How can we quantify and reduce the uncertainty of a watershed-scale pesticide transfer model? Application to the PESHMELBA model.

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Pesticide transfers in agricultural catchments are responsible for diffuse but major risks to water quality. Spatialized pesticide transfer models are useful tools to assess the impact of the structure of the landscape on water quality. However, before using such tools in operational contexts, a preliminary step consists in quantifying the uncertainties associated to the results they provide. In this study, we explored how global sensitivity analysis can be applied to the recent PESHMELBA pesticide transfer model to quantify uncertainties on transfer simulations. We set up a virtual catchment based on a real one and we compared different approaches for sensitivity analysis that could handle the specificities of the model: high number of input parameters, limited size of sample due to computational, cost and spatialized output. We compared Sobol' indices obtained from Polynomial Chaos Expansion, HSIC dependence measures and feature importance measures obtained from Random Forest surrogate model. Results showed the consistency of the different methods and they highlighted the relevance of Sobol' indices to capture interactions between parameters. Sensitivity indices were first computed for each landscape element (site sensitivity indices). Second, we proposed to aggregate them at the hillslope and the catchment scale in order to get a summary of the model sensitivity and a valuable insight into the model hydrodynamical functioning. The methodology proposed in this paper may be extended to other modular and distributed hydrological models as there have been a growing interest in these methods in recent years.