



Adapting to changing climate in the transport sectors

Project manager Bjørn Kristoffer Dolva,
Experience exchange seminar on
"Practical solutions to climate risk and
vulnerability assessments"

Oslo, February 16, 2016

Introduction

Adapting to changing climate in the transport sectors

- How does the transport sector adapt to a changing climate?
- About the NIFS project
- Experiences, challenges and needs in the future



Photo: Norfilm

Higher risk of flood and erosion, insufficient drainage capacity



Odda, 2014

Photo: Gunnar Moland

[Flood damage in Flåm, 2014](#)



Photo: Ove Strømme

Wave erosion, flooding from sea, storm surge –
- important for coastal roads and elevation of sub-sea tunnels.

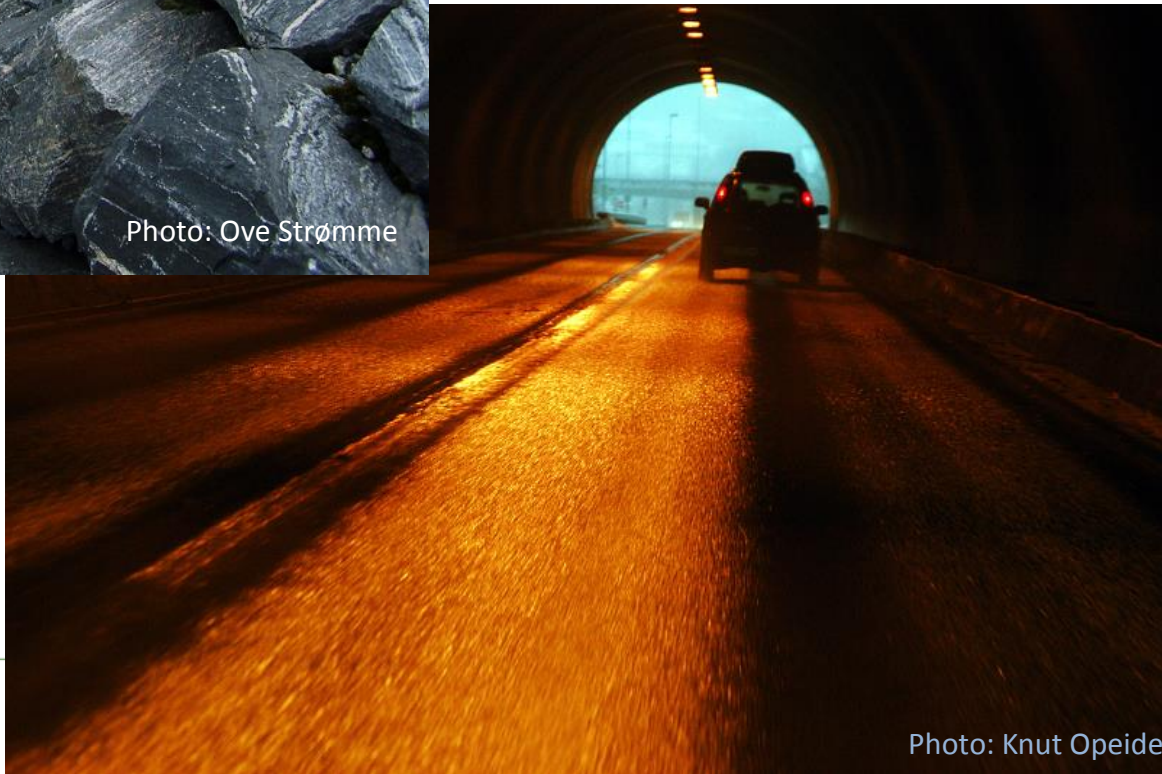


Photo: Knut Opeide



Foto: Tore Humstad

Higher risk of landslides and avalanches, occurring new places and more frequently.



Foto: Ole Andre Helgaas



Photo: Niklas Eriksson



Debris flows & slush avalanches

Operation problems due to heavy snowfall.



Actions and framework for adaptation

Climate change

NPRA addressing climate change

R&D program «Climate and Transport»



Aim: investigate all effects of climate change on roads & propose remedial measures.

Budget € 2,2 mill over four years



NPRA addressing climate change

R&D program «Natural Hazards – - Infrastructure, Floods and Slides»

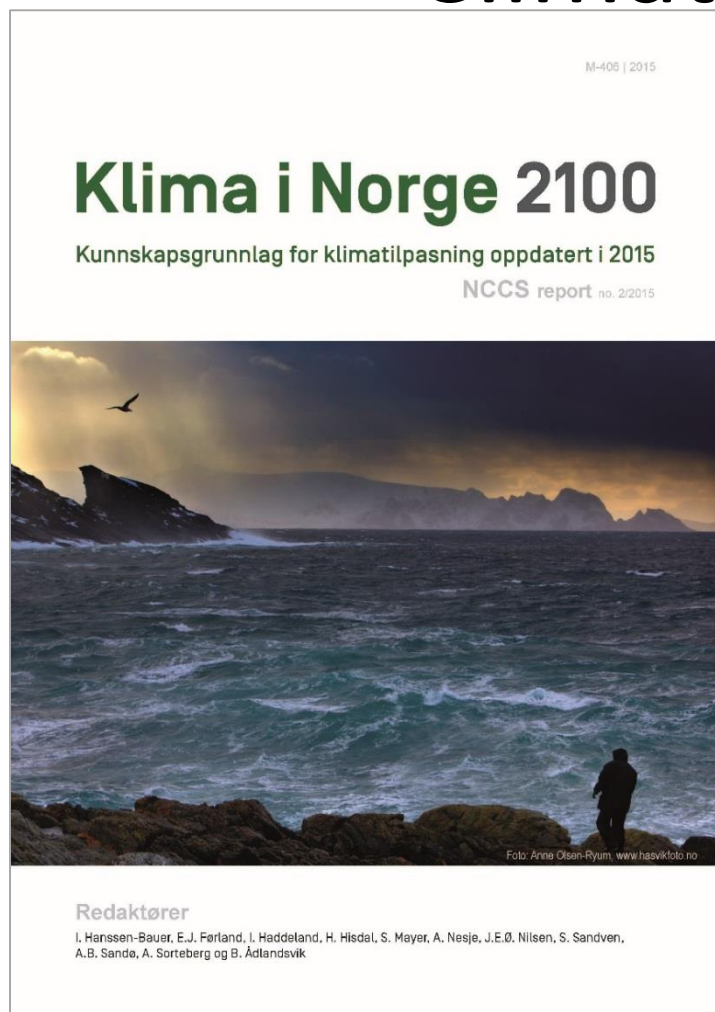


Collaboration between:

