The effect of increasing surface water oxygen concentrations on metal mobility in sediments from the Schelde Estuary

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Domestic and industrial waste water was untreated in many Belgian streams for decades. A high organic load resulted in low surface water oxygen concentrations while contaminants, including trace metals, were often concentrated in the sediments. Under these hypoxic conditions the formation of insoluble metal sulfides is found to reduce metal mobility and toxicity in sediments (Di Toro *et al*., 1992). However, after the implementation of waste water treatment plants last years, an increase in surface water oxygen concentrations was observed in many rivers, the Schelde and its tributaries included. Under these conditions, sulfides may be oxidized and associated metals can become more available in the sediment or migrate to the surface water. Then the risk exists that historically contaminated sediments will be turned from a trace metal sink into a trace metal source. In an experimental setup the effect of surface water aeration on trace metal mobility was investigated. Natural sediments from the Zenne and Moerbeek with high concentrations of metals and sulfides were exposed to aerated surface water (oxygen = 90%). This resulted in increasing sediment redox potential values and decreasing sulfide concentrations. Trace metals, precipitated with these sulfides, became more mobile. An increase in sediment metal availability, release to the surface water and higher toxicity to *Daphnia magna* were observed after 2 months exposure to the high oxygen surface water.

Long term field data were used to explore the effects found in the experiments on a larger scale. Due to the implementation of a waste water treatment plant near Brussels in 2007, an abrupt increase in oxygen concentrations in the Zenne surface water was observed. However, this did not result in increasing metal concentrations in surface water of the Zenne, as could be expected based on the experimental results. Also in the Schelde Estuary oxygen concentrations raised the last 10 years but differences concerning the effect on trace metal mobility may exist. The gradual decrease in surface water concentrations of most metals between 1960 and 2005 is followed by a recent increase of some metals in the river water. Additionally, surface sediment metal concentrations in freshwater tidal marshes of the Schelde showed a recent increase. Increasing oxygen concentrations in the Schelde resulting in higher metal mobility in the sediments can be one of the possible explanations.

These results may indicate a large scale mobilization of trace metals from Schelde sediments which contain a huge amount of historically accumulated trace metals. Even when the migration towards the surface water may be negligible in terms of toxicity, a substantial increase in metal availability in the superficial sediment layer can be expected. Since this layer is of main importance for benthic invertebrates and consequently for feeding migrating birds, metal toxicity in this biologically important zone may have a large impact on the estuarine ecosystem.

References

Di Toro, D.M., J.D. Mahony, D.J. Hansen, K.J. Scott, A.R. Carlson and G.T. Ankley. 1992. Acid volatile sulfide predicts the acute toxicity of cadmium and nickel in sediments. Environ Sci Technol. 26:96-101.