Scenarios of adaptive capacity, climate change exposure and sensitivity for an indicator-based vulnerability assessment

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Vulnerability to climate change is a function of:

- exposure (E)
- sensitivity (S)
- adaptive capacity (A)

$$V = f(E, S, A)$$

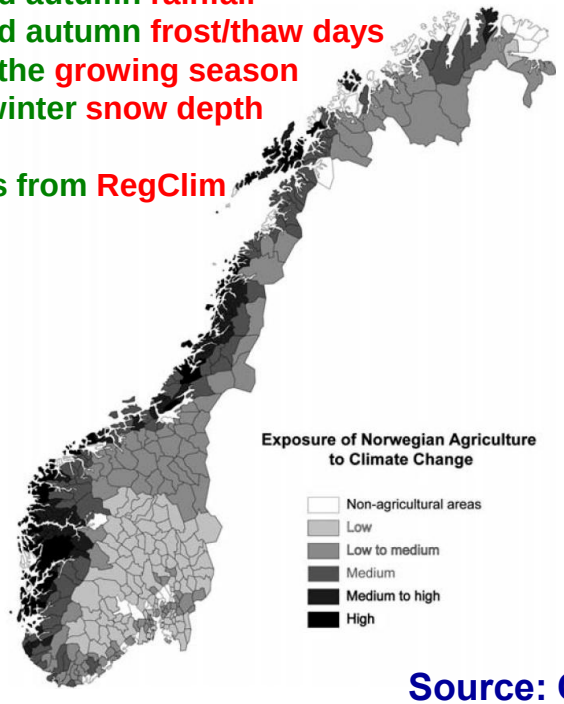
Metzger and Schröter (2006)

Exposure of Norwegian agriculture to climate change (by municipality)

Defined as a function of changes (2030–2050 relative to 1980–2000) in:

- spring and autumn rainfall
- spring and autumn frost/thaw days
- length of the growing season
- average winter snow depth

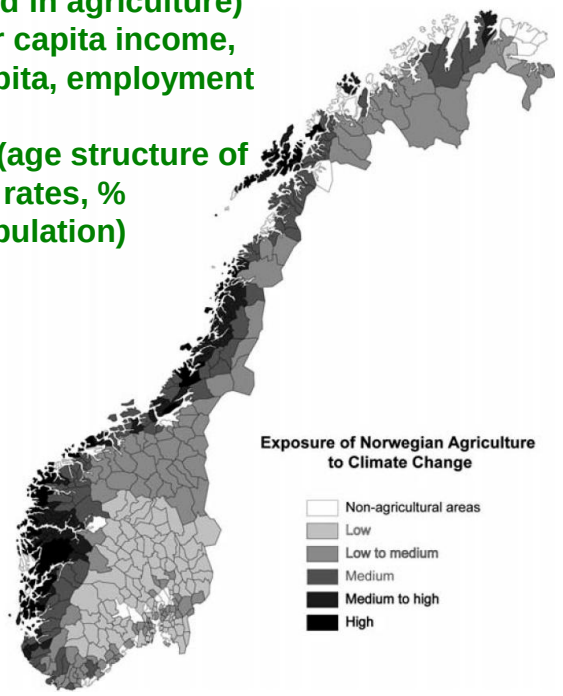
Projections from RegClim



Adaptive capacity of Norwegian agriculture by municipality

Defined as a function of:

- socioeconomic sensitivity (% population involved in agriculture)
- economic factors (per capita income, state transfers per capita, employment prognoses)
- demographic factors (age structure of work force, migration rates, % dependents in the population)



Source: O'Brien et al. 2006

Aims of the study

- Quantifying regional vulnerability to climate change; two themes: elderly and cross-country skiing
- Indicator-based approach on municipal-scale for Finland
- Attempt to estimate future adaptive capacity

Vulnerability of the elderly

- Number of elderly in Nordic countries is growing dramatically – there are more older people who are living longer
- The eldery are vulnerable to heatwaves, icing associated with freeze/thaw conditions, and extreme events such as storms that cut off access to services and social networks
- Risk factors include living alone; chronic or severe illness; dependency on medications, and social exclusion

Indicators of adaptive capacity for the elderly

Demographic

- **Elderly population**, present-day and future (2040) projection from population model

