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Communicating landslide risk by combining hazard and open infrastructure data in interactive visualizations

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The DIGENTI project ("DIGitaler ENtscheiderTIsch für das Naturgefahrenmanagement auf Basis von Satellitendaten und Volunteered Geographic Information") has the goal of quantifying and communicating the threat of natural hazards in the Cesar and La Guajira departments of northeast Colombia. The end-goal of the project is to provide an interactive guide for policy and decision makers, and for disaster relief coordination. Over the last years, abundant research has been done in order to analyze risk and to provide relevant information that improves effectiveness in disaster management. The communication of natural hazards risk has traditionally been built upon the estimation of hazard maps. In the context of landslides, hazard maps are used to depict potential danger from landslides and visualize the possibility of future landsliding throughout a given area. Such hazard maps provide a static snapshot of the local estimated threat in a region. However, in mountainous regions, a sufficiently large landslide in remote mountainous areas may represent a potential threat to settlements located downstream of a landslide event. The research presented here proposes an approach to visualize and interactively explore landslide risk by combining static hazard maps, hydrologic networks, and OpenStreetMap data.

We estimated the potential for hillslope instabilities scenarios in the region of interest by using the TanDEM-X World DEM to calculate a suite Factor of Safety (FOS) maps. The FOS estimates the ratio of total resisting and driving forces to hillslope mass movements. By combining the World DEM with other environmental data (e.g., the Harmonized World Soil Database), we were able to create a suite of high-resolution landslide potential maps for the region of interest. The suite of FOS maps are calculated based on user-selectable parameters (e.g, total mass sliding thickness) that are not well constrained by field observations. We additionally use the TanDEM-X World DEM to calculate the hydrologic network for our study area. This allows not only to delineate the stream network, but also to calculate the area upstream of settlements located near rivers or streams that may be impacted by distal landsliding. By integrating the potential landslide hazard in the upstream area, we create a more robust threat estimate for vulnerable settlements.

Disaster relief is not only affected by the physical consequences of a hazardous event, but also by the area's accessibility and mobility capability for internal displacements. We therefore also estimate the threat along roads and to other infrastructure (e.g. bridges). Decisions based on the area's road network have to be constantly taken, for instance, to send rescue teams or to coordinate humanitarian logistics. With our approach, we are able to identify critical spots along roads with high likelihood of getting damaged. Furthermore, given a particular potential landslide location and the calculation of its downstream hydrologic network, it is possible to estimate which settlements, roads or bridges may be at risk. This approach could be integrated into flooding early warning systems and into the disaster management response phase to foresee dangers and losses and plan evacuations on time.