- NPRA
- Norwegian National Rail Administration
- Norwegian Water Resources and Energy Directorate

Budget € 4.5 mill over four years

Climate projections



Update following IPCC's AR5

The basis for calculations:

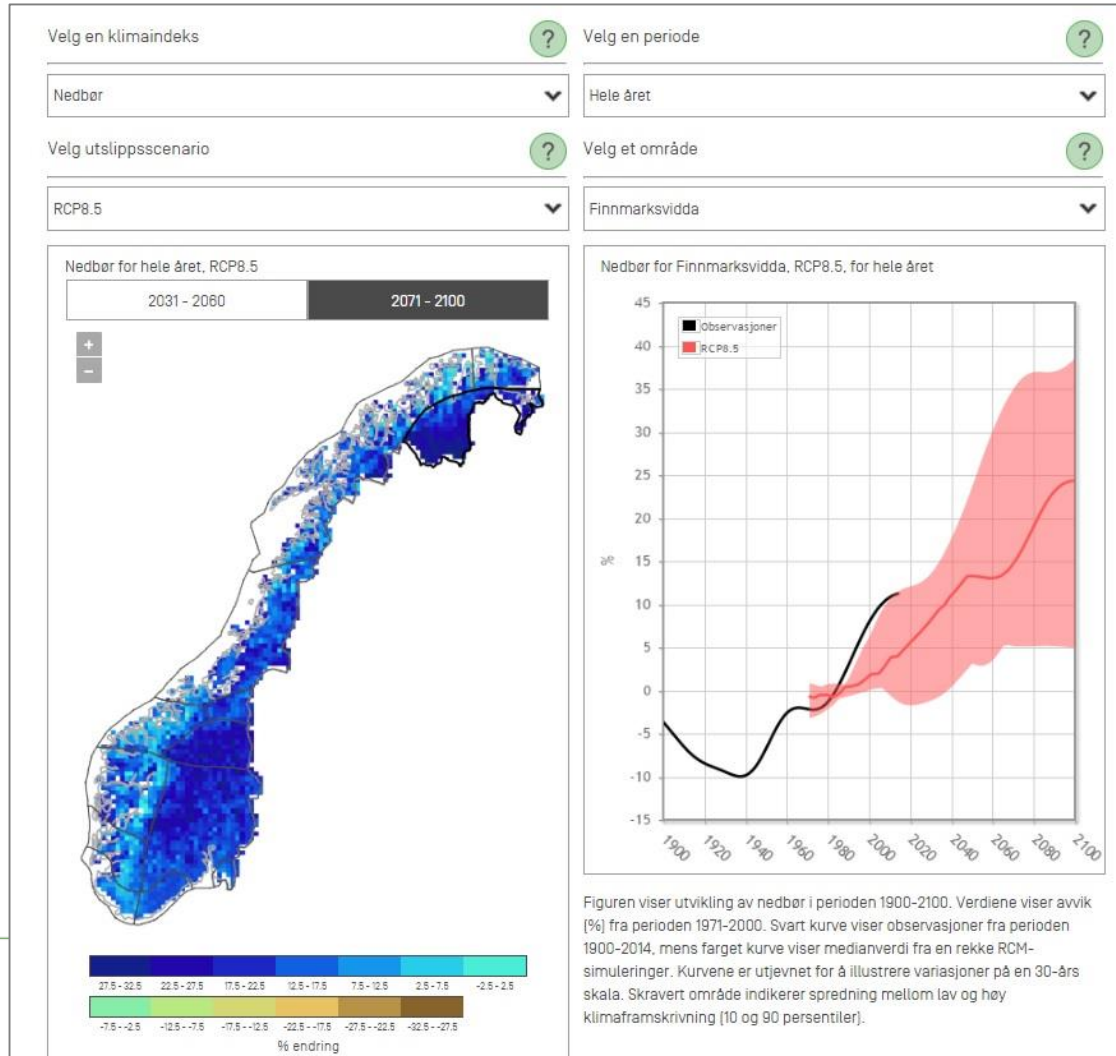
- climate developments in Norway so far
- assumptions about future greenhouse gas emissions.

Climate projections

6 temperature regions
13 precipitation regions

>> annual and seasonal projections

[Interactive maps](#)



Norwegian Centre for Climate Services

eklika.met.no

Free access to weather- and climate data: historical, real time, forecast

www.senorge.no

Daily updated maps of snow, weather and water conditions and climate.

[Sea level change for Norway](#)

[Flood charts and flood projections](#)

[Short term precipitation](#)

