

D.1.3.1

Report on the hazards and threats of the pilot areas in the medium and long term

Vransko jezero catchment pilot site

Version of 29/09/2025

(PP5 contribution to Deliverable n. D.1.3.1)

Project acronym	ACTION
Project ID Number	ITHR0200390
Project Title	Increasing coastal ecosystem resilience to climate change
Programme priority	Green and resilient shared environment
Specific objective	1.2: Ecological and socio-economic analyses
Work Package Number	1
Work Package Title	Analysis of Pilot areas
Activity Number	1.3
Activity Title	Identification of hazards and threats at medium and long term
Partner in charge	PP5
Partners involved	PP6
Status	Final
Distribution	Internal partners repository



Index

Abstract.....	4
1. Introduction.....	5
2. Methodology.....	5
2.1. Sheet 1 – Qualitative Sensitivity analysis.....	6
2.2 Sheet 2 – Exposure analysis.....	10
2.3. Sheet 3 – Adaptation analysis.....	12
2.4. Sheet 4 – Residual vulnerability assessment.....	15
3. Results.....	17
3.1. Biodiversity.....	17
3.2. Tourism.....	19
3.3. Agriculture.....	21
3.4. Fishing and aquaculture.....	22
4. Discussion.....	24
5. Conclusions.....	26
Annexes.....	27
ANNEX 2- The sensitivity assessment, resulting from the integration of the analyses completed by PP5 NPVL on threats and related impacts for the Vransko lake catchment pilot site.....	28

Abstract

This report analyzes the main hazards and threats related to climate change in the Vransko lake catchment pilot site, based on a shared methodology developed among scientific, administrative, and management partners. The approach combines sensitivity, exposure, adaptive capacity, and residual vulnerability assessments to evaluate risks for key sectors – biodiversity, tourism, agriculture, fisheries, and aquaculture – in the medium and long term. Results show that the area is highly vulnerable to temperature increase and heatwaves, wildfires, changes in the hydrological regime, sea level rise and saltwater intrusion, which generate cross-cutting and systemic impacts. These findings confirm the urgent need for integrated adaptation strategies, based on ecosystem-based and multi-sectoral approaches, in order to strengthen the socio-ecological resilience of the territory.



1. Introduction

This report presents a structured methodology for assessing climate vulnerability and resilience in the Vransko lake pilot site, within the framework of the ACTION – Increasing coastal ecosystem resilience to climate change project.

This freshwater lake located in the coastal zone, characterized by ecological fragility, socio-economic relevance, and exposure to multiple stressors, is particularly sensitive to the impacts of climate change. The main climate change threats are rising temperatures, declining inflows and sea level rise, that are influencing increased salinity, intensifying agricultural nutrient pollution, and domination of invasive species, all driving the lake into a permanent turbid and degraded ecological state. The aim of the analysis is to identify the main climate-related risks, sectoral vulnerabilities, and systemic interlinkages, thereby supporting the design of targeted adaptation measures and integrated planning.

The study adopts a common assessment matrix, agreed upon by project partners, which considers medium- and long-term hazards and threats and prioritizes them across relevant sectors (biodiversity, tourism, agriculture, fisheries and aquaculture).

The report thus provides a scientific and operational basis for the development of local scenarios and adaptation solutions, which will be discussed in detail in deliverable D.1.4.1.

2. Methodology

The methodology adopted in this study is based on a framework provided by the European Commission's Technical Guidance on Sustainability Verification for the InvestEU Fund (EU, 2021) and it is adapted to a local scale by integrating ecological, socio-economic, and governance dimensions.

The assessment combines:

- Qualitative Sensitivity analysis (Sheet 1 of attached file): evaluating how system components respond to climate threats.
- Exposure analysis (Sheet 2 of attached file): assessing expected impacts under climate projections.
- Adaptation analysis (Sheet 3 of attached file): identifying the capacity to mitigate risks through available measures.
- Residual vulnerability assessment (Sheet 4 of attached file): integrating the above to provide risk-based prioritization.

This multi-layered approach ensures a structured and transparent methodology for identifying climate-related risks and adaptation needs. Hazards and threats are identified based on the



probability of occurrence (low, medium, high); expected severity of impact on ecological and socio-economic systems, and relevance at seasonal and long-term scales.

To ensure a more robust and representative assessment of the levels of environmental sensitivity/criticality, the matrix has been compiled in at least three separate versions, each by a subject with a complementary perspective:

- A research organization, to ensure a scientific and technical analysis.
- A national government/public administration to integrate aspects of planning, governance and political feasibility.
- A representative from a protected area or environmental management body, to bring the operational and territorial point of view, rooted in concrete knowledge of the natural context.

A final matrix was put together merging the three different contributions. This triangulation of inputs mitigated bias, enabled cross-sectoral comparisons, and ensured legitimacy of the results.

For the analysis of hazards and threats and local scenarios of the Vransko lake pilot site the following stakeholders were involved: i) Ruđer Bošković Institute, as research organization; ii) Ministry of environmental protection and green transition, as national public administration; and iii) the PP5 Public institution Nature park Vransko jezero, as a protected area management body.

2.1. Sheet 1 – Qualitative Sensitivity analysis

The goal of this evaluation is to identify how climate threats affect the components of each thematic area based on their inherent characteristics and role in the socio-ecological system.

The assessment is applied to four selected sectors that characterize the context of the pilot areas, each broken down into three key components (Fig. 1):

1. **Biodiversity** (protected habitats, species richness, ecosystem services).
2. **Tourism** (infrastructure and services, economic development and employment, cultural/natural attractions).
3. **Agriculture** (land use and landscape, agricultural income and employment; agricultural biodiversity).
4. **Fishing & Aquaculture** (resource use, income and employment, multifunctionality).

These four selected sectors represent both ecological and socio-economic pillars of coastal systems. They were selected for their high exposure to climate threats and their relevance for local communities.

Each component is assessed against four climate factors:

- **Temperature** (increase, heat/cold waves, wildfires),
- **Wind** (changes in the wind regime, storms; whirlwinds),
- **Water** (change in the hydrological regime and type of precipitation; sea acidification; saltwater intrusion; sea level rise; flooding.),
- **Solid Mass** (coastal erosion; soil degradation/erosion; landslide; subsidence).



These four climate factors allow for a comprehensive capture of different stressors. These categories encompass both gradual processes (e.g., sea level rise, acidification) and extreme events (e.g., storms, heat waves, floods).

Each key component is assigned a sensitivity level for each threat, ranging from 'low sensitivity' (score 1) to 'high sensitivity' (score 3).



