Advancing our predictive understanding of river corridor exchange

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The exchange of water, solutes, and energy between rivers and their landscapes is crucial to water quality, ecosystem health, and ecosystem services derived from the river corridor. The connectivity between surface waters, hyporheic zones , riparian zones, floodplains, hillslopes, and aquifers – collectively termed "river corridor exchange" – is essential to these ecological benefits. While the primary controls on river corridor exchange are broadly agreed upon, we have little ability to predict exchange fluxes, timescales, or the associated ecological processes. After decades of research, our ability to predict river corridor exchange as a function of geologic setting and hydrologic forcing remains limited, with conflicting results reported for a majority of known controls. My long-term research goal is to advance process understanding of transport and transformation in the river corridor at scales ranging from flowpaths to river basins.

Three key advances are required to significantly improve prediction of river corridor exchange and associated ecosystem services and functions: (1) improved understanding of dynamic exchange processes in the river corridor as a function of geologic setting and hydrologic forcing; (2) development of methods to extend geomorphic feature-scale knowledge to the reach- and network scales; and (3) improvement of predictive capacity that is applicable across a range of sites and does not require extensive field characterization. Here, I review recent progress, current work, and future directions in addressing these advances. I highlight advances spanning spatial scales from individual features to river basins, and temporal scales spanning diurnal fluctuations through long-term trends in climate.