



Risk assessment of contaminated sediments in the Netherlands

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A short history

Soil protection act (1987-2009)

1987 - 2006

- Remediation to multi functional conditions is compulsory (sooner or later)
- Priorities are set based on risk assessment
- Urgent cases should be remediated within 4 years. Non-urgent cases should be remediated before 2015

• 2006-2009

- Urgency is based on risk assessment
- Urgent cases should be remediated to acceptable risks for the water quality; the time frame is connected to the Water Framework Directive (WFD)
- Non-urgent cases need to be managed with a minimum of maintenance

Risk assessment within the Soil protection act

National manual for sediment evaluation (2008, in Dutch)

http://www.helpdeskwater.nl/algemene-onderdelen/zoeken-site/@7255/richtlijn_nader/

After evaluation of the quality of recontamination, a step-by-step assessment system is performed for 4 pathways:

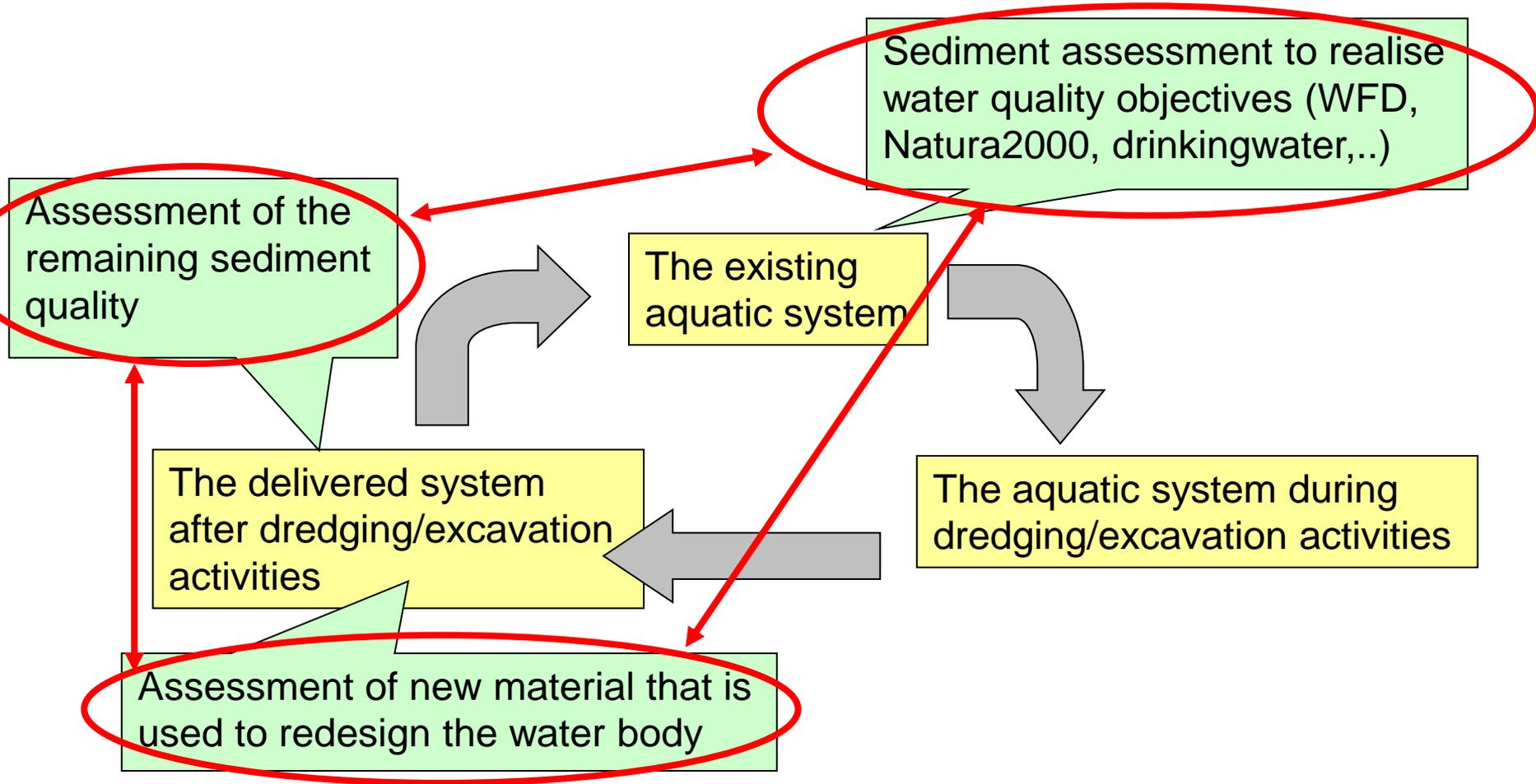
- Risk to humans
- Ecological risk to sediment dwelling organisms
- Risk for diffusion to surface water
- Risk for diffusion to groundwater

If the sediment causes actual risks, the location is appointed as 'urgent'.

