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Rainfall Thresholds for Shallow Landslides by coupled Physically-Based Models and Machine Learning methods in Colombian Andes Basins

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Landslides have taken thousands of lives worldwide in the last decades, especially in developing countries. In the Colombian Andes, tropical rainfall conditions and steep terrains are the most common triggering factors of landslides. According to DESINVENTAR in Colombia between 1921-2020, 10.438 landslides have been registered and left almost 7.313 fatalities and destructive outcomes to the economic system. Rainfall thresholds have been used to forecast the occurrence of landslides. Physically-based rainfall thresholds take into account the effects of rainfall coupling hydrological and geotechnical models providing a wide understanding of the physical behavior of the rainfall through the hillslope and infiltration processes. On the other hand, Machine Learning methods have been implemented to evaluate the correlation between the spatial distribution of the landslide hazard and the morphometric parameters of the basin (e.g. average slope, area, and Melton ratio).

This work was performed implementing the physically-based model TRIGRS to analyze the distribution of the safety factor under different combinations of intensity and duration from gauge-based IDF curves. And, morphometric parameters were calculated to 14 basins distributed along the Colombian Andes; all of them were processed by machine learning methods to correlate the influence of each parameter with the rainfall threshold. The results of coupling physically-based models and machine learning methods could provide criteria that allow setting up a procedure that defines a condition of instability based on the distribution of the safety factor in a basin.

Keywords: Rainfall thresholds, Shallow Landslides, Morphometric Parameters, IDF Curves, TRIGRS