Georeferenced modelling as complementary approach to environmental monitoring

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Introduction

The Water Framework Directive (WFD) created a legal framework that imposed the protection of common water resources on European states. The aim of the directive is to achieve good ecological and chemical status in European waters. Member states are obliged to monitor the occurrence of substances that may exert harmful effects to the environment. Continuous basin-wide monitoring, however, is virtually impossible resulting in the need for support by appropriate simulation models.

Model description

The Georeferenced Regional Exposure Assessment Tool for European Rivers (GREAT-ER) constitutes a model tool for exposure and risk assessment of down-the drain chemicals such as pharmaceuticals in surface waters (Fig. 1). It delivers spatially resolved predicted environmental concentrations (PEC) in a whole catchment based on chemical and physical properties under the assumption of steady state [e.g. 1,2]. Estimated emissions from sewage treatment plants and hospitals are taken into account to simulate the status quo of contaminations in the catchment. To consider parameter uncertainty and natural variability, probabilistic simulations with 10,000 deterministic runs were performed.

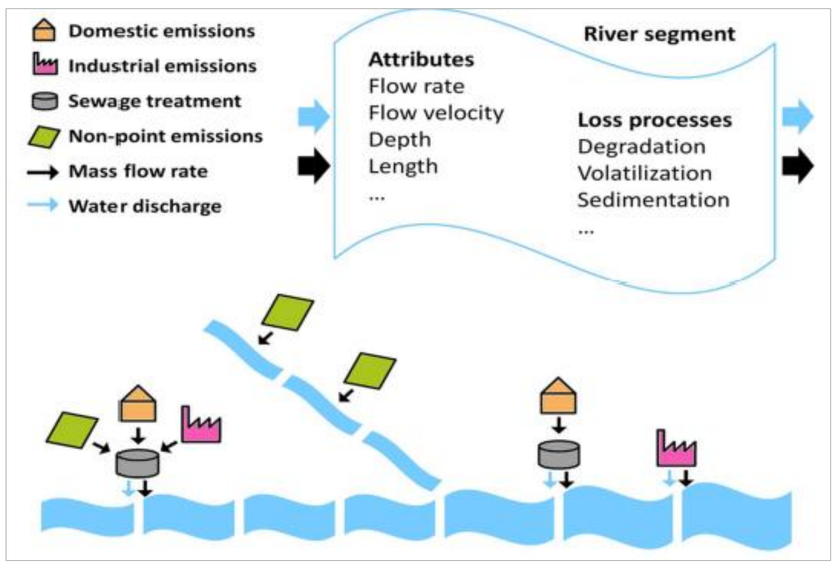

Figure 1: Schematic diagram of the GREAT-ER model

Aim of the study

The objective of this study is to demonstrate how GREAT-ER simulations can be easily used for an a priori evaluation of risk management options for pharmaceuticals in surface water.

Study area

The study area comprises the catchment of the Dutch-German cross-border river Vecht covering an area of around 6000 km². Discharge at the outlet is approximately 50 m³/s having received wastewater of 1.5 million inhabitants.

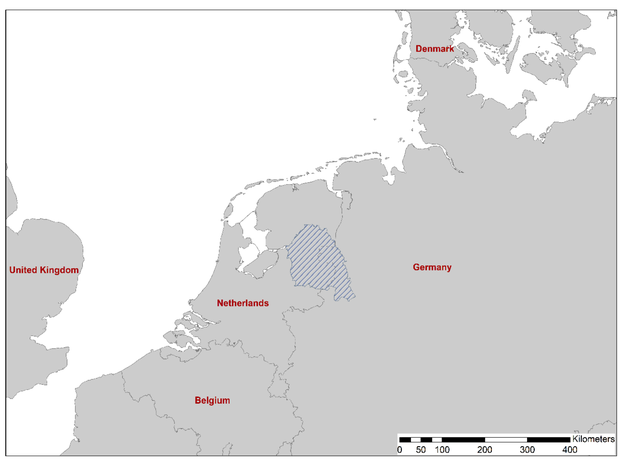

Figure 2: Location of the Catchment

Presentation of results

Selected results can be made publically available on a Web GIS platform. The WIS (Watershed Information System) has been developed within the EU-Interreg project MEDUWA. Several interactive maps offer and interested users information about predicted concentrations of pharmaceuticals in the area. The information system combines, manages and properly visualizes data from several sources, which are collected by different partners including background information, monitoring data and potential risks.

