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# Climate Change Vulnerability Indicators for Cross-Country Skiing

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# Background

- Project '**MAVERIC** - Map-based Assessment of Vulnerability to Climate Change Employing Regional Indicators (2009 -2012)
- Project partners: the Finnish Environment Institute, the Finnish Forest Research Institute, the Finnish Meteorological Institute, MTT Agrifood Research Finland and Aalto University
- Investigates climate change impacts on outdoor recreation and tourism, among other topics
- Cross-country skiing is found to be the most sensitive to climate change

# Vulnerability of cross-country skiing

- In Finland cross-country skiing has a long tradition but it might be lost due to warming winters
- Skiing has health-related benefits for skiers
- Ski tourism provides an income source for many regions

## Information is needed

- on the direct impacts on skiing conditions for skiers (demand side) and ski area management (supply side)
- on skiers' behavioral responses to changing conditions (indirect impacts) for ski area management

# Number of annual snow days - snow cover more than 20 cm

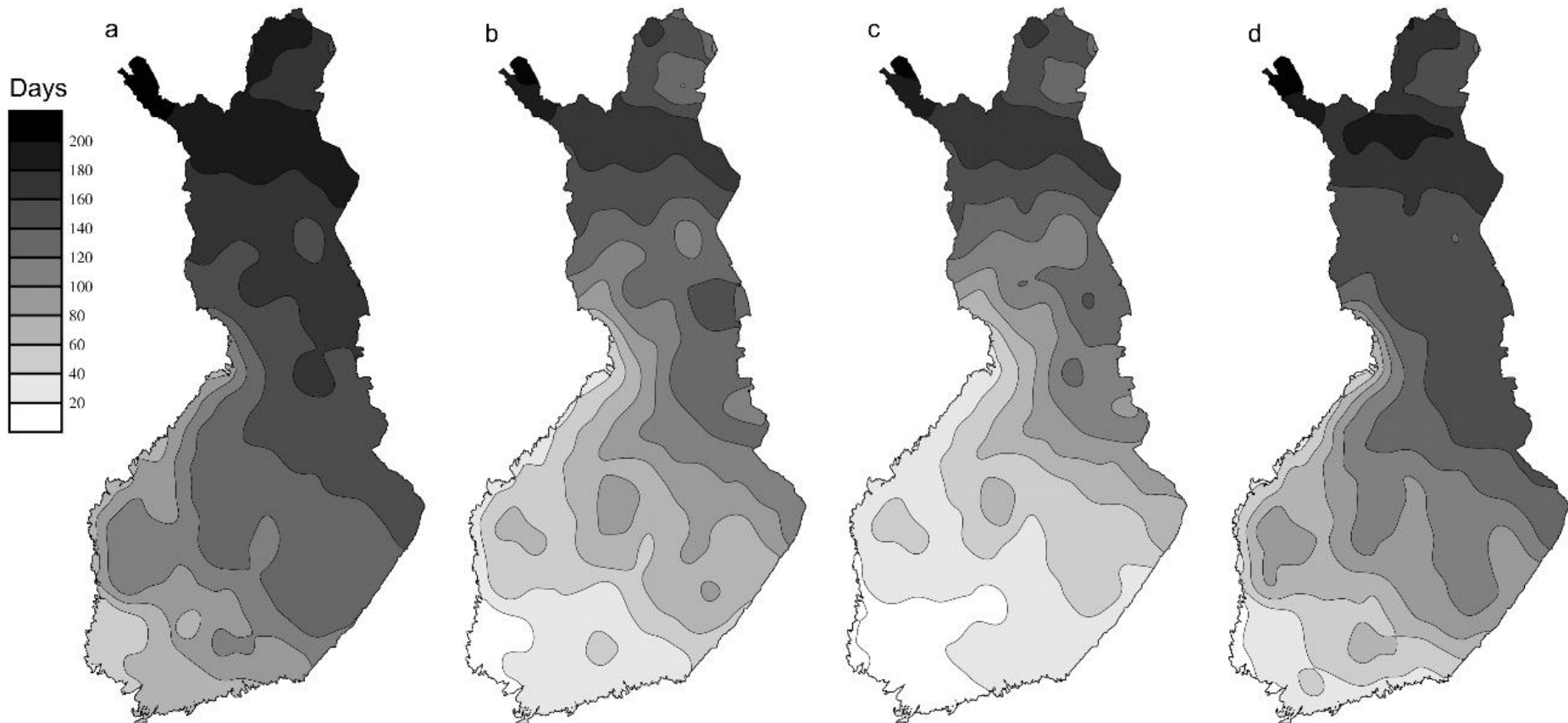
In 2010-39:

