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Dynamic connectivity and response to change in a river network: what can be learned for managing river basins?

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River networks are the pathways for transport and transformation of fluxes generated by the landscape, e.g., overland flow, sediment, nutrients, pollutants. For long-term prediction of environmental response to natural and human disturbances in a basin, detailed physically-based models become uncertain especially when the transport time scales range from tens to thousand of years, such as in sand and gravel transport. In previous work we explored a network-based framework for studying the partitioning, amplification, and synchronization of fluxes at the outlet of a basin and demonstrated how it can be useful for long-term management planning. In this work, we go further to explore internal dynamics of the system as the flux propagates downstream governed by the system's "dynamic connectivity". During this process, the river network acts as a filter that transforms a steady external input into a heterogeneous flux inside the system. We use simulated and real river networks with varying topology and variable physics of flux propagation to understand how the heterogeneity of the internal flux depends on the topological (network branching structure), geometrical (link lengths), and physics of the flux (propagation velocity). We also explore the system's resilience to change, that is the ability of the system to maintain dynamic connectivity in the presence of disturbance.