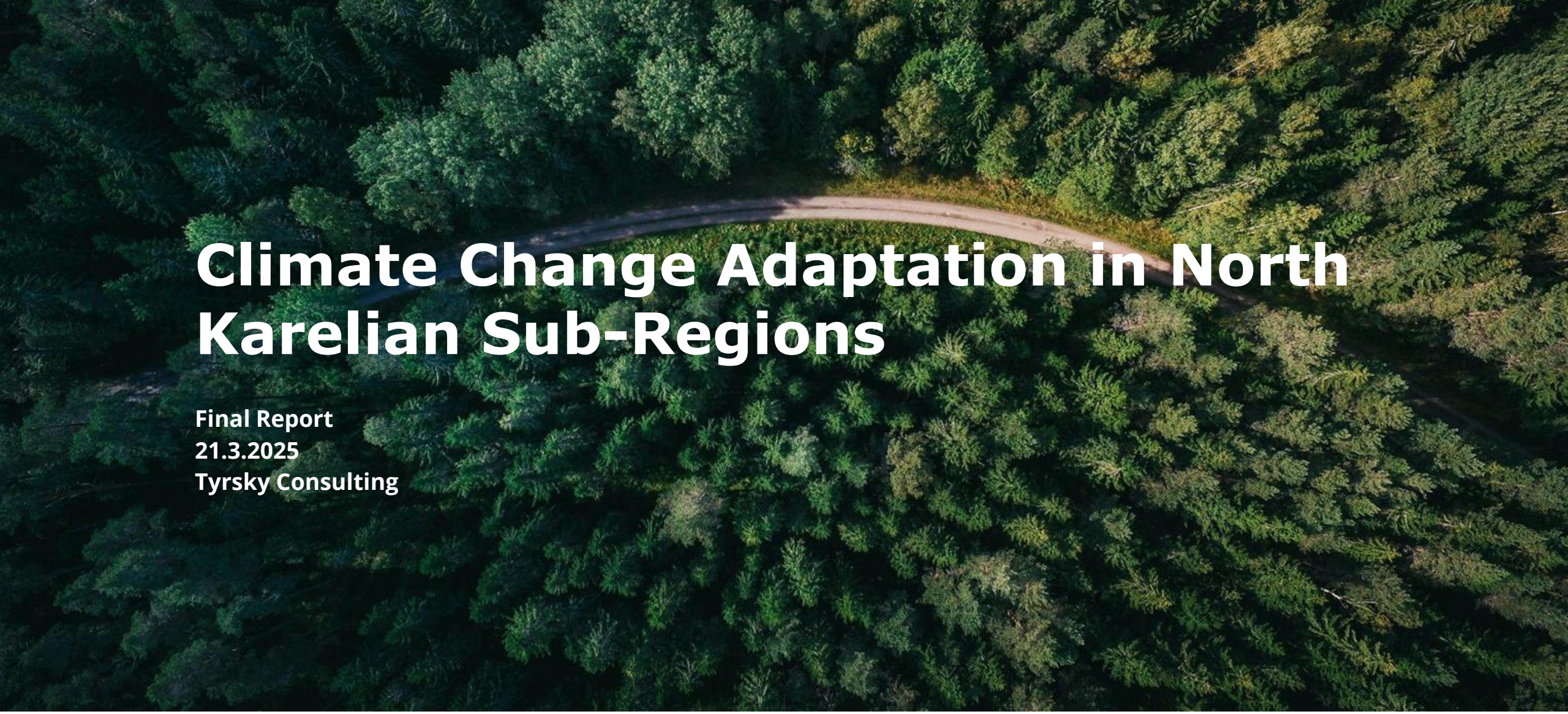
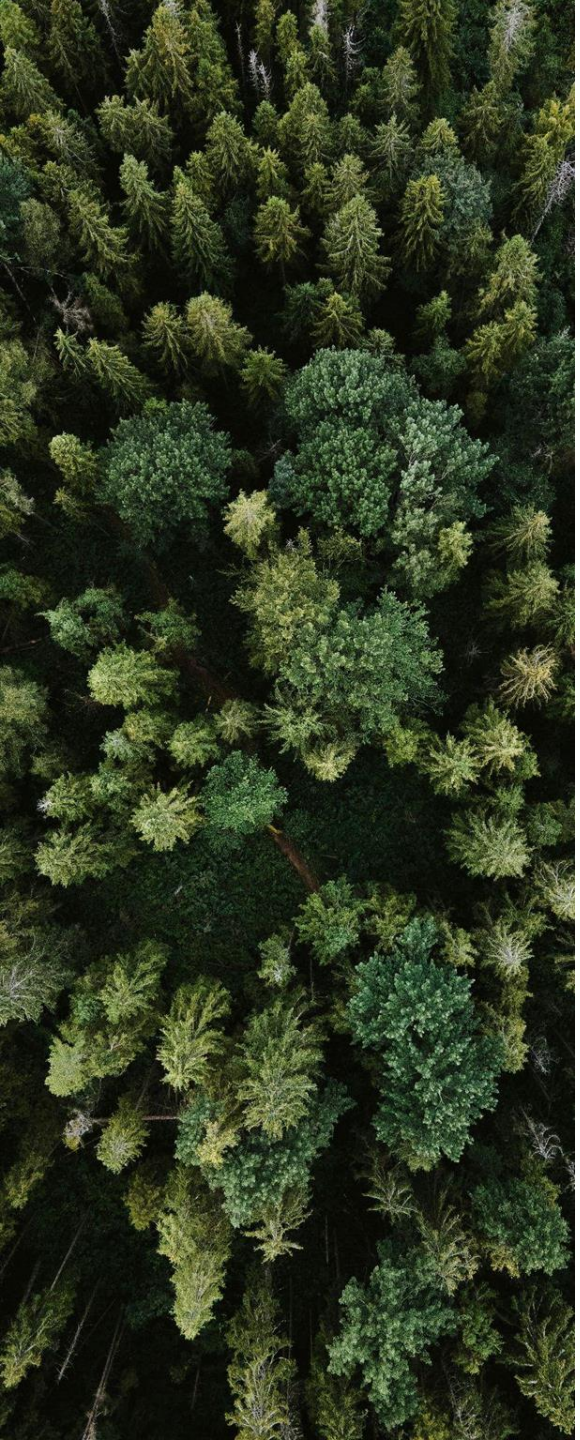


Climate Change Adaptation in North Karelian Sub-Regions

Final Report
21.3.2025
Tyrsky Consulting



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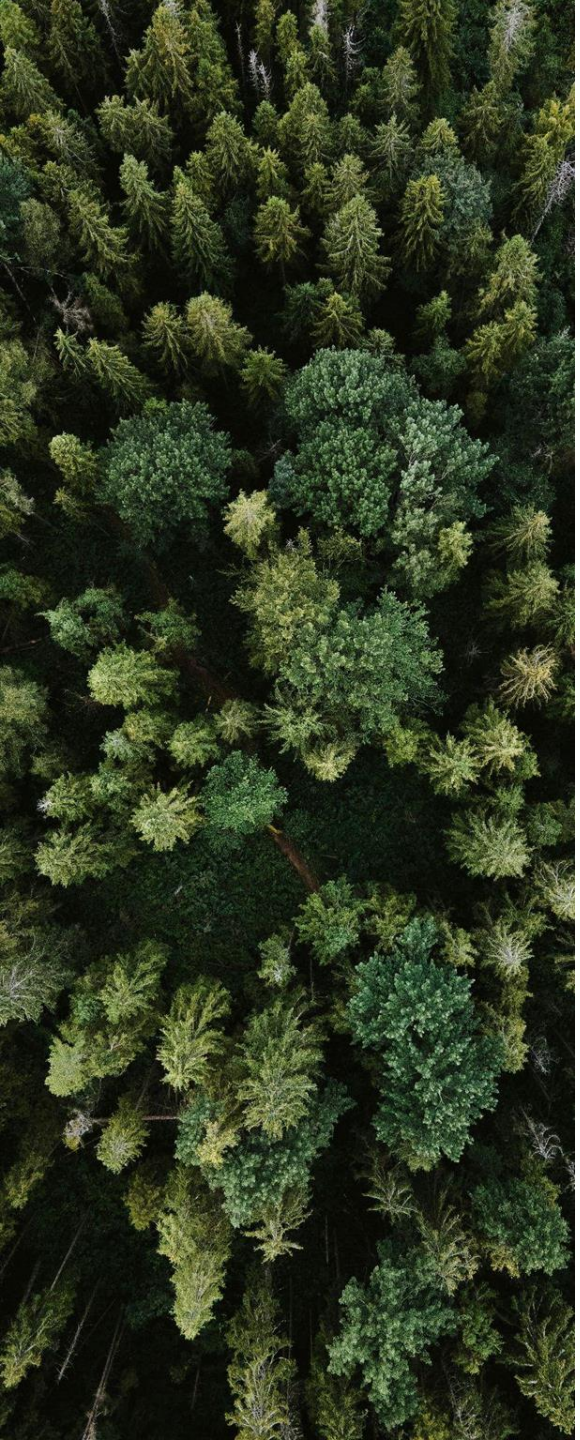


Summary

This report examines the characteristics of North Karelia's sub-regions from the perspective of climate change adaptation. It describes the sub-regions of Joensuu, Central Karelia and Pielinen Karelia, their climate risks, as well as the current state and needs of adaptation work. The objective of the work is to determine whether the regional-level adaptation plan is sufficient to meet the needs of the sub-regions or whether separate plans are needed.

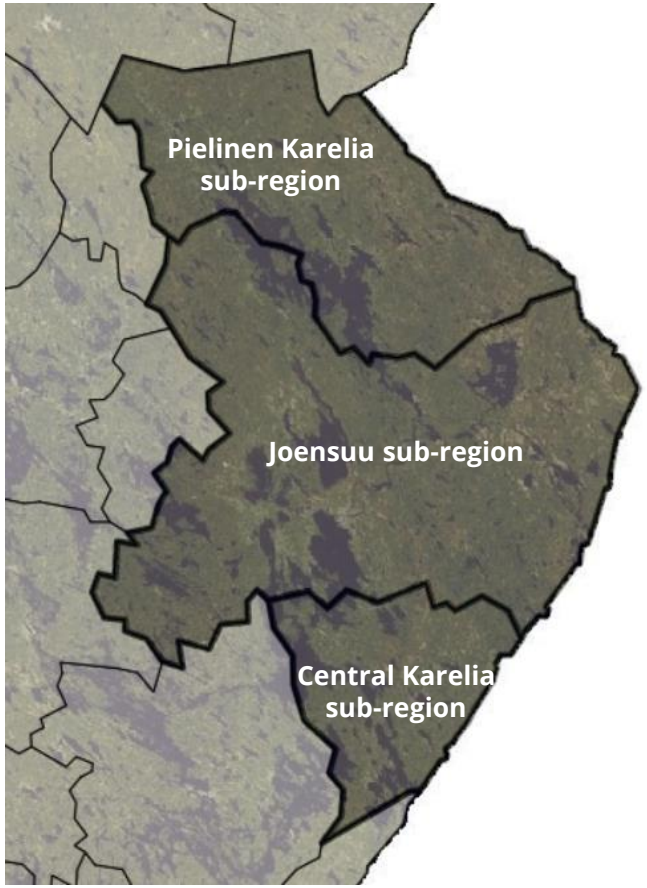
The report is based on the draft of the climate change adaptation roadmap prepared by the Regional Council of North Karelia. In addition, information about the sub-regions and the impacts of climate change has been collected from statistics and other public sources. This information was supplemented by sub-region-specific workshops and expert interviews. The workshops focused on climate risks in the sub-regions, their impacts, as well as vulnerabilities and exposure.

