

Adapting Europe to climate change: what does research have to offer?

Timothy Carter

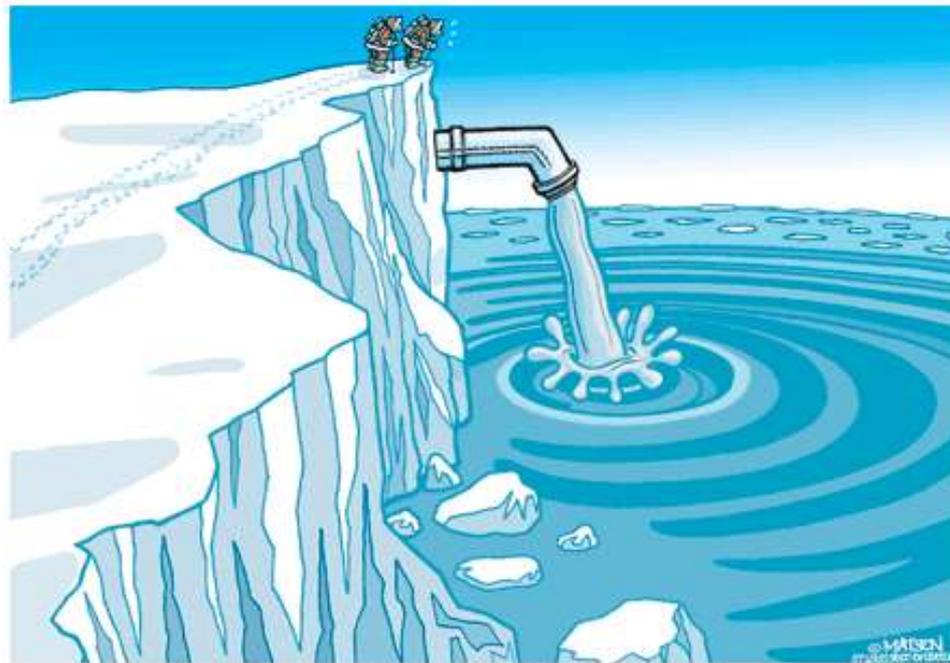
**Finnish Environment Institute (SYKE)
Climate Change Programme**

Outline

1. **Why is adaptation important?**
2. The policy context
3. Research *for* adaptation
4. Research *on* adaptation
5. Conclusions

1. Why is adaptation important?

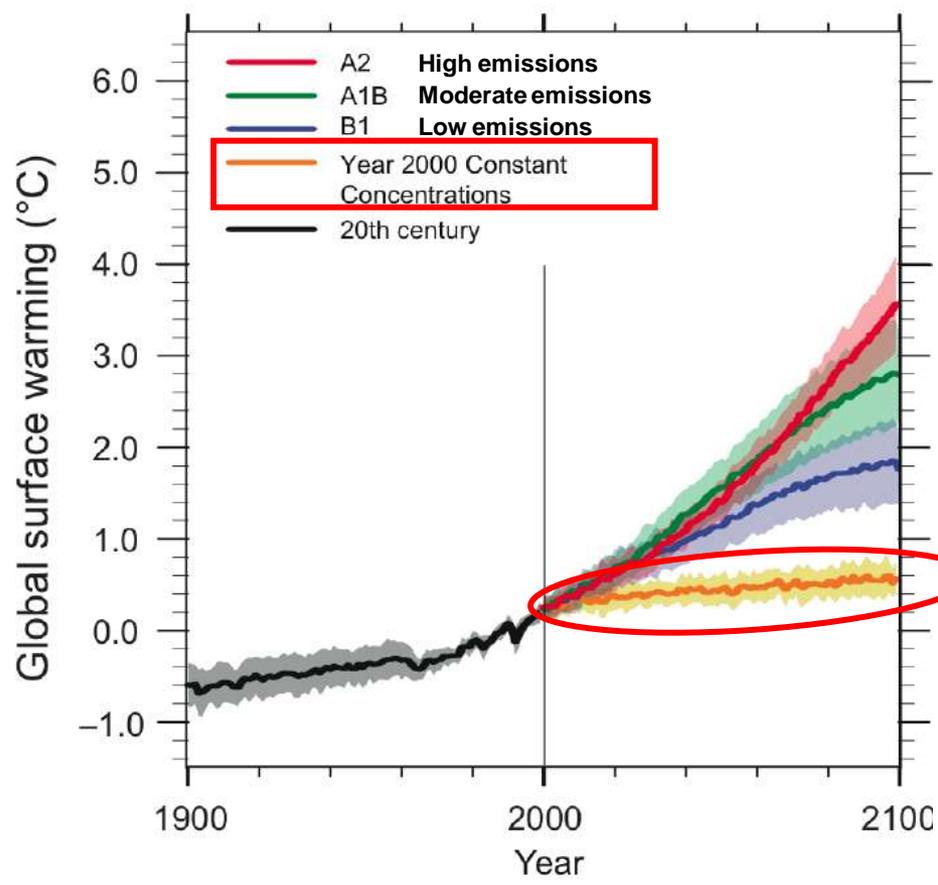
Anthropogenic climate change is underway, and natural and human systems are being affected



"HOW ON EARTH DO WE TURN IT OFF?"

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MILITARY SYSTEMS
caglocartoons.com

Global mean temperature increases observed during the 20th century are projected to continue throughout the 21st century



**Committed temperature rise by 2100:
~+0.6°C or ~1.3°C above pre-industrial**

Changes relative to 1980-1999

Source: IPCC (2007) – annotated

Mitigation and Adaptation

- **Mitigation** is the reduction of greenhouse gas emissions in order to prevent dangerous climate change
- **Mitigation alone is not enough. The earth is already committed to some climate warming**
- **Adaptation** is adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities

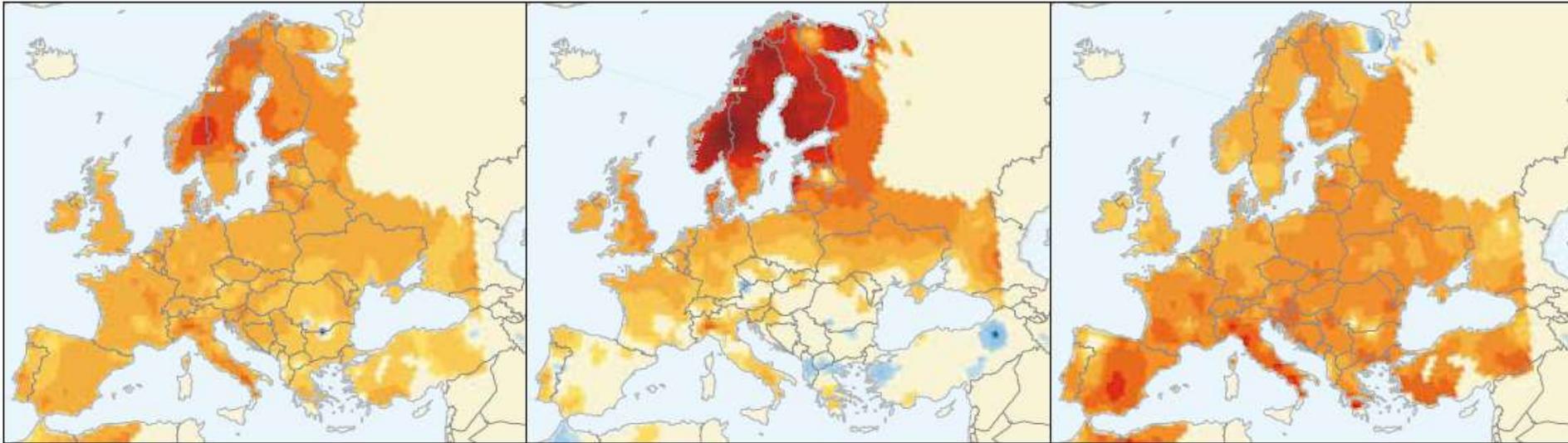
IPCC (2007)

Europe has been warming since the mid-1970s

Annual

Winter (DJF)

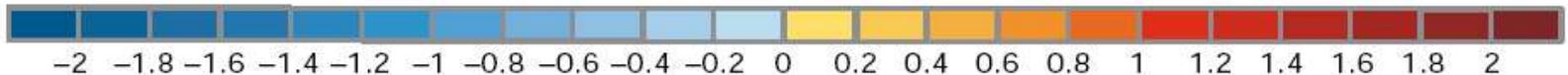
Summer (JJA)



Observed temperature change over Europe during the period 1976–2006

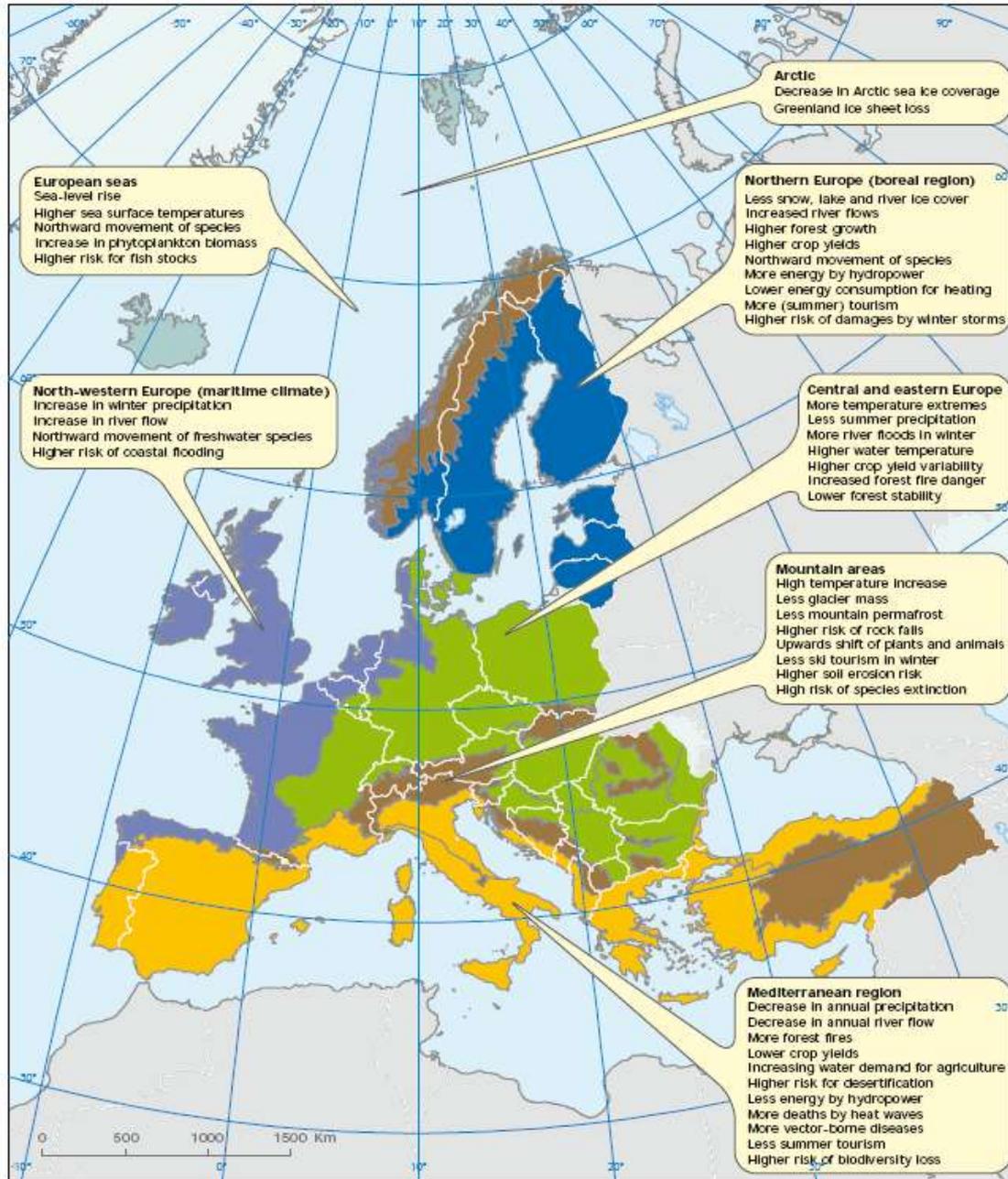
Left: annual mean; middle: winter (DJF); right: summer (JJA)

