# Deliverable Phase 2 – Climate risk assessment

# Initiative for Climate-Proof Future of Banská Bystrica Region CLIMAAXInsight

## Slovakia, Banská Bystrica Self-Governing Region

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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 | Deliverable 2 provides a regional-scale climate risk assessment for the Banská Bystrica Region within the CLIMAAXInsight project. It expands the European-scale screening of Deliverable 1 by integrating national datasets[1] at regional level and stakeholder input. |
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| Author(s) | • Martin Jančovič #1 Banská Bystrica Self-Governing Region<br>• Martin Tuchyňa #2 Banská Bystrica Self-Governing Region<br>• Andrea Rúfusová #3 Banská Bystrica Self-Governing Region |
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[1] National-level datasets were used as input, but all analyses and results refer exclusively to the regional level.

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# Abbreviations and acronyms

*Table 1 Abbreviations and acronyms*

| Abbreviation / acronym | Description |
|---|---|
| BBR | Banská Bystrica Region |
| BBSGR | Banská Bystrica Self-Governing Region |
| CDS | Copernicus Climate Data Store |
| CHELSA | Climatologies at High Resolution for Earth's Land Surface Areas |
| CLC | CORINE Land Cover |
| CRA | Climate Risk Assessment |
| CSV | Comma-Separated Values (file format) |
| DEM | Digital Elevation Model |
| DRMKC | Disaster Risk Management Knowledge Centre |
| ECLIPS | European Climate Index Projections |
| EFFIS | European Forest Fire Information System |
| EU | European Union |
| EURO-CORDEX | European Coordinated Downscaling Experiment (CORDEX Europe domain) |
| FWI | Fire Weather Index |
| GCM | Global Climate Model |
| GDP | Gross Domestic Product |
| GHS | Global Human Settlement |
| GHG-POP | Global Human Settlement - Population |
| IEP | Institute for Environmental Policy |
| JRC | Joint Research Centre |
| KPI | Key Performance Indicators |
| LUISA | Land Use-based Integrated Sustainability Assessment |
| ML | Machine Learning |
| NGO | Non-Government Organisation |
| NUTS | Nomenclature of Territorial Units for Statistics |
| OSM | Open Street Maps |

| | |
|---|---|
| RCP | Representative Concentration Pathway |
| SHMI | Slovak Hydrometeorological Institute |
| SK | Slovakia/Slovak (national dataset/context) |
| SWME | Slovak Water Management Enterprise |
| WUI | Wildland Urban Interface |

## Executive summary

**This deliverable presents the outputs of the second phase of the CLIMAAX project in the Banská Bystrica region** and builds on the initial climate risk assessment and testing of the CLIMAAX framework conducted during Phase 1.

Phase 2 was undertaken to examine whether, in a heterogeneous region such as the Banská Bystrica region, extending initial European datasets with **national data** leads to more meaningful and usable climate risk assessment results. The work examined how these results improve the understanding of climate risks and to what extent they are suitable for decision-making and risk management.

Deliverable and annexes will provide the readers with the overview of the work done, results from the usage of CLIMAAX methodology framework and toolbox, utilising more precise national data, including achievements and challenges.

Phase 2 did not expand the scope of the assessment to additional hazards but rather **deepened the analysis of previously identified priority risks — river floods and wildfires.** The assessment focused on capturing spatial variability, comparing current and future risk conditions, and exploring the interpretation of results for different governance and user levels.

**Key Findings**

- ✓ **Priority risk and improved local relevance through national data:**
  Building on the Phase 1 focus on floods and wildfires, applying the CLIMAAX framework with national datasets substantially improved spatial detail and local relevance compared to Phase 1, while also underlining where data availability, spatial coverage, scale effects and uncertainty require careful interpretation at the regional scale.
- ✓ **Structured interpretation via the Key Risk Assessment framework:**
  The Key Risk Assessment Protocol confirms floods and wildfires as high-priority risks, indicating substantial to critical severity and immediate action for floods, and substantial (potentially critical) risk for wildfires requiring strengthened preparedness, based on a preliminary, predominantly qualitative assessment of response capacity, pending further refinement in Phase 3.
- ✓ **Usability insights from stakeholder engagement:**
  Consultations with key stakeholders and pilot public engagement confirmed demand for risk information but also surfaced practical constraints—limited time and technical capacity, differing institutional mandates, and the challenge of communicating complex, region-wide outputs in a user-friendly way. These insights directly inform how results will be packaged, presented, and disseminated in Phase 3.

**Future Directions**

- ✓ **Focused use of existing results:**
  Phase 3 will prioritise the practical uptake of existing outputs (rather than further analytical expansion), with emphasis on application in regional planning, risk management, and targeted communication.
- ✓ **Tailored communication and stakeholder engagement:**
  Results will be communicated in formats adapted to different stakeholder and user groups to support understanding, relevance, and uptake – for example through the Climate Hub, a

regional conference, and targeted briefings tailored to the needs of decision-makers and governance bodies.

- ✓ **Sustainability and future developments.** Phase 3 will also identify options to sustain and extend project results beyond CLIMAAX, including maintenance of data/visual outputs and potential future enhancements.

This project contributes to the practical testing of the CLIMAAX methodology and toolbox in a regional context, providing insights into their applicability, limitations, and transferability across different regions in Europe.

# 1 Introduction

## 1.1 Background

**The Banská Bystrica Region (BBR) is the largest region in Slovakia by area and is characterised by a low population density and a highly fragmented settlement structure, with many small municipalities**. The region is administered by the Banská Bystrica Self-Governing Region (BBSGR) authority, which is responsible for regional development, public services, and infrastructure and acts as the project leader and grant beneficiary of this project. BBSGR is engaged in EU-level adaptation initiatives; key linkages are summarised in Section 2.1.2.

**The region faces long-term demographic and socio-economic challenges**, including population ageing, youth outmigration, and structural unemployment, particularly in rural and marginalised areas. These factors contribute to lower economic performance and reduced adaptive capacity compared to other Slovak regions.

**Climate change is adding pressure to these existing challenges.** Several sectors in the region are particularly sensitive to climate-related impacts, including forestry and agriculture, water management, biodiversity, transport infrastructure, housing, tourism, and human and animal health.

**The high number of small municipalities, often operating with limited financial, technical, and administrative capacities,** highlights the importance of effective coordination at the regional level to support local adaptation efforts and ensure a more coherent approach to climate resilience.

## 1.2 Main objectives of the project

The overarching goal of the CLIMAAXInsight project remains consistent across all phases: to establish enabling conditions at the regional level for climate adaptation by delivering reliable, science-based climate risk assessments (CRA) that support evidence-based decision-making and climate risk management by **municipal authorities, regional stakeholders** and strengthen **citizens awareness**.

**Phase 2 was important for the BBSGR because it shifted the work from conceptual workflow testing (Phase 1) towards operationalisation and improved relevance for regional and local stakeholders.** The key added value out of Phase 2 is the integration of higher-quality datasets maintained at national level by competent Slovak public institutions and their processing for regional-scale analyses, combined with a systematic evaluation of their suitability within the CLIMAAX methodology. Phase 2 used **national datasets maintained by relevant competent Slovak institutions (e.g., the Slovak Water Management Enterprise and the Ministry of Interior of the Slovak Republic)** to produce more granular, context-specific outputs that better reflect regional exposure, vulnerability and priority needs, with a focus on floods and wildfires.

Phase 2 outputs primarily support three application areas:

1. **Refining regional policies:** strengthening the evidence base for future updates of key regional policy frameworks by providing decision-relevant risk analyses and spatial patterns at regional scale.

2. **Enhancing civil protection preparedness:** exploring how CRA outputs can inform preparedness and intervention capacity planning through closer cooperation with emergency and crisis-management actors.
3. **Raising awareness and cooperation:** improving communication of project outputs, collecting feedback, and fostering cooperation and synergies among stakeholders involved in climate adaptation.

**The CLIMAAX Handbook remains the primary methodological framework in Phase 2** and, together with the Jupyter Notebook–based workflows, ensures a transparent and reproducible CRA process while enabling efficient integration of nationally maintained datasets into a common methodology. This allows us to keep the analytical workflow consistent and directly compare results between Phase 1 (European datasets) and Phase 2 (national datasets), while also creating outputs that can be comparable across Slovak regions in the future if they adopt the same methodology and data inputs.

Use of national data helped to better understand, importance of data availability and quality, as well as added value and limitations of the CLIMAAX toolbox. Particularly when selecting data (for analysis or underlying location), defining the area of interest and level of detail (regional, vs. local) in relation to the specific aspects of CRA (hazard, exposure, vulnerability or risk assessment).

An additional benefit is the use of the "**Model bias and uncertainty**" dashboard, which supports a transparent assessment of systematic biases in regional climate models against observations (e.g., E-OBS, ERA5) and helps select more accurate model inputs for the analyses. Finally, implementation is further strengthened by the CLIMAAX service desk, which provides methodological and technical support related to the framework, workflows, datasets, and software.

Second phase also brought strengthening of the cooperation and knowledge transfer with other Slovakian regions and cities involved in the CLIMAAX cascade subproject schema. This was possible, thanks to voluntary initiative driven by the KAJO s.r.o. (SK SME company, a CLIMAAX consortium partner), organising regular monthly informal online meetups, creating the space for discussion of the issues and experience sharing.

Lastly, experience in interpretation and communication of the outcomes with the stakeholders helped the project team better understand importance of appropriate communication approach/strategy. That will have an impact on the final phase mainly in the way of adjustment of the presentation and dissemination of the outcomes achieved so far and identification of the measurements supporting further sustainability and innovations.

In overall, Phase 2 offered a robust analytical and cooperation foundation for subsequent phase, in which CRA results will be further interpreted with stakeholders and translated into recommendations and practical use in regional and local planning.

## 1.3 Project team

**The core team from Phase 1 remains central to project delivery.** Andrea Rúfusová continues to lead strategic planning, focusing on integrating climate risk outputs into regional policies. Martin Tuchyňa and Martin Jančovič have expanded their roles with identifying new data and technology resources, testing new options to improve communication and dissemination as well as customization and optimalisation of CLIMAAX workflows.

Since Phase 1, the team has gained experience in data interpretation, stakeholder engagement, and the development of interactive tools for communication. To ensure institutional ownership and effective dissemination, we coordinated communication activities with the BBSK Office's Communication Department and the Department of Environment and Spatial Planning. The project also has financial manager provided within the capacities of the BBSGR.

*Table 2 Updated CLIMAAXInsight project team*

| Name | Position | Skills and previous experience | Framework assessment | Climate hazards | Climate risk assessment | Data handling | Programming | Economy |
|---|---|---|---|---|---|---|---|---|
| Andrea Rúfusová | Strategic planning specialist | Knowledge on the understanding of climate risk in the region, along with expertise in the strategic framework design and implementation. | x | x | | | | |
| Martin Tuchyňa | Environmental and spatial data expert | Experience in geospatial and environmental data management, including climate risk assessments, | | x | x | x | | |
| Martin Jančovič | ICT and data analyst | Expertise in climate risk assessments, data processing, analytics and software coding. | | | x | x | x | |
| Lenka Hulinová | Financial management | financial management skillset, including budgeting, forecasting, grant/contract administration, financial reporting. | | | | | | x |

## 1.4 Outline of the document's structure

This deliverable provides an overview of Phase 2 of the CLIMAAXInsight project, emphasising the refinement and practical application of the climate risk assessment for the Banská Bystrica Region. **Chapter 1 (Introduction)** summarises the updated regional context (1.1), the objectives and significance of Phase 2 (1.2), and the project team (1.3). The core of the report is **Chapter 2 (Climate risk assessment)**, which follows the CLIMAAX CRA steps through Scoping (2.1), Risk Exploration (2.2) and Regionalized Risk Analysis (2.3), including advanced workflows for the priority hazards—floods and wildfires. The analytical outputs are synthesised in Key Risk Assessment Findings (2.4) and complemented by a structured assessment of data quality, added value, and remaining limitations and gaps, which are addressed throughout the report and summarised in the conclusions. Monitoring and Evaluation (2.5) and the Work plan for Phase 3 (2.6) outline progress since Phase 1 and define next steps. Overall summary comes with **Conclusions (Chapter 3)** and **Progress evaluation (Chapter 4)**, followed by **Supporting documentation (Chapter 5)** and **References (Chapter 6).** Communication activities are documented in an Annex 1, while additional technical outcomes (datasets, scripts, reports) are provided in the Annex 2 for transparency and verification. Where content remains unchanged from Phase 1, the report refers to Deliverable 1 rather than repeating detailed descriptions.

# 2 Climate risk assessment – Phase 2

**The Climate Risk Assessment (CRA) of the CLIMAAXInsight project was prepared and executed following the CLIMAAX Framework, taking into consideration the specific requirements and conditions of the Banská Bystrica region.** Building on the experience from Phase 1, the assessment in Phase 2 integrated nationally maintained datasets processed at regional scale and applied the workflow not only across the region, but also—where feasible—at a finer local scale through a pilot focus on the municipality of Sliač. This dual-scale approach helped to test the practical usability of outputs for local decision-making and implementation contexts. The Phase 2 work therefore focused on comparing the outputs between Phase 1 and Phase 2, assessing data quality, identifying remaining data gaps, and exploring how results can inform decision-making and implementation processes. These activities were supported by participatory processes involving relevant stakeholders.

## 2.1 Scoping

This part ensures a common understanding of the assessment framework and confirms the selection of priority climate hazards based on regional conditions and expert input. The focus was placed on advancing beyond the first phase of the project, building on previous findings and experiences; basic information regarding the initial phase can be found in Deliverable 1. In Phase 2, the scoping step placed stronger emphasis on integrating and evaluating nationally maintained datasets processed at regional scale, and on testing the practical usability of CRA outputs for regional and municipal decision-making (including a pilot local scale focus where feasible).

### 2.1.1 Objectives

**The objectives and purpose of the CRA remain unchanged from Deliverable 1:**

- To provide a solid evidence base for regional climate adaptation planning.
- To support policymaking, prioritization of investments, and stakeholder cooperation.
- To communicate climate risks and motivate action.

In Phase 2, the emphasis is on strengthening the regional applicability and usability of these outputs through improved data inputs and workflow implementation. To advance these objectives, Phase 2 focuses on the following CRA-related actions:

- **Leverage regional datasets** to produce CRA outputs in line with the CLIMAAX methodology, ensuring consistency and quality checks.
- **Identify and address data gaps and limitations** by collaborating with stakeholders and data providers to improve data quality and availability.
- **Deepen understanding of strategic planning and risk management processes** across multi-government level to enable effective integration of CRA outputs into future decision-making.

**Limitations and Boundaries – phase 2 status**

In Deliverable 1, we identified potential risks related to data availability, stakeholder engagement, and the decision relevance of outputs. During Phase 2, some of these risks materialized, and the following mitigation measures were applied:

**Data availability:** Access to selected datasets required formal data requests, which caused delays and increased the workload. These delays primarily affected *additional overlay analyses planned for Phase 3* (e.g., linking risk hotspots with response capacity or municipal project intentions) rather than the core CRA outputs produced in Phase 2. Where suitable, interim workarounds were applied (e.g., using historical wildfire data), and remaining data gaps and limitations were documented for follow-up with data providers.

**Stakeholder involvement:** While stakeholder consultations continued, limited time capacities for systematic output verification remain a constraint. This will be addressed through targeted follow-up discussions and validation steps in the next phase. A feedback mechanism via the Climate Hub has been prepared and will be activated once the outputs have been verified.

**Relevance of outputs:** The CLIMAAX methodology and workflows were applied consistently, and outputs underwent internal consistency and plausibility checks. No major issues affecting interpretability or practical use were identified at this stage; remaining limitations are primarily linked to data coverage, verification capacities and interpretation. Following table summarizes the risks, initial mitigation measures, and Phase 2 status:

*Table 3 Limitations and Boundaries for Our Climate Risk Assessment (CRA) – phase 2 status*

| *Risk and Constraints* | *Responsibility* | *Risk Management (Deliverable 1)* | *Phase 2 Status* |
|---|---|---|---|
| **Limited data availability and quality** | BBSGR project team | Conduct analysis to identify available data sources, engage providers, assess quality, and communicate needs. | Encountered delays due to formal data requests; applied workarounds (historical fire data). Gaps documented for Phase 3 discussions; core Phase 2 CRA outputs were not materially affected; delays mainly impacted planned Phase 3 overlays. |
| **Insufficient stakeholder involvement and public awareness** | BBSGR project team | Use communication channels, create webpage on Open Data Portal, provide interactive visualizations, and create feedback space. Early collaboration with Fire and Rescue Corps. | Organized pilot public event at *Zatváranie Bánoša*; positive feedback received. Limited stakeholder capacity for output verification remains unresolved; negotiations planned. Feedback mechanism prepared but pending activation. |
| **Limited relevance of outputs for selected hazards (fires and floods)** | BBSGR project team | Follow methodology strictly, use provided tools, consult helpdesk for emerging issues. | Methodology applied consistently; internal consistency/plausibility checks performed; no major issues identified. No significant relevance concerns raised during consultations; limitations mainly relate to data coverage and verification capacity. |

### 2.1.2 Context

**The conclusions and findings identified in Phase 1 regarding the regional climate adaptation context, governance challenges, and sectoral vulnerabilities were fully validated during Phase 2.**

The overall problem definition, institutional setting, and structural barriers related to climate risk assessment and adaptation remain essentially unchanged. To avoid repetition, this section focuses on (i) how the understanding of the system was deepened in Phase 2 and (ii) contextual developments that influence climate risk governance and the practical uptake of CRA outputs.

As noted in Deliverable 1, the region lacks a comprehensive, publicly available climate risk assessment and has so far relied mainly on national-level studies that provide generalised or high-level categorisations of risks for municipalities. A relevant example is the Institute for Environmental Policy (IEP) study *"Vedúci! Horia obce!" (Nánásiová et al., 2023)*, which identifies climate risk levels across Slovak municipalities but is not designed as an operational CRA tailored to regional planning workflows and decision contexts. Several partial studies and sector-specific models also exist, yet their accessibility and reusability for regional and municipal planning have been limited. As a result, many local actions have remained ad hoc and reactive, rather than systematically driven by forward-looking risk information. At the same time, Phase 2 took place in a shifting national context: new climate scenarios prepared by the Slovak hydrometeorological institute (SHMI) in 2025 are increasingly being interpreted and referenced in adaptation-related processes, strengthening the evidence base for long-term planning[2].

**Validation and deepening of understanding through Phase 2**

Phase 2 enabled a more refined and shared understanding of how the adaptation and risk management system functions in practice. Through structured stakeholder engagement, consultations, and joint discussions, key institutions confirmed the relevance of previously identified challenges and contributed to clarifying roles, competencies, and interdependencies across governance levels.

Rather than revealing fundamentally new issues, Phase 2 strengthened collective awareness of where climate risks are formally addressed, how responsibilities are distributed in practice, and where coordination mechanisms are weak or fragmented. This shared understanding provided the basis for the development of the organizational diagram presented in the following section, which maps the involved institutions and their competencies across strategic planning, risk management and preparedness, and implementation of measures.

**Integration of climate risks across governance levels and thematic areas**

The Phase 2 analysis confirmed that climate risk integration varies significantly across governance levels and thematic areas.

The Phase 2 analysis confirmed that **climate risk integration varies significantly across governance levels and thematic areas**. In strategic planning and policy, climate risks are formally recognised at national level through strategies and policy documents, but translation into sectoral policies and enforceable implementation mechanisms often remains limited. At regional level, the degree of integration depends on capacities, resources, and political prioritisation, which can result in fragmented approaches. At local level, municipalities typically address climate risks through spatial and development planning, but face persistent constraints related to data availability, funding, and technical expertise. Regarding **risk management and preparedness**, national institutions provide strong technical capacities, particularly in data provision, forecasting, and early warning. However, the system remains predominantly oriented towards response, and it is not yet

[2] https://klima-adapt.sk/scenare-buducej-klimy

systematically linked to long-term climate risk reduction and adaptation planning. Regional authorities play an important coordination role in crisis preparedness yet often lack dedicated analytical capacity and forward-looking risk information to anticipate future impacts. Municipal authorities and volunteer fire brigades focus primarily on immediate threats and emergency response, with limited capacity to incorporate future climate scenarios or cascading risks into preparedness planning. In terms of **implementation of measures**, national-level financial instruments and eligibility frameworks exist, but systematic monitoring and evaluation of adaptation effectiveness remains limited. At regional level, implementation is largely project-based—enabling piloting and innovation but often lacking continuity and strategic alignment. Local-level implementation is typically the most visible, driven by municipalities, NGOs, and community initiatives; however, significant disparities persist due to uneven capacities and access to resources.

**Relevant sectors and climate impacts**

The Phase 2 analysis confirmed that the most climate-sensitive sectors in the region remain largely unchanged since Phase 1. These include forestry and agriculture, water management, biodiversity and ecosystems, transport infrastructure, housing and urban development, tourism, and human and animal health. Climate change is expected to exacerbate pressures in these sectors through more frequent and intense droughts, floods, heatwaves, wildfires, and related cascading impacts. This reinforces the need for coordinated cross-sectoral adaptation approaches that account for interdependencies between natural systems, infrastructure, and socio-economic activities.

**Outside influences and evolving policy context**

Key external developments that may influence adaptation and climate risk governance include:

- **EU Mission on Adaptation:** BBSGR is a Charter signatory of the EU Mission on Adaptation to Climate Change (listed among signatories published in March 2023), which creates an EU-level cooperation and learning framework for accelerating resilience planning.
- **MIP4ADAPT technical assistance and pathway focus:** In line with the Mission engagement, BBSGR participated in the MIP4ADAPT technical assistance initiative, which supported reflection on adaptation governance set-up and helped identify priorities for strengthening implementation capacity—particularly around public communication and broader stakeholder engagement.
- **National adaptation policy process and climate scenarios:** National-level work on adaptation (including the use and interpretation of SHMÚ climate scenarios prepared in 2025) provides an important enabling backdrop for regional planning, even though open-data availability and practical guidance remain uneven.
- **Spatial planning and building construction reform:** Recent reforms increase expectations that climate risks and adaptation needs will be better embedded in spatial and land-use planning; impact will depend on municipal capacities and the availability of usable climate risk data and guidance. Similarly new building construction policy framework will influence the way future buildings and infrastructure developments take place. Potential climate change impacts therefore shall be carefully considered.

- **Political cycle and prioritisation:** Changes in political leadership at national or regional level may influence the continuity, ambition, and resourcing of adaptation policies and programmes.
- **Financing and absorption capacity:** Challenges in absorbing EU structural and investment funds may constrain the ability to mobilise resources for large-scale and long-term adaptation measures, despite the availability of funding instruments.
- **Civil protection system reform:** Ongoing reforms may redefine institutional roles and coordination mechanisms in disaster risk management and emergency response; implications for climate-related risks will depend on final scope and implementation.

**Towards a comprehensive resilience pathway**

Phase 2 confirms that effective adaptation in the region will require a **coherent resilience pathway rather than isolated measures**. Building on the CRA outputs, this pathway can progressively move from risk knowledge to planning and implementation through:

- Institutionalising risk knowledge: adopting a harmonised CRA approach and improving access to usable climate data.
- Mainstreaming into planning: embedding identified risk hotspots into spatial and sectoral planning processes.
- Strengthening preparedness: reinforcing early warning, preparedness and response planning informed by forward-looking risk information.
- Targeting investments: prioritising nature-based solutions and climate-resilient infrastructure, including water retention and runoff management.
- Enabling delivery: strengthening capacities at municipal and regional level and improving coordination across governance levels to sustain long-term risk reduction and adaptation action.

### 2.1.3 Participation and risk ownership

**Organigram of stakeholders and responsibilities**

In Phase 2 of the CLIMAAX project, we built on the foundations established in Phase 1 by deepening the analysis of how the regional adaptation and risk management system functions in practice. The analysis was structured around three thematic areas:

- **strategic planning and policy,**
- **risk management and preparedness,**
- **implementation of measures**.

To ensure a shared and practice-based understanding of institutional roles and linkages, the stakeholder mapping in Phase 2 followed a participatory and iterative approach. It combined analytical review with targeted consultations, bilateral meetings and workshop-style discussions, during which key institutions discussed and validated their roles, responsibilities and interconnections across governance levels. The main output of this process is the **organigram** presented below.

The organisational chart (Figure 1) provides an overview of the relevant stakeholders, the distribution of responsibilities, and interactions between institutions at **national, regional and local** levels across the three thematic areas. It also distinguishes stakeholders that actively engaged in Phase 2 CLIMAAX-related activities. The organigram applies a consistent **multi-level governance logic**, reflecting that each governance level fulfils a distinct yet complementary function within the overall adaptation and risk management system.

*(Broader stakeholder engagement activities in Phase 2 are summarised in Section 2.1.5, while stakeholder feedback and validation related to CRA outputs are reported in Section 2.4.1.)*

| | **STRATEGIC PLANNING & POLICY**<br>*→ What are the long-term policy and planning objectives?* | **RISK MANAGEMENT & PREPARADNESS**<br>*→ What risk exist, and how we prepare and respond?* | **IMPLEMENTATION of MEASURES**<br>*→ What measures are implemented in practice?* |
|---|---|---|---|
| NATIONAL LEVEL | • **Ministry of Environment** (National adapatation strategy and policy framework; monitoring, methodological guidance, and coordination at national level)<br>• **Slovak water management** (Providing hydrological data, modelling, and expert input for strategic and regional adaptation planning.) | • **Ministry of Interior** (Civil protection and crisis managment governance, coordination of fire and rescue services)<br>• **Slovak Hydrometeorological Institute** (Climate and hazard data provision, forecasts and early warnings) | • **Ministry of environment** (Oversight of environmental adaptation projects; strategic investments and funding allocation)<br>• **Ministry of interior** (National funding, legislative framework, and support for civil protection implementation) |
| REGIONAL LEVEL | • **Banska Bystrica Self-Governing Region** (Integration of climate risks into regional strategies; stakeholder coordination and facilitation) | • **Regional Security Council** (Advisory and coordination role in regional risk management and crisis preparedness)<br>• **Regional Directorate of Fire and Rescue Servies** (risk assessment and preparedness planning, coordination of emergencyresponse operations)<br>• **District Offices** (Crisis planning and coordination at district level; supervision of municipal preparedness and response)<br>• **Slovak Water Management** (Flood risk planning and management at basin and regional level; operation of flood protection infrastructure.) | • **BBSGR** (Regional coordination of adaptation investments, pilot projects, and alignment with regional strategies) |
| LOCAL LEVEL | • **Municipalities** (Local development and spatial planning; integration of climate risks and adaptation measures into municipal strategies and plans) | • **Municipalities** – municipal risk management: creation and implementation of flood and emergency plans, local risk preparedness and crisis management, as well as warning and protection of the local population.<br>• **Voluntary fire brigades** (Local prevention and first response; support to state fire and rescue units)<br>• **State firefighters corps** (Emergency response to extreme events; protection of population and critical infrastructure)<br>• **Slovak water management** (Operational cooperation with municipalities and district offices on localized flood preparedness, response, and technical interventions.). | • **Municipalities** (Local implementation of adaptation and preventive measures; community engagement and risk communication)<br>• **Slovak water management** (Implementation and maintenance of flood protection infrastructure and water management measures)<br>• **Forestry** (Implementation of forest adaptation, erosion control, wildfire prevention, and nature-based solutions)<br>• **NGOs/Community Organisations** (Awareness raising, support to vulnerable groups, and local capacity building)<br>• **Local population** (Exposure to climate risks, participation in local initiatives, and contribution of local knowledge) |

*Figure 1 Organisational diagram of stakeholders and responsibilities.*
*Figure source: CLIMAAX Insight Phase 2*

**Organization of risk ownership in the region**

Risk ownership in the region follows a functional division of responsibilities across governance levels, reflecting the multi-level structure of the adaptation and risk management system.

