Do we monitor the most critical slopes? Recent Norwegian cases and response

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Abstract:

Recent small rock avalanches in Norway have occurred from slopes without previously mapped instabilities, fortunately without any casualties. As the national authority responsible for landslides risk management, the Norwegian Water Resources and Energy Directorate (NVE) must consider how to efficiently prevent related future fatalities.

A large effort has been put into systematic mapping and risk classifying unstable slopes with potential to fail catastrophically. Until now 1144 unstable slopes have been identified, of which 122 have been hazard and risk classified in detail. The remaining slopes have been assigned a preliminary hazard and risk score to help prioritize the mapping efforts. The inventory is believed to include almost all visible large unstable slopes in Norway. The most critical slopes are monitored continuously (10) or periodically (21). In parallel, another project has mapped the source areas and deposits of 423 historic and prehistoric rock avalanches. This inventory is believed to be complete where the event occurred on land while probably incomplete where the failures went fjords and lakes. The Geological survey of Norway (NGU) compiled both the database of unstable slopes and the past rock avalanche events.

There is a clear discrepancy when comparing the mapped or monitored unstable slopes to the historic or prehistoric rock avalanches. Most obvious is that past failures statistically tend to originate on steeper slopes whereas most of the mapped instabilities are on gentler slopes. This suggests that steep slopes may fail rapidly with limited geomorphic precursors such as back scarps that typically develop over longer timescales. Consequently, there may be a bias in monitoring priorities, potentially overlooking steep slopes with limited visible deformation. NVE is concerned that the hazard from instabilities on steep slopes gets underestimated or not identified at all. This could be the largest residual risk of fatalities from rock slope failures. To address this, NVE strategy so far is:

- Develop tools for identifying changes in movements from satellite InSAR data within the framework of InSAR Norway (work in progress)
- To see if we can use repeated airborne LiDAR scans to identify movements
- Encouraging municipalities and citizens to report rockfalls and increased activity, which may precede larger failures, and follow up reports with investigation on available online data and in the field
- To have a “emergency monitoring instrument kit” available for fast deployment, and preparedness for rapid assessment of hazard zones to be used in case evacuations are required
- Toolboxes for rapid volume estimation and hazard zones delineation for evolving situations

In conclusion, we believe that preventing fatalities from large rock avalanches requires both a sustained mapping effort and a dynamic approach to identify the unstable slopes, particularly those that only become apparent close to the time of failure.