



Adapting to climate change - from research to “operation” (R2O)

Hege Hisdal



Outline

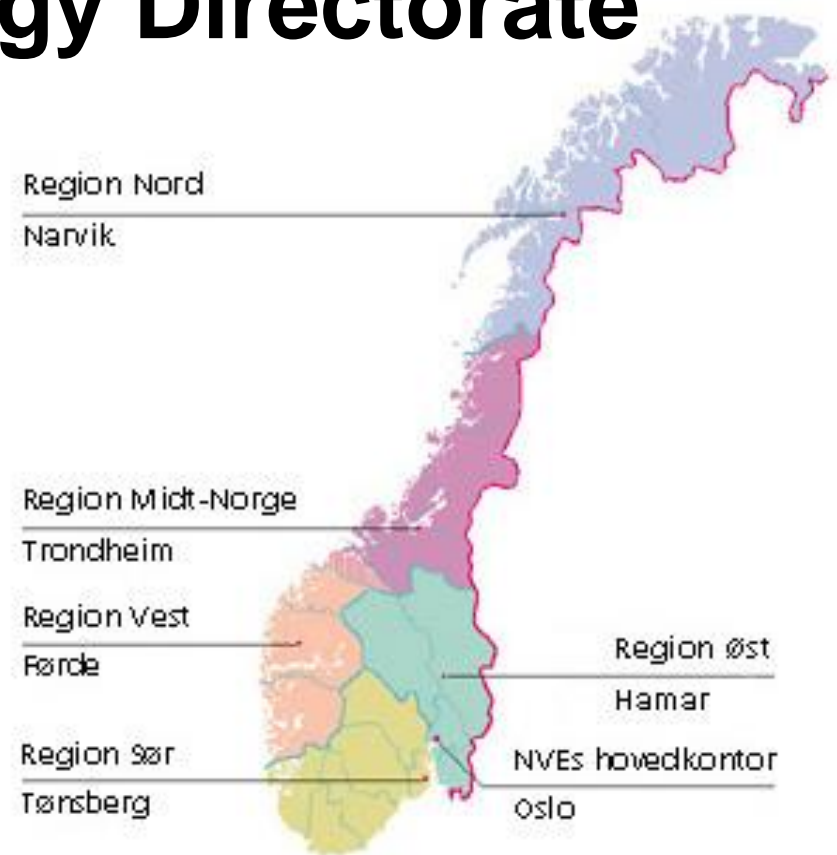
- NVE and NCCS
- Changing climate and hydrology - research
- Land use planning – “operation”
- From R2O – the role of NCCS



Trøndelag, June 2011
Photo: Geir Otto Johansen/Scanpix

NVE - The Norwegian Water Resources and Energy Directorate

- Established in 1921
- Staff ~550
- 5 Regional Offices
- 6 Departments
(Administration, Licensing, Energy, Supervision and Preparedness, Landslides and Water Resources and Hydrology)
- International Office



The role of NVE

- Directorate under the Ministry of Petroleum and Energy
- Responsible for the management of Norway's water and energy resources (land based/stationary)
- Central role in flood & landslide contingency planning
- Overall responsibility for maintaining national power supplies
- National centre for hydrology



NVE cross-cutting aim on CC:

- NVE will *document climate change* by collecting hydrological data, *research* and analyses.
- NVE will *assess the implications* of CC for the management of Norway's renewable energy and water resources.
- NVE will *carry out CC adaptation* within its areas of responsibility. This includes changing requirements set related to dam safety, robust power supply, flood and land slide contingency planning and land use planning.
- NVE will contribute to *increasing knowledge* about CC in society....

Floods and flooding – management responsibilities

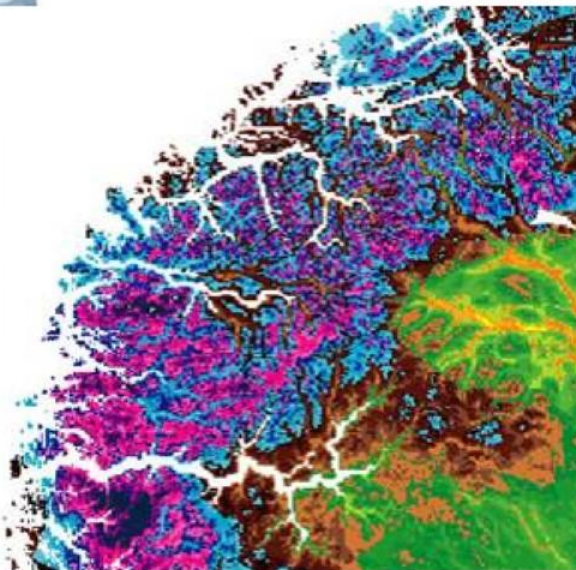
- Mapping – including flood inundation maps
- Land use planning
- Flood protection
- Forecasting
- Preparedness and crisis management



Photo: Grethe Holm Midttømme, NVE

Hydrology

- Collecting streamflow, groundwater and soil moisture data and information about glaciers, ice and snow conditions
- Responsible for the national flood, landslide and avalanche forecast services
- Analyses and R&D-activities



Norwe

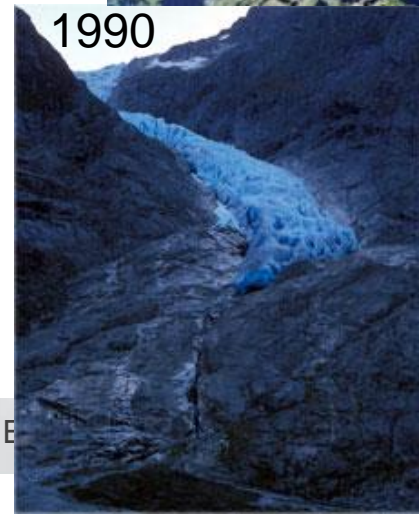
orate

Climate research at NVE: Effects of climate change on hydrology

1. **Identify changes in long time series:** Has the river flow changed? Do the glaciers retreat?
2. **Modelling hydrological projections:** Will flood magnitudes increase? Will droughts be more severe? When will the glaciers disappear?
3. **Understanding processes:** Climate affects hydrology, but hydrology also affects climate. We need to understand the processes to be able to project future changes globally and locally.



Sediments
from glaciers



The Norwegian Centre for Climate Services

The Norwegian Centre for Climate Services

NCCS

NCCS - a cooperation between:



Background of NCCS

- Official Norwegian Reports NOU 2010:10

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



<http://www.regjeringen.no/pages/14545340/PDFS/NOU201020100010000DDDPDFS.pdf>

- White paper on climate adaptation in Norway, 2013:
«Stortingsmelding 33 (2012-2013)»

Norwegian Centre for Climate Services:

- A cooperation between MET, NVE and UNI
- The Norwegian Environment Agency is represented in the board
- Main purpose:
Provide decision makers in Norway with information relevant for climate adaptation



