

# CARAVAN: A tool for quantifying vulnerability to climate change in the Nordic region

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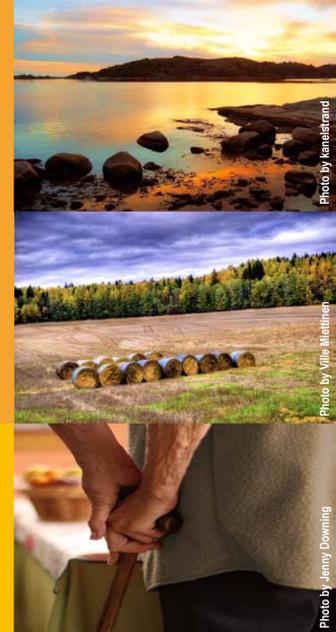


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## Assessing vulnerability

Human beings account for climate variations in managing a wide range of natural resources (e.g. for agriculture, forestry, water supply). They do this through operational procedures (e.g. seasonal planting times, thinning regimes, flow regulation) and sometimes deploy decision support tools (e.g. seasonal weather forecasts, flood forecasts), infrastructural interventions (e.g. flood defenses, land drainage) or policies (e.g. subsidies, insurance). However, anthropogenic climate change may present additional new challenges, to which some regions and groups may be more vulnerable than others. Vulnerability assessments can hence provide useful insights for informing the development of adaptation strategies. Unfortunately, the fact that the concept of vulnerability is used across a range of disciplines generates problems for its definition and operationalization. Nevertheless, in assessing vulnerability to climate change communities, organizations and other stakeholder groups are generally seeking information about two overarching questions: 1) How will specific systems, sectors or populations be affected by the impacts of climate change; and 2) How do non-climate factors like demographic trends, social and economic welfare, or community cohesion influence a society's ability to cope with or respond to those impacts?

Vulnerability can be described as a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity. While one can discuss vulnerability exclusively from a biophysical perspective or from a social one, both of these aspects need to be assessed together to reflect human capacity to cope with the biophysical impacts of climate change.

## Adaptation to what?

Temperatures in the Nordic region are expected to rise more rapidly than the global mean and there has been considerable effort in the national research programs throughout the region to estimate the potential consequences. The results suggest impacts that are mixed across the region and in different sectors. Moderate amounts of climate change are estimated to enhance the growth of forest trees, increase yields of some agricultural crop species and reduce winter energy demand for space heating. On the other hand, increased risks of invasive pests and diseases, depletion of cold water fisheries, a loss of unique permafrost features in the north, and greater flood damage from more intense precipitation events are also expected.

With their commitment to universal, tax-funded public services, the Nordic countries are often perceived as relatively "safe" from climate change, but high national levels of adaptive capacity can mask potential barriers and constraints to adaptation at local scales. For instance, rural areas are gradually becoming depopulated, creating an ageing population that is increasingly vulnerable to extreme weather events as rural services are run down. The Nordic countries therefore provide an interesting example of how adaptation to climate change is likely to take on different significance at regional, national, and local scales.

