Geophysical Research Abstracts
Vol. 16, EGU2014-**PREVIEW**, 2014
EGU General Assembly 2014

Progress and Future Directions in Simulating Ground- and Surface-Water Exchange and Biotic Solute Processing in a Large River Alluvial Aquifer

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Over the past 15 years, we have worked to develop the Water Resources Exchange Network (WREN) modeling system, which links fully hydrodynamic models of floodplain inundation and subsurface water flow, with models of heat transport, solute transport, and biotic solute processing within the alluvial aquifer. During this time, we have applied the model to the 15 sq km Nyack Floodplain of the Middle Fork Flathead River, Montana, USA, to describe the hydro-ecology of the system. Published research findings from our modeling efforts include descriptions of the hydrologic response of the alluvial aquifer to flood events, quantification of the influence of surface- and groundwater exchange on the hydrologic residence time of the floodplain, and simulations that predict >75% of the annual variance in aquifer temperature and >65% of the annual variance in dissolved oxygen, both laterally and vertically, throughout the entire aquifer. Here we present a synopsis of past progress on model development, model application, and future directions, including progress on our current efforts to link the WREN hydrologic model with a thermodynamically-based sub-model of microbial growth and metabolism in the alluvial aquifer. Using the resulting model, we aim to simulate biotic consumption/production of multiple dissolved solutes (including species of carbon, nitrogen, sulfur, and oxygen) based on the transient advection and availability of electron donors and acceptors throughout the alluvial aquifer.