°C per decade



Source: European Environment Agency (EEA), 2008

Key past and projected impacts and effects on sectors for the main biogeographic regions of Europe



Main biogeographic regions of Europe (EEA member countries)

-  Arctic
-  Arctic — Greenland (not EEA member)
-  Boreal region
-  North-western Europe
-  Central and eastern Europe
-  Mountain areas
-  Mediterranean region

Source: after EEA, 2008

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EU White Paper (2009)



COMMISSION OF THE EUROPEAN COMMUNITIES

Brussels, 1.4.2009
COM(2009) 147 final

WHITE PAPER

Adapting to climate change: Towards a European framework for action

{SEC(2009) 386}
{SEC(2009) 387}
{SEC(2009) 388}

EU White Paper on Adapting to Climate Change

Pillar 1

Pillar 2

Pillar 3

Pillar 4

EU White Paper on Adapting to Climate Change

Improve the knowledge base on CC vulnerability (impacts and adaptive capacity) and on the costs and benefits of adaptation options:

- Build on EU and national research
- European Clearing House Mechanism (CHM)

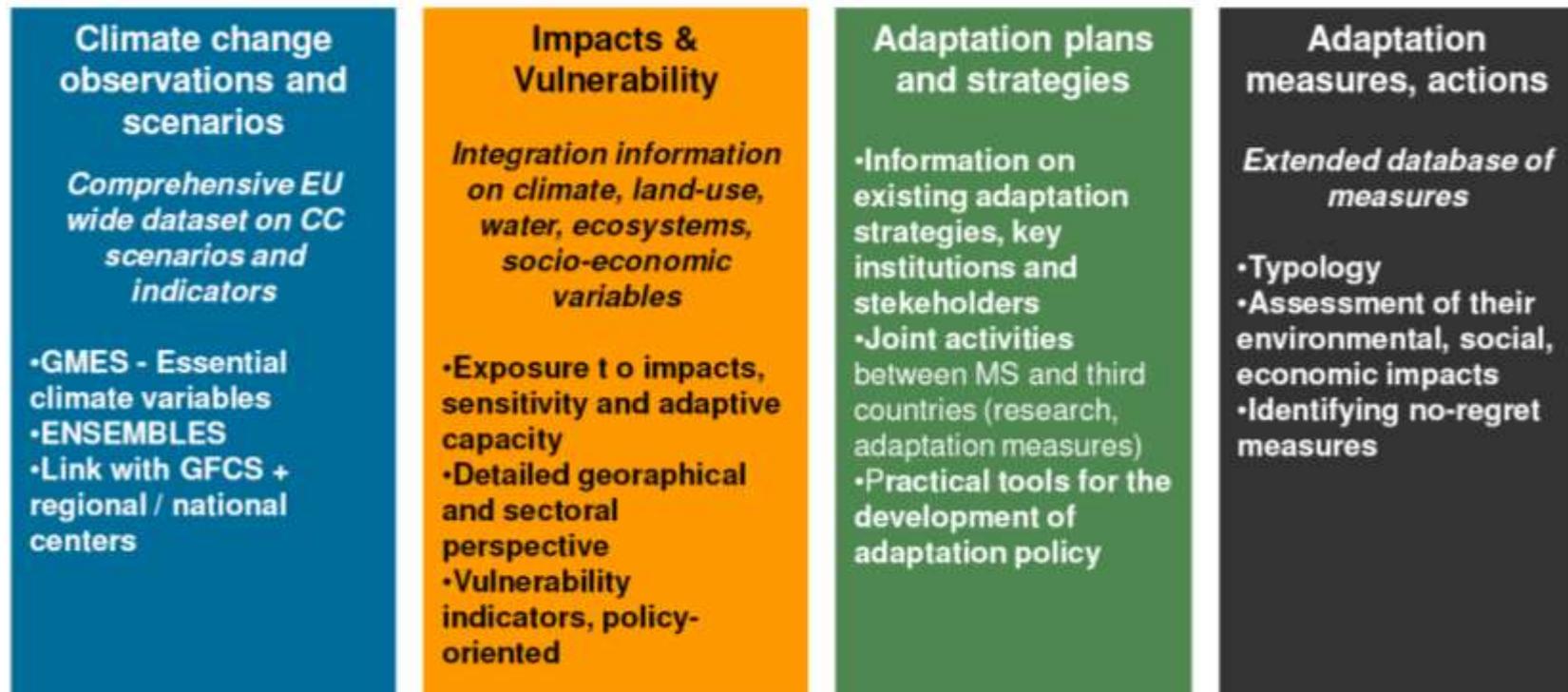
Pillar 1

Pillar 2

Pillar 3

Pillar 4

Proposed European Clearing House on Climate Change Impacts, Vulnerability and Adaptation



Source: Jacques Delsalle, European Commission, DG Environment
<http://www.circle-era.net/fileadmin/upload/documents/Delsalle.pdf>

National Adaptation Strategies

- *The National Adaptation Strategy (NAS) for a country refers to a **general plan of action** for addressing the **impacts of climate change**, including climate variability and extremes*
- *It will include a mix of **policies and measures** with the overarching objective of **reducing the country's vulnerability***

After: Burton, I., Malone, E. L. & Huq, S. (2005). *Adaptation Policy Frameworks for Climate Change. Developing Strategies, Policies and Measures*. Cambridge University Press, Cambridge

Europe Adapts to Climate Change

Comparing National Adaptation Strategies

Rob Swart, Robert Biesbroek, Svend Binnerup, Timothy R. Carter, Caroline Cowan, Thomas Henrichs, Sophie Loquen, Hanna Mela, Michael Morecroft, Moritz Reese and Daniela Rey



PARTNERSHIP FOR EUROPEAN ENVIRONMENTAL RESEARCH



More information at:
www.peer-initiative.org

Which European countries have a NAS?

Adopted a NAS:	Preparing a NAS:	IVA assessments for:
Finland (2005)	Czech Republic (2008?)	Greece
France (2006)	Norway (2008?)	Iceland
Spain (2006)	Romania (2008?)	Ireland
Netherlands (2007)	Estonia (2009?)	Lithuania
Denmark (2008)	Latvia (2009?)	Sweden
United Kingdom (2008)	Portugal (??)	Switzerland
Germany (2008)	Austria (2011)	
Hungary (2008)	Belgium (2011)	

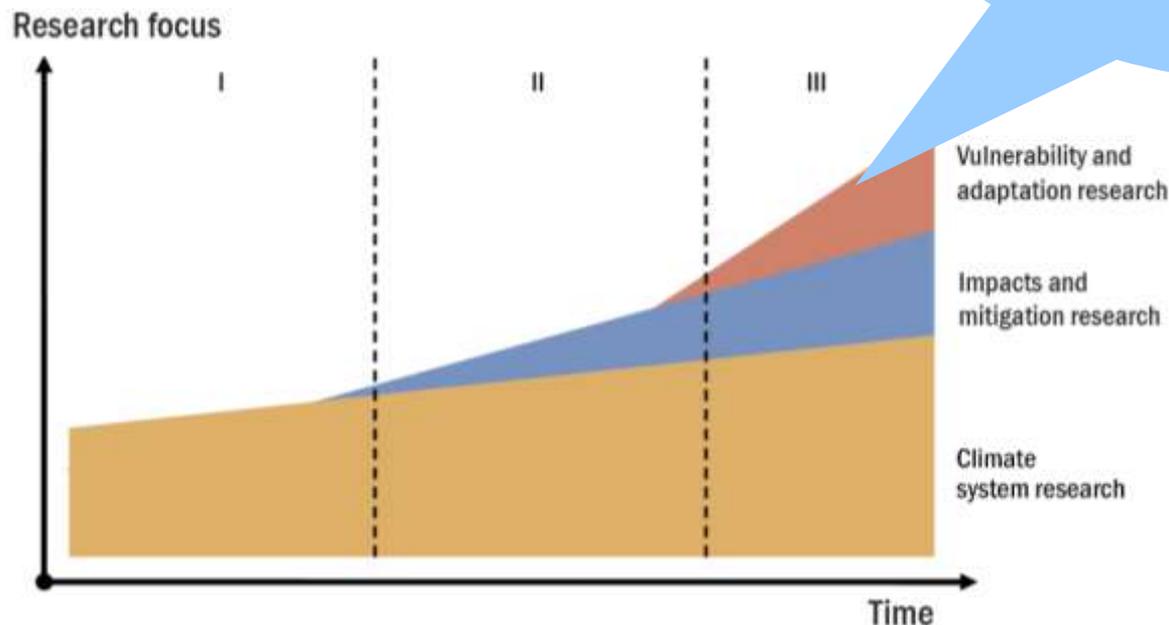
(2011?)

RED: Included in the PEER study – those in the 1st and 2nd columns are described in the PEER report (updated)

Adjusted from: EEA (2008). *Impacts of Europe's Changing Climate - 2008 Indicator-Based Assessment*. European Environmental Agency, Copenhagen

Can research keep up with accelerated policy development?

- **Stage I: Climate system emphasis (1980s-)**
 - e.g. SILMU (FI), NOP (NL)
- **Stage II: Mitigation and national impacts (1990s-)**
 - e.g. SIAM (PT), KALME (LV), ECCE (ES)
- **Stage III: Local impacts, vulnerability and adaptation (2000s-)**
 - e.g. FINADAPT/ISTO (FI), KfC (NL)



Policy-relevant scientific, technical and economic knowledge about vulnerability and adaptation options is still scarce

Source: Swart et al. (2009)

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3. Research *for* adaptation

Assessing vulnerability

Rankings of 100 Countries by descending vulnerability

Lowest Third	Middle Third	Highest Third
Sierra-Leone	Cambodia	Trinidad-and-Tobago
Bangladesh	Iran	Papua-New-Guinea
Somalia	Iraq	Ukraine
Mozambique	Viet-Nam	Iceland
Ethiopia	Peru	Romania
Rwanda	Bolivia	Poland
Benin	Tunisia	Hungary
Yemen	Mexico	Albania
Angola	Paraguay	Israel
Kenya	Algeria	Greece
Senegal	Philippines	Portugal
Nigeria	Brazil	UK
Uganda	Jordan	Bulgaria
Madagascar	Sri-Lanka	S-Korea
Sudan	Lebanon	Ireland
Nepal	China	Belarus
Haiti	Egypt	Spain
Guatemala	Gabon	New-Zealand
Syria	Saudi-Arabia	Australia
Kuwait	Libya	Netherlands
Swaziland	Kyrgyzstan	United Arab Emirates
Zimbabwe	Ecuador	Italy
Pakistan	Indonesia	Belgium
S-Africa	Uruguay	Denmark
Ghana	Jamaica	USA
Nicaragua	Thailand	France
India	Colombia	Austria
Congo	Chile	Japan
Morocco	Panama	Canada
Honduras	Turkey	Switzerland
El-Salvador	Costa-Rica	Sweden
Cameroon	Malaysia	Finland
Dominican-Republic	Argentina	Norway
	Venezuela	

Source: Yohe et al. (2006)

