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Hydrologic controls on river trophic dynamics

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Streamflows play a fundamental role in sustaining and regulating fluvial ecosystem integrity. A quantitative analysis of the possible implications of hydrological fluctuations on river ecosystems is deemed of major concern. River ecosystem dynamics are indeed deeply connected to streamflows variability, which chiefly relies on rainfall, climate, land use, and geomorphologic properties. On the basis of a food-web perspective, the response of riverine species to hydrologic change is aimed to be predicted in a quantitative way. Modifications in discharge, water depth and water velocity may alter trophic relations and populations dynamics, in terms of resources, prey and predators presence or absence. To this aim, we start from the theoretical characterization of the probability distribution functions of streamflows, p(Q), water depths, p(y), and flow velocity, p(u), and an appropriate time-correlation structure. We make use of a suitable river food-chain model, based on mass balance equations for benthic biota (Rosenzweig-McArthur prey-predator model) to explore the linkages between fluvial ecosystem dynamics and hydraulic and hydrologic variables. From experimental evidence it is known that vegetation dynamics, in terms of the logistic growth rate, can be expressed as a function of both water depth and flow velocity, while invertebrate dynamics are mainly influenced by flow velocity. Therefore, analytical relations between trophic parameters and the abovementioned hydraulic properties are defined. A comparison between the effects of (i) a constant hydrologic environment and (ii) a stochastic fluctuating environment on trophic temporal behavior is performed by analyzing both transitory-state and steady-state. Moreover, an equilibria analysis concerning the temporal coexistence of different trophic groups is carried out to understand the effects of stochasticity on the food-chain model.