Introduction to NIFS



Recent experiences



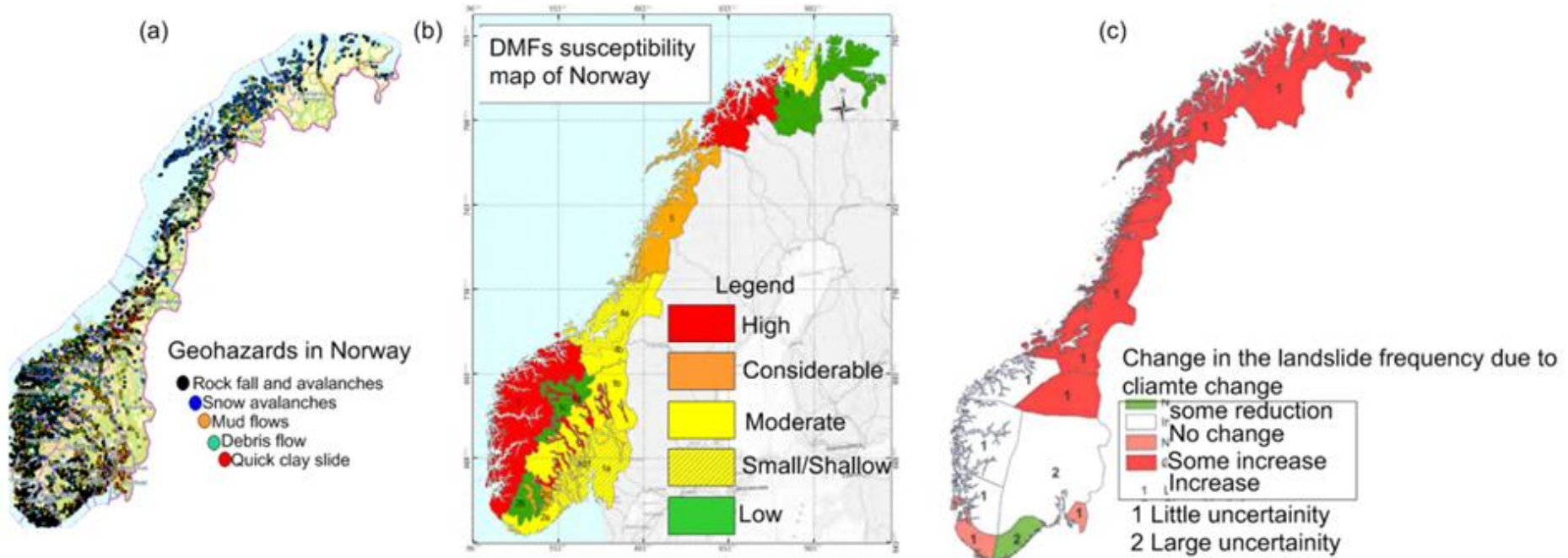
Impact of extreme weather event triggered natural hazards on Norwegian transportation infrastructure (Source: NNRA and NPRA).

Recent experiences and studies

with Extreme Weather Events (EWEs)

- an increase in the frequency and/or intensity of EWEs including unusual, severe or unseasonal rainfall, temperature fluctuations and strong winds
- the size and frequency of natural hazards such as flooding, debris- and mudflow (DMF) types have also increased
- in areas that we have not experienced in the past

Natural hazard challenges in Norway



(a) Natural hazard challenges in Norway, based on www.skrednett.no.

(b) DMF's susceptibility map of Norway illustrated using a recent study carried out by NIFS

(c) Change in landslide frequencies due to climate change triggered EWEs as suggested by NVE

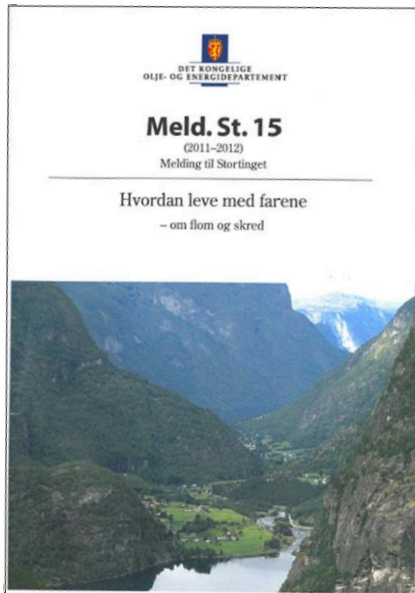
Natural hazards, infrastructure, floods and slides (2012-2015)

Budget = 42 MNOK

Quick clay = 10 MNOK

A partnership between

- Norwegian National Rail Administration
- Norwegian Water Resources and Energy Directorate
- Norwegian Public Roads Administration



The Natural Hazards Project:
Programme plan 2012-2015
for the Government Agency
Programme
"NATURAL HAZARDS – Infrastructure for floods
and slides (NIFS)"

57
2013

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www.naturfare.no



How to live with the risks

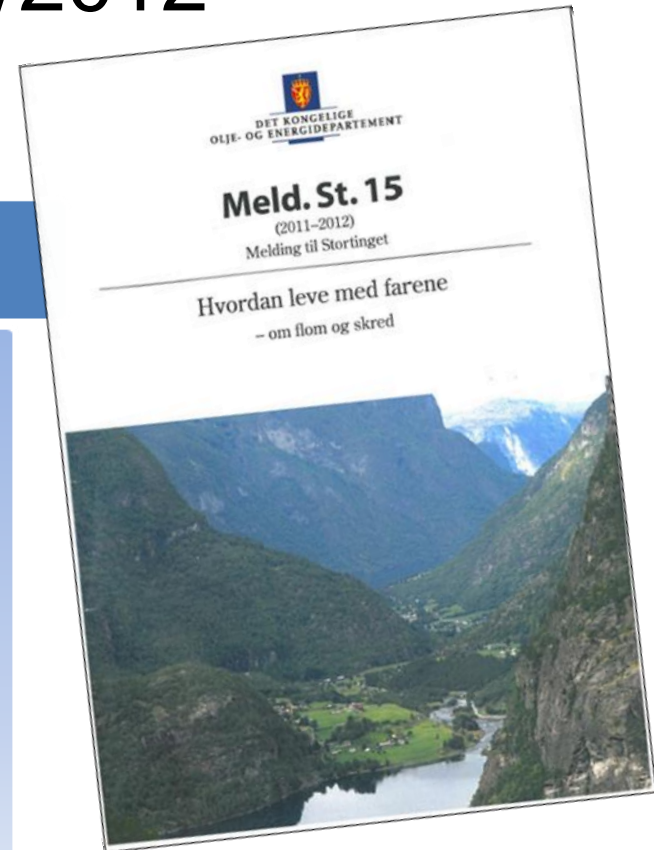
– about floods and slides
white paper no. 15/2012

NATURAL HAZARDS- infrastructure for floods and slides (NIFS)

