CLIMAAX
climate ready regions

Deliverable Phase 1 – Climate risk assessment

Name of the project

Bosna and Herzegovina, Herzegovina-Neretva Canton /Municipality Neum

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Document Information

Deliverable Title	Phase 1 – Climate risk assessment
Brief Description	This deliverable deals with climate hazards and climate risks in the Municipality of Neum, in southwestern part of Bosnia and Herzegovina. It is a climate risk assessment and a part of the project based on CLIMAAX approach and instructions. The deliverable identifies climate hazards and risks as part of the global climate change, defines stakeholders involved in the process of implementation of climate change adaptation and mitigation policies and the geographic areas exposed to the hazards. This risk assessment sets the scene for future research of the issue based on stakeholder engagement and adaptation measures.
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Leading Institution	
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Abbreviations and acronyms

Abbreviation / acronym	Description
CLIMAAX	CLIMAte risk and vulnerability Assessment framework and toolboX
CRM	Climate Risk Management
CRA	Climate Risk Assessment

Executive summary

This deliverable was made as an initial stage of the CLIMAAX project which is focused on developing a unique methodologic approach for climate risk assessment of regions and communities. The project is a part of European Union's efforts aimed at preparing the continent for climate hazards by designating climate change adaptation policies and strategies. Such approach should help European regions and communities to face contemporary climate change and to act accordingly. This deliverable is a climate risk assessment addressing climate hazards in the Municipality of Neum, the only seaside administrative unit of Bosnia and Herzegovina. Situated in the southern part of the country, it is an area at the contact of waterless karstic terrain and Adriatic coast characterized by Mediterranean climate. The reader will learn from this deliverable about the most important climate hazards and their geographic and time dimensions just as the most relevant stakeholders involved in the implementation of climate adaptation policies in the Municipality.

During this initial phase of the project several main actions were undertaken like assessment of the relevant climate hazards and geographic areas that are especially threatened by their impact and assessment of local stakeholders affected by implementation of climate change adaptation policies. The main results and findings of research during the first phase of the project are understanding of the most relevant climate hazards, definition of vulnerable areas, recognition of local stakeholders and climate risk analysis. Besides humans and their activities, climate hazards in the municipality also have a negative impact on ecosystems in the rural hinterland and for those in the Adriatic Sea. The research also showed the impact of salinization of freshwater in the neighbouring Neretva River Delta, from where municipality of Neum gets drinking water for its water-supply system. If salinization in the Delta region continues, the Municipality of Neum would be forced to use local sources which get the water from rainfall. In such circumstances, the impact of contemporary climate hazards on humans and their activities would be even more important. All the results achieved are fundamental for next stage of the project since they are necessary for research in the future, especially for designation of climate change adaptation strategies and policies on local level together with their implementation in various parts of the Municipality.

Climate risk assessment in the Municipality of Neum showed that climate hazards are an important issue not only on regional but also on local level. The assessment confirmed that climate change accelerates climate hazards and raises concerns among certain groups of the local population. These social groups form stakeholders whose way of life and activities may be affected by climate adaptation policies. The research showed that there are two key hazards in the municipality: droughts and heatwaves. Droughts are characteristic for prolonged period of warm part of the year and are registered throughout the Municipality. On the other hand, heatwaves are predominantly typical for densely urbanized seaside areas of the town of Neum, almost exclusively oriented towards beach tourism. The two hazards may have a very negative impact in the future because droughts determine local water-supply of dwellings and development of agriculture while heatwaves may have an impact on beach tourism in the coastal area.

1 Introduction

1.1 Background

Municipality of Neum is the only coastal Municipality in the Republic of Bosnia and Herzegovina. Under its jurisdiction are all 20 kilometers of the Adriatic coastline that belong to Bosnia and Herzegovina (Figure 1-1). Beside the coastline the Municipality also incorporates the hinterland. The total area of this local administrative unit is 246,03 km^2 in total. It comprises of one 27 settlements with a total of 4653 inhabitants (2013 census) and density of only 22 inhabitants per square kilometer. Almost two thirds of the total population are in the town of Neum (population 3013.) which is the only urban settlement in the Municipality. The Neum town is the economic centre of the Municipality thanks to the dynamic tourism development that started in the mid-1960s after construction of the Adriatic highway. The construction of big hotels and resorts for industrial workers was followed by the fast expansion of weekend houses. Since predominantly karstic terrain, characterized by bare rocks, no forests or watercourses and very small parcels of arable land, gives very limited economic opportunities, the population is heavily dependent of beach tourism during the summer months. Its expansion at the turn of the century has brought about very concentrated over construction in the coastal area with predominance of modern building materials (concrete, glass, asphalt) on the steep terrain.

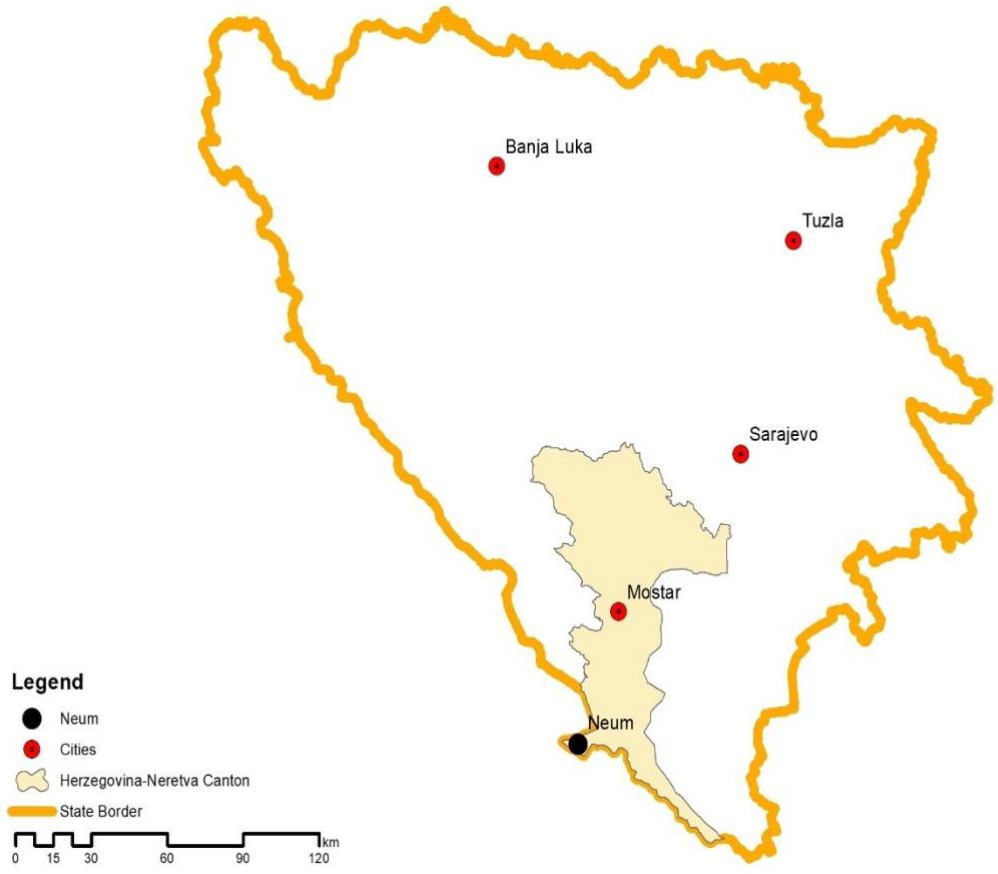

Figure 1-1 Geographic situation of Municipality of Neum inside Herzegovina-Neretva Canton of Bosnia and Herzegovina

1.2 Main objectives of the project

There are **multiple objectives** of the CLIMAAX project for the Municipality of Neum that the authors of this delivery tend to achieve.

1) Define and research the most relevant climate risks that the Municipality of Neum is facing just as its influence on the local population, tourists and local economy.

2) Define and analyze the climate adaptation action that is possible to implement in the Municipality of Neum.
3) Research the possibility of the stakeholders involvement and their behavioural change toward the climate change.

Since the administrative unit of Neum, as an integral part of Bosnia and Herzegovina, is dedicated to climate change mitigation and adaptation, the CLIMAAX project is a way of its incorporation into the European Municipality of area that address the climate change in a systematic manner.
Since the project is based on relevant data and scientific analysis, it would be the first systematic study of the climate risks and hazards in the coastal part of Bosnia and Herzegovina. At the same moment, the projects will take into consideration the environmental dimension of the climate change: the natural ecosystem in interaction with the man-made system. The environment in the Municipality of Neum differs significantly: the coastline is heavily urbanized and under significant tourism pressure while the hinterland is rural, sparsely populated and underdeveloped. Therefore, the project would approach these two areas taking into consideration its specific characteristics when dealing with the climate change impact. The CLIMAAX project will also stimulate the local decision makers to face the climate change issue more boldly and promptly than before. This dimension is especially important from the economic point of view since beach tourism is the principal source of income in the Municipality and certain climate risks like heatwaves and droughts are influencing contemporary tourism in a negative way.
The most important **expected benefit** of applying the CLIMAAX Handbook is the designation of climate risk assessment of the Municipality Neum as an inicial phase of and climate adaptation plan and risk management plan. Such documents are necessary for a small coastal administrative unit that economically depends on coastal tourism.

1.3 Project team

Associate Professor Višnja Bukvić, Ph.D. is biologist specialized in ornithology, ichthyology and wetlands habitat. She is retired after decades of working at the University of Herzegovina in Bosnia and Herzegovina where she was teaching biological subjects and participating in various research from the field of biology.

Full Professor Nikola Glamuzina, Ph.D. is a geographer specialized in economic geography, urban geography and research of conflicts in the protected nature areas. He works at the University of Split, where he teaches geographic subjects.

Associate Professor Ivan Vučković, Ph.D. is a biologist specialized in water conservation and research of freshwater habitat. He currently works in the private sector as an expert in water ecology and environmental impact analysis. He also teaches biology at the University of Zagreb.

1.4 Outline of the document's structure

This documents according to the CLIMAAX deliverable generic guideline and consists of the following sections:

Executive summary provides a whole view of the document in a short form enabling a reader of the deliverable to understand the document without reading it in full.

Introduction consists of a short description of the area researched, the main objectives of the project and the members of the project team.

Climate risk assessment – phase 1 is a section focused on detailed climate risk analysis that begins with three subsections: scoping (definition of objectives, context and stakeholders involved in the process), risk exploration and risk analysis. The second part consists of two subsections about preliminary key risk assessment findings and preliminary monitoring and evaluation. The section ends with a brief description of the work plan for the remaining phases of the project.

Conclusion – phase 1 concerns the conclusion regarding the climate risk assessments.

Progress evaluation and contribution to future phases describe the future work on the project in connection with the very deliverable.

This document ends with two sections that classify and list all the outputs produced during the work on the deliverable (**Supporting documentation**) and the literature consulted and cited (**References**).

2 Climate risk assessment – phase 1

This climate risk assessment for the Municipality of Neum relies on CLIMAAX Framework and tends to answer questions regarding the relevant local climate risks.

2.1 Scoping

Scoping is the first step in the climate risk assessment divided into three phases: definition of objectives, context and stakeholder involvement. This section will introduce us to the impact of climate change in the Municipality of Neum.

2.1.1 Objectives

The objective of this CRA is basic research into the complex impact of climate risks in the Municipality of Neum on local population and activities. The purpose of this document is to design a general overview of the local climate risk applying the CLIMAAX methodological approach. **The expected outcome of this deliverable is to encourage the local decision makers, stakeholders and various individuals and organizations to face the climate risks and approach them with adequate strategic action.**
The objective of our CRA is to be in touch with local policy and decision making since the local political frame is already sensitive to the issues of climate risks and climate change in general. Therefore, the outcome of these projects would serve the decision makers in designation of local development plans, strategies and policies from the area of climate change adaptation and mitigation.
The most important **limitation of this CRA** is the availability of relevant climate data from the local weather station: air temperature, precipitation.
Although this deliverable aims to define all the relevant stakeholders, their involvement depends on many factors which is not easy to address at every stage of communication.
Our experience from previous research is that the stakeholders' involvement can always be deeper and wider because they have a special place in the implementation of various plans, strategies and policies.

2.1.2 Context

The issue of climate hazards, impacts and risks is well known in the region as part of the global climate change process. This issue is well covered by various documents and acts on national and regional levels. However, the fact is that not much has been done by now to materialize everything that is written in legislative documents. Specific action regarding climate change adaptation and mitigation is still missing just like action about climate hazards and risks.

The project is trying to address **the problem of major climate hazards and risks** in the Municipality of Neum. Since it is the only seaside Municipality in Bosnia and Herzegovina it is heavily dependent of beach tourism during the summer month at the coast (the town of Neum) and agriculture in the rural area in hinterland. However, because of **climate hazards such as heatwaves and droughts during summer, the principal economic activities in the Municipality are under pressure**. We are trying to address this problem to direct the local stakeholder toward better designed climate hazards adaptation policies.

The national laws in Bosnia and Herzegovina proscribes and empowers regional and local levels of governance to pass various acts that address the climate change issue. This issue is well known in

the country and addressed accordingly from the legislative perspective in the form of various acts, regulations and strategies.

The Municipality of Neum almost exclusively relies on beach tourism (on the coast) and agriculture (in the hinterland).
They may be affected by climate change in a negative way because they make summer stays for guests unbearable in the urbanized seaside area. On the other hand, heatwaves, combined with prolonged summer droughts, are threatening agriculture (both farming ang cattle breeding) in the rural hinterland.

Currently there is **no relevant outside influence on the problem**. There are very few initiatives with no significant results considering the problem.

Possible **adaptation interventions** that can help meet objectives are from the realm of decision-making activities. **We believe that directing local decision makers toward active (instead of generally prevailing reactive) climate change policies the effect of climate hazards on the local economy could be significantly diminished.** Various interventions from the area of water saving, **Municipality greening, precipitation use, sustainable construction can be introduced in the Municipality on the ground of introduction of new climate adaptation policies**.

2.1.3 Participation and risk ownership

Climate change and climate hazards influence vast groups of the local population. However, there are certain sectors of the local population who are more influenced and therefore more involved in the process. Their participation in the project is crucial for the successful implementation of the CLIMAAX project. Our research showed that there are following **local stakeholders involved in the process: tourism sector, decision makers, farmers, citizen groups concerned about the quality of life**.
It is important to consider **interrelations between these stakeholders** (Figure 2-1). While decision makers on local and regional levels oversee implementation of climate change adaptation and mitigation policy, at the same time they must take care of other stakeholders. Current democratic system determines electiveness of governing bodies on every level, and such a situation leads to various trade-offs among them and stakeholders involved in the process: decision makers are trying to implement the policy without getting into conflict with various stakeholders because they are a part of electoral body. Such a fact may result in half-hearted implementation of some segments of the adaptation policy especially if they conflict with stakeholders' concerns. Climate change adaptation policy demands participation from the three stakeholders: such participation also may be full or just formal if the policy is unfavourable for their concerns.

While **relevant representatives** of local decision makers are easy to define since they come from the governing political structures, other stakeholder groups are more informal and have no official representation. We are planning to define them during research through communication as part of the field work.

