NVE

# MAPPING AND MONITORING UNSTABLE ROCK SLOPES IN THE INSAR NORWAY PROJECT

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# Outline of presentation

- The risk from large unstable rock slopes (rockslides)
- InSAR Norway project
- InSAR Norway data in mapping unstable rockslopes (NGU)
- InSAR Norway data for periodic monitoring (NVE)
- Conclusions

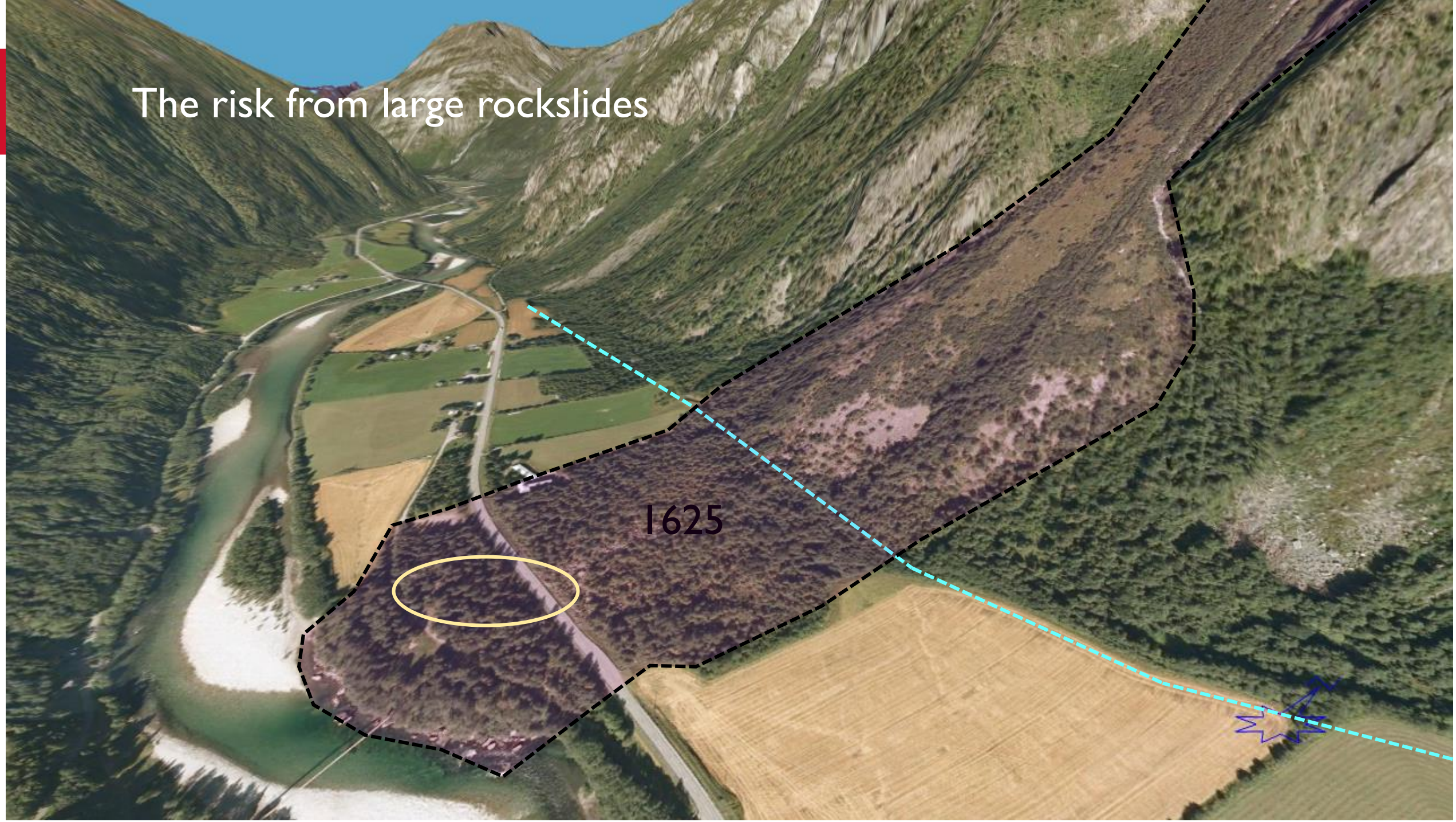
# NVE: The Norwegian Water Resources and Energy Directorate

**Directorate under the Ministry of Petroleum and Energy**

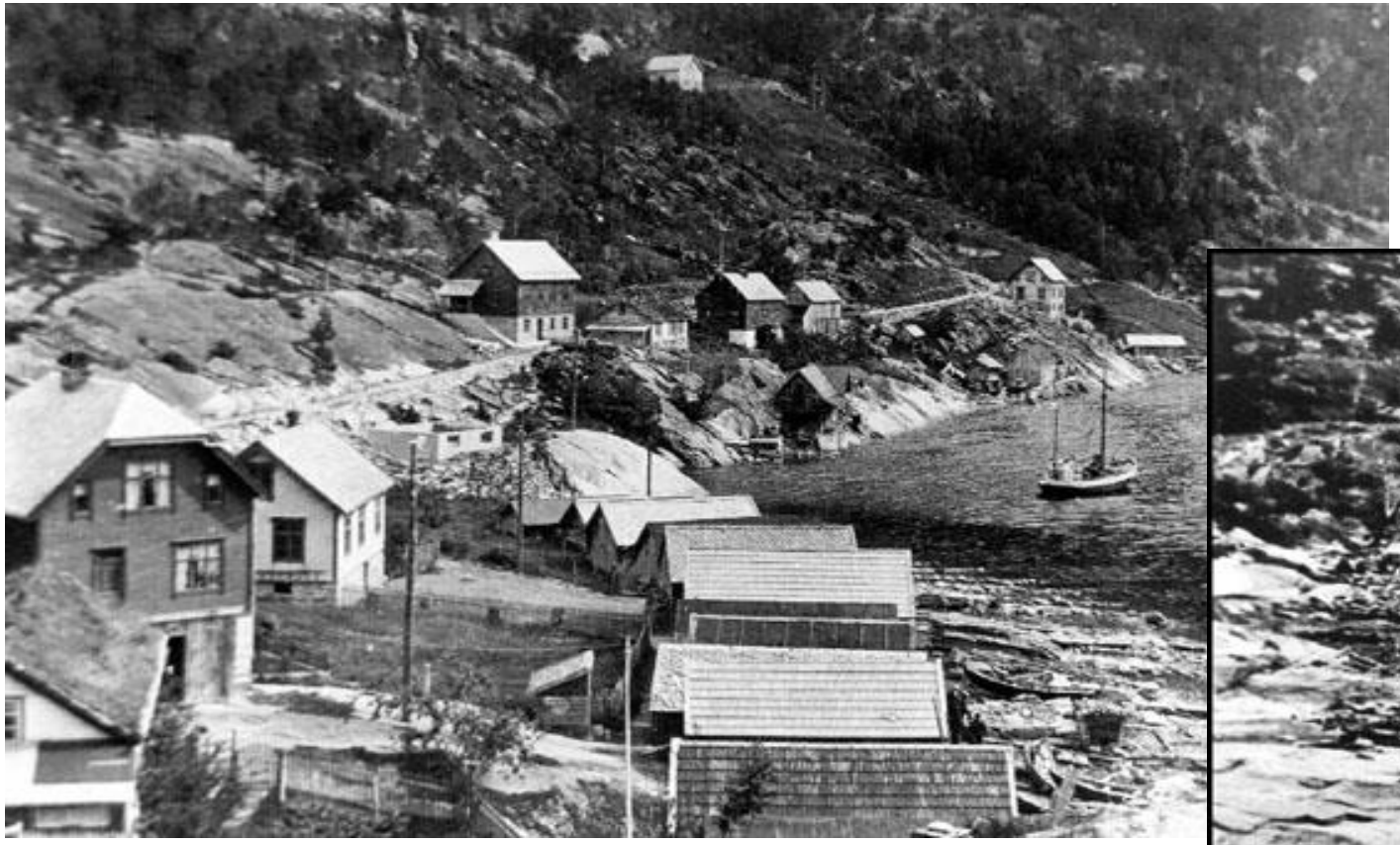
National responsibility for:

- Hydro power and dam safety
- Power supply
- Hydrology and glaciology
- Risk from flooding, landslides and avalanches and mitigation measures

# The risk from large rockslides



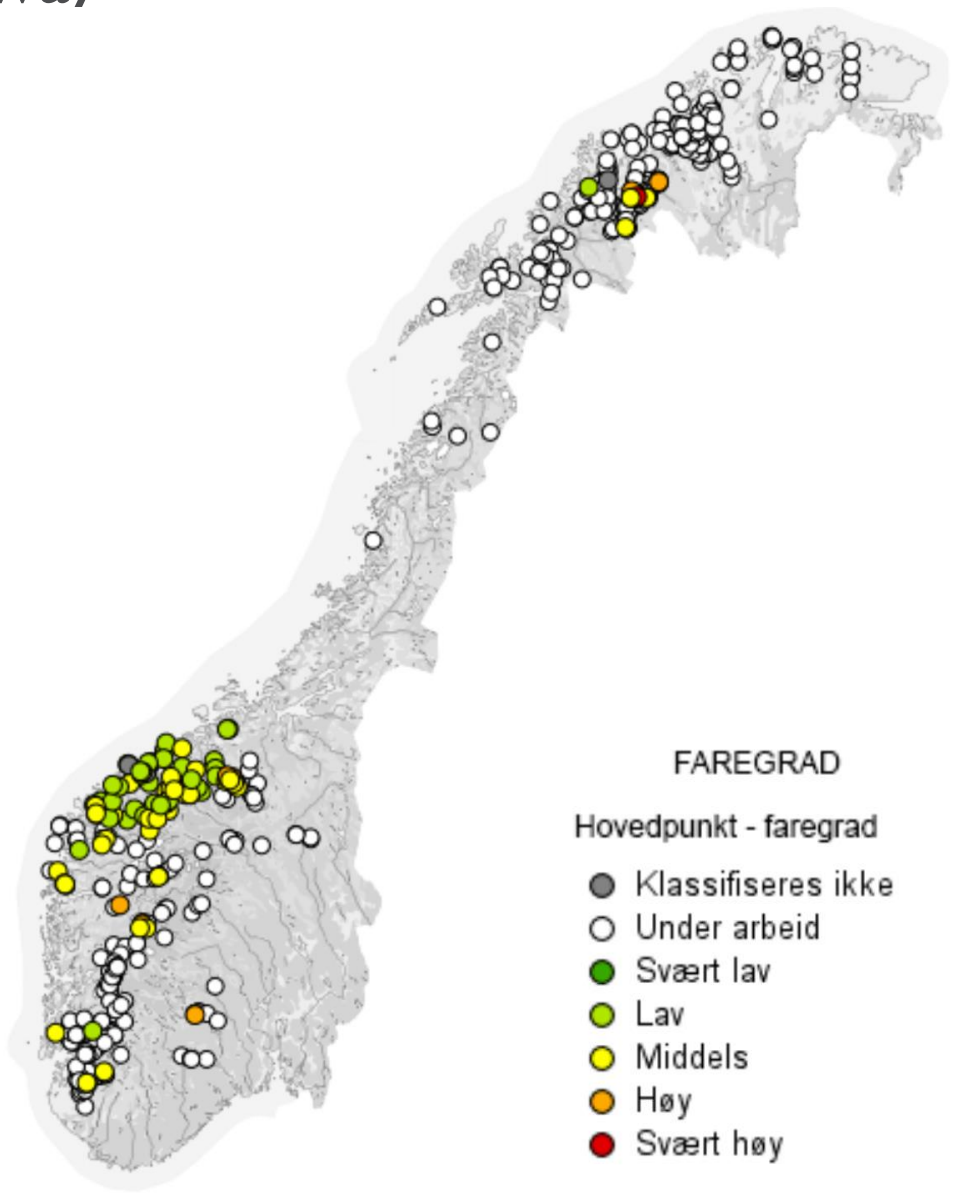
# *Tafjorden, 1934*
# *Before tsunami*



## *After tsunami*

# Large rockslides – risk management in Norway

- > 100.000 m3
- Potential for large consequenses (loss of human lives)
- NGU is mapping and risk classifying on a national scale
- NVE is monitoring classified high and medium risk rockslides