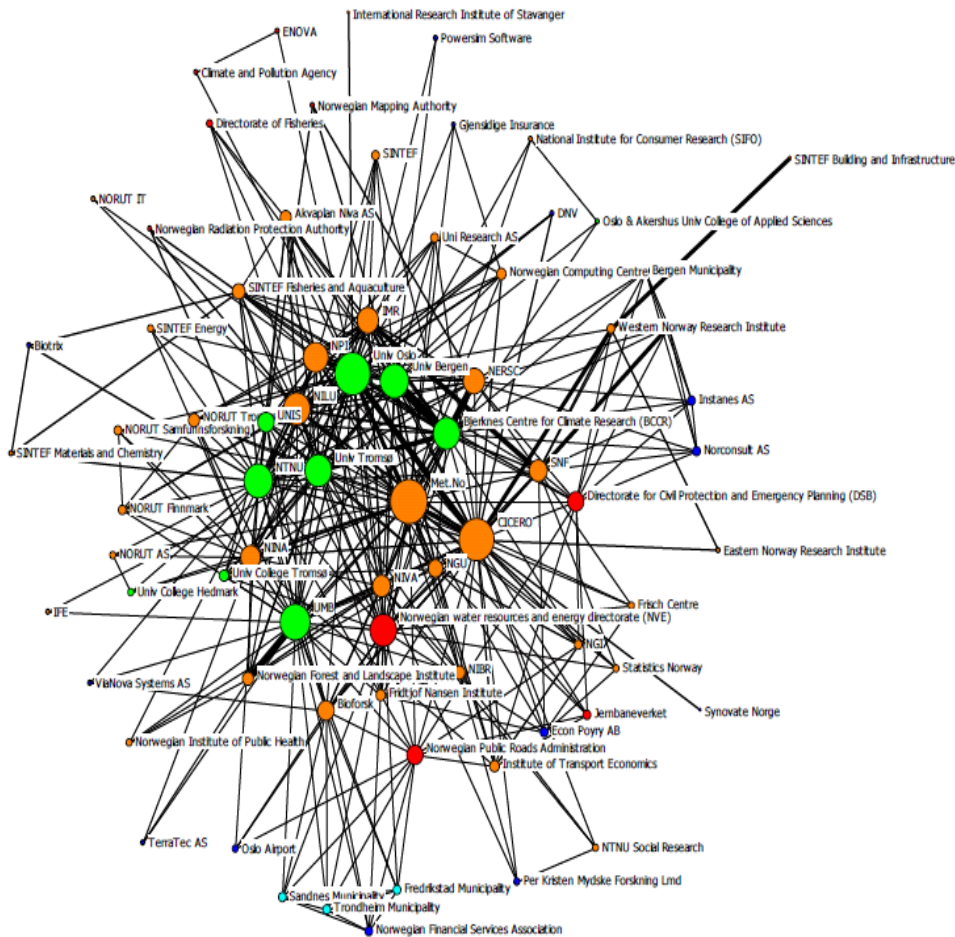
Knowledge gap 1



Present products

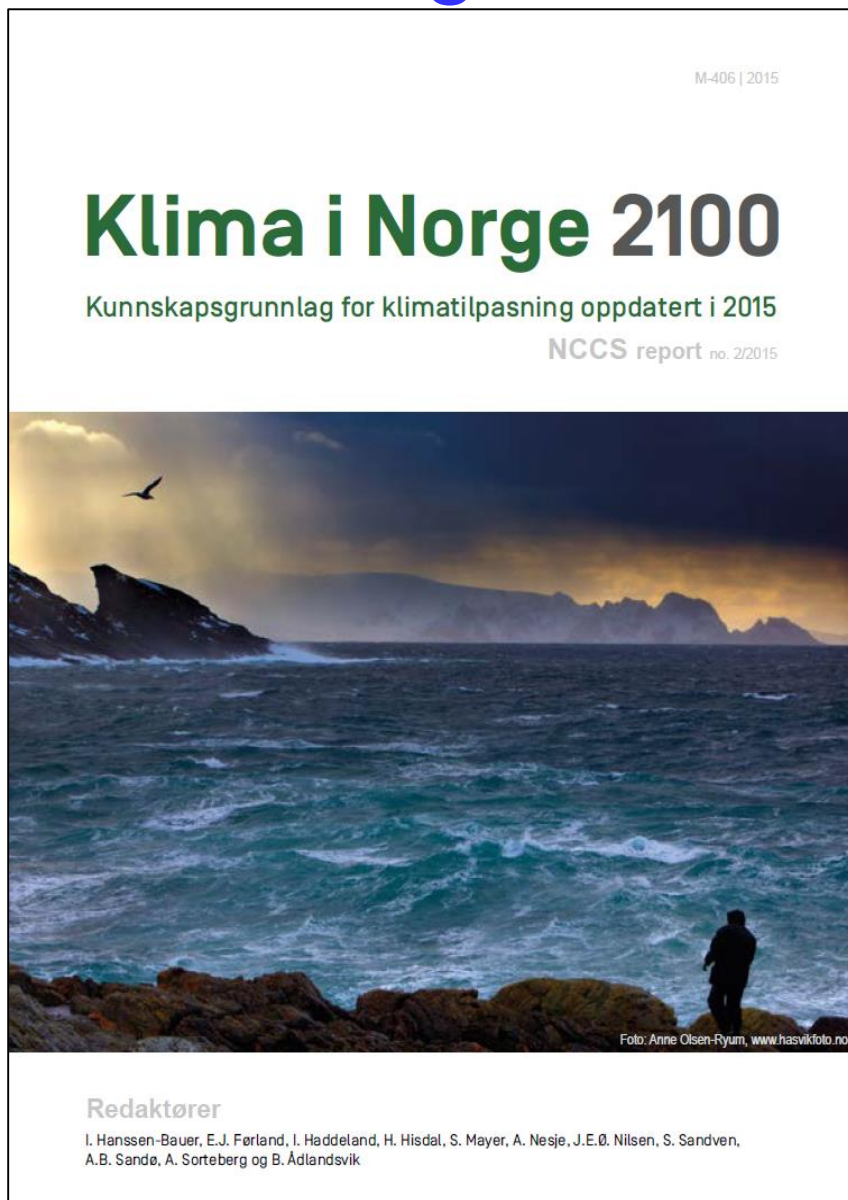
- Climate projections for Norway:
“Klima i Norge 2100”
- “Climate profiles” for counties
- User interfaces

NVE and NCCS two actors in climate change adaptation



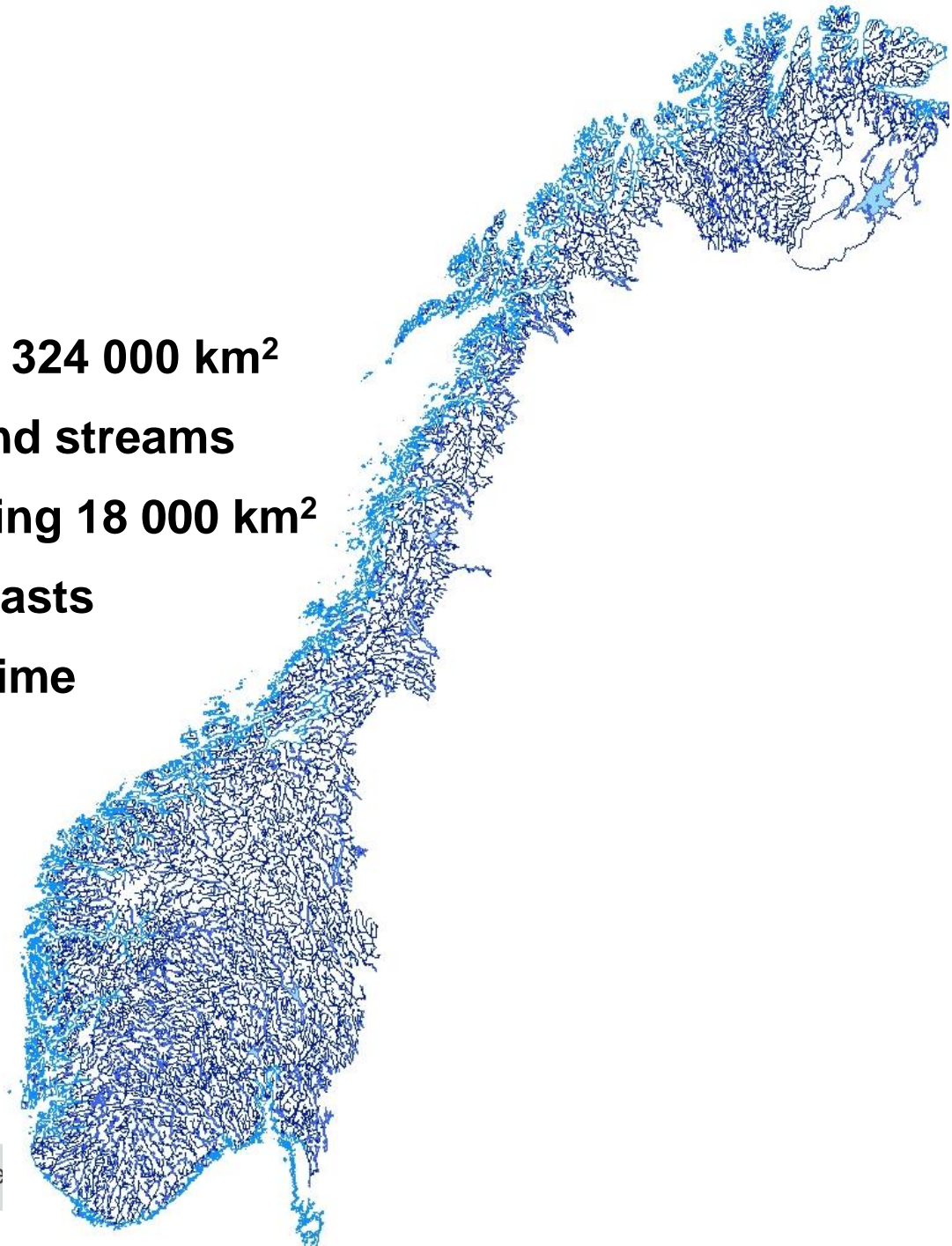
- Scientific community
- Governmental bodies
- Private sector
- Consulting Companies
- Regional authorities
- Municipalities
- Individuals
- The Norwegian Centre for Climate Services – NCCS
 - MET, NVE, Uni Research

Climate change - research



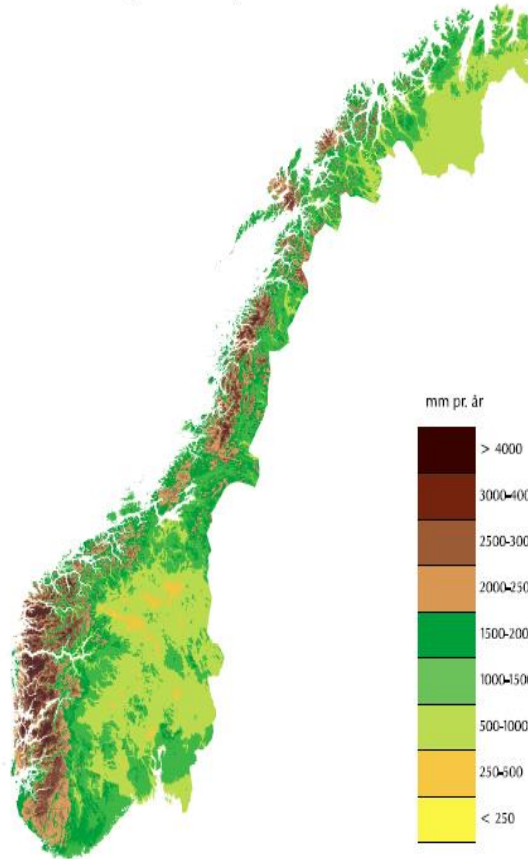
Geography

- Norway's total area: 324 000 km²
- 410 000 km rivers and streams
- 968 444 lakes covering 18 000 km²
- Large climatic contrasts
- Flood season: any time