In summary, there are many similarities between the sub-regions, but also clear differences. In the municipalities of North Karelia, climate change adaptation is a highly current issue, and many municipalities have already undertaken concrete actions to prepare for and adapt to the impacts of climate change.

Adaptation to climate change is closely linked to local conditions. A more localised examination than the regional level supports the implementation of effective adaptation actions and increase knowledge related to climate change adaptation. Municipalities with similar characteristics can advance adaptation together, for example by developing joint adaptation plans. The Regional Council plays an important role in developing the region's adaptive capacity, particularly by promoting cooperation between municipalities.

1 Introduction and Implementation of the Work

1.1 Background and Objective



Sub-regions of North Karelia

Adaptation to climate change is being developed in North Karelia. As a part of this effort, the Regional Council of North Karelia is preparing a roadmap for climate change adaptation. The roadmap examines climate risks and impacts affecting the region and lists necessary actions for adaptation. The aim of the roadmap is to serve as an information source that enables regional actors to develop their own adaptation work.

This report complements North Karelia's adaptation roadmap by providing additional information on the specific characteristics of the sub-regions from the perspective of climate change adaptation. The report describes the sub-regions of Joensuu, Central Karelia, and Pielinen Karelia, their climate risks, as well as the current state and needs of their adaptation work. In addition, the report provides recommendations for the development of adaptation work in the sub-regions.

The objective of the report is to answer the question of whether the region-level plan is sufficient to address the challenges of adaptation in North Karelia or are the differences between sub-regions so significant that they require their own adaptation plans as part of a broader regional strategy.

The report was funded by the Centre for Economic Development, Transport and the Environment (ELY Centre) for North Karelia. The work was guided by a steering group composed of representatives from the Regional Council of North Karelia and the North Karelia ELY Centre. The work was carried out by Tyrsky Consulting Ltd.

Sources: Geodata portal Paikkatietoikkuna, 2025

1.2 Implementation and Methods

I Analysis of Climate Change Impacts and Climate Risks

The work was based on the draft version of the climate change adaptation roadmap for North Karelia. In addition, information was collected on regional climate risks, impacts, and preparedness actions from public reports and data sources, as well as from municipal climate plans.

The compiled data was analysed by sub-region, and preparatory materials for the workshops were created based on this analysis.

II Identifying the Characteristics of the Sub-Regions

In the second phase of the work, the specific characteristics of the sub-regions were examined. Background information was gathered from statistics and other public sources that describe the region and its sub-regions.

The information was enriched regarding the impacts, vulnerabilities, and exposures related to climate change through six sub-region-specific workshops and two interviews. The workshops are described in more detail on the following pages.

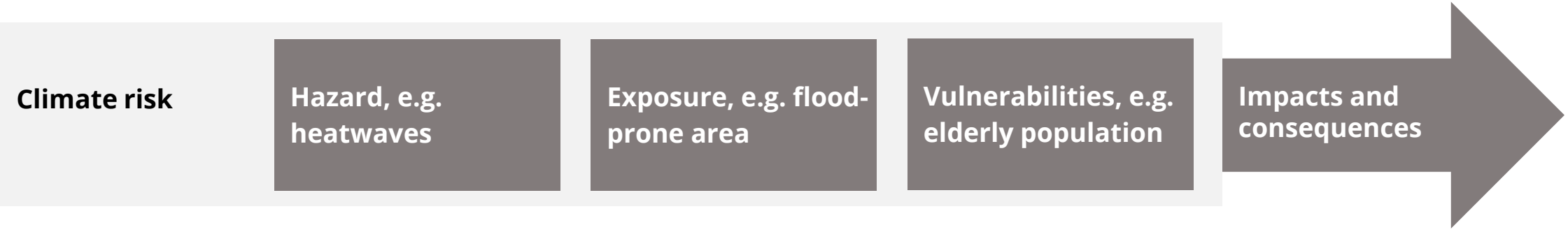
III Synthesis of Results and Preparation of Recommendations

In the final phase of the work, the results of the study were compiled into a final report, which describes the identified vulnerabilities, exposures, and impacts of climate change for each sub-region.

Additionally, a summary and recommendations were prepared to guide the continued adaptation efforts in the sub-regions.

1.3 Approach: What is the Climate Risk at Sub-Regions: Sub-Region-Specific Analysis

Differences between the sub-regions were examined from the perspective of climate risks and their impacts



The analysis focuses on the hazards identified in the regional climate adaptation roadmap

Are there specific exposure factors in the sub-region?

Are there specific vulnerabilities in the sub-region?

What climate change impacts are affecting the sub-region?

1.4 Sub-Region-Specific Workshops

In the project six online workshops were organized between January 21 and February 5, 2025 – two for each sub-region. The first workshop in each sub-region focused on **climate risks and their impacts**, while the second addressed the **sub-region's vulnerabilities and exposure to climate change**.

In the workshops, preliminary sub-regional summaries prepared through desk research were presented and then validated and supplemented through participant feedback.

The workshops aimed to

- Gather information about the unique characteristics, adaptation needs, and status of climate adaptation efforts in the sub-regions;
- Increase the awareness of sub-regional representatives regarding local climate change impacts, climate risks, vulnerabilities, and exposure;
- Engage the sub-regions in climate adaptation efforts.

Participants included representatives from municipalities and other local organisations:

- Joensuu sub-region workshops: City of Joensuu, City of Heinävesi, Finnish Forest Centre, Karelia University of Applied Sciences, Municipality of Kontiolahti, Municipality of Liperi, North Karelian Society for Social Security
- Central Karelia sub-region workshops: Municipality of Rääkkylä, Municipality of Tohmajärvi, City of Kitee, Kiteen Lämpö Oy, North Karelia Rural Services. North Karelia District of the Finnish Association for Nature Conservation
- Pielinen Karelia sub-region workshops: City of Lieksa, City of Nurmes, Finnish Forest Centre, North Karelia Rural Services, Municipality of Juuka*
- Additionally, representatives from the Regional Council of North Karelia and the North Karelia ELY Centre participated in the workshops

*The Municipality of Juuka participated in the Pielinen Karelia sub-region workshops, as it is climatically and environmentally more closely aligned with Pielinen Karelia than with the Joensuu sub-region

1.4 Sub-Region-Specific Workshops

Workshop Content

The workshops focused on climate risks and their impacts; participants were asked to mark on a map of the sub-region the effects of climate risks they had identified. These identified impacts were categorised based on the source (climate risk) and the target of the impact (built environment, population, livelihoods, natural environment). After this, participants listed implemented, planned, and necessary actions for adapting to and preparing for the impacts.

In the workshops addressing vulnerabilities and exposure factors, participants were asked to identify and map locations, groups, livelihoods, or other factors in the sub-region that are vulnerable to the effects of climate risks. These identified vulnerabilities and exposures were again grouped by risk and by sector. Finally, participants documented actions already taken and new necessary actions to reduce climate-related sensitivities, identify and mitigate vulnerabilities and exposures, and strengthen adaptive capacity.

Workshop Results

The preliminary risk and vulnerability analyses created through desk research were supplemented with the results of the workshops. In the Joensuu sub-region workshops, the focus was primarily on risks to the built environment, whereas in the Central Karelia and Pielinen Karelia workshops, the emphasis was on aspects related to agriculture and forestry. This difference was partly due to a higher number of participants from those specific sectors in the respective workshops. The workshop findings were further enriched by expert interviews with representatives from the Regional Council of North Karelia and the University of Eastern Finland, providing additional perspectives on public health, well-being, and culture. Updates were incorporated into the risk analyses based on the Regional Council's climate adaptation roadmap (these additions are shown in *italics*). The selections were made based on expert judgment.

actions already implemented and planned by municipalities – identified in the workshops – were compiled and used to supplement the perspectives from municipal climate plans, helping to clarify the current state and needs of adaptation efforts within the sub-regions.

1.5 Results of the Study and Limitations

The results of the study are a synthesis of the climate change adaptation roadmap by the Regional Council of North Karelia, written sources, workshop discussions, and expert assessments.

When interpreting the findings, it is important to note that the sub-region-specific climate risk analyses compiled in the report are based, in terms of vulnerabilities, exposure factors, and impacts, on the themes that emerged during the workshop discussions. The significance of these vulnerabilities, exposure factors, and impacts has not been separately evaluated in this study. Instead, the analyses reflect the participants' current thoughts and perspectives at the time of the workshops. Additionally, the results are influenced by the size and composition of the participant group.

Despite the methodological limitations, the results are valuable. They provide insight into which climate change impacts are currently considered most relevant in the sub-regions. Moreover, they reflect the level of knowledge among workshop participants regarding the effects, vulnerabilities, and exposure related to climate change.

1.6 Key Concepts

Climate Change Adaptation: According to the Climate Act, climate change adaptation refers to actions taken to prepare for and adjust to climate change and its impacts, as well as actions aimed at taking advantage of the potential benefits brought about by climate change.

Preparedness: The implementation of proactive actions intended to mitigate and prevent threats posed by climate change. For example, investing in cooling systems or maintaining operational readiness for emergency situations.

Climate Risk: A hazard caused by climate change. The level of risk is influenced by the likelihood of the hazard, the extent of exposure to it, and the degree of vulnerability. The assessment of climate risks makes use of various future scenarios related to climate change. This study uses information on the development of climate risks projected to the year 2050.

Risk Level: An assessment of the significance of a climate risk, based on the anticipated impact and the likelihood of the risk occurring.

Hazard: A phenomenon caused by climate change that, if realised, can cause harm to people, the environment, and society. Examples include floods, storms, or drought.

Vulnerability: The sensitivity to damage or danger caused by climate change. Individuals, institutions, and natural environments can all be vulnerable.

Exposure: The presence of people, livelihoods, natural environments, natural resources, or infrastructure in locations where they may be harmed or endangered due to climate change.

Adaptive Capacity: The ability or potential of an organisation or individual to successfully adapt to and respond to climate change and its impacts. Adaptive capacity refers to both the ability to cope with harmful effects and to benefit from the opportunities in a changing climate. It can be strengthened through resources, new technologies, and the enhancement of skills and knowledge.

Sources: Climate Act, 2022; IPCC, 2022; Ministry of Agriculture and Forestry of Finland 2023a; University of Vaasa, n.d.

