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ecossa ecological sediment & soil assessment

Ökologische Aussagekraft von Qualitätsstandards für Feinsedimente

-

Ecological relevance of quality standards for fine sediments

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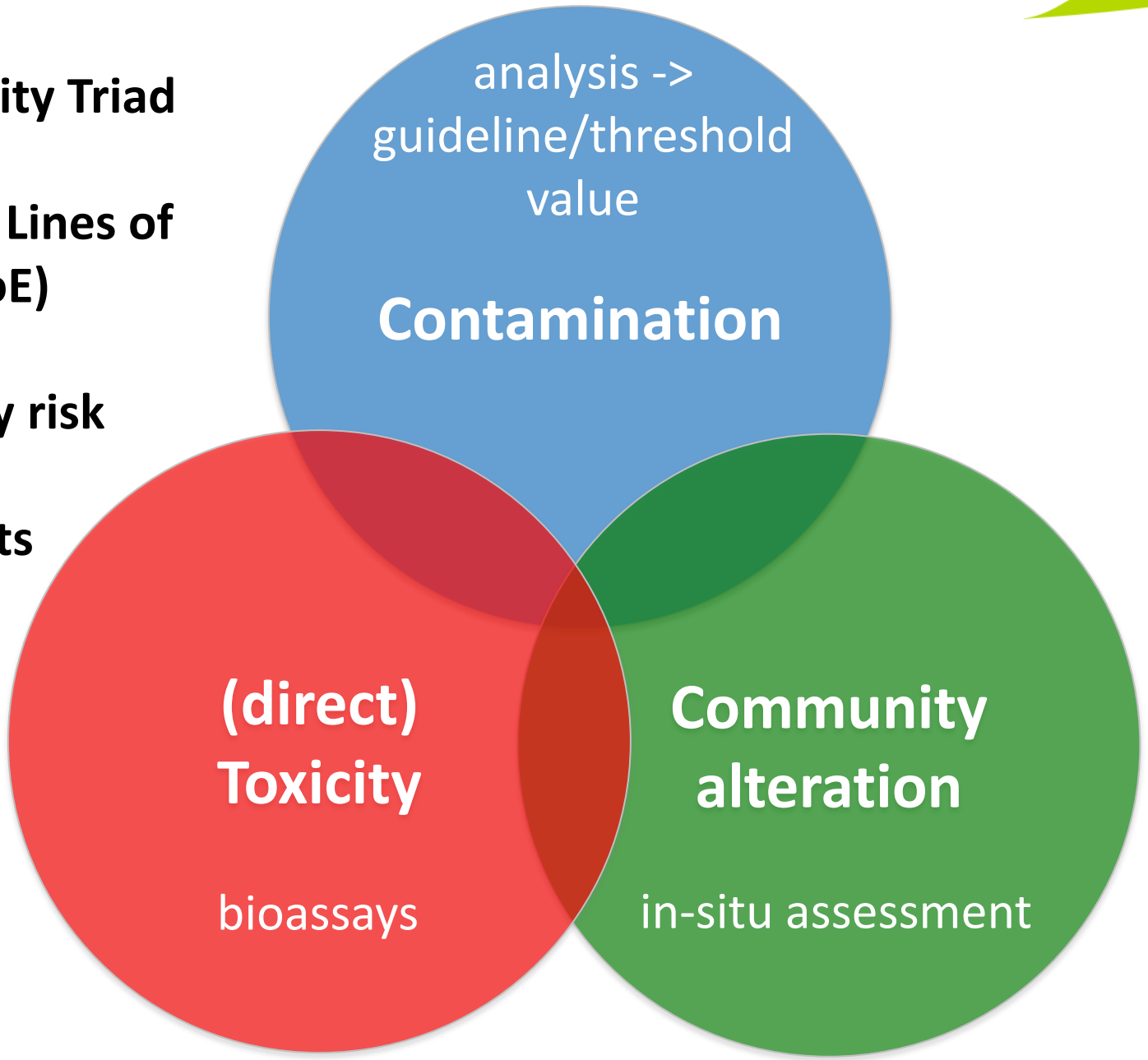
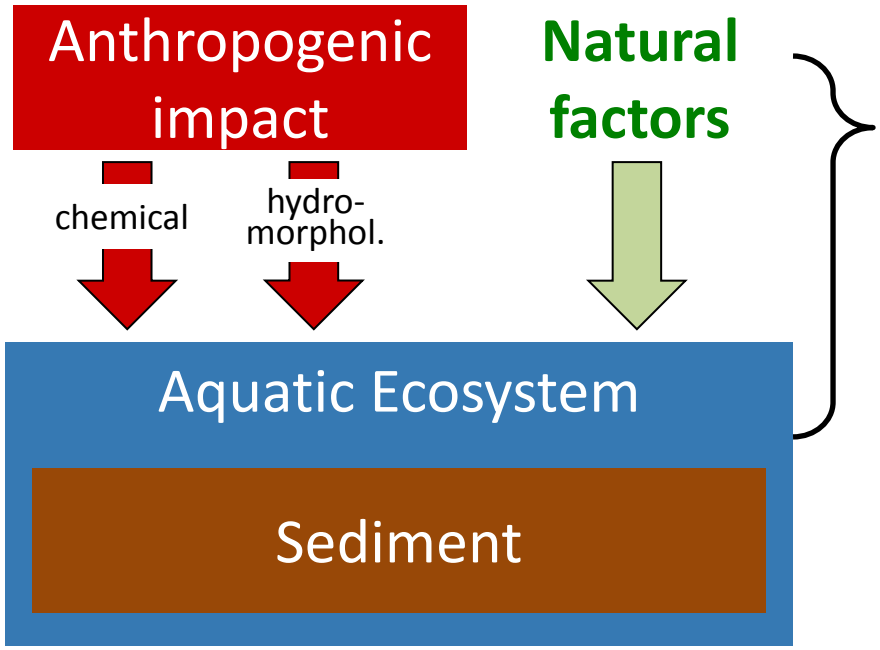
Sediment Quality Triad

