

Investigating anthropogenic and climate factors driving groundwater nitrate concentrations over time

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Over the last century, increases in fertilizer application, animal husbandry and nitrogen deposition have led to a worldwide problem of nitrate groundwater pollution. Also in Europe, nitrate levels in groundwater often surpass water quality guideline limits, leading to potential health effects or high treatment costs. Understanding the temporal variability in nitrate concentrations for individual sites and its main drivers is essential for developing effective local mitigation strategies for nitrogen leaching and therefore lessening the groundwater nitrate problem. In this study, we use a machine learning approach to model temporal changes in nitrate concentrations at 400 monitoring stations of the National Groundwater monitoring Network (NAQUA) of Switzerland between 2002 and 2021. The monitoring network represents a wide variety of catchments and aquifers across the diverse Swiss landscape, including mountains, valleys and plateaus, as well as karst, clastic and alluvial aquifers. In the models, temporal data of factors influencing nitrate dynamics are used as predictor variables, i.e., climate, land use, crop type, animal husbandry, vegetation indexes and nitrogen deposition. The importance and effect of these variables in the models are assessed to understand the main drivers of yearly changes for each site. Understanding these drivers for individual sites can inform management decisions and help identify larger patterns, relevant beyond the specific study area. Finally, the proposed novel data driven approach for modelling groundwater quality can be applied to other areas and datasets.