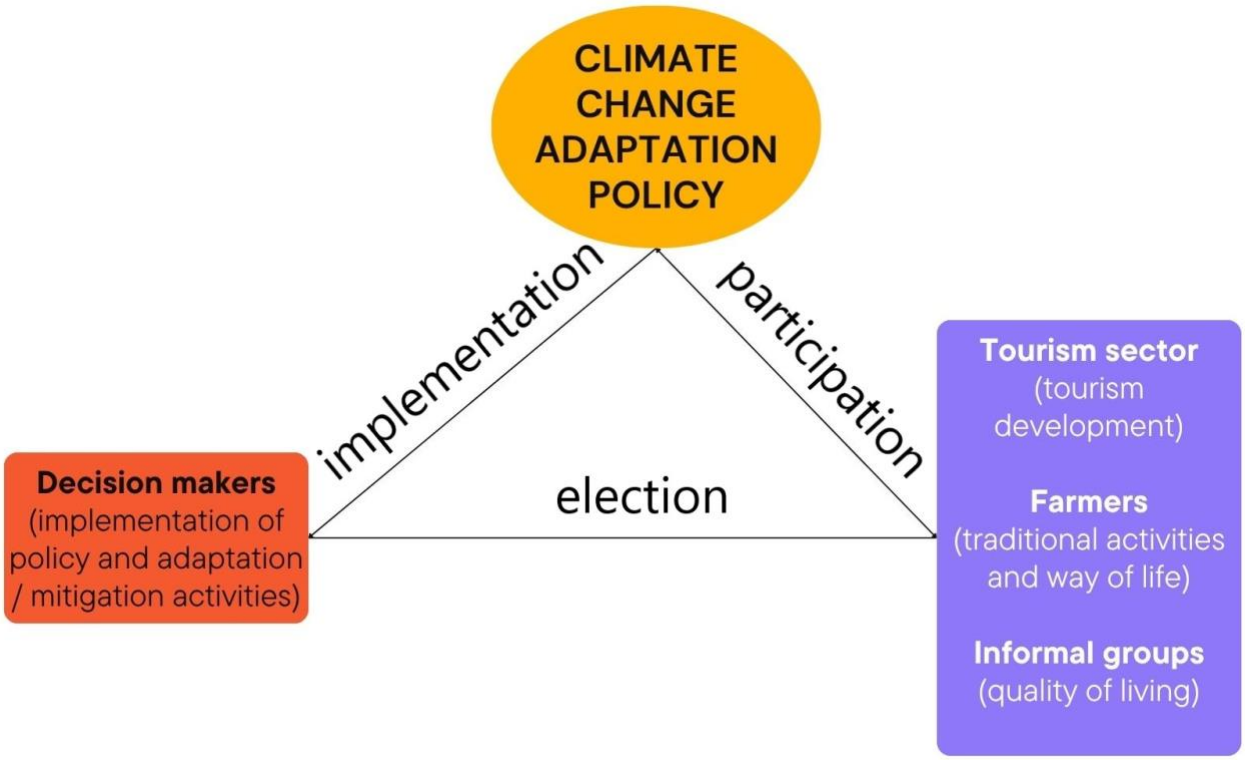

Figure 2-1 A chart showing the relevant stakeholders, their concerns and interconnections

The **risk ownership is owned by all the relevant stakeholder groups**. The ownership of the risk will be more precisely defined in later stages of the projects when the stakeholder interaction and their relationship with climate change consequences is better researched and understood.

Our preliminary research shows that the **level of risk acceptable to the Municipality** should be low since there is a concern among the stakeholders that the principal sources of income in urbanized seaside and rural hinterland could be negatively influenced by the introduction of restrictive climate change and climate hazard adaptation policies.

We want to **communicate our results** publicly over the Internet, that is widely used in the Municipality. We would also like to communicate the results through workshops so we could obtain feedback from the relevant stakeholders.

2.2 Risk Exploration

Defining climate hazards, just as **screening of the risks** was done through communication with wide selection of local population and key stakeholders. Our goal was to get the best possible picture of climate change issues in the Municipality that are visible to the local population. At the same time, we tried not to divert from the CLIMAAX list of relevant hazards and definition of climate risks. **The first results showed that the locals are fully aware of climate change and climate hazards while on the other hand, many do not fully understand the concept of climate risks, or they simply deny the risks are in any connection with human activities.** However, we found that there is a significant

concern about the impact of climate change and especially the relevant climate hazards in the future, primarily from the point of view of prevailing economic activities and quality of life.

The stakeholder's engagement during focus group discussions and workshop was crucial for identifying risk severity, urgency, resilience capacity and risk priorities (Figure 2-2). The analysis showed that there are two risk workflows with very high-risk priority: heatwaves and drought.

One risk workflow – fire – is of moderate risk priority. Fire, in form of wildfire, occur almost exclusively during the dry season, especially in the summer months and demand certain precautions in the future. Remaining four risk workflows (river flooding, coastal flooding, heavy rainfall, snow, wind) have low risk ranking.

2.2.1 Screen risks (selection of main hazards)

The field research, combined with analysis of meteorological data, **showed that there are two relevant climate-related hazards: droughts and heatwaves**. These hazards have been perceived by the locals during the warm part of the last five years in continuity. **There is a general attitude that both hazards seem to be more intense each year and that their impact on the environment, human activities and quality of life get worse.**

Risk workflow	Severity		Urgency	Capacity	Risk priority
	C	F		Resilience/ CRM	
River flooding					Low
Coastal flooding					Low
Heavy rainfall					Low
Heatwaves					Very high
Drought					Very high
Fire					Moderate
Snow					Low
Wind					Low

Severity	Urgency	Resilience Capacity	Risk Ranking
Critical	Immediate action needed	High	Very high
Substantial	More action needed	Substantial	High
Moderate	Watching brief	Medium	Moderate
Limited	No action needed	Low	Low

Figure 2-2 Key Risk Assessment of each risk workflow in the Municipality of Neum

The analysis helped us to single out two most important workflows in the municipality: drought and heatwaves (Figure 2-3). Both droughts and heatwaves are recognized to have substantial current severity that is expected to turn into critical in the future severity with immediate action needed. At the same time, medium resilience capacity is determined by insufficient lack of adequate policies that should address these issues.

Droughts and heatwaves are interconnected and occur primarily during the dry season, with peaks during the summer months. They got more severe since 2020, due to prolongation of dry season to a longer period than just two summer months (July and August). Draughts have special meaning for water supply because Neum lacks sufficient drinking water from local sources and is bound to use fresh water from the Neretva River delta. The recent problem of salinization of freshwater in the delta has special impact on the local water supply, especially during the summer months when Neum registers significant number of tourist arrivals and must use the water from the delta. Therefore, the problem of draughts is additionally related to the water supply of the households, hotels, weekend houses and even future irrigation systems in the rural settlements in the interior of the municipality.

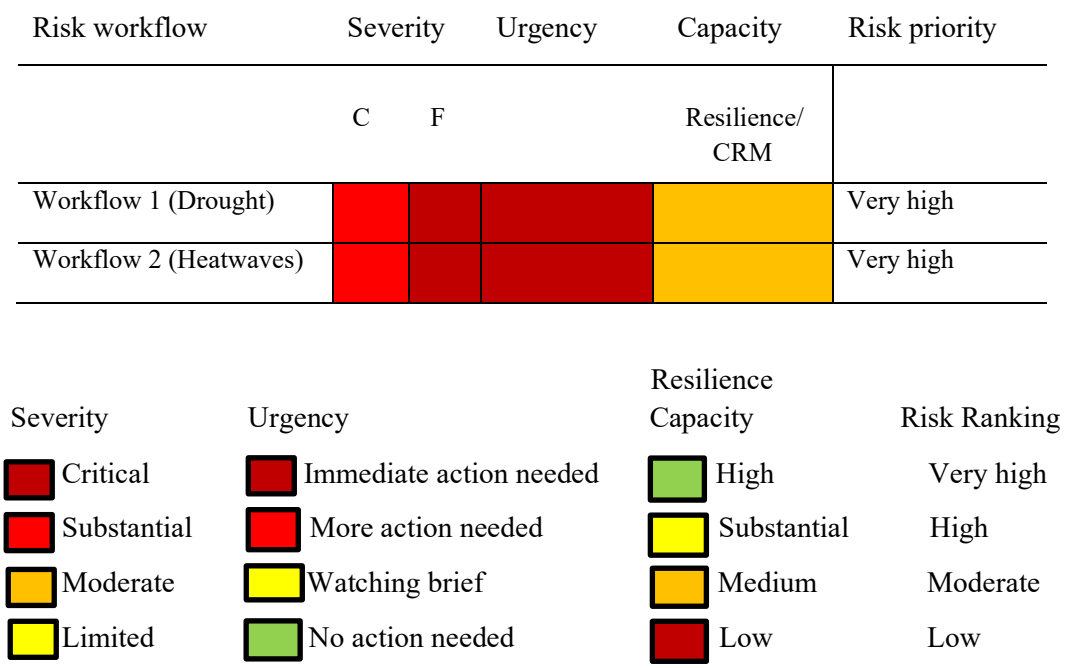

Figure 2-3 Risk prioritization of two most important risk workflows in the Municipality of Neum: droughts and heatwaves

The current situation regarding these climate hazards is widely perceived by the local Municipality as threatening and serious during the summer months. However, during the other parts of the year, their impact is diminished by the local population although it is a general view that droughts sometimes last through the Autumn months all the way till the end of the year. **The first hazards, droughts, occur in every part of the Municipality but have the biggest impact in the rural hinterland of the Municipality.** It is an area of karstic terrain with no surface waterflows or bodies of water. **Severe prolonged droughts have a negative impact on agriculture, the sole source of income in the rural hinterland. The second hazard is heatwaves. Although they are relevant for the whole**

Municipality, their impact is especially strong in the heavily urbanized seaside zone of the town of Neum. Since Neum is a resort town that was built during the second half of the 20thcentury its coastal area is covered by tons of concrete and asphalt in the shape of big hotels and many weekend-houses. Orientation toward mass tourism had defined a very compact type of construction with extremely limited areas of urban green. Because of that, **this urbanized area absorbs lots of sunshine irradiance during the summer months and makes tourists stay in the open air almost unbearable**. Such a situation affects primarily the tourism economy, the main source of income for the Municipality just as few locals who live inside this part of the town.

We observed **two hazards** for the Municipality of Neum: **droughts and heatwaves**. **The Copernicus Atlas shows that the Mediterranean region of Bosnia and Herzegovina, where the Neum Municipality is located, shows high values of several climate indicators: mean daily air temperature, numbers of extreme hot days and tropical nights and potential evapotranspiration.** These indicators are closely connected to climate change, primarily to global warming that is observed in various parts of the planet. They are also directly related to the two hazards that we have observed (droughts and heatwaves) and their impact is widely present in different parts of the Earth. The Copernicus Atlas also provides us with a broad picture of the problem because it is clearly visible that the geographic dimension of the problem is much bigger and more serious. It also warns us of necessity for the local action and implementation of local climate change adaptation and mitigation policies.

In this risk assessment we will **cover two hazards: droughts and heatwaves**. **We decided to focus on these hazards because they are the most relevant when compared to other climate hazards and because their impact on the local economy and quality of life is the most important.** In addition, these hazards are also singled out by the local population and local stakeholders as the most severe and worrying.

Data and knowledge that we have about these hazards, their impact and risks is based on the field work and communication with local population and the stakeholder groups. We gave priority to such a methodological approach because we considered that we should focus on the problems induced by climate change that burden the local Municipality and life of local population.

2.2.2 Workflow selection

Selection of two relevant climate hazards in the Municipality of Neum is the first step for climate risk assessment. The very assessment will be made in relation to vulnerable groups of the local population and local stakeholders just as to the areas that are exposed to them.

2.2.2.1 Workflow #1: Drought risk

Drought risk in the Municipality of Neum is observed primarily during the warm part of the year, from late Spring to early Autumn. **It is a natural mechanism typical of the Mediterranean climate that has been modified during the contemporary period in a negative way: droughts get more severe, and they last longer.** Droughts have multiple effects on the environment. Besides being a serious problem for local agriculture severe droughts are closely related to wildfires in the Mediterranean area. **Such wildfires have devastating consequences for the environment, destroying scarce forests and vast areas of macchia vegetation. Its impact on biodiversity is destructive.**

Local farmers and shepherds constitute the most vulnerable group to droughts because their activities depend primarily on precipitation. Since there are no surface waterflows or bodies of

water in the Municipality and no complex irrigation systems agriculture during the summer droughts depend on individual irrigation. **Prolonged droughts in the future may have a negative impact on the water supply system, especially during the summer months when the number of tourists surpasses the number of local inhabitants.** Currently, the Municipality of Neum gets drinking water from the neighbouring Neretva Delta region combined with the local water sources. Since the water in the **Neretva Delta is threatened by salinization, the local water sources become more important.** Prolonged and severe droughts will have a negative impact on local water sources in the future.

In a small Municipality like Neum's **droughts happen in every part at the same time and there is no difference regarding the duration**. Currently, they impact more rural hinterland of the Municipality that depends on traditional agriculture. Nevertheless, in the future, under condition that the Municipality be forced to rely on local water sources, droughts may seriously impact the urbanized seaside resort area.

2.2.2.2 Workflow #2: Heatwaves risk

Heatwaves present another climate hazard in the Neum Municipality. While they occur during the summer months it is important to point out that the first summer heatwave now comes in June, earlier than before. **Heatwaves are closely connected with air temperature rise, hot days and nights, tropical heat and drought.** They strongly diminish the quality of life of local population and have a **negative impact on human activities such as agriculture and beach tourism**. Mediterranean setting of the Municipality with very small areas covered with forests and with predominantly rocky karstic terrain reinforce the negative impact of heatwaves on the local environment.

When dealing with the question of vulnerability to heatwaves, it is important to single out their negative and severe impact on human beings but also vegetation and animals. **Heatwaves significantly decrease the quality of life of locals who must spend most of the day inside their dwellings that are air conditioned.** Heatwaves also make spending time in the open **air unbearable for tourists who visit Neum almost exclusively because of beach tourism. Farmers and shepherds just like their activities also feel the bad impact of heatwaves.**

The seaside area of the Municipality is especially negatively affected by heatwaves. It is a zone of the Neum town, which started to develop during the last quarter of the 20th century as a seaside resort. Predominance of concrete and asphalt with very limited urban green induce *the heat island effect* during the summer months in the town of Neum. **This effect may have an extremely negative impact on beach tourism that is a backbone of the Municipality's economy.**

2.2.3 Choose Scenario

2.2.3.1 Workflow #1: Drought risk

The Municipality of Neum, as the only municipality from Bosnia and Herzegovina participating in the European CLIMAAX project, has developed a drought map that illustrates the current drought conditions across its territory. The map is based on the CLIMAAX methodology, which enables local communities to assess climate risks using scientifically grounded tools and data.

The map incorporates data from the Federal Hydrometeorological Institute of Bosnia and Herzegovina, satellite observations, regional climate studies, and local indicators of soil moisture and vegetation stress. Its purpose is to inform the public, agricultural producers, and decision-makers about current drought conditions, and to serve as a tool for planning adaptation measures and managing climate risks.

This drought map serves as an important tool for local government, agricultural producers, and all relevant stakeholders, enabling timely responses to climate challenges, resource protection, and community resilience.

Drought Risk Map – Municipality of Neum (2050–2080) Developed using the CLIMAAX methodology

This map presents a projection of drought risk across the Municipality of Neum for the current period, near futur 2050 to far future 2080 (Figure 2-4 to 2-10), developed using the CLIMAAX methodology – a European framework for assessing climate risks at the local level. The map is based on a combination of regional climate models, satellite simulations, local meteorological data, and vulnerability assessments specific to the Neum area.

The maps follow CLIMAAX visual standards, featuring clearly defined colors. It serves as a strategic tool for climate adaptation planning and public awareness regarding future challenges related to water availability, agriculture, and the environment.

Important: Since Bosnia and Herzegovina does not have NUTS classification, neighboring Croatian region HR037 was used in this workflow.

