Risk assessment of dioxin-contaminated sediments
An integrated approach

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Introduction: An explosion, 40 years ago, of a chemical factory in Amsterdam, the Netherlands, resulted in a major dioxin spill that contaminated parts of the brackish Noordzeekanaal. For nautical reasons, the main channel has to be dredged, removing part of the contamination. An intensive field study was carried out in order to assess the risk of dioxin and other contaminants in the remaining sediment of the main channel and the surface layer in the adjoining harbours.

Methods: For the selection of the sampling points we used the geo-statistical technique "nested sampling". With this technique relations are been investigated between the distance of the sampling points and the differences in concentrations.
In the main channel, sediment samples were taken with a tube corer in order to obtain samples from the bed sediment beneath the layer that has to be dredged. In the harbour areas next to the main channel, sediment samples were taken from the sediment surface-layer. The sediment samples were tested on a mix of chemical analyses and bio-assays.
In all sediment samples the fast desorbing concentration of organic compounds was analyzed using an XAD-extraction. Heavy metals were analysed in the pore water using a Chelex-extraction in order to obtain the freely dissolved concentrations. In a smaller selection of sediment samples also total concentrations were analyzed. All concentrations are expressed on a dry weight basis.
The DR-CALUX assay was used to assess the concentration of dioxins and dioxin-like compounds in the sediment samples [1,2].
At six locations in the area eel (*Anguilla anguilla*) was caught.

Human health risks were assessed by using the model SEDISOIL. Ecological risks were assessed by using two bioassays (Microtox® Solid Phase and an amphipod test with *Corophium volutator*) and a bioaccumulation test with the ragworm *Nereis virens*. Total concentrations, as well as fast desorbing and pore water concentrations were used to calculate the risk that the remaining contaminants may diffuse to the overlying water and into the groundwater [3].

Results:

Human risks

With the risk model SEDISOIL the human risks are calculated, results to be expected in one month.

Ecological risks

Based upon the results of the amphipod test, DR-CALUX assay and secondary poisoning studies, an ecological effect was found for 70% of the samples.

Dispersion to groundwater

Despite the infiltration situation in the harbours there is no unacceptable risk of dispersion of contaminants through the groundwater, within a time span of 30 years that is indicated in environmental law. This is caused by the slow transportation of the measured components in the pore water.

Dispersion to surface water

Shipping in the Noordzeekanaal and the adjoining harbours causes a mixing of the contaminated pore water with the surface water. Further implications to be reported in one month.

Discussion:

For dioxins, the geo statistical technique "nested sampling" shows a correlation between distance and concentration. For other contaminants the relations were less clear.
For most organics components a good correlation was found between whole sediment concentrations and the fast desorbing concentration in the sediment. This is not the case with heavy metal concentrations in whole sediment and pore water.
Accumulation of contaminants did not correlate with whole sediment concentrations.

References : [1] Stronkhorst et al. (2002) *Environ. Toxicol. Chem.* **21**:2552-2561; [2] Van den Berg et al. (1998) *Environ. Health Perspect.* **106**:775-792.
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