Geophysical Research Abstracts
Vol. 21, EGU2019-3148-1, 2019
EGU General Assembly 2019

Physically based landslide prediction over a large region: coupling low-resolution hydrological modelling with high-resolution slope stability assessment

Sheng Wang (1), Ke Zhang (1), Thom Bogaard (2), and L.P.H. van Beek (3)

(1) State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Hohai University, Nanjing, China, (2) Department of Water Management, Delft University of Technology, Delft, the Netherlands, (3) Department of Physical Geography, Utrecht University, Utrecht, the Netherlands

Rainfall-triggered landslides are widespread natural hazards all over the world, causing a lot of fatalities and property loss. Different hydrological and slope stability models have been developed to predict rainfall-triggered landslides in order to reduce their damages. However, most of the studies focused on a single slope or on landslide events in relatively small catchments: to simulate the processes that control landslide occurrence, in particular to include the effect of topography, high-resolution modelling is needed ($\sim$ 10 m). This resolution is also a prerequisite to validate model results against observed landslides from inventories. Yet, the corresponding computational load make it hard to transfer physically based modelling to larger areas (e.g., basins » 1000 km2)and to obtain and regionalize the necessary model parameters, especially as calibration is prohibitively taxing. In order to apply physically-based models for landslide prediction, therefore, meaningfully to large basins, some computational expediency is needed.

Low-resolution hydrological models (like macro-scale hydrological models, typically applied at 1 km resolution or coarser) are widely available and increasingly gain from the increasing availability of climate data (e.g., satellite-based rainfall data, GCM-based climate projections) and from the rising number of land surface datasets (e.g., of soil and land cover). These models can be calibrated rigorously against observed discharge and with orthogonal data (e.g., evapotranspiration from MODIS, SPOT soil moisture data, etc.) that help to capture the spatio-temporal variations across the basin accurately, albeit at a relatively coarse resolution. Still, the hydrological information should be downscaled to link it to the topographic variation at the scale of a single slope at which landslides occur. The main objective of this study is to use topographic information to transfer the results of the coarse-scale hydrological model to the finer resolution at which landslides occur in an efficient and expedient manner. The hydrological model we used is the distributed hydrological model, the Coupled Routing and Excess STorage (CREST) model, that was applied at a resolution of 1 km to the Shaanxi Province in Northwest China with an area of more than 200,000 km2 for the period 2009-2012. We downscaled the hydrological information using topographical variables and land surface conditions to the finer resolution of 90 m which can be deemed as an upper limit at which process-based landslide hazard assessments can be made. For the landslide assessment, we used a physically-based landslide model, the SLope-Infiltration-Distributed Equilibrium (SLIDE) model. Our study develops and tests the method for the physically based downscaling of the hydrological information and evaluates its performance in terms of the hydrological regime and the occurrence of landslides prior to assessing regional slope stability for selected design storms (5, 10 years).