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Parameter exploration for hydrological hazard interactions in a data-scarce catchment.

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Extreme rainfall events are increasing the frequency of hydrological hazards such as landslides, debris flow, and erosion processes. Understanding the coupling of these hazards is still a challenging task, current methodologies often take a single hazard approach without integrating the mechanisms that describe the influence of one hazard on another under the same rainfall event. Physically-based distributed models have overcome these limitations incorporating the coupling of hillslope-hydrological processes that influence the interactions of hydrological hazards at the catchment scale. Nonetheless, within these models, the physical characteristics of the catchment domain are subject to a large spatial variability increasing the uncertainty in the parameters that influence the interaction of these hazards, hindering their representation in data-scarce catchments. The aim of this study is to elaborate an experimental design to parameterize a physically-distributed model to identify the parameters that have an acceptable influence in representing and describing hydrological hazard interactions under a data-scarce environment.

The study area is set in the Soufriere catchment in Saint Lucia, which recorded multiple landslides and debris flows with impacts on catchment erosion triggered by Hurricane Tomas in October 2010. The OpenLISEM model was used to estimate the parameters that influenced the triggering of hydrological hazards that occurred during Hurricane Tomas. The parameter estimation was performed through a Global Sensitivity Analysis (GSA) All-At-a-Time (ATT) to assess simultaneously under 144 simulations the estimation of hydrological and geotechnical parameters. The parameters subject to Sensitivity Analysis were saturated moisture content, saturated hydraulic conductivity, soil cohesion, and internal friction angle. The results were verified through the Sorensen-Dice coefficient. The coefficient was calculated through a spatial overlapping method between landslide simulated areas and landslide inventory areas corresponding to the Hurricane Tomas triggered landslides obtained from the British Geological Survey (2014). The results indicated that the representation of landslides, debris flows, and erosion processes on the OpenLISEM model highly depend on the quality of the input data. The latter was confirmed by the Sorensen-Dice coefficient indicated low spatial overlap values between the simulations performed. Nevertheless, the response of the OpenLISEM model to an acceptable landslide representation similar to the landslides triggered by Hurricane Tomas was influenced in the first place by the soil cohesion and internal friction angle and in the second place by the saturated moisture content

and saturated hydraulic conductivity. The identification of these parameters introduces an improvement to provide an acceptable representation of hydrological hazards interactions given the data available in a data-scarce environment.