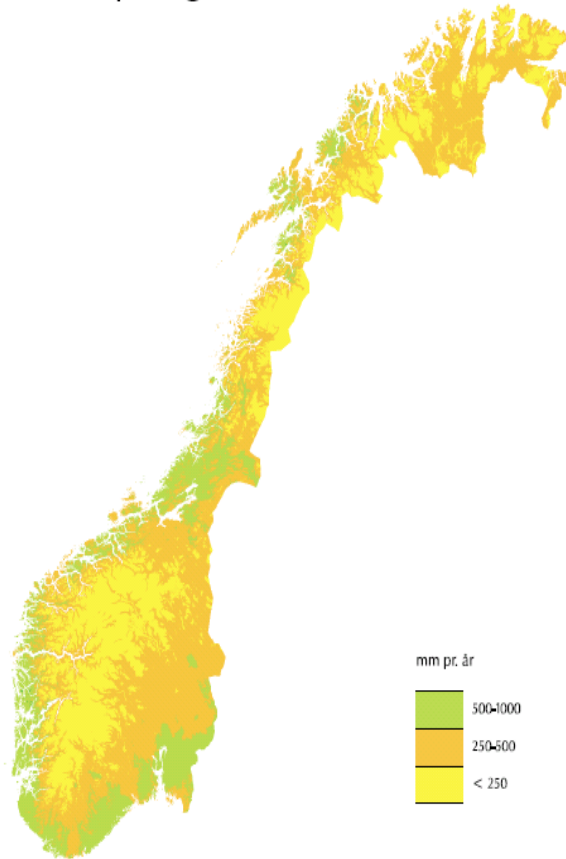


Meteorology and hydrology

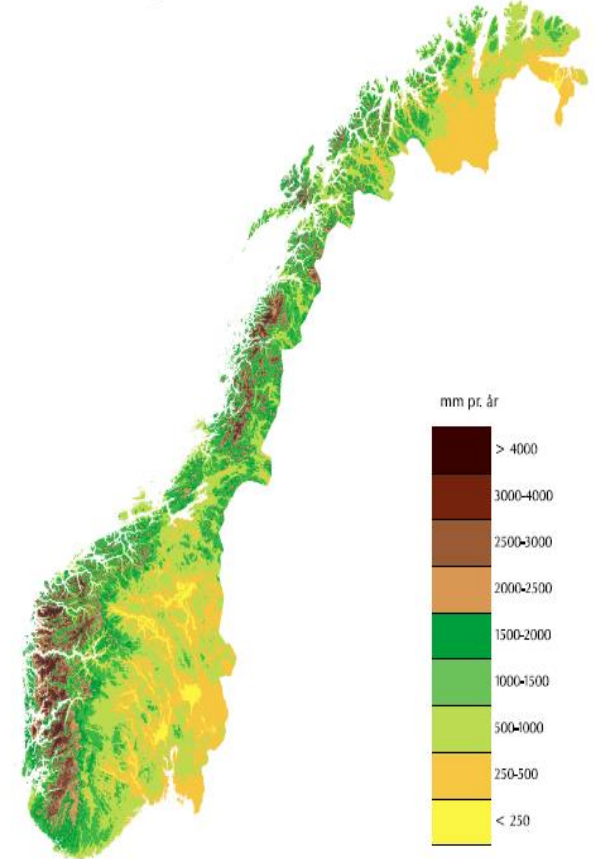
Nedbør (mm/år) 1961-90



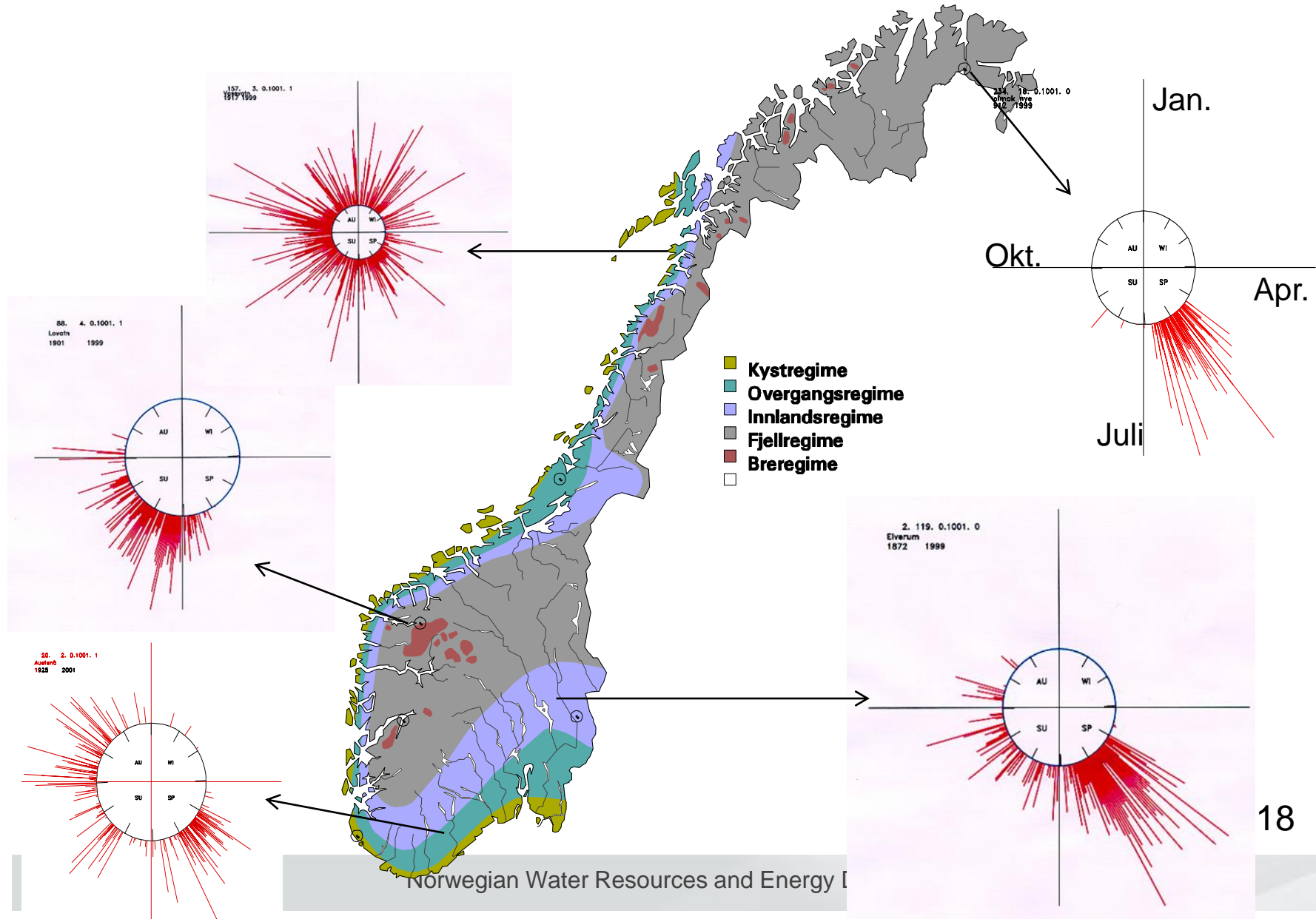
Fordampning (mm/år) 1961-90