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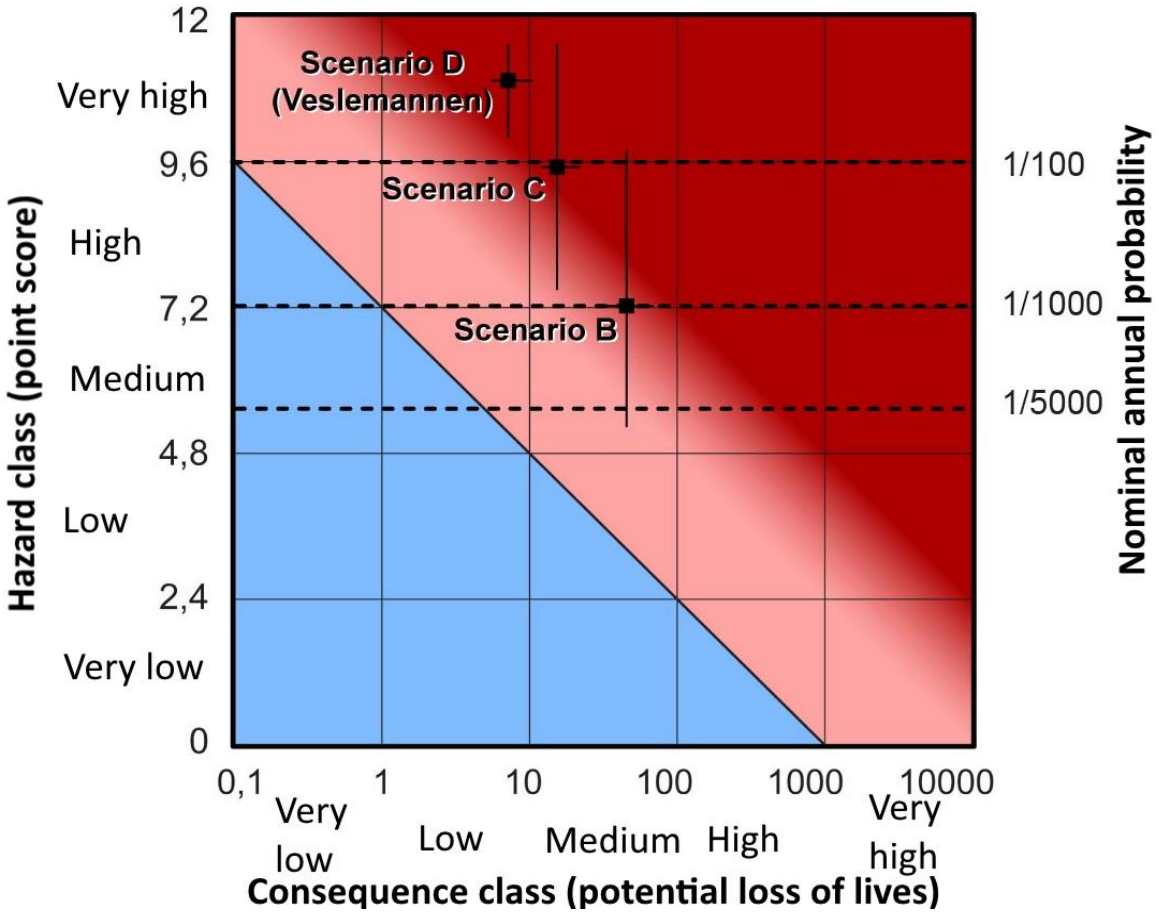

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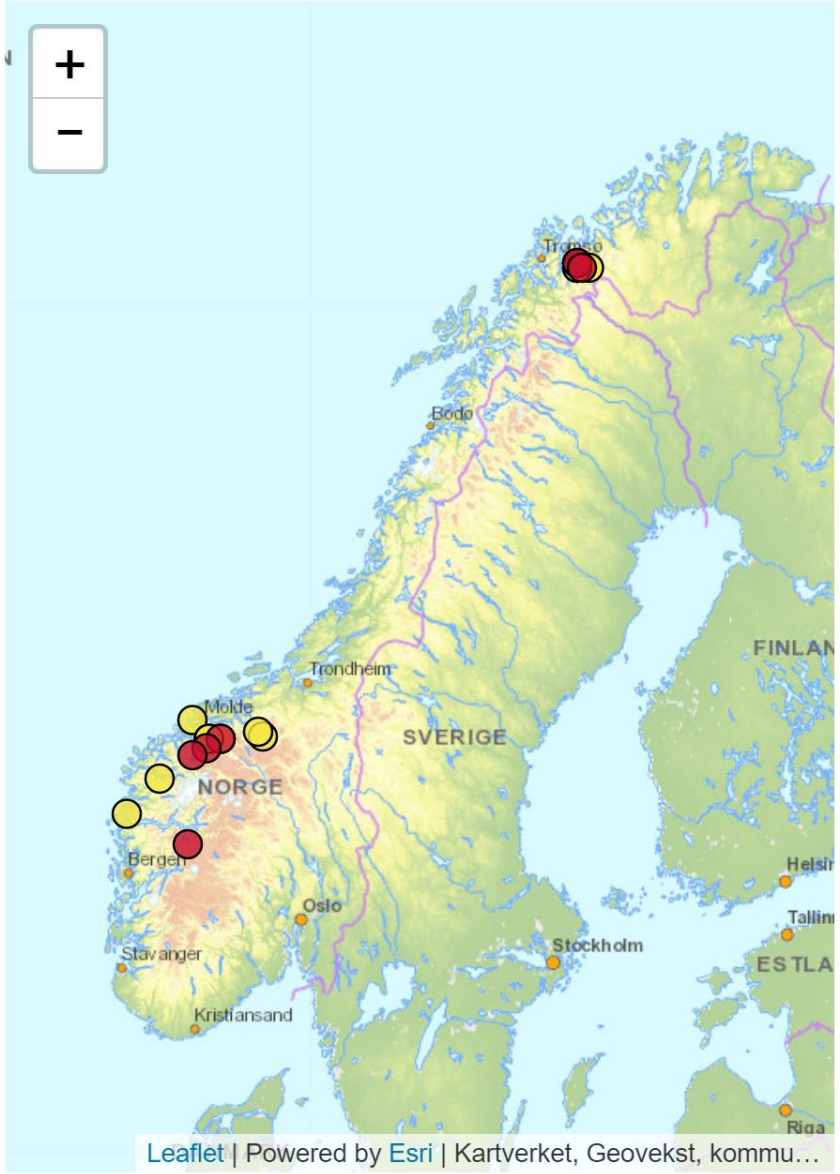
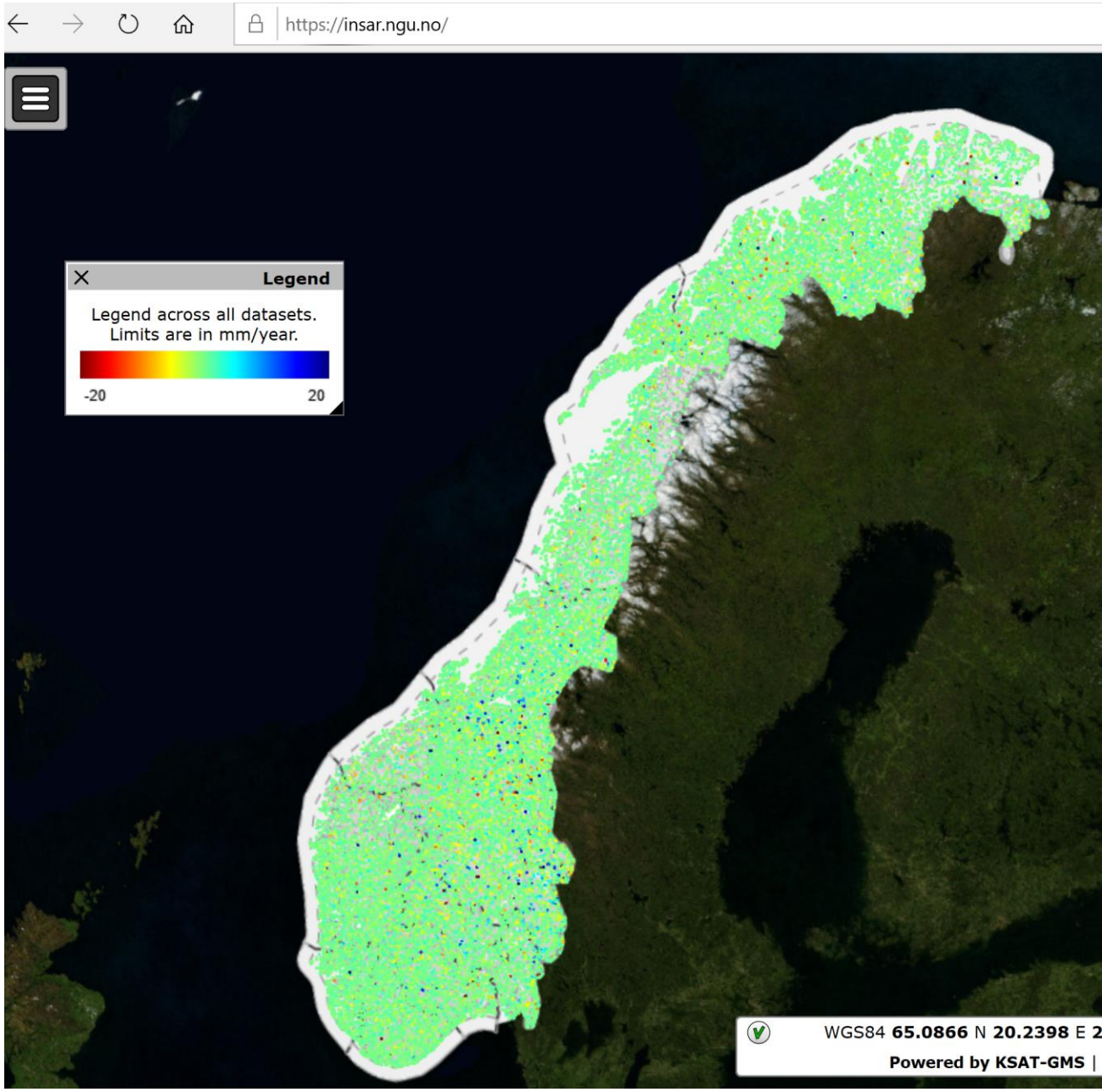


