Modeling functional heterogeneity of interactive ecological currencies: applications for understanding dynamics of and linkages among channel, floodplain, and aquifer systems

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H.T. Odum depicted ecosystems as currency flux within networks, a useful concept for considering the importance of water, energy, and nutrient (currency) exchange among the channels, floodplains, and alluvial aquifers in stream ecosystems. Despite the recognized importance of multiple currencies (e.g., stoichiometry) and currency exchange (e.g., longitudinal, lateral, and vertical connectivity in streams), most conceptual and simulation models of streams incorporate few currencies and consider only in-channel dynamics and longitudinal connectivity. We have developed "Network Exchange Objects" (NEO), a simulation framework that uses hierarchical model design to simply simulation of functionally heterogeneous, three-dimensional, multicurrency flux networks of any desired topology. We present examples of linked hydrologic and biogeochemical models developed in NEO and show how modeled network topology can be used to represent, e.g., various landscape structures or conceptualized patterns of linkage among channels, floodplains, and aquifers. Combined with detailed field observations, our models help test the hypothesis that complex ecological phenomena (such as physiochemical patterns within alluvial aquifers or spatio-temporal variation in wetland soil biogeochemistry) emerge from interactions among relatively simple behaviors of multiple ecological currencies within flux networks.