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Inverse modelling of the risk of diffuse pollution in agricultural catchments

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The hydrological and biogeochemical processes that operate in catchments influence the ecological quality of freshwater systems through delivery of fine sediment, solutes and organic matter. Most models that seek to characterise the delivery of diffuse pollutants from land to water are reductionist. The multitude of processes that may be parameterised in a model to ensure generic applicability results in the development of complex models that require input data that are rarely available. Here we outline an alternative based on 'inverse modelling' where the focus is upon using extant measured data in Bayesian approach to learn the kind of model representation that is required to explain those data. We invert SCIMAP, a simple risk based model with an explicit treatment of hydrological connectivity, and use a Bayesian approach to determine the risk that must be assigned to different land uses in a catchment order to explain the spatial patterns of measured instream solute concentrations. We apply the model to identify the key sources of nitrogen (N) and phosphorus (P) risk in eleven UK catchments across a range of landscape characteristics focussing on the Hampshire Avon, Eden and Wensum catchments. The model results show that: 1) some catchment land use generates a consistently high or low risk of diffuse nutrient pollution; but 2) the risks associated with different land uses vary both between catchments and between N and P delivery; and 3) that the dominant sources of N and P risk in the catchment are often a function of the spatial configuration of land uses. Our results suggest that 'inverse modelling' may be used to learn what our model assumptions should be, in ways that, on a case by case basis, can be used to inform the focus of interventions to reduce diffuse pollution risk for freshwater ecosystems.