementation of climate change adaptation/mitigation practices. For each obstacle, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Obstacles	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Lack of financial resources	0	1	6	9	2	0	3,67
Inefficiency	3	5	7	2	0	1	2,47
Lack of specific expertise	0	2	6	6	4	0	3,67
Lack of adequate programming/planning	1	2	9	4	2	0	3,22
Lack of appropriate policies/legislation	1	5	4	5	3	0	3,22
Lack of consciousness	0	1	2	7	8	0	4,22
Lack of authority	0	2	8	4	3	1	3,47

Fragmentation of responsibilities of competent authorities	1	1	7	5	4	0	3,56
Difficulties in dialogue with stakeholders	1	1	4	7	3	2	3,75

Table 07. Views of representatives of public authorities on the relevance of obstacles to the implementation of climate change adaptation/mitigation practices Source: Survey questionnaire results

Respondents highlight lack of awareness as the most relevant obstacle to the implementation of adaptation/mitigation practices. It is to be assumed that the respondents consider that citizens, as well as other stakeholders (especially those performing economic activity), are not sufficiently aware of the negative effects of climate change in Croatia. As the least relevant obstacle, respondents consider it not cost-effective, from which it follows that respondents consider that the implementation of activities that will contribute to climate change adaptation/mitigation in the long term is multi-cost-effective because the negative effects of climate change lead to the creation of negative effects for the economy and the public sector (as a consequence of compensation for damages, etc.).



Graph 3: views of representatives of public authorities on the availability of information related to the impacts of climate change Source: Survey questionnaire results

Only 11.1% of respondents think information on climate change is simple and understandable to the public. The fact that 61.1% of respondents think information is available but not understandable to the public is worrying. Taking into account the fact that almost half of the representatives of protected area managers consider information to be available, simple and understandable to the public, the question arises as to why there are significant differences in statistical data for these two target groups.

It would be advisable to simplify information so that it is understandable to the public, regardless of the characteristics of users of information (age, gender, level of education, etc.). It is also recommended to

adapt the use of channels for publication of information depending on the characteristics of the target group to be informed about specific adverse effects of climate change.

Views of representatives of public authorities on the appropriateness of information on the impacts of climate change:

- Scientific articles/journals – 5 subjects;
- State organisations – 4 respondents;
- Konferencije/seminari/radionice – 12 subjects;
- Mandatory training – 7 respondents;
- Social networks and blogs – 13 respondents;
- TV/radio – 12 respondents;
- Information boards/local portals – 10 respondents; and
- Oral communication - 9 subjects.

In this question, respondents were able to select multiple responses. It is noted that the majority of respondents consider social networks/blogs to be the most appropriate method of information on the effects of climate change. The smallest number of respondents think that state organisations are least suitable for informing about the effects of climate change, which can be partly linked to the fact that Croatians often have misconceptions about the work of state institutions.

SECTION 4 - farmers

A total of 28 responses were reported in this section. These are the following agricultural producers:

- OPG Strbic;
- OPG JOHN THE CAMERAMAN;
- The OPG of Daniel;
- OPG Ned Gladovic;
- OPGs;
- OPG Ivo Pamic;
- OPG Niksa Marevic;
- OPG Danijel Bakovic;
- OPG Thomas;
- OPG Petar Strbic;
- OPG Ika Bakovic;
- OPG Marjan Cerimi;
- OPG Strbic;
- OPG Susa;
- OPG Tanja Vlatkovic;
- OPG Damir Bakovic;
- OPG Ante Nakicen;
- OPG Ivan Raven;

- OPG Anisia Knezic;
- OPG Schuman Stipo;
- OPG Mario Polegubic;
- OPG Mark Cirjak;
- OPG Duje Opralic;
- OPG Nena;
- OPG Puvalo;
- OPG Jadran Bakovic;
- OPG Rakusic and
- OPG Anne and I.

One of the farmers is from the area of Zadar County, 1 from the area of the city of Zadar, 2 from the area of the town of Opuzen, Dubrovnik-Neretva County, 1 from the area of the municipality of Livno, Dubrovnik-Neretva County, 1 from Dusina, the town of Vrgorac, Split-Dalmatia County, while the remaining farmers are from the area of the town of Ploce (including marc as one of the settlements covering the administrative area of the city).

A linear scale of 1-3 was used in the next question (1 – poorly informed, 2 – fairly well informed and 3 – very well informed). All respondents, i.e. agricultural producers, said they were aware of the negative impact of climate change. The average score of 2.29 indicates that farmers feel fairly well informed about the impacts of climate change in their area. However, improvements may also be made, which calls for additional actions to inform farmers, in particular the long-term negative effects of climate change in the agricultural sector.

Perception of Climate change issues linked to socio-economic activities

As many as 92.9% of farmers believe that climate change could affect their economic activity. Only 7.1% of farmers do not consider that climate change could affect their economic activity. Based on the answer to this question, it can be concluded that farmers are already aware of the negative impact of climate change on their operations (which refers in particular to the negative effects of drought).

A linear scale of 1-3 was used in the next question (1 — slightly relevant, 2 — medium relevant and 3 — very relevant). The mean score of 2.46 indicates that respondents consider the impact of climate change on their business to be of medium relevance. Given the high grade, it can also be pointed out that the majority of respondents are very relevant to business, which is directly related to the fact that agriculture is open-air production, which is subject to climate change (extreme drought, natural disasters, extreme winds, etc.).

Below, respondents were asked to assess which of the adverse effects of climate have or could have negative effects on their activity. For each effect, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Effects	1	2	3	4	5	I don't know.	Average rating
Elevated temperatures	0	1	5	7	15	0	4,29
Increased coastal erosion	5	5	5	6	5	2	3,04
Increased Salting	6	0	3	3	12	4	3,63
Reduced availability of fresh water	4	3	4	4	13	0	3,68
Habitat degradation	3	3	6	9	5	2	3,38
Droughts	0	0	5	5	16	2	4,42
Extreme weather events (i.e. floods, extreme winds …)	2	1	5	4	13	3	4,00
Increase in the number of parasites	1	3	5	4	14	1	4,00
Loss of soil fertility	2	2	7	7	8	2	3,65

Table 08. Farmers' views on the negative effects of climate change that have or are likely to have a negative impact on their economic activity Source: Survey questionnaire results

Based on the results presented in the table above, it is noted that farmers have identified droughts as one of the effects of climate change that have or could have negative consequences on their economic activity. In the second place, higher temperatures have been identified as one of the most pronounced effects, whose negative effects have been observed for several decades across the coast of Croatia. Farmers identified increased coastal erosion as one of the effects having or likely to have the least pronounced negative consequences on their economic activity. All the effects listed in the table have relatively high mid-grades, indicating that farmers are already aware that many impacts resulting from climate change will have a negative impact on their operations, and some already have a pronounced negative impact (e.g. fever, associated with the heat wave effect and drought).

As many as 78.6% of respondents believe that climate change could have a negative impact on other economic activities in their territory (e.g. tourism, fishing, etc.). 3.6% of respondents disagree with this claim, while 17.9% of respondents are uncertain. Almost half of respondents, or 46.4% of respondents, think that their work can contribute to climate change adaptation or mitigation. 14.3% of respondents disagree and 39.3% of respondents are uncertain. It is desirable that the majority of respondents consider that their actions can contribute to mitigating the adverse effects of climate change. As before, it is noted that individuals feel that their actions are not significant enough to create a change that will contribute to adaptation or mitigation of the consequences of climate change. It should be pointed out that while the action of individuals is less significant, the collective effect is certainly significant and pronounced and can have long-term positive effects on adaptation or mitigation of climate change.

In the following question, farmers were asked to select one or more responses, i.e. to indicate which of the following activities/strategies they are implementing to understand/mitigate the effects of climate change in their territory. It was recorded as follows:

- Precision farming – 15 respondents;
- Crop rotation – 19 respondents;
- Introduction of varieties/species more tolerant of excess water and thermal stress – 14 subjects;

- Cooperation with local authorities – 6 respondents;
- Participation in awareness-raising activities – 12 respondents;
- Participation in specific training activities – 8 respondents;
- Application of water consumption reduction practices – 13 respondents;
- Working with other stakeholders to address global change – 7 respondents;
- Application of soil organic carbon conservation practices – 10 respondents; and
- Other – 0 subjects.

The largest number of farmers apply a crop rotation strategy, which is actually a desirable practice, i.e. one of the natural solutions for soil regeneration and prevention of crop-specific pests (especially for one-year crops). The smallest number of respondents benefit from the possibility of cooperation with local authorities, which should be improved, in particular because the majority of farmers farming larger agricultural areas use state or urban land, in which case a number of solutions could be developed through cooperation with public authorities and other public authorities that would encourage the long-term mitigation or elimination of adverse effects of climate change.

In the following question, farmers were asked to highlight which types of adaptation strategies they had adopted or considered most relevant. Some of the replies raised by farmers were:

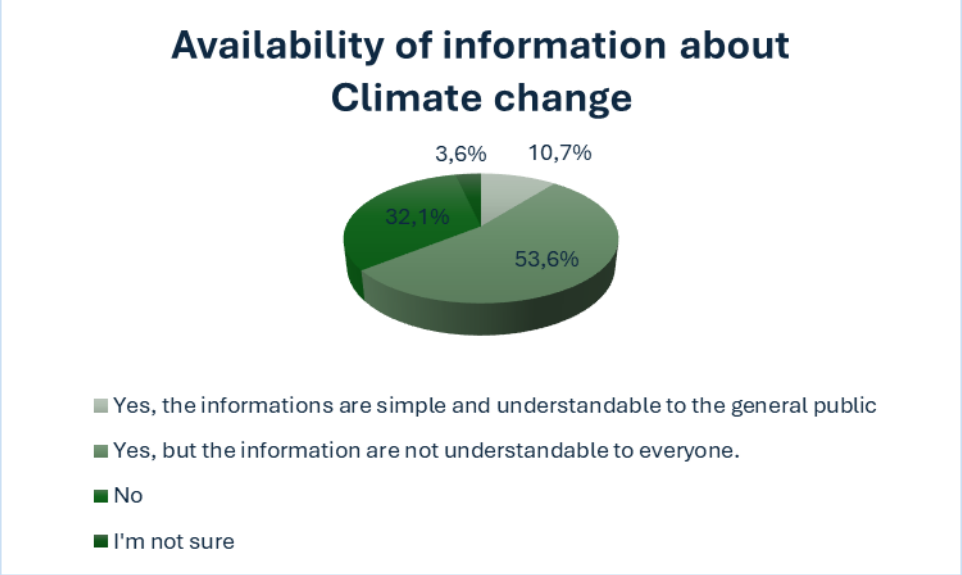
- Precision farming;
- Crop rotation;
- Reducing water consumption;
- Eco-production;
- Organic fertiliser, single mowing of soil moisture, natural pesticides;
- Prevention;
- Tolerant varieties;
- Reducing water consumption;
- Introduction of new varieties;
- Less ploughing;
- Tolerant varieties;
- The introduction of more resilient varieties;
- Tillage, precision agriculture - use of organic fertilisers, integrated plant protection;
- Precise use of pesticides and precise watering of crops;
- Reduced use of pesticides;
- Adapting the species of seedlings to this area;
- Crop rotation; and
- Participation in awareness-raising activities.

