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Scale appropriate modelling to represent dominant pollution processes in agricultural catchments, to underpin management and policy decisions

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We present the development of scale appropriate modelling techniques to represent dominant pollution processes in agricultural catchments to underpin catchment management and its implications on policy. A quasi-physically based, spatially lumped macro-model (CRAFT), has been developed to assess mitigation options for nitrogen and phosphorus. CRAFT has been developed to use daily time series data of rainfall, stream flow and nutrient concentration data, and can be applied to catchments varying in size from a few hectares to 100s of square kilometres. If stream flow routing is added to the model then potentially larger catchments and sub-daily time steps could be represented.

There are two key issues addressed here. Firstly, the model can be used to assess the usefulness of monitoring data collected at a high temporal resolution at considerable expense compared to routine grab sampling. An earlier study in the Frome catchment in southern England collected sub-daily water quality data for more than 12 months at the catchment outlet, comprising: total oxidised nitrogen (TON); soluble reactive phosphorus (SRP) and total phosphorus (TP) concentrations. The three data sets have quite different temporal signals relating to flow pathways with different residence times and the importance of runoff events in generating acute pollution. The flexible model structure was therefore developed to include different sources of runoff including overland flow from impervious areas in the catchment, where pollution hotspots will be located (e.g. farmyards). The model has been used to assess the value of collecting high resolution monitoring data, in this case by resampling the Frome sub-daily data to a daily timestep, and comparing these model simulations against those calibrated using all the samples. The usefulness of the high resolution data can be assessed on whether a daily model would undepredict (for example) high nutrient concentrations that can be identified in the sub-daily monitoring data.

Secondly, the study aims to investigate the mitigation measures that can be used to address the catchment scale sources of N and P, under EU or other governmental legislation designed to reduce their loads. In a complex catchment like the Frome, the mitigation measures are likely to target both point and non-point sources, particularly of SRP (e.g. wastewater treatment plant discharges and soluble fertilizer applications respectively). For a modelling tool to be useful to land holders and policy makers, it is imperative that these stakeholders can investigate different scenarios by easily manipulating the model input parameters, e.g. by reducing the diffuse sources of SRP and TON (by parameter adjustment), or modifying flow pathways through runoff attenuation (e.g. reducing runoff from farmyards), and the model structure reflects this functionality allowing it to be used as a runoff attenuation tool.