Since 2009: Water Framework Directive (WFD)

**Sediment management
is water management**

Sediment management in practice



Three assessment frame works for sediment

- Sediment assessment to realise water quality objectives:
 - Manual for sediment assessment
- Assessment of the remaining sediment quality:
 - Water quality test and sediment immission test
- Assessment of new material that is used to redesign the water body
 - Soil quality decree

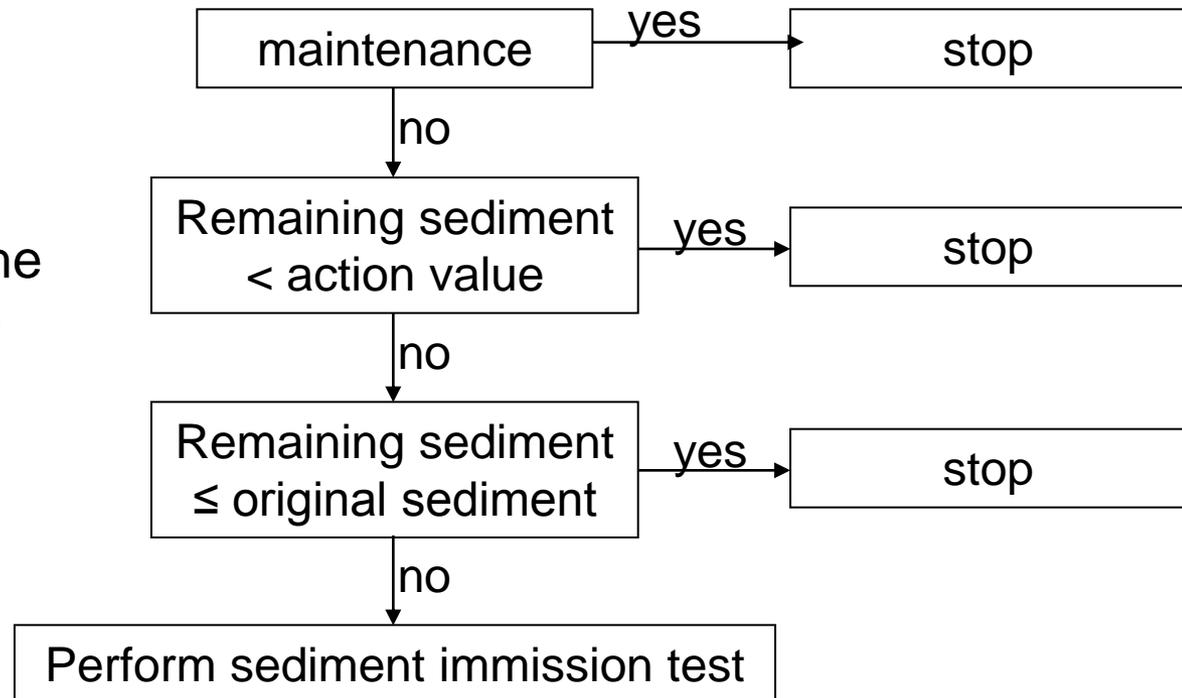
However, the objectives of the WFD are leading

Water quality test and Sediment immission test

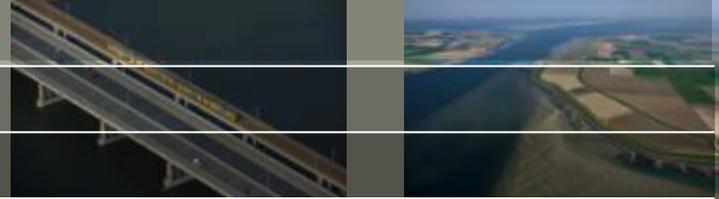
Assessment of the remaining sediment quality

The water quality test evaluates the effects of physical changes (depth, shore, slope, texture) on the ecological status of the waterbody

The sediment immission test evaluates the immisions from the sediment into the surface water