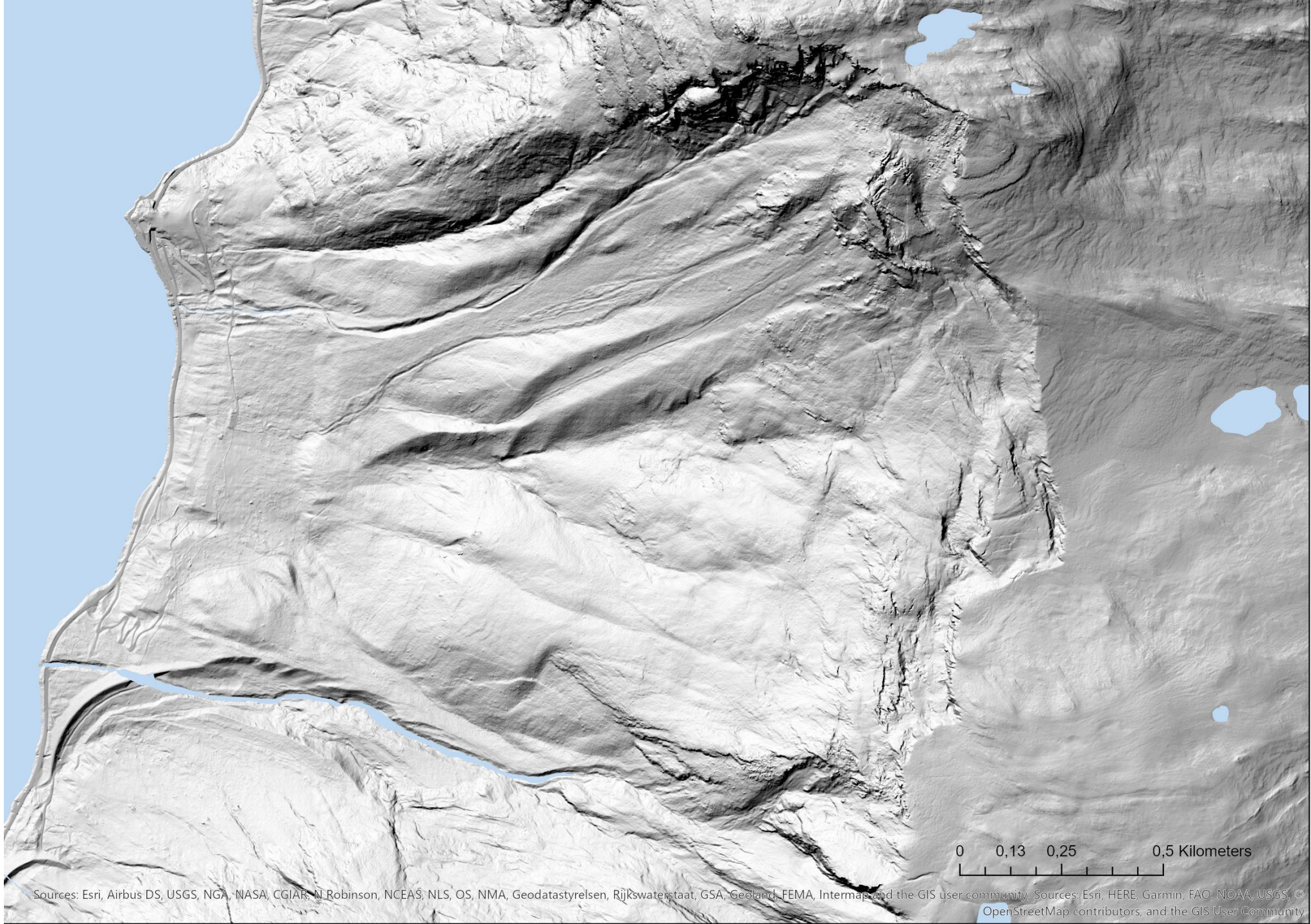
# InSAR Norway project

- National web-based service of ground motion data (updated annually)
- https://insar.ngu.no/
- Launced November 2018
- Processing PS InSAR data from Sentinel-1 satellites
- 4 billion datapoints with time-series for the snow-free season
- Data in ascending and descending geometries
- NGU (project leader), NVE, Norwegian Space Centre. Norce a key developer



NVE

# Mapping and risk classification (NGU)

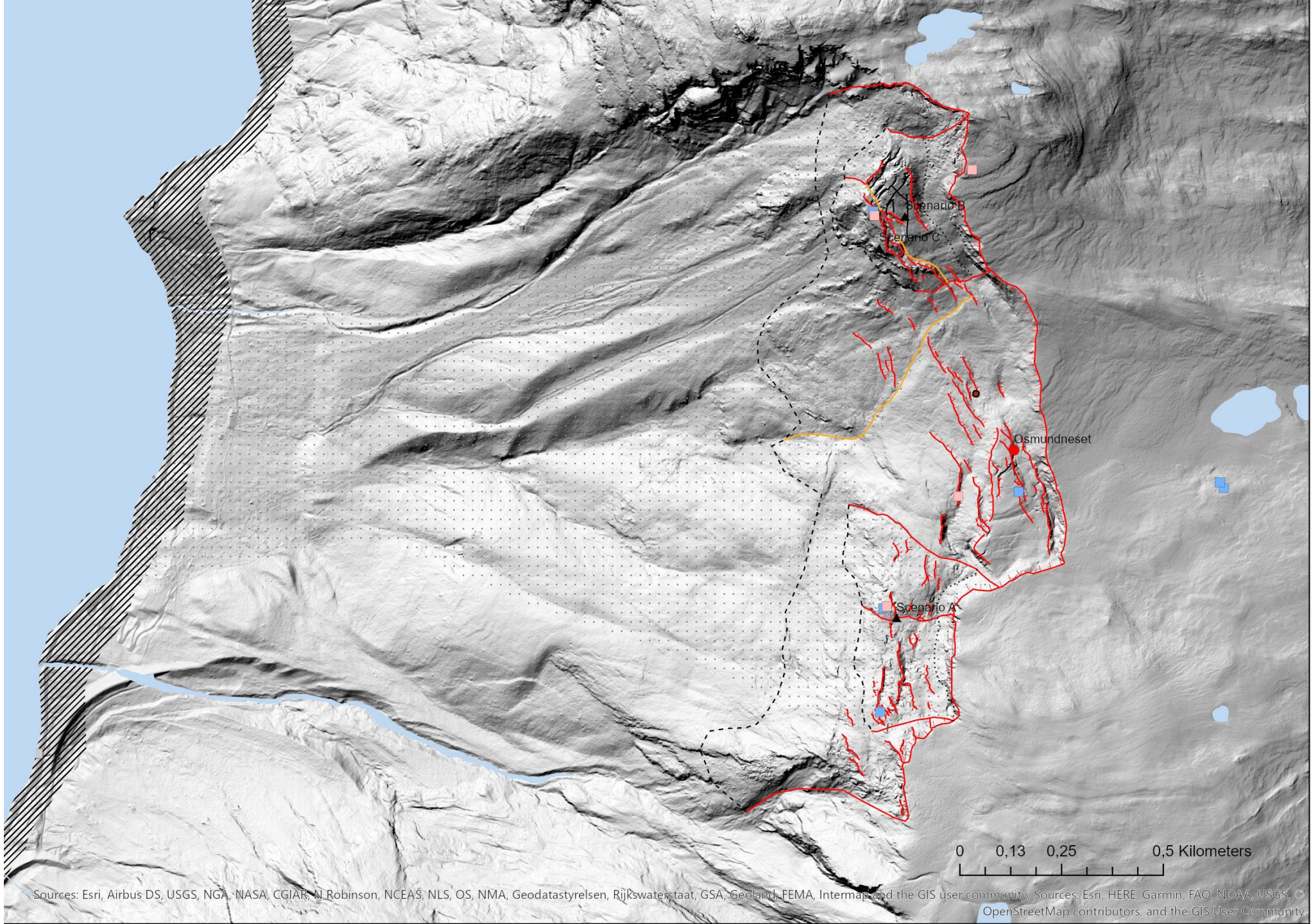



Deformed slope Osmundneset in Gloppen

NVE

# Mapping and risk classification (NGU)

# Structures and scenarios



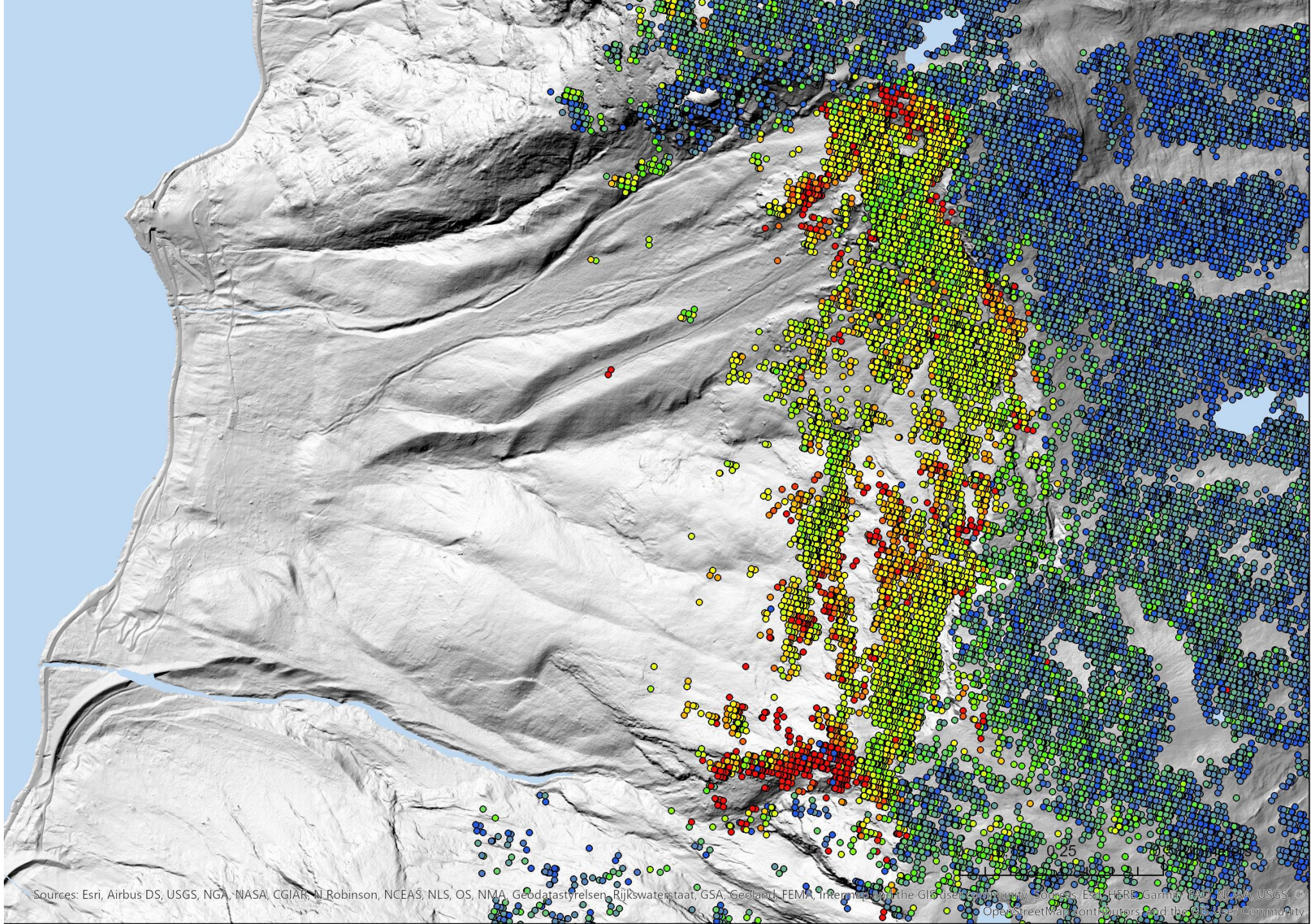
# Mapping and risk classification (NGU)

