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NORWEGIAN INSTITUTE OF
BIOECONOMY RESEARCH

Methodological approaches to risk and vulnerability assessment for adaptation to climate change

Norwegian green paper – approach for addressing effect
of climate change in different sectors

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Outline

- Climate Change, from knowledge to recognition and action
- Norwegian climate policy – reports to the Parliament and and green papers to the Government
- Methodological approach
- Principles for climate change adaptations
- Recommended adaptation measures

Norwegian Institute of Bioeconomy Research - NIBIO

NIBIO's main areas of expertise:

Agriculture and plant health, environment and climate, surveys,
land use, genetics, forestry, economics and social sciences

NIBIO: Leading expertise

- 700 employees
- Research stations in all regions
- Extensive international collaboration

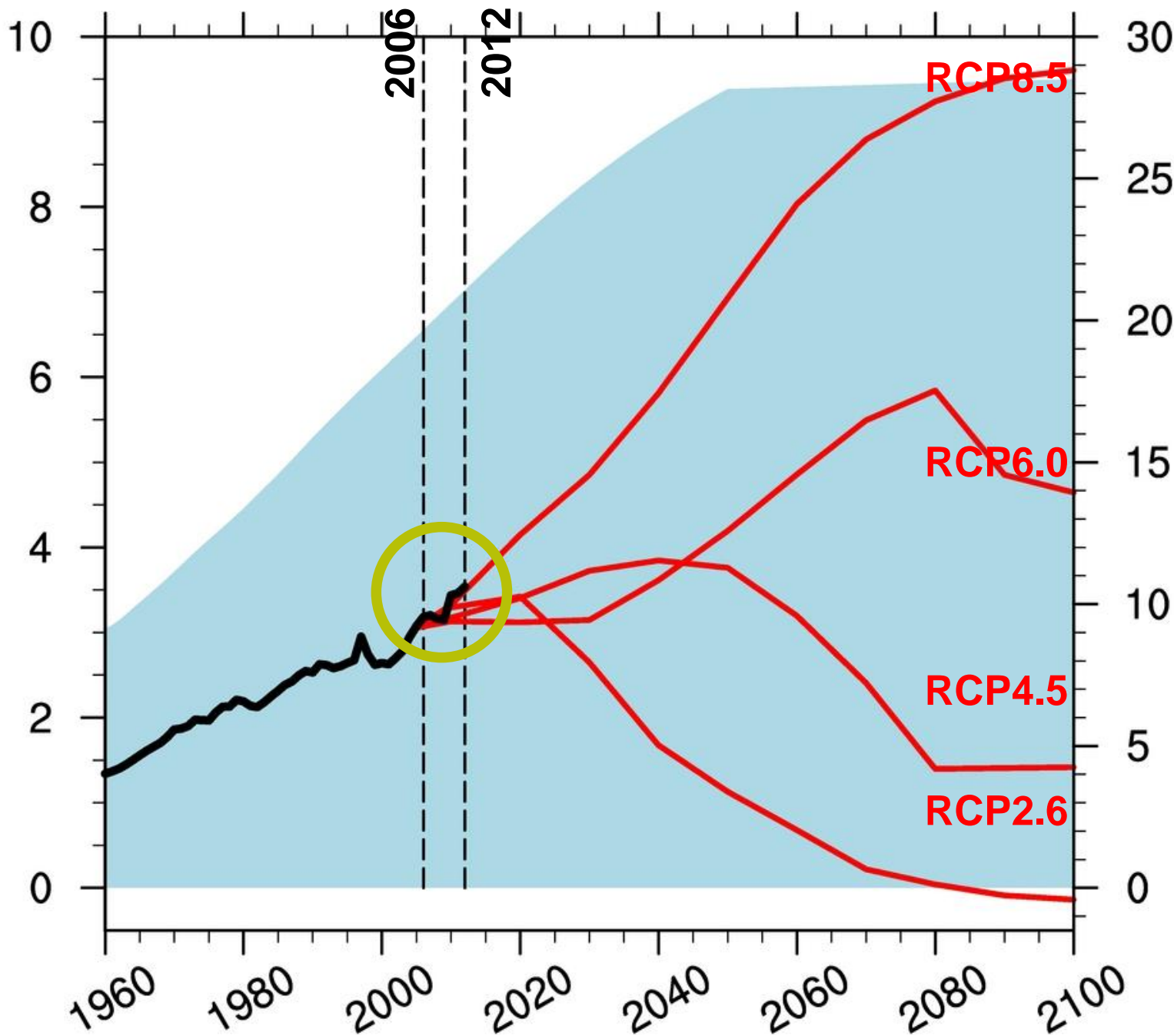


From knowledge to action – do we need more reports?



Global population (bill.)

Global CO₂-emissions (Gt-C/year)



Climate Change is reality - huge challenges for society and sectors

- **Job number one: Emission reduction, the challenge of low carbon transition**
- **The need for adaptation**, on national, regional and local level, in due time - must be recognized
- The need for **clarification of responsibilities** between authorities and other stakeholders
- The need for **identification of the most relevant and cost-effective adaptation measures**