Socio-economic

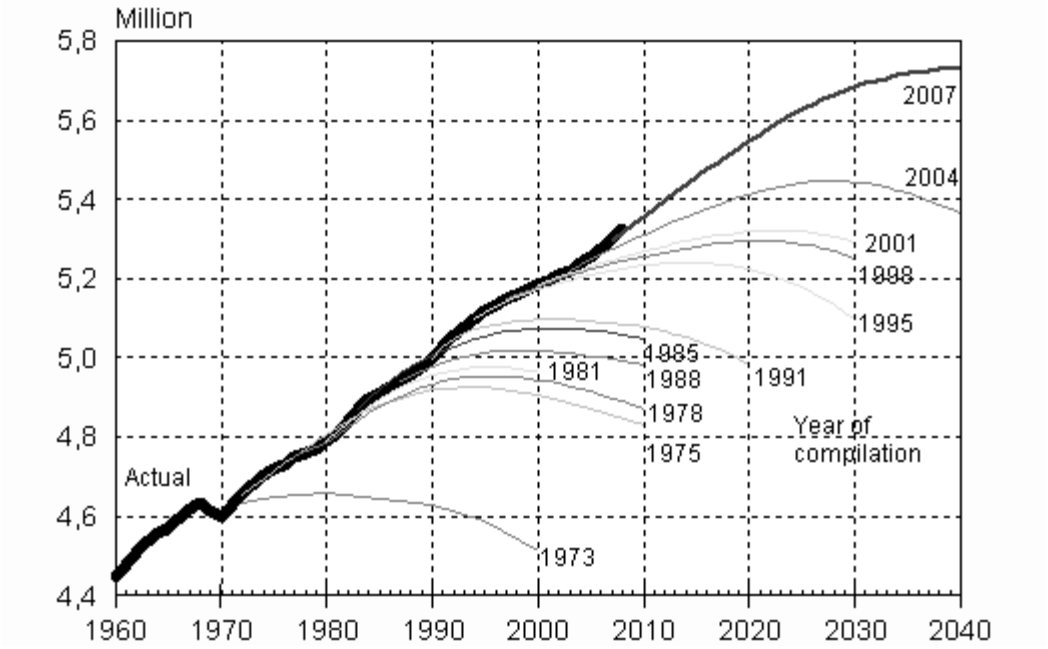
- **Elderly living alone**, present-day and future (2040) extrapolated from 2005-2009 historic trend
- **Health care personnel**, present-day and future (2040) from 1990-2007 trend
- **Home health care**, present-day and future from 1995-2009 trend

Economic

- **Elderly welfare recipients**, present-day (historic trend 1991-2009)

Population forecasts are not perfect

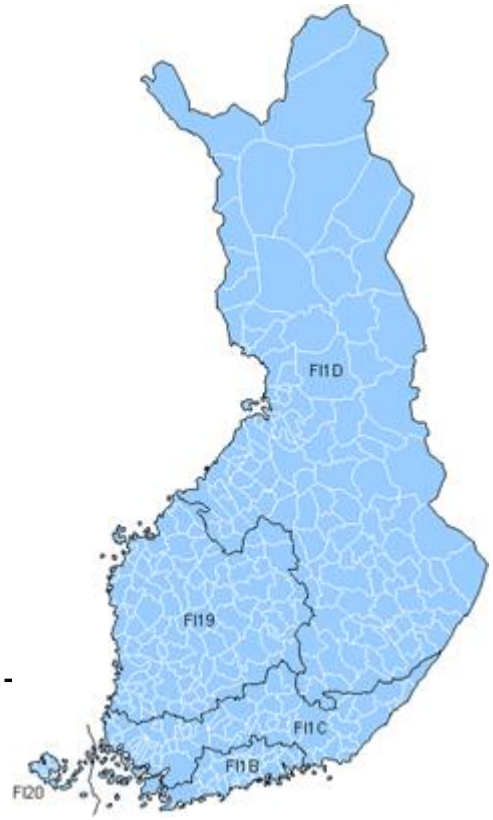
Population of the whole country in Statistics Finland's population projections by municipality for 1973 to 2007



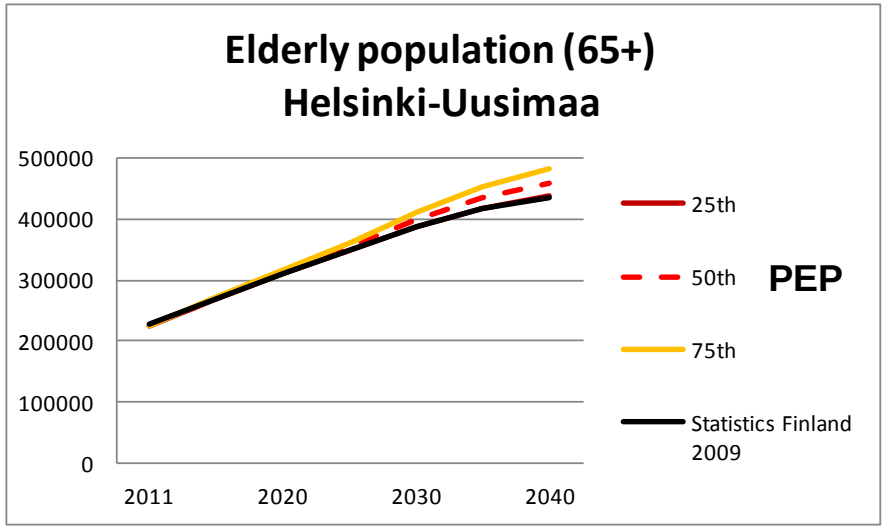
Source: Official Statistics of Finland (OSF): Population projection [e-publication]. ISSN=1798-5153. 2009, Quality description: Population projection 2009–2060 . Helsinki: Statistics Finland [referred: 28.8.2012], http://tilastokeskus.fi/til/vaenn/2009/vaenn_2009_2009-09-30_laa_001_en.html