- **Risk identification** is primarily supported by national and regional institutions responsible for data provision, monitoring and expert assessments (e.g., climate, hydrological and hazard information), in cooperation with regional and municipal authorities that contribute location-specific knowledge and operational experience.
- **Risk assessment** combines national-level methodologies and frameworks with regional-scale analyses (e.g., basin-level or territorial assessments) and local-level risk considerations embedded in municipal planning and emergency preparedness processes.
- **Risk mitigation and risk management** responsibilities are shared across levels: national authorities provide strategic direction, legal frameworks and funding mechanisms; regional actors coordinate and help prioritise actions across territories; and municipal authorities and operational actors implement concrete risk reduction and adaptation measures on the ground.

In practice, this distribution of responsibilities is reflected in established planning and preparedness instruments (e.g., municipal emergency preparedness planning and flood risk management arrangements) and in operational response planning coordinated through professional and voluntary fire services.

**Relevant stakeholders representing vulnerable groups and exposed areas**

Vulnerable groups and exposed areas identified in the CLIMAAXInsight project build on the detailed vulnerability analysis conducted in Deliverable 1, which focused on the priority hazards of river floods and wildfires. That analysis identified population groups, economic sectors, and assets with increased sensitivity and lower adaptive capacity, and it provides the baseline for interpreting CRA outputs in Phase 2.

Across the region, key vulnerable groups include **older adults and persons with limited mobility**, **children**, and **low-income households**, whose vulnerability is driven by health sensitivity, mobility constraints, and limited capacity to recover from climate-related impacts. In addition, **visitors such as tourists and hikers** represent a specific exposed group, particularly in flood-prone and fire-prone areas, due to limited familiarity with local risks and evacuation procedures. From an economic and occupational perspective, **farmers**, **forestry workers**, and other **outdoor workers** operating in floodplains or near fire-prone areas are exposed to both direct physical risks and potential livelihood losses. **Emergency responders**, including professional and voluntary fire brigades, constitute a priority group due to their direct exposure during response operations. Finally, **critical infrastructure and essential services** (e.g. transport networks, water supply, energy and communication systems) represent highly exposed assets with cascading impacts on communities when disrupted.

In practice, these vulnerable groups and exposed areas are primarily represented through **municipal authorities**, which are responsible for local risk management and emergency planning, as well as through **sectoral institutions**, **public service providers**, **non-governmental and community-based organisations**, and **volunteer structures** that work directly with affected populations. In Phase 2, this understanding was used to support the interpretation of CRA outputs and to frame stakeholder discussions on risk relevance, preparedness, and prioritisation, while further validation and targeted engagement with vulnerable groups are planned for Phase 3.

**Information on acceptable and tolerable levels of risk**

**Information on acceptable or tolerable levels of climate-related risk is currently available in a fragmented manner, primarily through sector-specific standards, technical norms, emergency thresholds, and crisis management procedures.** These instruments provide operational reference points for managing specific hazards, but they do not constitute a comprehensive, explicitly defined framework for acceptable climate risk at the regional level.

As a result, decisions regarding acceptable or tolerable risk are often made implicitly within planning, investment, and emergency management processes, rather than through a unified regional risk tolerance framework. **For wildfires, risk tolerance is operationalised mainly through short-term emergency thresholds.** In Slovakia, a *"time of increased fire danger"* may be declared at district level for the whole district or part of it, triggering preventive restrictions in forests and their protective zones (e.g. limitations on activities involving open flame), and in extreme situations also temporary restrictions on public access to forests.

**A similar approach applies to flood risk**, where acceptable or tolerable risk is implicitly defined through the declaration of flood activity levels and flood emergency situations. These are triggered based on hydrological thresholds and forecasts and activate predefined response measures and responsibilities. While such mechanisms are essential for emergency response and crisis management, they primarily address short-term conditions and do not replace a strategic, forward-looking definition of acceptable risk levels for long-term adaptation planning.

Addressing this gap represents an important opportunity for strengthening evidence-based adaptation planning and risk governance, to which the CLIMAAX project aims to contribute.

### 2.1.4 Application of principles

**Social justice, equity, inclusivity**
The analysis of vulnerable groups remained in its original scope. In this phase, however, we strengthened participation by organizing a public event that enabled broad public involvement. On the Climate Hub platform, we have prepared a feedback mechanism that will be activated after the verification of CRA outputs; the page is not yet communicated to the public. Preparation of the communication assets to ensure equal access to the project results. Communication of the project results via various events to diverse communities (conference, public event, domain specific experts).

**Quality, rigour, transparency**
The analysis is carried out according to the same CLIMAAX methodology as in Deliverable 1. In this phase, we published the first outputs on the Climate Hub platform[3] as open data, plus shared openly all results from the first phase via Zenodo platform[4]. Transparency was enhanced by adding metadata descriptions to the initial datasets in cooperation with the Ministry of environment of Slovak republic[5], ensuring clear identification of sources, scope, and limitations. All data is managed according to internal data management standards established by the regional

[3] https://klima.opendata.bbsk.sk/pages/projekty-climaax
[4] https://zenodo.org/records/17085537
[5] https://rpi.gov.sk/metadata?full_text=po%C5%BEiare

authority, which are aligned with higher-level national and EU relevant policies and recommendations.

**Precautionary approach**
We continue to use RCP4.5 and RCP8.5 scenarios, and recommendations include preventive measures even for moderate risk levels. The “better safe than sorry” approach remains the foundation—favouring solutions that reduce risk despite data uncertainties.

### 2.1.5 Stakeholder engagement

Stakeholder engagement in Phase 2 was designed to support the implementation of the Climate Risk Assessment (CRA) by facilitating access to relevant data, increasing awareness of the project objectives and intermediate results, and preparing the ground for the interpretation and future uptake of outputs. The engagement activities built on the stakeholder mapping and risk ownership analysis described in Section 2.1.3 and followed a differentiated approach tailored to institutional stakeholders, experts, municipalities, and the wider public.

Engagement during Phase 2 combined analytical work with targeted communication and interaction through multiple channels, including:

- **Bilateral meetings and consultations** with key institutional partners, focusing on data availability, data requirements, and potential use of CRA outputs.
- **Workshops, conferences, and inter-regional exchanges**, where BBSK presented preliminary analyses, the CLIMAAX methodology, and intermediate results.
- **Internal communication** within the regional administration, primarily through the Viva Engage platform, to clarify project goals, share progress, and identify opportunities for cross-departmental cooperation.
- **Public communication and outreach**, including public events and social media, aimed at translating technical content into accessible messages and testing public interest and perceptions.

An overview of the main stakeholders engaged in Phase 2, the type of engagement, the immediate outputs, and the planned next steps is provided in Table 3. Detailed documentation and evidence of all communication and dissemination activities (including dates, formats, and materials) are included in the Annex 1.

*Table 4 An overview of the main stakeholders engaged in Phase 2, the type of engagement, the immediate outputs, and the planned next steps.*

| Stakeholder | Type of participation/communication | Output phase 2 | Next step (phase 3) |
|---|---|---|---|
| Ministry of environment of SR | Workshop | Mutual information sharing on the National Adaptation Strategy preparation process and on the CLIMAAXInsight project at the regional level | Alignment of regional activities with the national level, use of national-level outputs, and coordination of further steps in line with the objectives and measures of the National Adaptation |

| | | | |
|---|---|---|---|
| | | | Strategy (responsible BBSGR) |
| Ministry of interior of SR | Bilateral meetings, email communication | Project information sharing; provision of data on historical wildfires, synergies with the PCP WISE project[6] | Closer cooperation on the risk management agenda; alignment of activities with the national level; provision of feedback on the relevance of the data for the Climate Risk Assessment (CRA), support of resilience via PCP WISE SK use cases |
| Slovak Water Management | Bilateral meeting, email communication | Project information sharing; provision of data on flood hazard and risk zones | Further discussion on practical applications of outputs and harmonisation with national-level hydrological modelling |
| Regional Security Council | Not yet engaged | - | In Phase 3, presentation of project outputs, particularly results and recommendations related to risk management |
| Regional Directorate of Fire and Rescue Services | Bilateral meetings | Memorandum of cooperation on preparedness; identification of datasets to be provided in Phase 3 | Cooperation on recommendations for optimisation of intervention and response capacities (Phase 3 output) |
| Municipalities | Building on the outcomes of an existing activity focused on the collection of project ideas related to the preparation and implementation of the EU structural funds programme. | Identification of needs through the collection of project intentions | Direct involvement in verification of outputs, collection of empirical data on climate risks, awareness raising, and mapping needs related to implementation |
| NGOs | Not yet engaged | - | Planned engagement in Phase 3, particularly in awareness raising and community-level activities |

[6] https://pcp-wise.eu

| | | | |
|---|---|---|---|
| Public | Social media, public event | Positive feedback; results of public voting on perceived climate risks | Broader awareness-raising campaign and organisation of additional public event |

Stakeholder engagement in Phase 2 primarily served the following purposes:

- Supporting the **integration of nationally maintained datasets** into the CRA workflow.
- Increasing **institutional and stakeholder awareness** of climate risks and the CLIMAAX approach.
- Identifying **needs, expectations, and constraints** related to the practical use of CRA outputs.
- Preparing conditions for **more targeted interpretation and validation of results** in the subsequent project phase.

Several **challenges** were encountered during the engagement process, including:

- Variability in data availability and formats across institutions.
- Capacity constraints limiting stakeholders' ability to engage continuously.
- The technical complexity of climate risk analyses, requiring tailored communication and translation into practical language.
- The need to balance internal, expert-level, and public communication within limited resources.

Despite these constraints, Phase 2 engagement activities established a solid foundation for continued cooperation and for the further use of CRA outputs in strategic planning, preparedness, and adaptation-related discussions.

Detailed stakeholder feedback and validation of the CRA results are reported in 2.4.1 Mode of engagement for participation.

## 2.2 Risk Exploration

**Floods and wildfires were identified as the key climate risks in the first phase of the project and remained unchanged during the second phase of the Climate Risk Assessment.** Their prioritisation was based on their severity and urgency, supported by empirical evidence and available data, as well as on the potential to build on existing institutional capacities and established cooperation mechanisms in the field of risk management.

The selection of risks was further informed by consultations with stakeholders involved in crisis and risk management, ensuring that the assessment reflects both observed impacts and practical experience from the field. Additional background and methodological details are provided in Deliverable 1.

**The continued relevance of the prioritised risks was underscored by the occurrence of extreme events during the second phase of the project**, including a large-scale wildfire in the Low

Tatras[7]and flood events observed in November 2025[8]. Although not analysed as case studies, these events provided important real-world context and highlighted the ongoing exposure of the region to the selected hazards.

### 2.2.2 Screen risks (selection of main hazards)

Compared to the first deliverable, **no new climate-related hazards** were identified in the Screen risks step. The results of Phase 1 confirm that the originally identified hazards and associated risks remain relevant and a priority for the region.

**Accordingly, the Climate Risk Assessment in Phase 2 continues to focus on river floods and wildfires**, which are both observed and expected to pose significant risks to the community and the region, as also indicated by available climate projections and European-scale evidence, including the Copernicus Climate Atlas.

To reflect the continuity with Phase 1 while improving the assessment using higher-quality, localized data, the following hazard-specific **workflows were applied in Phase 2**:

River floods:
1.1. River Floods - River flooding

1.2 River floods - Flood building damage and population exposure

Wildfires:
2.1. Wildfire (ML approach)

2.2 Wildfire FWI

These workflows support a more detailed and locally relevant analysis of the selected hazards and provide a stronger basis for risk management and adaptation planning.

### 2.2.3 Choose Scenario

**The relevance of the RCP4.5 and RCP8.5 climate scenarios remains consistent from Phase 1 through Phase 2, as these scenarios continue to best represent the plausible climate futures for our region.** The RCP4.5 scenario supports short- and medium-term planning with moderate emission reductions and a focus on enhancing adaptation capacities, which is crucial for our region. The RCP8.5 scenario serves as a warning for vulnerable areas, reflecting a more severe future with more frequent and intense extreme weather events. This approach aligns with the findings and recommendations of the SHMI, which recognizes these scenarios as the most appropriate for national-level climate risk assessments. While newer, regionally tailored climate scenarios have been developed for Slovakia, they are not yet publicly available or integrated into our methodology. We therefore rely on the provided RCP4.5 and RCP8.5 scenarios to ensure continuity, comparability, and robustness of our risk assessments across project phases. This consistent use facilitates effective tracking of climate risk trends over time and supports adaptive management planning. Moreover, our methodology remains flexible to incorporate updated scenarios as soon as they become accessible.

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[7] https://translate.google.com/translate?sl=sk&tl=en&u=https://spravy.stvr.sk/2024/08/lesny-poziar-na-horehroni-sa-hasicom-v-piatok-nepodarilo-uhasit/

[8] https://spectator.sme.sk/politics-and-society/c/news-digest-severe-flooding-hits-banska-bystrica-region-after-heavy-rain-and-melting-snow

**In addition, based on regional data, we adjusted the workflow's return periods for hydrological events to better reflect local conditions.** Specifically, we now consider 10-year, 100-year, and 1000-year return periods for flood events, which aligns with the regional hydrological risk profiles and improves the relevance and accuracy of our climate risk assessments.

## 2.3 Regionalized Risk Analysis

In Phase 2, the workflows were refined using national data to ensure that the results are relevant for regional and local decision-making. At the same time some workflows were optimised in order to improve their usage and configuration.

The analysis considers both current and future risk conditions, combining climate projections with available socio-economic information. This section outlines how the selected workflows were adapted, which datasets were used in Phase 2, and which new or refined risk outputs were produced. It also highlights key data limitations and uncertainties relevant for interpreting the results. Detailed dataset overviews are provided in the tables below, while visual materials are included selectively to support the assessment.

### 2.3.1 Hazard #1 - River Floods - River flooding[9]

This workflow is designed to help in exploring the regional risks presented by fluvial flooding (river flooding) and assessing the impact of climate change on these risks.

*Table 5 Data overview for workflow River Floods - River flooding*

| *Hazard data* | *Vulnerability data* | *Exposure data* | *Impact metrics/Risk output* |
|---|---|---|---|
| SK Flood hazard and risk map 2023[10] | Damage Curves for land use | LUISA - Different land use classes | SK Flood hazard and risk map 2023, Comparison of flood depth maps between the future and historical climates, Flood damage map |

**Flood hazard and risk maps in Slovakia 2023** were developed primarily for larger rivers and their catchment areas and exposed areas, in accordance with the EU Floods Directive. However, detailed and high-precision flood maps for smaller watercourses and tributaries are not fully covered. This coverage constraint implies that regional-scale results primarily represent flood risk along major rivers, while local flood risks linked to smaller tributaries may be underrepresented.

Therefore, Phase 2 results should be interpreted as a best-available evidence base for strategic prioritisation, complemented by local knowledge and additional hydrological detail where needed. It is important to note that the data are provided by the official national authority, the Slovak Water Management Enterprise, which has the highest level of expertise regarding flood-prone areas in Slovakia. While smaller watercourses are not comprehensively mapped, the dataset remains the most reliable officially endorsed source for national-scale flood risk assessments.

[9] https://handbook.climaax.eu/notebooks/workflows/FLOODS/02_River_flooding/FLOOD_RIVER_intro.html
[10] https://mpt.svp.sk/svp_vmapportal Slovak Water Management Enterprise (State Enterprise)

For the assessment, predefined datasets derived from OpenStreetMap, CORINE Land Cover, population rasters, etc. were used, as no more suitable, harmonised local datasets were available for implementation within the workflow. Even if local or regional land-use datasets were available, their structure, classification schemes, and overall data quality would not be compatible with the workflow requirements. While such datasets could theoretically be used, their integration would require substantial modifications to the scripts and would significantly increase computational and development workload.

Consequently, all key input datasets recommended by CLIMAAX were adopted, including HDP, return-period water levels, historical fires, etc., to ensure consistency, robustness, and reproducibility of the workflow.

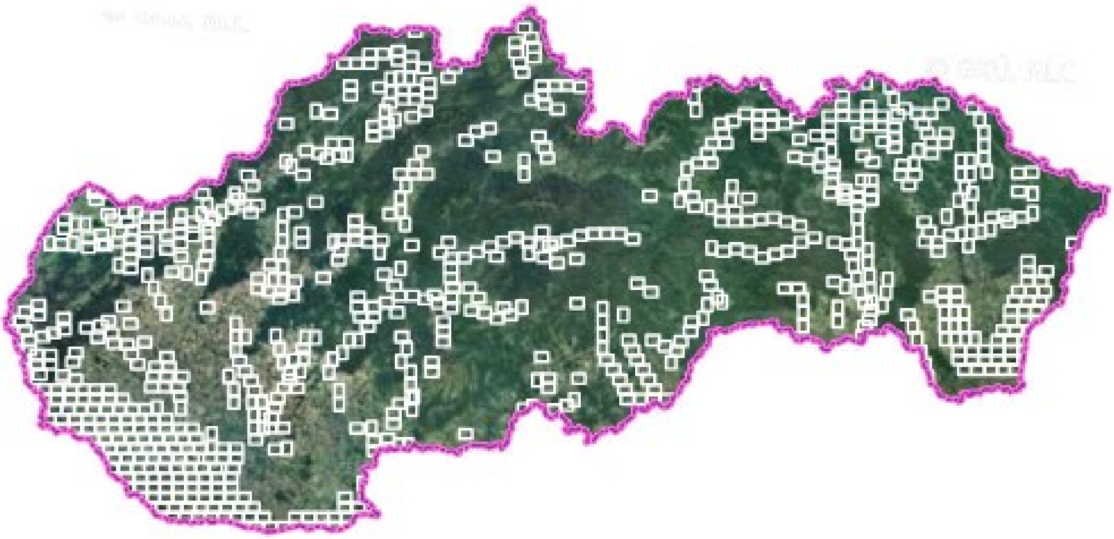

*Figure 2 Coverage of SK Flood hazard and risk map 2023*
*Figure source: Webový mapový portál SLOVENSKÉHO VODOHOSPODÁRSKEHO PODNIKU, štátneho podniku Používateľská príručka*11

**During Phase 2, we adjusted the return periods used in our workflows to better align with national hydrological data.** While this adjustment has partially reduced the comparability of results with Phase 1, it has significantly improved the relevance and accuracy of flood risk assessments for our regional context. Specifically, we adopted the 10-year, 100-year, and 1000-year return periods, which are standard for flood risk evaluation in Slovakia.

These return periods serve different purposes:

- The **10-year return period** represents more frequent, smaller-scale flood events and is useful for assessing local and short-term flood risks.
- The **100-year return period** is the standard reference for medium-scale floods and is commonly used for regional flood risk management and spatial planning.
- The **1000-year return period** covers rare, extreme flood events and supports long-term strategic planning and preparedness for worst-case scenarios.

[11] https://mpt.svp.sk/svp_vmapportal/manual_TIS.pdf

Using these standardized return periods allows for a consistent approach to flood risk assessment and facilitates the integration of findings into regional and local planning documents. This adjustment enhances the applicability of our analyses to local conditions and supports more effective decision-making for climate adaptation and civil protection.

In addition, where relevant 2 main levels of detail were used during this Phase 2 for floods related assessments, with aim to highlight the strengths and limitations of the workflows as well as used datasets:

- Regional – whole BB region (scale cca 1:50 000), taking into consideration wider regional scope.
- Local – Sliač city (scale cca 1:10 000), reflecting details related with application practice, as well as taking into the consideration recent floods taking place during the end of November 2025.

The dual-scale approach was selected to serve two complementary purposes: (i) at the regional scale, outputs **can** support strategic prioritisation and comparison across the territory; (ii) at the local scale (Sliač), outputs are used as a pilot to **explore** whether the workflow results are sufficiently detailed and interpretable for municipal planning and practical risk communication. This approach is intended to help distinguish whether differences between Phase 1 and Phase 2 are primarily driven by data resolution/coverage or reflect genuine spatial risk patterns, and it provides a basis for more targeted validation and usability testing in Phase 3.

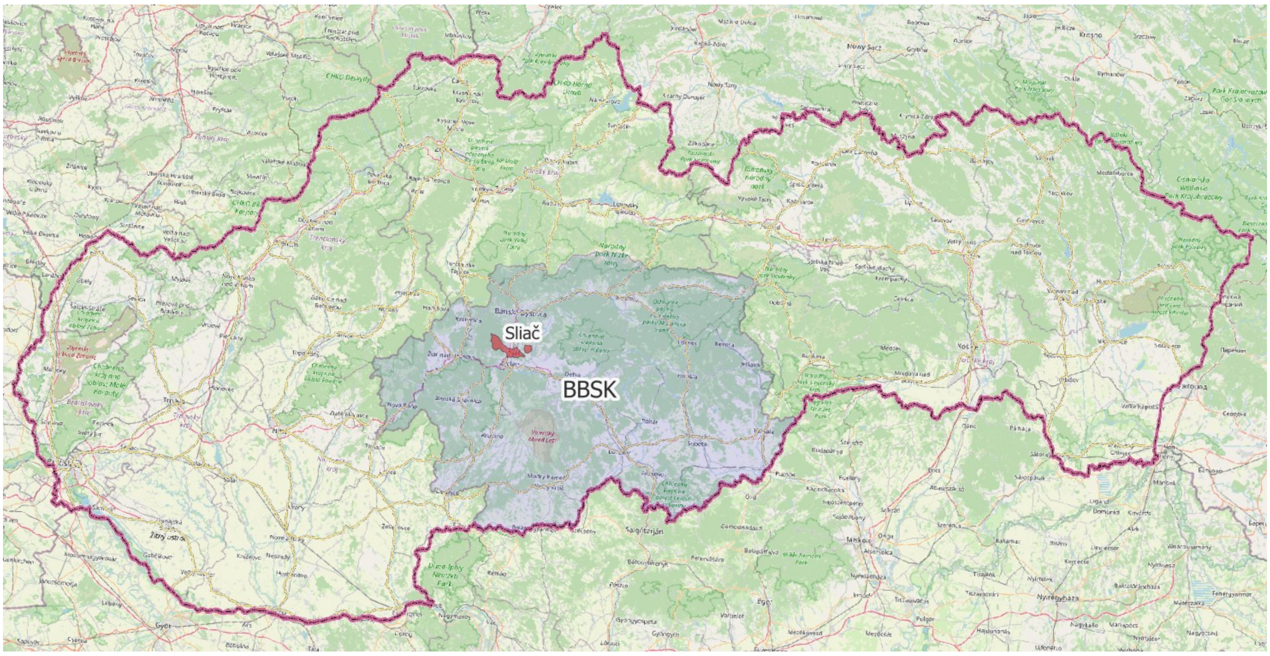


*Figure 3 Location of Banská Bystrica region and Sliač city within the Slovakia*
*Figure source: CLIMAAX Insight Phase 2*

#### 2.3.1.1 Hazard assessment

For the hazard assessment for river flooding, flood hazard maps from Phase 2 were compared with the Phase 1 results. At the regional scale, this was done using the river flood potential under the present scenario for 3 selected return periods (Figures 4 and 5).

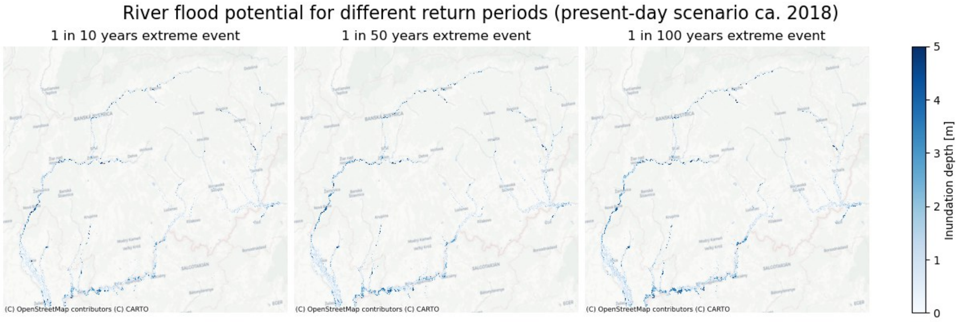


*Figure 4 River flood present scenario for return periods 10, 50 and 100 years with EU data from Phase1*
*Figure source: CLIMAAX Insight Phase 2*

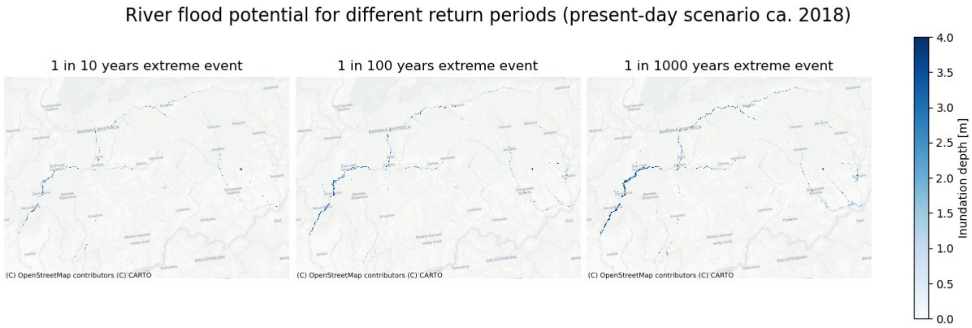


*Figure 5 River flood present scenario for return periods 10, 100 and 1000 years with SK data from Phase2*
*Figure source: CLIMAAX Insight Phase 2*

In Phase 2, the national SK Flood hazard and risk map 2023 dataset was used. Compared to the European-scale dataset applied in Phase 1, the national dataset covers fewer water bodies but provides higher spatial precision and more reliable inundation depth information for the mapped river sections. As a result, differences between Figures 4 and 5 should be interpreted primarily as a coverage–precision trade-off rather than a direct change in hazard intensity across the entire territory.

