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Spatial uncertainty propagation analysis using 'spup' R package - a case study with a catchment scale water quality model

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Environmental models, including catchment scale water quality models are known to incorporate many model inputs and parameters. Some of these inputs and parameters are estimated statistically whereas others have physical significance and are usually measured using resource intensive field exercises. Due to lack of sufficient data, these model inputs and parameters are often estimated via calibration with no sufficient information on the level of their influence on the model prediction. We undertook a study that focuses on assessing uncertainty propagation in a catchment scale water quality model used for prediction of metaldehyde concentrations. The spatial uncertainty propagation analysis were carried out using R package 'spup', a Monte Carlo based spatial uncertainty analysis tool. Main focus has been given in establishing the relative importance of model inputs and parameters in improving prediction accuracy. Results from the uncertainty analysis indicated that predicted metaldehyde concentrations at catchment outlets are moderately sensitive to variations (likely greater than errors during calibration) in input and parameter values. Additional sensitivity analysis results have clearly shown that metaldehyde application area and channel surface runoff travel time parameters have main influence on the model output. Identification of inputs and parameters with the most influence on predicted metaldehyde concentration would help in the planning and design of future field exercises to collect data, which would result in significant reductions in costs and effective utilization of limited resources. We highlight that these uncertainty quantification and analysis in R has enabled probabilistic presentation of predicted metaldehyde concentrations, which provides more information to decision makers on model prediction error.