**Simulating the Hydro-Ecology of a Large River Floodplain and Alluvial Aquifer: Progress and Future Directions**

The Water Resources Exchange Network (WREN) modeling system links fully hydrodynamic models of floodplain inundation, hyporheic exchange, and subsurface water flow, with models of heat transport, solute transport, and biotic solute processing within an alluvial aquifer. We have applied the model to describe the hydro-ecology of the 15 $km^2$ Nyack Floodplain, Middle Fork Flathead River, Montana, USA. Resulting publications characterize floodplain hydrologic residence time, hyporheic exchange, and temperature/dissolved oxygen regimes throughout the aquifer. We present a synopsis of results from past model development, current model applications, and future directions, including progress on efforts to integrate a new, thermodynamically-based sub-model of aquifer microbial growth, metabolism, and biogeochemical cycling. Our two-decade modeling effort demonstrates that sufficient description of the dynamic hydrologic template of stream ecosystems allows simple governing ecological concepts to explain complex spatiotemporal patterns in rivers and streams.