The added value of the national dataset for Phase 2, can be identified on local. scale. In the pilot area of Sliač, Phase 2 outputs provide a more detailed representation of flood extent and depth patterns, and they delineate flood-prone areas more comprehensively than the European-scale results (Figures 6 and 7). This suggests that the higher-resolution national mapping captures local flood pathways and inundation features that may be smoothed or underrepresented in European-scale datasets. At the same time, quantitative comparisons should consider differences in dataset coverage and available return periods.

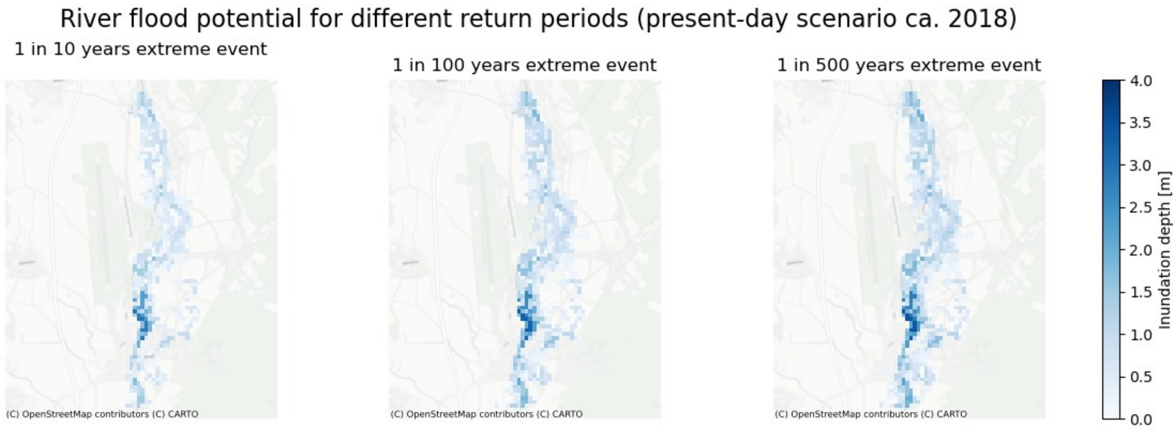


*Figure 6 River flood present scenario for return periods 10, 100 and 500 years with EU data at Sliač location from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

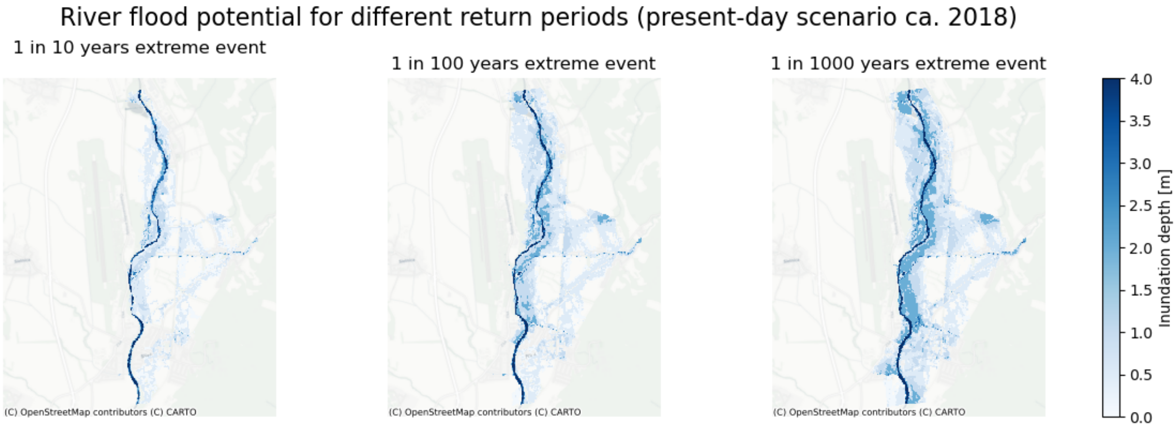


*Figure 7 River flood present scenario for return periods 10, 100 and 1000 years with SK data at Sliač location from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

In connection with the assessment of the impact of climate scenarios on river flood hazard, a comparison of flood inundation depth maps for different future time horizons (2030, 2050, and 2080) under the high-emission RCP8.5 scenario was performed (Figure 8). These results were compared with outputs from Phase 1. The scenarios applied in Phase 1 and Phase 2 were identical, as the Aqueduct input datasets did not change between the phases and the same RCP8.5 emission scenario was used throughout.

As indicated by the plots, the informational and practical value of these outputs is limited for decision-support at regional and local scales. This can also be interpreted as a consequence of the workflow scripts not being optimized for analyses at such a large spatial scale, and the way scenario-driven changes are visualized may reduce interpretability. This limitation should therefore be taken into account when selecting appropriate visualizations for communicating the results to relevant stakeholders, and these outputs should be treated as exploratory.

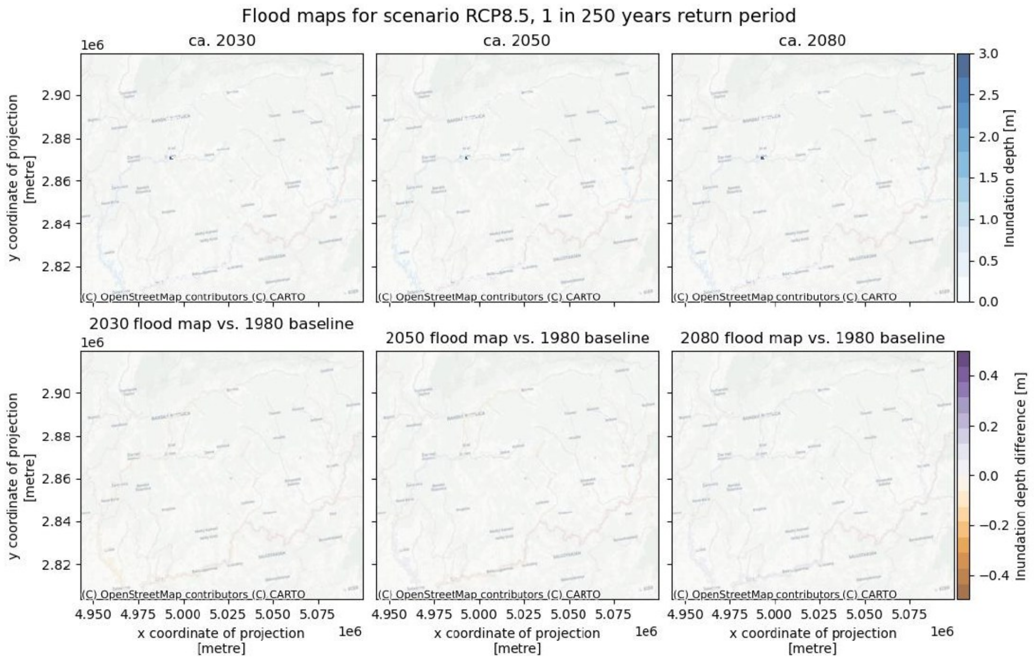


*Figure 8 River flood future scenarios for RCP 8.5 in 250 years return period for 2030, 2050 and 2080 with EU data from Phase 1 and 2*
*Figure source: CLIMAAX Insight Phase 2*

Figure 9 also helps to demonstrate the difference between baseline and scenario-based modelled outputs. Upper set of plots shows modelled flood (via inundation depth in meters) for three different time periods (2030, 2050 and 2080), whilst the lower set of plots provides a difference in inundation depth between the baseline flood in 1980 and modelled floods for the same time periods. In this case the interpretation is not straightforward for results in first two plots in lower set, where despite the RCP8.5 scenario, results show decrease of the floods depth (2030 and 2050).

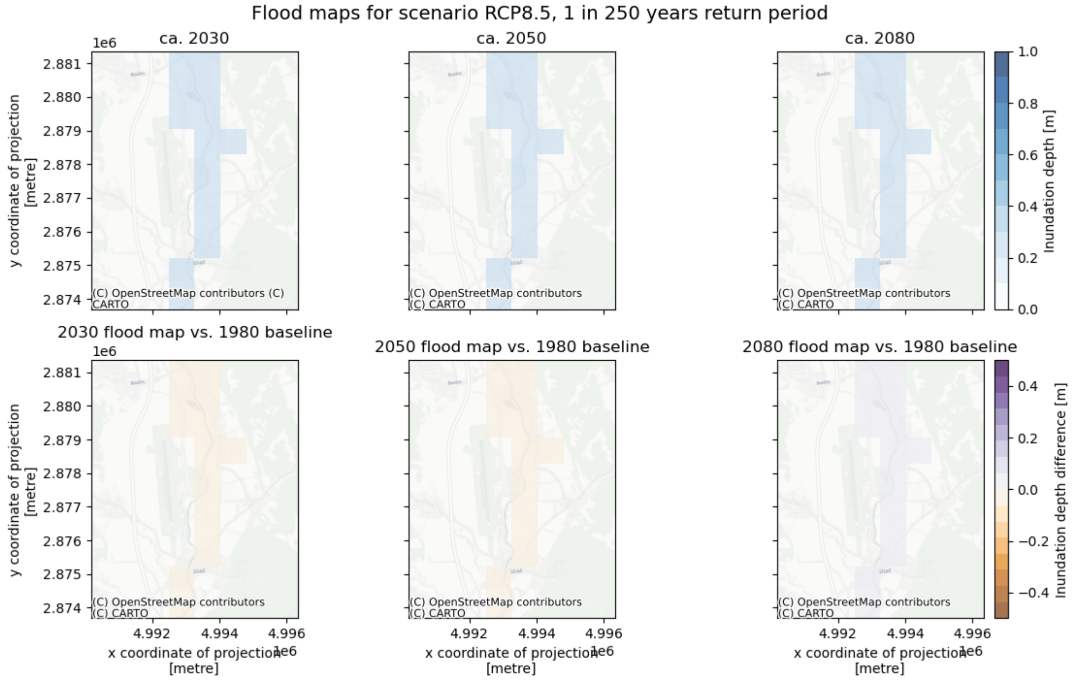


*Figure 9 Flood maps for different years and comparison with baseline situation under the RCP8.5 scenario for Sliač city*
*Figure source: CLIMAAX Insight Phase 2*

#### 2.3.1.2 Risk assessment

Similarly, risk assessment for this workflow was executed with SK Flood hazard and risk map 2023 datasets with aim to demonstrate how the **level of spatial detail and coverage** affects damage estimates at regional and local scales. The analysis focused on potential damage to build infrastructure by river (fluvial) flooding.

Following the workflow logic, after the calculation of the potential economic damage to the infrastructure, results were plotted as on regional as well as local scale. It is again important to bear in mind that comparing the first phase results national SK Flood hazard and risk map 2023 datasets were covering smaller area, therefore results must be interpreted accordingly. We also had to consider some differences in the return periods available in the national datasets. When comparing Phase 1 and Phase 2 results at the regional scale, the overall damage magnitude appears lower in Phase 2 (Figures 10 and 11). **However, this difference should primarily be interpreted in light of the lower spatial coverage of the national flood maps and differences in available return periods, rather than as a direct indication of reduced flood risk across the entire region.**

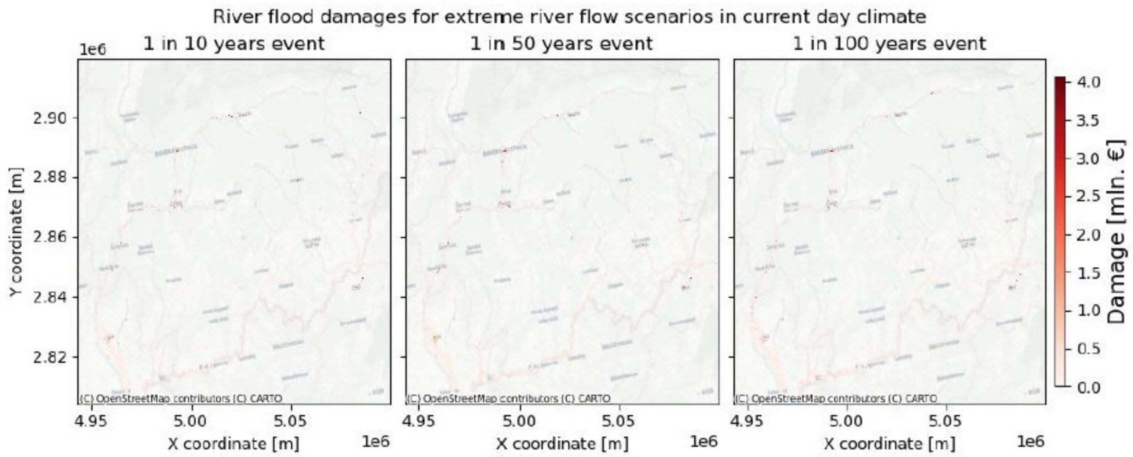


*Figure 10 Overview of estimated river flood damages for whole BB region for return periods 10, 50 and 100 years with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

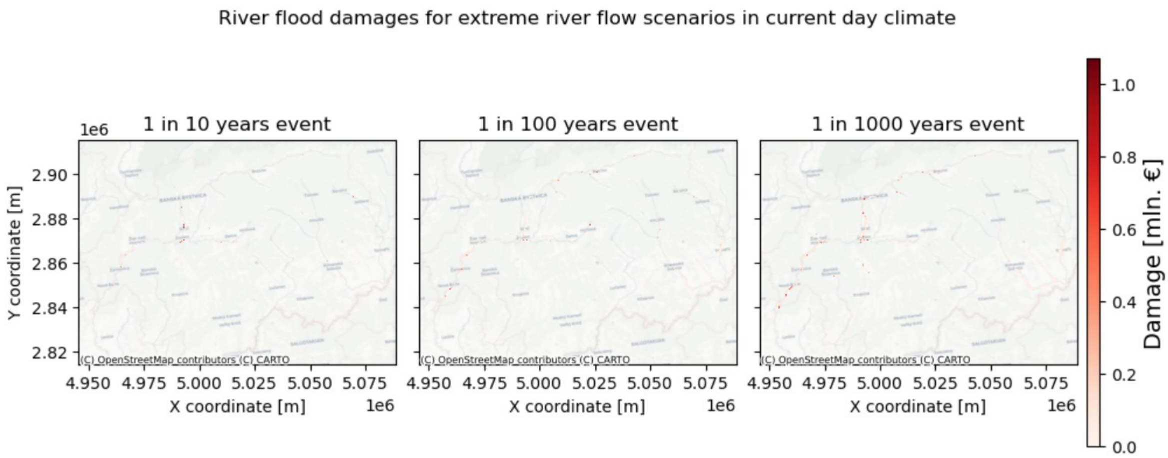


*Figure 11 Overview of estimated river flood damages for whole BB region for return periods 10, 100 and 1000 years with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Much clearer results can be observed on local scale (Figures 12 and 13), where damages calculated using national data provide more precise spatial distribution / location of the areas with the highest damage potential. Particularly the extend of the damages seems to be wider from Phase 2, where visually affected area is larger comparing the plots from the Phase 1 as on northern part of the Sliač city as well as on the eastern and southern side of the city. The scale of the damage remains the same across both phases. **This suggests that higher-resolution hazard inputs better capture local inundation pathways and their intersection with exposed land-use types, improving interpretability for municipal risk prioritisation.**

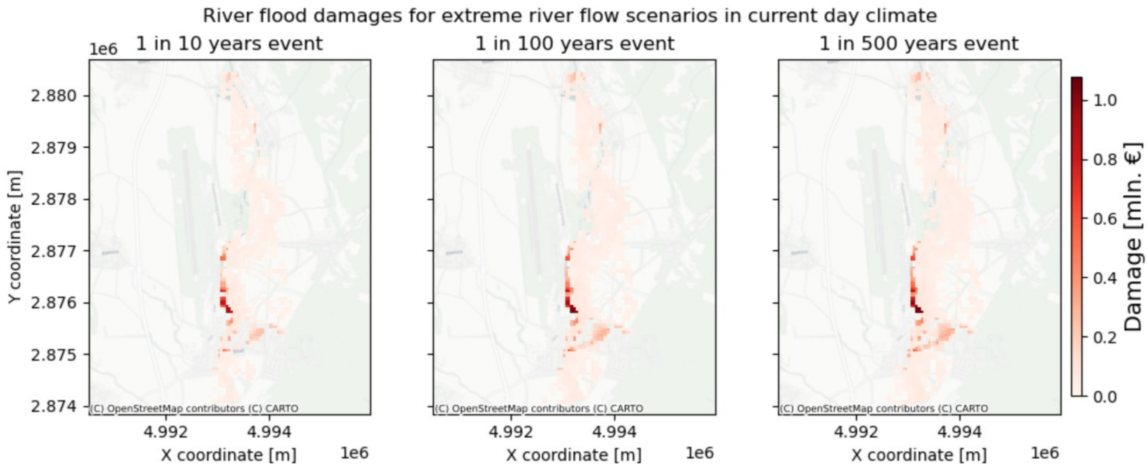


*Figure 12 Overview of estimated river flood damages for whole Sliač city for return periods 10, 100 and 500 years with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

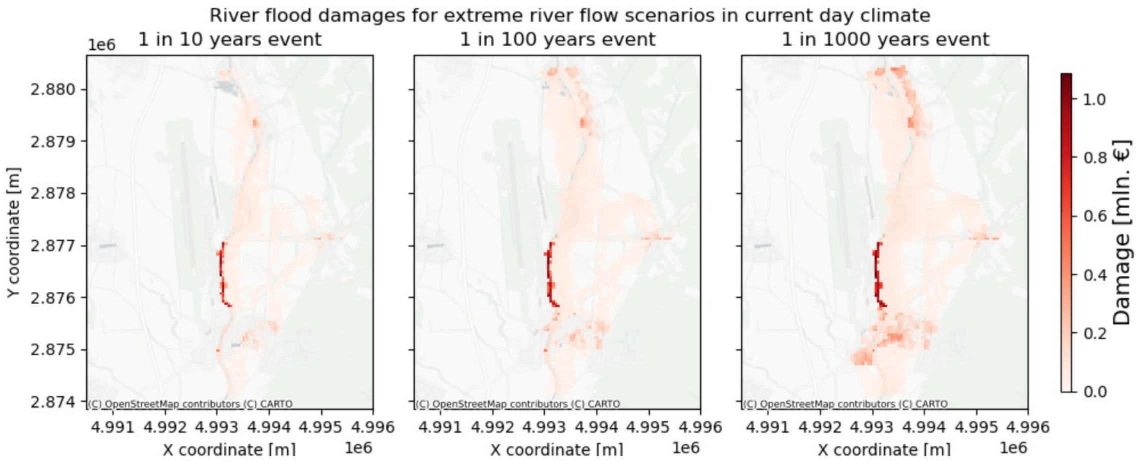


*Figure 13 Overview for estimated river flood damages for Sliač city for return periods 10, 100 and 1000 years with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

To better understand why some areas, experience more damage than others, next set of plots provides an overlay with flood depth maps and LUISA land cover map for a given return period for regional and local scale. Here you can better see how important level of detail is, as mainly on local level the flood damage location and size are clearly visible including the relevant land use type (Figures 14 and 15).

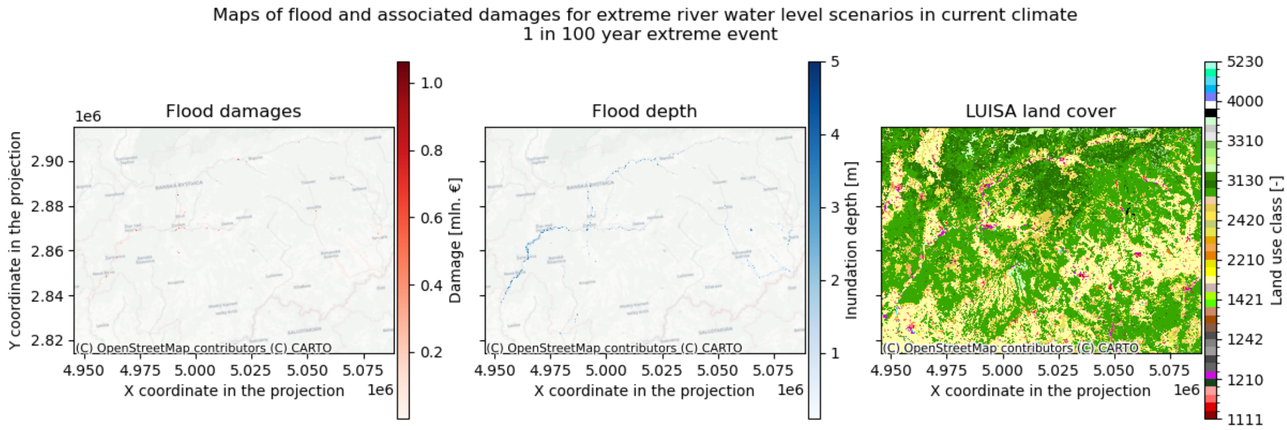


*Figure 14 Flood damages, flood map depths and land cover for whole BB region and the return period 100 years with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

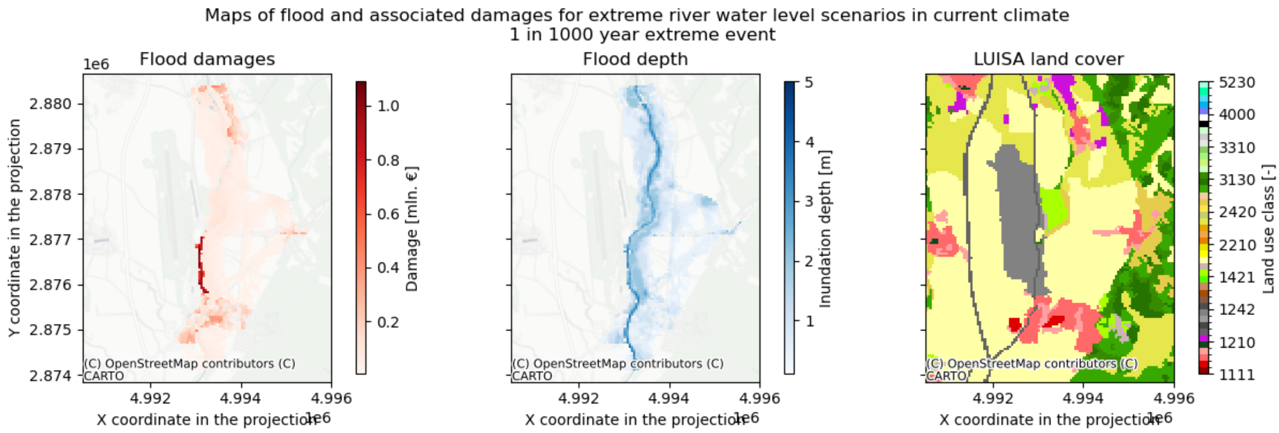


*Figure 15 Flood damages, flood map depths and land cover for Sliač city and the return period 1000 years with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Final type of outcomes from risk analysis is a tabular comparison of **potential damage for land use categories**. Despite the slight differences in return periods across the phases and limitations related to the lower spatial coverage of the SK Flood hazard and risk map 2023 datasets, overall estimated damages from Phase 2 appear lower (Tables 5 and 6). This is primarily due to the lower spatial coverage of the national flood hazard maps: **where hazard layers are not available, potential damages cannot be estimated** and therefore do not appear in the results. Differences in land-use/exposure data may further influence absolute damage estimates **within the mapped areas**. Precision might be improved with wider coverage of national flood hazard and risk related datasets, as well as more detailed and accurate local land use/exposure data (if available), which would most likely require further adaptation/modification of the workflow.

*Table 6 Damage calculations for selected return periods and relevant land cover types from Phase 1*

Risk_assessment_FLOOD_RIVER

| | Description | RP10 | RP50 | RP100 | RP200 | RP500 |
|---|---|---|---|---|---|---|
| **2110** | Non irrigated arable land | 4012.177325 | 4967.331782 | 5297.183071 | 5591.344333 | 5940.859109 |
| **1210** | Industrial or commercial units | 1356.503125 | 1627.076529 | 1729.689712 | 1810.305956 | 1916.161514 |
| **2310** | Pastures | 853.191097 | 1001.596281 | 1047.798654 | 1089.091142 | 1136.031044 |
| **2430** | Land principally occupied by agriculture | 686.330382 | 789.394808 | 822.211747 | 848.718429 | 881.534839 |
| **1122** | Low density urban fabric | 545.681755 | 703.227158 | 766.019319 | 818.656364 | 874.364377 |
| **1123** | Isolated or very low density urban fabric | 226.759401 | 277.012132 | 292.978144 | 308.810242 | 326.722081 |
| **3210** | Natural grassland | 212.442107 | 250.950487 | 262.908397 | 273.551656 | 284.247103 |
| **1221** | Road and rail networks and associated land | 154.206913 | 186.707165 | 199.114967 | 209.008843 | 222.437999 |
| **1121** | Medium density urban fabric | 105.724063 | 139.429272 | 152.335722 | 164.663972 | 179.286927 |
| **4000** | Wetlands | 86.226330 | 101.826745 | 107.649238 | 111.557524 | 116.453303 |

*Table 7 Damage calculations for selected return periods and relevant land cover types from Phase 2*

| | Description | RP10 | RP100 | RP1000 |
|---|---|---|---|---|
| **2110** | Non irrigated arable land | 584.613739 | 1272.899630 | 1761.366745 |
| **1210** | Industrial or commercial units | 254.658158 | 625.979137 | 1183.857144 |
| **1122** | Low density urban fabric | 138.941157 | 360.336878 | 652.339785 |
| **2430** | Land principally occupied by agriculture | 359.158994 | 507.406807 | 604.912893 |
| **1123** | Isolated or very low density urban fabric | 73.875774 | 160.763697 | 240.984570 |
| **1121** | Medium density urban fabric | 26.943423 | 99.351822 | 183.413532 |
| **2310** | Pastures | 64.060535 | 106.404211 | 147.076294 |
| **1221** | Road and rail networks and associated land | 43.860748 | 77.800764 | 108.852420 |
| **1241** | Airport areas | 31.121323 | 38.904443 | 44.553997 |
| **1111** | High density urban fabric | 0.911384 | 11.488621 | 36.699213 |

### 2.3.2 Hazard #2 River floods - Flood building damage and population exposure[12]

This workflow aims at assessing how floods affect built-up areas by looking at economic damage represented by building damage, impact on critical infrastructures (such as hospitals, water tower, etc.), as well as the impact on the population by estimating the number of people exposed to the flood hazard and the number of people displaced by it.

