

Catchment scale tools for risk assessment

Background

Recent legislative and regulatory developments such as the Water Framework Directive, the DWI expectation that water suppliers implement WHO-style Drinking Water Safety Plans and the recent explicit inclusion of catchment management of water quality under the next Water Industry AMP funding round have increased the need for risk-based assessment tools at catchment level. These may be single-issue assessment (e.g. for pesticides, nitrate, sediment etc.) but more logically would allow a consideration of trade-offs, gains and losses for a range of determinands to support decision making. Cranfield University have been involved for many years in the development and testing of such models (CatchIS: based on the UK (Hollis) SWAT model; the USDA Soil Water Assessment Tool: US SWAT; Catchment Resources and Soil Hydrology: CRASH; and most recently the Sediment Relative Risk Framework for the EA). The approaches we have taken range from relatively simple scoring systems, through to sophisticated process-based semi-distributed models. The need for development and testing of such models was identified as a priority at a recent NERC-UKWIR meeting on Prioritising Water Catchment Management Research, and was the underlying principle of the recent EU RISKBASE project.

The focus of this PhD will be on development and testing of diffuse pollution models embedded within Cranfield's GIS-based Catchment Information System (CatchIS). The pesticide models in CatchIS were designed as national level catchment-scale risk assessment tools. They are based on predicting pesticide losses from crop-specific usage on the mosaic of different land uses and soils in a catchment. The response of each soil to hydrologically effective rainfall is determined by its HOST (hydrology of soil types) class and the soil organic carbon content is assumed to control chemical retention via sorption. Once catchment boundaries have been defined, uncalibrated predictions can be made very quickly for any part of England and Wales. The most commonly used tools in CatchIS for surface water catchments are currently:

- The "hot-spots" tool, which predicts the spatial distribution of soil, climate and land use - associated risks for pesticide losses
- The "top pesticides" tool, which provides a list of expected peak concentrations at the catchment outlet for those pesticides known to be used in the catchment.
- The "surface water catchment" tool which predicts a probability distribution of weekly concentrations at the catchment outlet for a particular pesticide, for comparison with water quality standards (i.e. the calculation of probability of exceedence).

CatchIS also has capabilities to predict pesticide and nitrate concentrations in groundwaters, although these are less developed than the surface water models.

Proposal

We currently have the possibility of two studentships focussing on evaluation and development of the groundwater and surface water components of CatchIS, respectively. Both studentships offer suitable candidates the opportunity to work closely with the water industry to develop modelling tools that will be used to improve risk-based assessment of water quality issues and potential solutions. The water companies will help to shape the objectives and focus of the PhDs.

Objectives

- To test CatchIS predictions of pesticide concentrations against water industry monitoring data for a range of substances in a range of different catchments (with very different physical conditions and land use) in order to better-understand where and for which chemicals CatchIS performs well and where it performs less well. This will also underpin user confidence in model predictions and allow users to help guide model developments.
- To develop the CatchIS pesticide models to improve their performance and fitness-for-purpose, in collaboration with industry partners. For example, it could be advantageous to use daily meteorological data in order to give better predictions of episodic flows and concentrations; or it may be relevant to look at historical use of pesticides to understand trends (particularly when assessing groundwater contamination).
- To develop and test risk-based catchment-scale predictive models for other water quality parameters.