Vulnerable sectors addressed in some European National Adaptation Strategies

Priority sectors or cross-cutting issues are marked with two crosses

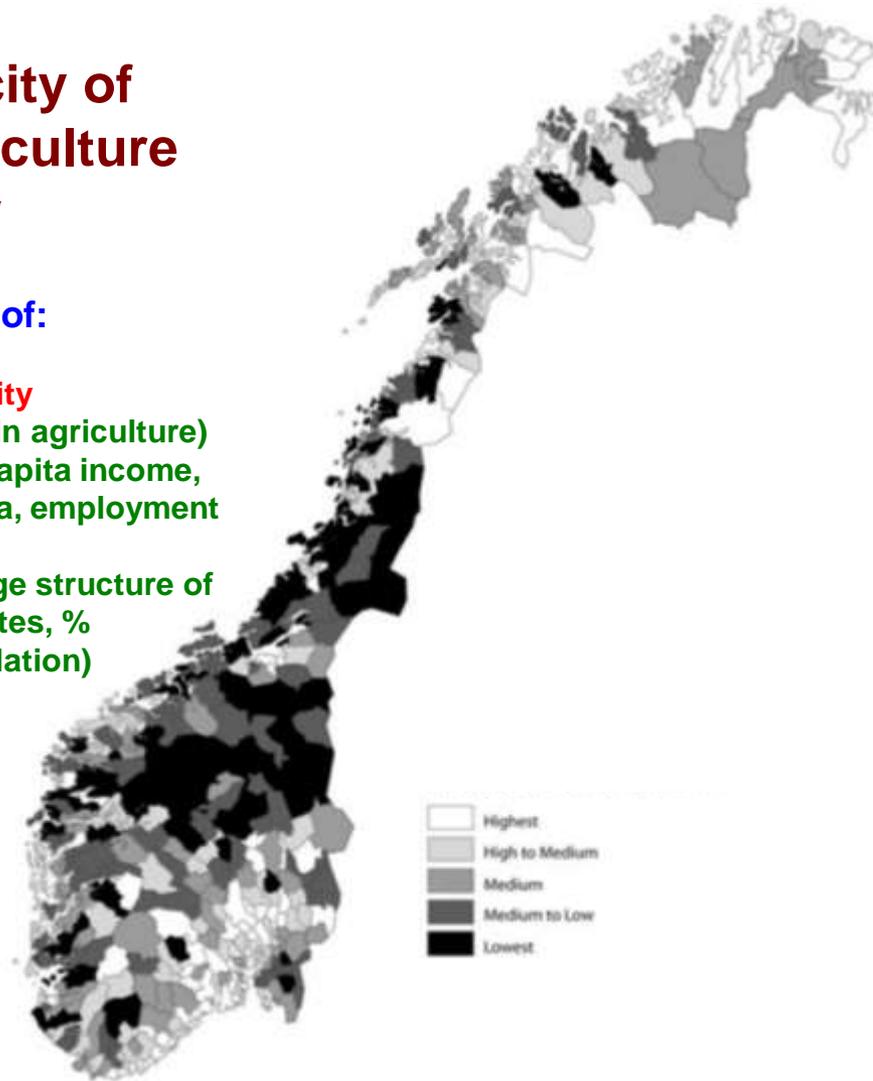
Vulnerable sector	DE	DK	ES	FI	FR	LV	NL	NO	PT	SE	UK
Agriculture	X	X	X	X	X	X	X	X	X	X	X
Biodiversity/nature conservation	X	X	XX	X	XX	X	X	X	X	X	X
Energy, electricity supply	X	X	X	X	X	X		X	X	X	X
Finance and insurance	X	X	X	X	X	X	X	X	X		X
Forests, forestry	X	X	X	X		X	X	X	X	X	X
Human health	X	X	X	X	XX	X		X	X	X	X
Water resource management	X	X	XX	X	XX	X	XX		X	X	X
Construction and buildings	X	X	X	X	X		X		X	X	X
Fisheries	X	X	X	X		X		X	X	X	X
Coastal management	X	X	XX			X	X		X	X	X
Tourism and recreation	X		X	X	X		X		X	X	X
Spatial planning, land use	X	X		X			XX	X	X		X
Transport	X	X	X	X	X		X			X	X
Communications and infrastructure	X	X		X			X	X		X	
Industry	X		X	X	X						X
Emergency and rescue services	X	X				X					

Source: Swart et al. (2009)

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)

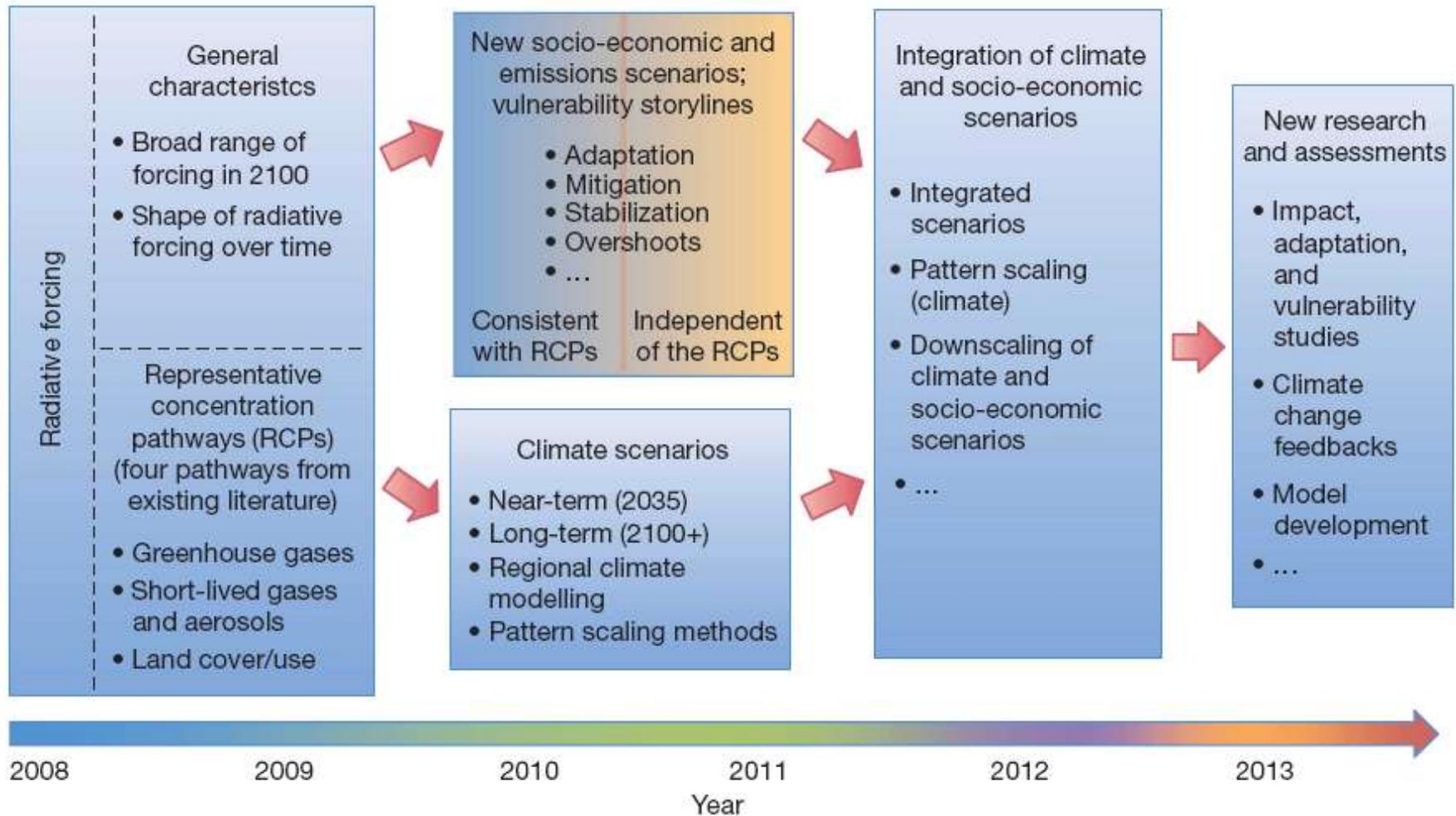


O'Brien et al. 2006

3. Research *for* adaptation

Projections of the future for risk assessment

New scenarios for climate change research



Source: Moss et al. (2010)

3. Research *for* adaptation

The identification of practical adaptation examples

Illustrative example of adaptation in practice

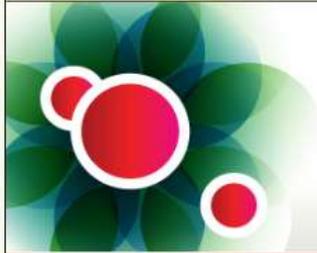
	Rules or regulations	Organisational structure	Behavioural norms
Building adaptive capacity	Minister creating a new policy that all government projects had to allow 'financial headroom' for the impacts of climate change.	Creation of the UK Climate Impacts Programme	Members of the Chamber of Commerce discussing how they will cope with increased levels of flooding
Implementing adaptation	Trade association implementing policy changes that commit the industry to respond to climate change	Local architecture firm establishes technical and staff capacity in designing houses for adaptation to climate change	A farmers' cooperative is changing farming methods as a result of water logged soils.

Source: Tompkins et al. (2005)

This study produced an inventory of examples of adaptation in practice for four sectors in the UK,

3. Research *for* adaptation

Web portals: outlets for research results



Norwegian Climate Adaptation Programme

The climate is changing, and as a result, climate adaptation is necessary. The work to adapt to climate change involves all administration levels and most sectors of society. A challenge in the climate change adaptation process will be to gain better knowledge through research, mapping and practical experience. Klimatilpasning.no is an online portal which collects this knowledge. [Read more about the Norwegian Climate Adaptation Programme](#)

What's new

[Climate Change Adaptation in Norway](#)

Adaptation to climate change is an important priority area for the Norwegian Government. This brochure gives you information about how the work is organised.

Directorate for Civil Protection and Emergency Planning, Norway, 06/04/2010



[Increased strain on coastal constructions](#)

Sea level rises and more frequent storm surges could increase the strain on coastal constructions and lead to stricter flood-safe height requirements. The objective of the Norwegian Public Roads Administration's project 'Climate and Transport' is to assess the condition of a selected number of underwater tunnels and embankments exposed to wave erosion.

Norwegian Public Roads Administration, 04/01/2010



[Sea level rise in Norway in the 21st century](#)

The report "Havnivåstigning i norske kystkommuner" (Sea Level Rise in Norwegian coastal municipalities) (revised edition) presents estimates for future sea level rises for all coastal municipalities in Norway. The tables show estimated values for sea level rise, land rise and flooding for the years 2050 and 2100.

Directorate for Civil Protection and Emergency Planning, Norway, 05/01/2010



[Sectoral Responsibility](#)

- [Building and Construction](#)
- [Private Sector](#)
- [Energy sector](#)
- [Fisheries and Coastal Sector](#)
- [Agriculture and Forestry](#)
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[Counties](#)

Select county

Click on map to select county:



[Climate Impacts](#)

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The **climate** is changing – what's the **outlook** for you?



NEWS HEADLINES:

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[Next UKCIP User Forum, May 18 2010 in Cardiff](#)

[Click here for the revised Adaptation Wizard.](#)

[For guidance about what individuals can do to adapt to climate change, click here.](#)

[Subscribe to our monthly newsletter on climate change impacts and adaptation.](#)

The UK Climate Impacts Programme (UKCIP) helps organisations to adapt to inevitable climate change. While it's essential to reduce future greenhouse gas emissions, the effects of past emissions will continue to be felt for decades.

Since 1997 UKCIP has been working with the public, private and voluntary sectors to assess how a changing climate will affect:

- construction
- working practices
- demand for goods and services
- biodiversity
- service delivery
- health
- ...and much more.

Warmer temperatures, heavier rainfall, rising sea levels: our website can help you to understand climate change and how these changes might affect your organisation. It can help you plan to adapt, so that you can prepare for negative impacts, and take advantage of any positive ones. We have examples of what people have already done to adapt, and links to information and advice in your area or sector. All our tools and services are freely available.

To go to the UK Climate Projections website, click [here](#).