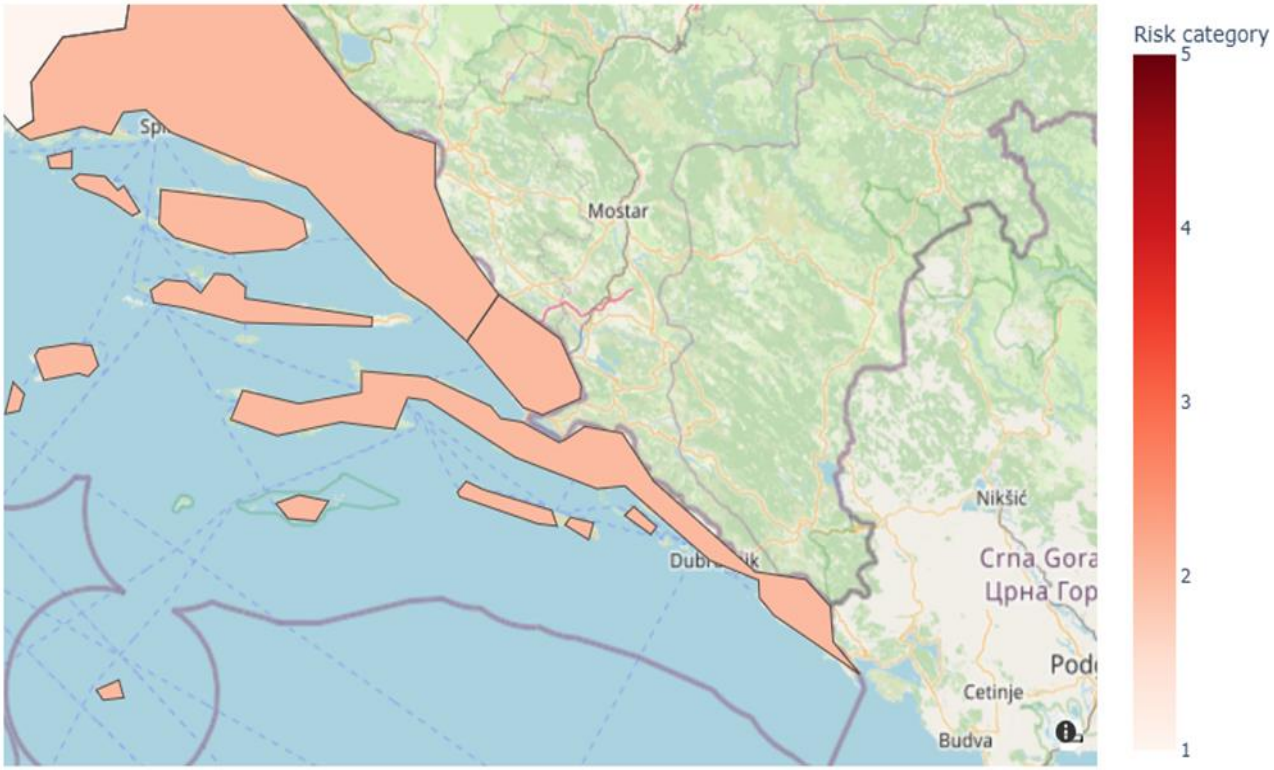

Figure 2-4 Geographic distribution of drought risk in Municipality of Neum by areas: current situation

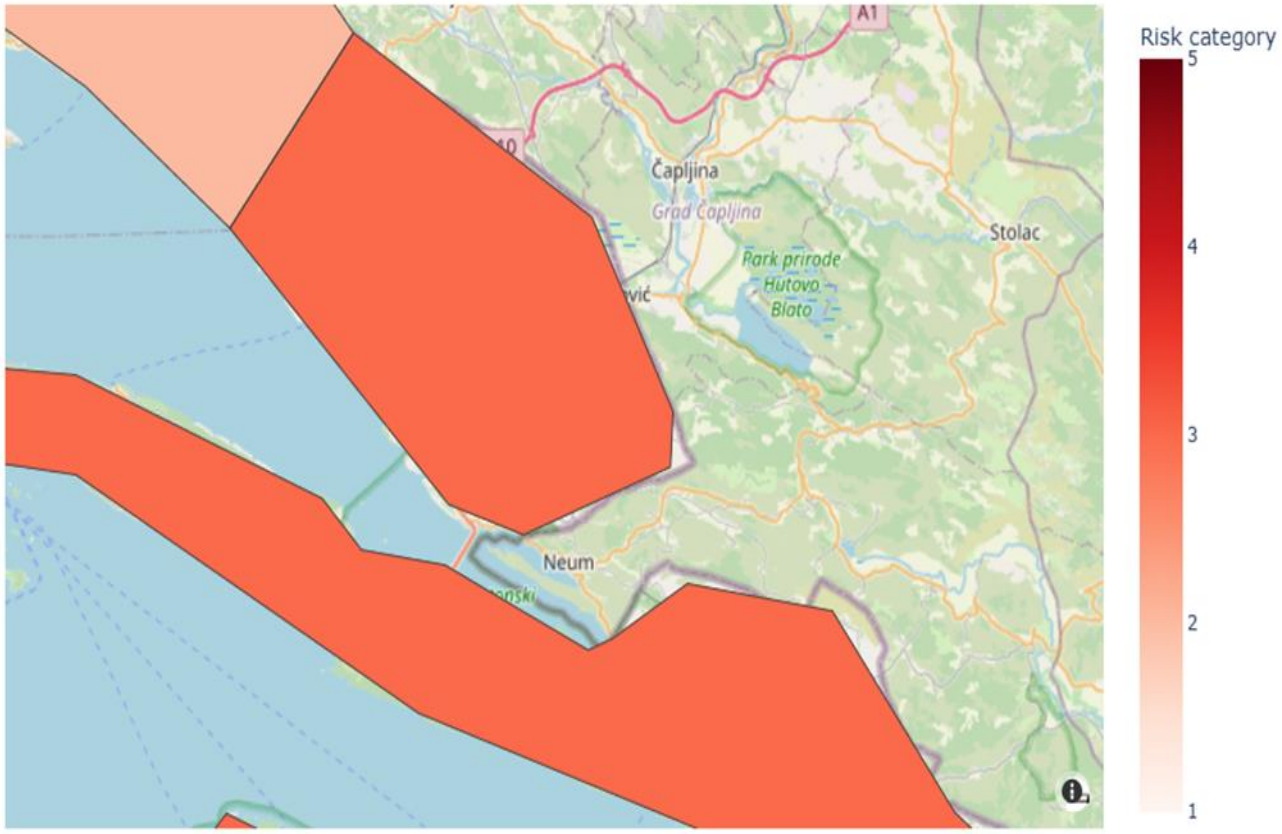

Figure 2-5 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 1-2.6 until 2050

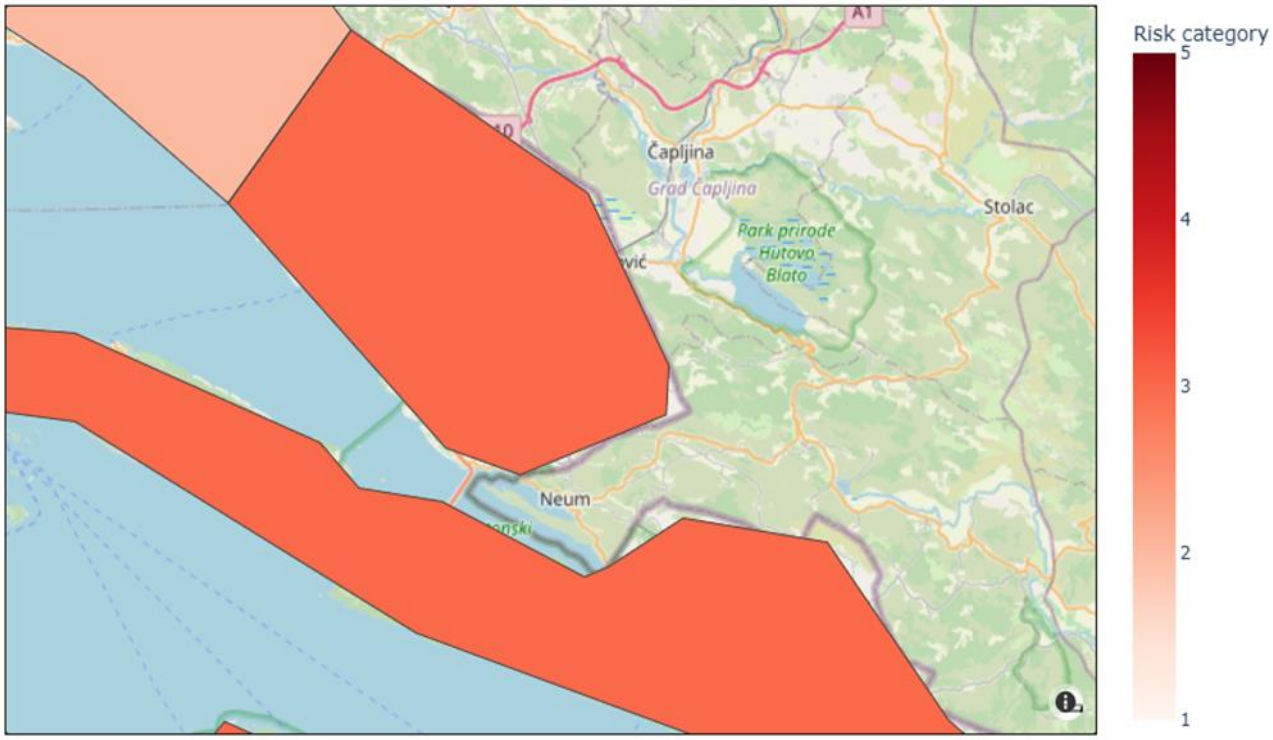

Figure 2-6 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 1-2.6 until 2080

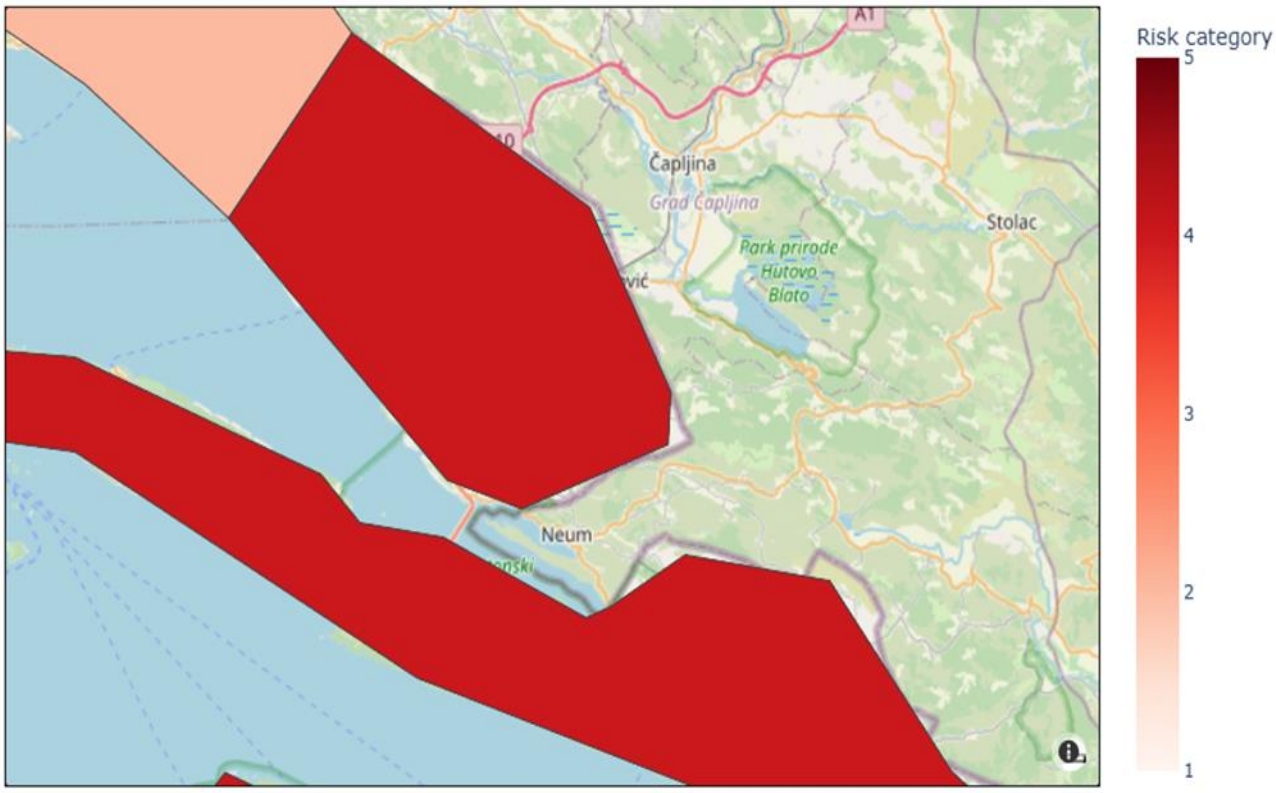

Figure 2-7 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 3-7.0 until 2050

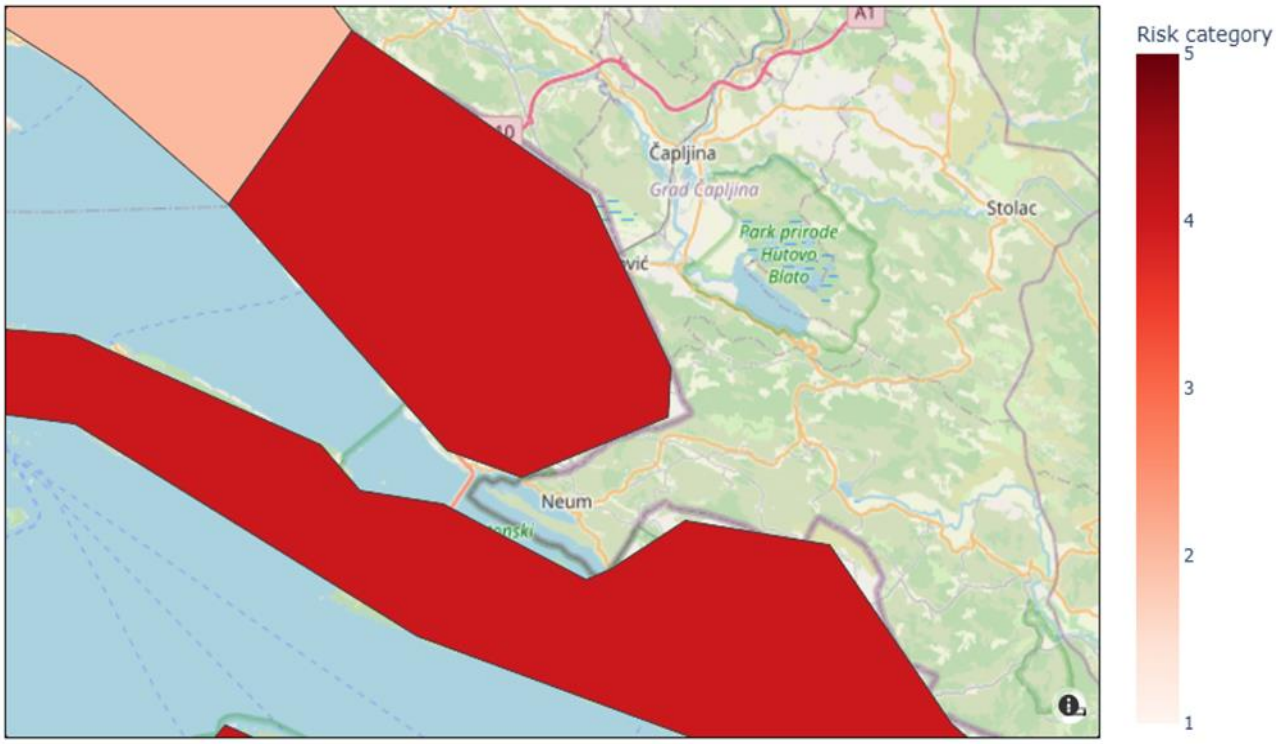

Figure 2-8 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 3-7.0 until 2080

