CLIMAAX
climate ready regions

Deliverable Phase 2 – Climate risk assessment

Updating Västernorrland's Climate Risk and vulnerability Assessment using the CLIMAAX methodology

UVCRA

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Summary of evaluation criteria for this deliverable

- The document is well-structured and technically sound

- Sufficient attention is given to the first part of the deliverable and the steps of the CLIMAAX framework are well addressed

- The methods / data / models applied are described with sufficient detail to make the assessment fully understandable to the reader not familiar with the data and region

- Data included is relevant and sources are traceable.

- Results are clearly presented in good quality graphic and visual materials

- The report contains extra materials on top of the standard output of the workflows

- The results are clearly described

- An interpretation of the results is given (what does this mean for the region, are the results in line with expectations / earlier assessments, what are the consequences for the different stakeholders)

- For the Phase 2 and 3 deliverables: It is clear from the deliverable what extra work has been conducted in this phase compared to the previous phase

- For the Phase 2 and 3 deliverables: You do not one-on-one repeat the information from the first phase, but rather deepen the analysis and highlight any new or more detailed information

- For the Phase 1 and 2 deliverables: The steps to be conducted in the next phase are brief but clearly described

- The report reflects on shortcomings, potential improvements and the value of the outcomes for the region

Document Information

Deliverable Title	Phase 2 – Climate risk assessment
Brief Description	This report describes the Climate Risk and Vulnerability Assessment for Västernorrland County conducted in accordance with the CLIMAAX methodology. It focuses on intensifying hazards such as heavy rainfall, snow-related risks, and rising temperatures. The assessment combines the previous Climaax analysis with climate scenarios from Swedish Meteorological and Hydrological Institute, historical analysis along with local insights gathered through workshops with municipalities, the Sámi community, and regional experts to identify sector-specific vulnerabilities. The report concludes with a prioritized risk ranking that serves as a foundation for developing targeted adaptation measures and enhancing regional resilience in the project's final phase.
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Abbreviations and acronyms

Abbreviation / acronym	Description
CABV	The County administrative Board of Västernorrland
CRA	Climate Risk Assessment
GIS	Geographic Information System
MSB MCF	Swedish Civil Contingencies Agency (old name) Swedish Civil Defence and Resilience Agency (new name)
SGI	Swedish Geotechnical Institute
SMHI	Swedish Meteorological and Hydrological Institute

Executive summary

Västernorrland County is situated in eastern Central Norrland. Its landscape is hilly, with high mountains and deep river valleys. This landscape has been influenced by post-glacial rebound, a process that has been ongoing since the Ice Age and continues today. The land rises by approximately 8 mm each year. The County is one of the most forested areas in Sweden, with 74% of its total area covered by forests, 3% by agricultural land, and 2% by developed land.

Västernorrland is particularly vulnerable to climate change due to its combination of coastal and inland areas, critical infrastructure, and reliance on natural resources. **The CLIMAAX project** provides an opportunity to update the region's Climate Risk and Vulnerability Assessment, ensuring that adaptation measures are based on the latest climate data and stakeholder insights.

The **climate data** used for the project comes from the Swedish Meteorological and Hydrological Institute (SMHI), which provides Swedish regions and municipalities with long-term climate data, scenario modelling, and tools that help assess risks.

During Phase 2, the County Administrative Board of Västernorrland (CABV) combined Phase 1 CLIMAAX results with climate projections from SMHI, historical observations, municipal datasets, and stakeholder workshops. The assessment focused on increasing temperatures, heavy precipitation, and changing snow conditions under the RCP4.5 and RCP8.5 scenarios. Local input from municipalities, the Sámi community, and regional stakeholders helped identify vulnerabilities and validate the findings. Together, the results indicate a warmer and wetter future climate, with increasing risks from heavy precipitation, reduced snow cover, and impacts on critical societal functions.

The analytical data and maps were used during the workshops with municipalities, relevant national authorities and other organisations. Besides heavy rainfall and snow, we also addressed rising mean temperatures and heatwaves in the workshops. The key risk assessment shows that **heavy rainfall is the most critical risk in our region**, but that snow and rising temperature also pose great threats.

The severity and urgency of the risks in our region became particularly evident during September 2025, when heavy rain severely affected the Västernorrland region. The rain caused severe damage to infrastructure – approximately 40 roads and railway were affected. Passenger train traffic was suspended northward from Sundsvall. Water levels became extremely high in many waterways and numerous property owners experienced flooded basements and other water damage. The CABV activated its emergency response team to manage the situation. The **Copernicus Emergency Management Service** was activated by the CABV in cooperation with MSB. Satellite-based analyses were used to map flood extents and assess impacts on infrastructure and affected communities, underlining the scale and severity of the flooding across the region.

This event and the findings of phase 2 underscore the need for immediate action to address heavy rainfall risks, including infrastructure upgrades and improved emergency response. Phase 3 will focus on developing targeted adaptation measures and integrating climate risks into regional planning.

1 Introduction

1.1 Background

Västernorrland County is located in the eastern part of Central Norrland and consists of seven municipalities. Ånge and Sollefteå are inland municipalities, while Sundsvall, Timrå, Härnösand, Kramfors, and Örnsköldsvik have both coastal and inland areas. The county has approximately 244,000 inhabitants spread over an area of 21,548 square kilometres. While the larger Sàmi population is concentrated further north in Swedish Lapland, Västernorrland retains a significant Sàmi community that identifies strongly with their heritage.

The landscape is hilly, with high mountains and deep river valleys. The county's largest rivers are the Ångermanälven, Indalsälven, and Ljungan. In addition, there are many smaller rivers and streams. Many of these waterways are regulated, and the hydropower produced in the county accounts for 9% of Sweden's total electricity production.

The landscape is influenced by post-glacial rebound, which has been ongoing since the Ice Age—and continues today. The land rises by about 8 mm per year. In most parts of the county, the topsoil consists of moraine. The moraine and eskers are partially covered by younger fine sediments.

The county is one of the most forest-rich in the country, with 74% of the total area covered by forest land, 3% by agricultural land, and 2% by developed land. The local economy has evolved from the county's natural resources in the form of forests and energy. The foundational industries (forestry, pulp/paper, and hydropower) remain strong, alongside a well-developed technology and environmental technology sector.

1.2 Main objectives of the project

Project Specific Objectives:

- Develop a *Climate Risk and Vulnerability Assessment* using the CLIMAAX methodology, with a focus on three key hazard profiles: **heavy snowfall & blizzards, extreme precipitation, and increasing temperatures**.
- The **goal of Phase 2** is to **update the analysis using national and local data**, supported by the SMHI Climate Scenario Tool and discussions with municipalities, national authorities, and other relevant organisations. The phase aims to incorporate **additional region-specific hazards** into the Climate Risk and Vulnerability Assessment and to apply the **CLIMAAX handbook** as guidance for the assessment process.

- **Integrate the assessment results into internal planning and decision-making processes** at Länsstyrelsen Västernorrland, serving as a guiding document for future work.

- **Disseminate updated knowledge** and materials derived from the project to support urban planning and decision-making at the municipal level, as well as within civil society, including Sámi villages and local organizations.

The project is expected to bring increased attention and knowledge to the work on climate adaptation and the impact of climate change in the county among local stakeholders. It provides an opportunity to update the Climate Risk and Vulnerability Analysis, along with the accompanying Action Plan, which was developed in 2018. This will offer guidance to the county's municipalities, authorities, and citizens on how the region may be affected by a changing climate, and what measures we can take today to address these changes.

Throughout the project's implementation, we will engage in various communication efforts with our stakeholders, for example in the forms of workshops and meetings. This will give us opportunities to discuss the effects of the climate change on the regional level as well as explore the actions to reduce those vulnerabilities.

The project also enables us to exchange experiences with other regions in Europe undertaking similar work, allowing us to learn from them and share our own insights from the efforts being carried out in our region.

By using the handbook's working method, we will ensure that our region, and other participating regions, conduct these analyses in the same way. This allows us to make sure that Europe's regions carry out this work according to a unified approach. It also gives us the opportunity to propose the method improvements and test the available factual data.

1.3 Project team

The project team at the County Administrative Board of Västernorrland has consisted of:

- Unit Manager Viveka Sjödin, Community Planning
- Project Manager Asta Gulijeva
- Marine Spatial Planning and Climate Adaptation officer Anna Döhlen Wedin
- Emergency Preparedness Officer Fabian Erlandsson.

The project manager, Asta Gulijeva, has been recruited and began her employment on August 13, 2025. The Marine Spatial Planning and Climate Adaptation officer Anna Döhlen Wedin have joined the team in October 2025.

1.4 Outline of the document's structure

Following the introduction, Chapter 2 presents the Phase 2 Climate Risk Assessment, including the scoping process, stakeholder engagement, risk exploration, scenario selection, and the regionalized analysis of increasing temperatures, heavy rainfall and heavy snowfall. The chapter concludes with the key risk assessment findings, monitoring and evaluation, and the work plan for Phase 3.

Chapter 3 summarizes the main conclusions of Phase 2, while Chapter 4 reports progress against the project's key performance indicators and milestones. Chapter 5 presents supporting documentation, including the Visual Outputs document, and Chapter 6 lists the references used in the assessment.

2 Climate risk assessment – phase 2

2.1 Scoping

2.1.1 Objectives

Sweden is divided into 21 counties, each overseen by a County Administrative Board (Länsstyrelsen). These boards are responsible for ensuring that national objectives are implemented at the regional level, while also considering local conditions and needs. The County Administrative Board operates from a comprehensive governmental perspective, coordinating societal interests and the efforts of national agencies. It also monitors regional development and informs the government about the county's needs.

For the past decade, in response to a government mandate, **the County Administrative Board of Västernorrland** has worked to enhance understanding of how climate change may impact our county. Throughout this period, awareness has steadily increased, and we have actively shared insights with municipalities, public agencies, and other regional stakeholders. However, due to insufficient funding, this work has not continued over the past few years.

Our aim with the updated Climate Risk and Vulnerability Assessment (CRA) is to bring back attention on climate-related risks within our own organization. We would like to ensure that the impacts of climate change are systematically integrated into our work, including the guidance and policy documents we oversee across various sectors. This initiative will also help raise awareness among municipalities, which must account for climate risks in areas such as spatial planning, long-term strategies for drinking water supply, and efforts to strengthen crisis preparedness among public authorities and the wider community.

At the national level, the legislation now includes more requirements to consider the impacts of climate change (for example, within municipal land and water use planning). A regional **CRA will be a valuable support tool for municipalities as they develop new comprehensive plans.** National agencies have also worked to produce knowledge platforms and guidance documents on climate adaptation for various sectors, and we can help disseminate that knowledge within our county.

The CRA, along with its associated action plan, will improve the capacity of **regional authorities and the public to understand the increasing risks posed by a changing climate.** This will help ensure that these risks are systematically integrated into decision-making processes and will strengthen our resilience against the negative consequences that climate change may bring to our county. At the same time, we aim to harness the positive effects, for example, increased opportunities for our agricultural sector, which may benefit from improved growing conditions and a longer growing season.

One of the main challenges is collecting and synthesizing diverse types of **data and statistics**. We have access to climate-related data provided by the Swedish Meteorological and Hydrological Institute (SMHI), which will be used as a foundation for our climate risk and vulnerability analysis. In addition, the County Administrative Board has produced several regional analyses, including a report

on cultural heritage in risk environments. These reports will serve as important complementary sources for our analysis.

Engaging municipalities and other relevant authorities is a key part of our work. Between 2018 and 2022, the County Administrative Board maintained an active collaborative network with regional and municipal actors as well as other relevant authorities. This network was reactivated during Phase 2 of the project. In parallel, we have continued to identify and collaborate with relevant projects and cooperative networks, such as the Nordic climate adaptation network of County Administrative Boards, which contribute valuable input to our analysis and serve as important channels for reaching different target groups across the county. This collaborative work will continue during Phase 3.

2.1.2 Context

Climate hazards, impacts and risks have been assessed in our region through national coordination efforts (various research initiatives coordinated by the national institutions) as well as through the implementation of the *Regional Action Plan for Climate Adaptation in Västernorrland County* (2018) and its *Follow-up report* (2018-2022). In addition, the Swedish Meteorological and Hydrological Institute (SMHI) supports the regions and municipalities in Sweden with long-term climate data, scenario modeling, and tools like the Climate Change Scenario that helps to assess risks. With the support of the CLIMAAX project, the County Administrative Board in Västernorrland has resumed active work in the field of climate adaptation and increased awareness of this issue among regional stakeholders. At the national level, authorities are working to strengthen knowledge and provide guidance on the measures needed to enhance resilience to the negative impacts of climate change.

The Swedish *Planning and Building Act*, *the Environmental Code*, and *the Civil Protection Act* highlight the need for implementing climate change adaptation measures on the national, regional and municipal levels. In the legislation governing municipalities' planning of land and water use (*the Planning and Building Act*), new provisions have been introduced recently to promote more climate-resilient construction. The municipal comprehensive plan, a politically adopted document that outlines the long-term planning for the entire municipality, must now also include:

The municipality's view on the risk of damage to the developed environment that may result from flooding, landslides, landslides, and erosion related to climate change, as well as how such risks can be reduced or eliminated. The Planning and Building Act (2010:900).

There is additional legislation that requires consideration of various risks, including those related to flooding, landslides, and erosion. However, these laws have not yet been updated to address the increased risks due to climate change. Currently, several legislative proposals are under review, aiming to align Swedish laws with evolving European Union regulations in this area.