	Adaptation Wizard
	UK Climate Projections
	Risk framework
	LCLIP
	Business
	Training
	Climate Digest
	Publications
	Subscribe to enews
	FAQ

Window with reflections © Phil James Photography 2007; Chickens © A Mother's Heart 2007; Cornish waves © Sebastian de Gange 2008

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We have 3 guests online

Climate change influences many areas of our lives. This portal contains knowledge about climate change and provides ideas on how we can adapt to it.

Citizens

Are you prepared for climate change?



Municipalities

Danish municipalities and climate change



Businesses

Danish enterprises and climate change



What does climate change mean for Danish enterprises?



Danish Strategy

- ▶ [Read the Danish strategy for adaptation to a changing climate](#)

Latest news in English:

- ▶ [Newsletter #1](#)

Cases

- ▶ [New storm surge scheme to promote climate change adaptation actions](#)
- ▶ [No more overloaded sewer systems](#)
- ▶ [Can the roads cope with more water?](#)

▶ [View all](#)

Climate change

Climate change means changes in temperatures, precipitation and other extremes.



- ▶ [Read about the future climate](#)

FAQ

- ▶ [How is the risk of flooding and coastal erosion assessed?](#)
- ▶ [Will climate change bring new diseases to Denmark?](#)
- ▶ [What will a more humid climate mean for the indoor climate?](#)
- ▶ [How can forests be adapted to climate change?](#)

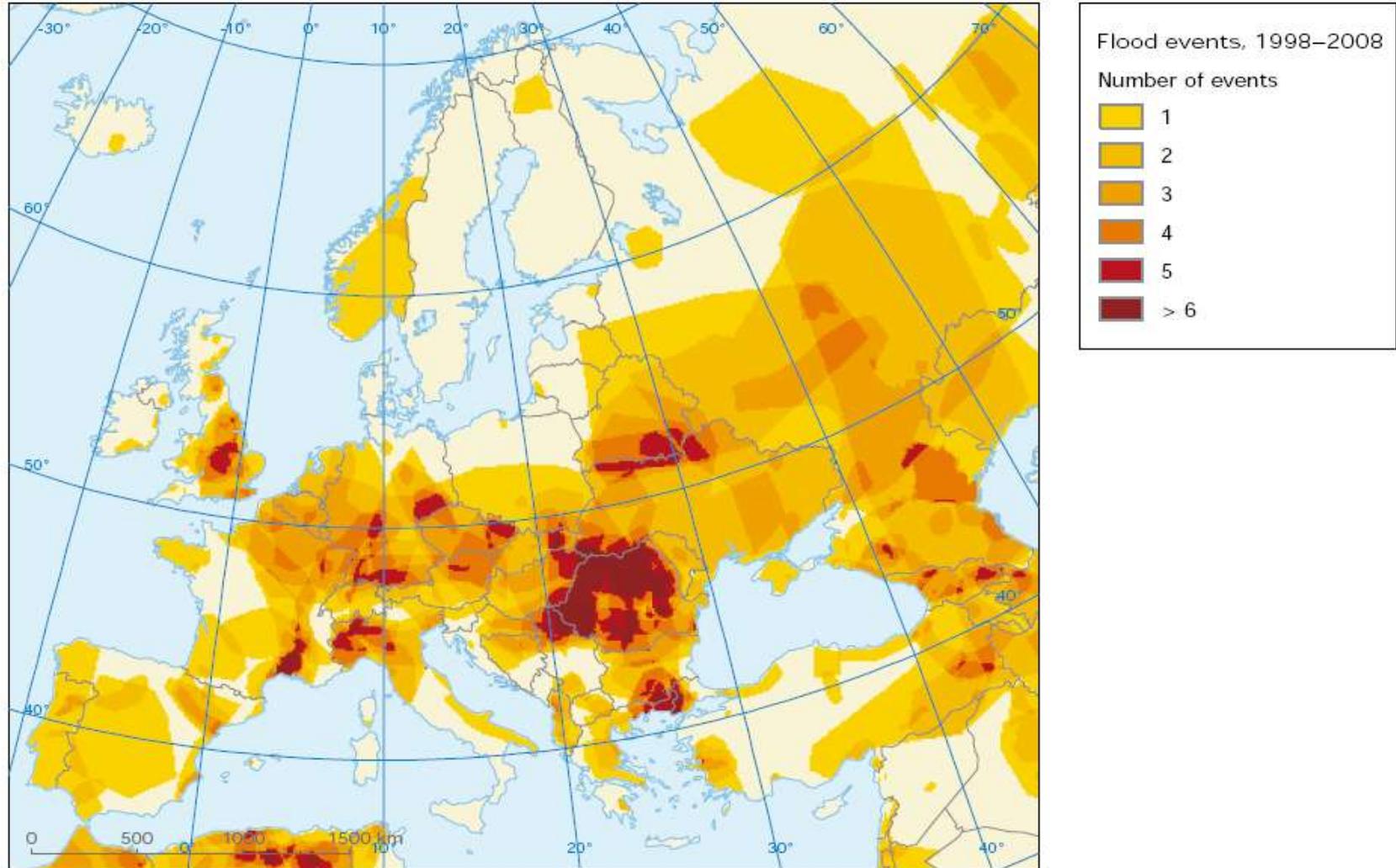
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4. **Research *on* adaptation**
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4. Research *on* adaptation

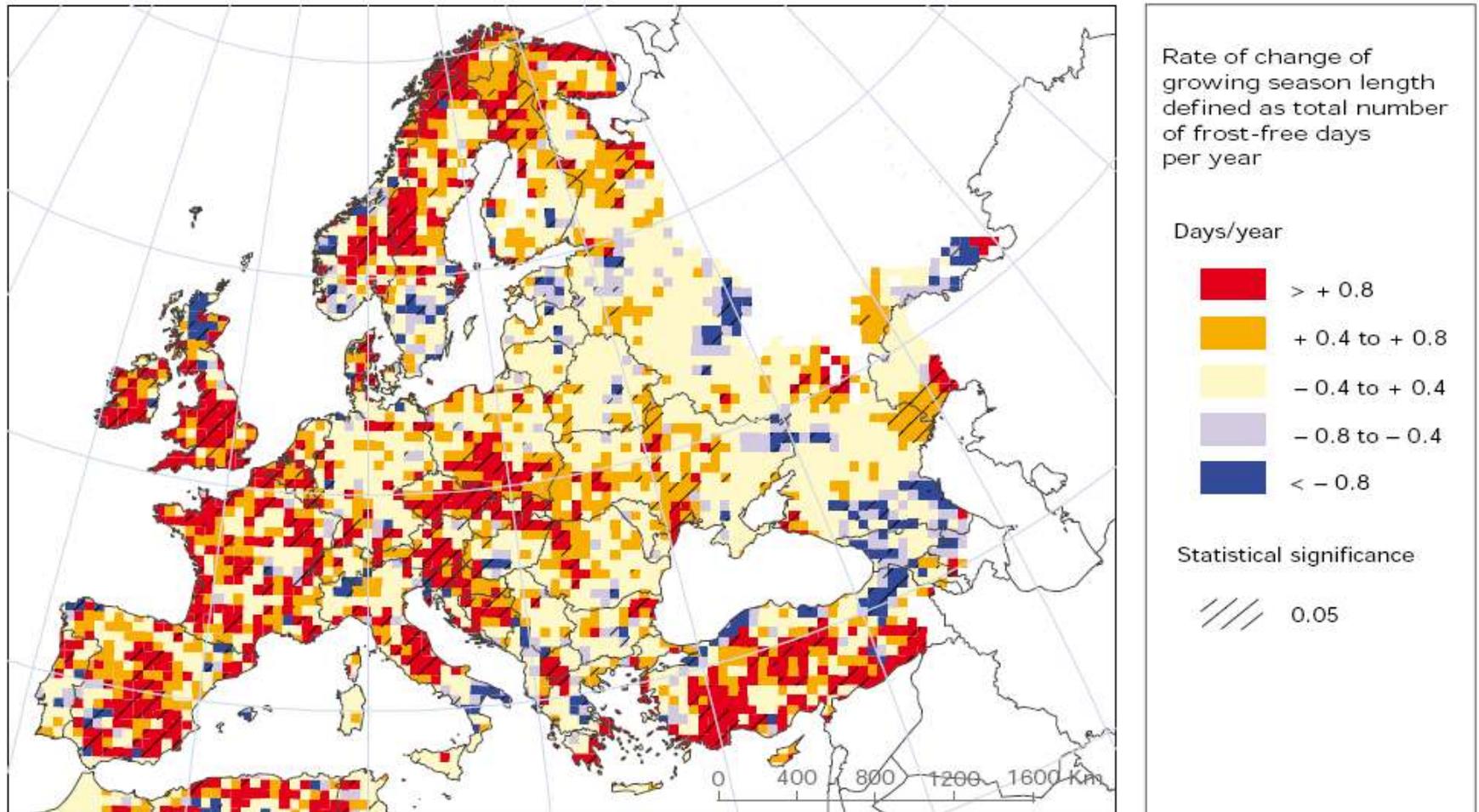
Observations and monitoring

Occurrence of flood events in Europe 1998–2008



Source: EEA (2008)

Rate of change of crop growing season length, 1957-2007

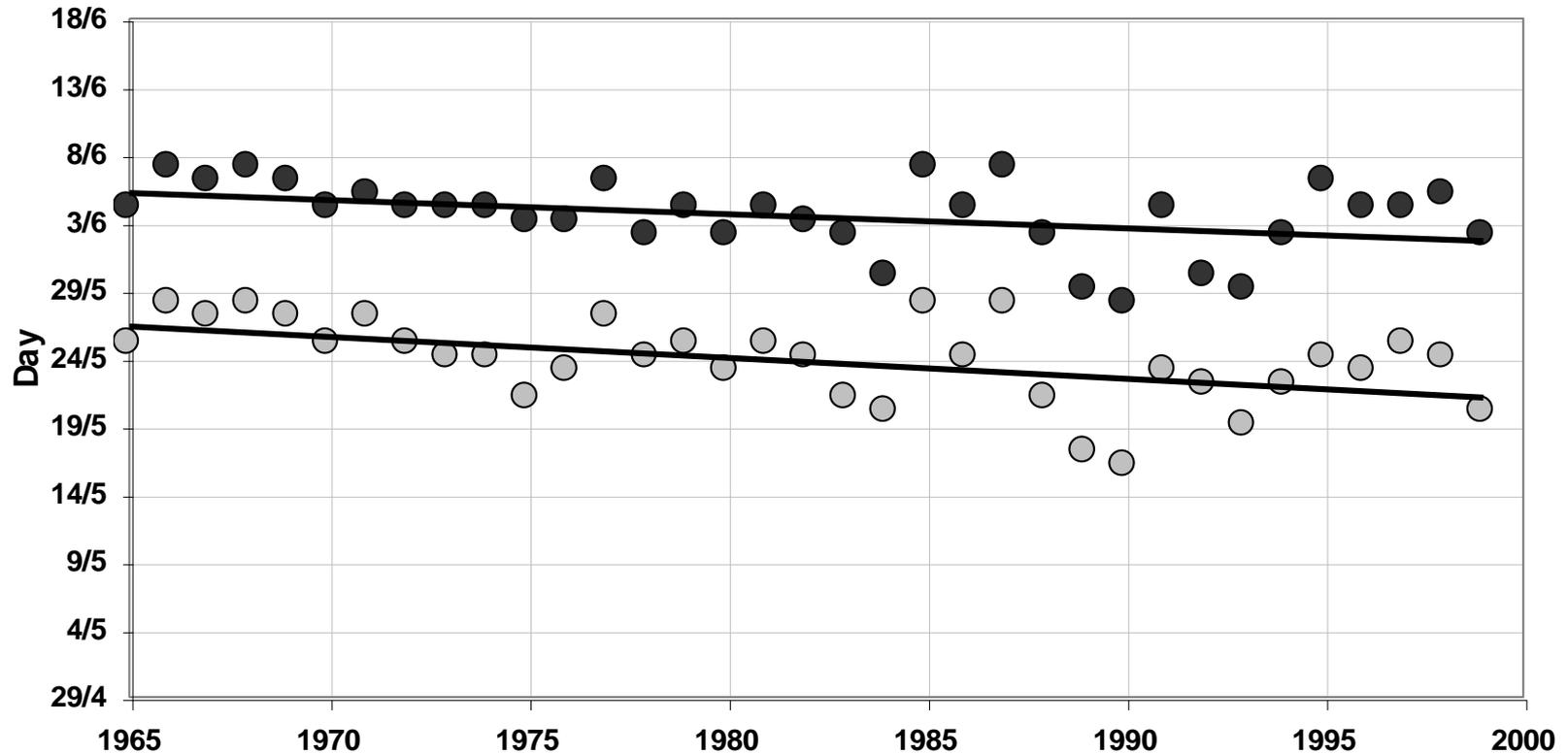


Note: The rate of change (number of days per year) of the duration of the growing season (defined as total number of frost-free days per year) as actually recorded during the period 1975–2007.

