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A statistically driven spatial model to delineate (dis)connected debris flow release areas

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Debris flow processes are known to contribute substantial amounts of sediment to the fluvial system in mountainous areas, such as the Alps. In fact, debris flow release areas represent relevant sediment sources that should be taken into account when mitigating flood hazards for lower order streams. However, terrain that frequently produces debris flows is not necessarily connected to the channel network while structurally connected areas may often not produce debris flows. Therefore, the relevance of an area to contribute debris flow material to a channel mainly depends on the co-occurrence of two aspects: a high debris flow susceptibility which coincides with a high structural sediment connectivity.

In this work, we present a novel data-driven approach that allows to identify areas that are both, susceptible to debris flow initiation and structurally connected to the main channel network. The methodology was developed for a debris flow prone basin located in the Dolomites (Italy) and further tested for other catchments that exhibit different geomorphological settings.

The methodical approach was based on the manual mapping of event-specific connected and disconnected debris flows areas that allowed to (i) calibrate a statistically based debris flow release susceptibility model and (ii) to derive quantitative thresholds for the previously derived connectivity index map (IC). The joined results reflect debris flow connectivity-susceptibility maps that were evaluated from numerous perspectives, including the evaluation of the spatial transferability of the approach.

We present (i) quantitative IC index thresholds that allow to discriminate connected from disconnected debris flow release areas, (ii) well-performing debris flow release susceptibility models and (iii) joint debris flow connectivity-susceptibility maps that allow identifying zones that are differently relevant in terms of debris flow connectivity. Issues related to the geomorphic plausibility of the results and the spatial transferability of the approach are discussed. The proposed approach requires few basic input data sets and therefore will be applied over vast areas with similar geomorphological settings.