Title: OpenMI based integrated modelling of the river Zenne, Belgium.

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Abstract: The use of modelling tools to represent the reality in a simplified form has been practiced for a long time. Different modelling tools in various forms and implementations exist. While these modelling tools are generally meant for a single purpose, there is an increased need for more holistic solutions to the complex and interrelated real world problems. For a holistic analysis of the water management problems, integrated modelling is also imperative in the framework of regulations such as the EU Water Framework Directives (WFD).

Practitioners have adopted different approaches for model integration. While, in the hydrological domain a tightly integrated approach was traditionally applied, the popularity of loosely integrated frameworks is growing in recent times. We used one of the popular loosely integrated frameworks, the Open Modelling Interface (OpenMI), to integrate models for the simulation of different water quantity and quality processes: the hydrology in the river basin, the hydraulics in the river and in the sewers, erosion and sediment transport, the Carbon-Nitrogen-Phosphorus (C-N-P) cycle, the transport of trace metals and the transport and decay bacteria. Existing simulators were adapted to OpenMI standards; for the modelling of upstream rural catchment processes (the Soil and Water Assessment Tool -SWAT); for the modelling of rivers, canals and sewer systems (the Storm Water Management Model - SWMM). New, OpenMI compliant, codes have been developed for sediment, the C-N-P cycle, faecal bacteria, trace metals and the water temperature.

These simulators were then applied on the river Zenne (Belgium) in the scope of a multidisciplinary project called Good Ecological Status of river Zenne (GESZ). The integrated models were calibrated and validated at different locations, using data obtained through different agencies and data measured during GESZ sampling campaigns. The results show that the integrated model simulates the different water quality parameters with reasonable accuracy.

The results show that, while the Zenne is relatively clean upstream of Brussels, the situation worsens due to (still) untreated effluents just upstream of Brussels and due to polluted effluents of the Brussels South Waste Water Treatment Plant (WWTP). On the other hand, the impact of the effluents of the WWTP Brussels North was found to be positive for most of the water quality indicators. Another important problem is related to the sporadic combined sewer overflows (CSOs) from the sewer system of Brussels that lead the river water to near anoxic conditions at times. From this, it is clear that the ecological status of the river Zenne in and downstream of Brussels does not meet the EU WFD standards.

Globally, we conclude that we have a successful implementation of the OpenMI to integrate different models. However, the calculation time overhead of this approach is found to be very significant. Hence, solutions to optimize the efficiency of the computer hardware and software, such as grid computing or parallel computing, need to be explored.