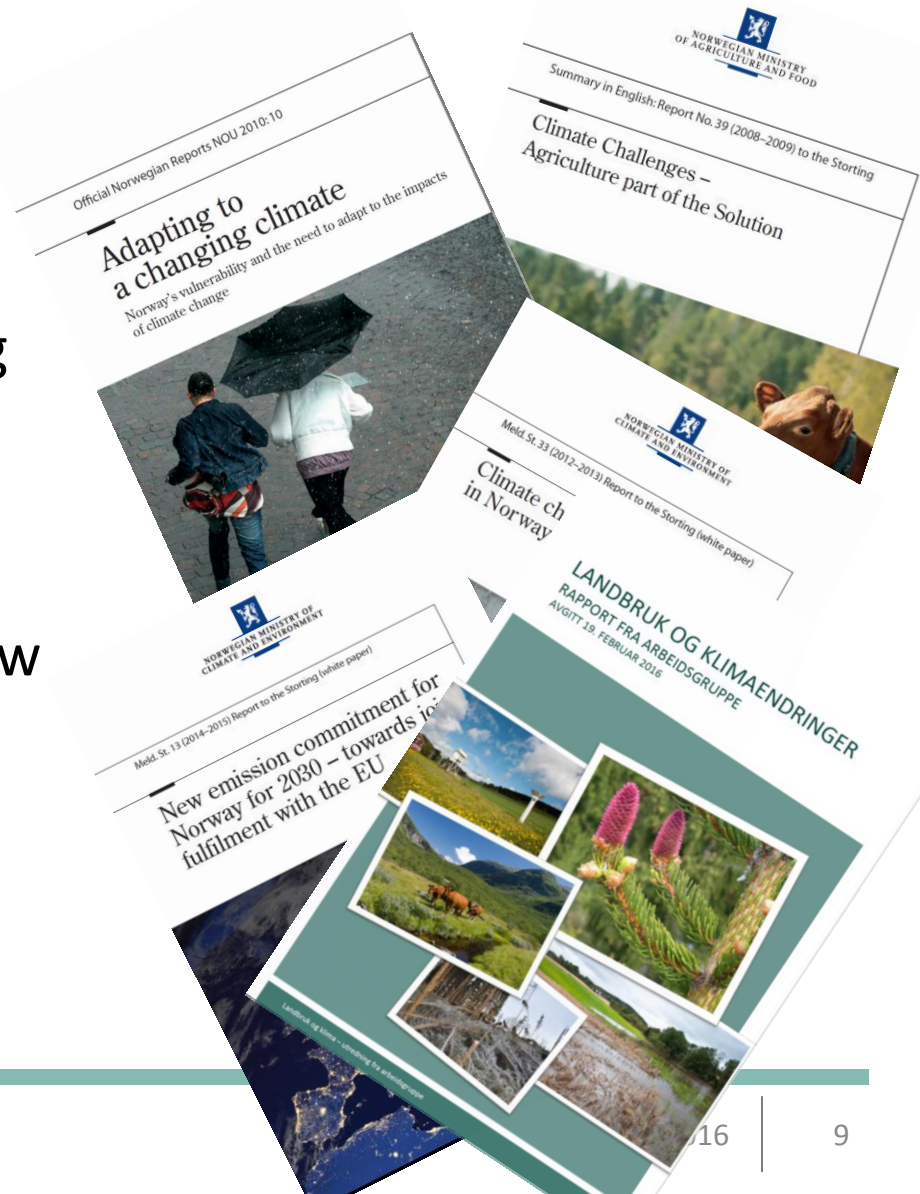
Uncertainty and risks - globally

- So far the global emissions curve for greenhouse gases is above the level known as the two-degree target
- Internationally, this development will be so grave that the global community will have major problems preventing dramatic consequences.



Norway: Ambitious climate policy!

- Report No 39 (2008-2009) Agriculture a part of the Solution
- Official Norwegian Report 2010:10 Adapting to changing climate
- Report No 9 (2011-2012) Climate Change Adaptation
- Report No 13 (2014-2015) New emission commitment for Norway for 2030 – towards joint fulfillment with the EU
- Report 2016 on agriculture, forestry and climate policy



Mitigation: Climate mitigation measures and emission trajectories up to 2030

- The third report on low carbon transition presents **new figures for historical emissions and projections** based on updated values for global warming potential (GWP) and **new emission projections**.
- It reviews measures that could be implemented by 2030 and the emission reduction effect **of three different mitigation packages**, split between the ETS and non-ETS sectors.
- The main report presents **84 measures, with emission reduction potentials and cost levels**.
- **Co-benefits** are also described, and **possible consequences of the measures are assessed, inclusive in adaptation context**.



Climate mitigation measures and
emission trajectories up to 2030
Summary



Norwegian approach to adaptation

Through the Royal Decree of 5 December 2008, the **Norwegian government appointed a committee to study society's vulnerability and the need to adapt to the effects of climate change.**

NOU 2010: 10 Green paper to the Government: Organizing and mandate

- 17 committee members from different sectors and administrative levels, complementary competences
- A secretariat consisting of 6 persons – full time or part-time engagement
- Recommendation by the committee submitted to the Ministry of the Environment on 15 November 2010.

The report reviews the impact of climate change on Norway

Official Norwegian Reports NOU 2010: 10

Adapting to a changing climate

Norway's vulnerability and the need to adapt to the impacts of climate change



Assessment on Norway's vulnerability and the need to adapt to the impacts of climate change - and what we as society can do to cope with it

Mandate in short

The Committee was asked to:

- Present a **general assessment of risks** related to effects of climate change on sectors and society
- Identify and discuss strategies, instruments and measures to reduce vulnerability and strengthen adaptability
- Analyze **opportunities** resulting from climate change
- Identify priority **areas and priorities for action**

Mandate more in detail

The committee shall study the risks that climate change entails for the **natural environment and society**.

The committee shall give an account of the **geographical areas, industries and sectors** that are **most exposed to negative impacts of climate change**.

These impacts shall be studied with **particular focus** on

- health and safety for humans
- physical infrastructure and buildings
- business and industry
- the natural environment and primary industries

Mandate

- **Risk:** An account shall be given of the effects of climate change that entail **increased risk of extensive material damage with significant financial consequences**
- **Principles:** The committee shall undertake a discussion of **the principles that should be considered** when determining **the ways in which society should respond to uncertainty** concerning the scope and effects of climate change
- **Framework:** The framework for **society's long-term adaptation** shall be studied and analyzed

Mandate

- The committee shall **review relevant research programs** and discuss the **areas in which there is a special need for more knowledge** concerning the consequences of climate change and relevant strategies and measures for adapting to it
- An estimate shall be made of the **long-term financial costs and benefits for the sectors that will be most severely affected by climate change**
- The committee is asked to provide a comprehensive assessment of how climate change will affect the **international community and specify the potential impact on Norway**

Mandate

- In its work, the committee should seek **close dialogue with and involvement** from affected parties, authorities, organizations and businesses in order to **ensure that the committee's assessments and recommendations also reflect the affected parties' expertise and assessments.**
- The committee will obtain **expert studies on specific topics and assessments from selected professional institutions and authorities** as needed

Extensive stakeholder involvement

- A number of experts and interested parties were invited to attend the committee's own meetings. The committee meetings encouraged dialogue and input
- The committee and the secretariat prioritised attending, contributing to and obtaining input on topics relevant to adaptation in national and international venues

