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Network analysis of sediment cascades derived from a digital geomorphological map - an example from the Gradenbach catchment (Schober Mountains, Austrian Alps)

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A detailed geomorphological map of the Gradenbach catchment (32 km^2, Schober Mountains, Austrian Alps) is presented that focuses on the sediment transfer system. Data were acquired in the field and by the interpretation of orthophotos, LIDAR data and derivatives (slope, curvature, aspect, shaded relief). The resulting digital geomorphological map contains polygon representations of landforms together with their morphometric parameters and an assessment of recent geomorphic activity. Special attention was paid to landform coupling, i.e. an additional table was constructed that indicates recently observable coupling between specific landforms (based on their ID in the database). From these data, we can obtain sediment cascades as a succession of coupled landforms along which sediment transfer occurs through the activity of various geomorphic processes.

Based on this digital landform inventory the sediment transfer system is analysed using graph theory. As a rather new approach in geomorphology (already established within several disciplines; e.g. hydrology, biogeography), graph theory provides a promising framework for connectivity analysis in geomorphologic systems and powerful tools to visualise and analyse catchment-wide sediment transfer networks. Since the concept is arbitrarily scalable it can be applied to discrete land surface units (e.g. mapped landforms) or to continuous surface data (e.g. grid cells). In combination with geomorphological mapping, the concept allows for the (abstracted) visualisation of complex coupling relationships between multiple sediment storage landforms. Graph networks can be analysed at the level of nodes (e.g. the number of incoming and/or outgoing edges and their character as sediment source, sink or link), edges (e.g. importance within the network as conveyors of sediment from different sources), pathways (e.g. edge sequences leading to the catchment outlet or to storage landforms; these can be termed sediment cascades), or the whole graph. The information contained in graph nodes and edges enables to establish a conceptual model of system structure which can be useful for comparing different (sub-)catchments.

In this study, we present a network analysis of sediment cascades between 433 mapped landforms and discuss the applicability of graph theory to connectivity analysis in geomorphic systems.