

*« Climate and Transport »
R&D Programme for the Adaptation of
Norwegian Roads to Climate Change*

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R&D program evaluating the effect of climate change on the road network and remedial actions

Norwegian Public Roads Administration

2007- 2010, cca 2,75 M€



Climate
and
transport

R&D program evaluating the effect of climate change on the road network and remedial actions

Main objective: Improve design, construction and maintenance of the road network in order to adapt to climate changes.

Even in a changed climate...

... the roads have to
meet the society's
safety and
environmental
requirements

and ensure
efficient
transportation



EUROPE



Climate in Norway 2100

Temperature: annual mean temp. increase 2.3 - 4.6 °C

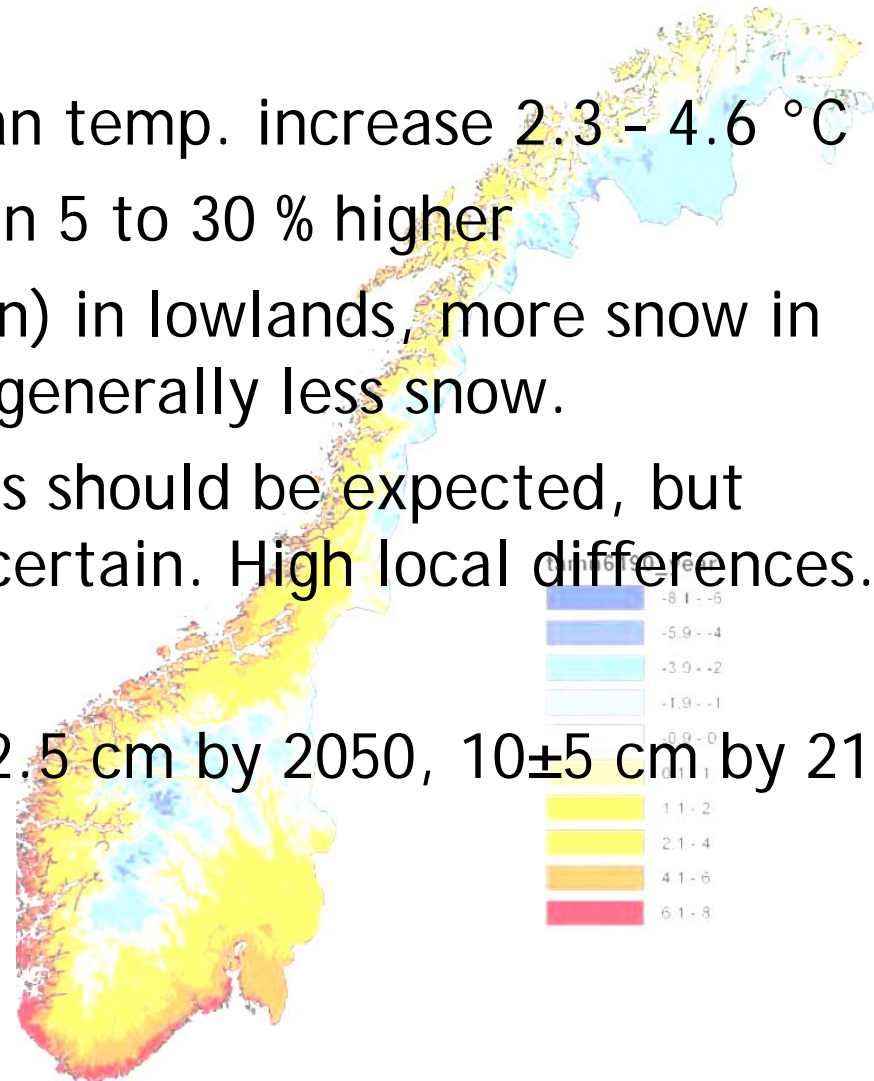
Precipitation: annual mean 5 to 30 % higher

Snow: less snow (more rain) in lowlands, more snow in mountain areas. 2100 - generally less snow.

Flood: Higher risk of floods should be expected, but projections are very uncertain. High local differences.

