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Characterizing housing stock vulnerability to floods by combining UAV, Mapillary and survey data – A case study for Karonga, Malawi

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To accurately identify the most vulnerable areas to floods, physical (e.g., building material) and social (e.g., education, health, income of households) housing stock information is required. However, in developing countries, this information is often unreliable, unavailable or inaccessible, and manual data collection is time-consuming. This can lead to difficulties for humanitarians or policymakers in implementing appropriate disaster risk reduction and response interventions. Therefore, there is a need for the development of alternative approaches to data collection and analysis. An alternative approach to on-site vulnerability assessment is to extract physical vulnerability characteristics, such as land use type or rooftop material, from satellite or Unmanned Aerial Vehicle (UAV) imagery. However, other social or physical vulnerability information on the household level can often not be extracted from only the remote sensing data. This research develops an approach for integrating multiple data sources into a Geographic Information System to improve the completeness of data on different vulnerability indicators. This approach is applied on the housing stock of the Karonga district in Malawi. An Object-Based Image Analysis on UAV imagery is combined with a machine learning analysis of Mapillary data to enable remote identification of both rooftop and wall material. Depth-damage curves were created to describe the impact on the housing stock for different categories of physical vulnerability (such as building material) and levels of inundation. Moreover, local survey data is used for the creation of a social vulnerability index. Combined, the datasets represent the spatial distribution of housing stock vulnerability for multiple flood scenarios. This approach is useful in situations where proactive risk analyses must be carried out or where local-scale interventions, such as building strengthening- or flood awareness projects, have to be implemented. Finally, we give recommendations for scaling the methodology to areas where only lower resolution data is available.