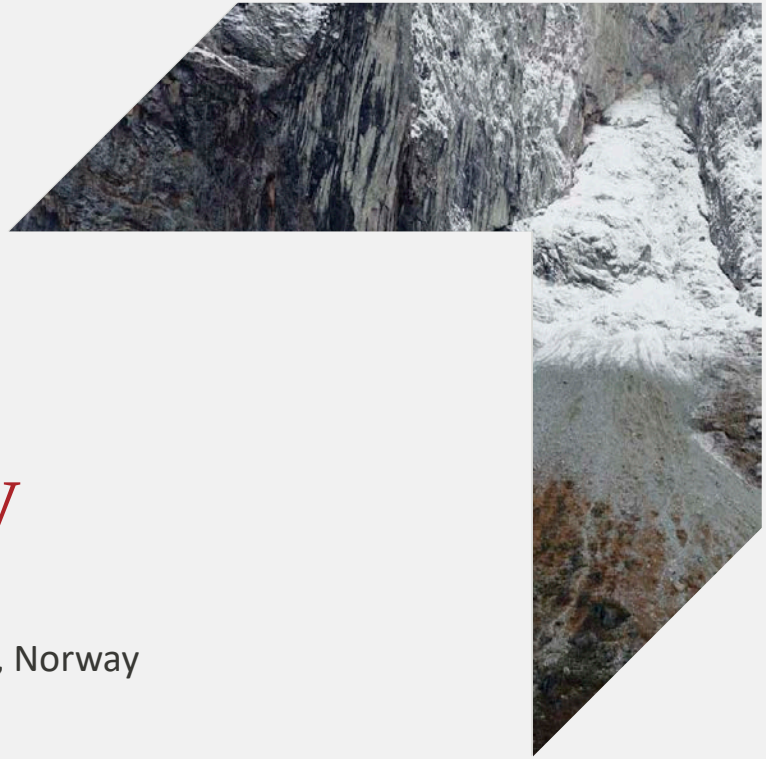
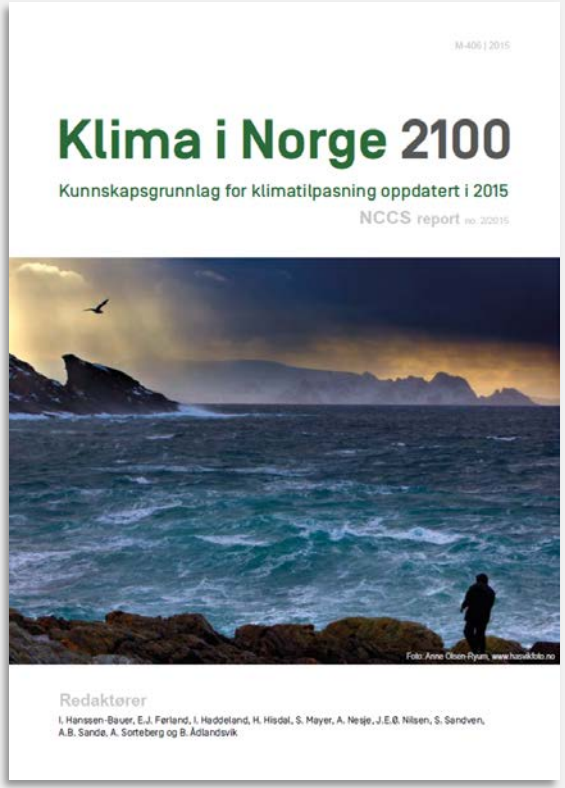


Climate threats, Norway

Bjørn Kalsnes
Technical Lead Georisk and Climate Change Impact, NGI, Norway

ELGIP meeting, Linkøping, 5th April 2018

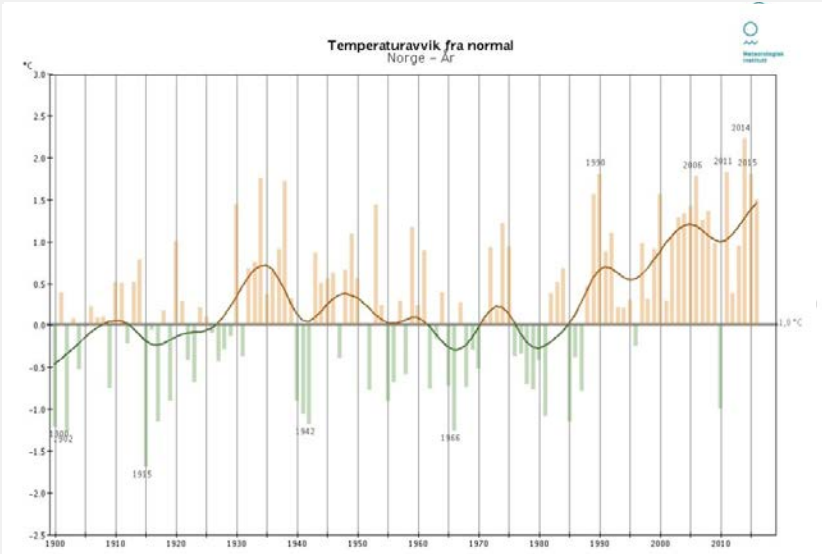
- It will be hotter
- It will be wetter
- It will be more extreme events
- The flood pattern will change
- The landslide hazard will increase