- 1 - Natural hazards strategy
- 2 - Emergency preparedness and crisis managemner
- 3 - Mapping, land use and RVA
- 4 - Monitoring and forecasting
- 5 - Floods and surface water management
- 6 - Landslides in quick clays
- 7 - Avalanche, landslide and flood protection

Data coordination

Adjacent projects





Natur
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pro



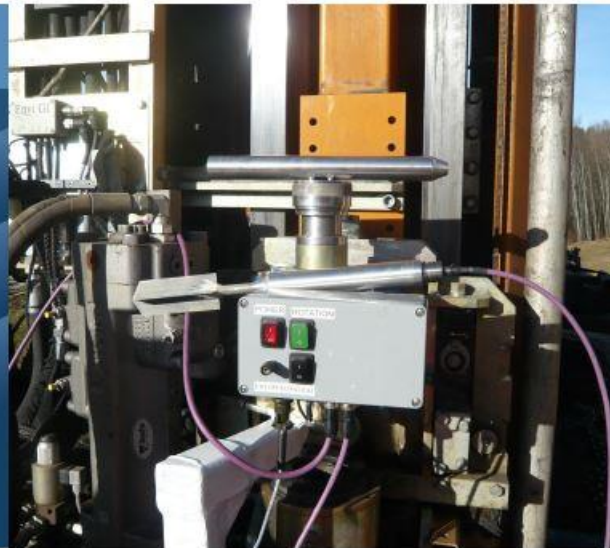
Jernbaneverket



Statens vegvesen

Detektering av kvikkleire ved hjelp av R-CPTU
og elektrisk vingebor. Resultater fra feltstudie.
Naturfareprosjektet: Delprosjekt 6 Kvikkleire

101
2015



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Statens vegvesen

vann på avele
Norge
km²

66
2013

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Notodden 23. July 2011



Photo: Kjell Aulie

Theory



Practise

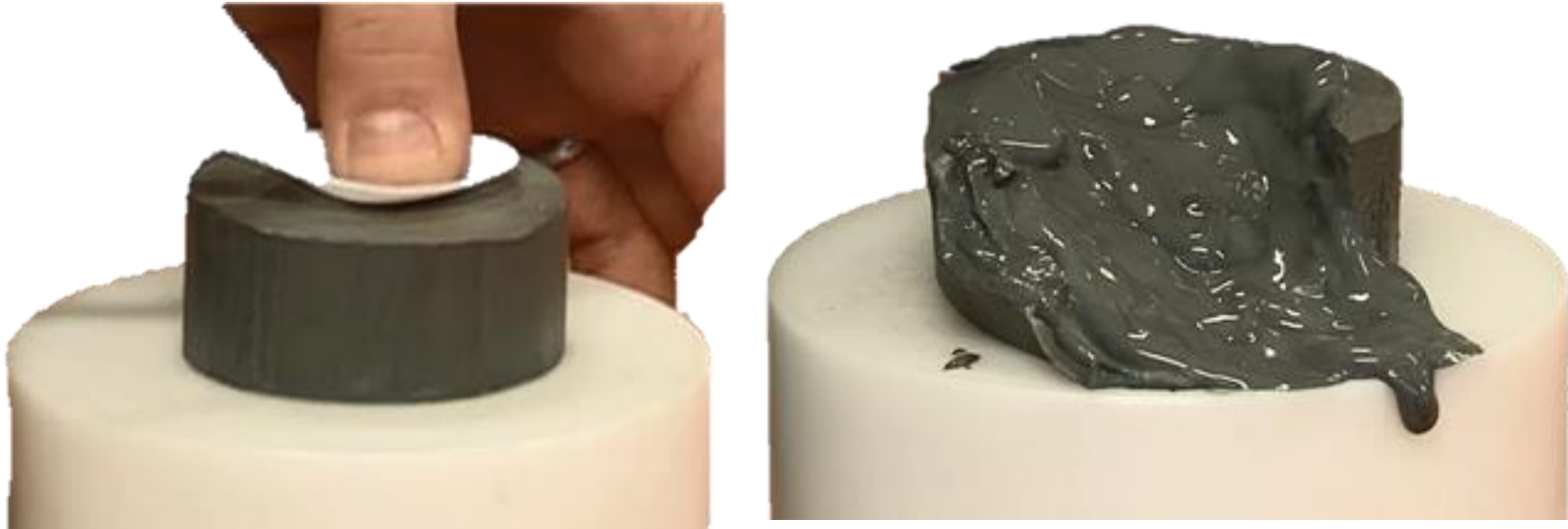
- Develop robust infrastructure
- Handling of floods and slides
- Collaboration within f.ex. geographical area, in a defined rain field



Slope stability and landslides related challenges in Quick clay

- Definition and delineation of overall stability
- Source data for risk assessment
- Shoreline slides
- Site investigation for surveying quick clay
- Numerical models
- Safety policies and regulations
- Landslide retrogression and run-out
- Stabilisation of quick clay

Quick clay



Left: Norwegian sensitive clay at the intact state,
Right: Remoulded due to the loading.

Landslide in highly sensitive clays (quick clays)

