NORDRESS Kick-off Meeting

Reykjavik, 29 January 2015

WP5 Infrastructure Resilience – Tasks 5.1 & 5.2

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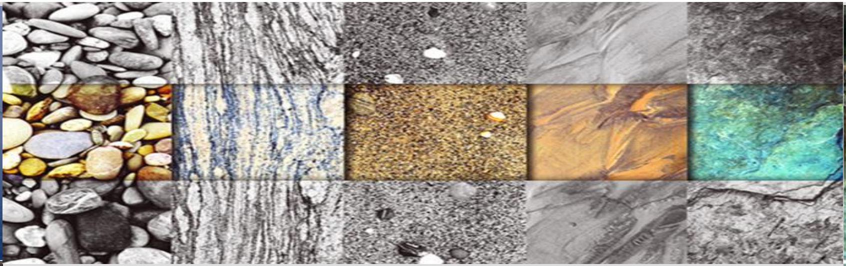
NORDRESS

Nordic Centre of Excellence
On Resilience and Societal Security

Norwegian Geotechnical Institute (NGI) is a geo-science competence centre established in 1953


NGI develops optimum solutions for society and its clients through R&D and consulting services in four market areas:


- Offshore energy
- Natural hazards
- Building, construction and transportation
- Environment

NGI today

- Leading international competence in the geosciences
- Main office and laboratories in Oslo
- Branch offices in Trondheim (Norway), Houston (USA), and Perth (Australia)
- Organized as a private foundation
- Led the Centre of Excellence: "International Centre for Geohazards" (ICG) from 2003 to 2012
- 230 employees from 35 nations
- 20-30 guest researchers every year
- Annual turnover 2014: NOK 380 mill. (~44 mill. €)

Task 5.1 Mitigation of risk posed by slope failures on transport infrastructure (**NGI**, SGI, IMO)

- Analysis of factors contributing to transport infrastructure vulnerability and resilience in Nordic countries
- Risk analyses for selected engineered slopes and embankments to identify main sources of vulnerability (case studies, modelling and stakeholder interaction)
- Focus on the impact of poor land use practices that may change runoff patterns during precipitation events.

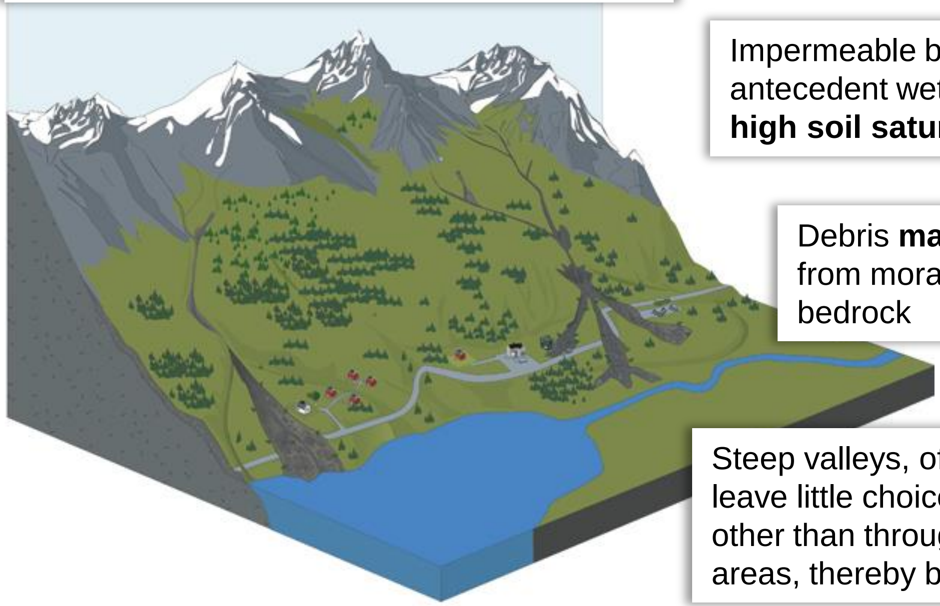
Failure of old railway embankments in Norway during storms due to insufficient drainage

Munkedal landslide of 20 Dec. 2006 affecting Highway E6 between Oslo & Gothenburg