The *Regional Action Plan for Climate Adaptation in Västernorrland County* (2018 and its update in 2022) highlights **several sectors as vulnerable to climate change**, including infrastructure, cultural heritage, land-based industries and tourism, technical supply systems, public health, and natural environment. To address these risks the report addresses a need for stronger collaboration, better data access, and integrated planning across municipalities and agencies.

Moreover, SGI (Swedish Geotechnical Institute) and MCF (Swedish Civil Contingencies Agency) have identified in the report *Risk Areas for Landslides, Erosion and Flooding* (2021) our county, as **a high-risk area for climate-related hazards such as landslides, erosion, and flooding.** Furthermore, the largest town in the region, **Sundsvall, has been identified as a high-risk area for flooding** under Sweden's implementation of the EU Floods Directive (2007/60/EC). These designations highlight the region's vulnerability and the need for targeted climate adaptation measures. The classification is part of a broader national effort to map and manage areas facing the risks of landslides, erosion and flooding. During the second phase of the project, stakeholder began discussing possible adaptation interventions. This work will be continued in the third phase, which will place particular emphasis on drafting the Regional Action Plan for Climate Adaptation.

2.1.3 Participation and risk ownership

Climate risk ownership in Sweden is distributed across several governance levels. At the **national level** institutions such as Swedish Meteorological and Hydrological Institute and Swedish Civil Contingencies Agency provide strategic guidance, climate data, early-warning systems and scientific support for risk assessment and adaption. At the **regional and local levels** - the County Administrative Board plays a central role in coordinating and supporting climate-adaptation work at the regional level. It leads the overall coordination of adaptation efforts across the region and brings together municipalities, regional authorities, government agencies, businesses, and other stakeholders. Municipalities have planning monopoly and are responsible for ensuring that climate risks are addressed in comprehensive and zoning plans.

Currently, there is no formal or widely agreed definition of **"acceptable risk"** in the region. *The Planning and Building Act* states that new buildings may not be constructed in areas where there is a significant risk of flooding and other natural hazards. Within this context, the **CLIMAAX project** plays an important role by initiating dialogue on what levels of risk communities consider acceptable. The project encourages greater awareness of how responsibility for risk prevention and climate adaptation should be shared. These discussions take place during our workshops with municipalities and other stakeholders across the region.

To support the CLIMAAX work, during **Phase 1,** the County Administrative Board of Västernorrland (CABV) identified internal roles, responsibilities, and areas of cooperation within the institution. An **inter-disciplinary project team was formed**, comprising experts from various units, including the Civil Protection and Emergency Preparedness Unit and the Community Planning Unit, bringing together diverse competencies and a shared understanding.

The County Administrative Board is also part of a **regional network of climate-adaptation experts** representing county administrative boards across Sweden. During **Phase 2,** two members of the core **CLIMAAX team** participated in seminars and meetings focused on best practices for developing and updating Climate Adaptation and Vulnerability Analyses. Regional and National authorities in Sweden that have already completed this work shared valuable insights and practical experiences, particularly regarding the writing process and effective approaches to structuring the analysis.

During Phase 2, **four workshops** were held with our **internal experts at the County Administrative Board**, each workshop focusing on one of the key sectors and systems – 'built environment and infrastructure', 'ecosystems', 'health', and 'economic activities, natural resources, and food production'. The purpose of these workshops was to analyse how each sector is affected by climate change, with particular attention to risks linked to heavy snowfall and intense rainfall.

During Phase 2, the County Administrative Board carried out an analysis of **external stakeholders** and initiated collaboration with the most relevant actors. These stakeholders were invited to a joint digital meeting held on 25 February 2026. Following this meeting, a series of **targeted workshops** were organised with individual municipalities in the region, as well as with other projects and community groups, during the period from March to June. These stakeholders will continue to be actively involved during **Phase 3** to strengthen project ownership and ensure that a broad range of perspectives, approaches, and competencies is represented.

Contacted **external project stakeholders** during **Phase 2**:

- Civil servants, including planners and climate change strategists and representatives from municipal organisations such as energy companies and housing companies in the region's **seven municipalities**: Sundsvall, Ånge, Timrå, Härnösand, Kramfors, Sollefteå, and Örnsköldsvik. **Seven workshops were organised**, one with each municipality, to analyse how key sectors and systems are affected by climate change. These workshops brought together local expertise, to examine vulnerabilities in the region.

- The **Sámi villages** of Vornese, Jinjavaerie, Jovnavaerie, Paedtievaneri, Ohredakhe, Vilhelmina södra, and Vilhelmina norra as well as the climate coordinator for **The Sámi Parliament in Sweden. A joint meeting** was held with two Sámi villages to analyse how climate change is affecting their communities, with a particular focus on reindeer herding. Discussions highlighted how changing snow conditions, ice crust formation, and increasingly unpredictable weather patterns are disrupting grazing access, migration routes, and the overall wellbeing of the reindeer which is central to both livelihoods and cultural continuity of the Sámi communities.

- **EU-funded project** "Beredda byar" (EU CAP, LEADER/CLLD) examines how small, rural communities can prepare for climate change and develop resilient social structures in response.

- **EU-funded project INTERREG ClimaResponse**. The project helps local authorities reduce climate and disaster risks, improve their response to extreme weather events, and build long-term regional climate resilience through targeted strategies, training and cooperation.

- **A study visit** was carried out in collaboration with the **Skåne Region**/County Administrative Board (Länsstyrelsen), that is also recipient of Climaax funding. The visit took place in *June 2026*. The group consisted of the *Project Manager* and the *Marine Spatial Planning and Climate Adaptation Officer* from the County Administrative Board of Västernorrland and 2 Climaax representatives from the County Administrative Board of Skåne. The purpose of the

visit was to facilitate knowledge exchange, deepen understanding of regional climate adaptation approaches, and draw on experiences from the Climaax project.

A small number of stakeholders were unable to participate or were identified during the workshops. During **Phase 3** we plan to contact and cooperate with those stakeholders:

- Regional fire and emergency services.
- Regional office for the The Swedish Transport Administration
- Regional office for the Swedish Forestry Agency

2.1.4 Application of principles

During Phase 2, the climate and vulnerability analysis integrated principles of social justice, equity, and inclusivity by actively engaging municipalities, Sámi villages, national institutions, and relevant local and international initiatives. This approach ensured that a broad range of perspectives and knowledge systems were reflected in the assessment. Through targeted workshops with internal experts and regional stakeholders, the process captured sector-specific vulnerabilities and climate risks grounded in lived experience, thereby strengthening both inclusiveness and contextual relevance.

We have also tied colleagues working with social sustainability and human rights to the process, ensuring that social justice, equity and inclusivity have been integrated into our analysis of climate risks. Besides integrating the perspective of the indigenous Sámi population, we have explicitly addressed how children and the elderly can be affected by the various climate change risks, as they are some of the key vulnerable groups in our region.

Quality, rigour, and transparency were ensured by combining intermediate CLIMAAX results with locally validated insights, alongside continuous knowledge exchange with national and regional expert networks. The systematic documentation of stakeholder input, together with the integration of both scientific data (such as national datasets from SMHI) and experiential knowledge from workshops, enhanced the robustness and credibility of the analysis.

A precautionary approach was applied by focusing on key climate risks, including heavy snowfall and intense rainfall, and by initiating early discussions on potential adaptation measures. This forward-looking process supports the development of a proactive and well-informed Regional Climate Adaptation Action Plan to be finalised in Phase 3.

2.1.5 Stakeholder engagement

During **Phase 2**, CABV expanded the process to include external actors. An analysis of relevant stakeholders was conducted, and these actors were invited to a **joint digital meeting on 25 February 2026 to communicate the project goals and intermediate results**. This meeting marked the formal start of regional cooperation within CLIMAAX. Between **March and June 2026**, CABV organised a series of targeted workshops with individual municipalities, Sámi villages, and other community-based projects (described in the section 2.1.3). These workshops focused on how key sectors and systems, such as the built environment, infrastructure, ecosystems, health, economic

activities, and food production, are affected by climate change, with particular attention to risks linked to heavy snowfall and intense rainfall.

During **the workshops**, our aim was to assess the regional sectors using local knowledge and practical experience from stakeholders. The goal was to complement the intermediate CLIMAAX results with additional data, insights, and contextual understanding needed for a thorough Climate Risk Assessment. The workshops were the major source of **regional knowledge**, as participants were highly engaged and eager to contribute their expertise. Their **active involvement** provided detailed information on sector-specific vulnerabilities, local conditions, and **climate-related challenges that cannot be captured through datasets alone.** These perspectives complemented the quantitative climate data and ensured that the assessment reflected regional realities.

CABV also engaged with **national and regional expert networks** and participated in seminars with climate-adaptation experts from other Swedish counties, where best practices for developing Climate Adaptation and Vulnerability Analyses were shared. These exchanges provided valuable insights into structuring the analysis and integrating scientific and local knowledge.

All engaged stakeholders will continue to participate in **Phase 3**, ensuring strong project ownership and bringing diverse perspectives into the final Climate Risk Assessment. The focus will shift toward discussing climate-adaptation measures, and the input gathered will directly inform the drafting of the *Regional Climate Adaptation Action Plan*. Beyond CLIMAAX, the intention is to keep the network with municipalities and other stakeholders alive to continue working collaboratively with adaptation to climate change in the region.

2.2 Risk Exploration

2.2.2 Screen risks (selection of main hazards)

During **Phase 2**, the screening of climate risks has been further developed and expanded compared to Phase 1 through a more systematic and participatory approach. While the initial screening drew on existing studies by national agencies such as the Swedish Meteorological and Hydrological Institute (SMHI) and the Swedish Civil Contingencies Agency (MSB), as well as regional strategies including the Regional Action Plan for Climate Adaptation in Västernorrland (2018) and its 2022 follow-up, the current phase integrates additional insights from stakeholder engagement, recent events, and updated knowledge sources.

Relevant climate-related hazards and risks:

The analysis confirms that key hazards in the region include heavy snowfall, intense rainfall, flooding, and erosion. These hazards are associated with risks to critical infrastructure, the built environment, ecosystems, public health, and economic activities such as forestry and agriculture. To give a fuller picture of climate change in the region (and building on recent events), we have chosen to also address temperature increase and possible heatwaves in our workshops with stakeholders and in the key risk assessment. Rising temperatures pose both short-term and long-term challenges for agriculture, ecosystems and human health.

Current situation and affected areas:

Recent events have further highlighted the region's exposure to climate-related hazards. During the summer of 2025, the region was struck by a heatwave. For over two weeks temperatures were unusually high at above 30 degrees causing health issues and straining the agricultural and forestry sectors.

In September 2025, Västernorrland experienced episodes of intense rainfall that led to local flooding, disruptions to infrastructure, one person dying, and increased pressure on emergency response systems. These events demonstrated the vulnerability of transport networks, drainage systems, and built-up areas, particularly in flood-prone catchment areas. Local communities, municipalities, and critical service providers were among those affected, illustrating how both geographic and socio-economic factors influence risk levels.

In January 2026, parts of the region experienced extreme snow where some parts experienced 1,5m of snow falling in 24 hours, leading to power cuts and limiting the possibility for emergency services and home care to access those in need. As such, the need for addressing climate change and managing such climate risks is very much felt and understood in the region.

Hazards prioritised in the assessment:

The project has prioritised heavy snowfall and intense rainfall, including their cascading effects such as flooding, erosion, and infrastructure disruption. These hazards were selected due to their high relevance for the region, their increasing frequency and intensity, and their significant impacts across multiple sectors, as demonstrated both in previous studies and recent events such as the September 2025 rainfall. In phase 2, we have also chosen to address temperature increase and possible heatwaves in our workshops with stakeholders and in the key risk assessment.

Data, knowledge, and remaining needs:

The risk screening is supported by a combination of scientific data (e.g. national datasets from SMHI), regional analyses, documented events, and local knowledge from municipalities and stakeholders. During Phase 2, targeted workshops and participation in national and regional knowledge exchange networks have significantly strengthened the evidence base by incorporating practical experience and sector-specific insights. However, further work is needed improve understanding of cascading effects between sectors to support a development of the action plan during **phase 3.**

The screening process will continue throughout Phase 3 through ongoing stakeholder collaboration, interdisciplinary workshops, and participation in climate adaptation networks and conferences. In particular, cooperation with municipalities remains essential to ensure that local planning processes are informed by up-to-date climate risk assessments and aligned with regional and national strategies. This iterative process ensures that new events, such as the heavy rainfall in September 2025, are continuously integrated into the assessment, strengthening its relevance and reliability.

2.2.3 Choose Scenario

During Phase 2 we have chosen to work further with the most common **scenarios RCP 4.5 and RCP 8.5** so that the level of information and comparability would stays manageable and insightful. We

have chosen to look at the end of the century (2070-2100) while emphasizing that adaptation measures must be implemented well before then, as climate risks are already evolving.

Climate conditions considered for the region

The future climate of Västernorrland is projected to be significantly **warmer and wetter**, with the **most significant changes occurring during the winter months**.

In assessing future climate risks and adaptation needs for the Västernorrland region, we have focused on a set of climate conditions that are expected to change significantly over the coming decades. These conditions are central because they influence environmental stability, infrastructure resilience, public health, and long-term regional development.

Analysis shows a clear **increase in average temperature**, which will contribute to a longer growing season and fewer cold days. While this may benefit certain types of agriculture and forestry, it also alters ecosystems and affects species composition. The region is also expected to experience **reduced snow depth**, which impacts reindeer herding and Sámi culture, winter tourism, hydrological cycles, and natural habitats. More **frequent zero-degree crossings** will increase wear on roads and buildings.