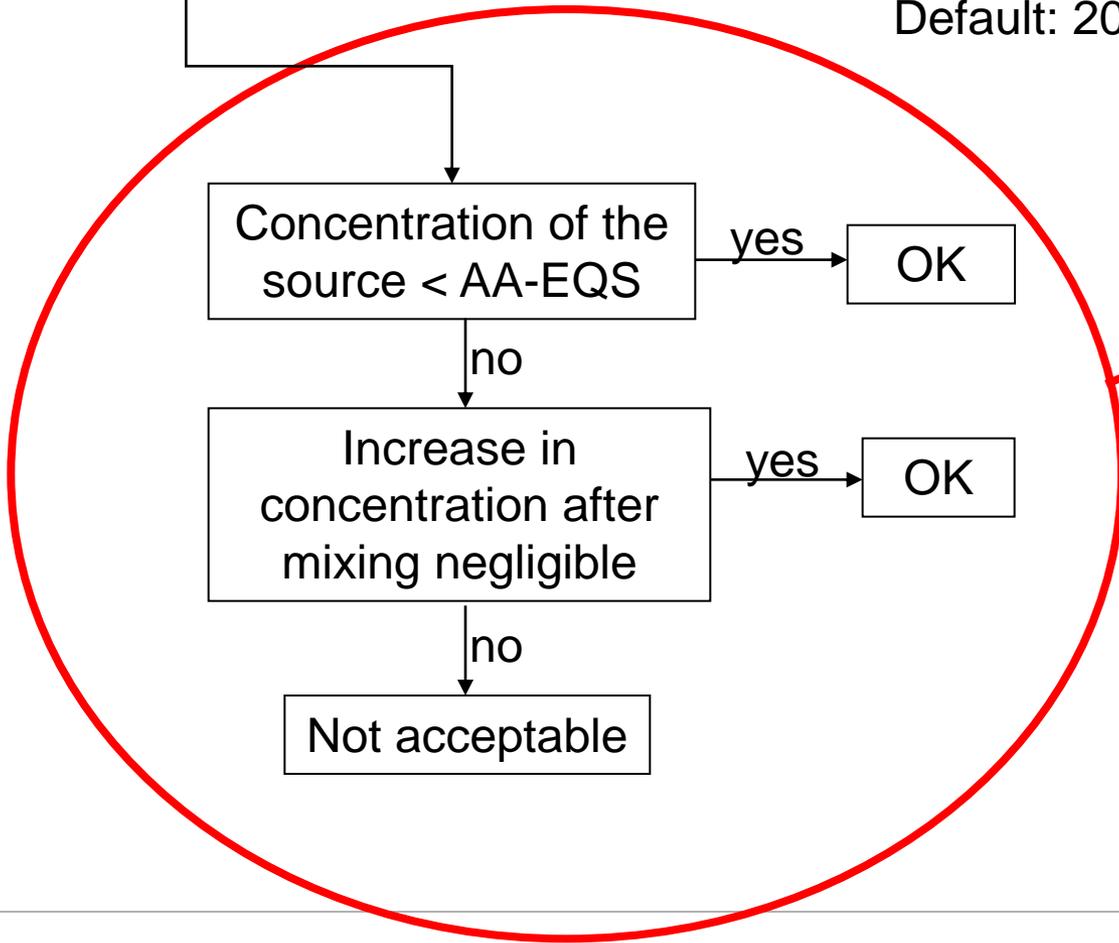


Sediment immission test



$$\text{Yearly load} = \text{Surface area} * (\text{erosion layer/ year}) * (C_{\text{remaining}} - C_{\text{original}})$$

↑
Default: 20 cm



General emission - immission test to evaluate discharges with respect to permits requests

Manual for sediment assessment....



Sediment assessment to realise water quality objectives (WFD, Natura2000, drinkingwater,..)

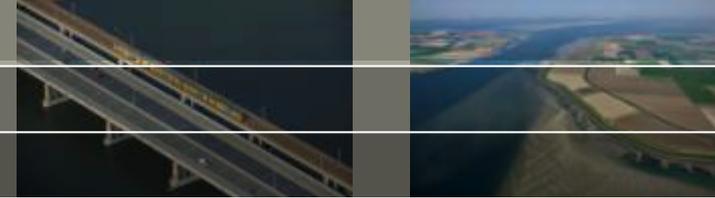
.... assists the water manager to quantify the effects of a contaminated sediment on the water quality as realistic as possible (no worst case).