## Quantifying vulnerability

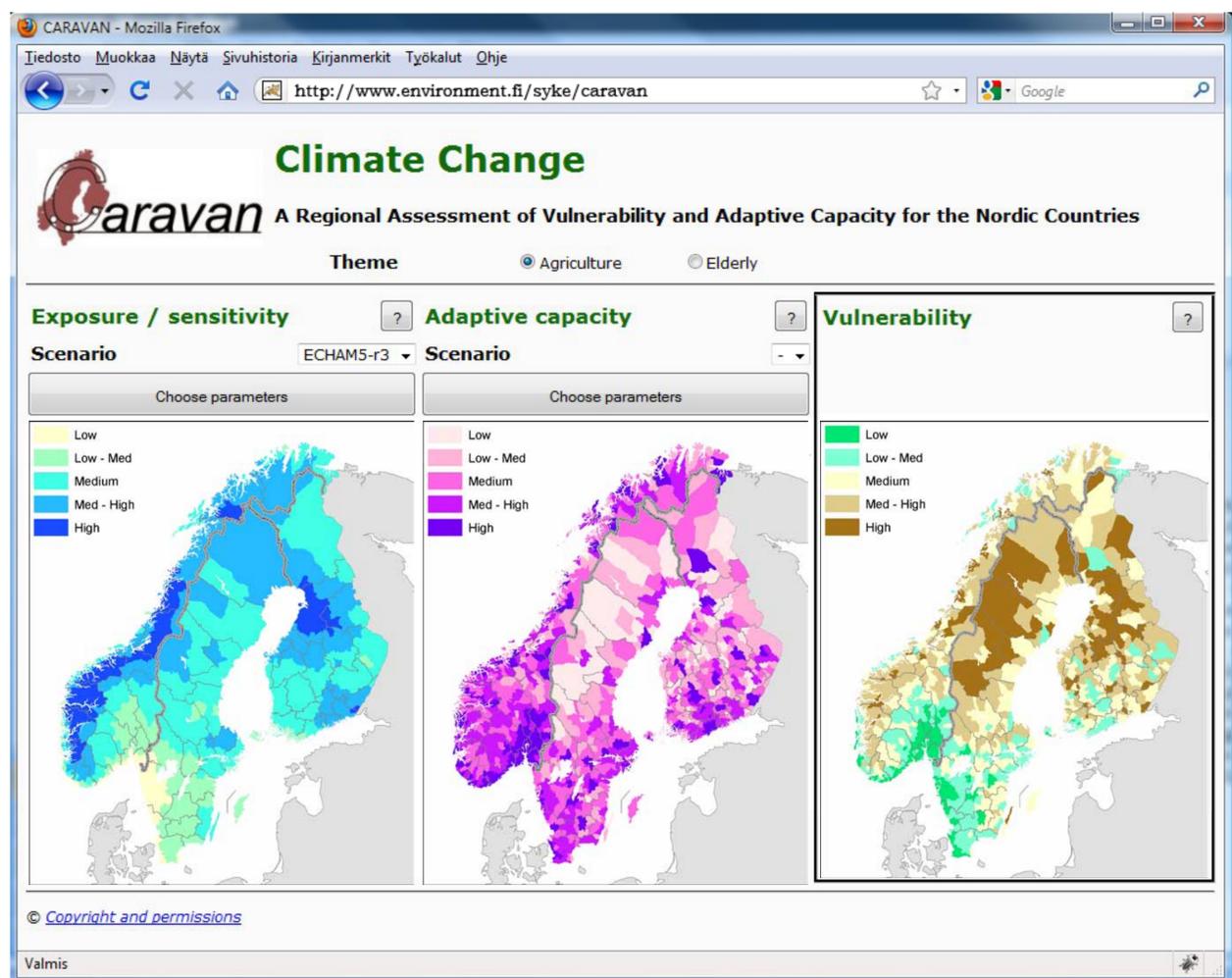
Delivering information to stakeholders is often a bottleneck for turning research results into effective decisions and policies; however, the emergence during the past five years of a new generation of web applications, combined with mapping technology and data interoperability, has presented novel opportunities for enhancing communication between scientists and non-scientists. Such technologies are typically orientated toward supporting multimedia representations of spatial information, including text, photographs and sounds, thus allowing for contextualized understandings of complex issues like climate change.

Recognizing that the Nordic countries each have different strengths and approaches to climate change research, this exploratory project seeks to develop a common framework for quantifying and visualizing vulnerability to climate change across the region. The primary outcome of this work is an interactive tool for assisting stakeholder groups to design more in depth assessments of local and regional vulnerability. While the mapping of biophysical and social indicators at a sub-national scale across three countries presents methodological challenges, it also reveals focal points (i.e. regions, sectors or communities) that may have difficulties in meeting the challenge of climate change through high exposure, enhanced sensitivity, limited adaptive capacity, or a combination thereof. Once identified, these focal points can then be analyzed in bottom-up processes to assess the need for policy interventions to enhance adaptive capacity and to examine the possible barriers in implementing such measures.

## A prototype for quantifying vulnerability

One of the major challenges facing the climate change community is to deliver relevant information to decision-makers in a manner that allows them to turn research results into effective adaptation decisions and policies. To address this gap, an interdisciplinary team of researchers from Finland, Norway and Sweden have conducted an exploratory project to develop an interactive platform for mapping vulnerability to climate change across the Nordic region.

Recognizing that vulnerability to climate change is context specific, and that detailed studies at the local level are necessary to provide a thorough understanding of the processes determining vulnerability, this tool is intended for high-level planners wishing to identify specific regions, sectors or communities that may have difficulties meeting the challenge of climate change. Once identified, these focal points can be analyzed in greater detail at the local level.



## Vulnerability of Nordic agriculture

Agriculture contributes a relatively minor share to the economies of Nordic countries but nevertheless plays an important role in maintaining rural populations, providing local employment and preserving cultural landscapes. A previous study in Norway mapped vulnerability in the agricultural sector by combining a number of indicators into composite indices of exposure and adaptive capacity. As a preliminary exercise, we repeated the Norwegian analysis, updating the indicators, collecting comparable data for Finland and Sweden, and mapping the indices by municipality across the region.

