CLIMAAX
climate ready regions

Deliverable Phase 2 – Climate risk assessment

Name of the project

Bosna and Herzegovina, Herzegovina-Neretva Canton /Municipality Neum

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HORIZON-MISS-2021-CLIMA-02-01 - Development of climate change risk assessments in European regions and communities based on a transparent and harmonised Climate Risk Assessment approach

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Document Information

Deliverable Title	Phase 2 – Climate risk assessment
Brief Description	This section provides an evaluation of the progress achieved in Phase 2 of the CLIMAAX Climate Risk Assessment for **Municipality Neum**. It summarizes the link between analytical outputs and upcoming Phase 3 adaptation activities, reviews performance through key indicators and milestones, and assesses overall implementation efficiency. The deliverable outlines how hazard and risk results support future planning, documents stakeholder engagement outcomes, and presents an integrated view of achievements, remaining challenges, and readiness for the next project phase.
Project name	
Country	Bosnia and Herzegovina
Region/Municipality	Municipality of Neum
Leading Institution	
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2.0	…	CLIMAAX's FSTP team	Review completed
5.0	…		Final version to be submitted

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Abbreviations and acronyms

Abbreviation / acronym	Description
CLIMAAX	CLIMAte risk and vulnerability Assessment framework and toolboX
CRA	Climate Risk Assessment
EU	European Union
IPA	Instrument for Pre-Accession Assistance
NGO	Non-Governmental Organisation
RCP	Representative Concentration Pathway

Executive summary

This document is deliverable for the second stage of the CLIMAAX project that is based 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 second phase of the climate risk assessment that addresses climate hazards in the Municipality of Neum, the only seaside administrative unit of Bosnia and Herzegovina. The Municipality is situated in the southern part of the country, in an area at the contact of waterless karstic terrain and Adriatic coast. It is characterized by Mediterranean climate, marked by the interchange of humid and dry seasons with mild winter air temperatures and hot summers. The readers who have seen the deliverable from the first phase of the project will find in this deliverable a deeper analysis of the most important climate hazards and their geographic and time dimensions. Throughout the second phase the most relevant stakeholders in the Municipality were more involved in the process of climate risk assessment.

The second phase of the project relies on deeper analyses of the relevant climate hazards and geographic areas of the Municipality that are exposed to their negative impact. Local stakeholders, affected by the climate hazards as well as the implementation of climate change adaptation policies, participated in the research. The main results and findings of research during the second phase of the project are: deeper understanding of the geographic impact of the most relevant climate hazards, analysis of vulnerable areas, additional feedback of local stakeholders and climate risk analysis based on unique methodological approach. The research also showed differences between the urbanized coast and rural inland of the Municipality regarding the negative impact of the most relevant climate hazards: droughts and heatwaves. While the coastal area is more vulnerable to droughts, the inland is more exposed to negative impact of heatwaves. 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.

This second phase climate risk assessment in the Municipality of Neum showed that climate hazards are not only a regional phenomenon but also have a local dimension. Interaction with assessment confirmed the concerns among certain groups of the local population especially from the field of the local government, vulnerable groups of the local population and businessmen (primarily from tourism sector and mariculture).

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.

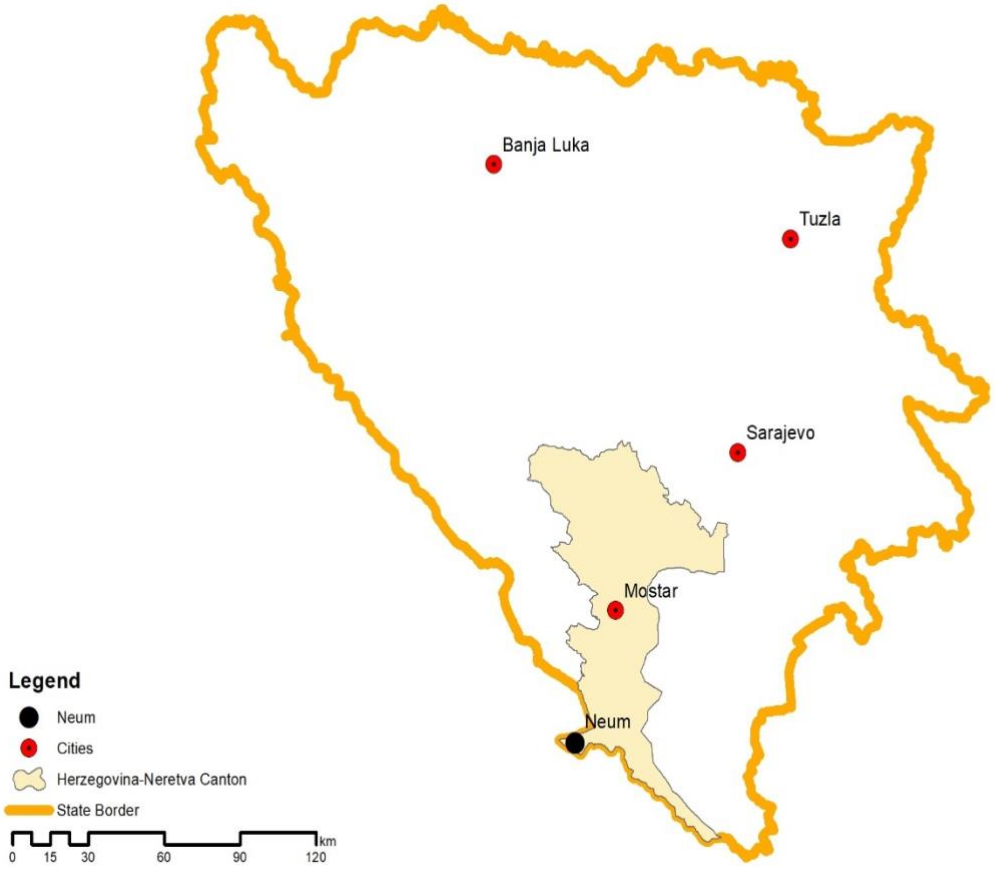

Figure 1-1 Geographic situation of Municipality of Neum inside Herzegovina-Neretva Canton of Bosnia and Herzegovina

1.2 Main objectives of the project

The objectives of Phase 2 are as follows:
1) Utilize and analyze existing high-resolution climate datasets and geospatial mapping tools to assess climate risks in Neum's coastal areas and to create detailed risk maps pinpointing areas of critical concern, such as flood-prone zones and erosion hotspots.
2) Apply climate modeling tools with the support of external technical experts to understand potential impacts on ecosystems and infrastructure.
3) Focus on assessing risks to key economic sectors like tourism, agriculture, and aquaculture to guide the development of sector-specific adaptation measures.
The significance of Phase 2 of the project is in further and deeper analyses of the climate hazards and risks that involve local stakeholders in the process of climate change adaptation and mitigation. The most important **expected benefit of applying the CLIMAAX Handbook** is the designation of climate risk assessment of the Municipality Neum which is a first step in creating an adequate climate adaptation plan and risk management plan. Such plans would help the Municipality to react quickly to climate change and to engage local stakeholders in the global process of climate mitigation. The prescribed methodological approach would make the analysis comparable with studies of other researched areas inside the CLIMAAX project.

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 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 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.

The 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 2 is a section focused on detailed climate risk analysis that relies on CLIMAAX Methodology Framework: Scoping, Risk Exploration, Regionalized Risk Analysis, Key Risk Assessment Findings, Monitoring and Evaluation, brief Work Plan for the Phase 3. The first section begins with three subsections: scoping (objectives, context, participation and risk ownership, application of principles, stakeholder engagement). The second part consists of

selection of main hazards and analyses of future development scenarios. The third part is focused on regionalized risky analysis of two climate hazards finetuned to local context together with additional assessments based on local models and data. The fourth part deals with mode of engagement for participation, output from risk analysis step, assessed severity and urgency of hazards, understanding of resilience capacity and definition of risk priority. The section wo subsections about preliminary key risk assessment findings and preliminary monitoring and evaluation. The section ends with a brief description of monitoring and evaluation and the work plan for the third phase of the project.

Conclusion – phase 2 concerns the conclusion regarding the climate risk assessments.

Progress evaluation describes 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 2

2.1 Scoping

Scoping, as the initial phase of the climate risk assessment, relies on definition of objectives, context and definition of the relevant stakeholders, experts and priority groups involved in the project.

2.1.1 Objectives

The objective of this CRA is to define, analyze, quantify, evaluate, prioritize and understand the principal climate hazards, risks and vulnerabilities in the Municipality of Neum at the present moment as well as in the future. **The purpose of this CRA** is to build awareness and resilience among the local stakeholders and the decision-makers just as to encourage them to take a crucial step from awareness to action, enabling the local community to adapt, mitigate and manage different risks from short-term weather extremes to long-term climate changes. **The expected outcome of the CRA** is obtaining comprehensive evidence-based and actionable outputs that would direct and guide future decision-making, planning and creating of proactive climate change adaptation and mitigation plans and strategies. **Our objective should be fed into policy and decision making** by ensuring strategic prioritization and action planning, incorporating the CRA outcomes into existing policies, fostering just adaptation through identifying the most vulnerable population groups, setting objective and measurable targets as well as introducing dynamic decision-making and adaptive management. By identifying specific climate hazards, risks and vulnerabilities the project outcomes directly inform upcoming local development plans, strategies and policies in sectors of land use and planning zoning, future infrastructure investment and capital planning, specific adaptation strategies, just as emergency preparedness and public safety policy.

Limitations and boundaries of our CRA stem from relevant climate data scarcity and quality, methodological uncertainty of every long-term climate projection for the future, challenges regarding the decision-making process and maintaining stakeholder involvement in the future. **We encountered some challenges and bottlenecks** such as limited technical expertise and resources on the Municipality, lack of relevant climate data, inconsistency between stakeholder expectations and possible solutions as well as the problem of accuracy of climate projection models. **We addressed those problems** by using data from available internet platforms, increasing geospatial analysis and intensifying interaction with various stakeholders.

2.1.2 Context

Climate hazards, impacts, and risks in Bosnia and Herzegovina have been assessed and handled until now primarily through international partnerships. Although the national government has completed major strategic documents its implementation has been burdened by limited institutional capacity and heavy reliance on international funding. The most important strategic documents are: National Adaptation Plan, Climate Change Adaptation and Low-Emission Development Strategy (2020–2030) and Nationally Determined Contributions (proscribing the reduction in greenhouse gas emission).

This CRA for the Municipality of Neum is trying to address the problem of threats from climate hazards such as heatwaves and droughts that jeopardize its tourism-dependent economy, water-supply system and local agriculture. It aims to proactively manage risks and build resilience against these hazards in accordance with the national Climate Change Adaptation and Low-Emission Development Strategy that strive to reduce economic losses, especially in coastal regions.

The governance context of Municipality of Neum's CRA is determined by a mix of international, national, and European Union governance frameworks that aim to improve coastal resilience. The assessment aligns with Bosnia and Herzegovina's aforementioned National Adaptation Plan and the Climate Change Adaptation and Low-Emission Development Strategy (2020–2030) that prioritize protecting coastal areas and tourism. Neum is notably proactive, positioning itself towards sustainable energy management and integrated planning and being a signatory of Covenant of Mayors initiative. The Municipality is also Neum is a partner in the "ClimBeach" project, funded by the Interreg IPA Croatia – Bosnia and Herzegovina – Montenegro 2021-2027 program, that focuses on coastal resilience, sustainable beach stabilization, and mitigation of climate change impacts.

Municipality of Neum relies heavily on tourism in the urbanized coastal area and agriculture in the hinterland rural area. These sectors face significant risks from climate hazards such as heatwaves and droughts especially during the summer months. In addition, the water supply system is currently challenged by increased climate change just as biodiversity of land and maritime ecosystems.

The Municipality of Neum is very influenced by international climate initiatives such as regional cross-border cooperation projects, national strategies, and Adriatic coastal protection plans. The most important is EU IPA cross-border cooperation programme between Bosnia and Herzegovina, Croatia and Montenegro that targets the management of water supply, wastewater and solid waste systems to improve climate resilience. In addition, there is a regional Adriatic-Ionian regional cooperation project that addresses climate adaptation strategies in coastal areas.

Possible adaptation intervention that can help meet the objectives are interconnected with European green initiatives that address biodiversity loss and climate risks, especially in the Mediterranean coastal areas. Adaptation interventions should focus on water supply stability, tourism resilience, sustainable agriculture and nature-based solutions form municipal infrastructure and dwellings: restoring coastal ecosystems, establishing wastewater treatment and reuse systems, enforcing the water-harvesting systems, constructing irrigation systems in the rural hinterland and implementing green infrastructure for shade in the urbanized area.

2.1.3 Participation and risk ownership

During phase 2 of the project the stakeholder involvement was deepened especially during the workshops and continuous communication outside the formal meetings. Interaction with stakeholders has provided us with better understanding of climate change issues in the Municipality. 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**. We managed to involve individuals and NGOs for each of the named stakeholders.
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.

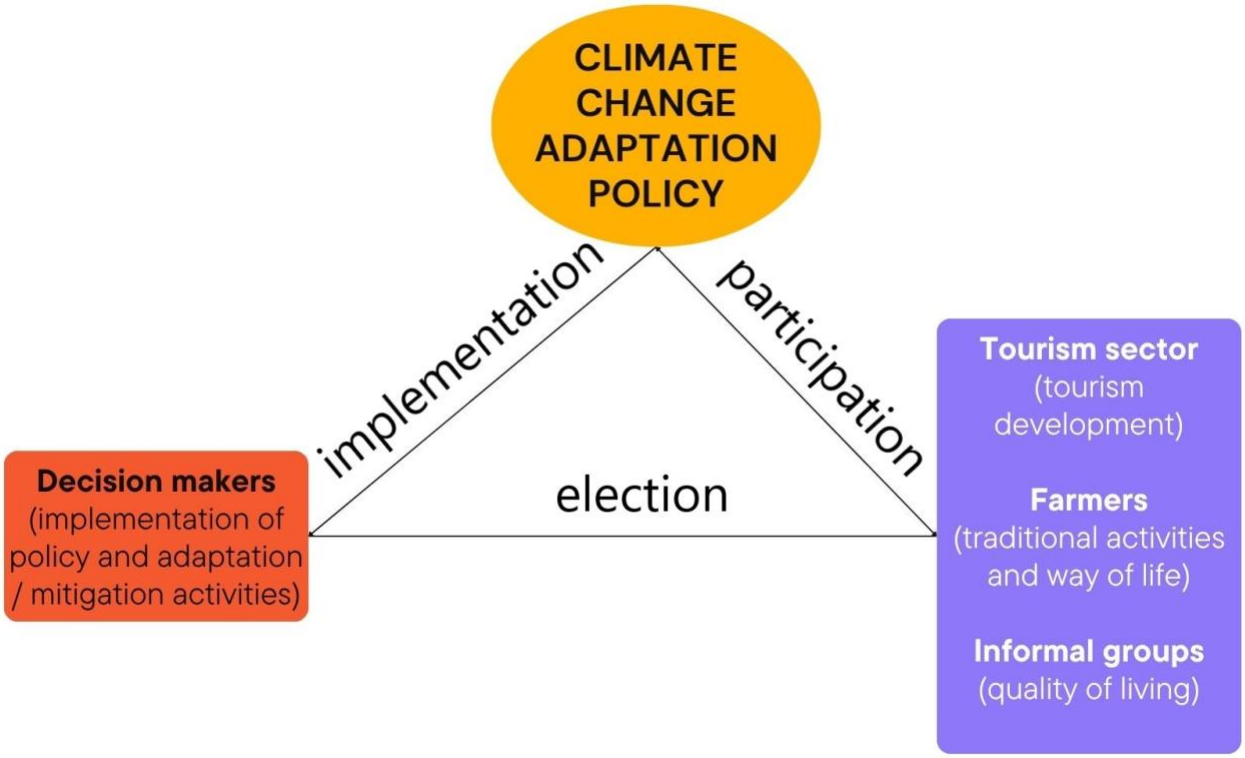

Figure 2-1 A chart showing the relevant stakeholders, their concerns and interconnections

Responsibility for the identification, assessment and mitigation of specific climate risks in the Municipality of Neum is shared between local, regional and (sub)national actors. The local government is responsible for addressing wildfire risks and managing coastal erosion. On the wider subnational level of the entity (Federation of Bosnia and Herzegovina) there is the Ministry of Environment and Tourism which, along with relevant water management agencies, coordinates climate change adaptation, especially for high-risk areas.