- **three major Lines of Evidence (LoE)**
- **... to identify risk posed by contaminants**



Sediment quality assessment / risk assessment

- polluted sediments conflict with achieving good chemical and good ecological status of waterbodies (e.g. EU WFD, river basin management plans)
- however, multiple impact by several stressors



Cause-Effect-Relationship

- reason for failing good status?
- choice of appropriate actions?

Specific indices might help

- to characterize quality status
- to prioritize sites / actions
- to distinguish between stressors

Stressor

Chemical contamination

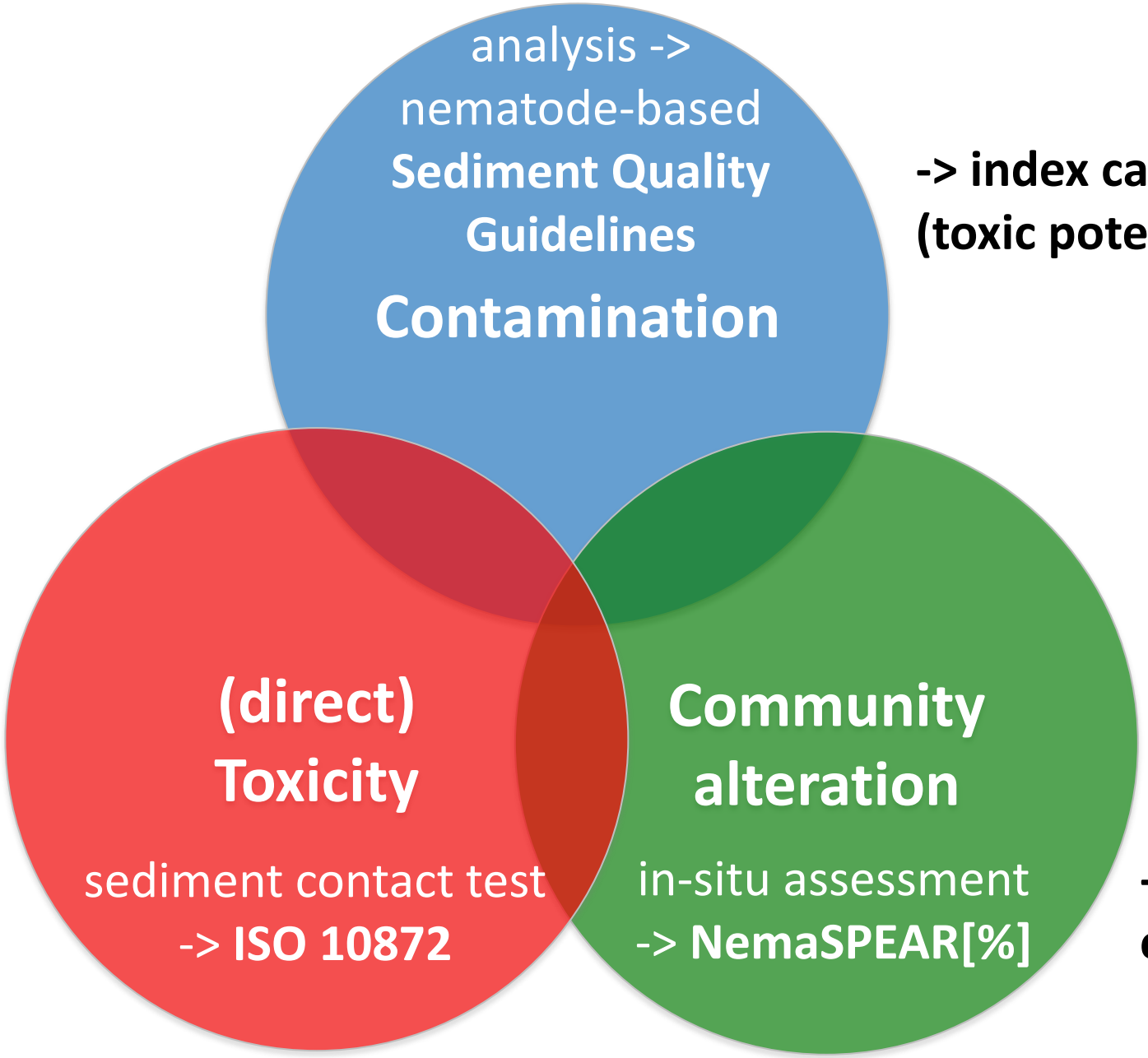
Subject of protection

Fine sediments

- hotspot for chemical contamination
- provide ecosystem functions, hence services
- specific fauna: more **meiobenthos** than macrobenthos

Meiobenthos

Assessment tools / indices based on meiofauna (nematodes)



-> index can be calculated (toxic potential of sediment)

-> pollution-sensitive ecological index

SQGs – effect-based guidelines for sediment/dredged material assessment

Threshold effect concentration (TEC):

„Concentration below which adverse effects on benthic invertebrates are unlikely to be observed “

Probable effect concentration (PEC):

„Concentration above which harmful effects on benthic invertebrates are very likely to be observed “

also:

- SQ benchmarks
- SQ criteria
- SQ standards -> e.g. Environmental Quality Standard (EQS)
  (CIS-EU TGD No. 27 suggests using TECs)

Derivation nematode-based SQGs

- **TECs and PECs for 44 substances and sum parameters**
  - As, Cd, Cu, Pb, Cr, Hg, Ni, Zn
  - 16 single-PAH, and sum of 5, 6, and 16
  - 7 single-PCB, and sum of 7
  - non-polar HC, 3x HCH, 3x DDX, HCB, TBT-cation

- **Screening level concentration approach** (SLCA; see Persaud et al., 1993 or de Deckere et al., 2011)
  - samples: broad range of contamination and of regions/ river basins from Germany
  - co-occurrence derivation: „matching chemistry and effects“
    - nematode community analysis (350 species identified)
    - chemical analysis including physico-chemical parameters (e.g. TOC)