2 Characteristics of the Sub-Regions in North Karelia

Summary of the Characteristics of North Karelia's Sub-Regions

North Karelia is a forested and lake-rich region that includes both densely built urban areas and very sparsely populated rural areas. The region is experiencing both population decline and ageing. From the perspective of climate change adaptation, the sub-regions of North Karelia are differentiated by the city Joensuu and the challenges posed by its dense urban structure, such as the urban heat island effect and the risk of stormwater flooding. Stormwater floods caused by heavy rainfall also pose a risk in other urban areas. The most significant vulnerability and exposure factors across the sub-regions include long distances, an ageing population, and a natural environment, economy, and lifestyle that are adapted to winter conditions.

The Joensuu sub-region contains both densely populated urban areas and sparsely populated rural areas. It includes the municipalities of Heinävesi, Joensuu, Juuka, Kontiolahti, Liperi, Outokumpu, and Polvijärvi.

Population: The population is growing, especially due to the expansion of the city of Joensuu. However, in the more remote parts of the sub-region, the population is declining.

Livelihoods: The sub-region serves as a hub for services, commerce, higher education, and research in the area. Key economic sectors also include forest and bioeconomy industries, as well as the technology sector.

Nature: The area features a combination of urban and natural environments

Central Karelia sub-region locates in the southern part of the region. The rural sub-region contains the municipalities of Kitee, Rääkkylä, and Tohmajärvi.

Population: The population is declining and ageing.

Livelihoods: Forestry, agriculture, and metal industry are central to the local economy. The area also demonstrates strong entrepreneurship and is home to numerous small and medium-sized enterprises. Kitee is known for its traditional focus on livestock farming. Central Karelia has the highest share of primary production employment among the sub-regions.

Nature: The natural environment is characterised by Lake Saimaa, smaller clear-water lakes, and deciduous forest zone.

Pielinen Karelia covers the northern part of the region, characterised by scenic hill landscapes and Lake Pielinen. The sub-region includes the municipalities of Lieksa and Nurmes.

Population: The population is declining and ageing.

Livelihoods: Key economic activities include forestry, livestock farming, tourism, and the utilisation of natural resources. In tourism, the area is especially known for Koli National Park, which attracts visitors year-round.

Nature: The region features vast forests, wetlands, and Lake Pielinen. The Koli hills and other elevated landscapes make the sub-region scenically iconic.

2.1 Population - Demographics

North Karelia Region

At the end of 2024, the population of North Karelia was approximately 162,000. The overall population has been declining, particularly in rural areas. There are significant differences in age and gender distribution between municipalities, and in sparsely populated areas, the population is ageing.

Population (2024):	162,100
Over 64 years old (2023):	29 %
Higher education attainment (2023):	28 %

Joensuu Sub-Region

Approximately 78 % of the region's population lives in the Joensuu sub-region. The population is growing in Joensuu, Kontiolahti, and Liperi, while more remote areas within the sub-region are experiencing population decline. The population is younger and more highly educated compared to the other sub-regions, partly due to the presence of higher education institutions in Joensuu. Both Joensuu and Kontiolahti are undergoing urbanisation.

Population (2024):	127,600
Over 64 years old (2023):	26 %
Higher education attainment (2023):	31 %

Central Karelia Sub-Region

The population of Central Karelia is declining and ageing. Retirees are the largest demographic group in the area.

The proportion of foreign-language speakers (6.9 %) is higher than the regional average (5.7 %).

Population (2024):	15,400
Over 64 years old (2023):	40 %
Higher education attainment (2023):	20 %

Pielinen Karelia Sub-Region

The population of Pielinen Karelia is declining and ageing. Retirees are the largest demographic group in the area.

The proportion of residents under the age of 15 is 10 %, the lowest in the region (regional average 13 %).

Population (2024):	19,000
Over 64 years old:	40 %
Higher education attainment (2023):	20 %

Sources: Regional Council of North Karelia, 2024a, 2024b; Statistics Finland, 2025a; n.d.-a.

2.1 Population – Wellbeing

North Karelia Region

North Karelia faces several wellbeing challenges, including the accumulation of lifestyle-related issues and high morbidity rates. The lifestyle habits of the region's residents are, on average, poorer than in the rest of the country, and people in North Karelia perceive their health to be worse than the national average.

Overweight and obesity have become more common among residents, and more than half of North Karelians do not meet the recommended levels of physical activity for health.

The region also has the highest unemployment rate in Finland, and unemployment is on the rise. Furthermore, the region is characterised by low levels of social participation.

Long distances also affect wellbeing: nearly 30 % of those who had used health services reported that travel distances had hindered access to care.

The length of treatment periods related to falls and slipping accidents is shorter in North Karelia than the national average.

Unemployed Job Seekers:	14.4 %
HYTE Index 2024:	41
(North Karelia Wellbeing Services County)	

The HYTE index (coefficient based on health and wellbeing performance) reflects the level at which municipalities promote health and wellbeing. In 2023, the national average HYTE index in Finland was 67. A higher index indicates that a municipality has been more successful in promoting wellbeing and health, and it receives a larger share of state funding tied to this performance.

Joensuu sub-region

HYTE index:	57.5
HYTE index, variation:	36–71
(2024, municipal average and coefficient variation)	

Central Karelia sub-region

HYTE index:	66
HYTE index, variation:	61–77
(2024, municipal average and coefficient variation)	

Pielinen Karelia sub-region

HYTE index:	51
HYTE index, variation:	51
(2024, municipal average and coefficient variation)	

Sources: Regional Council of North Karelia, 2024c; Finnish Institute for Health and Welfare, 2024; Sotkanet, n.d.-a, n.d.-b, n.d.-c, n.d.-d

2.2 Built Environment – Settlement

North Karelia Region

The majority of North Karelia's population lives in urban areas, but the region also includes very sparsely populated rural areas. This means the region encompasses both dense urban structures with supporting infrastructure and widely dispersed settlements in areas not covered by municipal technical services.

Population density:	8.6 res./km2
Urbanisation rate:	74 %
Living in terraced and detached houses:	67 %

Joensuu Sub-Region

The Joensuu sub-region stands out from the others with a higher urbanisation rate and a larger share of residents living in apartment buildings. The city of Joensuu contains densely built-up areas. A significant portion of the region's buildings were constructed in the 1970s and 1980s, but there is also a notable amount of newer building stock in the area.

Population density:	12 res./km2
Urbanisation rate:	79 %
Living in terraced and detached houses:	63 %
Residents in single-person households:	25 %

Central Karelia Sub-Region

Central Karelia has the lowest urbanisation rate in the region.

The area contains many buildings constructed in the 1970s and 1980s, but also a considerable amount of older building stock.

Population density:	6 res./km2
Urbanisation rate:	46 %
Living in terraced and detached houses:	83 %
Residents in single-person households:	25 %

Pielinen Karelia Sub-Region

The Pielinen Karelia area includes both urban settlements and very sparsely populated rural areas. It has a higher proportion of single-person households compared to other sub-regions.

The area contains many buildings constructed in the 1970s and 1980s, but also a considerable amount of older building stock.

Population density:	3 res./km2
Urbanisation rate:	66 %
Living in terraced and detached houses:	75 %
Residents in single-person households:	29 %

Sources: Regional Council of North Karelia, 2024d; Statistics Finland, 2024a; 2024b; n.d.-a.

2.2 Built Environment – Transport Network

North Karelia Region

North Karelia has an extensive road network and a high volume of road traffic. The total length of the highway network exceeds 5,400 kilometres, accounting for about 7 % of Finland's entire highway system. The number of kilometres driven annually on these roads exceeds the expected amount based on the region's share of the national population.

The region's key transport connections include major highways (6, 9, 23), railway lines (the Karelian Line, Joensuu-Pieksämäki, and Joensuu-Siilinjärvi), the Saimaa deep-water route, and air travel to Joensuu. The importance of the road network is particularly pronounced given the region's predominantly rural character. Additionally, the transport network is vital to the functioning of the local economy.

Road Network Length: 5,400 km
Poor-Condition Road Network: 4.9 % / 15.8 %
(Condition of the road network in Eastern Finland as a whole, heavily trafficked paved roads / lightly trafficked paved roads)

Joensuu Sub-Region

Joensuu serves as the transportation hub of the region. In the urban area, the development of transportation emphasises the roles of walking, cycling, and public transport.

The sub-region also includes sparsely populated rural areas that are heavily dependent on private car use.

Central Karelia Sub-Region

The sub-region is characterised by sparsely populated areas that are heavily dependent on private car use. Municipal centres serve as hubs for public transportation. In urban areas, the importance of walking and cycling is also emphasised.

Pielinen Karelia Sub-Region

The sub-region is characterised by sparsely populated areas that are heavily dependent on private car use. Municipal centres serve as hubs for public transportation. In urban areas, the importance of walking and cycling is also emphasised

Sources: Regional Council of North Karelia, 2020; Ministry of Agriculture and Forestry of Finland, 2023b

2.2 Built Environment – Energy

North Karelia Region

Most of the region's energy is produced from bioenergy, primarily wood. Additional energy sources include hydropower, peat, heat pumps, biogas, and solar energy. In recent years, the share of renewable energy has increased. The area is served by a 110kV transmission grid and an extensive distribution network.

Energy Use:	10–12 TWh/a
Renewable Energy Share:	72 %
Energy Self-Sufficiency:	69 %

Joensuu Sub-Region

In Joensuu, Ilomantsi, Juuka, Liperi, and Outokumpu, there is a district heating network. Heat is generated using biomass, heat pumps, peat, and oil, as well as waste heat from activated carbon production. Approximately 60 % of Joensuu residents are connected to district heating.

Joensuu has combined heat and power (CHP) plant that primarily uses wood and peat as fuel. The sub-region also includes hydropower plants, the most significant being the Pamilo power plant (85MW). Some wind power parks are planned for the western part of the area, and solar power projects are also under development.

Central Karelia Sub-Region

In Kitee, Rääkkylä, and Tohmajärvi, district heating is produced using biomass, peat, heat pumps, biogas, and oil.

The area also has small hydropower plants.

Kitee is home to a 5 MW solar power plant, with additional facilities in the construction and planning stages. In Tohmajärvi, solar power plants are also in the planning and permitting phases.

Pielinen Karelia Sub-Region

In Lieksa and Nurmes, district heating is produced by using biomass, heat pumps, peat, and oil.

The area also has small hydropower plants.

Additionally, a solar power project is planned for Lieksa.

Sources: Regional Council of North Karelia 2023a; Finnish Energy, n.d.; Renewables Finland, n.d.; Savon voima, 2019.; Fingrid, n.d.; "Luettelo Suomen vesivoimalaitoksista", 2025; City of Lieksa, 2023

2.2 Built Environment– Groundwater Resources

North Karelia Region

North Karelia has 340 groundwater areas, of which 97 are classified as important for water supply (classes 1 and 1E). These critical groundwater areas are distributed throughout the entire region. All domestic water used in the area comes exclusively from groundwater sources.

Residents living in the region's sparsely populated areas are typically outside the municipal water supply network and thus depend on small, local groundwater reserves. These are particularly sensitive to changes in precipitation.