Source: EEA, 2008

Mean sowing dates for potato in Finland, 1965-1999

Upper line: latest sowings; lower line: earliest sowings



FINADAPT

Hildén et al., 2005
Kaukoranta and Hakala, 2008

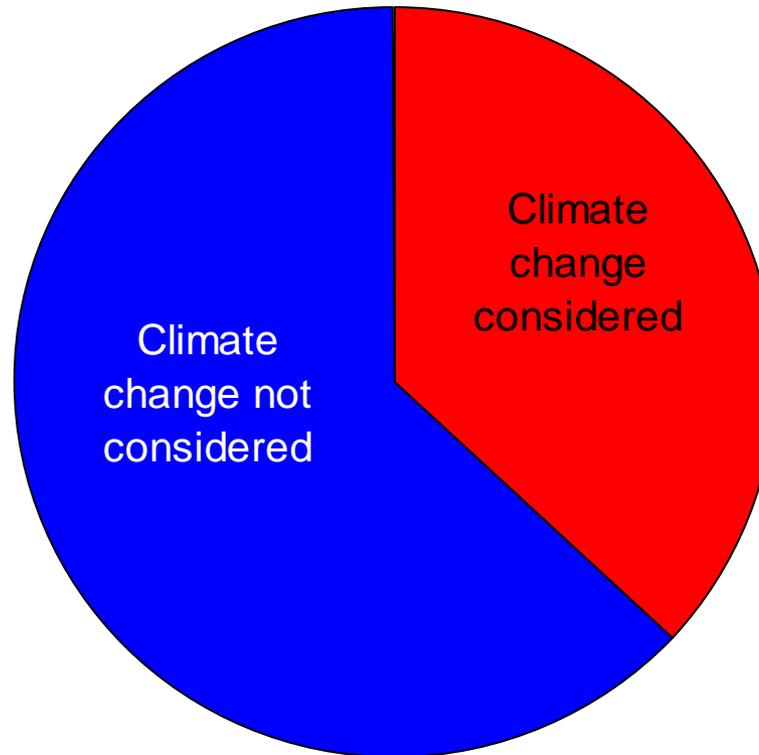
4. Research *on* adaptation

The process of adaptation

2004 stakeholder survey in Finland: consideration of climate change in operational planning

Number of responses: 532

Response rate: 47%



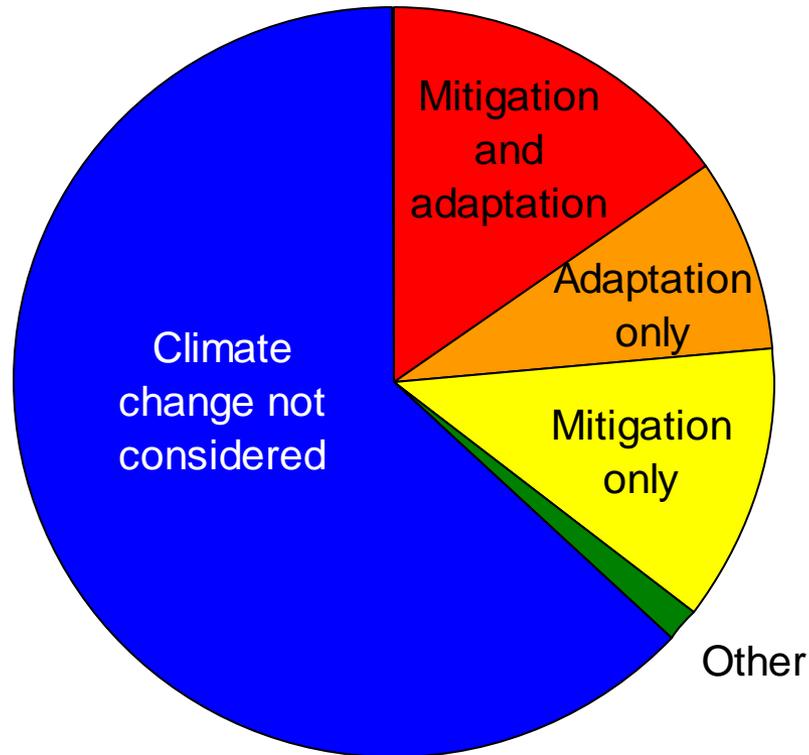
FINADAPT

Kankaanpää et al., 2005

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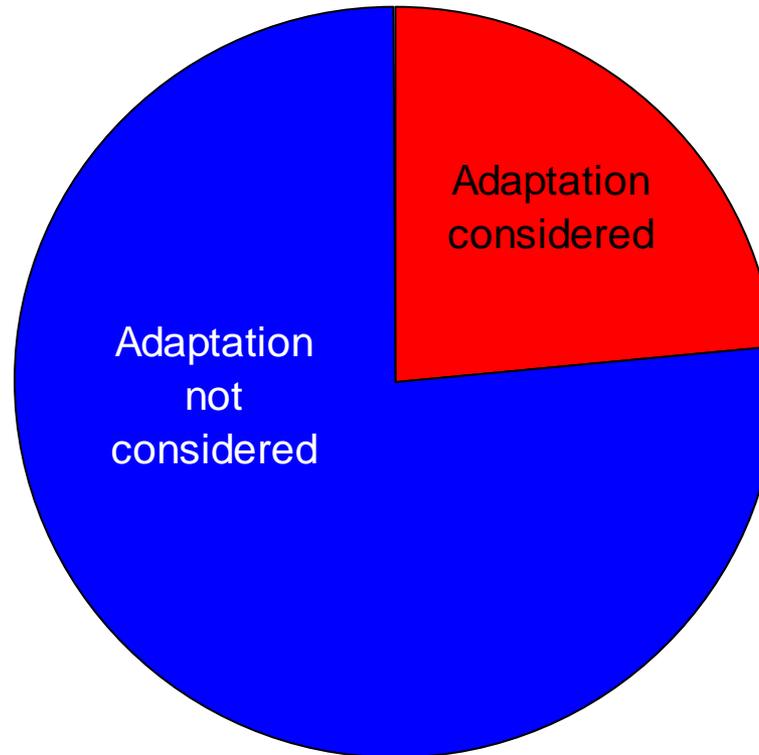
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Kankaanpää et al., 2005

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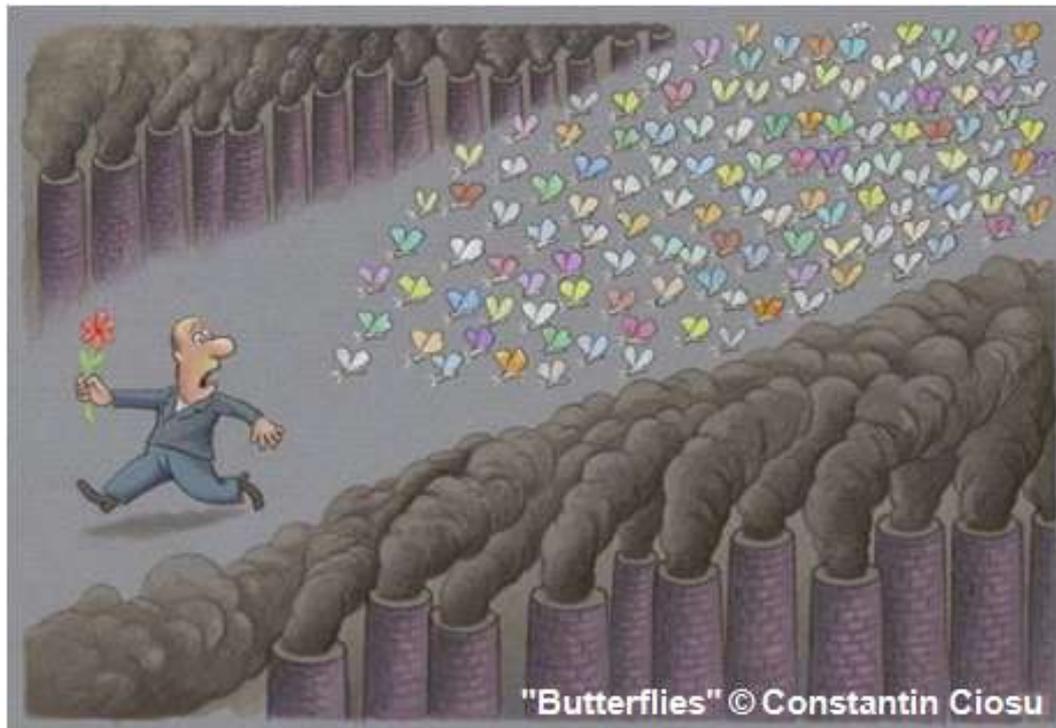


**That was 2004;
what is the
situation today?**

FINADAPT

Kankaanpää et al., 2005

Modelling impacts and adaptation



Desk study: Simplified summary of climate change impacts in Europe and their intensity for 11 indicators