According to the legislative frame relevant official **representatives for known vulnerable groups** are various governmental bodies such as Federal Ministry of Agriculture, Water Management and Forestry and for stallholder farmers (vulnerable to droughts and heatwaves), Federal Ministry of Environment and Tourism for tourism sector (vulnerable to heatwaves and droughts), Federal Ministry of Labour and Social Policy for elderly individuals and rural residents with low mobility. At the same time, there are environmental agencies (NGOs) that address environmental hazards while at the same time advocating for sustainable environmental policy. There are also various local NGOs that focus on vulnerable groups (such as elderly population and people with special needs) and traditional activities (such as farming and fishing).

Available information on acceptable climate risk for Municipality of Neum is generally proscribed by the Climate Change Adaptation and Low Emission Development Strategy (2020-2030) for Bosnia and Herzegovina. The strategy focuses on mitigating risks from sea-level rise, temperature increases and extreme weather, determining tolerable thresholds through vulnerability assessments.

2.1.4 Application of principles

The CLIMAAX Framework proscribes key principles that are crucial to comprehensive CRA approach that aims to be fair, robust and prudent.

- *Social justice, equity, inclusivity*
- *Quality, rigour, transparency*
- *Precautionary approach*

The implementation of these principles is strongly connected to participatory multi-stakeholder processes. In this section we will explain how we have incorporated these principles into our CRA for the Municipality of Neum.

Social justice, equity and inclusivity are the first group of interconnected principles that address the vulnerability of certain groups of local population and involve them in the decision-making process. To deal with this group of principles we applied an inclusive and participatory process to achieve a certain level of procedural justice. Therefore, we encouraged meaningful community engagement, especially the most vulnerable and marginalized groups, and strived to empower local knowledge by integration of local knowledge with scientific expertise. We also tried to achieve distributive justice through application of relevant risk indicators of social vulnerability and analysis of non-economic damages such as biodiversity loss.

Quality, rigour and transparency were included by adopting standardized CLIMAAX framework and engagement of various stakeholders. Quality relies on robust scientific data from trusted data sources, integration of local knowledge and multi-disciplinary approach. Rigour is achieved through systematic, evidence-based methodologies that consider both physical (such as climate) and transition (policies, technology) risks that incorporate identification of relevant risks, analyses of different future scenarios, vulnerability analysis and consideration of interactions between climate risks and other types of risks. Transparency is guaranteed through clear reporting and openness in following sectors: clear documentation of assumptions, limitations and methodology, stakeholder engagement, open access and sharing of results and reporting of scientific uncertainties.

Precautionary approach is understood as attempting to prevent potential or irreversible damages moving the focal point to planning for worst-case climate scenarios. We aimed to integrate precautionary approach by setting the context (by defining of uncertainties, and worst-case scenarios), identifying and evaluating climate risks, developing strategy of adaptation and mitigation and introducing the policy of monitoring and flexible policymaking.

2.1.5 Stakeholder engagement

Our engagement with stakeholders, experts and priority groups in the Municipality was established during workshops and maintained on a regular basis. Initial contacts were established with local government and deepened during frequent meetings. Other stakeholders were engaged through workshops and unofficial meetings where we got their feedback on climate change and hazards in the Municipality. These meetings started from the beginning of the project, and we plan to continue with them until they end. All the stakeholders involved in the process participated in two workshops in October of 2025 and March 2026.

The participants in the meetings/surveys were coming from official and unofficial sectors of the Municipality. The official was represented by the local government while the unofficial consists of various NGOs concerned with various sectors of economy (tourism, mariculture, agriculture) just as those that deal with social issues.

We used workshops as the principal way to **communicate the project goals and intermediate results** because we wanted to give opportunity to each stakeholder to voice their views, concerns and attitudes. Our communication with stakeholders did not stop on workshops but was further expanded during our separate informal meetings.
Regarding the way **our results were received by participants** we were met with very constructive discussion and an atmosphere of mutual understanding and tolerance. On the contrary, the results were received with interest, a positive reaction and **extremely constructive feedback**. It is obvious that stakeholders are already aware of the climate change issues in the Municipality, that stretch for half a year (from late Spring to early Autumn). On the other hand, various organisations and individuals are very sensitive concerning various environmental issues and ways of saving the environment and economic activities for future generations. A significant number of them expressed a wish to maintain the local nature and an economic activity.
The project outcomes will be presented and served to the participants for further use in climate change adaptation and mitigation projects, programmes and policies. We expressed our preparedness to provide them with our scientific and project application expertise. By now we have not got any feedback from them regarding their further plans except for the local government that is interested in continuing with similar projects, especially on the European level, in the future.
We encountered some difficulties during our work in the field of availability of specific climate data for such a small rural area that we needed for maps, diagrams and further hazards/risks analysis.

2.2 Risk Exploration

During Phase 1 of the project, we have defined the sectors (farming, mariculture and tourism) and geographic areas (urbanized coastline and rural hinterland) at risk by climate change. We have also encountered a serious problem of devastating effect on the biodiversity of the Adriatic Sea marine species that are a result of two most relevant climate hazards in the Municipality: droughts and heatwaves.

2.2.2 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.**
Research during Phase 1, which was completed until the end of August, showed that severe droughts and heatwaves continue to be an important hazard in the Municipality. The season of droughts stretched from late spring till early autumn and was especially severe during the summer months, just like periodical 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 20th century 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 the locals who live inside this part of the Municipality.
We did not register any new development regarding the geographic distribution of the hazards or their impact compared to Phase 1 of the project. The summer of 2025 was very dry and hot with periodic heatwaves and high air temperatures.
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.

2.2.3 Choose Scenario

We considered future climate conditions for the Municipality of Neum in accordance with the global warming trend in shape of two climate scenarios:

1) Scenario RCP 8.5 that 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

2) 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.

These future climate conditions are realistic in the wider area of the Adriatic coast, and the trends of these indicators are noticeable at an annual level.

We considered future socio-economic developments in the Municipality of Neum that relies on sustainable tourism and mariculture in urbanized coastal areas and farming in rural hinterland while introducing eco-friendly economies and improving its transport links to the wider region.
Population Changes are defined by wider trends in Bosnia and Herzegovina of long-term population decline, aging and emigration and shrinking of the working-age population. While the permanent population of the Municipality is slowly growing it is obvious that the growth is slowing and nearing the stagnation. At the same time the process on population concentration on the coast in the town of Neum and population loss of the rural hinterland is expected to continue. On the other hand, due to heavy dependence on tourism, there is a need for workers during summer months that puts an additional strain on local infrastructure in the urbanized coastal area. **Future Economic Activities** will be marked by domination of beach tourism in overall economy with secondary role of faming, mariculture and catering. **Future Food Consumption and Prices** are expected to move towards sustainable and locally sourced food, driven by the tourism sector's need for high-quality, authentic products. Since local agriculture is highly sensitive to climate change there is realistic danger of fluctuations in the supply and price of local food products. At the same time, prices are under influence of broader European and global economic context that is defined by inflation.
Future climate conditions, in shape of Representative Concentration Pathways (RCPs), are combined with future socio-economic development – Shared Socio-economic Pathways (SSPs). We combined by using scenario matrix pairing RCPs scenarios with SSPs scenarios. In addition, we used social vulnerability projections to describe societal development interconnected with climate change and overall changes in the environment.
In the analysis we considered medium-term time horizon of two to three decades as the most relevant from the point of view of assessing climate change risks and evaluating changes of the policy and stakeholder behaviour. Since actual change would not be possible without policy and behavioural changes, we assessed that it would be unrealistic to expect such changes in shorter period. On the other hand, we found long-term time horizons to be insecure due to current political, economic and population developments on the European continent.

2.3 Regionalized Risk Analysis

The regionalized risk analysis for the Municipality of Neum downscales the standard CLIMAAX drought and heatwave workflows to the 27 official FGU BiH settlements. Droughts were assessed with a 6-month Standardised Precipitation Index (SPI-6) computed from merged station, reanalysis and CHELSA CMIP6 precipitation data, while heatwaves were assessed with the EuroHEAT historical and projected heatwave-day rasters. Risk was quantified with the IPCC/CLIMAAX framework R = H × E × V, using GHSL population and built-up surfaces, CORINE agricultural land and ISRIC soil-water holding capacity as exposure and vulnerability proxies. Future scenarios cover three SSPs and two RCPs across near-, far- and far-future time horizons. All settlement-level maps are provided as supporting figures at the end of the report.

2.3.1 Hazard #1 - fine-tuning to local context

Table 2-1 Data overview workflow #1

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
Merged DHMZ/FHMZ station precipitation + ERA5-Land monthly precipitation (0.1°); SPI-6 computed via gamma distribution.	Soil available water capacity (ISRIC 250 m); FAO GAEZ v5 irrigation suitability; water bodies (OSM + BiH Cadastre).	GHSL GHS-POP 2020 population density; CORINE 2018 agricultural land; GHSL GHS-BUILT-S 2020 built-up surface.	Settlement-level drought frequency (% months with SPI-6 ≤ −1), drought severity (mean SPI-6 in drought months), composite drought hazard.
CHELSA V2.1 CMIP6 1 km monthly precipitation climatologies (MPI-ESM1-2-HR) for SSP1-2.6, SSP3-7.0 and SSP5-8.5 across near (2011–2040), far (2041–2070) and ff (2071–2100) horizons.	Same static vulnerability layers as above; future socioeconomic changes not modelled.	Same exposure layers as above; future land-use changes not modelled.	Future drought severity maps per SSP and period; change relative to historical baseline.

2.3.1.1 Hazard assessment

The drought hazard for Neum was characterised through two complementary metrics: drought frequency (Figure 2-2) and drought severity (Figure 2-3). Drought frequency was defined as the percentage of months during the 1991–2024 period in which the 6-month Standardised Precipitation Index (SPI-6) fell below −1, indicating moderate or worse meteorological drought. Monthly precipitation inputs were obtained from a merged station–reanalysis dataset. In-situ observations comprised DHMZ records from the KMP Opuzen and KMP Metković stations for the Croatian side of the study area and FHMZ records from the Neum station for the Bosnian side. Where station records were incomplete, ERA5-Land reanalysis data extracted from 19 grid points at 0.1° resolution were used to fill gaps by means of a K-nearest-neighbour temporal imputation (K = 5). SPI-6 was computed for each point using a gamma distribution fit to the precipitation time series, and the resulting drought frequencies were interpolated to the 27 official FGU BiH settlement polygons by inverse-distance weighting (IDW). Across the Municipality of Neum, drought frequency values are compact and moderate, generally ranging between 14 % and 18 % of months, reflecting the municipality's narrow Mediterranean coastal strip and limited internal climatic gradients.

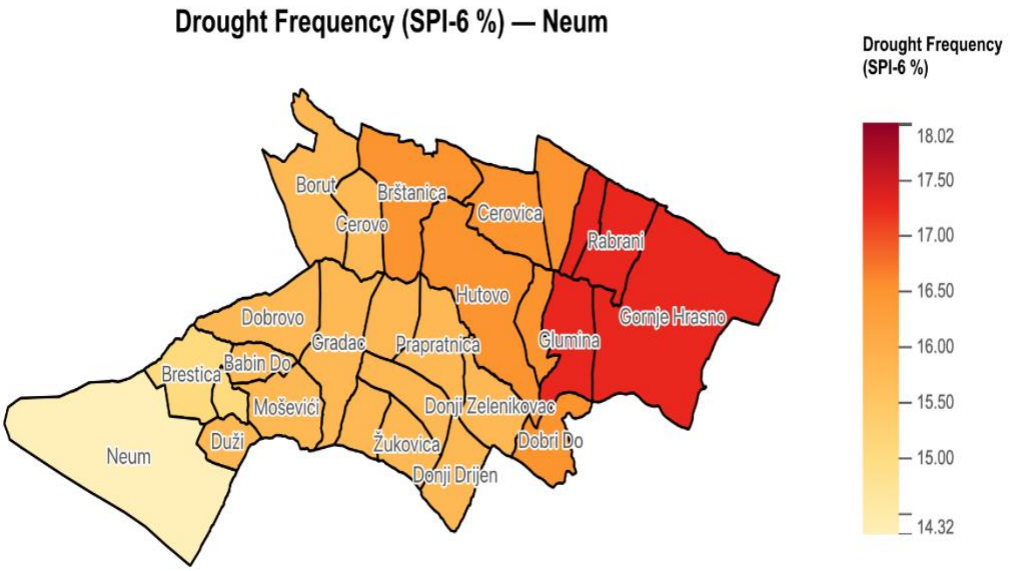

Figure 2-2 Historical drought frequency by settlement, Municipality of Neum (1991–2024).

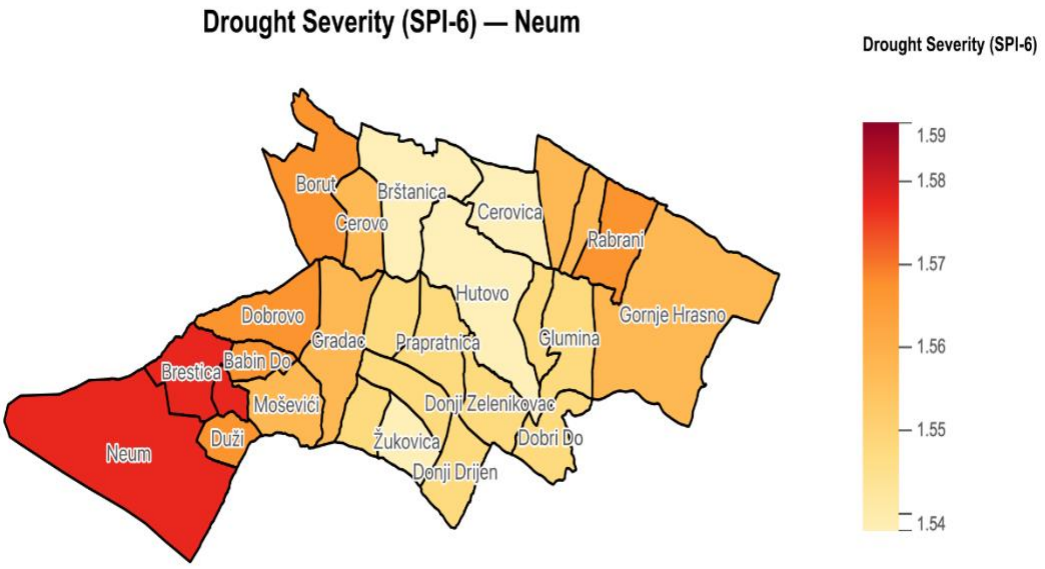

Figure 2-3 Historical drought severity by settlement, Municipality of Neum (1991–2024).

Drought severity was computed as the mean SPI-6 value during all drought months (SPI-6 ≤ −1) over the same 1991–2024 record. More negative values denote more intense drought conditions. Because the same merged precipitation record and interpolation procedure were used, the severity

map is fully consistent with the frequency map. Severity mirrors frequency: settlements that experience more drought months also tend to experience more negative mean SPI-6 values. Neum shows a moderately uniform severity pattern without extreme outliers.

Future drought conditions were assessed using CHELSA V2.1 CMIP6 downscaled monthly precipitation climatologies at 1 km resolution, driven by the MPI-ESM1-2-HR global climate model. Nine combinations of Shared Socio-economic Pathways (SSP1-2.6, SSP3-7.0 and SSP5-8.5) and time horizons (near 2011–2040, far 2041–2070, and far-future 2071–2100) were evaluated. For each scenario, SPI-6 was computed at the same 19 grid points used for the historical analysis, interpolated to the settlement polygons, and normalised against the historical baseline using global minima and maxima. Under the highest-emission SSP5-8.5 pathway, Neum shows a clear intensification of drought severity by mid-century and beyond, with most settlements shifting into higher severity classes. SSP1-2.6 shows the smallest change, while SSP3-7.0 occupies an intermediate position. The use of 1 km CHELSA data replaces an earlier uniform GCM-delta approach and better captures local orographic variability (Figures 2-4 to 2-12).