Groundwater areas:	340
Share of groundwater in domestic water:	100 %

Joensuu Sub-Region

In the southern parts of the region, groundwater is abundant, whereas in the northern areas, groundwater formations are narrower and less common. However, groundwater availability is still sufficient for water supply needs.

The region's only surface water intake facility locates in Heinävesi, where it functions as a backup water source.

Central Karelia Sub-Region

In the southern part of the region, groundwater areas locate in the II Salpausselkä and its associated esker and seam formations. The area contains extensive sand and gravel deposits and abundant groundwater resources.

Pielinen Karelia Sub-Region

In the northern part of the region, groundwater formations are narrow in extent and relatively few. However, groundwater availability is sufficient to meet water supply needs.

Sources: Mononen et al., 2021; Finnish Environment Institute. (n.d.-a)

2.3 Livelihoods – Agriculture and Forestry

North Karelia Region

Forestry is the cornerstone of the region's economy. The forests in the area are predominantly coniferous and managed for commercial use. Agriculture is especially focused on dairy cattle farming and supporting crop cultivation. The number of farms is decreasing, while the average farm size is increasing.

Forest land share of total area:	89 %
Agricultural land share of total area:	4.6 %
Share of grassland in arable land:	62 %

Joensuu Sub-Region

In the Joensuu sub-region, the share of employment in primary production is the smallest among the sub-regions. However, there are significant differences between municipalities within the sub-region.

Forestry accounts for approximately 2 % of the area's economy.

Jobs in primary production:	3.4 %
Arable land:	43,000 ha
Sub-Region area:	10,454 km^2

Central Karelia Sub-Region

Agriculture plays the largest role in Central Karelia, where the proportion of arable land is more than double that of the other sub-regions. Berry cultivation is also concentrated in Central Karelia, particularly in Kitee.

Forestry accounts for just under 10 % of the sub-region's economy.

Jobs in primary production:	14 %
Arable land:	23,400 ha
Sub-Region area:	2,519 km^2

Pielinen Karelia Sub-Region

The area is particularly known for dairy cattle farming.

Forestry accounts for just under 10 % of the sub-region's economy.

Jobs in primary production:	11 %
Arable land:	18,700 ha
Sub-Region area:	5,819 km^2

Sources: Regional Council of North Karelia, 2024e, 2023b, n.d.; ELY Centre for North Karelia, 2023a.

2.3 Livelihoods – Tourism, Recreation, and Leisure

North Karelia Region

North Karelia is known for the iconic national landscape of Koli. The region features four national parks, hundreds of kilometres of various outdoor trails, and numerous nature and hiking destinations. The share of tourism in the regional economy is relatively small.

Outdoor activities and spending time in nature are common ways to spend leisure time in North Karelia. In the summer, people enjoy water activities, fishing, and berry and mushroom picking. In the winter, activities that rely on snow and ice become prominent. These include skiing, ice fishing, and snowmobiling. The region also has many summer cottages.

Amount of summer cottages: 24,300

Joensuu Sub-Region

Events, services, and restaurants in the region are primarily concentrated in Joensuu.

Central Karelia Sub-Region

Tourism is not a particularly significant industry in Central Karelia. However, the seine fishing of vendace on Lake Puruvesi has been inscribed on UNESCO's list of intangible cultural heritage.

Pielinen Karelia Sub-Region

Koli, located in Pielinen Karelia, is a popular nature and tourism destination. The region also features the Bomba tourism complex. Koli's national landscape attracts visitors from both Finland and abroad.

In winter, Koli ice road significantly shortens the driving distance between Lieksa and Koli by 50 kilometres and serves as a unique tourist attraction.

Sources: Finnish Heritage Agency, n.d.; Regional Council of North Karelia 2024d.

2.4 Natural Environment – Nature and Water Bodies

North Karelia Region

North Karelia's natural landscape is characterised by large lakes, vast forests, extensive mires, and scenic hill ranges. Nearly 90 % of the region's land area is covered by forest, though the share of untouched natural forest is low due to a long history of intensive forestry. Most of the area belongs to the Vuoksi water body. 93 % of the region's lakes and 83 % of its rivers are in good or excellent condition. There are no significant flood risk areas in the region.

The most critical habitats for endangered species in North Karelia are forests and traditional biotopes. Within the region's Natura 2000 sites, particularly important habitat types include boreal natural forests, large mires, and deciduous forests in the Central Karelia grove centre and the hill region extending north of it.

Forest Cover:	89 %
Water Bodies:	18 %
Number of Natura Sites:	134
Total Area of Natura Sites:	122,000 ha

Joensuu Sub-Region

In the sub-region, a large proportion of the lakes and rivers are various types of humic waters. The area's Natura sites play a crucial role in the conservation of species associated with old-growth forests, mires, and other wetland habitats.

The sub-region also contains endangered habitat types and species, such as the great crested newt in the Joensuu area and the serpentine spleenwort habitats in Juuka.

Central Karelia Sub-Region

Central Karelia represents the typical landscape of Finnish Lakeland, where the water bodies are naturally nutrient-poor and clear, and the proportion of mires is low.

The sub-region is home to valuable deciduous forest habitats, including the Central Karelia grove centre and the hill region extending north of it. The area also contains endangered species, such as the Saimaa ringed seal.

Pielinen Karelia Sub-Region

Pielinen Karelia is a mire-rich area, with water bodies that are typically high in humic content and slightly eutrophic. Lake Pielinen is the largest lake in the region.

The sub-region contains endangered species and habitat types, such as fens. Its Natura sites are vital for the conservation of old-growth forests, mires, and other wetland-associated species.

Sources: Mononen et al., 2021; ELY Centre for North Karelia, 2023b, 2023c

3 The Most Significant Climate Risks in North Karelia

Climate Risks Affecting North Karelia

This chapter examines the key climate risks affecting North Karelia. As precipitation increases and intensifies, the risk of flooding in the region grows, particularly during autumn and winter. The average temperature is projected to rise by 2-3 degrees Celsius by 2050. In addition, heatwaves and drought periods are expected to become longer and more frequent.
Storms and severe weather events may intensify, even though their frequency is not expected to increase based on current knowledge. Winters will become shorter, and the amount of snow will decrease, which will reduce ground frost and impact ice conditions.
The changes will have widespread effects on the environment, including shifts in vegetation zones and challenges to species survival.

In the climate change adaptation roadmap for North Karelia, the following have been identified as the most significant climate risks:

- **Increased precipitation and rainfall**
- **Rising temperatures**
- **Intensification of storms**
- **Changing winter conditions**
- **Environmental change**

3.1 Increased Precipitation and Rainfall

Current situation: There is significant variation in precipitation levels across North Karelia, especially between the Pielinen valley and the surrounding hill areas. The region's average annual precipitation ranges from 550 to 650 millimetres, but in the Maanselkä and Karjalanselkä watershed regions, it can reach up to 700 millimetres.

Projected change: Precipitation is expected to increase by approximately 6-8 %. This would raise the annual total to 580-700 millimetres, and up to 740-756 millimetres in watershed areas by 2050.

Precipitation levels are anticipated to rise in almost every month of the year, with November to February becoming the wettest period. In contrast, July is expected to see relatively minor changes. The frequency of driving rain is also projected to increase.

Consequences: The risk of stormwater flooding will increase as the frequency and intensity of heavy rainfall events grow. Spring floods are expected to decrease due to reduced snow cover, but autumn and winter flooding is likely to become more common. Projections suggest that the flood risk could rise by the end of century, but a significant increase in risk is not expected in the coming decades.

Sources: Annila et al., 2024; Finnish Meteorological Institute, 2022; The Finnish Climate Change Panel, 2021; Regional Council of North Karelia, 2024f

3.2 Rising Temperature

Current situation: The average annual temperature in North Karelia typically ranges between +2°C and +4°C. The northeastern parts of the region are the coldest, and temperature variability is particularly high in the eastern areas.

Projected change: North Karelia's climate has already warmed by approximately 0.6°C during the period 1991-2020 compared to the previous reference period. The average temperature is expected to rise during all seasons. Depending on future emission trajectories, the mean temperature could increase by approximately 1.8-3°C by 2050, and according to FINSCAPES project scenarios, by 4-8°C by 2080.

Consequences: As a result of warming, heatwaves and drought periods are projected to become longer and more intense. Rising temperatures are also linked to other climate risks and intensifying hazard factors, such as ecosystem threats and changing winter conditions.

Sources: Finnish Meteorological Institute, 2022; The Finnish Climate Change Panel, 2021; Regional Council of North Karelia, 2024f

3.3 Increase and Intensification of Storms

Projected change: According to current knowledge, the frequency of thunderstorms, downbursts, and tornadoes is not expected to change significantly over the coming decades. Year-to-year variability and randomness remain key characteristics, particularly for severe storms.

The increase in summer temperatures increases the occurrence of favorable conditions for severe weather, but the increase in temperature alone is not enough to increase the probability of severe weather. The increase in precipitation and the intensity of rain increases the risk of heavy rains and floods.

Climate model simulations suggest that severe thunderstorms could become 5-40 % more frequent in Northern Europe, which would also increase the risk of strong gusty winds.

Consequences: Even if the number of storms does not increase, the impacts of winter storms may become more significant due to reduced ground frost.

Sources: The Finnish Climate Change Panel, 2021; Laurila, 2022; Regional Council of North Karelia, 2024f; Pilli-Sihvola et al., 2023

3.4 Changes in Winter Conditions

Current situation: North Karelia is traditionally a snow-rich region. By mid-March, snow depth typically ranges from 50 to 70 centimetres, and in the Maanselkä and Karjalanselkä areas, it can reach 70 to 80 centimetres. On hill slopes and summits above 250 metres in elevation, wet, heavy snow can accumulate on tree canopies and branches. In the higher areas of Karjalanselkä, the snow cover lasts significantly longer, with up to a month's difference compared to areas south of Joensuu.

Projected change: The number of frost days has already decreased by an average of 5 days during the 1991-2020 period compared to the previous 30-year reference period and is expected to decline further. The onset of permanent snow cover has been delayed by 2-3 days per decade, while snow depth has increased by 1-2 centimetres per decade, likely due to greater precipitation.

However, the overall snow amount and duration are projected to decrease significantly in the future. By 2050, the winter season is expected to shorten by approximately 40 days, while the other seasons will lengthen by 10-20 days each.

Consequences: In the future, the relative share of rainfall during winter months (December-February) will increase, raising the risk of winter floods. Ground frost will become less common, and the frost season will shorten. Across Finland, the load-bearing frost season has already shortened by about 7 days per decade (1991-2020 compared to 1981-2010). Rising temperatures may also lead to frequent freeze-thaw cycles.

Sources: The Finnish Climate Change Panel, 2021; Regional Council of North Karelia, 2024f; Wallius, 2020

3.5 Environmental Change

Current situation: The length of the thermal growing season and the accumulated effective temperature sum during the season vary across North Karelia. In the southern part of the region, the growing season lasts around 170 days, while in the northeastern border areas it lasts about 160 days. The temperature sum is approximately 1,150 degree-days in the Maanselkä and Karjalanselkä areas, and about 1,350 degree-days in the southern parts of the region.

