Deliverable Phase 1 – Climate risk assessment

Evaluating Vulnerabilities and Optimizing Local Vitality and Ecosystems in Belsh (EVOLVE-Belsh)

Albania, Belsh Municipality

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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

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Brief Description	This document is Deliverable 1 (D1) of the *EVOLVE_Belsh*, titled " *Evaluating Vulnerabilities and Optimizing Local Vitality and Ecosystems in Belsh* ". It establishes the baseline multi-risk climate assessment for the Belsh Region. Applying the CLIMAAX methodological framework, it quantifies the current and future impacts of four priority hazards: wildfires, droughts, heatwaves, and floods.
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Author(s)	• Emirjeta Adhami (Institute for Nature Conservation in Albania) • Elson Salihaj (Institute for Nature Conservation in Albania) • Arben Pambuku (Institute for Nature Conservation in Albania) • Paolina Rusta (Municipality of Belsh)
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Table of contents

List of figures

List of tables

Abbreviations and acronyms

Abbreviation / acronym	Description
EVOLVE–Belsh	**E**valuating **V**ulnerabilities and **O**ptimizing **L**ocal **V**itality and **E**cosystems in **Belsh**
CLIMAAX	**CLIMA**te risk and vulnerability **A**ssessment framework and toolbo**X**
RCP	Representative Concentration Pathways
GIS	Geographical Information System
ERA5	Fifth generation ECMWF atmospheric reanalysis of the global climate
INSTAT	**In**stitute for **stati**stics
AMBU	Agency for water Resources Management
IGJEO	Institute of Geosciences
RAPA	Regional Administration of Protected Areas
NGO	Non-governmental organization
INCA	Institute for Nature Conservation in Albania
CRA	Climate Risk Assessment
PVNK/LCAP	Local Climate Change Plan
UNDP	United Nation Development Programme
LCCP	Local Climate Change Plan
ND-GAIN	The Notre Dame Global Adaptation Initiative
EM-DAT	The Emergency Events Database
UNFCCC	United Nations Framework Convention on Climate Change
MFZ	Mediterranean Field Zone
MHZ	Mediterranean Hilly Zone
MPMZ	Mediterranean Pre-Mountain Zone
MMZ	Mediterranean Mountainous Zone
RCP	Representative Concentration Pathways
RP	Return period

Executive summary

This deliverable presents the results of Phase 1 of the EVOLVE–Belsh project, conducted under the CLIMAAX program, focusing on the development of a comprehensive climate risk assessment for Belsh Municipality in Albania. The assessment addresses the growing need for structured, evidence-based climate adaptation planning at the local level, particularly in rural areas with limited institutional capacity and high exposure to climate hazards.

The report applies the CLIMAAX methodology to identify and analyse four priority climate hazards: Heavy rainfall, Floods and Flood damage and population exposure, based on historical data, stakeholder input, and scenario- based projections. Each hazard was assessed through dedicated workflows that integrated hazard intensity, geographic exposure, and social vulnerability.

Key actions undertaken during this phase include the establishment of a municipal implementation team, the signing of a cooperation agreement with the Institute for Nature Conservation in Albania (INCA), and the successful completion of stakeholder consultations. These efforts ensured inclusive participation and strengthened local ownership of the risk assessment process. Visual outputs such as risk maps and vulnerability profiles were produced to support decision-making and future planning.

The deliverable also identifies critical capacity gaps in data availability, technical expertise, and early warning systems. It proposes a structured work plan for subsequent phases, including validation of risk outputs, prioritization of adaptation measures, and integration into municipal planning frameworks. The findings contribute directly to the overarching goals of the CLIMAAX program by aligning local adaptation efforts with European climate governance standards.

In conclusion, this phase has established a robust analytical foundation for climate resilience in Belsh Municipality. It highlights the urgency of targeted interventions, the value of participatory approaches, and the importance of sustained capacity-building to address climate risks effectively. The outputs of this deliverable will inform future adaptation strategies and support the municipality's transition toward a climate-smart and inclusive development pathway.

1 Introduction

1.1 Background

The Municipality of Belsh is situated in central Albania, approximately 30 km southwest of Elbasan, covering an area of 196.44 km², with spatial bounds defined by coordinates (398,549.131, 4,523,509.729) to (414,368.027, 4,541,800.064). It comprises five administrative units—Belsh, Grekan, Kajan, Fierzë, and Rrasë—and includes 30 villages. Belsh town serves as the traditional centre of the Dumre region, a distinctive karst landscape characterized by rolling hills, semi-natural pastures, and over 85 lakes that shape its ecological and cultural identity.

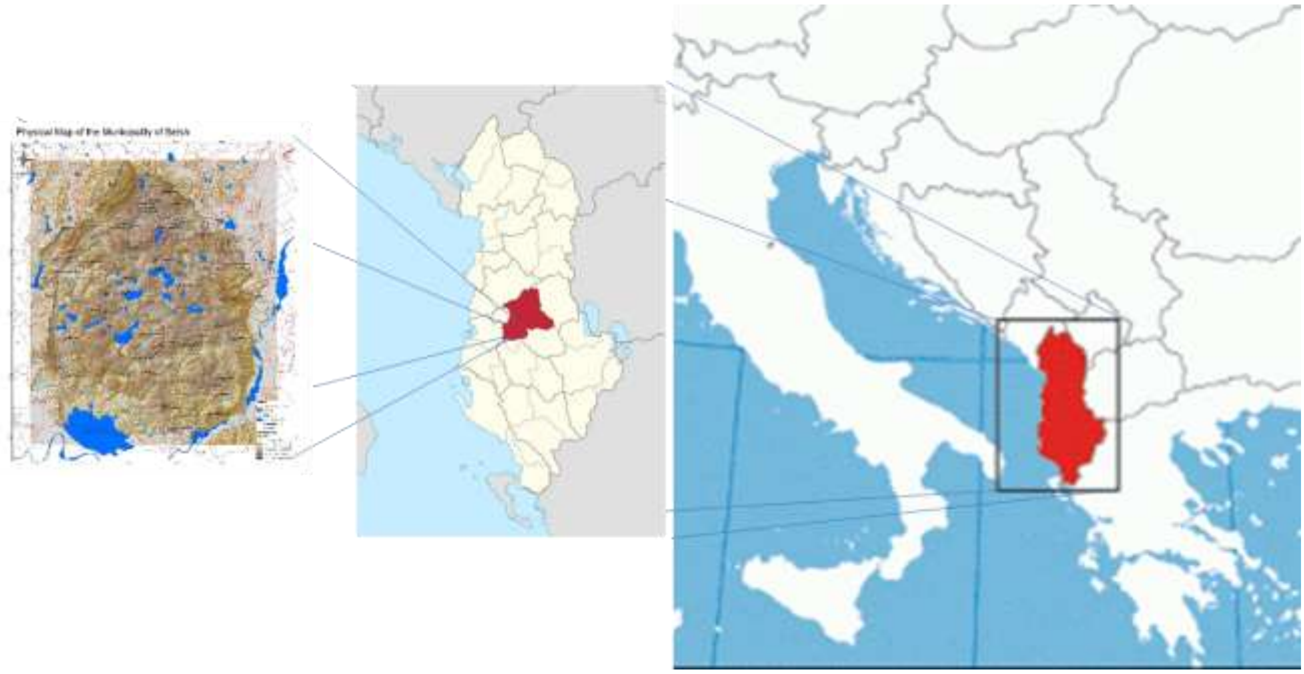

Figure 2.1.1-1 Map of Belshi Municipality

According to the 2023 Population and Housing Census (INSTAT, 2023)[1], Belsh is home to 17,123 residents. Local livelihoods are primarily based on agriculture and livestock, supported by fertile soils rich in potassium and moderately supplied with nitrogen and phosphorus. These conditions favour the cultivation of cereals, tobacco, vegetables, vineyards, and fruit trees. Despite its agro-climatic potential, the region faces increasing climate stress, particularly drought and soil degradation, which threatens both ecological integrity and economic stability.

The Belsh lake system is the most densely populated area within Dumre. The town of Belsh lies adjacent to Lake Belsh, while Gradishti Peak rises among the lakes, offering panoramic views of the karst formations and surrounding terrain. The area also contains archaeological traces of ancient settlements, adding cultural significance to its natural beauty. Scenic viewpoints such as Destores (259 m), Gradishta (239.2 m), Chevdi e Madhe (233 m), and Sukubora (209 m) enhance its tourism potential, with facilities located in Belsh, Seferan, and Gradishta.

1 https://databaza.instat.gov.al:8083/pxweb/sq/DST/START__Census2023__Census_Bashki/CENS_33_1/table/tableViewLayout1/

Geographically, the region is bordered by the hilly terrain of Lushnja to the west, the Devoll River and Cerrik area to the east and southeast, and the Shkumbin River to the north. Beyond agriculture, Belsh hosts natural resources including oil and mineral deposits. Historical mining sites in Trojas and Gradishtë have supported industrial activity, and exploratory drilling continues across Dumre. The lakes also contribute to local employment through fishing, with species such as trout, carp, and eel present.

The municipality supports approximately 125 private enterprises, including cafés, restaurants, fuel stations, clinics, pharmacies, and construction firms. Public services are modest but active. Health infrastructure dates back to 1937, with a regional hospital established in 1971. While each village has a nurse, many lack formal facilities, leading to improvised micro-clinics in private homes. Educationally, Belsh is a historically engaged community, with eight schools, seven primary and one secondary, serving as foundations for higher education and local development.

Although institutional capacity remains limited, Belsh demonstrates growing commitment to climate adaptation and environmental governance. Community engagement is strong, with active participation from youth and women's groups. These dynamics position Belsh as a strategic pilot site for the EVOLVE-Belsh project, offering both challenges and opportunities for building climate resilience under the CLIMAAX program.

1.2 Main objectives of the project

This section outlines the strategic objectives of EVOLVE–Belsh and the anticipated benefits of applying the CLIMAAX Handbook within the local context.

The primary objective of EVOLVE–Belsh is to assess climate change risks and formulate adaptive strategies for Belsh Municipality, guided by the CLIMAAX methodology. This process enhances the resilience of key local sectors, particularly agriculture, infrastructure, and public health, against climate-related hazards such as floods, heavy rainfall, landslides, and other extreme weather events. The project holds strategic significance for the region by fostering evidence-based planning, strengthening institutional capacities, and promoting inclusive, locally grounded responses to climate challenges.

EVOLVE–Belsh is designed to deliver a robust, locally tailored climate adaptation framework for Belsh Municipality. Its specific objectives are:

- **Risk Identification**: Conduct a comprehensive multi-hazard climate risk assessment using the CLIMAAX methodology to pinpoint vulnerabilities unique to the municipality.
- **Data-Driven Precision**: Integrate high-resolution local data and stakeholder insights to refine risk profiles and ensure context-specific adaptation strategies.
- **Sectoral Adaptation Planning**: Develop actionable, evidence-based adaptation measures and improved risk management plans, with targeted interventions in agriculture, urban development, and tourism.
- **Capacity and Ownership**: Strengthen institutional capacities and foster inclusive stakeholder engagement to ensure effective implementation, long-term ownership, and sustainability of climate adaptation efforts.

EVOLVE–Belsh is a forward-looking initiative that helps Belsh Municipality better understand and respond to the growing risks of climate change. Guided by the CLIMAAX Handbook, a practical tool developed by European experts, the project identifies the specific threats facing the region, including floods, heavy rains, landslides, and other extreme weather events that increasingly disrupt daily life.

But EVOLVE–Belsh goes beyond identifying problems. It brings together scientific expertise, detailed local data, and the lived experiences of residents to co-create smart, targeted solutions. These strategies are designed to protect what matters most: our farms, our towns, our tourism, and the wellbeing of our communities.