Below, farmers are asked to assess what they consider to be an obstacle to the implementation of climate adaptation/mitigation practices. For each factor, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Obstacles	1	2	3	4	5	I don't know.	Average rating
Lack of financial resources	1	1	5	5	15	1	4,19
Inefficiency	3	4	6	6	8	1	3,44
Lack of appropriate initiatives	0	1	8	10	8	1	3,93
Lack of specific expertise	0	2	10	6	8	2	3,77
Lack of adequate programming/planning	0	4	5	9	7	3	3,76
Lack of appropriate policies/legislation	2	5	4	9	5	3	3,40
Lack of consciousness	0	3	8	10	6	1	3,70
Lack of authority	0	2	12	9	3	2	3,50
Fragmentation of responsibilities of competent authorities	1	3	5	7	9	3	3,80
Difficulty in dialogue with the authorities	1	2	7	6	9	3	3,80

Table 09. Farmers' views on obstacles to implementation of climate adaptation/mitigation practices
Source: Survey questionnaire results

The highest average score was recorded in the absence of financial resources, indicating that the largest number of farmers consider that they do not have sufficient financial resources to implement practices that could contribute to the adaptation/mitigation of the effects of climate change. The lowest average score was recorded in the case of non-cost-effectiveness, indicating that farmers consider that non-cost-effectiveness is one of the abovementioned obstacles that have the least impact on the implementation of practices that could contribute to the adaptation/mitigation of the effects of climate change. The observed mid-grades are relatively high, indicating that the majority of respondents consider these barriers to be relevant for them as farmers.



Graph 04. Farmers' views on the availability of information related to the impacts of climate change
Source: Survey questionnaire results

Only 10.7% of respondents believe that information on the impacts of climate change is available and understandable to the public. More than half of respondents, i.e. 53.6% of respondents, consider the information to be available but not understandable to the public, indicating that it is necessary to adapt publicly available information on the effects of climate change to make it easily understandable to the public. (to all citizens, regardless of their sex, age, educational attainment or other characteristics). 32.1% of respondents considered that information was not available and 3.6% of respondents were uncertain. As almost a third of respondents feel that information is not available, it is necessary to publish more information or change the channels through which existing information is published, as in practice it is often evident that public authorities choose wrong channels to communicate with farmers.

Farmers' views on the adequacy of information on the impacts of climate change:

- Scientific articles/journals – 3 subjects;
- State organisations – 4 respondents;
- Konferencije/seminari/radionice – 15 respondents;
- Mandatory training – 15 respondents;
- Social networks and blogs – 12 respondents;
- TV/radio – 12 respondents;
- Information boards/local portals – 6 respondents;
- Oral communication - 15 respondents; and
- Other – leaflets in agricultural pharmacies (1 respondent) and financial support (1 respondent).

In practice, it is evident that public authorities often use the possibility of publication in scientific articles/journals as well as information boards and publication on local portals, which few farmers consider to be effective methods of informing about the effects of climate change. For farmers, it is recommended to organise konferencija/seminara/radionica and compulsory training, in particular oral communication with farmers. Namely, representatives of public authorities, as well as their employees, as well as other stakeholders who are familiar with the negative effects of climate change, should, through oral communication, educate farmers about the negative effects of climate change.

SECTION 5 - commercial or recreational fisherman

A total of 10 respondents were reported in this section. Of these, there are 5 subjects from the City of Ploce (Dubrovnik-Neretva County), 1 subject from Bibinje (Zadar County), 2 subjects from Pakostane (Zadar County), 1 subject from Pirovac (Sibenik-Knin County) and 1 subject from Tisno (Sibenik-Knin County).

Almost all, or 90% of fishermen, have declared themselves aware of the impact of climate change on their territory. 10% of fishermen have declared themselves unaware of the impact of climate change on their

territory. In the following question, respondents were asked to indicate on the level 1-3 linear scale (1 – poorly informed, 2 – fairly well informed and 3 – very well informed) the degree of awareness of the impacts of climate change in their area. The mean score of 2.7 indicates that respondents are very well informed about the impact of climate change on their territory.

Perception of the link between climate change and socio-economic activities

All respondents believe that their economic activity could be affected by climate. Since the negative impact of climate change on the structure and abundance of fish stocks and the spread of invasive species in water (sea, rivers and lakes) is already visible, it is expected that the negative consequences associated with climate change will have a more pronounced negative impact on fishing as an economic activity in the future.

A linear scale of 1-3 was used in the next question (1 — slightly relevant, 2 — medium relevant and 3 — very relevant). The mean score of 2.1 indicates that fishermen consider the impact of climate change to be of medium relevance for their activity.

Below, fishermen are asked to assess which of the effects of climate change has or may have negative consequences on their operations. For each effect, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Effects	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Rising surface water temperatures	0	1	3	3	2	1	3,67
Increased coastal erosion	4	1	1	3	0	1	2,33
Increased salinization in coastal lagoons	0	0	6	2	1	1	3,44
Salting of freshwater with freshwater fish fauna	0	1	4	2	2	1	3,56
Degradation of natural habitats	0	0	5	2	2	1	3,67
Extreme climatic events (i.e. floods, extreme winds, …)	1	0	5	2	1	1	3,22
Changes in marine currents	1	1	4	2	1	1	3,11
Changes in the structure of fish communities	0	1	2	3	3	1	3,89
Increase in the presence of invasive species (e.g. blue crab, foreign bivalve molluscs …)	0	0	4	3	2	1	3,78
Increase in populations of opportunistic species such as gelatinous macrozooplankton (especially jellyfish and tunicates)	1	0	5	1	1	2	3,13
Reduction of the pH of marine waters	1	1	3	2	1	2	3,13

Table 10. Attitudes of fishermen on the effects of climate change that have or may have negative consequences on their business Source: Survey questionnaire results

Based on the average mean grades highlighted in the table above, it is noted that fishermen consider that changes in the structure of fish communities resulting from climate change have and will have an impact on their operations in the future. They identified increased coastal erosion as the least pronounced factor in their operations. It is evident that fishermen emphasized the medium level of relevance for a larger number of impacts of climate change, which may indicate that fishermen are not sufficiently familiar with the negative effects of climate change and their impact on their business, especially future business. For this reason, additional activities should be carried out to inform fishermen about the negative impacts of climate change.

The majority of fishermen, i.e. 80% of fishermen, consider that climate change affects or may affect other economic activities in their community (e.g. tourism and agriculture). 10% of respondents disagree and 10% of respondents are uncertain. The answers to this question show that most fishermen also notice a negative impact on other economic activities. This is particularly important because the business of a number of entrepreneurs is linked, while the negative impact of climate change on tourism can also directly affect fisheries (e.g. through reduced demand for fish and seafood).

Most of the fishermen, or 70% of them, consider that their actions can contribute to mitigating or adapting to the adverse effects of climate change. 10% of respondents disagree and 20% of respondents are uncertain. The fact that the action of each individual is significant is again emphasized, especially if the collective effect of the action of a larger number of fishermen is taken. For this reason, it is necessary to encourage fishermen to do business in the direction of sustainable development and to contribute to mitigating the adverse effects of climate change.

In the following question, fishermen were asked to choose one or more responses, that is to say, to indicate which of the following activities/strategies they are implementing in order to suppress or adapt to the effects of climate change in their territory. It was recorded as follows:

- Cooperation with local authorities – 5 respondents;
- Participation in awareness-raising activities – 4 respondents;
- Participation in specific training activities – 3 respondents;
- Changes in the fishing season – 4 subjects;
- Introducing a gradual adjustment to the selectivity of fishing gears — 1 subject;
- Activities that have a positive impact on the environment (removal of invasive species, removal of algae blooms, collection of waste, etc.) – 8 subjects;
- Diversification of fishing practices — 2 subjects; and
- Other: more active participation in local actions (1 subject).

Based on previous responses, it can be concluded that fishermen are willing to carry out activities that are considered to have a positive impact on the environment such as removal of invasive species. On the other hand, fishermen are least willing to introduce a gradual adaptation of the selectivity of fishing gears and the diversification of fishing practices because these strategies have a significant impact on their

operations and can lead to an increase in costs, which may jeopardise the sustainability of their operations in the long term.

As the practices they are currently implementing, respondents stated the following:

- Removal of invasive species;
- Collection of waste;
- A clean environment, litter-free;
- Since global climate change cannot be affected, we have until we adapt as adequately as possible;
- Where appropriate;
- Reducing the use of plastics and plastic products;
- Participation in specific training activities;
- Raise awareness for other fishermen;
- Cooperation with local authorities, participation in actions; and
- Reduction of greenhouse gas emissions.

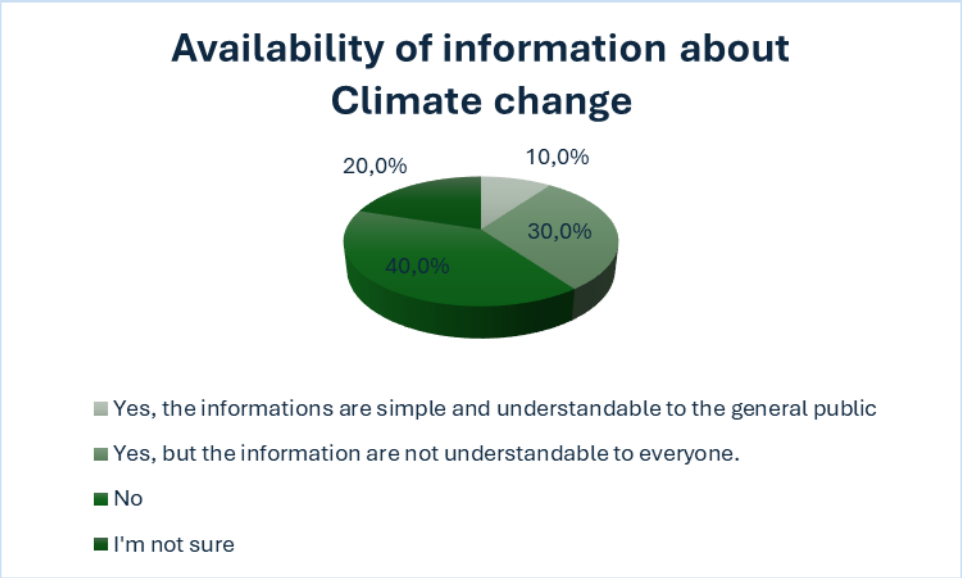
It shows that most respondents apply waste reduction practices. However, it is necessary to encourage the implementation of more practices by fishermen in order to more effectively encourage environmental protection and mitigation/elimination of adverse effects of climate change.

Below, respondents were asked to assess the relevance of obstacles to the implementation of climate adaptation/mitigation practices. For each obstacle, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Obstacles	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Lack of financial resources	1	0	1	4	3	1	3,89
Inefficiency	1	0	4	1	3	1	3,56
Lack of scientific evidence on the impact of climate change on fisheries	0	2	3	2	2	1	3,44
Lack of appropriate initiatives	1	1	0	4	4	0	3,90
Lack of specific skills	0	2	5	1	2	0	3,30
Lack of adequate programming/planning	1	2	1	2	4	0	3,60
Lack of appropriate policies/legislation	0	1	1	2	4	2	4,13
Lack of consciousness	0	0	1	3	6	0	4,50
Lack of authority	1	1	2	2	3	1	3,56
Fragmentation of responsibilities of competent authorities	0	1	1	3	4	1	4,11
Difficulty in dialogue with the authorities	0	0	3	3	3	1	4,00

Table 11. Attitudes of fishermen on obstacles to implementation of climate adaptation/mitigation practices Source: Survey questionnaire results

Based on the results of the survey, it can be concluded that fishermen consider that the fundamental obstacle to climate change adaptation/mitigation is a lack of awareness. The lowest average score was recorded in the lack of specific skills. If all average grades in this issue are considered, it is noted that fishermen consider a number of obstacles relevant, and since they already see a lack of awareness, it is necessary to act in the direction of raising awareness. This applies in particular to young fishermen, who are significantly more easily affected than older fishermen.