*Table 8 Data overview for workflow River floods - Flood building damage and population exposure*

| *Hazard data* | *Vulnerability data* | *Exposure data* | *Impact metrics/Risk output* |
|---|---|---|---|
| SK Flood hazard and risk map 2023 | Damage Curves | Open Street Maps (OSM),<br>Population density GHS-POP R2023A | Building flood exposure maps, building damage maps and estimated annual building damage graph, Critical infrastructure map combined with the flooded area, Maps of exposed population and estimated annual exposed population graph, Maps of displaced population and estimated annual displaced population graph. |
| | | | |

#### 2.3.2.1 Hazard assessment

Hazard assessment was again the same one as in previous workflow River Floods – River flooding. Hazard assessment follows the same flood extent/depth hazard layers and return periods as in Workflow 2.3.1, using the SK Flood hazard and risk map 2023 dataset.

#### 2.3.2.2 Risk assessment

Within this workflow, we were trying to use the SK Flood hazard and risk map 2023 datasets similarly on both regional and local scale, respecting the differences in scope as well as return periods. As you can see in Figures 16 and 17 on regional level differences between Phase 1 and 2

12 https://handbook.climaax.eu/notebooks/workflows/FLOODS/03_Flood_damage_and_population_exposure/Risk_workflow_description_FLOOD_BUILDING_POPULATION.html

in estimated damages are quite significant (in Phase 2 estimates are substantially lower - almost one third comparing the Phase 1). This is most likely driven by the lower spatial coverage of the national flood hazard maps and differences in return periods, rather than indicating a uniform reduction in flood risk across the region.

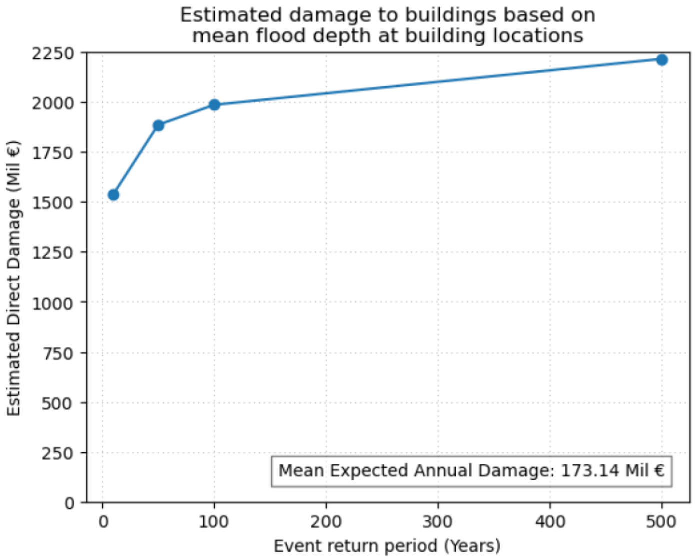


*Figure 16 Building damages vs return periods of the flood maps & mean expected annual damage on BB region level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

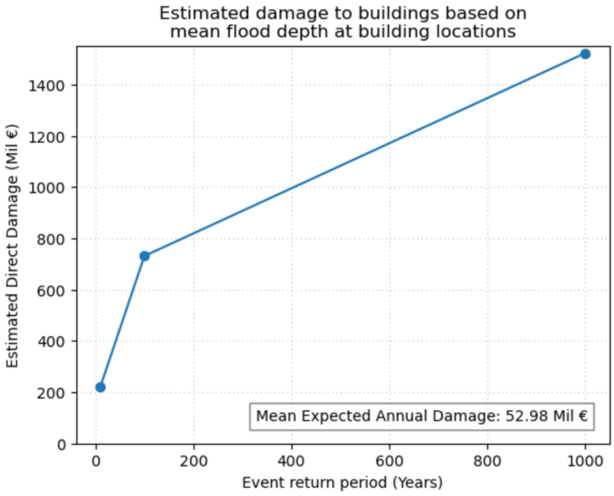


*Figure 17 Building damages vs return periods of the flood maps & mean expected annual damage on BB region level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Closer results come on local level, where based on the outcomes in Figures 18 and 19, we can see more similar level of estimated direct damages as the spatial coverage is smaller and considering the fact SK national data are more precise, estimations from the Phase 2 might be more reliable.

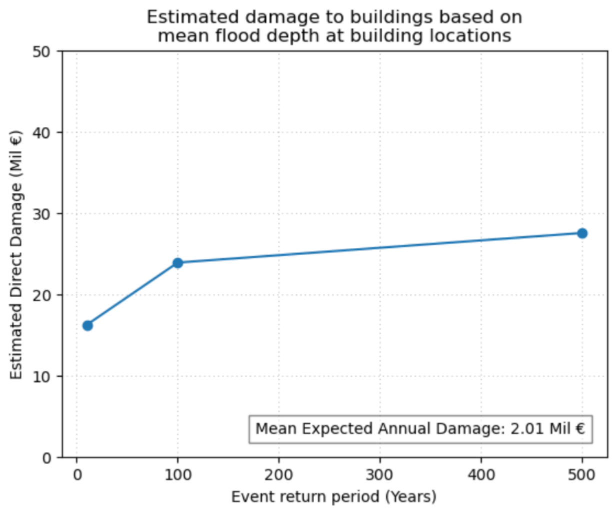


*Figure 18 Building damages vs return periods of the flood maps & mean expected annual damage on Sliač city level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

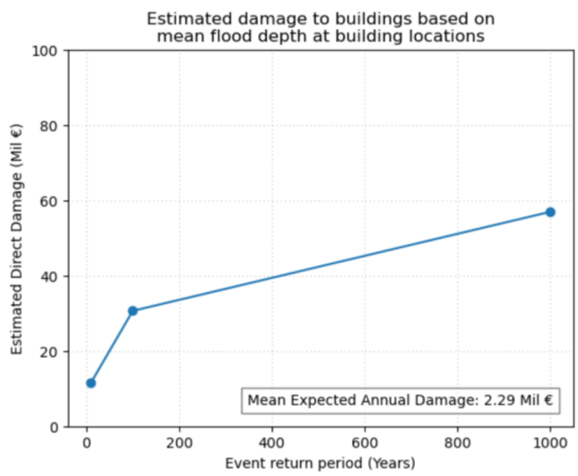


*Figure 19 Building damages vs return periods of the flood maps & mean expected annual damage on Sliač city level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Similarly in tabular representation of the total damage reflecting the building classification results from second phase on regional level indicate lower costs than from Phase 1 (Tables 8 and 9). Main impact remains on universal building class with reduced costs mainly on commercial buildings.

*Table 9 Total damage for the BB region with EU data from Phase 1*

| Building Class | 10-yr | 50-yr | 100-yr | 500-yr |
|---|---|---|---|---|
| Residential | 88 873 640 € | 108 927 292 € | 115 193 097 € | 128 175 816 € |
| Commercial | 152 569 387 € | 185 538 821 € | 191 182 607 € | 207 211 265 € |
| Industrial | 87 466 283 € | 108 724 138 € | 116 338 412 € | 127 596 066 € |
| Universal | 1 209 530 683 € | 1 482 624 436 € | 1 563 395 484 € | 1 753 087 964 € |
| Total | 1 538 439 994 € | 1 885 814 687 € | 1 986 109 600 € | 2 216 071 112 € |

*Table 10 Total damage for the BB region with SK data from Phase 2*

| Building Class | 10-yr | 100-yr | 1000-yr |
|---|---|---|---|
| Residential | 12 020 087 € | 37 496 636 € | 95 749 624 € |
| Commercial | 6 556 910 € | 31 271 346 € | 102 032 252 € |
| Industrial | 9 834 317 € | 56 259 406 € | 108 776 656 € |
| Universal | 192 349 134 € | 606 200 626 € | 1 215 975 853 € |
| Total | 220 760 448 € | 731 228 013 € | 1 522 534 384 € |

Local scale again provided more balanced results, where total costs are much closer across the return periods as well as according to the covered building classes. Again, universal building class remains dominant, but the building classes proportion remains more equal in both phases (Tables 10 and 11). Interesting is higher level of the damages from Phase 2 in 100 years return period compared to 10 years, which might be caused by the larger amount of the buildings covered by the SK national data.

*Table 11 Total damage for the Sliač city level with EU data from Phase 1*

| Building Class | 10-yr | 100-yr | 500-yr |
|---|---|---|---|
| Residential | 2 193 880 € | 2 788 081 € | 3 112 484 € |
| Commercial | 787 933 € | 1 148 343 € | 1 295 814 € |
| Industrial | 105 003 € | 362 834 € | 568 129 € |
| Universal | 13 138 817 € | 19 597 757 € | 22 571 371 € |
| Total | 16 225 634 € | 23 897 015 € | 27 547 798 € |

*Table 12 Total damage for the Sliač city level with SK data from Phase 2*

| Building Class | 10-yr | 100-yr | 1000-yr |
|---|---|---|---|
| Residential | 1 435 907 € | 2 485 665 € | 8 083 222 € |
| Commercial | 213 889 € | 733 425 € | 1 110 438 € |
| Industrial | 105 308 € | 3 276 615 € | 6 068 338 € |
| Universal | 9 784 225 € | 24 152 572 € | 41 718 313 € |
| Total | 11 539 329 € | 30 648 277 € | 56 980 311 € |

In comparison of the spatial visualization of the building damages between the Phase 1 and Phase 2, main difference is visible in the range of the damage bar on the right side of the maps, where results from Phase 2 indicates lower amount of damages. Anyway, the interpretability of damage intensity at the regional scale is limited due to the wide value range and map scale (Figures 20 and 21).

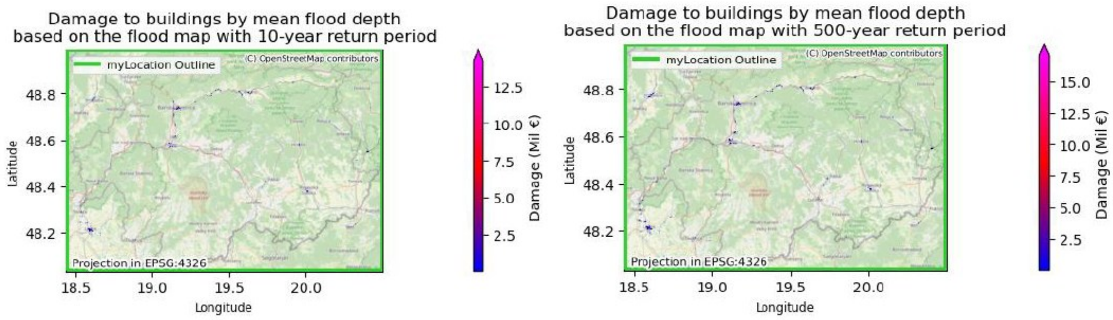


*Figure 20 Map visualization of the economic damage to buildings on BB region level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

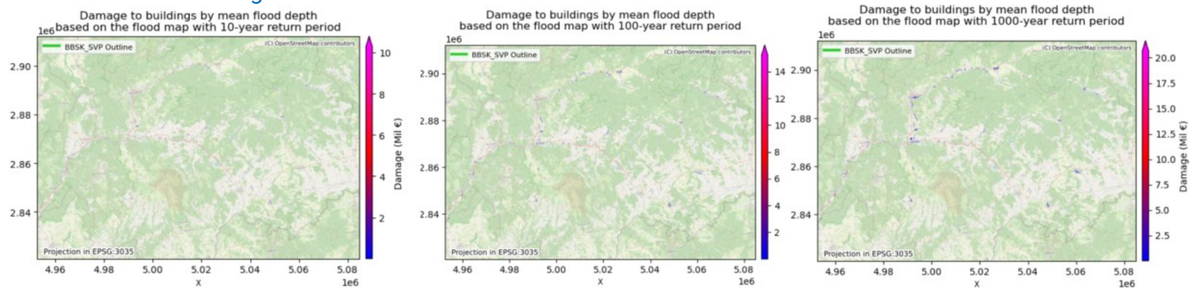


*Figure 21 Map visualization of the economic damage to buildings on BB region level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Likewise, also on local level in case of Sliač city, the extend of damages seems to be lower with the results from Phase 2 with slightly better visual recognition of the impacted location (Figures 22 and 23). Results might be improved towards the future with another underlying map background.

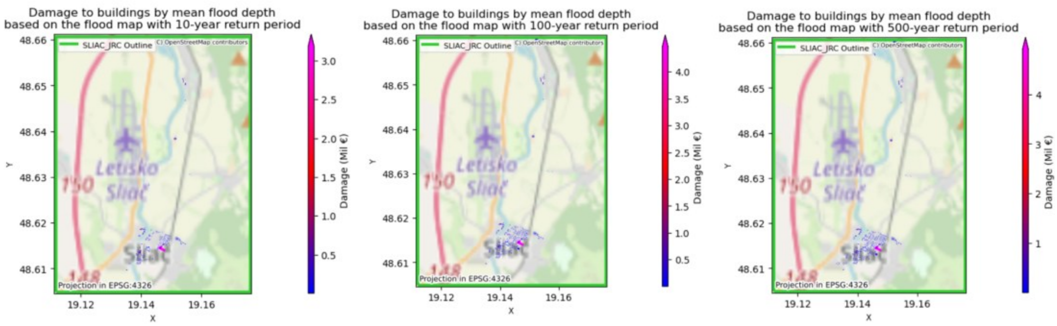


*Figure 22 Map visualization of the economic damage to buildings on Sliač city level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

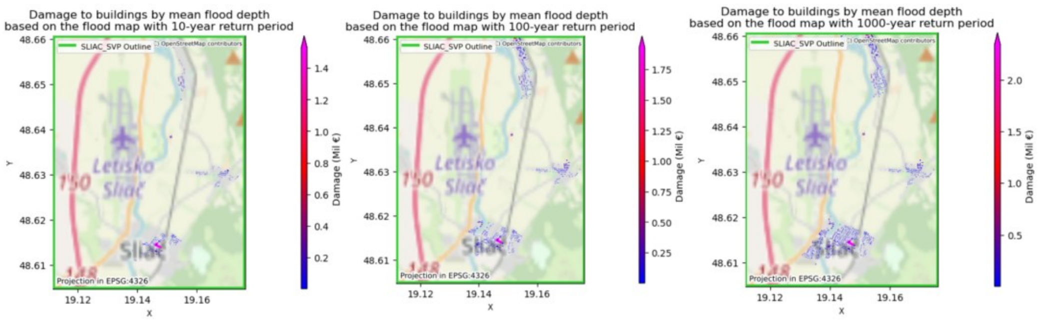


*Figure 23 Map visualization of the economic damage to buildings on Sliač city level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Following set of tables provides an **overview of exposed population** on average in any given year, based on the flood depth maps. Here the outcomes initially provided quite opposite results as in case of regional as well as local scale higher number of exposed people was calculated from the results of Phase 2. During **quality control** with the same values for Exposed population as well as

Displaced population, where the values were same, workflow script has been analysed. During this analysis, a **raster resolution mismatch in the local input data was identified**, as the basic workflow script was designed to operate with a fixed 3 arc-second raster resolution. The script did not allow proper adjustment to locally used datasets with different spatial resolution, which led to incorrect results. After applying the necessary fixes and enabling adaptation to local data resolution, the workflow delivered more realistic outcomes (Tables from 2-9 to 2-14).

**Fixed scripts are available in Annex 2 of this report.**

*Table 13 Exposed population for the BB region with EU data from Phase 1*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 83303 |
| 50 | 95472 |
| 100 | 99915 |
| 500 | 106697 |

*Table 14 Exposed population for the BB region with SK data from Phase 2 before correction*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 183588 |
| 100 | 467501 |
| 1000 | 850901 |

*Table 15 Exposed population for the BB region with SK data from Phase 2 after correction*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 12879 |
| 100 | 32796 |
| 1000 | 59692 |

*Table 16 Exposed population for the Sliač city level with EU data from Phase 1*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 818 |
| 100 | 1488 |
| 500 | 1613 |

*Table 17 Exposed population for the Sliač city level with SK data from Phase 2 before correction*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 17817 |
| 100 | 35705 |
| 1000 | 58854 |

*Table 18 Exposed population for the Sliač city level with SK data from Phase 2 after correction*

| Flood event return period (years) | People Exposed |
|---|---|
| 10 | 1129 |
| 100 | 2263 |
| 1000 | 3730 |

Last tabular set of outcomes provides information about the displaced population, representing the calculated expected number of people displaced on average per year. This information was also subject of script fixing and following tables provide the amounts after the corrections (Tables from 18 to 21).

*Table 19 Displaced population for the BB region with SK data from Phase 1*

| Event Return Period (years) | People Exposed |
|---|---|
| 10 | 39452 |
| 50 | 47857 |
| 100 | 49852 |
| 500 | 54975 |

*Table 20 Displaced population for the BB region with SK data from Phase 2*

| Event Return Period (years) | People Displaced |
|---|---|
| 10 | 3588 |
| 100 | 8067 |
| 1000 | 16610 |

*Table 21 Displaced population for the Sliač city level with EU data from Phase 1*

| Event Return Period (years) | People Displaced |
|---|---|
| 10 | 238 |
| 100 | 406 |
| 500 | 496 |

*Table 22 Displaced population for the Sliač city level with SK data from Phase 2*

| Event Return Period (years) | People Displaced |
|---|---|
| 10 | 64 |
| 100 | 156 |
| 1000 | 334 |

Next type of workflow outcomes depicts **exposure of the critical infrastructure** for the regional and local scale. As in case of region, there were no visual differences between Phase 1 and 2, we keep for reference critical infrastructure exposure on regional level (Figure 24).

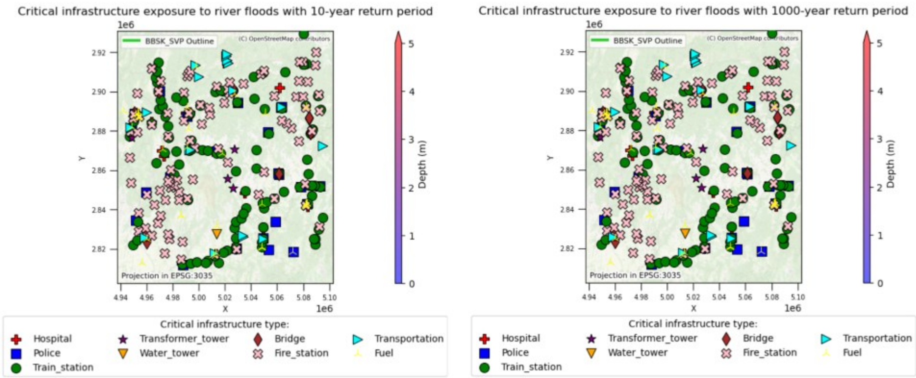


*Figure 24 Exposure of critical infrastructure in BB region with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

On local level, visual experience becomes more tangible. Also indicated flood depths sound more realistic. Outcomes from Phase 2 provides more precise spatial distribution of potentially impacted infrastructure (Figures 2-25 and 26).

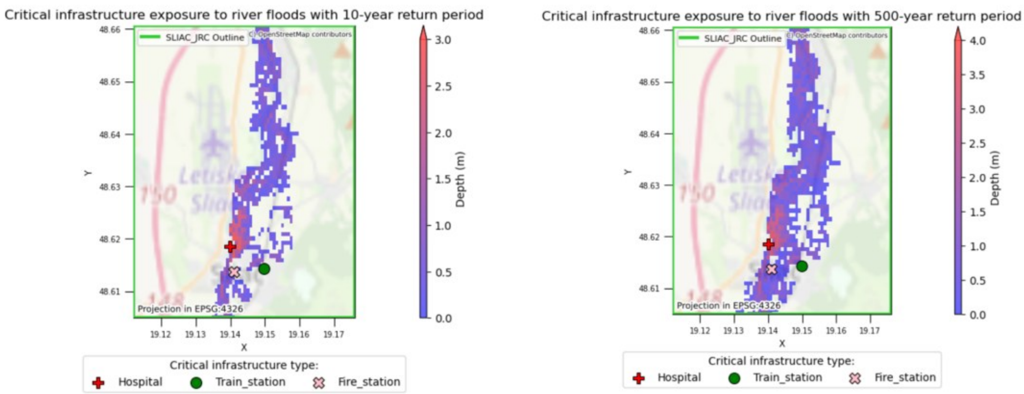


*Figure 25 Exposure of critical infrastructure on Sliač city level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

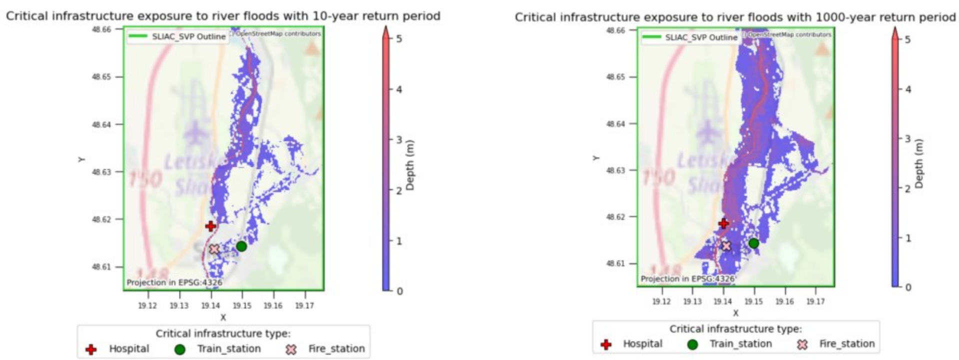


*Figure 26 Exposure of critical infrastructure on Sliač city level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Final type of graph representation of the risk outcomes provides an overview of estimated exposed and displaced population across the scales and phases. Whilst on regional level, Phase 2 delivered much sober expected total and annual amounts of exposed and displaced people, local results in Phase 2 delivered slightly increased amounts of exposed people (Figures from 27 to 30).

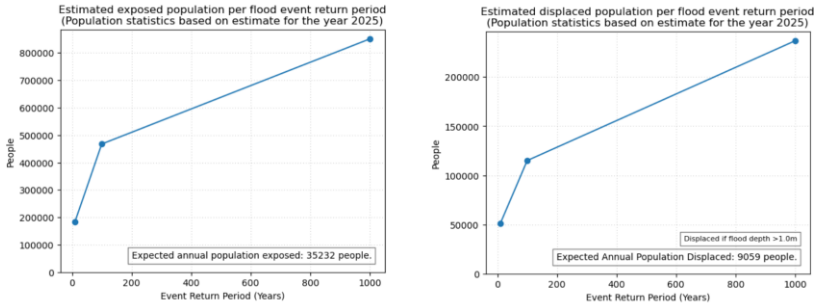


*Figure 27 Exposed and displaced population in BB region with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

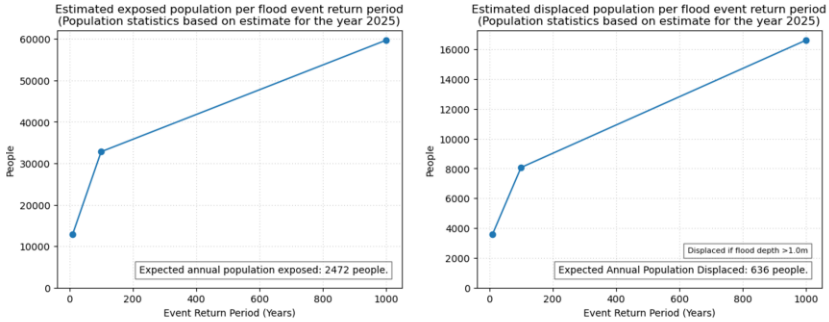


*Figure 28 Exposed and displaced population in BB region with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

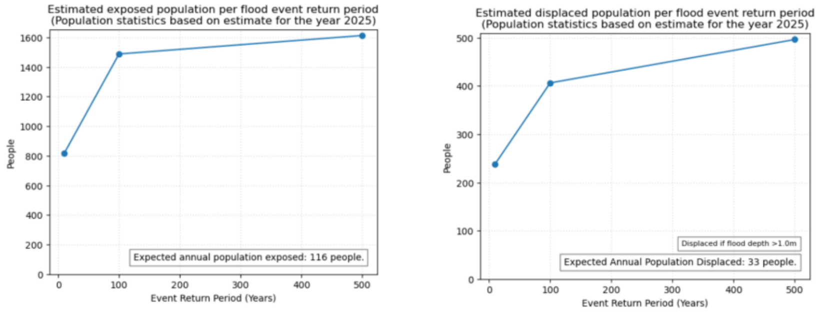


*Figure 29 Exposed and displaced population on Sliač city level with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

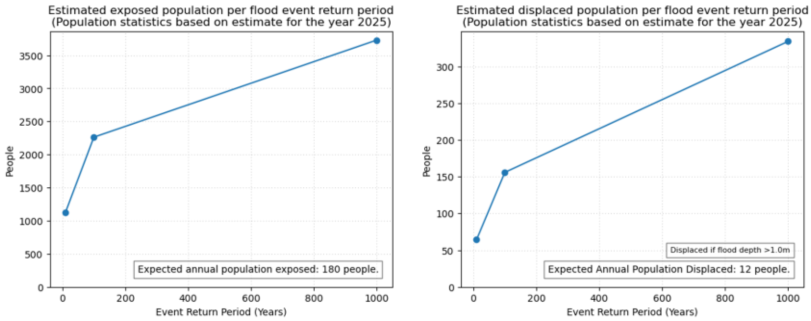


*Figure 30 Exposure of critical infrastructure on Sliač city level with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

In addition, **simplification of the scripts** took place in order to improve the way, how certain variables are changed across the cells. With the updated scripts, users can modify all variables on the beginning of the script and don't need to search and change them in various parts of the script (Figure 30). Updated scripts and html report are available in Annex 2 of this report.

```
In [2]: # --- Single-point configuration (edit this cell) ---
config = {
    "location": {
        "name": "Sliač",
        "preset": "sliac",  # choose a preset key or set to None to use custom bounds below
        "latitude_bounds": (48.604913, 48.660713),
        "longitude_bounds": (19.111948, 19.176076),
    },
    "location_presets": {
        "florence_example": (48.0071, 48.9984, 18.4345, 20.5244),
        "sliac": (48.604913, 48.660713, 19.111948, 19.176076),
        "bb_kraj": (48.0071, 48.9984, 18.4345, 20.5244),
        "zilina": (49.2, 49.25, 18.69, 18.78),
        "sevilla": (37.31092657797497, 37.43506820432209, -6.020294323590795, -5.876442087023754),
    },
    "return_periods": [10, 100, 1000],
    "image_return_periods": [10, 100, 1000],
    "custom_max_depth_legend": -1,  # set -1 to auto-scale legend to data maxima
    "flags": {
        "flood_composed": True,
        "flood_difference": True,
    },
    "paths": {
        "workdir": ".",
        "hazard_dir": "data",
        # Choose which pattern to use: europe_flood_depth_pattern or local_flood_depth_pattern
        "use_europe_depth_pattern": False,
        "europe_flood_depth_pattern": "Europe_RP{rp}_filled_depth.tif",  # template for downloads and reads
        "local_flood_depth_pattern": "../RP_{rp}_20x20m.tif",  # alternative template (was commented in original)
        "flood_difference_pattern": "Europe_Flood_difference_RP{rp_min}_RP{rp_max}.tif",
    },
    "download": {
        "enabled": False,  # set False to skip downloads when files are already present or using local data
        "base_url": "https://jeodpp.jrc.ec.europa.eu/ftp/jrc-opendata/CEMS-EFAS/flood_hazard/",
        "timeout": 90,
        "max_retries": 5,
```

*Figure 31 Example of script simplification and improvement for customization of variables*
*Figure source: CLIMAAX Insight Phase 2*

### 2.3.3 Hazard #3 Wildfires (ML approach)13

This workflow relies on a machine learning approach to understand the drivers of the fire activity, by linking past wildfire occurrence with geophysical, vegetation and climatic variables. The resulting outputs primarily indicate relative spatial patterns of wildfire susceptibility learned from past events rather than deterministic predictions of individual future fires. In case of Banska Bystrica region, the focus was on **integrating** national SK forest wildfire event data and comparing the outcomes with Phase 1.