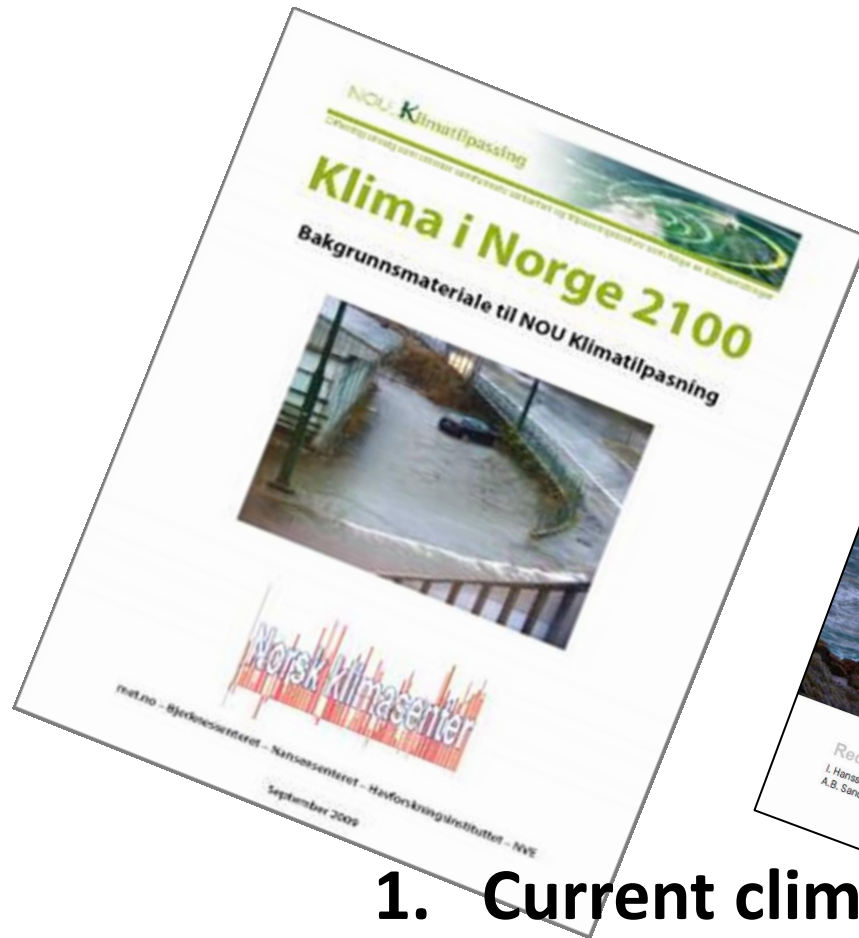
Framework for the assessments

Future climate projections

Adapt to what – how will future climate be in our nordic region, our country, regions and local communities?

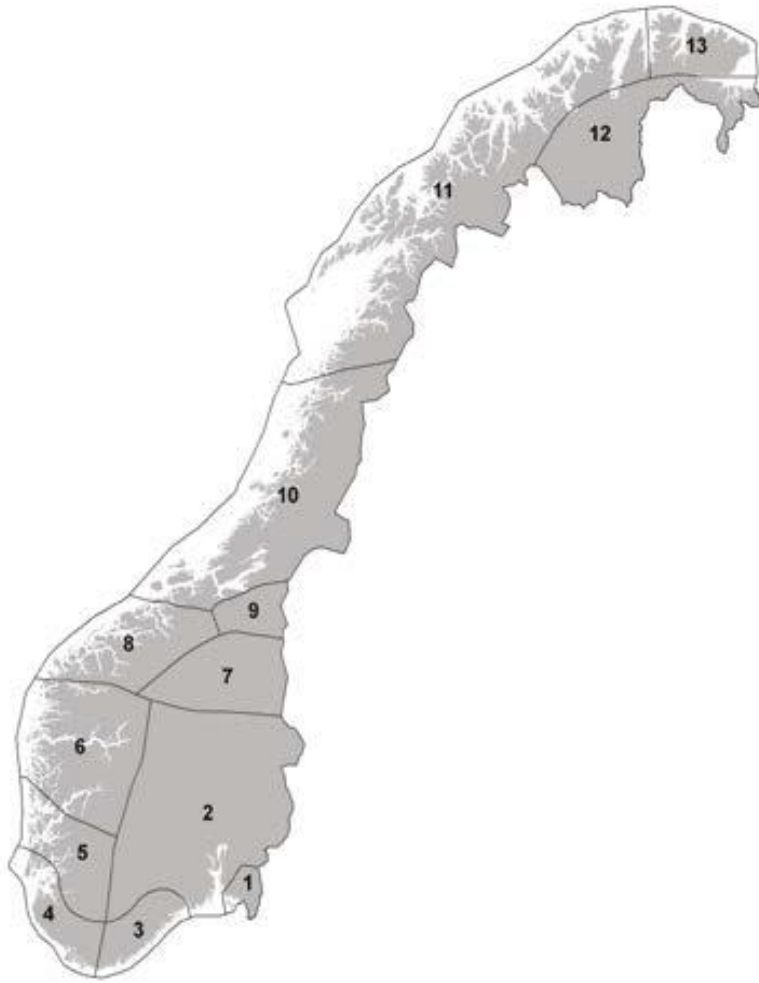
The committee has chosen to base the comprehensive risk scenario for Norway on the climate projections presented by the report “**Klima 2100**”.

The report is based on best available climate projections from IPCC and National scientific reports



1. Current climate and trends
2. Future climate projections

Downscaling to 13 «precipitation regions» (not available in 2010)



1. «Østfold»
2. «Østlandet»
3. «Sørlandet»
4. «Sørvestlandet «
5. «Sunnhordland/Ryfylke»
6. «Sogn og Fjordane/
Nordhordland»
7. «Dovre/ Nord-Østerdal»
8. «Møre og Romsdal»
9. «Inntrøndelag»
- 10.«Trøndelag/ Helgeland»
- 11.«Hålogaland»
- 12.«Finnmarksvidda»
- 13.«Varanger»

Downscaling to 6 «temperature regions» - (not available in 2010)



1. «Østlandet»
2. «Vestlandet»
3. «Trøndelag»
4. «Nordland/Troms»
5. «Finnmarksvidda»
6. «Varanger»