## Displacement

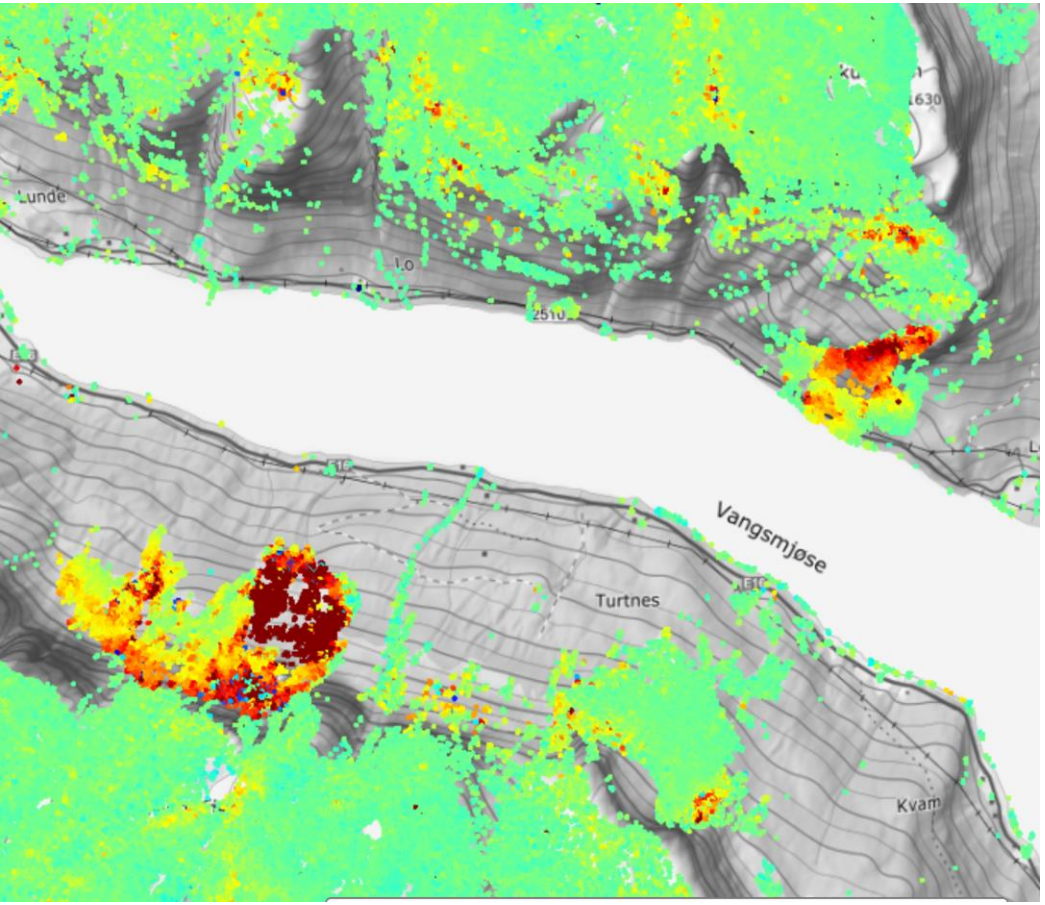
DGPS

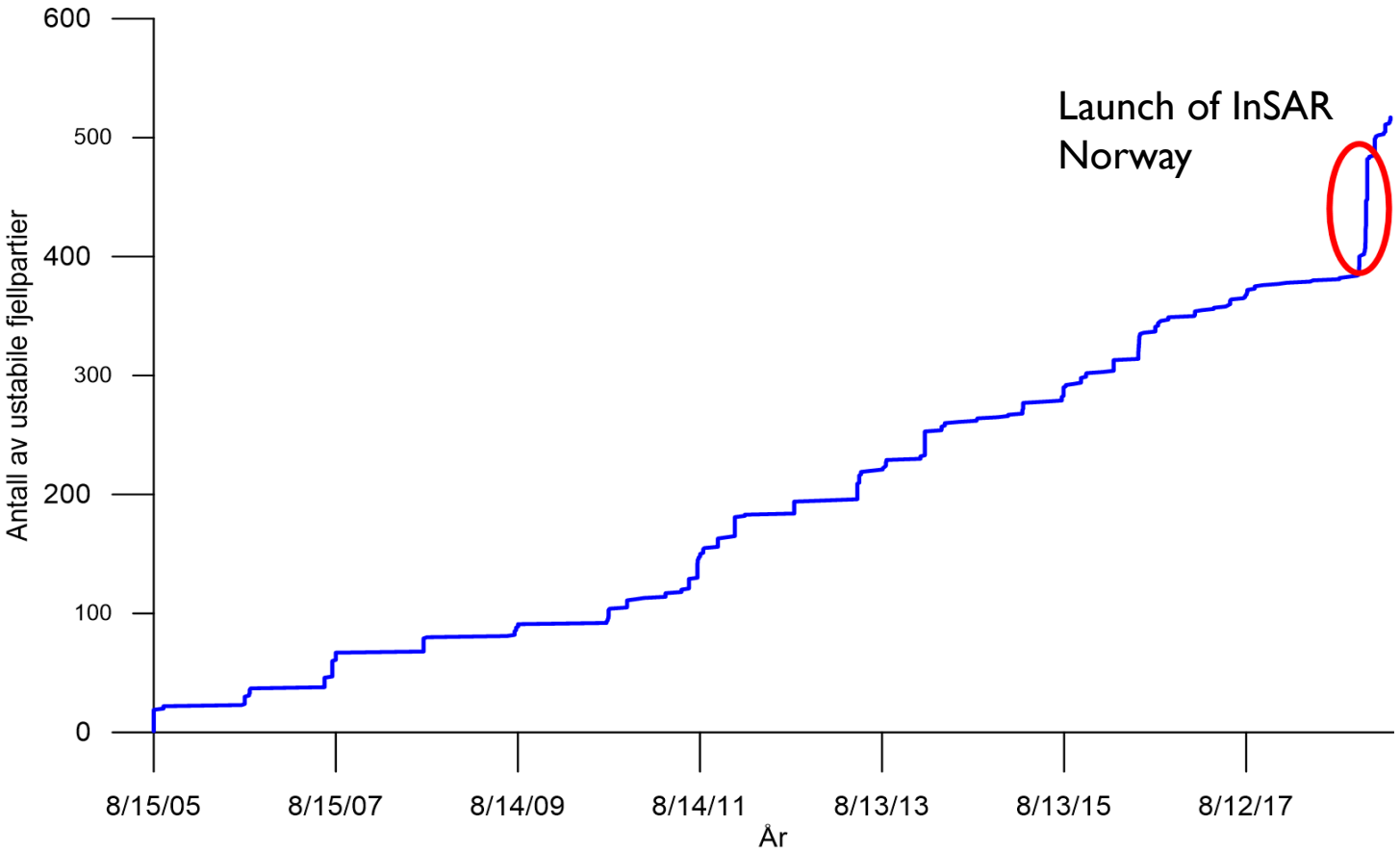
extensometer

InSAR



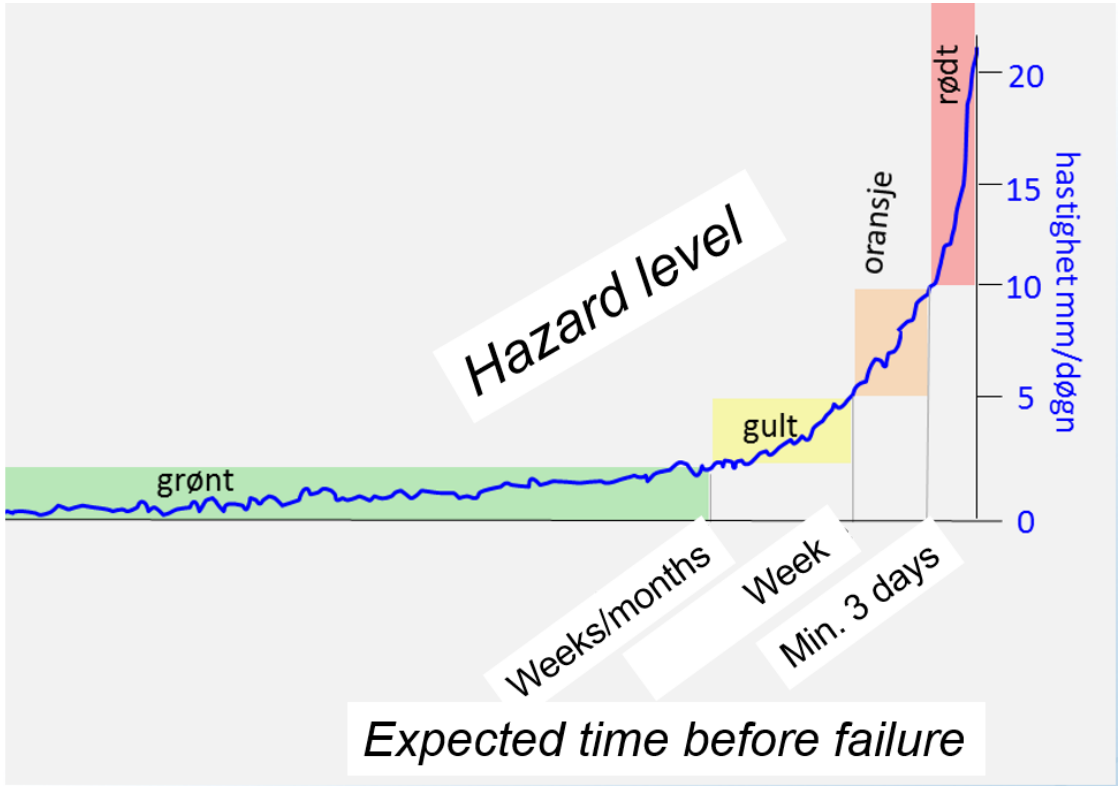
# InSAR Norway: Large increase in discovery of moving rock slopes