*Table 23 Data overview for workflow Wildfires (ML approach)*

| *Hazard data* | *Vulnerability data* | *Exposure data* | *Impact metrics/Risk output* |
|---|---|---|---|
| SK Forest fires[14] | JRC data - population, economic, ecological and ecological- | Open Street Maps - roads, hospitals, hotels, schools, shelters, | *Population, economic and ecological risk for reference period and RCP 8.5 2021-40, Risk in* |

13 https://handbook.climaax.eu/notebooks/workflows/FIRE/01_wildfire_ML/Risk_workflow_description_FIRE_ML.html

14 https://geoportal.gov.sk/maps/lesne-poziare/datasets

| *Hazard data* | *Vulnerability data* | *Exposure data* | *Impact metrics/Risk output* |
|---|---|---|---|
| ECLIPS/CHELSA, Corine Land Cover, historical EFFIS, DEM, NUTS | economic vulnerability indicators | Wildland Urban interface (WUI) | *roads for reference period and RCP 8.5 2021-40* |
| | | | |

Currently there does not exist any official geospatial dataset mapping the forest fires in Slovakia. To execute this second phase of the CLIMAAX Wildfires workflows, we approached representatives of the Ministry of interior of Slovak republic to request available information on historical forest fires. We received initial data sources in a tabular format with heterogenous quality and only indirect spatial references by the addresses for the forest fires documented by the official and voluntary firefighters in Slovakia during the period 2015–2024 (Table 23). This required additional data cleaning and georeferencing to make the dataset suitable for the ML workflow, and it introduces uncertainty related to location accuracy and potential underreporting.

*Table 24 Input data on forest fires for the period 2015–2024*

| | | | | | | | Miesto udalosti | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Rok | Dátum a čas vytvorenie | Plocha požiaru [m²] | Obvod požiaru [m] | Škoda | Uchránené hodnoty | popis udalosti | Kraj | Okres | Obec | Ulica |
| 2015 | 10.1.2015 9:54 | 4 | 8 | | | Veľké zadymenie v lese na Magurke. | Žilinský | Námestovo | Námestovo | Námestovo |
| | 18.1.2015 6:50 | 100 | 50 | | 1000 | Požiar chaty | Bratislavský | Malacky | Láb smer Jakubov | kat.obce Láb |
| | 26.1.2015 17:28 | 1 | 4 | | | Požiar stromu | Trnavský | Dunajská Streda | Šamorín | Požiarnická |
| | 22.2.2015 19:06 | 25 | 20 | | | požiar pravdepodobne odpadu | Bratislavský | Bratislava IV | Bratislava - Záhorská Bystrica | Hodonínska |
| | 5.3.2015 17:28 | 1 | 1 | 150 | 500 | BB/124požiar stromuvýjazd: 17:28návrat: 18:28 | Banskobystrick | Banská Bystrica | Banská Bystrica | Malachovská cesta |
| | 8.3.2015 17:39 | 25 | 20 | 10 | 20000 | Požiar lesa | Košický | Spišská Nová Ves | Krompachy | Lišti Vrch |
| | 17.3.2015 15:57 | 9750 | 410 | | | požiar lesa - hustý čierny dym vidno z cesty | Bratislavský | Malacky | Leváre | z Malaciek do Levár |
| | 17.3.2015 18:26 | 300 | 80 | | | požiar porastu | Bratislavský | Malacky | Malacky | D2 21km |
| | 19.3.2015 12:51 | 60000 | 1000 | 300 | 500 | Požiar trávy. | Košický | Spišská Nová Ves | Rudnany | Pätoracké |
| | 19.3.2015 14:56 | 10000 | 400 | 500 | 1000 | Požiar lesa, volal šéf Urbariátu Markušovce. | Košický | Spišská Nová Ves | Markušovce | Jareček |
| | 19.3.2015 16:02 | 60000 | 1000 | 400 | 3000 | TOR/64Požiar trávy.Výjazd: 16.02Návrat: 17.45 | Banskobystrick | Revúca | Gemerská Ves | Dolinka |
| | 20.3.2015 13:20 | 1800 | 380 | 1000 | 10000 | Požiar trávy | Košický | Spišská Nová Ves | Rudňany | Stupy |
| | 21.3.2015 11:55 | 35 | 24 | | 1000 | BR/120Požiar lesa (cca 10 m2)Výjazd:11:59Návrat:12:46 | Banskobystrick | Brezno | Valaská | Cesta Osloboditeľov 136 |
| | 21.3.2015 13:13 | 6000 | 320 | 500 | 1500 | poz.porastu | Košický | Košice - okolie | Lorincik | pri kláštore |
| | 21.3.2015 15:21 | 160000 | 1600 | 1000 | 10000 | Požiar lesa | Košický | Spišská Nová Ves | Rudnany | Petoracke |
| | 25.3.2015 11:35 | 800000 | 3600 | 5000 | 50000 | požiar trávy, cesta smerom na Rakové, tretie a aut. zastávka,doprava, okolo chaty | Žilinský | Žilina | Trnové | časť Rakové |
| | 25.3.2015 18:18 | 6000 | 380 | 20 | 100 | Požiar lesa | Prešovský | Humenné | Dlhé nad Cirochou | Dlhé nad Cirochou |
| | 25.3.2015 18:37 | 10 | 14 | | 1000 | požiar porastu 10x2m | Bratislavský | Malacky | Veľké Leváre | Veľké Leváre,pri žel.prekladisku |
| | 26.3.2015 18:02 | 180000 | 1800 | 500 | 10000 | Požiar trávy | Košický | Spišská Nová Ves | Žehra | Dreveník |
| | 26.3.2015 18:28 | 0 | 0 | | | č. 117 Požiar lesa | Prešovský | Vranov nad Topľou | Juskova Vola | urbár pri družstve |
| | 29.3.2015 20:37 | 0 | 0 | | | požiar lesa | Košický | Gelnica | Mníšek nad Hnilcom | nad Kolóniou |
| | 30.3.2015 15:58 | 20000 | 600 | 3000 | 10000 | Požiar trávy Švedlár | Košický | Gelnica | Švedlár | Šajby |
| | 9.4.2015 14:08 | 900 | 120 | 100 | 1000 | požiar porastu a trávy | Košický | Košice - okolie | Drienovec | Máj |
| | 9.4.2015 16:05 | 900 | 120 | 50 | 2000 | požiar lesa | Prešovský | Levoča | Roškovce Dolany | les za romskou osadou |
| | 10.4.2015 8:36 | 8 | 12 | | | požiar lesa | Žilinský | Liptovský Mikuláš | k.u. Lipt. Anna | súkromný les lok. Za vodou |
| | 10.4.2015 12:41 | 10000 | 400 | 100 | 1000 | požiar trávy | Košický | Spišská Nová Ves | Vítkovce-Chrasť | CHrasť n/Hor. |

Based on the cooperation with the KAJO (initial georeferenced SK Forest fires dataset has been prepared, containing all identified forest fires (Figure 32). In order to use the data within the CLIMAAX workflow, second version of the dataset (Figure 33) was prepared, containing only large forest fires (with the extent above 10 000 $m^2$[15]). To visualize the forest fire occurrence at municipalities level, additional dataset was prepared, too (Figure 34). This threshold was applied to improve data consistency for ML training, acknowledging that smaller events may be underrepresented.

[15] This threshold was applied to reduce noise and reporting inconsistencies in the historical records and to focus the ML training on events with more reliable spatial attribution.

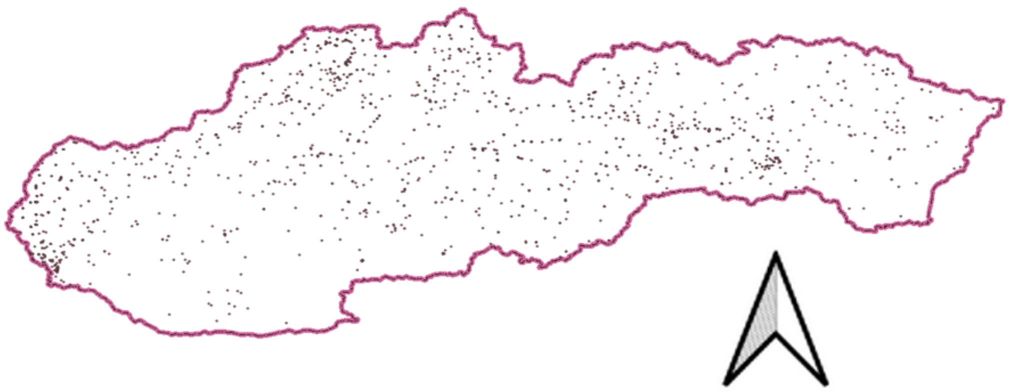

*Figure 32 Initial georeferenced forest fire layer (2,139 records)*
*Figure source: CLIMAAX Insight Phase 2*

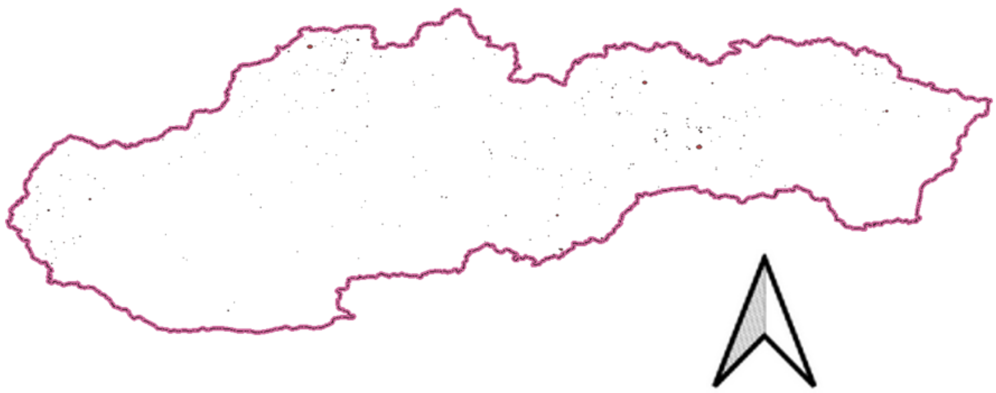

*Figure 33 Processed georeferenced forest fire dataset (414 records)*
*Figure source: CLIMAAX Insight Phase 2*

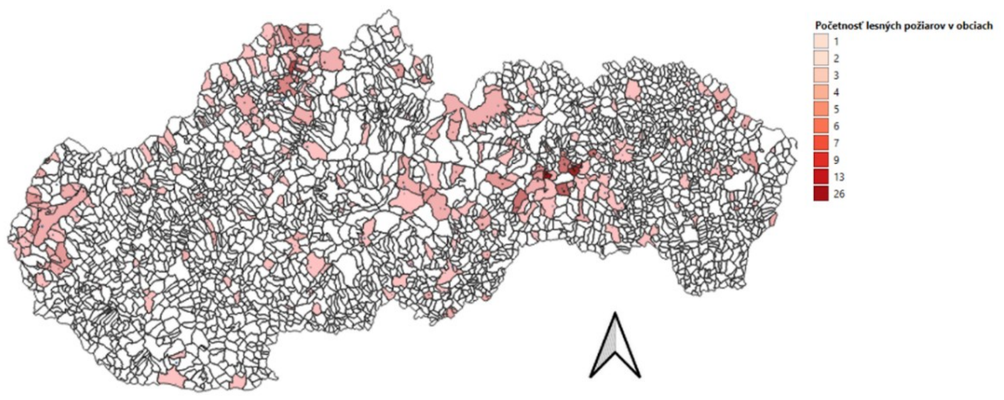


*Figure 34 Frequency of forest fires in municipalities*
*Figure source: CLIMAAX Insight Phase 2*

A dashboard to explore **EURO-CORDEX model biases**[16] presented by the CLIMAAX project consortium in November 2025 has been also used to support the climate model selection in the risk assessment workflow. The dashboard helped identify model configurations with lower bias for variables relevant to fire risk, thereby improving the plausibility of scenario-based results.

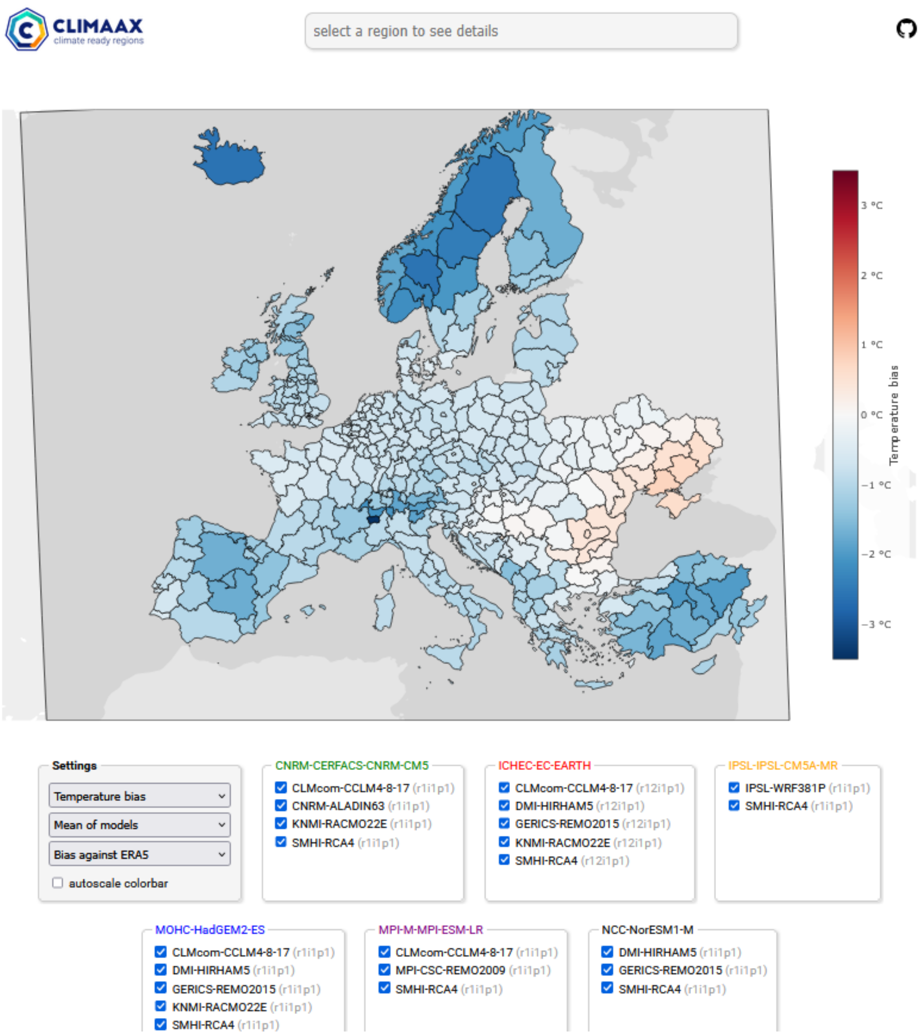


*Figure 35 A dashboard to explore EURO-CORDEX model biases*
*Figure source: CLIMAAX Insight Phase 2*

### 2.3.3.1 Hazard assessment

Building on the Phase 1 approach, the hazard assessment in this phase continued to use the same climate datasets, ECLIPS and CHELSA, to document the final spatial patterns of wildfire hazard. The key change in Phase 2 was the addition and update of local inputs on historical fire occurrence (Slovakia-specific records), which refine information on where fires have actually occurred. Overall, the results show similar spatial trends in the location and relative level of hazard for historical and future classes across both phases; however, Phase 2 outputs depict a **larger extent of areas classified in higher hazard** classes (Figure 37). As the other workflow steps remained largely unchanged, the most likely explanation for this shift is the use of more detailed

[16] https://handbook.climaax.eu/dashboards/bias-uncertainty/

and/or more numerous historical fire records in Phase 2, which may have led to identifying a larger area as having elevated hazard.

Figure 37 also shows that the mapped hazard classes are **sensitive to the choice of climate predictor dataset**: in some areas, ECLIPS and CHELSA agree (similar hotspot locations and hazard levels), while in others they diverge (differences in spatial continuity or class assignment). These differences are also related to dataset methodology: CHELSA captures topographic and orographic effects in greater spatial detail (particularly relevant in mountainous terrain), whereas ECLIPS provides a consistent regional picture based on processed climate projections (well suited for comparisons across scenarios and time horizons, often resulting in a smoother spatial pattern). Therefore, agreement between the two datasets increases confidence in identified hotspots (a more robust signal), while divergence should be interpreted as input sensitivity and prioritised for verification.

The highest wildfire hazard remains concentrated mainly in the northern parts of the region, where terrain is mountainous and forest cover is extensive. Fragmented hazard zones also occur across the area, particularly where fuel sources are available. Compared to Phase 1, where medium hazard was more prevalent, very low and low hazard classes dominate future scenarios in the central and southern parts of the region according to Phase 2 results.

Taken together, these results should be communicated as **relative screening information** (to identify hotspots and support prioritisation), rather than as a definitive quantification of absolute hazard magnitude.

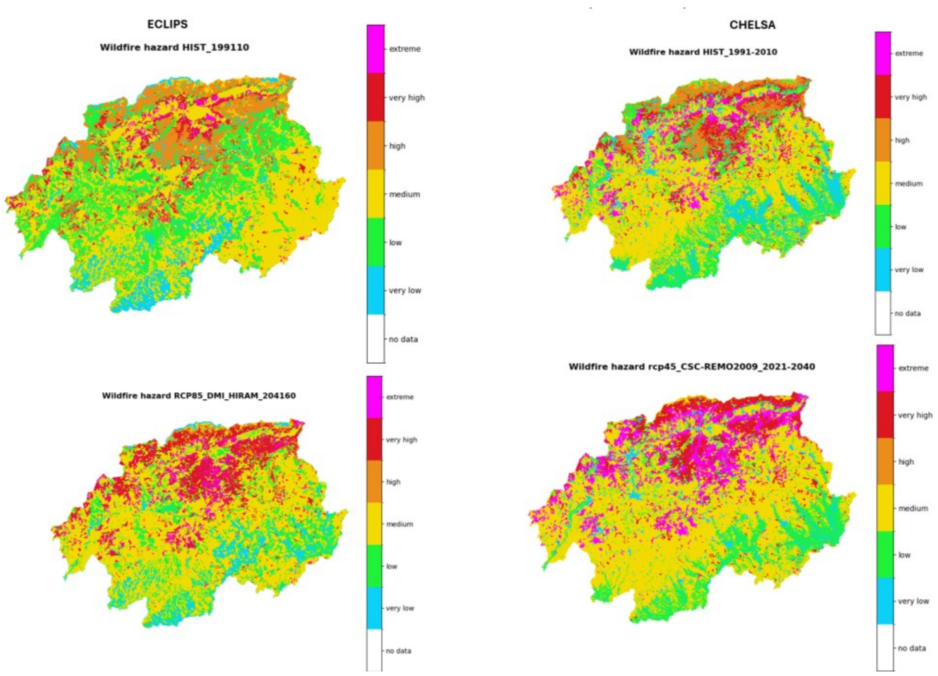


*Figure 36 Comparison of the wildfire hazard assessment between ECLIPS and CHELSA datasets for BB region with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

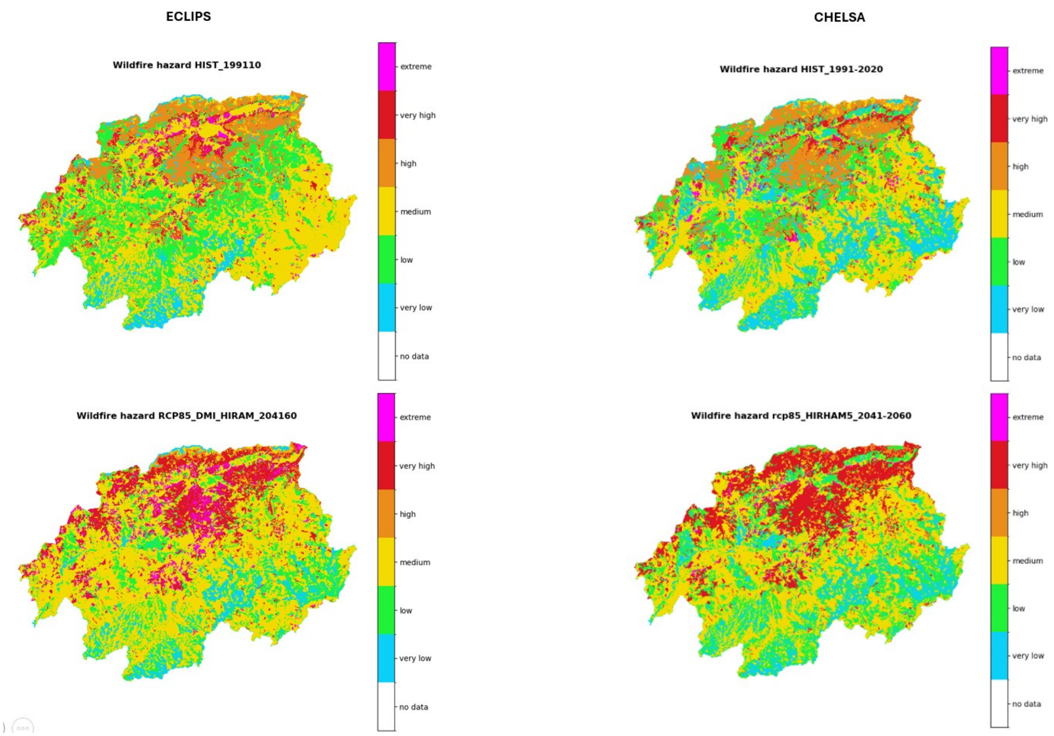


*Figure 37 Comparison of the wildfire hazard assessment between ECLIPS and CHELSA datasets for BB region with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

#### 2.3.3.2 Risk assessment

To calculate the risk, the results from hazard assessment outputs were combined with vulnerability and exposure layers. Vulnerability was represented through population, ecological and economic indicators for both historical and future perspective. Exposure data were used from OpenStreetMap (as in Phase 1). The resulting integrated risk maps provide an overview of current and future wildfire risk patterns at both raster and municipal levels, illustrating relative differences in risk intensity under the selected climate scenario(s) and time horizon(s). These outputs should be interpreted as relative risk screening information (hotspot identification and prioritisation), rather than as absolute estimates of expected losses.

Comparison of the risk maps via spatial gridded visualisation delivered higher differences between the Phase 1 and Phase 2 particularly when using the ECLIPS climate dataset, but overall spatial pattern of risk hotspots has not been changed significantly, using the national data in Phase 2. In Phase 2, future risk was assessed under the RCP8.5 scenario, which should be considered when interpreting the scenario-based outputs. Anyway, outcomes from Phase 2 indicates more areas with fragmented / more diverse types of risks, mainly in central and southern part of the region.