EVALUATION OF SENSITIVITY

OUTPUT: inviduating the sensitivity of the components of each area to climatic factors

This analysis aims to:
 * Analyse how climate factors translate into climate threats and hazards.
 * Identify the impacts of these threats for the area of reference.

Guide for compilation:
 * Do not add rows, insert the info in the rows provided
 * Select the level of sensitivity from the drop-down menu in the respective cell

AREA: BIODIVERSITY			Area of protected habitats	Species richness	Ecosystem services
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves				
	Cold waves, frost				
	Wildfires				
WIND	Changes in the wind regime, storms (rain-snow and wind)				
	Whirlwinds				
WATER	Change in the hydrological regime (water stress, drought) and type of precipitation				
	Sea acidification				
	Saltwater intrusion				
	Sea level rise				
SOLID MASS	Flooding (coastal, fluvial, pluvial, groundwater)				
	Coastal erosion				
	Soil degradation/erosion				
	Landslide				
	Subsidence				

AREA: TOURISM			Tourism infrastructure and services	Economic development and employmen	Preservation of tourist attractions
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves				
	Cold waves, frost				
	Wildfires				
WIND	Changes in the wind regime, storms (rain-snow and wind)				
	Whirlwinds				
WATER	Change in the hydrological regime (water stress, drought) and type of precipitation				
	Sea acidification				
	Salthwater intrusion				
	Sea level rise				
SOLID MASS	Flooding (coastal, fluvial, pluvial, groundwater)				
	Coastal erosion				
	Soil degradation/erosion				
	Landslide				
	Subsidence				

AREA: AGRICULTURE			Land use and landscape	Agricultural income and employment	Agricultural biodiversity
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves				
	Cold waves, frost				
	Wildfires				
WIND	Changes in the wind regime, storms (rain-snow and wind)				
	Whirlwinds				
WATER	Change in the hydrological regime (water stress, drought) and type of precipitation				
	Sea acidification				
	Saltwater intrusion				
	Sea level rise				
SOLID MASS	Flooding (coastal, fluvial, pluvial, groundwater)				
	Coastal erosion				
	Soil degradation/erosion				
	Landslide				
	Subsidence				

AREA: FISHING AND AQUACULTURE			Use of resources	Income and employment	Multifunctionality
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves				
	Cold waves, frost				
	Wildfires				
WIND	Changes in the wind regime, storms (rain-snow and wind)				
	Whirlwinds				
WATER	Change in the hydrological regime (water stress, drought) and type of precipitation				
	Sea acidification				
	Saltwater intrusion				
	Sea level rise				
SOLID MASS	Flooding (coastal, fluvial, pluvial, groundwater)				
	Coastal erosion				
	Soil degradation/erosion				
	Landslide				
	Subsidence				

Fig. 1 – Structure and input fields for the qualitative sensitivity analysis.



2.2 Sheet 2 – Exposure analysis

The goal is to assess how climate risks are expected to affect the pilot site over time, based on global scenarios, local projections and seasonal variability.

Two IPCC Shared Socio-economic development Pathways (SSPs) were selected (IPCC, 2023):

- **SSP2-4.5 (“Middle of the Road”)**: an intermediate scenario where socio-economic and technological trends follow historical trajectories, without major shifts in development, leading to medium-level warming. CO₂ emissions remain roughly stable until mid-century before declining, but they do not reach net zero by 2100. This pathway results in a projected global warming of about 2.7 °C by 2100 (relative to 1850–1900), with a likely exceedance of 1.5 °C between 2021 and 2040.
- **SSP5-8.5 (“Fossil-Fueled Development”)**: a high-emission pathway characterized by energy-intensive growth driven by intensive fossil fuel use and reliance on technological progress, resulting in severe warming and associated impacts. Under this pathway, CO₂ emissions roughly triple by 2075, leading to a projected global warming of about 4.4 °C by 2100 (range 3.3–5.7 °C). In this scenario, exceeding 1.5 °C of warming in 2021–2040 is very likely, with severe consequences for ecosystems, societies, and economies.

These scenarios enable comparison of vulnerabilities under both realistic and extreme climate futures, highlighting the range of possible risks and adaptation needs.

The four climate factors from sheet 1 are converted into risk factors (Fig. 2):

- **Thermal risk and climate extremes** ← Temperature
- **Hydraulic and hydrogeological risk** ← Water
- **Wind and weather storm risk**
- **Geological and land degradation risk** ← Solid Mass

For each season (spring, summer, autumn, winter) and for each risk factor, an exposure level is assigned, ranging from ‘low exposure’ (score 1) to ‘high exposure’ (score 3).

Each risk is assessed for its probability and expected impact, establishing a baseline (current state) and projected future conditions under 2 selected IPCC climate (SSP2-4.5 and SSP5-8.5).

EVALUATION OF EXPOSURE

OUTPUT: Identification of the climate risk factors of the location/area under consideration at present and in the two scenarios

This analysis assesses future exposure to climate risks with reference to the location of the pilot action (macro-climatic area), using the climate projections available according to the latest IPCC Report, choosing scenarios SSP2-4.5 and SSP5-8.5. The expected seasonal climate variations and the resulting impacts in terms of risks for the pilot area are qualitatively assessed.

Current climate exposure				
Season	Thermal risk and climate extremes	Hydraulic and hydrogeological risk	Wind and weather storm risk	Geological and land degradation risk
Spring				
Summer				
Autumn				
Winter				

Future climate exposure: SSP2-4.5 scenario - "Middle of the Road" world where trends largely follow their historical patterns				
Season	Thermal risk and climate extremes	Hydraulic and hydrogeological risk	Wind and weather storm risk	Geological and land degradation risk
Spring				
Summer				
Autumn				
Winter				

Future Climate Exposure: Scenario SSP5-8.5 - Fossil-fueled Development "Taking the Highway", a world characterised by rapid and unlimited growth in economic production and energy use				
Season	Thermal risk and climate extremes	Hydraulic and hydrogeological risk	Wind and weather storm risk	Geological and land degradation risk
Spring				
Summer				
Autumn				
Winter				

LEGEND

HIGH: High probability of occurrence with potential significant impacts
 MODERATE-HIGH
 MODERATE: Medium probability of occurrence with manageable impact
 MODERATE-LOW
 LOW: Limited probability and low impacts

Fig. 2 – Structure and input fields for the exposure analysis.

