Towards a national overview for rock avalanche potential

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Abstract:

Several rock avalanches with significant consequences have occurred in Norway over the past centuries, leading to high societal awareness of this natural hazard. Consequently, a national program for mapping unstable rock slopes was initiated in 2006. Since then, several high-risk sites have been investigated in detail and are now continuously monitored. To date, five out of eleven Norwegian counties have been systematically analyzed for unstable rock slopes. Identified slopes are assessed using a hazard and risk classification system established in 2012 (Hermanns et al., 2012). This process is time-consuming, and ongoing mapping activities may not always target the slopes requiring the most urgent follow-up. National susceptibility maps exist for all other landslide processes in Norway and are essential tools for land-use planning and decision-making in construction projects. However, producing similar susceptibility maps for large rock slope failures is currently impossible, as such failures may occur on slopes that do not yet show clear signs of gravitational deformation. The lack of a national overview of unstable rock slopes—and the extended lag time between initial detection and final classification—has created challenges for major infrastructure and development projects. To address this, the Geological Survey of Norway has finalized a national mapping project aimed at establishing a complete overview of potentially unstable rock slopes and their associated indicative hazard and consequence potential. This approach enables a more effective prioritization of high-risk sites than the existing county-by-county framework. The project is structured in three main steps: Systematic analysis of remote sensing data (e.g., detailed DEMs, orthophotos, and InSAR data) to identify potential unstable rock slopes. Simplified ranking based on indicators of slope activity and stage of development. Assessment of potential consequences, including automated volume estimation, semi-automated run-out modeling, and empirical assessments of displacement wave run-up heights (Oppikofer et al., 2018; Tonnel et al., 2023). To optimize Step 1, known unstable slopes have been assessed against various criteria to define and target areas likely to contain additional unstable slopes. The results indicate that the study area can be limited—based on relief, population presence, and proximity to fjords and lakes—to roughly one third of Norway's total land area. Step 3 is designed to efficiently process a large number of slopes (>1000). By combining the results from the relative instability ranking and the consequence assessment, a national priority list of unstable rock slopes is produced. This list will guide future mapping, monitoring, and mitigation efforts and serve as a reference for prioritizing work related to other natural hazards in Norway. Moreover, the improved understanding of potential impact zones and consequences (both primary and secondary) will support more sustainable land-use planning and help prevent the development of new critical infrastructure in high-risk areas.

References

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