Application of dynamic modelling to identify buildings at risk and pedestrian travel times to safety areas in a debris flow worst-case scenario

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Abstract

Debris flows are one of the most hazardous types of landslides in mountain regions. In the upper part of the Zêzere valley (Serra da Estrela, Portugal) several debris flows events occurred in the last 200 years, some of them causing loss of lives and material damages. In this work, a methodology for pedestrian evacuation modelling, in a debris flow hazard scenario, was implemented. A dynamic run-out model was used to evaluate the debris flows velocities, thickness of the deposits and extent of the mobilized material. The buildings potentially affected by the impact of debris flows were identified and the potentially exposed population was estimated by applying a dasymetric distribution. The results lead to the conclusion that, in the study area, the elders are the most exposed to debris flows. Furthermore, the time lapse between the debris flows initiation and the arrival at the buildings at risk was estimated, allowing to account for the overall number of buildings where the evacuation time takes longer than the debris flows arrival. Additionally, the safe areas within the study area were identified, and several safe public buildings with the capacity to gather a large number of persons were selected. Considering that the study area is located in a mountain region, characterized by steep slopes, the evacuation modelling was performed based on an anisotropic approach, in order to consider the influence of slope direction on travel costs. At the end, three pedestrian evacuation travel time scenarios, based on different walking speeds to accommodate residents with different ages in safer places, were compared and the results mapped. The implemented methodology is not local dependent, which allows its reproduction elsewhere.

Key words: debris flows; dynamic run-out modelling; dasymetric distribution; pedestrian evacuation; anisotropic least-cost path.