European River Basins at Risk

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Sustaining goods and services for human development and wellbeing provided by European freshwater ecosystems are a main objective of European Union environmental policy. These goods and services include, inter alia, the supply with pristine drinking water in sufficient quantities, fish production, nutrient cycling, degradation of wastes and pollutants, flood control, as well as human recreation in natural environments. The European Union Water Framework Directive (EU WFD) and its strong focus on the conservation or restoration of a good ecological status in European rivers is driven by this understanding and demands for integrated scientific views and practical approaches and thus for close collaboration between water managers and scientists from different disciplines.

The conference on Risk Assessment in European River Basins—State of the Art and Future Challenges at the Helmholtz Centre for Environmental Research—UFZ in Leipzig (Germany) in November 2007 was designed to promote this collaboration by bringing together science and stakeholders for a discussion of major risks to European river basins and of concepts to identify, quantify, and assess these risks. This conference was organized within the frame of the European projects MODELKEY (511237-GOCE) and RISK-BASE (036938-GOCE). Key contributors to major European projects on risk assessment and water management such as MODELKEY (Brack et al. 2005), AQUATERRA (Barth et al. 2007), NoMiracle (Løkke 2005), ALARM (Settele et al. 2005), and EURO-limpacs (Birol et al. 2006) exchanged their results and shared them with policy makers and water managers.

One of the outcomes of this conference is a series of technical papers published in the January 2009 issue of IEAM addressing the range of discussions at the meeting. This series is opened by a general recommendation paper for management and research (Brack et al. 2009) followed by 2 papers dealing with water quality issues (Iglesias et al. 2009; Meyer et al. 2009). Subsequently, the focus is shifted to ecological quality starting with 2 overarching papers on uncertainty and multiple impact assessment (Ragas et al. 2009; de Zwart et al. 2009). The following papers provide concepts and approaches to deal with specific stressors in a multiple stress context including toxic pollution (von der Ohe et al. 2009; Altenburger and Greco 2009; Schulz et al. 2009, van Gils et al. 2009), hydromorphology (Friberg et al. 2009, Verdonschot et al. 2009) and invasive species (Panov et al. 2009). The recommendation paper was drafted by almost 20 scientists and stakeholders who attempted to point the way towards a holistic and risk-based management of European river basins (Brack et al. 2009). Multiple stress situations are predominating and provide a major challenge to water managers. Major stresses include, for example, droughts and floods, hydromorphological changes, eutrophication, invasive species, and anthropogenic pollution. Appropriate tools to identify dominant pressures and to predict multi-stressor effects are limited and among the strategic research needs claimed in this paper.

As a result of climate change, water quantity problems are an increasing issue for river basin management. Thus, risk assessment of droughts and floods is increasingly required, particularly since both do not only depend on temporary precipitation deficits or excesses, but to a great degree on management (Iglesias et al. 2009; Meyer et al. 2009). Socio-economic interaction among different users of water, the spatial distribution of risks, but also uncertainties associated with flood and drought risk assessment, are addressed in these papers.

Uncertainty is a key issue in risk assessment in general, regardless whether we focus on quantitative or on qualitative water problems. In this special series Ragas et al. (2009) provide a systematic overview of the implications of uncertainty for risk-based management of river basins. The authors show how additional scientific results may reduce the uncertainties embedded in the concept and use of environmental quality standards, which may result in significantly reduced costs of management activities, as is illustrated.

In European river basins several key stressors were identified to impact the ecological status, among them agriculture including nutrient load, hydromorphological degradation, the organic load, water chemistry, toxic pollution, and invasive species (CEC 2007; de Zwart et al. 2009; Panov et al. 2009). The examples show that different combinations of stressors play their roles on different spatial scales. Within the last years, promising diagnostic tools for the quantification of local ecosystem impairment and the identification of factors causing these local impacts have been developed and tested for specific river basins, such as the Scheldt basin (de Zwart et al. 2009). The results show significant ecological effects in terms of taxa loss at most study sites as well as highly variable contributions of different stress factor contributions among sites. High losses were found due to nutrients, water chemistry, and organic load. Acute toxic pressure of contaminant mixtures was found to likely cause significant loss of taxa for 35% of the monitoring sites. The high relevance of toxic pressure of mixtures for the loss of sensitive species could be confirmed by von der Ohe et al. (2009) by demonstrating a high correlation between the reduction of SPecies At Risk (SPEAR) and the local contamination levels expressed as toxic units (relative to the toxicity for the water flea, *Daphnia magna*) in the Llobregat river basin (Spain). Moreover, although considering only a very limited number of priority pollutants (currently 41), exposure levels of these compounds in European rivers indicate an insufficient chemical status at more than 90% of the monitoring sites in the 3 river basins Elbe, Scheldt, and Llobregat that were assessed in this study.

Although it is evident that aquatic ecosystems typically experience exposure to mixtures of toxicants, risk management often still focuses on the assessment of individual toxicants. This may result in an underestimation of risks