Graph 05. Attitudes of fishermen on the availability of information on the impacts of climate change
Source: Survey questionnaire results

Only 10% of respondents believe that information on the impacts of climate change is clear and accessible to the public. 30% of respondents think the information is available but not understandable to everyone. As many as 40% of respondents feel that information on the impacts of climate change is not available to the public, while 20% of respondents are uncertain. Based on the answer to this question, it is pointed out that it is necessary to select appropriate channels for the placement of information on the effects of climate change to fishermen and to adapt it in order to be comprehensible to all fishermen, regardless of their age, sex, level of education or other characteristics.

Attitudes of fishermen on the appropriateness of information on the impacts of climate change:

- Scientific articles/journals – 6 subjects;
- State organisations – 0 respondents;
- Konferencije/seminari/radionice – 6 subjects;
- Mandatory training – 4 respondents;
- Social networks and blogs – 4 respondents;
- TV/radio – 6 respondents;

- Information boards/local portals – 3 respondents;
- Oral communication - 4 subjects and
- Other – 0 subjects.

Based on the answer to this question, it is evident that a large number of respondents feel it would be appropriate to inform them through scientific articles/journals, konferencija/seminara/radionica and via the media or TV/radio. No respondent considers that they should be informed through state organisations, which is partly of concern since the Ministry of Agriculture, forestry and Fisheries and agencies established within the scope of the ministry's activities are responsible for fisheries.

SECTION 6 - Tourist worker

A total of 20 respondents, tourism workers, replied to the questionnaire. These are the following subjects:

- BIONDA travel d.o.o.;
- Red Luke d.d.;
- The physical renter Barbir Marko;
- Hotel Tolero;
- The Maritimo trade;
- Moreta T.A.;
- Platanus d.o.o.;
- Podravina Express tours d.o.o.;
- Ploče Tourist Board – 2 respondents;
- Pakostane Tourist Board;
- Tourist Board of the municipality of Pirovac;
- Ravni Kotar Tourist Board – 2 respondents;
- Zadar County Tourist Board;
- Association of Tourist guides of Split-Dalmatia County;
- Villa Ika;
- Villa Lovor;
- Villa Pinjol and
- Scissor tours d.o.o.

Respondents are from all over Dalmatia, Biograd na moru, Pakostane, Benkovac, Pirovac, Zadar, Dubrovnik and Durdjevac (Koprivnica-Cross County). The respondents are from Zadar, Sibenik-Knin, Split-Dalmatia, Dubrovnik-Neretva and Koprivnica-Cross County.

All tourism workers stressed that they are aware of the impact of climate change on their territory. In the following question, a linear scale of 1-3 (1 – poorly informed, 2 – fairly well informed and 3 – very well informed) was used, with a mean score of 2.25 indicating that subjects were fairly well informed about the impact of climate change on their area. This response also indicates that the quality of the answers to

subsequent questions should be very good and that the results should be used to formulate recommendations for future environmental action to prevent adverse effects of climate change.

Perception of the link between climate change and socio-economic activities

As many as 90% of tourism workers think climate change could affect their activity. 5% of respondents disagree with this claim, while 5% of respondents are uncertain. A linear scale of 1-3 was used in the next question (1 — slightly relevant, 2 — medium relevant and 3 — very relevant). The mean score of 2.55 indicates that respondents consider the impact of climate change on their activity to be very relevant. That is, it is reiterated that tourism workers recognise the negative impact of climate change on their economic activity. This can also motivate them to proactively act in the field of mitigation/prevention of adverse effects of climate change.

Below, tourism professionals are asked to assess whether the effects of climate change have or may have negative consequences on their business. For each effect, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Effects	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Temperature rise	1	1	5	3	10	0	4,00
Drought	1	3	4	5	7	0	3,70
Lack of drinking water	0	1	1	2	16	0	4,65
Extreme climatic events (i.e. floods, extreme winds, …)	0	0	1	5	14	0	4,65
Increased coastal erosion	2	0	3	6	9	0	4,00
Sea level increase	2	1	3	6	8	0	3,85
Degradation of natural habitats	3	0	3	6	8	0	3,80
Rapid growth of populations of organisms such as algae (blooming), jellyfish, blue crabs	0	2	3	5	9	1	4,11

Table 12. Views of tourism professionals on the possibility of adverse impacts of climate change on their business Source: Survey questionnaire results

Based on the average grades highlighted in the table above, it is noted that the identified effects are considered relevant or very relevant, i.e. there are no grades of lower degree of relevance, which confirms again the claim that tourism professionals observe the impact of negative effects of climate change. The highest mean scores were recorded in the absence of drinking water and extreme climate change. The lowest average score was observed in drought. This is a bit surprising because the lack of drinking water is directly causal related to drought. This points to the need to educate this group of stakeholders about all adverse effects of climate change, especially drought, etc.

All tourism professionals believe that climate change can have a negative impact on other economic activities in their community (e.g. agriculture and fisheries). 65% of respondents think that their work can contribute to climate change adaptation or mitigation, and 35% of respondents are uncertain.

In the following question, respondents were asked to highlight which activities/practices they carry out/engage in with a view to combating or adapting to the effects of climate change? Subjects were able to select multiple responses and were reported as follows:

- Active coastal defence interventions - 2 respondents;
- Diversification of tourist offer – 7 respondents;
- Nature-based solutions – 7 respondents;
- Cooperation with local authorities – 11 respondents;
- Participation in awareness-raising activities – 14 respondents;
- Participation in specific training activities – 2 respondents;
- Infrastructure and services for the reception of tourists based on natural solutions – 3 respondents
- Desesonalization of tourist offer - 11 respondents; and
- The rest.

The largest number of respondents expressed their participation in awareness raising activities, while the smallest number of respondents participate in active defence intervention measures and in specific training activities. Also, a very low number of responses were recorded with the item infrastructure and services for the reception of tourists based on natural solutions, which indicates that although tourism workers recognize the negative effects of climate change, they undertake little or no activities aimed at mitigating or eliminating the negative effects of climate change.

This is supported by the fact that a small number of respondents pointed out which strategies/activities they have adopted or would like to adopt in the future. Some of the responses given by tourism workers were:

- Desesonalisation and diversification of the tourist offer;
- Raising awareness and educating the public, training citizens in protection activities against the consequences of natural disasters (fires, floods). Investment in renewable energy sources. Recycling of plastics, paper, glass;
- Sustainable Development Strategy
- Participation in specific training activities. Infrastructure and services for the reception of tourists based on natural solutions;
- An offer of nutrition more suited to sustainable development;
- Offer year-round programmes (cultural, eno-gastro, active tourism) to reduce dependence on the summer season and adapt to changing weather conditions;
- Some of the strategies we are trying to adopt and implement in the future are education of the local population and tourists - organization of campaigns and workshops on sustainable tourism, conservation of nature and reduction of the ecological footprint. Informing tourists about the rules of

conduct in protected areas and the importance of environmental responsibility. Education of local entrepreneurs (hotels, restaurants and others) on sustainable practices and adaptation to climate change. Sustainable tourism and environmental initiatives - the development of eco-tourism with an emphasis on natural beauty and cultural heritage. Reducing plastic waste by encouraging the use of biodegradable and reusable materials. The introduction of green certifications for accommodation and the promotion of energy-efficient solutions. Improving infrastructure (cycling lanes, low-emission public transport) to reduce the negative environmental impact of tourism.

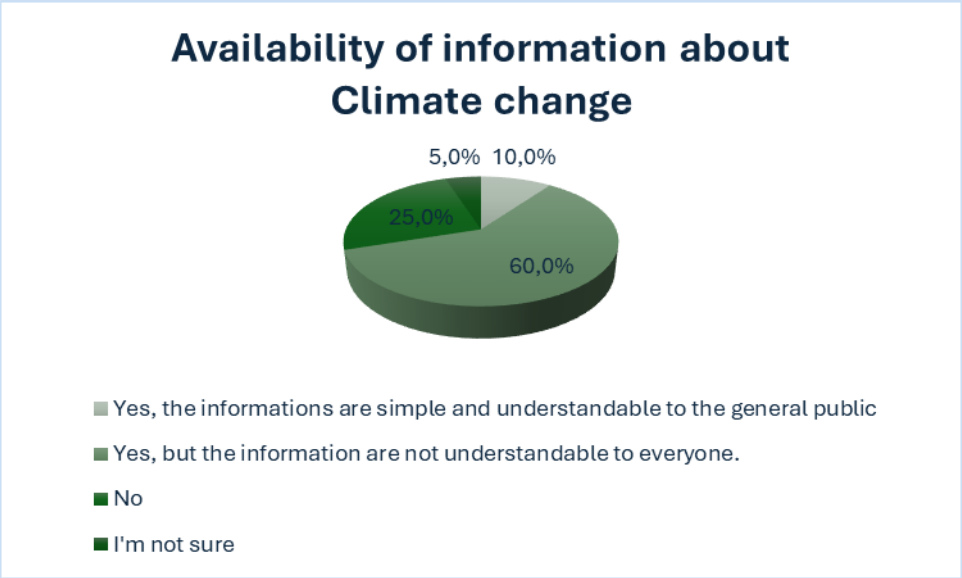
- Strategy for sustainable development of tourism in Zadar County - in the future;
- We are developing sustainable tourism;
- Introducing a higher euro standard in our vehicles; and
- Protecting ecosystems, raising awareness, restoring renewable energy.

Below, tourism professionals are asked to highlight what they consider to be an obstacle to the implementation of climate adaptation/mitigation practices. For each obstacle, subjects assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Obstacles	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Lack of financial resources	1	0	2	9	8	0	4,15
Inefficiency	3	3	6	4	4	0	3,15
Lack of appropriate initiatives	0	0	4	5	11	0	4,35
Lack of specific expertise	0	0	2	8	10	0	4,40
Lack of adequate programming/planning	0	0	1	10	9	0	4,40
Lack of appropriate policies/legislation	0	1	2	4	12	1	4,42
Lack of consciousness	0	0	2	4	13	1	4,58
Lack of authority	0	0	4	7	9	0	4,25
Fragmentation of responsibilities of competent authorities	1	0	7	3	9	0	3,95
Difficulty in dialogue with the authorities	1	0	10	4	5	0	3,60

Table 13. Views of tourism professionals on obstacles to implementation of climate adaptation/mitigation practices Source: Survey questionnaire results

Based on the above table, it is noted that the average scores are high, which refers in particular to the average score of 4.58 in case of lack of consciousness. It should also be noted that respondents consider that significant obstacles are the lack of adequate policies/legislation, the lack of specific expertise and the lack of adequate programming/planning. The lowest average score was recorded in the obstacle to non-cost-effectiveness, indicating that a large proportion of respondents are uncertain about the claim that non-cost-effectiveness is one of the obstacles to the implementation of climate change adaptation or mitigation practices.



