EGU21-15175
https://doi.org/10.5194/egusphere-egu21-15175
EGU General Assembly 2021

Uncertainty in debris flow rainfall thresholds

Matteo Berti and Alessandro Simoni
Bologna, Dip. BIGEA, Bologna, Italy (matteo.berti@unibo.it)

Rainfall is the most significant factor for debris flows triggering. Water is needed to saturate the soil, initiate the sediment motion (regardless of the mobilization mechanism) and transform the solid debris into a fluid mass that can move rapidly downslope. This water is commonly provided by rainfall or rainfall and snowmelt. Consequently, most warning systems rely on the use of rainfall thresholds to predict debris flow occurrence. Debris flows thresholds are usually empirically-derived from the rainfall records that caused past debris flows in a certain area, using a combination of selected precipitation measurements (such as event rainfall P, duration D, or average intensity I) that describe critical rainfall conditions. Recent years have also seen a growing interest in the use of coupled hydrological and slope stability models to derive physically-based thresholds for shallow landslide initiation.

In both cases, rainfall thresholds are affected by significant uncertainty. Sources of uncertainty include: measurement errors; spatial variability of the rainfall field; incomplete or uncertain debris flow inventory; subjective definition of the “rainfall event”; use of subjective criteria to define the critical conditions; uncertainty in model parameters (for physically-based approaches). Rainfall measurement is widely recognized as a main source of uncertainty due to the extreme time-space variability that characterize intense rainfall events in mountain areas. However, significant errors can also arise by inaccurate information reported in landslide inventories on the timing of debris flows, or by the criterion used to define triggering intensities.

This study analyzes the common sources of uncertainty associated to rainfall thresholds for debris flow occurrence and discusses different methods to quantify them. First, we give an overview of the various approaches used in the literature to measure the uncertainty caused by random errors or procedural defects. These approaches are then applied to debris flows using real data collected in the Dolomites (Northen Alps, Itay), in order to estimate the variabilty of each single factor (precipitation, triggering timing, triggering intensity..). Individual uncertainties are then combined to obtain the overall uncertain of the rainfall threshold, which can be calculated using the classical method of “summation in quadrature” or a more effective approach based on Monte Carlo simulations. The uncertainty budget allows to identify the biggest contributors to the final variability and it is also useful to understand if this variability can be reduced to make our thresholds more precise.