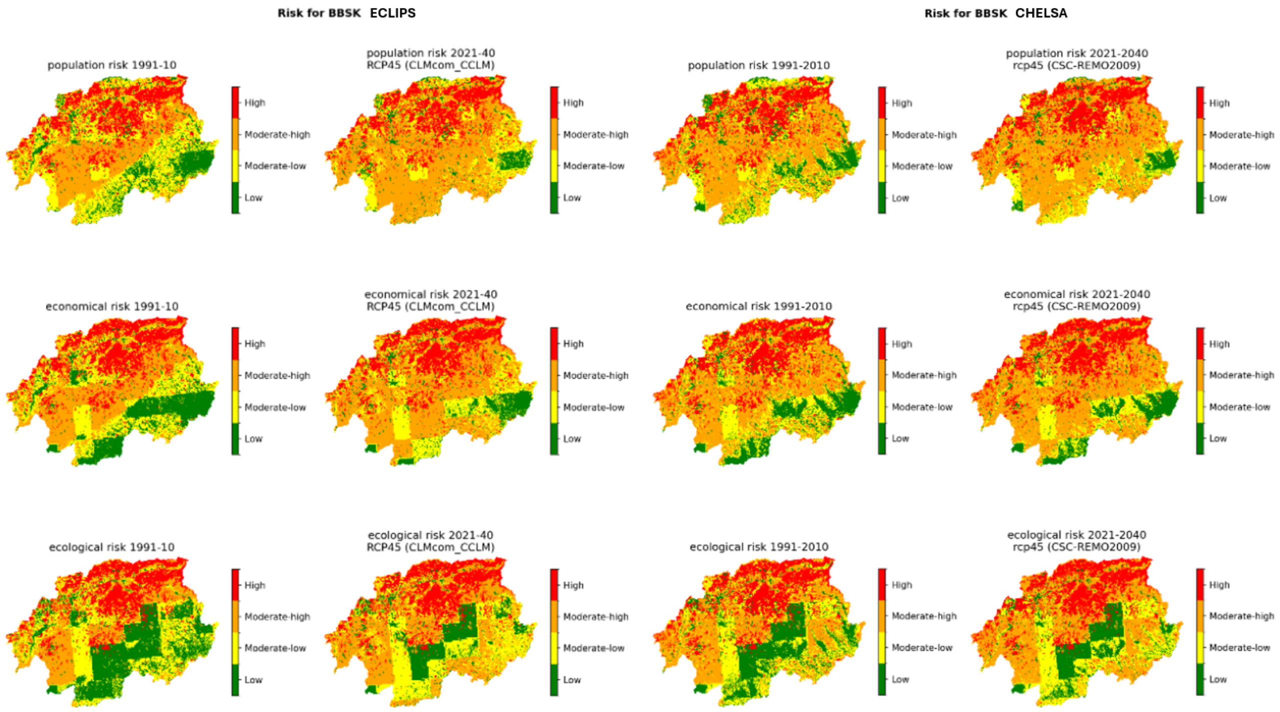


*Figure 38 Visualization of risk maps for ECLIPS and CHELSA datasets for BB region with EU data from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

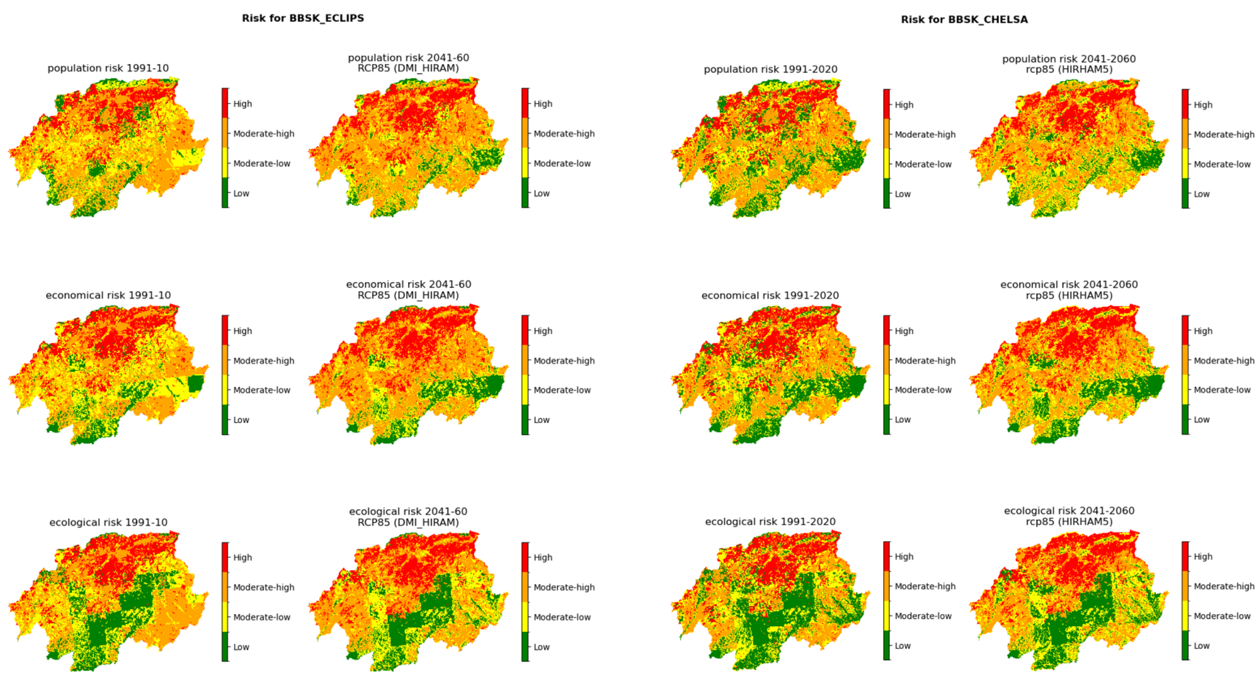


*Figure 39 Visualization of risk maps for ECLIPS and CHELSA datasets for BB region with SK data from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Aggregated district level visual risk assessment representation (Figure 39 and 40) provides comparison of the results between first and second phase. In overall, Phase 2 indicates for some districts lower risk level, whilst using local data, comparing the first phase mainly in central and southern part of the region, potentially reflecting lower fuel availability and land-cover characteristics in these areas. This type of aggregation is also useful for stakeholder communication, as it provides an easily interpretable overview of relative risk levels by administrative unit.

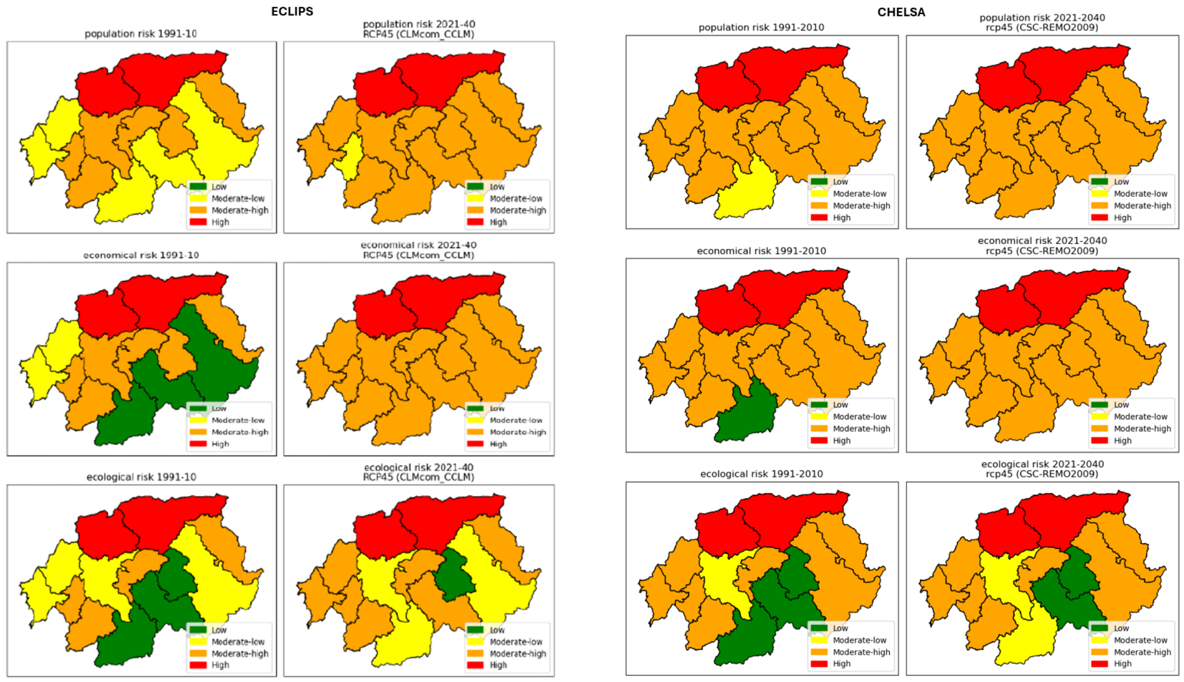


*Figure 40 Risk assessment on districts level based on the ECLIPS and CHELSA datasets from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

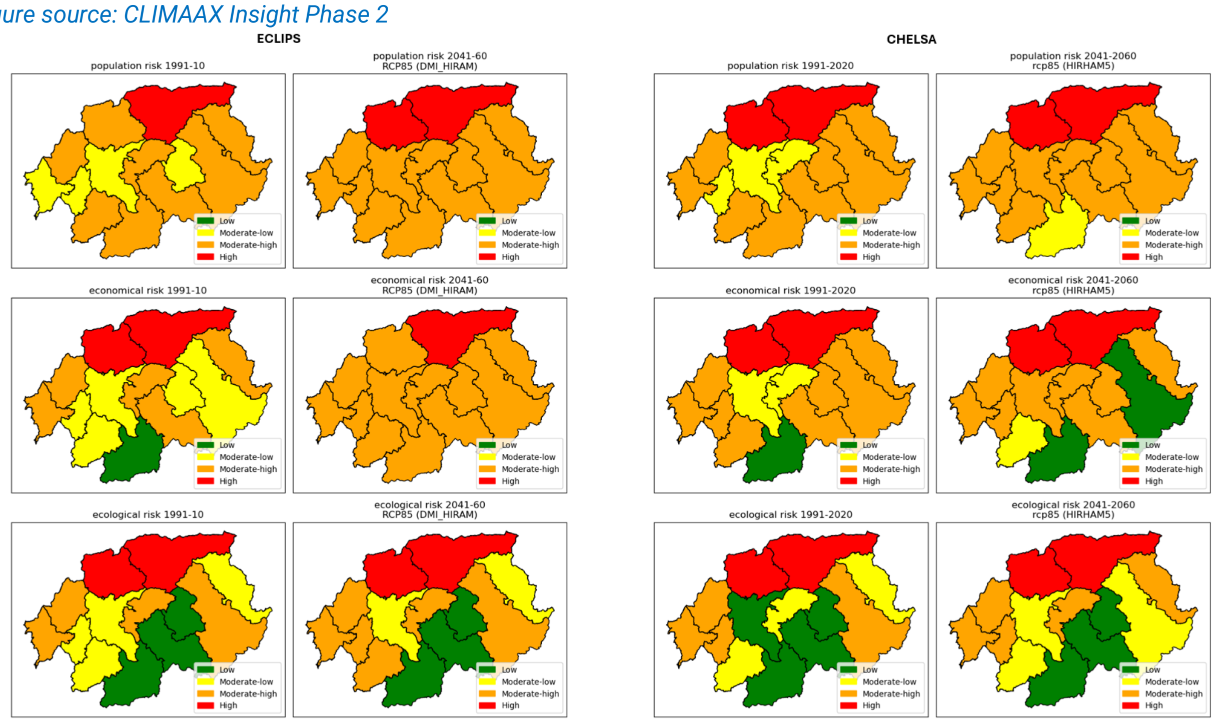


*Figure 41 Risk assessment on districts level based on the ECLIPS and CHELSA datasets from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

For road network risk maps, Phase 2 results indicate slightly lower relative risk levels for some road segments compared to Phase 1, particularly in the southern part of the region. As with other outputs, these differences may reflect input sensitivity (e.g., updated fire occurrence data and climate predictor choice) and should be interpreted as relative screening information rather than as an absolute reduction in risk.

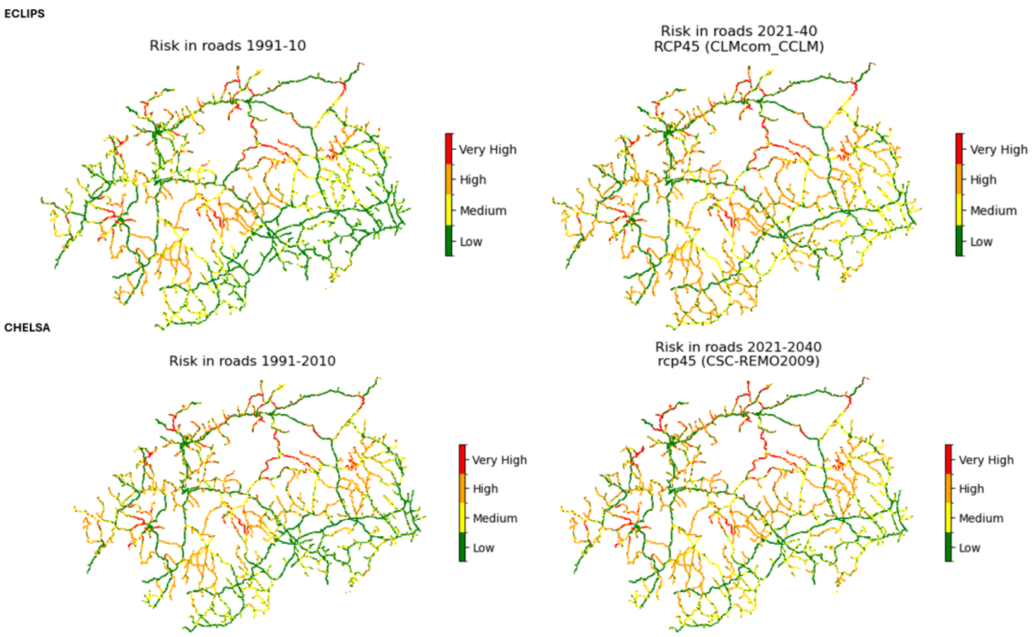


*Figure 42 Map of the risk in roads based on the ECLIPS and CHELSA datasets from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

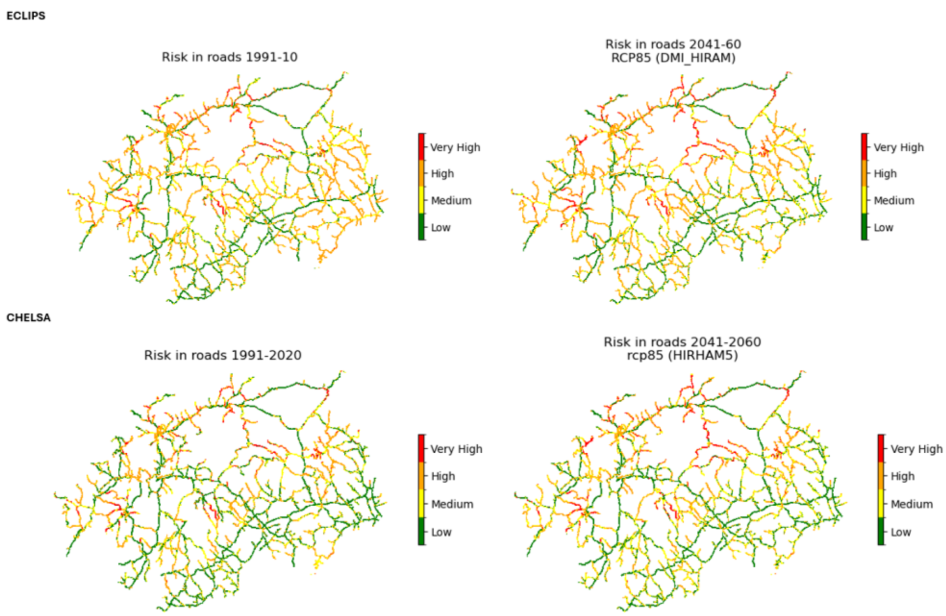


*Figure 43 Map of the risk in roads based on the ECLIPS and CHELSA datasets from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

In case of change of hazard / risk assessment for wildfire via degree of susceptibility, hazard, risk change in economy and risk change in population assessment results were also analysed across both phases.

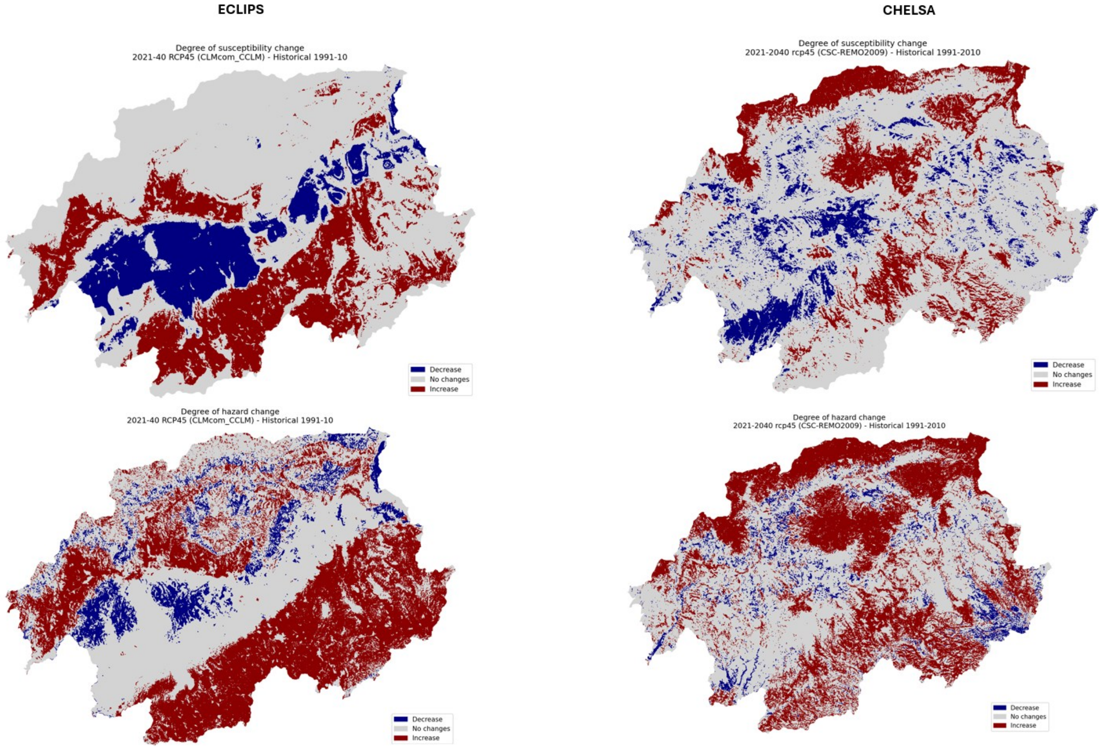


*Figure 44 Change assessments for susceptibility and hazard for ECLIPS and CHELSA datasets from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

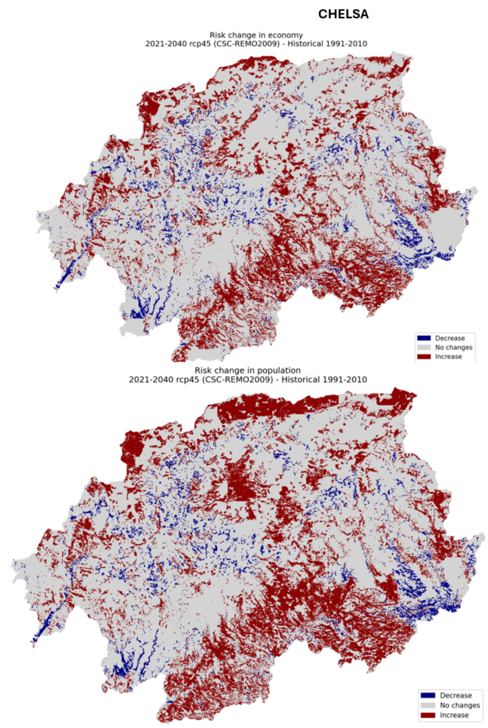


*Figure 45 Risk change in economy and population for ECLIPS and CHELSA datasets from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

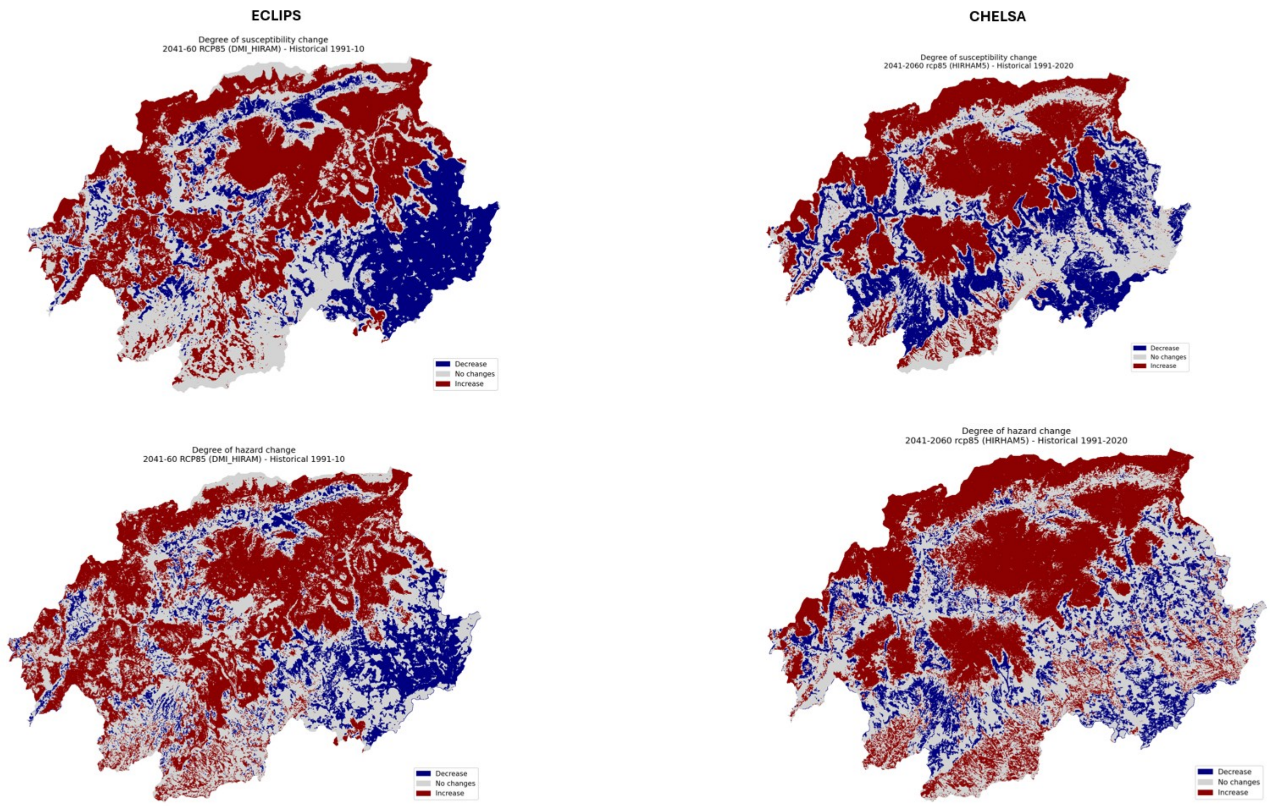


*Figure 46 Change assessments for susceptibility and hazard for ECLIPS and CHELSA datasets from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

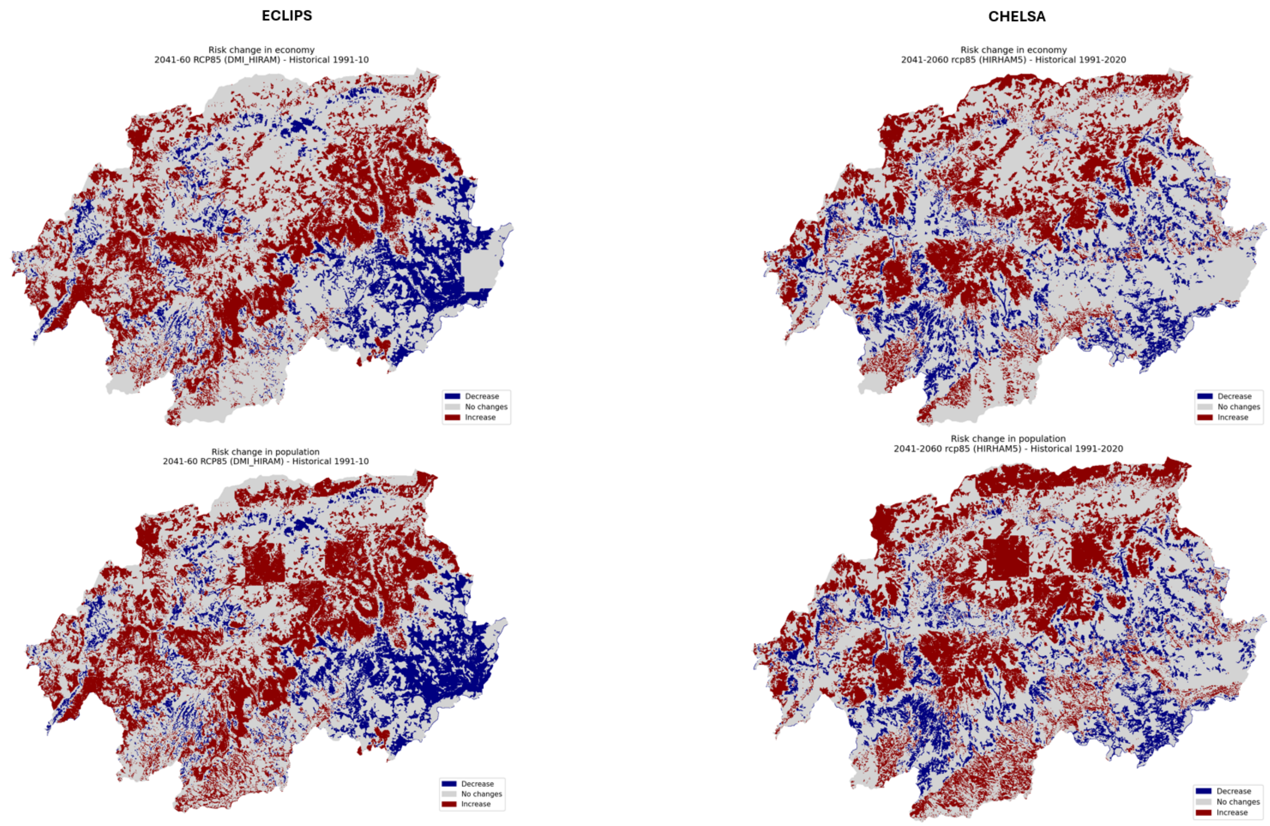


*Figure 47 Risk change in economy and population for ECLIPS and CHELSA datasets from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Results indicate a broader spatial extent of both increasing and decreasing change classes, accompanied by a reduction in areas showing no change. In case of the degree of susceptibility, the northern and central parts of the region show an increase, while a more significant decrease is visible in the south-eastern part under ECLIPS and south-western / central parts under CHELSA.

