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A fate model for nitrogen dynamics in the Scheldt basin

Pieter Jan Haest (1,2), Johannes van der Kwast (2), Steven Broekx (2), Piet Seuntjens (1,2,3)

(1) University of Antwerp, Belgium (pieterjan.haest@vito.be), (2) VITO NV, Mol, Belgium, (3) Ghent University, Ghent, Belgium

The European Union (EU) adopted the Water Framework Directive (WFD) in 2000 ensuring that all aquatic ecosystems meet 'good ecological status' by 2015. However, the large population density in combination with agricultural and industrial activities in some European river basins pose challenges for river basin managers in meeting this status. The EU financed AQUAREHAB project (FP7) specifically examines the ecological and economic impact of innovative rehabilitation technologies for multi-pressured degraded waters. For this purpose, a numerical spatio-temporal model is developed to evaluate innovative technologies versus conventional measures at the river basin scale.

The numerical model describes the nitrogen dynamics in the Scheldt river basin. Nitrogen is examined since nitrate is of specific concern in Belgium, the country comprising the largest area of the Scheldt basin. The Scheldt basin encompasses 20000 km2 and houses over 10 million people. The governing factors describing nitrogen fluxes at this large scale differ from the field scale with a larger uncertainty on input data. As such, the environmental modeling language PCRaster was selected since it was found to provide a balance between process descriptions and necessary input data. The resulting GIS-based model simulates the nitrogen dynamics in the Scheldt basin with a yearly time step and a spatial resolution of 1 square kilometer. A smaller time step is being evaluated depending on the description of the hydrology. The model discerns 4 compartments in the Scheldt basin: the soil, shallow groundwater, deep groundwater and the river network. Runoff and water flow occurs along the steepest slope in all model compartments. Diffuse emissions and direct inputs are calculated from administrative and statistical data. These emissions are geographically defined or are distributed over the domain according to land use and connectivity to the sewer system. The reactive mass transport is described using literature data. Process-knowledge on the innovative rehabilitation technologies, i.e. wetlands and riparian zones, will be derived from lab and field scale experiments. Datasets provided at the EU level are used to calibrate the model when available.

The fate model will be used to create a database driven Decision Support System (DSS) in which costs of measures and ecotoxicological effects are considered. The DSS can then be used to compare alternative combinations of rehabilitation technologies versus conventional measures in the Scheldt river basin taking into account the ecological status of the river basin.