DYNAMIC VULNERABILITY

Quantification of cumulated damage after multiple hazards

OBJECTIVE AND COMPONENTS

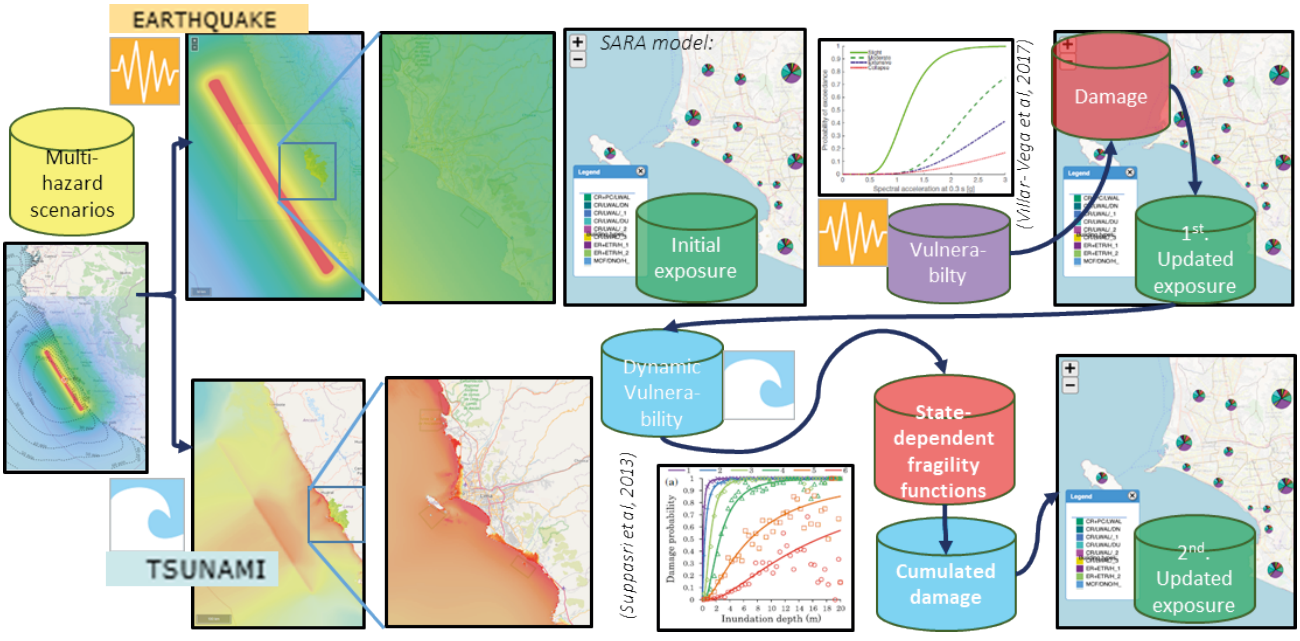
We have developed an innovative method to assess the **differential and cumulated damage suffered by the same residential exposed building stock to a series of cascading hazards**. The disaggregation of the damage and loss is key to assess cascading risks. This method is composed of a probabilistic building exposure model, their respective single-hazard vulnerability models, state-dependent fragility functions, and the probabilistic mapping between damage states and building classes.

PROBABILISTIC BUILDING EXPOSURE MODELS

For every set of hazard-dependent building classification, compatible probabilistic and **adaptable multi-state fragility functions for the specific South American building portfolio** have been chosen among the ones reported in the literature. We have integrated remote building survey data; remote sensing data products, open-source data information; census and cadastral datasets, and **statistical algorithms to construct probabilistic exposure models**.