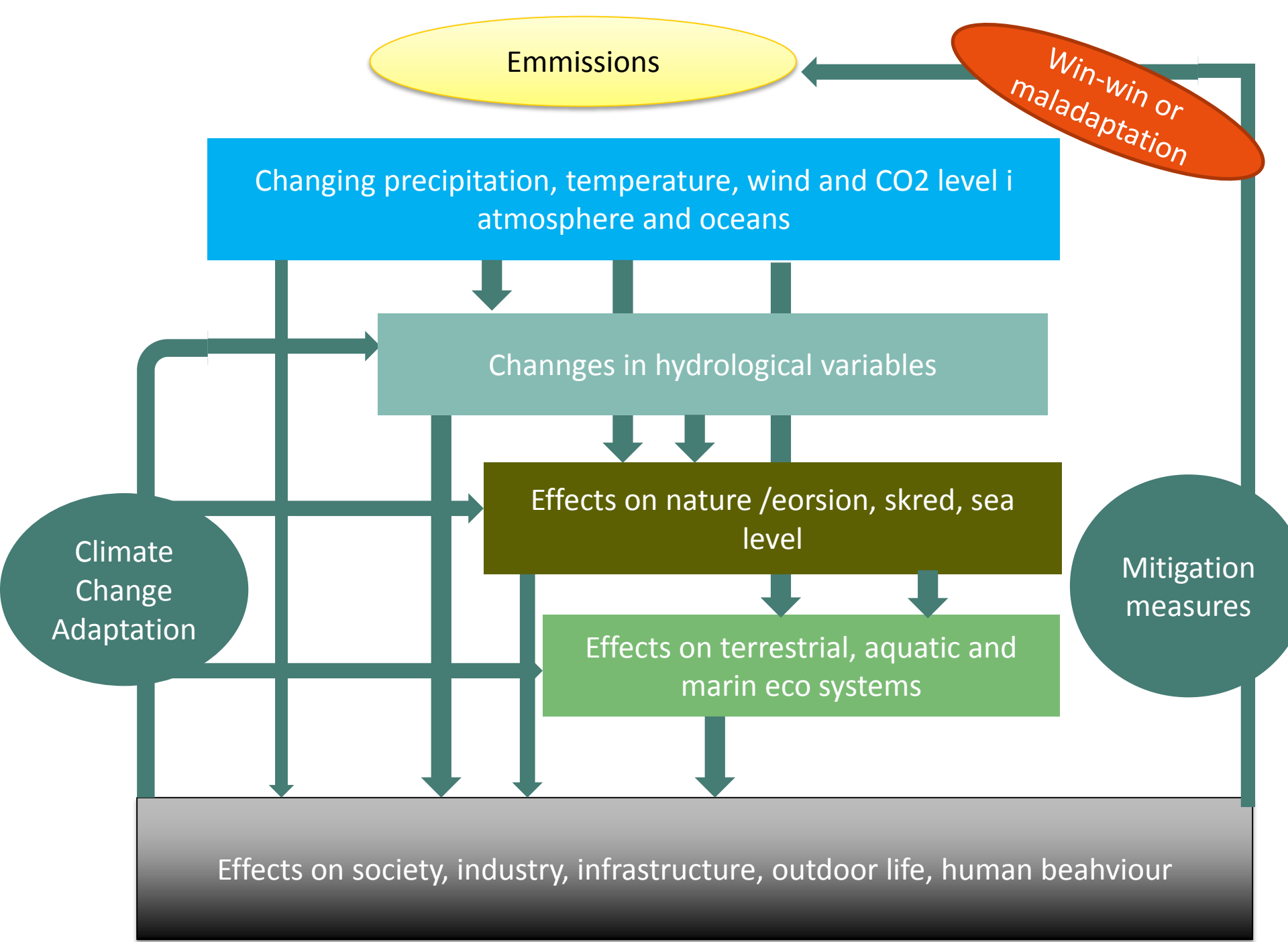
Relevant Climate parameters

Atmospheric climate

- Air temperature
- Precipitation
- Heavy showers and thunderstorms
- Wind and icing

Hydrology,

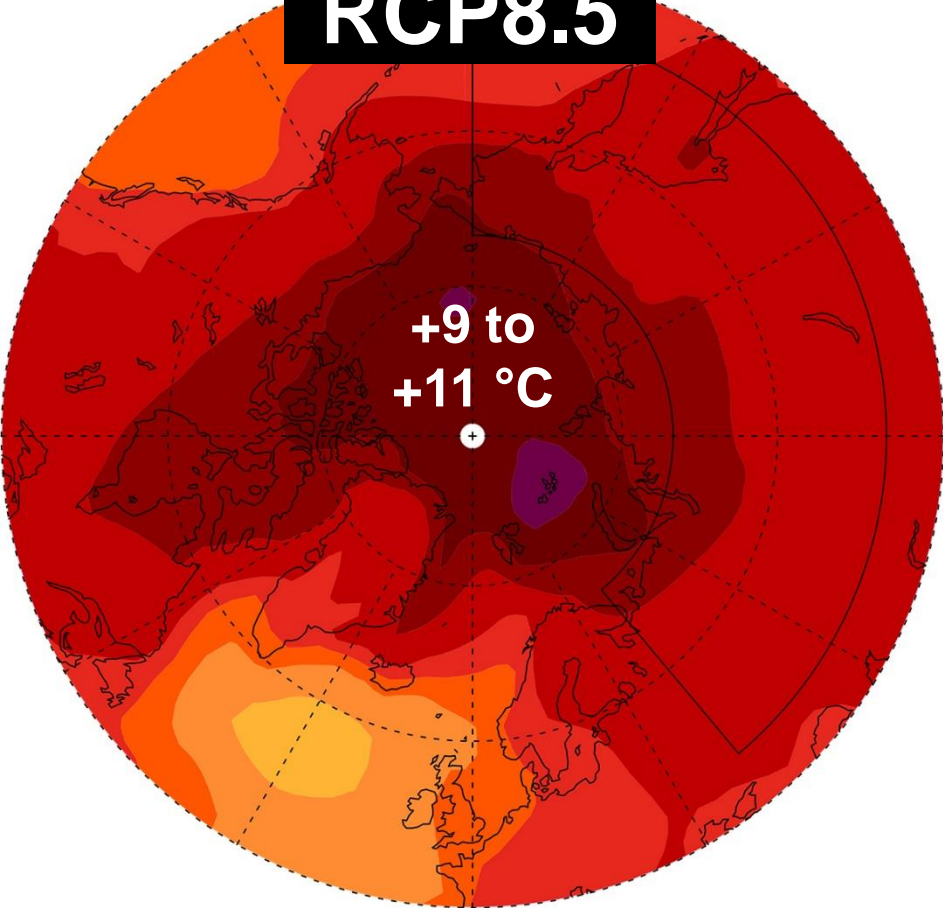
- Runoff, snow, glaciers, floods, drought, landslides and avalanches
- Oceans, changing the main oceans streams, acidification
- Sea level increase



Modelled change in annual mean temperature, Arctic

(2081-2100 relative to 1986-2005)

RCP8.5



[Celsius]

-2 -1.5 -1 -0.5 0 0.5 1 1.5 2 3 4 5 7 9 11

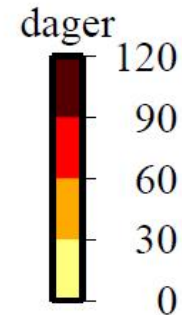
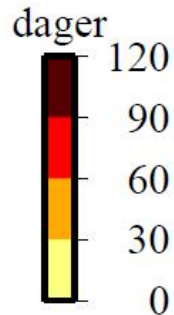
Increased growing season from 1971-2000 to 2071-2100

