Landslide risks in the Göta River Valley in a changing climate

Bo Lind, Swedish Geotechnical Institute

Exchange New Orleans - Gothenburg
Glaciated landscape with soft sediments (silt-clay)

Valleys and Low-lands
Post-glacial rebound – Erosion and landslides

Göta 1957

Vagnhärad 1997

Småröd 2006

Tuve 1977
Landslides and mudflows in Sweden
Dynamic landscape of landslide scars
The Göta river valley

- Large run-off area
- Source of water supply for 8% of the population
- Important infrastructure and settlements
- Sensitive to landslides
Catastrophic consequences of landslides
Landslide retrogression in areas with highly sensitive clay
Relative change in precipitation for a period of 30-years in the Vänerns runoff area (moving average)
Mapping of landslide risks - The Government's commission

“In order to address forthcoming climate changes and handle increased flow in the Göta River, greater understanding is required of the stability conditions along the entire Göta River. The funding is to be used for the improvement and production of landslide analyses and stability mapping along the Göta River.”
Landslides in a changing climate

- Driving forces affected by:
  - Increased groundwater pressure – *climate related*
  - Flow and river erosion – *climate related*
  - Loading by houses and infrastructure – *development*
Field and laboratory investigations
Methodology

- Extension of quick clays
- Geometry of the river
- Groundwater modelling
- Erosion
- Consequences

Bild: Sjöfartsverket

Life
Buildings
Industry
Energy supply
Water supply
Roads and railroads
Shipping
Contaminated sediments
Stability calculation
probability

Statistical analysis
Stability factor
Amount of data
Uncertainty

consequence

Valuation/Calculation
Life
Buildings
Industry
Energy supply
Water supply
Roads and railroads
Shipping
Contaminated sediments

Level of risk
Figure 4.1: Matrix with landslide risk levels based on the probability of a landslide and its consequences.
Conclusions

**Current conditions:**
- Many areas with high risk (red)
- High risk also in built-up areas
- Large areas with poor stability closest to the river and conditions for large landslides

**Future conditions:**
- Climate change means that the risks increase
- The area with the highest risk level (red) increases 10%
- The probability of landslides further increases in high-risk areas - unless action is taken
Suggestions

- Necessary to take actions to reduce the current landslide risks which also provide opportunities for increased flows in the future

- The estimated cost for the entire Gota River and the Northern River:
  4-5 billion SEK at today's maximum flows
  5-6 billion SEK for increased maximum flows
Example of what can be done

Figure 6-1
An example of the design of a section with improved stability due to the removal and redistribution of earth masses.
GIS platform
Thank you