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Hydrogeological, topographical and drain factors controlling water table depth variation and potential nitrate reduction in subsurface drained clayey till area

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Nutrient losses in agricultural areas have detrimental effects not only on the surface water quality but are also unfavorable for sustainable agriculture practices. In Denmark, there are currently nitrate regulations applied for ID15 catchments (15 square km scale), nevertheless, it is crucial to know how much nitrogen is retained in the root zone, saturated zone, riparian zone as N-retention varies widely within ID15 catchments. Currently, N-retention mapping does not incorporate N-retention in the root zone on ID15 scale. N-retention in the root zone of subsurface drained clayey areas is potentially influenced by the variation in water table depth. Therefore, we will evaluate the effect of shallow hydrogeology, topography and drain parameters on local (sub-field scale) water table depth variation using a case study in eastern Jutland, Denmark.

The aim of the study was to assess which hydrogeological variables, drain parameters and topographical variables control water table depth variation in the root zone. This analysis was aided by a groundwater flow model code (MODFLOW). For the following purpose, hydrological data (drain flow at the outlet and depth to the water table in piezometers) and geophysical data (subsurface electrical conductivity) were collected. The geophysical data was collected by two ground-based electromagnetic systems (DUALEM and tTEM). The electrical conductivities were directly translated into two zones of homogeneous hydraulic conductivities based on a threshold value. Hydraulic properties were varied for each zone. Areas with no geophysical data were simulated using Direct Sampling, a Multi Points Statistics method. We generated several flow models, which had a varying spatial distribution of hydraulic zones and varying hydraulic properties (input factors). Moreover, boundary conditions (lateral fluxes), topographical smoothing and drain parameters (drain conductance and drain depths) were some of the other input factors we considered in this work. Model boundary conditions data were obtained from the national hydrological model. The variation in input factors was related to variation in simulated water table depths and drain flow at the outlet using a one-at-a-time sensitivity analysis.

Drain flow fraction, depth to the water table and drain discharge are analyzed as the quantity of interest for both wet and dry periods. Drain fraction is calculated as the ratio of the area contributing to the drainage to the area contributing to the recharge within the same area. The results will discover crucial controlling components of water table depth with which variations in N-retention can be estimated between different fields. The emphasis is to discover the connection between hydrogeological, topographical, and drain variables, and water table depth. We will examine potential implications for evaluating drain fraction and potential nitrate reduction.

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