Graph 06. Views of tourism professionals on the availability of information on the impacts of climate change Source: Survey questionnaire results

A small part, i.e. only 10% of respondents, think that information on the impacts of climate change is available and understandable. The problem is that as many as 60% of respondents think that information is available but not understandable to everyone, so it is necessary to examine in detail why the available information is not understandable to the general public. Ultimately, the information needs to be adjusted in a way that is understandable to most citizens, if not to everyone. 25% of respondents consider that information is not available and 5% of respondents are uncertain.

Because this group is about respondents working with more citizens and tourists, and in direct contact with different stakeholder groups, it is necessary to take into account the views of the group, in particular the opinion on the need to improve the comprehensibility of information on the impact of climate change to the general public. It also reiterates the need to identify channels that will be more efficient for the dissemination of information to all stakeholders, since climate change has an impact on everyone, regardless of whether they are citizens, entrepreneurs etc.

Views of tourism professionals on the adequacy of information on the impacts of climate change:

- Scientific articles/journals – 2 subjects;
- State organisations – 4 respondents;
- Konferencije/seminari/radionice – 15 respondents;
- Mandatory training – 8 respondents;
- Social networks and blogs – 17 respondents;
- TV/radio – 12 respondents;
- Information boards/local portals – 9 respondents;

- Oral communication - 11 subjects; and
- Other – 0 subjects.

Tourism professionals primarily consider social networks and blogs to be the most efficient tool for informing tourists and other social groups about the effects of climate change. This is the result of the fact that almost all people today use social networks (e.g. Facebook, Instagram, X, etc.). Depending on the target group to be accessed, information methods and appropriate social networks will be selected. Thus, as one of the most efficient methods of informing stakeholders today, influencer engagement can be emphasized, since some people on Instagram are accompanied by several million people.

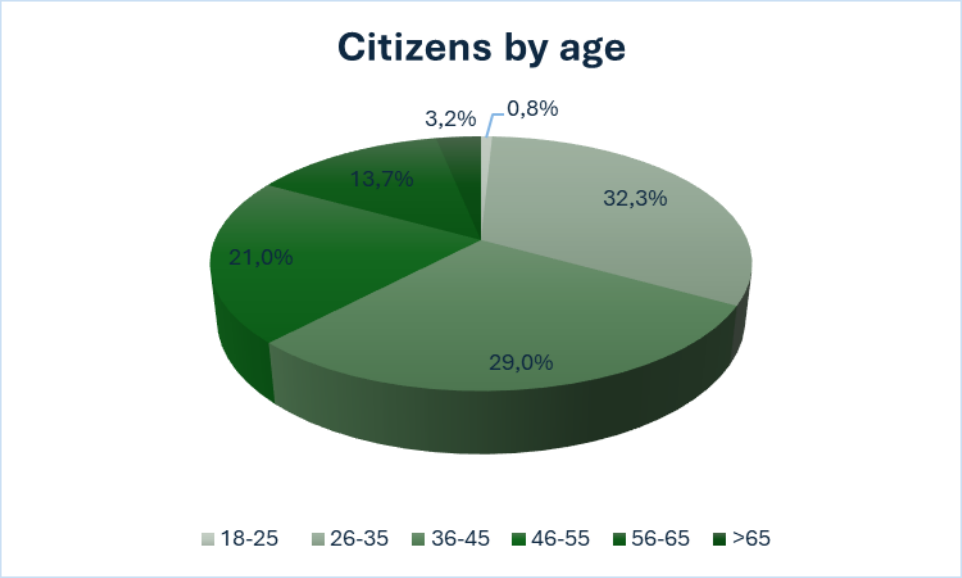
A number of respondents, tourism workers think that konferencije/seminari/radionice are one of the most appropriate instruments to inform about the impacts of climate change. At the same time, these events are crucial for knowledge transfer between multiple stakeholder groups, which makes it desirable to organise more frequent konferencije/seminare/radionice for target stakeholder groups with a view to more efficient transmission of information on adverse effects of climate change. Unlike some other stakeholder groups, the least tourism professionals consider scientific articles/journals to be one of the more appropriate tools to inform stakeholders about the impacts of climate change.

SECTION 7 - citizens

124 citizens from the following local self-government units (cities and municipalities) replied to the questionnaire:

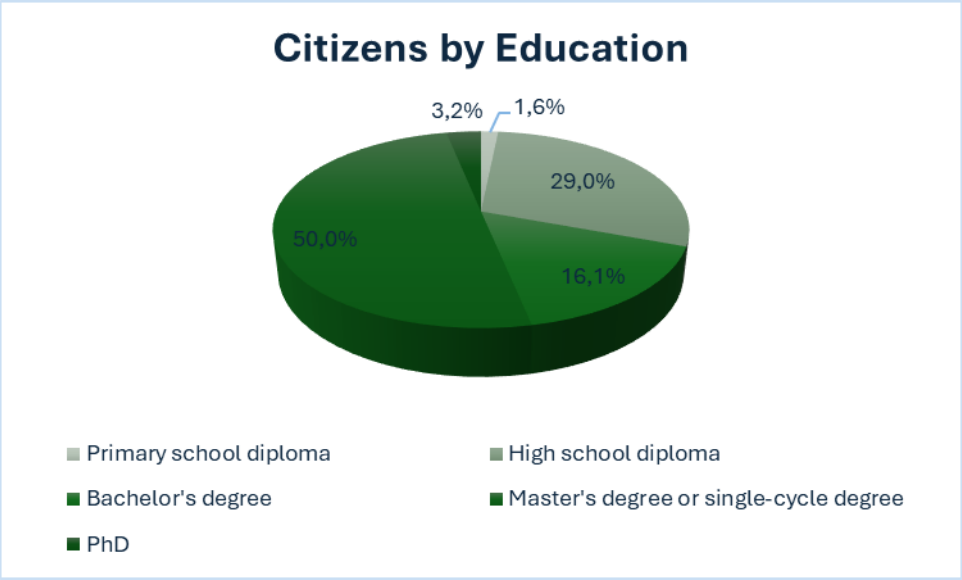
- Plates;
- Zagreb;
- Metkovic;
- Pakostane;
- Biograd at sea;
- Split;
- Gradac;
- Opuzen;
- Tower of Norina;
- Korčula;
- Zadar Te
- St. Philip and Jacob.

The majority of citizens are from the area of the Neretva Valley, primarily from the area of Ploče, which is one of the limitations of research, since it can affect the results (assuming that citizens from the vicinity of Lake Vrana have different views on climate-related risks).



Graph 07. Citizens by age Source: Survey questionnaire results

The previous chart shows that less than 25 years of age make up at least a large group of subjects, while over 26 years of age and under 35 years of age make up the most numerous group of subjects. This shows that the dispersion of subjects by age is good, since no age group has a primate (i.e. no more than half of subjects). It can be concluded that respondents over the age of 26 and under the age of 45 make up almost 2/3 of all respondents.



Graph 08. Citizens by level of education Source: Survey questionnaire results

The previous chart shows that at least a large number of respondents are citizens with completed primary school (the assumption is that these are high school students who did not graduate from high school but

turned 18). Half of the respondents have a master's degree or a master's degree. Against this background, it is assumed that the majority of respondents should be environmentally aware and familiar with the negative effects of climate change, as well as with the risks arising from the effects of climate change, which have an impact not only on citizens, but also on flora and fauna of the area.

Almost all citizens, or 97.6% of them, are aware of the impact of climate change on their territory. 2.4% of respondents said they were unaware of the impact of climate change on their territory. Given the number of respondents who profess to be aware of the negative impacts of climate change on their territory, it is to be assumed that they are already experiencing the negative effects of climate change today. That is, it is assumed that urgent action and work with citizens is necessary to mitigate or prevent the adverse effects of climate change.

In the following question, respondents were asked to point out to what extent they were informed about the impacts of climate change in their area. Linear scale 1-3 used (1 – poorly informed, 2 – fairly well informed and 3 – very well informed). The average score of 2.26 suggests that most respondents are fairly well informed. However, taking into account the fact that previously respondents pointed out that they are already seeing the negative effects of climate change, it is questionable whether they are sufficiently informed about the negative effects of climate change, on the basis of which it is estimated that additional measures should be taken to inform citizens about the negative effects of climate change and the measures each can take to mitigate or prevent the negative effects of climate change.

Perception of climate change issues related to nature protection

The majority of citizens, or 84.7% of them, think that habitats and species in their territory are already or will soon be affected by climate change. 4.8% of respondents disagree with this claim and 10.5% of respondents are uncertain. Given that most citizens see that habitats and species in their area are already affected or threatened by the effects of climate change, it is necessary to urgently formulate strategies and public policies, as well as active action by all participants that will encourage the conservation of habitats and species, so that certain plant/animal species do not soon become extinct and that habitats are completely degraded.

Below, citizens are asked to assess the impact of certain types of threats that threaten their territory. For each threat, respondents assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Threat types	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
INCREASED Salt gear	9	17	29	21	38	10	3,54
Surface water Pollution	2	12	32	35	41	2	3,83
Groundwater Pollution	6	12	27	38	36	5	3,72
Eutrophication	7	18	38	29	20	12	3,33

Coastal erosion	14	16	43	29	14	8	3,11
Salinity changes in coastal lands	4	18	30	31	34	7	3,62
Over-exploitation of Freshwater	8	16	38	29	24	9	3,39
Sea level rise	6	18	37	31	26	6	3,45
Droughts	4	18	37	29	30	6	3,53
Extreme climatic events (e.g. floods, extreme winds …)	5	20	33	36	27	3	3,50
Rise temperatures	1	10	29	38	41	5	3,91

Table 14. Citizens' views on threats to their territory Source: Survey questionnaire results

If you look at mid-grades related to threats that citizens think are endangering their area, mid-grades are relatively high. That is, each medium score shows a medium or higher level of relevance, which indicates that citizens perceive the risks posed by individual threats arising from climate change. The highest mean score of 3.91 was recorded in the threat of temperature increase, which is expected, since summers in the territory of the Republic of Croatia are increasing and average temperatures are increasing, leading consequently to droughts and other negative consequences. The lowest mean score of 3.11 was recorded in the threat of coastal erosion. It is possible to point out that citizens generally do not perceive the risk posed by coastal erosion because the characteristics of the coast of the Republic of Croatia are such that there is rarely a possibility of pronounced coastal erosion in a short period of time, and citizens usually do not notice changes that are progressively occurring.

Impacts of climate change observed by citizens in their territory:

- Loss of marine ecosystems – 64 respondents;
- Loss of terrestrial ecosystems – 36 respondents;
- Loss of the brackish/freshwater ecosystem – 49 respondents;
- Reduction of ecosystem services – 25 respondents;
- Loss of animal species – 73 subjects;
- Loss of plant species – 57 subjects;
- Increase in the presence of invasive species – 72 subjects; and
- Other: increase in the abundance of alien and locally absent species (1 subject).

It is noticeable that the largest number of citizens noticed the disappearance of animal species, while also disappearing land species, as well as species that inhabit water surfaces. Also, a large number of respondents pointed out the increase in the presence of invasive species as one of the primary problems they perceive in their area (one of the respondents points out that they are actually alien and locally absent species, which are most often misclassified as invasive species). The lowest number of respondents identified the reduction of ecosystem services as a climate change effect they observed in their territory.