In the control period  
**1971-2000**

With 19 GCM average  
scenario with A1B  
emission scenario

With CCSM3 climate  
model with A2 emission  
scenario

With ECHAM/MPI-OM  
climate model with A1B  
emission scenario



Based on simulations with the WSFS model.  
Source Finnish Environment Institute SYKE

## Objective of the study on cross-country skiing

- To produce **vulnerability<sup>1</sup> indicators** based on
  - **exposure**
  - **sensitivity** and
  - **adaptive capacity (awareness, ability and action)**
- To implement index-based techniques when measuring (regional) climate change vulnerability of winter tourism and outdoor recreation

<sup>1</sup> *The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes (McCarthy, et al. 2001, p. 995)*

# Data

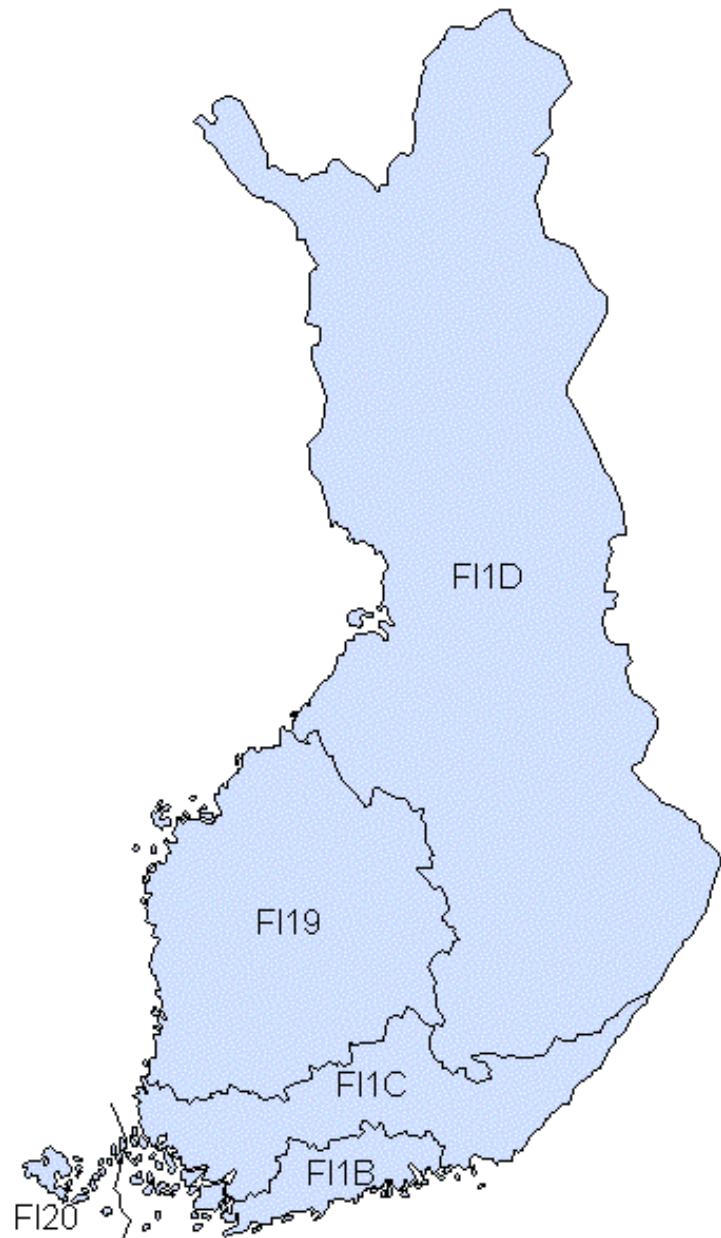
## National Outdoor Recreation Demand Inventory (LVVI2) 2009 – 2010:

- Web and mail survey on all outdoor activities; age range 15-74 years
- Follow-up survey in spring 2010 was sent to 828 winter recreationists
- 480 respondents participated, of which 60% (n=287) were cross-country skiers
- This study is based on cross-country skiers who received activity-specific questions on skiers' preferences and behavior in general and under conditions of climate change

