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Applications of graph theory to assess and compare sediment connectivity in three complex catchments

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One main criticism expressed by geomorphologists is that connectivity does not directly reflect and explain the amount of sediments delivered at the outlet; the area of highest connectivity is not the area that contributes the most to the sediment delivery at the outlet. The connectivity indeed reveals more complex mutual interferences among all components of the system and, consequently, the potential of the geomorphic system to react. In other words, the connectivity framework does not focus on the absolute values of sediment discharge but, rather, on signals. In this presentation we focus on three study cases to exhibit that connectivity assessment may predict how various signals (e.g., climatic signals and sedimentary signals at different points within catchment) can be propagated throughout a sediment cascade. In that way, graph theory is here applied to abstract the network structure as nodes (sediment sources, sediment stores, outlet) and links (linkage by a transportation agent), represented as vertices and edges. The goal is to obtain a simple pattern that can be described using algebraic tools (typology of linkages, identification of local sinks, etc.) and connectivity metrics. We exhibit and compare the overall structure of the sedimentary cascade in three catchments where sedimentary signals have revealed a “sedimentological anarchy” because of complex external forcing and internal interactions (climate change in French Alps, Anthropogenic practices in Burgundy, landscape structure in Normandy). By applying graph theory metrics and simulating sediment routes we here decipher the complexity of such geomorphic systems. In details, the three catchments are characterized by significant disconnection patterns implying that the sedimentary signal at the outlet cannot reveal the sediment delivery from sources.