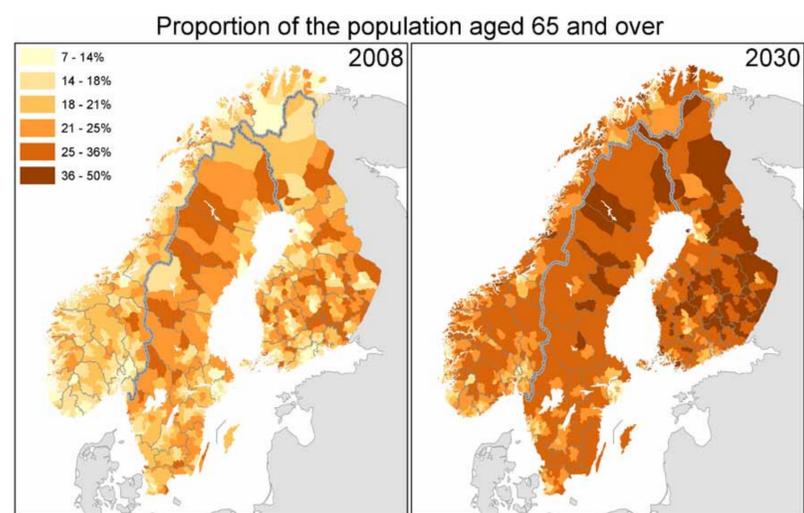
The basic premise of our approach is that the vulnerability of a system or population can be described as a function of its exposure to climate change, its sensitivity to the impacts of that change, and its capacity to adapt to those impacts. Each of these elements is represented spatially in a web-based system and combined to estimate vulnerability to climate change across the region (see figure above). Rather than the research team making academic choices about how to combine the indicators, the interface is designed to allow end-users to make informed choices about those combinations themselves.

The data comprising the exposure and adaptive capacity indices can be obtained or derived from readily available national sources. The exposure indicators include seasonal precipitation, length of the growing season, frequency of freezing point days, and surface snow amount; changes between 1971-2000 and 2021-2050 were calculated based on output from a regional climate model. The index of adaptive capacity is based on normalized indicators for the year 2008 representing sectoral employment, an ageing working population, net migration rates, a dependency ratio, and untied public income.

## Climate change and the elderly

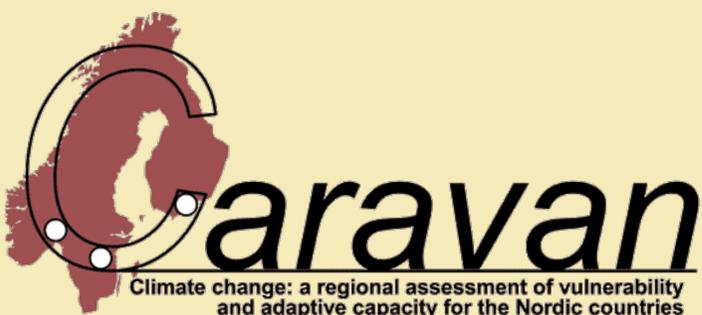
As illustrated tragically in Paris during the heat wave of 2003, the elderly can be especially vulnerable to extreme weather events. Elderly people have a diminished ability to regulate body temperature and to adapt physiologically to heat, thus advanced age represents one of the most significant risk factors for heat-related death. In addition, the elderly are more likely to live alone, have reduced social contacts and experience poor health, all of which contribute to their general vulnerability.

The cohort of the Nordic population aged 65 and older is growing (see figure to the right), meaning that there are more older people in the region who are living longer. The proportion of the total Nordic population aged 65 and older will increase from 16% in 2008 to 23% in 2030 and this trend represents an emerging vulnerability in the context of climate change. The CARAVAN team is compiling a set of indices of extreme weather conditions alongside statistics representing demographic and socio-economic risk factors in order to develop a regional measure of vulnerability to climate change among the elderly.



Preliminary data and analysis

Source: national statistical offices.



CARAVAN is an interdisciplinary collaboration between researchers in Finland, Norway and Sweden to exchange methodologies and develop a Nordic perspective on climate change vulnerability and adaptation. It is funded through CIRCLE ERA-Net, an initiative under the European Commission's Sixth Framework Programme to promote cooperation on climate and adaptation research through networking and coordination of national research in CIRCLE (Climate Impact Research Coordination in a Larger Europe) partner countries. For more information visit [www.environment.fi/syke/caravan](http://www.environment.fi/syke/caravan).

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