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On the physical vulnerability of buildings exposed to landslide hazard: application to the Lisbon Metropolitan Area

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This work aims to assess the physical vulnerability of buildings (PVB) exposed to landslides that can be triggered by rainfall and earthquake in the Lisbon metropolitan area (LMA).

Susceptibility to landslides triggered by rainfall was assessed with a statistical model (Information Value), using seven predisposing factors: slope, aspect, geology, curvature, land use, and topographic wetness and position (TPI) indexes. A landslide inventory containing 4k landslides identified in the Lisbon and Tagus Valley region was used. The ROC curve of this model produced an AUC of 0.92. In this approach, the area defined as most susceptible was selected to assess the PVB for each exposed building to landslides with a slip surface depth of 1 m and an accumulated material height of 0.5 m.

Susceptibility to landslides triggered by earthquakes was assessed with an Analytic Hierarchy Process to achieve the relative weights based on the Saaty's scale of influence using six predisposing factors: slope, curvature, TPI, geology, PGA and distance to faults. The results of this model were compared with a historical inventory of landslides triggered by earthquakes in the LMA obtained from documental sources (Vaz and Zêzere, 2016). The area most susceptible to landslides (8^{th} and 9^{th} deciles) was selected to assess the PVB for each exposed building to landslides with a slip surface depth of 3 m and an accumulated material height of 1 m.

In both cases, the PVB assessment considered all exposed buildings with a residential function surveyed in the 2011 Census (Georeferenced Buildings Database - BGE), including the following parameters: construction material, presence of reinforced structure, number of floors, conservation status, and need for repairs in the structure and finishes. Each parameter was divided into a set of building classes obtained from BGE. A score was given to each building class and the respective parameter. Both scores and parameters' weights are based on expert opinion and dedicated literature (Guillard-Gonçalves et al., 2016; Pereira et al., 2020).

The analysis allowed us to observe meaningful regional multi-hazard potential interactions between earthquake and rainfall triggered landslides which can generate, in space and time, a complex level

of damages scenarios for residential buildings. Additionally, it contributes to identifying risk hotspots and possible risk adaptation and mitigation measures.

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References:

Guillard-Gonçalves, C., Zêzere, J. L., Pereira, S., & Garcia, R. A. (2016). Assessment of physical vulnerability of buildings and analysis of landslide risk at the municipal scale: application to the Loures municipality, Portugal. Natural Hazards and Earth System Sciences, 16(2), 311-331.

Pereira, S., Santos, P. P., Zêzere, J. L., Tavares, A. O., Garcia, R. A. C., & Oliveira, S. C. (2020). A landslide risk index for municipal land use planning in Portugal. Science of the Total Environment, 735, 139463.

Vaz, T., & Zêzere, J. L. (2016). Landslides and other geomorphologic and hydrologic effects induced by earthquakes in Portugal. Natural Hazards, 81(1), 71–98.