Identification and Prediction of Site-specific Concentrations in Rivers
using the Georeferenced Exposure Assessment Tool GREAT-ER

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Introduction

Wastewater contains even after treatment still a fraction of xenobiotic substances which is discharged into surface waters.

GREAT-ER (Georeferenced Regional Exposure Assessment Tool for European Rivers) [1] [3] is a tool to estimate site-specific concentration patterns for river basins from discharges of point-source pollutants by taking into consideration the local substance input, substance properties, the hydrologic regime and spatial aspects of the rivernet.

This poster presents results for boron, as a conservative tracer to wastewater fractions, and ammonium, which is as well a tracer for wastewater, but "instream" removable. The Ruhr Catchment is a subcatchment of the Rhine in Northrhine-Westfalia, Germany. About 2.3 million inhabitants are connected to nearly 100 wastewater treatment plants, discharging into a system of approx 3000 km surface waters.

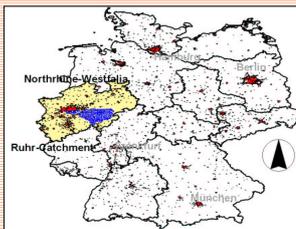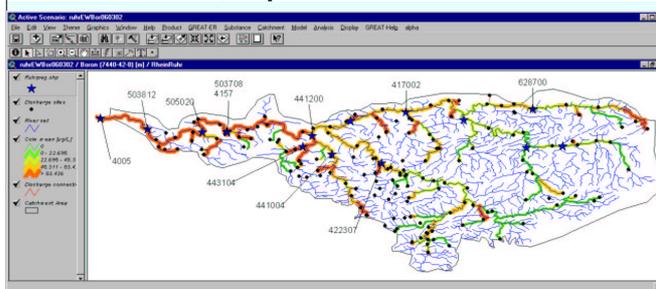In Fig. 1 a survey of Gemany is given to locate the Ruhr Catchment.

The Ruhr Catchment is coloured blue, the state of Northrhine-Westfalia yellow.

Fig. 1 Location of the Ruhr Catchment

Ruhr Catchment, Exposure to Boron

Fig. 2 Simulation results for Boron in the Ruhr Catchment

In Fig. 2 the exposure of surface waters to boron resulting from waste-water discharges in the Ruhr-Catchment is shown. The scenario is based on a per capita usage of 113 g/(cap*a) [2].
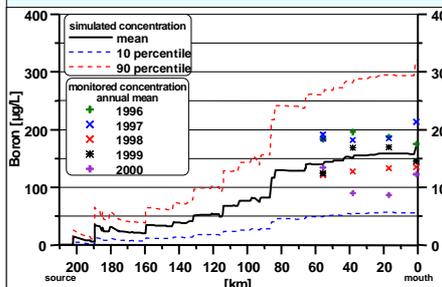

Fig. 3 Concentration Profile of Boron in the River Ruhr
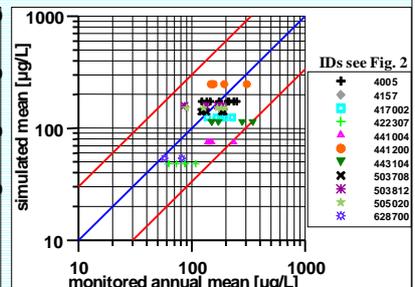

Fig. 4 Comparison Monitoring / Simulation Boron

Fig. 3 presents the concentration profile of Boron in the the Ruhr river according to Fig. 2. Additionally, measured annual mean concentrations are shown. A comparison of local simulated mean concentrations with available monitoring data, based on annually mean concentrations, is given in Fig. 4.
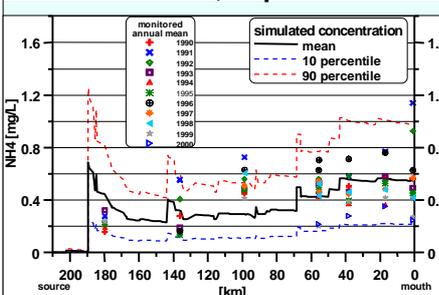
Ruhr Catchment, Exposure to Ammonium
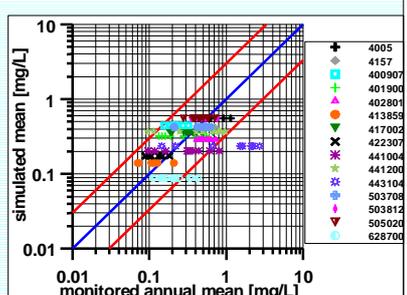

Fig. 5 Concentration Profile River Ruhr

Fig. 6 Comparison Monitoring / Simulation NH4

Fig. 5 & 6 present data for the exposure of the Ruhr-Catchment to Ammonium (NH4). Annual emission rates were assumed to be 3,1 kg/(cap*a) into Wastewater Treatment Plants with removal efficiencies between 10 and 95 % depending on technology. "In-stream" removal was estimated to be at half life about 8 days .

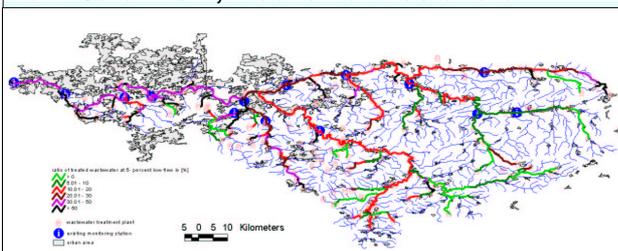## Ruhr Catchment, Fraction of Wastewater

Fig. 7 Fraction of Urban Wastewater in Ruhr Catchment at 5 % Low-Flow

An indicator for a potential exposure of surface waters to xenobiotic substances is the fraction of treated wastewater. In Fig. 7 this is presented for the Ruhr catchment at 5 % low-flow regarding an input about 306 L/inhabitant- unit.

Discussion

Calculated concentration profiles of boron and ammonium exposure in the Ruhr catchment are in good agreement with measurements. A problem for the validation is the high regional and temporal variability of monitoring data and flow conditions.

As the model was calibrated with long-term average data for water flow and substance usage, the conditions differ from the actual conditions at monitoring sites and dates. Nevertheless, comparing mean values for simulation and monitoring a deviation of about factor 3 is reached in most cases.

Uncertainty results from lack of monitoring data in the upper catchment area where high waste water fractions and thus high substance concentrations occur. An improved calibration would require more monitoring data, especially in upstream areas with high percentages of waste water.

The next step will be to incorporate rarely monitored, low concentrated xenobiotic substances like pharmaceuticals. GREAT-ER can give hints on expected concentrations, even below detection limits, and allows the identification of potential hot spots.

References
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USF (2002): GREAT-ER Hompage
        http://www.usf.uni-osnabrueck.de/projects/GREAT-ER
Data for calibration: Ruhrverband Essen
                Landesumweltamt Nordrhein-Westfalen
Monitoring data: Landesumweltamt Nordrhein-Westfalen
GREAT-ER software is available for free at http://www.great-er.org