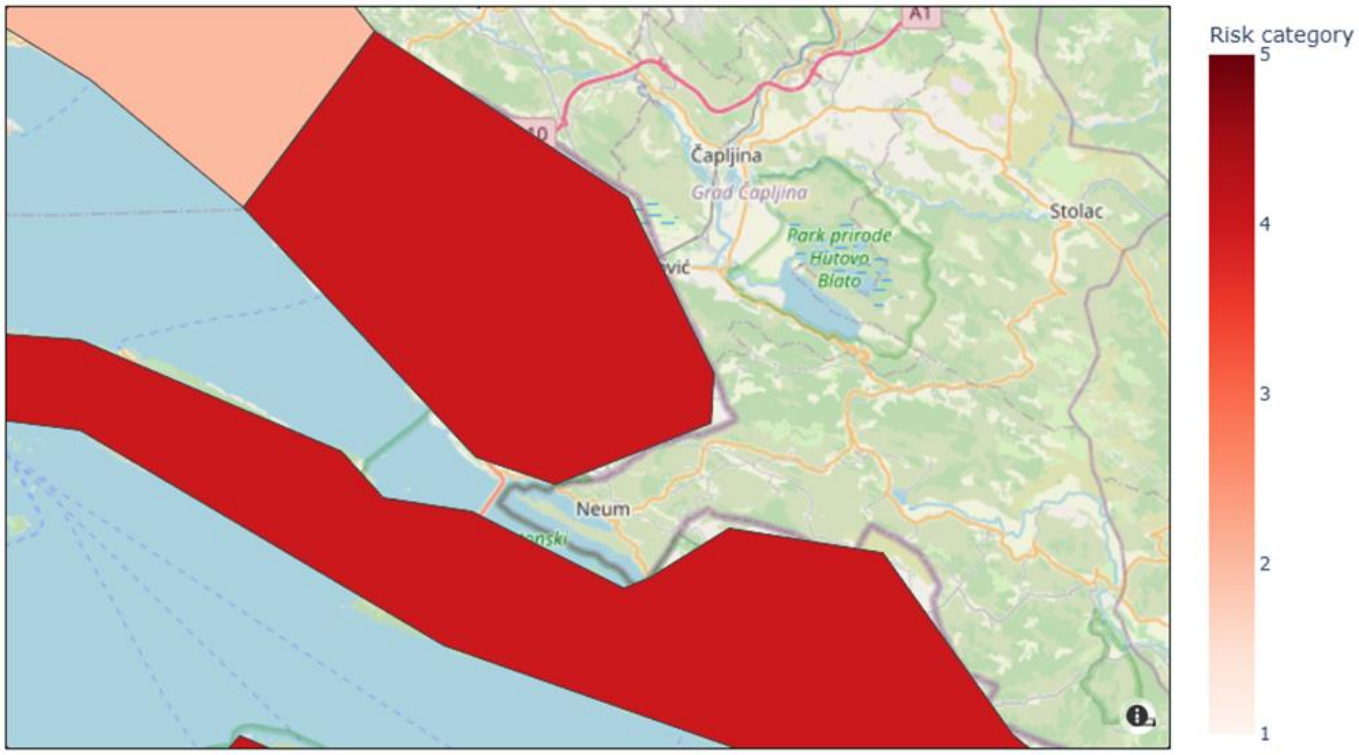

Figure 2-9 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 5-8.5 until 2050

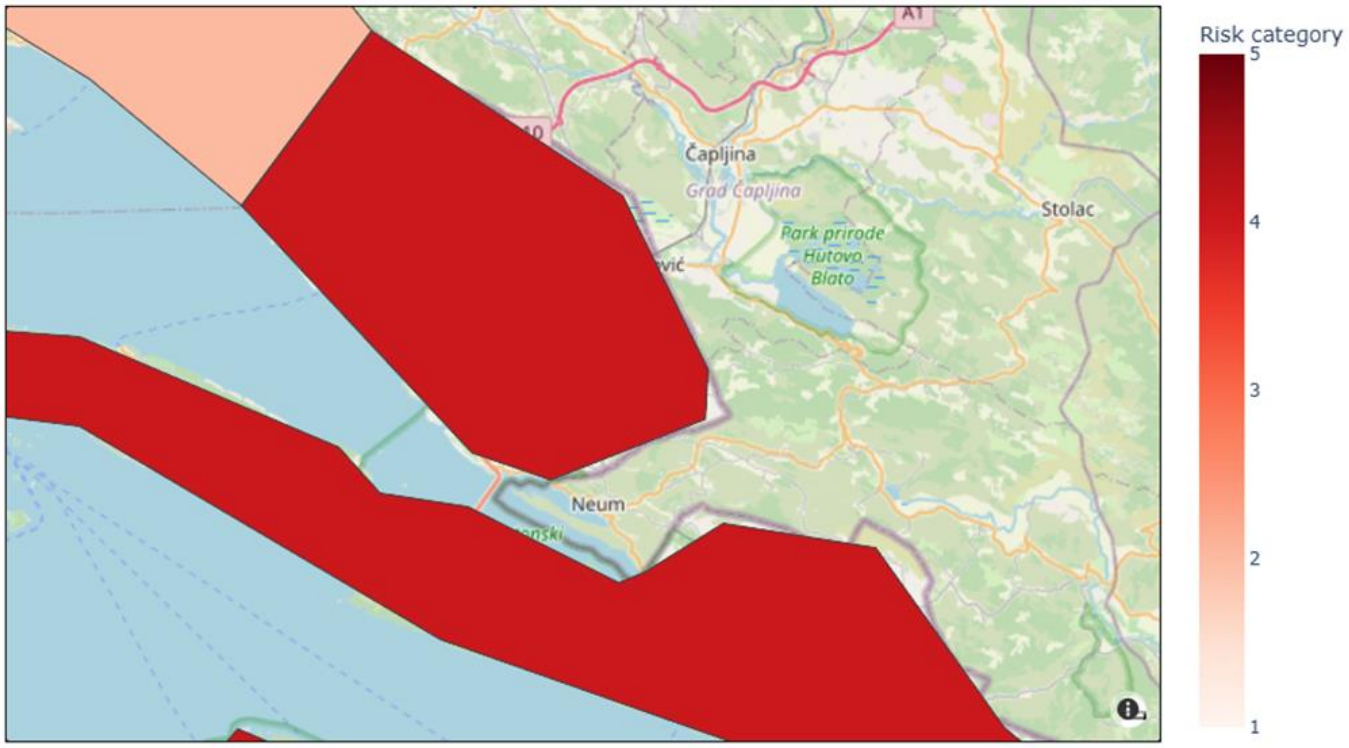

Figure 2-10 Geographic distribution of drought risk in Municipality of Neum by areas: scenario SSP 5-8.5 until 2080

2.2.3.2 Workflow #1: Heatwaves risk

This map presents the spatial distribution of heatwave risk across the Municipality of Neum for the period 1986 to 2025, developed using the CLIMAAX methodology. It is based on an analysis of climate data and local geographic features, applying a standardized color palette that indicates risk levels ranging from very low to catastrophic.

Changes in Heatwave Risk – Municipality of Neum

Comparison of the periods 1986–2025 and 2046–2075 with climate scenarios

The map for the period 2046–2075 (Figure 2-11) shows a marked increase in heatwave risk across the Municipality of Neum compared to the period 1986–2025. The analysis was conducted using the CLIMAAX methodology, incorporating climate projections based on scenarios developed by the Intergovernmental Panel on Climate Change (IPCC).

Applied Climate Scenario: RCP 8.5

This projection uses the RCP 8.5 scenario, which assumes continued high greenhouse gas emissions without significant global mitigation efforts. Under this scenario:

- Average summer temperatures are expected to rise by 2.5–4.5 °C by mid-century
- The duration of heatwaves will increase
- The number of days with moderate temperatures will decline

Alternative Scenario: RCP 4.5

If global mitigation measures are implemented, the RCP 4.5 scenario projects a more moderate temperature increase (1.5–2.5 °C) and a slower rise in risk levels. In that case:

- Gradac would likely remain in the low-risk category
- Zelenikovac would fall within the moderate to high-risk range
- Broćanac would remain among the most vulnerable areas, but without expansion of the extreme zone

Changes in Heatwave Risk – Municipality of Neum

Comparison of the periods 2016–2045 and 2045–2075 using CLIMAAX methodology

The map for the period 2016-2045 2046–2075 (Figure 2-9) reveals a further deterioration in climate conditions across the Municipality of Neum, with a significant increase in heatwave risk in nearly all settlements. The analysis was conducted using the CLIMAAX methodology, applying the official seven-level risk palette ranging from very low to catastrophic.

Conclusion

During the period 2046–2075, the Municipality of Neum enters a phase of extremely high climate risk. Under the RCP 8.5 scenario, average summer temperatures are projected to rise by more than 4 °C, with longer and more intense heatwaves. The map clearly highlights the urgent need for adaptation measures, including:

- Urban cooling and greening
- Protection of vulnerable populations
- Climate-resilient building standards
- Public awareness and education

This map serves as a critical tool for strategic planning and risk management in the context of climate change.

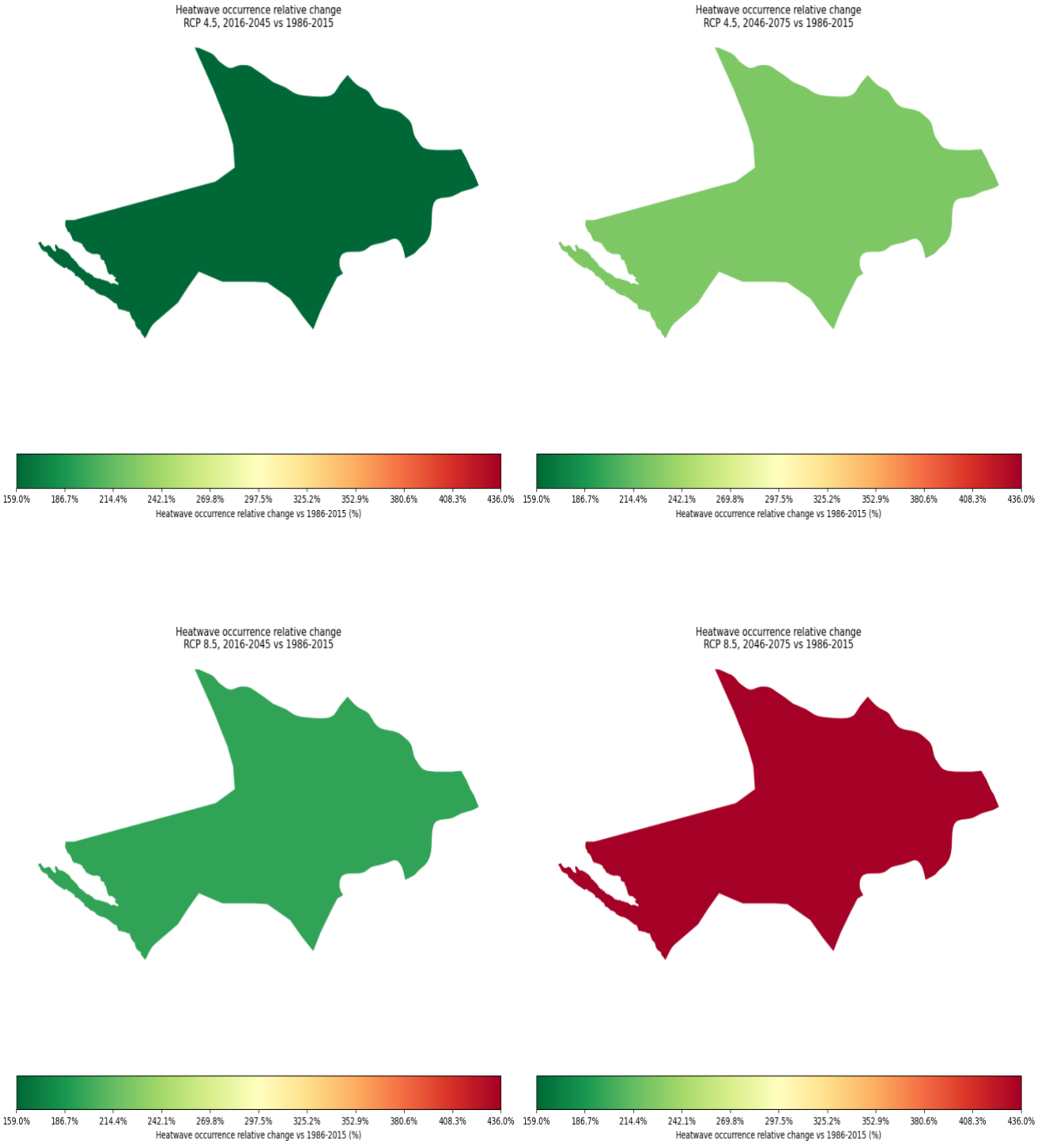

Figure 2-11 Geographic distribution of heatwaves occurrence relative change in Municipality of Neum for scenario RCP 4.5 for period 2016-2045 vs 1986-2015 and for period 2046-2075 vs 1986-2015(up) and for scenario RCP 8.5 for period 2016-2045 vs 1986-2015 and for period 2046-2075 vs 1986-2015 (down)

2.3 Risk Analysis

2.3.1 Workflow #1: Droughts risk management

2.3.1.1 Hazard assessment

Drought hazard analysis in the Municipality of Neum is done on level of areas. The analysis shows three key results:

1) The intensity **of drought ranges from mild to catastrophic with fastest negative development till 2045 and then no change in the level of the risk till the end of the century**.
2) Geographic dimension shows that **the risk is the biggest (extreme to catastrophic) in the hinterland with the second affected zone in the southern seaside areas**. The superficies of these two areas combined make up more than half of the Municipality.
3) The analysis does not consider an additional effect of the densely **urbanized Neum area where dominant use of modern construction materials causes overheating of the land surface**.
4) **Warming of the sea** is also not considered in the analysis. **It represents a special issue with negative consequences on local ecosystems.**

Table 2-1 Data overview workflow #1

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Precipitation, air temperature, solar irradiance	Rural population, GDP/capita	Land cover, population	Droughts risk categories (1-5)

2.3.1.2 Risk assessment

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Drought risk is severe in the Neum area primarily because of over construction in the eponymous town. These two of the most threatened areas differ significantly regarding the population density, characteristics of the settlements and type of economy. Inland Broćanac area is exclusively rural with low number of inhabitants divided into small settlements that rely on agriculture. On the contrary, the seaside Neum area is urban with high population concentration (almost two thirds of the Municipality's population live there) and oriented towards tourism economy more needed in certain areas.

Therefore, although these areas are especially threatened by droughts their characteristics demand different approaches when dealing with drought risk. Primal concern of Neum area would be securing the water supply during the tourism season in the summer while agricultural areas need integral solutions when dealing with droughts in accordance with rhythm of agricultural works. Reforestation, rainwater harvesting, urban cooling, installation of household water saving appliances, just like education on water saving techniques should be taken in all the areas with specific selection of those that are more needed in certain areas.

Since the projection shows acceleration of droughts risk till the end of the decade there is a need for action without postponement. This risk projection does not consider the problem salinization of freshwater in the neighbouring Neretva River Delta form where the Municipality of Neum gets running water. Further salinization would force Neum to use more local water sources with

questionable outcomes for a Municipality oriented towards mass tourism as the principal source of income.

2.3.2 Workflow #2: Heatwaves risk management

2.3.2.1 Hazard assessment

To monitor the increase in the number of hot days in Neum related to climate change, it is necessary to use standardized climatological and meteorological methods for monitoring, defining and analysing hot days. Here's how you can do it:
In climatology and meteorology, a hot day (often also "hot day") is defined as a day on which the highest daily air temperature reaches or exceeds a certain threshold - usually 30°C. This threshold is used in official statistics and climate analyses.

