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Damage assessment mapping of rural environments; integration of SAR and Optical data

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The damage caused by a natural disaster in rural areas differs in nature, extent, landscape and in structure, from the damage in urban environments. Previous and current studies focus mainly on mapping damaged structures in urban areas after catastrophe events such as an earthquake or tsunami. Yet, research focusing on the damage level or its distribution in rural areas is absent. In order to apply an emergency response and for effective disaster management, it is necessary to understand and characterize the nature of the damage in each different environment.

Havivi et al. (2018), published a damage assessment algorithm that makes use of SAR images combined with optical data, for rapid mapping and compiling a damage assessment map following a natural disaster. The affected areas are analyzed using interferometric SAR (InSAR) coherence. To overcome the loss of coherence caused by changes in vegetation, optical images are used to produce a mask by computing the Normalized Difference Vegetation Index (NDVI) and removing the vegetated area from the scene. Due to the differences in geomorphological settings and landuse\landcover between rural and urban settlements, the above algorithm is modified and adjusted by inserting the Modified Normalized Difference Water Index (MNDWI) to better suit rural environments and their unique response after a disaster. MNDWI is used for detection, identification and extraction of waterbodies (such as irrigation canals, streams, rivers, lakes, etc.), allowing their removal which causes lack of coherence at the post stage of the event. Furthermore, it is used as an indicator for highlighting prone regions that might be severely affected pre disaster event. Thresholds are determined for the co-event coherence map (≤ 0.5), the NDVI (≥ 0.4) and the MNDWI (≥ 0), and the three layers are combined into one. Based on the combined map, a damage assessment map is generated.

As a case study, this algorithm was applied to the areas affected by multi-hazard event, following the Sulawesi earthquake and subsequent tsunami in Palu, Indonesia, which occurred on September 28th, 2018. High-resolution COSMO-SkyMed images pre and post the event, alongside a Sentinel-2 image pre- event are used as inputs. The output damage assessment map provides a quantitative assessment and spatial distribution of the damage in both the rural and urban environments. The results highlight the applicability of the algorithm for a variety of disaster events and sensors. In addition, the results enhance the contribution of the water component to

the analysis pre and post the event in rural areas. Thus, while in urban regions the spatial extent of the damage will occur in its proximity to the coastline or the fault, rural regions, even in significant distance will experience extensive damage due secondary hazards as liquefaction processes.