Higher temperatures also increase the probability of **heatwaves**, which can affect public health, especially among vulnerable groups. Additionally, longer dry periods combined with warmer conditions heighten the risk of forest and vegetation fires, which can spread more rapidly in a warmer climate.

At the same time, Västernorrland is projected to receive **higher average precipitation**, including more **intense cloudbursts**. These changes significantly raise the risk of flooding, both from heavy rainfall and from rivers that overflow during extreme weather events.

The combination of saturated soils, steep terrain, and heavier rainfall increases the likelihood of **landslides, erosion, slumps, and debris flows**, particularly in valleys and along watercourses. These hazards pose direct threats to transportation networks, settlements, and critical infrastructure.

While **sea-level rise** is an important climate factor for many coastal regions, Västernorrland is not expected to experience significant impacts from rising sea levels. Under current projections, Västernorrland is not expected to experience significant impacts from sea-level rise in the coming decades, primarily because the region is still undergoing post-glacial land uplift. This uplift currently offsets most of the global sea-level increase. However, sea-level rise could become problematic later in the century or beyond under the following conditions:

If global sea-level rise accelerates significantly, especially under high-emission scenarios where global sea levels may rise by more than one meter by 2100. In such cases, uplift may no longer fully compensate for rising water levels (SMHI, 2022).

Future socio-economic developments considered

We have assumed a **slight population growth**, consistent with long-term demographic trends for northern Sweden. Västernorrland is not characterized by rapid urban expansion, and the region does not contain any highly urbanized metropolitan areas. The largest urban center, **Sundsvall**, has approximately 71,000 inhabitants, while the remaining population is distributed across smaller towns, rural communities, and coastal settlements. This demographic profile suggests that future

climate impacts will need to be managed across a mix of sparsely populated inland areas and more concentrated coastal zones.

We have not considered a significant change in **economic activities** in the region or future food consumption. These assumptions are intentionally cautious, as current projections do not indicate major shifts in population size, economic structure, or land-use patterns. The regional economy is expected to remain broadly similar to today, with forestry, manufacturing, energy production, and public services continuing to play central roles.

Similarly, we have not assumed major shifts in **future food consumption** or agricultural production. Västernorrland's agricultural sector is relatively small compared to other regions in Sweden, and no substantial expansion is anticipated. However, the projected **longer growing season** may create new opportunities for local production, even if these are not included as core assumptions in the socio-economic baseline.

Overall, these socio-economic considerations provide a stable reference scenario that allows climate impacts to be assessed without the added uncertainty of major demographic or economic transformations.

2.3 Regionalized Risk Analysis

The data used for the analysis

During Phase 2, the assessment was further developed using data from SMHI's Climate Change Scenario Tool, together with associated regional climate data and maps. This publicly available platform provides climate projections for specific geographical areas and allows users to select climate indicators, emissions scenarios (RCP4.5 and RCP8.5), future time periods (2041–2070 and 2071–2100), and presentation formats (absolute values or changes relative to a reference period).

The tool offers higher spatial resolution and greater regional relevance than the datasets available through the CLIMAAX workflows used during Phase 1. In particular, the tool enables analyses to be carried out directly within the administrative boundaries of Västernorrland County, making the results more applicable to regional planning and stakeholder discussions.

The results obtained from the CLIMAAX workflows in Phase 1 nevertheless served as an important complementary source of information. They provided a regional overview of climate hazards and risks and formed the basis for the more detailed analyses conducted in Phase 2. However, the spatial resolution of the datasets available through the selected workflows (Phase 1, Figurer 4 and 5) was insufficient for detailed assessments at the municipal and local scales. Therefore, additional climate information and locally relevant datasets were incorporated to strengthen the regional analysis.

The purpose of Phase 2 was not to repeat the climate projections generated during Phase 1, but to regionalise and validate them using local information and stakeholder knowledge. This was achieved through the integration of historical climate observations, municipal cloudburst mapping, local GIS datasets, national climate projections from SMHI, and structured workshops with municipalities and regional stakeholders. The resulting assessment therefore combines modelled

climate hazards with locally identified vulnerabilities, observed impacts, and exposure information relevant to Västernorrland County.

The assessment used SMHI climate indicators describing projected changes in mean annual temperature, the number of days with heavy precipitation (>10 mm/day), snow conditions and snow cover duration under the RCP4.5 and RCP8.5 scenarios.

Historical heavy rainfall and snow indicators and regional climate analyses published by SMHI were also used to provide a longer-term perspective on observed climate trends and variability. These datasets were used to compare future projections with historically observed climate conditions and extreme events in the county.

To complement both the CLIMAAX workflow outputs and the SMHI climate projections, a series of workshops was conducted with municipalities across Västernorrland County. During these workshops, maps from the SMHI Climate Change Scenario Tool (Figure 8 and 9) were combined with cloudburst mapping data (Skyfallskartering lågpunkter) (Figure 11) to identify low-lying areas where surface water is likely to accumulate during intense rainfall events.

Cloudburst maps are widely used by Swedish municipalities as a practical planning tool for identifying areas vulnerable to flooding during extreme rainfall. Municipal representatives also contributed local knowledge regarding previous flood events, including locations where roads, drainage systems, and critical infrastructure had been affected by heavy precipitation. Workshop participants were also asked to identify locally known problem areas, climate-sensitive sectors, recurring impacts, critical societal functions, and existing adaptation challenges.

This local validation strengthened the assessment by improving the understanding of spatial flood patterns and helping to identify areas that may be particularly vulnerable to future heavy rainfall, flooding, erosion, slope instability, and other climate-related impacts.

The method used for the climate and vulnerability analysis

The Swedish governmental agency SMHI (Swedish Meteorological and Hydrological Institute) has recently published a methodological guide for Swedish regions conducting climate and vulnerability analyses. We followed this method during our workshops with external stakeholders, such as municipalities, because it aligns closely with the CLIMAAX methodology. SMHI has confirmed that their method has been adapted to be consistent with the CLIMAAX approach.

The method recommends using a system-based analysis, and identifies six key systems to consider when assessing climate risks and potential consequences:

- Health
- Ecosystems
- Infrastructure and built environment
- Food supply
- Business sector and natural resources
- Water

In addition, throughout our workshops and meetings with stakeholders, we incorporated **additional local information provided directly by the municipalities**. Each of the seven municipalities in the region maintains its own GIS systems and related databases containing detailed local data. Some of this information is publicly accessible, while other datasets are subject to security restrictions and therefore require controlled access. Due to the security restriction this local information was used during the discussions and not saved in our databases. Integrating this municipal knowledge strengthened the analysis by ensuring that local conditions, assets, and vulnerabilities were accurately reflected in the regional climate and vulnerability assessment.

Please find the description of **the hazards used during our workshops with the stakeholders** below. In this section, increasing average temperature is treated as one hazard and increasing precipitation as another hazard. The latter will distinguish between heavy rain and changes in snow during the key risk assessment, but as the climate indicators for these are so intertwined, they are treated jointly in the following section.

2.3.1 Increasing average temperature - fine-tuning to local context

Although our first CLIMAAX report focused on **heavy snow** and **heavy rainfall**, it is also relevant to include **increased temperatures** as a separate hazard. Rising temperatures influence several climate-sensitive systems in Västernorrland, including an extended vegetation period, altered winter conditions, and more frequent zero-degree crossings, all of which affect infrastructure, ecosystems, and land use. Higher temperatures also increase the risk of wildfires and create challenges for traditional practices such as Sámi reindeer herding, where changing snow and vegetation patterns directly impact grazing conditions.

During the workshops with our main stakeholders (municipalities) contributed with detailed information on **indirect impacts**, such as infrastructure sensitivity, changes in snow and local operational challenges. These indirect impacts form an essential part of the vulnerability and consequence analysis, complementing the physical hazard assessment.

The maps and information about the data used can be directly accessed at Climate Change Scenario Tool — SMHI:

RCP4.5

During the reference period 1971–2000, the modelled **average temperature per year** (Figure 1) for Västernorrland County was 2.2°C. If the climate develops according to the scenario, the average temperature will increase by 3.4 °C for the period 2071-2100 compared with the reference period. The largest temperature increase occurs during the months December–February.

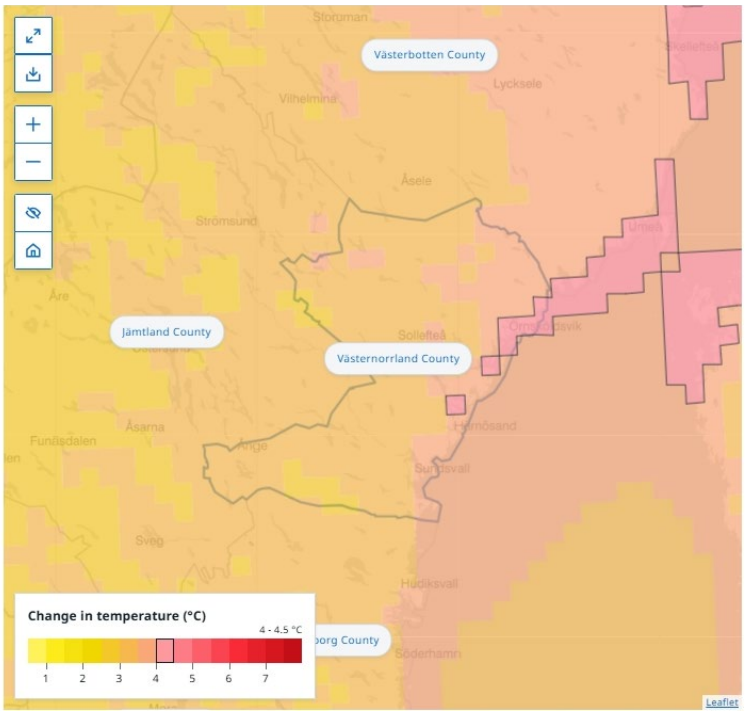


Figure 1: Calculated change of the mean temperature (°C) for the period 2071-2100 compared to 1971–2000. The map is based on an average of a number of climate models for emissions scenario RCP4.5.

Figure source: SMHI Climate change scenario tool (2024b).

RCP8.5

During the reference period 1971–2000, the modelled **annual mean temperature** for Västernorrland County was 2.2°C (Figure 2). If the climate develops according to the scenario, the average temperature will increase by 5.2 °C for the period 2071-2100 compared with the reference period. The largest temperature increase occurs during the winter months (December–February).

High-latitude regions such as Västernorrland are expected to experience greater warming than the global average, as warming generally increases with latitude and is strongest near the poles. SMHI notes that Sweden's temperature increase is already approximately twice the global average, driven by faster warming over land than over oceans and amplified by declining snow and ice cover. As snow cover decreases, less solar radiation is reflected into the atmosphere, creating positive feedback that further reinforces warming (SMHI, 2026).

This is consistent with the IPCC's assessment that northern Europe is experiencing faster warming than the global average, with significant impacts on ecosystems, snow and ice conditions, and permafrost in high-latitude regions (Bednar-Friedl et al., 2022). The projections for Västernorrland similarly indicate that the most pronounced temperature increases will occur during the winter season, leading to substantial changes in snow conditions, winter climate, and climate-sensitive sectors across the region.

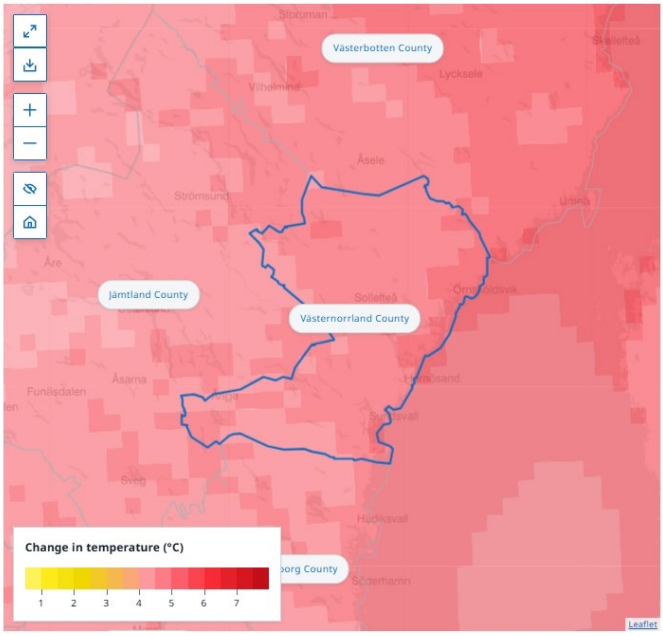


Figure 2: Calculated change of the mean temperature (°C) for the period 2071-2100 compared to 1971–2000. The map is based on an average of a number of climate models for emissions scenario RCP8.5.

Figure source: SMHI Climate change scenario tool (2024b).

