Prognosis of Groundwater Nitrate Pollution in the Upper Rhine Valley Aquifer for Land Use Scenarios and Remedial Actions

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The Upper Rhine Valley Aquifer with a volume of approx. 80 km² is one of the largest ground water resources of Europe. Its nitrate pollution recedes only very gradually or even remains stagnant in many places. In order to assess the impact of land use changes by socio-ecenomic developments as well as possible improvements by remedial actions a decision support system MoNit was developed in a trinational INTERREG-III A-project “Modellierung der Grundwasserbelastung durch Nitrat im Oberrheingraben” (LUBW, 2006).

The relevant processes are modelled by the following main modules:

a) Land use changes, especially distribution of crops: Socio-economic model SÖM (Graveline et al., 2005)

b) Nitrate leaching, including changes due to remedial actions: Balance model STOFFBILANZ (Gebel, 2003) and soil-plant-model STICS (Brisson et al., 2003)

c) Groundwater flow and transport: Modified MODFLOW and MT3DMS with additional modules for recharge, boundary inflow, river interaction etc. (Lang et Gudera, 2004).

Final result of the model chain is the groundwater nitrate distribution, which permits the verification of the model chain by using extensive data from repeated transnational groundwater surveys (Région Alsace, 2000 and 2005). The verification proved the system to satisfactorily permit a comparative evaluation of different remedial actions.

Scenarios of possible land use changes due to socio-economic developments up to 2015 indicate future changes in crop cultivation and management practices, which in turn lead to changes in nitrate leaching. The driving forces investigated are 2003 CAP reform, corn rootworm proliferation, energy price, EU enlargement, water policy, development of bio-fuels. Evolution of cropping patterns and resulting nitrate pollution are estimated for the most probable development (Tendenzszenario T), a liberalized policy (Szenario A1) and an energy-ecologically oriented policy (Szenario B2), which even leads to a less favorable development of nitrate pollution than scenario T.

Possible improvements in management practices are modelled first on plot scale for representative locations and then applied with the balance model in the whole area. Best of all measures was a combination of strictly demand-oriented fertilizing, intertillage and extensivation of 20 % of the arable farm land.