Perception of the problem of climate change related to public health

The majority of citizens, 93.5% of them, say they believe that climate change affects or may affect public health. 4% of respondents disagree and 2.4% of respondents are uncertain. Given that almost all respondents consider that climate change has or may have an impact on public health, it is to be assumed that in everyday life they have felt the impact of climate change on health (personally, acquaintances or others). For this reason, it is necessary to carry out educational activities aimed at protecting the health of citizens, especially endangered social groups such as elderly, children and chronic patients. This claim is supported by the fact that due to the effects of heat waves as a result of climate change, the activity of emergency services has increased during the summer months, but also by the emergence of emergency conditions such as heart attack or stroke. In the long run, this can lead to increased mortality, but also the emergence of other chronic illnesses of citizens.

As many as 79% of citizens said they have seen health problems in their community that they think are related to climate change. 8.9% of respondents disagree and 12.1% of respondents are uncertain. It should be pointed out that the fact that more than 2/3 citizens are already seeing health problems due to negative climate change is worrying, which again points to the fact that it is high time to take measures aimed at preventing or mitigating the negative effects of climate change.

Below, respondents were asked to assess which of the subsequent impacts of climate change. For each threat, respondents assessed its relevance (1 = not relevant, 2 = small relevant, 3 = medium relevance, 4 = relevant, 5 = very relevant, I do not know).

Types of impacts of climate change	**1**	**2**	**3**	**4**	**5**	**I don't know.**	**Average rating**
Increased frequency of heat-related diseases	5	16	37	39	23	4	3,49
Increased frequency of respiratory diseases	4	7	31	41	37	4	3,83
Increased frequency of water quality related diseases	6	18	42	34	20	4	3,37
Increased frequency of pest-related diseases	7	27	37	27	21	5	3,24
Increasing personal security risks (accommodation, infrastructure, transport …)	15	31	34	24	18	2	2,99
Increase in food prices	3	8	23	28	49	13	4,01

Table 15. Citizens' views on the health and safety impacts of climate change Source: Survey questionnaire results

The average score 4.01 suggests that citizens consider climate change to have a relevant impact on food price growth. This can be directly linked to the negative effects of climate change on agriculture and the processing industry, because the negative effects of climate change cause phenomena (drought, insect infestations, new fungal diseases, etc.) that increase the production costs of primary products and consequently the processing costs.

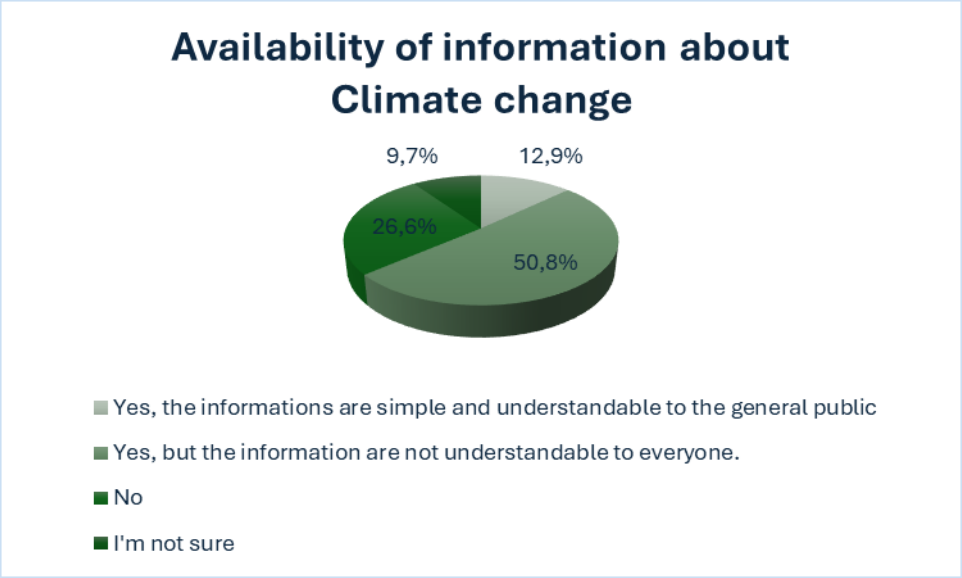
The lowest average score was observed when risks related to personal infrastructure increased. This can be partly linked to the fact that the majority of citizens of the coastal part of the Republic of Croatia are not threatened by housing due to extreme climatic phenomena, the state area is becoming increasingly infrastructurally connected, etc.

In the following question, citizens are asked to highlight the level of concern about climate-related health risks? For each risk, citizens assessed the level of concern using a scale of 1-5 (1 = not worried, 2 = a little worried, 3 = moderately worried, 4 = worried, 5 = very worried)

Health risks	**1**	**2**	**3**	**4**	**5**	**Average rating**
Extreme heat and heat waves	6	7	32	45	34	3,76
Vector-borne diseases (e.g. malaria, dengue fever)	12	21	45	26	20	3,17
Water pollution	3	7	29	48	37	3,88
Uncertainty of food supply	8	17	45	32	22	3,35
Water scarcity	6	17	40	32	29	3,49
Risk of landslides and floods from extreme weather events	9	14	40	39	22	3,41

Table 16. Citizens' level of concern about climate-related health risks Source: Survey questionnaire results

Based on the results highlighted in the table above, it can be concluded that citizens are most concerned about water pollution, especially drinking water. It is already pointed out that many countries in the world have problems with the supply of drinking water, especially underdeveloped countries. Considering that Croatia is one of the countries with significant supply of drinking water, it is partly surprising that citizens are already identifying the risk posed by the possibility of water pollution, especially drinking water. The smallest number of citizens are concerned about vector-borne diseases like mosquitoes. All mid-grades indicate that most citizens are concerned or moderately concerned about the health risks posed by climate change.



Graph 09. Citizens' views on the availability of information on the impacts of climate change
Source: Survey questionnaire results

More than half of respondents, i.e. 50.8% of respondents, think that climate change information is available but not understandable to the public, which again points to the fact that climate change information needs to be adapted to the characteristics of the target groups. More than a quarter of respondents, 26.6% of respondents, feel that information on climate change is not available to citizens. For this reason, it reiterates the need to create announcements that will inform citizens about key determinants of the impact of climate change.

Citizens' views on the appropriateness of information on the impacts of climate change:

- Scientific articles/journals – 39 respondents;
- State organisations – 33 respondents;
- Konferencije/seminari/radionice – 50 subjects;
- Mandatory training – 44 respondents;
- Social networks and blogs – 90 respondents;
- TV/radio – 81 respondents;
- Information boards/local portals – 57 respondents;
- Oral communication - 40 respondents; and
- Other – Social Communities and organisations (1 respondent).

Most respondents think social media and blogs are the most efficient way to inform citizens about the impacts of climate change. On the other hand, the smallest number of citizens feel that state organisations are suitable to inform about the effects of climate change. It is to be assumed that this is a direct consequence of the growing level of citizens' distrust of state organisations in terms of climate change and the negative effects of climate change.

Conclusions

Risks and threats

The condition of the Vransko lake was very variable - the exchange of favourable and unfavourable hydrological conditions with the tendency of more frequent negative phenomena and processes which resulted in the 2020 degradation to a permanent turbid state of the lake. Salinity increases with declining inflows, declining lake water levels and rising sea levels (highest mean sea levels most often during the summer dry season), increased evaporation and water use for water supply and irrigation. All this also affects the rise in water temperature. Climate change models show that temperatures will rise further, precipitation will stagnate or fall slightly with more pronounced extremes, and inflows of freshwater will decline. Continued climate change will encourage the intensification of negative trends with the increased need for water for water supply and irrigation. The lake accumulates the chloride content, so there are problems if dry periods last, and freshwater and sea water exchange in terms of desalination reduces. In addition to climate change, the cause of negative phenomena is anthropogenic changes in water use (digging of the Prosika canal, water use for agriculture in the basin).
Water and sediment are connected. Inflows of fresh water to the lake are from springs at the contact of carbonates and flysch on land, from freshwater and brackish springs on the lake bottom and from the sea through the karst. The influence of sea water also changes sedimentation through the influence on production in the food chain. If nothing is done in the long run, it is possible the NW part of the lake will become more and more shallow and dry out, but the process is slowed down by rising sea levels accompanied with the entire associated hydrological system rising, but with an increased risk of salinization in the lake.
Ecologically, there are two alternative conditions in shallow lakes such as Vransko Lake. A shallow clear state dominated by macrophytes that stabilize sediment, draw nutrients from water, and as a habitat allow optimal development of zooplankton and macrozoobenthos and indicate greater biodiversity. Macrophytes inhibit the development of phytoplankton by competition for nutrients. The ideal condition of macrophytes in a lake is when the presence of *Characeae* meadows and *Potamogeton pectinatus* species on more than 50% of the lake surface. The number and biomass of zooplankton macrofilters are also important for a stable lake ecosystem, because they feed on phytoplankton and thus reduce their biomass. The relationship between macrophytes, zooplankton and fish, which are a significant predator of zooplankton, is very important. Therefore, it is necessary to look at all groups together: phytoplankton, zooplankton, macrophytes and fish and model the entire food network.
Of all natural lakes in Croatia, only the ecological condition of Vransko lake in Croatia was assessed as moderate due to the moderate condition of macrozoobenthos and fish, which can be attributed to the presence of foreign and invasive species that are also related to environmental factors. Measures need to be taken to improve the condition towards a good or very good status.
The ecological status of both main fresh water inflows, The Kotarka Canal and the Lateral Canal were graded as very poorly / moderate status of ecological quality due to elevated nitrogen and nitrate concentrations, which is a visible and expected impact of agriculture in the basin, and it is to be expected

that this impact will be seen in the lake over time. The lake was resistant to nitrate and phosphate intake precisely because of previously abundantly developed macrophytes and reeds.
In the state of turbid water, macrophytes disappear, sediment is destabilized (which further reduces the transparency of the lake), the disappearance of habitats leads to a decrease in zooplankton and macrozoobenthos biomass, and phytoplankton dominance and significant biodiversity decline (significant decline of wintering waterbirds). Also, the increase in temperature and salinity has a negative effect on zooplankton, while in macrozoobenthos there are spatial and temporal changes in the composition of communities, and biodiversity decreases with increasing salinity. The key mechanism for the disappearance of macrophytes in 2020 was not yet determined but there are indications that the entire length of the melioration network of canals in Vransko polje cleaning in 2019/2020, may be one of the main causes. By removing the riparian vegetation that performed the water purification ecological service, nutrient rich water entered the lake and caused the shift to turbid water state.

The permanent state of turbid water is not easily reversible without undertaking significant management activities such as reducing nutrient inflows or selective removal of benthivorous fish.
The advantage of a closed shallow system is that, although they are brought to the limit values, no macrophytes bottom species are lost. Characeae have permanent stages and are pioneers of vegetation because as soon as favourable conditions are created, they can grow again. Also, due to the closed nature of the system, it is possible to influence nutrient intakes and adapt to climate change. Precisely because there are no large inflows of fresh water in the period of lowest water levels it is subject to a higher degree of control.