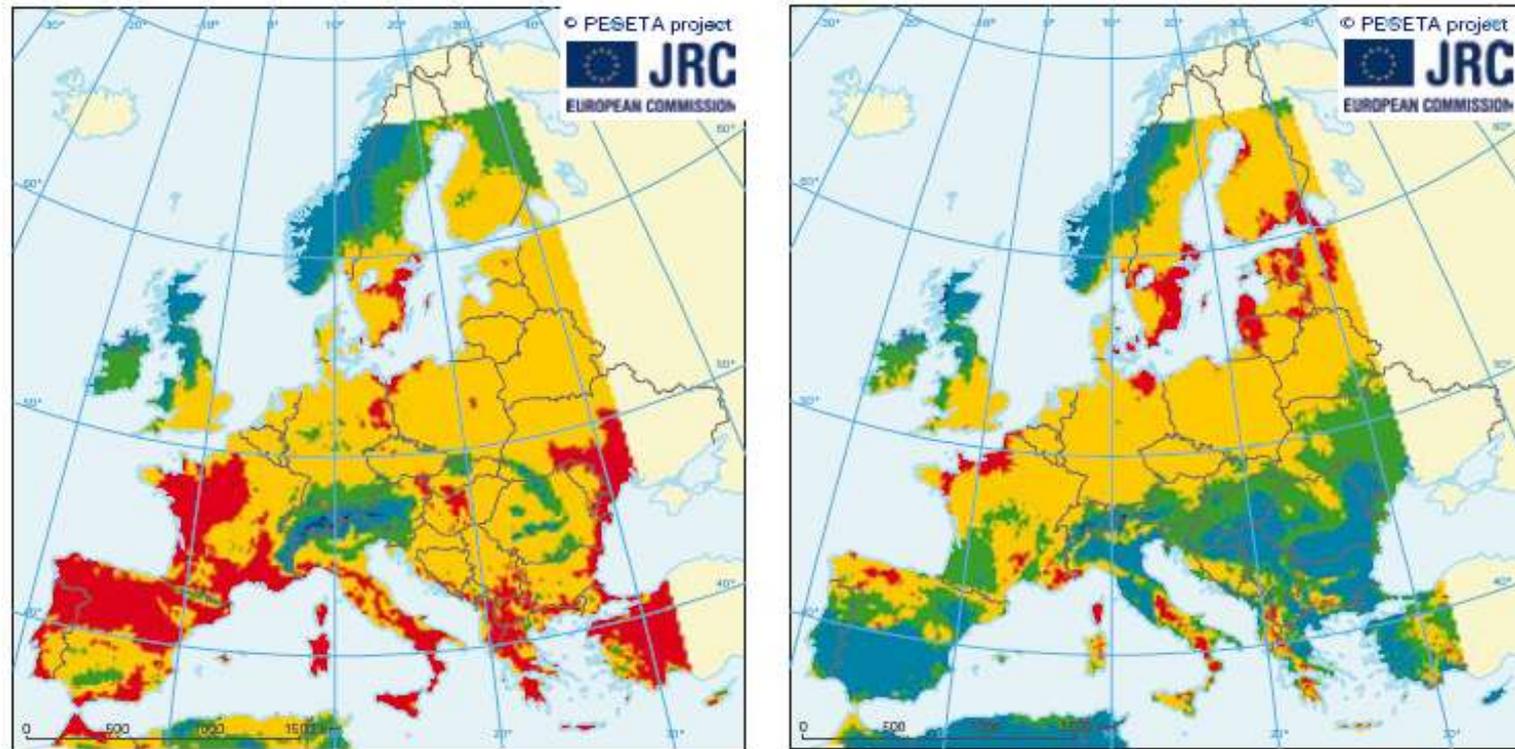
Climate change indicators	Northern Europe	Central and Eastern Europe	Mediterranean
Direct losses from weather disasters	M(-)	M(-)	H(-)
River flood disasters	M(-)	H(-)	L(-)
Coastal flooding	H(-)	M(-)	H(-)
Public water supply and drinking water	L(-)	L(-)	H(-)
Crop yields in agriculture	H(+)	M(-)	H(-)
Crop yields in forestry	M(+)	L(-)	H(-)
Biodiversity	M(+)	M(-)	H(-)
Energy for heating and cooling	M(+)	L(+)	M(-)
Hydropower and cooling for thermal plants	M(+)	M(-)	H(-)
Tourism and recreation	M(+)	L(+)	M(-)
Health	L(-)	M(-)	H(-)

Notes: H: High; M: Medium; L: Low; (+): Positive impact; (-): Negative impact

Source: Author's compilation.

Source: Behrens et al., 2010
Centre for European Policy Studies

Modelled conditions for summer tourism in Europe for 1961–1990 and 2071–2100



Simulated conditions for summer tourism in Europe for 1961–1990 (left) and 2071–2100 (right) according to a High-Emissions Scenario (IPCC SRES A2)

Tourism Comfort Index (TCI)

Unfavourable (TCI: 0–40)

Good (TCI: 60–70)

Excellent (TCI: 80–100)

Acceptable (TCI: 40–60)

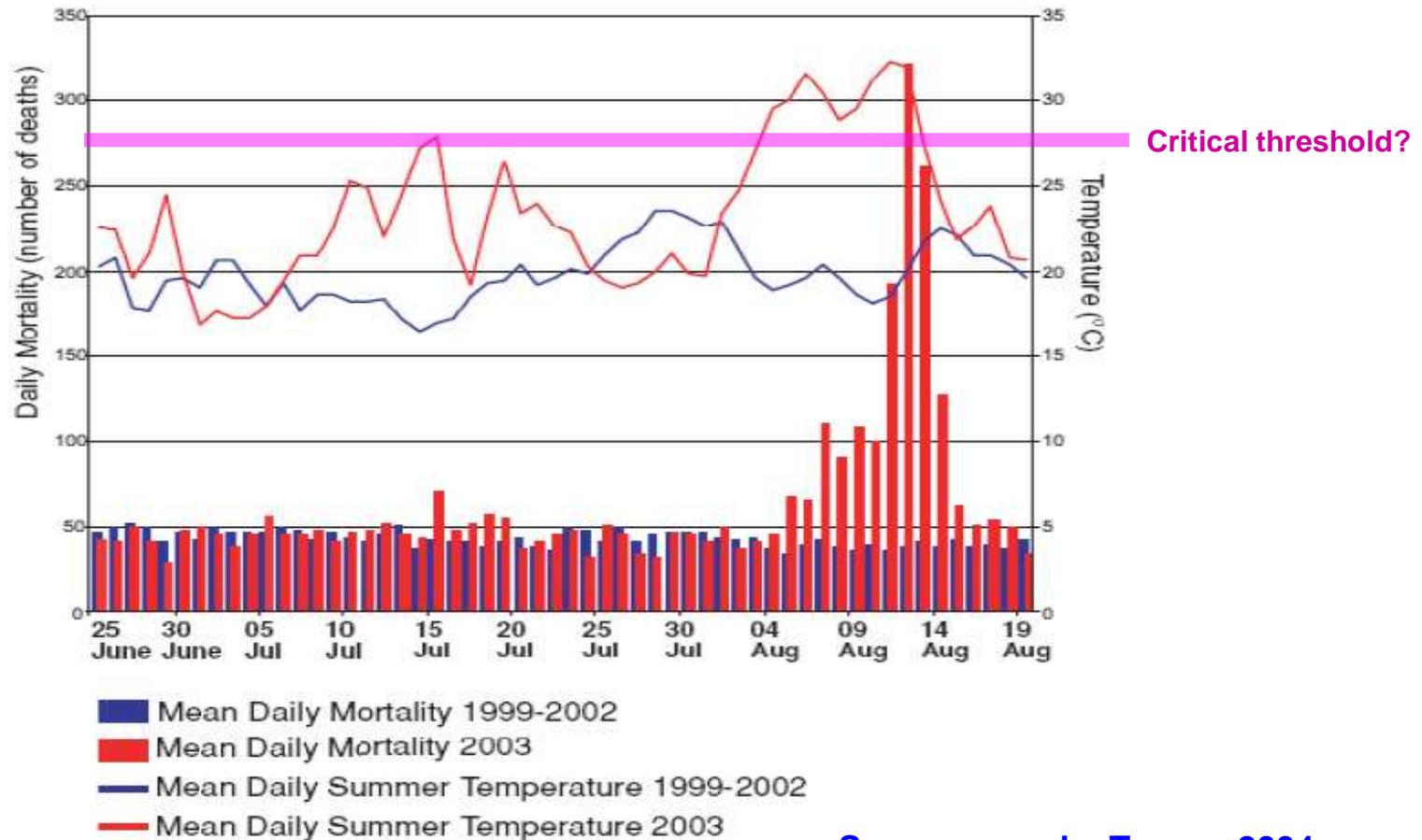
Very good (TCI: 70–80)

Source: EEA (2008)
Peseta project

4. Research *on* adaptation

Adaptation to extreme events

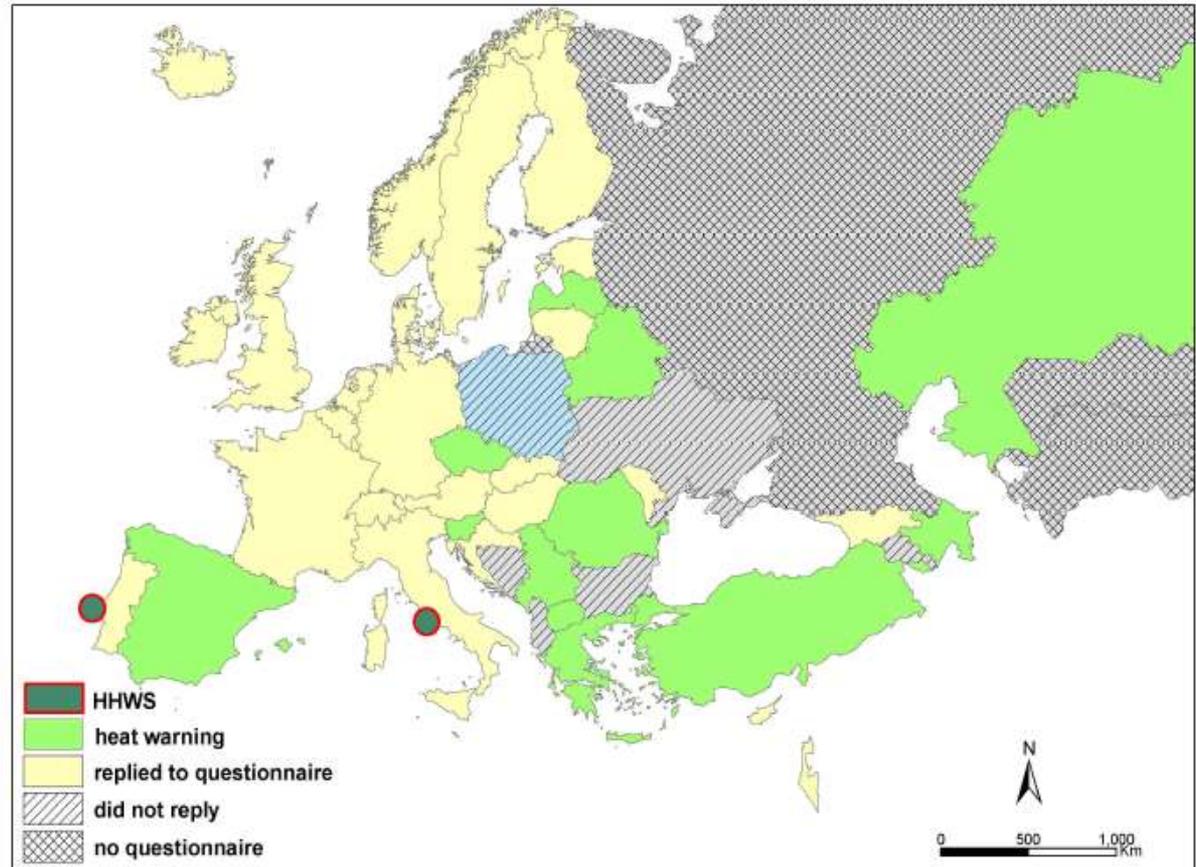
Daily mortality in Paris during the August 2003 heatwave compared with the four-year average for 1999-2002



Source: van denTorren, 2004

Heat health warning systems in Europe

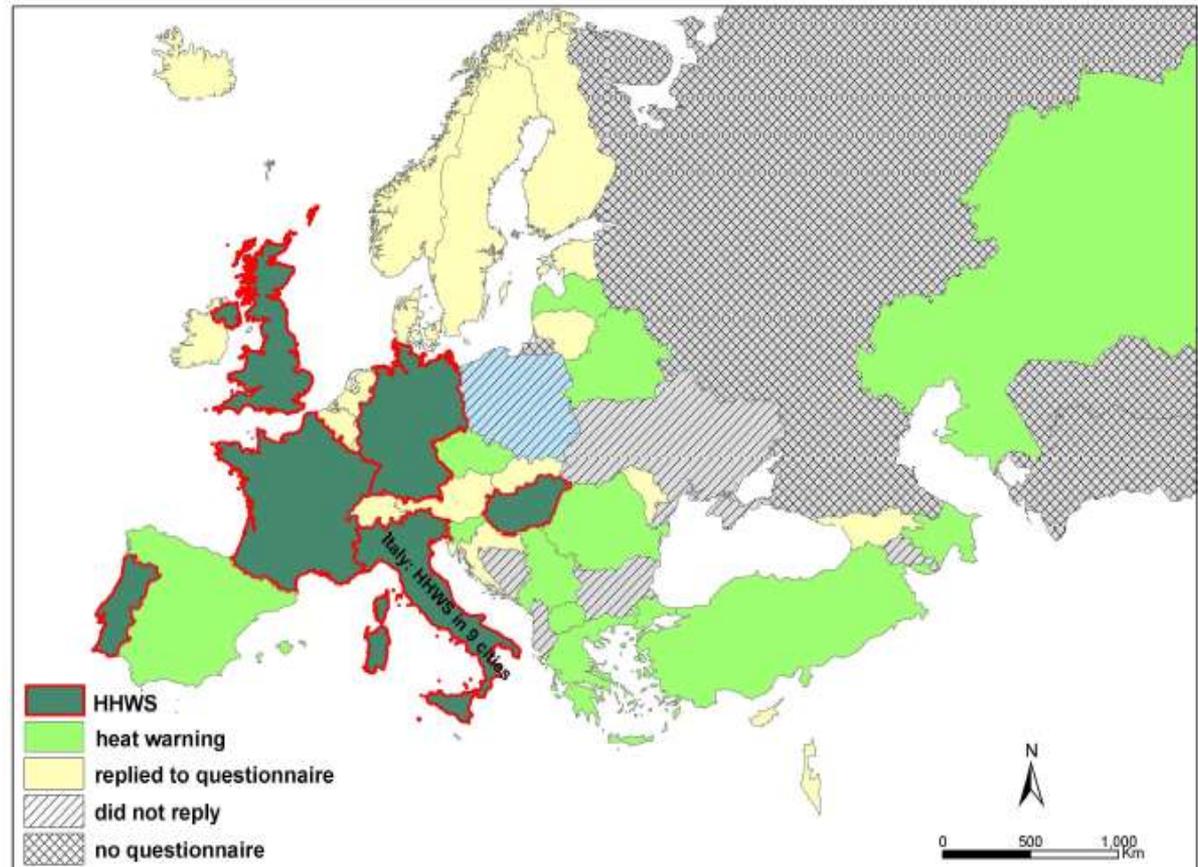
Before 2003



Source: F. Matthies (cCASHh project)