By involving local voices and institutions at every step, the project ensures that its plans are not only technically sound but also deeply rooted in Belsh's realities. It builds the capacity of local leaders and strengthens community engagement, so that climate adaptation becomes a shared effort, one that's inclusive, practical, and sustainable.

Thanks to the CLIMAAX Handbook, Belsh now has a clear roadmap for managing climate risks. This means better decisions, stronger partnerships, and a more resilient future for everyone who calls Belsh home.

1.3 Project team

After signing the agreement with the CLIMMAX program, the Municipality of Belsh approved through the Decision of the Municipal Council dated 17.03.2025 (No. Ref. 386/1) the engagement of the municipal staff and decided to officially establish a team dedicated to leading the implementation of the EVOLVE-Belsh project. The team was established through the Order of the Mayor No. 206, dated 07.04.2025. This internal working group is composed of municipal specialists from the departments of urban planning, legal affairs, public procurement and IT, each of whom has been assigned specific responsibilities to support the implementation of the project.

To strengthen the technical capacity, the Municipality procured and established a cooperation agreement with the Institute for Nature Conservation in Albania (INCA), acting as a subcontractor. INCA mobilized a multidisciplinary team of experts, including:

- **Climate Adaptation Specialist**, responsible for assessing climate risks and identifying priority adaptation measures;
- **GIS and Cartography Expert**, leading spatial analysis and developing thematic risk and vulnerability maps to support decision-making;
- **Data Analyst**, tasked with processing environmental and socio-economic data to inform planning;
- **Hydrologist**, providing expertise on water-related risks and hydrological modelling;
- **Institutional and Legal Advisor**, ensuring compliance with national legislation and supporting governance frameworks in line with international frameworks.

Together, this integrated team is leading the development of the Climate Adaptation Plan of the Municipality of Belsh, combining local knowledge with scientific analysis to build a resilient future for the municipality.

1.4 Outline of the document's structure

This Climate Adaptation Action Plan for the Municipality of Belsh is structured to provide a clear and evidence-based framework for understanding local climate risks and identifying priority measures for resilience. The document begins with a summary of the current socio-economic context of Belsh, highlighting the main demographic trends, economic activities and environmental characteristics that shape the municipality's vulnerability to climate change.

This document is structured to provide a comprehensive overview of the EVOLVE–Belsh project implementation under the CLIMAAX program, with a focus on Phase 1: Climate Risk Assessment. It follows a logical progression from contextual framing to technical analysis and forward-looking planning.

The report begins with an **Executive Summary**, offering a concise synthesis of the project's objectives, activities, and key findings.

Section 1 – Introduction presents the background of the Belsh Municipality, the main objectives of the EVOLVE–Belsh initiative, the composition of the project team, and this structural outline.

Section 2 – Climate Risk Assessment (Phase 1) constitutes the core of the report. It is divided into six subsections:

- *Scoping*: Defines the objectives, local context, and stakeholder engagement approach.
- *Risk Exploration*: Details the selection of hazards, methodological workflows, and scenario development.
- *Risk Analysis*: Applies selected workflows to assess vulnerabilities and exposure.
- *Preliminary Key Risk Assessment Findings*: Summarizes severity, urgency, and adaptive capacity.
- *Monitoring and Evaluation*: Introduces initial indicators and approaches for tracking progress.
- *Work Plan*: Outlines next steps and implementation priorities.

Section 3 – Conclusions synthesize the main insights from Phase 1 and reflects on their implications.

Section 4 – Progress Evaluation and Future Contributions assesses the current status and potential alignment with subsequent CLIMAAX phases.

Section 5 – Supporting Documentation includes annexes, visuals, and technical materials produced during the project.

Section 6 – References lists all sources, methodologies, and tools consulted throughout the process.

This structure ensures clarity, traceability, and alignment with the CLIMAAX Handbook, facilitating both local ownership and replicability across other municipalities.

2 Climate risk assessment – phase 1

The following sections of this report follow the analytical steps outlined in the CLIMAAX Framework, including Scoping, Risk Exploration, Risk Analysis, and Preliminary Assessment. Guiding questions from the CLIMAAX Handbook have been used to structure the analysis. Where information was insufficient to provide a complete response, this has been clearly indicated.

2.1 Scoping

The scoping phase of the climate risk assessment establishes the analytical basis for the EVOLVE–Belsh project. It defines the main objectives of the assessment: to identify climate-related risks, assess vulnerabilities, and inform locally tailored adaptation strategies that strengthen resilience across key sectors. This phase also outlines the contextual conditions in which the project is implemented, including the geographical, socio-economic, and institutional characteristics of Belsh Municipality.

Despite favourable agro-climatic conditions, the region faces increasing climate stress, particularly drought, soil degradation, and seasonal variability. These pressures are compounded by limited access to localized climate data, constrained institutional capacity, and the absence of integrated planning tools.

Climate change represents a deep and accelerating transformation in long-term patterns of temperature, precipitation, and wind, with serious consequences for people, ecosystems, and rural systems. While some climatic variations are natural, scientific consensus clearly links global warming to human activities, especially the burning of fossil fuels, intensive agriculture, and uncontrolled urban expansion that disrupts natural systems. These changes have led to increased risks at both local and regional levels, including floods, heatwaves, droughts, wildfires, and erosion.

Unlike larger urban centres, which have initiated strategic climate planning through instruments like the Local Climate Change Plan (LCCP) Belsh has yet to develop a formal framework for climate adaptation. The National Adaptation Plan serves as a model for integrating mitigation and adaptation across all levels of local planning, empowering institutions and communities to respond to climate impacts while identifying opportunities for green, inclusive development. EVOLVE–Belsh seeks to replicate this strategic approach in a rural context, tailored to the needs and capacities of smaller municipalities.

The scoping phase also identifies relevant stakeholders to be engaged throughout the project. These include municipal authorities, local farmers and businesses, youth and women's groups, environmental NGOs, and technical experts. Their participation ensures that the risk assessment reflects local realities, builds ownership, and supports inclusive decision-making. Stakeholder engagement is essential not only for data collection and validation, but also for co-designing adaptation measures that are practical, equitable, and sustainable.

2.1.1 Objectives

The primary objective of the CRA in Phase 1 is to gain a clearer understanding of the characteristics and limitations of the tools and datasets used in the workflows by applying the CLIMAAX methodology in the study area (Belsh Municipality). This phase focuses on conducting an initial assessment of risk (flood-related building damage and population exposure, extreme rainfall), hazard (flood-related building damage and population exposure, extreme rainfall), and the potential impacts of climate change on river flood risk and extreme rainfall patterns.

The expected outcome of Phase 1 is a comprehensive assessment of the risks, hazards, and climate change impacts mentioned above, specifically for urban areas highly vulnerable to flooding during extreme rainfall events.

In Phase 2, this initial assessment will serve as the foundation for a comparative analysis with locally available data, which primarily relies on historical events and/or empirical methods. It will also support the identification of new sectors that represent high-risk, high-hazard, and high-impact hotspots of climate change.

The results of the first two phases will be translated into proposed measures for updating the program of measures for the study area within the Local Climate Change Adaptation Plan for Belsh Municipality, in alignment with the requirements of the National Adaptation Plan.

The main limitations identified in Phase 1 of the CRA are linked to the availability and resolution of data for the Devoll River area. The absence of the following datasets represented the key constraint in the Phase 1 analysis:

- building footprints and types;
- transport infrastructure layer;
- future socio-economic development scenarios;
- maximum discharge values and percentage changes in maximum discharge values for current and future scenarios;
- high-resolution river flood maps for future climate scenarios.

In Phase 2, the integration of high-resolution local datasets (using the Toolbox package as expert users to create a fully customized regional risk assessment package), combined with valuable insights from local knowledge of exposed areas (gathered through consultations with local communities during the first planned workshop in the study area), alternative methodologies, and newly developed hydraulic models, will produce updated hazard and risk maps. These outputs will enhance local understanding of climate change-related risks.

A key contribution to strengthening adaptation to climate change impacts is the advancement of national hydrological forecasting systems, along with enhanced quantitative and qualitative monitoring and early warning mechanisms.

To achieve the objectives of managing climate hazards, impacts, and risks, several adaptation interventions can be considered:

- Upgrading and modernizing existing infrastructure to minimize flood risk.
- Promoting and applying nature-based solutions and water retention measures, such as large-scale afforestation of torrential watersheds, allowing space for river mobility, undertaking river restoration works, reinforcing natural water retention areas, and relocating certain dam structures at the watershed level.
- Mitigating risks from urban flooding through spatial planning that incorporates measures for collecting and temporarily or permanently storing rainwater.

2.1.2 Context

Albania is vulnerable to a range of natural disasters. The main hazards affecting Albania are earthquakes, floods, forest fires and landslides. Other hazards include snowstorms, droughts, temperature extremes, epidemics, avalanches and windstorms. The International Disaster Database (EM-DAT) shows that, during 1979-2019[2], floods accounted for the majority of disaster events (38%), followed by earthquakes (15%). The vulnerability of the Albanian population to disasters of large and small scales is compounded by poverty, poor quality infrastructure and communications, a construction boom and a range of human-influenced environmental factors, from rapid deforestation and poor watershed management to environmental pollution. Moreover, the education and awareness of the population on these risks remains low.

The latest data shows Albania is exponentially more vulnerable to disasters as in the past decade all of the above-mentioned hazards have at some point turned into a large-scale emergency or a disaster. Numerous reports and documents evidence the high level of risks that threaten the country, the high exposure, and vulnerability, but also the insufficient capacity to cope with and adapt to them.

Climate change intensifies these vulnerabilities. Extreme rainfall often results in destructive floods, while prolonged dry periods threaten agriculture and drinking water supplies. Rising temperatures are expected to increase the severity and frequency of both wet and dry extremes, alongside a decline in annual precipitation. These dynamics place communities, hydropower, and tourism at considerable risk. Albania's socio-economic development trajectory amplifies exposure, as reflected in its ND-GAIN ranking in 2021: 80th overall among 182 countries, with vulnerability ranked 78th and readiness 96th. National Communications to the UNFCCC confirm that vulnerability remains high.

To address these challenges, Albania has adopted a series of governance frameworks, including the National Climate Change Strategy (2019–2030)[3], the Climate Change Law (2020)[4], the Nationally Determined Contribution (2021)[5], and the Fourth National Communication (2022)[6]. The country launched the Albania's Second National Adaptation Plan (2026–2036)[7] which sets a long-term vision to strengthen climate resilience against heatwaves, droughts, floods, storms, and sea-level rise that threaten communities, infrastructure, and ecosystems. Developed through a country-driven, inclusive process (2021–2025) with national institutions and eight municipalities, and supported by UNDP and the Green Climate Fund, the plan includes 66 priority measures across agriculture & forestry, energy, transport, urban development, and tourism, supported by cross-sector actions on governance, data, and finance. Despite these commitments, implementation remains constrained by limited financial resources, technical capacity, and reliance on donor support.

[2] https://www.emdat.be/categories/report/
[3] https://mjedisi.gov.al/wp-content/uploads/2021/10/2.-Strategjia-e-Ndryshimeve-Klimatike-dhe-Planet-e-Veprimit_Qershor-2019_-1.pdf
[4] https://mjedisi.gov.al/wp-content/uploads/2021/10/1.-Ligji-nr.-155-dt.-17.12.2020_PER-NDRYSHIMET-KLIMATIKE-1.pdf
[5] https://mjedisi.gov.al/wp-content/uploads/2021/10/3.-Kontributi-Komb%C3%ABtar-i-Percaktuar-KKP-i-rishikuar-p%C3%ABr-Shqip%C3%ABrin%C3%AB-1.pdf
[6] https://www.undp.org/albania/publications/fourth-national-communication-albania-climate-change
[7] https://www.undp.org/albania/publications/albanias-national-adaptation-plan-2026-2036

At the local level, Belsh Municipality illustrates the urgency of structured climate risk assessment. Historically, hazards such as droughts, floods, heatwaves, and fires have been managed through fragmented and reactive responses. Communities have relied on traditional agricultural knowledge to cope with seasonal variability, but no formal or systematic climate risk assessment has been conducted. This absence of structured planning has limited the municipality's ability to anticipate and mitigate growing climate impacts.

