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Spatially-explicit hydrologic controls on benthic invertebrate habitat suitability

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Streamflow variability is a major determinant of basin-scale distribution of benthic invertebrates. Here we present a probabilistic approach for a spatially explicit quantitative assessment of benthic invertebrate abundance as derived from near-bed flow variability throughout an entire stream network.
We consider aquatic invertebrates as these are widely employed as sensitive indicators of fluvial ecosystem health and human-induced perturbations. Moving from the analytical characterization of site-specific probability distribution functions of streamflow and bottom shear stress, we achieve a spatial extension to a stream network ranging up to 5th order. Bottom shear stress distributions, coupled with habitat suitability curves derived from field studies, are then used to produce maps of invertebrate habitat suitability based on shear stress conditions. The proposed framework allows to inspect the possible impacts of human-induced perturbations of streamflow variability on river ecology. We apply our approach to an Austrian river network, for which rainfall and streamflow time series, river network hydraulic properties and local information on invertebrate abundance for a limited number of sites are available. This allows a comparison between observed species density versus modeled habitat suitability based on shear stress.
Although the proposed strategy neglects ecological determinants other than hydraulic ones and thus represents an ecological minimal model, it allows derivation of important implications of water resource management and fluvial ecosystem protection for basin-scale distribution patterns of organisms.