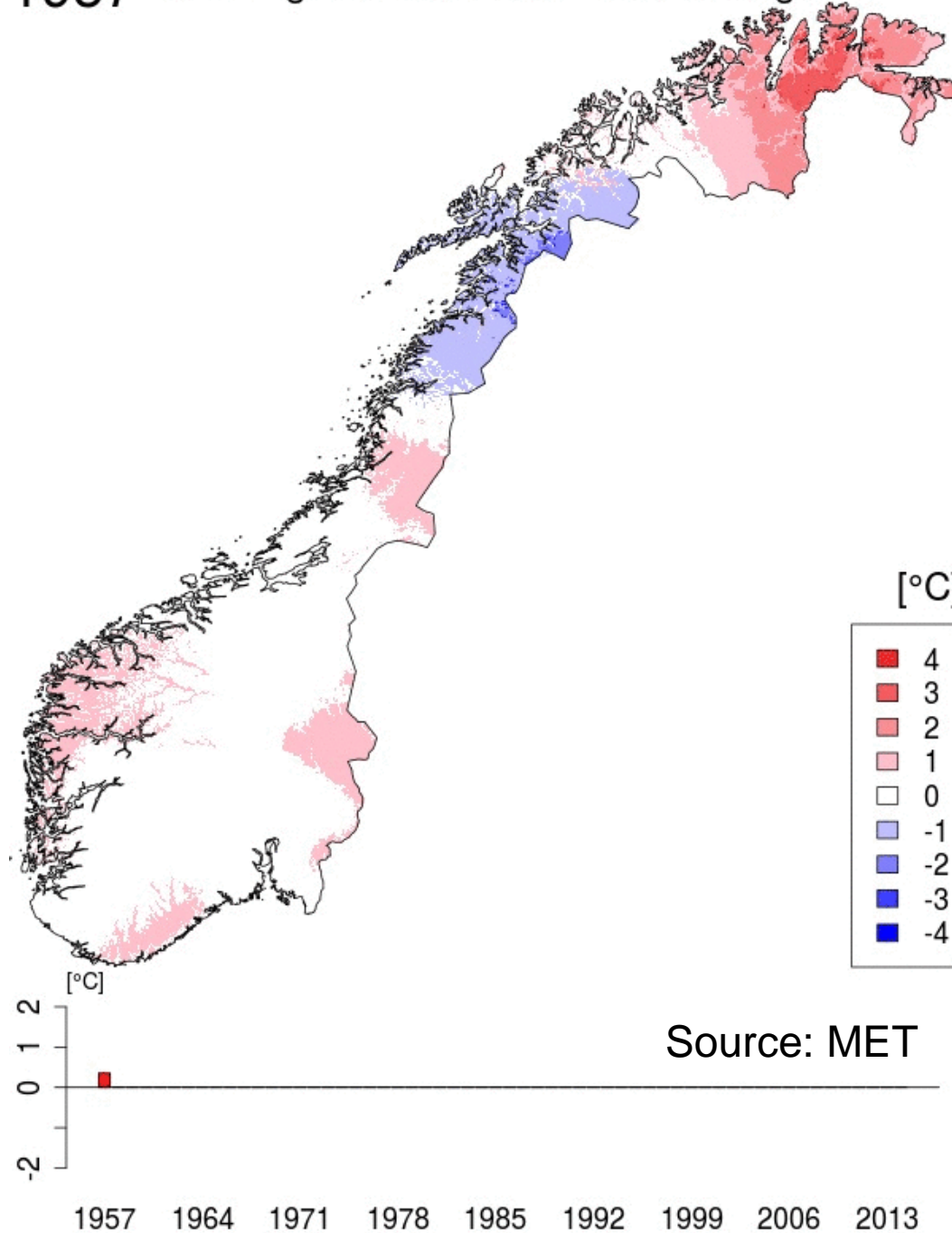
Avrenning (mm/år) 1961-90



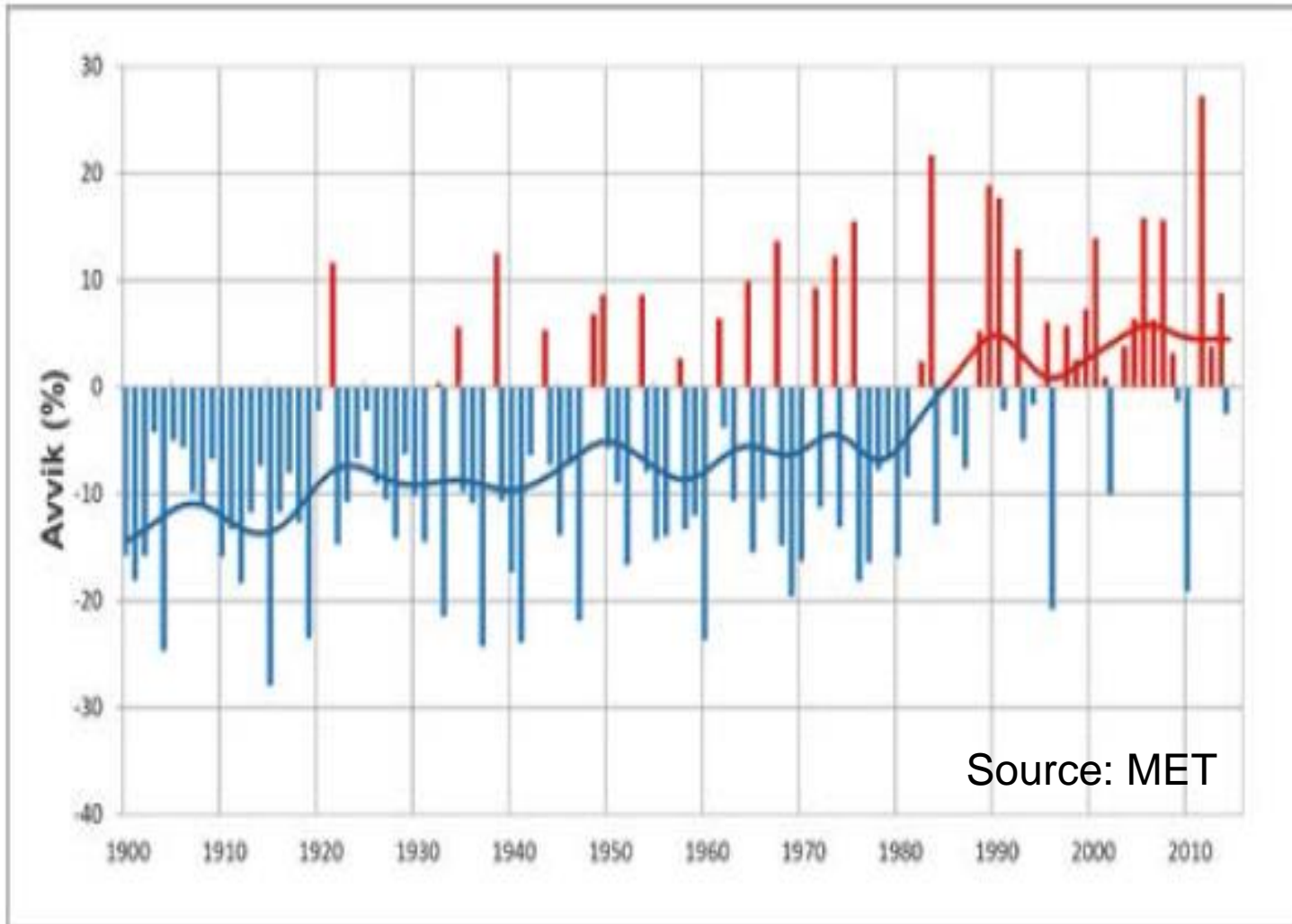
Flood season



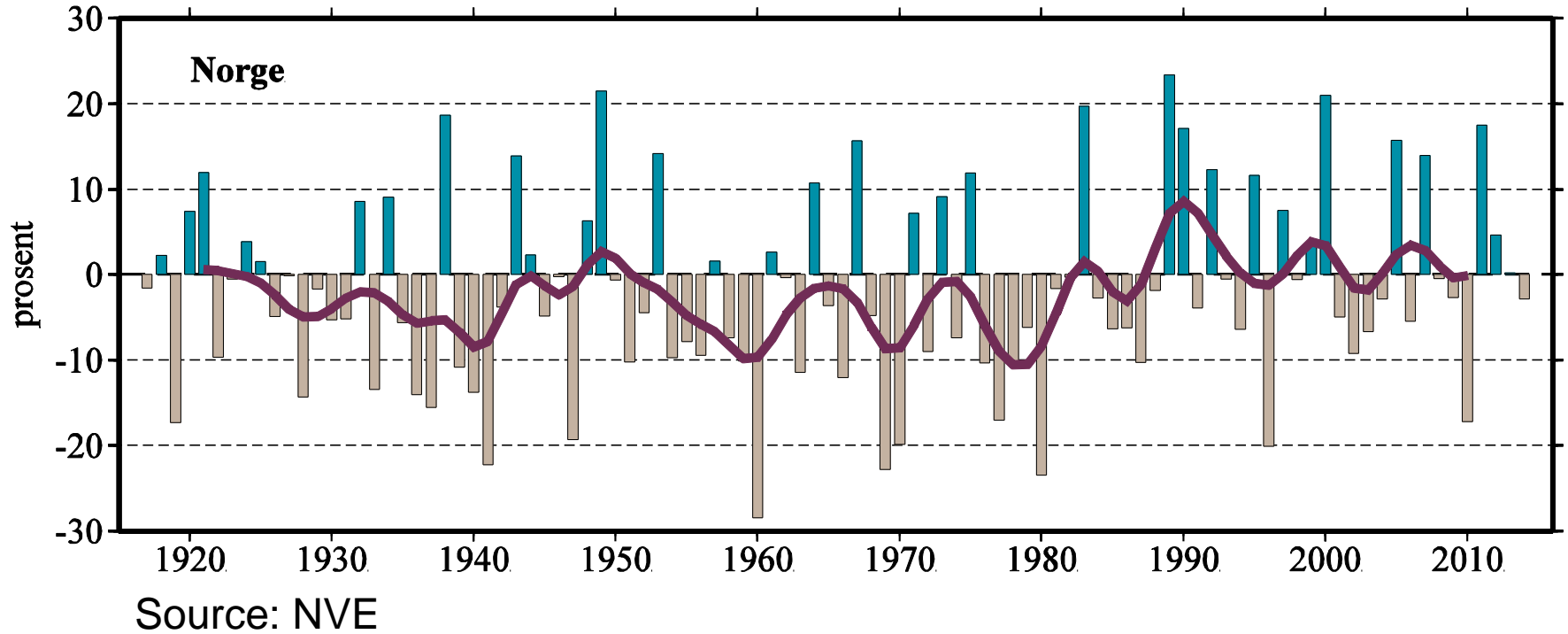
1957 Warming relative to 1961-1990 average



