The complexity of sediment contamination in backwaters of the Elbe River, what can we learn from it and does it matter?

Susanne Heise[1], Ulrich Rieth[2]

[1] Hamburg University of Applied Sciences, Ulmenliet 20, D-21033 Hamburg
[2] Institut für Hygiene und Umwelt, Marckmannstraße 129a, D-20539 Hamburg

Phone: +49-(0)-4042875-6217
E-mail: susanne.heise@haw-hamburg.de

Introduction: There are more than 1000 backwaters, lakes and small harbors in the floodplain area of the Elbe River. They are mostly remains of previous river courses which have been cut off by natural causes or by anthropogenic alterations of the river. Nowadays, as large areas of the Elbe floodplain have been declared a biosphere reserve, people attend to backwaters and floodplain lakes, use them for outdoor activities like water sports and angling. However, the Elbe floodplain is prone to high water, flooding many of these side structures. And considering that 30 % and more of the annual contaminant load is transported downstream during a few weeks of high water discharge, it is easy to assume, that these water bodies could act as sinks for contaminants, potentially affecting fish, habitat, Elbe river quality and quite a few other ecosystem services. In spite of this, very little data existed on sediment quality in these areas. Thus, in two sampling surveys, in 2013 and in 2014, we examined 25 floodplain lakes and backwaters in order to answer the following questions:

- To what extent do backwater sediments store historic contaminants in the Elbe catchment and how dynamic are they under flood conditions?
- Do they have a negative effect on aquatic organisms?
- Are there parameters that allow us to predict which of these 1000 side structures could be a risk to ecosystem services and should be managed?

Methods: 25 backwaters were investigated along the Elbe river in two surveys: April/May 2013 (15 backwaters), and May to July 2014 (10 backwaters). 4 water bodies from the 2013 survey were re-visited in 2014 in order to investigate the impact of the 100 years flood in the Elbe in June 2013.
Sediments were collected from 3 depths (0-10 cm, 10-20 cm, > 50 cm) at up to 3 locations/backwater. The samples were analyzed for historic contaminants and most for ecotoxicological effects (algae growth inhibition test, luminescence bacteria test, bacterial contact test) following international standardized norms.
Erosion stability was tested on cores from all locations with a resuspension device acc. to Gust [1].
Sediment cores of up to 1 m depth were sampled at the locations re-visited in 2014. Depth profiles of metal distribution and ^{137}Cs activity were determined in order to gain insight into sediment dynamics.

Results and Discussion: While 3 sediment samples contained chemical substances in concentrations below the current sediment quality classification, 147 samples (including samples below 50 -100 cm depth) exceeded it, and - mostly – by far. The sediment quality classification of the IKSE has been developed to ensure the sediments' ecosystem services [2]. With the exceedance by so many sediments, this cannot be guaranteed for these backwaters. Ecotoxicity did not correlate with sediment quality. Biotests thus contribute an additional information to the assessment.
Erosion stability also varied, but most visited stations showed a high resuspension potential.
Comparing sediment profiles at the same stations of 4 side structures before and after the flood, and watching the distribution of contaminated sediments in the sampled backwaters, the following assumptions were derived:
Sediments which are furthest away from the confluence with the Elbe river show the lowest contamination.
How sediments are shifted in backwaters, that have a small, narrow connection to the river, depends very much on the way they are flooded and the water is contained inside.
Sediments which are closer than 200 m to the river and belong to a backwater that does not connect to the Elbe at an eroding bank accumulate fine, contaminated material from the river resulting in high contamination.
These assumptions would mean that it is the site of the Elbe and not the transport of fines with high water discharges flooding the side structures from upstream which impacts the sediment quality in backwaters. This, however, needs further confirmation.

References: [1] Porter, E.T., et al., Marine Ecology Progress Series, 2004. **271**: p. 43-60. [2] IKSE, *Sedimentmanagementkonzept der IKSE*. 2014, p. 202.