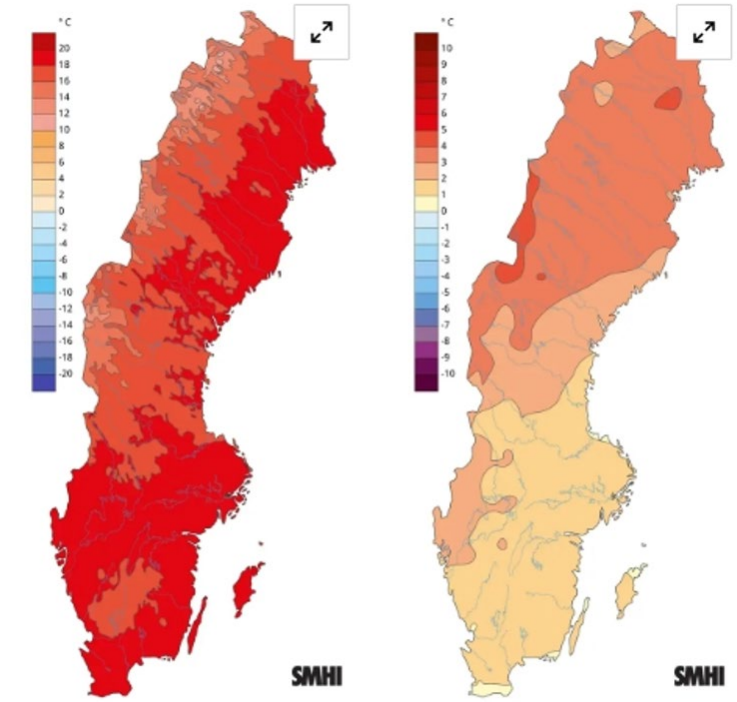
Table 2-1 Data overview workflow - Increasing average temperature

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
Gridded historical and scenario data for daily mean temperature from SMHI's Climate Change Scenario Tool. Each grid cell represents an area of approximately 12 × 12 km. The analysis is based on an ensemble of climate models for the RCP4.5 and RCP8.5 scenarios. County-level projections show an increase in mean annual temperature of approximately 3.4°C under RCP4.5 and 5.2°C under RCP8.5 by 2071–2100 compared with 1971–2000. *Data:* Climate Change Scenario Tool — SMHI	*Stakeholder information on climate-sensitive sectors, including public health, transport infrastructure, forestry, ecosystems, agriculture, water resources, winter recreation, and Sámi reindeer herding.*	General population data and spatial information from the County Administrative Board's GIS platform (LstY Klimat - WebbGIS), including municipalities, settlements, critical infrastructure, and areas of strategic importance. LstY Klimat - WebbGIS	*Calculated change of the mean temperature (°C) for the period 2071-2100 compared to 1971–2000.* *Severity, urgency, adaptive capacity and risk ranking from the Key Risk Assessment workshops; identification of vulnerable sectors, exposed assets and adaptation needs.*

2.3.1.1 Hazard assessment

The spatial distribution of the projected temperature increase shows that **the largest changes are expected along the coastal parts of Västernorrland**, while somewhat smaller increases are projected for inland and higher-elevation areas. This pattern is particularly important from a risk perspective, as most of the county's population is concentrated in the coastal municipalities of Sundsvall, Timrå, Härnösand, Kramfors and Örnsköldsvik. Consequently, a larger share of the population, critical infrastructure, healthcare services, transport networks and economic activities will be exposed to increasing temperatures and heat-related impacts. The projected warming therefore has significant implications not only for natural systems but also for the county's most densely populated areas.

Recent events further illustrate the growing relevance of heat-related hazards in Västernorrland. SMHI reports that July 2025 was characterized by an unusually long heatwave across northern Sweden (defined as at least five consecutive days with maximum temperatures of 25°C or higher) beginning around 10 July and continuing into early August in parts of Norrland (SMHI, 2025b). For some Norrbotten stations, such as Haparanda and Jokkmokk, this was among the longest heatwaves recorded in over a century (SMHI, 2025b). Within Västernorrland, Junsele (Ångermanland) recorded 32.9°C on 24 July 2025 its warmest day of any month since the July 1933 heat record (SMHI, 2025a) and matched its own 2014 record of seven consecutive days at or above 30°C (SMHI, 2025c).



Monthly mean temperature, July 2025.

Deviation of mean temperature from the 1991–2020 reference period, July 2025.

Figure 3: Monthly mean temperature in Sweden during July 2025 (left) and deviation from the 1991–2020 reference period (right). Figure source: SMHI (2025a).

The projections is a robust long-term climate signal for Västernorrland County and was therefore used as one of the principal hazards considered during the subsequent vulnerability and risk assessment process. During stakeholder workshops, these projections were discussed in relation to infrastructure performance, ecosystem impacts, forestry, water resources, and reindeer herding activities.

2.3.1.2 Risk assessment

Rising temperatures were identified by stakeholders as an increasingly important climate risk for Västernorrland County. The climate projections presented during the workshops, together with recent experiences from municipalities and other regional actors, confirmed that many temperature-related impacts are already being observed across the region and are expected to intensify in the future.

Stakeholders highlighted that warmer summers, heatwaves, and changing seasonal conditions are already affecting public health, infrastructure, ecosystems, forestry, agriculture, and water resources. The prolonged heatwave experienced during the summer of 2025 was frequently mentioned as an example of a climate-related event that demonstrated the vulnerability of local communities and critical services. Future heatwaves are expected to become more frequent and longer-lasting, increasing risks particularly for elderly people and other vulnerable groups.

Workshop participants also confirmed that warmer winters and reduced snow cover are already influencing winter transport, forestry operations, outdoor recreation, and Sámi reindeer herding. Representatives from forestry and environmental sectors highlighted concerns regarding drought stress, pest outbreaks, wildfire risk, and changes in species composition and biodiversity. Sámi representatives emphasized that changing snow and vegetation conditions are making grazing conditions and traditional reindeer herding practices increasingly challenging.

Stakeholders generally agreed that many of these impacts are already visible today and that the projected warming shown in the climate scenarios is likely to amplify existing vulnerabilities throughout the county. Based on the climate projections, observed impacts, and stakeholder input, increasing temperatures were assessed as a significant and growing climate risk for Västernorrland. These findings were incorporated into the integrated climate risk assessment presented in Section 2.4, where temperature-related hazards were assessed together with regional exposure, vulnerability, and resilience capacity.

2.3.2 Increased precipitation - heavy rainfall and heavy snowfall

Finetuning to local context

The risk assessment for increased precipitation in Västernorrland integrates historical observations, climate projections, and stakeholder insights to evaluate the region’s vulnerability to heavy rainfall and snow-related hazards.

While the Phase 1 CLIMAAX analysis provided a broad overview of precipitation risks, Phase 2 has refined this understanding by incorporating local data, recent extreme events, and sector-specific

impacts identified through workshops and dialogues with municipalities and other stakeholders. These discussions provided important local knowledge regarding vulnerable locations, observed impacts, critical societal functions, and adaptation needs that complement the climate projections and spatial analyses.

2.3.2.1 Hazard assessment – Heavy rain and snow

Before assessing future climate scenarios, it is important to understand the historical occurrence of heavy rainfall in Västernorrland. SMHI has conducted several national studies of extreme precipitation, including analyses of “extreme areal precipitation” (defined as at least 90 mm of rainfall within 24 hours over an area of 1,000 km² or more) and studies of extreme precipitation events between 1900 and 2011 (Wern, 2012). These studies identify the **southern Norrland coast, including Västernorrland, as one of Sweden's most rainfall-prone regions,** characterized by both high annual precipitation and a relatively high frequency of intense rainfall events.

According to Wern (2012), the region’s exposure to heavy rainfall is partly explained by **a coastal convergence effect**. This occurs when northerly winds interact with warm, moist air from the Baltic Sea, leading to prolonged and intense rainfall over coastal and near-coastal areas.

To better understand the local context, an **internal review of historical heavy-rainfall events** was undertaken in 2026 using SMHI open data, previous national studies, and historical newspaper records. The review **identified 37 documented heavy-rainfall events exceeding 70 mm within 24 hours in Västernorrland between 1878 and 2025**. Most events were concentrated within a few tens of kilometers of the coastline, **with Härnösand (9 events), Örnsköldsvik (8 events), and Kramfors (6 events)** being the most frequently affected municipalities.

The analysis also showed that Västernorrland has **recorded several national daily precipitation records**. Both the Swedish April (1959) and June (1908) precipitation records were measured in Härnösand, while the heavy rainfall event of 6-7 September 2025 produced the second-highest September daily precipitation (140 mm) total ever recorded in Sweden (Länsstyrelsen Västernorrland 2026).

These findings demonstrate that heavy rainfall is **not an isolated or emerging hazard in Västernorrland but a well-documented and recurring feature of the regional climate**. They also provide an important benchmark for evaluating future climate projections and assessing how climate change may alter the frequency, intensity, and consequences of heavy-rainfall events across the county.

The historical observations described above are also consistent with the results of the CLIMAAX Phase 1 assessment, which identified heavy rainfall as significant climate hazards for Västernorrland County.

Phase 1 findings

Figure 4 below shows that the highest projected intensities of *24-hour precipitation events with a 10-year return period* are **concentrated along the coastal parts of Västernorrland County**. This spatial pattern corresponds well with both the historical distribution of documented heavy-rainfall events and the regional precipitation pattern identified by Wern (2012), where the southern Norrland coast

experiences unusually high annual precipitation and a relatively high frequency of intense rainfall events.

The projected coastal concentration of extreme precipitation is also **consistent with the September 2025 rainfall event**, which primarily affected coastal and near-coastal municipalities and caused severe flooding, infrastructure damage, and widespread societal disruption. Together, these findings indicate that coastal areas are likely to remain particularly exposed to future heavy-rainfall hazards.

Rainfall events exceeding 100 mm within 24 hours were projected during Phase 1 to become more frequent in many areas of the county (Figure 5). The analysis also highlighted that several settlements, transport corridors, schools, healthcare facilities, and other critical infrastructure assets are located in areas where the frequency and intensity of extreme rainfall are expected to increase (Figure 5).

However**, the CLIMAAX outputs from Phase 1 should primarily be interpreted as indicative of broad regional trends rather than as site-specific predictions**. The Phase 1 assessment was based on climate model data with a spatial resolution of approximately 12.5 km and a limited model ensemble, which does not fully capture Västernorrland's complex topography, local precipitation patterns, or historically observed extreme events (reported during Phase 1). Consequently, Figures 4 and 5 are useful for illustrating the overall direction and geographic distribution of future climate risks, but they should not be used in isolation for heavy rainfall or local flood-risk assessments. As Norconsult (2025) reported, such applications require higher-resolution climate data, local calibration, and hydrological modelling.

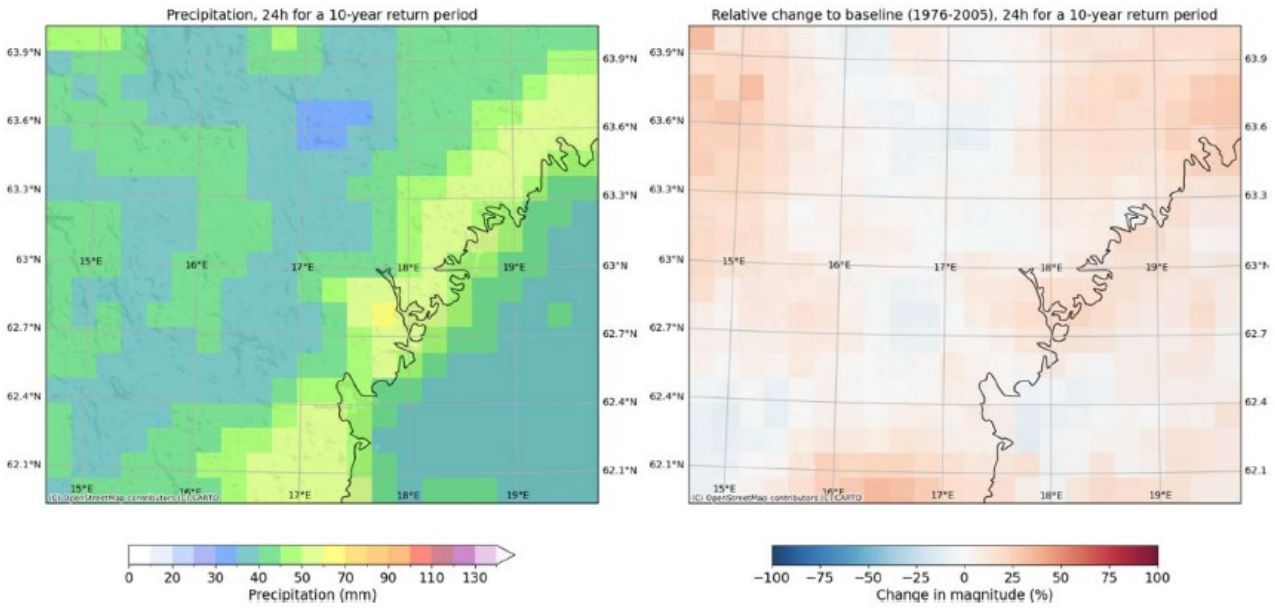


Figure 4: Extreme precipitation for 2041-2070 under RCP8.5 climate projections. The figure shows projected precipitation for a 10-year return period, 24-hour rainfall event and the relative change compared with the historical period 1976-2005.

Figure source: Norconsult, CLIMAAX Phase 1 Assessment Report (2025).

