Metamodeling approaches to help designing vegetative filter strips and improve the water quality

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Significant amounts of pollutant are measured in surface water, their presence due in part to the use of pesticides in agriculture. One solution to limit pesticide transfer by surface runoff is to implement vegetative filter strips (VFS) along rivers. The sizing of these strips is a major issue, with influencing factors that include local conditions (climate, soil, etc.). The BUVARD modeling toolkit was developed to design VFSs throughout France according to these properties. This toolkit includes the numerical model VFSMOD, which quantifies dynamic effects of VFS site-specific pesticide mitigation efficiency. However, the toolkit is quite complex to use with many input uncertain parameters (quantitative - such as the slope, the Curve Number - or qualitative -such as the soil type or the rainfall event), making it not easy to use for risk management.

In this study, a metamodeling (or model dimension reduction) approach is proposed to ease the use of BUVARD and to help users design VFSs that are adapted to specific contexts. Different reduced models, or surrogates, are compared, based on Bayesian learning approaches or not: Polynomial Chaos Expansions, Mixed-kriging, and Deep-GP. Mixed-kriging is a kriging method that was implemented with a covariance kernel for a mixture of qualitative and quantitative inputs. Kriging and Deep-GP are built by couple of modalities and PCE and Mixed-kriging are built considering mixed quantitative and qualitative variables. As a last step, Finally, we perform a global sensitivity analysis with the help of the two surrogate models with the best accuracy. The results show that they give the same ranking of the importance of the input parameters.

The metamodel is a simple way to provide a relevant first guess to help design the pollution reduction device. In addition, the surrogate model is a relevant uncertainty tool, to visualize the impact that lack of knowledge of some parameters of filter efficiency can have when performing risk analysis and management.