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Planning and implementation of nitrogen reduction measures in catchment areas based on a determination and ranking of target areas

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Abstract

The implementation schedule for the EU water framework directive requires the creation of monitoring programmes for water bodies according to the intensity of the pollution risk by the end of 2006. Until 2009 river basin district management programmes have to be established followed by the implementation of measures from the management plans (until 2012). The WAgriCo-project (Water Resources Management in Cooperation with Agriculture), is a collaborative project funded by the European Commission Life Fund within the period October 2005 to September 2008, involving six British and four German institutions. The WAgriCo-project is based around the catchment management process, of identifying diffuse pollution issues and potential management solutions, involving land managers/advisors to implement methods and to assess their effectiveness in terms of pollution reduction and costs. For a basic understanding of the interactions between these issues an integrated hydrological/hydrogeological conceptual model has been set up. The model consists of three main features: natural characteristic assessment, anthropogenic impact assessment using monitoring data and model tools providing a linkage between the first two parts.

In this paper the application of the integrated hydrological/hydrogeological conceptual model for geographical prioritization and determination of environmental target areas in the case study area Große Aue in the Federal State of Lower Saxony, Germany is described and discussed. It is demonstrated how area differentiated parameters like the denitrification condition in soils, the runoff ratio, nitrate concentrations in the leachate and groundwater monitoring data are determined and combined in order to determine target areas. With the given example of the case study area Grosse Aue, the importance of defining the receptor of nitrate outputs (groundwater or surface water) and the environmental target prior to the delineation of environmental target areas could be shown.

Keywords: Catchment management; Diffuse source pollution; Mitigation methods; River basin management; Water Framework Directive

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1. Introduction

The implementation schedule for the EU water framework directive [1] requires the creation of monitoring programmes for water bodies according to the intensity of the pollution risk by the end of 2006. River basin district management programmes have to be established until 2009 followed by the implementation of measures from the management plans, which have to be finalized until 2012. The necessary programmes of measures for reducing diffuse nitrogen, phosphate, pesticide and biological contaminant emissions will be drawn up and implemented in co-operation with local stakeholders. Supporting evidence of environmental and economic effects will be assessed on the basis of impact scenarios. Strategies for the integration of the programmes of measures in agro-environmental programmes will also be developed to ensure make maximum possible use of synergies in the design of agro-environmental measures.

The WAgriCo-project (Water Resources Management in Cooperation with Agriculture), is a collaborative project funded by the European Commission Life Fund (Project no LIFE ENV/D000182) within the period October 2005 to September 2008, involving six British and four German institutions. The project aims to aid the implementation of the Water Framework Directive, develop nitrogen management options adapted to hydrological and agro-economic site properties and demonstrate the use of new participation approaches and technologies suitable for programmes of measures to reduce diffuse pollution from agriculture and to promote sustainable water resources management. On the basis of an assessment of the pollution risk, the environmental objectives will be specified and measures for endangered water bodies will be specified, discussed with the local stakeholders and implement at farm level. The results achieved in the pilot areas and the socio-political, financial, geographical and hydrological factors influencing the impact of the measures are evaluated. On the basis of an extrapolation to Federal State level, the administrative requirements for state-wide implementation are specified and evaluated. In this paper we will focus on the assessment of the pollution risk and the geographical prioritization for measures in catchment areas.

2. Conceptual hydrological/hydrogeological model

The WAgriCo-project is based around the catchment management process, of identifying diffuse pollution issues, identifying potential management solutions, working with land managers/advisors to implement methods and to assess their effectiveness — in terms of pollution reduction and costs. For a basic understanding of the interactions between these issues an integrated hydrological/hydrogeological conceptual model (Fig. 1) has been set up. The model consists of three main features: natural characteristic assessment, anthropogenic impact assessment using monitoring data and model tools providing a linkage between the first two parts.

Based on the conceptual model the interactions between agricultural practice, nitrogen surpluses, nitrogen concentration in the leachate and in groundwater are analyzed. In the same way nitrogen intakes into surface waters and, finally, the characterization of the state of groundwater is carried out. In the following sections selected natural characteristics, monitoring data and model tool application results are presented for the Große Aue case study area (Fig. 2).

2.1. Natural characteristics

The natural site conditions represent an important basis for the understanding of groundwater status. In a first step, a hydrogeological characterization has been done using a number of different data sets available on a Federal State level, e.g. from geological maps, geological/hydrogeological profiles and the distribution of clay covers above the aquifers. A hydrochemical/hydrodynamic