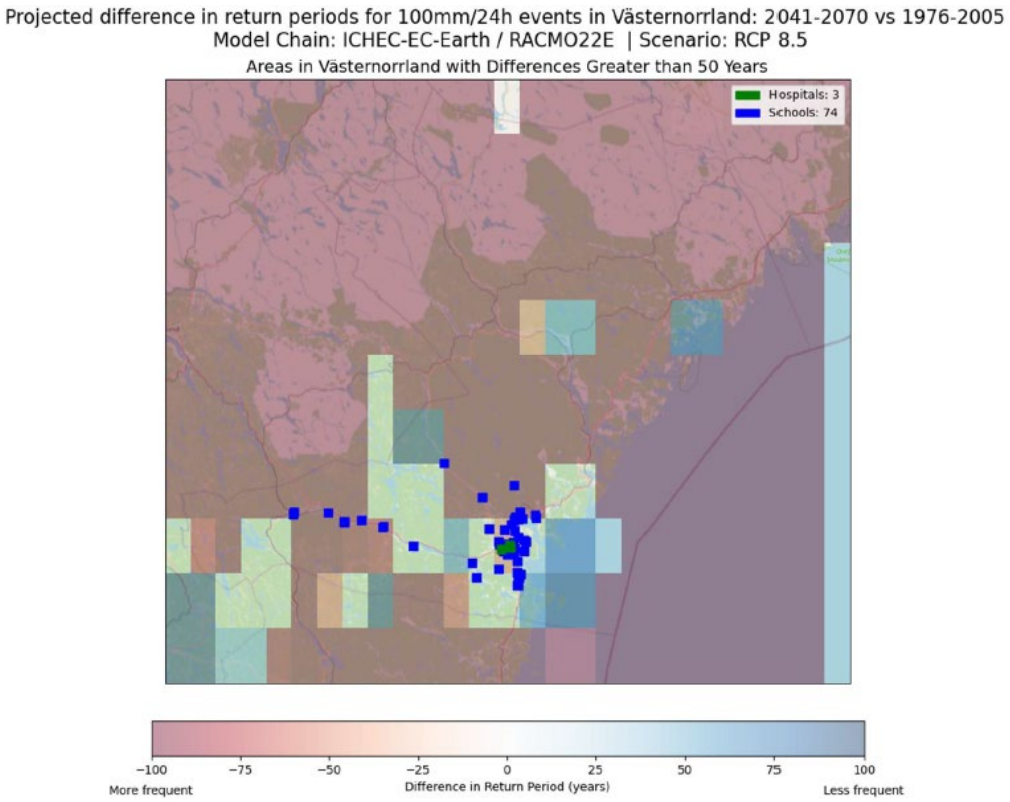


Figure 5: Projected change in return periods for 100 mm/24-hour rainfall events during 2041-2070 under RCP8.5 compared with the historical period 1976-2005. Schools (blue) and hospitals (green) illustrate the exposure of critical societal functions.

Figure source: Norconsult, CLIMAAX Phase 1 Assessment Report (2025).

September 2025 event

The relevance of Phase 1 findings became particularly evident during the **extreme rainfall event of 6-7 September 2025** (Figure 6), which caused widespread flooding, damage to roads, railways, and properties, and significant societal disruption across the county. The event demonstrated that the vulnerabilities identified through historical analyses and climate modelling already exist today and may become more significant as heavy rainfall events increase in frequency and intensity (Länsstyrelsen Västernorrland, 2026).

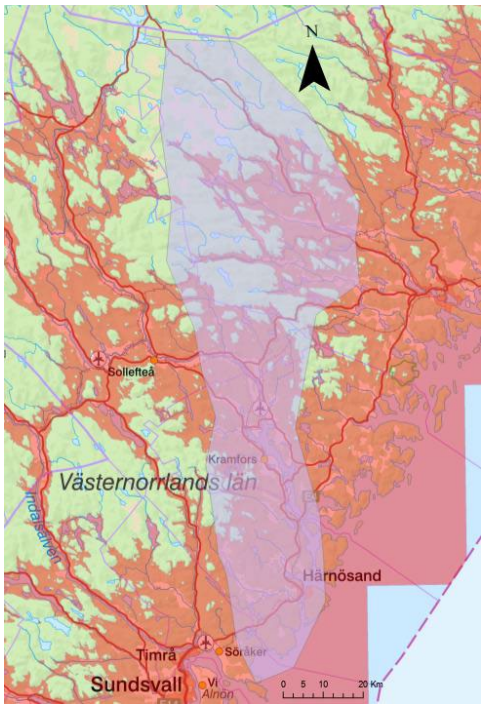
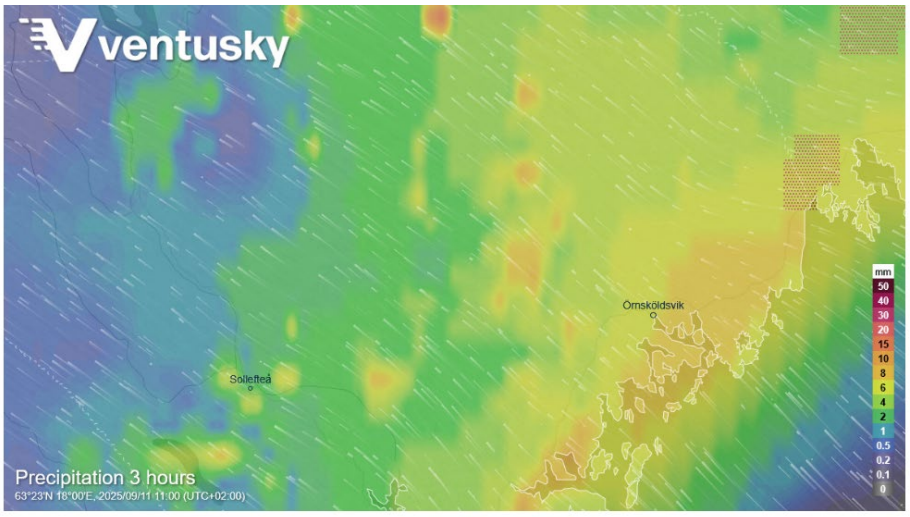


Figure 6: Area affected by the September 2025 heavy rainfall event.

Figure sources: County Administrative Board of Västernorrland (2026).

The September 2025 event (6-7 September) was followed by additional periods of heavy rainfall affecting the county. Figure 7 illustrates precipitation across Västernorrland on 11 September 2025 and shows continued rainfall activity concentrated in coastal and near-coastal parts of the county. Although Figure 7 represents a single weather event, the spatial pattern corresponds well with both the historical distribution of documented heavy-rainfall events and the future precipitation patterns projected in Figure 4. This correspondence further highlights the vulnerability and continued exposure of coastal municipalities, infrastructure, and critical societal functions to heavy precipitation and flooding-related hazards.



Precipitation on the 11/09/2025 over Vasternorrland County

Figure 7: Precipitation over Västernorrland County on 11 September 2025.

Figure source: Copernicus Emergency Management Service (2025)

Heavy precipitation in future climate scenarios, using national SMHI data

When assessing future changes in precipitation, it is important to note that national climate indicators provided by SMHI and used in our analysis, do not distinguish between rainfall and snowfall. The following analysis therefore presents predicted changes in the number of days with heavy precipitation, regardless of whether the precipitation falls as rain or snow. This chapter is complemented by a separate analysis of predicted changes in snow conditions.

The indicator used in the analysis represents *the number of days per year with precipitation exceeding 10 mm*. According to the SMHI Climate Scenario Tool, the number of days with heavy precipitation is projected to increase across Sweden, although the magnitude of change varies between regions and seasons.

RCP4.5

According to the SMHI Climate Change Scenario Tool (Figure 8), the modelled mean number of days with **heavy precipitation** in Västernorrland County during the reference period 1971-2000 was 16.3 days per year. Under the RCP4.5 scenario, the mean number of days with heavy precipitation is projected to increase by 3.9 days during the period 2041-2070 compared with the reference period (SMHI, 2024).

The projected increase is consistent with the results from the CLIMAAX Phase 1 assessment, which identified increasing precipitation intensities and more frequent extreme rainfall events across large parts of Västernorrland and especially by the coastal municipalities.

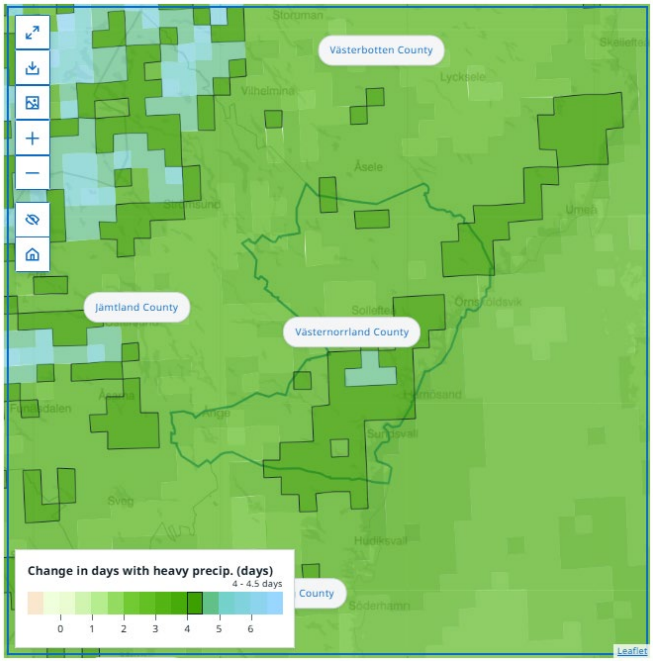


Figure 8: Calculated change of the number of days with heavy precipitation (days) for the period 2041-2070 compared to 1971–2000. The map is based on an average of a number of climate models for emissions scenario RCP4.5.

Figure source: SMHI Climate change scenario tool (2024b).

RCP8.5

According to the SMHI Climate Change Scenario Tool (Figure 9), the modelled mean number of days with **heavy precipitation** in Västernorrland County during the reference period 1971-2000 was 16.4 days per year. Under the RCP8.5 scenario, the mean number of days with heavy precipitation is projected to increase by 4.5 days during the period 2041-2070 compared with the reference period (SMHI, 2024).

The stronger increase under RCP8.5 is also reflected in the Phase 1 analysis, which showed larger increases in precipitation intensity and more pronounced changes in the return periods of extreme rainfall events under the high-emission scenario. Together, the analyses indicate that extreme rainfall events historically considered rare may occur considerably more frequently in the future, increasing the exposure of communities, infrastructure, transport systems, and other critical societal functions to flooding and water-related impacts.

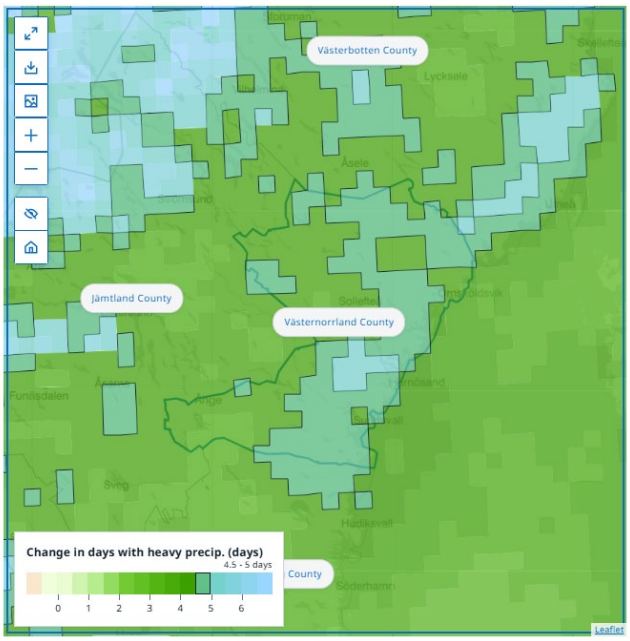


Figure 9: Calculated change of the number of days with heavy precipitation (days) for the period 2041-2070 compared to 1971–2000. The map is based on an average of a number of climate models for emissions scenario RCP8.5.

Figure source: SMHI Climate change scenario tool (2024b)

Together, the historical record, the CLIMAAX Phase 1 assessment, stakeholder input from Phase 2 workshops, and SMHI climate projections provide a robust basis for understanding future precipitation-related risks in Västernorrland. The results consistently indicate an increase in heavy precipitation and associated impacts on communities, infrastructure, and critical societal functions across the county.

Table 2-2 Data overview workflow - heavy rainfall and heavy snowfall

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
Gridded historical and scenario data for daily precipitation. Each grid cell represents an area of	*Stakeholder information on climate-sensitive*	Population data, our	*Calculated **change of the number of days with heavy precipitation** (days) for the period 2041-2070 compared to*

Hazard data	*Vulnerability data*	*Exposure data*	*Impact metrics/Risk output*
about 12x12 km. The map is based on an average of a number of climate models for emissions scenario RCP8.5 and RCP4.5 Climate Change Scenario Tool — SMHI *Historical snow-cover data for Southern Norrland compiled by SMHI for the period 1904/05-2020/21.* *https://www.smhi.se/klimat/klimatet-da-och-nu/klimatindikatorer/sno*	*sectors, infrastructure and ecosystem vulnerabilities*	internal GIS platform LstY Klimat - WebbGIS	*1971–2000. The map is based on an average of a number of climate models for emissions scenario RCP4.5.* *Historical trend showing a **decline in the number of days with snow cover** in Southern Norrland since the 1980s.*
…	…		

Days with snow

For this analysis, snow depth data compiled by SMHI for the period 1904/05-2020/21 were used (Figure 10). The dataset is based on observations from 43 stations for annual maximum snow depth and 37 stations for the number of snow-covered days (SMHI, 2024). Continuous time series were created by combining data from nearby stations where observation records were incomplete and by interpolating missing values. As no equivalent long-term snow dataset exists for northern Sweden, the SMHI regional dataset for Southern Norrland was used as the best available representation of snow conditions. Our Västernorrland region is located within the larger Southern Norrland region.