RCP 4.5

RCP 8.5

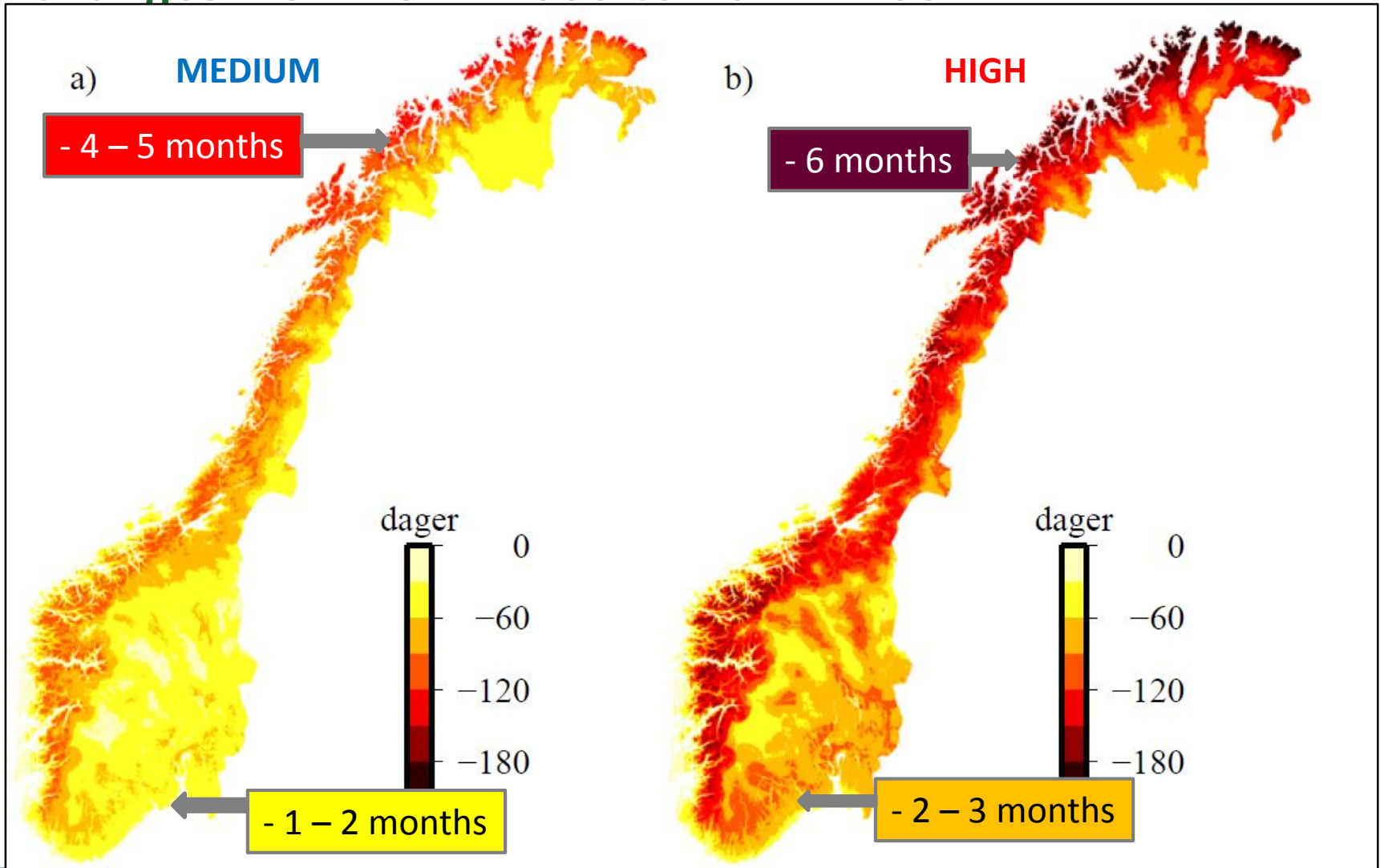
+ 1 – 2 months

+ 2 – 3 months



Length of snow season

Changes from 1971-2000 to 2071-2100

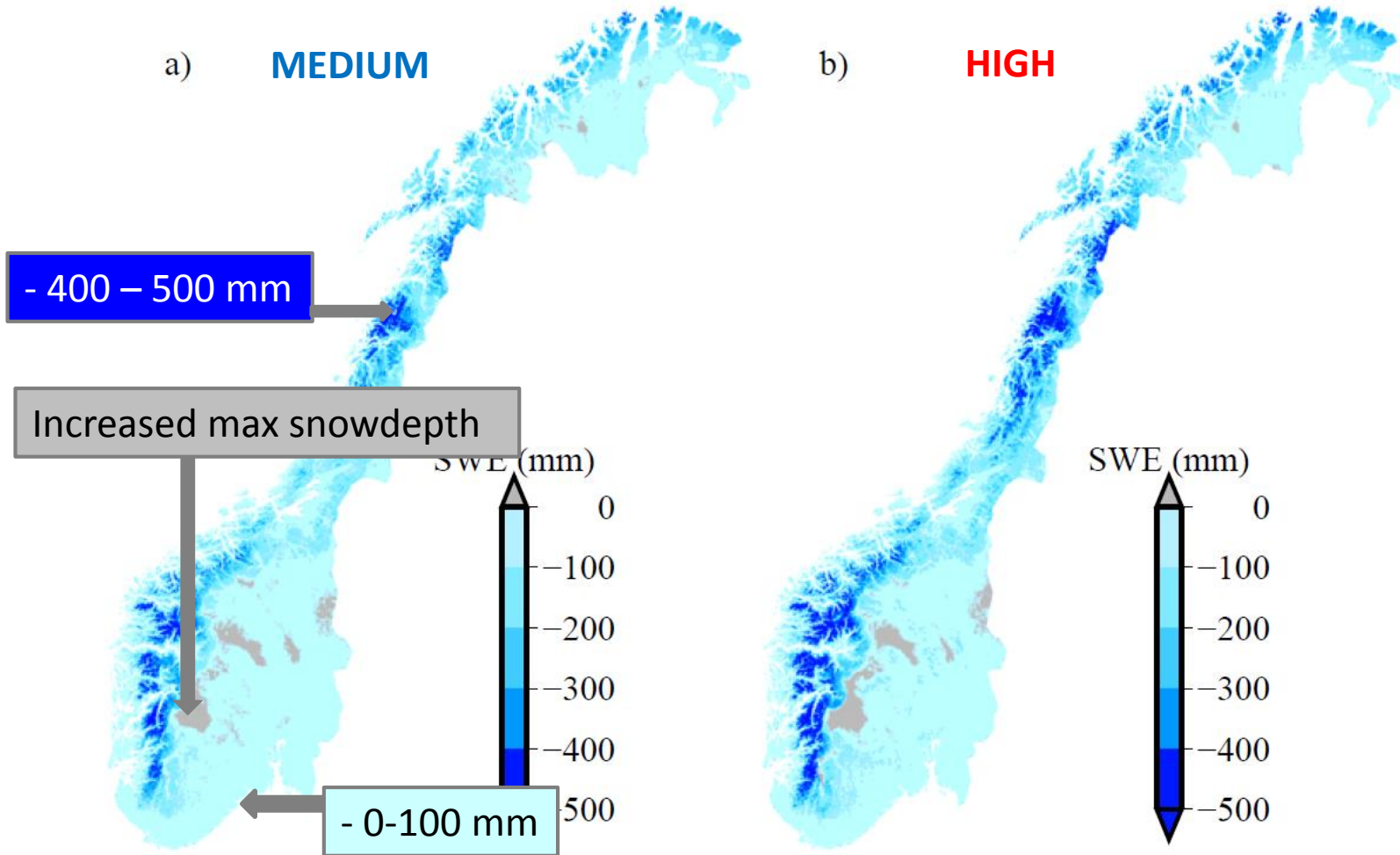


Average winter snow maximum

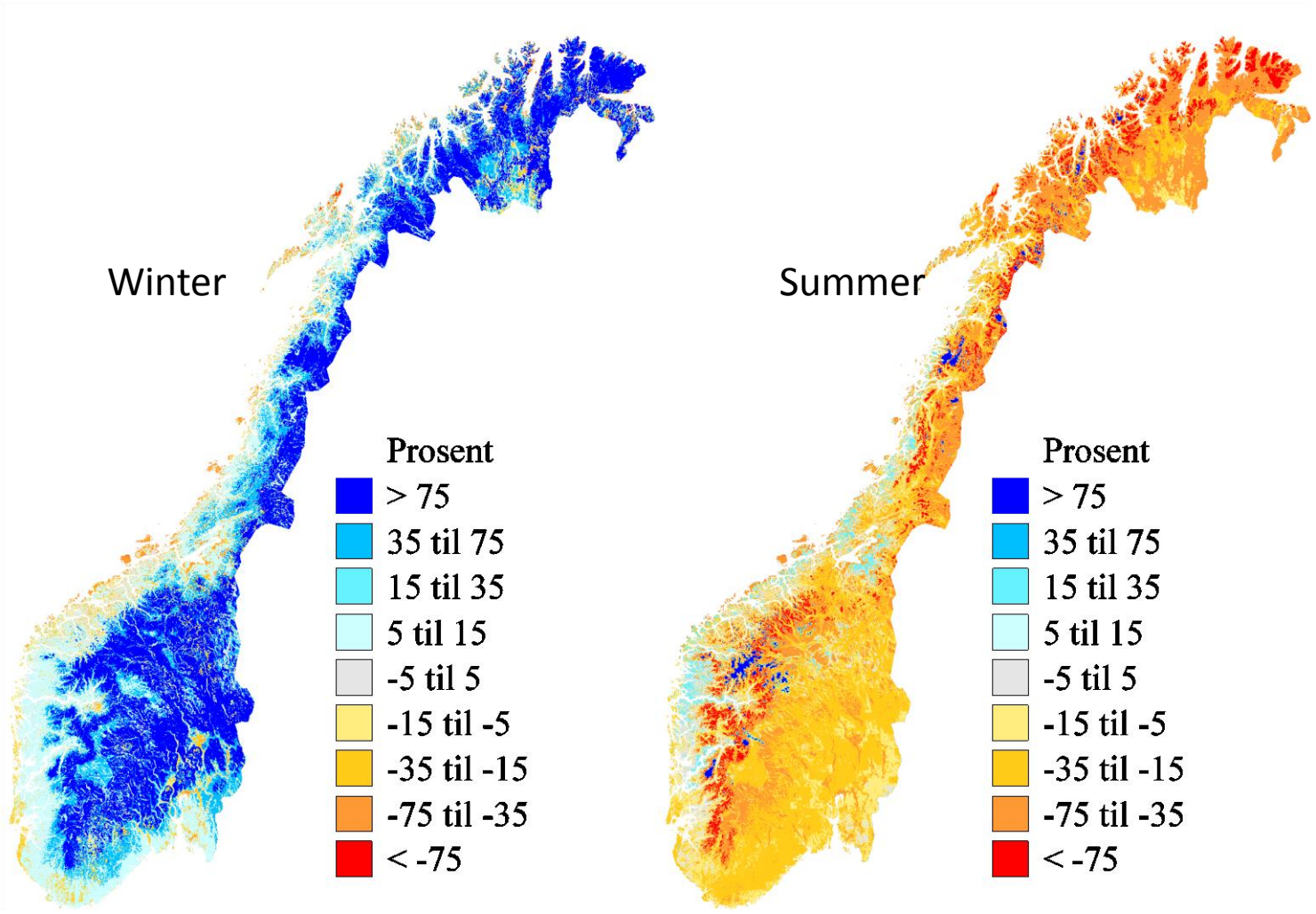
Changes from 1971-2000 to 2071-2100

a) MEDIUM

b) HIGH



More water in the rivers in winter – less in summer

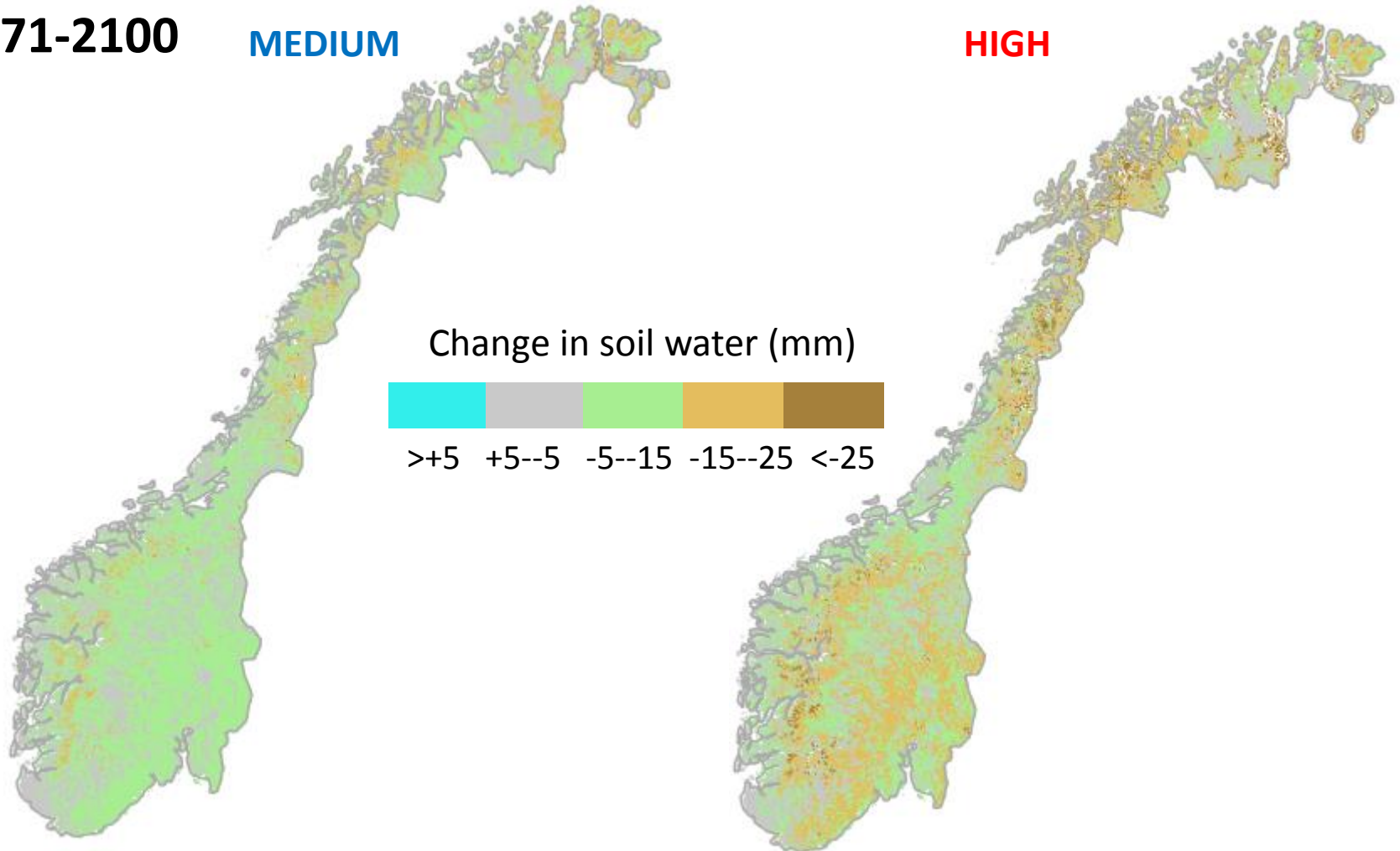


Increased soil water deficit in summer

2071-2100

MEDIUM

HIGH



Climate change adaptation - definition

Adjustments in biophysical or social systems as a result of actual or expected climate effects

- to reduce harm or
- take advantage of possibilities.

Types of Climate change adaptation (IPCC)

- **Proactive adaptation** is adaptation that takes place before the consequences of climate change occurs (advance adaptation, "precautionary" - adaptation).
- **Spontaneous adaptation** is adaptation that do not constitute a conscious response to climate change, but is triggered by changes in natural environment, marketability forces or welfare changes in the social systems. It is referred to as autonomous adaptation or as reactive adaptation if adaptation is initiated by a climate-related event.
- **Planned adaptation** is adaptation resulting from policy decisions, based on the understanding that the climate has changed or is going to change and that action is required, to maintain a stable and safe situation in sector or society as a whole.

Use of climate projections in adaptation assessment and planning

- There are many causes of **uncertainty** associated with future climate trends.
- This yields a **spread among different climate projections**, and it is not possible to quantify the relative probability of the individual projections.