# NVE: Monitoring unstable rock slopes

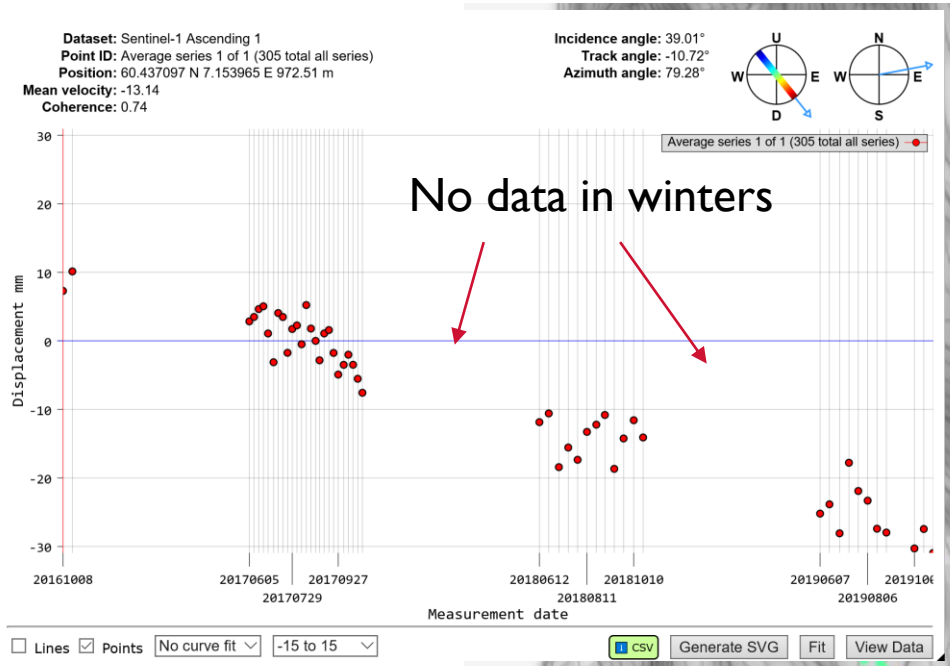
- Monitoring movement and identifying acceleration
- Issuing hazard levels and communication with local authorities

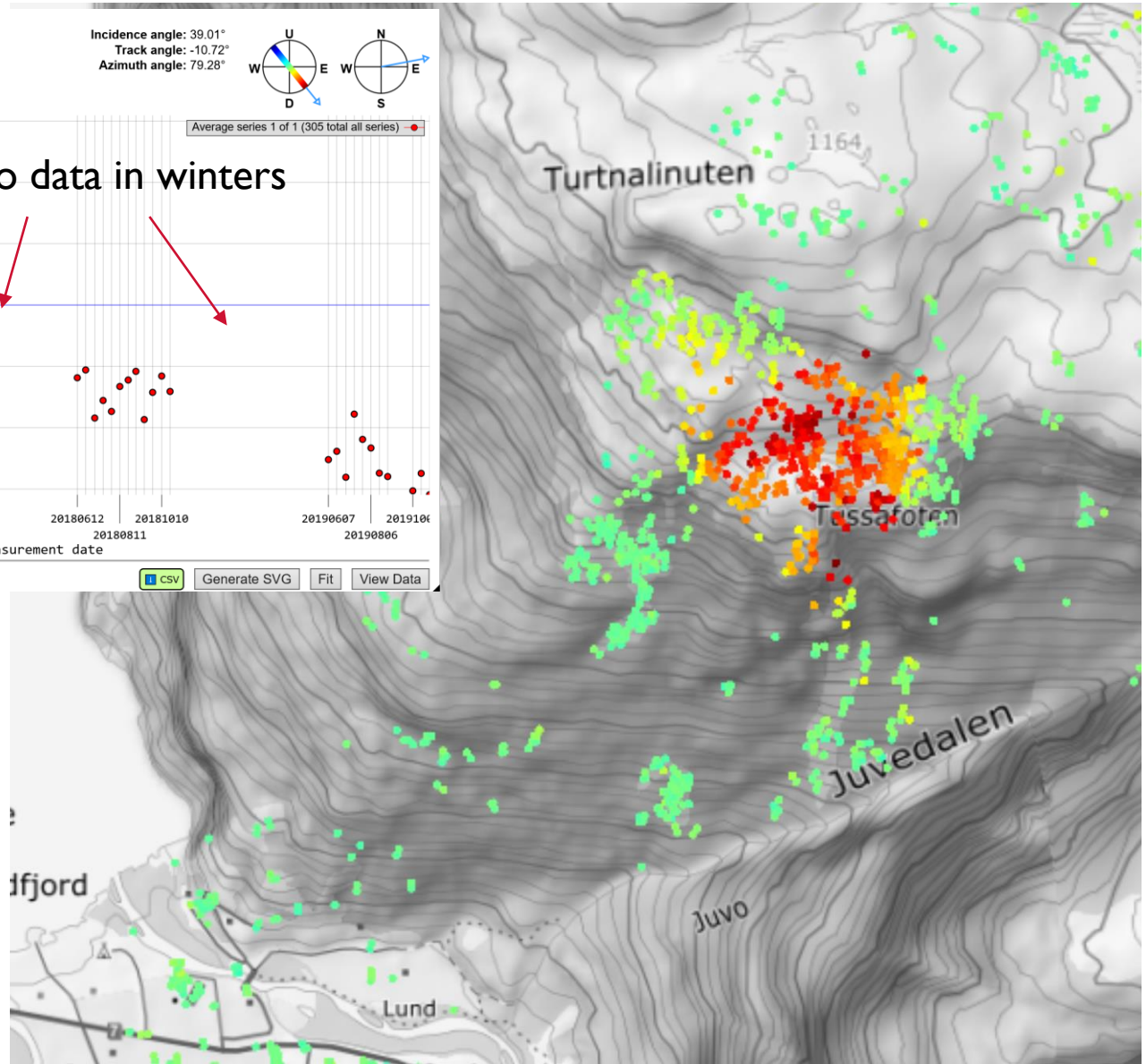



## Instruments used for «high risk» rockslides

# Use of InSAR Norway Project in the rockslide monitoring

- Mainly for «medium risk» rockslides
- Two datasets
  - 1: The distributed map of points (including time series)
  - 2: Corner reflectors



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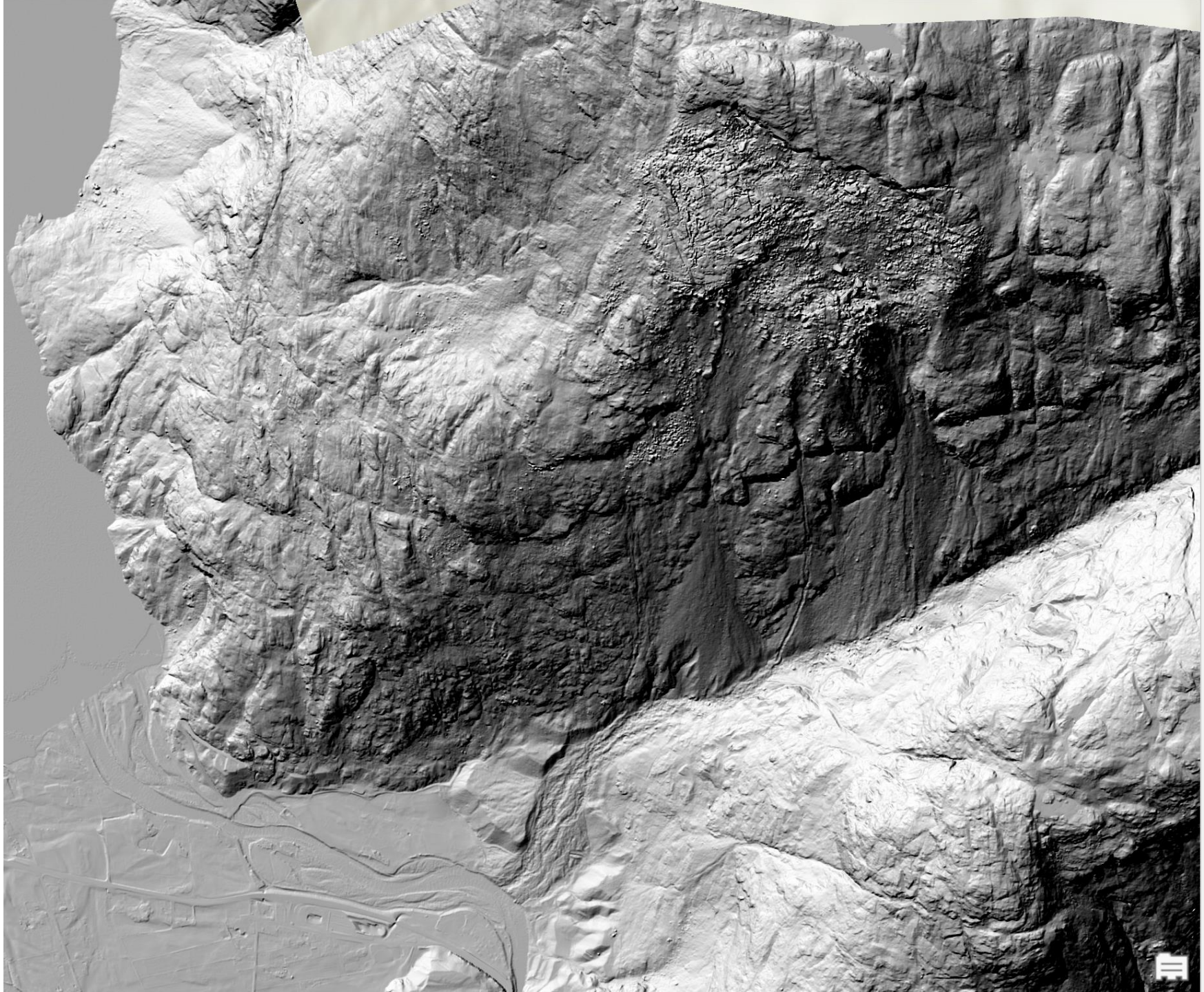
# Tussefoten
# Eidfjord