Sea level rise: 40 - 70 cm

Storm surge increase: 5±2.5 cm by 2050, 10±5 cm by 2100



Higher risk of floods



Numedalslågen juli 2007



Bridge scouring

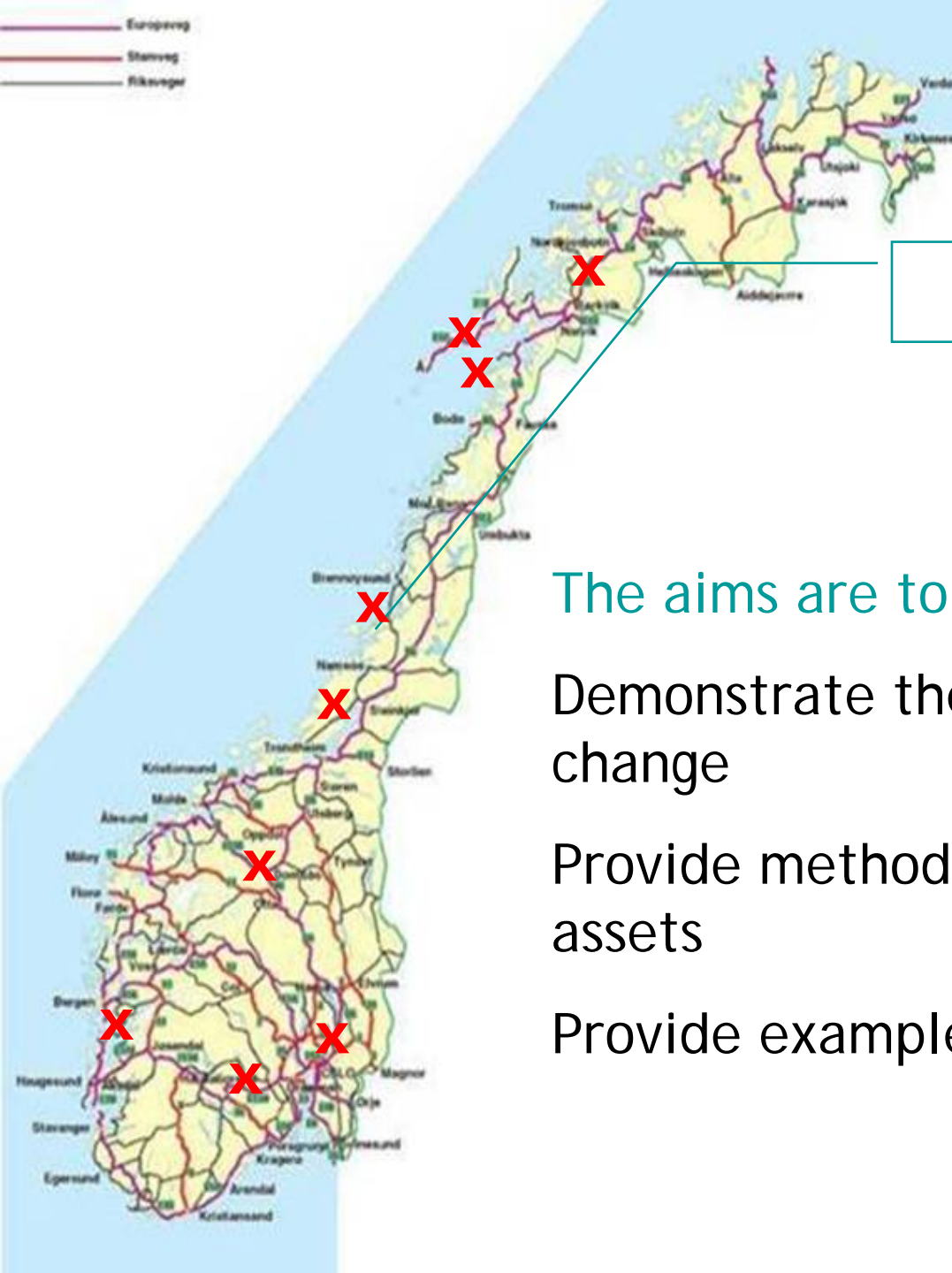
Serkeland, Telemark, 2007



Inadequate structure?



Middøla bru, Telemark, July 2008



Pilot projects

The aims are to:

Demonstrate the effect of climate change

Provide methods for survey of vulnerable assets

Provide examples of remedial measures

Need for better drainage capacity



$$Q = C \times I \times A \times K_f$$

Climate
factor

depending of
the return
period

Small mistakes big consequences



E136 Romsdal



E136 Romsdal



Insufficient maintenance procedures?