The manual does not imply legal obligations; the ultimate goal of the assessment is whether a measure to reduce the negative effects from the sediment is useful to reach water quality objectives.

The manual should be used during the planning phase of river basin management plans

It can be used for 'wet' sediments as well as for 'dry' parts of wetlands and shores.

How does the manual work?

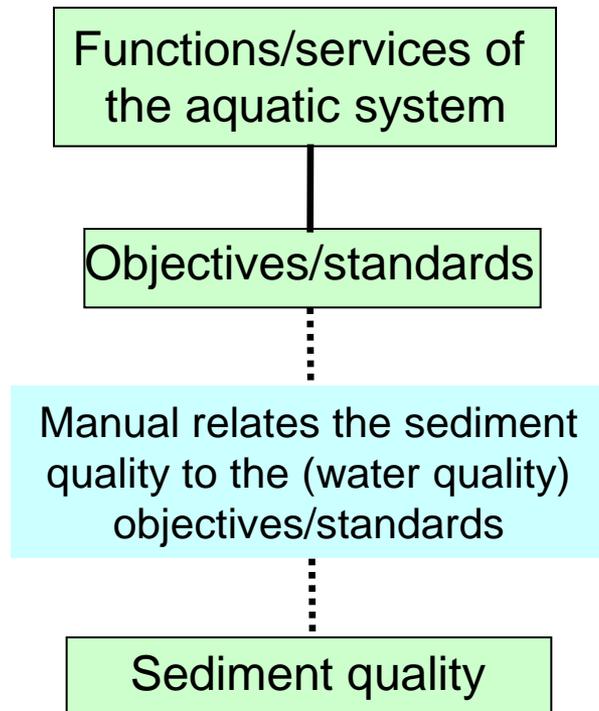


Functions that may be affected by the sediment quality:

- A healthy ecosystem

User functions:

- Nature
- Fishing
- Leisure (swimming, fishing, boating)
- Intake of drinking water
- Formal swimming spot
- Water for agricultural use



From functions via standards to sediment quality

Standards in surface water

WFD: total, dissolved (filtrated), or contents in biota

National: concentrations in standard water (30 mg SPM/l) or SPM

Standards in groundwater

Ground water directive, and national: dissolved concentrations in groundwater

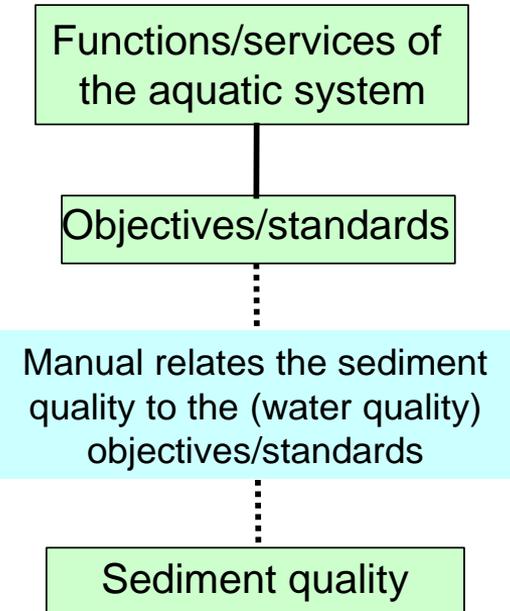
Biological standards

WFD: EQR's (macrofyten, fytoplankton, macrofauna, vis)

Natura2000: Nature conservations goals (species, habitats)

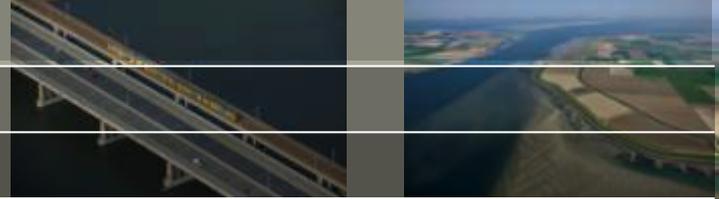
European Food standards (fish and other aquatic organisms)

Duty to maintain: Human intake of contaminants (MPC_{human})



How to relate these standards to sediment quality?

Basic assessment



The basic assessment is suitable for all sites, also for relatively small sites where it is not feasible to spend a lot of money on the investigation.