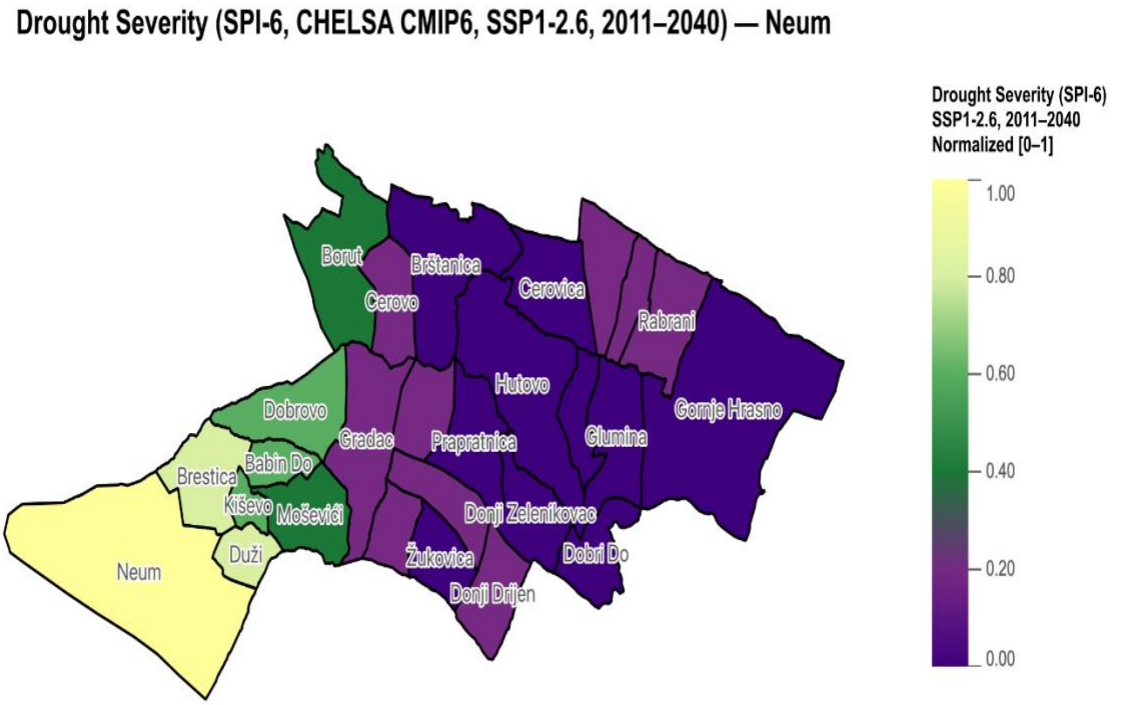

Figure 2-4 Future drought severity by settlement under SSP1-2.6 near (2011–2040), Municipality of Neum.

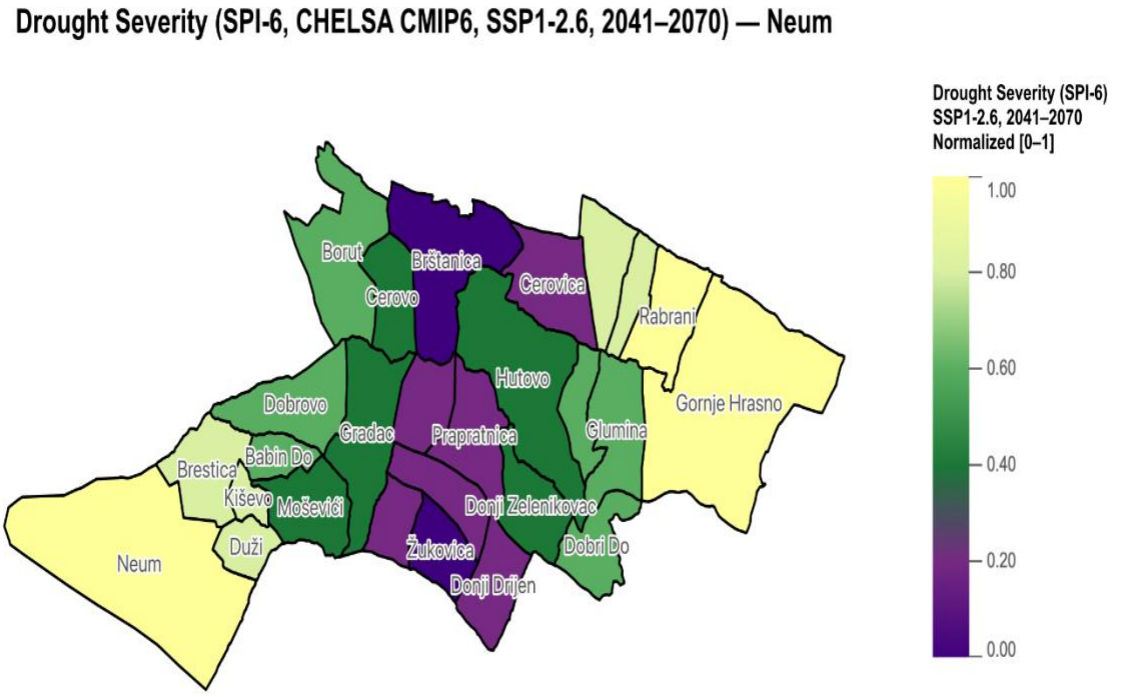

Figure 2-5 Future drought severity by settlement under SSP1-2.6 far (2041–2070), Municipality of Neum.

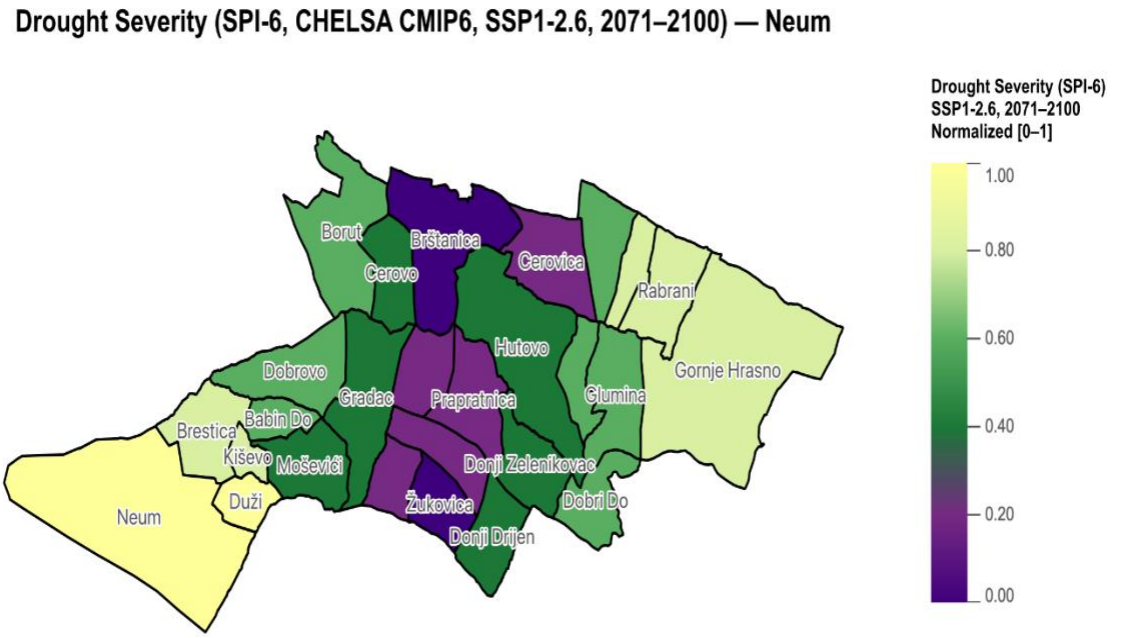

Figure 2-6 Future drought severity by settlement under SSP1-2.6 far-future (2071–2100), Municipality of Neum.

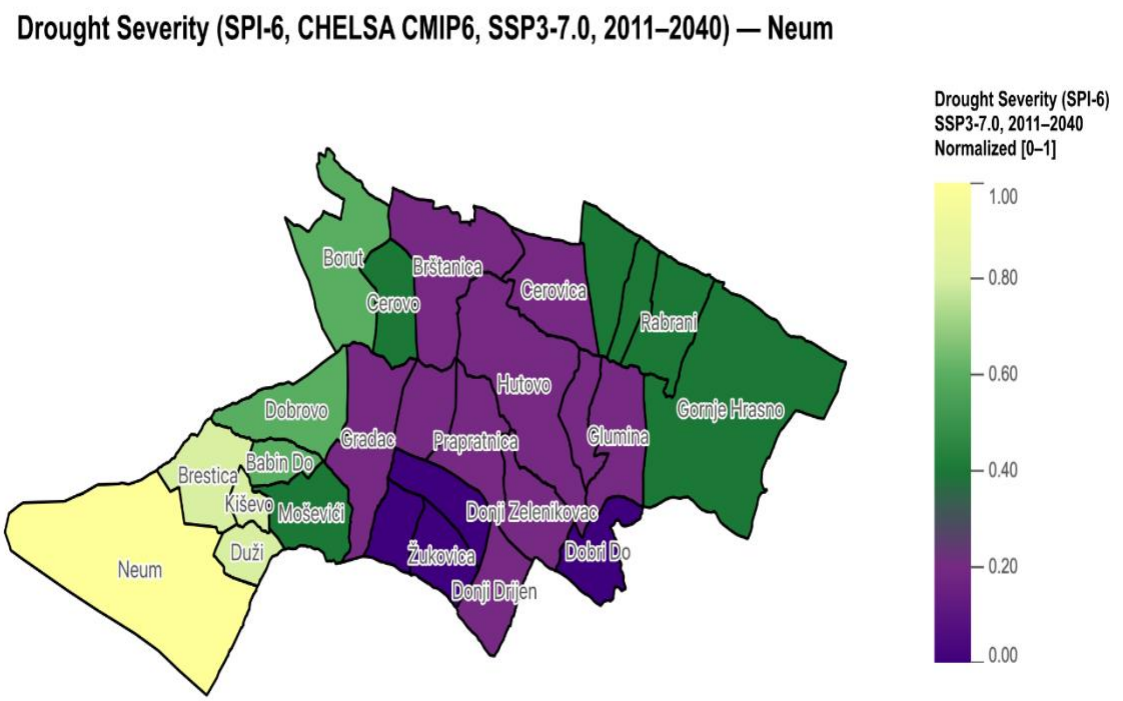

Figure 2-7 Future drought severity by settlement under SSP3-7.0 near (2011–2040), Municipality of Neum.

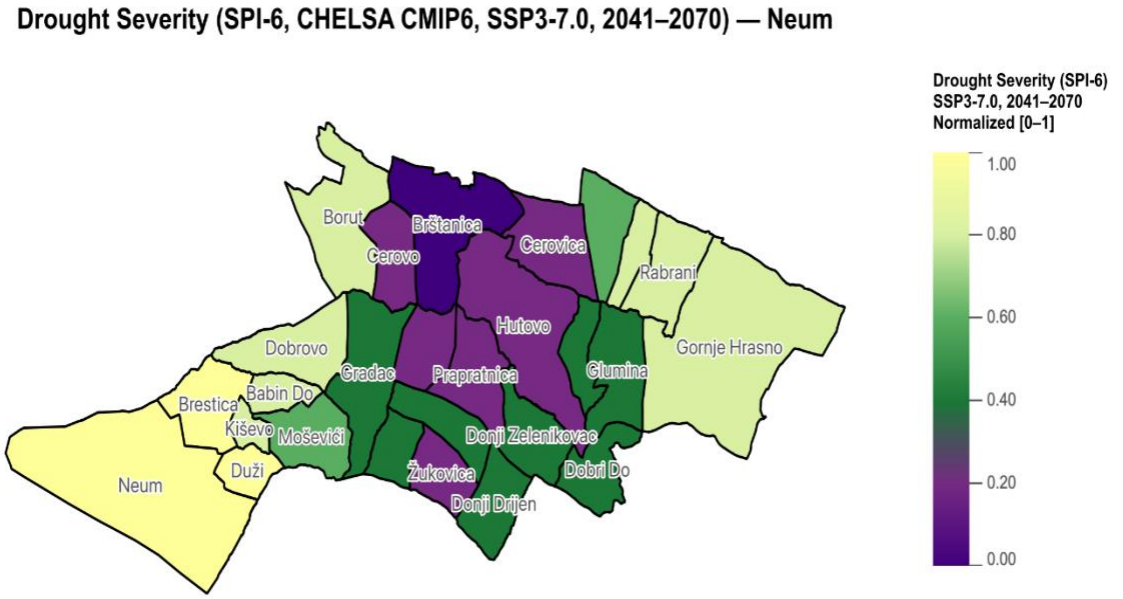

Figure 2-8 Future drought severity by settlement under SSP3-7.0 far (2041–2070), Municipality of Neum.

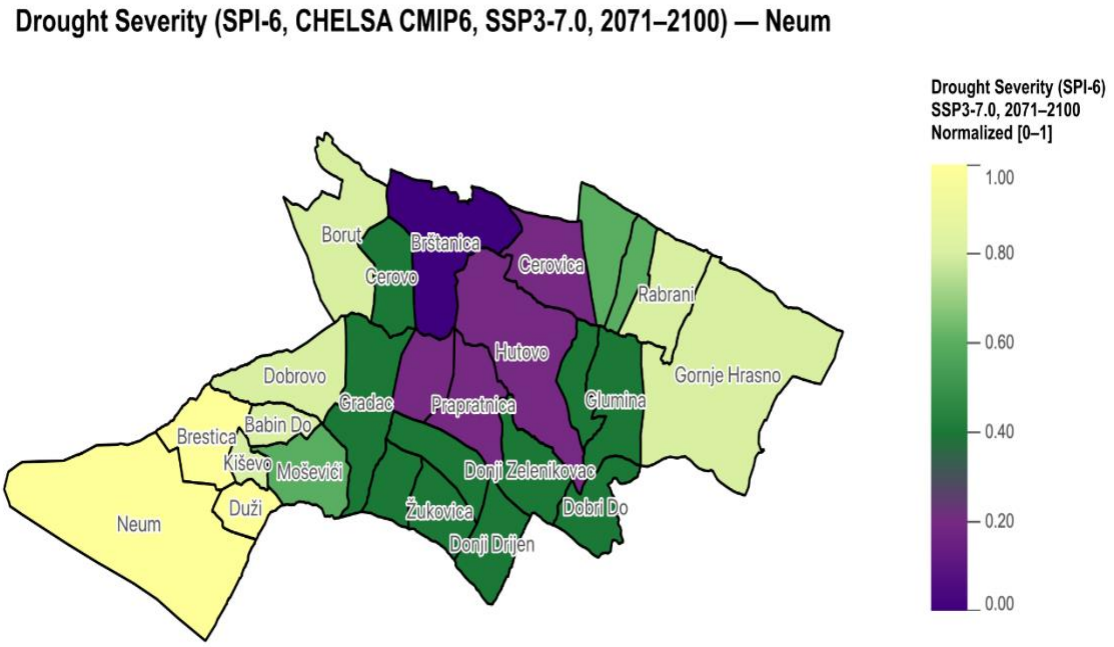

Figure 2-9 Future drought severity by settlement under SSP3-7.0 far-future (2071–2100), Municipality of Neum.

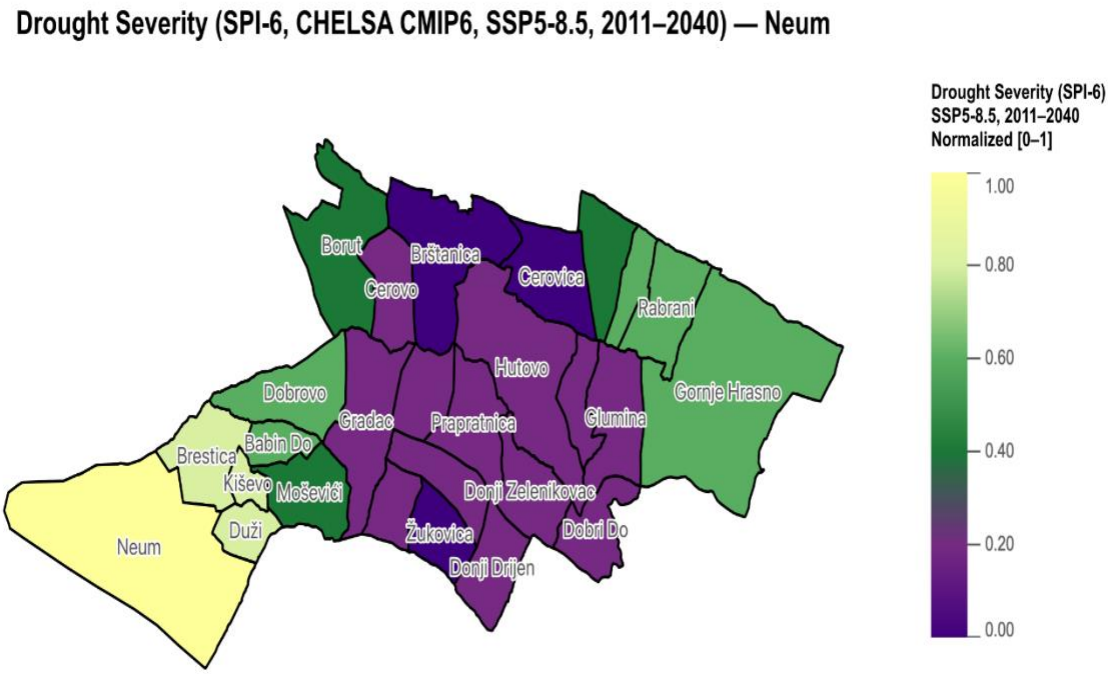

Figure 2-10 Future drought severity by settlement under SSP5-8.5 near (211–2040), Municipality of Neum.