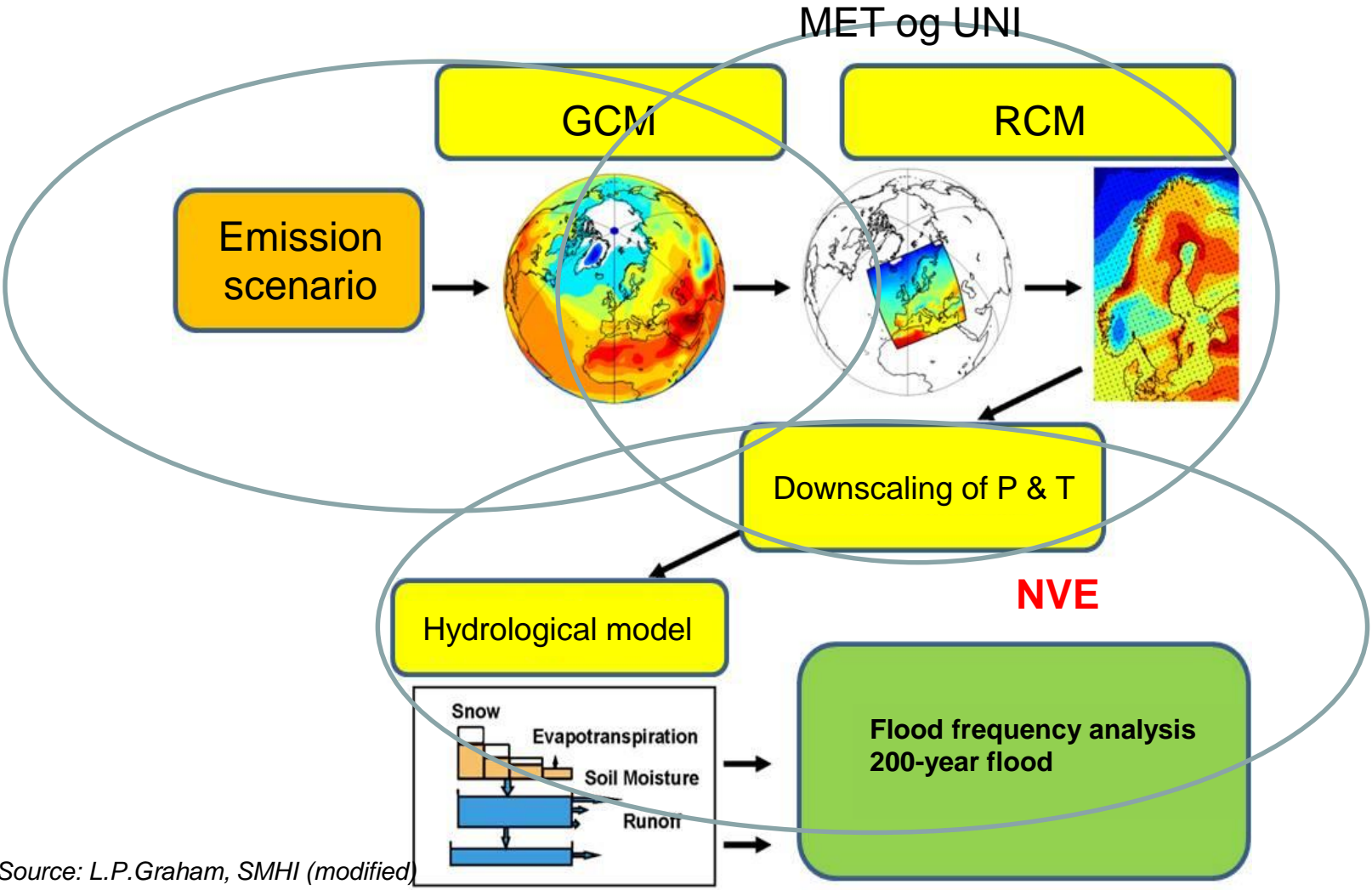
Precipitation (1900 – 2014)



Runoff (1914 -2014)



The modelling chain

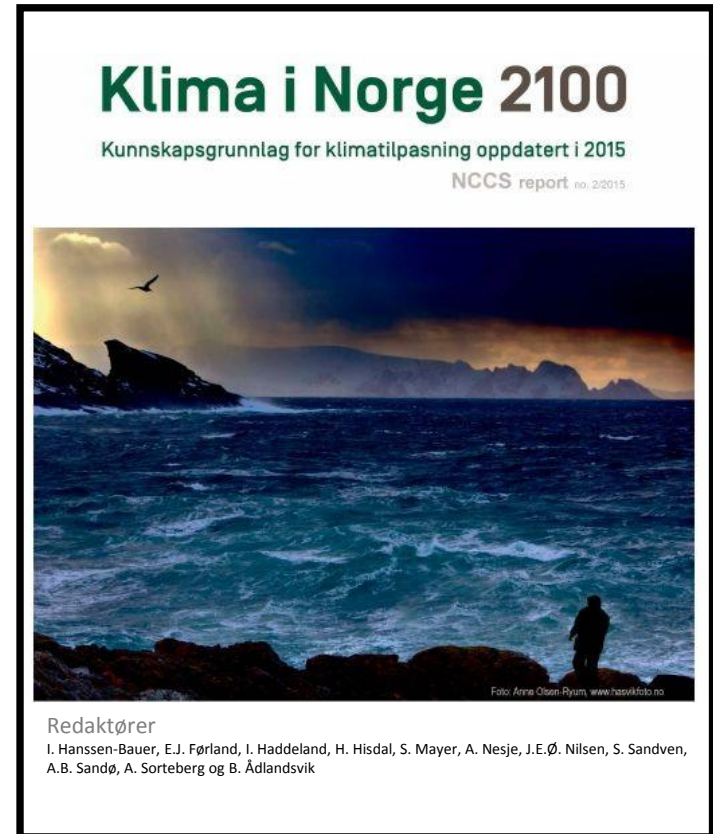


Source: L.P.Graham, SMHI (modified)

Climate in Norway 2100

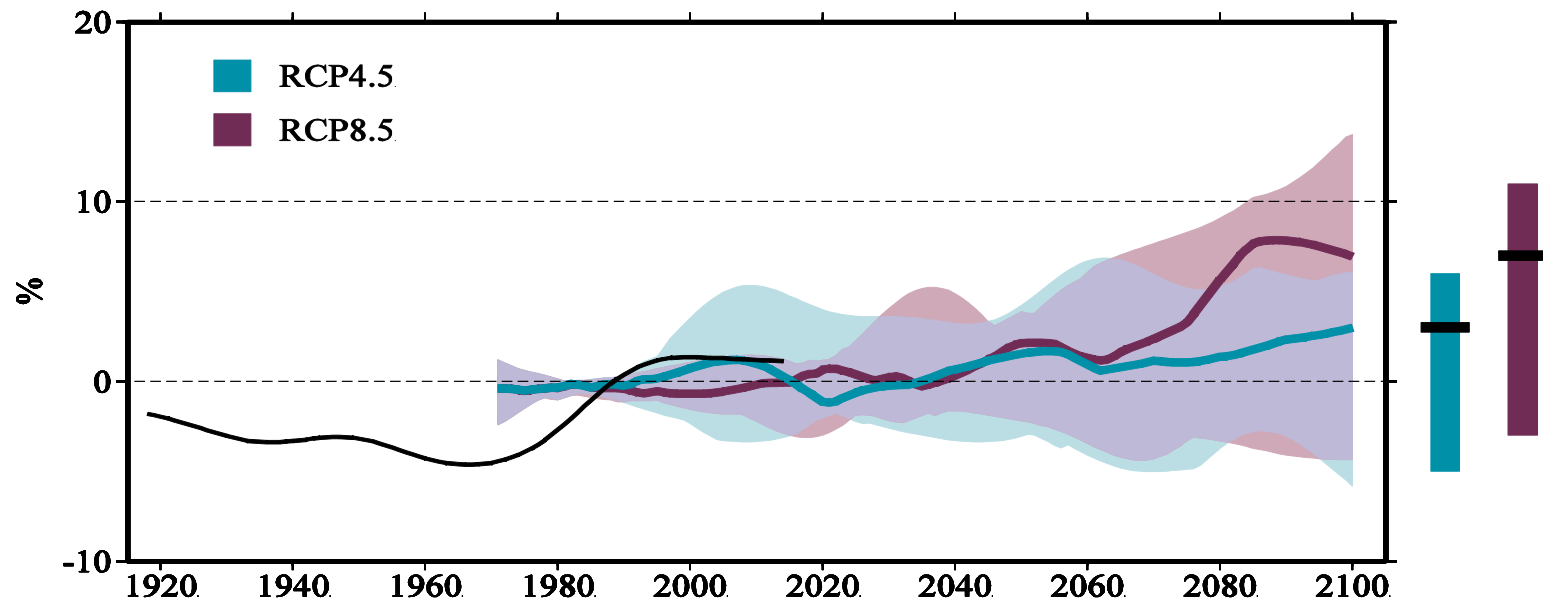
Results *high* emissions:

- Warmer? **YES** Temp.: + 4.5 °C (3.3-6.4)
- Wetter? **YES** + 18 % (7-23 %)
- More intense and frequent extreme rain? **YES**
- Sea level rise: **YES** + 15–55 cm (depends on location)



Annual runoff

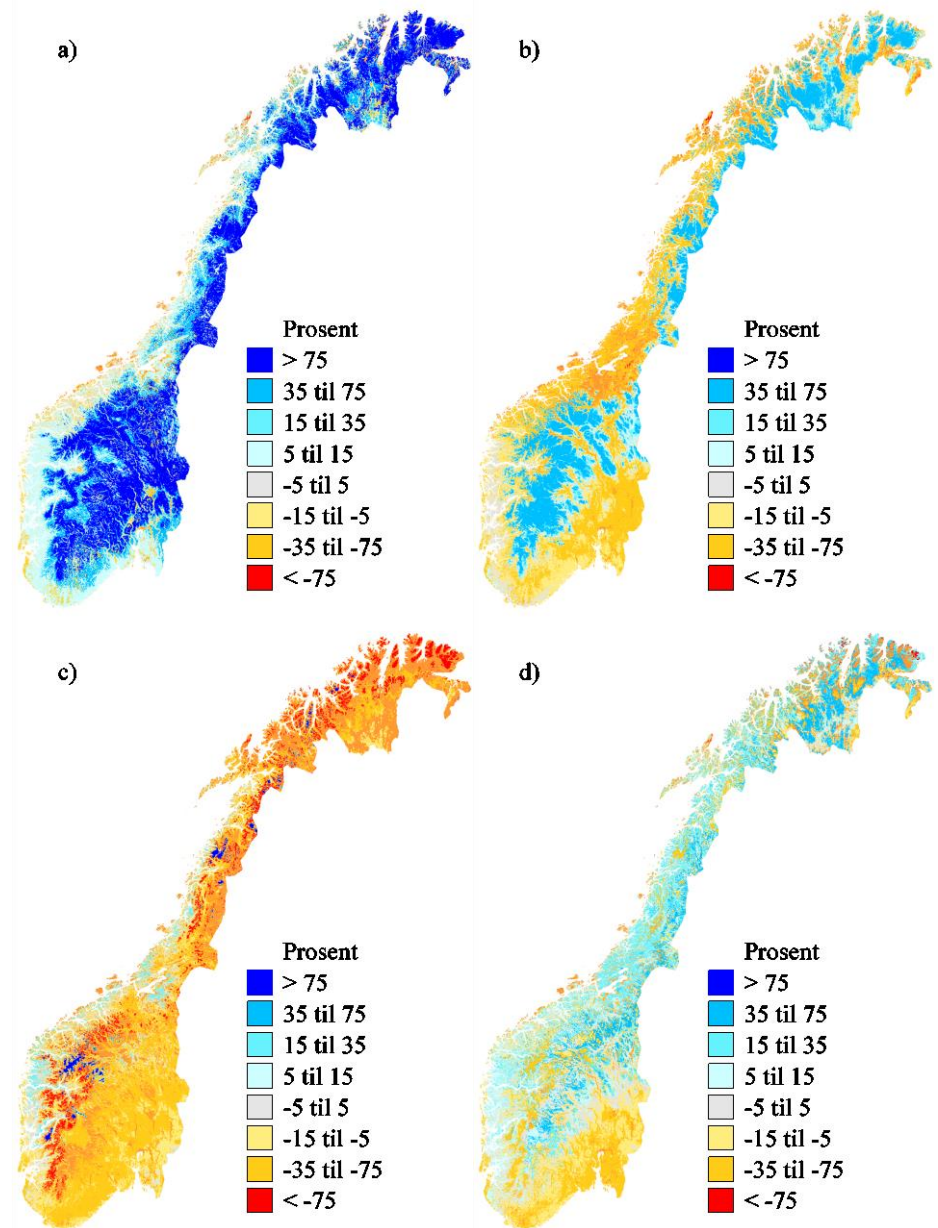
- 10-, 50- og 90-percentiles (filtered)



