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Relationship between sediment connectivity and debris flow in a mountain catchment

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The hillslope-channel coupling has a fundamental role in sediment control of a catchment, especially when the catchment is prone to mass movements. Debris flow is a type of mass movements that provides an important sediment contribution to a channel, which is influenced by hillslope-channel coupling degree. This coupling can be represented by the connectivity, a concept utilized as an approach to many queries regarding water and/or sediment transport through methodologies which relates a river with its drainage area. In this regard, this study addresses the representation of debris flow in terms of connectivity. We applied a debris flow computational modelling (DFM) and an index of connectivity (IC) in Mascarada catchment, south Brazil, where hundreds of mass movements were triggered in 2017, to evaluate the potential, limitations and capacity of IC to represent patterns of mass movements' connectivity. The IC is calculated for each cell of the catchment's digital elevation model (DEM) (horizontal resolution of 1 m) in relation to the drainage network. Therefore, the IC represents the lateral connectivity (hillslope-channel) and its capacity to mobilize sediment to the channel. The DFM utilizes the Multiple Flow Direction to distribute volumes of a fluid with a determined kinematic viscosity through a slope, originated from initiation areas with a depth pre-determined by the user. The model utilizes uniform and steady flow solutions for Newtonian fluid, considering a rectangular channel. The DFM simulated the observed debris flow reasonably well, with an accuracy of 68%. However, since the simulation reached the channel and carried the volumes beyond the observed debris flow scar, it presented an overestimation area of 65%. When relation the simulated debris flow paths with the IC, we observed a superposition between those paths and high IC values. Also, the results showed a pixel-by-pixel positive linear correlation between high flow depths (representing convergence of flow) and IC, with values varying from 0,1 and 0,5. Only one of the nine simulated debris flow did not reach the channel and it had the lowest mean IC value along its flow path. Simulated debris flow that reached the channel showed high hillslope-channel connectivity, denoting the important role of high magnitude sediment transport events in sediment connectivity. Therefore, the IC was capable to represent and indicate patterns of debris flow that reached the channel. Though, the results also indicated that IC must be carefully interpreted when employed to understand debris flow and related processes – some areas have high fluid depth due to low connectivity, but others have high depth in response of convergence of flow due to highly connected areas. In this regard, an integration of connectivity and debris flow modelling tools can by an important step to understand sediment connectivity and to represent patterns of high magnitude mass movements

events.