- Therefore, users of climate projections **must assess various issues in light of uncertainty, risks, vulnerability** or other possibilities
- The committee recommended that possible **consequences and measures are assessed based on the scenario(s) that project the greatest challenges.**

Uncertainty and risk assessments

- The possibility that the actual climate trend may be below the “low” or above the “high” projection can not be ignored.
- Assessments of issues where the consequences of climate change may be **especially serious or extensive**, should be aware that climate changes may exceed the range covered by the low and high projections.
- Based on current climate change and our existing knowledge, it is deemed to be more likely that the future trend in temperatures will be near (or above) the high rather than the low projections

Climate system and society – complex structures and interactions

- The climate system is complex, and the relationships between climate change and the impacts on the natural environment and society are numerous and, at times, uncertain. In addition, society will continue to evolve and change in the next century.
- Moreover, adaptation is cross-sectoral and integrated, making it difficult to isolate one area from the others with regard to costs and benefits.
- This depicts the importance of a holistic approach to these issues

Climate change and uncertainty

Criteria for decisions under increased uncertainty

- The goal of sustainable development
- The cost-benefit criterion
- The precautionary principle
- Risk aversion or risk accept

The risk of maladaptation

- Is the measure expected to be relevant for today's climate – or for future climate?
- When is it appropriate to implement the measure?
- Is the cost – benefit ratio positive?