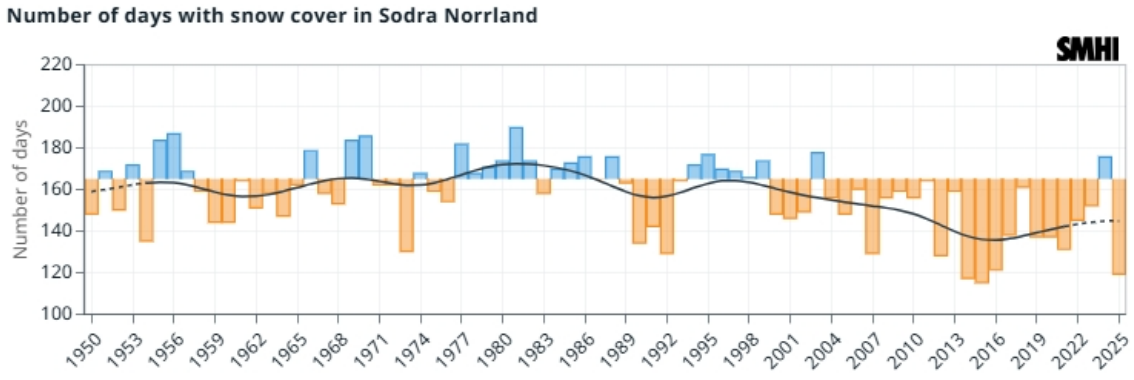


Figure 10: Number of days with snow cover in Southern Norrland. Source: SMHI - Snow data (2024a)

Note: Blue bars show more and orange shows fewer days than the average value for the normal period 1961-1990. The gray line shows a running mean calculated over about ten years. The year shown represents the year in which the season ends. That is, 2000 stands for the 1999/2000 season.

Historical observations for Southern Norrland show a clear decrease in the number of days with snow cover since the 1980s (Figure 10). Although individual winters vary considerably, the long-term trend indicates shorter snow seasons and reduced snow cover across the region. The lowest values were recorded during the 2010s, while a few recent winters have shown temporary increases, illustrating the continued year-to-year variability. For Västernorrland, these observations confirm that changes in winter conditions are already occurring and support climate projections indicating continued reductions in snow cover and snow-season length in the future. At the same time, individual years may still experience heavy snowfall and extreme snow events despite the overall declining trend.

2.3.2.2 Risk assessment – increased precipitation

In addition to the regional climate analyses presented above, the County Administrative Board maintains **municipal cloudburst mapping** (skyfallskartering) within the **Climate GIS platform** (Figure 11). The datasets include maps of low points with estimated water depths (lågpunkter djupvärden) and flow paths (rinnvägar), which identify areas where water may accumulate and the routes through which runoff may flow during extreme rainfall events. **The maps provide valuable information on flood-prone areas, drainage patterns, potential inundation depths, and vulnerable infrastructure.**

The datasets were used during the **Phase 2 stakeholder workshops to** support discussions on local flood vulnerabilities, critical societal functions, and potential climate adaptation measures. The workshops formed an important part of the risk assessment process, allowing municipalities and other stakeholders to validate identified risk areas, provide examples of previous impacts, and identify vulnerabilities that may not be evident from available datasets alone. The participating municipalities were generally well acquainted with these datasets and reported that they are frequently used in spatial planning, flood-risk management, emergency preparedness, and climate adaptation work.

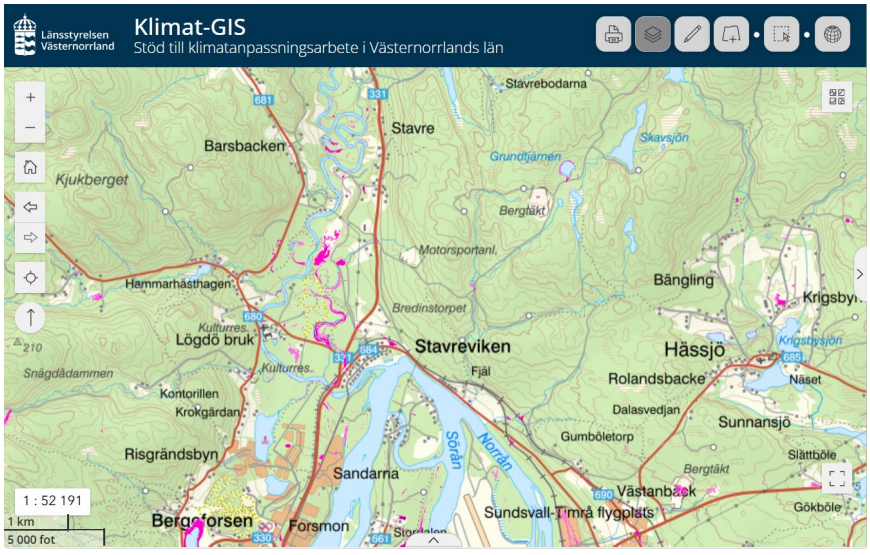


Figure 11: Example of a cloudburst mapping (skyfallskartering) layer showing estimated water depths (m) in mapped low-point areas (lågpunkter). The map identifies enclosed low-lying areas where water may accumulate during extreme rainfall events and provides an indication of potential inundation depths.

Figure source: County Administrative Board Climate GIS Platform (LstY Klimat WebbGIS), Skyfallskartering – Lågpunkter djupvärden (m)..

The cloudburst mapping indicates that numerous settlements, transport corridors, and critical infrastructure assets are located in areas where surface water may accumulate during heavy rainfall. Several of these areas correspond with locations affected during the September 2025 flood event, providing additional evidence of their vulnerability to pluvial flooding.

Feedback from workshop participants confirmed many of the locations highlighted by the cloudburst mapping and **provided additional local knowledge** regarding recurring flooding, drainage challenges, transport disruptions, and impacts observed during both recent and historical rainfall events. This process helped combine climate projections and spatial analyses with practical local experience and knowledge.

The **September 2025 flood event provided a recent example** of the consequences that extreme rainfall can have for communities and infrastructure in Västernorrland. According to the Copernicus Emergency Management Service (EMSR841), approximately 4,000 people, 348.9 hectares of built-up areas, more than 262 km of roads, and sections of the regional railway network were located within flood-affected areas during the event. These figures illustrate the considerable exposure of communities, transport infrastructure, and other critical societal functions to heavy-rainfall hazards in the county. The event resulted in widespread disruption to transport systems, damage to roads, railways, properties, and public infrastructure, and significant societal consequences.

The risk associated with increasing precipitation is not limited to flooding alone. Heavy rainfall, high flows, erosion processes, and prolonged periods of elevated soil moisture can interact and reinforce one another. National assessments by the Swedish Geotechnical Institute (SGI) and the Swedish Civil Contingencies Agency (MSB) identify the central Norrland coast, including parts of **Västernorrland, as one of Sweden's national risk areas for landslides, erosion, and flooding** (Figure 12). Within the county, the Sundsvall area and the Ångermanälven valley have been identified as particularly vulnerable locations where future increases in precipitation may further increase geotechnical risks.

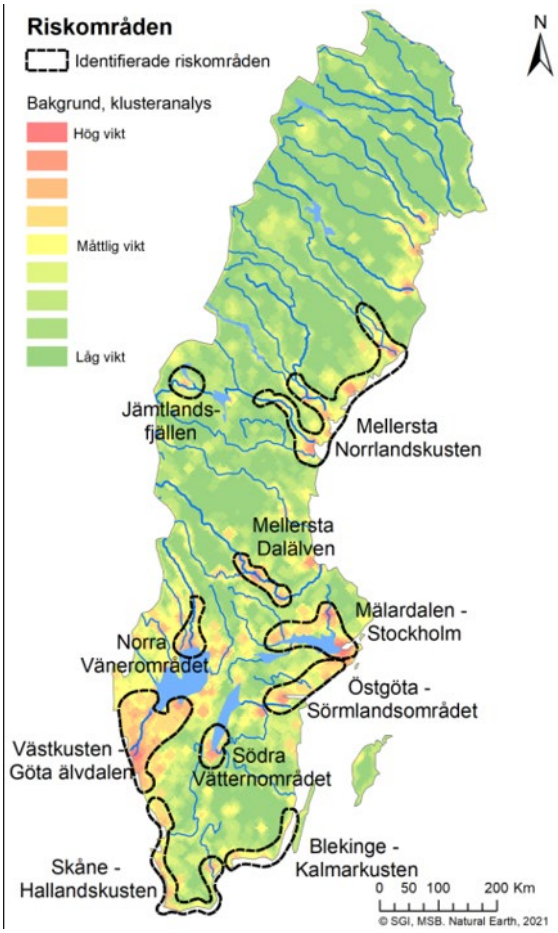


Figure 12: Nationally Identified Risk Areas for Landslides, Slope Failures, Erosion, and Flooding. The Central Norrland Coast (Mellersta Norrlandskusten), including parts of Västernorrland County, is identified as one of Sweden's national risk areas.

Figure source: Swedish Geotechnical Institute (SGI) and Swedish Civil Contingencies Agency (MSB) (2021)

The September 2025 event, together with historical observations and experiences shared by stakeholders during the workshops, highlighted the importance of **cumulative and cascading effects**. According to SMHI, the extreme rainfall caused high flows and extensive flooding across Västernorrland, leading to major impacts on infrastructure and transport systems. **Similar events have previously occurred in the county**, **showing that repeated periods of heavy rainfall** and high runoff can increase pressure on infrastructure and affect multiple sectors simultaneously. Saturated soils, elevated groundwater levels, erosion, and concentrated surface-water flows may also increase the susceptibility of slopes and riverbanks to instability, thereby increasing the risk of landslides and erosion-related impacts.

The combined evidence from cloudburst mapping, stakeholder workshops, historical events, and the September 2025 flood indicates that several communities and critical societal functions are already exposed to heavy-rainfall hazards. Transport infrastructure, public services, healthcare facilities, schools, residential areas, businesses, and emergency-response functions may be affected when rainfall exceeds local drainage capacity or when flooding, erosion, and slope instability occur simultaneously.

As described in the hazard assessment, both the frequency of heavy precipitation days and the intensity of extreme rainfall events are projected to increase in the future. Consequently, the likelihood of flooding, surface runoff, erosion, slope instability, infrastructure damage, and

disruptions to transport systems and public services is expected to increase. Repeated events may also place growing pressure on stormwater systems, municipal resources, emergency-response capacity, and long-term maintenance of critical infrastructure.

Overall, the risk level is expected to increase, particularly toward the end of the century. The concentration of settlements, transport infrastructure, healthcare facilities, schools, and other critical societal functions within potentially flood-prone areas highlights the importance of continued climate adaptation planning and risk-reduction measures across the county.

Snow seasons in Sweden, particularly in Southern Norrland, have become shorter since the 1980s, increasing risks related to water availability, ecosystem stability, winter tourism, forestry operations, and other winter-dependent activities. Reduced snow cover may also contribute to changes in seasonal runoff patterns, increased winter flooding, and freeze-thaw related impacts on infrastructure and the built environment.

2.3.3 Additional assessments based on local models and data: Flooding in Sundsvall

For Sundsvall, the largest urban area in our region, additional analyses were based on officially adopted risk map for the Selångersån River (Figure 14) and hazard map for heavy rainfall (a 100-year rainfall event, Figure 13). These datasets were adopted in December 2025 and produced in accordance with the Flood Risk Ordinance (SFS 2009:956).

The Swedish Civil Contingencies Agency (MSB), currently named the Swedish Civil Defence and Resilience Agency (MCF), was responsible for the development of the hazard map, while the County Administrative Board was responsible for the development of the risk map. Together, these datasets provide a consistent and locally detailed basis for flood risk analysis in Sundsvall.

2.3.3.1 Hazard assessment

The hazard assessment was based on the flood hazard map (Figure 13), which shows the spatial extent and water depth of flooding. For Sundsvall, this map covers flooding from the Selångersån River as well as a 100-year rainfall event.

The map identifies areas exposed to significant flood hazards and provides a clear representation of the potential extent and depth of inundation. This supports the identification of the most flood-prone areas and improves understanding of local flood dynamics.



Figure 13: Hazard map, Sundsvall - Flood extent during a 100-year rainfall event.

Figure source: Översvämningsportalen MSB (2025a)

Note: The map illustrates the spatial extent and water depth of a flood event. Water depth is classified from light blue (0-0.5 m) to dark blue (>1.5 m).

2.3.3.2 Risk assessment

The risk assessment is based on the risk map (Figure 14), which build on the hazard map by showing what is exposed to flooding. This includes population, infrastructure, and various types of activities and land use located within the inundated areas.

By combining hazard information with exposed zones, the risk maps identify areas where flooding may have the greatest consequences. These map supports the prioritization of mitigation measures, spatial planning, and emergency preparedness in Sundsvall.

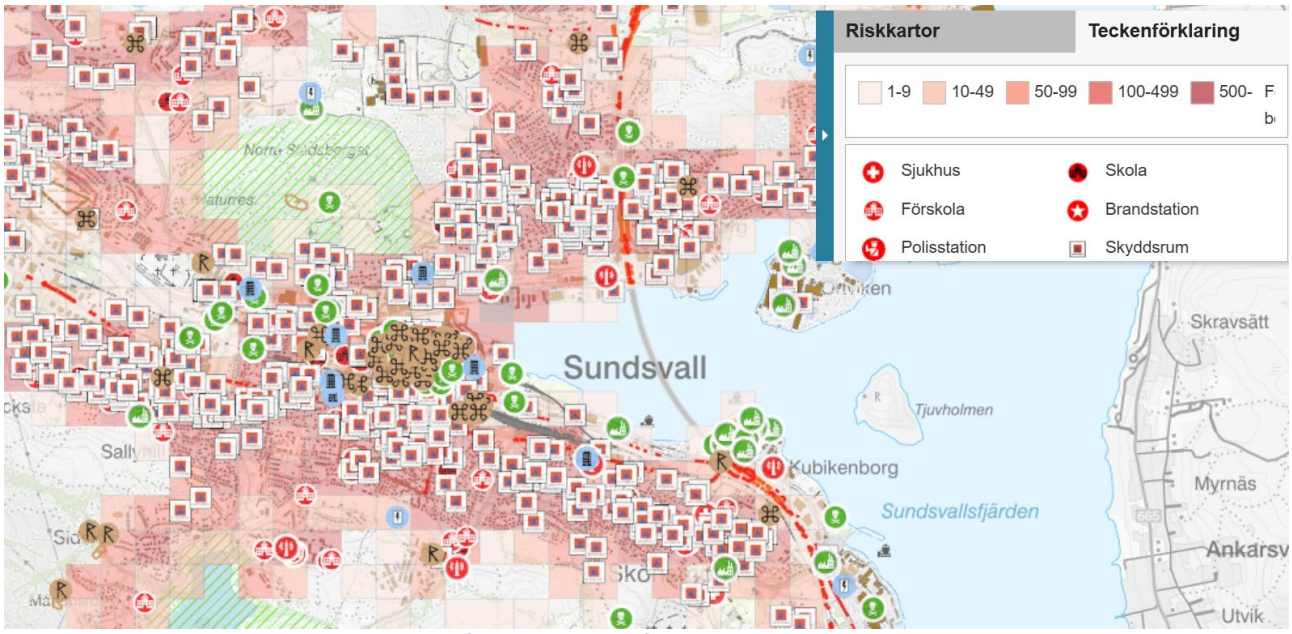


Figure 14: Risk map, Sundsvall – Heavy Rainfall, 100-year rainfall event.