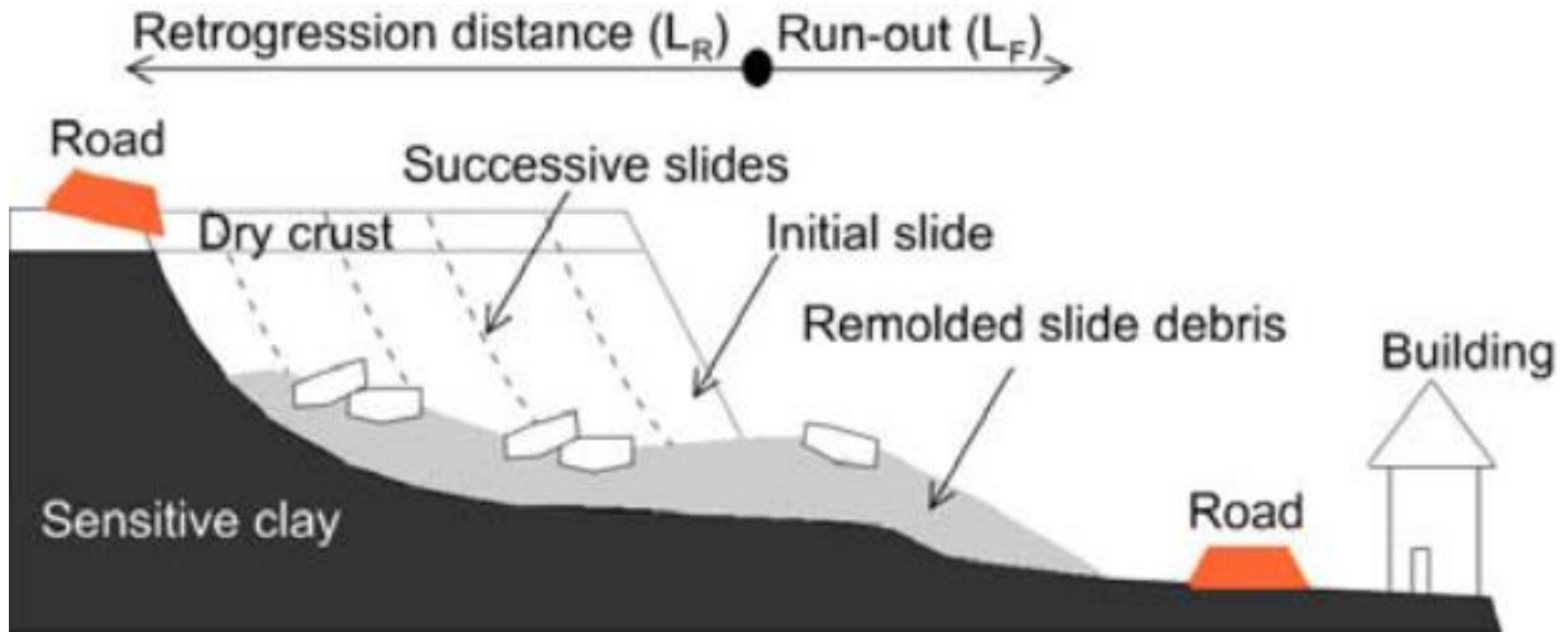
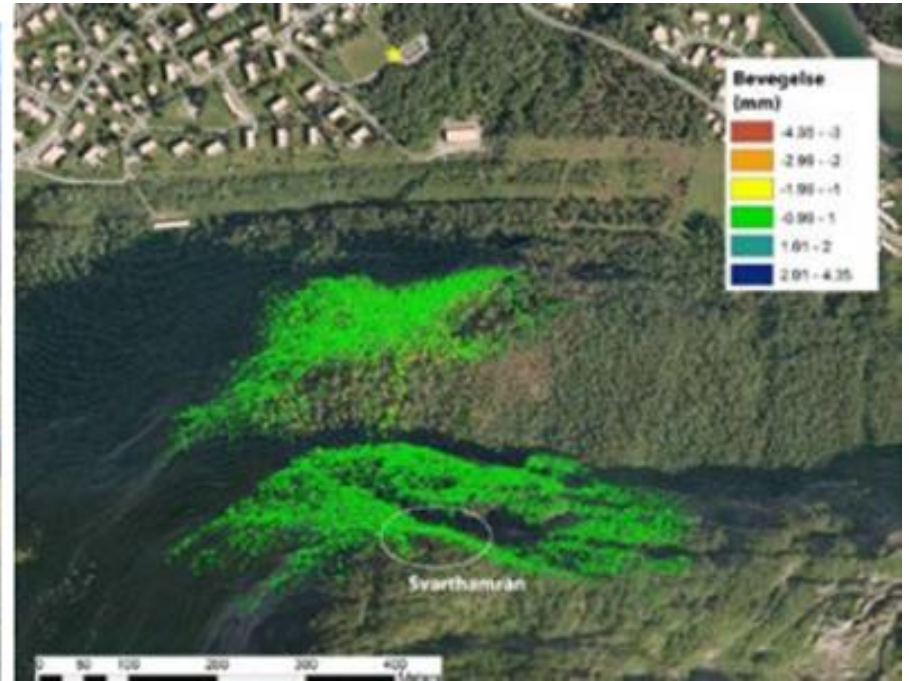


Illustration of a landslide in highly sensitive clays (quick clays)
(Source: Thakur et al. 2013).

Avalanche, landslide and flood protection

- Slide processes and protective measures (why things go wrong).
- Guidelines/handbooks/checklists (how to prevent things from going wrong).
- Flood, avalanche and landslide acceptance (when it is okay that things go wrong).