Projected change: Rising temperatures will extend the growing season, especially during spring. Other changing conditions – such as increased precipitation and alternations in winter weather – will also affect species survival and distribution, as well as the composition of ecosystems.

Consequences: Vegetation zones will shift, with species from southern Finland moving northward and new invasive species spreading into the country. Climate warming will accelerate the spread of non-native species introduced by humans. Biodiversity loss will be intensified by climate change, which in turn reduces the capacity of ecosystems and species to adapt to rapidly changing conditions. In contrast, diverse ecosystems are more resilient to environmental stress and disruptions.

Northern boreal species may disappear entirely, and the current conifer-dominated forests may change to a temperate zone mixed forests. Rising temperatures are expected to increase damage caused by plant diseases and insect pests, and human health risks may also rise as diseases spread more easily. For example, diseases carried by ticks are expected to become more common as tick habitats expand.

Sources: Finnish Environment Institute, n.d.-b; Finnish Environment Institute , n.d.-c; The Finnish Climate Change Panel 2021; Regional Council of North Karelia, 2024f

4 Sub-Region-Specific Climate Risk Assessments

The Sub-Regional Climate Risk Assessments Compile the Key Risks and Impacts

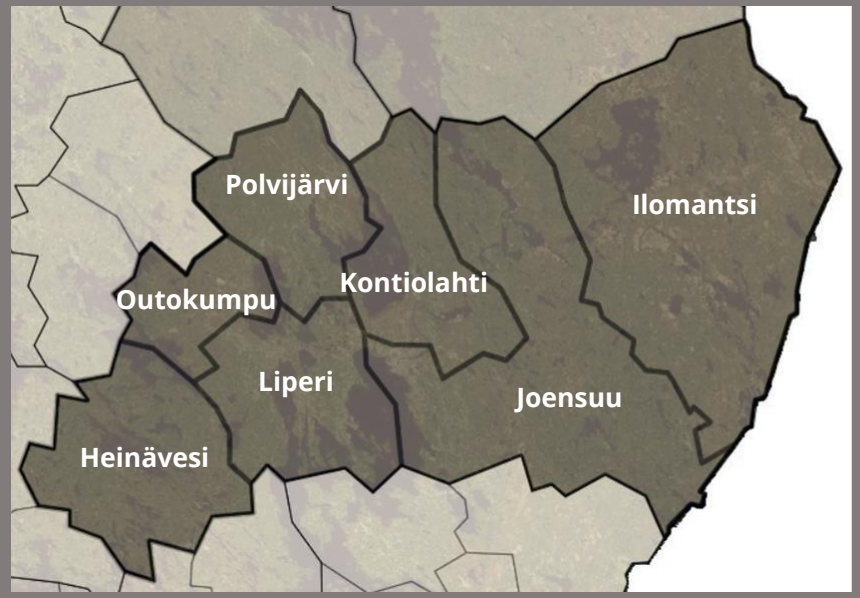
Summaries of Climate Risks in the Sub-Regions

A. **The climate risks and hazard descriptions** are drawn from the climate risk assessment presented in chapter 3 of the report.
B. **Risk level** indicates the significance of a climate risk, based on the anticipated impact and the likelihood of its occurrence. **Timeframe** refers to when the hazard factors and impacts associated with the risk are expected to begin materialising. Both the risk level and timeframe are based on expert evaluations drawn from chapter 3 and the results of the workshops.
C. **Vulnerability and exposure factors:** The column includes examples of the most significant vulnerability and exposure factors, provided as expert assessments.

Risk-Specific Assessments for Sub-Regions

D. **The projected changes and impacts** are summarised based on the climate risk descriptions from chapter 3.
E. **Vulnerability and exposure factors,** as well as the **impacts** caused by climate risks, are compiled from workshop discussions and interview data. Additional perspectives selected as expert assessments from the regional adaptation roadmap are indicated in *italics*.
F. **Risk level** is consistent with the one presented in the summary of sub-regional climate risks.

Climate Risks:
Joensuu Sub-Region



Juuka is included in the climate risk assessment for the Pielinen Karelia sub-region instead of the Joensuu sub-region, as it is climatically and environmentally more closely aligned with Pielinen Karelia.

Summary of Climate Risks in the Joensuu Sub-Region

Climate Risk	Hazard	Risk level	Time-frame	Examples of the Sub-Region's Most Significant Vulnerability and Exposure Factors
Increased Precipitation	Increased precipitation and rainfall intensity Driving rain Stormwater and inland flooding	Moderate	0–15 y.	Impermeable surfaces in densely built areas Lower-tier road network and roads in poor condition
Rising Temperature	Rising average temperature and heat Heatwaves and drought periods Lengthening of seasons (excluding winter) Lowering of groundwater levels	High	0–15 y.	The elderly and people with impaired health Densely built urban areas Buildings without cooling systems
Storms	Intensifying thunderstorms and heavy rainfall Stormwater and inland flooding Increased wind speeds, including strong, hard, and gusty winds	Moderate	Uncertain	Long distances and remoteness from services Spruce forests
Changes in Winter Conditions	Winter rainfall and flooding Reduction in (load-bearing) ground frost Shortening of winter and periods with snow and ice cover Changes in freeze-thaw cycles	High	0–15 y.	The elderly and people with impaired health Lower-tier road network in poor condition Species adapted to winter conditions Winter tourism and recreational sites Fishing
Environmental Change	Lengthening of the growing season and shifts in vegetation zones	Moderate	0–15 y.	Endangered species and habitat types Spruce forests

Risk level: high – moderate – low

Increased Precipitation and Rainfall

Precipitation is expected to increase by approximately 6-8 % by 2050.
Winter precipitation is increasing, heavy rainfall is becoming more frequent and intense, and driving rain is becoming more common.

Consequences: The risk of stormwater flooding is increasing. Spring floods are expected to decrease, while autumn and winter floods are becoming more frequent. By the end of century, the overall flood risk in the region may increase.

Risk level:

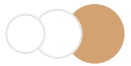
	Vulnerability and Exposure Factors	Impacts
Population	Low-income individuals *Residents living in flood-prone areas*	Health impacts caused by poor indoor air quality Deterioration of well water quality and related health issues
Built Environment	*Impermeable surfaces in densely built areas* Building surface materials and structural designs Lower-tier road network and roads in poor condition Ageing water supply networks Water utilities	Flooding in urban areas and damage to buildings and infrastructure caused by stormwater Water intrusion and moisture damage to structures; breakage of rain gutters Exceeding the capacity of stormwater drainage systems Deterioration of the road network and increased need for maintenance Decline in groundwater quantity and quality Impaired operational capacity of emergency services Increased challenges in keeping clean water and wastewater separated
Natural Environment	*Endangered species* *Sensitive ecosystems*	Nutrient runoff and deterioration of water quality
Livelihoods	Agriculture Hydropower plants	Increasing difficulty in regulating hydropower operations

Rising Temperature

The temperature is projected to rise by 1.8-3 °C by 2050, and up to 4-8 °C by 2080.

The average temperature will increase in all seasons.

Consequences: Heatwaves and drought periods will become longer and more intense. Spring, summer, and autumn will lengthen. Drought conditions will lead to a lowering of groundwater levels.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	The elderly and people with impaired health Children Low-income individuals People living alone. Residents in small, poorly maintained, and non-cooled dwellings	Direct and indirect health impacts caused by heat Deterioration and eutrophication of water bodies, e.g., increased occurrence of blue-green algae (reducing recreational opportunities) Growing popularity of swimming beaches
Built Environment	Densely built and unshaded areas, e.g., daycare yards. Heat-retaining building and surface materials, as well as asphalted areas. Limited amount of urban greenery. Old buildings. Properties without cooling systems, e.g., nursing homes and small apartments. Long distances and remoteness from services. Summer cottages reliant on lake water for domestic use	Urban heat buildup Deterioration of groundwater quality, drying of wells Dying of green areas, e.g., scorched lawns Increased need for indoor cooling
Natural Environment	*Endangered species.* *Sensitive ecosystems*	Increasing challenges for species due to drought (decline in biodiversity) Decrease in berry and mushroom yields Wildfires and forest fires increase
Livelihoods	Agriculture	Growing need for irrigation

The Impacts of Storms and Severe Weather Events Will Intensify

No significant changes in storms frequency or strength are projected.

Yearly variability and randomness will remain prominent.

Consequences: The effects of storms may become more severe as ground frost decreases. Stormwater and inland flooding will become more frequent due to increased heavy rainfall.

Risk level: 

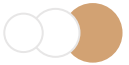
	Vulnerability and Exposure Factors	Impacts
Population	Elderly people *Residents living in sparsely populated rural areas* *Low-income individuals* *People living alone and those experiencing loneliness*	Feeling of insecurity *Overburdening of healthcare services*
Built Environment	Long distances and remoteness from services *Overhead power lines*	Deterioration of buildings sensitive to storm winds and increased precipitation Damage to properties and infrastructure, along with other storm related destruction. Increasing frequency of power outages and their consequential effects, such as disruptions to water and sewage treatment facilities Growing disturbances in energy supply and telecommunications networks
Natural Environment	Spruce forests	*Storm damage to forests*
Livelihoods	*Overhead power lines*	Direct and indirect forest damage and crop losses Other property damage to agriculture and forestry *Economic losses and challenges for businesses caused by power outages* Decline in tourism due to forest damage and changes to iconic national landscapes

Winter Conditions Will Change

The number of frost days is decreasing, and the arrival of permanent snow is being delayed.

Winters are projected to shorten by approximately 40 days by 2050.

Consequences: Rainfall and flooding will increase during winter. Ground frost will become less frequent, and the frost season will shorten. Temperatures will fluctuate around the freezing point more often, increasing the slippery conditions.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	Elderly people People with impaired health (e.g., musculoskeletal disorders, heart diseases)	Increased risk of accidents due to falls caused by slippery conditions Rise in traffic accidents linked to deteriorating road conditions Indirect well-being impacts from slipperiness, such as reduced physical activity and outdoor mobility, difficulties in handling daily errands, increased risk of social exclusion, and heightened social isolation Growing importance of neighbourly support Challenges in practicing winter sports and moving on ice
Built Environment	Lower-tier road network in poor condition	Lengthening of the frost heave period Increased slipperiness on roadways and pedestrian/cycling paths Rising damage to buildings caused by heavy snow loads Insufficient space for snow storage Increased costs for anti-slip actions and road maintenance, although snow ploughing expenses may decrease
Natural Environment	Clear-cut forest areas *Species adapted to winter conditions*	*Species composition and overwintering patterns are changing; for example, the competitiveness of species adapted to winter conditions is declining*
Livelihoods	(Winter) tourism and recreational sites Agriculture Fishing	*Challenges to winter tourism due to delayed and unreliable snowfall* Disruptions in business logistics chains caused by the deterioration of private and forest road networks, particularly affecting agriculture and forestry Decline in berry harvests Increased difficulty in winter timber harvesting; however, some forest management practices (e.g., soil scarification) may become more feasible during winter Increase in forest damage incidents

Environmental Change is Altering Ecosystems

The growing season is lengthening, especially in spring.

