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

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The concept of connectivity is increasingly being applied in an attempt to move beyond the traditional models for runoff generation and 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 in humid catchments that can generalize a significant proportion of the time-averaged spatial variability in connectivity, in terms of both the propensity to and duration of connection (Lane et al., 2009). Here we go on to assess the ability of this index to improve instream water quality predictions. We compare the performance of instream Nitrate (N) and Phosphate (P) risk predictions from the SCIMAP risk-based water quality model with and without our connectivity treatment for four UK catchments: Hampshire Avon, Deben, Eden and Wensum. We find that even this simple, static, topographically based connectivity metric, considerably improves the model's predictive ability in every catchment for P and in half the catchments for N. We suggest that this is primarily because the spatial distribution of time-averaged (static) connectivity implicitly contains a temporal component as locations in a catchment that are less likely to connect in space are, by implication, connected for shorter durations. We also find major differences between the risk that should be associated with a land use with and without the connectivity treatment, suggesting that in policy terms we must be careful about inferring the importance of a land cover without thinking about its "hydrological" position in a landscape i.e. its connectivity.

Lane SN, Reaney SM, Heathwaite AL. Representation of landscape hydrological connectivity using a topographically driven surface flow index. Water Resour Res 2009; 45: W08423.