Kilde: Hans Olav Hygen, met.no

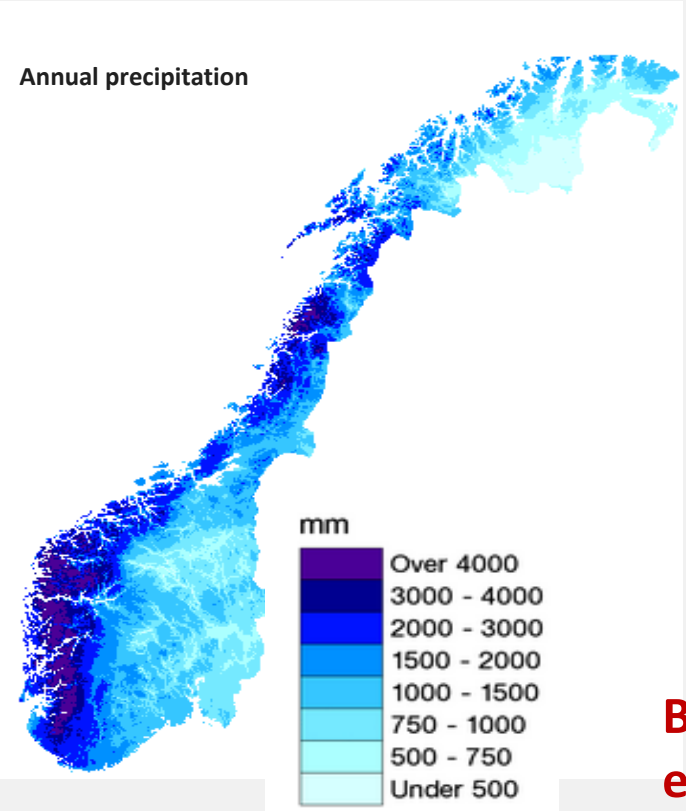
Natural hazards in Norway

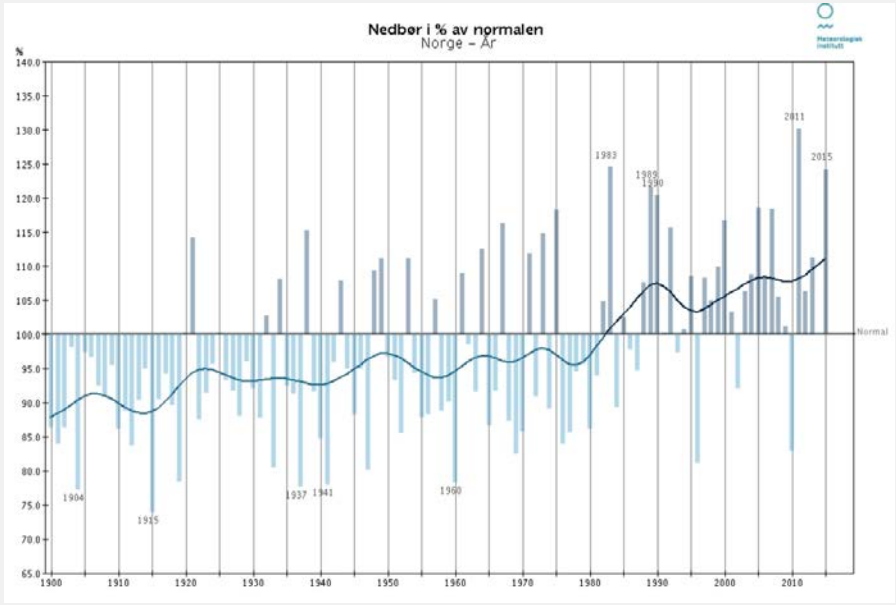
- Debris slides, debris flows, and landslides in sensitive clays (‘Quick clay’)
- Snow avalanches – Dry, wet and slushflows
- Rock slides and rock fall
- Tsunamis triggered by landslides
- Flooding, Storms and storm surge,
- Extreme temperatures



Most are climate related!