Vegetation zones are shifting northward, leading to changes in ecosystems.

Consequences: Species are migrating to north, and new species are spreading into Finland. Northern boreal species are at risk of disappearing entirely, and coniferous forests may change into temperate mixed forests.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	*Elderly people* *People with impaired health*	Health impacts caused by forest fires *Health effects (e.g., increased prevalence of diseases spread by ticks)* *Decline in ecosystem services*
Built Environment		Increasing use of oaks and new species in green spaces
Natural Environment	Spruce forests *Endangered species* *Sensitive ecosystems* *Cultural landscapes and traditional biotopes* *Land border with Russia (as a potential pathway for the spread of species and diseases)*	Changes in plant and animal species composition Increase in (harmful) invasive and newcomer species
Livelihoods	Tourism Food production *Agriculture and forestry*	Changes in cultivated crop species *Declining forest resilience to various disturbances, such as forest damage and pests*

Climate Risks:
Central Karelia Sub-Region

Summary of Climate Risks in the Central Karelia Sub-Region

Climate Risk	Hazard	Risk Level	Time-frame	Examples of the Sub-Region's Most Significant Vulnerability and Exposure Factors
Increased Precipitation	Increased precipitation and rainfall intensity Driving rain Stormwater and inland flooding	Moderate	0–15 y.	Wastewater treatment plants and water intakes. Agriculture
Rising Temperature	Rising average temperature and heat Heatwaves and drought periods Lengthening of seasons (excluding winter) Lowering of groundwater levels	High	0–15 y.	The elderly and people with impaired health. Asphalted and unshaded areas. Agriculture and forestry
Storms	Intensifying thunderstorms and heavy rainfall Stormwater and inland flooding Increased wind speeds, including strong, hard, and gusty winds	Moderate	Uncertain	Long distances and remoteness from services. Dwellings and critical facilities without backup systems. Agriculture and forestry
Changes in Winter Conditions	Winter rainfall and flooding Reduction in (load-bearing) ground frost Shortening of winter and periods with snow and ice cover Changes in freeze-thaw cycles	High	0–15 y.	The elderly and people with impaired health. Road network in poor condition. Fishing
Environmental Change	Lengthening of the growing season and shifts in vegetation zones	Moderate	0–15 y.	Endangered species and habitat types

Risk level: high – moderate – low

Increased Precipitation and Rainfall

Precipitation is expected to increase by approximately 6-8 % by 2050.
Winter precipitation is increasing, heavy rainfall is becoming more frequent and intense, and driving rain is becoming more common.

Consequences: The risk of stormwater flooding is increasing. Spring floods are expected to decrease, while autumn and winter floods are becoming more frequent. By the end of century, the overall flood risk in the region may increase.

Risk level:

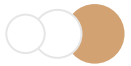
	Vulnerability and Exposure Factors	Impacts
Population	Low-income individuals Tourists Summer cottage residents	Health impacts caused by poor indoor air quality Deterioration of well water quality and its associated health effects
Built Environment	Wastewater treatment plants, pumping stations, and water intakes Buildings and roads located near insufficient stormwater drainage systems	Increasing flood risks More frequent occurrences of frost heave
Natural Environment	*Endangered species* *Sensitive ecosystems*	Deterioration of small water bodies' quality (e.g., eutrophication) Fluctuations in water levels
Livelihoods	Agriculture Berry farming Livelihoods dependent on waterborne transportation	Increased difficulty with autumn sowing and harvesting Variability in crop yields and decline in quality, e.g., in strawberry cultivation Weakening of the local economy (e.g., retail and services)

Rising Temperature

The temperature is projected to rise by 1.8-3 °C by 2050, and up to 4-8 °C by 2080.

The average temperature will increase in all seasons.

Consequences: Heatwaves and drought periods will become longer and more intense. Spring, summer, and autumn will lengthen. Drought conditions will lead to a lowering of groundwater levels.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	Elderly people and people with compromised health People with limited mobility Residents living in small apartments	Direct and indirect health impacts caused by heat Increased popularity of summer cottages
Built Environment	Asphalted urban areas Unshaded locations in urban environments, e.g., playgrounds *Buildings without cooling systems.*	Lowering of groundwater levels Drying of wells Increased energy demand for cooling buildings Water scarcity at the municipal water intake facility
Natural Environment	*Endangered species* *Sensitive ecosystems* Fish species other than roach, e.g., salmon fish, vendace Water bodies prone to eutrophication Rare plant species and habitat types, such as deciduous forest species	Increasing prevalence of invasive species and pests, e.g., the European spruce bark beetle Changes in bird species composition, such as more overwintering birds, altered migration timing, and shifts in species abundance More frequent occurrences of blue-green algae blooms Increased need for irrigation
Livelihoods	Fishing, particularly fisheries dependent on vendace Agriculture and forestry	Challenges caused by new weed species Changes in mushroom and berry yields (flowering, quantity, quality, ripening time) Increase in plant diseases and pest infestations Increased difficulties in cultivation, especially strawberry Difficulty navigating waterways due to lowered water levels and receding shorelines

The Impacts of Storms and Severe Weather Events Will Intensify

No significant changes in storms frequency or strength are projected.

Yearly variability and randomness will remain prominent.

Consequences: The effects of storms may become more severe as ground frost decreases. Stormwater and inland flooding will become more frequent due to increased heavy rainfall.

Risk level: 

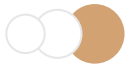
	Vulnerability and Exposure Factors	Impacts
Population	Elderly people *Residents living in sparsely populated rural areas* *Low-income individuals* *People living alone and those experiencing loneliness*	Feeling of insecurity Property damage Increased difficulty of living in both permanent and vacation homes due to power outages Growing importance of preparedness *Overburdening of healthcare services*
Built Environment	Apartments, buildings, and critical service facilities without backup systems *Long distances and remoteness from services* *Overhead power lines*	Property damage Bypasses of wastewater systems
Natural Environment	Spruce forests	Storm damage to forests Spread of pest insects
Livelihoods	Agriculture and forestry Sensitive crops (e.g., rye) Fields vulnerable to moisture, such as low-lying and peat-based soils Metal industry Biogas plants Industries sensitive to power outages *Overhead power lines*	Damages and challenges for businesses caused by power outages

Winter Conditions Will Change

The number of frost days is decreasing, and the arrival of permanent snow is being delayed.

Winters are projected to shorten by approximately 40 days by 2050.

Consequences: Rainfall and flooding will increase during winter. Ground frost will become less frequent, and the frost season will shorten. Temperatures will fluctuate around the freezing point more often, increasing the slippery conditions.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	Elderly people Individuals with compromised health (e.g., musculoskeletal disorders, heart conditions) People with allergies and asthma People who spend time in nature Pedestrians	Increased risk of accidents due to falls on slippery surfaces Reduced mobility Indirect well-being impacts from slipperiness, such as decreased physical activity and outdoor time, difficulties in handling daily tasks, increased risk of social exclusion, and growing social isolation Rise in accidents, e.g., during snowmobiling on ice Health problems caused by dust from road sanding
Built Environment	Road network in poor condition	Increasing prevalence of slippery conditions Deterioration of road conditions Increased need for maintenance, e.g., sanding
Natural Environment	Fish species sensitive to environmental changes *Species adapted to winter conditions*	Changes in mushroom and berry yields (flowering, quantity, quality, ripening time) *Changes in species composition and overwintering patterns, e.g., reduced competitiveness of species adapted to winter conditions*
Livelihoods	(Winter) tourism and recreational sites (Winter) fishing, including vendace seine fishing Seine fishing cooperatives Recreational fishing Road infrastructure and logistics Ski manufacturing industry	*Challenges for winter tourism due to delayed and uncertain snowfall* Increased need for road sanding, e.g., for access to dairy farms Increase in winter damage to grasslands and autumn-sown crops Rise in plant diseases and pest infestations Growing difficulties in strawberry cultivation

Environmental Change is Altering Ecosystems

The growing season is lengthening, especially in spring.

Vegetation zones are shifting northward, leading to changes in ecosystems.

Consequences: Species are migrating to north, and new species are spreading into Finland. Northern boreal species are at risk of disappearing entirely, and coniferous forests may change into temperate mixed forests.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	*Elderly people* *People with compromised health*	*Health impacts (e.g., increased prevalence of tick-borne diseases)* *Decline in ecosystem services*
Built Environment		
Natural Environment	*Spruce forests* *Endangered species* *Sensitive ecosystems* *Cultural landscapes and traditional biotopes* *Land border with Russia (as a potential pathway for the spread of species and diseases)*	Water quality impacts caused by darkening of water bodies and climate change Increased occurrence of blue-green algae *Changes in species composition*
Livelihoods	*Agriculture and forestry*	*Declining forest resilience to various disturbances, such as forest damage and pest outbreaks*

Climate Risks:
Pielinen Karelia Sub-Region and Juuka

Juuka is included to the Pielinen Karelia sub-region climate risk assessment instead of the Joensuu sub-region, as it is climatically and environmentally more closely aligned with Pielinen Karelia.

Summary of Climate Risks in the Pielinen Karelia Sub-Region and Juuka

Climate Risk	Hazard	Risk Level	Time-frame	Examples of the Sub-Region's Most Significant Vulnerability and Exposure Factors
Increased Precipitation	Increased precipitation and rainfall intensity Driving rain Stormwater and inland flooding	Moderate	0–15 y.	Properties built on shorelines Water intakes and groundwater
Rising Temperature	Rising average temperature and heat Heatwaves and drought periods Lengthening of seasons (excluding winter) Lowering of groundwater levels	High	0–15 y.	The elderly and people with impaired health Agriculture and forestry
Storms	Intensifying thunderstorms and heavy rainfall Stormwater and inland flooding Increased wind speeds, including strong, hard, and gusty winds	Moderate	Uncertain	Buildings vulnerable to driving rain Long distances and remoteness from services Dairy and livestock farms
Changes in Winter Conditions	Winter rainfall and flooding Reduction in (load-bearing) ground frost Shortening of winter and periods with snow and ice cover Changes in freeze-thaw cycles	High	0–15 y.	The elderly and people with impaired health Residents living in sparsely populated rural areas Forests located above 200 metres in elevation vulnerable to snow damage Winter tourism and recreational sites
Environmental Change	Lengthening of the growing season and shifts in vegetation zones	Moderate	0–15 y.	Endangered species and habitat types

Risk level: high – moderate – low

Increased Precipitation and Rainfall

Precipitation is expected to increase by approximately 6-8 % by 2050.
Winter precipitation is increasing, heavy rainfall is becoming more frequent and intense, and driving rain is becoming more common.

Consequences: The risk of stormwater flooding is increasing. Spring floods are expected to decrease, while autumn and winter floods are becoming more frequent. By the end of century, the overall flood risk in the region may increase.

