The Elbe gives, the Elbe takes…
Flood events probably relocated backwater sediments

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Introduction: The Elbe river has one of the largest catchment areas in Europe with 150 000 km^2. Roughly, one third lies in the Czech Republic, two thirds in Germany. Before 1990, the Elbe was considered one of the most polluted rivers in Europe due to industrial effluents from the then existing Czechoslovakia and GDR. Since the fall of the Iron Curtain 1989 and the following decrease of industrial activity in the former area of the GDR, the water quality has largely improved. The sediments in the Middle Elbe, however, are still significantly polluted with "historic" contaminants and could impair the water quality when being resuspended during extreme flood events. Potential sinks of sediments along the Elbe are "backwaters", which are mostly remains of the former river course, now detached from the Elbe under average water discharge or only still connected at one end. Even though there are about 1000 of such backwaters in the flood plain of the Elbe, adding up to an area of about 50 km^2, little was known of the quality of the backwaters' sediments and even less on their mobility. With the investigations, presented in this paper, we tried to get a better understanding of the contaminant risk from these areas for the downstream regions of the Elbe River.

Methods: In a field survey in 2014, 14 backwaters were studied, that were still connected with the river (see Fig. 1). At each backwater, 2 to 3 sites were investigated with regard to (a) depth of the fine sediment layer, (b) sediment contamination, (c) ecotoxicity, and (d) surface stability. Additionally, in order to confirm the sediment erosion history, we took sediment cores at 10 backwaters and determined the profiles of ^{137}Cs-activity and heavy metal concentration with depth.

Fig. 1: Connected backwater close to Grippel

Results: The contamination of 75 % of all sampled sediments exceeded the upper threshold values for sediment quality, set by the International Commission for the Protection of the Elbe (IKSE), for p,p'DDX, As, Pb, Cd, Hg, and Ni. Within backwaters, there was no general trend of increasing contamination with depth, but contamination seemed to decrease with distance from the river. Sediments varied strongly in their ecotoxic responses and in erodibility.

Of the 10 backwaters, where cores were taken for dating the sediment, 2 had not been continuously connected to the Elbe over the last decades and thus did not show any specific layering. 2 of the remaining cores could be dated on the basis of the two ^{137}Cs-Peaks from 1963 (end of nuclear bomb testing) and 1986 (Chernobyl nuclear disaster) in combination with the heavy metal profiles. In the remaining 6 cores (one measurement is still ongoing), only the ^{137}Cs peak from 1963 was detected.

Discussion: The observation, that contamination seemed to be especially high towards the confluence of the backwater with the river led us to hypothesize initially, that contaminated material had been deposited in these areas during average water discharge conditions (see SedNet conference 2015). The ^{137}Cs-Analysis, however, seems to indicate that sediments from at least 30 years have disappeared from these sites, exposing the contaminated sediments from the 70s and 80s. This assumption is based on the following observations:

(1) of the two sites in which both ^{137}Cs peaks were found, one is protected by a dam upstream from being completely flushed during high water.

(2) The maximum concentrations of heavy metal contamination which go back to the 80s and 70s are close to the recent sediment surface.

(3) studies from before 1998 still reported a Chernobyl peak in sediments from Elbe flood plains, which indicates that events after 1998 may be responsible for eroding the material.

The extreme Elbe floods that occurred within a short period of time, in 2002, 2006, (2011) and 2013, are likely candidates to have caused this extensive resuspension and the relocation of potentially millions of m^3 of contaminated material in the Elbe river.