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Development of a local impact-based Landslide Early Warning System using physically-based multi-hazards modelling and machine learning in Java, Indonesia.

Andy Subiyantoro[1], Cees van Westen[1], Bastian van den Bout[1], Jetten Victor[1], Agus Muntohar[2], Akhyar Mushthofa[3], Ragil Andika Yuniawan[3], and Ratna Satyaningsih[4]
[1]University of Twente, ITC (Geoinformation Science and Earth Observation), Earth System Analysis, Enschede, Netherlands (a.subiyantoro@utwente.nl)
[2]Universitas Muhammadiyah Yogyakarta, Civil Engineering, Yogyakarta, Indonesia (muntohar@umy.ac.id)
[3]Sabo Technical Center, Ministry of Public Works and Housing, Yogyakarta, Indonesia (akhyar.m@gmail.com, ragil2506.ray@gmail.com)
[4]Meteorological, Climatological, and Geophysical Agency, Jakarta, Indonesia (ratnasat@gmail.com)

Early Warning Systems are one of the most effective tools for reducing disaster risk, however the development of Landslide Early Warning Systems (LEWS) is complicated due to the random nature of landslide occurrence and the uncertainty in mapping the parameters that cause them. Local LEWS have been effective for known landslides, but regional scale LEWS based on rainfall thresholds have not been very effective up to now. In recent years physically-based multi-hazard models have been developed which allow to predict mass movement hazards at a local scale. However, it is still difficult to apply these in LEWS in a local scale due to the coarse resolution of rainfall estimates and the high computational modelling requirements for running such models real-time. On the other hand, machine learning approaches have been used to assess the relationship between the distribution of the landslide hazard and the catchment morphometric features.

This research applies a physically-based multi-hazard model combined with machine learning to forecast the mass movement impact, based on rainfall predictions in an area in Java, Indonesia. The landslide inventory was developed using a combination of local reporting data and machine learning techniques. The integrated physically-based multi hazard model OpenLISEM is used to create a database of hazard intensity maps under various rainfall scenarios. The resulting hazard intensity maps are subsequently used to subdivide the area in homogeneous zones for which warning levels are given. Machine learning is used to query the database and extract the most likely hazard intensity map based on the rainfall prediction. The intensity is then combined with exposure information of people, buildings, transportation infrastructure and agriculture to provide impact forecasts. The output of combining physically-based models with machine learning approaches has the potential to improve the prediction of landslide impact. The method also allows to make more specific local decisions related to the actions for various levels of warning (e.g. increased vigilance, removal of resources, evacuation of people). The method is currently

under development as part of an Indonesian-Netherlands collaboration project to develop a blueprint to use tailored rainfall data, in combination with empirical and physically-based hydrological and landslide models, and historical landslide data for the development of thresholds for landslides and debris flows, as the basis for early warning at settlement level, applied to several test sites in Java.