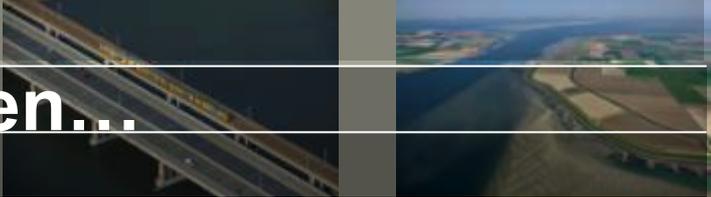
The basic assessment:

- Comprises a flow chart for each type of water quality standard
- uses simple measurements and calculations
- Can be performed by an experienced consultant.

Simple measurements and calculations

- Determination of total contents in the sediment
- Use of SEDIAS, an Excel-file, to calculate:
 - Porewaterconcentraties via equilibrium partitioning
 - Fluxes of dissolved or total concentrations caused by seepage, resuspension or dispersion/diffusion
 - The msPAF to quantify ecological effects including bioaccumulation
- Use of Sedisoil to calculate human risks by swimming and consumption of fish

Use of specialist methods when...

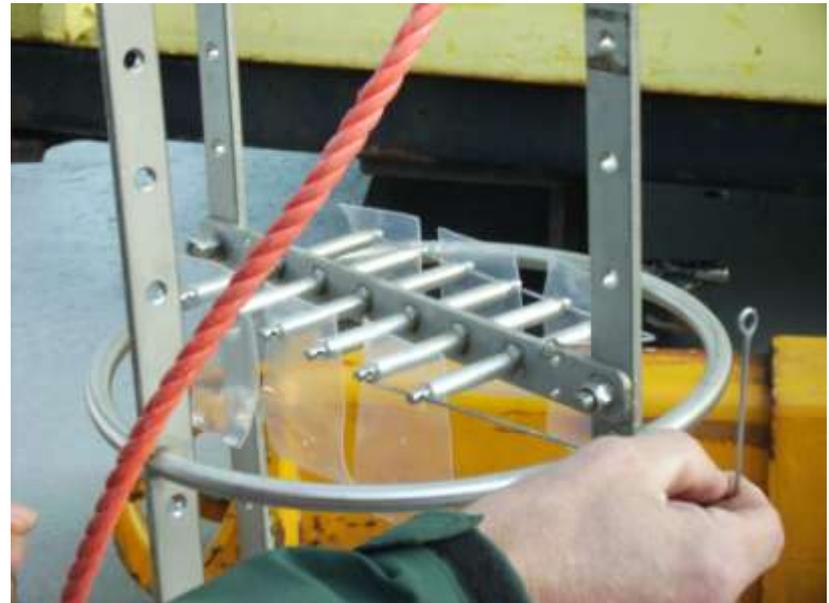


- Compounds with complex behaviour play an important role (e.g. mercury, TBT, or dioxines).
- The financial implications in case of measures are large (large sites)
- There is a lot (social) concern about the site, which requires extra certainty.