Runoff, seasons

RCP8.5, percentage change 2071-2100 vs. 1971-2000

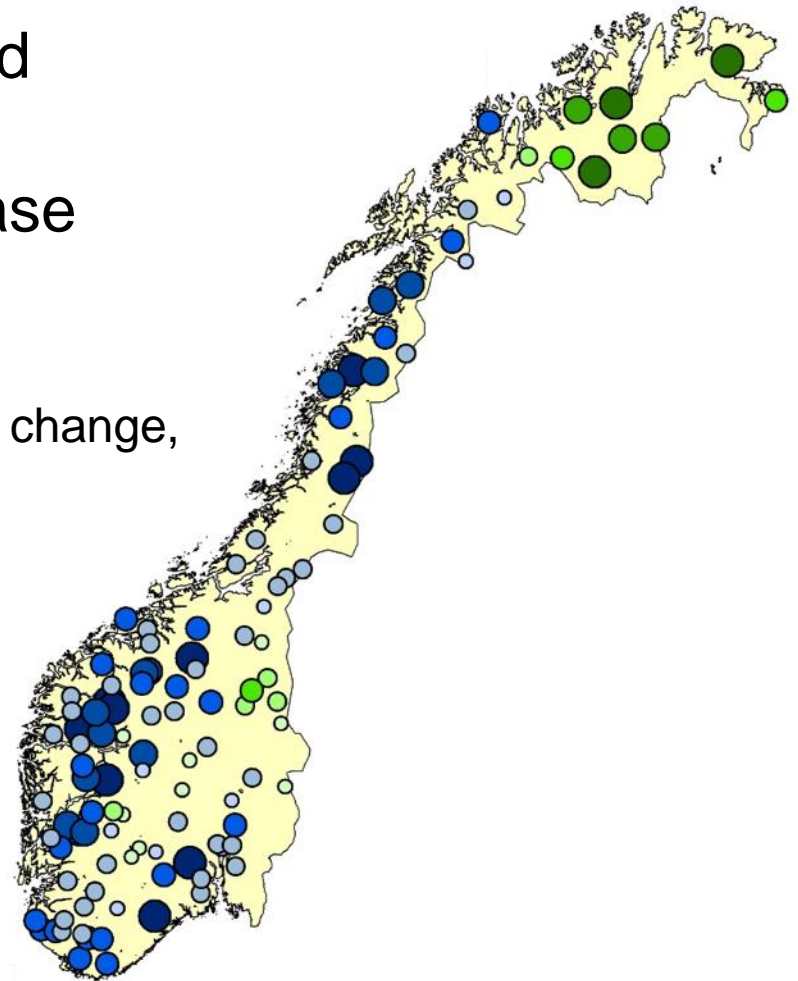
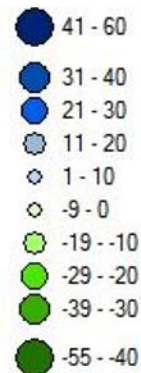
- a) Winter
- b) Spring
- c) Summer
- d) Autumn



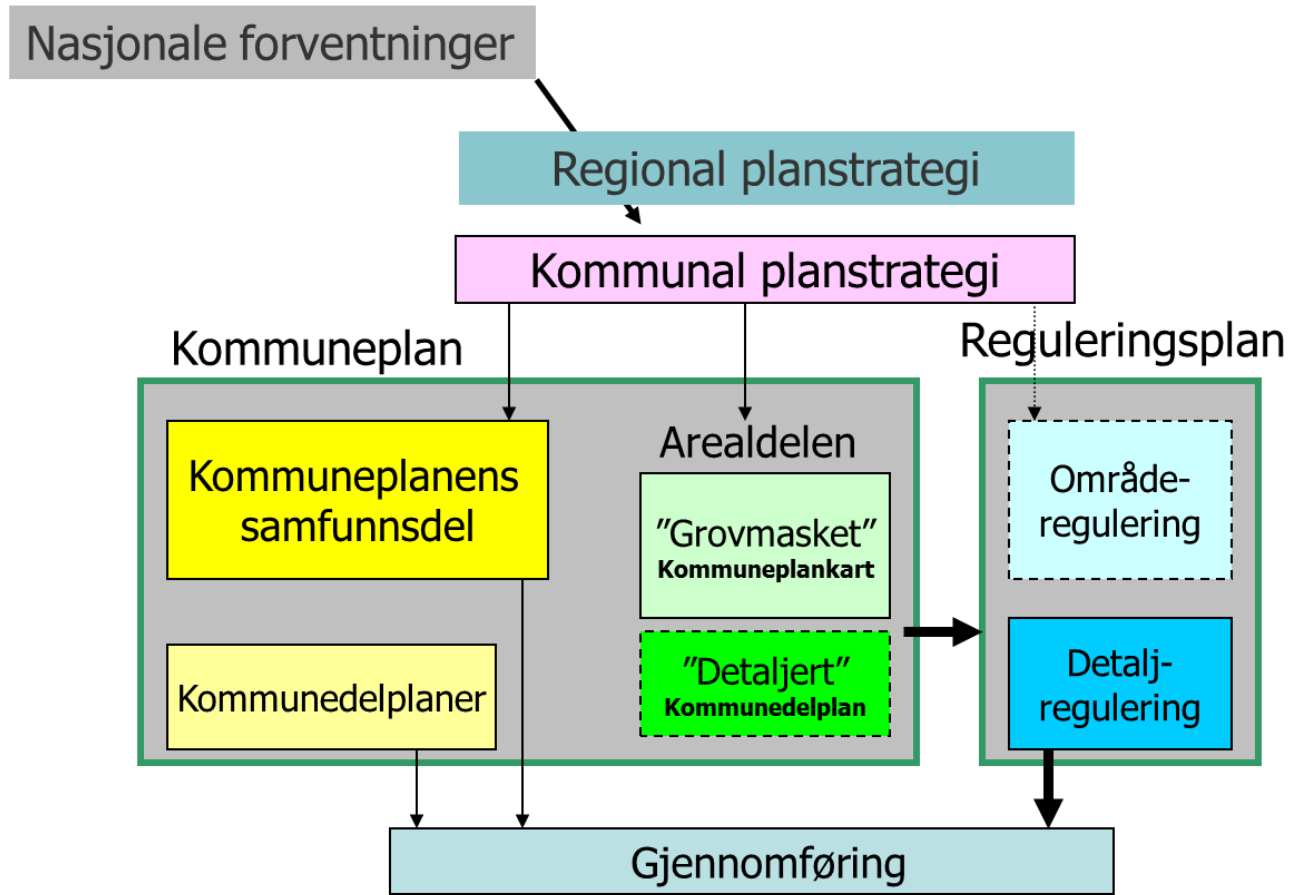
Flood increase here and decrease there

- Rain floods will increase and become more frequent
- Snowmelt floods will decrease and become less frequent