In recent years, Belsh has faced increasing exposure to climate-related threats due to shifting rainfall patterns, rising temperatures, and land-use changes. These pressures have strained agriculture, water resources, and rural infrastructure. However, the lack of localized climate data, limited

technical expertise, and absence of integrated planning tools have hindered proactive risk management and long-term resilience building.

The EVOLVE–Belsh project addresses this gap by introducing the first structured climate risk assessment for the municipality, guided by the CLIMAAX Framework. Its objective is to institutionalize climate adaptation planning, enabling Belsh to align with national and European climate resilience goals. The project responds to a core problem: the lack of integrated climate governance at the local level, which leaves key sectors vulnerable and undermines sustainable development efforts.

Belsh operates within a governance context shaped by Albania's national climate strategies and EU-aligned environmental policies. Yet municipal institutions continue to face constraints in technical expertise, financial resources, and access to climate-relevant data, delaying the integration of risk considerations into local decision-making. Several sectors are particularly sensitive to climate variability, including agriculture, livestock, tourism, infrastructure, and public health. Droughts threaten crop yields and water availability; floods and erosion damage roads and buildings; and heatwaves pose risks to vulnerable populations. Without targeted adaptation measures, these sectors will remain exposed to escalating challenges.

External influences, such as regional initiatives on biodiversity conservation, water resource management, and rural revitalization, provide opportunities for synergy and knowledge exchange. These efforts can complement EVOLVE–Belsh by offering technical inputs, policy alignment, and community engagement models.

2.1.3 Participation and risk ownership

To effectively address climate and environmental challenges in the Municipality of Belsh, it is essential to understand the institutional, legal and planning framework that supports local action. The current framework represents an interaction between local and central actors, legal instruments and strategic plans, which together constitute the foundation on which climate governance is based. This part of the document examines the institutional role, competences and interactions, as well as the coherence of existing policies with climate change adaptation needs, identifying opportunities for better cross-sectoral integration and improvement of local capacities. The stakeholder engagement process for EVOLVE–Belsh began with a mapping of relevant stakeholders across local government, civil society and technical fields. Initial consultations were held with municipal authorities, community representatives and environmental experts to identify key stakeholders and define their roles in the climate risk assessment. The Institute for Nature Conservation in Albania (INCA), as implementing partner, facilitated this process by coordinating the outreach of activities and ensuring inclusive participation.

Relevant key stakeholders include:

Local Government: Municipality of Belsh, administrative units and planning departments;

Regional Institutions: Elbasan Prefecture - civil emergencies directorate, regional environmental office, regional administration of protected areas Elbasan, AMBU - Shkumbi River Basin Council;

Civil Society: Local NGOs, youth and women's groups, farmers'/livestock associations, beekeepers, medicinal plant collectors, guesthouses & agribusinesses;

Private Sector: tourism operators, small businesses, hotels, credit associations, bars/restaurants,

tourist guides;

Academia and Experts: University of Elbasan – Faculty of Natural Sciences (Department of Biology), biodiversity specialists, climate researchers, technical consultants (such as urban planner, hydrologist, agricultural, natural resources manager, social and economic, etc.);

Citizens: residents of vulnerable areas, especially those in flood-prone or resource-dependent areas.

An organogram (fig.2-1) has been developed to visualize institutional relationships, responsibilities and communication flows. This tool supports coordination and clarifies how stakeholders contribute to risk identification, data collection and decision-making.

Figure 2.1.3-1- Organogram of key actors and their connection

Priority groups include smallholder farmers, pastoralists, older people and women in rural areas, communities that are disproportionately exposed to climate risks and often lack access to adaptive resources. Their inclusion ensures that the assessment reflects lived realities and promotes equitable resilience planning.

Risk ownership is primarily regulated through the municipal government, which is responsible for integrating climate risk into local development plans and emergency response systems. INCA provides technical support, while community stakeholders contribute local knowledge and monitoring capacity. This shared ownership model fosters accountability and sustainability.

The acceptable level of risk for the community is low, particularly in relation to threats to livelihoods, water security, and public health. Residents express concern about increasing climate variability and support proactive measures to reduce vulnerability.

Project results will be communicated through multiple channels:

- Local dissemination through public meetings, visual materials and community workshops;
- Institutional reporting to municipal and regional authorities;
- Technical documentation for national agencies and CLIMAAX partners;
- Public outreach through media, social platforms and educational campaigns.

This multi-level communication strategy ensures transparency, fosters trust and supports the integration of findings into broader climate governance frameworks.

2.2 Risk Exploration

Risk exploration marks the starting point of the climate risk assessment, focusing on the careful identification of climate-related risks, exposures, and vulnerabilities specific to Belsh. To ensure the assessment addresses the most pressing threats in the area, this step involves engaging key stakeholders and incorporating public concerns. The outcomes of this process provide a foundation for more detailed analyses and the design of targeted adaptation measures.

2.2.1 Screen risks (selection of main hazards)

Figure 2.2.1-1 The main climatic regions in Albania (Source: SUPPORT TO FILLING GAPS IN Climate Change Adaptation. Data and Risk Analysis. Government of Albania

According to the Koeppen climatic classification, Albania has a Mediterranean climate, which includes mild and humid winters, followed by hot and dry summers. Within this typical Mediterranean climate, because of the varied topography, substantial climate variations are observed, ranging from very cold winters in the northern, north-eastern and south-eastern areas, to very hot and dry summers along the coast. Considering the spatial variation of the mentioned climatic elements and based on the changes in temperature and precipitation regimes, Albanian climatologists divide Albanian territory into 4 climatic zones (Figure 2-2): Mediterranean Field Zone (MFZ), Mediterranean Hilly Zone (MHZ), Mediterranean Pre-Mountain Zone (MPMZ) and Mediterranean Mountainous Zone (MMZ) and 13 subzones. The temperature change in the territory is shown in the figure 2-3, where its increase is clearly visible, especially in the last two decades.

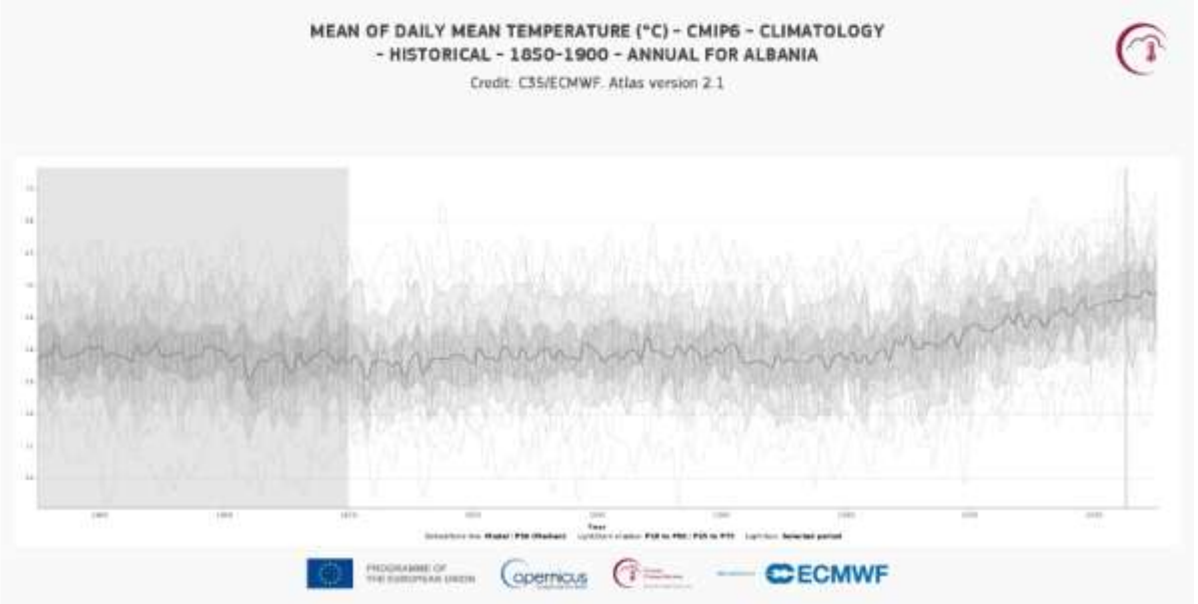

Figure 2.2.1-2 Mean of daily mean temperature-Annual for Albania

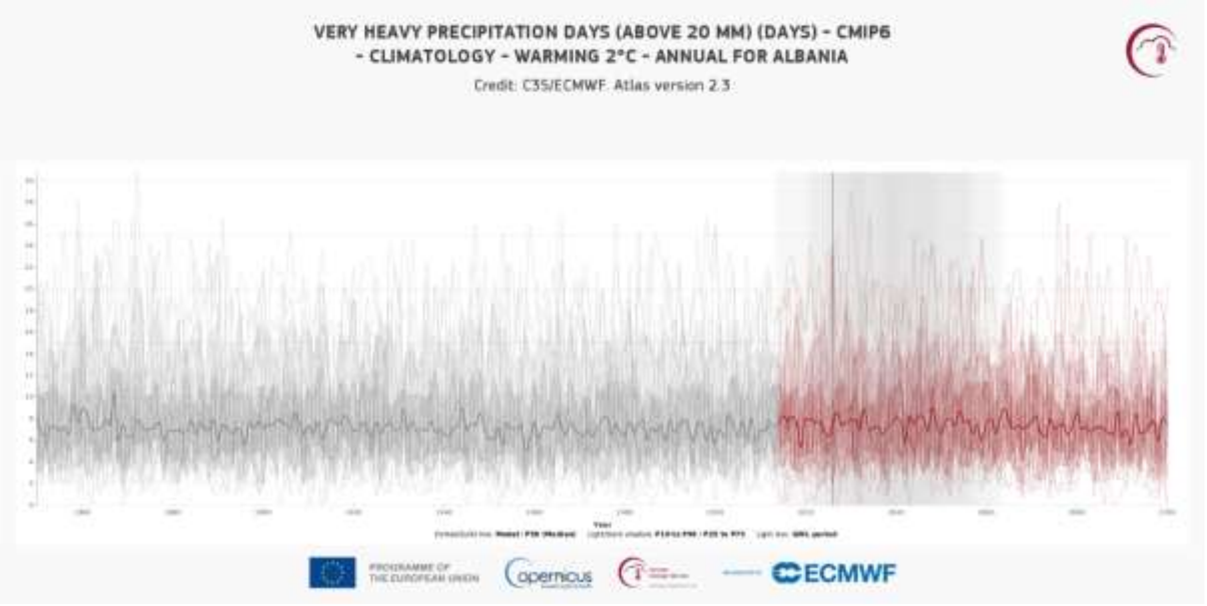

Figure 2.2.1-3 Very heavy precipitation days - annual for Albania

The Copernicus Climate Atlas graph (figure 2-4) indicates that Albania has experienced increasing variability in rainfall over recent decades, with more frequent extreme precipitation events. Projections under high-emission scenarios suggest a continued rise in rainfall intensity during extreme events, while total annual precipitation is expected to decline. This dual trend, less overall rainfall but more intense downpours, heightens the risk of both droughts and floods. For Belsh Municipality, this means agricultural zones and rural households will face greater exposure to water stress and flood damage, underscoring the need for improved hydrological forecasting, localized flood mapping, and climate-resilient infrastructure.

