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Contamination Problems With and After the Elbe Flooding of 2002

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Beyond the direct impacts of the "Elbe-flood 2002" questions appeared about sources, sinks and fate of pollutants. During and after the flood event nearly 30 research groups from different scientific disciplines like space research, geology, biology, chemistry and ecotoxicology cooperated with the concerned ministries and authorities of the Czech Republic (Ministry of the Environment of the CR, 2004, 23.08.2004; Martinek, 2002) and the Federal Republic of Germany (Geller, 2002) to estimate flood-based contaminations in the Elbe-River basin. According to the direction of the Ministry of Environment, an extraordinary monitoring program was organised in the Czech Republic (CR). It was primarily executed by the River Basin Authorities, the Czech Inspection, the Research Institute TGM Prague and the Prague Water Works & Sewage. In the Czech stretch of the Elbe River downstream of the confluence with the Moldau River (from Obristvi to Decin), the first 5 water quality profiles were sampled beginning on 16th August. The first sediment samples were taken from 6 localities on 19th August (Martinek, 2002). Additionally to the basic network of extraordinary monitoring, there were 14 measurement profiles sampled with a frequency of 2 times a week (Ministry of the Environment of the CR, 23.08.2004).

The *water quality* in both Rivers Elbe and Mulde showed a strong increase of concentrations of toxic substances and of the microbial load during the flood. Sources were flooded industrial areas, flushing and erosion of waste dumps of the mining industry, and the remobilisation of contaminated old sediments. In CR, flooding of industrial areas with dangerous matters happened in 13 cases -- the most severe situation was in Spolana Neratovice. In flooded areas, 20 or more other outflows of dangerous matter occurred – in spite of the fact that 29 filling stations were flooded, there was no significant outflow of gas (Ministry of the Environment of the CR, 2004).

Water quality predominantly returned to basic levels of contaminations after the end of the flood event, but the mixture of inorganic (mainly As and heavy metals) and organic compounds has been transported down the river, where *flooded urban areas, flooded soils, sediments of rivers and of flowed-through lakes functioned* as sinks. The flood-affected soils and sediments now are potential new sources of contamination as they did in the past during smaller floods. Comparisons between heavy metals in sediments or soils before and after the Elbe-flood 2002 didn't show dramatic enhancements or reductions. Most other results likewise don't indicate flood-based changes. Thus, the flood 2002 does not appear to have severe consequences for the environment, speaking from the point of concentration approach.

The soil-contamination as found in the investigation programme with some toxic substances (As, Cu, Hg, dioxins) exceeded legal guideline values, independently of the flood in 2002. Obviously, these contaminations are long-term effects of smaller floods in the past. Most areas which were flooded for the first time in 2002 did not exceed the guideline limits. The main sources for long-term contaminations are eroded mining waste dumps (heavy metals, As) and industry based emissions.

Areas in front of dikes are polluted with dioxins and mercury along the Elbe, downstream of River Mulde. For assessment of contamination of flooded areas along rivers, there were used 64 samples from localities with longer flood water detention and 6 samples from oxbows

(Ministry of the Environment of the CR, 2004). This load is a result of deposits of many floods past, and there was no significant change by the 2002 deposits.

Flushed-through lakes are long-term sinks of contaminated sediments (Lake Muldestausee), whereas river sediments are often exchanged depending on discharge. Thus, river sediments function as sinks and sources in dependence of the flow velocity. For one well-investigated groyne field the erosion during the flood 2002 of old deposits could be modelled and measured.

Because of mobilizable fractions of different elements (Cd, Cu, Pb, Zn, As) there is a potential threat for ground waters and drinking water supply. This is true for both the Elbe and the Mulde river catchments. Ground water quality was significantly affected in parts of flooded areas within the Elbe and Moldau Rivers in the CR primarily in parameters of organic contamination (Ministry of the Environment of the CR, 2004).

A mixture of different organic and inorganic toxic compounds was found in the Bitterfeld area and in the river-sections between Bitterfeld and the Elbe. Beyond well-known problem materials, a non-target-screening analysis has shown unknown substances to occur in these waters. Changing flow-directions of contaminated ground waters adjacent to the Bitterfeld area presumably will bring about additional future contaminations of surface waters. Results of ecotoxicological experiments with water and sediments from this area underline the problematic condition of the water quality.

A significant portion of the bacteria species were not of riverine origin. Future research should focus on the survival time of pathogenic bacteria in the environment (soils and mud). The fraction of antibiotic-resistant bacteria was surprisingly high. Sources are not yet identified. Most possible sources are agricultural (pastures, liquid manure) and sewage treatment plants. There were, for example, 124 waster water treatment plants out of operation during the flood event in the CR, from which 36 with a capacity of over 10,000 EI – anyway, toxic matter was not found in samples of flood water (Ministry of the Environment of the CR, 2004).

Literature

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