Percentage change,
large floods



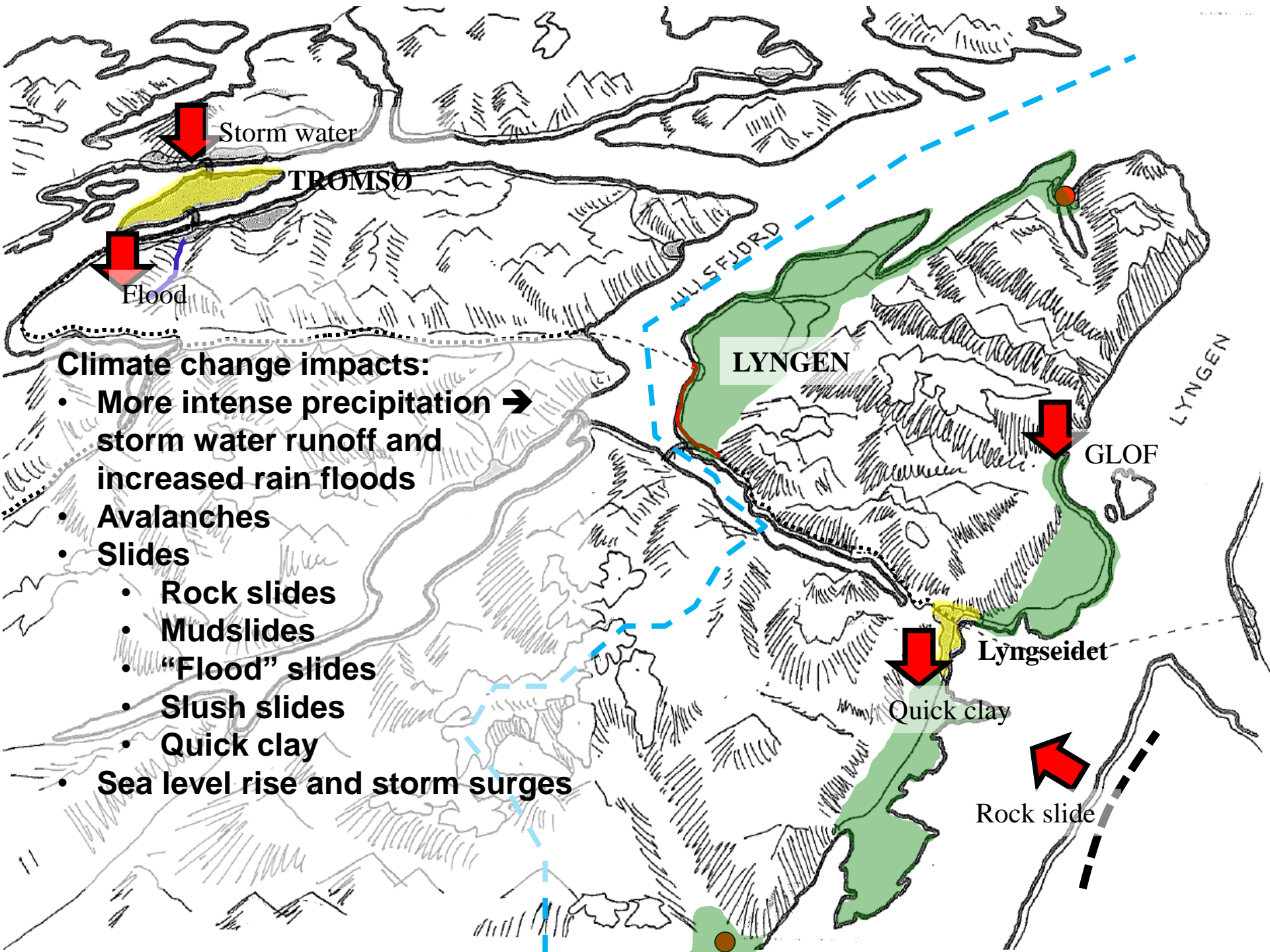
Operation - land use planning : Planning in the municipalities



Operational needs:

The message from the municipalities

- The planning process includes many aspects, we have limited time to consider natural disasters and climate change
- There is a lot of information, how do we know where to find what we need?
- Tell us where there is a risk of flooding – give us numbers



Storm water

TROMSØ

Flood

HILSFJORD

LYNGEN

LYNGEN

GLOF

Lyngseidet

Quick clay

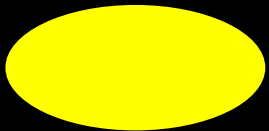
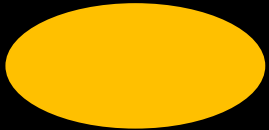
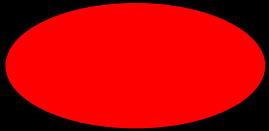
Rock slide

Climate change impacts:

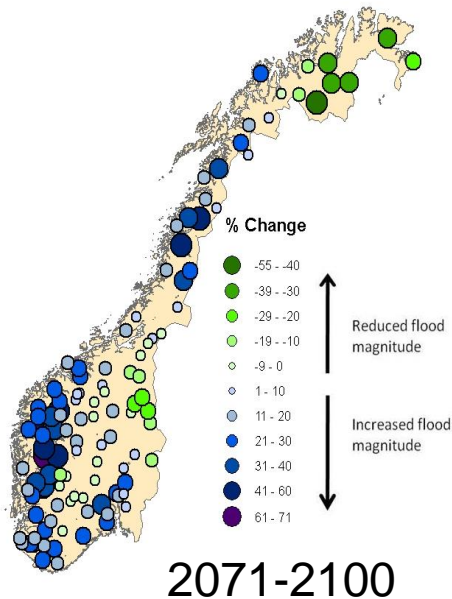
- More intense precipitation → storm water runoff and increased rain floods
- Avalanches
- Slides
 - Rock slides
 - Mudslides
 - “Flood” slides
 - Slush slides
 - Quick clay
- Sea level rise and storm surges

Laws and regulations

- The planning and building act: Housing properties not allowed within area of 200-year flood
- ➔ Where can you build, i.e. a need for “numbers” of overall heights



The role of NCCS in filling the gap



SCIENCE



- How can we take account of changed floods in land use planning etc.?

PRACTICE

NCCS: A key role in deciding the ensemble members and recommend how to use the results for adaptation, including informing about uncertainty

From R20

Floods and land use planning

Decision made by scientists & the water managers at NVE:

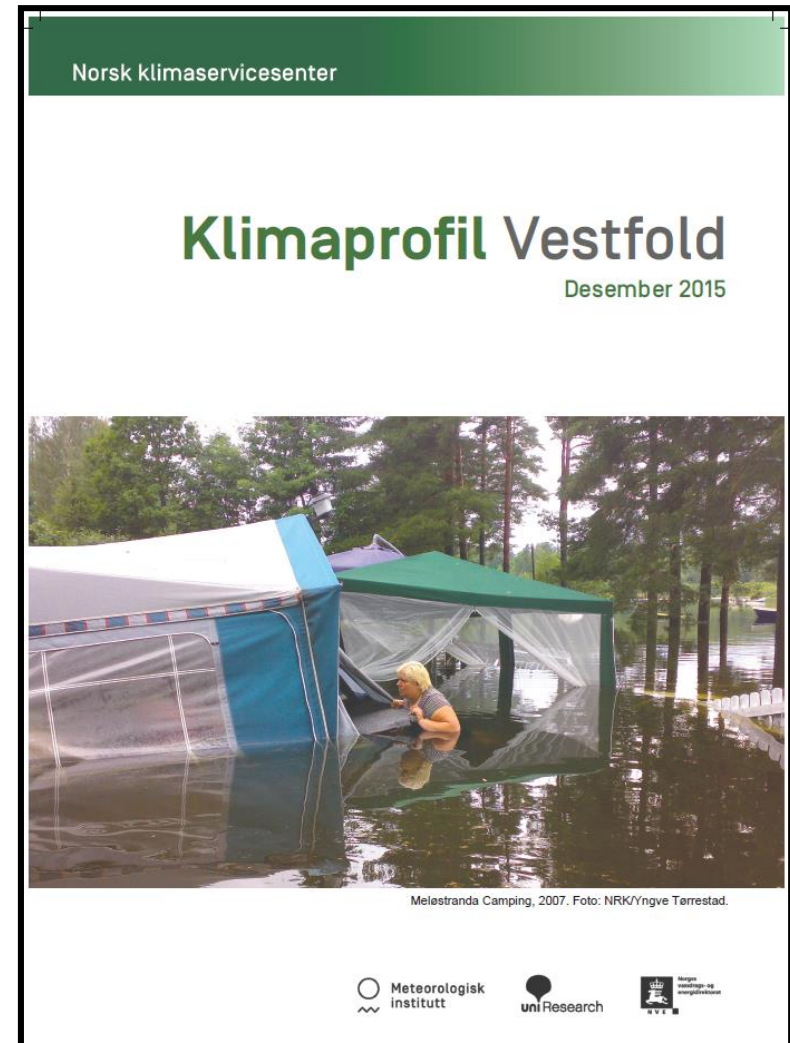
- Use the median change
- If the flood projections indicate more than 20 % increase in the 200-year flood, the flood projections will be used as a basis for flood inundation maps
- If the flood projections indicate less than 20 % increase, historical data will be used as a basis for the flood inundation maps



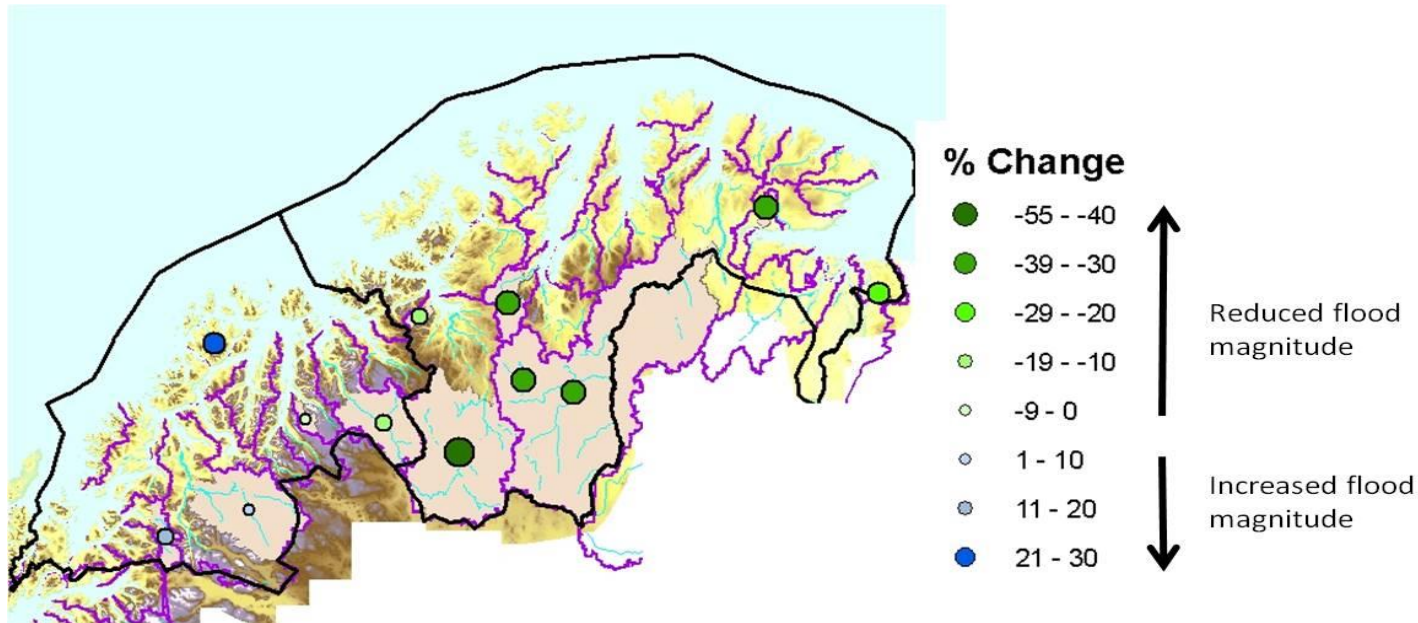
Photo: A. T. Hamarsland, NVE

For each county: «Climate profiles»