2.3. Sheet 3 – Adaptation analysis

This sheet evaluates the adaptive capacity of each area, focusing on strategies to mitigate or buffer impacts from the exposure risks (Fig. 3), such as:

- **Infrastructural** (e.g., barriers, drainage),
- **Managerial** (e.g., land use planning, irrigation solutions),
- **Formative** (e.g., awareness and training campaigns),
- **Ecosystemic** (e.g., wetland restoration, green infrastructure).

Capacity is scored qualitatively as High (robust systems in place, good governance, financial/technical resources - score 3), Medium (partial coverage, possibility for improvement - score 2), or Low (limited or no capacity, lack of awareness/tools/resources - score 1), reflecting governance, resources, and technical feasibility.

Adaptation analysis

OUTPUT: Adaptation strategies of the components examined for each area in relation to climate risks

Overall objective: Compile a vulnerability assessment for the future for each thematic area, identifying:
 1. The adaptation measures needed for each component of the scope.
 2. The level of adaptive capacity (High, Medium, Low) with respect to different types of climate risks.

For each component and type of risk, identify specific and concrete mitigation/prevention actions, e.g.:
 * Infrastructural (e.g. barriers, shelters, drainage)
 * Managerial (e.g. planning, monitoring, soil/water management)
 * Formative (e.g. capacity building, vocational training)
 * Ecosystemic (e.g. nature-based solutions)

Assign a level of adaptive capacity for each combination.

LEGEND:
 * High: if effective measures already exist or the context is favourable (resources, governance, awareness).
 * Medium: if supportive actions are needed but there is some operational scope.
 * Low: if tools, resources, knowledge or political will are lacking.

AREA: BIODIVERSITY					
Component	Scenario SSP2-4.5	Adaptation to thermal risk and climate extremes	Adaptation to hydraulic and hydrogeological risk	Adaptation to wind and weather storm risk	Adaptation to geological and land degradation risk
Area of protected habitats	Measures	List potential adaptation/prevention measures and their level			
	Adaptive Capacity				
Species richness	Measures	List potential adaptation/prevention measures and their level			
	Adaptive Capacity				
Ecosystem services	Measures	List potential adaptation/prevention measures and their level			
	Adaptive Capacity				
AREA: TOURISM					
Component	Scenario SSP2-4.5	Adaptation to thermal risk and climate extremes	Adaptation to hydraulic and hydrogeological risk	Adaptation to wind and weather storm risk	Adaptation to geological and land degradation risk
Tourism infrastructure and services	Measures				
	Adaptive Capacity				
Economic development and employment	Measures				
	Adaptive Capacity				
Preservation of tourist attractions	Measures				
	Adaptive Capacity				

AREA: AGRICULTURE					
Component	Scenario SSP2-4.5	Adaptation to thermal risk and climate extremes	Adaptation to hydraulic and hydrogeological risk	Adaptation to wind and weather storm risk	Adaptation to geological and land degradation risk
Land use and landscape	Measures				
	Adaptive Capacity				
Agricultural income and employment	Measures				
	Adaptive Capacity				
Agricultural biodiversity	Measures				
	Adaptive Capacity				
AREA: FISHING AND AQUACULTURE					
Component	Scenario SSP2-4.5	Adaptation to thermal risk and climate extremes	Adaptation to hydraulic and hydrogeological risk	Adaptation to wind and weather storm risk	Adaptation to geological and land degradation risk
Use of resources	Measures				
	Adaptive Capacity				
Income and employment	Measures				
	Adaptive Capacity				
Multifunctionality	Measures				
	Adaptive Capacity				

Fig. 3 - Structure and input fields for the adaptation analysis.



2.4. Sheet 4 – Residual vulnerability assessment

The goal is to quantify residual vulnerability after adaptation is considered, allowing for risk-based planning. Residual vulnerability provides a prioritization tool for identifying critical areas requiring urgent adaptation measures.

Residual vulnerability is automatically calculated using the formula:

$$\text{Residual Vulnerability} = \text{Sensitivity} * \text{Exposure} / \text{Adaptation Capacity}$$

Under SSP2-4.5, adaptation capacity is considered active, while under SSP5-8.5 it is fixed at 1, reflecting the nullification of adaptation in extreme scenarios. Final residual vulnerability (Fig. 4) is scaled from 1 to 9, where higher values indicate greater climate risk, based on the following categories:

- o 1–2: Low residual vulnerability
- o 3–5: Moderate vulnerability
- o 6–9: High residual vulnerability which suggest need od critical intervention.

Residual vulnerability analysis

OUTPUT: weighted assessment of sensitivity and exposure and how adaptation measures can reduce the impacts of risks

On the basis of the matrices in the previous sheets, a summary is made to allow verification of the impact of the different types of risks for each area. If every part is compiled correctly, the table below will automatically upload and it will not be necessary to insert any input

AREA: BIODIVERSITY	Scenario	Sensitivity	Exposure	Adaptation	Residual vulnerability
Thermal risk and climate extremes	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Hydraulic and hydrogeological risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Wind and weather storm risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Geological and land degradation risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D

AREA: AGRICULTURE	Scenario	Sensitivity	Exposure	Adaptation	Residual vulnerability
Thermal risk and climate extremes	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Hydraulic and hydrogeological risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Wind and weather storm risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Geological and land degradation risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D

AREA: TOURISM	Scenario	Sensitivity	Exposure	Adaptation	Residual vulnerability
Thermal risk and climate extremes	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Hydraulic and hydrogeological risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Wind and weather storm risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Geological and land degradation risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D

AREA: FISHING AND AQUACULTURE	Scenario	Sensitivity	Exposure	Adaptation	Residual vulnerability
Thermal risk and climate extremes	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Hydraulic and hydrogeological risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Wind and weather storm risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D
Geological and land degradation risk	SSP2-4.5	#N/D	#N/D	#N/D	#N/D
	SSP5-8.5	#N/D	#N/D	1.00	#N/D

Sensitivity: the sensitivity to climate factors is averaged for each area, evaluated as a number from 1 (low sensitivity) to 3 (high sensitivity)

Exposure: the exposure to the individual risks in the case of SSP2-4.5 and SSP5-8 is evaluated as a number from 1 (low exposure) to 3 (high exposure)

Adaptation: averaged over the effectiveness of the adaptive capacity of the measures that can be implemented in the SSP2-4.5 scenario (=1, i.e. null, in case of SSP5-8.5), evaluated as a number from 1 (low mitigation/adaptation capacity) to 3 (high capacity)

Residual vulnerability: calculated as the product of sensitivity and exposure, divided by the effectiveness of adaptation

Fig. 4 - Structure and input fields for residual vulnerability assessment.

3. Results

Following the description and discussion of the threats and impacts for each considered sector in the Pilot Area.