Risk level: 

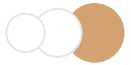
	Vulnerability and Exposure Factors	Impacts
Population	Low-income individuals *Residents living in flood-prone areas*	Health impacts caused by poor indoor air quality Health impacts caused by deteriorated well water quality Diminished recreational opportunities due to boating difficulties caused by significant fluctuations in water levels
Built Environment	Properties built along shorelines Water intakes and groundwater resources	Lowering of groundwater levels Summer drought and excessive wetness
Natural Environment	Species that require clear and cool water, such as salmonids Small water bodies *Endangered species* *Sensitive ecosystems*	Fluctuations in the water level of Lake Pielinen Forest damage Changes in species composition and ecosystems, e.g., fish populations
Livelihoods	Deteriorating, extensive road network Agriculture Fisheries operators	Flooding of agricultural lands Increase in forest damage

Rising Temperature

The temperature is projected to rise by 1.8-3 °C by 2050, and up to 4-8 °C by 2080.

The average temperature will increase in all seasons.

Consequences: Heatwaves and drought periods will become longer and more intense. Spring, summer, and autumn will lengthen. Drought conditions will lead to a lowering of groundwater levels.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	Elderly people and individuals with compromised health People with limited mobility Residents living in small apartments	Direct and indirect health impacts caused by heat Deterioration of recreational opportunities (e.g., swimming)
Built Environment	*Properties without cooling systems*	Drying of wells
Natural Environment	*Endangered species* *Sensitive ecosystems* Species sensitive to drought and heat (e.g., spruce) Small water bodies	Eutrophication of water bodies Increased occurrence of blue-green algae
Livelihoods	Agriculture and forestry, especially livestock farms Fisheries	Possibility to cultivate new species Impact of changes to the Koli landscape on tourism Damage caused by the European spruce bark beetle Increasing difficulty in renewing cultivation and perennial crops

The Impacts of Storms and Severe Weather Events Will Intensify

No significant changes in storms frequency or strength are projected.

Yearly variability and randomness will remain prominent.

Consequences: The effects of storms may become more severe as ground frost decreases. Stormwater and inland flooding will become more frequent due to increased heavy rainfall.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	Elderly people *Residents living in sparsely populated rural areas* *Low-income individuals* *People living alone and those experiencing loneliness*	Feeling of insecurity Residents becoming isolated in rural areas due to storms *Overburdening of healthcare services*
Built Environment	Buildings vulnerable to driving rain *Long distances and remoteness from services* *Overhead power lines*	Property damage Storm damage and power outages
Natural Environment	*Spruce forests*	Windthrow (trees uprooted or broken by strong winds)
Livelihoods	Agriculture, especially dairy and livestock farms *Overhead power lines*	*Damages and challenges to businesses caused by power outages* Impact of changes to the Koli landscape on tourism

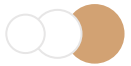
Winter Conditions Will Change

The number of frost days is decreasing, and the arrival of permanent snow is being delayed.

Winters are projected to shorten by approximately 40 days by 2050.

Consequences: Rainfall and flooding will increase during winter. Ground frost will become less frequent, and the frost season will shorten. Temperatures will fluctuate around the freezing point more often, increasing the slippery conditions.

Risk level:



	Vulnerability and Exposure Factors	Impacts
Population	Elderly people Individuals with compromised health (e.g., musculoskeletal disorders, heart conditions) Low-income individuals People living alone Residents in sparsely populated rural areas Winter sport athletes People who spend time in nature	Increased risk of accidents due to falls on slippery surfaces Reduced and more difficult mobility *Indirect well-being impacts from slipperiness, such as decreased physical activity and outdoor time, challenges in handling daily tasks, increased risk of social exclusion, and greater social isolation* Deterioration of recreational opportunities (e.g., skiing, ice skating) Increased difficulty in operating school transportation services
Built Environment	Long distances between residential areas and critical services	Heavy snowfall Increase in snow-related damage Scarcity of snow cover Thaw weakening, especially on secondary roads, and deterioration of road conditions Slippery road surfaces
Natural Environment	Forest areas located over 200 metres above sea level vulnerable to snow damage *Species adapted to winter conditions*	Snow damage Erosion *Changes in species and overwintering patterns, e.g., reduced competitiveness of species adapted to winter conditions*
Livelihoods	Winter tourism and recreational sites Agriculture Snow ploughing contractors	*Challenges to winter tourism due to delayed and uncertain snowfall.* Difficulties in timber harvesting and transport during winter Logistic challenges, e.g., for dairy farms Shortened operational period of ice roads

Environmental Change is Altering Ecosystems

The growing season is lengthening, especially in spring.

Vegetation zones are shifting northward, leading to changes in ecosystems.

Consequences: Species migrate to north, and new species are spreading into Finland. Northern boreal species are at risk of disappearing entirely, and coniferous forests may change into temperate mixed forests.

Risk level: 

	Vulnerability and Exposure Factors	Impacts
Population	*Elderly people* *Individuals with compromised health*	Health impacts (e.g., increased prevalence of tick-borne diseases) *Decline in ecosystem services*
Built Environment		
Natural Environment	*Spruce forests* *Endangered species* *Sensitive ecosystems* *Cultural landscapes and traditional biotopes* *Land border with Russia (as a potential pathway for the spread of species and diseases)*	Biodiversity benefits from deadwood Damage caused by European spruce bark beetles *Changes in species composition*
Livelihoods	*Agriculture and forestry*	Challenges caused by new weed species Impact of European spruce bark beetles on forestry and tourism (due to changes in the landscape) *Declining forest resilience to various disturbances, such as forest damage and pest outbreaks*

5 Adaptive Capacity and Actions

Adaptive Capacity and Actions in the Sub-Regions

North Karelian municipalities are actively preparing for the impacts of climate change. As of January 2025, several municipalities in North Karelia have developed climate plans or comparable programmes. These include Heinävesi, Joensuu, Kontiolahti, Liperi, and Nurmes. Of these, Joensuu has a dedicated plan specifically focused on climate change adaptation. The adaptation-related elements in the plans emphasise actions in urban planning and construction, biodiversity, and water supply and management. Adaptation is also addressed in themes related to agriculture and forestry, as well as communication and collaboration.

According to information gathered from the workshops, municipalities have already implemented several practical actions to adapt to the changing climate. These actions are mostly concentrated in the technical sector, including stormwater management, securing water supply operations, cooling of buildings, and increasing green areas and vegetation. Municipal forest management and forest planning are considered for climate risks, particularly those related to storms and pest outbreaks. Administrative actions have also been taken, especially in risk management, and municipalities have made investments, for example, in sanding equipment. To support residents' adaptation to changing winter conditions, municipalities have distributed anti-slip devices to the elderly and provided sand for citizen use.

Further adaptation needs were identified primarily within technical services, especially enhancing stormwater infrastructure, improving the condition of the road network, increasing the climate resilience of buildings. In addition, there was a recognised need to increase knowledge and skills as well as to strengthen regional cooperation. In the economic sector, identified needs were especially related to agriculture and forestry.

A critical factor influencing municipalities' ability to adapt is the availability of resources. Workshop discussions highlighted the importance of securing resources, while also acknowledging the challenge posed by tightening municipal budgets. Adaptation often requires investment.

Interviews also highlighted how other societal trends impact adaptive capacity and well-being. In North Karelia, village communities have traditionally played an important role in supporting one another in sparsely populated areas. These communities foster social cohesion and a sense of security. However, population ageing and decline, especially in rural areas, combined with reduced public support for civil society organisations, is weakening this village-level community activity, which in turn increases vulnerability to the impacts of climate change.

Existing and Planned Municipality-Specific actions

Examples of Implemented Adaptation actions Shared in the Workshops

- **Joensuu:** stormwater management, implement of the Green Factor in planning, risk management strategies, use of biochar, operating instruction cards for rare/extreme events, protecting of critical operations, use of native plant species, control of invasive species.
- **Liperi:** distribution of anti-slip devices, increased vegetation in daycare yards, risk mapping and assessments, invasive species control.
- **Heinävesi:** mapping of stormwater flood risks, evaluation of water distribution systems, support for private road associations.
- **Kontiolahti:** expansion of stormwater pipe capacity, invasive species strategy, construction of open ditches.
- **Juuka:** increased building cooling capacity, infrastructure condition surveys.
- **Rääkkylä:** evaluation of stormwater flood risk areas, acquisition of backup generators, anti-slip actions, cooling of buildings, renovation of wells at the water intake facility, stormwater study at the wastewater treatment plant.
- **Kitee:** stormwater management plan, flood risk mapping, preparation of water utilities for power outages, expansion of sanding equipment, green cover requirements integrated into building regulations, preparation of a climate plan, construction of wetlands.
- **Lieksa:** consideration of storm damage risk in logging practices, providing sanding materials to residents, risk management plan for water services, adjustments in forest management.
- **Nurmes:** update of the stormwater management plan, enhanced street maintenance, cooling of critical buildings, planning for snow storage areas, promoting mixed-species forests, addition of shaded areas in yards, cooling of indoor spaces.
- **Other actions:** risk and preparedness plans, training programmes, volunteer fire and rescue organisations, promotion of mixed forest growth and selective logging on peatlands, wildfire risk management, backup generators at heat plants and recovery of waste heat, use of timber terminals, climate and environmental training for farmers, clearance and underground cabling of power lines, training for landowners, backup power sources for farms, training for agricultural processors and cooperatives.

Adaptation Needs Identified in the Workshops

Examples of Needed actions Shared by Workshop Participants:

Joensuu Sub-Region

Collaboration and coordination: Coordination of regional adaptation work, cooperation between wellbeing service county and municipalities, involvement of organizations.

Stormwater management: Municipality-specific stormwater management plans, integration of stormwater control into land use planning and construction practices.

Construction: Building cooling solutions, assessment of required upgrades to the existing building stock, preparedness for increased precipitation.

Other actions: Preparedness for wildfire risk, practical and action-oriented response plans, assessment of hydrological impacts caused by drought and winter flooding.

Central Karelia Sub-Region

Forestry: Increasing tree species diversity in commercial forests, utilization of shelter trees, enhancing expertise related to edge forest management, integrating climate adaptation into regional forest programs.

Water supply: Planning for backup water sources.

Stormwater management: Expanding infrastructure for stormwater retention and delay, municipality-specific stormwater management plans.

Other actions: Increasing backup power systems in municipal buildings, restoration of former peat production areas, raising awareness of vulnerable species, renovating nature trails, designing boat landing areas, invasive species control.

Pielinen Karelia Sub-Region

Infrastructure: Rehabilitation of road infrastructure, funding for private roads, ensuring the resilience of logistic chains.

Water supply: Mobile equipment for transporting clean water to livestock farms, designation of backup water intake sites.

Agriculture: New seed and plant varieties, local testing and experimentation, preparedness for extreme weather events in livestock production.

Other actions: Securing resources, additional resources to implement adaptation actions, enhancing collaboration and coordination.

6 Conclusions and Recommendations

Summary

The Sub-Regions of North Karelia are already adapting to climate change

Climate Risks Are Shared Across North Karelia

Changing winter conditions challenge people, municipalities, and livelihoods of North Karelia.

In addition, increasing rainfall brings floods, prolonged heatwaves strain the population, and the intensified effects of storms are especially felt in sparsely populated rural areas.