Sea level rise and storm surges

Sub-sea tunnels (level)

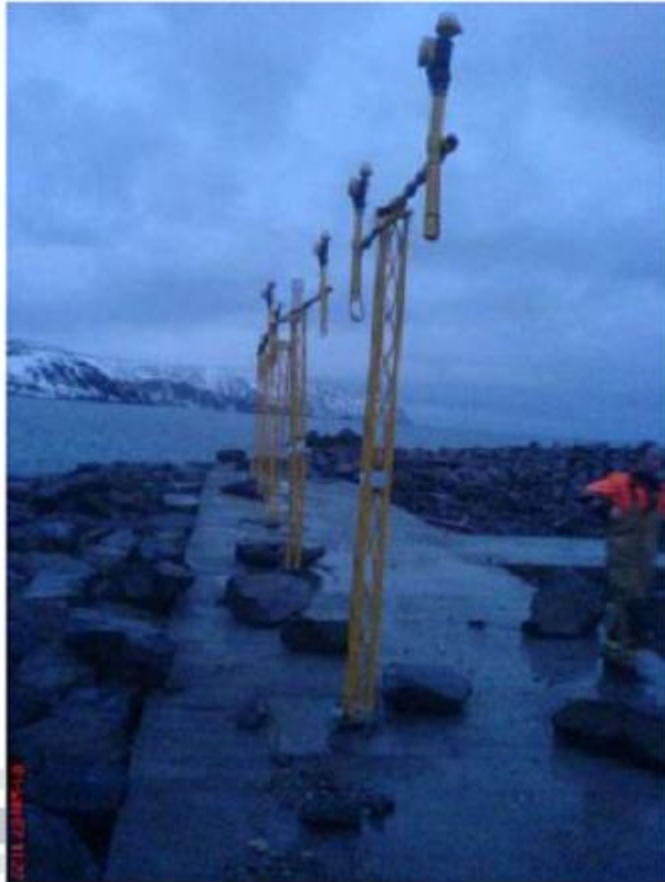
Coastal roads
(erosion)







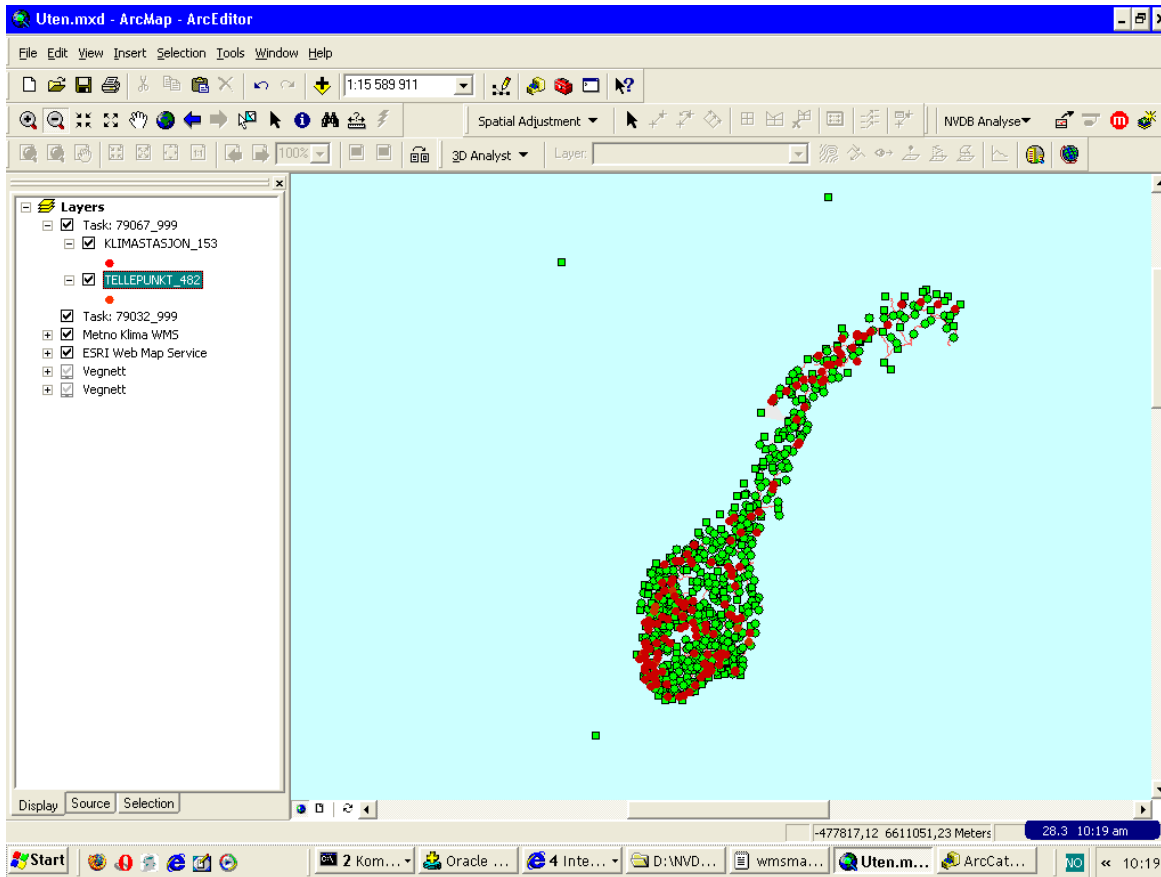
Airport in the North of Norway after a storm