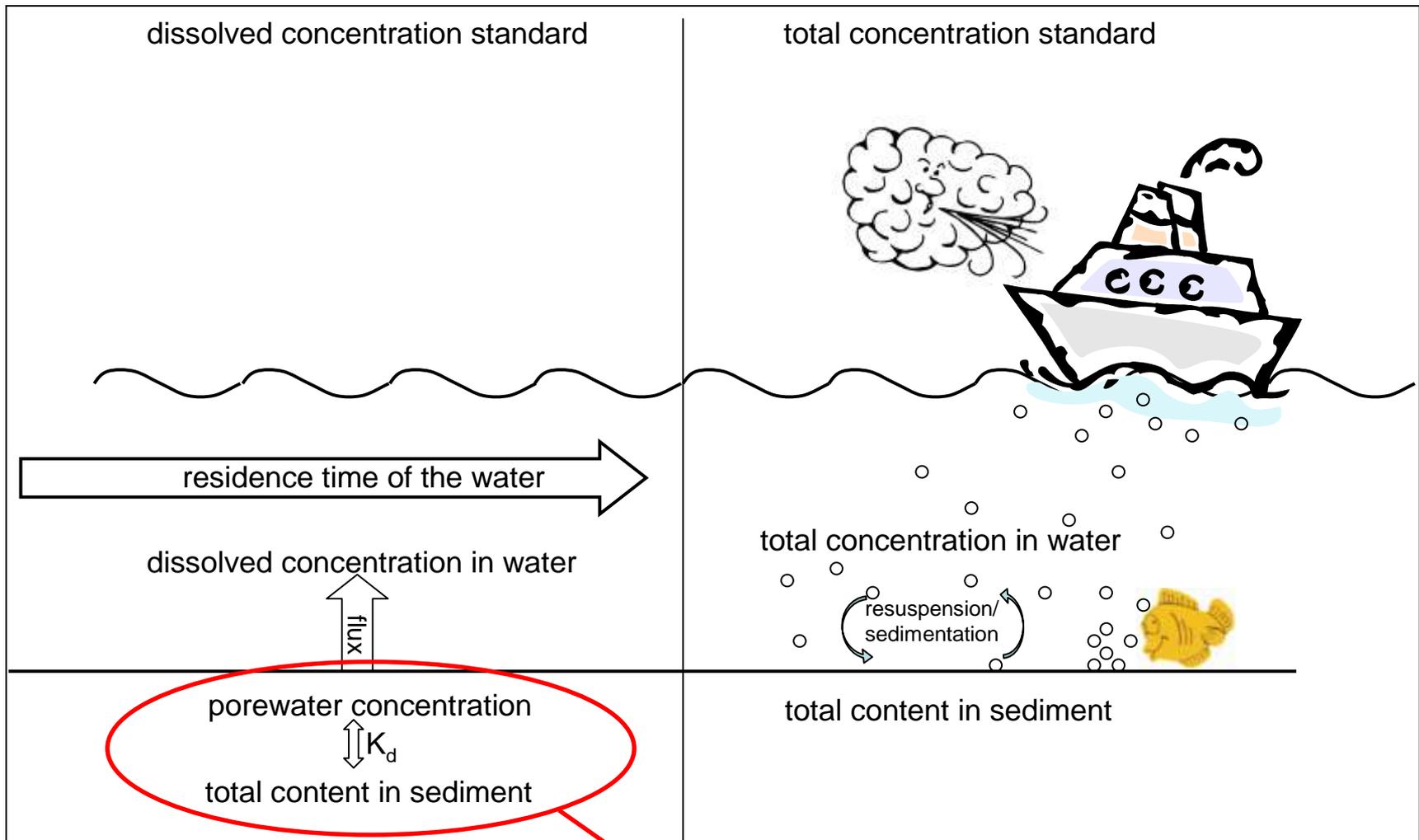
The use of specialist techniques requires specialist people to be involved.

Specialist methods

- Bioavailability analyses (pore water, passive sampling, mild extractions)
- Measurement of complex compounds, e.g. methyl mercury or dioxines
- Measurement of erosion
- advanced models (FREEQ-C, BIOCHEM, DELFT3D, OMEGA45, etc.)
- bioassays
- Field inventories (e.g. sediment invertebrates or nematodes)