Figure source: Översvämningsportalen MSB (2025b)

Note: Red shaded areas indicate levels of potential impact (number of affected people/assets), while icons represent exposed functions such as hospitals, schools, emergency services, and infrastructure within flood-prone areas.

2.4 Key Risk Assessment Findings

2.4.1 Mode of engagement for participation

Our engagement process, which is laid out in more detail in section 2.1.5, involved a **collaborative framework** that significantly enhanced our understanding of climate risks in Västernorrland**. The workshops with expert groups** employed a systems mapping approach that revealed the complex interconnections between climate impacts on different societal and ecological systems. This methodology proved particularly valuable in demonstrating the wide range of impacts a specific climate hazard can lead to.

The municipal workshops provided critical local insights that were especially valuable given Västernorrland's context of small, resource-constrained municipalities. These sessions brought to light the specific challenges faced by local governments in addressing climate adaptation, highlighting the need for cost-effective solutions and emphasizing the importance of regional collaboration. The opportunity to discuss climate risks and future adaptation measures in a local context was highly appreciated by workshop participants, who consistently emphasized the value of early and structured engagement with local actors.

The engagement revealed that while municipalities possess valuable local knowledge through their GIS systems and operational experience, they often lack the resources to fully engage with climate adaptation independently. This insight has shaped our approach moving forward, particularly as we progress into Phase 3, where we will focus on identifying practical, low-maintenance solutions and advocating for increased regional cooperation and state support.

2.4.2 Gather output from Risk Analysis step

For our **risk evaluation process**, we utilized a set of climate risk assessment outputs that combined regional climate projections with historical and recent extreme event data. **In addition to the Phase 1 analysis, we used SMHI's Climate Change Scenario Tool**, which provided high-resolution projections for our region under both RCP4.5 and RCP8.5 emissions scenarios. This included detailed information on predicted future temperature trends, changes in mean and extreme precipitation patterns, and evolving snow conditions.

The analysis of these outputs took place through **two parallel workshop streams**. With our **expert groups**, we examined how the climate data intersected with different societal systems, exploring potential impacts on health, ecosystems, infrastructure, and economic sectors. **Recent extreme weather** events that occurred during the project period, including the summer 2025 heatwave, the September 2025 torrential rainfall event, and the January 2026 snowstorm, were also used during the workshops. These real-world events served as critical validation points for our climate projections and provided concrete examples of how climate risks manifest in our region.

In separate **workshops with municipalities**, we analysed the data in relation to local geographies, considering how climate risks would affect specific communities, critical infrastructure, and local assets. This dual approach allowed for rich qualitative discussions about the severity of both experienced and forecasted climate hazards, their potential consequences, and the urgency of response requirements. The workshops also provided a forum to assess existing resilience capacities and identify critical gaps that need to be addressed.

2.4.3 Assess Severity

Increasing Temperatures and Heatwaves

While our initial CLIMAAX analysis focused primarily on precipitation-related hazards, the inclusion of increasing temperatures proved essential for developing a comprehensive understanding of climate risks in Västernorrland. Rising temperatures influence several climate-sensitive systems in our region, including an extended vegetation period, altered winter conditions, and more frequent zero-degree crossings that affect both infrastructure and land use patterns. The summer of 2025 provided a clear demonstration of these risks, when temperatures exceeded 30°C for over two weeks, which is extremely unusual in this northern region.

The impacts of rising temperatures extend across multiple sectors and systems. Healthcare facilities reported increased cases of heat-related illnesses, particularly among vulnerable populations such as the elderly and outdoor workers. Agricultural producers faced drought conditions and reduced yields, while infrastructure systems experienced stress from heat-related expansion and increased energy demand for cooling. For the Sámi community, changing temperature patterns affect grazing conditions and traditional practices, adding another layer of cultural vulnerability to the physical climate risks.

The region's ecosystems and human systems are adapted to historical temperature patterns, and deviations from these norms create significant stress. During our workshops with experts and stakeholders, it became clear that many temperature-related impacts are difficult to fully capture through traditional data collection methods alone. While we can measure increased heatwave frequency and duration, the cascading effects on e.g. ecosystems, human health, agricultural

productivity, and energy demand require more nuanced analysis that considers local conditions and vulnerabilities.

Given these observations, **we assess the current severity of temperature-related risks as moderate. Looking ahead, we expect the severity of these risks to escalate to substantial if no significant adaptation measures are implemented.**

Snow and blizzards

The assessment of risks associated with snow and blizzards presents a nuanced picture that reflects both declining and intensifying threats. While climate models project a clear reduction in the overall number of snowy days and extreme snow events, this trend carries significant consequences for our region's ecosystems, infrastructure, and local communities. The flora and fauna of Västernorrland are adapted to cold, snowy winters, and changes in snow cover patterns can disrupt these ecological balances in ways that are difficult to capture through maps or numerical data alone.

During our workshops with experts and stakeholders, it became evident that many of these effects manifest in subtle but important ways. For example, reduced snow cover can leave tree root systems unfrozen during winter storms, significantly increasing the risk of storm-felled trees. This presents concerns for both the forestry industry and infrastructure maintenance, as fallen trees can block roads and damage power lines. The impacts extend beyond immediate physical damage, affecting ecosystem services and potentially altering forest composition over time.

For the Indigenous Sámi population, the decline in snowfall represents an existential threat to their traditional way of life. Reindeer herding, which is central to Sámi culture and economy, relies heavily on snow cover for mobility. Without sufficient snow, herders cannot use snowmobiles to traverse the vast areas necessary for managing their herds. This jeopardizes not only a vital economic activity but also an entire cultural tradition that has been passed down through generations. Other snow-dependent activities, such as skiing, ice fishing, and snowmobiling, are also at risk, further eroding local traditions and recreational opportunities that contribute to the region's cultural identity.

Paradoxically, despite the overall trend toward milder winters, our region has experienced several extreme snow events in recent years. This apparent contradiction stems from the fact that the sea no longer freezes over as it once did, creating conditions for more intense winter storms. The January 2026 snowstorm serves as an example of this phenomenon, when record-breaking snowfall in parts of the region caused power cuts and blocked roads. With over a meter snowfall in less than 24 hours, emergency services, including home care, struggled to reach those in need, particularly the elderly living in remote areas. This highlights the risks associated with heavy snowfall, even as the long-term trend points toward less snow overall.

Given these insights, we assess the **current severity of risks related to snow and blizzards as substantial**. This classification reflects both the ongoing occurrence of extreme snow events that disrupt infrastructure and emergency services, and the already noticeable shortening of the snow season that affects ecosystems and cultural functions. Looking ahead, **we expect the severity to remain substantial, though the nature of the risks will shift.** While threats to infrastructure and emergency response capabilities may decrease over time, the consequences for Sami culture, ecosystems, and snow-dependent industries will become increasingly pronounced. This evolving risk profile underscores the need for both immediate response capabilities and long-term adaptation strategies.

Heavy rainfall

The severity of risks associated with heavy rainfall became starkly apparent during the project period, particularly through the extreme rainfall event of September 2025. The September 2025 event served as a defining moment for our region, causing immediate and severe damage to critical infrastructure. Approximately 40 roads and three national railway lines were affected. A train carrying hazardous materials and a timber train both derailed. Passenger train services north of Sundsvall were suspended or several days, causing significant disruptions to both local and regional transportation networks. One person lost their lives when driving off a washed-away road. Many property owners experienced flooded basements and other water-related damage, while flooding at a local water treatment facility prompted authorities to advise residents in one area to boil their drinking water as a precautionary measure.

This extreme rainfall event has served as a critical case study in our analysis of climate-related hazards, underscoring the urgent need to strengthen our region's preparedness for future scenarios. The County Administrative Board of Västernorrland collaborated with the Swedish Civil Contingencies Agency (MSB) and accessed Copernicus EMS On-Demand Rapid Mapping data related to this event. This data has proven invaluable for decision-making purposes and is particularly relevant for municipalities in our region, providing them with concrete examples they can use to plan and implement climate adaptation measures – assuming political motivation and sufficient resources are available.

In the project's first phase, we conducted a comprehensive analysis of heavy rainfall risks, which has since been validated against similar datasets from the Swedish Meteorological and Hydrological Institute (SMHI). The Sundsvall area is specifically covered by the EU Floods Directive, and our region has also been identified as particularly vulnerable to landslides and erosion. Workshops with stakeholders have revealed that vulnerability to heavy rainfall is widespread across all municipalities and affects all societal systems. **Today, we assess the severity of this risk as substantial, with certain areas facing critical conditions. If no major adaptation measures are implemented, we expect the severity of heavy rainfall risks to escalate to critical in the future.**

2.4.4 Assess Urgency

Increasing Temperatures and Heatwaves

Rising temperatures present growing risks to public health, agriculture, and critical infrastructure in our region. The 2025 heatwave provided a clear demonstration of these risks. Climate projections indicate that these events will become more frequent and intense in the coming decades, creating an urgent need for both immediate protections and long-term adaptation strategies.

We assess the urgency of temperature-related risks as "More Action Needed". Current heatwaves already strain healthcare systems and affect vulnerable populations, while future projections show significantly worsening conditions. The risk profile includes both sudden events (heatwaves) and slow-onset changes (ecosystem shifts and agricultural impacts), requiring a comprehensive approach that addresses both immediate needs and long-term adaptation.

The persistent nature of temperature increases demands both immediate health protections and long-term adaptation measures. Without intervention, we risk facing increasingly severe heatwaves that could overwhelm our healthcare systems and disrupt agricultural production. The complex

interplay between these factors requires a coordinated approach that addresses both the immediate health risks and the broader systemic impacts of rising temperatures.

Snow and Blizzards

The urgency of addressing snow-related risks presents a complex picture that requires careful consideration of both current conditions and future projections. While climate models indicate a long-term decline in snowfall, the persistence of extreme events and their immediate impacts demand a nuanced approach to urgency classification that accounts for both sudden disruptions and slow-onset changes.

We assess the urgency of snow-related risks as "More Action Needed". Current extreme events, such as the January 2026 snowstorm, demonstrate how quickly infrastructure and emergency services can be overwhelmed, requiring immediate response capabilities. At the same time, the gradual decline in snow cover threatens Sámi culture and ecosystems, necessitating proactive measures to prevent irreversible damage to traditional livelihoods and ecological systems.

The dual nature of this risk – combining sudden extreme events with slow-onset cultural and ecological changes – requires a comprehensive approach that addresses both immediate response needs and long-term adaptation requirements.

The persistence of extreme snow events, despite the overall declining trend, further complicates the urgency assessment. This apparent contradiction means that while average conditions may become less challenging, the most severe events may continue to pose significant risks. This pattern underscores the need for continued investment in emergency response capabilities even as we develop longer-term adaptation strategies.

Heavy Rainfall

The urgency of addressing heavy rainfall risks has become increasingly apparent through recent events and climate projections. The September 2025 flooding event provided concrete evidence of the immediate and severe impacts that extreme rainfall can have on our region's infrastructure, transportation systems, and communities. These events have made it clear that we are already experiencing the consequences of changing precipitation patterns, while future projections indicate that these risks will only intensify.

We assess the urgency of heavy rainfall risks as "More Action Needed". Current impacts are already severe, with infrastructure damage, transportation disruptions, and public health risks becoming increasingly common. Future projections show significantly worsening conditions, with more frequent and intense rainfall events expected in the coming decades. The sudden nature of these events requires rapid response capabilities that can minimize damages and protect vulnerable populations.

Stakeholders have been vocal about the gaps in the current preparedness, emphasizing the need for upsizing road culverts to handle the anticipated increase in extreme rainfall event as well as a need for an adapted forestry practice. The economic consequences of recent events, including the disruption of national goods transport during the 2026 floods, have further highlighted the far-reaching impacts of heavy rainfall beyond our immediate region.

The combination of immediate threats and escalating future risks demands urgent action to enhance our region's resilience. Without significant adaptation measures, we risk facing increasingly

severe consequences that could overwhelm our current response capabilities and cause lasting damage to our infrastructure, economy, and communities.

2.4.5 Understand Resilience Capacity

Increasing Temperatures and Heatwaves

Our capacity to manage heat-related risks is developing but remains insufficient to address the growing challenges posed by rising temperatures. While some heat action plans exist, coverage is uneven across the region. Agriculture and ecosystems remain vulnerable to heat stress, and support for vulnerable populations is limited, particularly in remote areas.