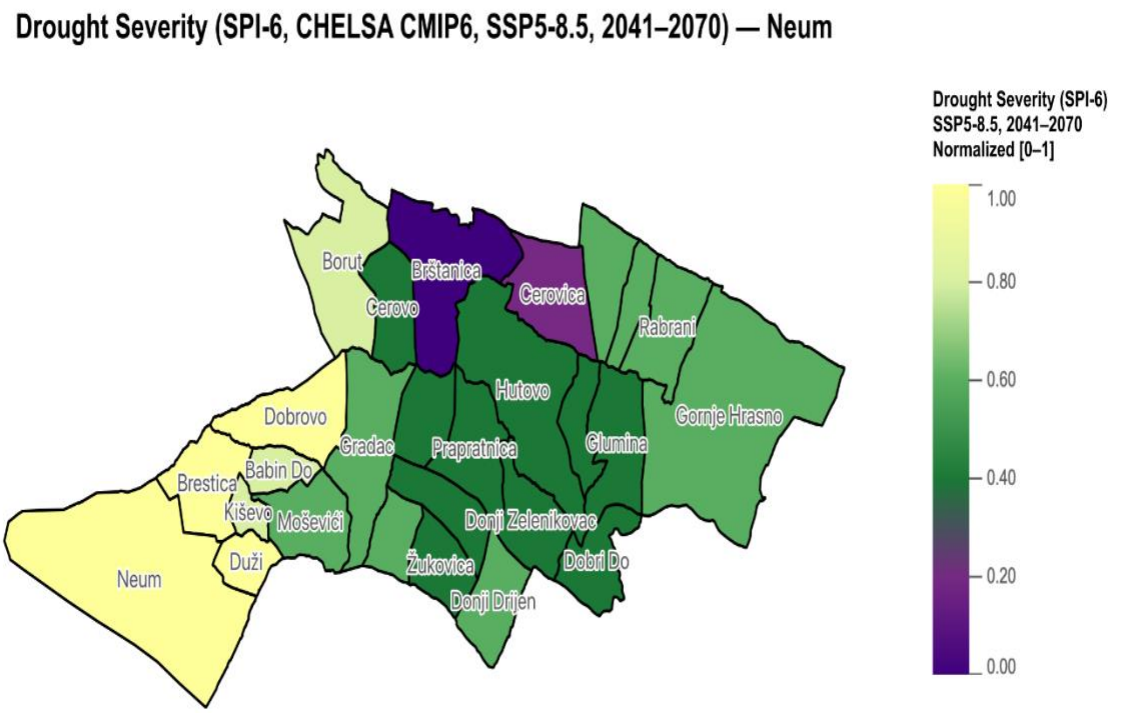

Figure 2-11 Future drought severity by settlement under SSP5-8.5 far (2041–2070), Municipality of Neum.

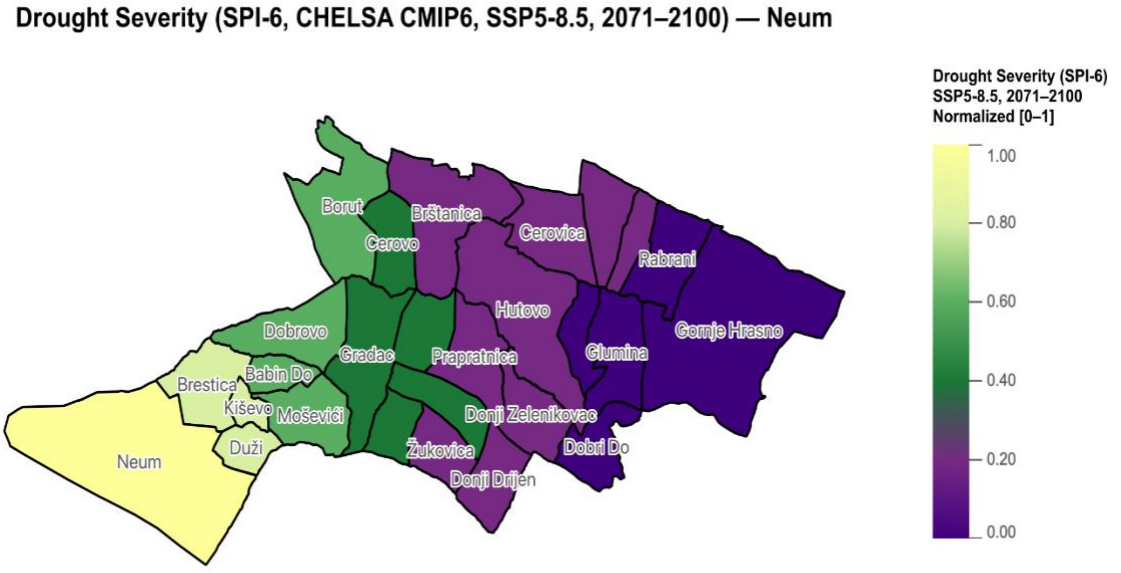

Figure 2-12 Future drought severity by settlement under SSP5-8.5 far-future (2071–2100), Municipality of Neum.

2.3.1.2 Risk assessment

The drought risk (Figure 2-13) assessment follows the IPCC/CLIMAAX risk framework R = H × E × V, where H denotes hazard, E exposure and V vulnerability. Hazard H is the composite drought hazard index obtained by min–max normalising drought frequency and drought severity separately and averaging the two normalised values. Exposure E and vulnerability V were represented by settlement-scale indicators derived from globally consistent datasets, combined in the same multiplicative formulation.

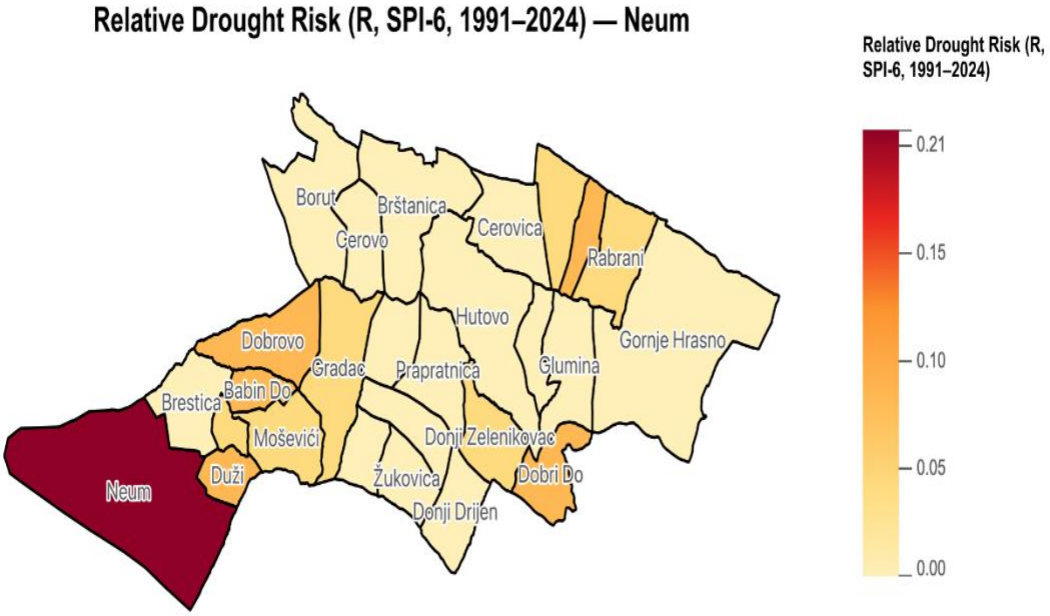

Figure 2-13 Historical relative drought risk by settlement, Municipality of Neum (1991–2024).

Vulnerability to drought was represented by soil available water capacity and the presence of irrigable cropland (Figure 2-14). Soil available water capacity was derived from the ISRIC SoilGrids 250 m product and averaged per settlement; higher values reduce crop water stress and therefore lower vulnerability, while lower values increase it. Irrigation suitability from FAO GAEZ v5 was used to identify settlements where agricultural drought impact could be partially buffered (Figure 2-15). Population density from GHSL GHS-POP 2020, expressed in people per hectare, served as a social vulnerability proxy and indicates the number of residents potentially exposed to water-supply shortages.

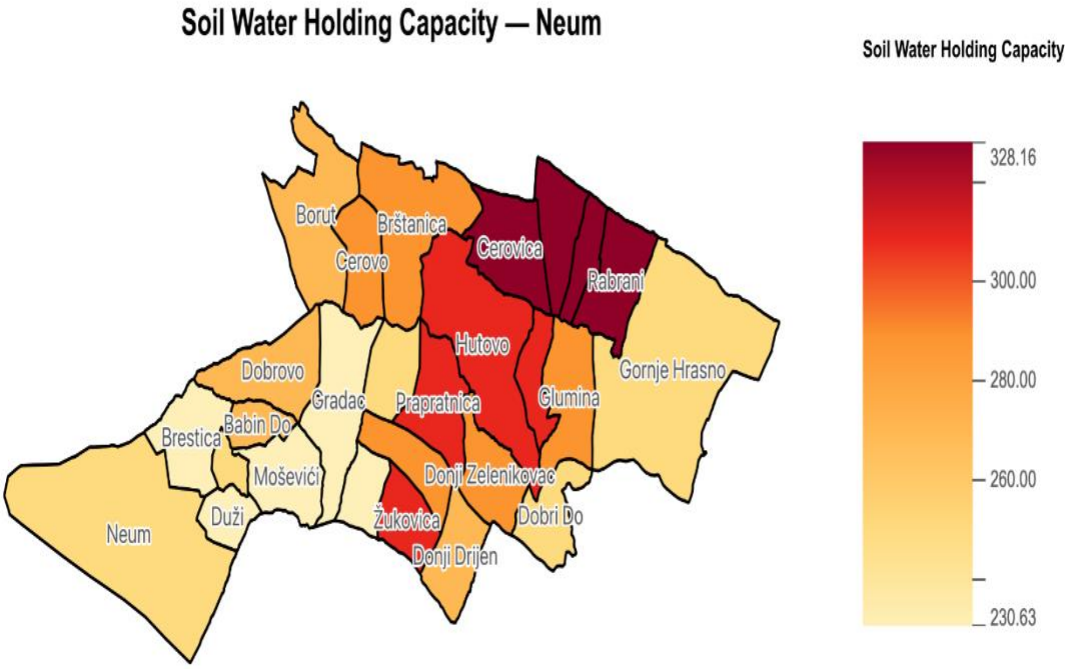

Figure 2-14 Soil water holding capacity by settlement, Municipality of Neum (1991–2024).

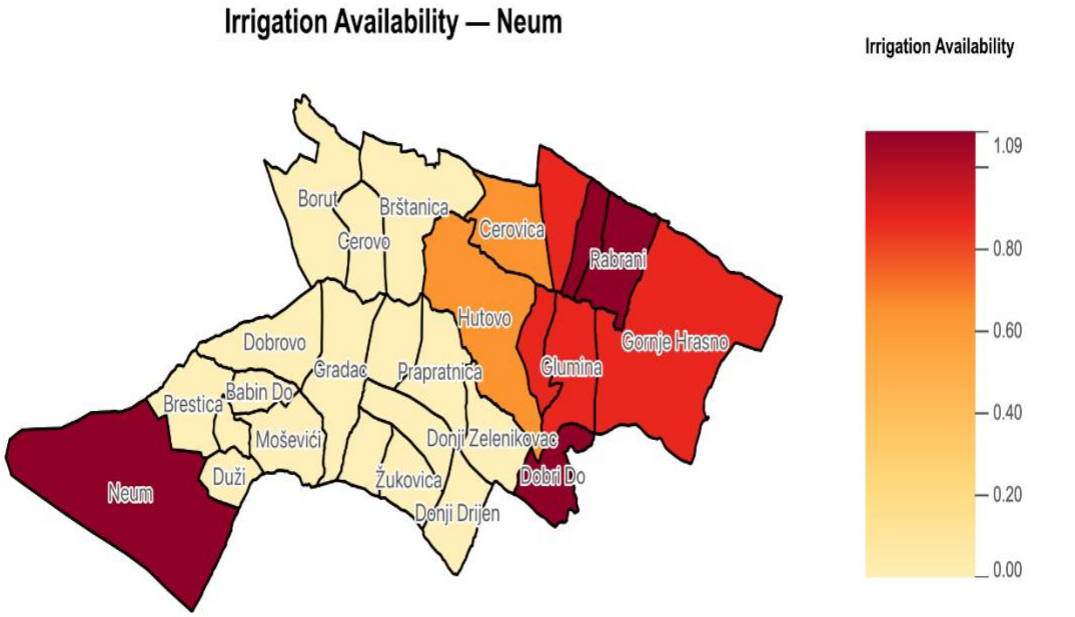

Figure 2-15 Irrigation availability by settlement, Municipality of Neum (1991–2024).

Exposure was quantified through two land-use indicators. Agricultural land exposure (Figure 2-16) was computed as the percentage of each settlement area classified as agricultural use in CORINE Land Cover 2018 (classes 2xx: arable land, permanent crops and pastures). The vector layer was reprojected to EPSG:3765 and intersected with the official settlement polygons. The Municipality of Neum has very limited agricultural land overall; most settlements show negligible agricultural area, with only Miše in the inland hinterland displaying a somewhat higher share. Built-up surface (Figure 2-17) from GHSL GHS-BUILT-S 2020 was also summed per settlement to capture the exposure of property and infrastructure to soil-moisture deficits and associated water restrictions.

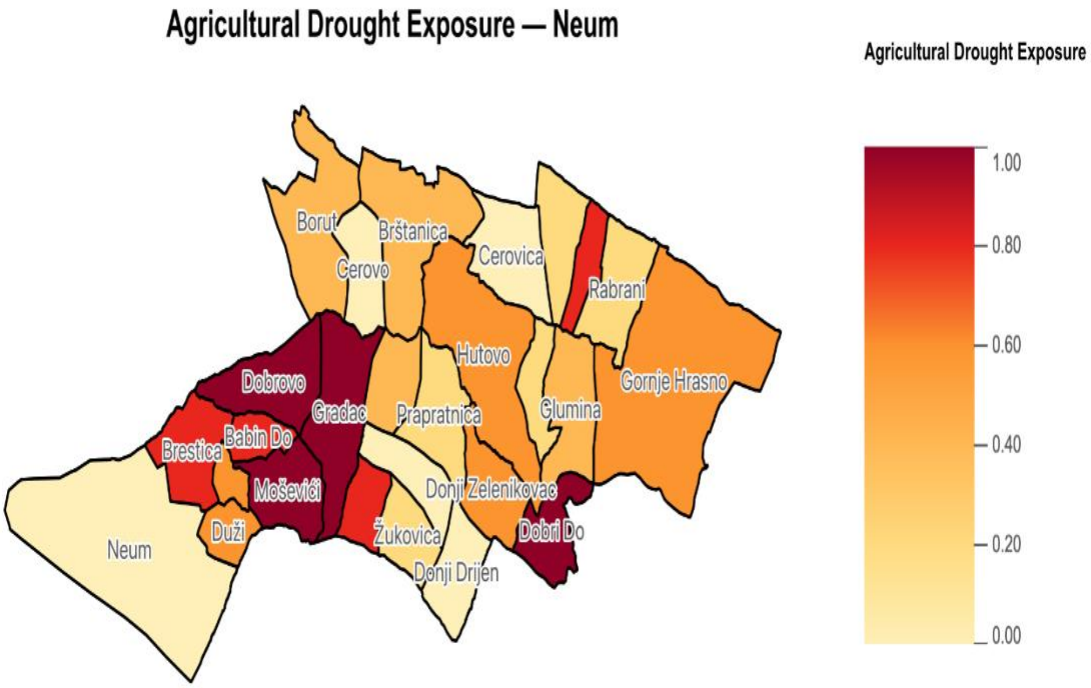

Figure 2-16 Agricultural land drought exposure by settlement in 2026, Municipality of Neum

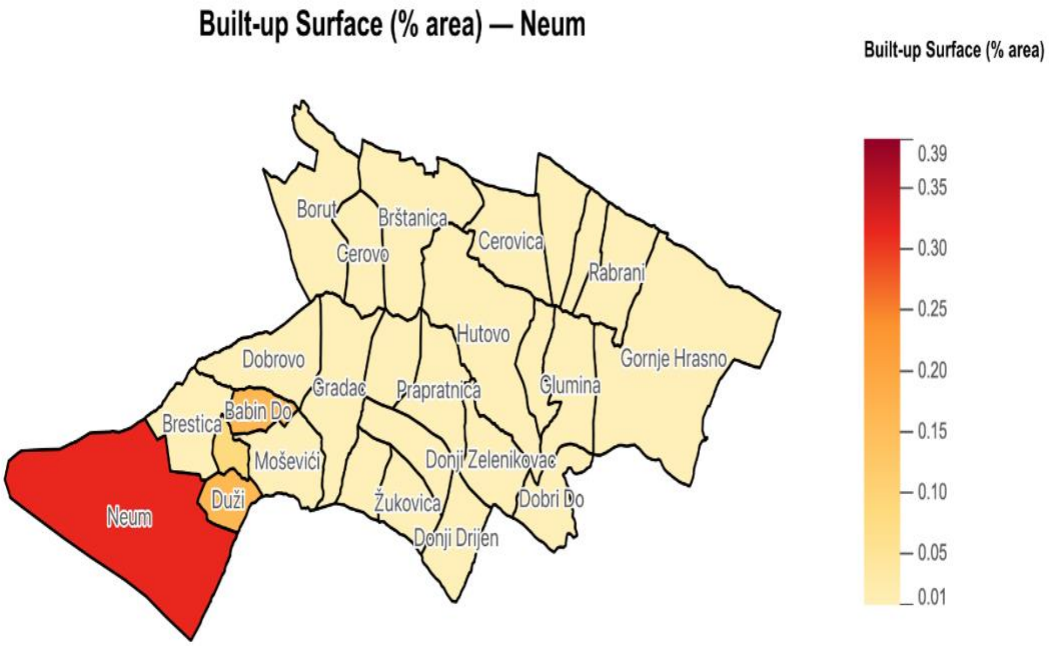

Figure 2-17 Built-up area by settlement in 2026, Municipality of Neum

The resulting drought risk map reflects the interplay of moderate and relatively uniform hazard with spatially concentrated exposure and vulnerability. Highest risk appears in Neum town and nearby coastal settlements, where elevated population density (Figure 2-18) and built-up surface coincide with moderate drought hazard, rather than from strong hazard gradients. Inland settlements have lower risk because their population and built-up exposure are small, even though their drought hazard is comparable to the coast (Figure 2-19).