Proposed activities and measures

In seeking an optimal solution, it is extremely important to approach the problem in an integrated manner, while simultaneously trying to address and optimize all the set goals. For example, in order for the movable gate at Prosika channel to be able to maintain a higher water level in the lake for a longer period of time, without increasing the risk of flooding, it is necessary to ensure and improve the ability to quickly evacuate large waters from the lake, by maintaining and possibly increasing the flow rate of the Prosika channel, as well as increasing the capacity to retain water in the basin and slow its flow into the lake, by building a system of retentions, accumulations, and returning part of the current agricultural areas, primarily parts of the Jasena and Jezerine areas, back to the natural water regime. The restoration of wet meadows and wetlands in part of the area would have a significant positive impact on the state of conservation and distribution of rare and endangered target habitat types and related species, and would also have a significant function in regulating the water regime, as well as in purifying water that flows from agricultural areas in the basin into the lake. The planned establishment of regenerative agricultural production in the area would be a demonstrative example of the desired and necessary transformation of current agricultural production in the basin in the direction of better compliance with conservation goals.
A positive step in this direction was made by developing a conceptual design for the restoration of wetlands and the establishment of regenerative agriculture in the Jasen and Jezerine areas (Održivo,

2021). Three scenarios were considered, which partly differ in the assumed water regime and management in the area, and in relation to this in the proposed systems and practices of regenerative agriculture, but all have in common greater retention of flood waters in the Jasen and Jezerine areas. All three scenarios envisage the revitalization of existing wet grasslands. In a scenario with a minimum grassland area, the revitalized area could support approximately 80 livestock units (e.g. 80 large cattle or horses or 800 sheep). In the upcoming period, the conceptual design needs to be refined in accordance with the conclusions of additional analyses of the hydrotechnical aspects of the proposed solutions, since they are not covered in sufficient detail in the initial project for the development of the conceptual design. The restoration plan for the area will be developed, containing the detailed drawings which will also allow to initiate permit procedures. In addition, property-legal relations in the area of the planned intervention should be resolved.

References

- Alegro, A., Koletić, N., Vuković, N., Rimac, A., Šegota, V. (2021): Istraživanje sastava vrsta algi porodice Characeae. Završni izvještaj 2018. – 2021. Hrvatsko botaničko društvo, Zagreb.
- Agencija za praćenje u poljoprivredi, ribarstvu i ruralnom razvoju (2022): Sumarni podaci iz Upisnika poljoprivrednika. https://agronet.apprrr.hr/v1/Forms/PublicForms/Public Data.aspx (16.03.2022.)
- Andlar, G., Ljeljak, M., Šteko, V. (2020): Krajobrazna osnova sa studijom vrednovanja i osjetljivosti krajobraza Parka Prirode Vransko jezero. Zavod za ukrasno bilje, krajobraznu arhitekturu i vrtnu umjetnost Studija krajobrazna arhitektura Agronomskog fakulteta Sveučilišta u Zagrebu, 3E projekti d.o.o., Zelena infrastruktura d.o.o. Zagreb.
- Bišćević, C., Bota, H., Gracin, M., Ivasović H., Rako, I., Trifunović, V., Zlojtro, I. (2021): Idejno rješenje regenerativne poljoprivrede za prilagodbu na utjecaje klimatskih promjena na području Jasen u NATURA 2000 području Vransko jezero i Jasen. Održivo d.o.o., Split.
- Blaće, A. (2014): Prilog poznavanju regionalne strukture Primorske Hrvatske – regionalizacija ravnokotarskog prostora, Geoadria, 19 (1), 129-145.
- Blaće, A. (2015): Razvoj i suvremena preobrazba krajolika Ravnih kotara. Dizertacija. Sveučilište u Zagrebu, Prirodoslovno-matematički fakultet, Zagreb.
- Bogunović, M., Vidaček, Ž., Racz, Z., Husnjak, S., Sraka, M., (1997): Namjenska pedološka karta Republike Hrvatske mjerila 1:300.000, Agronomski fakultet, Zagreb.
- Clarke, I. Stokes, Z. and Wallace, R., 2010, Habitat Restoration Planning Guide for Natural Resource Managers, Government of South Australia, through Department of Environment and Natural Resources, Adelaide
- Čolak, A. (1983): Pedološka karta SFRJ 1:50.000, List Žirje 2, Projektni savjet za izradu pedološke karte RH, Zagreb.
- DGU (2021): Topografska karta Hrvatske u mjerilu 1:25000. Geoportal Državne geodetske uprave. Available at: http://geoportal.dgu.hr/

- Državni zavod za statistiku (2021): Popis stanovništva, kućanstava i stanova 2021. – Prvi rezultati. www.dzs.hr
- HAOP - Hrvatska agencija za zaštitu okoliša i prirode (2018): ENVI atlas okoliša. http://envi.azo.hr/ (2.11.2022)
- Heček, N. (2017): Idejni projekt sustava javnog navodnjavanja Vransko polje – podsustav Malo Blato, Elektroprojekt d.d., Zagreb.
- Hrvatske vode (2023): Plan upravljanja vodnim područjima do 2027. Available at: https://voda.hr/
- IGH (Institut Građevinarstva Hrvatske) (2013): Studija navodnjavanja Vranskog polja.
- IGH (Institut Građevinarstva Hrvatske) (2020): Problematika vezana uz izgradnju zapornice na kanalu Prosika na Vranskom jezeru. 2. prezentacija.
- Ilijanić, N., Miko, S., Hasan, O., Marković, T (2018): Geološka, strukturno-tektonska i hidrogeološka obilježja područja Pakoštana i Vranskog jezera. Institut za pomorsku baštinu ARS NAUTICA, Sveučilište u Zadru, Zadar, 161-177
- Kovačić, M., Zannela, D. (2014): Nacionalni program praćenja vrsta u Hrvatskoj: glavočić vodenjak (Knipowitschia panizzae), DDZP, Zagreb.
- Kremenić, D. i Ozimec, R. (2014): Katalog proizvođača tradicionalnih proizvoda Ravnih kotara i Bukovice, Sveučilište u Zagrebu, Trg maršala Tita 14, 10 000 Zagreb
- Lajtner, J. i Crnčan, P. (2015): Malakološka istraživanja lokve Benče u Parku prirode Vransko jezero, Natura – društvo za zaštitu prirode Hrvatske, Zagreb.
- Majcen, Ž. & Korolija, B. (1973): Osnovna geološka karta SFRJ 1:100 000, Tumač za list Zadar L33-139, Institut za geološka istraživanja, Zagreb (1967); Savezni geološki zavod, Beograd, str. 44.
- Majcen, Ž., Korolija, B., Sokač, B., Nikler, L. (1970): Osnovna geološka karta SFRJ 1:100 000, List Zadar L33-139, Institut za geološka istraživanja, Zagreb (1963-1969); Savezni geološki zavod, Beograd.
- Mamužić, P. & Nedela-Devide, D. (1968): Osnovna geološka karta SFRJ 1:100 000, List Biograd K33-7, Institut za geološka istraživanja, Zagreb (1963); Savezni geološki zavod, Beograd.
- Mamužić, P. & Nedela-Devide, D. (1973): Osnovna geološka karta SFRJ 1:100 000, Tumač za list Biograd K33-7, Institut za geološka istraživanja, Zagreb (1963); Savezni geološki zavod, Beograd, str. 27.
- Mamužić, P. (1971): Osnovna geološka karta SFRJ 1:100.000, List Šibenik K33-8. Institut za geološka istraživanja, Zagreb (1962–1965); Savezni geološki institut, Beograd.
- Mamužić, P. (1975): Osnovna geološka karta SFRJ 1:100.000, Tumač za list Šibenik K33-8. – Institut za geološka istraživanja, Zagreb (1966); Savezni geološki institut, Beograd, 37 str.
- Mrakovčić, M., Mustafić, P., Zanella, D., Marčić, Z., (2017): Ribolovno-gospodarska osnova na ribolovnoj zoni PP Vransko jezero, Zoologijski zavod, PMF, Zagreb.
- Ministarstvo zaštite okoliša i energetike (MZOE) (2018): Rješenje za procjenu utjecaja na okoliš za namjeravani zahvat – sustav navodnjavanja Vransko polje – I. Faza. https://mingor.gov.hr/djelokrug/uprava-za-procjenu-utjecaja-na-okolis-i-odrzivo-gospodarenje-

otpadom-1271/procjena-utjecaja-na-okolis-puo-spuo/procjena-utjecaja-zahvata-na-okolis-puo-4014/puo-postupci-2016-4024/4024 (20.11.2021.).

- Poljoprivredni fakultet Osijek (2015): Pedološko hidrološka osnova za idejni projekt sustava navodnjavanja Vranskog polja.
- Razović, M. (2022): Strategija razvoja turizma Ravnih kotara 2022.- 2032., Turistička zajednica Ravnih kotara, Benkovac.
- Rubinić, J., Radišić, M., Kalajžić, D. (2022): Praćenje stanja u Vranskom jezeru kao i upravljačkih akcija vezanih uz procese zaslanjivanja i smanjivanja rizika od njegove pojave, Građevinski fakultet, Rijeka.
- Stanković, I. (2010): Monitoring algi iz porodice Characeae. Konačni izvještaj Characeae PP Vransko jezero. Udruga BIOM, Zagreb.
- Stanković, I. (2011): Monitoring algi iz porodice Characeae u Parku prirode Vransko jezero u 2011. godini. Konačni izvještaj Monitoring Characeae 2011. Udruga BIOM, Zagreb.
- Stanković, I. (2013): Monitoring algi iz porodice Characeae u Parku prirode Vransko jezero u 2012. godini, Hrvatsko botaničko društvo, Zagreb.
- Stanković, I. (2014): Monitoring algi iz porodice Characeae u Parku prirode Vransko jezero u 2013. godini, Hrvatsko botaničko društvo, Zagreb.
- Stipanić, D., Zaharija, L., Družeta, S (2021): Idejno rješenje. Analiza varijantnih rješenja za poboljšanja stanja vode u Vranskom jezeru i kanalu Prosika, Hidromodeling d.o.o. i Tehnički fakultet Sveučilišta u Rijeci, Rijeka.
- Stroj, A. (2012): Hidrogeološka istraživanja Vranskog jezera, Hrvatski geološki institut, Zagreb.
- Tutiš, V., Kralj, J., Radović, D., Ćiković, D., Barišić,, S. (ur.) (2013): Crvena knjiga ptica Hrvatske. Ministarstvo zaštite okoliša i prirode, Državni zavod za zaštitu prirode, Zagreb.
- Uzelac Obradović, T. (2017): Studija o utjecaju na okoliš sustava za navodnjavanje Vransko polje - 1. faza – Netehnički sažetak (za naručitelja Hrvatske vode), Dvokutecro d.o.o., Zagreb.
- Vuković, N., Alegro, A., Koletić, N., Rimac, A., Šegota, V. (2020): Analiza makrofita Vranskog jezera od 2010. do 2019. godine u okviru projekta CHANGE WE CARE, Hrvatsko botaničko društvo, Zagreb.
- Žutinić, P., Gligora Udovič M., Plenković-Moraj, A., Kulaš, A., Kanjer, L. (2020): Istraživanje promjena fitoplanktona Vranskog jezera od 2014. do 2019. godine - u okviru projekta CHANGE WE CARE, Prirodoslovno-matematički fakultet Sveučilišta u Zagrebu.