Three topics of work - preliminary results

1. Data: collection, processing and storage
2. New model for risk avalanche
3. Modelling of deterioration of roads – effect of climate change

1) Data: collection, processing and storage

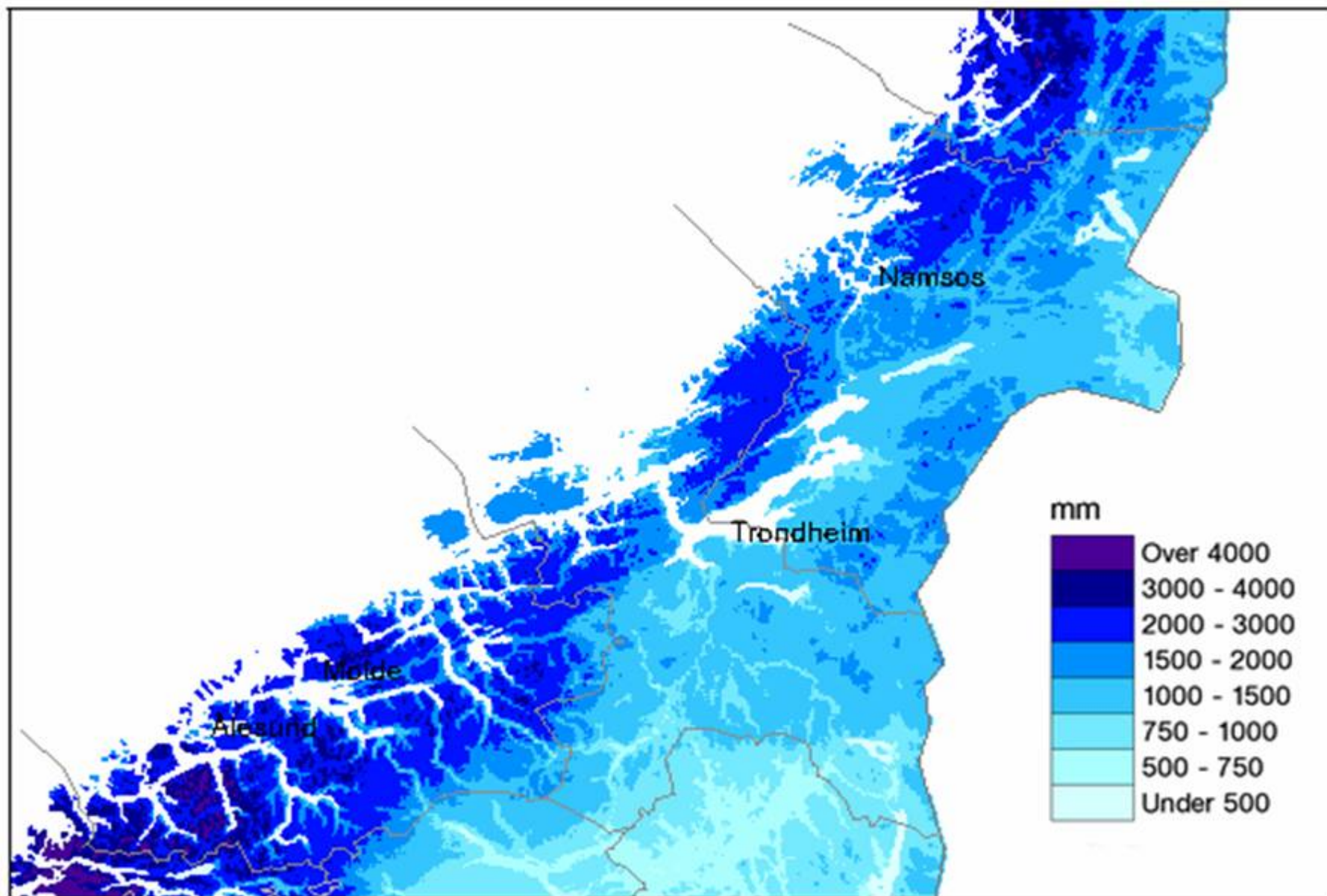


Measurement of climate parameters needs to be coordinated

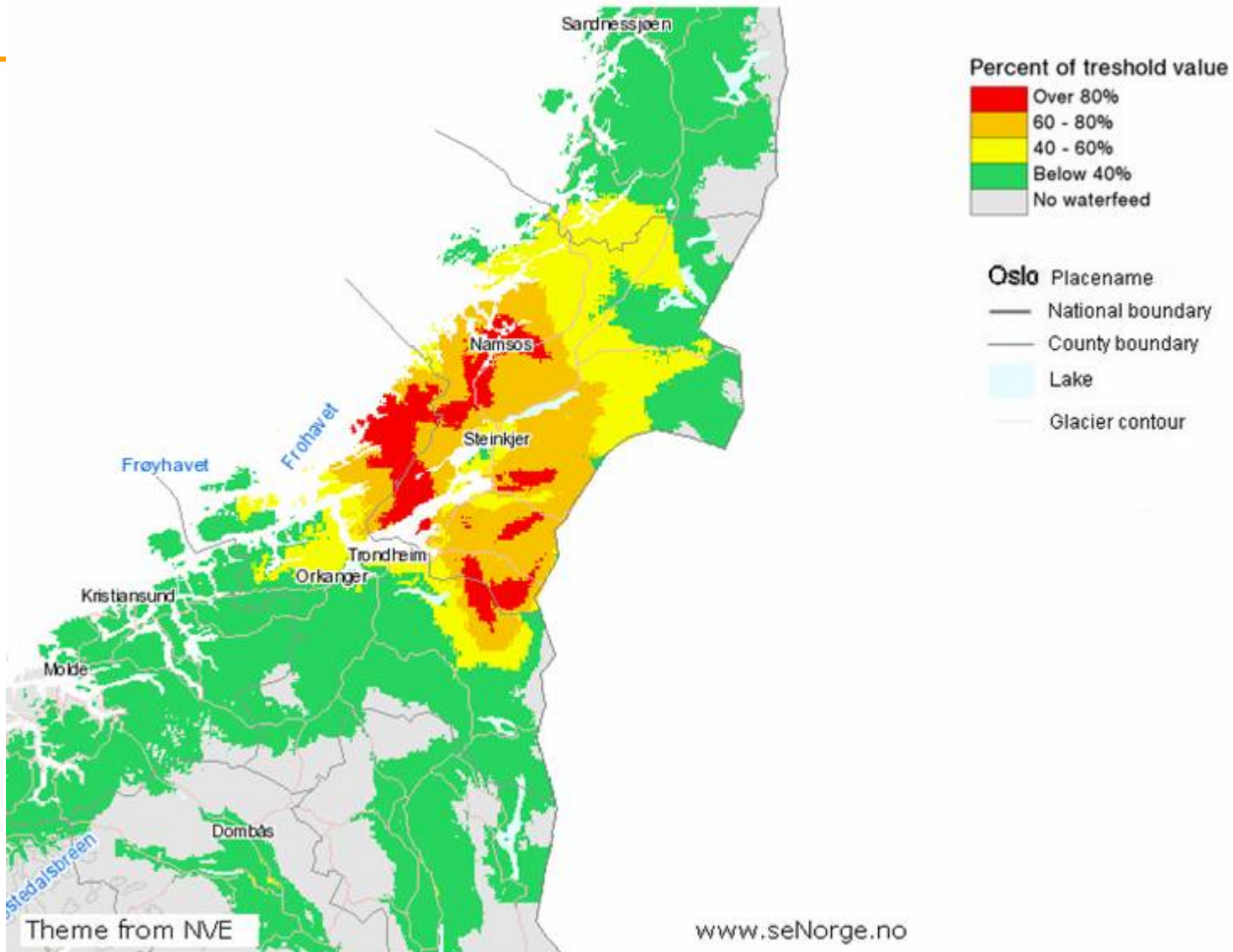
Registration of weather related events including landslide:

www.skrednett.no,

Norwegian Road Databank

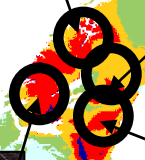


Water supply - generated from observations (31.01.2006)



24

Flood in Trøndelag 2006



Møre og Romsdal - March 2010

Fv 655

2) Risk model for landslides and avalanches





Sunnmøre, November 2011



Eikesdalen 2003

Ice fall in spring



Troms 2009

Developing the model

Probability for the occurrence of landslide, rockfall or snow avalanche.

