GEO-REFERENCED AQUATIC EXPOSURE MODELLING OF AREA-RELATED EMISSION SITUATIONS

UNIVERSITÄT OSNABRÜCK

O. Heß, J. Klasmeier and M. Matthies

Institute of Environmental Systems Research, University of Osnabrück

Umwelt Bundes Amt

Abstract

To estimate site-specific concentration patterns of point source pollutants, GREAT-ER (Geo-referenced Regional Exposure Assessment Tool for European Rivers) model system has been developed [1, 2]. Such a geo-referenced approach enforces explicit knowledge about location and amount of emissions. GREAT-ER was extended to area-related emission pattern and successfully applied to the herbicide N-(3,4-dichlorophenyl)-N,N-dimethyl urea (*diuron*) in Ruhr River catchment. Measured concentration profile is well reflected by model simulations supporting validity of underlying assumptions.

Introduction

Diuron (CAS-Nr 330-54-1) is a herbicide commonly used for the control of vegetation in urban environments [3], whereas agricultural use is comparably small [4]. Due to its water solubility of 42 mg/L *diuron* emissions within urban areas are preferably collected in the sewer system and after almost unaffected passage of wastewater treatment plants distributed into surface waters [5]. Photo-sensitized transformation has been reported to be the only removal process in river water with a mean half-life of approximately 36 hours [4]. Monitoring data suggest higher emissions in urban compared to rural areas.

Catchment characteristics

Ruhr River basin is a sub-catchment of Rhine River in North Rhine-Westphalia (Germany) covering an area of 4488 km². About 2.3 million inhabitants are connected to nearly 100 wastewater treatment plants (WWTPs). Effluents are discharged into a river network of approximately 3,000 km accumulated length.

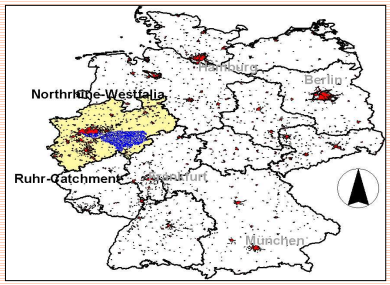

Fig. 1: Ruhr catchment (blue) located within the state of North Rhine-Westphalia (yellow)

GREAT-ER scenarios

Estimated consumption was related to total surface area for traffic purposes (main application field). WWTP influent loads were calculated by multiplying area-related emission rates with estimated share of respective areas draining into each treatment plant.

(S1) *whole year scenario:* Mean annual emission rate of 0.43 mg/(m²*a) calculated from long-term observations of diuron loads at the mouth of Ruhr River [5].

(S2) *summer scenario:* About 75% of yearly emissions occur in main use period (May - August). Emission rate and hydrological parameters were adapted to represent this time period.

Results and Discussion

- Monitoring data collected from May until August in the years 1994 - 1998 show an almost constant concentration level in urbanized areas (Fig. 2).
- Simulated concentration profiles assuming area-related emission rates agree well with measured data.
- Mean values and variability in main use period (May - Aug) are well reflected by GREAT-ER simulation (summer scenario).

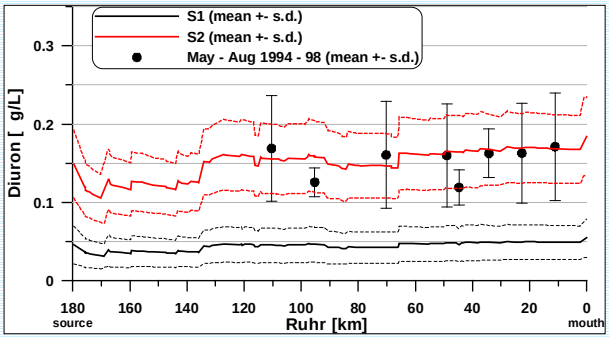

Fig. 2: Simulated and measured diuron concentration profiles in Ruhr River

- Mean surface water concentrations were calculated with a generic multimedia approach parameterized for Ruhr River catchment. According to statistical analysis of GREAT-ER results these generic means are likely to be exceeded in 20% (whole year) and 30% (summer) of accumulated river length in Ruhr River basin, respectively (Figure 3).
- Whole year scenario suggests that about 75% of annual mean values are smaller than 0.05 µg/L (detection limit), whereas in summer only 10% are below.

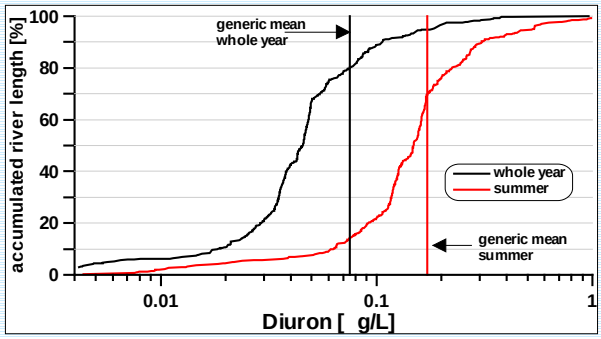

Fig. 3: Spatial statistical analysis of mean diuron concentrations in Ruhr River (vertical lines represent mean values calculated with standard generic approach (TGD)

Conclusions

For the first time, an area-related emission approach is developed instead of the per-capita approach which is usually applied in GREAT-ER for down-the drain chemicals [1,2]. Comparison with monitoring data reveals that seasonal restriction gives good agreement with simulated concentration profiles. Statistical analysis of whole river network delivers the frequency of exceeding specific values such as detection limits, regulatory environmental quality standards or mean values from generic models.

More information can be found on GREAT-ER Homepage:
http://www.usf.uni-osnabrueck.de/projects/GREAT-ER
GREAT-ER software is available for free at http://www.great-er.org

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