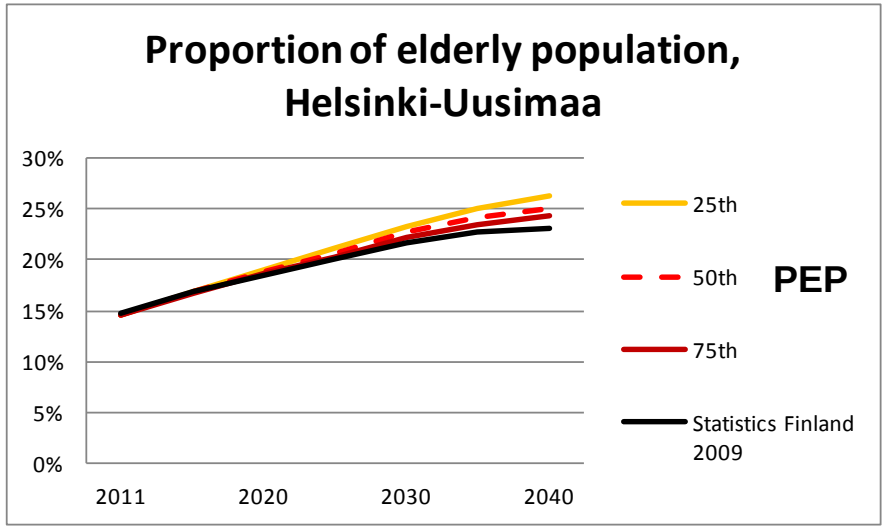
PEP - Program for Error Propagation

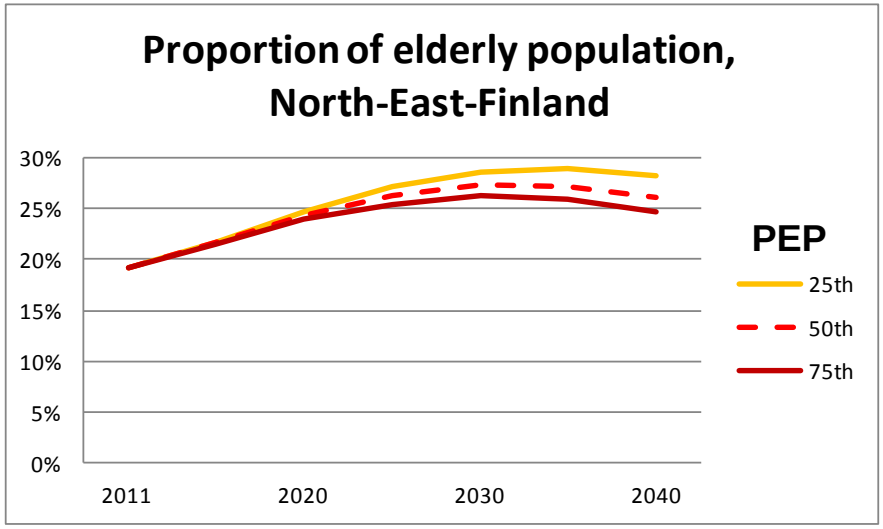
- produces demographic forecasts probabilistically
- incorporates stochastic propagation of error using simulation techniques (mortality, fertility, migration)
- Sources:
  - http://joyx.joensuu.fi/~ek/pep/pep.html
  - Alho and Spencer, 1997. J. Official Statistics 13(3): 203-225
- Simulations for NUTS-2 regions, input parameters from Statistics Finland



