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Scenario- based multi- risk assessment on exposed buildings to volcanic cascading hazards

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In order to assess the building portfolio composition for a particular natural hazard risk assessment application, it is necessary to classify the built environment into schemas containing building classes. The building classes should also address the attributes which may control their vulnerability towards the different hazards associated with their failure mechanisms, which along with their respective fragility functions are representative of a particular study area. In the case of volcanic risk, former efforts have been carried out in developing volcanic related fragility functions, this has been done mostly for European, Atlantic islands and South Asian building types (SEDIMER, MIA VITA, VOLDIES, EXPLORIS, SAFELAND projects). However, in other parts of the globe, particular construction practices, materials, and even occupancies may describe very diverse building types with different degrees of vulnerability which may or not be compatible with the existing schemas and fragility functions (Spence et al. 2005, Zuccaro et al. 2013, Mavrouli et al. 2013, Jenkins et al. 2014, Torres-Corredor et al. 2017).

As highlighted by Zuccaro et al. 2018, since in the case of volcanic active areas, the built environment will not only be exposed to a single hazard but to several compound or cascading hazards (e.g. tephra fall, pyroclastic flows, lahars), with different time intervals between them, a dynamic vulnerability with cumulated damage on the physical assets would be the baseline upon a multi-risk- volcanic framework should be described. In this similar context, single- hazard but still multi-state fragility functions have been very recently used in order to set up damage descriptions independently on the reference building schema. We propose to generalize this novel approach and further extend it in the volcanic risk assessment context. To do so, the very first step was to generate a multi-hazard- building- taxonomy containing a set of exhaustive mutually exclusive

building attributes. Upon that framework, a probabilistic mapping across single- hazards- building-schemas and damage states has been achieved.

This methodological approach has been tested under the RIESGOS project over a selected study area of the Latin American Andes Region. In this region, cities close to active volcanos have been experienced a non-structured grow, which is translated into a significantly vulnerable population living in non- engineering buildings that are highly exposed to volcanic hazards. The Cotopaxi region in Ecuador has been chosen in order to explore the ash falls and lahars damage contributions with several scenarios in terms of volcanic explosivity index (VEI). Local lahars simulations have been obtained at different resolutions. Moreover, probabilistic ash- fall maps have been recently obtained after exhaustive ash fall and wind direction measurements. Lahar flow- velocity and ash- fall load pressure were respectively used as intensity measures. Furthermore, local and foreign building schemas that define the building exposure models have been constrained through ancillary data, cadastral information, and remote individual building inspections, to then been associated with a multi-state fragility function. These ingredients have been integrated into this novel methodological scenario-based- multi-risk- volcanic assessment.