The major climate-related hazards that local communities in Belshi site close to Devolli river are facing the flooding and heavy rainfall as a major risk factor for flash floods. These hazards were selected for analysis within the scope of the project. The risks derived from the selected hazards are loss of life, damage to properties, disruption of livelihoods and essential services. Through discussions among stakeholders and initial environmental evaluations, a thorough assessment of climate-related hazards was carried out as part of the EVOLVE-Belsh project. This process identified River Flooding and Heavy Rainfall as the most relevant and pressing climate risks affecting the Belshi region.

Belsh Municipality is already experiencing the tangible effects of climate-related hazards, with several areas and population groups facing recurring challenges. The current situation reveals a pattern of increasing exposure and vulnerability across both natural and socio-economic systems.

2.2.2 Workflow selection

Given that river flooding and heavy rainfall were selected as key hazards for analysis in the project, the risk workflows relevant to the Climate Risk Assessment (CRA) include River Flooding, Flood Damage and Population Exposure, and Extreme Precipitation. While the initial work plan referred

only to the two main workflows: River Flooding and Extreme Precipitation, it was considered valuable to also include the Building and Population Exposure workflow. This addition is directly linked to the river flooding workflow, as it is based on the same underlying hazard.

2.2.2.1 Workflow #1- Extreme precipitation

This workflow focuses on areas within Belsh Municipality that are regularly impacted by intense and prolonged rainfall, a hazard that is becoming more frequent due to climate change. The most vulnerable zones include rural settlements located on steep slopes, poorly drained urban corridors, and road infrastructure linking the city centre with surrounding rural areas. Critical hotspots such as central transport routes, hilltop housing complexes, and inadequately designed stormwater systems face heightened risks of rain-induced surface runoff, landslides, and flash flooding.

Regional analyses show that most landslides in hilly areas are directly triggered by extreme rainfall events (National Disaster Risk Reduction Strategy, pp. 22–24). Although typically localized and sudden, these events often cause severe damage and disrupt access roads and infrastructure due to the steep terrain and the proximity of settlements to streams and slopes. In Belsh, soil saturation in hillside settlements frequently leads to small-scale landslides, directly damaging homes and living spaces.

The populations most at risk include hill dwellers in structurally unsafe housing, rural households along landslide-prone slopes, and commuters reliant on vulnerable transport networks. Socio-economically disadvantaged groups, particularly women, the elderly, and low-income families, face heightened vulnerability due to limited adaptive capacity, restricted mobility, and inadequate access to early warning systems. Agricultural and seasonal workers are also heavily affected, as extreme rainfall disrupts access to farmland, damages crops, and interrupts work cycles essential to livelihoods.

2.2.2.2 Workflow #2 – River flooding

Seasonal floods triggered by intense rainfall represent a recurring hazard for Belsh Municipality, particularly in Belsh town, Seferan, and Gradishta, where settlements near lakes and rivers are highly exposed. Households in low-lying areas and elderly residents are among the most vulnerable groups, facing risks such as infrastructure damage, water contamination, and disruption of mobility. The absence of detailed floodplain mapping and limited drainage data continue to hinder effective planning and preparedness, leaving communities without the necessary tools to anticipate and mitigate flood impacts.

2.2.2.3 Workflow #3 - Flood building damages and population exposed

In cases of flood damage to buildings and risks affecting the population, the most vulnerable groups and exposed areas are primarily those located within urban zones and the communities residing there. In regions with tourist development, particularly in hilly and sub-mountainous areas and resorts situated along rivers and lakes, risk levels rise significantly during the tourist season due to increased population density. The increasing frequency and intensity of heavy rainfall events pose a significant hazard for Belsh Municipality, particularly affecting agricultural zones in Grekan, Rrasë, and Fierzë, where lowland fields and river-adjacent farmlands are highly exposed. Vulnerable groups such as smallholder farmers, livestock keepers, rural women, and seasonal agricultural workers face mounting risks, as flooding and waterlogging reduce crop yields, erode soils, damage pastures, and compromise rural infrastructure.

2.2.3 Choose Scenario

In the National Strategy for Adaptation to Climate Change, regional climate model outputs are applied to future time horizons under scenarios of moderate and high increases in global greenhouse gas (GHG) emissions and concentrations through the end of the century. For the Belshi region, scenario selection was guided by both climatic and socio-economic considerations to ensure that the analysis supports long-term, risk-informed decision-making. The medium-term horizon, set for 2050, was chosen reflecting a realistic timeframe for the implementation of public policies and investment planning. Hazard assessments based on return periods of 50, 100, and 500 years further provide insights into medium- and long-term risk exposure.

To capture the potential impacts of future climate change, the high-emission RCP8.5 scenario was adopted. This pathway offers a conservative estimate of climate risks, projecting more frequent and intense extreme weather events. In the case of Belshit, two hazard workflows are particularly relevant: river flooding and heavy rainfall, both expected to intensify under future climate conditions.

Although socio-economic assumptions were not quantitatively modeled at this stage, they are acknowledged as critical contextual factors. Population growth, urban expansion into hazard-prone areas, and rising demand for infrastructure and services are anticipated to heighten vulnerability. In addition, regional economic development and shifts in food and energy consumption patterns may influence both exposure and resilience to climate hazards.

By integrating physical hazard projections with broader socio-economic trends, the selected scenario assumptions provide a comprehensive understanding of future risks in the Belsh region.

2.3 Risk Analysis

This section outlines how risk workflows from the CLIMAAX Manual were systematically applied in Belsh Municipality to evaluate flood risk associated with the Devoll River and nearby lakes. The analysis combines hazard, exposure, and vulnerability data to deliver a spatially explicit assessment of flood risk, with all primary datasets aligned to CLIMAAX methodological standards.

Key elements of the risk assessment included:

- **Risk Assessment**:

Flood risk was analysed using historical flood depth maps from the Joint Research Centre (JRC), covering return periods from 10 to 500 years. To capture future dynamics, climate projections from the Watershed Floods dataset under RCP4.5 and RCP8.5 scenarios for 2030, 2050, and 2080 were incorporated, providing insights into potential changes in flood severity.

- **Exposure Assessment**:

Exposure was mapped using detailed land-use data (residential, agricultural, industrial), with emphasis on flood-prone infrastructure in Belsh such as the city hospital, the lakeshore belt, and peri-urban agricultural lands. The economic value of land-use categories was integrated through site-specific assessment tables.

- **Vulnerability Assessment**:

Vulnerability was examined through demographic and socio-economic indicators, focusing on groups such as the elderly, children, people with disabilities, and low-income households. Rural households reliant on agriculture and livestock, particularly those along the Devoll River, were also considered due to their heightened exposure to economic disruption and land degradation.

2.3.1 Workflow #1 - Extreme precipitation

Table 2-1 Data overview workflow #1 - Extreme precipitation

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
EURO-CORDEX precipitation flux projections (12 km resolution; RCP4.5, RCP8.5)	....		Areas at risk of pluvial flooding under future rainfall extremes; exceedance of critical thresholds
Rainfall intensities by duration and return period (e.g., 1h, 3h, 6h events)	....		

2.3.1.1 Hazard assessment

Key findings highlight the following trends:

- EURO-CORDEX model outputs (12 km resolution) under RCP4.5 and RCP8.5 scenarios show a marked intensification of short-duration rainfall events (1–6 hours) by 2050 and 2080.
- The occurrence of 10- and 20-year return period rainfall events is expected to rise, particularly during late summer months.
- Urban and coastal areas with a high proportion of sealed surfaces are especially vulnerable to these short, high-intensity rainfall episodes.
- In many modelled scenarios, projected rainfall surpasses the design thresholds of existing drainage systems, posing significant risks for older or informal settlements.

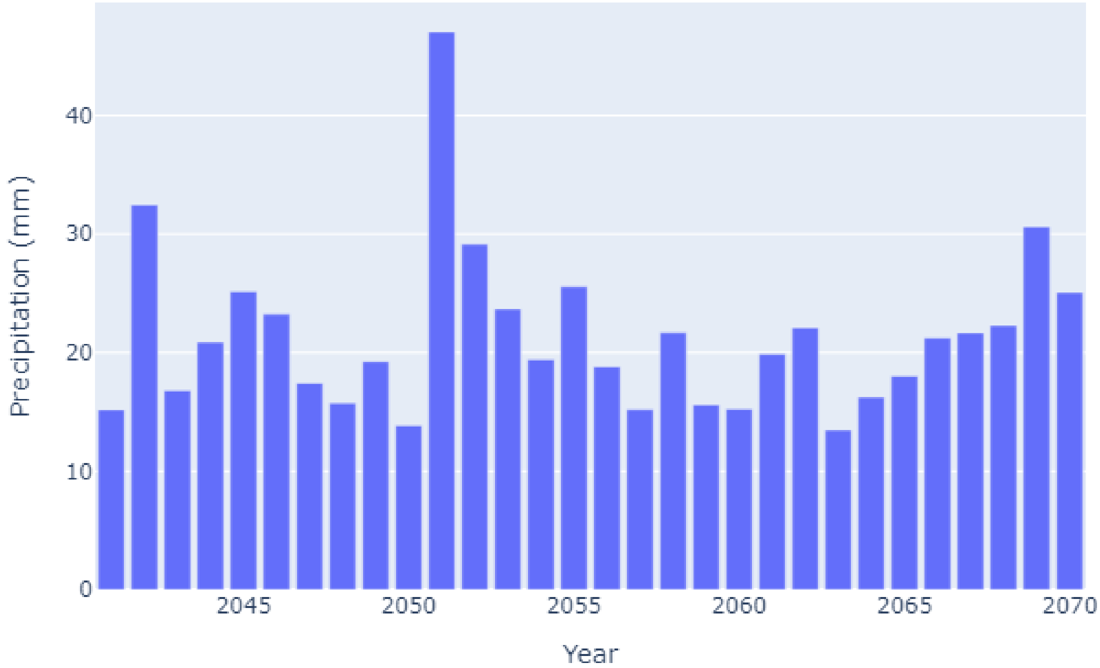

Figure 2.3.1-1 Annual maximum precipitation for 3h duration in Belsh

Flash floods caused by extreme precipitation are identified as the primary hazard risk in the Devolli River Basin, and climate change is expected to increase both the frequency and severity of such events. Following the analysis of the extreme precipitation workflow, it was selected for a regional-scale assessment covering the entire basin, as this broader scope provides valuable insights into the cumulative impacts of extreme rainfall across the area.

Figure above (figure 2.3-7) shows the temporal evolution of **annual maximum precipitation for a 3-hour duration** at a selected location in **Belsh**, based on **EURO-CORDEX regional climate projections** under the **RCP8.5 scenario** for the period **2041–2070**.

The time series was extracted from the newly generated netCDF files containing annual precipitation maxima for different accumulation durations. A reference point defined by geographic coordinates (41.0°N, 20.8°E) was reprojected to the EURO-CORDEX coordinate system, and the closest model grid cell was used to represent local conditions.

The bar chart reveals a **clear year-to-year variability** in short-duration extreme precipitation. Annual maximum 3-hour rainfall values typically range between **about 15 mm and 45 mm**, with several years standing out due to notably higher peaks, particularly around the middle of the projection period. These peak values reflect years with more intense short-duration rainfall events, while other years are characterised by more moderate extremes.

Overall, the time series does not show a consistent increasing or decreasing trend. However, the repeated occurrence of high annual maxima throughout the period indicates that **intense short-duration precipitation remains a significant climate hazard for the Belsh area under a high - emission scenario**. This analysis contributes to the hazard characterisation within the climate risk assessment and provides a useful basis for further local-scale analyses, such as **intensity–duration–frequency (IDF) assessments** and impact-oriented evaluations.