PEP and Statistics Finland 2009 population projections

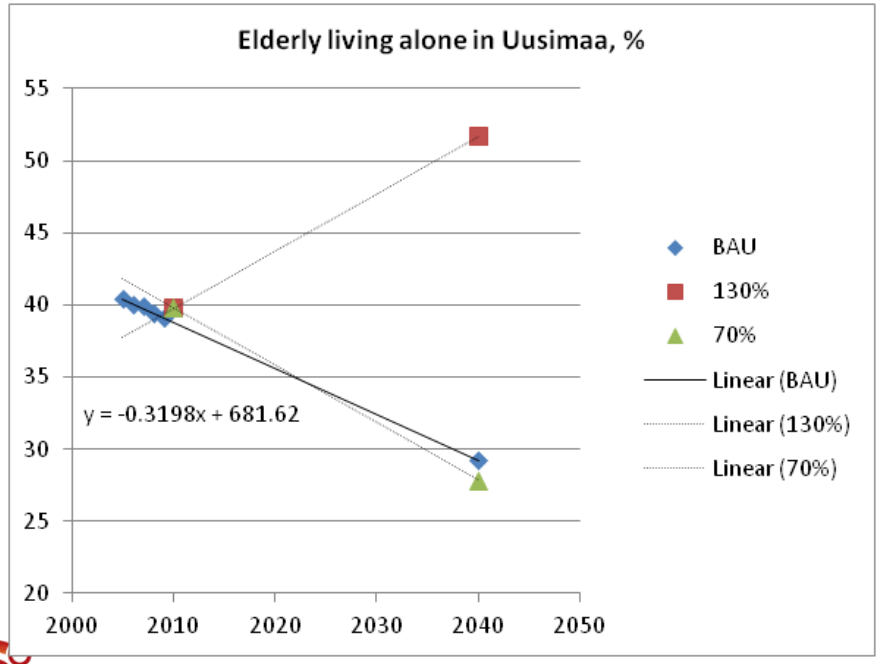


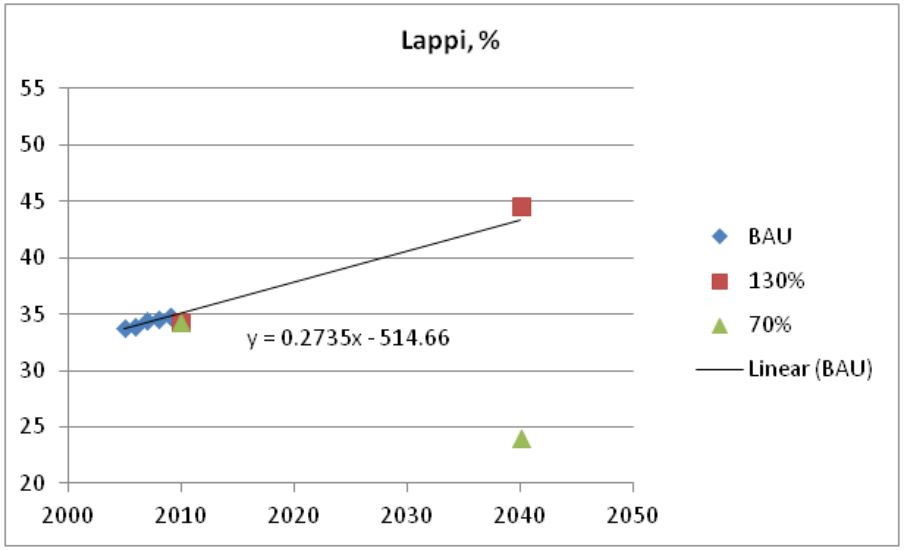




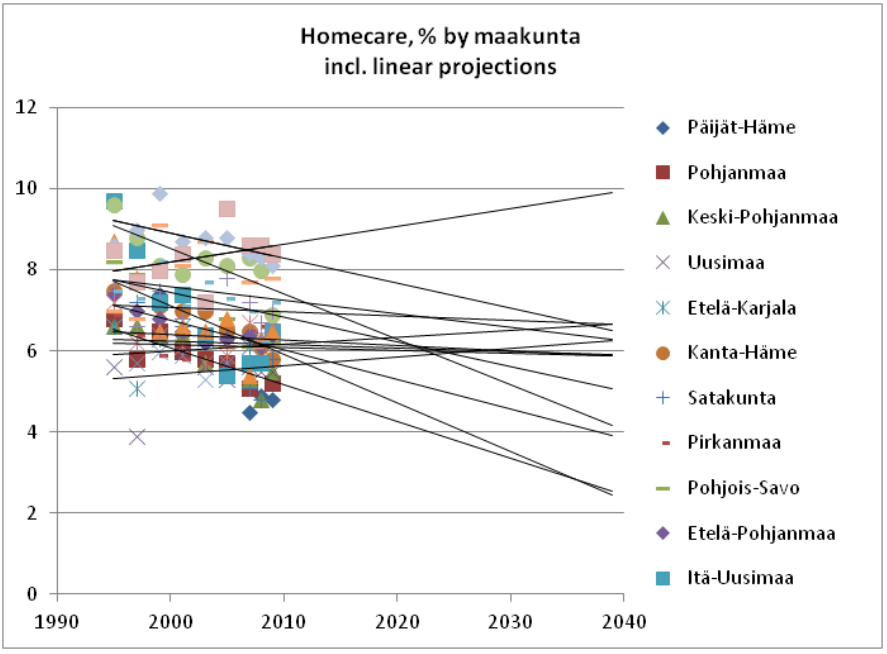
Extrapolation of historic trends in elderly living alone

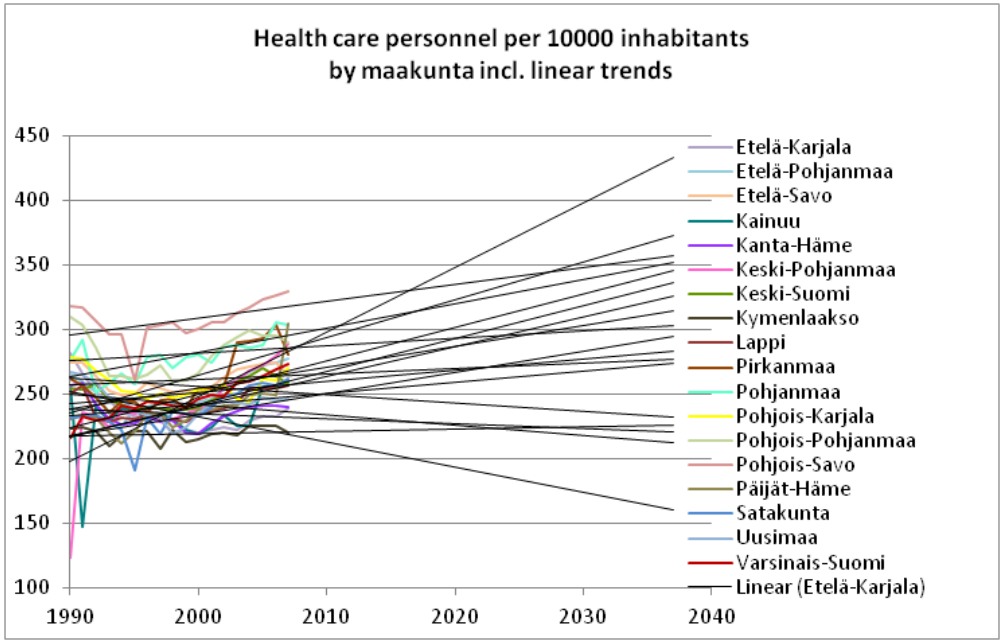
- Range of linear trends from regions (maakunta) extrapolated to 2040 define a low and high scenario