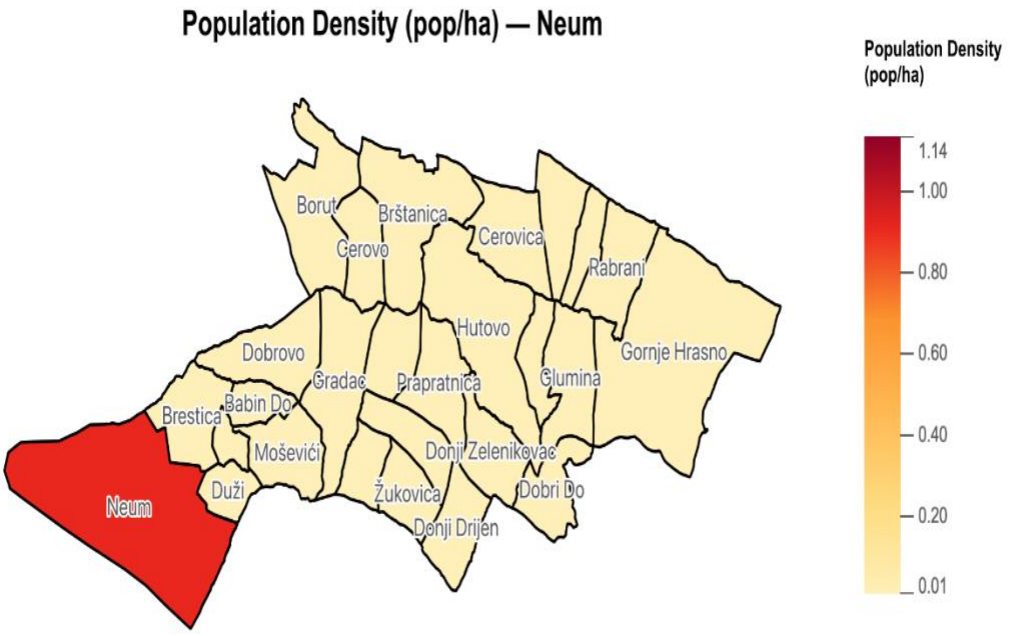

Figure 2-18 Population density by settlement in 2026, Municipality of Neum

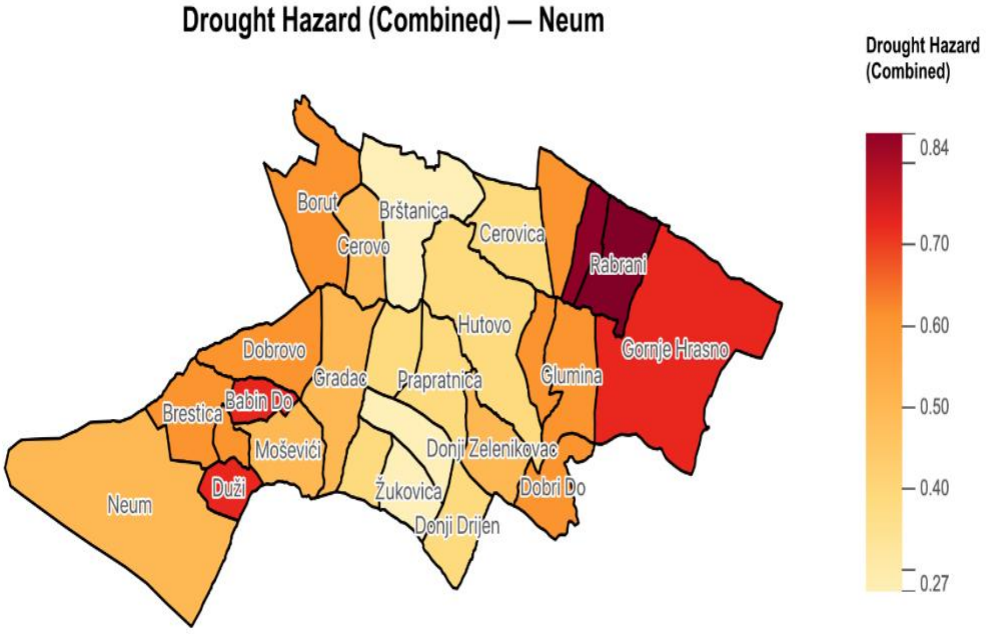

Figure 2-19 Drought hazard by settlement in 2026, Municipality of Neum

2.3.2 Hazard #2 - finetuning to local context

Table 2-2 Data overview workflow #2

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
EuroHEAT historical heatwave frequency rasters (RCP4.5 and RCP8.5 baselines, 1971–2000); average of hw45hc and hw85hc zonal means.	GHSL GHS-POP 2020 population density as a vulnerability proxy; age/health disaggregated data not available at settlement level.	GHSL GHS-BUILT-S 2020 built-up surface; GHSL GHS-POP 2020 population density.	Settlement-level historical heatwave frequency (HW days/yr), heatwave severity (mean projected Δ HW days/yr), composite heatwave hazard.
EuroHEAT future heatwave frequency rasters for RCP4.5 and RCP8.5 near-future (2011–2040) and far-future (2041–2070) periods.	Same population-density vulnerability proxy as above.	Same built-up and population-density exposure layers as above.	Future heatwave frequency maps per RCP and period; combined heatwave–drought indicator map.

2.3.2.1 Hazard assessment

The heatwave hazard was assessed using the EuroHEAT historical heatwave frequency dataset (Figure 2-20). Historical heatwave frequency was expressed as the number of heatwave days per year and computed for each settlement as the average of the RCP4.5 baseline (hw45hc) and RCP8.5 baseline (hw85hc) zonal means over the 1971–2000 reference period. The EuroHEAT rasters were reprojected to EPSG:3765 and mean values were extracted for each of the 27 official FGU BiH settlement polygons. Historical frequencies in Neum range from approximately 7 to 9 heatwave days per year, with modest spatial variation consistent with the municipality's narrow coastal configuration. Slightly elevated values occur in inland vegetated settlements.

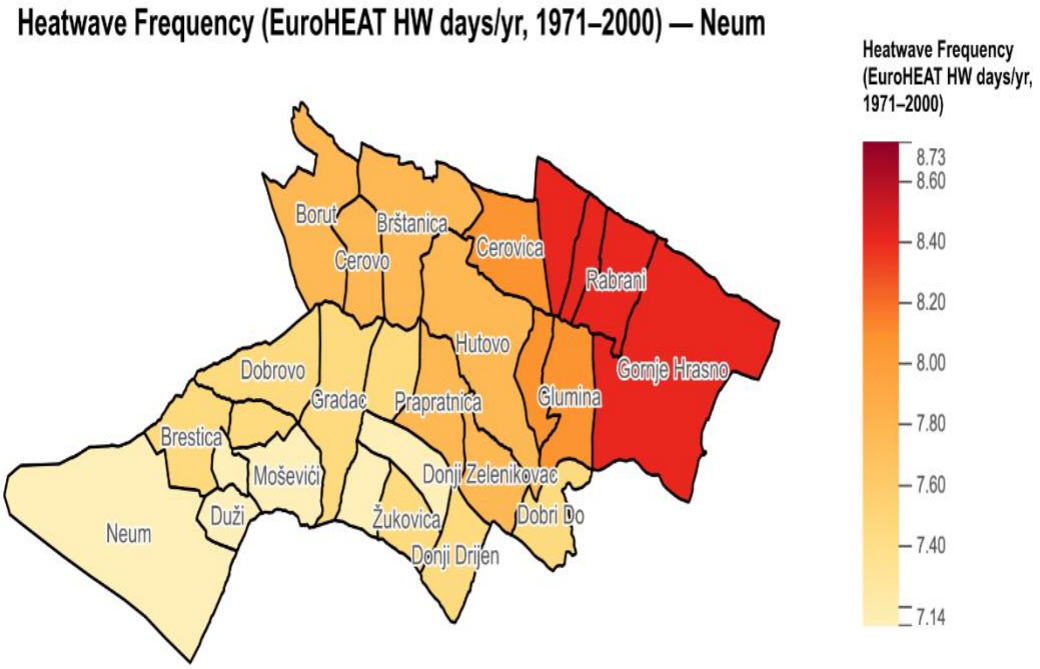

Figure 2-20 Historical heatwave frequency in days per year (1971-2000) by settlement, Municipality of Neum

Heatwave severity was defined as the multi-scenario mean projected increase in heatwave days per year relative to the historical baseline (Figure 2-21). Future inputs comprised the four EuroHEAT scenario rasters: RCP4.5 near-future (2011–2040), RCP4.5 far-future (2041–2070), RCP8.5 near-future (2011–2040) and RCP8.5 far-future (2041–2070). For each settlement the per-scenario increase in heatwave days was computed and the four values were averaged to obtain hw_sev. Severity values across Neum range from approximately 19 to 21 additional heatwave days per year, with slightly stronger projected increases in inland vegetated areas.

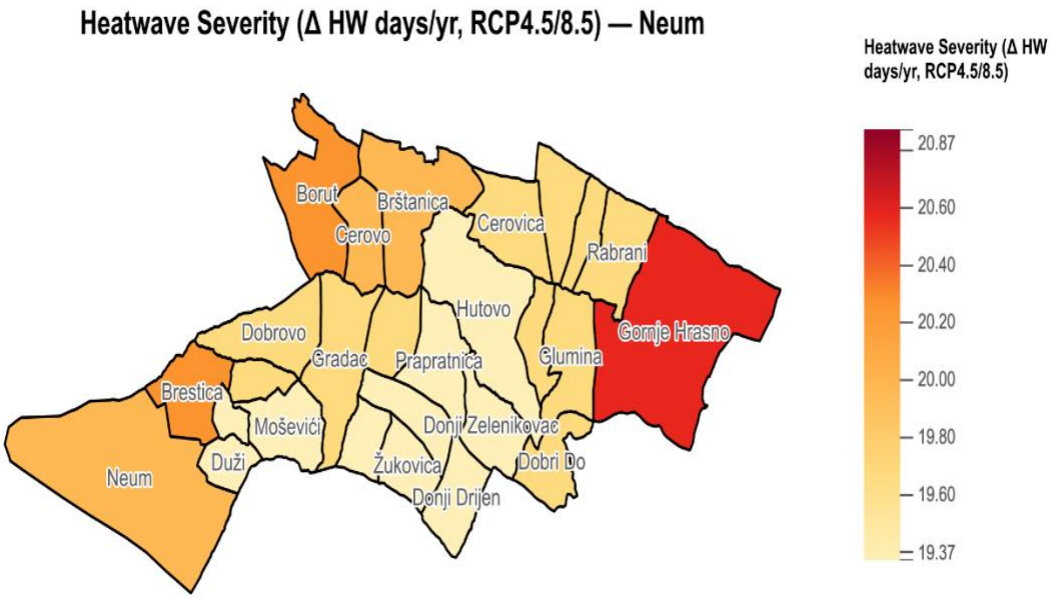

Figure 2-21 Heatwave severity in days per year (RCP4,5/8,5 projection by settlement, Municipality of Neum

Future heatwave frequency maps (Figures 2-22 to 2-25) were produced for each of the four EuroHEAT scenarios by classifying the projected heatwave days per year into six equal-interval classes using the future-scenario colour ramp (deep purple to pale yellow). Under RCP8.5 far-future, all Neum settlements shift to markedly elevated frequency classes, whereas RCP4.5 produces a more moderate increase. These future hazard layers do not include projected changes in population, urbanisation or adaptation capacity; they represent the climate-driven component of future heatwave exposure only.

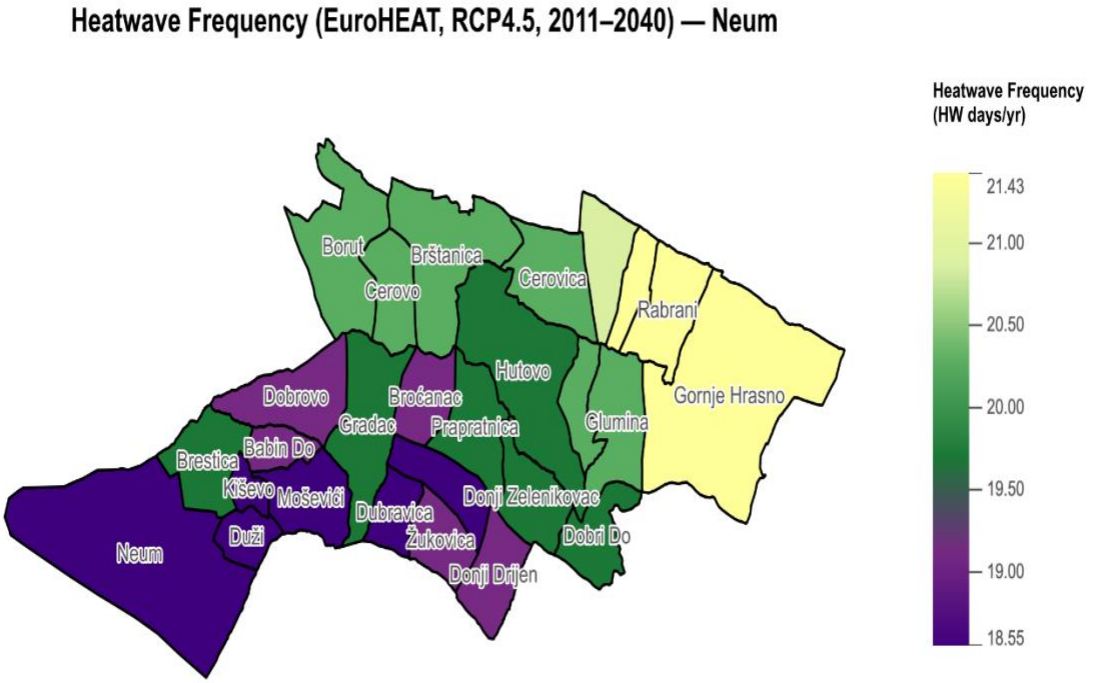

Figure 2-22 Future heatwave frequency by settlement under RCP4.5 near (2011–2040), Municipality of Neum.

