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Concepts of catchment-scale sediment connectivity for physically-based and dynamic modeling

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Research on erosion, sediment transport and deposition processes in catchment systems, which are often complex in their nature, has been increasingly centered around connectivity issues (e.g. de Vente et al., 2006; Gumiere et al., 2010; Heckmann et al., 2010; Lexartza-Artza and Wainwright, 2009; Wainwright et al., in press). It is acknowledged by various authors that an integrated analysis of dynamics and interactions of variables across multiple spatial and temporal scales is needed to understand catchment system processes like sediment movement. Findings in the field of connectivity can fill the gap, as the evolving concept is applied in multiple disciplines like hydrology, geomorphology and ecology, and expresses relations, contiguity and directionality of (landscape) elements.
Despite the wide array of applications and definitions of connectivity (Michaelides and Chappell, 2009), there is a lack of measurable units or criteria describing physical linkages between landforms associated with sediment sources and sinks. Besides, there is a need to conceptualise interactions and feedback mechanisms in structural and functional connectivity issues on a catchment-wide scale (Wainwright et al., in press). Attention should be given to the spatialization of parameters not only of source and sink cells but also of the transport paths. These parameters should account for the morphological and topological interrelations between erosion and deposition processes on hillslopes, drainage system and floodplain. Concerning geostatistical methods for this purpose, a raster-based model like LAPSUS (Schoorl et al., 2000) can be detailed enough, although a vector-based would be preferred to spatially identify sources, paths and sinks. A second point of importance is the temporal (dis)continuity as the system evolves and changes over time due to erosion and deposition, changing the surface and landforms (Kirkby, 2010).
Therefore, our aim is to provide a framework of concepts of the processes of erosion, transport and deposition of sediments on different scales within a catchment area through distributed physically-based and temporal-dynamic modeling. These concepts will be analysed with field data of runoff, sediment, morphological maps and interpretations of connectivity from experimental catchments in Navarre, Spain. This combination of concepts and field data on sediment dynamics will add spatial and temporal parameters of connectivity to existing distributed physically-based erosion and sediment transport models.