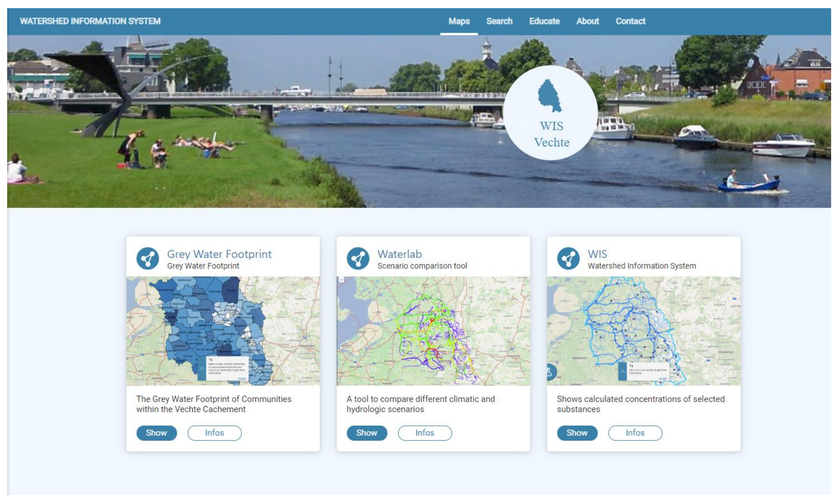

Figure 3: Presentation of GREAT-ER results in the WIS

Management scenarios

One of the key functionalities is the built-in scenario creator which allows for evaluating the effect of various reduction measures without cost-intensive on-site measurements. These include, for example, refitting of sewage treatment plants with tertiary/quaternary treatment (ozonation, activated charcoal) or newly developed techniques (such as nanofiltration). Simulation results can be directly compared with the status quo (simulations and monitoring data) for an a priori evaluation of the effectiveness of the measures.

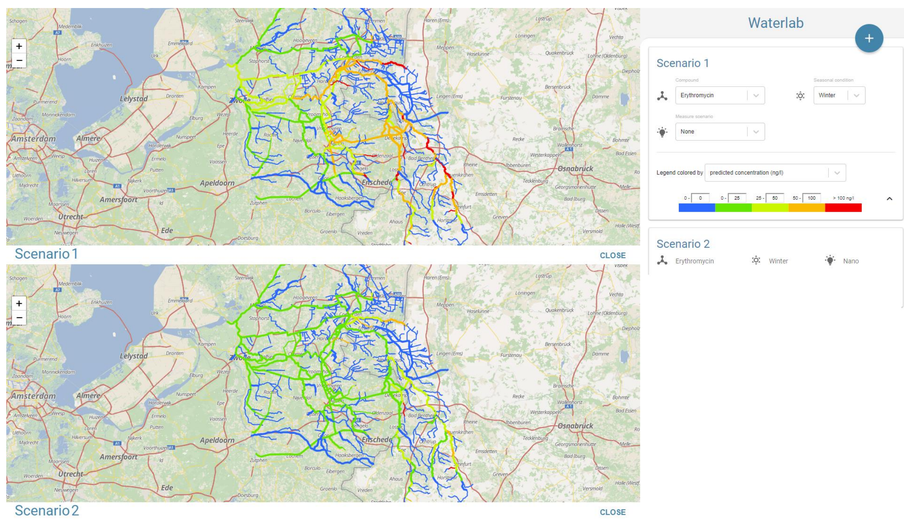

Figure 4: Comparison of scenarios in the WIS

Figure 4 shows, for example, how the implementation of nanofiltration at six selected wastewater treatment plants would affect the entire catchment area. Especially in small tributaries with insufficient dilution ratio it is often enough to upgrade just a few treatment plants to reduce the concentration levels on a large scale.

Conclusions

- Predicted PEC/EQS exceedances are in a range also measured by monitoring campaigns in Europe (3) and in the Meduwa project
- The model allows an a priori evaluation of reduction strategies
- The information system combines, manages and properly visualizes data from several sources, including background information, simulation results and monitoring data → therefore the system effectively contributes to the field of science communication

References

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Acknowledgements

The authors thank EUREGIO for financial support of the "MEDUWA-Vecht(e)" project (142118) under the INTERREG V A program

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