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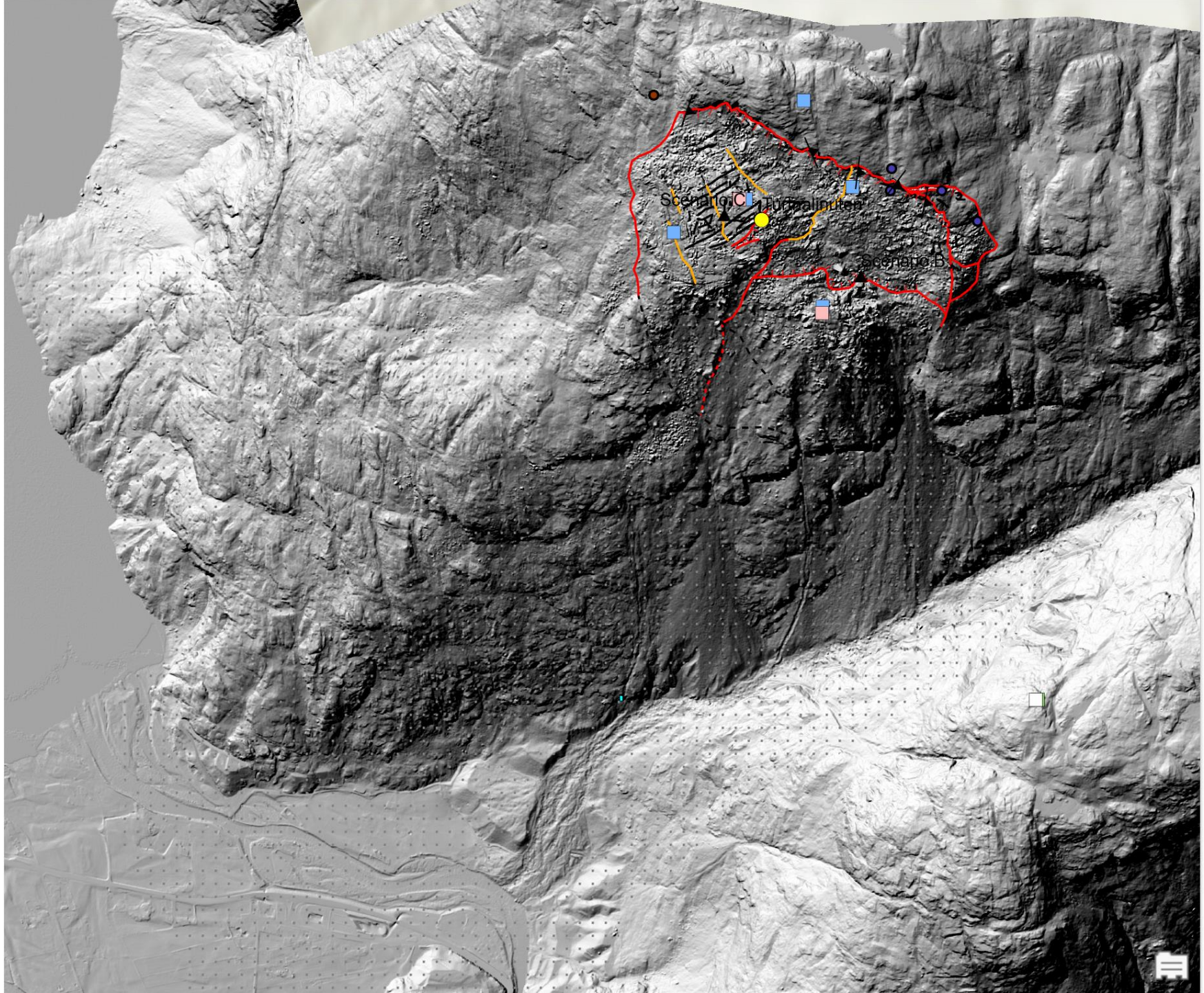

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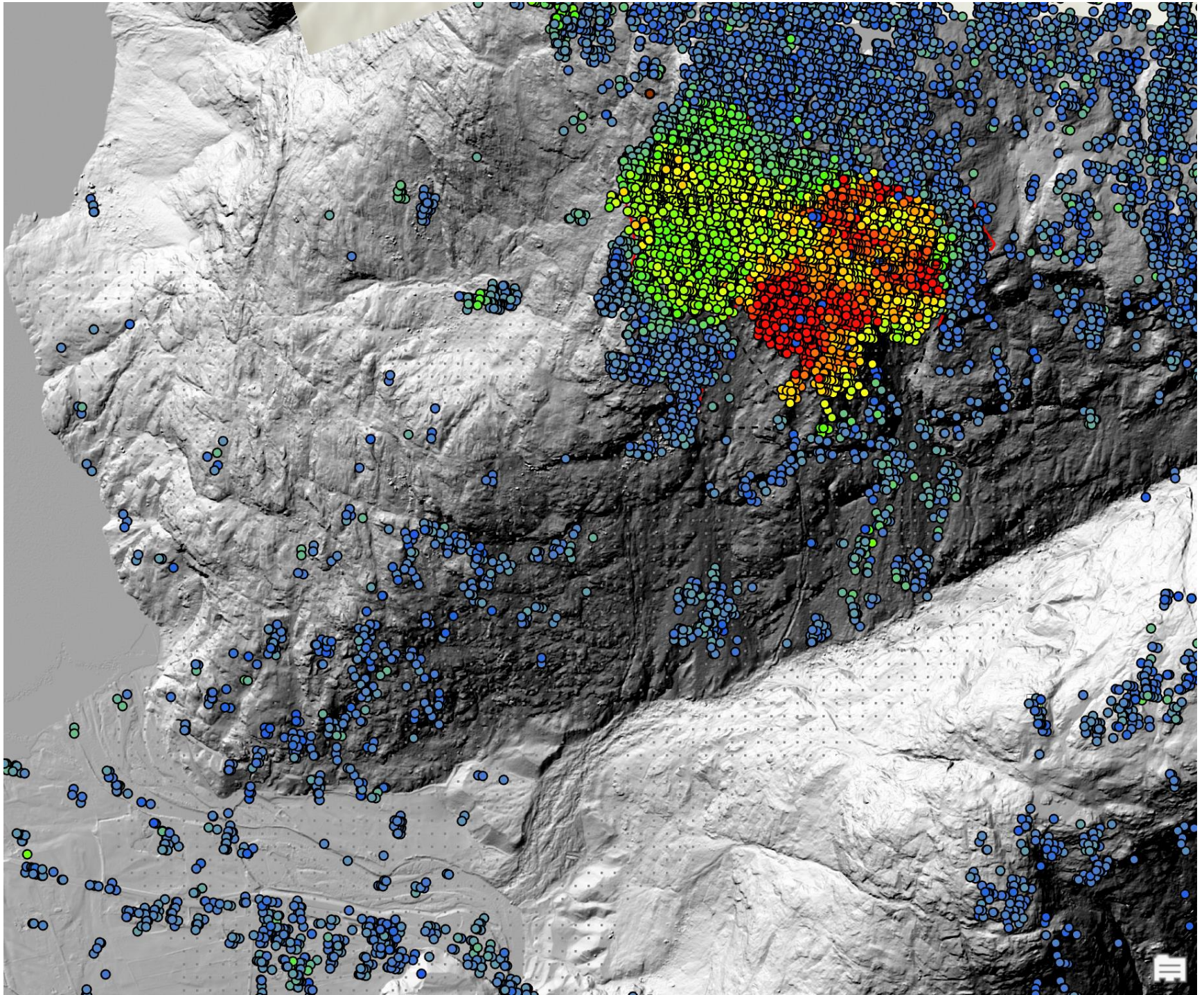
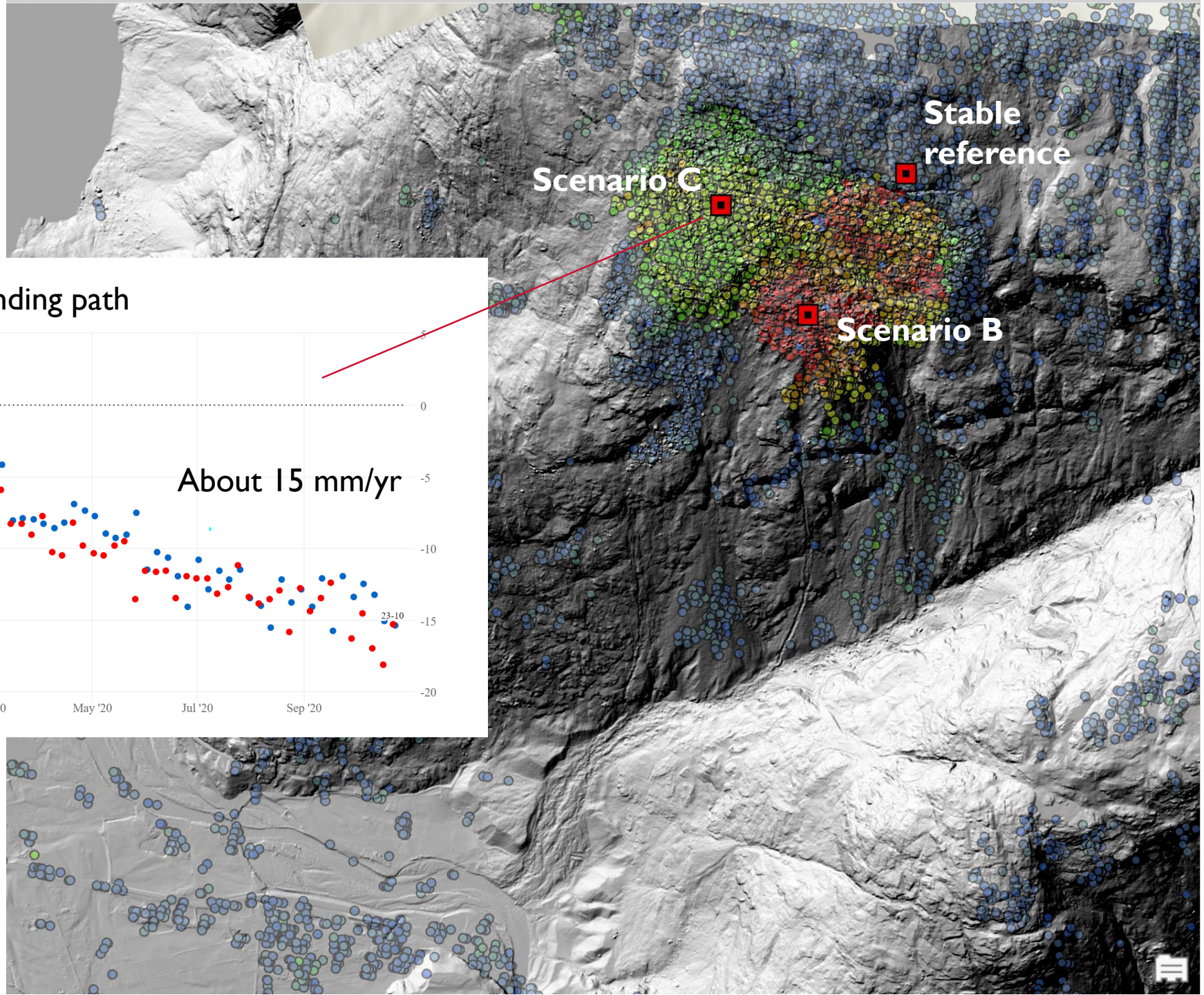
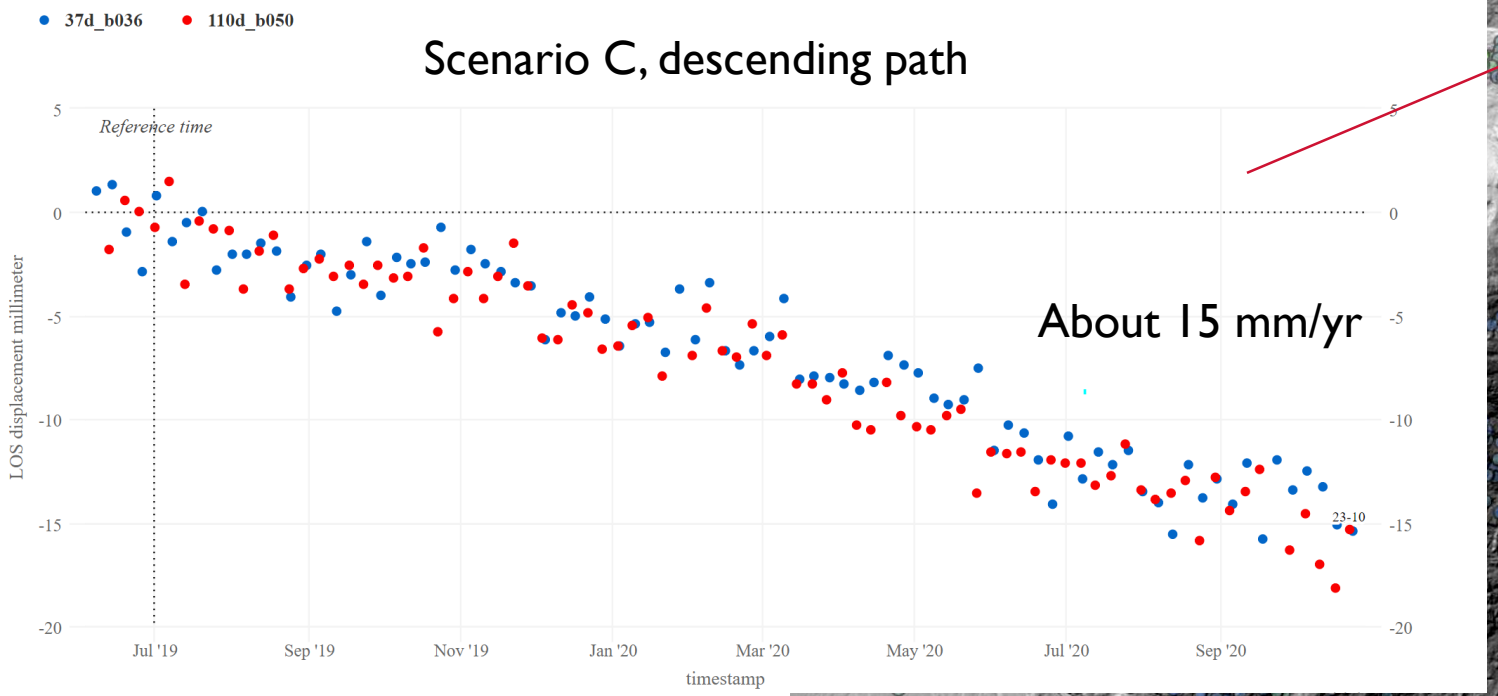


