MODELKEY: New evidences on the impact of environmental key pollutants on aquatic ecosystems

Michaela Hein[1], Joop Bakker[2], Eric de Deckere[3], Dick de Zwart[4], Sovan Lek[5], Isabel Muñoz[6], Claudia Schmitt[3], Mechthild Schmitt-Jansen[1], Jos van Gils[7], Peter C. von der Ohe[1], Werner Brack[1]

[1]Helmholtz Centre for Environmental Research - UFZ, Permoserstrasse 15, 04318 Leipzig, Germany

[2]National Institute for Coastal and Marine Management, Haren, The Netherlands,

[3]University of Antwerp, Dept. Biology, Wilrijk, Belgium

[4]National Institute for Public Health and the Environment, Bilthoven, The Netherlands

[5]Centre National de Recherche Scientifique, Toulouse, France

[6]University of Barcelona, Dept. Ecology, Barcelona, Spain

[7]WL | Delft Hydraulics, Delft, The Netherlands

Phone: +49-(0)-341-2351529

E-mail: michaela.hein@ufz.de

Introduction: Triggered by still existing lacks in tools for cause identification of insufficient ecological status the Integrated Project MODELKEY was started in 2005 [1]. MODELKEY is the acronym for 'Models for assessing and forecasting the impact of environmental key pollutants on freshwater and marine ecosystems and biodiversity'. MODELKEY comprises a multi-disciplinary approach aiming at developing interlinked tools for an enhanced understanding of cause-effect-relationships between insufficient ecological status and environmental pollution as causative factor and for the assessment and forecasting of the risks of key pollutants on fresh water and marine ecosystems at a river basin and adjacent marine environment scale.

Methods: Modelling is closely interlinked with extensive laboratory and field investigations as well as with extensive monitoring data. Early warning strategies on the basis of sub-lethal effects *in vitro* and *in vivo* are provided and combined with fractionation and analytical tools for effect-directed analysis of key toxicants. Integrated assessment of exposure and effects on biofilms, invertebrate and fish communities linking chemical analysis in water, sediment and biota with *in vitro*, *in vivo* and community level effect analysis is designed to provide data and conceptual understanding for risks arising from key toxicants in aquatic ecosystems and will be used for verification of various modelling approaches. The developed tools are tested in case studies representing European key areas including Mediterranean, Western and Central European river basins. An end-user-directed decision support system for cost-effective tool selection and appropriate risk and site prioritisation is under development.

Results & Discussion: While hydromorphology and eutrophication are often reported to be the main challenges for achieving good ecological status MODELKEY demonstrates evidence on the relationship between chemical stress and the ecological status. It needs to be stressed that the development and application of appropriate diagnostic tools including toxic-stress directed community quality indices such as the SPEcies At Risk (SPEAR) index [2] are crucial for unravelling these contamination-community relationships. In the Scheldt basin the impact of pollution is reflected clearly in the macro-invertebrate based indicators abundance, biomass and diversity. Integrating models on bioavailability for individual toxicants, species sensitivity distribution and mixture toxicity the ecological impact of toxicant exposure can be predicted. MODELKEY demonstrates e.g. for the Scheldt that this impact can be observed in the field. The relationship between chemical stress and ecological status could be confirmed applying neural network technique. In the Llobregat case study significant correlations provide evidence of alkylphenols and pharmaceuticals affecting macro-invertebrate assemblages.

In vitro and *in vivo* biotests together with higher tier approaches such as pollution induced community tolerance (PICT) [3] provide crucial links between contamination and community responses *in situ*. *In vitro* and *in vivo* test batteries were applied to hot spots and reference sites in the three case studies Elbe, Scheldt and Llobregat clearly indicating enhanced toxicity at polluted sites. Effects are confirmed *in situ* using caged organisms (e.g. for effects of estrogenic sediments on snails) and on the community level in microcosm studies [3]. Toxic effects *in situ* could be also confirmed applying toxicity-directed community quality indices such as the SPEcies At Risk (SPEAR) index.

Effect-directed analysis but also the evaluation of monitoring data using the toxic unit approach at contaminated sites clearly indicate that priority pollutants often do not explain measurable effects [4]. This stresses the requirement of identifying site-specific and effect-based key toxicants for linking toxic effects to contamination. Examples are given for the Elbe tributaries Bilina and Spittelwasser.

The translation of site-specific contamination and effects to basin scale risks together with prioritisation of pollution sources with respect to risks for downstream regions is provided by generic basin scale exposure models. Together with ecological and integrated risk indices and effect models they are linked to a decision support system helping the end-user to assess and prioritise risks and pressures on different scales [5].

Acknowledgements: The presented work was supported by the European Commission through the Integrated Project MODELKEY (GOCE 511237, www.modelkey.org).

References: [1] Brack et al. (2005) *Environ Sci Pollut Res* **12**:252-256; [2] von der Ohe et al. (2007) *J Environ Monitor* **9**:970-978; [3] Schmitt-Jansen et al. (2007) *Basic and Applied Ecology* in press; [4] Brack et al. (2007) *Environ Sci Pollut Res* **14**:30-38; [5]Agostini et al. (2006) Proceedings of the iEMSs Third Biennial Meeting, Burlington, USA, International Environmental Modelling and Software Society.