We assess the resilience capacity for temperature-related risks as "Medium". Some heat action plans are in place but need expansion to provide adequate coverage, particularly for vulnerable populations. Agricultural adaptation measures are currently insufficient to address the increasing drought risk but there is much knowledge on the topic. While some measures are in place to address immediate heat-related challenges, work remains to build long-term resilience that can withstand the increasing temperatures projected for our region.

Snow and Blizzards

Our assessment of resilience capacity to manage snow-related risks reveals a mixed picture, with some existing measures in place but significant gaps that need to be addressed. The region demonstrates moderate capacity to handle normal winter conditions, with established emergency response protocols and snow-adapted infrastructure. However, recent extreme events have exposed critical vulnerabilities, particularly in remote areas where emergency services struggle to reach affected populations.

We assess the resilience capacity for snow-related risks as "Medium". Emergency response systems exist but are often stretched during major storms, particularly in our region's remote areas. Infrastructure is generally robust enough to handle normal winter conditions but remains vulnerable to extreme events, as demonstrated by the January 2026 snowstorm that caused power cuts and road closures. The most critical gap in our current capacity relates to long-term support for Sámi livelihoods and ecosystem adaptation to changing snow conditions.

Heavy Rainfall

Recent flooding events have exposed critical vulnerabilities in our region's resilience to heavy rainfall. While some emergency response protocols exist, our infrastructure remains poorly prepared for such extreme events. This is complicated by the fact that municipalities face budget constraints that limit their ability to invest in flood protection measures and that the question of responsibility between road owners and forest owners needs to be clarified.

We assess the resilience capacity for heavy rainfall risks as "Medium". Emergency response systems tend to be reactive rather than preventive, focusing on immediate crisis management rather than long-term risk reduction. Infrastructure across the region is inadequate to handle current and future flood risks, with many areas lacking proper stormwater management systems. Regional coordination between municipalities and other actors remains limited, creating gaps in our collective ability to address widespread flooding events.

2.4.6 Decide on Risk Priority

The risk prioritization process applied the evaluation dashboard to synthesize the comprehensive assessments of severity, urgency, and resilience capacity for each climate hazard. This systematic approach enabled us to compare risks across multiple dimensions and identify the most critical priorities for our region. The dashboard visualization proved valuable in facilitating evidence-based decision making and ensuring that our priorities aligned with both scientific projections and stakeholder concerns.

Risk Workflow	Severity		Urgency	Capacity	Risk Priority
	C	F		Resilience/ CRM	
Snow and blizzards	3	3	3	2	High
Heavy rainfall	3	4	3	2	Very high
Increased temperature	2	3	3	2	High

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

Figure 15 Climate risk evaluation dashboard and prioritized risk ranking for Västernorrland region.

The dashboard analysis revealed priority rankings for our region's climate risks:

1. **Heavy rainfall** emerged as the highest priority risk. The recent flooding events have demonstrated the immediate and severe impacts of extreme rainfall on our infrastructure, transportation networks, and communities. Future projections indicate that these risks will only intensify, making this our most urgent priority for adaptation planning and investment.
2. **Snow and blizzards** were identified as the second priority. While extreme snow events continue to pose risks to infrastructure and emergency services, the overall declining trend in snowfall reduces the long-term urgency compared to other climate hazards. However, the cultural and ecological impacts on Sámi communities and ecosystems remain significant concerns that require ongoing attention.
3. **Increasing temperatures**, was prioritized third (currently not as severe as snow, though future assessment is similar). The 2025 heatwave provided clear evidence of the immediate health risks and economic impacts of extreme temperatures. Future projections show worsening conditions that will affect public health, agriculture, and culture across our region.

In all, all chosen hazards pose significant risks, and we will have to address them as we progress to identifying relevant measures in phase 3.

2.5 Monitoring and Evaluation

In the second phase of the climate risk assessment, it has become evident that municipalities vary significantly in terms of data availability, systems, and expertise. Moreover, many municipalities

have limited resources for conducting comprehensive local analyses and following them up with concrete measures.

Stakeholders play a central role in the Monitoring and Evaluation process by providing key input to the climate risk assessment (CRA). Their contributions help identify ongoing developments as well as gaps in available data and knowledge within the region. Learning is ensured through continuous stakeholder engagement and workshops, where experiences and insights are shared across municipalities, supporting mutual learning by highlighting both good practices and common challenges.

New data has been collected, particularly in the form of local and historical knowledge from municipalities. This has contributed to a better understanding of past events and region-specific risks, such as heavy rainfall and its consequences for built-up areas within municipalities.

Phase 2 outcomes will be communicated during a joint workshop with major project stakeholders in September, focusing on the development of an action plan for the region. This joint conference/workshop serves as a monitoring step to review and reflect on the analysed risks.

Cooperation with other regions in Sweden has been valuable and has contributed positively to the climate risk assessment process by enabling the exchange of knowledge, experiences, and approaches. However, the one-year timeframe has been relatively short for conducting a comprehensive analysis and involving all relevant actors in the region.

Resources have been used efficiently during the second phase by conducting physical visits to most municipalities (5 out of 7), which has strengthened engagement and data collection. The rest of the municipalities were contacted digitally. For the third phase, efficiency will be improved by organizing a joint conference, thereby reducing travel time and costs while maintaining effective collaboration. While this has supported timely progress and stakeholder engagement, the limited timeframe and resources may have constrained the depth of the analysis and the involvement of all relevant stakeholders.

Overall, the CRA process has contributed to an improved understanding of climate risks by increasing awareness among municipalities and strengthening engagement. It has also supported the development of institutional capacity by highlighting knowledge gaps and the need for improved coordination and resources.

2.6 Work plan Phase 3

Phase 3 of the project will shift focus from risk analysis to the development of **targeted adaptation measures** and the formal **drafting of the Regional Action Plan** for Climate Adaptation. A central component of this phase involves a desktop study and subsequent workshops focused on adaptive measures to address the high-priority risks identified in Phase 2, specifically heavy rainfall, snow-related hazards, and rising temperatures.

To ensure comprehensive coverage, the team will engage previously identified but currently missing stakeholders, including the regional fire and emergency services, the Swedish Transport Administration, and the Swedish Forestry Agency. Efficiency will be improved by hosting **a joint regional conference** in September to review analyzed risks and develop the action plan, reducing the need for individual municipal visits while strengthening regional coordination.

The project will culminate in **a final report**, participation in the concluding CLIMAAX **workshop in Brussels,** and a **presentation of the results to the regional project stakeholders**.

3 Conclusions Phase 2 - Climate risk assessment

Phase 2 of the CLIMAAX project has significantly strengthened Västernorrland's climate risk assessment by building on the Phase 1 results and further developing them through the integration of higher-resolution climate projections, historical climate analyses, local datasets, and stakeholder knowledge. The assessment has improved the understanding of both current and future climate risks and provided a more robust basis for climate adaptation planning across the county.

Key findings and progress:

1. Climate risks are already affecting the region and are expected to increase in the future

The assessment confirms that Västernorrland faces increasing risks associated with heavy rainfall, changing snow conditions, and rising temperatures. Historical climate analyses and recent extreme weather events, including the summer 2025 heatwave, the September 2025 rainfall event, and the January 2026 snowstorm, demonstrate that several of the projected climate impacts are already being observed. Climate projections indicate that these risks are likely to intensify further during the coming decades.

2. Phase 2 has regionalised and strengthened the Phase 1 assessment

A key achievement of Phase 2 was the integration of SMHI climate projections, municipal cloudburst mapping, local GIS information, historical observations, and stakeholder knowledge into the analysis. This process enabled the Phase 1 findings to be validated and interpreted in a local context. The assessment therefore provides a more detailed understanding of vulnerabilities, exposure, and climate risks within Västernorrland County than was possible through climate model outputs alone.

3. Stakeholder engagement has improved the understanding of local vulnerabilities

Workshops with municipalities, Sámi representatives, national authorities, and other regional stakeholders provided valuable information on vulnerable locations, critical societal functions, recurring impacts, and adaptation challenges. Local experiences from previous climate-related events helped validate the assessment results and identify vulnerabilities that are difficult to capture through available datasets and modelling alone.

4. Heavy rainfall remains the highest-priority climate risk

Historical analyses, climate projections, cloudburst mapping, and stakeholder consultations consistently identified heavy rainfall and associated flooding impacts as one of the most significant climate risks facing the county. The September 2025 rainfall event demonstrated the potential consequences for infrastructure, transport systems, critical societal functions, and communities. The assessment also highlights the importance of considering cascading impacts, including erosion, landslides, and disruptions to essential services.

5. Rising temperatures and changing snow conditions present significant long-term challenges

The assessment indicates that increasing temperatures will affect public health, infrastructure, ecosystems, forestry, water resources, and traditional livelihoods. At the same time, observations show declining snow cover and shorter snow seasons across the region, although severe snowfall events may still occur. These changes will require adaptation across multiple sectors and are expected to have particular implications for winter-dependent activities and Sámi reindeer herding.

6. Resilience gaps highlight the need for continued adaptation efforts

The assessment identified several challenges that may limit the region's ability to manage future climate risks. These include limitations in stormwater management and flood protection, resource constraints among municipalities, and the need for continued cooperation between regional actors. Stakeholders also highlighted challenges related to ecosystem adaptation, critical infrastructure, and long-term adaptation planning.

7. Phase 2 provides a strong foundation for Phase 3

The climate risk assessment provides a comprehensive understanding of climate hazards, vulnerabilities, exposure, and resilience across Västernorrland County. The prioritisation process identified heavy rainfall as the highest-priority risk, followed by snow-related hazards and increasing temperatures. These findings will guide the development of adaptation measures and support the preparation of the *Regional Climate Adaptation Action Plan* during Phase 3.

4 Progress evaluation

During Phase 2, the project team successfully utilized the CLIMAAX Toolbox to execute workflows analyzing both heavy snowfall and extreme precipitation. This regional analysis was further refined to include a third hazard, increased temperature, providing a more comprehensive risk assessment for Västernorrland. All seven municipalities in the region actively participated in the process through dedicated workshops and meetings to identify local vulnerabilities. Broad stakeholder engagement was achieved by involving regional experts, EU-funded projects, the Sámi Parliament, and representatives from Sámi communities. These achieved milestones, including a collaborative case study trip to the Skåne region, establish a firm foundation for developing targeted adaptation measures in the final project phase.

Table 4-1 Overview key performance indicators

Key performance indicators	***Progress***
Using the CLIMAAX Toolbox in 2 workflows, analysing snow and extreme precipitation, (phase 1-3)	Completed. Workflows for heavy snowfall and extreme precipitation were executed.
Regional refined analysis and risk assessment of 2 climate hazards: snow and extreme precipitation (phase 2)	Completed. The analysis performed during Phase 1 was complemented with the regional data that resulted in refined analysis and risk assessment of 3 climate hazards, snow, extreme precipitation and increased temperature.
7 municipalities participate in the analysis (phase 2)	Completed. 7 municipalities participated in analysis (meetings and workshops). The municipalities will continue the participation during Phase 3.
12 stakeholders (organizations) involved in the process of developing appropriate climate adaptation measures (phase 2-3)	Phase 3 will focus on the development of adaptation measures. So far 7 municipalities, our regional experts, external projects, Sámi villages and Sámi Parliament have been involved into regional analysis.
At least 3 information efforts about the project in our own channels (social media, website for example) (phase 2-3)	2 information efforts accomplished (our regional website as well as the local newspaper).
1 final report (phase 3)	
20 organizations have received information about the results of the project (phase 3)	
3 activities to report the project's results to stakeholders in the region (phase 3)	
1 presentation for policy makers (Chairmen of the seven municipal	

Key performance indicators	*Progress*
boards in the region) about the results of the project (phase 3)	
…	…

Table 4-2 Overview milestones

Milestones	*Progress*
M1: Subcontracting (phase 1)	Achieved
M2: Complete CLIMAAX common methodology (phase 1)	Achieved
M3: Attend the CLIMAAX workshop held in Barcelona (phase 1)	Achieved
M4: (Desktop study: analyze between existing CRA and result from CLIMAAX common methodology (M2)	Achieved
M5: Complete merging the results of M1 with the outdated regional CRA (phase 2)	Achieved and will be continued during Phase 3 as the older CRA included the action plan as well.
M6: Complete stakeholder and network analysis (phase 2)	Achieved
M7: Dialogue and workshop with interna and external networks and stakeholders: local actions and needs based on the outcome of M5 (phase 2)	Achieved, internal and external workshops implemented during March-June 2026. Dialogue and workshops will be continued during Phase 3.
M8: Case study trip (phase 2)	Achieved. Case study to Skåne Region/Länsstyrelsen (also received Climaax funding). The trip was performed in June 2026. Participants - the Project Manager and the Marine Spatial Planning and Climate Adaptation officer.
M9: Summarize the results (M2-M8) in a CRA (phase 3)	
M10: Desktop study on adaptive pathways and robust adaptation (phase 3)	
M11: Dialogue and workshop with interna and external networks and stakeholders: focus support and implementing adaptive pathways and robust adaptation (phase 3)	
M12: Attend the CLIMAAX final workshop in Brussels (phase 3)	
M13: Complete project result in a report (phase 3)	
M14: Holding final seminar to present the result to interna land external networks and stakeholders in the region (phase 3)	

5 Supporting documentation

Main Report (this document, PDF/Word)

Visual outputs Phase 1, Appendix

SMHI Climate Change Scenario Tool:

- https://www.smhi.se/en/climate/tools-and-inspiration/climate-change-scenario/climate-change-scenario-tool

MSB Översvämningsportalen (Swedish Flood Portal):

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