FLOOD RISK

Flood damage analyses and modelling

DAMAGE PROCESSES

Floods are among the most frequent natural hazards worldwide, affecting people and buildings along rivers or by torrential rain and surface water flooding. **The amount of damage depends on the hazard severity and the vulnerability of the exposed assets.** For buildings, engineers have defined classes of structural damage according to commonly observed patterns: e.g. from mildly affected, i.e., non-structural damage to doors, windows, or sanitation to irreparable damage or collapse.

Damage estimation is a challenge, due to a lack of knowledge and the stochastic nature of the complex damage processes. The situation is further complicated in the case of multi-hazard and compound events, which we are investigating in the project RIESGOS. Specifically, we assessed the **damage processes during the El Niño event 2017 in Peru**. Further, we developed a damage model to complement a story line for **possible cascading events at the Cotopaxi, Ecuador**, imagining that a lahar creates a dammed lake, leading to a flood after a dam breach.

Figure 1: Flood in Peru. Galería del Ministerio de Defensa del Perú, Lima-Perú, CC BY 2.0 (https://creativecommons.org/licenses/by/2.0), via Wikimedia Commons.

DAMAGE ASSESSMENT AND MAPPING

GFZ has, in cooperation with INDECI, assessed the damage to residential buildings resulting from the El Niño event of 2017 in Peru, **based on 20 explanatory features from remote sensing products and open geodata**. Figure 2 shows the effect of rainfall sum and maximum from the Tropical Rainfall Measurement Mission (TRMM) satellites, Height Above Nearest Drainage (HAND) and density of the Global Urban Footprint (GUF) on the predicted probability of 4 ordinal damage grades, ranging from D1 (mildly affected) to D4 (collapse). It is visible that increasing intensity of rainfall lead to increasing damage from D1 to D3. However, D4 occurred primarily under low or medium rainfall to buildings located close to a river (low HAND) or in rural areas (low GUF_density).

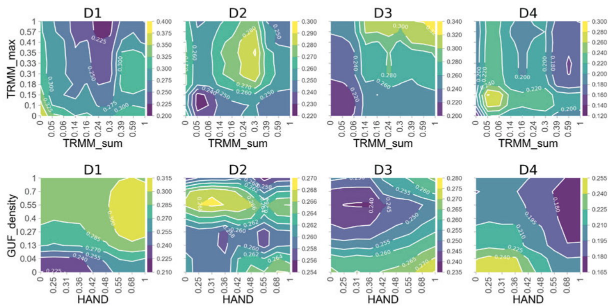

Figure 2: 2D partial dependence interaction plots.

Based on the data of this El Niño event, a **fully data-driven damage probability map for 2017** was developed (Figure 3), as demonstration of the technical feasibility. Since only valid for this one event, the map cannot be used for practical risk management.

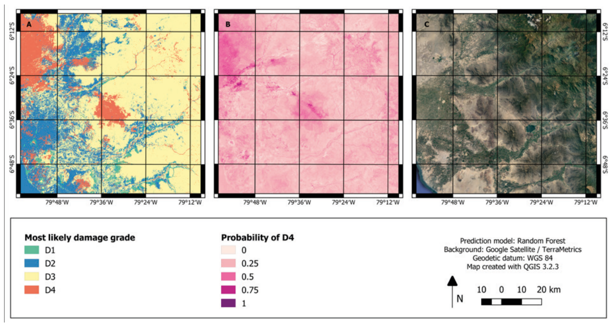

Figure 3: Damage probability map of 2017 El Niño event, produced by Random Forest on 20 features.

For the RIESGOS demonstrator, GFZ has provided a **river flood damage model as web processing service** (WPS). This probabilistic multi-variable model uses the following continuous input variables: water depth, velocity, duration, and building size. Figure 4 shows a visualization of computed damage on individual OpenStreetMap buildings and aggregated spatial units. The saturation of the colors indicates the confidence of the model, given the hazard scenario, for simplified communication of probabilistic information.

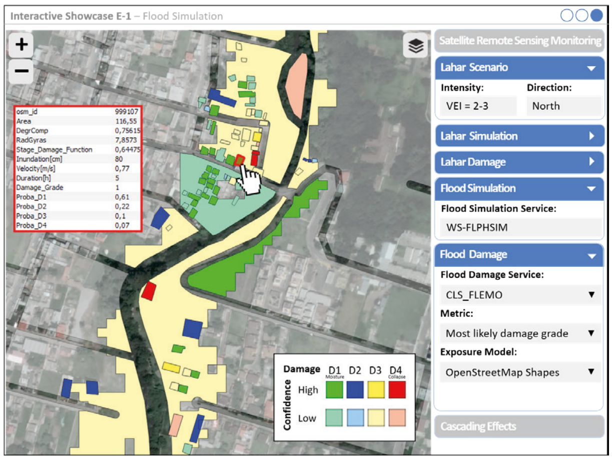

Figure 4: River flood damage prediction visualized.

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More information about the project:
www.riesgos.de

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