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Insights on landslide triggered by rainfall from a global database of landslide inventories.

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In mountainous region, landslides are an important source of damage and fatalities. Landsliding correlates with extreme rainfall events and may increase with climate change. Still, how precipitation drives landsliding at regional scales is poorly understood quantitatively in part because constraining hillslopes response to large storms has proved difficult. Indeed, obtaining detailed rainfall measurements in mountain is challenging, as well as detailed mapping of numerous landslides over large areas, and very few catalogues of rainfall induced landslides exist.

Here, we present and analyze a database of 8 comprehensive landslide inventories, mapped with a combination of satellite imagery and airborne photography in 2 cases, clearly associated with storms from Brazil, Taiwan, Micronesia, Japan, Colombia and the USA. Storms had total precipitation totals from <100m to >2000 mm, in a few hours to a few weeks, and caused from $\sim$ 100 landslides to $\sim$10,000. Given that the quality of rainfall information is variable, we focus on the landslide properties and their relations to first order storm indicators.

We found that total landsliding (number, area or volume) increases exponentially with total rainfall, but in a similar way than the area of the region affected by landslide. As a result, the mean landslide density does not correlate with storm index and localized hazard estimates would likely require a detailed spatio-temporal characterization of the rain field. This idea is supported by the observation that the maximum landslide density, within each inventory, do increase exponentially with the total rainfall. Comparing slope present in the affected area and slope affected by the landslides we found that, for all catalogues except 2, landslides do not occur preferentially on steep slopes, but appear to sample the topography almost uniformly. This is in sharp contrast with landslide triggered by earthquakes that are systematically over-sampling steeper slopes. The 2 cases where landslides favor steep slopes correspond to the smallest rainfall total and shortest duration, suggesting that comparing slope distribution of the topography and landslides contain information on the characteristics of the trigger. Size distribution have also been evaluated for all cases, showing that maximal landslide size increase with landslide total number, and thus total rainfall, but that no clear correlation with the distribution power-law scaling (or relative proportion of large and small landslide) exists. Mechanical properties of specific lithology may rather be the first control on the different landslide size distribution.

We propose that such an expendable collection of comprehensive rainfall-induced landslide inventories is essential to develop our understanding of rainfall induced landslides, by allowing to confront the various measures of landslide properties, to deterministic model outputs, to detailed rainfall measurements (from radar or satellite estimates), to topographic indexes (curvature, distance to rivers etc) and to geological information.