Management of metal contaminated sediments in Sørfjorden, West Norway – an internationally known site

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Introduction: In many countries primary point sources of contaminants to the marine environment are now reduced or eliminated. However, climate changes causing frequent storms, heavy rainfalls and exceptional high tides may accentuate the problems of stored contaminants in soil and sediments. The risk assessment is often based on assumptions that contaminated sediments are important secondary sources to elevated levels of contaminants in water, bottom fauna and seafood.

The environmental objectives related to sediment remediation are often vaguely formulated due to many assumptions and lack of scientific documentation. When it comes to decisions, the fundament of knowledge appears weak and decisions are delayed or cancelled. Consequently, it is important to present sediment management plans which are scientifically based, understood by all parties involved and well communicated both with respect to environmental goals and uncertainties.

Sørfjorden on the west coast of Norway was in the 70-ies considered as one of the most metal contaminated marine sites in the world with sediments in the vicinity of a zinc smelter containing several percent of zinc and lead and hundreds of ppm of mercury and cadmium [1].

Methods: Surface sediments from 22 sites in Sørfjorden were collected in June 2007. The sediments have been analysed for TOC, Hg, Cd, Pb and Zn. Some cores have been collected to illustrate the historical development of metal contamination. Experimental work on bioavailability and bioaccumulation of metals in a polychaete and a snail has been carried out as well as a whole sediment toxicity test (Ruus and Skei, separate presentation).

The sediments collected near the zinc smelter is strongly coloured due to waste material (fig.1).

Fig.1: Sediment core collected near a zinc plant in Sørfjorden

Results: Efforts to eliminate point sources have been made during the last 20 years [2], but recent investigations (2007) of the sediments show surprisingly high levels of contaminants in the surface sediments. As a result a remediation plan is under preparation.

The surface sediment collected in 2007 contained up to 156 ppm Hg, 225 ppm Cd, 9140 ppm Pb and 53700 ppm Zn. These levels are close the levels measured prior to major attempts to cut sources in 1986 (elimination of the discharge of jarosite waste to the fjord) and 1992 (capping of a hot spot).

Based on the results from the sediment survey and tests on bioaccumulation in sediment living organisms and toxicity testing, a sediment remediation plan is recommended.

Discussion: The maintenance of high levels of metals in the surface sediments in Sørfjorden, despite of drastic reduction in metals inputs, is presumably explained by repeated accidental discharges from the zinc plant in recent years. Additionally, although the sediments are highly contaminated, there is a considerable biological activity in the sediments which may cause a mixing between newly deposited, less contaminated material and underlying contaminated sediments.

With respect to remediation plans we recommend to avoid dredging as the underlying sediments are strongly influenced by industrial waste which could be easily exposed during the dredging. To improve the quality of the most biologically active layer we recommend thin layer capping with sandy material. The environmental benefits from the capping will depend on the frequency of accidental discharges in the future.

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References: [1] Skei et al. (1972) Water, Air & Soil Poll., **1**: 452-461; [2] Skei (1992) Hydrobiologia, **235/236**: 629-638.