# Corner reflectors

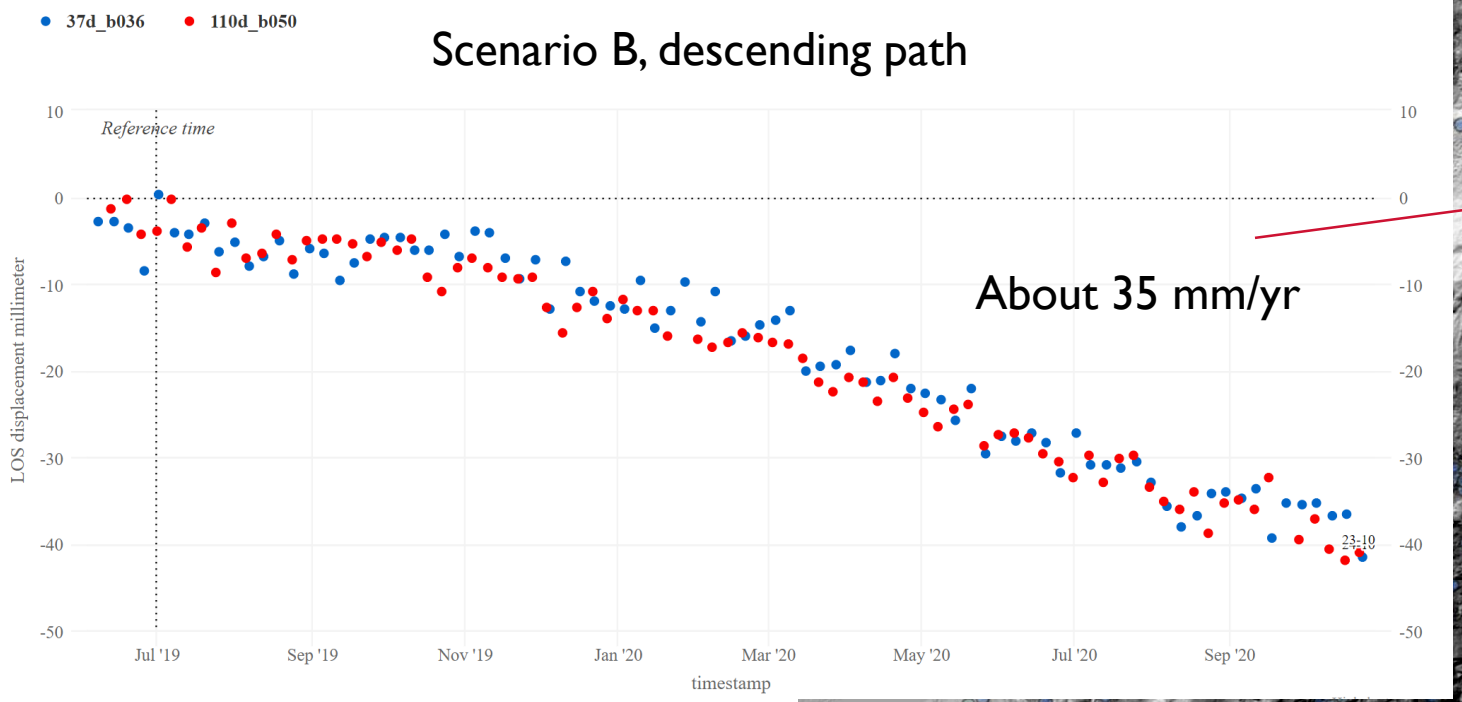


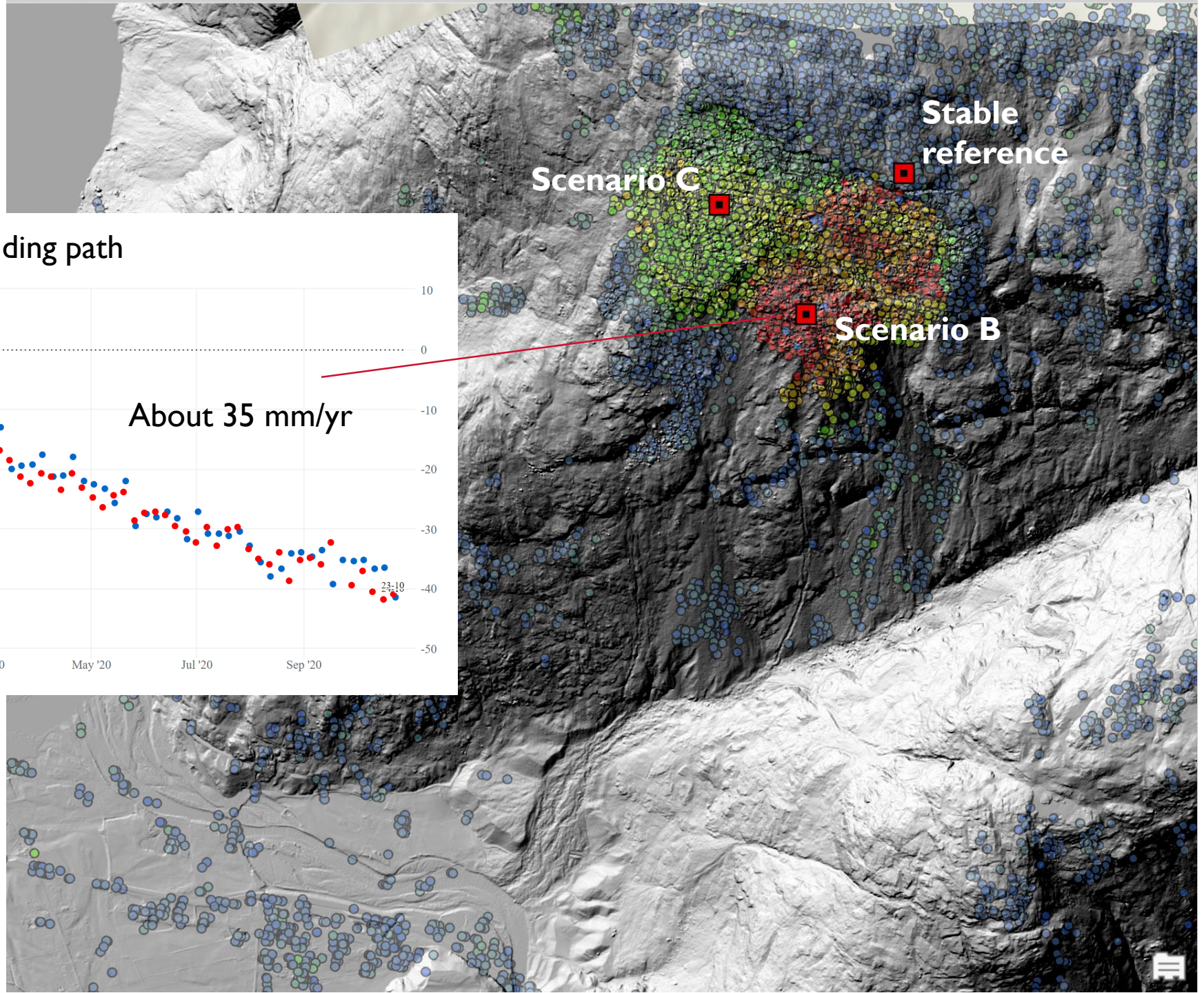




Data not influenced by snow cover or vegetation

Time series with 3-6 days resolution

# Corner reflectors

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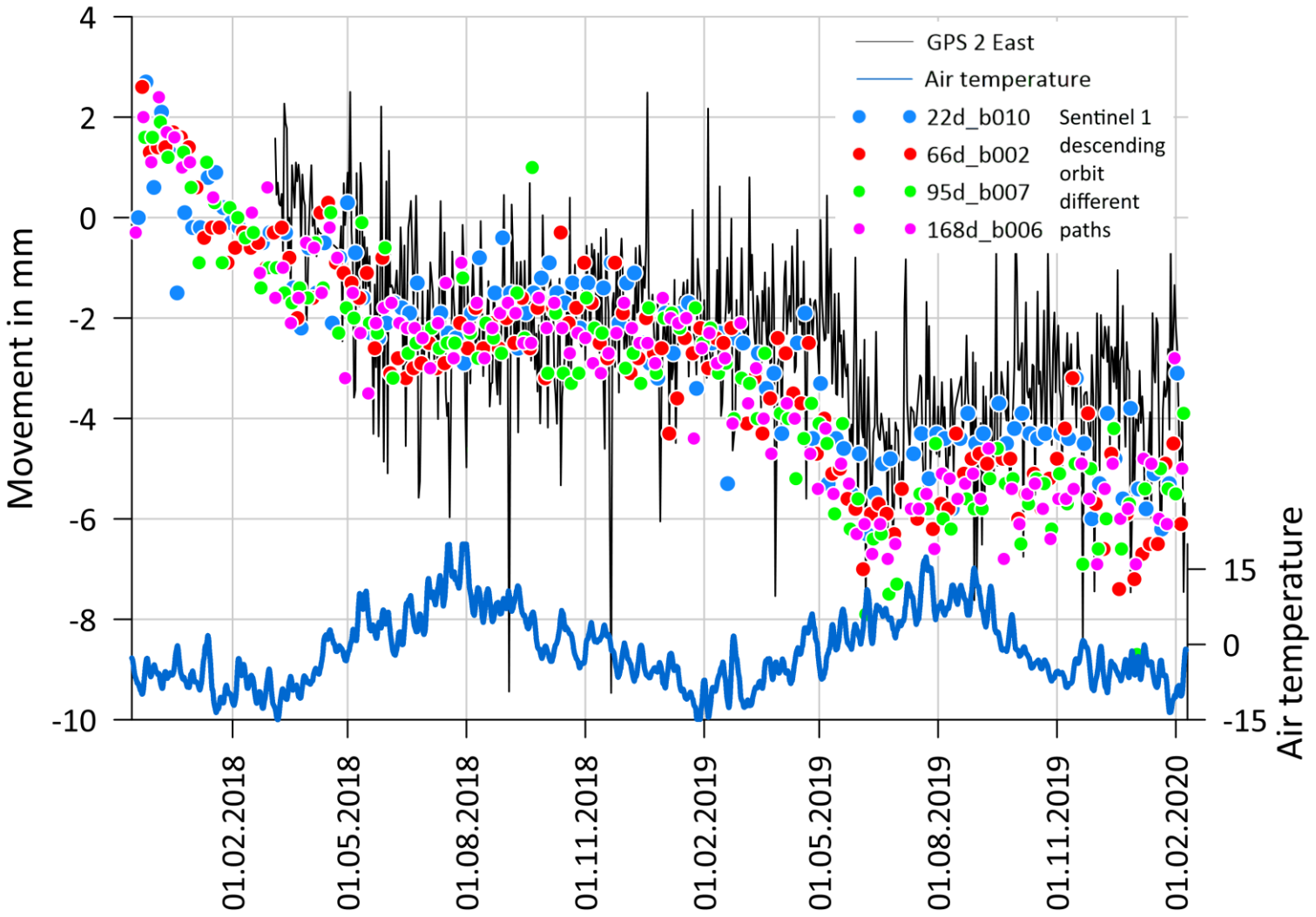
# Comparing corner reflectors to DGPS

