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# Integrating structural and functional connectivity to characterize sediment dynamics in a small Alpine catchment

Marco Cavalli (1), Stefano Crema (1), Michiel Blok (2), Ana Lucía (3), Francesco Comiti (3), Lorenzo Marchi (1), and Saskia Keesstra (2)

(1) Research Institute for Geo-Hydrological Protection, National Council of Research, Padova, Italy (marco.cavalli@irpi.cnr.it), (2) Soil Physics and Land Management, Wageningen University, Wageningen, The Netherlands, (3) Faculty of Science and Technology, Free University of Bozen-Bolzano, Bolzano, Italy

Sediment connectivity can be regarded as a descriptor of the internal linkages between different landscape components within a catchment. The recent focus of the scientific community on connectivity related topics, both concerning hydrological and sediment connectivity, stresses the importance of understanding the main active pathways for a better estimation of energy and matter transfer at catchment scale. This task can be addressed using topography-based indices that analyse the linkages between landscape units. This approach to characterize connectivity is known as structural connectivity. The main limitation of structural connectivity is that it does not account for the processes driving sediment and energy fluxes (i.e., functional connectivity).

In this work the integration between structural and functional approaches is proposed for characterizing sediment connectivity in mountain catchments. The structural approach, based on a topography-based sediment connectivity index, was used for assessing hillslope-to-channel connectivity. Since field data on processes driving sediment transport along the channel network are available, a functional approach has been devised to estimate within-channel connectivity. An index of unit stream power computed from the hydraulic properties of the channel (i.e., discharge, slope and channel width) has been compared with the critical unit stream power computed from incipient motion thresholds derived from field data to identify the cells of the Digital Terrain Model (DTM) in which sediment can be mobilized under near-bankfull conditions. The index expressing the within-channel connectivity is given by the length of the reaches consisting of contiguous cells that exceed the critical unit stream power. During high-magnitude floods, when unit stream power values exceed the threshold for incipient motion, channels experience an increase in both hydrological and sediment connectivity. The proposed index characterizes those sections of the channel network that are effectively connected under near-bankfull conditions. The model has been developed and tested in a small mountain catchment in the Italian Alps (Strimm catchment, 8.42 $km^2$) in which a high-resolution DTM and monitored discharge and sediment transport data are available. The integration between structural and functional indices of sediment connectivity has permitted characterizing the spatial pattern of sediment connectivity on the hillslope and pointing out potential sites for sediment erosion, entrainment and deposition along the main channel network. This combined approach represents a new development of the index of connectivity considering sediment transport process along the channel network, with the only limitation related to field data availability. However, further testing is required to validate the index in order apply it to other catchments.