A water balance approach to enhance national (GB) Daily Landslide Hazard Assessments

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The British Geological Survey (BGS) is a member of the Natural Hazards Partnership (NHP) and delivers a national (GB) daily landslide hazard assessment (DLHA). The DLHA is based largely on 'expert' driven evaluations of the likelihood of landslides in response to antecedent ground conditions, adverse weather and reported landslide events. It concentrates on shallow translational slides and debris flows – events that most frequently have societal consequences by disrupting transport infrastructure and affecting buildings.

Considerable experience with the issuing of DLHAs has been gained since 2012. However, it remains very difficult to appropriately assess changing ground conditions throughout GB even when good quality precipitation forecasts are available. Soil moisture sensors are available, but the network is sparse and not yet capable of covering GB to the detail required to underpin the forecasts. Therefore, we developed an approach where temporal and spatial variations in soil moisture can be obtained from a water balance model, representing processes in the near-surface and configured on a relatively coarse grid of 1 km2. Model outputs are not intended to be relevant to the slope scale. The assumption is that the likelihood of landslides being triggered by rainfall is dependent upon the soil moisture conditions of the near-surface, in combination with how much rain is forecast to occur for the following day. These variables form the basis for establishing thresholds to guide the issuing of DLHA and early warnings. The main aim is to obtain an insight into regional patterns of change and threshold exceedance.

The BGS water balance model is still in its infancy and it requires substantial work to fine-tune and validate it. To test the performance of the BGS model we focused on an analysis of Scottish landslides (2004-2015) comprising translational slides and debris flows where the BGS model is conditionally evaluated against the Grid-to-Grid (G2G) Model. G2G is a physical-conceptual distributed hydrological model developed by the Centre for Ecology & Hydrology, also an NHP member. G2G is especially suited to simulate river flows over ungauged areas and has the capability to forecast fluvial river flows at any location across a gridded model domain. This is achieved by using spatial datasets on landscape properties – terrain, land-cover, soil and geology – in combination with gridded time-series of rainfall to shape a rainfall pattern into a river flow response over the model domain. G2G is operational on a 1 km2 grid over the GB and outputs soil moisture estimates that take some account of terrain slope in its water balance calculation.

This research is part of an evolutionary process where capabilities of establishing the likelihood of landslides will develop as datasets are becoming increasingly detailed (and accessible) and the representation of hydrogeological and geotechnical processes continues to develop.