Data source

• Meteorological stations automatically record maximum, minimum and average daily temperatures. In Neum, there is available data from local stations, which can also be followed online (FHMZ BiH, Neum station).

• The Federal Hydrometeorological Institute of Bosnia and Herzegovina (FHMZ) has measurements and weather statistics that include daily temperatures.

Recording hot days

• Every day for which the maximum temperature (recorded in a standard meteorological shelter at 2 m above the ground) is 30°C or higher is recorded as a hot day.

Trend analysis and the impact of climate change

• In the long term, it is noted that the number of hot days is increasing over the years, which directly indicates the impact of climate change. Trends are monitored based on multi-decade data series, and various climatological reports and studies from Bosnia and Herzegovina a significant increase in the number of warm and hot days, especially in the southern regions.

• National climate studies predict an increasingly pronounced increase in these extremes by the middle and end of the 21st century.

The number of hot days in the Municipality of Neum has a significant connection with socio-economic conditions, as it affects multiple sectors and aspects of the population's life. Overall, a higher number of hot days in Neum through climate change leads to increased healthcare costs, reduced agricultural production, potential losses in tourism and greater demands for infrastructure

adjustments, which directly affects economic stability and quality of life in the Municipality.

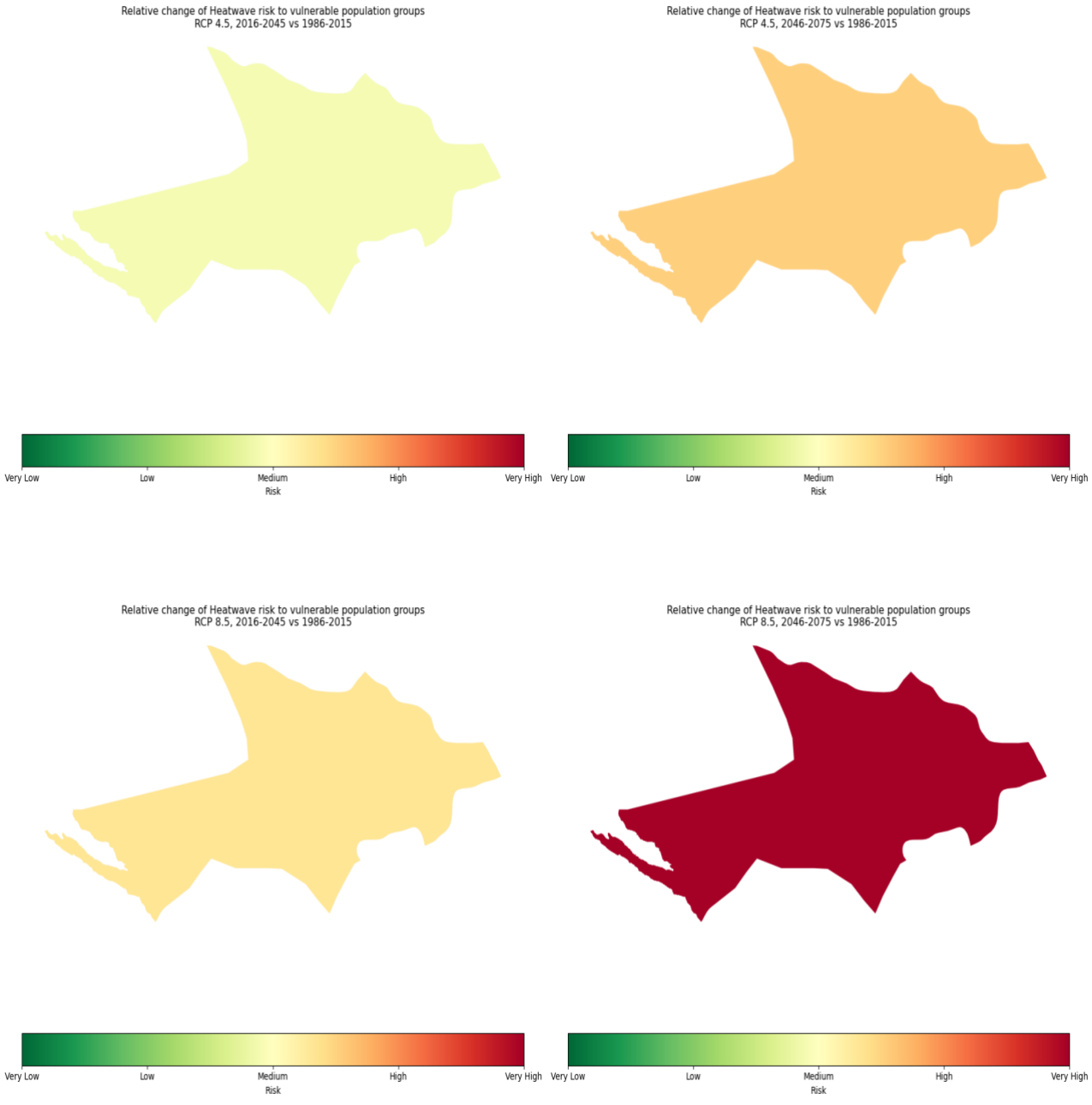

Figure 2-12 Relative change of heatwave risk to vulnerable population groups in Municipality of Neum for scenario RCP 4.5 for period 2016-2045 vs 1986-2015 and for period 2046-2075 vs 1986-2015 (up) and for scenario RCP 8.5 for period 2016-2045 vs 1986-2015 and for period 2046-2075 vs 1986-2015 (down)

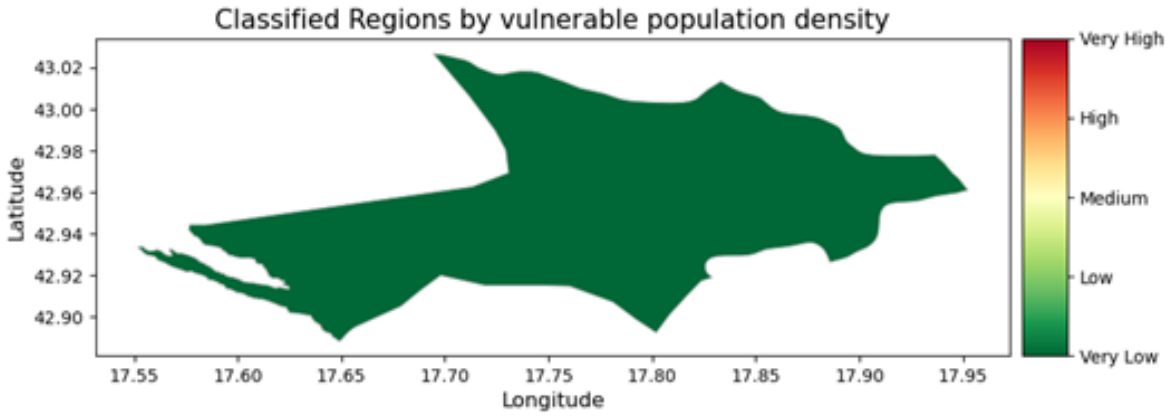

Figure 2-13 Classified Regions by vulnerable population density in Municipality of Neum

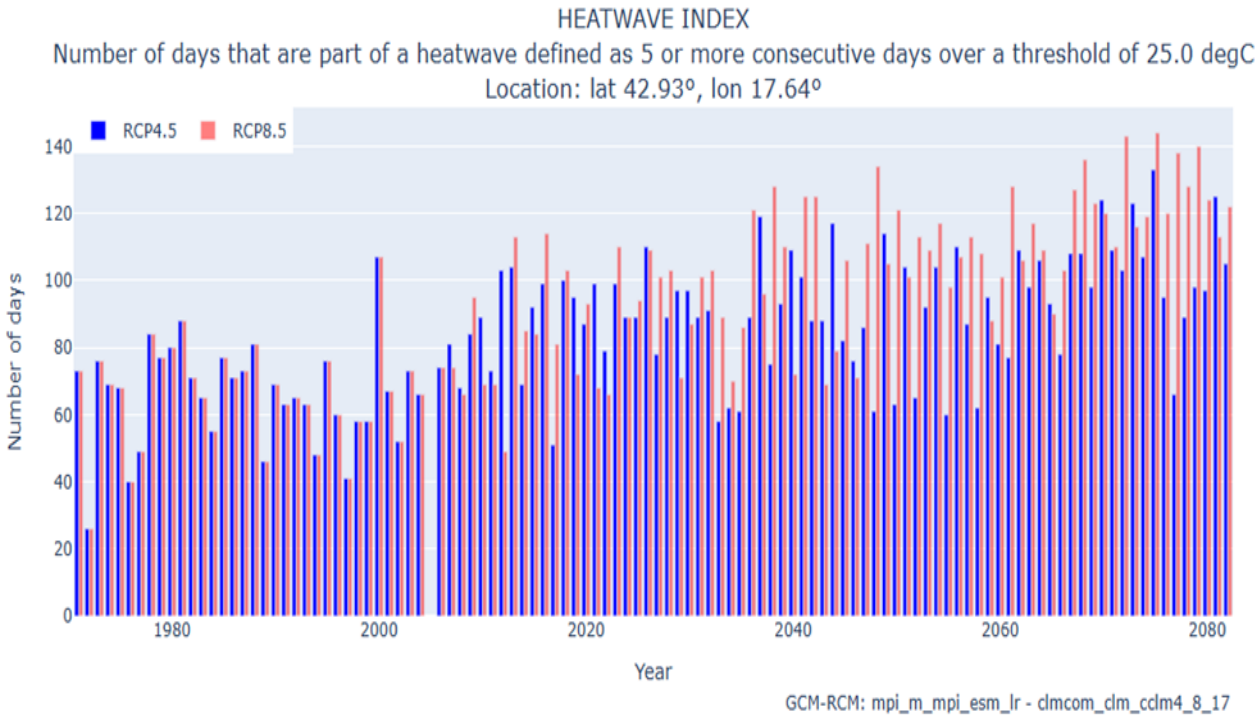

Figure 2-14 Heatwave Index based on number of days that are part of a heatwave defined as 5 or more consecutive days over a threshold of 25ºC in Municipality of Neum from 1980 to 2080 for scenario RCP 4.5 and RCP 8.5

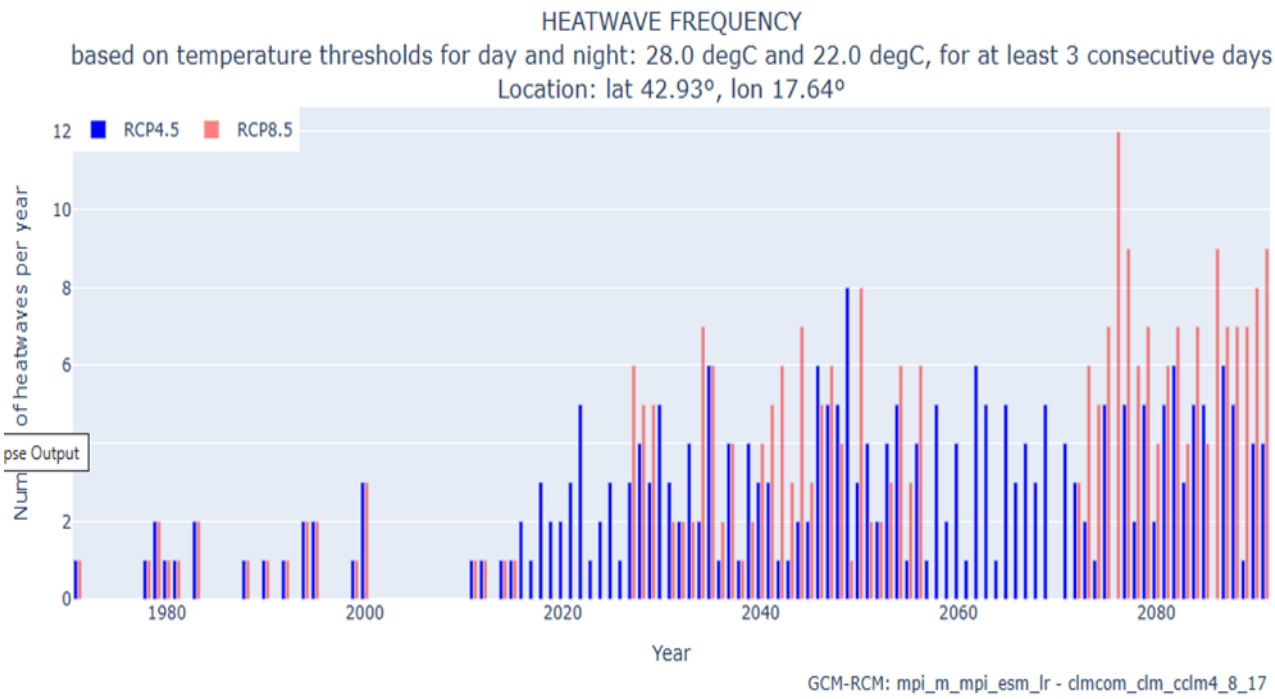

Figure 2-15 Heatwave Frequency based on temperature threshold for day and night; 28ºC and 22ºC for consecutive 3 days in Municipality of Neum from 1980 to 2080 for scenario RCP 4.5 and RCP 8.5

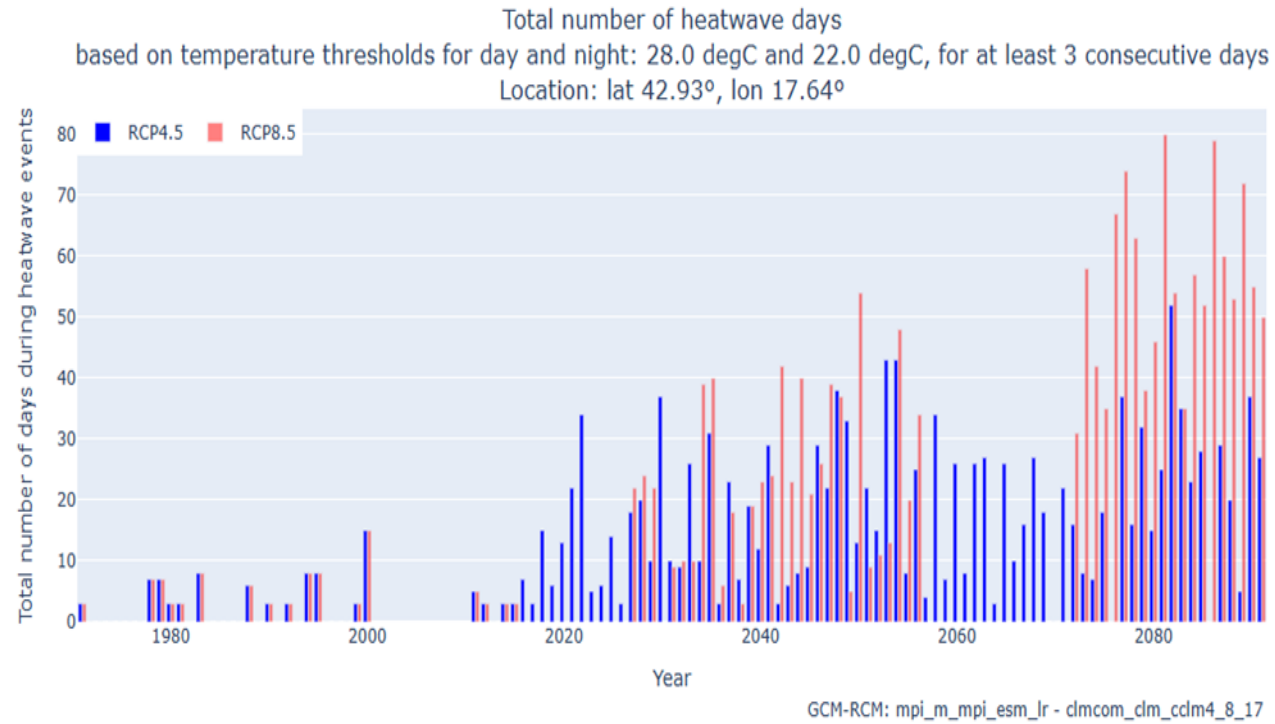

Figure 2-16 The number of Heatwave days based on temperature threshold for day and night; 28ºC and 22ºC for consecutive 3 day in Municipality of Neum from 1980 to 2080 for scenario RCP 4.5 and RCP 8.5

1. Health impacts
The increased number of **hot days increases the risk of heatstroke, dehydration and other health problems, especially in vulnerable groups (elderly, children, chronically ill)**. This burdens the health system and reduces the productivity of the population.