# Regions

- The regional investigations were based on four NUTS2 (2012: FI1 mainland – excluding Åland FI20) regions:
  - North and East Finland FI1D (30%)
  - West Finland FI19 (27%)
  - South Finland FI1C (16%)
  - Helsinki-Uusimaa FI1B (27%)

(Map credits: Statistics Finland)



# Results:





# Vulnerability index construction procedure

## **STEP 1: Variable selection**

22 survey items consisting of 49 variables

## **STEP 2: Pointed scale definition**

## **STEP 3: Indicator item selection**

Exposure to climate change effects

Potential behavioral response

Perception of climate change

Ability to adapt

Tendency to adapt

## **STEP 4: Indicator aggregation**

Exposure (bphys\*)

Sensitivity (soc\*)

Awareness (soc\*)

Ability (soc\*)

Action (soc\*)

## **STEP 5: Standardization**

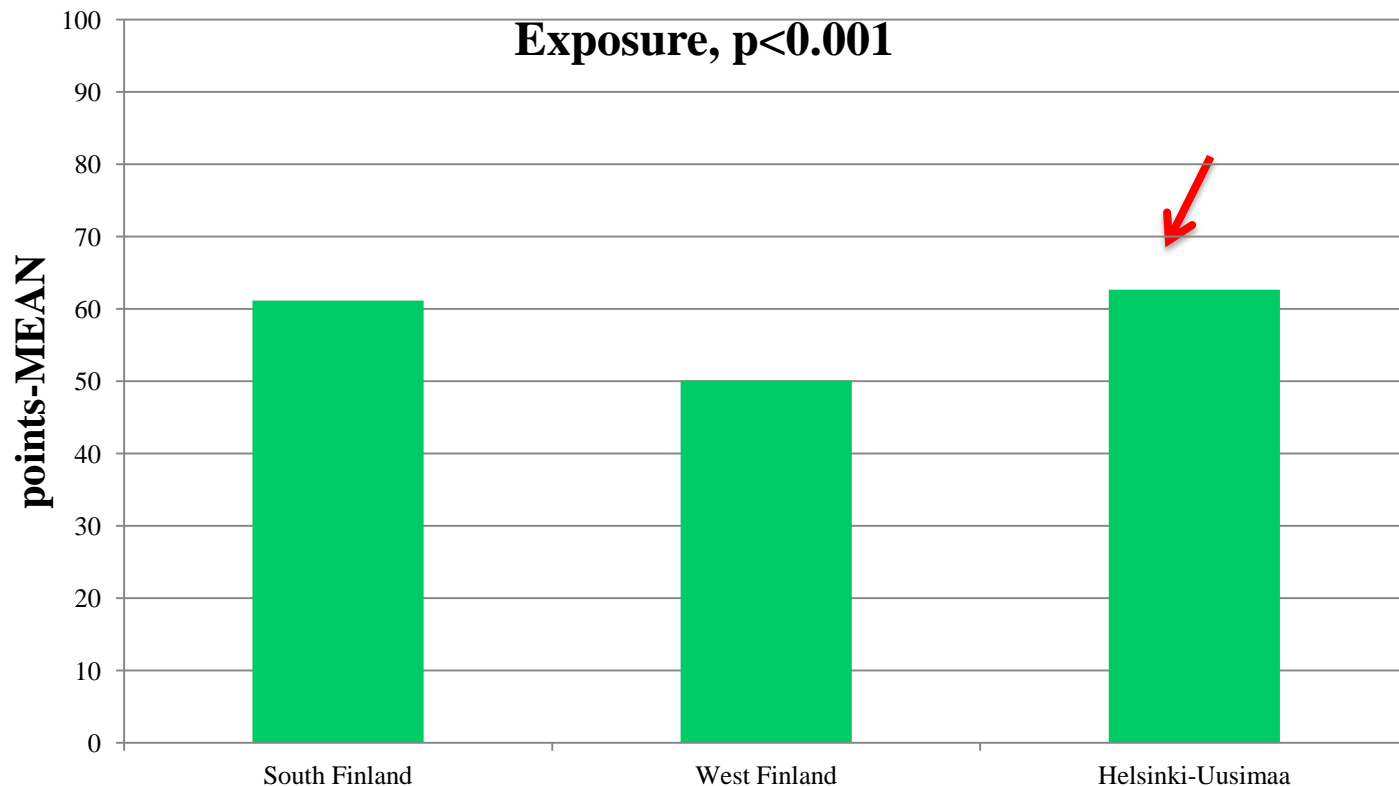
**VULNERABILITY  
INDEX**

# Exposure as a biophysical indicator to measure vulnerability

- Direct climate change impacts on actual skiing conditions
- The number of annual snow days (natural snow) suitable for skiing during the survey winter 2009-2010
- Considers the regional variations in snow availability for the respondents