- What instruments and measures will be most cost effective?
- Based on holistic analysis – is the measure a win-win?
- In an environmental perspective, is the measure assessed in relation to the do-no harm principle?

Integrated approach to adaptation and emergency, key organizational principles

- 1. The responsibility principle** means that the agency which is responsible for a subject area in a normal situation also has the responsibility to deal with extraordinary events in the area
- 2. The similarity principle** means that the organization responsible during emergency situations , shall be most similar to the organization normally operating
- 3. The subsidiarity principle** means that crisis should be handled at lowest effective organizational level

These principles should also be applied and when communities and sectors adapt to changing climate and climate related emergency situations!

3 Principles for climate change adaptation

1. A comprehensive (holistic) approach

A comprehensive approach implicate that the effects on greenhouse gas emissions, pollution and the natural environment are always assessed when planning adaptive measures.

3 Principles for climate change adaptation

2. Management of the natural environment must have an ecosystem-based approach

- The natural environment is particularly vulnerable as there are limits to the adaptive measures society can implement to support adaptation in nature.
- Largely, society can implement changes in land use and natural resource management to minimise the total impact on the natural environment and the ecosystems.
- This can best be achieved through ecosystem-based management, where the focus on preserving functional ecosystems helps reduce vulnerability, and maintaining or increasing, the natural adaptive capacity.