Annexes

Annex I – Questionnaire template (in EN)

Interreg Co-funded by the European Union
Italy – Croatia
ACTION

Annex I

ACTION QUESTIONNAIRE EN (template)

Legend:

- One answer
- Multiple answers

SECTION 1 - Join us in the ACTION project!

The ACTION project, which is being implemented with financial support from the European Union's INTERREG programme, aims to define and implement joint actions to tackle the ongoing process of climate change and to increase the knowledge of local communities and managers about risks and threats to cultural and natural heritage. The project will also develop a joint strategy and action plan to increase the resilience of territories in the programme area using nature-based solutions.

We ask for a few minutes of your attention to fill in the following questionnaire. The data collected will allow us to gather qualitative information about the perception of climate change in your territory.

Your opinion is important to us! Average filling-in time: 5 minutes.

Please note that the data provided to the site operator when filling out the questionnaire will be processed in accordance with the provisions of Legislative Decree 196/2003 and GDPR 2016/679.

1. Email: …….
2. Answer as:
    - Manager of the Natura 2000 network/protected areas → **SECTION 2**
    - Public institutions (municipality, county, province, ecc..) → **SECTION 3**
    - Economic operator in the field of agriculture → **SECTION 4**
    - Economic operator in the field of fishing → **SECTION 5**
    - Economic operator in the field of tourism → **SECTION 6**
    - Citizen → **SECTION 7**

SECTION 2 - Managers of natural areas and the Natura 2000 network

Name of your Institution/Park: …….

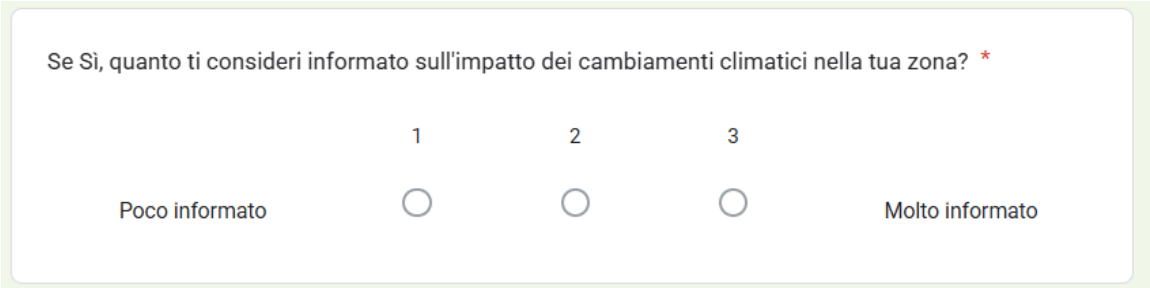
Indicate in full the names of the municipalities/counties included in the protected areas managed by the body/park:

……

1. As a natural area manager, are you aware of the impact of climate change on your area?
   - Yes
   - No

2. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
   - 1 – Poorly informed
   - 2 – Fairly informed
   - 3 – Very informed

Linear scale question, example below:



Perception of climate change issues linked to nature protection

3. Do you think that habitats and species in your area are or will be affected by climate change?
   - Yes
   - No
   - I'm not sure

4. If yes, which of the following threats affect your territory? Please indicate for each threat its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
   - Increased salt wedge
   - Surface water pollution
   - Groundwater pollution
   - Soil pollution/contamination
   - Eutrophication

- Coastal erosion
- Salinity changes in coastal wetlands
- Over-exploitation of freshwater
- Sea level rise
- Sea temperature rise
- Droughts
- Extreme climatic events
- Temperature rise
- Invasive alien species

5. Which of the following climate change-related impacts have you observed in your area?
   - Loss of marine ecosystems
   - Loss of terrestrial ecosystems
   - Loss of brackish/sweet water ecosystems
   - Decline in ecosystem services
   - Loss of animal species
   - Loss of plant species
   - Increase in the presence of invasive species
   - Other

6. Do you think your work can mitigate and/or contribute to climate change adaptation?
   - Yes
   - No
   - I'm not sure

7. Which of the following activities/strategies do you implement to understand/mitigate the effects of climate change on your territory?
   - Monitoring of key species and habitats
   - Surface water monitoring
   - Groundwater monitoring
   - Coastal erosion monitoring
   - Nature based solutions
   - Hydraulic models for water management
   - Installation of manageable gates
   - Active coastal dune defence interventions
   - Agreements with farmers for water management

- Working tables with local authorities
- Dissemination activities
- Other

1. What type of Nature Based Solutions have you adopted or would like to adopt in the future?
   Open question ……..

8. Which of these do you consider an obstacle to implementing climate change adaptation/mitigation practices? Please indicate for each obstacle its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
   - Lack of economic resources
   - Lack of specific expertise
   - Lack of adequate programming/planning
   - Lack of adequate policies
   - Lack of awareness
   - Authorisation obstacles
   - Fragmentation of responsibilities of competent territorial authorities
   - Difficulties in dialogue with stakeholders

9. Do you think there is enough information about the effects of climate change?
   - Yes, information is simple and understandable to a wider public
   - Yes, but the information is not understandable to everyone
   - No
   - I'm not sure

10. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs
    - TV/radio
    - Info boards/local portals
    - Oral communication/speaking
    - Other

SECTION 3 – Public institutions

Name of your Public Institution: ……
Indicate the municipalities/counties you manage (in full and in capital letters):
……

2. As a public institution, are you aware of the impact of climate change on your area?
    - Yes
    - No

3. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
    - 1 – Poorly informed
    - 2 – Fairly informed
    - 3 – Very informed

Perception of climate change issues linked to nature protection

4. Do you think your territory is or will be affected by climate change?
    - Yes
    - No
    - I'm not sure

5. If yes, which of the following threats affect your territory? Please indicate for each threat its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increased salt wedge
    - Surface water pollution
    - Groundwater pollution
    - Soil pollution/contamination
    - Eutrophication
    - Coastal erosion
    - Salinity changes in coastal wetlands
    - Over-exploitation of freshwater
    - Sea level rise
    - Sea temperature rise
    - Droughts
    - Extreme climatic events
    - Temperature rise

- Invasive alien species

6. Which of the following climate change-related impacts have you observed in your area?
   - Loss of marine ecosystems
   - Loss of terrestrial ecosystems
   - Loss of brackish/sweet water ecosystems
   - Decline in ecosystem services
   - Loss of animal species
   - Loss of plant species
   - Increase in the presence of invasive species
   - Other

Perception of climate change issues linked to public health

7. Do you think climate change has or can impact public health?
   - Yes
   - No
   - I'm not sure

8. Have you experienced health problems in your community that you believe are related to climate change (i.e. heat waves, worsening air quality, new diseases)?
   - Yes
   - No
   - I'm not sure

9. Which of the following effects of climate change on health and safety do you consider relevant? (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
   - Increase in heat-related illnesses
   - Increase in respiratory problems
   - Increase in water quality-related diseases
   - Increase in pest-related diseases
   - Increase in risk related to personal safety (housing, infrastructure, transport...)

Perception of climate change issues linked to socio-economic activities

10. Do you think climate change affects or may affect economic activities in your community (i.e. agriculture, tourism, fishing)?

- Yes
- No
- I'm not sure

11. Which of the following effects of climate change have or may have negative consequences on economic activities in your community? For each, please indicate its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increased temperatures
    - Increased coastal erosion
    - Increased salinization
    - Loss of freshwater availability
    - Deterioration of habitats
    - Droughts
    - Extreme weather events (i.e. floods, extreme winds, …)

12. Do you think your work can mitigate and/or contribute to climate change adaptation?
    - Yes
    - No
    - I'm not sure

13. Which of the following activities/strategies do you implement to understand/mitigate the effects of climate change on your territory?
    - Surface water monitoring
    - Groundwater monitoring
    - Coastal erosion monitoring
    - Nature-based solutions
    - Hydraulic models for water management
    - Active coast defence interventions
    - Installation of manageable gates
    - Agreements with stakeholders for land management
    - Working tables with local authorities
    - Awareness-raising activities
    - Stakeholder Discussion Tables
    - Dissemination activities
    - Other

14. What types of territorial agreements have you adopted or would like to adopt in the future?
    Open question ……..

15. Which of these do you consider an obstacle to implementing climate change adaptation/mitigation practices? Please indicate for each obstacle its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Lack of economic resources
    - Not cost-effective
    - Lack of specific expertise
    - Lack of adequate programming/planning
    - Lack of adequate policies
    - Lack of awareness
    - Authorisation obstacles
    - Fragmentation of responsibilities of competent territorial authorities
    - Difficulties in dialogue with stakeholders

16. Do you think there is enough information about the effects of climate change?
    - Yes, information is simple and understandable to a wider public
    - Yes, but the information is not understandable to everyone
    - No
    - I'm not sure

17. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs
    - TV/radio
    - Info board/local portals
    - Oral communication/speaking
    - Other

SECTION 4 – Farmers

Name of your organisation/activity: ……
Indicate the municipality/county where you operate (in full and in capital letters):
……

1. As a farmer, are you aware of the impact of climate change on your area?
   - Yes
   - No

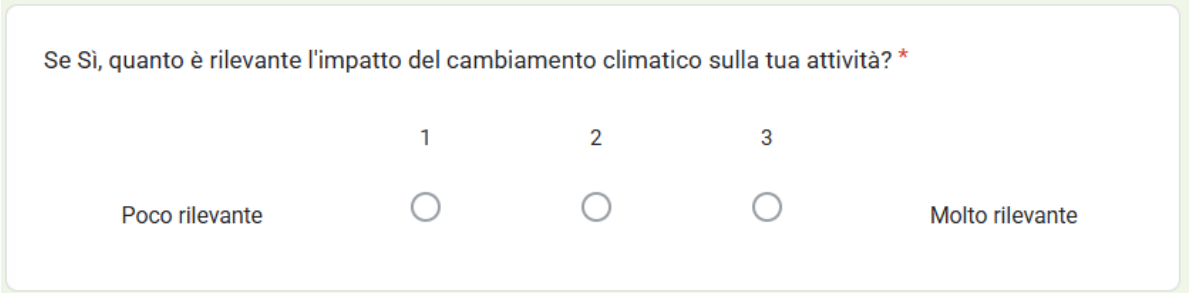
2. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
   - 1 – Poorly informed
   - 2 – Fairly informed
   - 3 – Very informed

Perception of climate change issues linked to socio-economic activities

3. Do you think your economic activity may be affected by climate change?
   - Yes
   - No
   - I'm not sure

4. If Yes, how relevant is the impact of climate change on your activity?
   - 1 – Little relevant
   - 2 – Medium relevant
   - 3 – Highly relevant

Linear scale question, example below:



5. Which of the following effects of climate change have or may have negative consequences for your activity? For each indicate its relevance to your activity (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increased/decreased temperatures
    - Increased coastal erosion
    - Increased salinization
    - Loss of freshwater availability
    - Deterioration of habitats
    - Droughts
    - Extreme weather events (i.e. floods, extreme winds, …)
    - Increase in parasites
    - Loss of soil fertility

6. Do you think climate change also affects or may affect other economic activities in your community (tourism, fishing)?
    - Yes
    - No
    - I'm not sure

7. Do you think your work can mitigate and/or contribute to climate change adaptation?
    - Yes
    - No
    - I'm not sure

