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Performance evaluation of the national early warning system for shallow landslides in Norway

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As a consequence of the increased number of rainfall-and snowmelt-induced landslides (debris flows, debris slides, debris avalanches and slush flows) occurring in Norway, a national landslide early warning system (EWS) has been developed for monitoring and forecasting the hydro-meteorological conditions potentially necessary of triggering slope failures. The system, operational since 2013, is managed by the Norwegian Water Resources and Energy Directorate (NVE) and has been designed in cooperation with the Norwegian Public Road Administration (SVV), the Norwegian National Rail Administration (JBV) and the Norwegian Meteorological Institute (MET).

Decision-making in the EWS is based upon hazard threshold levels, hydro-meteorological and real-time landslide observations as well as landslide inventory and susceptibility maps. Hazard threshold levels have been obtained through statistical analyses of historical landslides and modelled hydro-meteorological parameters. Daily hydro-meteorological conditions such as rainfall, snowmelt, runoff, soil saturation, groundwater level and frost depth have been derived from a distributed version of the hydrological HBV-model. Two different landslide susceptibility maps are used as supportive data in deciding daily warning levels. Daily alerts are issued throughout the country considering variable warning zones. Warnings are issued once per day for the following 3 days with an update possibility later during the day according to the information gathered by the monitoring variables.

The performance of the EWS has been evaluated applying the EDuMaP method. In particular, the performance of warnings issued in Western Norway, in the period 2013-2014 has been evaluated using two different landslide datasets. The best performance is obtained for the smallest and more accurate dataset. Different performance results may be observed as a function of changing the landslide density criterion, Lden(k), (i.e. thresholds considered to differentiate among classes of landslide events) used as an input parameter within the EDuMaP method. To investigate this issue, a parametric analysis has been conducted; the results of the analysis show clear differences among computed performances when absolute or relative landslide density criteria are considered.