Hazard change patterns in Phase 2 also show stronger increase with quite different main location, comparing to Phase 1 – mainly in central and northern part of region.

For economic and population risk change, Phase 2 results indicate comparatively lower risk increases (or locally decreasing change classes) in the south-eastern part of the region, particularly under the ECLIPS-based configuration. A limitation of the CHELSA-based results is the lack of feedback from the data provider regarding the applied RCM and GCM models. Consequently, it was not possible to verify whether the selected model configuration represents the lowest-bias option for the study area, which introduces additional uncertainty into the CHELSA-derived outcomes.

### 2.3.4 Hazard #4 Wildfire FWI[17]

This workflow enables a wildfire risk screening based on the seasonal Fire Weather Index (FWI) and a set of parameters linked to wildfire vulnerability. At the BB region, this workflow provides a straightforward tool to identify areas with the most favourable conditions for wildfire development, based on climatic factors and fuel availability. In parallel, it highlights parts of the region that are most vulnerable to wildfires from a human, economic, and environmental perspective. By synthesizing information on wildfire hazard (FWI-based danger) and vulnerability, the workflow ultimately delivers a regional wildfire risk assessment and helps identify priority areas where adaptation and risk-reduction measures should be focused.

In phase 2, the FWI workflow was applied as an alternative to the ML-based approach, given the limited availability of consistent historical forest fire occurrence data. We therefore re-applied the workflow under the RCP8.5 scenario and compared the resulting patterns with those obtained in Phase 1.

*Table 25 Data overview for workflow Wildfire FWI*

| *Hazard data* | *Vulnerability data* | *Exposure data* | *Impact metrics/Risk output* |
|---|---|---|---|
| CDS - seasonal and daily Weather Index Data, EFFIS - Burnable vegetation | EFFIS - Population, Protected Areas, Ecosystem Irreplaceability Index, Population density, Ecosystem Restoration Cost | | Fire Risk RCP 8.5 |

#### 2.3.4.1 Hazard assessment

This workflow allows us to visualize wildfire hazard using the Fire Weather Index (FWI) outputs. The FWI is a climatic index combining data on daily noon surface air temperature, rainfall intensity,

[17] https://handbook.climaax.eu/notebooks/workflows/FIRE/02_wildfire_FWI/FWI_Risk_Description.html

wind speed and relative humidity accounting for the effect of fuel moisture and weather conditions on fire behaviour.  In this analysis we focused on comparison of the results for seasonal FWI and days with FWI > 30 between the first (RCP 2.6: a strong climate-mitigation pathway where emissions peak early and rapidly declines) and the Phase 2 (RCP 8.5: a very high-emissions pathway with little to no mitigation) for BB region.

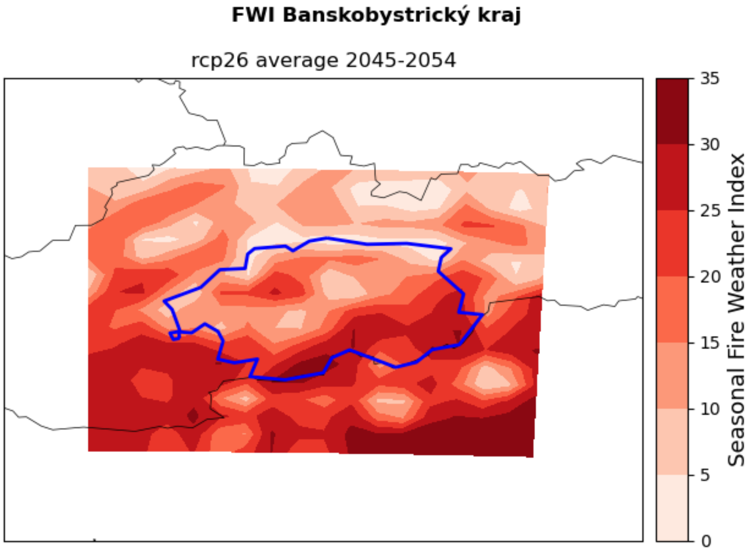


*Figure 48 Seasonal Fire Weather Index averaged over the selected period from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

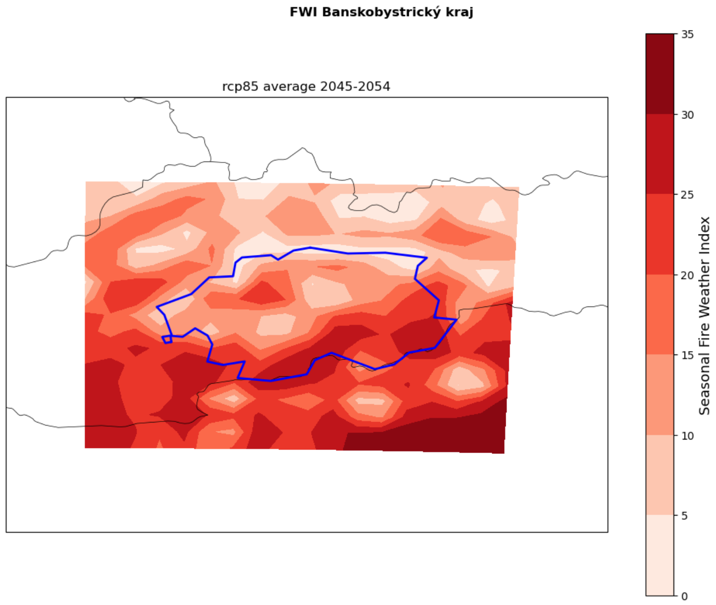


*Figure 49 Seasonal Fire Weather Index averaged over the selected period from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Seasonal FWI values represent average danger levels during the peak fire season (June-September). Values above 30 are commonly used as an indicator of high to extreme fire-weather danger, where fire can ignite easily, reach high intensity and rapid spread. Suppression in such cases becomes difficult or ineffective. Comparing results between phases, Phase 2 generated slightly smaller spatial extent of areas exceeding FWI > 30 (Figures 48 and 49). This result may reflect differences in scenario inputs (RCP2.6 vs RCP8.5), climate dataset characteristics, or threshold-based classification, and should therefore be interpreted as a relative pattern rather than an absolute change in danger.

Daily data are used to determine the length of the fire weather season—defined as the number of days exceeding a user-defined FWI threshold (FWI > 30). Comparing Phase 1 future results (RCP 2.6), with Phase 2 (RCP8.5), no substantial differences were observed in the length of the fire-weather season, and the highest seasonal hazard remains concentrated in the southern part of the region. These outputs support prioritisation of adaptation and preparedness measures in the most affected districts/municipalities, particularly where high FWI conditions coincide with vulnerable assets and communities.

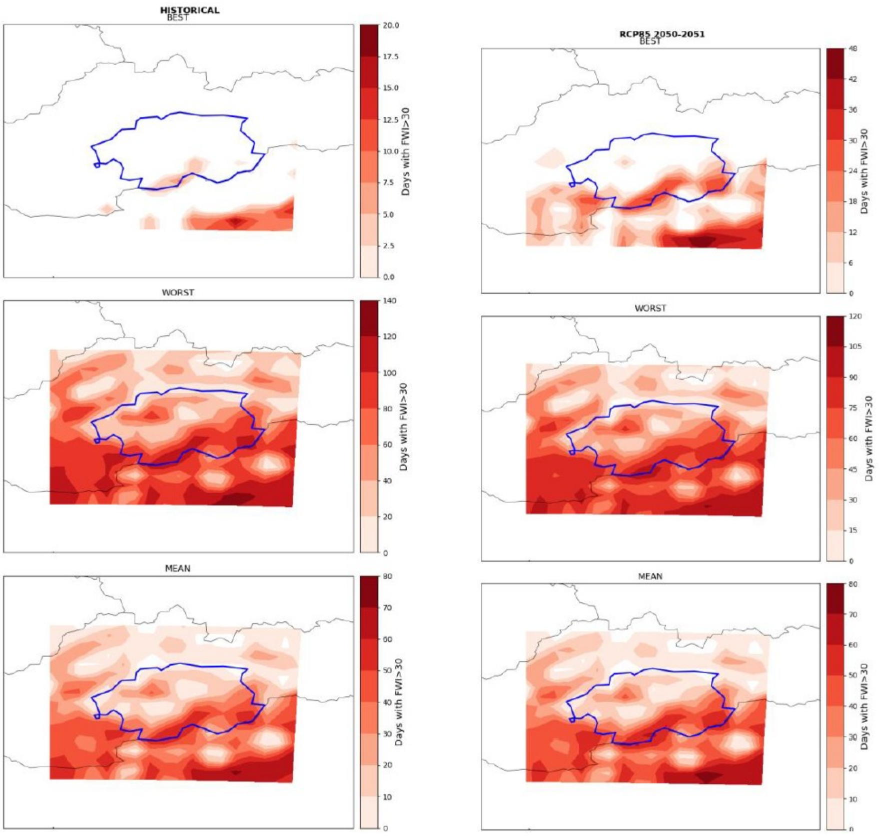


*Figure 50 Fire weather season length map from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

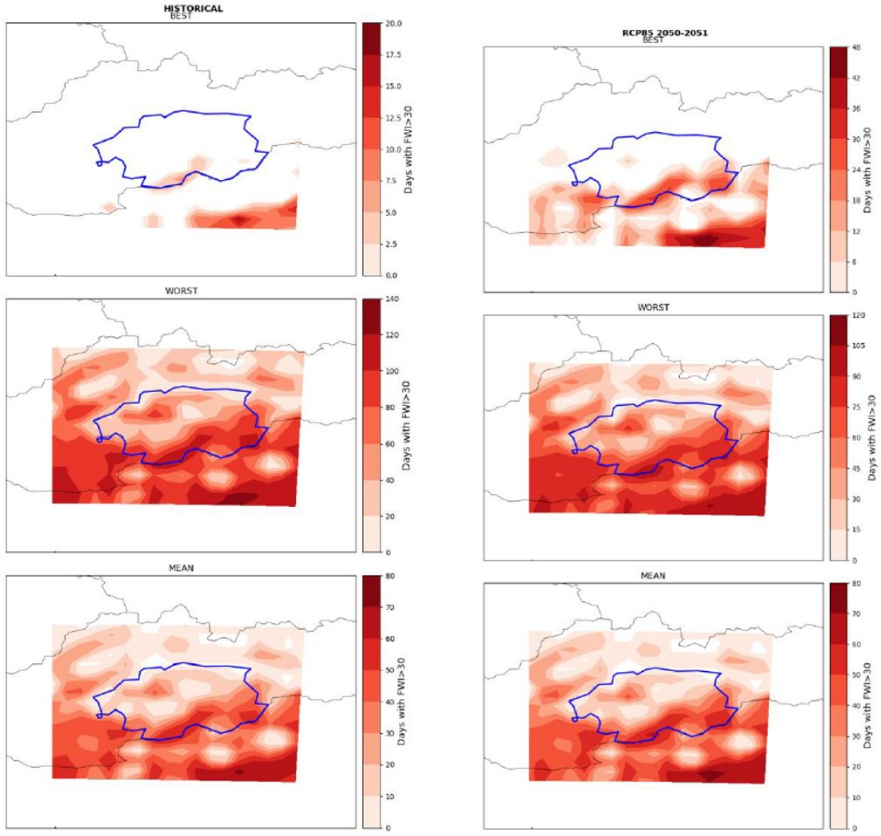


*Figure 51 Fire weather season length map from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

#### 2.3.4.2 Risk assessment

Final outcomes of this workflow are visualization of the forest fires risk, building on the seasonal Fire Weather Index (FWI) and selected vulnerability indicators to identify areas of highest risk. Using multi-criteria Pareto analysis, the workflow identifies areas where climatic fire-weather danger and socio-environmental vulnerability factors most strongly overlap (i.e., areas that score high across multiple criteria simultaneously). This type of risk mapping provides a more comprehensive perspective than fire danger models alone and can support actionable insights for regional adaptation planning and risk reduction measures.

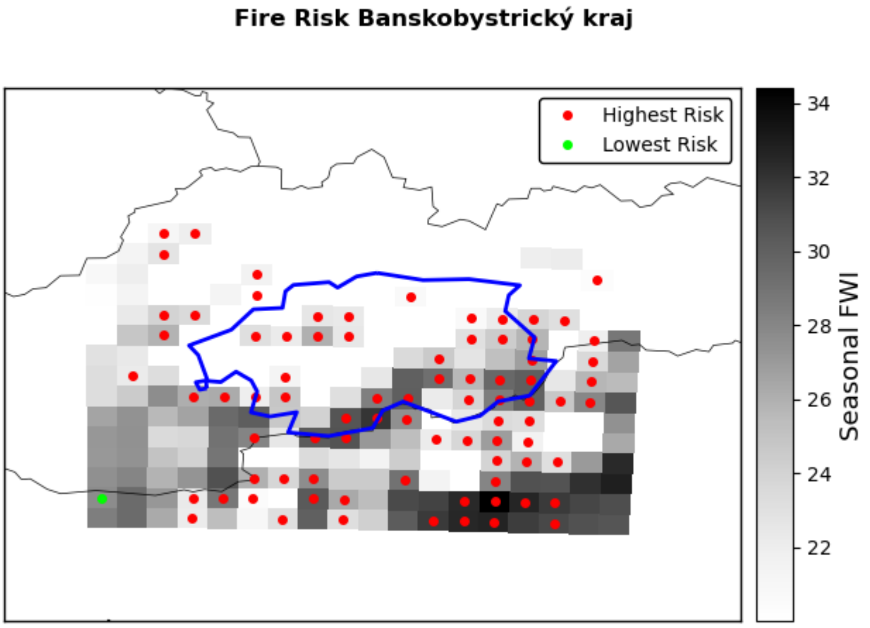


*Figure 52 Wildfire risk map visualization from Phase 1*
*Figure source: CLIMAAX Insight Phase 2*

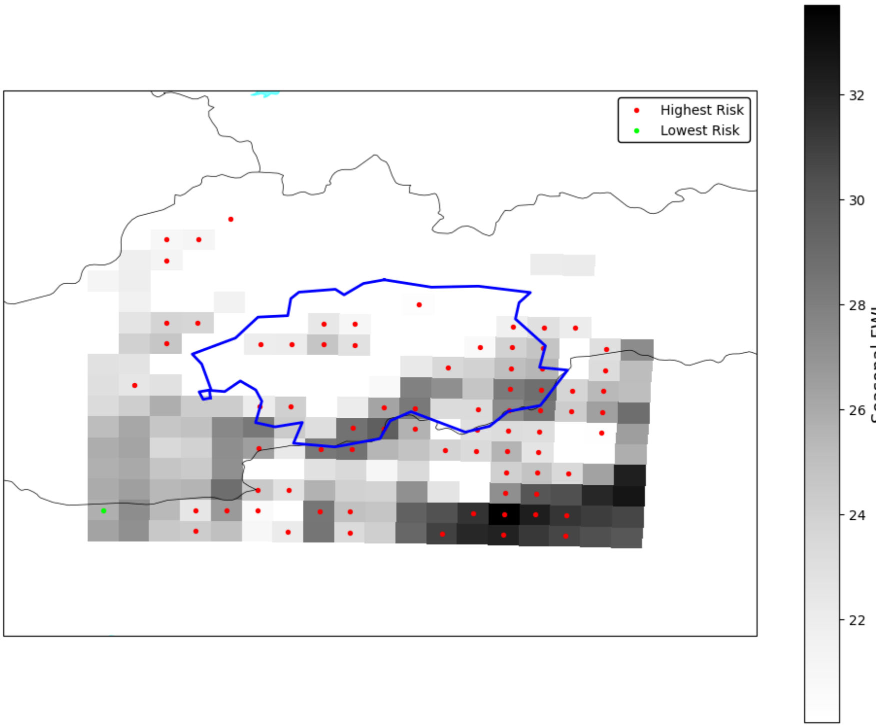


*Figure 53 Wildfire risk map visualization (SK level) from Phase 2*
*Figure source: CLIMAAX Insight Phase 2*

Comparison of the results from Phase 1 (RCP 2.6) and Phase 2 (RCP 8.5) did not generate significant difference for BB region. Minor differences include one newly highlighted high-risk location outside the region (Kysuce, north-west) and one location identified in Phase 1 but not in Phase 2 (Spiš, north-east). Overall, the main seasonal FWI patterns and the highest-risk locations within BBSK remain consistent across phases.

### 2.3.5 Additional assessments based on local models and data

In addition to the assessments documented above, Phase 2 considered the relevance and feasibility of further workflows, local datasets, and locally available tools that could strengthen the regional applicability and interpretability of the CRA outputs. In case of the future use of workflows Agricultural drought workflow might be relevant to the needs of the Banská Bystrica region.
For potential future application, the Agricultural Drought workflow is likely to be relevant to the Banská Bystrica region, as agriculture is a key sector, climate-change-related losses are already being observed, and preliminary screening indicates that residents perceive drought as a significant risk factor.

#### 2.3.5.1 Hazard assessment

Phase 2 did not include additional hazard modelling using locally developed models. Instead, the additional work focused on leveraging locally available datasets and tools to improve the regional applicability and interpretability of the CRA outputs.

#### 2.3.5.2 Risk assessment

**Further analyses are planned for Phase 3 to strengthen the operational relevance of the CRA results.** Specifically, the project aims to overlay priority risk areas (floods and wildfires) with the region-wide distribution of response forces and assets (e.g., professional and voluntary units, key equipment and facilities) to assess coverage patterns and potential capacity gaps. This work will help translate Phase 2 risk outputs into actionable recommendations for preparedness and intervention capacity optimisation.

**As an additional ambition for Phase 3, the project aims to explore the alignment between identified flood risk hotspots and municipalities expressed needs and planned adaptation project** intentions—particularly measures related to water retention and runoff management. Where relevant information is available, this will support strategic planning and decision-making by helping to indicate whether proposed interventions are being considered in the areas where they could deliver the greatest risk-reduction benefits.

## 2.4 Key Risk Assessment Findings

The Key Risk Assessment step builds on the outputs of the Risk Analysis and aims to translate analytical results into a decision-oriented understanding of climate risks. In line with the **Key Risk Assessment Protocol**, risks were evaluated by considering three key dimensions: **severity**, **urgency**, and **capacity to respond**.

The assessment was supported by the **evaluation dashboard**, which synthesises risk analysis outputs for current and future conditions and enables a structured interpretation of risk profiles. Rather than serving as a new screening exercise, the Key Risk Assessment was used to **further characterise and confirm risks that had already been identified as priorities in earlier phases of the project**, namely floods and wildfires.

The dashboard and assessment framework are designed to support engagement with stakeholders, experts, and priority groups. In practice, this step also provided an opportunity to reflect on the applicability, interpretability, and usability of the risk outputs for different actors involved in climate risk management at the regional and local levels.

### 2.4.1 Mode of engagement for participation

Building on the stakeholder engagement activities described in Section 2.1.5, Phase 2 included targeted engagement with relevant institutional stakeholders, experts, and priority groups to support the interpretation and evaluation of the Climate Risk Assessment (CRA) outputs. The primary objective of this engagement was to gather feedback on the relevance, interpretability, and potential practical use of the analytical results for risk evaluation and decision-making.

During Phase 2, engagement for risk evaluation focused mainly on expert consultations and bilateral discussions. Key stakeholders involved in this process included the **Slovak Water Management Enterprise**, the **Regional Directorate of the Fire and Rescue Service in Banská Bystrica**, a **risk management expert from BBSGR**, representatives of the **Ministry of Interior of the Slovak Republic**, and the **Slovak Hydrometeorological Institute**. With their input, appropriate datasets were identified, selected, and prepared, and their suitability for use in the CRA workflows was discussed.

Due to limited time availability and operational constraints of the involved institutions, it was not possible to formally verify the final CRA results with all stakeholders during Phase 2. Nevertheless, targeted discussions—particularly with the Regional Directorate of the Fire and Rescue Service—focused on the **practical applicability** of the outputs. These discussions highlighted challenges related to the integration of GIS-based CRA results into existing operational and planning systems, as the required technical solutions and digital infrastructure are not yet routinely used in practice. As a result, the modalities for delivering and operationalising these outputs remain subject to further discussion. At the same time, the willingness of stakeholders to cooperate on this agenda is reflected in the ongoing preparation of a **memorandum of cooperation**, which will provide a framework for continued collaboration in Phase 3.

During Phase 2, we involved an internal BBSGR risk management expert. The expert primarily contributed to (i) the interpretation of results and a **qualitative reflection on resilience/response capacity** (acknowledging that the capacity dimension was supported by limited dedicated outputs in this phase), (ii) the identification and selection of **appropriate datasets and indicators** for the regional context, and (iii) targeted knowledge transfer within the project team.

In parallel, public and community-level engagement was piloted through the event *"Closing of Bánoš"*, organised in cooperation with the *Stredná odborná škola pod Bánošom (Secondary vocational school)*. The event attracted nearly 300 visitors and provided an opportunity to present the project objectives, preliminary findings, and their relevance for the region. Due to the format of the event, which was designed for public outreach and awareness-raising, it was not suitable for the formal validation of analytical CRA results. Nevertheless, a short survey conducted during the event indicated that drought, snowless winters, heatwaves, intense rainfall, floods, and wildfires are perceived by participants as the most significant climate-related threats. This engagement therefore provided valuable qualitative insights into local risk perception and demonstrated strong public interest in practical adaptation measures.

*Figure 54 The figure illustrates public engagement activities conducted during Phase 2, supporting qualitative feedback collection for the Key Risk Assessment process.*
*Figure source: CLIMAAX Insight Phase 2*

Additional engagement activities included participation in professional conferences and regional workshops, such as the Czech Slovak conference *"Inšpirujme sa 2025 (Let's get inspired)"* and the regional workshop *"Climate Change Adaptation – National Goals and Regional Solutions"*. These events facilitated knowledge exchange with experts from research institutions, public administration, and risk management practice, and supported communication of regional needs related to the use of climate data for decision-making.

Overall, engagement activities in Phase 2 enabled initial feedback on **data relevance**, **risk perception**, and the **usability of CRA outputs**. At the same time, they revealed important limitations related to scale, technical capacity, and stakeholder availability—particularly in a region comprising more than 500 municipalities. These lessons underline the need to further structure and tailor stakeholder engagement and the presentation of Key Risk Assessment outputs, which will be addressed in the final phase of the project.

Detailed information on these public engagement and outreach activities, including formats, communication materials and participation metrics, is provided in the Annex 1.

As part of this engagement approach, we also published pilot outputs on the project webpage[18] to support awareness, feedback, applications usability testing and discussion of the CRA results.

[18] https://klima.opendata.bbsk.sk/pages/projekty-climaax


*Figure 55 Project webpage*
*Figure source: CLIMAAX Insight Phase 2*

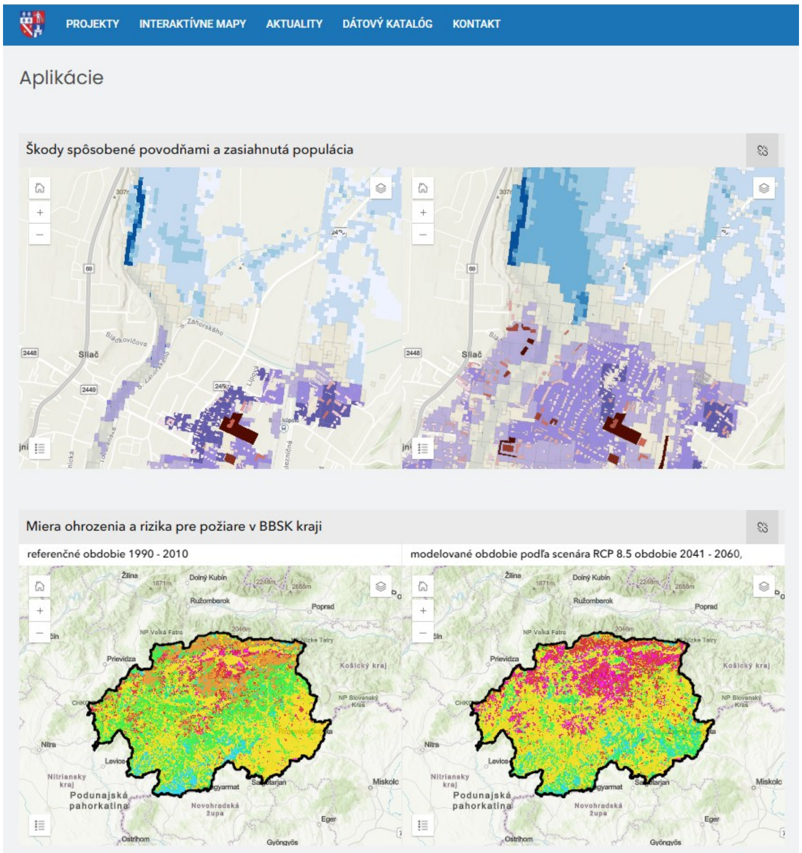


*Figure 56 57 Applications allowing users to interact with the project results for area of their interest*
*Figure source: CLIMAAX Insight Phase 2*

### 2.4.2 Gather output from Risk Analysis step

The Key Risk Assessment builds on selected outputs generated during the Risk Analysis step. These outputs were used as inputs for evaluating the severity, urgency, and capacity to respond to the identified priority risks. Priority was given to outputs considered more robust for decision support (e.g., local-scale analyses and consistent hotspot signals across input datasets).Where outputs were sensitive to input choices (e.g., ECLIPS vs CHELSA, fire occurrence records, or national flood-map coverage), they were used primarily as screening evidence and **identified as priorities for further interpretation and refinement in Phase 3**.

Based on earlier screening and prioritisation, **floods and wildfires** were selected for detailed assessment. The risk analysis produced a range of spatial, quantitative, and qualitative outputs for these hazards at the regional level, complemented by selected local-scale examples.

For **flood risk**, the following outputs were used:

- spatial flood hazard and exposure maps,
- identification of exposed population, assets, and critical infrastructure,
- analysis of historical flood events and observed impacts,
- projections of future flood-related hazards based on climate-driven changes in extreme precipitation.

For **wildfire risk**, the assessment drew on:

- fire hazard and risk indicators, including drought-related stress and fire weather conditions,
- spatial distribution of forested areas exposed to elevated fire risk,
- historical records of wildfire occurrence,
- projections of future wildfire risk under changing climatic conditions.

