Proposed session : H06: The Impacts of Environmental Changes on Hydrologic and Eco-biologic Processes in Large River Basins

Modeling the impact of the nitrate contamination on groundwater at the groundwater body scale : The Geer basin case study

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In the next decades, groundwater managers will have to face regional degradation of the quantity and quality of the groundwater under pressure of land-use and socio-economic changes. In this context, the objectives of the European Water Framework Directive require that groundwater be managed at the scale of the groundwater body taking into account not only all the component of the water cycle but also the socio-economic impact of these changes. One of the main challenges remains to develop robust and efficient numerical modeling applications at such a scale and to couple them with economic models, as a support for decision support in groundwater management. An integrated approach between hydrogeologists and economists has been developed by coupling a hydrogeological model, the SUFT3D and a cost-benefit economic analysis to study the impact of agricultural practices on the groundwater quality and to design cost-effective mitigation measures to decrease the nitrate pressure on the groundwater and to ensure the highest benefit to the society.

A new modeling technique, the 'Hybrid Finite Element Mixing Cell' approach has been developed for large scale modeling purposes. The principle of this method is to fully couple different mathematical and numerical approaches to solve the groundwater flow and solute transport problem. The mathematical and numerical approaches used can thus be adapted to the level of the local hydrogeological knowledge and the amount of available data. In combination with long time series of nitrate concentrations and tritium data, this approach has been used to develop a 3D spatially distributed groundwater flow and solute transport model of the Geer basin (Belgium) of about 480 km^2. The model is able to reproduce the temporal evolution of nitrate concentrations and the spatial distribution of nitrate trends.

The model has then been used to predict the future evolution of nitrate trends for two types of scenarios: (i) a "business as usual scenario" where current polluting pressures remain the same and (ii) two contrasted scenarios that simulate the implementation of programs of measures aiming at reaching good chemical status. The results of the hydrogeological model under the "business as usual scenario" have been used to assess the cost for the society of the continuous degradation of the groundwater quality. The results of the hydrogeological model under the two contrasted scenarios have been used to assess the economical benefit as avoided damage resulting from the decrease in the nitrate load. A cost-benefit analysis has been thus performed to assess the programme of mitigation measures which provides the more benefits at the lower cost.