# Exposure

- Results revealed significant regional\* differences:

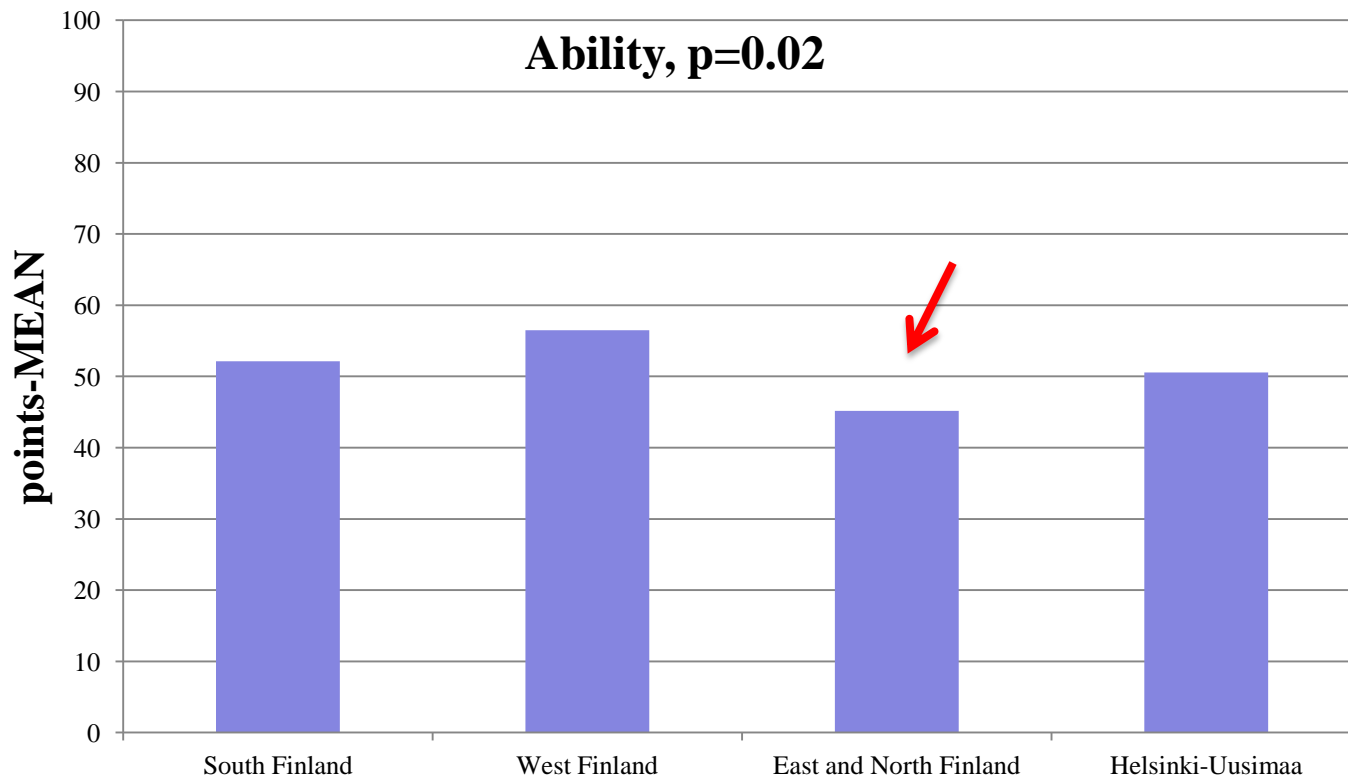


## Social vulnerability indicators

- **Adaptive capacity** (Awareness, Ability, Action) and **Sensitivity** measure social vulnerability to climate change
- **Ability:** The level of skiing skills, equipment maintenance skills, owned equipment and preparedness to travel to be able to ski provided an essential measures of vulnerability:

# Ability: Example of the regional differences

- Vulnerability in East and North Finland lower

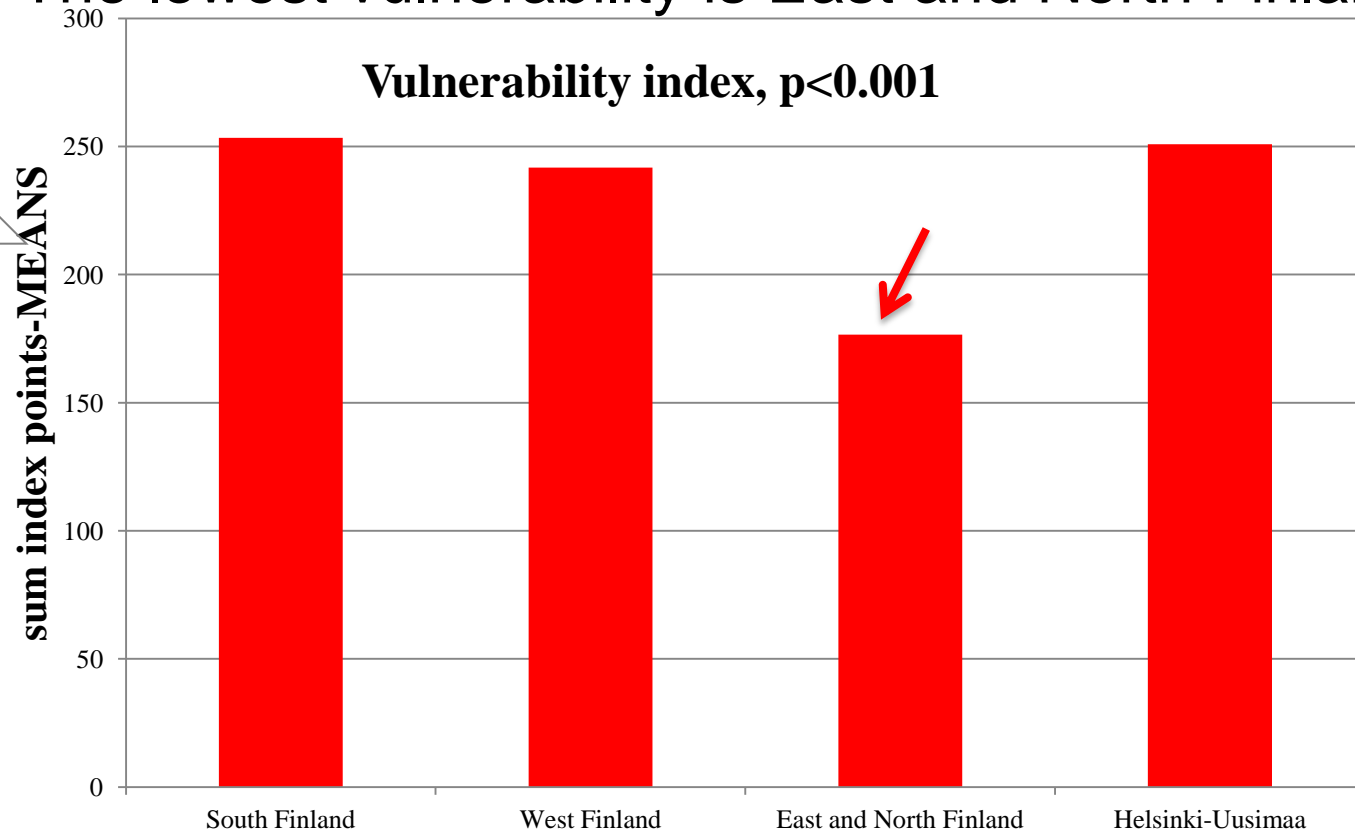


vulnerability

- **Sensitivity** to perceived and expected impacts (tendency to quit skiing, reaction to poor snow and track conditions, to weather changes, etc.), **Awareness** of climate change and **Action** were not significant in regional comparisons
- The power of them as individual indicators did not help explaining the regional differences but they provided relevant information for constructing the vulnerability index

# Vulnerability index

- Indicates high level of Exposure and Sensitivity, and low-level of Adaptive capacity: low level of Ability, Awareness and Action
- The lowest vulnerability is East and North Finland



# Summary and conclusions

- The study provides activity-specific, regional approach to measure vulnerability
- Vulnerability research of winter tourism and outdoor recreation is highly needed in Finland
- Measuring vulnerability and quantifying the phenomena empirically is important
- Indicator-based technique is useful in assessing short- and long-term benefits and losses related to cross-country skiing



- Vulnerability assessment make possible to guide policy development on national and sub-national scales
- The design and structure can be adopted for other survey-based data in the field of tourism and outdoor recreation

# Thank you!

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