

Cascading disequilibrium: a glimpse into dynamic hydro-biogeochemical processes in hyporheic zones

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The hyporheic zone is now widely recognized as a central feature of river corridors. The physical driver of hyporheic exchange, the interaction of river flow with irregular bed topography or bank morphology, has been extensively studied, but mostly for steady flow situations. Likewise, the biogeochemical consequences of hyporheic exchange have recently received substantial attention, but also mostly for settings where flow is steady. This raises the question: when is river flow actually at steady state? This seldom happens as rivers going through baseflow recession still experience exponentially-decaying flow reduction. Moreover, river chemistry and temperature typically change over minutes to hours. The corollary problem, therefore, is that the physical and chemical disequilibrium of rivers should cascade throughout and feedback with the river corridor, particularly to the hyporheic zone. The biogeochemical and ecological processes within the hyporheic zone are time sensitive; and perhaps, because of dynamic hyporheic flow fields, these are in a constant state of catching up. It is likely that biogeochemical equilibrium conditions are rare.

This presentation offers vignettes taken from some recent studies on dynamic processes within hyporheic zones. These studies span flume experiments, field observations, and computational simulations of coupled non-isothermal reactive transport of C and N. All support the idea that hyporheic exchange flows, reactions, and biota are very dynamic.