The Norwegian Grenland fjord dioxin story – Sediment remedial options and consequences

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Introduction: The Grenland fjords, South Norway, have received large amounts of dioxins from a magnesium plant operating from 1951-2002. This has led to servere contamination of the marine environment in the area, resulting in restrictions on commercial fishing and dietary advices to comsumers of sea food. Remedial actions are now asked for. Due to the complexity, costs and also possibilities of unintended ecosystem alterations, a good scientific understanding of the system, including consequences of different remedial options, are paramount.

Methods: To explore effects of different remedial options an integrated multimedia modelling tool called **S**ed**F**lex was developed [1], [2]. The SF consists of 1) a flexible water-sediment fugacity model code for simulating the sources, sinks and transports of persistent organic pollutants (POPs) in a fjord, estuary or lake system, and 2) a bioaccumulation rate constant model code for simulating the intake and bioaccumulation of POPs in a food web. In addition, the SF-tool contains tools for uncertainty and sensitivity analysis of the model results. The compartment structure in the abiotic and biotic models can be flexibly defined, and both models can be executed both in dynamic and steady state mode. The model is used as a management decision tool to address the impact of planned contaminated sediment remedial alternatives on the future dioxin and furan levels in target organisms, i.e. cod and crab in the Grenland fjords.

Remedial actions in the Grenland fjords, will affects many square kilometers of soft bottom sediments. Hence, the question of possible unintended ecosystem alterations is relevant. Presently, this is addressed through investigations where effects of a thin layer displacement approach is explored.

Results: A significant reduction in the concentration levels in target organisms can first be seen when larger areas are capped. The model simulations seem to indicate that if one aims to make effective remediation measures affecting the dioxin levels in the organisms, one should start covering at areas where the organisms live and feed, where the sediment burial and resuspension rates are smallest, and where the active sediment layer depth and present concentration level are highest.

Traditional capping methods based on isolation of the contaminated sediments, have the potential to severely alter the soft bottom fanua community structure. Hence, a more sustainable method where the ecosystem alterations are minimized, are now under investigation and results will be presented.

The use of holistic simulations of the Grenland fjords abiotic and biotic system as well as the inclusion and propagation of model parameter value uncertainties in the model results, and thus their presentation as probability distributions instead of single values, has already provided a unique and valuable knowledge input for the local environmental managers and other stakeholders in the Grenland fjords dioxin pollution problem.

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References: [1] Saloranta et al. (2006) *Envion. Toxicol. Chem.* **25**:253-264; [2] Persson et al. (2006) *Sci. Total Environ.* **369**:188-202.