Foreseeing nitrate concentration in water: A review of available modelling approaches

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In the scientific community, increasing concerns on groundwater quality and quantity have motivated the development of numerical models for groundwater management since the 1970's. Mathematical and numerical models are, for example, promising tools for prediction of concentration and they can be used to make the dynamic link between nitrogen manure and the resulting evolution of nitrate concentration in groundwater. However, from a practical and managerial perspective, there have been very few real attempts of developing efficient calibrated and validated transport models in particular at the scale of the groundwater body, which is the management unit of groundwater resource in the European Union. Actually two main challenges remains, (1) performing numerical tools are not really available and (2) parametrisation of such transport models at the regional scale is difficult due to the large amount of data required.

Generally speaking models can be grouped in different categories ranging from black box models to physically based distributed models. The black box models such as transfer function are simple but attractive because they require relatively less data but with the drawback that modelling result are not spatially distributed while the predictive capability of these models is questionable due to the semi-analytical nature of the process descriptions. On the contrary, physically based distributed model require more data but, due to a more advanced description of ongoing processes, such models are expected to have better predictive capabilities than the black box models. Black box model and physically based distributed model approaches have all proved their utilities and have all their justifications, advantages and disadvantages regarding the development of regional scale groundwater model.

A new flexible methodology (the Hybrid Finite Element Mixing Cell method) has been developed that allows combining in a single model, and in a fully integrated way, different mathematical approaches of various complexities for groundwater in complex environment. This method has been implemented in the SUFTD, a finite element groundwater flow and solute transport numerical model. Combining on the one hand the use of a spatially distributed groundwater flow and solute transport model taking advantages of this Hybrid Finite Element Mixing Cell Approach method and on the other hand spatial datasets of tritium and nitrate contents, an illustration on the problem of nitrate trend assessment and forecasting for an important groundwater resource located in the Geer groundwater body (480 km²) in the Walloon Region of Belgium will be proposed.