Nature and Livelihoods Give Each Sub-Region Its Distinctive Character

Nature creates a unique and distinguishable identity for each sub-region. For example, Central Karelia is characterised by clear and oligotrophic lakes, Joensuu sub-region by humic waters, and Pielinen Karelia by its scenic hills.

The economic structure also differs between sub-regions.

The Vulnerabilities of the Population and Built Environment Create Shared Challenges

The sub-regions of North Karelia are united by long distances, extensive sparsely populated areas, and on the other hand, urban centres. The entire region is also challenged by population ageing and decline, as well as low-income levels and social isolation.

There is a Strong Will in the Region to Adapt to a Changing Climate

Adapting to the impacts of climate change is a current and important issue for the municipalities of North Karelia, and concrete actions have already been taken.

Now is a good time to invest in the development of comprehensive climate adaptation efforts.

6.1 Summary

The climate risks assessment in the sub-regions of Joensuu, Central Karelia, and Pielinen Karelia based on the North Karelia Regional Council's Climate Change Adaptation Roadmap and the specific characteristics of the sub-regions.

Each sub-region has its own distinctive features that affect how the impacts of climate change manifest locally. While city-level statistics are dominated by Joensuu, more localised differences emerge when examining the sub-regional level in more detail. Based on the assessment, it can be concluded that the five climate risks identified in the regional adaptation plan are also significant for each sub-region.

In terms of impact, the sub-regions are especially affected by changing winter conditions, which influence the population, built environment, and livelihoods. Additionally, precipitation impacts are highlighted in relation to the built environment, heatwaves affect the population, and storms have effects on infrastructure. The effects of environmental change were the least frequently identified, which is natural given their slow, complex, and hard-to-predict nature.

The specific characteristics of each sub-region illustrate different vulnerability and exposure factors. The sub-regions differ in terms of their natural environment and livelihoods – although forest and lakes define all North Karelia, the hilly and lake-rich landscapes of Pielinen Karelia differ from the clearwater lakes of Central Karelia. While all sub-regions are service oriented, primary production plays a more central role in Central Karelia and Pielinen Karelia.

However, the differences related to population and built environment are more internal than between sub-regions. North Karelia includes vast, sparsely populated areas experiencing population decline, but also has vibrant towns and a densifying Joensuu city. From the perspective of climate change impacts and adaptation, the challenges differ between urban centres, towns, and rural areas: urban and densely built areas face issues related to stormwater flooding and heat, while rural areas characterised by long distances struggle more with the effects of changing winter conditions and storm damage affecting both residents and businesses.

6.1 Summary

Challenges of the built environment are not limited to urban density, but also to development trends. In sparsely populated areas that are becoming depopulated, climate change adaptation actions become more difficult, for example, maintaining infrastructure. In contrast, during new investments it is easier to account for climate resilience, such as through material choices and structural solutions, compared to renovating older, underutilised properties.

Population vulnerability factors are primarily related to ageing, living in remote rural areas, low income, and social isolation. Based on the data gathered for this assessment, there are no significant differences between sub-regions in terms of population vulnerability, although the climate change impacts themselves may differ between urban and rural settings. The report does not forecast the development of vulnerability factors, but even so, it must be noted that ageing populations, associated health issues, and decreasing physical activity may increase vulnerability in the future. While the accumulation of vulnerability factors was not analysed, it is likely that multiple vulnerabilities affect the same individuals.

Municipalities in North Karelia are already actively preparing for the impacts of climate change. Many practical adaptation actions have been implemented, and climate plans have been drafted in several municipalities. Actions related needs focus strongly on the built environment, but actions targeting vulnerable population groups, especially the elderly, have also been implemented.

Effective climate change adaptation work requires knowledge, expertise, systematic planning, sufficient resources, and concrete actions. The North Karelia Regional Council’s Climate Change Adaptation Roadmap functions as a tool particularly in supporting knowledge building and capacity development. The regional council also plays a crucial role in facilitating regional cooperation, which is currently reflected in supporting municipalities in their climate planning work. Based on the discussions conducted during this assessment, it can be concluded that the impacts of climate change are already visible in the day-to-day operations of municipalities in the region. The topic is highly current, and now is the right time to further strengthen the region’s adaptation efforts.

Recommendations for Advancing Climate Change Adaptation Work in Sub-Regions

I
Taking Regional Characteristics into Account

Supporting adaptation efforts that recognise and address the unique characteristics of each sub-region and municipality. The sub-region-specific climate risk assessments included in this report provide a strong foundation for the next phase of climate adaptation work and for planning concrete actions at the municipal and-sub-regional levels.

II
Supporting Local Climate Change Adaptation Work.

Small municipalities in particular benefit from concrete support for adaptation efforts.

Supporting municipalities and municipal alliances by organising, for example, peer-to-peer adaptation clinics, expert consultations, and training sessions.

III
Facilitating Regional Collaboration

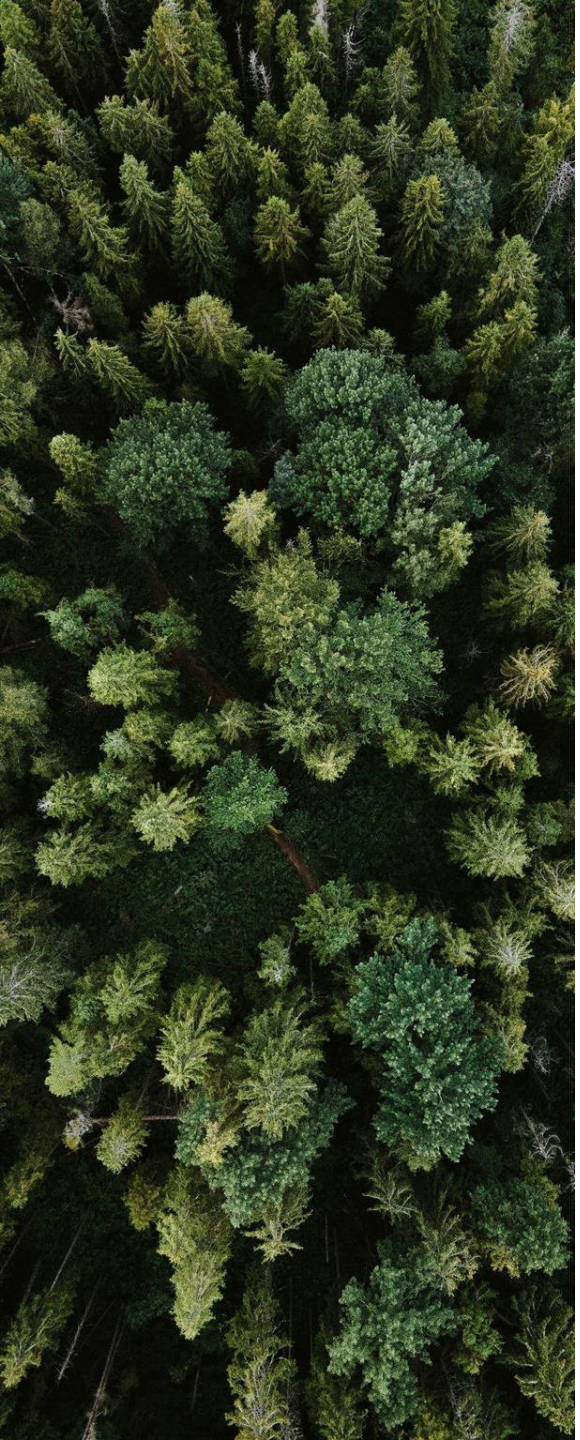
Bringing together actors across the region, beyond municipal and sectoral boundaries.

Utilising existing networks and integrating adaptation into them.

IV
Sharing Knowledge and Highlighting Regional Adaptation Work.

Effective adaptation requires up-to-date information, and the Regional Council is a natural intermediary between national and local levels.

Also highlighting the region's adaptation efforts and progress through the Regional Council's communications.



6.2 Recommendations for Advancing Climate Change Adaptation Work

The objective of the work was to determine whether the regional-level climate change adaptation roadmap is sufficient to meet the needs of all sub-regions or whether separate plans are necessary.

The conclusion is that while the regional roadmap supports sub-regional efforts, effective adaptation to climate change requires local actions tailored to local conditions. Therefore, a more localised perspective and concrete support – in addition to the regional-level approach – would further strengthen the adaptation work of municipalities and sub-regions. Especially small municipalities would benefit from concrete support. For example, the support provided to municipalities through the *Climate-Resilient North Karelia 2030* project has produced positive results.

The region plays a significant role in developing adaptation capacity. The importance of the region is especially emphasised in knowledge sharing and the promotion of regional cooperation.

In North Karelia's municipalities, the impacts of climate change are already visible, and adaptation work is underway. There is strong motivation among local actors to advance this work, so now is a good time to speed up the municipal and sub-regional adaptation efforts.

6.2 Recommendations for Advancing Climate Change Adaptation Work

I Consideration of Regional Characteristics.

Adapting to climate change requires local actions tailored to local conditions. Municipalities with similar conditions can prepare joint adaptation plans, as they face similar risks, vulnerabilities, and requires actions. These municipal coalitions can exist within a sub-region or across sub-regional boundaries.

The climate risk assessment conducted in this study provides a ready-made overview of local vulnerabilities, exposure factors, and impacts. This forms a solid foundation for municipalities and sub-regions to initiate the next phase of adaptation work – planning and prioritising adaptation actions. For example, when updating a municipality's climate plan, it is advisable to integrate adaptation into the broader strategy, thereby promoting a systematic approach to managing climate risks.

II Supporting Local Adaptation Work.

The Regional Council can support municipalities and municipal coalitions in their adaptation efforts in several ways:

- **Peer clinics for adaptation**: Organising focused, targeted discussion sessions on specific adaptation themes, such as the development of stormwater solutions.
- **Expert coaching**: Providing expert consultation from regional specialists to help municipalities develop systematic climate adaptation strategies.
- **Trainings**: Arranging training sessions for regional stakeholders – for example, educating farmers about the impacts of climate change and new cultivation methods, or offering municipalities training on winter road maintenance and anti-slip techniques.

6.2 Recommendations for Advancing Climate Change Adaptation Work

III Facilitating Regional Cooperation.

Collaboration supports the sharing and dissemination of effective solutions and is especially important in small municipalities with limited resources.

The region can support the work of municipalities and sub-regions by bringing together different actors, for example, through cooperation groups. In addition to municipalities, it is beneficial to include wellbeing services counties and other key local stakeholders, such as NGOs. The ELY Centre can act as an expert in this process. Adaptation should be included as permanent or rotating theme in existing networks.

IV Sharing Information and Highlighting Local Work and Successes.

Municipalities need information on the impacts of climate change to plan and implement effective adaption actions. A significant amount of data is produced at the national level, for example on the progression of climate change impacts, and the region can serve as an intermediary between the national and local levels.

The regional adaptation roadmap plays a part in this role. In addition, the region can regularly communicate about local adaptation work – for example, by highlighting best practices and progress made – thereby sharing knowledge both within the region and between regions.

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