Heat health warning systems in Europe

After 2003



Source: F. Matthies (cCASHh project)

4. Research *on* adaptation

The identification of adaptation options

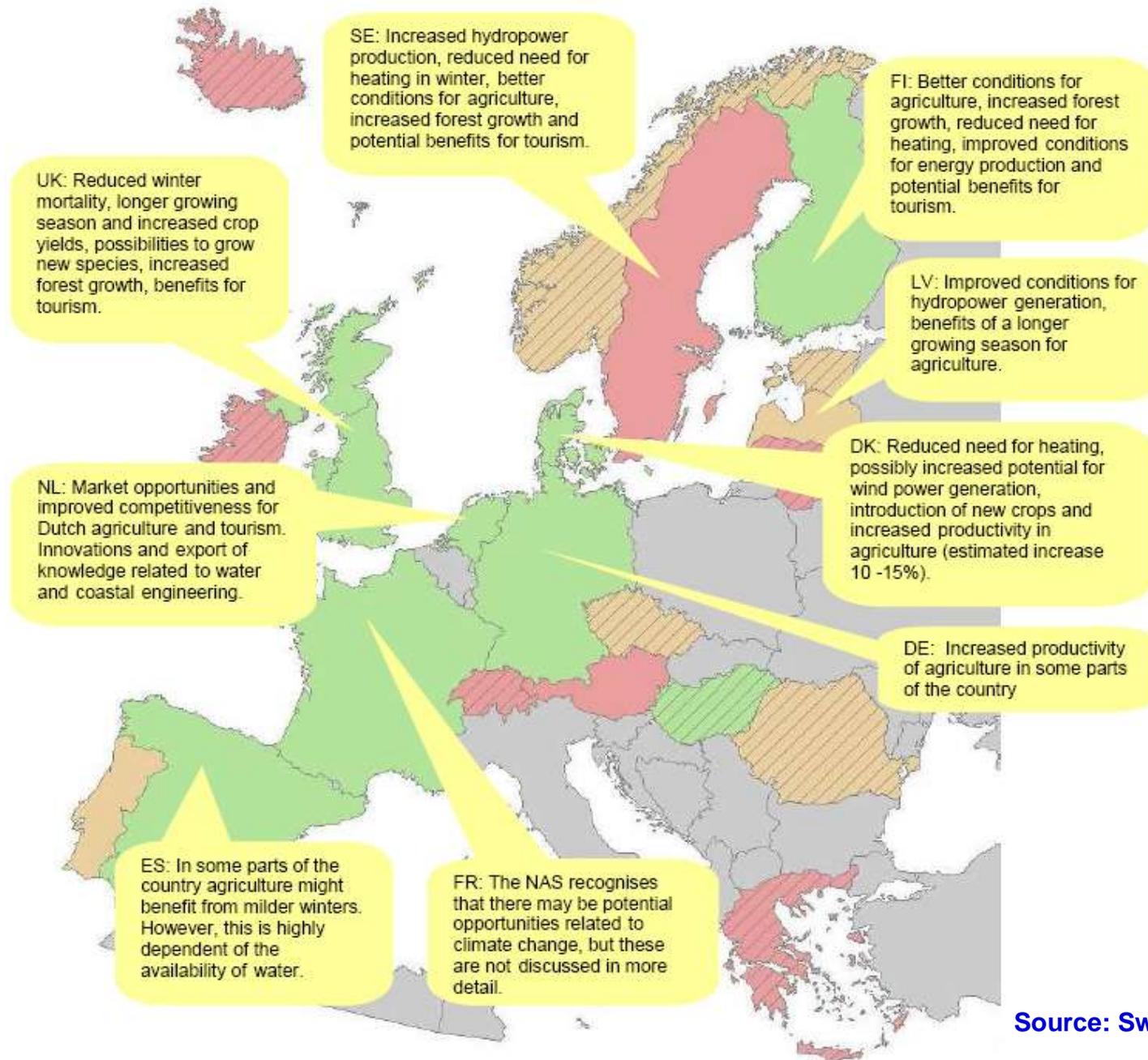
Some adaptation options

- **Agriculture**: changes in crop/animal husbandry; altered land allocation; irrigation; agroforestry; soil conservation
- **Forestry**: flexible forest management for efficient production, carbon sequestration and soil conservation; forest conservation; adapted species
- **Health**: improved information provision; better surveillance of disease vectors; vector control; enhanced vaccination
- **Water resources**: water conservation; flood plain management; pricing mechanisms
- **Coastal/sea-level rise**: managed retreat; accommodation; coastal protection; storm warning systems
- **Energy**: exploitation of changing conditions for renewables (solar, wind, wave, bio- and hydro-power)
- **Biodiversity**: siting of protected areas; migration corridors

4. Research *on* adaptation

Opportunities and limits of adaptation

Opportunities related to climate change identified in Strategies



Some barriers to engagement with climate change based on interviews, questionnaires and focus groups

Individual

- Lack of knowledge
- Distrust in information sources
- Uncertainty and scepticism
- Externalising responsibility and blame
- Climate change is a distant threat
- Other things are more important
- Reluctance to change lifestyles
- Inconvenience, cost (monetary and time)
- Fatalism
- “Drop in the ocean” feeling

Social

- Lack of political action
- Lack of action by business and industry
- Worry about free-rider effect
- Social norms and expectations
- Lack of enabling initiatives

Source: Lorenzoni et al. (2007)

4. Research *on* adaptation

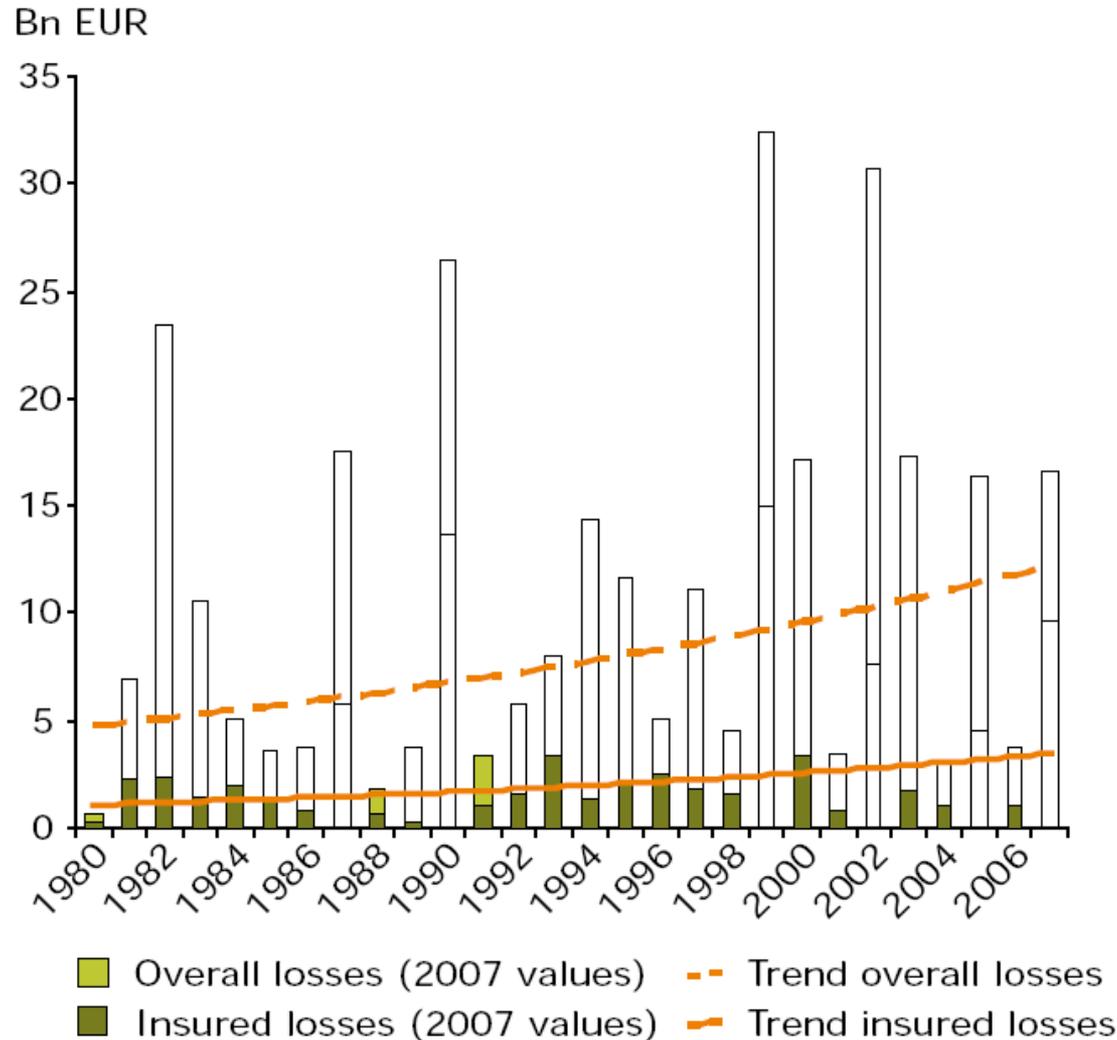
Adaptation costs and benefits

The State of Knowledge on Adaptation Costs and Benefits

	Analytical Coverage	Cost Estimates	Benefit Estimates
Coastal zones	Comprehensive	√√√	√√√
Agriculture	Comprehensive	—	√√√
Water	Isolated case studies	√	√
Energy	N. America, Europe	√√	√√
Infrastructure	Cross-cutting partly covered in other sectors	√√	—
Health	Selected impacts	√	—
Tourism	Winter tourism	√	—

