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Testing the transferability of a Bayesian Belief Network to diverse agricultural catchments using high-resolution hydrology and land management data sets

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Phosphorus (P) pollution from agriculture is a major pressure on maintaining and improving water quality worldwide. In Ireland, the Agricultural Catchments Programme (ACP) was created to evaluate the Good Agricultural Practice measures implemented under the EU Nitrates Directive. Considerable monitoring and research have been done into the drivers of, and controls on, nutrient loss in these catchments.

Managing P pollution in agricultural catchments requires informed decisions about the pollution risks using catchment-scale understanding which, in turn, requires a systemic modelling and assessment approach. Bayesian Belief Networks (BBNs) support system-level thinking as they can represent complex systems (such as rivers and catchments) and integrate disparate information sources while representing uncertainty. In a previous study, a BBN was developed using the 'source-mobilisation-transport-continuum' and parameterized for a 12 km^2 agricultural catchment with flashy hydrology on poorly drained soils and grassland as the dominant land use. Seven years of hourly turbidity and discharge measurements at catchment outlet, and mapped soil P content were used to inform parameterization. Literature data and expert opinion were included to complement the dataset when information on point-source pollution (farmyard and septic tank nutrient losses) was lacking.

In the current study, the BBN is developed further and is parameterized using a monthly time-step for three additional diverse ACP catchments: two arable land-dominated catchments with contrasting hydrology (well-drained vs poorly drained) and a well-drained grassland catchment to test model transferability. In a step forward from the previous model, we quantify P losses from a sewage treatment plant in one of the arable catchments, and we consider biota in-stream P removal as an additional process. Lastly, the observed TRP concentrations were bootstrapped to obtain monthly TRP distributions which are compared to predictions from the BBN to validate the model.

Results showed that the model performs well for the target catchment but applying it to other

catchments is key to assessing its generalizability and utility. Here, preliminary results explore whether the BBN can capture the differences in P loss risk between catchments and the reasons for this.

In addition, testing the model transferability to other catchments is important to (a) inform on the differences in P loss between catchments, and (b) inform model testing in data-sparse catchments. Future research will be focussed on integrating climate change scenarios in the model to inform the targeting of mitigation measures under future change, foster discussion with stakeholders, and provide support to decision-makers.