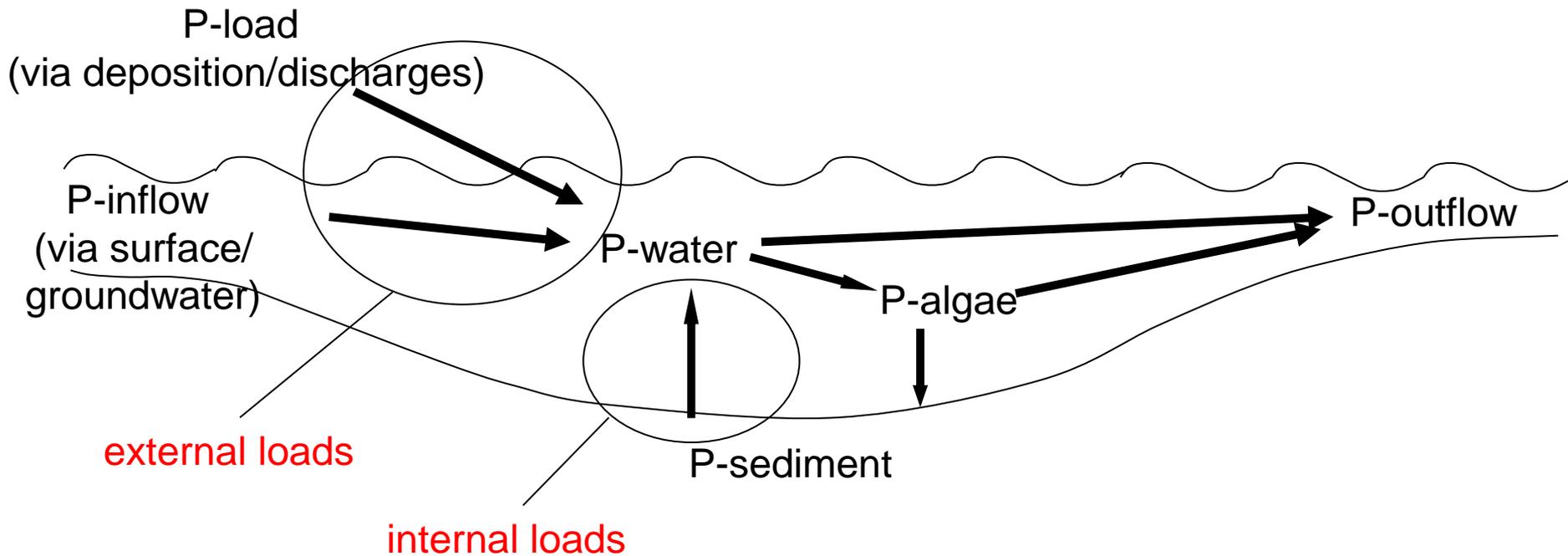
Contaminant standards in surface water



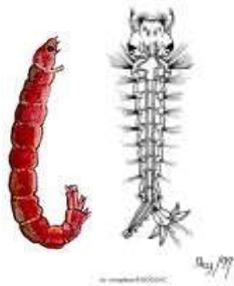
Equilibrium partitioning

Nutrient standards in surface water

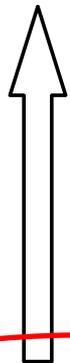
- More dynamic, depending on the season
- Focus on P (N equilibrates quickly).



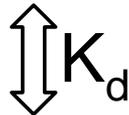
Biology: EQR benthic invertebrates



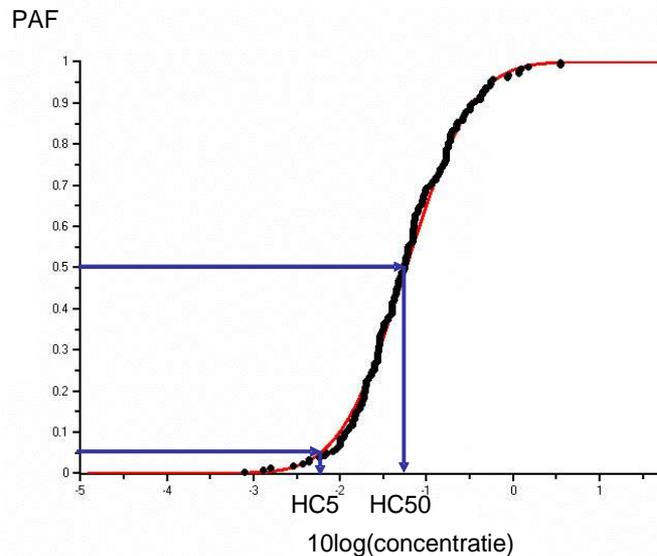
↑
msPAF



porewater concentration



total content in sediment



Recently, Posthuma et al. (2012) found that the msPAF was a good indicator for ecosystem health. ET&C 31(9): 2175–2188

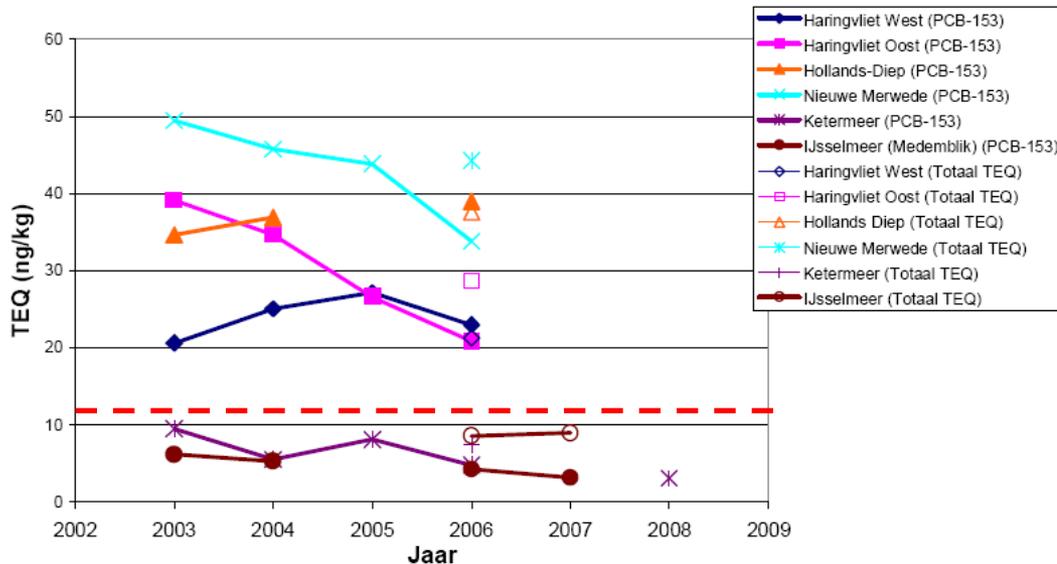
Equilibrium partitioning

Human risks (EU food standard)