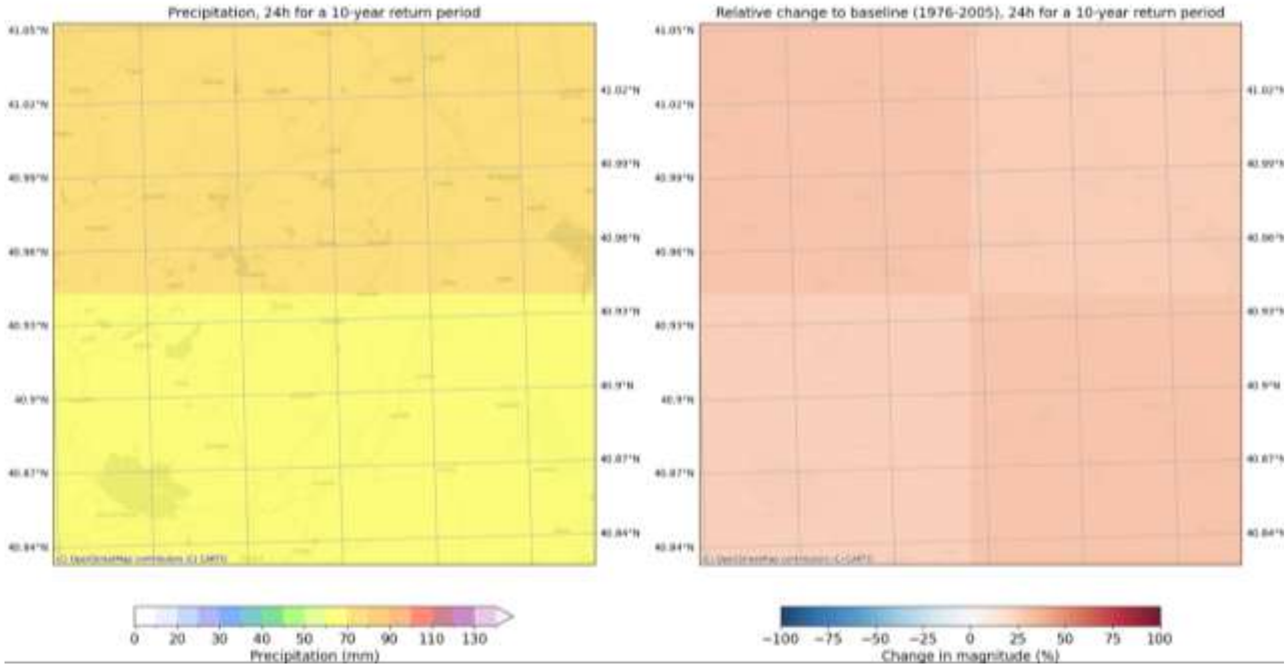

Figure 2.3.1-2 Extreme precipitation for 2041 - 2070munder RCP8.5 climate projections

The relative change in magnitude of these extreme precipitation events, is variable within the Belsh Municipality territory, with the most important increase for the 2071-2100 future period.

For all the future periods, we could expect in general an increase of these extreme precipitation events (3h and 100-year return period), with the exception of 2041-2070 period, when for some part of the Belshi area we could expect a decrease, comparing with the reference historical period (1976-2005).

2.3.1.2 Risk assessment

The risk analysis integrates climate hazard projections with urban exposure data and vulnerability indicators to identify where extreme precipitation could result in localised flooding.

2.3.2 Workflow #2 – Floods

The second workflow applied in the climate risk assessment focuses on seasonal floods, which pose a recurring threat to infrastructure, water quality, and community safety in Belsh Municipality. Flooding is most common in low-lying areas near lakes, rivers, and poorly drained urban zones, particularly in Belsh town, Seferan, and Gradishta.

Table 2-2 Data overview workflow #2 Floods

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
River flood hazard maps for Europe and the Mediterranean Basin region – Copernicus (depths over return periods 10, 100 and 500)	LUISA depth damage curves for land use - JRC	Europe LUISA Land Cover base map 2018 100m resolution JRC)	River flood hazard maps for 10, 100, 500 years RP for present day scenario Flood damage maps, expressed in economic value, for extreme events with different return periods based on available flood maps for the historical climate

Future river flood maps (Aqueduct; RCP4.5 & RCP8.5)			Comparative analysis of flood risk change under climate scenarios (2030, 2050, 2080)

2.3.2.1 Hazard assessment

The flood hazard map highlights areas within Belsh Municipality that are most exposed to seasonal flooding, particularly low-lying zones near lakes and rivers. Based on precipitation anomalies and terrain analysis, the map identifies Seferan, Gradishta, and parts of Belsh town as high-risk zones. This visualization supports the identification of flood-prone areas and informs the prioritization of mitigation measures.

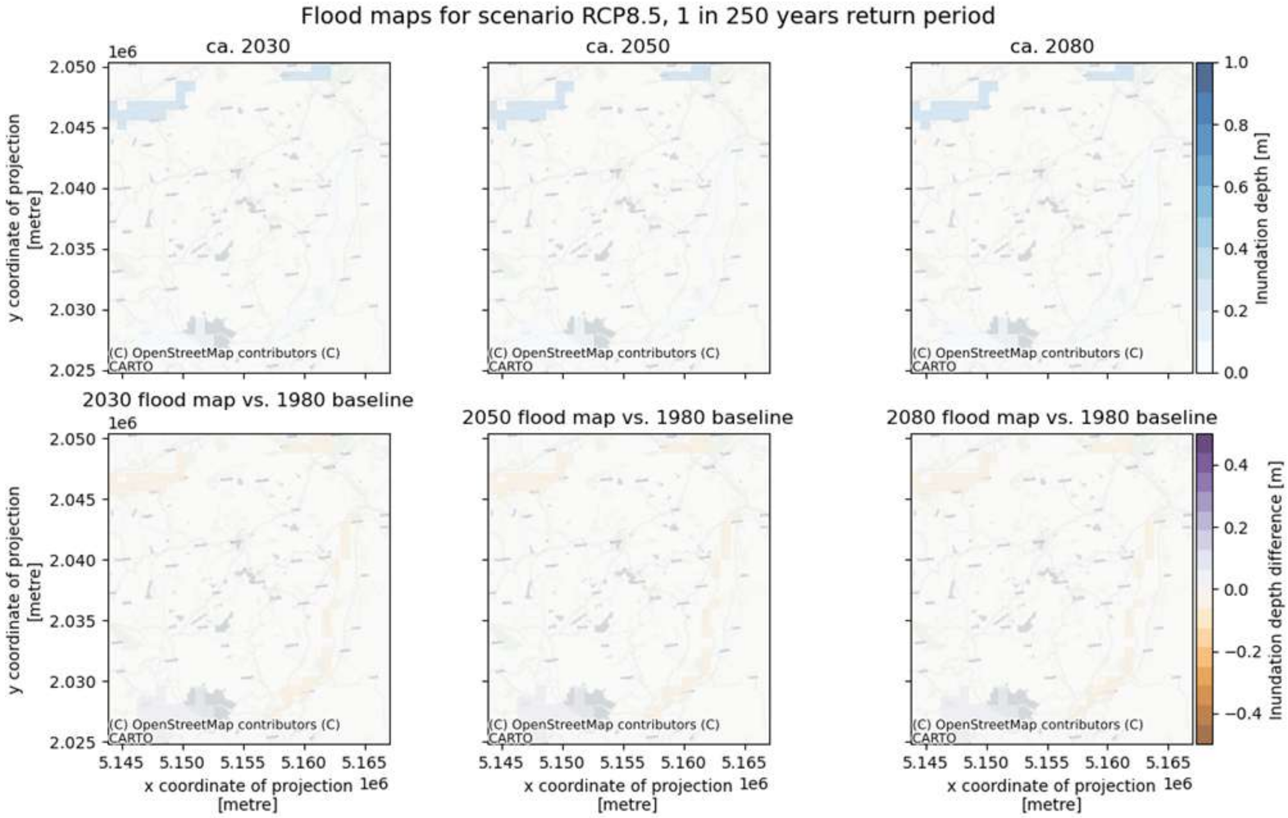

Figure 2.3.2-2 Flood maps for scenario RCP4.5, 1 in 250 years return period

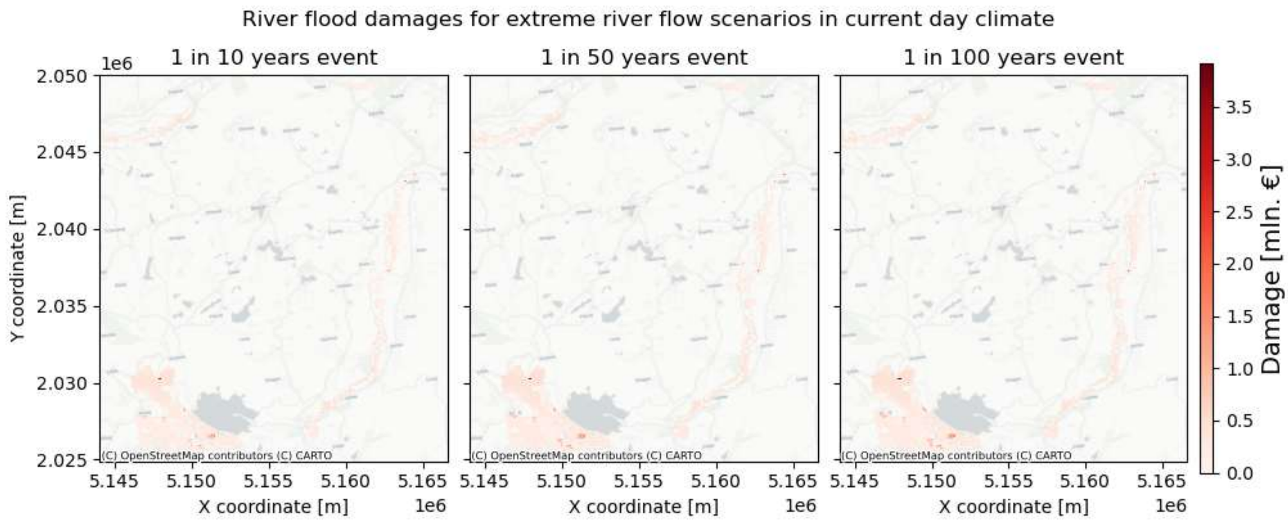

Figure 2.3.2-1 River flood damages for extreme river flow scenarios in current day climate

2.3.2.2 Risk assessment

The flood hazard map highlights areas within Belsh Municipality that are most exposed to seasonal flooding, particularly low-lying zones near lakes and rivers. Based on precipitation anomalies and terrain analysis, the map identifies Seferan, Gradishta, and parts of Belsh town as high-risk zones. This visualization supports the identification of flood-prone areas and informs the prioritization of mitigation measures.