2. Tourism
As a coastal destination, Neum is largely dependent on tourism. **Extreme heat can reduce the number of tourists, especially if long-lasting heat waves occur, as they adversely affect the comfort of staying and outdoor activities.** On the other hand, mild and optimal heat waves can increase tourist attractiveness in certain periods.

3. Agriculture and fisheries
Hot days lead to increased irrigation needs and can cause droughts, which negatively affect crop yields and quality. In Neum, where agriculture is an important sector, this can reduce incomes and threaten the local economy.

4. Energy sector
Increased demand for electricity due to cooling (air conditioning) **can increase energy costs for households and businesses, which further burdens the economy and socio-economic conditions**.

5. Social adaptation
The increased number of hot **days requires investments in infrastructure (cool zones, water availability, health care),** which is a challenge for local government and its resources.

Table 2-2 Data overview workflow #2

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
Number of hot days, temperature of Earth's surface	Age & sex, GDP/capita, social vulnerability index (SoVI)	Urban land, land cover, population, competition on water	Wildfires risk categories (1-5)
...	...		

2.3.2.2 Risk assessment

The increase in the number of hot days in the municipality of Nem (or Neum, Bosnia and Herzegovina) is linked to vulnerability, exposure and risk within the climate change adaptation process through the CLIMAAX project as follows:
1. Vulnerability represents the sensitivity of local sectors (such as health, infrastructure, agriculture) to the impacts of climate change, including an increase in the number of hot days. **A higher number of hot days increases the sensitivity of individual sectors due to exposure to temperatures that can endanger human health and reduce productivity.**
2. Exposure denotes the degree to which the population, resources and infrastructure are subject to more frequent and intense heat waves and high temperatures. **An increase in the number of hot days directly increases this exposure.**
3. Risk is calculated as a function of threat (in this case an increased number of hot days as a climate hazard), vulnerability (sensitivity) and exposure. According to the IPCC AR5 approach used in analyses such as the CLIMAAX project, risk = (threat x weighting factor) + (vulnerability x weighting

factor) + (exposure x weighting factor), where a higher number of hot days increases the threat and thus the overall climate risk.
4. **In the municipality of Nem, through the CLIMAAX project, this concept of risk assessment is being used to understand and quantify the link between the increase in the number of hot days and the impact on the vulnerability and exposure of the local Municipality.** This allows for better planning of adaptation measures and strengthening resilience to climate change.

In figure 2-17 the LST values represent the surface temperature, not the air temperature. The surface temperature reaches higher values than the air temperature. The ground surface temperature is an important influencing factor for the weather as it is perceived by humans. The temperature of the ground surface can be more than 10°C higher than the air temperature on a sunny day, and up to 10°C below air temperature on clear nights when the surface loses heat by radiation.

Classify based on the LST
In this step, you reclassify the LST into 5 categories (Very low - Very high) based on the temperature, each category will contain two values, we divided the values into 10 groups because of the better sensitivity in the urban areas. You can change the threshold values for each category:

- **Very low** < 20-25°C [values 1-2]
- **Low** 25-35 °C [values 3-4]
- **Medium** 35-45 °C [values 5-6]
- **High** 45-55 °C [values 7-8]
- **Very High** 55-60 <°C [values 9-10]

In figure 2-18 we display the measured data of the 2m air temperature together with the LST data, to see for which days we downloaded the LST data. This step will give us the information if we downloaded the data for the days with the highest air temperature.

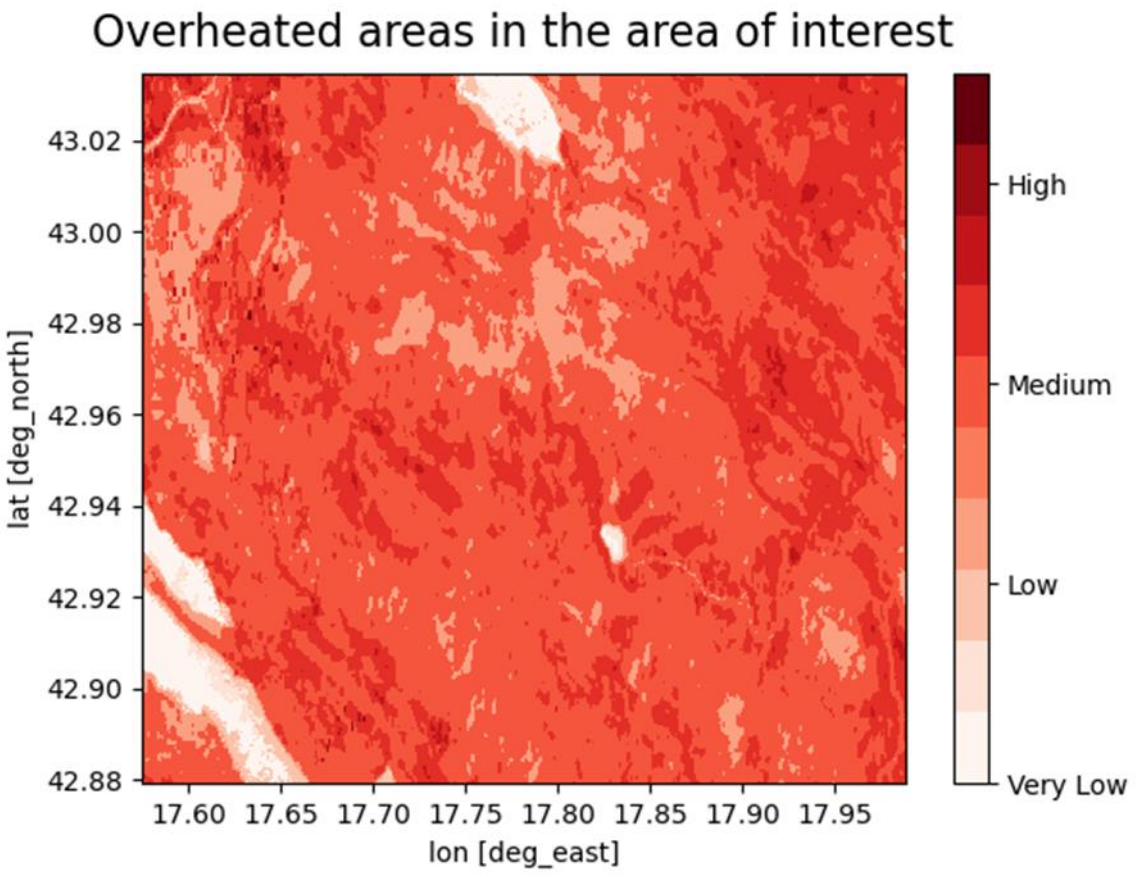

Figure 2-17 The image shows LST (Land Surface Temperature)

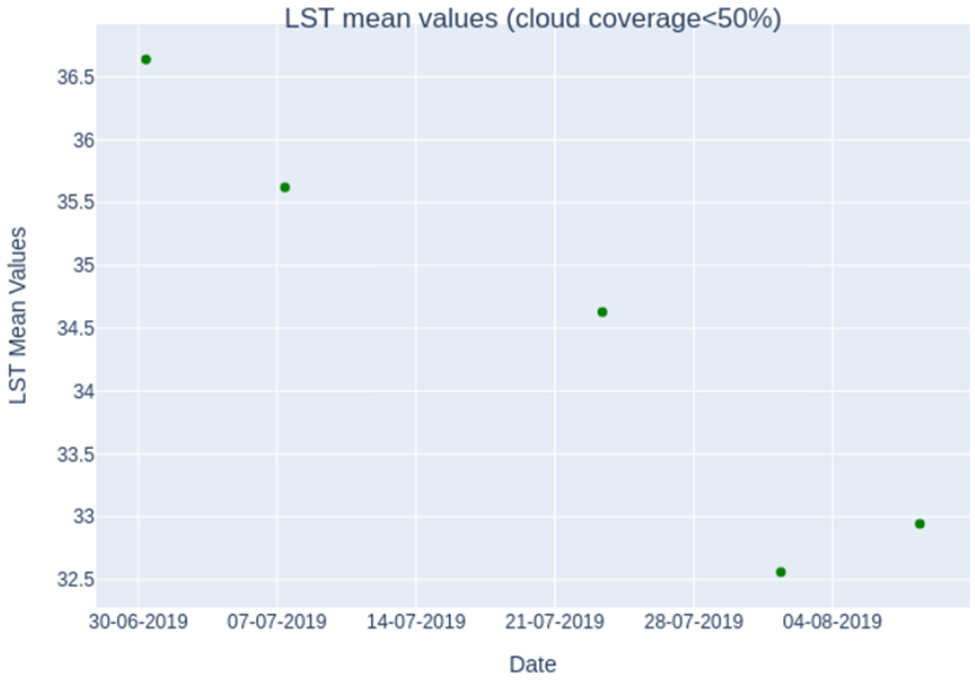

Figure 2-18 LTS mean values (cloud coverage <50%)

2.4 Preliminary Key Risk Assessment Findings

Vulnerability Index for the Municipality of Neum

On Figure 2-19 i 2-20 we can see the most overheated areas together with the population density of the vulnerable groups of the population (Vulnerable population is 0-5 and 65+ years old) These maps were reclassified to the 10 groups, for the computation of the final Risk map based on the 10+10 risk matrix
Risk matrix (Fig 2-21) sum of the places represent the greatest risk of **exposure** to high temperature and **vulnerable** population density (Very low group is the smallest because by sum we cannot get the value of 1)

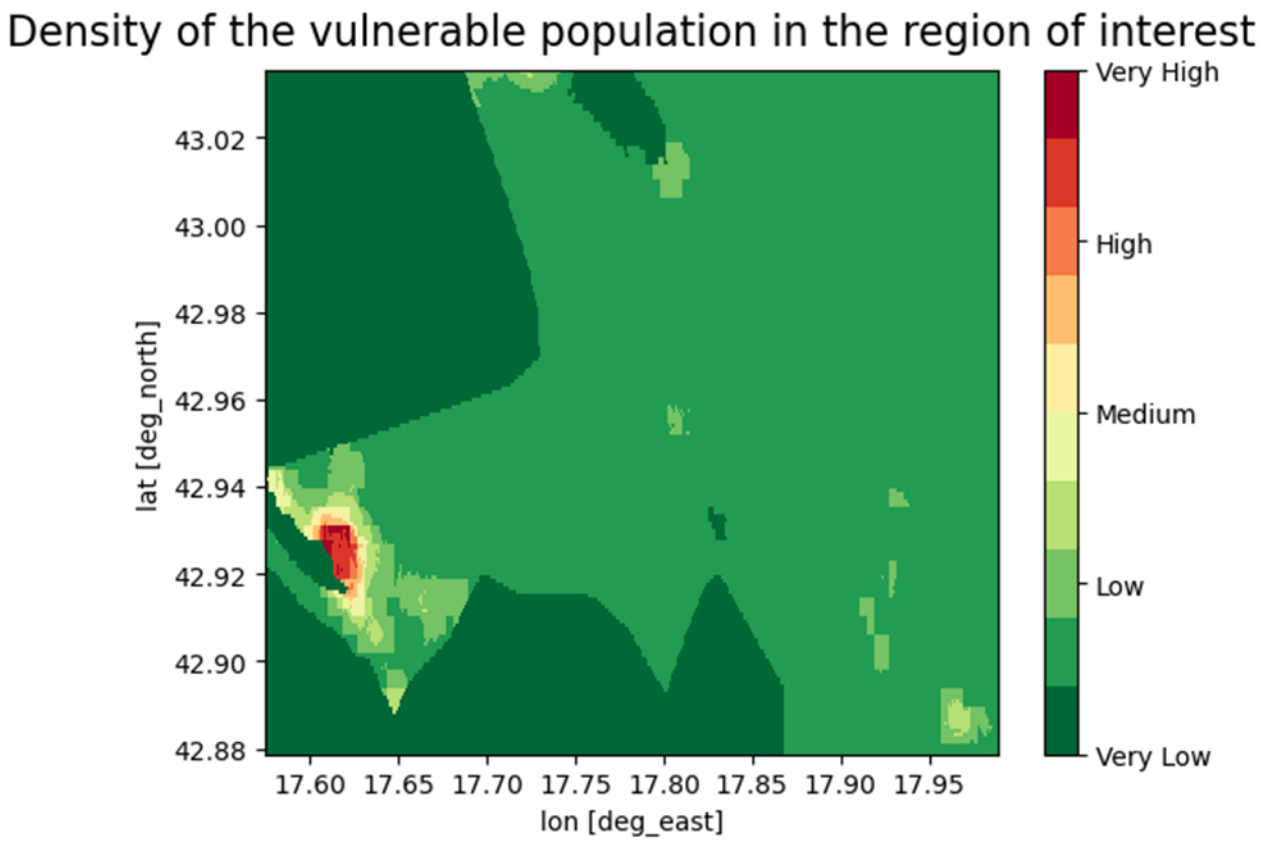

Figure 2-19 Density of the vulnerable population in the region of interest in Municipality of Neum

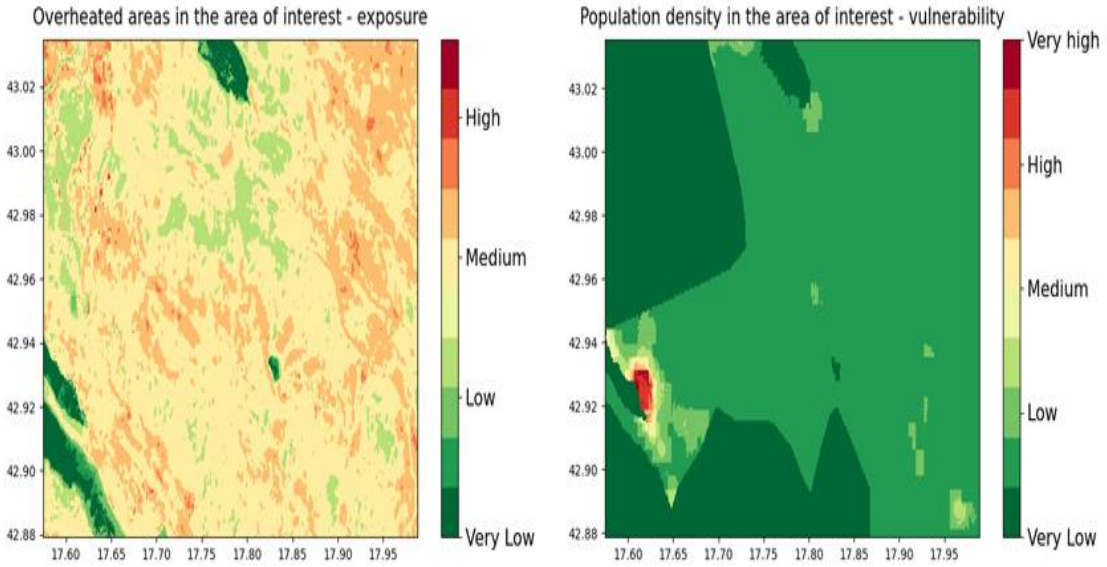

Figure 2-20 Overheated areas in the area of interest – exposure, population density in the area of interest - vulnerability in Municipality of Neum

