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Hydrological indices for quantifying ecologically relevant flow conditions in intermittent alluvial plain rivers

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Abstract Many alluvial plain river systems are under pressure from human impacts, including land-use changes, channel modifications, and hydrological alterations. Flow variation in alluvial plain rivers is influenced by groundwater–surface water exchange, changes of channel form, climatic variation, and water abstraction. Consequently, these rivers often have complex spatial and temporal flow patterns. The natural hydro-geomorphic complexity along intermittent alluvial plain rivers poses a challenge for: (i) developing relationships between recharge and river flows, (ii) predicting effects of water resource developments, and (iii) understanding hydrological effects on ecological systems. Hydrological models that can reconstruct historic flows and/or predict future flows are required for assessing potential hydrological impacts of changing water use, land use, or climate change. If strong flow–ecology relationships exist, these models can also be used to infer potential ecological effects related to the impact in question. In this paper we present a model that accounts for spatial and temporal flow variation in intermittent alluvial plain rivers, and we describe a suite of hydrological indices that can be used to examine flow–ecology relationships. The model we developed, the Empirical Longitudinal Flow MODel (ELFMOD), reconstructs longitudinal and temporal flow patterns along river sections using measured flows at sites along the section and other predictor variables (e.g. groundwater levels, rainfall). Spatio-temporal flow matrices simulated by ELFMOD are used to generate a large range of hydrological indices that describe flow states and flow changes in space and time. Interpretation of these indices increases our understanding of complex flow regimes and hydrological controls of ecological processes and can aid river management.

Key words alluvial plain river; intermittent; ephemeral; ecohydrology; surface water / groundwater interactions; New Zealand