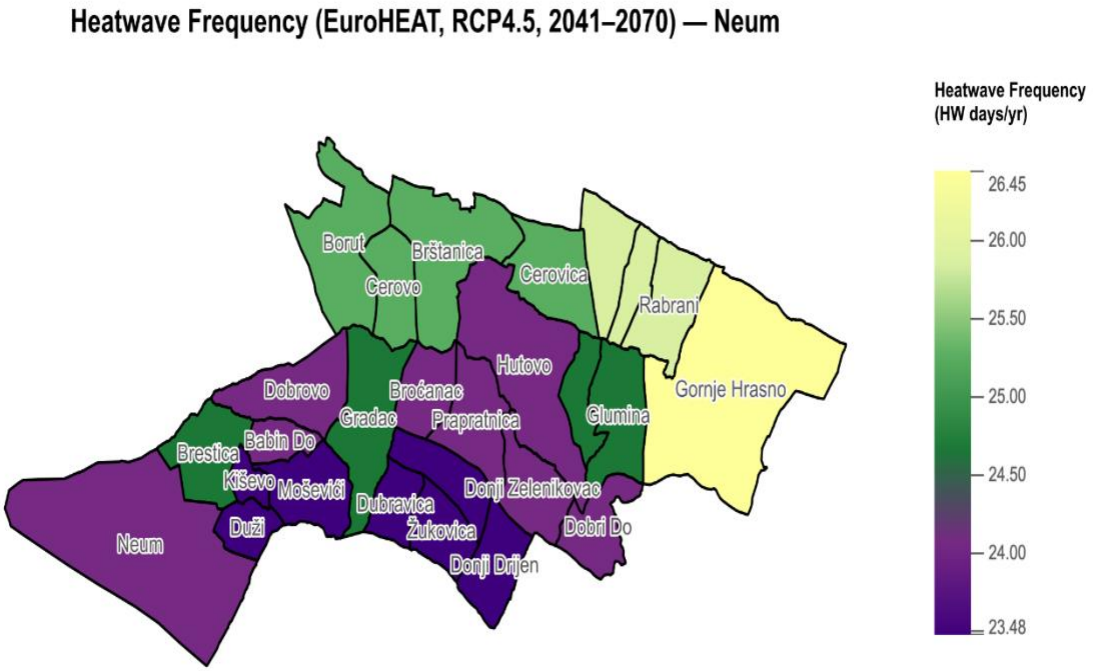

Figure 2-23 Future heatwave frequency by settlement under RCP4.5 far (2041–2070), Municipality of Neum.

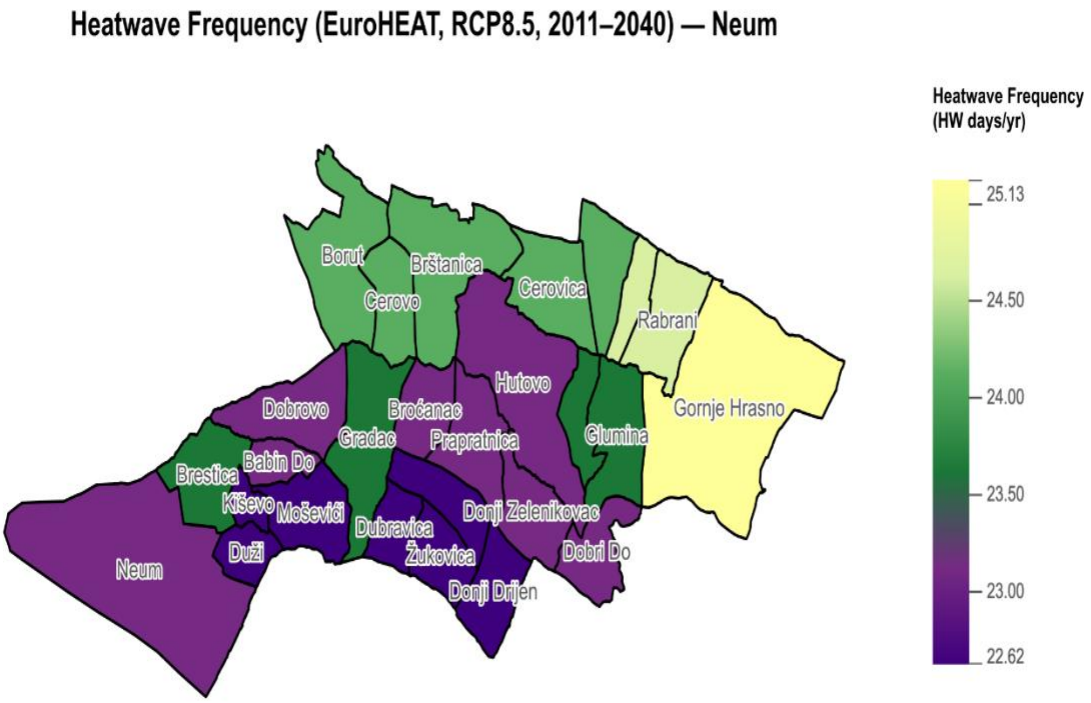

Figure 2-24 Future heatwave frequency by settlement under RCP8.5 near (2011–2040), Municipality of Neum.

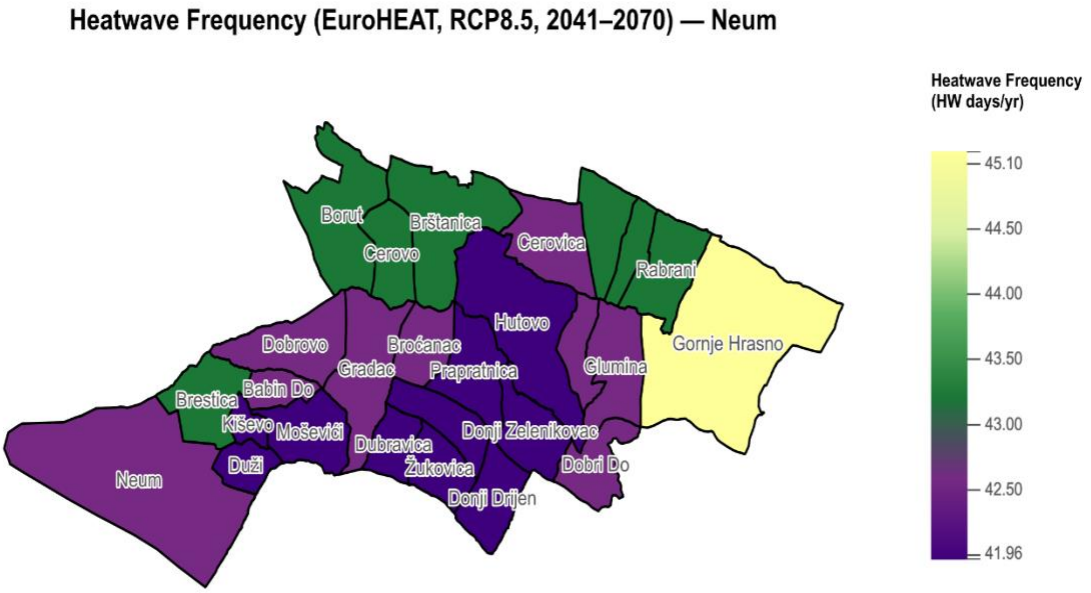

Figure 2-25 Future heatwave frequency by settlement under RCP8.5 far (2041–2070), Municipality of Neum.

2.3.2.2 Risk assessment

Heatwave risk was computed with the same IPCC/CLIMAAX formulation R = H × E × V. The heatwave hazard H is the composite of normalised historical heatwave frequency and normalised heatwave severity. Exposure E was represented by built-up surface fraction (Figure 2-26) and vulnerability V by population density, both derived from GHSL 2020 products. Because the risk product requires non-zero values in all three components, the highest risk is concentrated in Neum town, where elevated hazard coincides with high built-up surface and population density; inland settlements with low population and minimal built-up area register near-zero risk regardless of their heatwave hazard level.

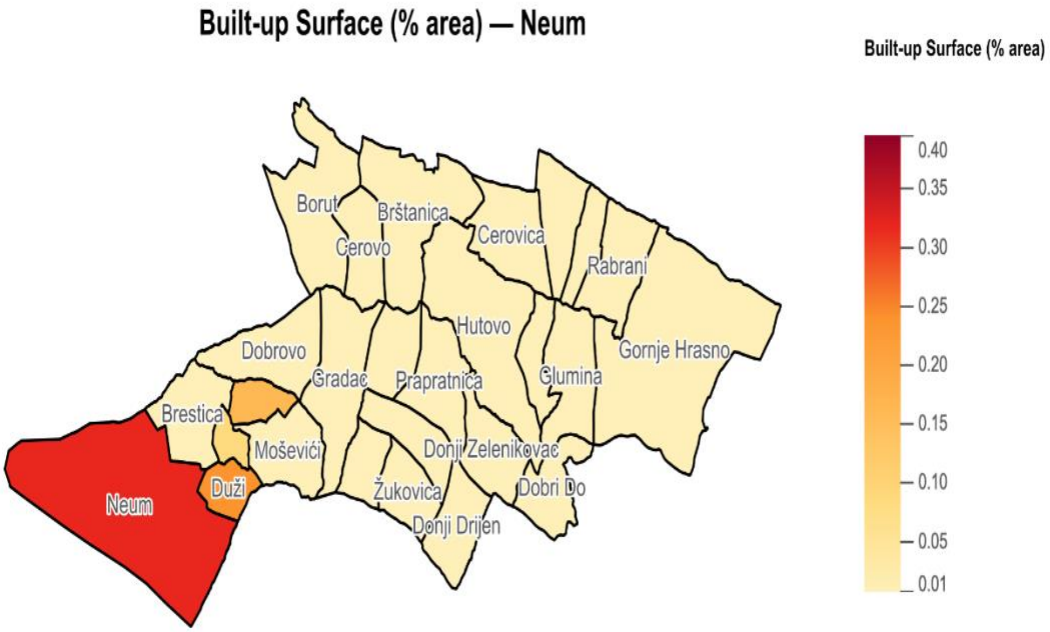

Figure 2-26 Built-up area by settlement in 2026, Municipality of Neum

For heatwaves, population density from GHSL GHS-POP 2020 was used directly as the vulnerability indicator (Figure 2-27). The same census-based limitation applies: the values do not reflect the large seasonal influx of tourists that characterises Neum's coastal economy, so summer heatwave vulnerability is likely underestimated in coastal settlements. No age- or health-disaggregated vulnerability layer was available at settlement scale for the study area.

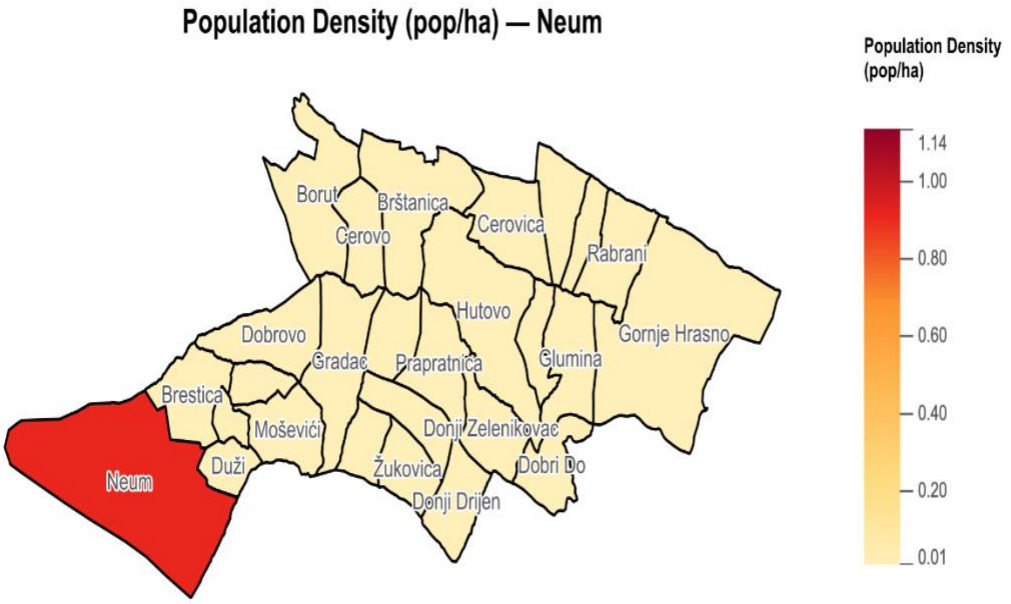

Figure 2-27 Population density by settlement in 2026, Municipality of Neum

Exposure was represented by the GHSL GHS-BUILT-S 2020 built-up surface fraction per settlement, computed as the sum of built-up pixels divided by settlement area. Neum town and the contiguous coastal strip contain the largest built-up fractions, while inland settlements are predominantly vegetated or agricultural and have very low built-up cover. This distribution is the dominant control on heatwave risk, because it determines where people live and where the urban heat-island effect is strongest.

The heatwave risk map therefore shows a strong coastal–inland gradient driven mainly by exposure and vulnerability, not by large differences in heatwave hazard. Neum town and adjacent coastal settlements display the highest risk, whereas inland vegetated settlements with comparable or slightly higher hazard remain low risk because of their sparse population and limited built-up area. This pattern highlights the importance of fine-scale population and land-use data when downscaling climate hazards to small municipalities (Figure 2.28).

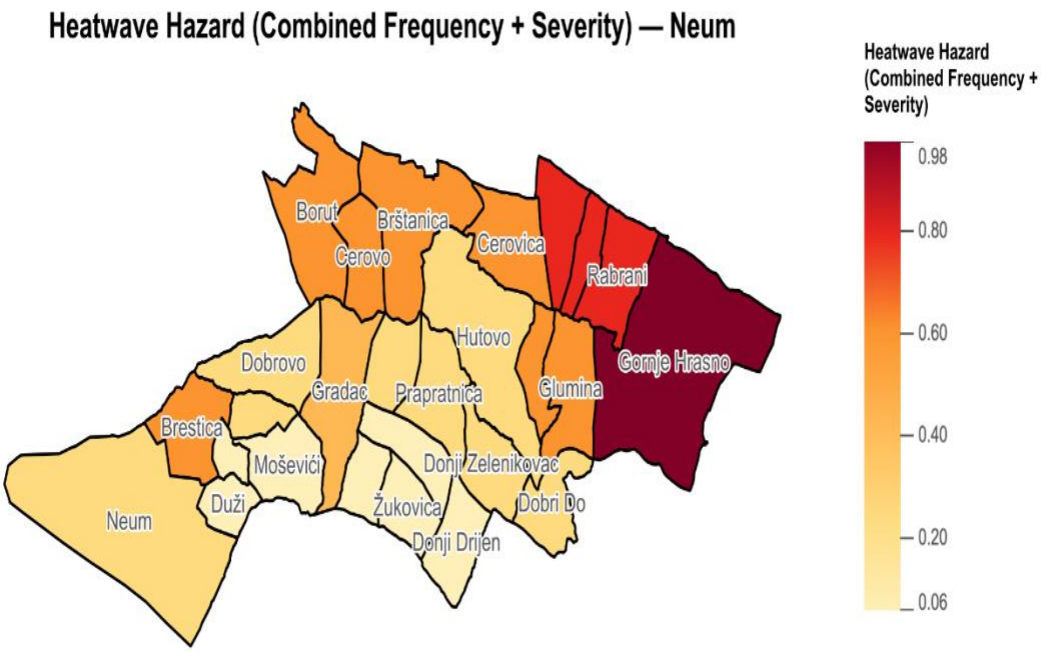

Figure 2-28 Heatwave hazard by settlement in 2026, Municipality of Neum

2.3.3 Additional assessments based on local models and data

The settlement-level maps described above represent a downscaling of the standard CLIMAAX drought and heatwave workflows to the 27 official FGU BiH settlements in Neum. The principal modifications relative to the standard workflow were: (i) replacement of NUTS3 or OSM spatial units with official cadastral settlement boundaries; (ii) integration of local meteorological station data (DHMZ and FHMZ) with ERA5-Land reanalysis for drought metrics; (iii) IDW interpolation of point-based climate indices to settlement polygons; (iv) addition of future scenario maps using CHELSA CMIP6 for droughts and EuroHEAT RCP4.5/8.5 for heatwaves; and (v) construction of a compound heatwave–drought indicator. What remained unchanged were the core hazard metrics (SPI-6 for droughts, EuroHEAT heatwave days for heatwaves), the IPCC/CLIMAAX Risk = Hazard × Exposure × Vulnerability framework, and the use of GHSL, CORINE, ISRIC and EuroHEAT as primary input datasets.

2.3.3.1 Hazard assessment

In addition to the single-hazard drought and heatwave assessments, a compound hazard indicator was produced by averaging the normalised drought hazard composite and the normalised heatwave hazard composite. This provides a first-order view of settlements that may be exposed to both dry and hot summer conditions in the same season. The compound hazard layer is described in more detail under the risk assessment below and is presented as Figure 2-29.