8. What activities/practices do you implement/participate in to counteract or adapt to the effects of climate change?
    - Precision farming
    - Changes to crop plans
    - Introduction of varieties/species more tolerant to water and heat stress
    - Working tables with local authorities
    - Participation in awareness-raising activities
    - Participation in specific training activities
    - Application of water-saving practices
    - Collaboration with other stakeholders to address global change
    - Application of practices for the conservation of organic carbon in soils

- Other

9. What types of adaptation strategies have you adopted and do you consider most relevant?
Open answer……..

10. Which of these do you consider an obstacle to the implementation of climate change adaptation/mitigation practices? Please indicate for each obstacle its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Lack of economic resources
    - Not cost-effective
    - Lack of appropriate incentives
    - Lack of specific skills
    - Lack of adequate programming/planning
    - Lack of adequate policies
    - Lack of awareness
    - Authorisation obstacles
    - Fragmentation of responsibilities of competent territorial authorities
    - Difficulties in dialogue with the authorities in charge

11. Do you think there is enough information about the effects of climate change?
    - Yes, information is simple and understandable to a wider public
    - Yes, but the information is not understandable to everyone
    - No
    - I'm not sure

12. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs
    - TV/radio
    - Info boards/local portals
    - Oral communication/speaking
    - Other

SECTION 5 – Fisheries

Name of your organisation/activity: ……..
Indicate the municipality/county where you operate (in full and in capital letters):
……

1. As a fisherman, are you aware of the impact of climate change on your area?
    - Yes
    - No

2. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
    - 1 – Poorly informed
    - 2 – Fairly informed
    - 3 – Very informed

Perception of climate change issues linked to socio-economic activities

3. Do you think your activity may be affected by climate change?
    - Yes
    - No
    - I'm not sure

4. If Yes, how relevant is the impact of climate change on your activity?
    - 1 – Little relevant
    - 2 – Medium relevant
    - 3 – Highly relevant

5. Which of the following effects of climate change have or may have negative consequences for your activity? For each indicate its relevance to your business (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increase in surface water temperature
    - Increased coastal erosion
    - Increased salinisation in lagoon waters
    - Salinisation of freshwater with freshwater fish fauna
    - Deterioration of natural habitats
    - Extreme climatic events (i.e. floods, extreme winds, …)
    - Modification of sea currents
    - Modification of fish communities

- Increase in the presence of invasive species (i.e. blue crab, allochthonous mussels, …)
- Population rise of opportunistic species such as gelatinous macrozooplankton (in particular, jellyfish and salps)
- Reduction in pH of marine waters

6. Do you think climate change also affects or may affect other economic activities in your community (tourism, agriculture)?
    - Yes
    - No
    - I'm not sure

7. Do you think your work can mitigate and/or contribute to climate change adaptation?
    - Yes
    - No
    - I'm not sure

8. What activities/practices do you implement/participate in to counteract or adapt to the effects of climate change?
    - Working tables with local authorities
    - Implementation of gradual changes in gear selectivity
    - Participation in awareness-raising activities
    - Participation in specific training activities
    - Application of gradual changes in gear selectivity
    - Variation in fishing seasonality
    - Environmental improvement activities (removal of invasive species, removal of algal blooms, waste collection, etc.)
    - Diversification of fishing practices

9. What types of adaptation strategies have you adopted or would like to adopt in the future?
   Open answer……..

10. Which of these do you consider an obstacle to the implementation of climate change adaptation/mitigation practices? Please indicate for each obstacle its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Lack of economic resources

- Not cost-effective
- Lack of scientific information about the impact of climate change on fisheries
- Lack of appropriate incentives
- Lack of specific skills
- Lack of adequate programming/planning
- Lack of adequate policies
- Lack of awareness
- Authorisation obstacles
- Fragmentation of responsibilities of competent territorial authorities
- Difficulties in dialogue with the authorities in charge

11. Do you think there is enough information about the effects of climate change?
    - Yes, information is simple and understandable to a wider public
    - Yes, but the information is not understandable to everyone
    - No
    - I'm not sure

12. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs
    - TV/radio
    - Info boards/local portals
    - Oral communication/speaking
    - Other

SECTION 6 – Managers of tourism facilities

Name of your firm/organization: ……
Indicate the municipality/county where you operate (in full and in capital letters):
……

1. As a tourism operator, are you aware of the impact of climate change on your area?
    a. Yes
    b. No

2. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
    - 1 – Poorly informed
    - 2 – Fairly informed
    - 3 – Very informed

Perception of climate change issues linked to socio-economic activities

3. Do you think your economic activity may be affected by climate change?
    - Yes
    - No
    - I'm not sure

4. If Yes, how relevant is the impact of climate change on your activity?
    - 1 – Little relevant
    - 2 – Medium relevant
    - 3 – Highly relevant

5. Which of the following effects of climate change have or may have negative consequences for your activity? For each indicate its relevance to your activity (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Temperature increase
    - Drought
    - Competition for freshwater availability
    - Extreme climatic events (i.e. floods, extreme winds, …)
    - Increased coastal erosion
    - Sea level rise
    - Deterioration of natural habitats
    - Population explosion of organisms such as algae, jellyfish, blue crabs

6. Do you think climate change also affects or may affect other economic activities in your community (agriculture, fishing)?
    - Yes
    - No
    - I'm not sure

7. Do you think your work can mitigate and/or contribute to climate change adaptation?
    - Yes
    - No
    - I'm not sure

8. What activities/practices do you implement/participate in to counteract or adapt to the effects of climate change?
    - Active coastal defence interventions
    - Diversification of the tourism offer
    - Nature-based solutions
    - Working tables with local authorities
    - Participation in awareness-raising activities
    - Participation in specific training activities
    - Infrastructure and services for tourist reception based on solutions in line with natural aspects
    - Deseasonalisation of the tourist offer
    - Other

9. What types of adaptation strategies have you adopted or would like to adopt in the future?
   Open answer……..

10. Which of these do you consider an obstacle to the implementation of climate change adaptation/mitigation practices? Please indicate for each obstacle its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Lack of economic resources
    - Not cost-effective
    - Lack of appropriate incentives
    - Lack of specific skills
    - Lack of adequate programming/planning
    - Lack of adequate policies

- Lack of awareness
- Authorisation obstacles
- Fragmentation of responsibilities of competent territorial authorities
- Difficulties in dialogue with the authorities in charge

11. Do you think there is enough information about the effects of climate change?
    - Yes, information is simple and understandable to a wider public
    - Yes, but the information is not understandable to everyone
    - No
    - I'm not sure

12. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs
    - TV/radio
    - Info board/local portals
    - Oral communication/speaking
    - Other

SECTION 7 – Citizens

Indicate the municipality/county where you live (in full and in capital letters):

……

1. Age:
    - 18-25
    - 26-35
    - 36-45
    - 46-55
    - 56-65
    - >65

2. Education
    - Primary education
    - Secondary school diploma
    - High school diploma
    - Bachelor's degree
    - Master's degree or single-cycle degree
    - PhD

3. As a citizen, are you aware of the impact of climate change on your area?
    - Yes
    - No

4. If yes, how informed do you consider yourself to be about the impact of climate change in your area?
    - 1 – Poorly informed
    - 2 – Fairly informed
    - 3 – Very informed

Perception of climate change issues linked to nature protection

5. Do you think that the area where you live is or will be affected by climate change?
    - Yes
    - No
    - I'm not sure

6. If yes, which of the following threats affect your territory? Please indicate for each threat its relevance (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increased salt wedge
    - Surface water pollution
    - Groundwater pollution
    - Eutrophication
    - Coastal erosion
    - Salinity changes in coastal wetlands
    - Over-exploitation of freshwater
    - Sea level rise
    - Droughts
    - Extreme climatic events (i.e. floods, extreme winds, …)
    - Temperature rise

7. Which of the following climate change-related impacts have you observed in your area?
    - Loss of marine ecosystems
    - Loss of terrestrial ecosystems
    - Loss of brackish/sweet water ecosystems
    - Decline in ecosystem services
    - Loss of animal species
    - Loss of plant species
    - Increase in the presence of invasive species
    - Other

Perception of climate change issues linked to public health

8. Do you think climate change has or can impact public health?
    - Yes
    - No
    - I'm not sure

9. Have you experienced health problems in your community that you believe are related to climate change (e.g. heat waves, worsening air quality, new diseases)?
    - Yes

- No
- I'm not sure

10. Which of the following effects of climate change on health and safety do you consider relevant? (1= not relevant, 2= little relevant, 3= medium relevance, 4= relevant, 5= very relevant, I don't know):
    - Increase in heat-related illnesses
    - Increase in respiratory problems
    - Increase in water quality-related diseases
    - Increase in pest-related diseases
    - Increase in risk related to personal safety (housing, infrastructure, transport...)
    - Increase in food prices

11. How concerned are you about the following health risks associated with climate change? Indicate for each of the risks your concern (1=not worried, 2=little worried, 3=moderately worried, 4=worried, 5=very worried)

    - Extreme heat and heat waves
    - Vector-borne diseases (e.g. malaria, dengue)
    - Water contamination
    - Food insecurity
    - Scarcity of water availability
    - Risk of landslides and flooding from extreme weather phenomena

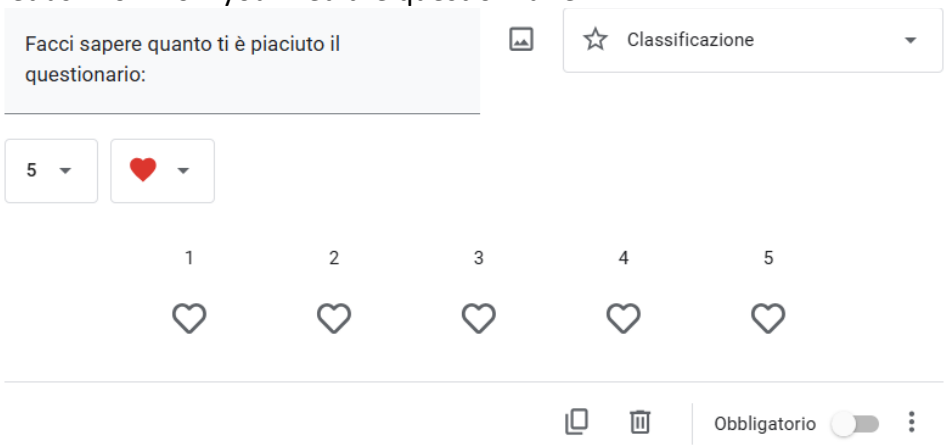
12. Do you think there is enough information about the effects of climate change?
    - Yes, information is simple and understandable to a wider public
    - Yes, but the information is not understandable to everyone
    - No
    - I'm not sure

13. Which channels do you think are or could be the most suitable to inform about the effects of climate change?
    - Scientific articles/magazines
    - Government organisations
    - Conferences/seminars/workshops
    - Mandatory trainings
    - Social media and blogs

- TV/radio
- Info board/local portals
- Oral communication/speaking
- Other

SECTION 8 - Thank you for your help!

Let us know how you liked the questionnaire:



We thank you for your collaboration. If you are interested in learning about and keeping up to date with the developments of the ACTION project, please visit the dedicated ACTION website! We also look forward to seeing you on Facebook and Instagram! Below, if you wish, you can leave us your feedback or suggestion: ……..