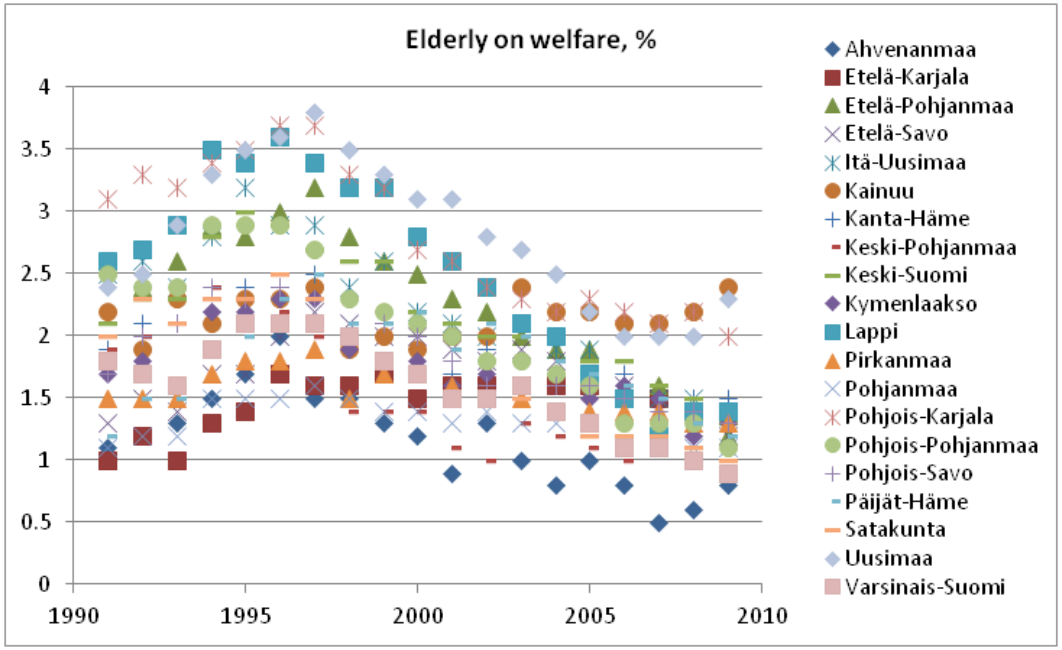


Trend extrapolations homecare and health care personnel





Historic trend in elderly receiving welfare



Indicators of exposure for the elderly

Heat-stress

- Change in very warm days (fixed threshold: TX>25°C)
- Change high temperature days (local threshold: TG>99th %-tile of observations)
- Change in the number of heat waves (local threshold for 6 days)

Cold-stress

- Change in the number of cold days (local threshold: TG<1th %-tile of observations)
- Change in cold spell days (local threshold for 6 days)

Icy conditions

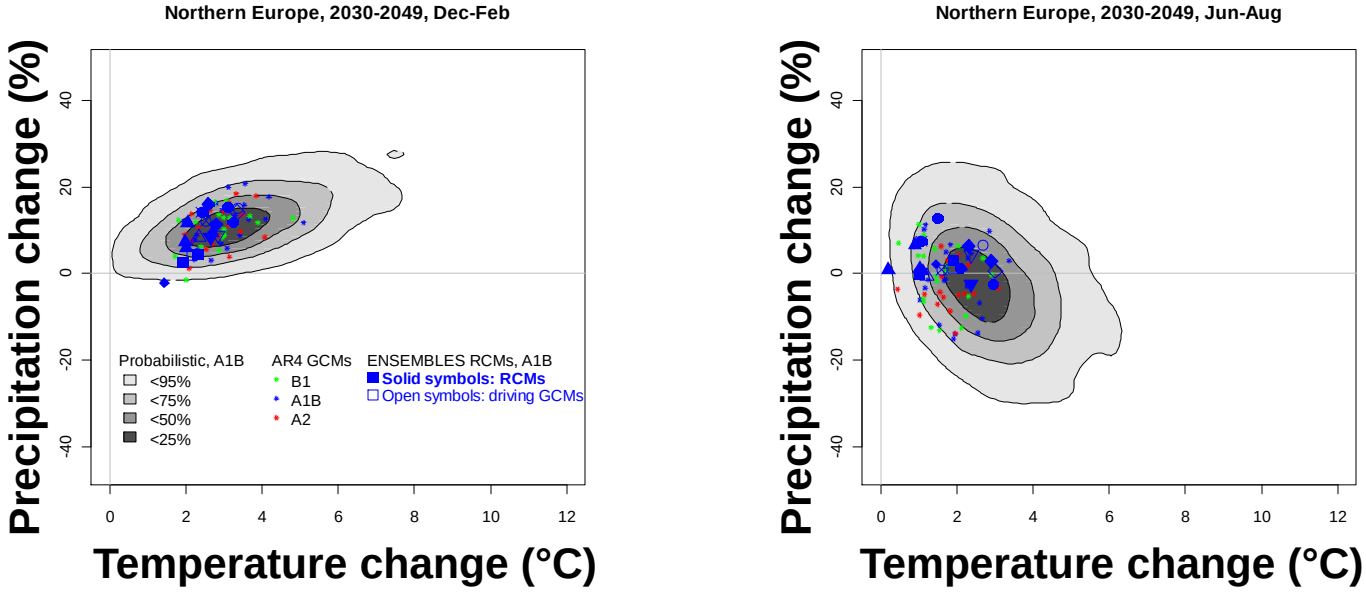
- Change in the number of freezing point days (TN < 0°C < TX)