Risk matrix 10+10

Magnitude of change in heatwave occurence	1	2	3	4	5	6	7	8	9	10
10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18	Very high 19	Very high 20
9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18	Very high 19
8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17	Very high 18
7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16	Very high 17
6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15	High 16
5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14	High 15
4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13	High 14
3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12	High 13
2	Very low3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11	Medium 12
1	Very low 2	Very low 3	Very low 4	Low 5	Low 6	Low 7	Low8	Medium 9	Medium 10	Medium 11

Vulnerable population density

Figure 2-21 Risk matrix 10+10

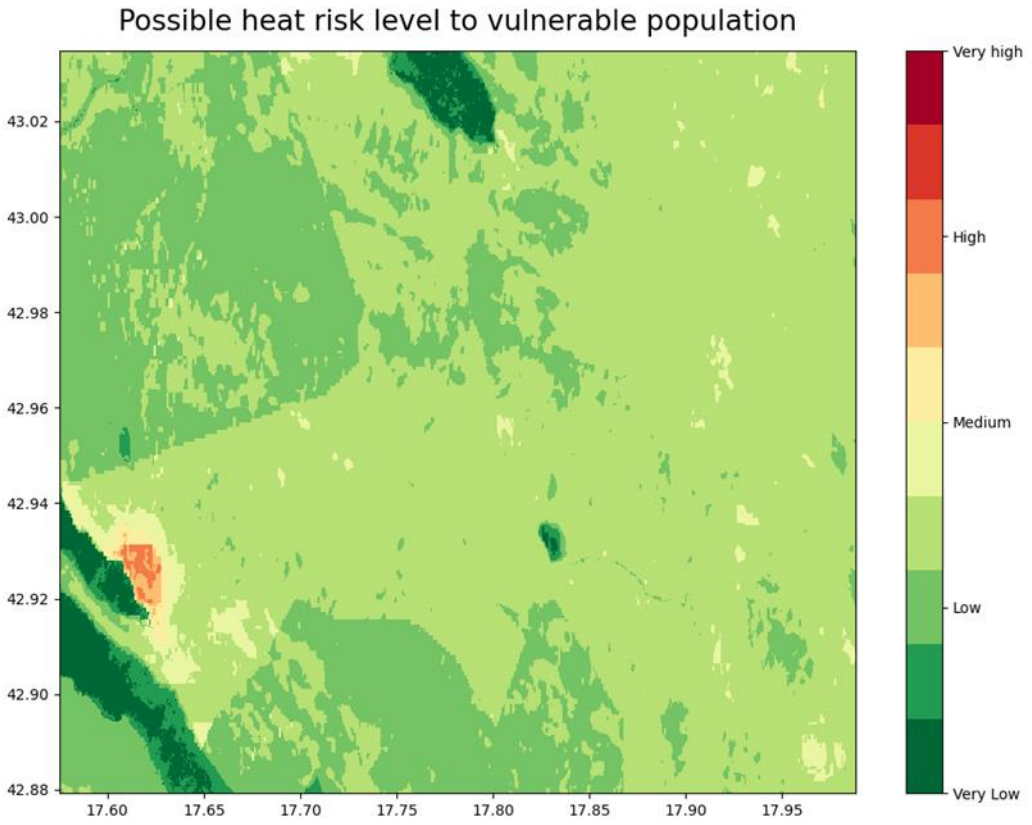

Figure 2-22 Vulnerable places in Municipality of Neum

2.4.1 Severity

The risk is still not severe at this moment although its trend is on the rise. Its potential impact may lead to significant lowering of quality of life and economic downfall of tourism and agriculture. The problem of salinization of water in the Neretve Delta (that continues) may easily result in insufficient water supply in the Municipality of Neum. Because of that the local population and economy would find themselves in a very hard situation.

Droughts and heatwaves are not high in impact although they occur with regular frequency every year during the last decade. However, since they are observed in continuity and since they are more severe every year it is important to address them in time instead of reacting with delay.

Droughts and heatwaves combined **may have both irreversible consequences and cascading effects** soon. The most important is destruction of ecosystems and biodiversity due to the rising water temperatures of the Adriatic Sea, driven by climate change. These impacts are interconnected with broader environmental changes in the Mediterranean region. Four key impacts have been identified by now.

1) **Spread of Non-Native and Invasive Species:**
   Higher Sea water temperatures facilitate the introduction and spread of non-native and invasive marine species (*Pterois volitans* – lionfish / devil firefish) *Lagocephalus sceleratus* - silver-cheeked toadfish *Siganus luridus* - dusky spinefoot. These species can outcompete

native organisms, disrupt local ecosystems, and threaten endemic species unique to the Adriatic.

2) **Habitat Degradation:**
   Increased Sea temperatures, combined with changes in salinity and precipitation, can lead to habitat loss and degradation. Sensitive marine habitats may be particularly vulnerable, resulting in reduced biodiversity and altered ecosystem functions.
3) **Shifts in Species Distribution:**
   Native marine species may be forced to migrate or adapt to new ecological niches as conditions change. This can result in the loss of some species and the arrival of others better suited to warmer waters, fundamentally changing the composition of local marine life.
4) **Increased Frequency of Extreme Events:**
   Climate change is expected to bring more frequent and severe weather events, such as droughts, which further stress aquatic and coastal ecosystems.

The Adriatic coast of BiH is a small but ecologically important area, influenced by both marine and freshwater systems. The region is part of a broader Mediterranean biodiversity hotspot, making the impacts of temperature rise particularly significant for conservation efforts. **The rise in Adriatic Sea temperatures poses a substantial threat to the biodiversity of Bosnia and Herzegovina. Key concerns include the spread of invasive species, habitat loss, changes in species distribution, and risks to endemic and migratory species. These changes highlight the need for coordinated conservation strategies and adaptation measures to protect the region's unique ecosystems.**

2.4.2 Urgency

Under condition that the current climate change trend continues **we expect that these risks will have a major impact in 10 to 20 years**. We are convinced that it would be necessary to act as soon as possible to minimize damage.
Both climate hazards (droughts and heatwaves) are expected to worsen in the near future since they are a result of global warming. Currently there is no sign that the situation regarding hazards is getting better in any way.
Climate hazards in the Neum Municipality are more associated with slow onset processes (such as air temperature rise because of global warming) than sudden events. Nevertheless, we are convinced it is not a reason for putting these issues in the background or for postponement of any action.
Both climate hazards do **have the potential to persist** because they are driven by the global process of climate change.

2.4.3 Capacity

There are no climate risk management measures that are already in place to tackle the risk. We are currently in the process of their definition. **We are in the process of considering financial aspects (introduction of green bonds), social (workshops with various stakeholders) and physical (urban greening project).**
Municipality of Neum does not have sufficient capacity to address the respective climate risks primarily when dealing with financial capacity. On the other hand, there are meaningful capacities in

other areas: human (existing awareness and knowledge with significant potential for learning), natural capacity (ecosystem health is on high level, both land and sea ecosystems) and social capacity (social inclusion, equity, social representation, favourable policy environment). There is more to be done in the segment of physical capacity where abilities to forecast and warn and to provide critical infrastructure and services deeply depend on financial and human capacities that are not favourable.
Though the legislative frame is favourable when dealing with climate change, it **does not proscribe special measures to tackle the problem**. Various laws and regulations that address climate change are primarily general documents that do not refer to various dimensions of climate change adaptation and mitigation. Therefore, not much has been done by now in the field of special interventions that should reduce climate risks.

2.5 Preliminary Monitoring and Evaluation

We learned from the first phase of the climate risk assessment that interaction among various climate change indicators is extremely subtle and intertwined. Besides communication with stakeholders, which regularly gets difficult, exhausting and sometimes even unpleasant, we encounter difficulties collecting the meteorological data (they are not available to the public, and it is possible to obtain them only at request).
We got **mixed feedback from stakeholders**, ranging from skeptical and denying all the way to positive and affirmative. In general, the feedback was encouraging and supportive, with many stakeholders' members voicing their satisfaction for such an important project being conducted in their Municipality. **We do not see that other stakeholders should be involved in the process.**
We are in the **process of obtaining the meteorological data** from the local weather station that would help us to further deepen the analysis.

2.6 Work plan

The Individual Follow Up Plan for phase 1 included the implementation of the following activities:

Phase 1: Establish a baseline understanding of climate risks in Neum.

Activity 1.1: Gather relevant environmental and climate data to map vulnerabilities across Neum's coastal and hinterland areas.

Activity 1.2: Engage local stakeholders, including community representatives, in workshops to discuss major climate threats, fostering awareness and collaborative input.

Activity 1.3: Conduct a systematic assessment of significant climate risks, such as extreme weather events, and biodiversity loss, to set the foundation for targeted adaptation measures

The work plan for the remaining phases of the project is based on field work, analysis of climate data from the local weather station, design of proposition for climate change adaptation/mitigation and final communication with the stakeholder for obtaining feedback.
The field work is the first phase of the work plan. During this phase we plan to have more interviews with the stakeholders involved in the process to better understand their points of view regarding climate hazards in the Municipality. We are also planning to get their opinions on the introduction of

climate adaptation measures so to get the full picture of those measures' effect on their activities, everyday life or other aspects of the social system.

The second phase is the analysis of climate data from the Neum's weather station. We would focus on comparisons of the relevant data such as air temperature, precipitation, solar irradiance from the past decades and contemporary period to get more relevant information about climate change in the Municipality.

The third phase of the work plan is designation of proposition for introduction of specific measures for climate change adaptation and mitigation. **We are planning to research possibilities of applying various to reduce greenhouse gas emissions from human activities in the coming years in the Municipality, enhancing energy consumption efficiency, applying alternative agricultural practices based on regenerative approaches, reforestation, rainwater harvesting, urban greening, introduction of green bonds and others.**

The fourth phase consists of workshops with stakeholders aiming to obtain feedback about the proposed measures for climate change adaptation and mitigation. **We would primarily focus on understanding aspects of the social system that may be affected by such measures in a positive or a negative way.**

We are not planning to study legislative system on climate change adaptation and mitigation (laws, regulations, policies) because all the proposed measures will come primarily from the realm of the EU countries. Since Bosnia and Herzegovina is in the process of accession to the Union and has been granted candidate status in December 2022, the country would apply the EU regulations and policies regarding climate change adaptation in complete during the years to come.

3 Conclusions Phase 1- Climate risk assessment

This project phase obtained us with new knowledge and provided us with better understanding of climate hazards and risks in the Municipality of Neum. It also gave us a deeper view into the issues of stakeholders' attitudes regarding the climate change adaptation and mitigation policies and potentials for its implementation. We may single out four conclusions in this project phase:

1) **There are two relevant climate hazards in the Municipality of Neum: droughts and heatwaves.**

Although these hazards are primarily results of global climate change trend (global warming) there are certain local aspects that influence them. These aspects are natural (karstic terrain with no surface waterflows, sparce vegetation, low forest cover) and anthropogenic (concreted shore with no urban green, traditional agriculture without climate-friendly innovations, lack of climate change policies). Initially, the two hazards were typical for summer months but with global air temperature rise, their impact is felt even before and after the summer.

2) While both **droughts and heatwaves are relevant for the whole Municipality,** there are certain Differences in respect of geographic distribution. The urbanized coastal area is especially sensitive to heatwaves because of predominance of modern building material (concrete, asphalt) with no urban green. In such an environment heatwaves influence beach tourism, the most important activity in the Municipality. The rural area in the hinterland is more under the influence of droughts which impact its principal activities: traditional farming and cattle raising. Both hazards have a negative impact on local populations' quality of life.

3) **Local stakeholders in general support implementation of climate change adaptation** and mitigation policies though they are generally very sensitive to such policies' impact on economic activities and their way of living. While there are groups that are extremely skeptical about the efficiency of adaptation and mitigation policies and who even deny anthropologic impact on global climate change, majority of local stakeholders are cooperative and open-minded regarding the issue.

Climate hazards in the Municipality of Neum **also impact biodiversity and ecosystems of the Adriatic Sea due to the seawater temperature rise.** It is a problem that is felt locally but that should be addressed on a wider international scale. This issue is partially overlooked by the local stakeholders although it is not unknown.

Climate risk assessment of the Municipality of Neum, as the Phase 1 of the research, casts light on various elements of the local social and economic system that have an important role in the everyday of this local administrative unit. Although those elements have not been researched specifically, their recognition is crucial to understanding the stakeholder groups of the local population. It is an issue that we are especially concerned about since the success of climate change adaptation/mitigation policies primarily depends on stakeholders' cooperation.
We have addressed various challenges during Phase 1: definition of climate hazards, recognition of relevant stakeholders and their attitudes toward climate change adaptation/mitigation policies, research of geographic areas that are exposed to the hazards. We have mentioned various aspects of the Municipality directly connected to the climate change policies (such as social, human, physical, natural) but we did not significantly address them. That issue is going to be researched during the next phases of the research.

Key findings of Phase 1 deal with understanding the social, political and economic background of the climate change issue in the Municipality of Neum. Its complexity is defined by the fact that climate hazards in the Municipality are threatening humans and their activities and quality of life but also maritime biodiversity.

Special attention in the future should be paid to droughts because that climate hazard may cause serious problems regarding the water supply, especially in the summer when consumption (because of many tourists) is the highest. This issue relates to a problem of salinization of fresh water in the neighbouring Neretva River Delta from where the Municipality of Neum gets majority of its drinking water. If salinization on the Delta continues, Neum will be forced to rely more on local water sources which are already endangered by prolonged and fierce droughts in the summer.
At this early stage we believe that it would be necessary to implement various measures to diminish the risk of hazards and to adapt to climate change.

4 Progress evaluation and contribution to future phases

This deliverable is a basic assessment of the climate hazards and risks associated with climate change in the Municipality of Neum. It defines and maps the risk areas and vulnerable groups of the local population that make stakeholders involved in the process of implementing the climate change adaptation and mitigation policies. Therefore, this deliverable is a basis for future actions regarding such policies. The outputs of this delivery, such as geographic definition of risk areas, vulnerability analysis and definition and initial involvement of relevant local stakeholders – all parts of the climate risk assessment – determine future actions. The results of Phase 1 will be elemental for the second phase that relies on further data analysis and integration, anticipation analysis and designation of adaptation strategies. The third phase will continue these results with designation of three local adaptation plans targeting key sectors such as coastal infrastructure, agriculture and tourism as well as finalization of four policy briefs to support climate adaptation strategies at municipal and regional levels.

Key Performance Indicators and **Milestones** achieved in the first phase of the project are presented in Table 4-1 and Table 4-2, together with the actions executed to achieve them, in accordance with Individual Follow Up Plan. Regarding the Key Performance Indicators, the very definition and basic analysis of risk areas and vulnerable groups set the foundation for the next stage that will be done during the second phase of the project: further quantitative analysis, mapping of endangered areas, public awareness campaigns and workshops with stakeholders. These activities will provide us with deeper insights into the issue of introduction, designation and implementation of climate adaptation and mitigation policies in the Municipality. It is important to point out that the Individual Follow Up Plan proscribes over 50 stakeholders to be engaged during Phase 1 and 2 of the project. During Phase 1 we have engaged 32 stakeholders and we are planning to be included during Phase 2.
Completion of the Climate Risk Assessment using the CLIMAAX methodology is the most important Milestone of the first phase. Attendance of the first workshop was very satisfactory while dissemination events are taking place in cooperation with the local media. This milestone is planned to be complete throughout all the phases of the project and therefore such activities will be continued during Phase 2 and 3.

