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Integration of a modeling task in water policy design – Example of a prospective scenarios approach on an agricultural catchment

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To meet the objectives of the Water Framework Directive in terms of nitrate pollution of surface water, numerous mitigation options have been proposed. To support stakeholders' decision prior to the implementation of regulations, scenario analysis by models can be used as a prospective approach.
The work developed an extensive virtual experiment design from an initial basic requirement of catchment managers. Specific objectives were (1) to test the ability of a distributed model (TNT2) to simulate hydrology and hydrochemistry on a watershed with a high diversity of production systems, (2) to analyse a large set of scenarios and their effects on water quality and (3) to propose an effective mode of communication between research scientists and catchment managers.
The focus of the scenario, in accord with catchment managers' requirement, is put on winter catch crop (CC). 5 conditions of implantation in rotations, 3 CC durations and 2 CC harvest modes were tested. CC is favoured by managers because of its simplicity to implement on fields and its relative low influence on farm strategy. Calibration and validation periods were run from 1998 to 2007 and scenario simulation period from 2007 to 2020. Results have been provided, for each scenario, by compartment (soil, atmosphere, plant uptake, water) but especially in the form of nitrogen mass balance at the catchment scale. The scenarios were ranked by integrating positive and negative effects of each measure. This 3-step-process: translation of a simple stakeholder question into extensive set of scenarios (complexification) – modeling process and data analysis – restitution to catchments' manager into a simple integrative form (simplification), gives an operational tool for decision support. In term of water quality, the best improvements in nitrate concentrations at the outlet reached a decrease of 0.8 mgL-1 compared to a "business as usual" scenario and were achieved by exporting the CC residue, by extending CC duration and by promoting CC in the autumn period.
To conclude, the ability of TNT2 model to simulate catchments hydrology and nitrogen cycle has been demonstrated with a fine spatial resolution and fine degree of details in agricultural practices. A generic participatory 3-step-method for scenario analysis has been developed to ensure an appropriation of the prospective modeling task in decision support. Finally, the most advantageous CC management has been brought out and its effect of N cycling quantified.

Keywords: hydrology, nitrogen, distributed model, diffuse pollution, scenario, decision support