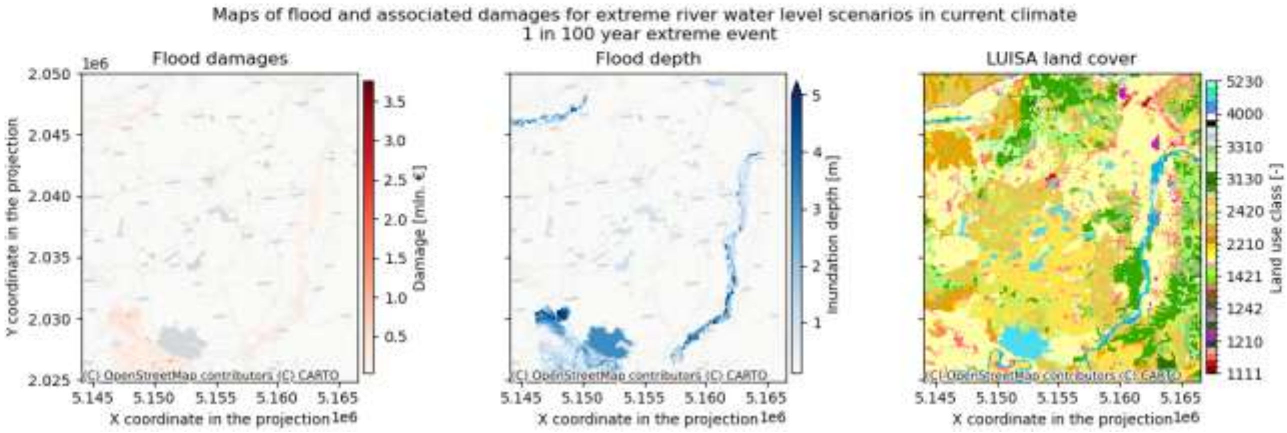

Figure 2.3.2-4 Maps of flood and associated damages for extreme river water level scenarios in current climate 1 in 100 years

2.3.3 Workflow #3 – Flood damage and population exposure

The Flood Damage and Population Exposure workflow was applied to the Belsh territory near the Devoll River, where high population density, displacement risks, and significant building damages were identified. The river flood hazard for the Devoll River was derived in line with the river flood workflow, using the River Flood Hazard Maps for Europe and the Mediterranean Basin Region dataset, after defining the geographical boundaries of the area of interest.

Table 2-3 Data overview workflow #3 Flood damage and population exposure

Hazard data	*Vulnerability data*	*Exposure data*	*Risk output*
River flood hazard maps for Europe and the Mediterranean Basin region –Copernicus (depths over return periods 10, 100 and 500)	Inundation depth thresholds for population displacement		Maps of exposed population Estimated annual exposed population graph Maps of displaced population Estimated annual displaced population graph
Number of hot days per year; heatwave duration indicators	Damage curves for buildings European Commission's Joint research Centre		Building damage maps Estimated annual building damage graph

2.3.3.1 Hazard assessment

The Building Population Flood Risk Assessment workflow was initially applied across the entire section of the Devoll River within Belsh Municipality. However, a detailed review of the available exposure data revealed that only certain localities in the Devoll River basin were adequately covered. Due to these dataset limitations, the workflow was refined to focus on the section of the river passing through Belsh territory, where exposure data coverage is sufficient and the area is recognized as highly susceptible to flooding from extreme events.

The assessment of river flood risk and its impacts on buildings and population followed the Building Population Floods workflow, which estimates economic damages to buildings using damage curves, EU-level economic parameters, and building geometry/type. It also evaluates exposed and displaced populations through population distribution maps. After defining the geographical boundaries of Belsh and the return periods of interest (10, 100, 500 years), flood extent and water depth rasters were retrieved from the Copernicus Earth Monitoring Service (Zenodo WF3). The 100-year return period flood map indicates that, during an event with a 1% probability of occurrence, the territory adjacent to the Devoll River faces a moderate risk of flood depths reaching up to 10 meters.

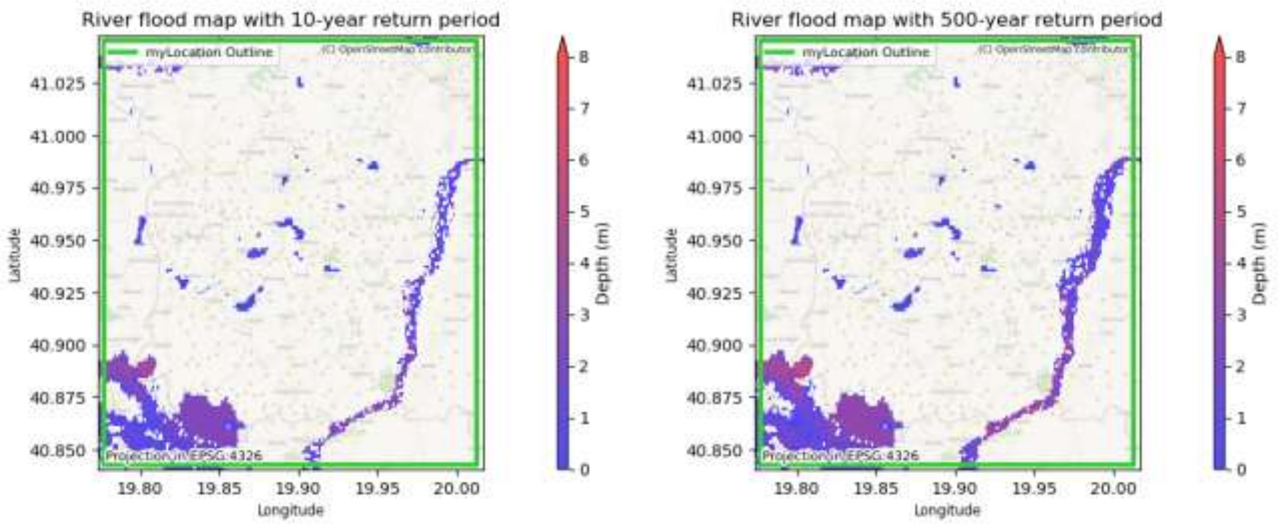

Figure 2.3.3-1 River flood hazard map with 10 and 500-years RP for Belshi area

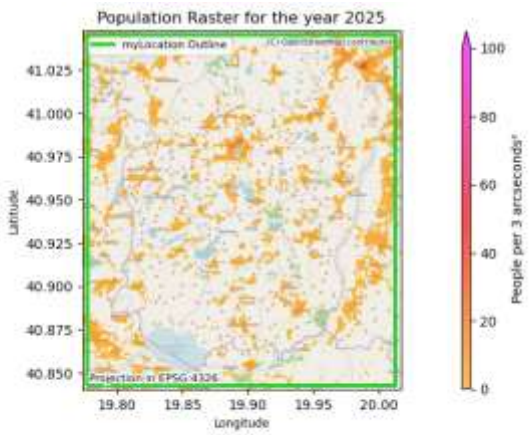

Figure 2.3.3-2 Population density map for Belshi area

Estimated population density data for Belsh were obtained from the European Commission's Joint Research Centre for the year 2025, expressed as the number of inhabitants per cell. Although Belsh is a relatively small locality, its economic significance is reinforced by the presence of a well-known tourist destination. As a result, the local population rises from around 800 permanent residents to more than 2,000 during the tourist season.

Building data for the Belsh area were obtained from OpenStreetMap, providing information on building locations and geometries. As building type classifications are not available in this dataset, all structures were categorized under the Universal class (Figure 2.3.3-3).

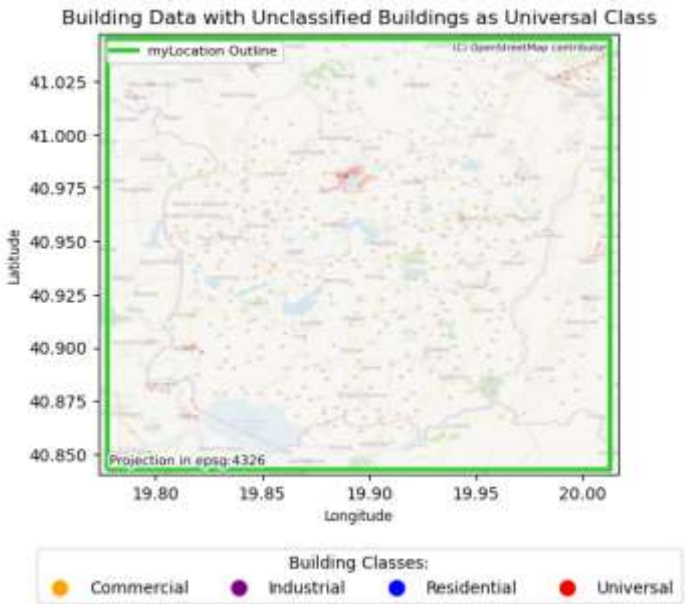

Figure 2.3.3-3 Building locations map for Belshi area

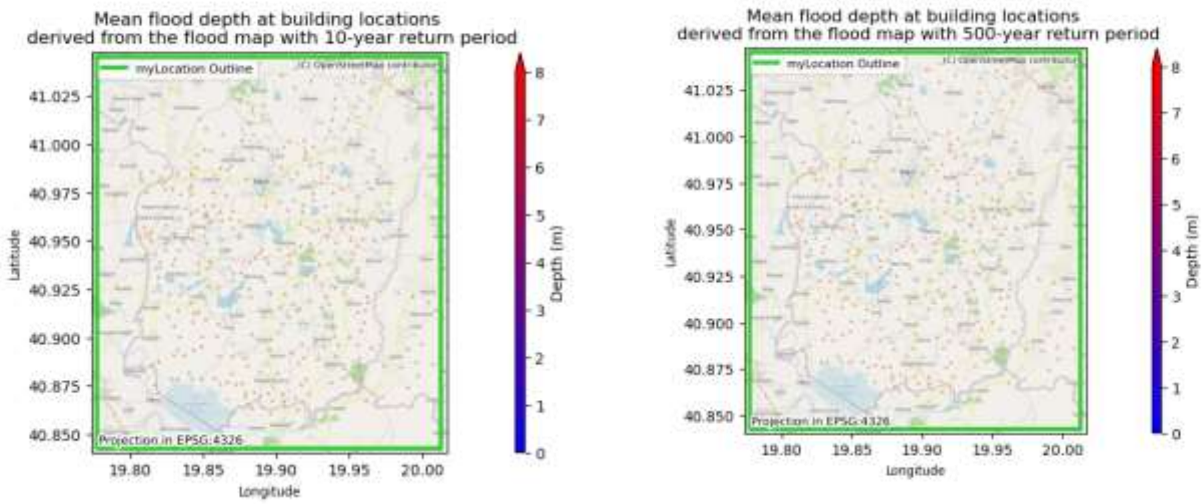

Figure 2.3.3-4 Mean flood depth building locations map for Belshi area for the event with 10 and 500-years RP

The next step in the workflow involved generating flood depth maps at building locations, derived from flood depth rasters for 10- and 500-year return periods combined with the building location dataset. The mean flood depth map for the 1% probability event (100-year RP) indicates high flood depths across nearly all building sites in Belsh.

Based on these flood depths, the economic damage to buildings—expressed as reconstruction costs, was calculated using the JRC damage function for Universal buildings (an average curve representing residential, commercial, and industrial types). This was multiplied by the maximum damage value per square meter and the footprint area of each building. Damage maps and plots were produced for the selected return periods, and the total building damage for Belsh was estimated.

The results show that reconstruction costs for the Belsh community range from approximately €28 million for a 10-year return period flood to €38 million for a 500-year return period flood (Figure 2.3.3-5).