Indices can be calculated based on SQGs

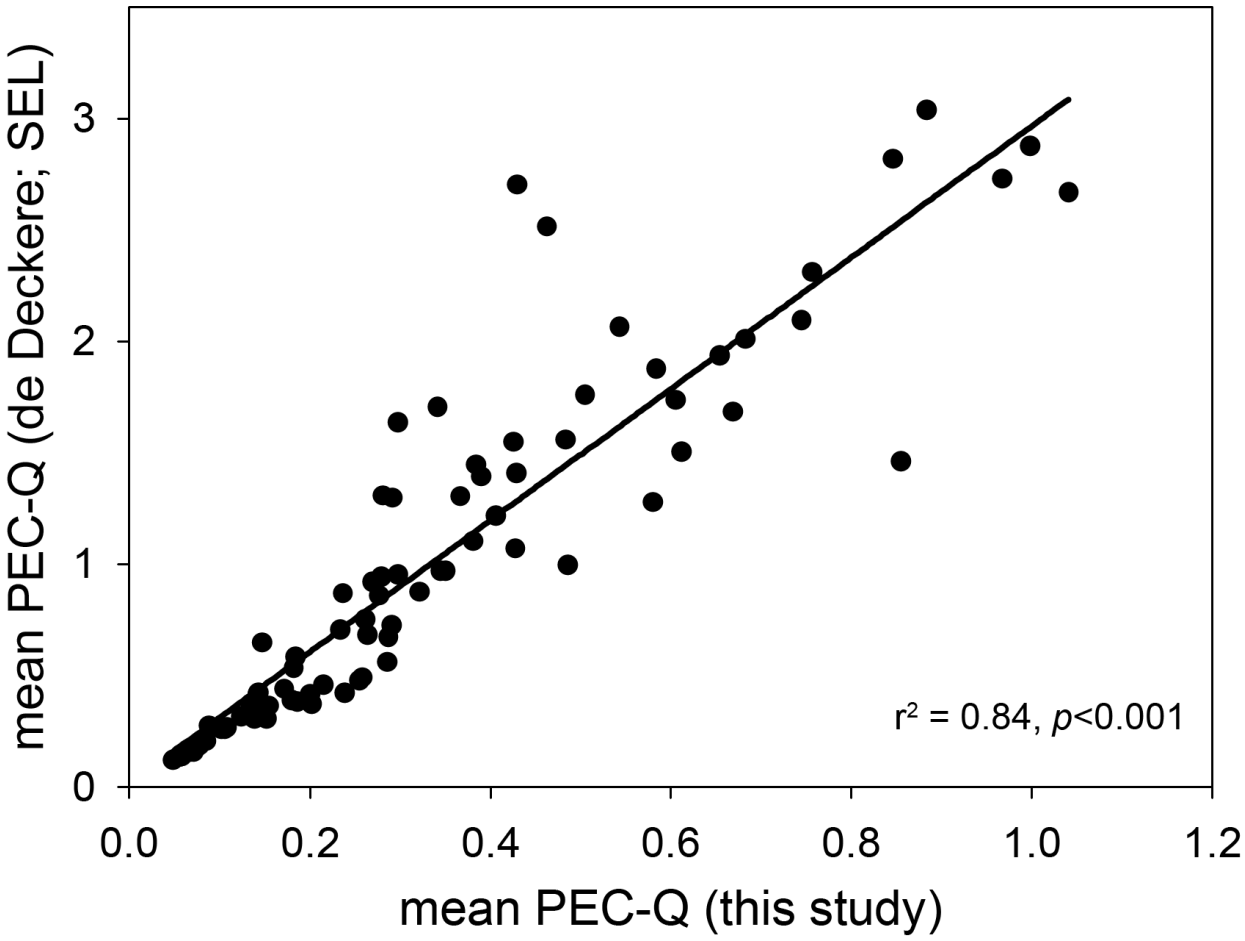
- for example:

$$\text{mean PEC-Q} = \text{mean}\left([A]/PEC_A; [B]/PEC_B; \ldots; [Z]/PEC_Z\right)$$

- consideration of contaminant mixture for classification and prioritization – not substance by substance – (toxic potential of sediment)

mean PEC-Qs: nematodes vs. macroinvertebrates

Calculation of **mean PEC-Quotient** for site assessment



- site assessments with both indices correlate
- However, differences of specific mean PEC-Q value in indicating the toxic potential likely

de Deckere et al. (2011), J Soils Sediments 11:504-517

Predictive ability

- Predictive ability of the mean PEC-Q?
- Probability that toxicity actually occurs at a specific mean PEC-Q?
- Ecological relevance of the mean PEC-Q?

