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Can a static metric for hydrologic connectivity improve predictions of instream water quantity and quality?

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The concept of connectivity is increasingly being applied in hydrology as researchers attempt to move beyond the traditional partial or variable source area models for runoff generation and consequent material transport to recognize that the flux of water and the materials it transports is spatially and temporally discontinuous. The network index is a topographically defined description of the spatial arrangement of catchment wetness that we suggest is a metric for landscape hydrological connectivity in temperate catchments. This static metric has been compared with the space-time patterns of connectivity from a physically based distributed hydrological model. The results demonstrate that it can generalize a significant proportion of the time-averaged spatial variability in connectivity, in terms of both the propensity to and duration of connection. Here we go on to assess its ability to improve instream water quality and peak river flow predictions. We compare the performance of 1) instream Nitrate and Phosphate risk predictions from the SCIMAP risk-based water quality model; and 2) high flow predictions from TOPMODEL, with and without our connectivity treatment. Our results suggest that even a simple, static, topographically based connectivity metric, like the network index, can considerably improve predictions of both water quality and peak flows. A primary reason for this is that the spatial distribution of time-averaged (i.e. static) connectivity implicitly contains a temporal component as locations in a catchment that are more difficult to connect in space are also, by implication, connected for shorter durations. This is an important property, and demonstration of its value is an important finding, because it opens up an alternative to complex continuous simulation models of hydrological and water quality response.