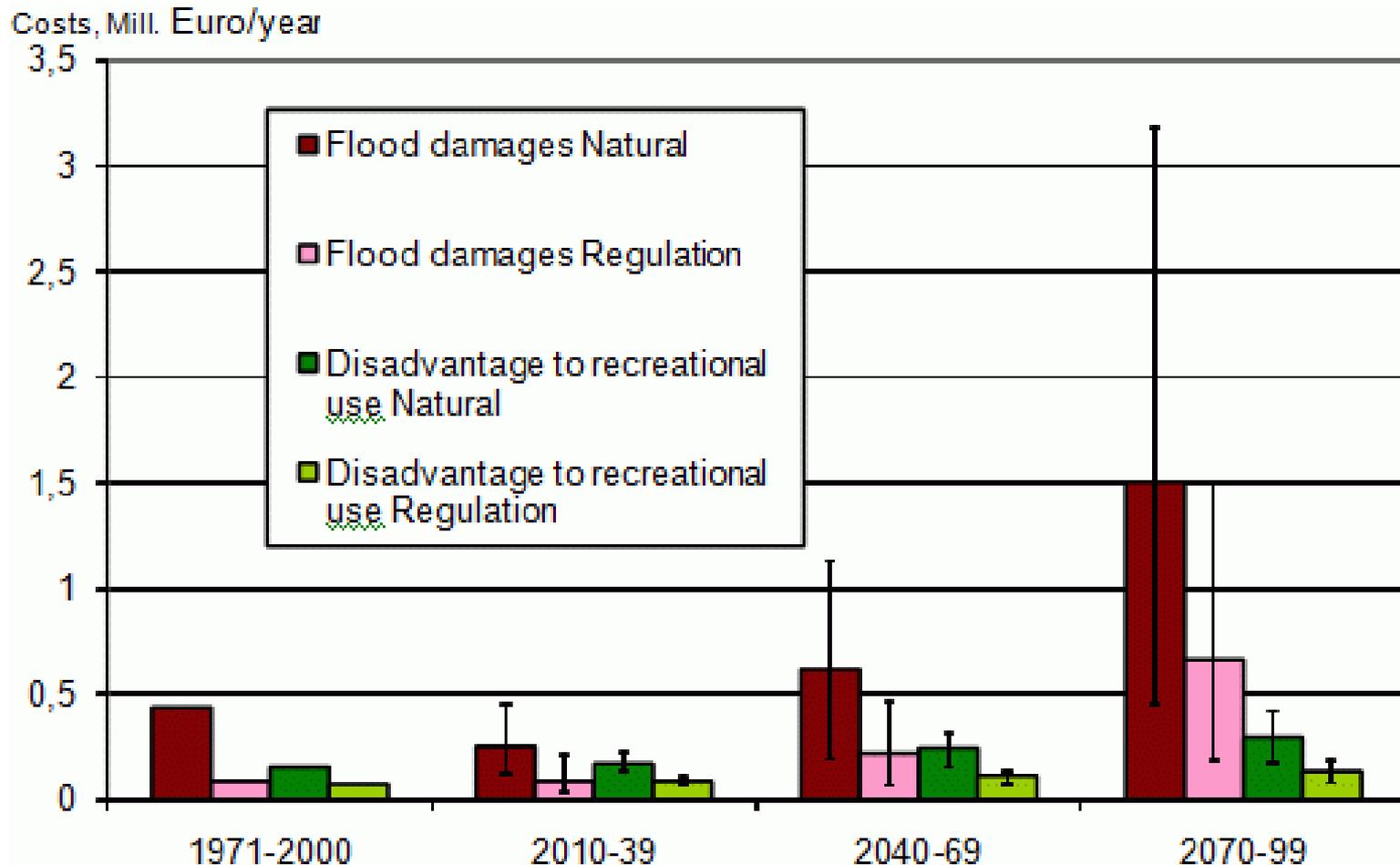
Source: Fankhauser (2010)

Overall and insured losses from weather disasters in Europe 1980–2007 (Munich Re)



Source: EEA (2008)

The projected costs of flood damage adjacent to Lake Pieline, northern Finland, with and without regulation

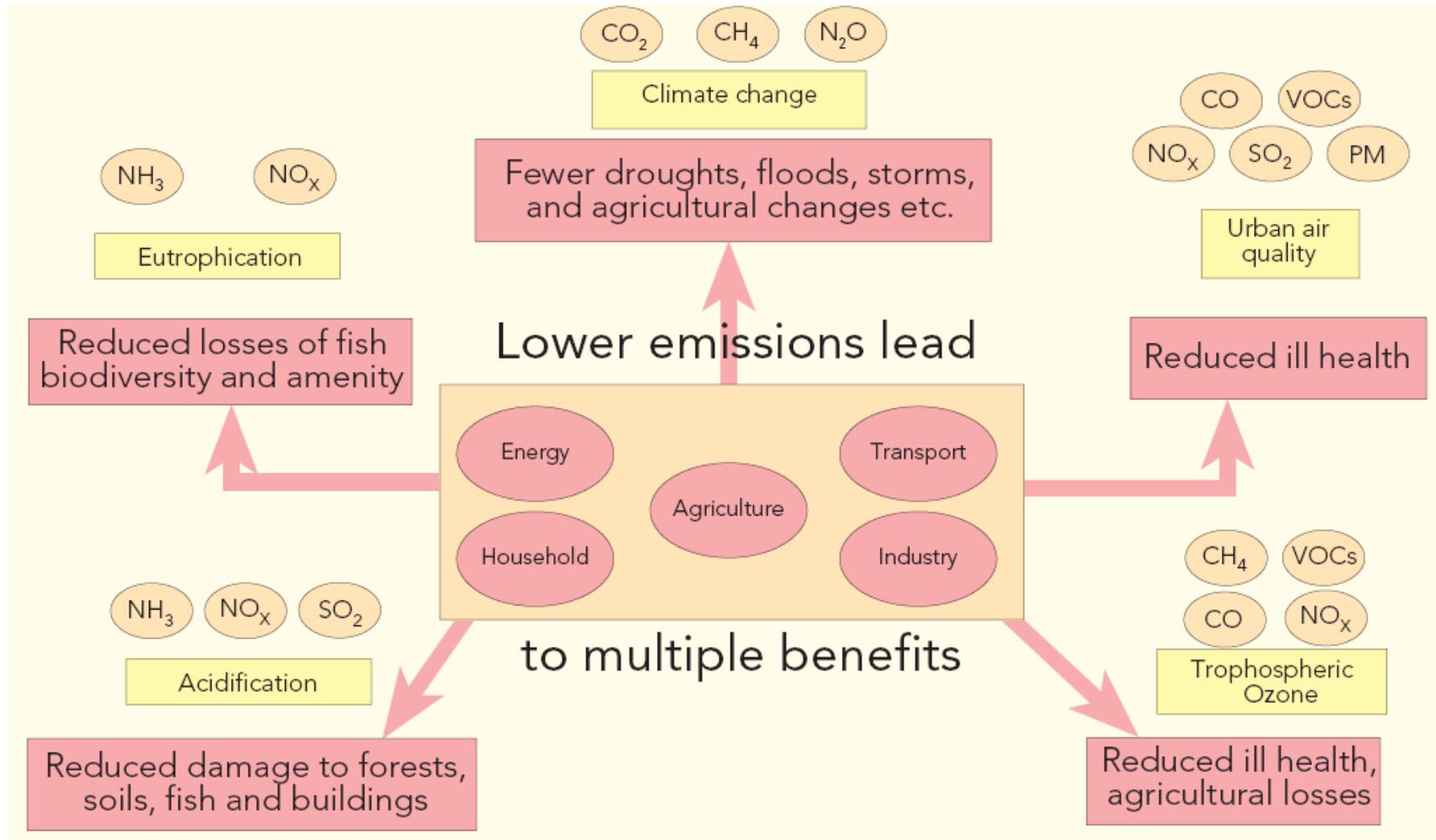


Vehviläinen & Veijalainen, unpublished
WaterAdapt project

4. Research *on* adaptation

Interactions between adaptation and mitigation

Mitigation affecting adaptation: M → A



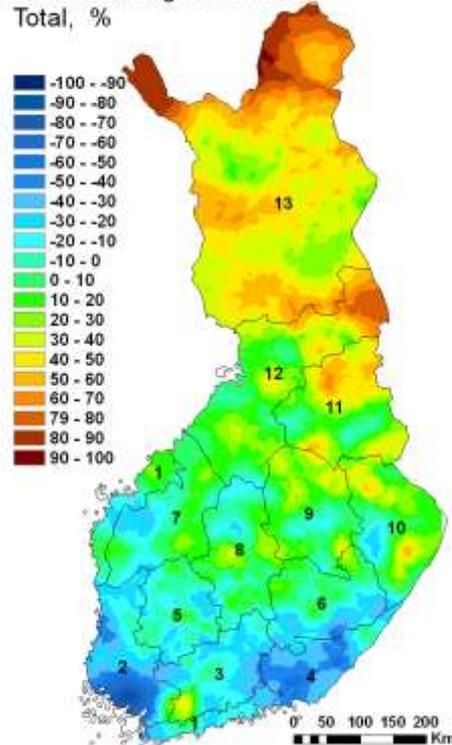
Adaptation affecting mitigation: A → M



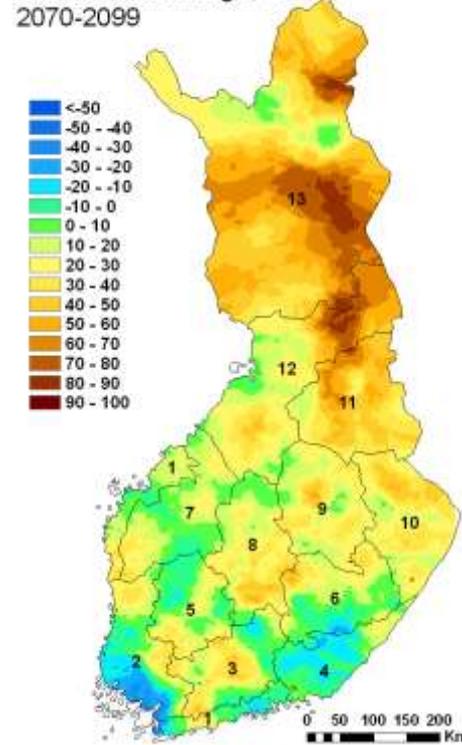
Synergies - adaptation and mitigation

Simulated change by 2070-2099 relative to 1971-2000 in stocking volume (left), carbon in the forest ecosystem (centre) and the amount of decaying dead wood (right) under the A2 (Retrenchment) scenario.

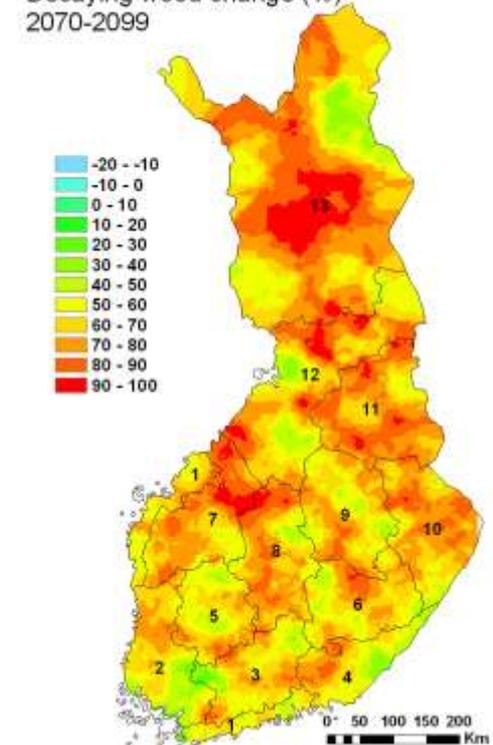
Volume change 2070-2099
Total, %



Total carbon change, %
2070-2099



Decaying wood change (%)
2070-2099



Kellomäki et al., 2005

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5. **Conclusions**

Conclusions: the role of research

- In Europe, adaptation is gradually being recognised as a necessary **policy response** to climate change alongside mitigation, but until recently has been sparsely researched
- A wide range of natural resource and socio-economic **sectors** are climate-sensitive and may require adaptation research
- Adaptation occurs continually – **monitoring** is essential to understand the processes, verify predictions and assess costs
- **Research for adaptation** services demand for information on relative vulnerability, future projections, practical examples of adaptation and awareness raising
- **Research on adaptation** enhances understanding of the processes of adaptation, including modelled impacts, extreme events, adaptation options, barriers to adaptation, economic costs and benefits and relationships to mitigation

How the results are used is another matter!