3.1. Biodiversity

The area of Lake Vrana and its catchment, due to the mosaic of wetland and agricultural habitats and the species associated with them, particularly the avifauna, is part of the ecological network, while the narrower lake area is designated as a Nature Park and is listed under the Ramsar Convention as a wetland of international importance. The northernmost section, comprising 900 hectares of the Nature Park, is also a Special Ornithological Reserve, characterized by diverse habitats: reedbeds, open lake waters, wet meadows, and gravelly-muddy shores, hosting the richest avifauna population. The area's exceptional biodiversity has already been partly degraded due to the combination of natural vulnerability, increasing anthropogenic pressures, and climate change, and is under further long-term threat. As in other parts of the Mediterranean, climate change is expected to amplify existing natural and anthropogenic pressures. The sensitivity analysis of interactions between climatic drivers and biodiversity components (protected habitats, species richness, and ecosystem services) indicates that many threats cause high (temperature increase, wildfires, changes in the hydrological regime (water stress, drought) and type of precipitation, salt water intrusion and sea level rise) or at least moderate (changes in the wind regime, storms (rain-snow and wind), whirlwinds, sea acidification, flooding and erosion) sensitivity, and it is evident that the habitat conservation and species diversity are strongly linked with the ecosystem services (Annex 2). Some of the threats are not applicable to Vransko pilot site, like coastal erosion, landslide or subsidence.

Temperature-related threats

Rising temperatures and recurrent heat waves significantly affect metabolism, growth, change in reproductive cycles of key bird species (i.e. nest failure and migration timing for birds), as well as biological cycles (i.e. increased metabolic rates in stress organisms) of aquatic species. It also affects bird distribution. These conditions destabilize predator-prey dynamics in aquatic habitats, increase vulnerability to disease, and favour invasive species. Protected habitats and species richness are highly sensitive, given the risk of mortality events, habitat degradation, and altered biological cycles. Ecosystem services are rated high in sensitivity due to impacts on water regulation (increased evapotranspiration), vegetation cover (reduced plant productivity), and carbon storage.

Cold waves and frost, particularly occurring in unusual times of the year, primarily affect temperature-dependent species (amphibians, reptiles, insects and certain plants), often allowing generalist or non-native species to replace them but can also cause mortality in migrating birds. These events make species richness moderately sensitive, while habitats and ecosystem services aren't significantly affected due to resilience and general decrease in colder periods and a trend of warmer winters. In case of prolonged colder periods carbon storage and nutrient cycling in wetlands may be impaired because of the reduction of plant productivity and microbial activity.

Wildfires destroy habitat's structure, faunal shelters, and ecosystem integrity, causing changes in soil microbial communities, increasing vulnerability to recolonisation with invasive species as well as erosion and toxic compounds inflow. This results in high sensitivity across habitats, species richness, and ecosystem services, including carbon emissions, cultural values, and recreational opportunities.

Wind-related threats

Storms, changes in wind regime, and extreme wind events have significant impact on water mixing in polymictic lake, sediment resuspension and turbidity that is also connected with pulling out of the submerged vegetation. They cause soil erosion, saltwater intrusion driven by high SE winds (sirocco) and water mixing, salinization of soil and water by strong NW winds (bora). Also, nesting birds can lose breeding sites and suffer mortality due to collision and hypothermia during extreme wind events. Habitats and species richness show medium sensitivity as well as connected ecosystem services.

Whirlwinds cause extensive habitat damage and sediment resuspension. Sensitivity across habitats, species richness, and ecosystem services is moderate, due to the significantly local occurrence of these disturbances.

Water-related threats

The main challenges in preserving the natural values of the area partly arise from its natural characteristics and partly from anthropogenic pressures in the region, while climate change intensifies risks associated with both factors. Due to its shallowness (with depths ranging from 0.5-1 m in the northwest part to 4-6 m in the southeast part), and the fact that the lake is a cryptodepression (with the lakebed at -3.47 m above sea level), separated from the sea by a narrow permeable karst barrier through which — depending on the lake's water level — fresh water flows into the sea or seawater penetrates the lake, Vransko Lake is a very sensitive coastal freshwater ecosystem. Even without additional anthropogenic influences, it is susceptible to salinity changes, which can have catastrophic consequences for its living organisms. Anthropogenic impacts have made it even more vulnerable. The most significant was the excavation of the Prošika canal as a direct outlet for high lake waters into the sea, along with the associated hydromelioration of the formerly vast swamp area in what is today the Vransko polje (Vrana field). This has resulted in a multiple reduction of the floodplain wetland habitat area and the loss of the wetland's function as a natural buffer against extreme water level fluctuations and habitat conditions in the lake. This land-use change has also caused the current most significant anthropogenic pressure on the lake: agricultural activities in the catchment area, which are mostly conventional and dependent on the input of chemicals (fertilizers and pesticides), which, through erosion and leaching, end up in the lake causing its eutrophication and pollution. An additional challenge is the use of water from the catchment for irrigating arable land, which reduces the inflow of fresh water and increases the risk of salinization, especially during the summer months when tributaries and the lake's water level are at their lowest, and irrigation demands are highest. Climate change — primarily hotter and drier summers with increased evaporation, reduced precipitation, and decreased water inflow from the catchment to the lake, combined with increased irrigation demands and rising sea level — increases the risk of



episodes with extreme salinity rises and catastrophic consequences for the lake's freshwater ecosystem. Another significant negative impact on the lake's ecosystem comes from the ichthyofauna dominated by allochthonous (non-native) species, which, by feeding, disturb the sediment and thus add to the eutrophication pressure. These combined pressures cumulatively cause the currently unsatisfactory conservation status of the lake ecosystem and many target habitat types associated with it.

Changes in the hydrological regime including prolonged droughts (especially relevant when there is the occurrence of two consecutive dry years as in 2008/2009, 2011/2012) and altered precipitation patterns and seasonal cycles affect habitat suitability, alter aquatic ecosystems and cause water salinisation. Being a very shallow lake, lower availability of freshwater and lower stream discharge cause higher water temperatures and higher evapotranspiration which again influences salt water intrusions and salt accumulation. Habitats, species richness and ecosystem services exhibit high sensitivity due to reduced water availability, and decreased buffering against salinization.

Sea acidification threatens alteration of sediment chemistry and nutrient cycling, and there is a potential influence on brackish stonewort algae (Characeae) species distribution by reducing the availability of carbonate ions. Sensitivity is medium across all biodiversity dimensions, reflecting long-term risks to community composition.

