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Graph theory – recent developments of its application in geomorphology

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Graph theory has been widely applied across a range of disciplines as different as population and landscape ecology, sociology, economic and transportation geography, informatics and climatology – yet these disciplines have in common that they deal with systems consisting of multiple subsystems or compartments that are coupled by relations. Although geomorphic systems lend themselves to network representations (see e.g. Chorley and Kennedy's systems approach to physical geography, 1971), the application of the conceptional and methodological toolbox of graph theory has been quite rare and restricted. In the 1960ies, graph theory was used to study the topology of river networks; since the 1970ies, studies in geomorphometry have employed it to model the topological structure of topographic surfaces.

The recent re-discovery and development of graph theory applications in geomorphology run on two lines. (a) The spatially explicit analysis of sediment cascades in geomorphic systems where nodes represent their compartments (depending on the spatial scale of the study the latter can be single landforms or larger terrain subunits up to whole catchments), and edges represent the linkage of system components through water or sediment flux. This approach is closely related to the analysis of hydrological and/or sediment connectivity. (b) The analysis of geomorphic systems whose properties are represented by graph nodes, and the relations between them by graph edges. Graph theoretical measures, derived e.g. by eigenvalue analysis of the adjacency matrix, have been shown to reflect system properties such as synchronization and scale relations.

Our contribution reports on these recent developments. We present case studies and discuss future applications in geomorphology that could benefit from graph theory.