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Implementation of numerical simulations for rockfall hazard mapping in the Norddal municipality, Norway.

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The Norwegian Water Resources and Energy Directorate (NVE) in cooperation with the Geological Survey of Norway (NGU) are implementing a nationwide program to systematically produce hazard maps for rockfalls, debris flows and snow avalanches in steep terrains. Activities during this program mapping are being carried out by both institutions, and for some areas, outsourced to the private sector. The results presented in this contribution focus on the rockfall component only, and are part of the hazard mapping activities carried out by NGU. Results from all parties involved will further lead in future, in combination with the components on debris flows and snow avalanches, to the preparation of guidelines for landslide hazard mapping. Those will be presented and recommended for the use of private consultants that work on municipality level. The first goal of the project is the preparation of hazard maps for critical areas where a large number of people are exposed to the threat of such type of mass movements. Results from a pilot area in Sylte (Norddal municipality) were presented in the EGU general assembly in 2012. The main objective of this contribution is to present the first finished rockfall hazard maps generated by NGU during the execution of the program.

The results presented in this contribution were obtained for the Norddal municipality (Møre og Romsdal county). The area was selected based on the hazard mapping plan of Norway published in 2011, where Norddal is considered a priority area. The area is located in a valley over-steepened by glacial erosion that is characterized by high cliffs of medium to coarse-grained quartz-dioritic to granitic gneisses of Proterozoic age. Multiple scree deposits product of older and recent rockfall activity can be seen along the bottom at both valley flanks. Sylte, the main locality in the Norddal municipality, is located at the valley outlet to the fjord. Several other smaller localities are found along the valley.

A spatial geodatabase containing information regarding block sources, block shape and size, rock type, geometry and material properties along the potential rockfall tracks, and presence of natural energy attenuators (i.e. forest) was generated with data obtained during field work. Remote sensing imagery (high resolution aerial photographs), and a high resolution airborne LiDAR-based terrain model (1 m of spatial resolution) were used to extrapolate the information collected during field work to the full extent of the study area. Based on statistical analysis of the observed rock blocks a probability density function of the block size was obtained. This information was used to define the frequency of rockfall events of different sizes. Three scenarios were generated that follow the Norwegian regulations for construction (the Norwegian Building Act) for three different return periods: 100, 1000, and 5000 years. Numerical simulations using Rockyfor3D v. 5.0 (www.ecorisq.org) were performed for the three selected scenarios. Curves representing the maximum reach of blocks for every defined scenario with the sufficient energy to cause enough damage on buildings and houses that could threat the life of their inhabitants were used to define the hazard maps.

Results show a good fit with the location of scree deposits found during field recognition. According to the results for events corresponding to the 100 year return period, populated areas are out of the hazardous zones except for the area of Sylte due to the proximity of the village to a large rock cliff. 1000 and 5000 year scenarios show some other localities along the valley prone to be affected by rockfalls. Maps will be communicated to local authorities to help defining short and long term policies regarding land use.