# Risk assessment of dioxin-contaminated sediments
# Ecological risks

**Anna C. Sneekes, Nicolaas H.B.M. Kaag**

TNO IMARES, P.O. Box 57, 1780 AB Den Helder, The Netherlands

Phone: +31-(0)-223-638800

E-mail: andrea.sneekes@tno.nl
klaas.kaag@tno.nl

**Introduction:** For nautical reasons, the brackish Noordzeekanaal between Amsterdam and IJmuiden has to be dredged. Parts of the area is contaminated by dioxins due to an accident more than 40 years ago. To assess the ecological risk of the sediments, remaining after the dredging is completed, an extensive field study was carried out.

**Methods:** 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, as these harbours do not have to be dredged.
The sediment samples were tested for effects with a 30-min bacteria test (Microtox® Solid Phase) and a 10-d amphipod test (*Corophium volutator*). The risk of dioxin and dioxin-like compounds was evaluated using the DR-CALUX assay. The risk for secondary poisoning was evaluated on a selection of samples covering the whole range of DR-CALUX responses, using a 28-d bioaccumulation test with the ragworm *Nereis virens*.

**Results:** The Microtox® Solid Phase test did not indicate toxicity in any of the appr. 100 samples tested. In most of the samples, the silt fraction (<63 µm) was very high, obscuring possible effects caused by contaminants.
With the amphipod test, highly significant mortality (>40%) was found in 53% of the 125 samples tested, while in 34% of the samples mortality was comparable to reference tests.
The DR-CALUX response exceeded the limits for dredged material of 50 ng TCDD-TEQ/kg dry sediment in 56% out of 191 samples tested. The highest DR-CALUX response found was 8800 ng/kg. For 29% of the samples the DR-CALUX response was below 25 ng/kg, considered ecologically safe [1].

Ragworms were exposed to 53 sediment samples and analyzed for dioxins. In half of the samples (27), PAH, PCB and organochlorines were analyzed and in a smaller subsample (10) also heavy metals. The body burdens (expressed on fresh weight basis) were compared with Dutch environmental risk limits for biomagnification [2]. The bioaccumulation tests showed that the risk for biomagnification primarily results from the accumulation of dioxins. In 60% of the tested samples a severe risk for biomagnification was indicated. As also a very good correlation was found between the DR-CALUX response and dioxin levels in ragworms (Pearsons r 0.814; $p<0.0001$), a regression was fitted in order to be able to estimate dioxin accumulation for al 191 samples tested with the DR-CALUX assay. The calculations indicated a severe risk for biomagnification in 42% of the 191 samples.

**Discussion:** The combination of tests applied, yielded a clear picture of the ecological risk that the remaining sediment will pose after the dredging operation is completed. The risk indicated by the DR-CALUX assay is more conservative, compared to the risk for biomagnification. This may partly be due to the fact that it is a risk calculated on the basis of DR-CALUX responses by regression techniques. The amphipod test yielded complementary results to the DR-CALUX and biomagnification tests.
By combining the results of the different analyses, it was concluded, that 133 samples (70%) posed an unacceptable ecological risk, while only 31 samples (16%) were 'ecologically safe'.

Picture results DR-Calux

**References:** [1] Stronkhorst et al. (2002) *Environ. Toxicol. Chem.* **21**:2552-2561; [2] Van Elswijk et al. (2002) *Rijkswaterstaat AKWA rapport* **2001.005**.