



## **Modelling of nitrogen inputs into groundwater and surface water in the Federal State of Schleswig-Holstein, Germany**

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The objective of the study was to identify hotspot regions and regionally dominant pathways of nitrogen input into groundwater and surface waters of the Federal State of Schleswig-Holstein, Germany. Therefore, state-wide modelling of long-term mean annual nitrogen input via six diffuse and four point source pathways has been carried out based on the model network RAUMIS-GROWA-DENUZ-WEKU. State-wide agricultural nitrogen balances derived with the RAUMIS model and rates of atmospheric nitrogen deposition were considered as the diffuse sources of nitrogen into the system. Nitrogen surpluses were coupled with the empirical hydrological model GROWA and the deterministic denitrification models DENUZ and WEKU to determine denitrification rates in soil and groundwater. This allowed the assessment of nitrogen input via the runoff components interflow, artificial drainage and groundwater discharge on the basis of a 25 m x 25 m raster. Additionally, direct nitrogen deposition on surface water bodies as well as nitrogen input via erosion and surface runoff has been quantified. Point source inputs originating from sewage plants, small sewage plants, separate sewer systems and industry have also been taken into account. Model results revealed artificial drainage as the dominant pathway of nitrogen pollution on the state level making up 68 % of the total diffuse nitrogen input into the surface waters followed by groundwater-borne nitrogen input into surface waters (ca. 25 %). As validation with measured nitrogen loads at different gauges showed satisfactorily results current emission rates have been used to assess reduction levels necessary to achieve a leachate concentration of 50 mg l<sup>-1</sup>. The results of the study have been evaluated for different purposes and spatial levels, e.g. water bodies, individual catchment areas, groundwater bodies. In this way, model results contribute directly to the implementation of the EU-Water Framework Directive in Schleswig-Holstein.