Data from Revdalsfjellet, Kåfjord, Troms og Finnmark

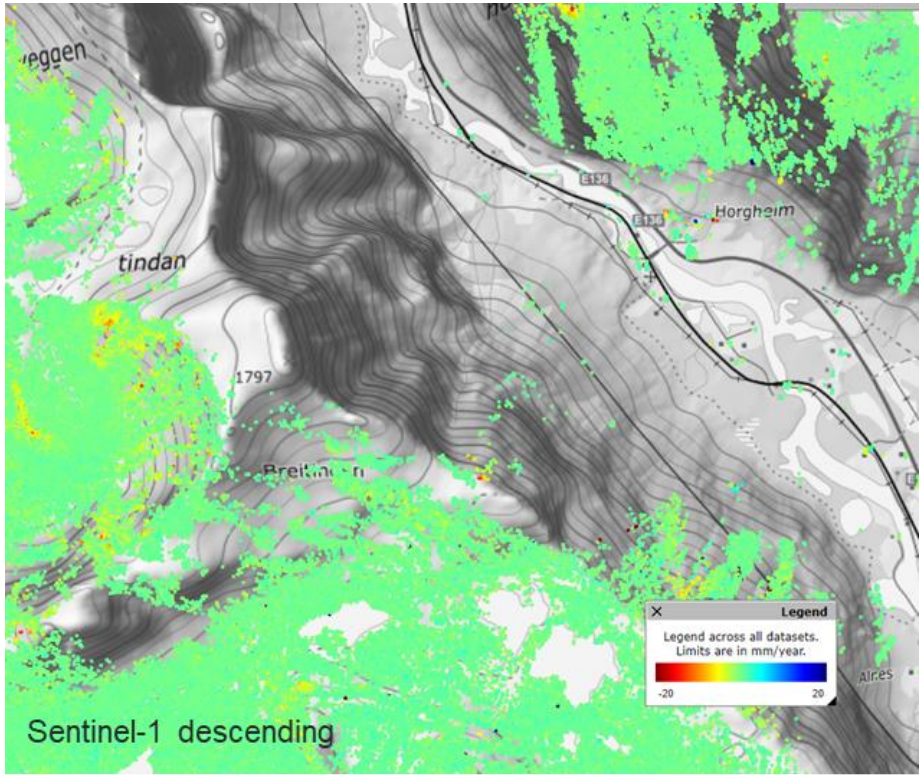
In most cases, data from InSAR Norway is sufficient to meet the requirements for periodic monitoring



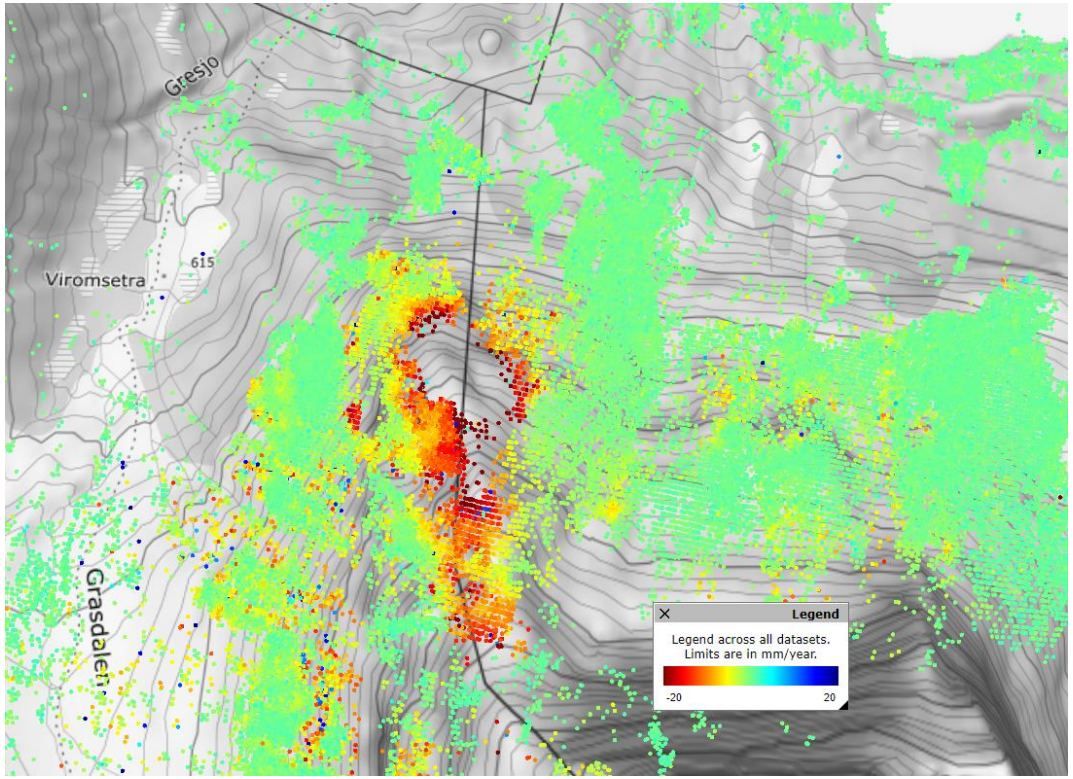
# Challenges: When are InSAR data less suitable?

Geometrical challenges:

- shadow and layover,
- unfavorable movement direction (N-S)

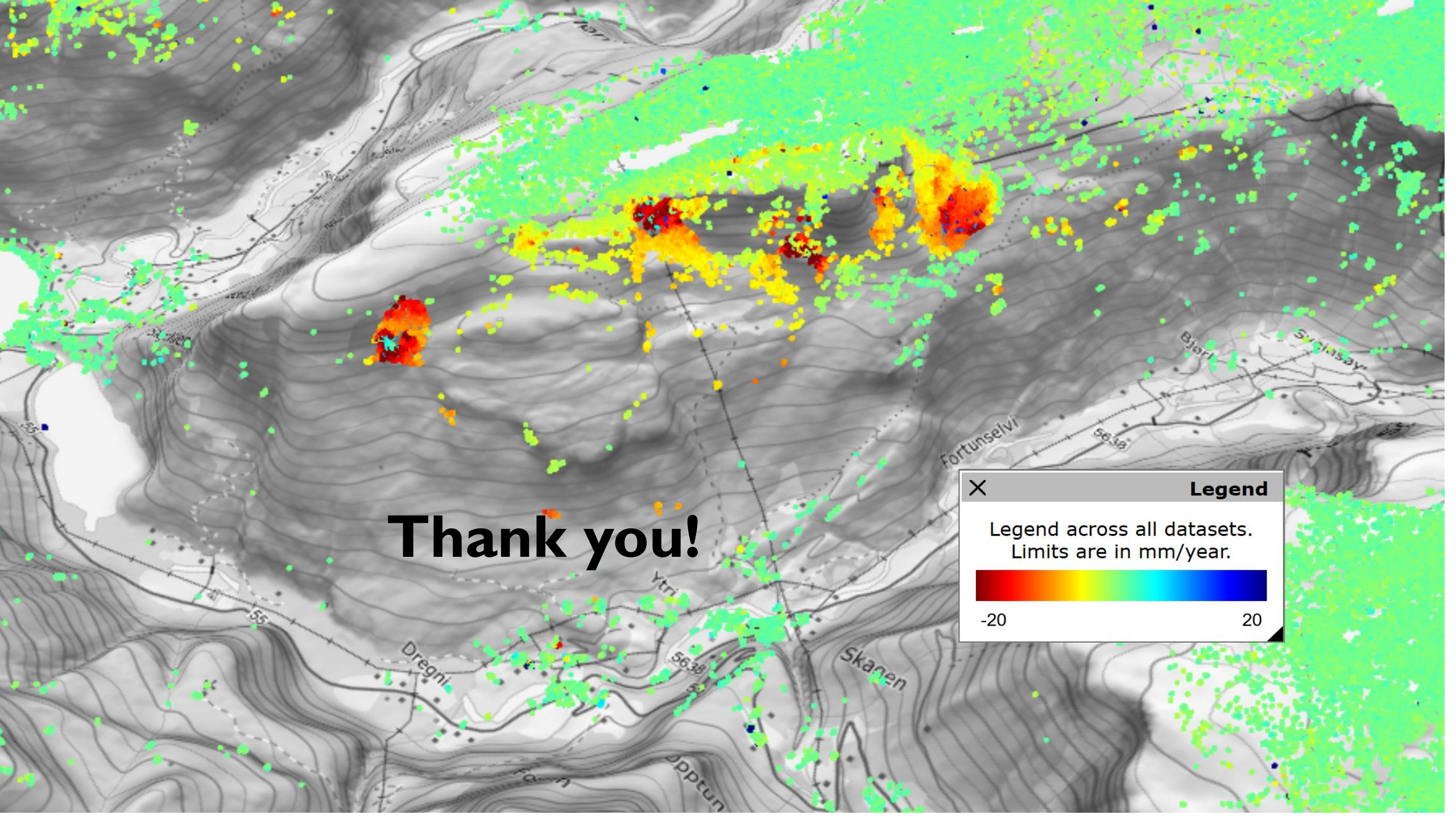



Too fast movements – loss of coherence



# Conclusions: InSAR Norway in the rockslide management

- An increasing number of unstable rockslopes are mapped
- When the objects are of medium or high risk, monitoring of movement is required
- For the medium risk objects, NVE is relying on data from InSAR Norway to meet the requirements
- When the infrastructure is in place (updated deformation map – corner reflectors installation and processing) the monitoring is inexpensive – in particular when comparing with *InSitu* field instrumentation


Legend
Legend across all datasets.
Limits are in mm/year.
-20
20
Fortunselvi
Skanen
Dregni
Ytri
Bjerk
Svinsay
Thank you!