3 Principles for climate change adaptation

3 Adaptation must be integrated into the regular planning processes

- The **responsibility for adapting to climate change should be delegated to the responsible authorities.**
- In areas without clearly defined and delegated responsibility, the responsibility should be assigned **to the institutions that have the best professional and organisational qualifications** to handle adaptation.
- Climate change considerations must be given **higher priority in the planning system.**
- The committee regarded a **strong land use planning system that takes climate change into account as the most important step** to adapt to a changing climate

Assessment of adaptive capacity in the various sectors, four key factors assessed

The review of how vulnerable an area of society or sector is to risk scenarios was based on assessment of:

What capacity the sectors have to cope with risk when it comes to:

- Legal instruments and administrative structures
- Resources
- Knowledge and competence
- Prioritizing

Also to ensure consistent methodology across sectors

Assessment of organizational capacity

- The capacity of the sectors to plan and implement adaptive measures is affected by the organization and distribution of authority.
- Legislation and requirements, e.g. requirements for risk and vulnerability analyses (RAV analyses ROS in Norwegian), and systems for following them up also play an important role.
- The ways in which information and competence-building are organized also affect the adaptive capacity
- Regulatory system, does it promote or counteract adaptation

Assessment of Resources available

- The capacity to implement measures is affected by the economy, technology, access to expertise and human resources.
- The efforts to adapt to the current weather conditions are used to assess factors related to expertise and human resources f ex in public administration.
- In addition a maintenance backlog has been found to be an important factor affecting the adaptive capacity of infrastructure and buildings

Assessment of the knowledge base

- The total knowledge from, and access to, research, surveys, monitoring systems and climate projections has an important effect on the adaptive capacity.
- Research based knowledge for climate policy, mitigation and adaptation measures on global, national, regional and local level, plays a key role as part of the knowledge base

Assessment of prioritisation in society and sectors

- The adaptive capacity of various sectors is related to the level of priority given to adaptation issues.
- In this context, the assessments of priority are mainly concerned with acceptance, and the understanding and the importance attached to risk.
- In addition, existing efforts to promote adaptation may also have some effect on the ways in which sectors prioritise adaptation.
- Insight into, and understanding of, climate related issues and climate change are factors that have an important effect on adaptive capacity

Different effects, also «positive»

- The adaptive needs will vary in different sectors.
- Adaption may involve anything from avoiding building in areas that may be affected by rising sea levels in the future to making use of new types of grain that are adapted to altered climate conditions.
- Adaptation does not just involve reducing vulnerability, but also our **ability to understand and exploit the opportunities offered by climate change.**

CC Adaptation over time – in a changing society – trends and uncertainty

- We expect that climate change will begin to be noticeably in earnest in the second half of this century.
- We must also expect that society will change considerably over the next 40–50 years.
 - Demography and population
 - Socioeconomic changes
 - Economic development and welfare
 - Technology
 - Infrastructure

The «sectors» assessed

- Natural environment
- Human health and safety
- Infrastructure and buildings
- Business and industry, including primary industries
- Society and administration
 - Local level, municipalities
 - Regional level, counties
 - National level, Government, Ministries, State agencies,

Opportunities for business in a changing climate

- Agriculture and forestry, higher theoretical production potential
- Hydropower sector: higher potential
- Offshore oil and gas industries, better conditions in fields close to the Arctic ice shelf
- Sea transportation; less ice in Arctic areas

But– utilizing the potential may also give risk of maladaptation – and higher pressure on nature, and increased emissions

Vulnerability and adaptation needs in the business sectors

- Rapid renewal in many industries
- Continuous autonomous adaptation
- Indirect vulnerability through reliance on infrastructure
- Changing conditions for primary industries
- Needs for a good framework for restructuring that also include adaptation to changing climate



Foto: Erik Eskedal

Businesses mostly exposed to weather

- **Agriculture, forestry**, reindeer herding, other outfield businesses
- Fishery and aquaculture
- Offshore oil and gas
- Hydropower
- Insurance
- (Nature based) tourism



Exposed to, but still not very vulnerable?

- Degree of exposure: The character, extent and degree of impact by climate changes on nature and society
- Robustness (resilience): The capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve the sustainability of the system, leaving it better prepared for future climate change impacts
- Adaptation capacity: A system 's ability to adapt to climate change , including natural climate variability and extremes , to reduce potential damages, exploit any advantages and opportunities that arise, or deal with the consequences .
- Climate vulnerability = exposure minus adaptation capacity
- Our assessment: The primary industries in Norway are exposed to effects of climate change, but still not very vulnerable

Assessment of agricultural sector (I)

- The agricultural sector has a holistic structure of administrative and research institutions which work in a well-functioning interaction. Stakeholders have clear focus on climate challenges.
- The close dialogue with the industry their organizations in the formulation of policy instruments, give the sector good preconditions for acting well coordinated in climate issues.



Assessment of agricultural sector (II)

- The Sector's good preconditions are rooted in coordinated investment in knowledge in prioritized areas, and it is clearly seen an efficient implementation of targeted measures and an ability to organizational restructuring processes.
- Reduced expertise and capacity, among other things in education system and municipal agricultural administration are considered as a threat to future adaptation capacity.
- Maintenance backlog and weakened agronomic and silvicultural knowledge in the industry, are in contradiction to the need for increased expertise when changed climate gives more demanding operational and academic challenges

7 action area for land-based primary industries

- Resource mapping, information management and user oriented information products and services
- Monitoring and forecasts
- Research and innovation
- Technological development
- Knowledge systems including dissemination structures.
- Land management and planning
- The legal regulation regimes and instruments

Infrastructure and buildings

- Transport system
- Electricity supply systems
- Elektronik communication
- Buildings
- Waste and pollution
- Water and humidity
- Water, drainage and runoff



Vulnerability and Infrastructure

- Highly exposed to climate change effects
- Critical functions
- Mutual dependence
- Decisive for vulnerability:
 - Maintenance lags
 - Lifetime
 - Priorities and resources
 - The information flow



Foto: Crestock



Foto: Erlend Ramsvik

Need for adaptation infrastructure

Key factors:

- Cover up adaptation deficit by focusing on maintenance and maintenance lag
- Clarify responsibilities among authorities and institutions, and in the private-public dimension
- Planning, sizing requirements and climatic zones



Key messages from the Committee

- Although Norway has considerable adaptive capacity, climate change will have high costs, both human and material, if climate change considerations are not taken in planning and decision making
- The report has been translated into English.
- Although adaptation is highly context specific, the report may provide useful insights on how climate vulnerability assessments may be conducted



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Thank you for your attention!
Questions, need for more information?
Please feel free to contact me

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