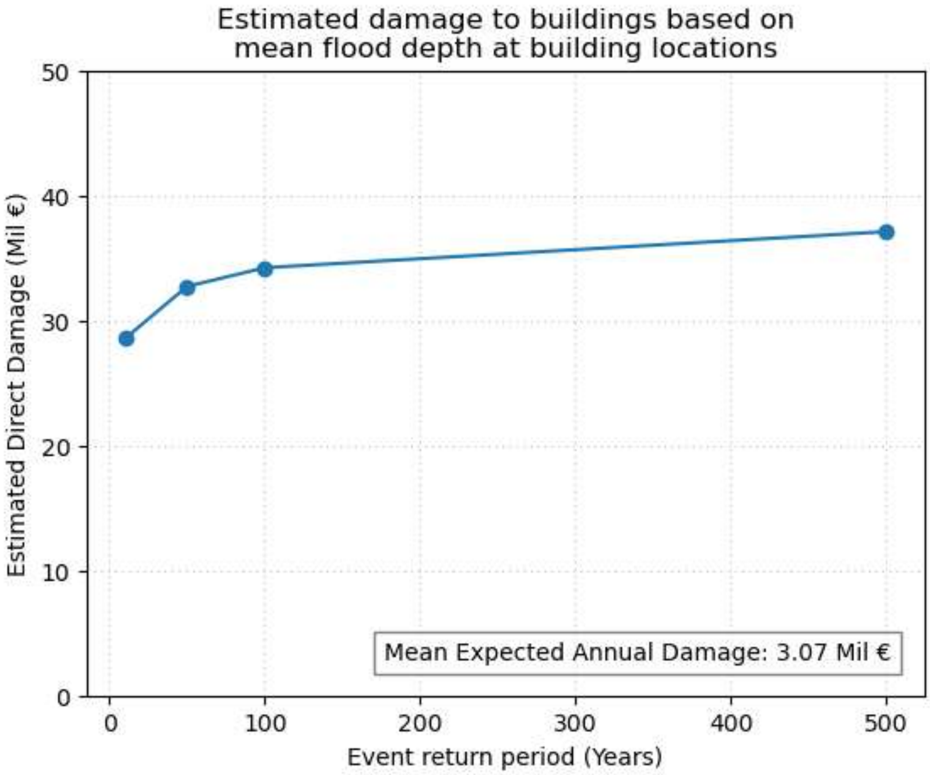

Figure 2.3.3-5 Estimated damage to building for Belshi area on mean flood depth for different RP

These damages are particularly significant given that local communities in the Belsh area have limited resources to strengthen climate and disaster resilience, lacking the capacity to adequately implement emergency response and recovery measures. In line with the workflow steps, population density data for Belsh were integrated with flood depth rasters to generate maps of exposed population across the selected return periods. The exposed population was then plotted against the flood scenarios, and the expected annual exposed population was calculated, representing the average number of individuals likely to be affected in any given year.

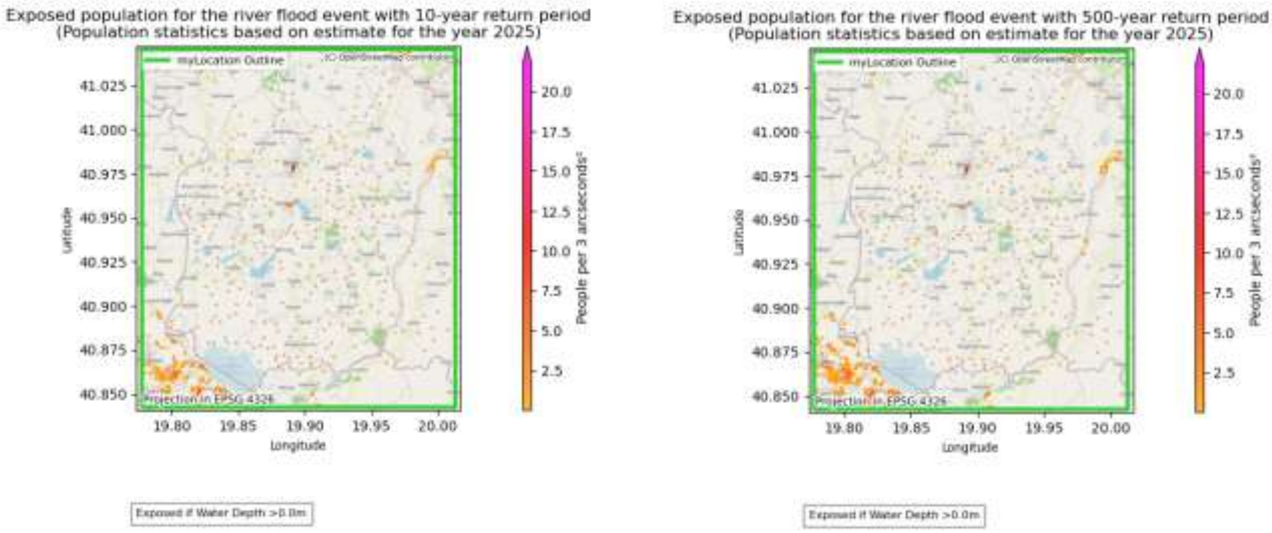

Figure 2.3.3-6 Map of exposed population in Belshi area for the flood event with 10 and 500-years RP

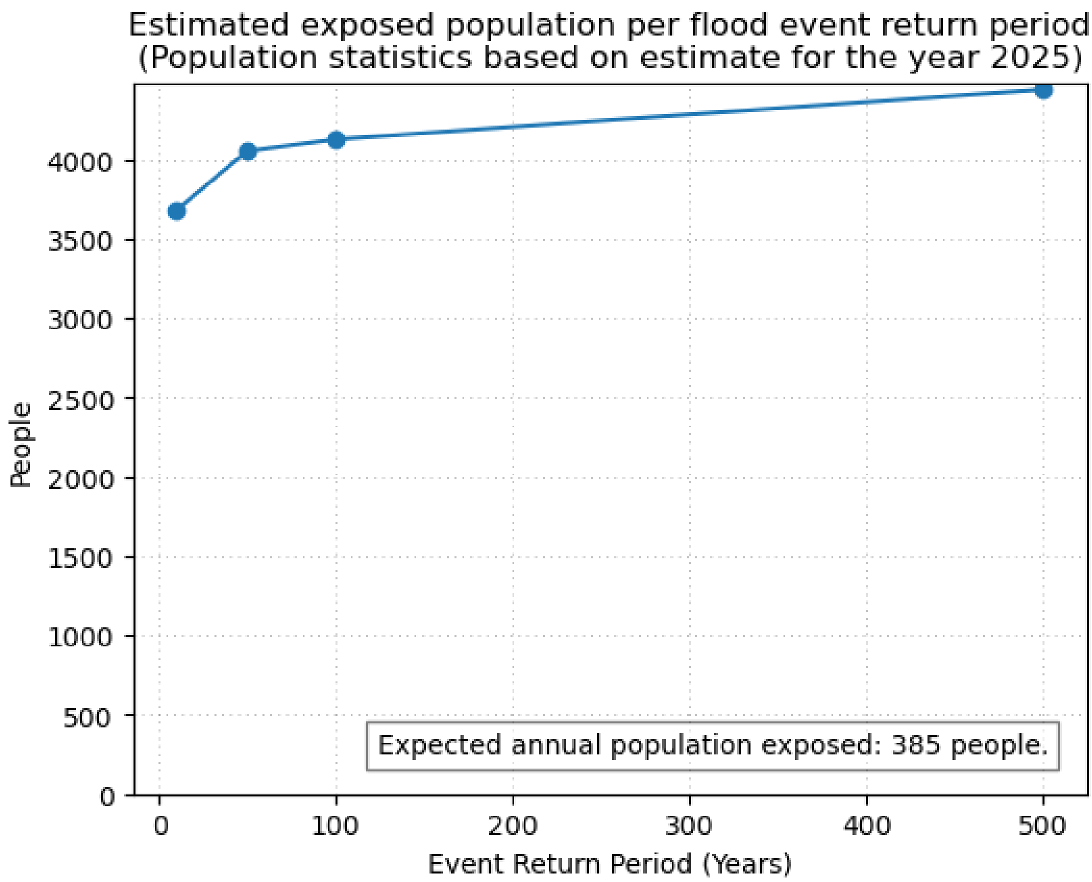

Figure 2.3.3-7 Estimated exposed population in Belshi area for different RP of flooding event

Using flood depth and population density maps, the displaced population was estimated by applying a threshold of water depth greater than 1.0 m. The resulting graphs of exposed and displaced populations across the selected return periods show comparable values, ranging from approximately 3,600 people for a 10-year flood to around 5,000 people for a 500-year flood. These maps and graphs illustrate how building damage and population exposure/displacement vary depending on flood recurrence intervals.

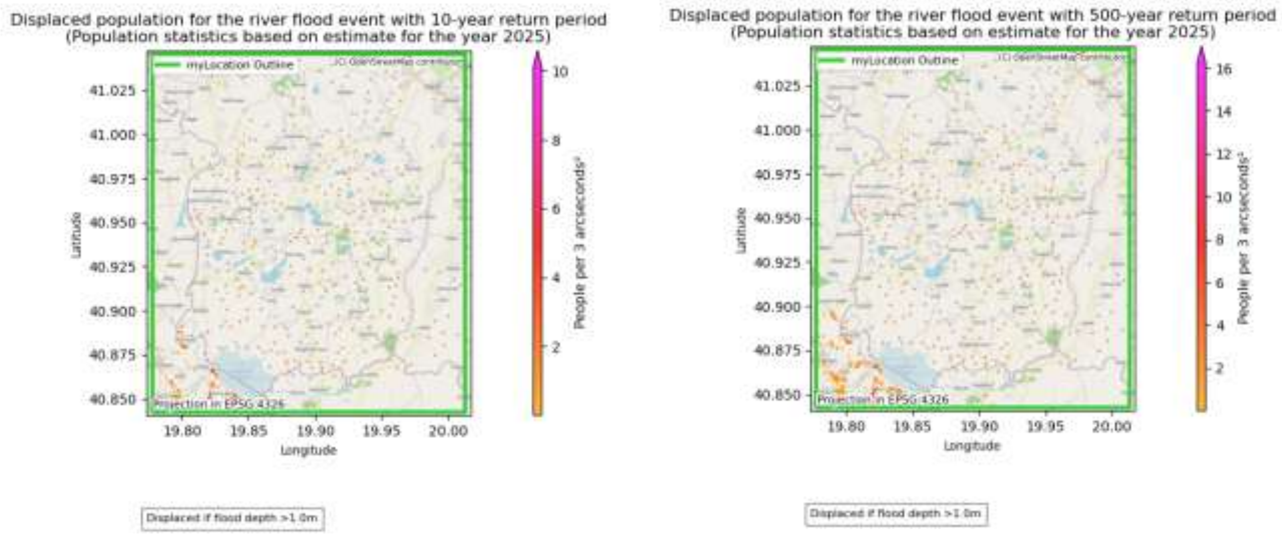

Figure 2.3.3-8 Displaced population for the river flood events with 10 and 500-years RP

The same workflow was applied to the building damage analysis, using the available dataset in the notebook. This produced graphs (Figures 2.3.3-8) showing the exposed and displaced population for 10- and 500-year flood events when water depth exceeds 0.0 m.

2.4 Preliminary Key Risk Assessment Findings

2.4.1 Severity

The key outcomes from Phase 1 of the CRA focus on identifying and mapping hotspots with elevated hazard and risk levels across Belsh Municipality, while also providing initial indications of how climate change may influence the future evolution of selected hazards. These findings form the foundation for the more detailed, localized CRA to be conducted in Phase 2 of the project.
The primary climate-related risks affecting Belsh Municipality are heavy rainfall, river flooding, and flash flooding. Despite the limitations of the datasets used, the Phase 1 outputs consistently highlight multiple areas with high hazard and risk values for the selected return period events, alongside a clear upward trend in risk under future climate scenarios.

2.4.2 Urgency

In the Belsh region, extreme rainfall stands out as the most urgent hazard requiring short- and medium-term adaptation measures. Both the frequency and intensity of such events are increasing due to climate change and are projected to worsen in the coming decades. Without timely risk reduction interventions, climate-induced disasters will intensify almost annually. Immediate priorities include strengthening infrastructure, upgrading drainage systems, establishing flood and flash-flood early warning mechanisms, monitoring landslide-prone areas, constructing retaining walls on vulnerable slopes, and, most critically, raising public awareness on disaster preparedness.

