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Assessing natural hazards in NE Colombia using Sentinel-1 interferometry

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The DIGENTI project (Digitaler Entscheidertisch für das Naturgefahrenmanagement auf Basis von Satellitendaten und VGI (Volunteered Geographic Information)) aims to assess the natural hazard threat to the Cesar and La Guajira departments of northeast Colombia as guidance for decision makers and disaster relief workers. As members of the DIGENTI project, we use Sentinel-1 synthetic aperture radar (SAR) interferometry to detect hillslope movements, delineate settlements, and monitor damage to urban areas. Our study area, located in the remote Serranía del Perijá mountain range on the border of Colombia and Venezuela, is mountainous, highly vegetated, and experiences high and spatially variable rainfall (between 1 and 4 m a-1). The remote nature of the region, coupled with the favorable conditions for mass movements and other hillslope instabilities, make it an ideal location to employ remote sensing techniques to monitor potential natural hazards.

In the highly vegetated Serranía del Perijá mountain range, traditional damage proxy mapping is complicated by vegetation-related coherence loss between SAR scenes. Cross-referencing existing maps, we define regions of consistently high coherence as settled or urban areas. Using the spatial extent of settled or urban areas as a mask, we establish an algorithm to use coherence loss only in these regions as a damage proxy in urban areas where the local population will be most affected. Outside of settlements, hillslope instabilities and movements are quantified and mapped using a two-prong approach: (1) Horizontal ground displacement is be calculated by dense amplitude cross-correlation using the topsOffsetApp in the InSAR Scientific Computing Environment (ISCE). This allows the location, direction, and magnitude of mass movements and hillslope instabilities to be identified and mapped; (2) We use a timeseries of interferograms to quantify vertical ground deformation (e.g., as caused by landsliding) during the Sentinel-1 time window. To do this we employ the small baseline subset (SBAS) technique to create a timeseries of potential landslides in our study area. This technique has the added advantage of overcoming poor coherence between individual InSAR scenes (e.g., caused by vegetation cover). The output of the SBAS analysis will be used to designate natural hazard “hot spots” that will enhance static estimates of factor of safety and landslide risk (e.g., based on digital elevation models). Both the timeseries of horizontal and vertical surface movements and their spatial extent are compared to regional rainfall and vegetation patterns to aid in future natural hazard assessment. Preliminary work is being done to apply these algorithms to other regions with markedly different climate and tectonic settings (NW Argentine Andes and the Arun Valley, Nepal).