Direct compliance check in market products

- Severe problems in the Netherlands with PCB's/dioxines in eel (other fish is nog → at the moment it is not allowed to market eel from the large rivers in the Netherlands)
- Limited number of compounds is regulated. Standards for other compounds (Pb, Cd, Hg, BaP) will not be exceeded in the Netherlands

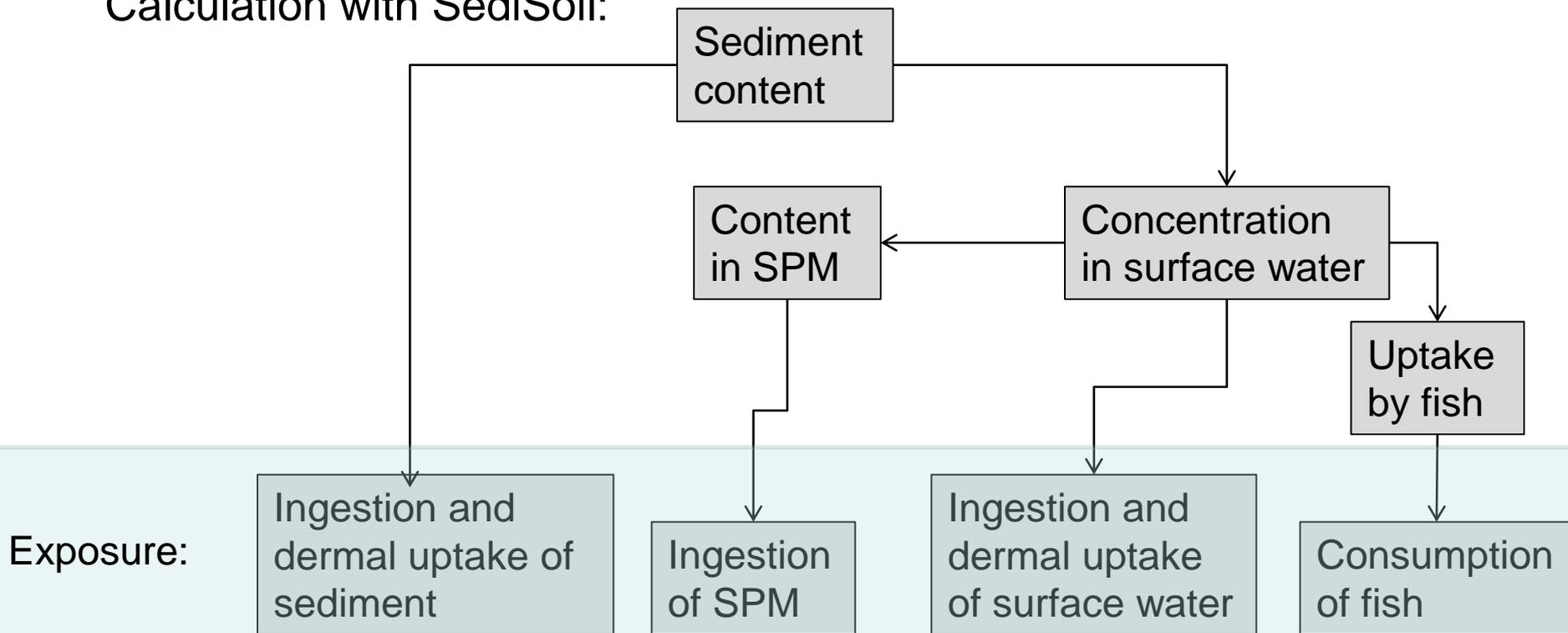
TEQ geschat uit PCB 153 en gemeten totaal TEQ



Human risks: swimming, angling

No formal standards, except general WHO-standards
Consumption of 'own' fish is the main exposure route.

Calculation with SediSoil:



Conclusion

**Sediment assessment
is water quality assessment**

Thank you