TN: daily minimum temperature, TG: daily mean temperature; TX: daily maximum temperature

Probabilistic projections of climate change, 2030-2049 wrt. 1961-1990

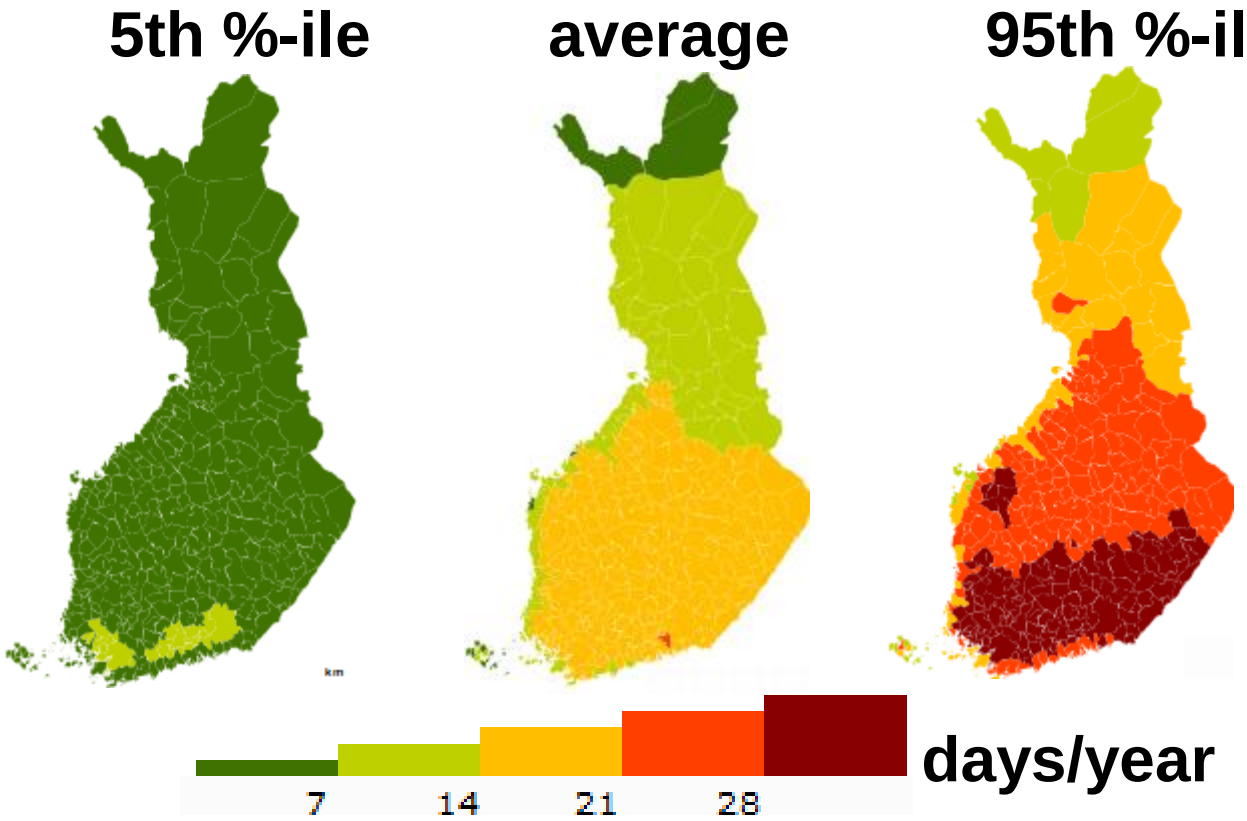
Harris et al. 2010, NHESS

- Uncertainties in the leading physical, chemical and biological feedbacks
- Using perturbed physics ensembles, multi-model ensembles and observations.



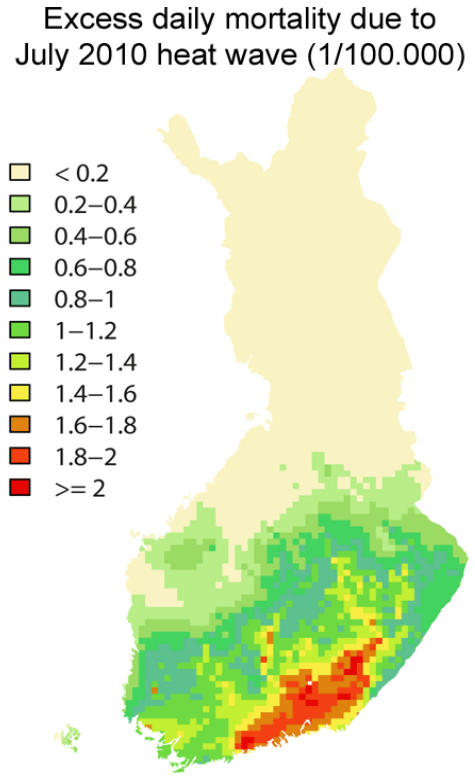
Change in number of days when max daily temperature >25°C, 2030-49 wrt. 1971-2000

