Ecological risk assessment of contaminated marine sediments – structure, experience, and general applicability of the Norwegian system

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Legacy contamination from past industrial and port activities has led to restriction on consumption and marketing of fish and shellfish in about 30 Norwegian fjord and coastal areas. As most of the point sources of contaminants have been eliminated the sediments are considered the main source of local contamination and hence the target for remediation. The price tag for this is 1-3 billion euros. In 2007 the Authorities developed a national guideline for assessing the ecological and human health risk from contaminated sediments. The guideline should ensure that potential sites for remediation were prioritized on basis of a common risk assessment procedure. This paper presents the structure of the risk assessment tool and the experience from application at a variety of sediment sites. These studies have shown the tool to be fit for the purpose. Since it is based on the EU environmental and health risk assessment principles, it should be easily applicable to marine sediment sites elsewhere in Europe as well.

The risk assessment follows a 3 step tiered approach. In Tier 1 the sediments are screened for potential ecological risk according to a toxicity based pollution classification guideline and selected bioassays. Sediments failing Tier 1 are subjected to Tier 2 where the risk for contaminant dispersal, ecological effects and effects on human health is assessed based on estimates of contaminant fluxes from the sediments due to diffusion, resuspension and food chain transport. These estimates are based on conservative generic values for constants and coefficients. In Tier 3 these fluxes are recalculated after replacement of generic constants and coefficients with measured values from the site in question. Tier 3 is optional and one may go directly to remedial action planning for sites failing in Tier 2.

Usage has revealed several improvement points for the risk assessment tool. It covers about 40 different micropollutants and chemicals, but in almost all assessments the conclusions depend strongly on the sediment levels of benzo(a)pyrene (due to low threshold value for human health risk) and tributyltinn (due to low threshold value for ecotoxicity). This dominance may to some extend be justified and real, but for both of these compounds as well as for most other higher PAH compounds Tier 3 estimates have shown that the fluxes from the sediment may be overestimated by 1-2 orders of magnitude in Tier 2 due to very conservative generic partitioning coefficients.

A sensitivity analysis has shown that the largest uncertainty in the risk calculations relates to the values which are used for 1) organic carbon sedimentation rate, 2) the factor by which bioturbation enhances contaminant diffusion, 3) the sediment to water partitioning coefficients, 4) the water to biota bioconcentration factors, and 5) the amount of sediment resuspended during arrival/departure of ships. It is recommended that locally measured rather than generic values are used for these factors in the risk assessment. The challenges in obtaining representative values for these factors will be discussed.

An intrinsic shortage of the present tool is that the Tier 2 and 3 assessments only estimate the gross flux of contaminants from the sediments. Resedimentation is not taken into account; hence the tool overestimates the contaminant mobilization and also the ecological and human health risk. As this could lead to costly remedial actions that may not be justified, ways of including this in the risk assessment guidelines will be proposed and discussed.