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Development of direct multi-hazard susceptibility assessment method for post-earthquake reconstruction planning in Nepal

Olga Mavrouli (1), Sohel Rana (1), Cees van Westen (1), and Jianqiang Zhang (2)

(1) Department of Earth Systems Analysis, Faculty of Geo-Information Science and Earth Observation (ITC), University of Twente, Netherlands, (2) Institute of Mountain Hazards and Environment, Chinese Academy of Sciences, Chengdu, China

After the devastating 2015 Gorkha earthquake in Nepal, reconstruction activities have been delayed considerably, due to many reasons, of a political, organizational and technical nature. Due to the widespread occurrence of co-seismic landslides, and the expectation that these may be aggravated or re-activated in future years during the intense monsoon periods, there is a need to evaluate for thousands of sites whether these are suited for reconstruction. In this evaluation multi-hazards, such as rockfall, landslides, debris flow, and flashfloods should be taken into account. The application of indirect knowledge-based, data-driven or physically-based approaches is not suitable due to several reasons. Physically-based models generally require a large number of parameters, for which data is not available. Data-driven, statistical methods, depend on historical information, which is less useful after the occurrence of a major event, such as an earthquake. Besides, they would lead to unacceptable levels of generalization, as the analysis is done based on rather general causal factor maps. The same holds for indirect knowledge-driven methods.
However, location-specific hazards analysis is required using a simple method that can be used by many people at the local level. In this research, a direct scientific method was developed where local level technical people can easily and quickly assess the post-earthquake multi hazards following a decision tree approach, using an app on a smartphone or tablet. The methods assumes that a central organization, such as the Department of Soil Conservation and Watershed Management, generates spatial information beforehand that is used in the direct assessment at a certain location. Pre-earthquake, co-seismic and post-seismic landslide inventories are generated through the interpretation of Google Earth multi-temporal images, using anaglyph methods. Spatial data, such as Digital Elevation Models, land cover maps, and geological maps are used in a GIS to generate Terrain Units in a semi-automated manner, which are further edited using stereo-image interpretation. Source areas for rockfall and debris flows are outlined from the factor maps, and historical inventory, and regional scale empirical runout models are used to define areas that might be affected. This data is then used in the field in an application that guides the user through the decision tree by asking a number of questions, which can be answered by using the existing data, and by direct field observations. The method was applied in a part of Rasuwa district, which was seriously affected by co-seismic and post-seismic mass movements, leading to the evacuation of a number of village, and temporary closure of a number of hydropower construction projects.