Extreme rainfall represents the primary climate challenge for Belsh, posing serious risks to public health, the local economy, and infrastructure if robust adaptation measures are not implemented.

To address this, comprehensive short-, medium-, and long-term adaptation strategies should be developed to foster disaster-resilient urbanization. Expanding disaster insurance schemes will help mitigate economic losses, while strong partnerships at both local and national levels are essential to design and implement effective action plans for risk reduction, emergency response, and recovery.

2.4.3 Capacity

In Belsh, although still limited, several initiatives to reduce climate risks have already been launched. In August 2025, the Municipality began preparing an Action Plan for Natural Disaster Management, marking an important first step toward strengthening institutional capacity. The plan, designed to mitigate risks from floods, landslides, and other hazards linked to extreme rainfall, outlines a series of activities that will contribute to climate risk reduction.

Planned measures include efforts to ensure residents are well informed about climate risks, raise awareness levels, and build a resilient community capable of withstanding disasters. In parallel, planning has been undertaken to promote sustainable and disaster-resistant living spaces. However, successful implementation of the Action Plan will require additional financial resources.

As a second step, the Municipality of Belsh has engaged with global initiatives such as the CLIMAAX project, further enhancing its capacity for climate risk management. In conclusion, while current measures have achieved partial effectiveness, Belsh urgently needs a more comprehensive, proactive, and well-funded strategy to address climate change. The CLIMAAX project is expected to play a key role in shaping and implementing such a strategy.

2.5 Preliminary Monitoring and Evaluation

Through the steps of Phase 1 of the CRA, we gained practical experience in applying the framework and using the toolbox to generate relevant results for the study area. Due to the specific characteristics of the area, certain modifications were required to adapt the notebooks. When interpreting the outputs, it was essential to consider both the features and limitations of the datasets available within the CRA.

Some challenges were encountered with the extreme precipitation workflow, particularly in understanding the details of the processing steps. To improve clarity, it would be useful to prepare schematic representations (data processing diagrams) for each workflow. In addition, the exact geographical details and projections associated with the bias-corrected and thresholded datasets were not fully understood and will be revisited in greater detail during Phase II.

According to the project work plan, three workshops will be organized with key stakeholders and beneficiaries in the study area: one preparatory meeting in August 2025 (Phase 1), followed by two workshops in March and June 2026 (Phases 2 and 3) for stakeholder consultation and dissemination of results. These workshops will inform participants about the project and its implementation stages, engage them directly in consultations, and involve them in finalizing new proposals for a program of measures addressing prevention, protection, and preparedness for current and future floods under climate change conditions.

For a more robust assessment of climate change impacts on river flood and flash flood risks, the most critical data required are maximum discharge values and the percentage changes in these values under current and future scenarios.

2.6 Work plan

The next phases of the EVOLVE–Belsh project will focus on deepening the climate risk analysis, refining adaptation priorities, and co-developing actionable strategies with local stakeholders. The work plan is structured around the following core activities:

Main Activities to Be Studied

- **Validation of Risk Maps and Indicators** Risk outputs from the three workflows (extreme rainy, floods, Flood damage and population exposure) will be reviewed with municipal staff, community representatives, and technical experts to ensure local relevance and accuracy.
- **Prioritization of Adaptation Measures** Based on severity, urgency, and capacity findings, targeted interventions will be identified for high-risk zones. These may include nature-based solutions, infrastructure upgrades, and public awareness campaigns.
- **Integration into Municipal Planning** Climate risk findings will be embedded into local development plans, emergency response protocols, and sectoral strategies (e.g., agriculture, water, health).
- **Stakeholder Engagement and Capacity Building** Workshops and consultations will be held to strengthen institutional ownership, build technical capacity, and ensure inclusive participation, especially of vulnerable groups.
- **Monitoring Framework Design** A preliminary set of indicators and tools will be proposed to track adaptation progress, institutional responsiveness, and community resilience over time.

Aspects Not Studied and Justification

- **Sea Level Rise and Coastal Hazards** These are excluded due to Belsh's inland geography and lack of exposure to marine systems.
- **Industrial Emissions and Urban Heat Island Effects** Belsh has limited industrial activity and low urban density, making these risks less relevant in the current context.
- **Detailed Economic Modelling** While financial impacts are considered qualitatively, complex macroeconomic simulations are beyond the scope and resources of this phase.

3 Conclusions Phase 1- Climate risk assessment

The first phase of the EVOLVE–Belsh project has laid a foundational understanding of climate risks affecting the municipality, using the CLIMAAX methodology to systematically assess five key hazards: droughts, floods, heatwaves, soil erosion, and wildfires. Through a combination of spatial analysis, stakeholder engagement, and scenario-based modelling, the assessment has produced actionable insights into the severity, urgency, and distribution of climate threats across Belsh.

Main Conclusions

- **Integrated Risk Mapping**: The application of CLIMAAX workflows enabled the development of hazard-specific risk maps, revealing high-risk zones for each climate hazard. These maps provide a visual and analytical basis for prioritizing adaptation measures.
- **Severity and Urgency Differentiation**: Droughts and heatwaves emerged as the most severe and urgent risks, with increasing frequency and intensity projected under RCP4.5 and RCP8.5 scenarios. Floods and wildfires, while episodic, pose acute threats to infrastructure and ecosystems. Soil erosion, though slower in onset, contributes to long-term land degradation.
- **Capacity Gaps Identified**: The assessment highlighted limitations in financial, technical, and institutional capacity to manage climate risks. While some measures are in place—such as awareness campaigns and pilot interventions—there is a need for stronger coordination, data systems, and long-term planning.
- **Stakeholder Engagement as a Strength**: Participatory consultations enriched the analysis, ensuring that local knowledge and lived experiences informed the identification of vulnerable zones and populations. However, engagement of marginalized groups remains a challenge and will require targeted outreach in future phases.
- **Scenario-Based Planning Validated**: The use of CLIMAAX scenarios helped frame the urgency of action, particularly for heat-related hazards and water stress. These projections will be critical in shaping medium- and long-term adaptation strategies.

Challenges Addressed

- Developed a multi-hazard risk profile using harmonized data sources;
- Initiated stakeholder dialogue and built awareness of climate risks;
- Identified priority zones for intervention based on severity and exposure.

Challenges Not Fully Addressed

- Limited availability of high-resolution and real-time data, especially for flood history and population exposition dynamics;
- Gaps in forecasting infrastructure and early warning systems;
- Need for deeper integration of climate risks into municipal planning and budgeting;
- Insufficient representation of vulnerable populations in decision-making processes.

✓ **Key Findings**

- **High-risk zones** include low-lying urban areas (floods), sloped agricultural lands, and peri-urban zones with limited vegetation;
- **Vulnerable groups** include elderly residents, outdoor workers, and livestock-dependent households;
- **Urgent action** is needed within the next 2–5 years to prevent irreversible damage, particularly in agriculture, water management, and public health;
- **Nature-based solutions** and inclusive governance are essential pillars for building long-term resilience.

4 Progress evaluation and contribution to future phases

The completion of Phase 1 of the EVOLVE–Belsh project marks a critical milestone in establishing a data-driven, participatory foundation for climate risk management. This deliverable—focused on multi-hazard risk assessment—has generated key outputs that directly inform the design and implementation of the next project phases, including adaptation planning, stakeholder engagement, and monitoring frameworks.

The outputs of this phase—risk maps, severity and urgency profiles, and capacity assessments—will serve as baseline references for:

- **Adaptation Prioritization**: Identifying high-risk zones and vulnerable populations for targeted interventions
- **Municipal Integration**: Embedding climate risk indicators into local development plans and emergency protocols
- **Stakeholder Mobilization**: Expanding engagement to include underrepresented groups and sectoral actors
- **Monitoring and Evaluation Design**: Establishing performance indicators and feedback loops for resilience tracking

These activities will build on the spatial and institutional insights generated in Phase 1, ensuring continuity and coherence across project phases.

Table 4-1 Overview key performance indicators

Key performance indicators	*Progress*
1 workflow (with focus on the HEAVY RAINFALL workflow) applied	The workflows for River Flooding and Heavy Rainfall/Extreme Precipitation were successfully adapted for Belshi Municipality and applied for the relevant return periods and scenarios. The Flood Damage and Population Exposure workflow was included in the plan and successfully applied. All outputs were analysed
1 consultation workshops with stakeholders	Completed – Introductory workshop held with municipal staff, farmers, youth and environmental NGOs to present project objectives and gather feedback

Table 4-2 Overview milestones

Milestones	*Progress*
M1: Initial stakeholder engagement completed	Following the agreement with the CLIMAAX program, the Municipality of Belsh formally established a dedicated implementation team through council and mayoral decisions, assigning municipal specialists across key departments. To enhance technical capacity, a cooperation agreement was signed with INCA as a subcontractor. The initial stakeholder engagement phase successfully mapped local actors and launched inclusive consultations, laying the groundwork for participatory project implementation.

M2: Climate hazard selection and indicator framework established	This milestone marks the successful identification of five priority climate hazards for Belsh Municipality: Heavy rainfall, Flood and Flood Damage and Population Exposure, based on historical data, local context, and CLIMAAX scenario projections. An indicator framework was developed to assess each hazard's intensity, exposure, and vulnerability, providing a structured basis for risk analysis in the following phases. This framework ensures consistency across workflows and supports evidence-based decision-making for adaptation planning.
M8: Attend the CLIMAAX workshop held in Barcelona	Project staff appointed by the Mayor and Municipal Council actively participated in the CLIMAAX workshop held in Barcelona, strengthening their understanding of the methodology and its application.
M3: First risk assessment draft completed	The first draft of the climate risk assessment report has been completed, consolidating hazard analysis, exposure mapping, and vulnerability profiling.
M10: Subcontracting done	To reinforce technical capacity, the Municipality finalized the subcontracting procedure and signed a cooperation agreement with INCA, formally engaging them as a project partner.

5 Supporting documentation

The following outputs were produced during Phase 1 of the EVOLVE−Belsh project and have been uploaded to the Zenodo repository for open access and future reference. These materials reflect the analytical, visual, and engagement components of the climate risk assessment process.

- ✓ Draft report on Deliverable Phase 1 – Climate risk assessment for the project “Evaluating Vulnerabilities and Optimizing Local Vitality and Ecosystems in Belsh (EVOLVE-Belsh)” in word and pdf formats
- ✓ Workshop associated documents (invitation, agenda, photos and participant list)
- ✓ Outputs of Workflow 1 Extreme precipitation:
    - WF1 – Outputs of Workflow 3 Hazard
    - WF1_Extreme precipitation_3h_100yearRP (3 maps)
    - WF1 - Outputs of Workflow 3 Risk
    - WF1_ProjectedRP_80mm3h_events_Ensemble mean (3 maps)
    - WF1_Shift in Return Periods_80mm3h_events_RCP 8.5 vs RCP 4.5 (3 maps)
    - WF1 – Other data Workflow 3
    - WF1_LocalSupportData
- ✓ Outputs of Workflow 2 River Flooding:
    - WF2 – Outputs of Workflow 1 Hazard
    - WF2_Floodmap_overview_JRC_PresentScenario
    - WF2_River_flood_hazard_maps_TAUs (12maps)
    - WF2_River_flood_maps_Aqueduct
    - WF2 - Outputs of Workflow 1 Risk
    - WF21_Luisa_info_damages_tables
    - WF2_Damage_maps
- ✓ Outputs of Workflow 3 Buildings and population exposure:
    - WF3 - Outputs of Workflow 2 Risk
    - WF3_Hazard_maps_Lepsa
    - WF3_Building_damage_maps_graphics
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- ✓ WF3_Population_exposure_Rastoaca

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