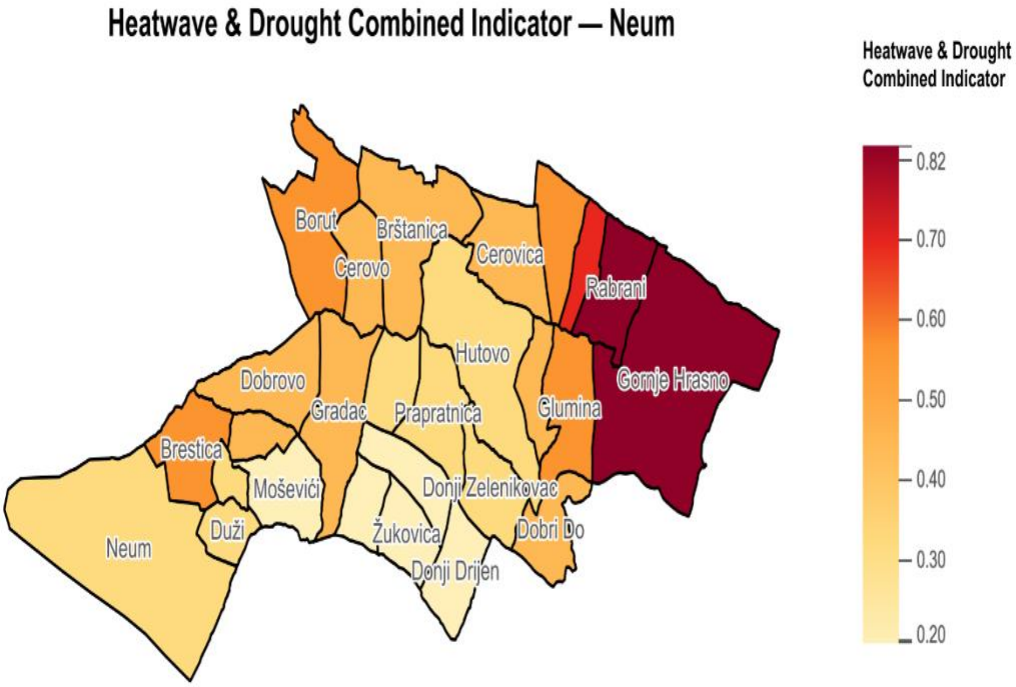

Figure 2-29 Heatwave and draught combined indicator by settlement in 2026, Municipality of Neum

2.3.3.2 Risk assessment

A simple compound risk screen was generated by multiplying the compound hazard with population density and built-up surface fraction, analogous to the single-hazard risk formulation. Because neither adaptation capacity nor dynamic socio-economic projections were available at settlement scale, the result should be interpreted as a sensitivity screen rather than a full probabilistic risk estimate. Validation against local knowledge and the stakeholder workshop confirmed that the spatial patterns are plausible: coastal tourist settlements rank highest for heatwave and compound risk, while inland agricultural settlements rank highest for relative drought exposure (Figure 2-30).

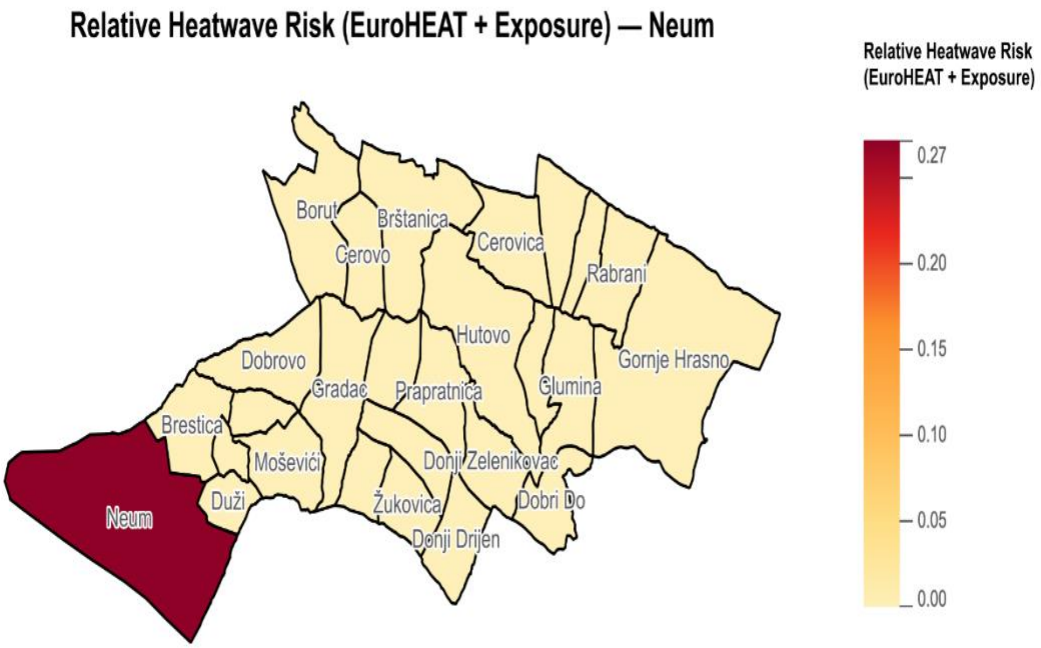

Figure 2-30 Relative heatwave risk by settlement in 2026, Municipality of Neum

2.4 Key Risk Assessment Findings

During Phase 1 of the project, through stakeholder engagement we identified risk severity, urgency and resilience capacity and risk priority (Figure 2-31). The analysis showed that there are two risk workflows with very high-risk priority in the Municipality of Neum: heatwaves and drought. One risk workflow, fire, is of moderate risk priority since it is relevant only during the summer months in the rural hinterland of the Municipality. Predominantly karstic terrain of the hinterland with very sparse vegetation limits the impact of fires. Remaining five risks – river flooding, coastal flooding, heavy rainfall, snow, wind – are of low priority.

Heatwaves are recognized as an important and growing climate risk for the Municipality of Neum. It is the risk with substantial current severity that is expected to reach the critical level in the future, meaning that immediate action is needed to address the issue. At the present moment, the Municipality has medium resilience capacity to heatwaves that is a result of a spontaneous individual approach when dealing with the issue.

Drought is another relevant high-frequency climate risk for the Municipality of Neum, determined by Mediterranean climate characterized by hot and dry summers with increasing rainfall scarcity in warmer months. Just like heatwaves, drought is the risk with substantial current severity that is expected to reach the critical level in the future, meaning that immediate action is needed regarding the urgency. Resilience capacity is characterized as medium because the Municipality lacks a systematic and comprehensive approach when dealing with the issue.

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 2-31 Key Risk Assessment of each risk workflow in the Municipality of Neum

2.4.1 Mode of engagement for participation

Engagement and participation process with relevant stakeholders, experts and priority groups have already been described in section 2.1.5. of this deliverable. The risk assessment gathered very constructive feedback from the stakeholders involved in the process. On the other hand, a minor part of the stakeholders expressed their different views regarding two issues:

1) From the beginning of current decade heatwaves and droughts are more interconnected and it is very hard to separate their impact. Because of that, some stakeholders had problems dividing their impacts into separate categories. On the other hand, the impact of human activities upon those two hazards was not too clear to some stakeholders.

2) Some stakeholders openly expressed their doubts about the effectiveness of adaptation and mitigation strategies and policies because these hazards continue to increase in frequency, intensity and duration.

2.4.2 Gather output from Risk Analysis step

Certain outputs from the Risk Analysis will be used for further risk evaluation. These outputs concern the subtle differences of the negative impact of droughts and heatwaves on the local level. Addressing such subtleties may prove to have an important influence on the stakeholders involved in the climate change adaptation and mitigation process. The outputs are connected with results of the second phase of the climate risk assessments that deal with differences between urbanized coast and rural inland of the Municipality, such as: frequency and severity of the relevant hazards, land use (built-up urbanized area opposed to agricultural rural zone), population density, natural features (such as soil water holding capacity) and infrastructural elements (such as irrigation availability).

2.4.3 Assess Severity

We assessed current severity for current and future risks during our field work, personal contact with stakeholders and during the workshops with the local stakeholders. Current impact was relatively easy to define, especially from the point of view of the stakeholders thanks to their local knowledge. Five risks (river flooding, coastal flooding, heavy rainfall, snow, wind) were defined as **limited** since that is the lowest category with no significant relevance in the Municipality. Fire was marked as a risk with **moderate** severity. Fire occurs during the intensive summer heat in the rural hinterland in the areas of Mediterranean shrubs. Heatwaves and drought were recognized as the risks with **substantial** severity primarily because of its impact on everyday life of the local population, farming in the rural hinterland and marine biodiversity.
The same approach was used to define the future risk severity that showed no significant changes. River flooding, coastal flooding, heavy rainfall, snow and wind stayed in the category of **limited** impact just as fire that is expected to have the same **moderate** severity in the future. On the other hand, it was a general view that severity of heatwaves and drought is going to increase and have a **critical** severity due to climate change, primarily the global warming process.

Climate risk in Neum is severe, driven by a rapid increase in summer temperatures (that are closely interconnected with heatwaves) and declining precipitation (that determine prolonged periods of drought). As part of the Mediterranean region, Neum also faces escalating threats from water scarcity and wildfires. Potential impacts are relevant in sectors of agriculture, tourism and ecosystems (primarily the maritime).
The Municipality of Neum, as a coastal administrative unit in the Mediterranean part of Bosnia and Herzegovina, faces a **high, rising climate risk** in terms of both impact and frequency. Climate hazards, such as heatwaves and drought, cause significant damage to the tourism sector, agriculture and mariculture causing economic losses while its negative impact on biodiversity is not possible to define in financial terms.

Respective climate risks in the Municipality of Neum can unleash irreversible consequences and trigger cascading effects, primarily because of irreparable destruction of ecosystems and devastation of arable land.

Stakeholder perspectives in Municipality of Neum significantly enrich our climate risk perception by shifting focus from solely technical assessments to more localized vulnerabilities. Integrating views from local businesses, residents and vulnerable groups highlights local climate risks and enables us to better perceive severity. While regional strategies exist, **local decision-makers** need to strengthen their capacities to implement localized, systemic risk management.

2.4.4 Assess Urgency

Assessing urgency was done applying the same approach as assessing the severity. The final assessment was done after consultations with the local stakeholders. As we expected, four hazards with lowest severity (river flooding, heavy rainfall, snow, wind) were designated to have lowest level of urgency (category **no action needed**). In next category named **watching brief** was assigned to risks of coastal flooding and fire. Although coastal flooding is a risk with low severity, the global problem of potential sea level rise, due to global warming, should not be easily discarded. There is a similar attitude towards risk of fire that often occurs in the Mediterranean area during the hot summer months. Heatwaves and drought are recognized as risks with highest urgency (**immediate action needed**) because of their prolonged and intensive negative impact.

In general, risk severity does not change significantly from current to future risk since it is staying in same category for six hazards (river flooding, coastal flooding, heavy rainfall, fire, snow, wind). Only for two hazards, heatwaves and drought, the severity is changing in a negative way by moving into the next (higher) category.

Major climate risks, such as heatwaves and drought, will have severe impacts in Municipality of Neum by the mid-21st century, with critical damage potential rising in the second part of the century. Since extreme weather events (heatwaves, drought) are becoming more frequent, immediate action is needed for disaster risk reduction, water supply management and infrastructure upgrades and adaptation, as climate risks can start causing substantial economic damage within the next few years.

Climate hazards are expected to worsen significantly in the Neum region, driven by rising summer temperatures, increased heat-related risks, and prolongated periods without rainfall. Therefore, the region faces intensified risks of drought and heatwaves, which can negatively impact tourism, agriculture, water supply and quality of life of the local population.

Climate hazards in the Municipality of Neum are not primarily associated with **sudden events** but are increasingly threatened by **slow onset processes** such as sea-level rise and rising temperatures on global level. Such a situation influences urgency scoring for climate action. While sea level rise is slow, its impact on infrastructure is becomes abrupt when a certain threshold is passed. There is also an issue of irreversibility since slow-onset processes like sea level rise are, to a large extent, irreversible over human timescales. This requires urgent action now to avoid higher adaptation costs in the future.

The two climate hazards **have the potential to persist**. The current year (2026) is the seventh in the row of intensive summer droughts and periodic heatwaves without any signs of decreasing or down trending.

Different perspectives from stakeholders, experts, or vulnerable groups in the Municipality of Neum enrich our climate risk perception by transforming abstract climate data into specific local impacts, shifting the focus from general awareness to urgent, localized action. The inclusion of diverse viewpoints highlights specific vulnerabilities that may be overlooked in top-down planning. At the same time, their perspectives helped us shift from abstract to Concrete and highlighting gaps in climate adpatation and mitigation documents.

2.4.5 Understand Resilience Capacity

Regarding various risks the Municipality of Neum has various resilience capacity. **Low** resilience capacity, meaning that systems are highly vulnerable with extremely limited capacity to absorb shocks, was not designated to any risk. In the second category of **medium** resilience (moderate resilience to respond) heatwaves and drought risks were placed. Although the Municipality's

capacities can handle disruptions caused by those risks severe heatwaves and drought may cause major damage. There are basic measures to deal with these risks, but they rely on reactive approach. **Substantial** resilience exists when dealing with fire hazard, meaning that Municipality can withstand majority of shocks while, at the same time, experiencing temporary disruptions. There are emergency protocols and established partnerships to deal with these risks with lots of areas to improve. When dealing with river flooding, coastal flooding, heavy rainfall, snow and wind, the Municipality has **high** resilience capacity meaning that local systems can withstand major shocks with minimal operational disruptions. Measures that are already in place consist of monitoring and strong resource mobilization capacity provided by national weather service, firefighting department and Federal Administration of Civil Protection.

Currently, our climate risk management measures are **still in the planning stage**. The local government is dedicated to applying climate change adaptation and mitigation policies on municipal level. Our climate risk management concept relies on various measures that are already being used in other parts of the world: carbon pricing, improving local infrastructure resilience, introducing principles of circular economy and various nature-based solutions.

The Municipality of Neum does **not have sufficient financial capacity** necessary to address the respective climate risks. These aspects demand continuous cooperation of the Municipality with financial institutions on national and international, primarily the EU, levels. There is a **human capacity** that still needs to be upgraded, especially in the sense of raising awareness, knowledge and use of existent learning potential. On the other hand, **natural** (resource management and ecosystem health) and **physical** (ability to forecast and warn and provide critical infrastructure and services) capacities are sufficient just as **social capacities** (social inclusion, equity, representation, favourable policy environment, willingness of decision makers to address the problem).

Our region has **specific interventions** in the form of various documents and financial aid in case of natural hazards. However, a set of detailed hazard mitigation and adaptation plans and acts are still missing. The climate change policy in the region is still primarily reactive instead of active and it is primarily set toward dealing with consequences instead of acting in advance to diminish the climate hazards.

2.4.6 Decide on Risk Priority

Stakeholder engagement provided us with access to their local knowledge and helped us in the process of assigning risk priorities (Figure 2-32) that are necessary for future CRM planning and implementation. The open mutual exchange of knowledge and scientific data through participation and inclusion was crucial in defining severity, urgency and resilience capacity of the Municipality.

Negative impact of **drought** in the Neum municipality is visible on five segements. The first one is agricultural damage in the rural hinterland where it affects local farmers and causes significant loss of vegetation, particularly for fruits, olives, and vines. The second is water supply: reduced precipitation in summer, combined with high evapotranspiration results in water deficits. This creates risks of limited potable water and reduced availability for irrigation during peak agricultural and tourism seasons. The third is negative impact on tourism, the principal source of income for the Municipality, because tourism season is highly susceptible to water shortages, which can impact local amenities and the overall visitor experience. The forurth is environmental degradation since droughts contribute to soil degradation, primarily in rural area. And final, fifth, segment is the firefighting: prolonged droughts, in combination with heat, significantly increase risk of wildfires.

Risk workflow	Severity		Urgency	Capacity	Risk priority
	C	F		Resilience/ CRM	
Workflow 1 (Drought)					Very high
Workflow 2 (Heatwaves)					Very high

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 2-32 Risk prioritization of two most important risk workflows in the Municipality of Neum: droughts and heatwaves

Heatwaves, another climate risk in the Municipality, has an increasing impact in the Neum area. As part of the Mediterranean region, Neum faces rising temperatures, while the season stretches from June till August. Heatwaves have a negative impact on residents, tourism, ecosystem and local infrastructure. Residents, especially the elderly, children, and outdoor workers, face high temperatures during the day and night which may cause various health problems such as heat exhaustion, heat stroke and cardiovascular or respiratory diseases. Tourism in Neum relies on traditional beach (often regarded as "sun and sand") tourism that is threatened by extreme heat and determines shorter daily exposure to the sunshine. In the future such a situation potentially leads to lower tourist flows during peak season, a scenario that would have extremely negative impact on local economy. High water consumption during the heatwaves puts pressure on local water supply. Marine ecosystems are also under pressure during heatwaves since rise of the sea surface temperatures decrease oxygen levels and affect local marine biodiversity. Local infrastructure in the town of Neum, that lacks green spaces, is under heat pressure that results by intensive warming of the densely built-up urban environment.

2.5 Monitoring and Evaluation

We **learned from the second phase** of the climate risk assessment that climate risks are no longer a theoretical future threat but an immediate, material reality, local society and biodiversity. We **encounter the most difficulties** while trying to convince certain stakeholders that inaction would result in irreparable economic, social and particularly biodiversity loss.