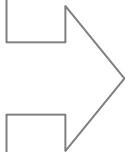
Probability for the landslide hitting the road

Probability

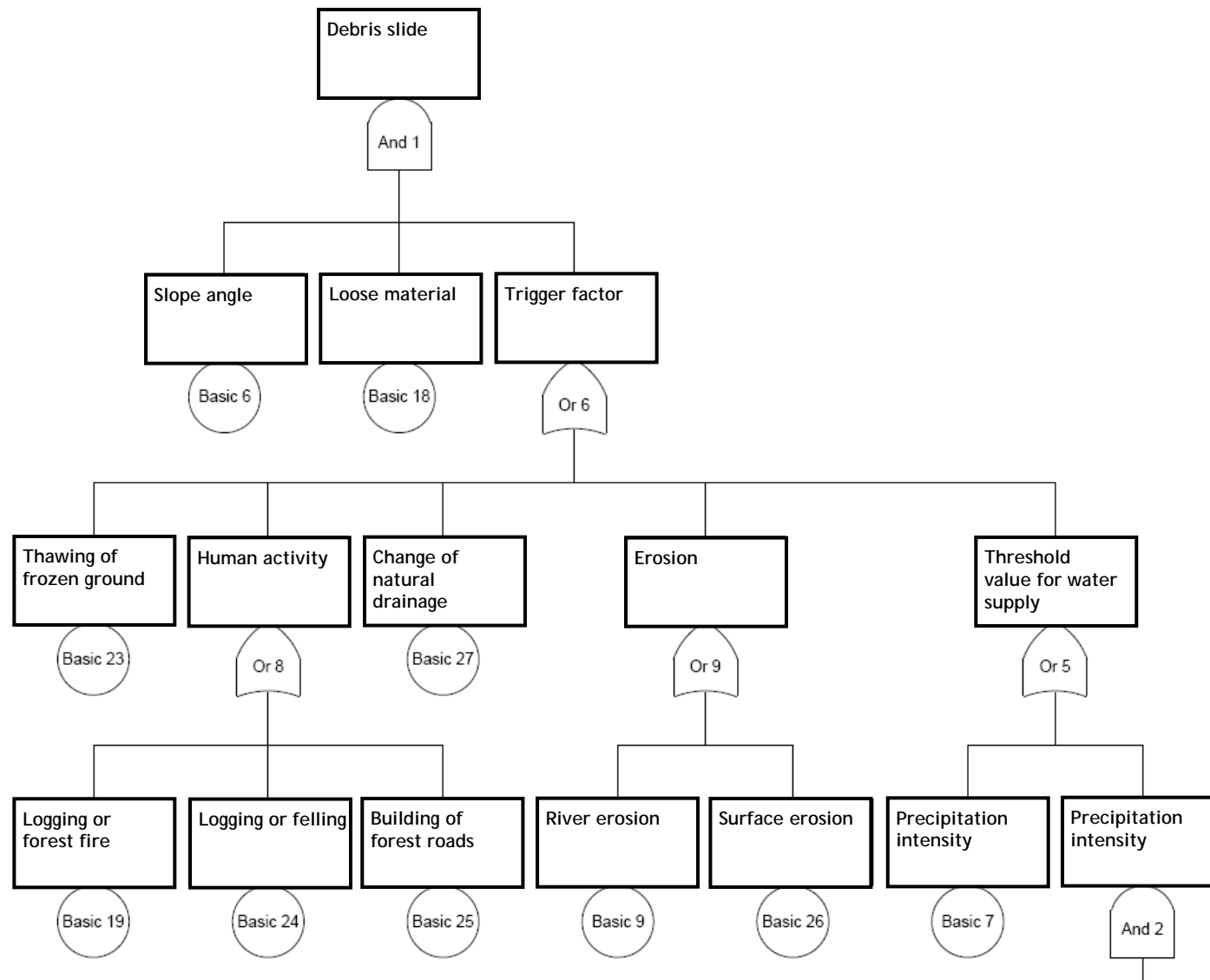
x

Consequences

road
traffic
detour
....



