DOCTORAL SCHOOL IN ENVIRONMENTAL ENGINEERING

Department of Civil and Environmental Engineering

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Hydrological controls on the triggering of shallow landslides: from local to landscape scale

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Abstract

This research tries to fill a gap between two very different scales of enquiry: the local (i.e. hillslope) scale, where detailed investigations are possible but difficult to generalize over large areas, and the landscape (i.e., catchment) scale, where representation of the physics is minimised, the resolution in space and time is maximised, and the focus is upon predicting emergent properties rather than system details. Specifically, this Thesis focused on an aspect of the geosciences that is of critical current concern: the representation of the interface between hydrological response and geomorphic processes, notable mass movements. At present there remains a great difficulty at this interface: detailed geotechnical and hydrological studies of mass movements reveal exceptionally complex interlinkages between water and the surface sediment mass, notably dynamically at the onset and during mass release; but these kinds of studies are only possible with a very detailed description of the three-dimensional structure of the porous media and its hydrological and mechanical response during (and after) rainfall events. Such analyses are feasible but tend to result in analyses that are restricted in terms of geographical generalisation. On the other hand, approaches that apply to larger spatial scales tend to over-simplify the representation of critical failure processes, such as in the assumptions that infinite slope stability analysis can be applied to failures that are finite in their

slope length, or that upslope contributing area can always act as a surrogate for the hydrologic response at a point in the watershed.

The innovative element in this research lies on the assessment of rainfall-induced shallow landslide occurrence over large spatial scales, whilst accepting that shallow landslides triggering may be influenced by processes that operate over much smaller scales. Specifically, this Thesis focuses upon connection by subsurface flow pathways. New model approaches that incorporate connectivity are required to address the findings of field hydrologists. Thus, this Thesis starts from the understanding of small-scale hydrological processes to develop a large-scale topographic index-based shallow landslide model that includes the concept of subsurface hydrological connectivity.

The research aims to provide a tool for more realistic assessments of when shallow landslides may occur and where landsliding may occur at the catchment scale to support decision makers in developing more accurate land-use maps and landslide hazard mitigation plans and procedures.