Investigation on sedimentation and erosion dynamics of groyne fields in the River Elbe and its relevance for contaminant transport)

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Introduction: River sediments store large quantities of hazardous contaminants, because in the past, great quantities of pollutants were discharged into the rivers. Many contaminants, such as heavy metals and organic micropollutants, are adsorbed to fine-grained sediments. Particle bound contaminants were deposited and accumulated over years in regions of low flow water bodies – such as groyne fields (Fig. 1). In recent years, the emission of pollutants has been reduced drastically. As a consequence, the older contaminated sediments are covered by less polluted younger deposits. Investigations (Schwartz 2006) on sediments in a groyne field of the River Elbe showed a significant increase of pollutant concentration with depth. Due to the complex and highly variable flow field great high spatial variability of deposited sediment properties can be observed. However, recent investigations show very high pollutant concentrations for the uppermost sediment layers.

Fig. 1: Section over the River Elbe near Magdeburg, trained by groynes.

Many adsorbed contaminants are very immobile within the anoxic sedimentary deposits. Polluted deposits often do not directly affect the river water quality. However extreme flood events can remobilize the sediments and transport them downstream to the Estuary and finally to the sea. Therefore, the groyne fields in the River Elbe can be regarded as temporal sinks and sources of pollutants. The risk of polluted sediment resuspension is important for assessing the environmental impact on the water body and the soil of the floodplains. The flood in August 2002 has it illustrated drastically. Unfortunately, there is a lack of data on erosion stability of fine grained contaminated sediments. Erodibility is a key issue for risk assessment and sediment management.

Methods: The University of Stuttgart (Institute of Hydraulic Engineering), in cooperation with the UFZ Magdeburg (Dept. River Ecology & Analytics) and the ELANA GmbH, performed a sediment sampling campaign in the Middle Elbe in order to fill in the data gap and to gain deeper insight into the sediment transport dynamics within some groyne fields. Undisturbed sediment cores (10 cm diameter) were taken at a groyne field near Magdeburg to determine the depth profiles of the critical erosion shear stress ($\tau_{crit,e}$), sediment bulk density and water content and pollutant concentrations. $\tau_{crit,e}$ was determined using the SETEG-flume (Kern et al. 1999), which allows measurements in 1-cm steps. The bulk density was measured by the non-intrusive gamma ray densitometer. Heavy metals, Arsenic (As) and Silica (Si) concentrations were measured applying the energy dispersive X-ray fluorescence (EDXRF) method after freeze-drying the sediment samples.

Geostatistical methods will be applied for interpolation of the measurements in order to gain the spatial distribution of the sediment properties in horizontal direction and with depth. Numerical modelling of flood scenarios will allow the quantification of the eroded mass of pollutants. Additionally, model results quantify the uncertainties associated with sediment erosion parameter and geochemical analysis.

References: [1] Schwartz R. (2006) *Acta hydrochimica et hydrobiologica* **34**:223-233; [2] Kern, U. et al (1999) *Wasserwirtschaft* **89**:72-77.