Example of a fault tree for debris slide



Possible uses for the riskmodel

- Compare different road sections regarding risk level
- Suggest classification of probability and consequence
- Consider changes in hazard due to climatic variations
 - Seasonal variations
 - Climate change



3) Modelling of deterioration of roads

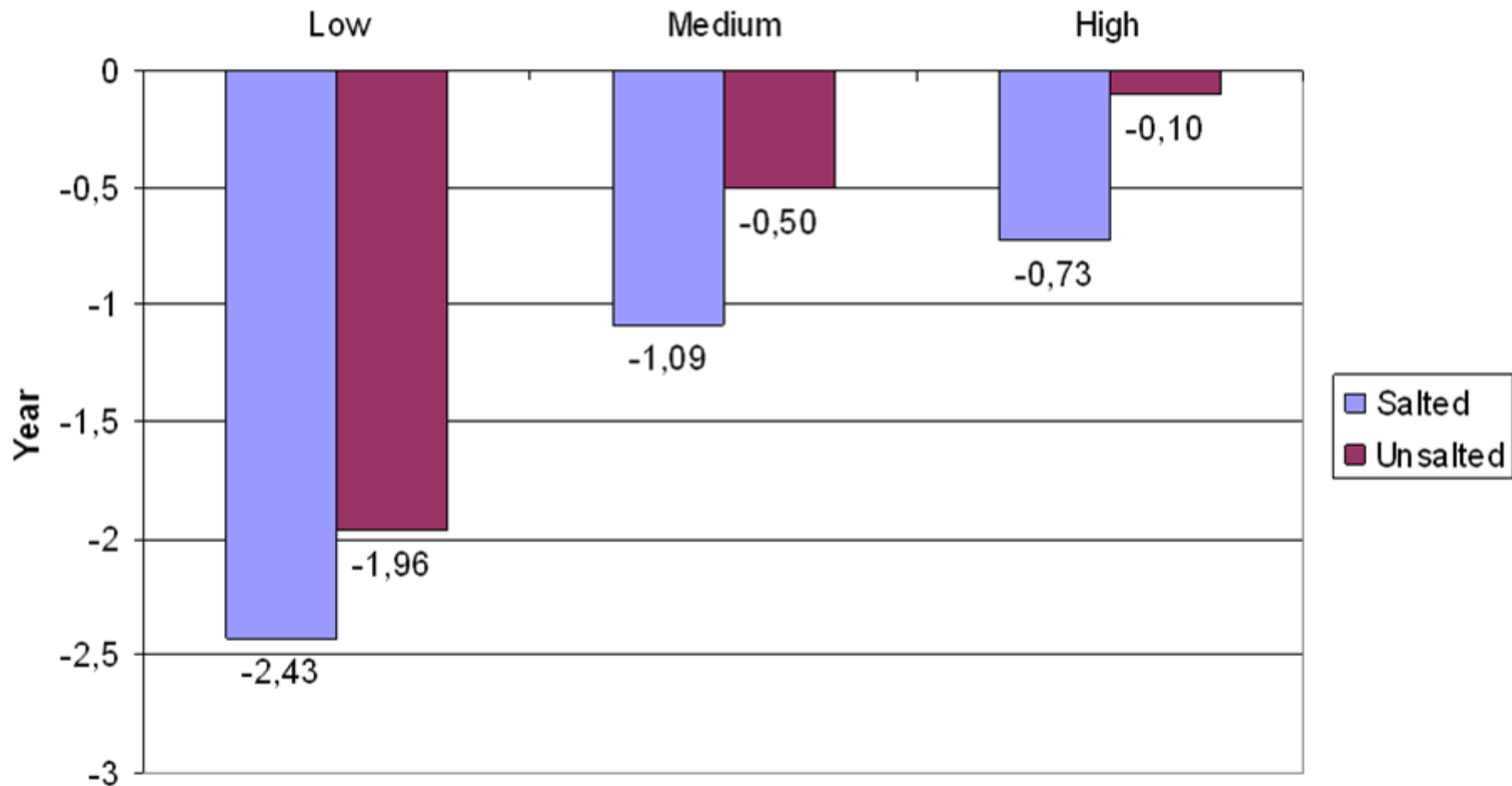
Deterioration

due to precipitation
(water content) and
some places freezing
and thawing.