Saltwater intrusion and sea level rise are among the most severe threats to the freshwater lake ecosystem causing osmotic stress, reduced growth and reproduction, or mortality of freshwater species (molluscs, fish, amphibians) and change in sediment microbial communities favouring methanogenic bacteria and causing methane production. Saltwater intrusion alters plant community composition, promotes soil salinization, and diminishes soil fertility. These pressures reduce freshwater availability, compromise terrestrial and aquatic habitats, and disrupt species richness and ecosystem service provision. Sensitivity is high across all dimensions, indicating systemic vulnerability.

Seasonal occurrence of extreme fluvial flooding causes erosion and sediment load impacting ecosystems also by increasing the nutrient load. The sensitivity is moderate across all biodiversity dimensions due to rare occurrence.

Solid mass and soil threats

Soil degradation and erosion reduce fertility, increase nutrient and carbon runoff, increase sediment deposition and degrade habitat conditions which also moderately threatens species richness and ecosystem functions.

3.2. Tourism

Tourism in the area of Vransko lake catchment pilot site is partly dependent on climate-sensitive assets, including infrastructure and services, local economic development and employment, and the preservation of cultural and natural heritage. Due to its geographical location and exposure to multiple climatic drivers, the area remains vulnerable to climate-related pressures. The main impacts

and sensitivities on the tourism sector deriving from the most relevant threats, are reported in the Annex 2 and summarized below.

Temperature-related threats

Rising temperatures and recurrent heat waves exert high sensitivity to economic development and employment and medium sensitivity to infrastructure and services and preservation of tourist attractions. Impacts include uncertainty due to shifts in peak tourism seasons, potential declines in visitation during hot months, loss of appeal in seasonal activities (birdwatching), risk to outdoor tourism reliability, higher operating costs for adaptation to hottest periods (e.g., air conditioning, insulation, increased demand for cooling and water), reduced tourist comfort and satisfaction, increased health risks (heatstroke, dehydration), unpredictability of weather that discourages bookings and difficulty in planning travel packages and events. All of this causes high sensitivity because of unreliability for the economic development and employment.

Wildfires, by contrast, represent a high sensitivity threat for attractions and infrastructure as well as preservation of tourist attractions and medium for economic development. They destroy natural landscapes and tourist attractions, degrade air quality, and pose safety risks for visitors demanding evacuation of areas. Long-term damage to the tourism brand exerts medium sensitivity to economic development and employment.

Wind-related threats

Changes in wind regime and storms show medium sensitivity for infrastructure, economic activity and attractions. While impacts include altered patterns of wind-dependent activities (e.g., sailing, paragliding), discomfort for tourists, cancellations of outdoor events, damage to attractions and property, increased maintenance costs, long recovery periods, restricted access to natural areas, and the need for visitor safety measures, they tend to be episodic and localized.

Whirlwinds, however, carry medium sensitivity only for infrastructure and economic activity. They may damage transport infrastructure, services and private infrastructures, disrupt services by causing problems to anglers, water sports and nature-based tourism. Their unpredictability can impact tourist confidence in safety of the destination and negatively affect the area attractiveness.

Water-related threats

Alterations in the hydrological regime (droughts, water stress, and irregular rainfall) show high sensitivity for services mainly, but medium sensitivity to economy and attractions. Reduced water availability and degradation of water quality causes changes in seasonality and reliability of tourism seasons and creates planning difficulties for operators. Destruction of natural landscapes and tourist attractions reduce interest to water sports and nature-based tourism.

Sea acidification is not applicable to tourism related activities at the pilot site.

Saltwater intrusion presents high sensitivity for attractions and medium for economic activities by decreasing of freshwater availability that impacts biodiversity in wetlands and freshwater-dependent areas.

Sea level rise presents high sensitivity for attractions and medium for economic activities and infrastructure. It causes restrictions on water use, conflict over water use between tourists and locals, landscape degradation and impacts on angling tourism.

Flooding is not applicable to the pilot area since it happens outside of the tourist season.

Solid mass-related threats

Coastal erosion, landslide and subsidence are not relevant for the pilot site, while soil degradation and erosion present medium sensitivity to economic development and attractions that impacts reductions in scenic landscapes and overall reduction of attractiveness of the destination.

3.3. Agriculture

Ravni Kotari belong to the most fertile region of northern Dalmatia, so it is not surprising that agriculture is the main activity of this region. 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 its low-lying coastal position, the system is highly exposed to climatic stressors such as extreme temperatures, hydrological variability, and soil and landscape dynamics. The results of the sensitivity assessment for three key agricultural components — land use and landscape, agricultural income and employment, and agricultural biodiversity — against the most relevant climate threats affecting the area are reported in the Annex 2.

Temperature-Related Threats

Temperature increase and heat waves show high sensitivity across all dimensions as they disrupt crop calendars, pose risk of early blooming followed by late frost damage, causing stress on crops (e.g., grapes, fruit trees) and livestock, reducing agricultural yields, affecting pollination, fruit set, and overall crop quality, and risk of overripening or sunburn in fruit and vegetables. It influences the water stress and increased irrigation needs.

Cold waves and frost are assessed as medium sensitivity across all dimensions, since it is causing damages to spring crops (e.g., orchards) and affecting vines and olive trees.

Wildfires exert high sensitivity across all dimensions, causing significant damage to rural lands and pastures and loss of forage, crops and present a fire risk to farm infrastructure.

Wind-Related Threats

Changes in wind regimes and storms exert medium sensitivity across all dimensions, through disrupted pollination, pest and disease spread, and direct crop and infrastructure damage which increases insurance and production costs. Salinization of plants, soil and water are also caused by extremely strong bora winds.

Due to their local impact whirlwinds show low sensitivity across all dimensions.

Water-Related Threats



Changes in the hydrological regime (drought, altered precipitation) are high sensitivity for income and employment, land use and biodiversity as they influence the availability of groundwater recharge and surface water which undermine irrigation scheduling and sowing/harvest reliability.

Saltwater intrusion is medium sensitivity across all components affecting water quality for irrigation in low-lying coastal areas and reducing crop yield by driving soil salinization.

Sea level rise is medium sensitivity across all components since it leads to soil salinization, drainage problems, reduced availability of irrigation water, conflict between agricultural and urban uses, crop failure, especially in water-sensitive crops, soil erosion, nutrient leaching, waterlogging, and crop loss causing a long-term threat to coastal farmland and increased reliance on emergency irrigation.

Flooding (fluvial) is medium sensitivity for income and employment, causing arable land loss and delayed or cancelled planting and infrastructure damage.