OPTIMAL AGGREGATION AREAS TO SERVE STATE-DEPENDENT FRAGILITY FUNCTIONS

We have investigated the optimal representation of multi-resolution irregular grid cells for the aggregation of the residential building exposure models. They have been customized through the combination and sampling of population density and hazard related intensities (IM) (e.g. tsunami inundation height). **These models ensure that a higher density of IM values are served to the respective fragility functions where the exposed assets and local variations of IM are encountered**. These are novel



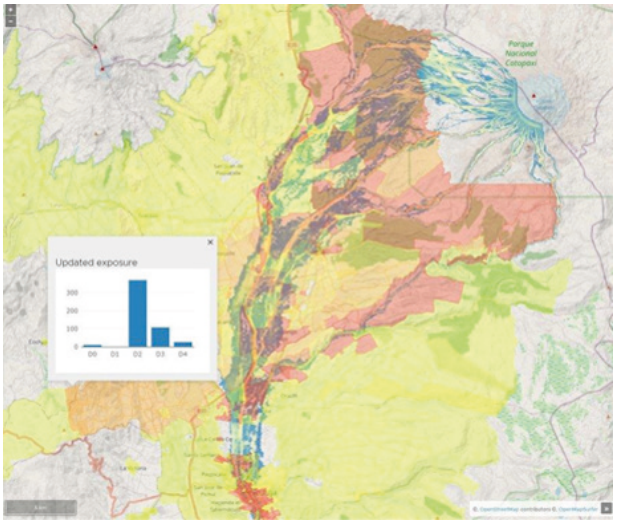
Workflow of the methodological approach proposed to calculate the cumulated damage for cascading hazards over the exposed residential buildings in the study areas. Illustrative example for the case of Earthquake-tsunami in Lima.

state-dependent fragility functions that account for damage state transitions in a multi-risk framework. For the vulnerability assessment, consequence models, and loss ratios for the selected building classes have been proposed. They ultimately **allow to update and disaggregate the expected losses from every hazardous event in the multi-hazard sequence**.

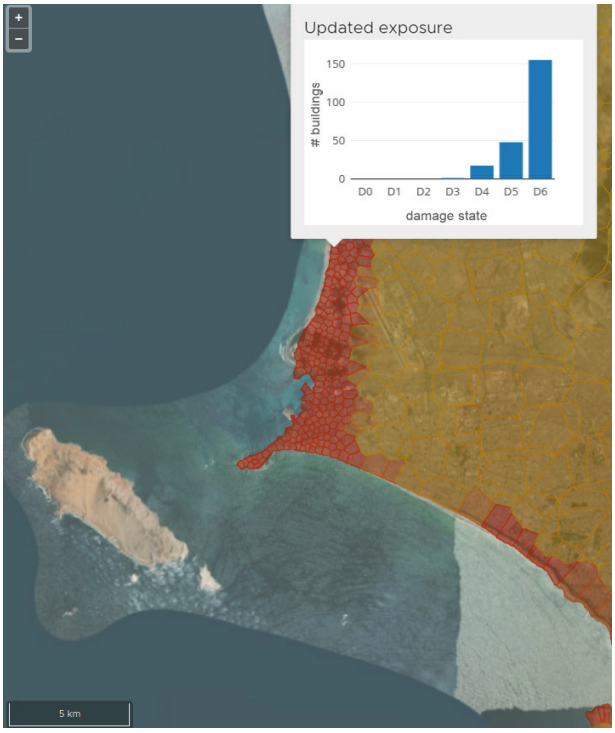
THE ONLINE COMPUTATION OF CUMULATED DAMAGE

Thanks to the components described, the physical vulnerability assessment can be carried out on the residential buildings exposed in the three study areas to each first natural hazard within the proposed cascade sequences (that is, earthquake and ashfall). The action of the second hazard on the already damaged building is calculated through a dynamic vulnerability methodological proposal that assesses the compatibility between the state of the damage and the building classes.

This is done through the **web service GFZ DEUS (Damage Exposure Update Service) using the scenarios and exposure models for buildings to calculate their expected damage and economic loss**. DEUS is the main web service used by the RIESGOS demonstrator to produce all the online calculations and display the results in a graphical interface.



Accumulated damage after ash fall and lahar impact on exposed buildings in the city of Latacunga, Ecuador visualized in the RIESGOS demonstrator.



Accumulated damage after earthquake and tsunami impact on exposed buildings in the city of Lima, Peru visualized in the RIESGOS demonstrator.

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More information about the project:
www.riesgos.de

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