AASTHO 2002, ME-PDG
(Mechanistic-Empirical
Pavement Design
Guide)

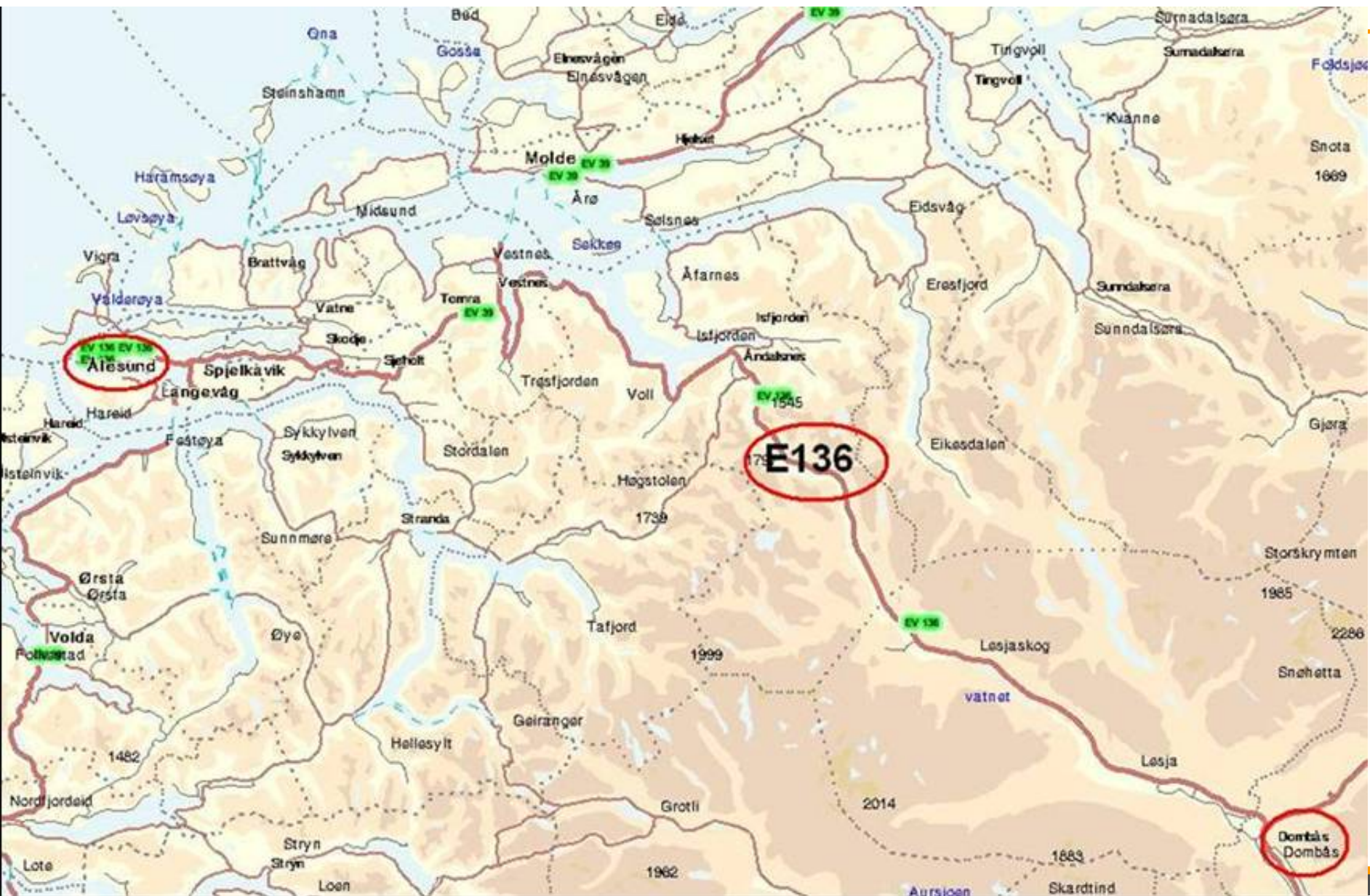


Sub-grade bearing capacity



Change in pavement life for an assumed 20 % increase in precipitation

E136 - Demonstration section



And some new challenges

Fv 858 Håkøybotn



A photograph of a mother duck swimming in a flooded road with her ducklings. The road has yellow painted markings. The background is a lush green forest. The text "Thank you!" is overlaid in the upper right.

Thank you!

www.vegvesen.no/klimaogtransport