Accounting for natural reduction of nitrogen

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Nutrient loads to groundwater, estuaries and inland freshwater systems poses a serious risk to the water quality and ecological state of these systems. In Denmark, nitrogen comprises the largest problem in many fjords and estuaries, where it is estimated that approximately 90% of the load is from diffuse sources, primarily agriculture. Regulation to reduce nitrogen excess, has historically been based on a uniform approach imposing the same restrictions for all areas independent on physical and hydro-geochemical conditions. However, during transport from the root zone to the marine environments, nitrate may be naturally reduced or subject to retention by sorption or sedimentation in surface water systems, but the amount of nitrate being reduced or retarded varies significantly in space. A spatially differentiated regulation, targeting areas with small natural reduction/retention, thus has the potential to be much more cost-effective compared to the uniform approach, and is currently under development in Denmark.

To utilise natural variation in nitrogen reduction and retention in regulation, detailed knowledge on the controlling processes and their spatial variability is required. The aim of the research project "TReNDS – Transport and Reduction of Nitrate in Danish Landscapes at various Scales" (www.nitrat.dk) is to advance the understanding of these processes and quantify their impact on nitrate transport and transformation. The project combines detailed field studies and model simulations and develops new methodologies and tools. Combining GPR and Dual EM it has been possible to detect the location of drain networks, but the method is sensitive to clay and moisture content. Intensive monitoring in two lowland areas have provided detailed insight in the complex interaction between water flow paths and reducing compounds, and its importance on the hydro-biogeochemical transformation of nitrate in riparian lowlands. During transport in the subsurface nitrate is reduced in anoxic environments and mapping the interface between the oxic and anoxic parts (the redox interface) is thus of great importance. A new redox-probe has been developed in the project that can provide us with many new measurements of the redox interface in a more cost-effective way. Furthermore, a new method is developed to construct a national map of depth to the redox interface that can be easily updated at local scale when new measurements are available. Learning from the detailed field studies, new methods to upscale and implement the local-scale processes in catchment scale models are currently under development. Finally, to utilise local conditions optimally and learn what is practically feasible, the project also have a large involvement of local stakeholders

Combining the project results, the current estimate on the spatially variation in nitrate reduction at national scale can be improved, and are expected to provide input to the implementation of a new targeted regulation strategy that will take effect in Denmark from 2019.