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GIS-based modelling of nitrogen loading at the catchment scale: a case study from the Karup Å catchment, Denmark

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Oxygen depletion in Danish waters has accelerated during the last 20 years and it has been documented that the human discharge of N plays an important role in this negative development. Since the first oxygen depletion case in 1982 it has been a political goal to reduce the nitrogen discharge, in order to reduce the frequency of oxygen depletion. Improper agriculture practice is responsible for approx. 68 % of the nitrogen load in Danish waters. In order to reduce the nitrogen discharge it is therefore necessary to change some agricultural practices.

The object of this paper is N-discharge from the Karup Å catchment. The river Karup Å feeds Skive Fjord, which is a particular delicate ecosystem, with frequent oxygen depletion happening during the summer months. We used data from soils from 12 sites in the catchment area, estimations on the nitrate content of soil water, and a GIS based modelling of solute fluxes at the catchment scale in order to estimate the agricultural contribution to the riverine nitrogen load in the Karup Å catchment. An estimate of the amount of leached nitrogen from the root-zone is derived by using the empirical based "Viborg-model". In addition, a distance based model using 1st order kinetics is used to estimate the area based distribution of the denitrification taking place from the source of emission to the river. The two models combined indicate which areas of the catchment contribute to the total nitrogen load and were efforts could be implemented in order to reduce nitrogen leaching.

On this background, initiatives to reduce nitrogen leaching and discharge in the Karup Å catchment are considered. This is done by assessing the area-based initiatives put forward by the Danish Action Plan for the Aquatic Environment (Vandmiljøplan III),

aiming at a countrywide reduction of nitrogen leaching by a further 13 %. These initiatives are combined with the regional plans set forth by Viborg and Ringkøbing Counties for the Karup Å catchment.

It was found that the crucial variable determining the amount of leached nitrogen to the riverine environment is the distance from the source of emission to the river, as this distance determines the amount of nitrogen denitrificated during the transport process in the groundwater. After defining the area with the highest proportion of nitrogen emission, four scenarios were put forward, each defined in Vandmiljøplan III: 1. All of the defined area is taken out of production. Reduction: 75 %. 2. Creation of 10 m buffer zones around the river. Reduction: 6 %. 3. Agri-environmental measures undertaken in the areas included in the vulnerable agricultural area (SFL) and NATURA 2000-areas. Reduction: 20 %. 4. Application of agri-environmental measures in 11 % of the vulnerable agricultural area (SFL). Reduction: 2 %

Based on the results from these four scenarios we conclude that scenario 2 will be the most appropriate.