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Hydrological indices for eco-hydrology of intermittent alluvial plains rivers.

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Alluvial plains river systems are frequently under pressures from land use changes, stream bed modifications, and hydrological alterations (e.g., for irrigation schemes). Flow variations in alluvial plain rivers can be influenced by variations in groundwater surface-water exchange, changes of channel planform, climatic variations, and abstractions. Hence they often show complex spatial and temporal patterns of river flows. Many plants and animals that inhabit alluvial plains rivers are sensitive to natural and anthropogenetic alterations to catchment hydrology and geomorphology. In this paper we present a model that accounts for spatial and temporal flow variations along intermittent alluvial plains rivers, and we describe a suite of hydrological indices that can be used to test for flow-ecology relationships along the river.

The natural hydro-geomorphic complexity along intermittent alluvial plains rivers poses a challenge for developing relationships between rainfall recharge and river flows, predicting effects of water resource developments, and for understanding hydrologic effects on ecological systems. Hydrological models that can reconstruct historic flows and/or predict future flows are required for assessing potential hydrological impacts from, for example land-use or climate change. If strong flow-ecology relationships exist, these models can be used to infer potential ecological effects related to the impact in question. The model we developed, the Empirical Longitudinal Flow MODel (ELFMOD), reconstructs longitudinal-temporal flow patterns along river sections using measured flows at sites along the section and other flow-state predictor variables (e.g., groundwater levels, rainfall). Spatio-temporal flow matrices simulated by ELFMOD can be processed into hydrological indices of flow states and flow changes in space and time. For example, for each simulated point in space and time the distance to a wetting or drying front along river can be calculated, or flow permanence derived. The model enables derivation of several hundred indices describing e.g., flow state, flow condition, flow duration, spatial proximity to flow, and temporal proximity to flow. Interpretation of these hydrological indices can increase our understanding of the complex hydrologic patterns as well as the hydrologic controls on ecological processes along alluvial rivers. Here, we provide an overview of flow and intermittence indices derived for several river systems. Applications of these indices for studying hydrological control of ecological patterns in alluvial plains rivers are demonstrated.