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Metamodeling for predicting drainage fraction in groundwater: Development of a decision-support tool

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Diffuse nitrogen pollution is a major cause of degraded water quality in rivers and groundwater across Europe. In artificially drained agricultural catchments, nitrate leaching from the root zone is either transmitted directly to streams by tile drains or transported to the groundwater system. Thus, the partitioning of the water flux to drains, the drainage fraction, is an indicator of surface-water/groundwater vulnerability to nitrogen application. This information can be used to target mitigation measures like drain filter technologies and cover crops. Hydrological models are usually employed to assist water management. Yet, for many decision-making applications numerical models are computationally too time-consuming. Additionally, as models are simplifications of the complex natural system, model results are inherently imprecise for grid-scale, and thus field-scale, predictions. To overcome these barriers, we develop metamodels to make predictions of drainage fraction. We train random forest and gradient boosted regression trees statistical metamodels to MIKE SHE-derived 16-year averages of drainage fraction in a regional groundwater model (100x100m) in Denmark. We explore the effects of mappable and non-mappable predictor variables on model performance. The metamodels are used to identify the most important predictor variables for drainage fraction prediction. Based on this, we investigate how grid cells of similar characteristics can be clustered in homogeneous subsets, in which the drainage fraction variability can be used as an uncertainty estimate. The findings could potentially support decision making on spatially differentiated regulation of nitrate emissions.