A basin-wide analysis identifying areas of risk in the Elbe watershed

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Introduction: In many Northern European river basins an intensive industrial history combined with little environmental concern have left their marks. Remains from mining and chemical production activities extensively contaminated sediments. The continued stress to the environment may be partially locally, if sediment surfaces are stable and not likely to be interfered with by management activities. Often, however, contaminated sediment is transported from one area in the watershed to another, undergoing a sequence of resuspension and deposition cycles and potentially exposing also planktonic organisms, pelagic fish and finally humans to the contaminants. Watershed-based solutions, aiming at measures to control these secondary sources in the main river and the sub-catchments, need to determine those regions which contribute most to the risks for different ecosystem services. In a bench-study on behalf of the Hamburg Port Authority (HPA) and Elbe River Community (FGG), a conceptual approach was followed that aimed at quantifying the contribution of the different sub-catchments to the contaminant load, putting ecosystem services at risk. Within the identified regions/sub-catchments, "areas of risk" from which the contamination originated, were indicated where it was possible to do so with certainty.

Methods: For the study, data on suspended matter and sediments were collected for the German part of the catchment, covering the time period 2000 to 2006. Along the main river, monthly averaged data on the contamination of suspended matter and discharge data were available for that period. Up to 8 locations at the main stream and 3 locations reflecting the input from the main tributaries were looked at in detail. Within sub-catchments, contaminant load data were calculated/used where possible, but were mostly scarce due to lack of frequent discharge information. Hence, in relevant tributaries, a weight of evidence approach was followed, trying to build a picture about sources from a) changes of sediment and suspended matter contamination with time, b) comparison of sediment data along the watershed, and c) discharge-contaminant concentration-relationships.

The conceptual approach comprised: 1) River Basin Objectives: Determination whether ecosystem services are compromised due to recently transported particle-bound contamination. Compliance with the WFD, health of the aquatic community, relocation of dredged material without endangering the environmental quality, consumption of Elbe fish, ensurance of soil quality after floodings, and agricultural use of flood plains were tackled. All were at risk due to particle-bound contaminants at all regions but the lower Elbe 2) Compounds were classified as "Substances of concern" when data availability and variability over several years showed with certainty that they frequently exceeded the chosen sediment quality guidelines, indicating a risk to the respective service. 3) Comparing the discharge-dependent particle-bound contaminant loads deriving from the Czech Republic and from the different tributaries with loads and contamination at a downstream reference station, the contribution of the different sub-catchments were assessed ("Regions of Risk"). 4) For the main contributing regions/sub-catchments, the sites from where the contamination originated was narrowed down where possible ("Areas of Risk").

Results: 1) A disproportionality between those contaminants that are regulated when bound to particles and those that, from a scientific point of view, pose a risk to ecosystem services became apparent. Accordingly some sediment quality criteria had to be calculated based on models and generalized assumptions. 2) Measures to reduce PCB, HCB, and DDX contamination in order to guarantee ecosystem services would have to tackle areas of risk in the Czech Republic. 3) In the German part of the catchment, the Saale and Mulde-tributaries contribute most to the contamination with regard to heavy metals (HM) and organic substances such as HCH, and Dioxins. Within the respective sub-catchments, the mining sites at the upper Mulde catchment (HM) and the industrial region around Bitterfeld, which strongly impacted the the Spittelwasser creek and its flood plains showed to be highly relevant. In the Saale tributary contamination of mobile sediments within the river seemed to be the main problem. 4) There is indication that the impact of the 9600 groyne fields along the Elbe has decreased over the last years.