Avalanche, landslide and flood protection



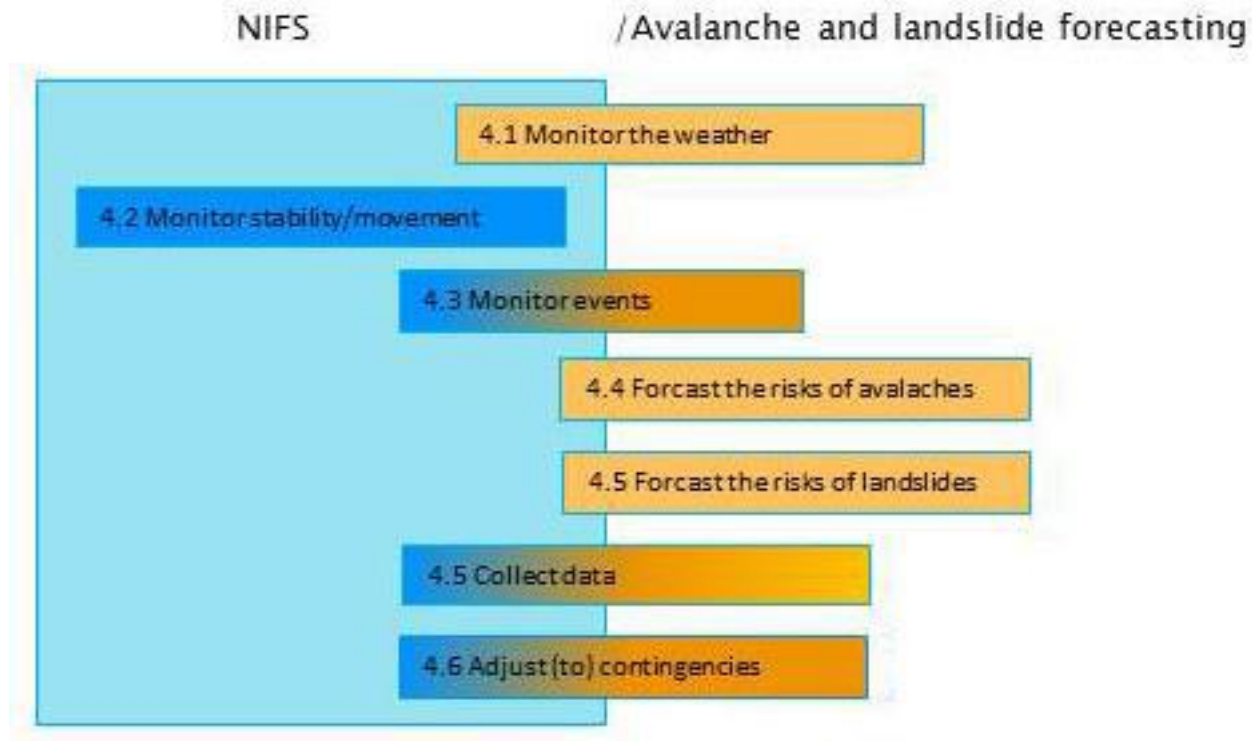
Left: Geohazards monitoring using radar and UAV.

Right: shows the movements registered in a rock slope in Norway

Mapping, data coordination and risk and vulnerability assessment

- Mapping floods, avalanches and landslides
- Data coordination
- Risk and Vulnerability Assessment (RVA) plan
- Flood and landslide events

Monitoring and forecasting



Emergency preparedness and crisis management

- Role and responsibilities
- Planning for emergencies
- Crisis management
- Drills and training across agencies
- Information flow
- Recommendations

Implemented measures & unsolved challenges

State of work

Revised manuals of design and practice

State of the work

- NPRA manuals: based on standards, with additional requirements, guidelines for roads and road assets.
- Amendments to incorporate climate change



State of the work

Revised manuals of design and practice

Examples

- climate conditions included in the premises **for planning**
- **200-year** flood level is the basis for design of road elevation + hydrological expertise



Revised manuals of design and practice

Examples

- drainage capacity: requires the **latest data** and the use of an additional **robustness factor**
- plan for water management required
- **comprehensive drainage plans**



Photo: Norfilm

State of the work

Revised manuals of design and practice

Examples

- **mainstreaming adaptation**: a part of all work processes and schedules maintenance.
- new template for **preparedness plans for natural hazards**: better data, maps etc..



Web portal xgeo.no

xgeo.no - a precautionary tool for notification and emergency

Location search Feedback About xgeo.no Norsk Logg inn

Floods and landslides Avalanche Road Railway All data

AWARENESS MAP Water supply previous 3 days at 08 AM on May 23, 2013

-1 year -1 week -1 day Today +1 day +1 week +1 year 5/23/2013 Vis rapport

Grid data **Point/line data** **Event data** **Height slider** **Stations** **Supporting maps** **Legend**

Day

- My favorites
- Weather
- Farekart
- Fresh snow last day
- Fresh snow previous 3 day
- Water supply (old)
- Water supply 3 days**
- xFreeze-thaw index 1
- xFreeze-thaw index 2
- xHydmet-index
- xSnow transport
- Weather

Filter events on map

Filter events [days] 0 show current date

Days back: 0

Days ahead: 0

- Landslides and snow avalanches database
- regObs - dangersigns
- regObs - incidents
- regObs - observations
- regObs - pictures
- Traffic report
 - Avalanche
 - Avalanche danger
 - Bad weather
 - Flood
 - Land slide
 - Rock fall

Water supply 3 days

Observation-based
Generated 03.12.2013 at 09:08
Based on interpolated weather observations

Map shows water supply (snow melt and rain) in percent of threshold value during previous 72-hour period. Threshold value for 72 hour period is 15.6% of normal annual value for the period 1971-2000 (Sandersen et al., 1996).

Updated around 6, 8, 9, 19 and 21 Norwegian standard time.