Solid Mass-Related Threats

Coastal erosion, subsidence and landslides do not occur in the pilot site while soil degradation and erosion are medium sensitivity across all dimensions undermining long-term productivity and land management costs, and causing soil fertility loss.

3.4. Fishing and aquaculture

Commercial fishing or fish farming no longer takes place on Lake Vrana, instead, only sport fishing is allowed, for which the lake is internationally renowned and rated as a highly attractive destination. A total of 20 fish species have been recorded in the lake. In addition to numerous small and economically uninteresting species, the ichthyofauna also includes several species attractive to sport anglers, which often yield trophy-sized fish - primarily the non-native species carp, catfish, and pike. Nevertheless, the condition of the ichthyofauna in Lake Vrana is alarming, with a real threat that some native fish species, including the target species of goby, could become extinct in the near future. There is also a noticeable decline in the population of the strictly protected European eel. The deliberate introduction of about ten fish species from the Danube and other catchments over the past century, among them several now recognized as invasive, has had far-reaching consequences on the lake ecosystem. The introduction of non-native species has significantly altered community structure by displacing native species, and it is also assumed that carp species (primarily common carp and Prussian carp, which account for roughly a quarter of the lake's total fish biomass), which feed by rooting in the sediment, contribute to silting and accelerate the processes of eutrophication and lake aging. The Public Institution of Vransko Jezero Nature Park holds the fishing right and is responsible for management within the park's fishing zone.

These activities are strongly tied to the stability of aquatic ecosystems and are therefore highly exposed to climatic stressors. The analysis below evaluates the impacts of major climate drivers — temperature, wind, water-related processes, and solid mass dynamics — on three critical components: resource use, income and employment, and multifunctionality (ecological services, cultural values, and tourism–fisheries interlinkages). The result table is showed in the Annex 2.

Temperature-related threats

Temperature increase and heat waves are among the most critical pressures, with high sensitivity for resource use and medium for employment and multifunctionality. Rising water temperatures alter fish reproduction, migration, and metabolism favouring invasive species like prussian carp (*Carassius gibelio*), sunfish (*Lepomis gibbosus*) and blue crab (*Callinectes sapidus*) that outcompete native species and disrupt food chains. Reduced oxygen levels and algal blooms trigger mass mortality events and vulnerability to disease.

Wildfires have only medium sensitivity, with indirect impacts from ash and debris entering water bodies, impacting water quality.

Wind-related threats

Changes in wind regimes and storms show medium sensitivity across all components by altering water circulation, influencing nutrient availability and fish distribution as well as limiting fishing activity, while whirlwinds have low sensitivity due to their local and short-term impact.

Water-related threats

Changes in the hydrological regime (drought and altered precipitation) have medium sensitivity for resource use and multifunctionality by affecting salinity and nutrient load, high temperatures reducing oxygen levels in water that impacts native fish species sensitive to water quality and causing algae blooms increase as well as affecting breeding and migration of freshwater-dependent fish.

Sea acidification has medium sensitivity for multifunctionality by impacting food chains. Saltwater intrusion registers high sensitivity for use of resources and multifunctionality, and medium in income and employment by raising salinity and negatively affecting freshwater species interesting for sports-fishing.

Sea level rise is a high-sensitivity driver for resource use and medium to income and employment and multifunctionality since it reduces freshwater inflow, and with decline in water levels and quality, increasing salinity in the lake affecting species composition. Flooding produces medium sensitivity for resource use and multifunctionality since it is causing erosion and sediment and nutrient load that are impacting target habitats and ecosystems.

Solid mass-related threats

Coastal erosion, subsidence and landslides do not occur in the pilot site, while soil degradation and erosion show medium sensitivity to use of resources and multifunctionality by increasing sediment load that degrades water quality and damages fish gills.

4. Discussion

The Vrana lake catchment's vulnerability stems from the interplay between its natural characteristics, escalating climate pressures, and intensifying human activities, fostering a cycle of ecosystem decline and unsustainable resource practices. The sensitivity analyses across biodiversity, tourism, agriculture, and fisheries in the catchment reveal a common exposure to multiple climate drivers, with temperature extremes and wildfires, hydrological variability, sea intrusions and sea-level rise emerging as the most disruptive. While each sector is affected according to its ecological or economic dependencies, the findings underline a deep network of interconnections: when habitats degrade, cultural and recreational values fade; when freshwater systems falter, agricultural yields and tourism potential shrink.

Temperature-related threats are prevalent across all sectors. Temperature increases, heatwaves, and prolonged droughts disrupt biological cycles, lower water availability, reduce agricultural yields, threaten native fish and bird populations, and diminish the seasonality and appeal of tourism activities.

Altered hydrology and water stress lower freshwater inflow, causing lake salinization, loss of aquatic habitat, and degraded water quality, impacting all water-dependent sectors. Ecosystem degradation is accelerated (salinization, eutrophication, loss of species), economic activities under stress (agriculture, tourism, fishing), and overall landscape resilience is undermined, requiring cross-sector adaptation and management to mitigate cumulative impacts.

Raising salinity levels due to decreased freshwater inputs and increased seawater intrusion damage wetland habitats, soil fertility, crop productivity, and threaten freshwater-dependent species (fish, amphibians, aquatic plants) crucial for biodiversity, fishing, and tourism. Nutrient runoff and eutrophication, driven by agriculture and invasive species, further weaken aquatic ecosystems, reduce water clarity and quality, and undermine recreational and fishing opportunities.

Wildfires and storms destroy infrastructure, habitats, and wildlife shelters, causing direct economic losses in tourism and agriculture, increasing air and water pollution, and amplifying overall ecosystem vulnerability.

Combined pressures such as climate extremes, coupled with intensive land and resource use, lead to cumulative degradation of ecosystem services, increase the risk of local species extinctions, jeopardize economic stability in agriculture and tourism, and erode the natural heritage upon which all sectors depend.

In summary, the main threats are interconnected: water stress (drought, salinization), climate extremes (heat, wildfires), invasive species, and habitat loss—each jeopardizing multiple sectors and



reinforcing overall vulnerability in the Lake Vrana region. The greatest threats across sectors at Lake Vrana are those that affect water availability and quality, disrupt ecological balance, and undermine economic activities reliant on natural resources like increased temperatures, more frequent heatwaves, prolonged droughts, and altered precipitation patterns that reduce water availability for ecosystems, agriculture, tourism, and fisheries. These effects intensify stress on both native species and human activities. Reduced inflows and rising sea levels cause freshwater shortages, increase salinity in soil and water, undermine agricultural productivity, alter habitats, and threaten freshwater biodiversity. More frequent or severe storms, wind events, and wildfires damage infrastructure, landscapes, crops, and habitats, impacting tourism and livelihoods across all sectors.