Table 4-1 Overview of key performance indicators

Key performance indicators	*Progress*
One comprehensive climate risk assessment using the CLIMAAX methodology	Completed
Over 50 stakeholders engaged, including local government officials, community members, environmental groups and business representatives	Completed – in the Phase 1 engaged 32 stakeholders, rest to be included in the Phase 2
Establishing baseline climate risks through data collection and GIS mapping	Completed

Table 4-2 Overview milestones

Milestones	*Progress*
Completion of the Climate Risk Assessment using the CLIMAAX methodology	Completed
Attendance at CLIMAAX workshops and dissemination events	Completed
Subcontracting process completed	Completed

The results obtained during the initial phase are closely connected with activities planned for the next stages. All the goals of the first phase have been fulfilled satisfactorily and the direction for the future research has been set together with new objectives. The next phase will face us with new challenges that will hopefully deepen our understanding of the problem and help us achieve planned goals.

5 Supporting documentation

All outputs produced during the first stage of CLIMAAX project – risk assessment – are classified and listed in this section. It includes:

Main report

Climate risk assessment for climate hazards in the Municipality of Neim – Phase 1

A comprehensive analysis that contains identification of climate hazards and their geographic dimensions, definition of stakeholders, mapping of exposure and vulnerability, risk exploration and analysis, and preliminary findings.

Format: PDF

Visual Outputs (infographics, maps, diagrams)

Drought risk in Municipality of Neum (seven maps)

Heatwaves risk in Municipality of Neum (seven maps)

These maps show geographic dimensions of the relevant hazards.

Hazards exposure and vulnerability in Municipality of Neum (seven diagrams)

Diagrams that provide further information regarding the climate hazards in the Municipality.

Format: .jpg

Communication Outputs

Official press release by the Municipality of Neum from 31st of March 2025 with general information about the project.

Općina Neum odabrana za provođenje procjene klimatskih rizika - Neum.online

Official press release by the Municipality of Neum from 12th of June 2025 with general information about the project.

Općina Neum prva lokalna zajednica u BiH koja je osigurala financijsku i tehničku pomoć za procjenu klimatskih rizika - Neum.online

Općina Neum u skopu projekta CLIMAAX u Barceloni - Općina Neum

Općina Neum odabrana za sudjelovanje u Europskom CLIMAAX projektu - Općina Neum

Press releases form other websites in Bosnia and Herzegovina.

Neum jedini iz BiH među 69 europskih regija u klimatskom projektu CLIMAAX

Fena.ba | Najnovije vijesti iz BiH, regiona i svijeta

Neum odabran za europski CLIMAAX program prilagodbe klimatskim promjenama | Radiotelevizija Herceg-Bosne

Općina Neum među 69 europskih područja s potporom za procjenu klimatskih rizika - Čapljinski portal

All the outputs listed are prepared for sharing in the Zenodo repository.

6 References

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Climate-Smart Neum: Stakeholder Engagement Report (Phase 1)

Neum is Bosnia and Herzegovina's only coastal town, a narrow 20-km strip on the Adriatic Sea. It lies between Croatia's Pelješac and Klek peninsulas, giving it a unique transboundary character. The town has about 4,000 residents (summer visitors boost the population several-fold). In mid-2025 Neum was selected as the sole Bosnian municipality to join the EU's Horizon-Europe CLIMAAX program. CLIMAAX (2023–2026) brings funding and expert support for local climate risk assessment and adaptation. Its goal is to help communities like Neum understand threats (sea-level rise, drought, extreme storms, etc.) and develop concrete adaptation strategies for environment and public safety. In this context, the Neum project team initiated broad stakeholder engagement during Phase 1, working with government, businesses, and residents to shape the climate-smart coastal development plan.

Stakeholder Mapping and Analysis

The CLIMAAX team identified a wide range of stakeholders who influence or are affected by climate planning in Neum. These include **municipal authorities** (the mayor's office, urban planning and environment departments, emergency services), **public utilities** (water and sanitation companies), and **tourism-related businesses** (hotels, restaurants, beach operators). In Neum the tourism sector is economically vital, coastal tourism accounts for about 10% of Bosnia's GDP, so local hoteliers and restaurateurs have very high interest in climate issues. For example, they closely watch sea-level trends and beach conditions, since their livelihoods depend on clean beaches and good weather. **Farmers and fishers** in the hinterland and coastal waters also stand to lose from climate change. Local farmers worry that summer drought or salt spray could harm vegetables and olives, while small fishing crews have noted changes in catches. Both groups showed strong concern during consultations. We found that tourism, decision-makers (municipal leaders), farmers and concerned citizen groups were the most prominent stakeholder categories. Environmental and civic associations (e.g. local NGOs focused on nature and heritage) also play a role in educating the public and advocating for sustainable policies.

Importantly, Neum's **transboundary context** expands the stakeholder network. Because Neum is enclosed by Croatia on both sides, regional authorities across the border have a de facto stake. For instance, Dubrovnik-Neretva County planners and Croatian water agencies have overlapping interest in Adriatic Sea conditions, and climate impacts on tourism in the shared region. Academic and technical partners (such as University of Herzegovina in Mostar or University of Split researchers) have been engaged as advisers. In summary, the mapping exercise shows Neum's stakeholders range from local officials (high influence) down to businesses and community groups (high interest). The municipality and planners must be closely involved in any decisions, while farmers, hoteliers and NGOs need to be kept informed and consulted as "high interest" groups. The analysis confirms that collaboration across these groups, and with neighboring Croatia, will be essential to Neum's climate-smart development.

Stakeholders workshop

A key step was a public workshop held on 7 July 2025 at Hotel Jadran in Neum. The workshop (opened by Mayor Dragan Jurković) drew 33 participants from across the town's sectors. CLIMAAX project leaders and scientists gave short, accessible presentations to set the stage. Zoran Mateljak (project coordinator) introduced the CLIMAAX objectives. Prof. Višnja Bukvić spoke on the importance of climate and climate change, highlighting local observations (e.g. more frequent heat spells and shifting rainfall). Dr. Ivan Vučković reviewed how restoring ecosystems (wetlands, dunes) can build coastal resilience. Prof. Nikola Glamuzina presented preliminary Phase 1 findings, including maps of Neum's hazard zones. He noted that stakeholders had already identified **heatwaves and droughts** as Neum's highest-priority climate risks. Another talk by Dr. Vučković focused on climate impacts to tourism, underscoring that hotter summers could shorten Neum's traditional season. After each presentation there was a lively Q&A; the tone was engaged and constructive, with speakers using clear language and visuals so all participants could follow.

In the interactive discussion that followed, local stakeholders voiced their concerns and ideas. **Farmers and gardeners** noted that recent summers have been increasingly dry, with irrigation turning on earlier. They asked for more reliable water supply guarantees. A **municipal water utility official** confirmed this: Neum's own wells are limited, so the town depends on fresh water pumped from the Neretva River. He showed data indicating rising salinity during the dry season and said this is a growing worry. Environmental group representatives pressed for protecting and even expanding coastal wetlands as natural buffers. Tourism business owners asked how the town can preserve beaches and potentially promote eco-tourism (such as nature trails or birdwatching) as climate changes. A small delegation of fishers mentioned declines in certain catches (for example fewer shellfish) and offered to help with any monitoring efforts. Finally, a visitor from neighboring Croatia

suggested establishing a shared storm-warning protocol, since weather in Neum and Dubrovnik is interlinked.

By the end of the workshop, there was broad agreement on the main climate challenges for Neum (water scarcity, coastal erosion/flooding, and heat impacts on infrastructure and health). Participants generally praised the project team for bringing science into the local conversation and many volunteered to remain involved. The workshop also helped solidify next steps: the group agreed to form a technical working group, maintain email updates, and hold smaller follow-up meetings on specific topics. In summary, the event succeeded in aligning local priorities with the CLIMAAX framework (e.g. confirming that drought and heat rank as top concerns) and in generating commitment from Neum's stakeholders to the climate adaptation process.

Bilateral Meetings with Local Stakeholders

Following CLIMAAX guidelines, the team also conducted focused one-on-one meetings (March–August 2025) with key stakeholder groups. These bilateral talks helped refine the risk assessment and project plans. For example, **municipal leaders** met several times with the team. The mayor and planning staff reviewed Neum's current spatial plan and infrastructure projects. They emphasized the need to retrofit the coastal promenade and upgrade drainage lines, projects which the climate analysis could inform. Officials were eager to "climate-proof" new developments but noted budget constraints. The team took detailed notes on local plans and said it would align the adaptation strategy to fit those priorities.

The **water utility company** in Neum was another priority. In a meeting with the utility manager, engineers shared reservoir data and pipe-network maps. They confirmed that Neum's local aquifers yield very little water, so the town imports water from the nearby Neretva delta. In summer, when river flow is lowest, saltwater intrusion has become a real issue. The utility director explained how past dry seasons have forced water rationing. He welcomed the CLIMAAX project's focus on drought resilience and asked the team to analyze options like a new backup reservoir or desalination unit. This session yielded valuable input: the team now plans to incorporate local pumping schedules and salinity observations into the Phase 1 risk analysis.

The team also met with **agriculture and fishing communities**. Local farmers (mainly vegetable growers) described how an earlier spring and longer dry period have stressed crops. A small fishermen's cooperative spoke about changing fish patterns in Neum Bay, noting that warmer winters bring different species into the inlet. Both groups expressed interest in low-cost adaptation measures. Farmers suggested reviving some traditional water storage (like small farm ponds) and shared soil data. Fishers offered to contribute decades of knowledge about coastal conditions. These meetings affirmed the importance of drought and salinity issues raised elsewhere, and they helped identify data sources (e.g. historic crop yield records, catch logs) that the project can use.

Tourism-sector consultations were held with the Neum Tourism Board and a local hotel association. The business leaders confirmed that climate considerations are becoming part of their planning. They reported that guests occasionally complain of extreme heat, and some operators are already investing in more shade trees and water-saving fixtures. They stressed that any erosion of Neum's beaches would hurt the town's image. The team noted these points and agreed to highlight coastal erosion in upcoming reports. Tourism reps also suggested linking adaptation plans to market ("green tourism"), so their input was passed to the communications plan.

Finally, the project team visited **civil society and education stakeholders**. A local environmental NGO (Green Neum) welcomed the project and offered volunteers for beach surveys and awareness

campaigns. One NGO leader insisted that local school curricula should include climate change topics. Acting on that, the team held a brief session with a high school science class, explaining the project. The enthusiastic students even helped sketch a map of local wetland spots. This interaction will support future public outreach. Through all these bilateral meetings, the team-built trust, filled information gaps, and ensured that each stakeholder group saw how the project addressed their concerns.

Community Questionnaire and Key Takeaways

At the start of Phase , a brief questionnaire was circulated town-wide to capture wider community input. Over 50 responses (from households, businesses, and officials) were collected. Participants were asked to list their biggest climate-related worries and what they would like the project to focus on. The responses were remarkably consistent with workshop feedback. Key takeaways included:

- **Water security:** Nearly every respondent cited summer drought and water shortages as a primary concern. Many noted that Neum's small reservoirs often run dry by late summer. People pointed out that the town has limited own water supply and relies on the Neretva River, so a bad drought could threaten taps.
- **Coastal erosion and tourism:** Respondents in tourism and business said that protecting Neum's beaches is essential. They were worried that sea-level rise or stronger storms could shrink the sand and damage waterfront hotels. This aligns with the broader fact that "beach and sea" tourism is economically critical (about 10% of the national economy). Maintaining wide, sandy beaches emerged as a top priority.
- **Salinization and ecosystems:** Farmers and fishers confirmed observing saltwater intrusion during low-flow seasons (e.g. salt in wells or rivers). They supported measures like restoring coastal wetlands or planting salt-tolerant crops to buffer their fields. A few noted that healthier marine habitats (like seagrass beds) could improve fish stocks.
- **Awareness and planning:** Many citizens asked for more education on climate risks. Suggestions included public workshops, information in schools, and regular updates from the municipality. Several said they want climate considerations explicitly included in Neum's development and emergency plans. In short, people want to better understand the risks and see local actions (flood maps, drought alerts) used in planning.
- **Regional coordination:** Several business owners and commuters highlighted Neum's connections with Croatia. They mentioned that weather events often affect the whole coast, and that road and border issues should be considered. This reinforced the idea that collaboration with Croatian authorities (for example on meteorological data sharing or joint tourism campaigns) would benefit Neum.

These survey results confirmed that the community is keenly aware of climate challenges and has aligned priorities: drought-induced water shortages, coastal and tourism impacts, and greater public engagement. This feedback will guide Phase 2, ensuring the project addresses local needs.

Ongoing Engagement and Adaptation

The CLIMAAX team has maintained active engagement with stakeholders throughout Phase 1. Regular online check-ins were set up with a core group of municipal staff, utility engineers, and NGO partners. After the July workshop, summary reports and slide decks were emailed to all participants. The team also sought informal feedback. For example, a hotel manager sent follow-up questions about beach monitoring, and a schoolteacher provided photos of a student climate project. These inputs were used to refine plans. In one case, feedback confirmed that **drought remains the community's highest climate concern**, so the risk assessment workplan was adjusted to analyze

water-supply scenarios first. Residents also flagged missing data (such as up-to-date groundwater measurements), prompting the team to organize a field visit to a pumping station.

In response to stakeholder suggestions, the project team adapted its communication as well. They prepared a plain-language factsheet in the local lenguage summarizing the workshop outcomes and planned a follow-up meeting on coastal ecosystem solutions. Every engagement, whether formal or informal, has been used as a chance to co-develop the project. This iterative approach (consistent with CLIMAAX practice) helps ensure that Neum's residents feel heard and that their concerns are woven into the climate adaptation strategy.

In summary, the first six months of the "Climate-Smart Neum" project have seen robust and collaborative stakeholder participation. Local authorities, businesses, and community groups have actively contributed their insights and priorities, from workshop discussions to personal interviews and surveys. This engagement has not only validated the focus on water and coastal hazards but also built a foundation of trust and ownership. Moving forward, these relationships will support co-designing Neum's sustainable coastal development in the face of climate change.

CLIMAAX

PROGRAM

VRIJEME	AKTIVNOSTI	MODERATOR
11:00 – 11:30	Registracija sudionika i osvježenje	
11:30 – 11.40	Uvodna riječ	Uvodna riječ Načelnik Neuma, Dragan Jurković
11:40 – 12:00	Predstavljane projekta	mr.sc. Zoran Mateljak
12.00 – 12:20	Važnost klime i klimatskih promjena u sadašnjim uvjetima	prof.dr.sc. Višnja Bukvić
12:20- 12:40	Restauracije/obnove ekosustava kao mjera prilagodbe klimatskim promjenama	doc.dr.sc. Ivan Vučković
12:40 – 13:00	Pauza (+ kava i osvježenje)	
13:00- 13:20	Važnost procesa ublažavanja klimatskim promjena u primorskim područjima	prof.dr.sc. Nikola Glamuzina
13:20 – 13:40	Utjecaj klimatskih promjena na turizam	doc.dr.sc. Ivan Vučković
13:40 – 14:00	Rezultati istraživanja prve faze projekta CLIMAAX na području općine Neum	prof.dr.sc. Nikola Glamuzina
14:00 – 14:20	Rasprava / pitanja i odgovori	Sudionici
14:30 – 15:30	Zajednički ručak	

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CLIMAAX climate ready regions

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PREDSTAVNJE PROJEKTA

“ Procjena višestrukih rizika za održivi razvoj obale – Općina Neum”

Potpisna lista

Datum: 07.07.2025.

Adresa: Hotel Jadran, Magistrala bb, 88390 Neum

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Progress in Data Collection (KPI Reference: D.1)

During Phase 1, significant progress was made in identifying, accessing, and pre-processing datasets required for the regional drought risk assessment in line with CLIMAAX recommendations.

Key Achievements:

- Official data on the measurement of average monthly air temperature and monthly precipitation from meteorological station Neum for the period 1991-2024. (Hydrometeorological Institute of Federation of Bosnia and Herzegovina)