Data from 01.01.1995 until today

Data owner: Norwegian Water Resources and Energy Directorate

% of threshold value

- > 80%
- 60-80%
- 40-60%
- < 40%
- No water supply

0 30 60km

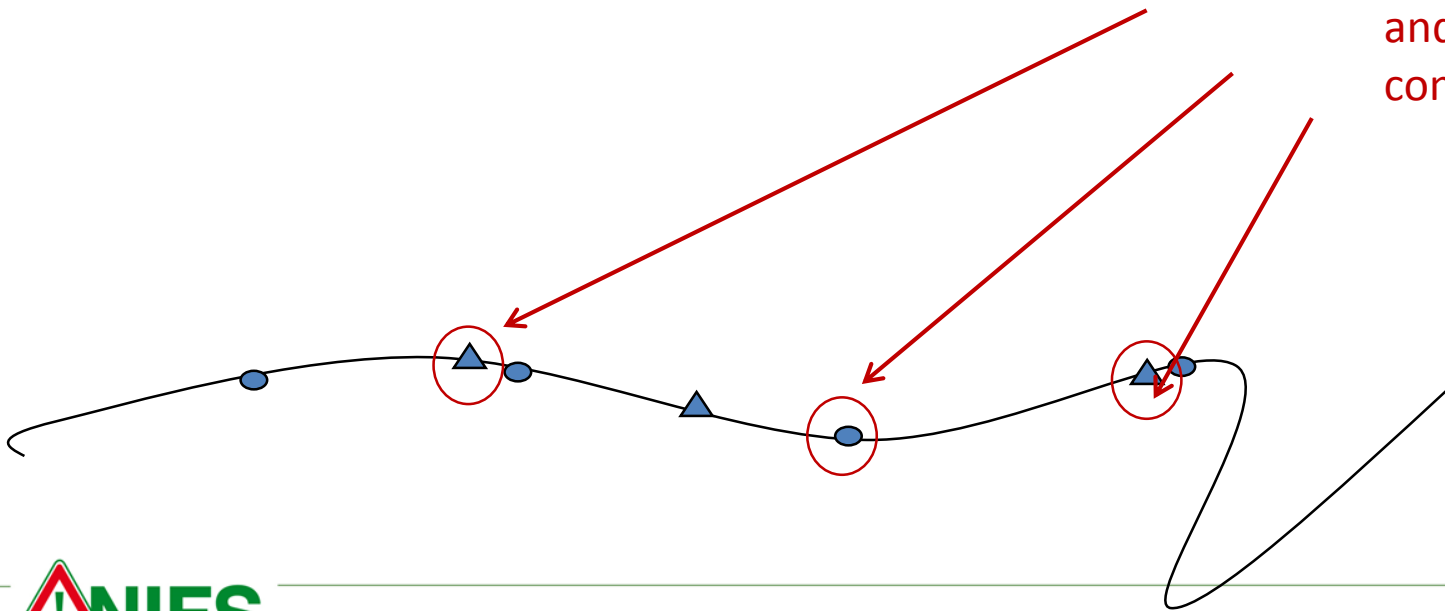
Change opacity: Change zoom:

20:32 06.09.2015

Concept for vulnerability surveys

- NPRA carries out a large scale surveys from the aspect of redundancy
- Climate change is introduced in the survey

More detailed analyses of assets and surrounding conditions

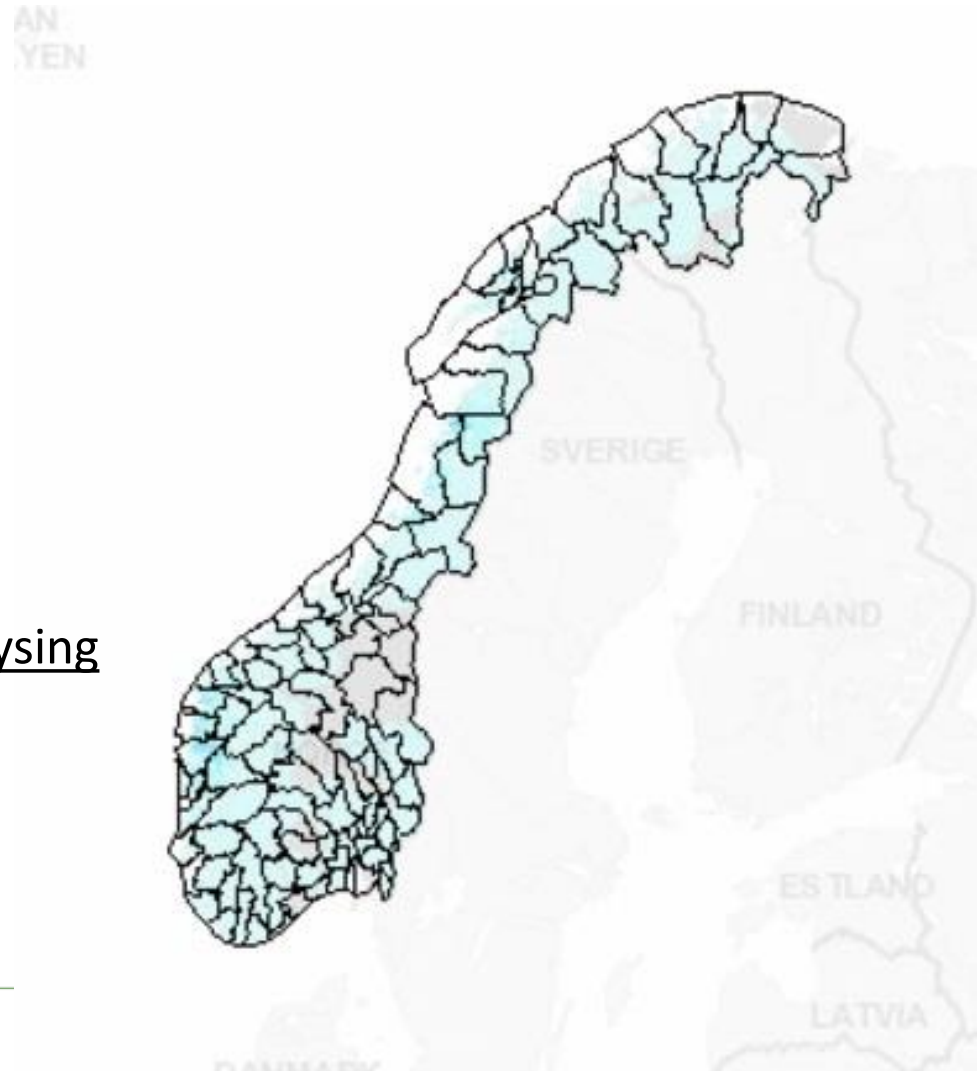


Inventory of vulnerable assets

However...

A lot of valuable work in **developing preparedness plans** for natural hazards.

An important part of the work is analysing vulnerability.