- Short summary of the main challenges for the county
- Developed in dialog with county authorities
- Concerns projected changes in temperature, precipitation, flooding, snow conditions, landslides and avalanches



Climate profile – floods in a future climate



Expected change in Troms – consequences for design values:

- Smaller snowmelt floods in the large rivers – use historical data
- Larger rain floods near the coast – increase discharge by 20%
- In small, steep rivers and urban areas, increased frequency of local intense precipitation – 20 % increase should be used

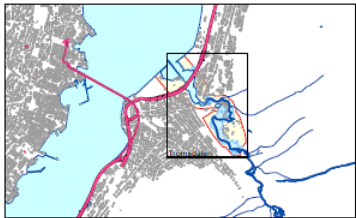
Flood inundation map

VANNSTAND VED TVERRPROFIL

Tromsdalselva

Profilnr	10 år	20 år	50 år	200 år	1000 år	200 år i 2100
1	1.9	2.0	2.1	2.2	2.4	2.9
3	2.1	2.2	2.3	2.6	3.0	3.2
4	2.1	2.2	2.4	2.7	3.1	3.2
5	2.1	2.2	2.4	2.7	3.1	3.3
6	2.7	2.8	2.9	3.1	3.2	3.2
7	4.4	4.5	4.6	4.8	4.9	5.0
8	5.2	5.2	5.3	5.5	5.6	5.6
9	5.4	5.5	5.6	5.7	5.8	5.8
10	6.3	6.4	6.5	6.9	7.0	7.0
11	7.0	7.1	7.2	7.3	7.4	7.4
12	7.1	7.2	7.3	7.3	7.4	7.4
13	7.2	7.3	7.4	7.5	7.6	7.6
14	7.2	7.3	7.4	7.5	7.6	7.6
15	7.1	7.2	7.5	7.6	7.7	7.7
16	7.4	7.7	7.8	7.8	7.9	7.9
17	7.9	7.8	8.0	8.1	8.2	8.2
18	8.2	8.4	9.1	9.0	9.1	9.1
18.5	8.9	9.1	9.2	9.3	9.3	9.4
19	9.0	9.1	9.3	9.3	9.4	9.4
20	9.0	9.1	9.3	9.3	9.4	9.4
21	10.1	10.1	10.2	10.2	10.3	10.3
22	11.2	11.2	11.3	11.4	11.4	11.4
22.8	11.2	11.3	11.4	11.5	11.6	11.6
24	11.9	12.0	12.1	12.2	12.4	12.4
25	12.0	12.1	12.1	12.3	12.4	12.4
26	12.6	12.6	12.7	12.7	12.8	12.8
27	12.6	12.7	12.8	12.8	13.0	13.0
28	13.0	13.0	13.0	13.1	13.2	13.2

OVERSIKT KARTBLAD

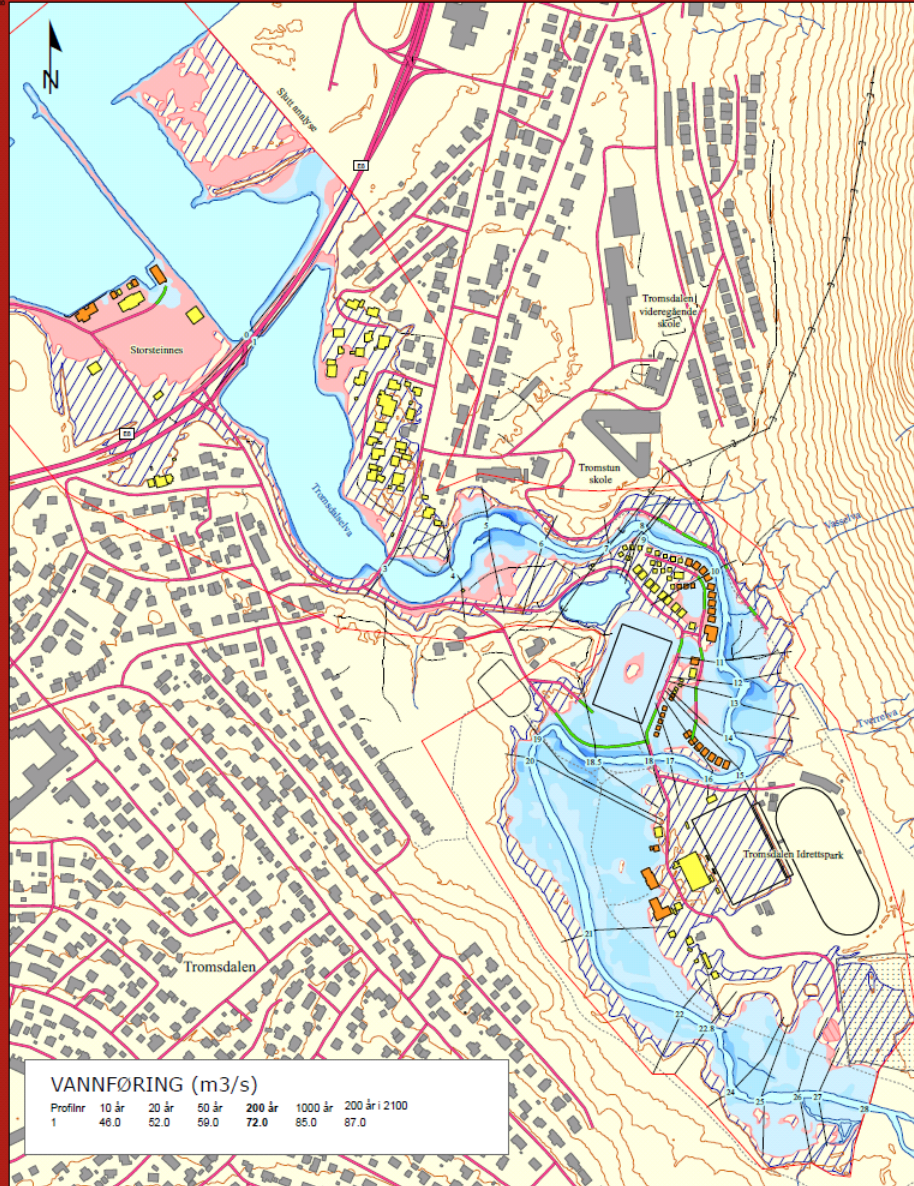


Analysområde

OVERSIKTSKART



Delprosjekt Tromsdalen
199.12, TROMSDALSELVA



VANNFØRING (m3/s)

Profilnr	10 år	20 år	50 år	200 år	1000 år	200 år i 2100
1	46.0	52.0	59.0	72.0	85.0	87.0

TEGNFORKLARING

Dagens 200-årsflom

< 0,5	1,5 - 2
0,5 - 1	> 2
1 - 1,5	

Lavpunter - områder som ikke har direkte forbindelse med elva (bak flomverk, kulvert, m.v.). Sannsynlighet for oversvømmelse må vurderes nærmere

Sone med fare for vann i kjeller - områder som ligger mindre enn 2,5 m høyere enn flomsone

Analysområde

Flomutsatte bygninger

Bygninger med fare for vann i kjeller

Oversvømt vei

Endret klima i år 2100

Oversvømt areal ved 200-årsflom i år 2100

Lavpunkt ved 200-årsflom i år 2100

Ikke flomutsatte bygninger

Elv og vann

Gravplass

Tverrprofil med profilnummer

Europa-, riks- og fylkesvei med vegnummer

Kommunal og privat vei

Kraftline

Bekk

Høydekurver med fem meters ekvidistanse



FLOMSONEKART

Prosjekt: Tromsdalselva

Kartblad Tromsdalen

200-årsflom

Godkjent 20. desember 2012

Målestokk 1:3 500

Koordinatsystem:	UTM 33
Kartgrunnlag:	
Situasjon:	Norge Digitalt 2011
Høydedata:	Laserdata, SK 2012
Flomsoneanalyse:	
Flomsoneier:	NVE notat. 05012012
Vannlinjer:	Mars 2012
Terrengmodell:	September 2011
GIS-analyse:	November 2012
Prosjektrapport:	NVE rapport nr. 63/2012
Prosjektnummer:	fs199_1

NORGES VASSDRAGS- OG ENERGIDIREKTORAT (NVE)

Pb. 5061 Majorstuen, 0301 Oslo
Tlf. 09575 Faks: 22 95 90 00
Internett: <http://www.nve.no/flomsonekart>

The role of NCCS

- Knowledge about the most recent scientific results
 - Knowledge about different actors and their role (distribution of responsibility)
 - Knowledge about requirements in laws and guidelines
 - Knowledge about requirements in different planning processes related to land use planning
 - Knowledge about the different needs of different user groups
- ➔ Recommend which “numbers” to use in a consistent way
- ➔ Contribute to capacity building at the national, regional and local level

Thank you!



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