For both hazards, **current and future risk conditions** were considered in order to capture evolving risk dynamics and trends. The outputs were aggregated and visualised in the **evaluation dashboard**, which served as the primary tool for synthesising analytical results and supporting the interpretation required for the Key Risk Assessment.

The selection and use of these outputs ensured consistency between the Risk Analysis and Key Risk Assessment steps, while enabling a focused, decision-oriented evaluation of the region’s priority climate risks.

*Table 26 Key Risk Assessment*

| Risk workflow | Severity | | Urgency | Capacity | Risk priority |
|---|---|---|---|---|---|
| | Current | Future | | | |
| River flooding | | | | | High |
| Wildfires | | | | | High |

### 2.4.3 Assess Severity

Severity was assessed for both current and future conditions in accordance with the Key Risk Assessment Protocol, using the four categories: **limited, moderate, substantial, and critical**. The assessment considered the magnitude, frequency, and potential consequences of impacts associated with the selected priority risks—floods and wildfires—based on analytical outputs and qualitative inputs.

**Floods**

For flood risk, severity was assessed as substantial to critical. Historical and recent flood events in the region have demonstrated the potential for significant impacts, including damage to residential and public infrastructure, disruption of transport networks, and financial losses. Flood events are typically associated with high-impact, short-duration processes that can affect large areas within a short time frame. Analytical outputs indicate that flood-prone areas overlap with settlements, critical infrastructure, and economically important zones, increasing the potential for high damage levels. In future scenarios, the projected increase in the frequency and intensity of extreme precipitation events suggests that flood-related impacts may intensify, reinforcing the severity assessment. Floods also carry the risk of cascading effects, such as long-term disruption of services, soil erosion, and secondary environmental impacts. While most flood impacts are not irreversible in the strict sense, repeated events can lead to cumulative damage and long-term vulnerability, particularly in exposed communities.

**Wildfires**

Wildfire risk was assessed as substantial, with potential to reach critical severity under extreme conditions. The assessment reflects both the current state of forest ecosystems and projected future changes driven by climate-induced drought and increased fire weather risk.

Wildfires can result in severe environmental impacts, including loss of forest cover, degradation of ecosystems, and biodiversity loss. In addition, wildfire events pose risks to nearby settlements, infrastructure, and human safety, particularly when fires escalate rapidly under adverse weather conditions. Although wildfire occurrence is more episodic than flooding, the consequences of large-scale events can be long-lasting and, in some cases, irreversible.

Future projections indicate increasing stress on forest ecosystems and a higher likelihood of conditions conducive to wildfire spread, suggesting a potential upward shift in severity over time.

**Stakeholder and community perspectives** Perspectives gathered through stakeholder consultations and public engagement activities enriched the severity assessment by providing insights into local experiences and perceived impacts. Stakeholders and community members frequently highlighted concerns related to long-term drought, increasing wildfire risk in forested areas, and the disruptive effects of extreme rainfall and flash floods. Although formal verification of severity scores by stakeholders was not conducted, these perspectives reinforced the analytical findings and supported the classification of both floods and wildfires within the higher severity categories.

**Overall severity assessment**

Considering current impacts, future projections, and qualitative inputs, both floods and wildfires were assessed as **high-severity climate risks** for the region. Floods were characterised by higher frequency and immediate socio-economic impacts, while wildfires were associated with potentially irreversible environmental damage and increasing future risk.

### 2.4.4 Assess Urgency

The urgency of the selected priority risks was assessed in accordance with the Key Risk Assessment Protocol, using the four categories: **no action needed**, **watching brief**, **more action needed**, and **immediate action needed**. The assessment considered (i) changes in risk severity from current to future conditions, (ii) the expected timing of major impacts and the lead time required to minimise damages, (iii) whether the hazard is expected to worsen in the near future, (iv) whether impacts are driven by sudden-onset events or slow-onset processes, (v) the potential for persistence and recurring impacts, and (vi) stakeholder perspectives.

**Floods**

Flood risk was assessed as requiring **immediate action**. Flood events in the region are predominantly associated with sudden-onset processes, such as intense rainfall and flash floods, which can lead to rapid and severe impacts with limited lead time for response. Historical experience and recent events demonstrate that flood impacts are already occurring and causing damage under current climate conditions. Future projections indicate an increased likelihood of extreme precipitation events, suggesting that flood severity is expected to remain high or increase over time. The sudden nature of flood events significantly influences the urgency assessment, as delayed action can result in substantial damage and loss. Flood risks also have the potential to persist through repeated events, compounding impacts over time. Stakeholder discussions underscored the challenges of responding effectively to rapidly evolving flood situations, further supporting the classification of flood risk as **immediate action needed**.

**Wildfires**

Wildfire risk was assessed as **more action needed**, with elements of **immediate action** particularly in relation to preparedness, prevention, and early warning. Unlike floods, wildfire risk is shaped by both slow-onset and sudden processes. Long-term drought, increasing temperatures, and declining forest health gradually elevate baseline risk, while individual wildfire events can escalate rapidly under extreme weather conditions. Future projections indicate that conditions conducive to wildfire occurrence and spread are likely to become more frequent, increasing the urgency of action over time. Stakeholder and community feedback highlighted concerns regarding limited preparedness and the potential for rapid fire spread, particularly in forested and rural areas. These perspectives reinforced the urgency scoring by emphasising the need for timely preventive actions, even if severe wildfire events are not observed every year.

**Overall urgency assessment**

In summary, both flood and wildfire risks were assessed within the higher urgency categories. Flood risk was classified as **immediate action needed** due to its sudden onset, existing impacts under current conditions, and the likelihood of intensification in the future. Wildfire risk was classified as **more action needed**, reflecting increasing future likelihood and the importance of strengthening preparedness and early-warning capacity in the near term.

### 2.4.5 Understand Resilience Capacity

Resilience capacity for the selected priority risks was assessed in Phase 2 in line with the Key Risk Assessment Protocol. As capacity-specific evidence and outputs were limited in this phase, the assessment is **preliminary and largely qualitative**, based on a review of existing measures and the basic institutional set-up across financial, human, physical/technical, natural and social dimensions. Core elements are in place across the region (monitoring and warning services, emergency response structures, crisis management arrangements). Flood response also benefits from experience with recurring events and selected preparedness/protection measures, while wildfire resilience depends strongly on local first-response capacity and coordination with professional services. An illustrative gap is voluntary firefighting corps coverage: volunteer fire brigades are established in 290 municipalities and agglomerations in the region, while more than 200 municipalities still lack such units, which may imply delayed initial response.

Beyond response, resilience also depends on the ability to **prepare and implement prevention and adaptation projects**. In Phase 2, this was noted qualitatively as a constraint, as many municipalities have limited staff, technical expertise and financial space to build project pipelines and deliver investment-ready proposals—highlighting the need for a broader resilience pathway linking risk evidence to strategic planning and feasible investment prioritisation.

Overall (preliminary) categorisation: resilience capacity was assessed as **medium**, while acknowledging variation across municipalities and dimensions and that capacity can locally be closer to **low** where gaps are more pronounced. This preliminary capacity assessment was conducted as a cross-hazard (overall) appraisal and was not differentiated separately for flood and wildfire risk at this stage. In Phase 3, we will further develop this part of the assessment; see Section 2.6 (Work plan – Phase 3) for details.

### 2.4.6 Decide on Risk Priority

Based on the evaluation dashboard principle—i.e., a structured synthesis of CRA evidence across hazards (severity/extent, urgency/trends and capacity to respond)—river floods and wildfires were confirmed as priority risks for the Banská Bystrica Region in Phase 2. The prioritisation reflects:

(i) the **regional-scale CRA outputs**, which indicate consistently high relevance and clear hotspot patterns requiring targeted attention,

(ii) the **increasing urgency demonstrated by recent events**, including the large wildfire near **Pohorelá in the Low Tatras (reported on 30 August 2024, with extensive ground and aerial firefighting)**, and the severe flooding episode in **late November 2025**, when heavy rainfall and snowmelt caused widespread flooding in parts of central Slovakia, affecting roads and settlements (including impacts around Sliač/Zvolen area). The prioritisation further reflects

(iii) (iii) **the need to strengthen preparedness and implementation capacity** in locations where risk and capacity gaps overlap, as reflected in the preliminary capacity assessment and discussed during consultations with a BBSGR risk management expert. These priorities directly inform Phase 3, which will focus on translating hotspot evidence into actionable recommendations and stakeholder-oriented products; see Section 2.6 (Work plan – Phase 3) for details.

## 2.5 Monitoring and Evaluation

**Lessons learned & challenges**

Phase 2 confirmed that moving from an **initial, indicative risk pre-assessment (Phase 1)** to more decision-relevant outputs is achievable when nationally/regionally managed datasets can be integrated and processed at scales meaningful for end users (regional and pilot local scale). The main added value was improved mapping inputs and more interpretable hotspot outputs for planning and preparedness.

Key challenges included: (i) **data access and incomplete coverage** of some layers, (ii) **data quality and processing effort** (cleaning, harmonisation, georeferencing, methodological choices), and (iii) **technical workflow adaptation and interpretation**, including the need to communicate limitations and uncertainty clearly.

**Stakeholders' role & feedback**

Stakeholders support (1) **validation of data and assumptions**, (2) **testing usability** of outputs for practice (emergency management, fire and rescue services, spatial planning), and (3) **feedback on formats and messaging**. Feedback was positive regarding relevance and potential use, while emphasising the need for clearer decision-oriented recommendations, tailored output packages for different audiences, and more time for formal verification (limited by partner capacities).

**Learning**

Learning is ensured through reproducible, documented workflows; iterative improvements based on Phase 2 experience; and ongoing consultation with data providers and experts. Phase 2 directly informs priorities for the next phase (what works, what to improve, and where the main data gaps remain).

**Data gaps & needs**

Phase 2 improved access and usability of selected national layers through coordination with institutions. Remaining needs include broader/updated hazard coverage, more standardised event records (consistent geolocation and classifications), and stronger municipal exposure layers (critical infrastructure, sensitive assets, vulnerable groups). Possible use of statistical socio – economic data resources will also be considered. Additional competencies are also needed for interpretation and communicating uncertainty, plus time for joint interpretation with stakeholders.

**Communication**

Communication will follow "the right format for the right user" approach: **Climate Hub** (interactive maps, open data, concise explanations and methodological notes), **Short policy briefs** for regional decision-making, **locally oriented materials** for municipalities, and expert **meetings**/results **forums**.

At the same time, communicating results remains challenging and we are still considering the best approach. A fully rigorous explanation becomes longer and more technical, while very brief messages risk inaccuracy or misinterpretation (e.g., "this area is safe" / "that area is the worst") without context.

**Monitoring system**

BBSGR does not have a direct mandate to systematically collect and maintain all long-term monitoring inputs (e.g., event/response/damage records); these are primarily collected by state institutions (e.g., district offices under the Ministry of Interior and other sectoral data owners). BBSK can request such data and use them for regional analysis.

We intend to continue climate risk assessment because systematic regional evaluations are still missing. We acknowledge that the future scope of monitoring and updates depends on capacities, data flows and cooperation. A key measure is to strengthen cooperation with state institutions and expand collaboration with scientific/research organisations, as parts of the work are research-oriented (methods, trend interpretation, uncertainty, scenarios). This agenda is currently led by the **BBSGR Data Analytics Department**. In parallel, we are preparing an open data portal (Climate Hub as part of it) where outputs will be published and, where feasible, updated. Going forward, the region will focus on implementing measures and supporting investment feasibility and prioritisation with robust climate data, including information on event frequency and impacts.

**What worked / what didn't**

Worked well: shift to more regionally relevant inputs; workflow improvements and more stable processing; cooperation with key institutions and experts.
Limitations: incomplete coverage of some layers; limited room for formal validation; need to further tailor communication formats for different target groups.

**Resources & efficiency**

Phase 2 was implemented efficiently in line with the approved Individual Follow-up Plan. We retain documentation for the purpose of complying with national fiscal rules. During the reporting period, **direct costs of EUR 28,449.74** were reported, including **travel costs of EUR 2,747.67**. **Indirect costs** amounted to **EUR 10,429.13**. Expenditure complied with Grant Agreement conditions, the eligible cost definition and the IFP budget, while respecting **no double funding** and the rule that CLIMAAX funds may only be used for activities directly related to the project.

Efficiency supported faster iteration and workflow adjustments, but limited time/staff capacity reduced room for broader joint evaluation and formal verification with stakeholders.

**Impact**

Phase 2 improved regional risk understanding by producing clearer spatial outputs, identifying key data gaps, strengthening institutional capacity to work with CRA methods, and providing a stronger basis for adaptation prioritisation, preparedness planning and investment-related discussions.

## 2.6 Work plan Phase 3

The final phase (M16–M22) will focus on the practical uptake of climate risk assessment results for **river floods and wildfires**. Building on the Key Risk Assessment findings, Phase 3 will translate analytical outputs into usable products supporting strategic planning, preparedness and climate awareness in the Banská Bystrica Region. The work plan follows three objectives in line with the Individual Follow-up Plan (IFP).

**1) Improvement of the Knowledge Base on Climate Change**

A core activity will be the consolidation and publication of project results through the **Climate Hub** as a dedicated section of the BBSGR Open Data Portal. The Hub will provide interactive maps, selected datasets and concise explanatory materials (including interpretation notes and key limitations) to support transparent access, reuse and understanding by municipalities, sectoral institutions, practitioners, research and the wider public.
Key output (IFP KPI): Project outcomes published at the OPEN DATA PORTAL BBSGR (1 complex section).

**2) Refining Regional Policy and Enhancing Stakeholder Engagement**

Phase 3 will organise a structured **Strategy Discussion Phase** with key stakeholders and experts to consult the findings, clarify practical implications and identify measures for effective implementation. Based on this process, the project will deliver targeted policy-oriented products to support uptake and integration into regional planning and decision-making:

- **Policy brief for the BBSK Council (including presentation)** and a **recommendation document for strategic integration and adaptive strategy development/existing environmental strategy[19] refinement**, supporting strategic planning and investment prioritisation.
- **Policy brief for the Regional Security Council** and a **recommendation for optimisation of intervention capacity** (mandatory output under the IFP), supporting preparedness and risk management.

**3) Raising Awareness and Promoting Cooperation**

Project results will be communicated and discussed through a combination of online and offline activities, centred around a **public Results Forum** and complemented by dissemination via the Climate Hub and targeted outreach. The aim is to increase public climate literacy, promote cooperation across sectors and governance levels, and support the long-term sustainability and practical use of project outputs.

**Aspects not studied in this phase**

Technical design and implementation of monitoring systems, early warning mechanisms, or specific technological solutions will not be studied in detail during Phase 3. These areas fall outside the scope of the current project and would require dedicated technical and investment-focused initiatives beyond this phase.

Subject to available capacity, we also plan to test additional CLIMAAX workflows as an extra step, with a particular interest in drought.

# 3 Conclusions Phase 2- Climate risk assessment

**Overview and Progress Since Phase 1**

In Phase 2, we implemented the selected CLIMAAX workflows using improved regional datasets, primarily sourced from the Slovak Water Management Enterprise (SWME) for flood hazard mapping and the Ministry of Interior of the Slovak Republic for historical fire records. Stakeholder engagement was strengthened through continuous communication with key data providers (SWME, Ministry of Interior, SHMI), as well as regional firefighting authorities and a risk management expert. Phase 1 and Phase 2 played complementary roles within the Climate Risk Assessment (CRA).

Phase 1 served as an initial screening exercise using European-scale datasets and standard CLIMAAX workflows to identify the main hazards and indicative risk hotspots at a broad regional level. Phase 2 built on this foundation by regionalising and refining the assessment through national and local datasets, workflow adjustments (e.g., flood return periods), and sensitivity checks to key input choices (e.g., ECLIPS vs CHELSA, fire occurrence inputs, and national flood-map coverage). Differences between Phase 1 and Phase 2 mainly reflect improved data and

[19] *https://www.bbsk.sk/zp*

methodological refinement, rather than a temporal trend in risk; Phase 2 provides more locally grounded evidence and highlights where results are robust versus where additional context is needed.

Phase 2 delivered the initial public-facing infrastructure for dissemination **within the planned Climate Hub (BBSGR Open Data Portal)**, including pilot outputs for both priority risks (floods and wildfires) published to support feedback and usability testing. Building on this, we plan to expand the content and interpretation materials through more user-friendly formats such as **ArcGIS StoryMaps** and an interactive **ArcGIS Experience Builder** application for exploring and comparing layers, complemented by short thematic briefs for different audiences.

**Key findings from the Phase 2 CRA outputs**

Overall, Phase 2 confirmed **river floods and wildfires** as the two priority risks for the Banská Bystrica Region and provided clearer, more locally grounded evidence on where risk hotspots are consistent and where results remain sensitive to input choices.

- **Floods:** Using national flood hazard mapping increased spatial precision for the mapped river sections. However, partial coverage across the region limits full comparability of regional totals and may underrepresent risks linked to smaller watercourses. Local-scale outputs (e.g., Sliač) are currently the most actionable for municipal interpretation and communication.
- **Wildfires (ML):** Outputs provide relative hotspot patterns but show sensitivity to input choices (fire occurrence records and climate predictor datasets such as ECLIPS vs CHELSA). Agreement across inputs strengthens confidence, while divergence highlights uncertainty zones to be prioritised for Phase 3 review and contextualisation.
- **Wildfires (FWI):** The FWI-based approach proved a practical, stakeholder-friendly complement to the ML workflow. It remains applicable even where historical fire occurrence data are limited, and district-level aggregation supports communication and prioritisation.

**Stakeholder engagement, verification and communication**
Stakeholder engagement in Phase 2 focused on data selection, interpretation and practical relevance of outputs. Verification was limited to targeted consultations rather than full formal validation due to time and operational constraints. Communication and outreach activities were implemented to disseminate project results and build awareness; however, communicating complex regional outputs in a way that remains both accessible and methodologically accurate remains a key challenge.

**Challenges addressed in Phase 2**

Phase 2 addressed key challenges identified after Phase 1 by strengthening the CRA evidence base and improving regional relevance. We integrated national/regional datasets for priority hazards (SWME flood hazard mapping and Ministry of Interior fire records) and adapted selected workflow settings (e.g., flood return periods). We also carried out sensitivity checks (e.g., ECLIPS vs CHELSA; ML vs FWI for wildfires) to better understand which patterns are robust across inputs and which require additional context. Continuous coordination with data providers and operational actors improved clarity on risk ownership and supported practical framing of results. Data preparation—especially cleaning and georeferencing wildfire records—significantly improved the usability of inputs for analysis.

**Challenges not addressed in Phase 2 (remaining limitations)**

Some challenges could not be fully addressed due to data, capacity and scope constraints. For floods, national hazard mapping improves detail where available but does not fully cover all river basins, limiting region-wide comparability and potentially underrepresenting smaller watercourses. For wildfires, historical records still show variable documentation and quality, affecting interpretation. Formal verification with all stakeholders was limited by partner availability, and the resilience capacity dimension remains preliminary and qualitative; more operational recommendations (e.g., intervention capacity optimisation and investment prioritisation) will be developed in Phase 3. Finally, communicating complex results in an accessible but accurate way remains challenging.

# 4 Progress evaluation

In the second phase of the project, we successfully applied the CLIMAAX methodology and toolbox for Climate Risk Assessment (CRA) utilizing regional data. This approach enabled a comprehensive evaluation of the relevance and availability of regional datasets, identification of existing data gaps, and comparison of outputs generated in both the first and second phases. Progress was also made in stakeholder engagement; however, it is acknowledged that further involvement is necessary, with a particular focus on the verification and practical applicability of the generated outputs.

**Connection Between Deliverable 2 Outputs and Planned Activities for Phase 3**

- **Climate risk assessment findings and interactive tools:**
  Findings from Phase 2 will be used to develop interactive maps and tools within the Climate Hub on the Open Data Portal. These resources will enhance understanding of climate risks and support informed decision-making.
- **Targeted outputs for key stakeholders:**
  Outputs will be customized for critical groups such as the regional council, municipalities, firefighters, and water and forest management authorities to foster adaptation implementation and strengthen collaboration.
- **Communication and awareness:**
  Public events will be organized, media outreach conducted, and data openly shared to increase awareness and support for climate adaptation measures.
- **Policy support:**
  Simple policy briefs and strategic recommendations will be prepared to facilitate integration of climate risk considerations into regional planning and to enhance risk management capacities.

The following section outlines the **Key Performance Indicators (KPIs) and milestones** achieved during this phase, along with the specific actions undertaken to meet the targets defined in the Individual Following Plan. Summary tables below provide a clear overview of the progress made.

*Table 27 Overview key performance indicators*

| *Key performance indicators* | *Progress* |
|---|---|
| At least 2 relevant Workflows for sele cted hazards documented in Delivera ble 2 -<br>Final number of workflows will be det ermined according to the available wo rkflows and guidelines specified in the CLIMAAX handbook | 2 two relevant workflows addressing the selected hazards have been thoroughly documented. |
| 4<br>posts on the enterprise social platfor m Phase 1,2,3 | We published a total of four posts on the enterprise social platform throughout phase 2. Details about the content of these posts can be found in the Annex 1. |
| 4 posts on social media Phase 2, 3 | We published a one post on the social Facebook platform throughout Phases 2. Details about the content can be found in the Annex. We plan to publish other 3 posts during the final phase. During this |

| *Key performance indicators* | *Progress* |
|---|---|
| | process, we realized that communicating such a complex topic via social media in a way that is engaging and generates meaningful feedback is challenging. Therefore, we also focused on other forms of engagement and supplemented the KPIs with additional activities, as detailed below under the optional KPI **Outreach and Dissemination Activity**. |
| Outreach and Dissemination Activity (optional KPI) | As part of our outreach and dissemination efforts, we successfully published an article in the National Newsletter on Climate Change Adaptation in April 2025. Additionally, project results were presented at the conference *Let's get inspired* held in Brno in October 2025.<br><br>To further raise awareness, we issued an informational bulletin in October 2025 and organized a public event during the same month, engaging the broader community and stakeholders. Details can be found in the Annex 1. |
| | |

*Table 28 Overview milestones*

| *Milestones* | *Progress* |
|---|---|
| M6 Collected local data and knowledge | **Milestone achieved:** In achieving Milestone M6, relevant local data and expert knowledge were successfully obtained from several key sources. Specifically, we secured access to data from the Slovak Water Management Enterprise and the Ministry of Interior of the Slovak Republic related to flood-prone areas and historical wildfire events. Additionally, information was gathered on the capacities of voluntary firefighting units, as well as on municipal project plans focused on adaptation and prevention of climate risks.<br><br>At the same time, we actively exchanged experiences with other regions and cities, which contributed to broadening our knowledge base.<br><br>An important part of the process was also the feedback received from stakeholders, providing valuable insights |

| *Milestones* | *Progress* |
|---|---|
| | for further improving project outputs and better targeting adaptation measures. |
| M7 Customized CLIMAAX Toolbox | **Milestone achieved:** In this milestone, we successfully customized the CLIMAAX toolbox by simplifying and optimizing the scripts to improve user interaction and flexibility. The updated scripts enable users to modify all key variables at the beginning of the code, removing the need to search for variable changes scattered throughout the script (see Figure 31). This enhancement significantly improves the toolbox's usability and efficiency. The revised scripts and the associated HTML report are provided in Annex 2 of the report. |
| M8 Executed extended multi risk asse ssment | **Milestone achieved:** In this phase, we conducted an extended multi-risk assessment by integrating regional data specific to the Banská Bystrica region. We carefully selected and applied models that are best suited to the local geographical and climatic conditions, ensuring a more accurate and relevant evaluation of the risks. |
| M9 Evaluated results | **Milestone achieved:** The evaluation primarily focused on comparing the quality and relevance of results obtained using regional data versus those derived from European-scale datasets. This comparison aimed to determine whether the use of regional data provided improved accuracy and detail for the assessment. Secondly, we assessed the overall data coverage, identifying existing gaps—particularly in flood-related datasets within the regional data—which highlighted areas requiring further data acquisition. Finally, we compared outputs within a selected Sliač area (in the case of floods) to better understand differences between the results generated by different datasets. |
| M10 Iterative Enhancement Phase co mpleted - refining the project based o n ongoing assessments and insights gained from the initial results | **Milestone achieved:** As part of the iterative enhancement phase, we utilized the EURO-CORDEX model biases dashboard, presented by the CLIMAAX project consortium in November 2025. This tool enabled us to better support the selection of an appropriate climate model within the risk assessment workflow, contributing to improved accuracy, usability, and relevance of the project outputs. |

| *Milestones* | *Progress* |
|---|---|
| M11 Evaluated results and identified " hot spots" for Phase 3 | **Milestone achieved:** In this milestone, we evaluated the assessment results and identified key "hot spots" to focus on in Phase 3. The identified hot spots include flood-prone areas corresponding to return periods of 50, 100, and 500 years, highlighting zones with significant flood risk. Additionally, areas with elevated wildfire risk were delineated as fire hot spots. These defined zones represent the critical areas where adaptation and risk management efforts will be prioritized in the next phase of the project. |
| M12 Published the results via DRMKC and OPEN DATA PORTAL BBSK | **Milestone partially achieved:** Following consultations with the CLIMAAX project team, we decided to forgo direct uploading of results to the Disaster Risk Management Knowledge Centre (DRMKC), where controlled access would have been established. However, a portion of the outputs from Phase 1 have already been published as open data on the Open Data Portal, within the Climate Hub section. It is important to note that the Open Data Portal is currently under development, and therefore the final publication will be made as soon as possible once the platform is fully operational. Furthermore, we intend to publish the complete outputs from Phase 2 only after the approval of Deliverable 2. This approach ensures that incomplete, unverified, or otherwise potentially irrelevant results are not prematurely released, thereby maintaining the integrity and reliability of the disseminated information. |
| M13 Attended the CLIMAAX workshop held in Barcelona. | **Milestone achieved:** We actively participated in the CLIMAAX workshop held in Barcelona, contributing both through a poster presentation and an oral presentation |
| M14 Submitted of deliverable 2 | **Milestone achieved:** We have submitted Deliverable 2 |

# 5 Supporting documentation

This deliverable is accompanied by following annexes:

- Annex 1 Overview of Communication and Dissemination Activities
- Annex 2 Technical outcomes

Zenodo reference: https://doi.org/10.5281/zenodo.18294264

# 6 References

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