Probabilistic projection, SRES A1B (Harris et. al 2010)



Heat-related mortality

- Temperature-mortality models currently being developed by the Finnish Met. Institute
  ➔ see poster presentation on Thursday
  Ruuhela et al.: Investigating the relationship between mortality and temperature and a possible acclimatization effect in Finland



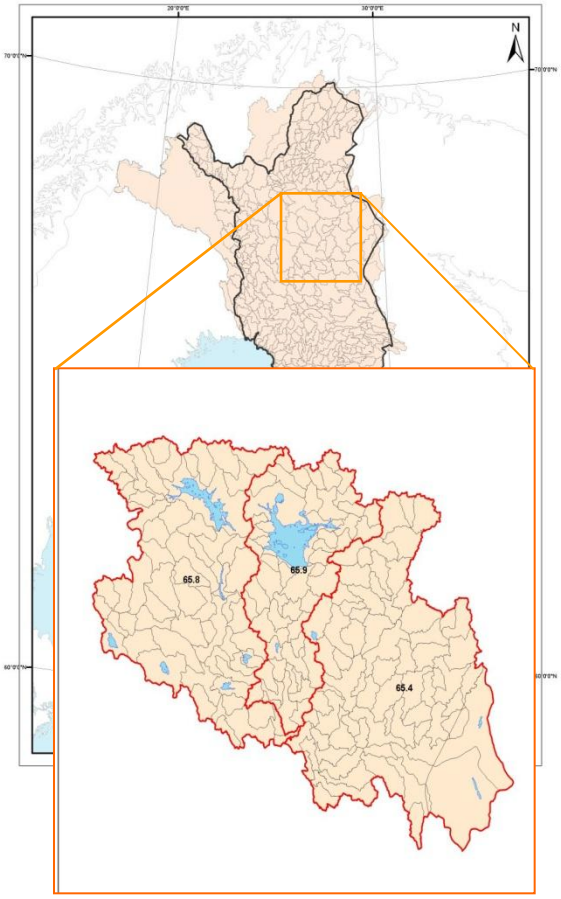
Cross-country skiing

- Adaptive capacity studied using a survey about cross-country skiing habits under future snow conditions

➔ **Landauer, Neuvonen & Sievänen: Climate change vulnerability indicators for cross-country skiing, Session 5.5.4 (Fri morning)**

Simulating snow conditions

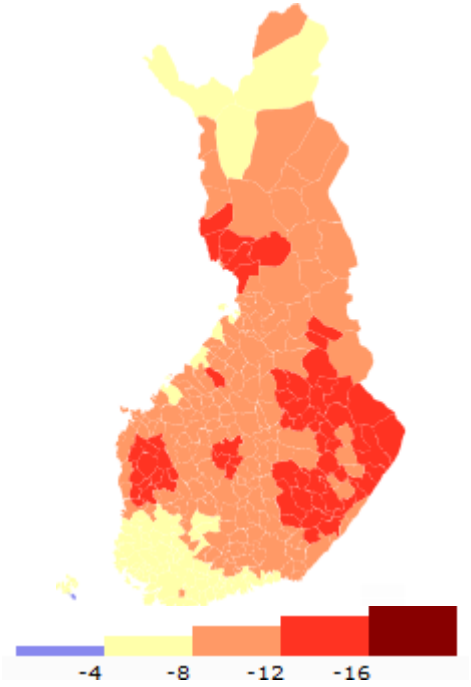
- Watershed Simulation and Forecasting System (WSFS) hydrological model developed and used in SYKE
- Includes snow depth model
- Simulations for present-day and 5 GCM-based scenarios



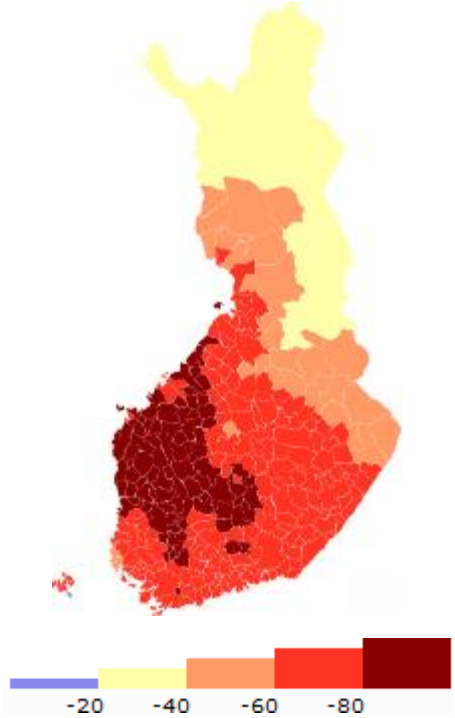
Source: Noora Veijalainen (SYKE)

Snow conditions simulated with WSFS for a 19-GCM ensemble mean/SRES A1B, 2040-69 wrt. 1971-2000

