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Impact-based Forecasting: Bridging the gap between forecast and post flood impact with remote sensing

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The economic loss associated with natural hazards has drastically increased over the past decades, reaching over $210 billion dollars worldwide in 2020. The explication of regional-scale climate change effects with the tendency to exacerbate local climate criticalities has long jeopardized disaster resilience and the coping capacity of many communities. There is a lack of a robust operational linkage between the pre-disaster and post-disaster segments when a disaster occurs. This hampers an effective emergency response often leading to delayed humanitarian intervention and unplanned evacuations. Moreover, the great amount of openly available impact information on past events is commonly discarded and the forecast potential which the data yields has yet to be fully explored. In this context, the Impact-based Forecasting (IbF) approach aims to interconnect pre-emptive planning for early action with post-disaster impacts while taking advantage of historical data. The underlying principle of IbF is that the magnitude of an event is translated to site-specific impact information. Therefore, a paradigm shift from the conventional magnitude-likelihood relationship to impact-likelihood is proposed. This research develops a method to fully exploit the potential of IbF while overcoming the typical site-specificity of emergency response through remote sensing and automation. While the IbF framework allows for a multi-hazard approach, here we present a method targeting the ex-ante impact assessment of riverine floods. The analysis consists of two main components: i) the delineation of the flood extent from Sentinel-1 SAR imagery and ii) the definition of the event impact on the population, land and built environment. The IbF impact-likelihood relationship is ultimately derived by matching the two components for a historical event series. A fully automated Google Earth Engine algorithm for flood extent mapping with a 10 m spatial resolution has been developed to detect floodwater with a single-scene classification based on an automated thresholding method. The flood magnitude is then matched with open-access geodata such as human settlements, population density, land cover and infrastructure from the OpenStreetMap catalogue to generate the impact assessment. Once trained on several site or region specific past events, it can

automatically forecast the impact associated with a given event magnitude. Here we apply the technique to three case studies including the flooding associated with the Tropical Cyclone Idai, which made landfall in Mozambique in March 2019 causing over 1200 fatalities and $2 billion worth of damage. The performance of the flood mapping algorithm has been evaluated as satisfactory for the impact application and further validation at two additional sites is ongoing. Therefore, local triggers can be set to ensure a valuable temporal window to promptly plan and estimate the cost of intervention on the field. This work is a first step to providing a consistent and regionally transferable disaster preparedness tool that allows for multi-hazard impact forecasts.