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## Including hydrologic signatures in the calibration of a groundwater-surface water model to improve representation of artificial drain

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About half of the Danish agricultural land is artificially drained to make land arable and increase crop yield. Those artificial drains, mostly in the form on tile drains, have a significant effect on the groundwater flow patterns and the whole water cycle. Consequently, the drainage system must also be represented in hydrological models that are used to understand and simulate, for example, recharge patterns, groundwater flow paths, or the transport and retention of nutrients. However, representation of drain in regional- and large-scale hydrological models is challenging due to i) issues with scale, ii) a lack of data on the distribution of the drain network, and iii) a lack of direct observations of drain flow. This calls for more indirect methods to inform such models.

We assume that drain flow leaves a signal in certain hydrograph signatures, as it impacts the generation of streamflow. Based on a dataset of observed discharge covering all of Denmark, and simulation results from regional-scale hydrological models, we use machine learning regressors to shed light on possible correlations between hydrograph signatures and artificial drainage. Building up on this step, we run a series of calibration exercises on a hydrological model of the agriculturally dominated Norsminde catchment, Denmark (~100 km<sup>2</sup>). The model is set up in the DHI MIKE SHE software, as distributed coupled groundwater-surface water models with a grid size of 100 m. The different calibration exercises differed in the objective functions used: either we only use conventional stream flow metrics (KGE), or also include hydrograph signatures that showed sensitive towards drain flow in our regression analysis. We then evaluate the results from the different calibration exercises, in terms of how well the model reproduces directly observed drain flow, and spatial drainage patterns.

Despite including hydrologic signatures in the calibration process, the representation of drain flow in large-scale models remains challenging. Eventually, the insight gained from this and similar studies will be incorporated in the National Water Resources Model for Denmark, to help improving national targeted regulation of nitrate application through fertilizers.