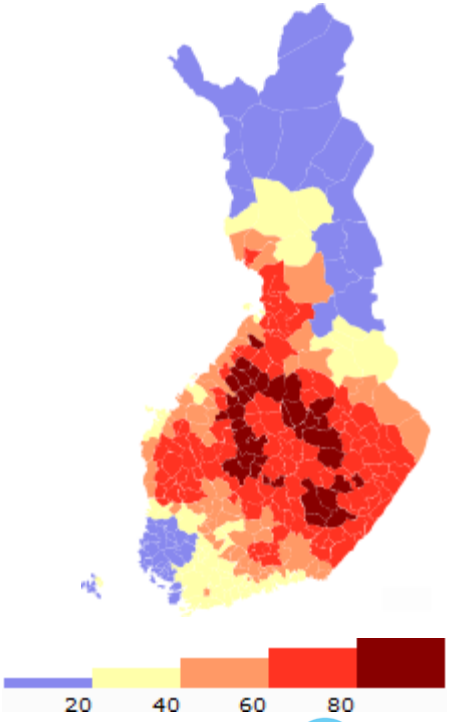
Change in mean snow depths (cm)



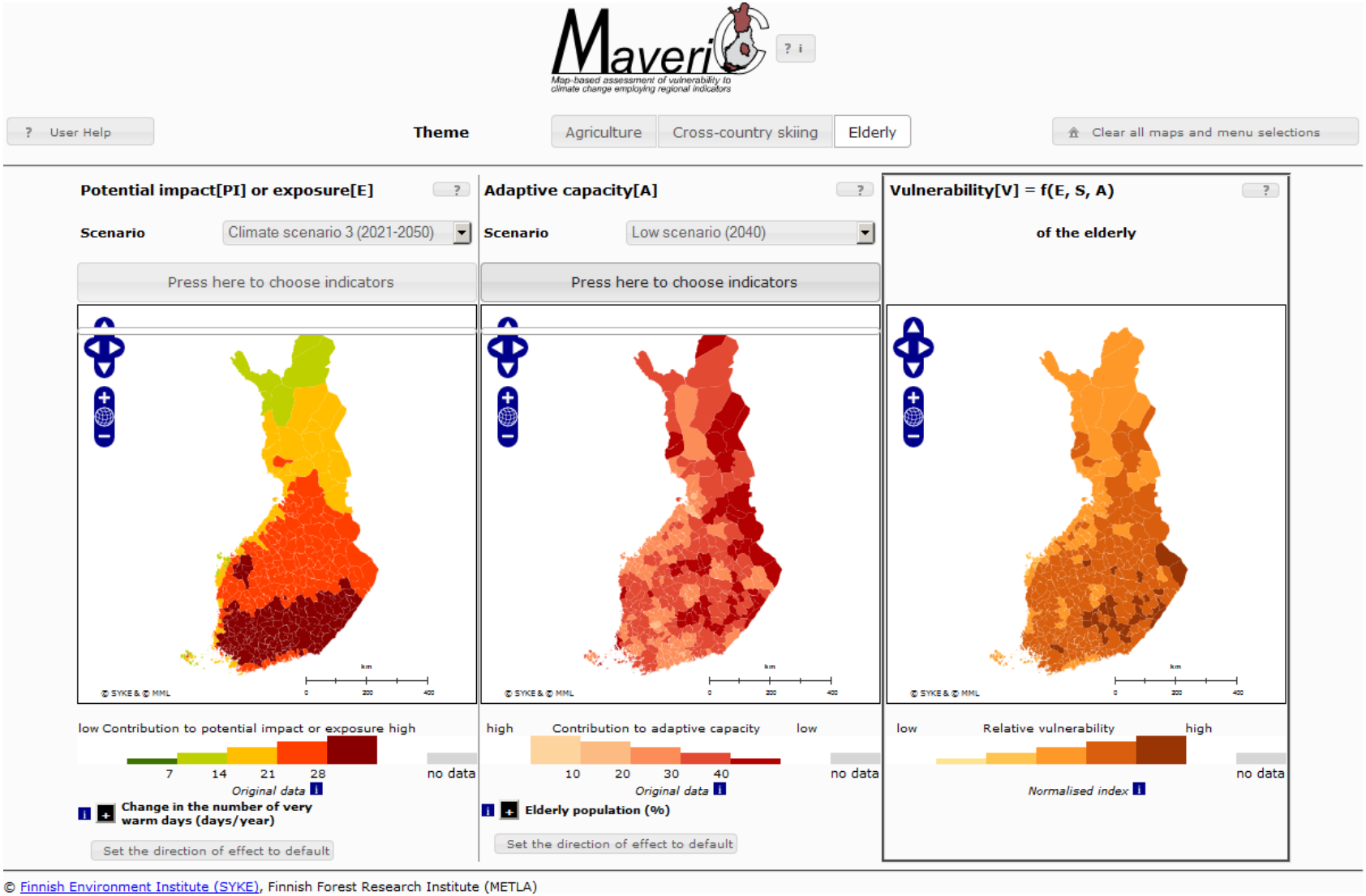
Change in mean duration of period with >10 cm snow depth (days)



Change in mean percentage of years with < 100 days snow (%/30yr)



Indicators are presented in a web-based mapping tool – demonstration of a preliminary version during the poster session



Summary

- Climate-based and socio-economic indicators at municipal-scale to quantify exposure, sensitivity and adaptive capacity
- Usually, future climate is compared with present-day adaptive capacity
- Attempt to develop scenarios of socio-economic indicators using population models, simple extrapolations of historic trends and survey questions about future adaptation
- Uncertainty of indicators, some probabilistically