Assessing contributions of hydrometeorological drivers to socioeconomic impacts of compound extreme events

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Natural hazards such as floods, hurricanes, heatwaves, and wildfires cause significant economic losses (e.g., agricultural and property damage) as well as a high number of fatalities. Natural hazards are often driven by univariate or multivariate hydrometeorological drivers. Therefore, it is crucial to understand how and which hydrometeorological variables (i.e., drivers) combine to contribute to the impacts of these hazards. Additionally, when multiple drivers are associated with a hazard, traditional univariate risk assessment approaches are insufficient to cover the full spectrum of impact relevant conditions originating from different combinations of multiple drivers.

Based on historical socioeconomic loss data, we develop an impact-based approach to assess the influence of different hydrometeorological drivers on the impacts caused by different hazard event types. We use the Spatial Hazard Events and Losses Database for the United States (SHELDUS™) to identify the historical hazard events that caused socioeconomic impacts (property and crop damage, injuries, and fatalities) in our case study area, Miami-Dade County, in south Florida. For 9 different hazard types, we obtained data for 13 hydrometeorological drivers from historical in-situ observations and reanalysis products corresponding to the timing and locations of the hazard events found in SHELDUS database. The relative importance of each hazard driver in generating impacts and the frequency of multiple drivers was then assessed. We found that many high-impact events were caused by multiple hydrometeorological drivers (i.e., compound events). For example, 61% of the recorded flooding events were compound events rather than univariate hazards and these contributed 99% of total property damage and 98.2% of total crop damage in Miami-Dade County. For several hazards, such as hurricanes/tropical storms and wildfires, all the events that caused damage are classified as compound events in our framework. Our findings emphasize the benefit of including socioeconomic impact information when analyzing hazard events, as well as the importance of analyzing all relevant hydrometeorological drivers to identify compound events.