Stakeholders in Monitoring and Evaluation are active participants rather than passive observers, responsible for ensuring the accuracy, relevance, and sustainability of project or policy outcomes. Their role includes providing feedback, collecting data, validating findings, and ensuring

that the project achieves its intended social impact. Their feedback on the CRA has been mostly cautious and reserved by now.
The learning process is still being developed and by now it is mostly done during the workshops and through unofficial contacts with certain stakeholders.
Just like during the first phase of the project, there is **no new data available** regarding the risks, or the system researched in the area although additional climatological data would certainly be useful for our research in the future.
We would like to **communicate the final outcomes of the projects** personally to the stakeholders involved in the process during workshops where representatives of each stakeholder group would be invited to participate. Since communication in the Municipality nowadays relies as well on digital technologies and the Internet is widely used as a means of communication, we would also make the results public on relevant websites.
We still **do not have a monitoring system in place** that considers the analysed risks. It is an issue that we need to negotiate with the stakeholders.
The willingness of stakeholders to participate in designation of the climate change adaptation and mitigation strategies just as implementation of the respective policies proved to be the most successive part of the project by now. On the other hand, some stakeholders still do not accept the theoretical frame of anthropologic influence on the global warming process.
Our use of resources, primarily of time and staff, was satisfactory and efficient from our point of view with no significant additional costs of the project.
We would like to have more time the designation of the CRA. Our efficiency has impacted the CRA process by moving it from static, periodic reporting toward dynamic, stakeholder engaging process. On the other hand, it may have impacted the CRA negatively since it introduces significant risks regarding reliability.
We value the impact of the CRA by considering how it raises public awareness, changes decision-making process and increases resilience of the Municipality. We will continue to observe this process during the next phase of the project.

2.6 Work plan Phase 3

The last part of the project, Phase 3 (M17–M22 | July–December 2026), is directed towards further exploring and suggesting climate hazards adaptation and mitigation options. Throughout the phase the local stakeholders will be actively engaged during workshops and consultations to identify community-driven climate adaptation strategies. Besides that, the third phase is also based on systematic use of the CLIMAAX Toolbox that effectively integrates localized high-resolution data with hazard and risk analysis.
In the final phase, the project will aim to translate assessment outcomes into actionable climate adaptation plans. Activities will include:
1) Developing comprehensive adaptation strategies tailored to high-risk areas, focusing on infrastructure protection, sustainable water management, flood control, and ecosystem preservation.

2) Conducting public consultations to ensure adaptation strategies align with community needs, fostering local ownership and resilience.

3) Incorporating adaptation measures into Municipality's long-term strategic development plans and establishing a monitoring and evaluation framework to track the effectiveness of implemented strategies.

3 Conclusions Phase 2- Climate risk assessment

The second phase of the project is based on detailed analysis of impact of droughts and heatwaves, the most relevant two climate hazards in the Municipality of Neum. Based on the results obtained by the analysis based on the exact climate data, we can conclude that impacts of droughts and heatwaves stretch throughout the Municipality that consists of two distinctive areas: the urbanized coast and rural inland. At the same time, future projections show that impact of droughts would be stronger at the coast while heatwaves are expected to be more severe in the inland area.

The results also show how geographic features of the research area determine the severity of the respectable hazards associated with human transformation of the Earth's surface (primarily in form of urban development that is not backed by adequate urban greening). An additional problem of the Municipality is rise of the Adriatic Sea temperature in the Neum's region that may have extremely negative repercussions on marine biodiversity. One of the results of the second phase show extremely severe combined effect of droughts and heatwaves because of extreme summer heats and prolonged droughts during the summer months.

The analysis still does not address the detrimental effects on local biodiversity and human activities such as agriculture, the principal source of income of the rural inland area, primarily because of reducing soil moisture and stressing local fruit and vegetable production. The effect on summer beach tourism, the most important activity of the urbanized coastal area, is endangered as well because of water scarcity and possible water supply restrictions during the extreme summer droughts. The effect on daily life of the local population is also an issue that needs to be closely researched.

The very risks of droughts and heatwaves prove to be geographically unevenly distributed although differences between the settlements show very small values. Of course, the quantitative methodological approach always may express subtle differences that cannot be perceived by field research.

Key findings of Phase 2 provide us with better understanding of the space (geographic) and time (both historical and future) dimensions of the most relevant climate hazards in the Municipality of Neum in Adriatic area of Bosnia and Herzegovina. Key findings show that, depending on the hazard, both urbanized costal area as well as the karstic inland of the Municipality are highly vulnerable to the contemporary global warming as the principal issue of the climate change.

4 Progress evaluation

This deliverable is the Phase 2 of the basic assessment of the climate hazards and risks that are associated with climate change in the Municipality of Neum, in Bosnia and Herzegovina. It gives a deeper analysis of 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. On the other hand, this deliverable also sets the stage for future actions regarding such policies. In general, Phase 2 is focused on conducting detailed, localized assessments to identify specific vulnerabilities through following steps:

- Utilizing and analysing existing high-resolution climate datasets as well as geospatial mapping tools to assess climate risks in Neum's coastal areas. By doing so it aims to create detailed risk maps pinpointing areas of critical concern.
- Applying climate modeling tools with the support of external technical experts to understand potential impacts on ecosystems and infrastructure.
- Focusing on assessing risks to key economic sectors like tourism, agriculture, and aquaculture to guide the development of sector-specific adaptation measures.

Key Performance Indicators and **Milestones** achieved in the second 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 second phase of the project focuses on creation of eight high-resolution risk maps highlighting geographic dimensions of climate risks. Another indicator is conducting detailed local vulnerability assessments, scenario analysis, and stakeholder consultations to develop sector-specific adaptation measures for stakeholders. Furthermore, the Individual Follow Up Plan proscribes over 50 stakeholders to be engaged during Phase 1 and 2 of the project. During the first phase 32 stakeholders were engaged and 45 during Phase 2. One more Key Performance Indicator – six public awareness campaigns and workshops focused on climate resilience and sustainable practices – is planned to be continued for the Phase 3.

Table 4-1 Overview key performance indicators

Key performance indicators	*Progress*
8 high-resolution risk maps highlighting erosion hotspots, flood-prone areas, and biodiversity risks	Completed
6 public awareness campaigns and workshops focused on climate resilience and sustainable practices	Completed 2, continues in Phase 3
Conducting detailed local vulnerability assessments, scenario analysis, and stakeholder consultations to develop sector-specific adaptation measures	Completed

Finalisation of the high-resolution, localized risk assessments is the most important milestone of the Phase 2. The second milestone – implementation of community engagement activities – is

planned to continue during the Phase 3 just like the third milestone (attendance at CLIMAAX workshops and dissemination events.

Table 4-2 Overview milestones

Milestones	*Progress*
M2: High-resolution, localized risk assessments finalized	Completed
M4: Implementation of community engagement activities	Completed, continues in Phase 3
M6: Attendance at CLIMAAX workshops and dissemination events	Completed, continues in Phase 3

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

This section classifies and lists all outputs produced during Phase 2 of the CLIMACHANGE climate risk assessment, following a clear and consistent structure aligned with their intended publication in the Zenodo repository.

Main Report

- **Climate risk assessment – Phase 2**

It summarizes the link between analytical outputs and upcoming Phase 3 adaptation activities, reviews performance through key indicators and milestones, and assesses overall implementation efficiency.

Format: PDF

- **Annex 1: Visual Outputs (Maps)-Full Climate Risk Map Portfolio (Hazard & Risk Indicators)**

Set of high-resolution thematic maps illustrating historical and projected drought conditions across all NUTS2 Municipality Neum. The annex includes 14 climate-risk maps covering relative drought and heatwave (2001–2020 baseline; RCP–8.5 2041–2070; SSP5–8.5 2071–20100).

Format: PDF

- **Annex 2: Data Tables (Methodological & Analytical Datasets)**

Comprehensive collection of tables summarizing all datasets, indicators, parameters, and scenario assumptions used in the Phase 2 Climate Risk Assessment. Includes climate scenario definitions, socio-economic pathways, workflow datasets, hazard and exposure metrics, vulnerability indices, and district-level drought risk summaries.

Format: PDF

Communication Outputs

- **Annex 3: Promotional and Dissemination Activities- Stakeholder Engagement**

Collection of visual documentation showcasing communication and promotional activities carried out during Phase 2, including photographs and graphics from stakeholder meetings, public presentations, roundtables, and dissemination events.

Format: PDF

Datasets Collected

- **Climate Data**

Comprehensive data set (precipitation) used for risk assessment.

Format: Excel

All listed outputs have been prepared for publication and dissemination via the Zenodo repository, ensuring accessibility, transparency, and ease of reuse for subsequent phases and broader stakeholder engagement.

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REPORT

Workshop on Climate Change within the CLIMAAX Project for the Municipality of Neum, held on 19 March 2026

1. Introduction

Within the framework of the European project **CLIMAAX – Multi-Risk Assessment for Sustainable Coastal Development**, the Municipality of Neum organised a workshop dedicated to climate change and the assessment of climate risks at the local level. The workshop was held on 19 March 2026 at Hotel Marea in Neum.

The CLIMAAX project is implemented under the Horizon Europe programme and focuses on providing support to local communities in understanding climate risks and developing effective adaptation measures.
The workshop was organised with the aim of informing participants about the project, presenting the activities carried out so far, and collecting the opinions, experiences and proposals of relevant stakeholders for the further implementation of the project. Special emphasis was placed on identifying the most important climate challenges in the Municipality of Neum and discussing possible measures to strengthen the resilience of the local community.

2. Objectives of the Workshop

The workshop presented the objectives and activities carried out so far within the project, with particular emphasis on the importance of climate change in the current context, ecosystem restoration and rehabilitation as adaptation measures, the impact of climate change on tourism, and the results of the first phase of research conducted in the Municipality of Neum.

The CLIMAAX project provides the Municipality of Neum with financial and technical support for the development of a climate risk assessment, focusing on risks such as sea-level rise, droughts and extreme weather events. Neum has been recognised as the only local community from Bosnia and Herzegovina included in this European programme.
The aim of the workshop was to familiarise participants with the results of the analyses carried out to date, open an expert discussion on possible adaptation measures, and encourage further cooperation among local stakeholders in strengthening the resilience of Neum's coastal area to climate change.

3. Course of the Workshop

The workshop began with an introductory address by the Mayor of the Municipality of Neum, Dragan Jurković, who presented the CLIMAAX project to interested and expert stakeholders. Josip Njavro, an employee of the Municipality of Neum, presented the Municipality of Neum's projects related to sustainability and the impacts of climate change. Participants were introduced to the basic objectives of the project, its methodology, and the importance of the local level in climate risk assessment and adaptation planning.

The following speakers participated in the workshop with the following topics:

- **Prof. Dr. Sc. Nikola Glamuzina** – Drought as a climate risk

- **Assoc. Prof. Dr. Sc. Ivan Vučković** – Drought as a threat to biodiversity in the Municipality of Neum

- **Prof. Dr. Sc. Višnja Bukvić** – Climate change and snakes in the Municipality of Neum

- **Prof. Dr. Sc. Jadranko Batista** – Light pollution in the Neum area and its impact on biodiversity

- **Karlo Krmek, MSc**, Director of Ancora-Commerce – The impact of climate change on cage farming of marine fish in the Municipality of Neum

- **Marin Kralj, MEng Mech**, Director of Public Company "Komunalno Neum" – The impact of climate change on municipal waste

The workshop presented the main climate challenges relevant to the Municipality of Neum, with a focus on risks related to extreme weather events, droughts and high temperatures. The discussion highlighted the need for a better understanding of local vulnerabilities, particularly in the context of an area oriented towards tourism and agriculture.

Workshop participants actively took part in the discussion and shared their own observations regarding environmental changes, the frequency of extreme events, and possible consequences for the population, infrastructure, tourism and natural resources. Particular attention was paid to the importance of cooperation between the municipality, experts and the local community in planning adaptation measures.
The workshop was attended by **45 stakeholders** from the Municipality of Neum and surrounding municipalities and towns. The stakeholders included employees of public and state-owned companies, as well as representatives of non-governmental organisations working in the fields of environmental and nature protection.

4. Key Conclusions

During the workshop, several important conclusions were highlighted:

- climate change is already affecting local conditions, and risks are expected to increase in the future;
- the municipal area is vulnerable to several types of climate hazards, particularly drought and high temperatures;
- it was emphasised that the project will include further and more detailed data analysis, as well as the preparation of more precise vulnerability assessments;
- adaptation measures should focus on protecting people, infrastructure, water, soil and natural ecosystems;
- local knowledge and the experience of the population represent an important contribution to the development of high-quality solutions.

5. Recommendations

Based on the workshop held, the following is proposed:

- continued collection and analysis of data on climate risks;
- development of priority adaptation measures for the municipal area;
- strengthening communication with the local population on climate change and possible responses;

- linking the project results with spatial planning, water management, environmental protection and civil protection.

6. Conclusion

The workshop successfully achieved its objective and confirmed the importance of timely climate change adaptation planning at the local level. It is important to emphasise that among the speakers were also people who live and/or work in the Municipality of Neum, namely Karlo Krmek, MSc, Director of Ancora-Commerce, and Marin Kralj, MEng Mech, Director of Public Company "Komunalno Neum".

Participants recognised the need for systematic action in order to reduce the vulnerability of the Municipality of Neum to climate extremes and increase the resilience of the community. The CLIMAAX project provides an important framework for the development of an expert and practically applicable climate risk assessment, as well as for the development of measures that will contribute to the long-term safety and sustainability of the municipal area.

Invitation to the workshop

OPCIINA NIEUM
Kralja Tomislava 1, 88390 Neum, Sosna i Hercegovina

RAD/ON/CA ZA PROJEKT

"Procjena visestruk;ih rizika za odrzivi razvoj obale - Opcina Neum"

Grad Neum odabran je za sudjelovanje u europskom CLIMMX projektu, koji je financiran kroz program Horizon Europe i provodi se u okviru EU Misije za prilagodbu klimatskim promjenama. U okviru projekta, Opcina iNeum dobiva financijsku i tehnicku podrsku za izvodenje procjene klimatskih rizika (***Climate Risk* Assessment - CRA**) na lokalnoj razini, ukljucujuci rizike poput porasta razine mora, susa, poplava i ekstremnih vremenskih nepogoda.

Cilj projekta je pomoci lokalnim zajednicama **u** razumijevanju rizika klimatskih promjena te razvoj ucinkovitih strategija prilagodbe za zastitu okolisa i sigurnosti stanovnistva. Opcina Neum koristi CLIMMX metodoloski okvir i alat za viserazinsku procjenu klimatskih rizika, uz strucnu podrsku medunarodnog konzorcija koji okuplja vodece institucije iz podrucja upravljanja rizicima, zastite okolisa i civilne zastite.

Datum: 19.03.2026.

Lokacija Hotel Marea, Rudera Boskovica bb, Neum

Vrijeme: 11:00 - 16:00h

CLIMAAX

PROGRAM

VRIJEME	AKTIVNOSTI	MODERATOR
1100-1130	Registracija sudionika i osvjezenje	
1130-11:40	Uvodna rijec	Uvodna rijec Nacelnik Neuma, Dragan Jurkovic
11:40 - 12:00	Predstavljanje projekata Opcine Neum na temu odrzivosti i ufeca·a klimatskih rom·ena	Josip Njavro, dipl.ing.eoc,
12.00-12:20	Susa kao klimatski rizik	prof.dr.sc. Nikola Glamuzina
12.20-12:40	Susa - prijetnja bioraznolikosti na podrucju Opcine Neum	doc.dr.sc. Ivan Vuckovic
12:40-13:00	Pauza (+ **kava** i osvjezenje)	
13:00 - 13:20	Klimatske promjene i zmije na podrucju Opcine Neum	prof.drsc. Visnja Bukvic
1320-13:40	Svjetlosno oneciscenje na podrucju Opcine Neum i njegov utjecaj na bioraznolikost	prof.dr.sc. Jadranko Batista
13:40-14:00	Utjecaj klimatskih promjena na kavezni uzgoj morske ribe na podrucju Opcine Neum	mr.sc. Karto Krmek, direktor Ancora-Commerce
14 00-14:20	Utjecaj klimatskih promjena na komunalni otpad	Marin Kralj, mag.ing.mach. Direktor J.P. ,,Komunalno Neum•
1420-14:40	Rasprava / pitanja i odgovori	Sudionici
14:45-16:00	Zajednicki rucak	

Funded by the European Unton

CLIMAAX climate ready regions

Participants List 19.03.2026.

CLIMAAX

CLIMAAX

List of participants

Hotel Marea Neum, Ruđera Boškovića bb

19.03.2026.

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CLIMAAX climate ready regions

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