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The Index of Connectivity on trial. How reliable is IC to quantitatively assess sediment connectivity in mountain basins?

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In mountain catchments connectivity regulates the capability of sediment to be transferred from sediment source areas to the stream network. Raster-based indices, such as the Index of Connectivity (IC), have become a widely used tool for analysing the relationships facilitating or inhibiting the coupling among different compartments of the catchment. However, despite the numerous applications in literature, few studies have tested the capability of IC to quantitatively represent the linkages between sediment sources and channels and to predict potential new linkages. In this study, the aim is the semi-quantitative validation of IC as a tool for depicting structural connectivity and for predicting sediment dynamics in a mountain basin. Moreover, a specific objective is to derive a crisp threshold between high and low connectivity that could enhance the communication of IC maps. To this end, a benchmark was set regarding the actual connectivity status of 420 sediment source areas present in a mountain headwater catchment in the Dolomites (Italy). The assessment of connectivity status was carried out through remote sensing analysis and field observations. Then, multiple IC variants were computed changing the weighting factor and the pixel resolution of the input DTM. Finally, logistic regression analyses were performed using the different IC variants as independent variables and connectivity status as dependent variable. Therefore, the predictive capacity of IC was tested and a crisp IC threshold was obtained to discriminate connected and disconnected sources. The results showed that only 64 out of 420 sediment sources are connected to the channel network. Moreover, IC as a structural index proved to be suited to depict structural connectivity whereas fails to fully represent process-induced sediment linkages, i.e. functional connectivity. Finally, it was possible to derive an IC threshold of -2.32, useful to differentiate between high and low IC and useful to improve IC maps. The threshold functions as a clear boundary between disconnected and connected sources but only applicable to the catchment under investigation. Nevertheless, the overall approach can be transferred to other mountain areas.