Precipitation pattern in Norway





Annual precipitation in Norway, 1900-2013
(% of ”normal” (1961-1990))

Both precipitation with long duration and short, extreme events can be critical.

Today’s climate is already problematic.

Soil landslides and debris flows – major threat to the built environment,

Almost always triggered by prolonged and/or intense precipitation, and snow melt, but <u>often assisted by human activity!</u>

- Directly linked to weather and climate
- Ca. 125 fatalities last 150 years
- Economic loss from:
  - Damage to buildings and critical infrastructure
  - Closed roads, railroads, etc.

NGI

..as well as to the transport infrastructure.

Flooding in village Kvam, 2011 and 2013

- Rebuilt after 2011, and hit again in 2013!
- Homes built on flood and debris flow fans are common in Norway!

Expected future changes

Debris slides / flows

- **Most of Norway will experience more days with strong / extreme precipitation, and hence increased frequency of landslides.**

Flooding

- **Frequency of floods will increase and be distributed more evenly in time (other than the typical spring –and autumn floods).**

Landslides in sensitive clay (Quick clay slides)

- **Most quick clay slides in recent 50-60 years are triggered by human activity.**
- **Probability of naturally triggered quick clay slides may increase due to increased erosion from flooding in rivers and streams.**

Rock fall and rock slides

- **Increase in number of days with strong precipitation may lead to increased frequency of rock fall.**
- **More frequent freeze – thaw episodes also increase the rock fall hazard.**

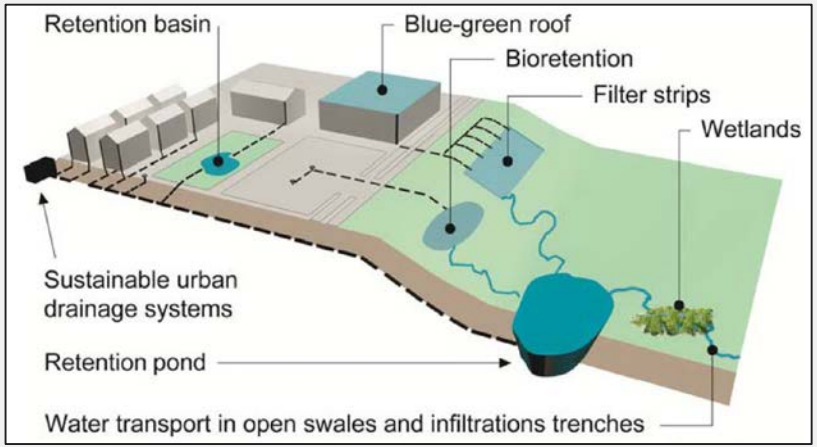
Snow avalanches:

- **Increased frequency of snow avalanches due to more precipitation.**
- **There are also indications of more days with strong wind, which also may increase the avalanche hazard.**
- **But! Increased temperatures lead to higher snow line and also higher tree line, both decreasing the hazard for the built infrastructure.**

RCN: Center for Research Based Innovation (SFI): ‘KLIMA2050’

- Risk reduction through climate adaptation of buildings and infrastructure
- 20 Partners from research, public sector, and industry.
- 8 years; 2015-2023
- Total budget NOK 221 mill. (24 mill. EURO)

WP 1: Climate adaptation of buildings
WP2: Urban flooding
WP3: Water triggered landslides(NGI)
WP4: Management and decision processes



NGI **www.klima2050.no**

WP 3 - Landslides triggered by hydro-meteorological processes

- Innovative measures for risk management.
- Innovative: improved existing, or new.
- Objective of risk management: cost-effective risk reduction.
- Risk reducation measures:
  - Slope stabilizations.
  - Protection of infrastructure from landslides.
  - Early Warning Systems.
  - Other risk management activities.
- Common aspects: technical/economic feasibility and optimization, maintenance/sustainability, active partner involvement (pre-, co-, post-)

PhD call WP3 (NTNU)

PhD position on innovative protection solutions from landslides triggered by extreme weather events (IV-119/18)

Deadline 15 April 2018

https://www.jobbnorge.no/ledige-stillinger/stilling/149851/phd-position-on-innovative-protection-solutions-from-landslides-triggered-by-extreme-weather-events-iv-119-18

Activities/goal for CCA working group

- Practical solutions, not basic research
- How can geotechnical engineers contribute to a sustainable development?
- Geotechnical contribution in an international perspective (e.g. subsidence)
- Coordination of activities with other sciences (ecological, societal, construction)
- Codes/regulations
- Dissemination

THANK YOU!