These threats are interlinked and cumulative, requiring integrated management to protect both natural and socioeconomic systems in the region.



5. Conclusions

Lake Vrana is highly vulnerable to a range of climate change risks that profoundly impact its ecosystems and surrounding sectors. Rising temperatures, more frequent heatwaves, and prolonged droughts disrupt biological cycles, reduce freshwater availability, and elevate water temperatures, leading to habitat degradation and increased mortality among sensitive species such as birds and freshwater fish. Altered precipitation patterns and hydrological variability intensify water stress, promoting lake salinization and eutrophication, which threaten aquatic biodiversity and ecosystem services. Sea level rise and saltwater intrusion impose further osmotic stress on freshwater species, degrade soil fertility, and compromise natural buffers. Extreme weather events, including wildfires and storms, exacerbate habitat loss and damage infrastructure, intensifying ecological vulnerability. Collectively, these climate-driven pressures undermine the resilience of Lake Vrana's habitats, agriculture, fisheries, and tourism, necessitating urgent, integrated climate adaptation strategies to mitigate long-term ecological and socio-economic risks.

Annexes

- 1 - The working Excel file used to perform the analysis of hazards and threats under different local climate scenarios.
- 2 - The sensitivity assessment, resulting from the integration of the analyses completed by PP5, on threats and related impacts for the Vransko lake catchment pilot site.



ANNEX 2- The sensitivity assessment, resulting from the integration of the analyses completed by PP5 NPVL on threats and related impacts for the Vransko lake catchment pilot site.

The matrix below shows the results of the sensitivity analysis examining the interactions between climatic drivers and the sectors of Biodiversity, Tourism, Agriculture, and Fisheries & Aquaculture.

EVALUATION OF SENSITIVITY

OUTPUT: individuating the sensitivity of the components of each area to climatic factors

This analysis aims to:

- * Analyse how climate factors translate into climate threats and hazards.
- * Identify the impacts of these threats for the area of reference.
- * Assess the sensitivity of the areas' components to these threats.

Guide for compilation:

- * Do not add rows, insert the info in the rows provided
- * Select the level of sensitivity from the drop-down menu in the respective cell

AREA: BIODIVERSITY			Area of protected habitats	Species richness	Ecosystem services
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves	<p>Effects on metabolism, growth and reproduction; change in reproductive cycles (i.e. nest failure and migration timing for birds), biological cycles (i.e. increased metabolic rates with stress organism);</p> <p>Changes in bird distribution;</p> <p>Alterations of survival of key species (higher mortality rates, particularly in larvae and juveniles of Amphibians and fish);</p> <p>Atered predator-prey dynamics;</p> <p>Increased vulnerability to disease outbreaks and invasive species;</p> <p>Reduced plant productivity;</p> <p>Increased evapotranspiration.</p>	High	High	High
	Cold waves, frost	<p>Sensitive species (wetland amphibians, reptiles, insects, temperature-dependent plants) are replaced by generalists or non-native species more tolerant to temperature variations, reducing overall biodiversity;</p> <p>Carbon storage and nutrient cycling in wetlands may be imparied if plant productivity and microbial activity are reduced;</p> <p>Migrating birds.</p>	Low	Medium	Low



	Wildfires	Destruction of the ecosystem; Destruction of habitat structure and faunal shelter; Changes in soil microbial communities; Increased vulnerability to invasive species; Increased erosion and toxic compounds inflow; Carbon emission.	High	Medium	High
WIND	Changes in the wind regime, storms (rain-snow and wind)	Impact on water mixing in polymictic lake, sediment resuspension and turbidity; Impact on submerged vegetation (pulling out); Soil erosion; Saltwater intrusion driven by high winds (sirocco) and water mixing; Salinization of soil and water by strong bora winds; Nesting birds can lose breeding sites and suffer mortality due to collision and hypothermia during extreme wind events.	Medium	Medium	Medium
	Whirlwinds	Extensive habitat damage; Wetlands may experience blowouts, or saltwater intrusion due to storm surges driven by high winds; Sediment resuspension; Nesting birds can lose breeding sites and suffer mortality during extreme wind events; Invertebrates and ground-dwelling species (e.g., amphibians) may be buried, displaced, or exposed.	Medium	Medium	Medium



WATER	Change in the hydrological regime (water stress, drought) and type of precipitation	Change in seasonal cycles affecting habitat suitability and water dependent species; Change in hydrological cycle impacting wetland dynamics and aquatic habitats; Reduced freshwater availability for ecosystems, especially in summer; decrease in aquifer recharge (water deficit); Higher water temperatures due to lower availability of freshwater and lower stream discharge; Higher evapotranspiration and availability of freshwater influences salt water intrusions and salt accumulation.	High	High	High
	Sea acidification	Alteration of sediment chemistry and nutrient cycling; Influence on brakish stonewort algae (Characeae) species distribution by reducing the availability of carbonate ions.	Medium	Medium	Medium
	Saltwater intrusion	Decrease in freshwater availability; Change in plant communities; Soil salinization and decrease in soil fertility; Causing osmotic stress, reduced growth and reproduction, or mortality of freshwater species (molluscs, fish, amphibians); Change in sediment microbial communities favouring methanogenic bacetria and causing methane production.	High	High	High



	Sea level rise	Saltwater intrusion; Soil and sediment salinization; Reduces freshwater inflow; Decrease of freshwater ecosystems.	High	High	High
	Flooding (coastal, fluvial, pluvial, groundwater)	Erosion and sediment load impacting ecosystems; Nutrient load increase.	Medium	Medium	Medium
SOLID MASS	Coastal erosion	n/a for Vransko	Low	Low	Low
	Soil degradation/erosion	Decrease in fertility; Increase in nutrient and carbon runoff; Sediment deposition; Habitat conditions degradation.	Medium	Medium	Medium
	Landslide	n/a for Vransko	Low	Low	Low
	Subsidence	n/a for Vransko	Low	Low	Low

AREA: TOURISM			Tourism infrastructure and services	Economic development and employment	Preservation of tourist attractions
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY



TEMPERATURE	Temperature increase, heat waves	Shift in peak tourism seasons; Potential declines in visitation during hot months; Loss of appeal in seasonal activities (birdwatching); Risk to outdoor tourism reliability; Higher operating costs for adaptation to hottest periods (e.g., air conditioning, insulation, increased demand for cooling and water); Reduced tourist comfort and satisfaction; Increased health risks (heatstroke, dehydration); Unpredictable weather discourages bookings; Difficulty in planning travel packages and events.	Medium	High	Medium
	Cold waves, frost	Risk to transportation and accessibility; Temporary closures of tourist services; Increased heating costs.	Low	Low	Low
	Wildfires	Destruction of natural landscapes and tourist attractions; Evacuation of areas; Air quality issues; Long-term damage to tourism brand.	High	Medium	High
WIND	Changes in the wind regime, storms (rain-snow and wind)	Altered patterns of wind-dependent activities (e.g., sailing, paragliding); Discomfort for tourists; Potential safety concerns; Event cancellations; Damage to attractions and property; Increased maintenance costs.	Medium	Medium	Medium



	Whirlwinds	Demages to transport infrastructure and services and private infrastructures; Long recovery periods; Reduced trust in safety of destination; Problems for anglers, water sports and nature-based tourism.	Medium	Medium	Low
WATER	Change in the hydrological regime (water stress, drought) and type of precipitation	Change in seasonality and reliability of tourism seasons; Destruction of natural landscapes and tourist attractions; Degradation of water quality; Reduction in interest to water sports and nature-based tourism; Freshwater availability.	High	Medium	Medium
	Sea acidification	n/a for Vransko	Low	Low	Low
	Saltwater intrusion	Affects freshwater availability.	Low	Medium	High
	Sea level rise	Restrictions on water use; Conflict over water use between tourists and locals; Landscape degradation; Impacts on angling tourism.	Medium	Medium	High
	Flooding (coastal, fluvial, pluvial, groundwater)	n/a for Vransko	Low	Low	Low
SOLID MASS	Coastal erosion	n/a for Vransko	Low	Low	Low
	Soil degradation/erosion	Degradation of scenic landscapes; Reduced attractiveness of destination.	Low	Medium	Medium
	Landslide	n/a for Vransko	Low	Low	Low
	Subsidence	n/a for Vransko	Low	Low	Low



AREA: AGRICULTURE			Land use and landscape	Agricultural income and employment	Agricultural biodiversity
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves	Alters crop cycles; Risk of early blooming followed by late frost damage; Stress on crops (e.g., grapes, fruit trees) and livestock; Reduced agricultural yields; Affects pollination, fruit set, and overall crop quality; Risk of overripening or sunburn in fruit and vegetables; Water stress and increased irrigation needs.	High	High	High
	Cold waves, frost	Damages to spring crops (e.g., orchards); Affects vines and olive trees.	Medium	Medium	Medium
	Wildfires	Damage to rural lands and pastures; Loss of forage, crops and fire risk to farm infrastructure.	High	High	High
WIND	Changes in the wind regime, storms (rain-snow and wind)	Impacts pollination; Spreads pests and diseases; Salinization of plants, soil and water by strong bora winds; Potential damage to greenhouses; Direct damage to crops (especially grapes, fruit, vegetables); Increases insurance and production costs.	Medium	Medium	Medium
	Whirlwinds	Localized destruction of crops, greenhouses, and farm equipment.	Low	Low	Low



WATER	Change in the hydrological regime (water stress, drought) and type of precipitation	Altered irrigation scheduling; Unpredictable sowing and harvest periods; Impacts on groundwater recharge and surface water availability for irrigation.	High	High	High
	Sea acidification	n/a for Vransko	Low	Low	Low
	Saltwater intrusion	Affects water quality for irrigation in low-lying coastal areas; Reduces crop yield.	Medium	Medium	Medium
	Sea level rise	Long-term threat to coastal farmland; Soil salinization and drainage problems; Reduced availability of irrigation water; conflict between agricultural and urban uses. Crop failure, especially in water-sensitive crops; Increased reliance on emergency irrigation. Soil erosion, nutrient leaching, waterlogging, and crop loss.	Medium	Medium	Medium
	Flooding (coastal, fluvial, pluvial, groundwater)	Loss of arable land and delayed or canceled planting; Infrastructure damage.	Medium	Medium	Medium
SOLID MASS	Coastal erosion	n/a for Vransko	Low	Low	Low
	Soil degradation/erosion	Loss of soil fertility; Impacts on long-term productivity and land management costs.	Medium	Medium	Medium
	Landslide	n/a for Vransko	Low	Low	Low
	Subsidence	n/a for Vransko	Low	Low	Low



AREA: FISHING AND AQUACULTURE			Use of resources	Income and employment	Multifunctionality
CLIMATE FACTORS	THREATS	IMPACTS	SENSITIVITY	SENSITIVITY	SENSITIVITY
TEMPERATURE	Temperature increase, heat waves	Alters water temperature, affecting fish reproduction, migration, and metabolism. Increased fish mortality and vulnerability to disease. Invasive species like prussian carp (<i>Carassius gibelio</i>) sunfish (<i>Lepomis gibbosus</i>) and blue crab (<i>Callinectes sapidus</i>) outcompete native species and disrupt food chains. High temperatures reduce oxygen levels in water; Algae blooms increase.	High	Medium	Medium
	Cold waves, frost	No negative effect.	Low	Low	Low
	Wildfires	Indirect effects through ash and debris entering water bodies, impacting water quality.	Medium	Low	Low
WIND	Changes in the wind regime, storms (rain-snow and wind)	Alters water circulation, influencing nutrient availability and fish distribution; Limits fishing activity.	Medium	Medium	Medium
	Whirlwinds	Can damage boats and onshore facilities; very localized impact.	Low	Low	Low
	Change in the hydrological regime (water stress, drought) and type of precipitation	Affects salinity and nutrient load; High temperatures reduce oxygen levels in water; Impacts fish species sensitive to water quality. Algae blooms increase. Affects breeding of migratory and freshwater-dependent fish.	High	Medium	High



WATER	Sea acidification	Impacts food chains.	Low	Low	Medium
	Saltwater intrusion	Increases salinity; Negatively affects freshwater species.	High	Medium	High
	Sea level rise	Reduces freshwater inflow; Decline in water levels and quality; Increased salinity in coastal waters affecting species composition.	High	Medium	Medium
	Flooding (coastal, fluvial, pluvial, groundwater)	Erosion and sediment load impacting ecosystems; Nutrient load increase.	Medium	Low	Medium
SOLID MASS	Coastal erosion	n/a for Vransko	Low	Low	Low
	Soil degradation/erosion	Increased sediment load in water; impacts water quality and fish gills.	Medium	Low	Low
	Landslide	n/a for Vransko	Low	Low	Low
	Subsidence	n/a for Vransko	Low	Low	Low