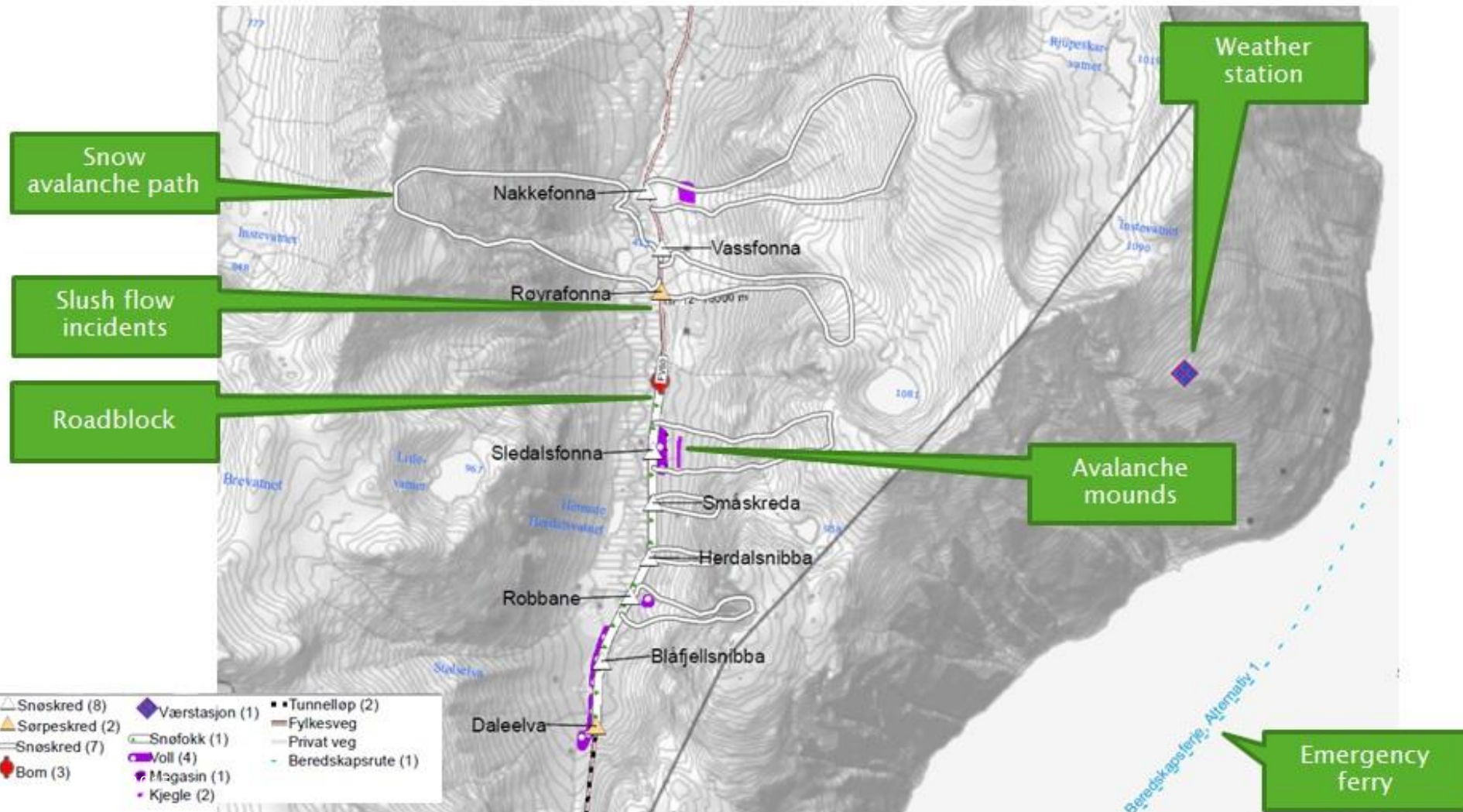


Assessing vulnerabilities in contingency plans

Current tasks

Assessing vulnerability in contingency plans

Mapped information



The document template

Assessing vulnerability in contingency plans

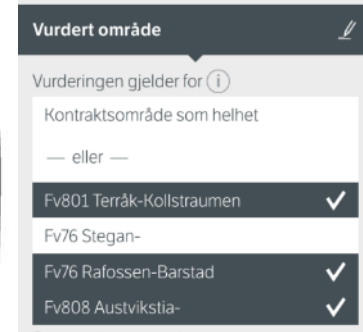
- Scope
- Description of area:
topography, climate, geology, hydrology, main road sections and road structures, etc.
- Describing vulnerabilities
 - Landslides and avalanches
 - Flood risk sections
 - Vulnerable constructions
 - Unfavourable weather conditions
- Threshold values
e.g. snowfall in 3-hr period, 24-hr period
- Ongoing improvement: Broader perspective of possible natural hazards



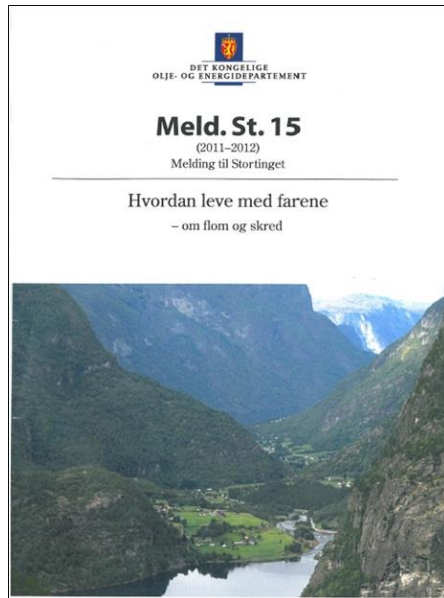
Assessing vulnerability in contingency plans

Registration of natural hazards

Web and smartphone application



White paper no. 15 «How to live with the risks»



>>> Holistic approach

... in areas where the risk of flooding and / or landslides is particularly high, the relationships can be complex

... may be relevant in a more coordinated planning. Such plans may be developed in cooperation between **NVE** as a technical agency, municipalities, counties and other concerned agencies.

National strategy - floods and slides

- NVE and other governmental agencies shall together develop a national strategy for cooperation and coordination
- NVE will take initiative and have the responsibility of continuous monitoring. The objective should be to achieve better coordination and cooperation on dealing with flood and landslide risk. The strategy will concretize cooperation areas and identify measures to improve the interaction between the actors.

NIFS provides contribution to this strategy:

- input for better management, communication, education etc
- coordination measures: common databases for avalanche data, soil investigation data etc.
- data development (common tools), for example. Map sites and warning system

Closing remarks & video

This is not the end.

It is not even the beginning of the end.

But it is, perhaps, the end of the
beginning

(Churchill, 1942)

- [The use of drone at Skjeggestad, Norway](#)