Cause: A thin layer of quick clay that was not detected

Debris flows – Hazard and risk posed to transportation infrastructure for Norway

Intensive or pro-longed rainfall events and rapid snowmelt events are common **trigger events**



Impermeable bedrock and antecedent wet climate cause **high soil saturation**

Debris **material available** mainly from moraine deposits and weathered bedrock

Steep valleys, often dissected by fiords, leave little choice for routing traffic lines other than through potentially hazardous areas, thereby becoming **elements at risk**


Debris flow, Baklia
June 2011


Debris flow, Balestrand
December 2011

Landslide risk mitigation strategies

(1) Susceptibility and hazard mapping + land use plans

(2) Active countermeasures to stabilise the slope or construction of barriers in path of the slide

(3) Early warning systems

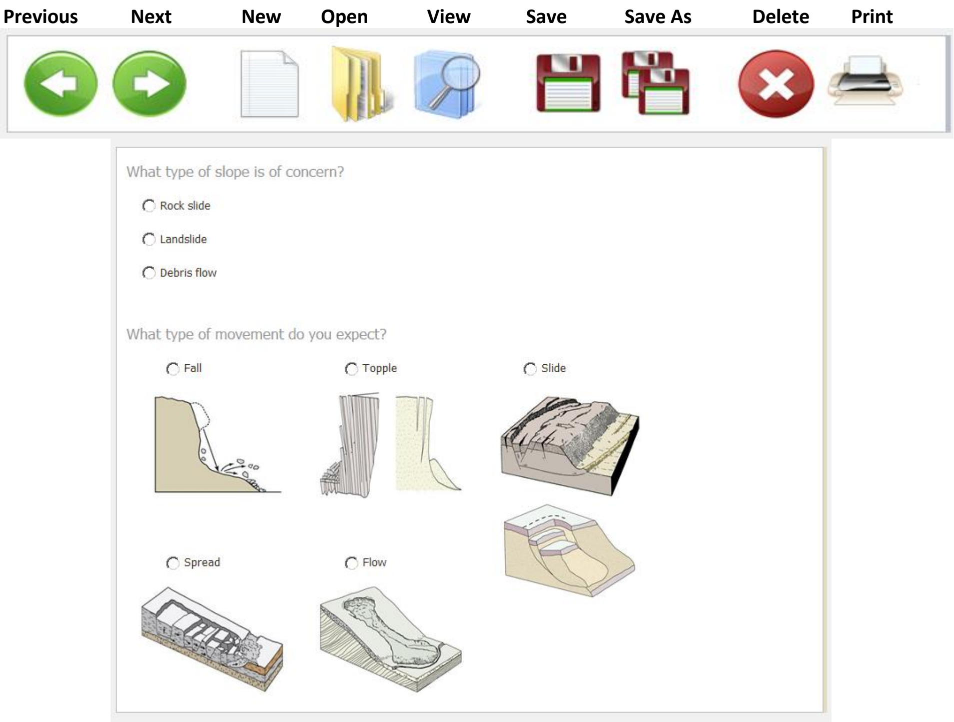
(4) Community preparedness and public awareness campaigns

(5) Enforcement of design codes and good construction practice

(6) Measures to pool and transfer the risks (insurance and re-insurance)

Web-based toolbox of mitigation measures for landslides

Example web page



Task 5.2 Mitigation of risk posed by snow avalanches on transport infrastructure

(**NGI**, SGI, IMO)

- Development of a probabilistic snow avalanche impact (including triggering & runout) model to estimate the probability of an exposed road/railway being hit by a snow avalanche in the coming 24 hours.
- Overview of existing mitigation measures to reduce the risk to transport infrastructure
- Detailed analysis of selected cases considering cost effectiveness of physical protection measures versus use of monitoring and early warning

Risk posed by snow avalanche to transportation infrastructure

Snow avalanche R&D at NGI

- Through a cross-disciplinary team effort involving avalanche experts, georisk professionals, and statisticians, a probabilistic approach for hazard mapping and avalanche warning is being developed.
- The methodology will be tested and validated in selected mapping and warning case studies.

Model: Conditional probability chain

Weather: What is the probability of various degrees of unfavourable conditions?

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Stability of snow cover: Given the terrain characteristics and weather conditions, what is the probability of triggering of an avalanche?

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Run-out: What is the probability that the triggered avalanche will reach the exposed element?

Examples of mitigation measures for snow avalanche