➢ Instead of bioassays, using the NemaSPEAR[%]-index as a toxicity indicator

NemaSPEAR[%]: a pollution-sensitive ecological index

1. **Nema**tode **SPE**cies **A**t **R**isk –> nematode species were classified into two groups:

NemaSPEAR = „sensitive species“	NemaSPE$_{not}$AR = „tolerant species”
- missing in sediments with higher contamination -	- occur in all sediments irrespective of contamination -

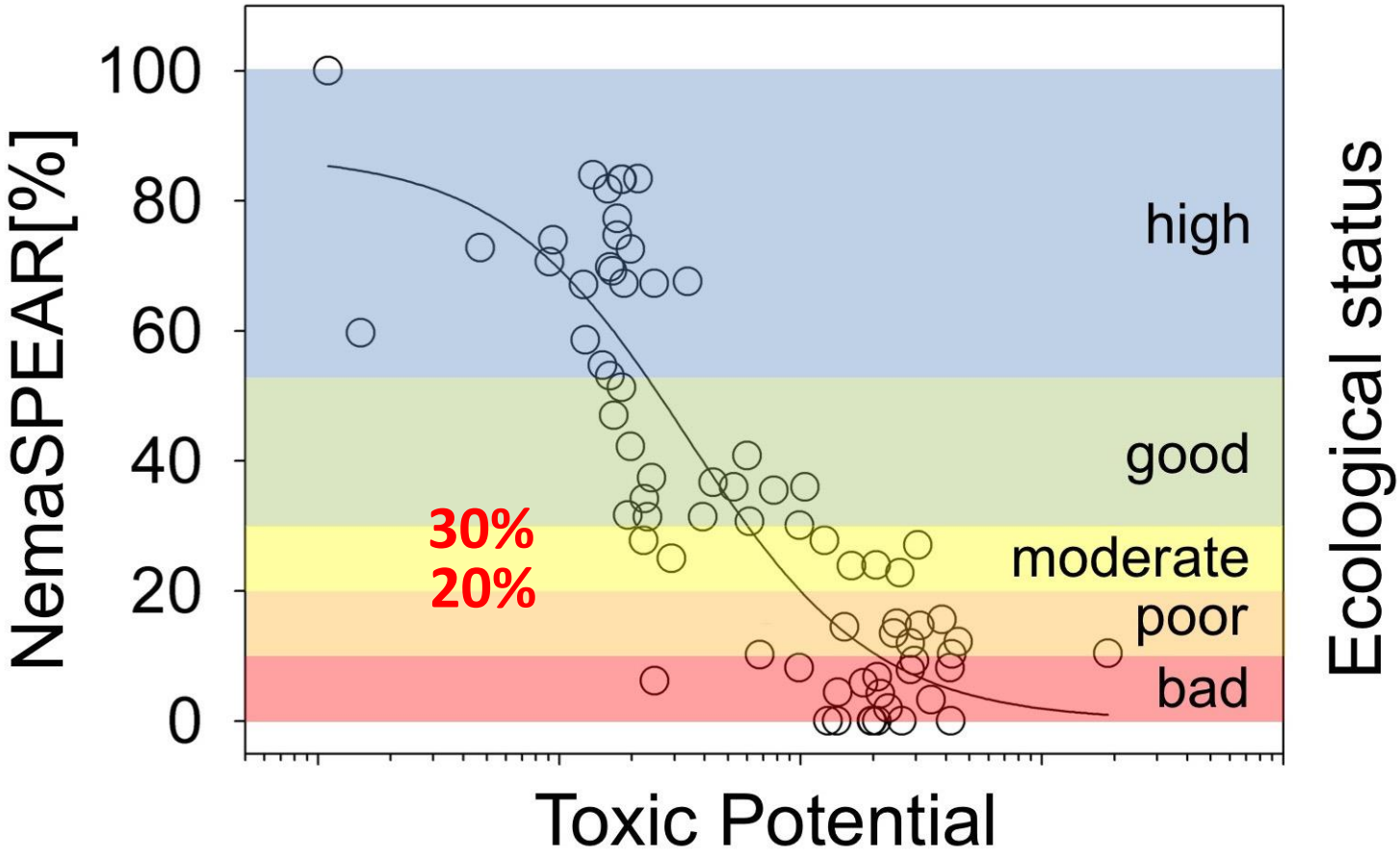
2. **Calculation of the index for sediment quality assessment:**

$$\text{NemaSPEAR[\%]} = 100 \times \frac{\Sigma \log [\text{NemaSPEAR}]_{relAb}}{\Sigma \log [\text{All Species}]_{relAb}}$$

⟶ **The index decreases if the proportion of pollution-sensitive species declines in a community**

- Höss et al. (2011): Environ. Int. 37, 940–949.
- Höss et al. (2017): Ecol. Indic. 73, 52–60.

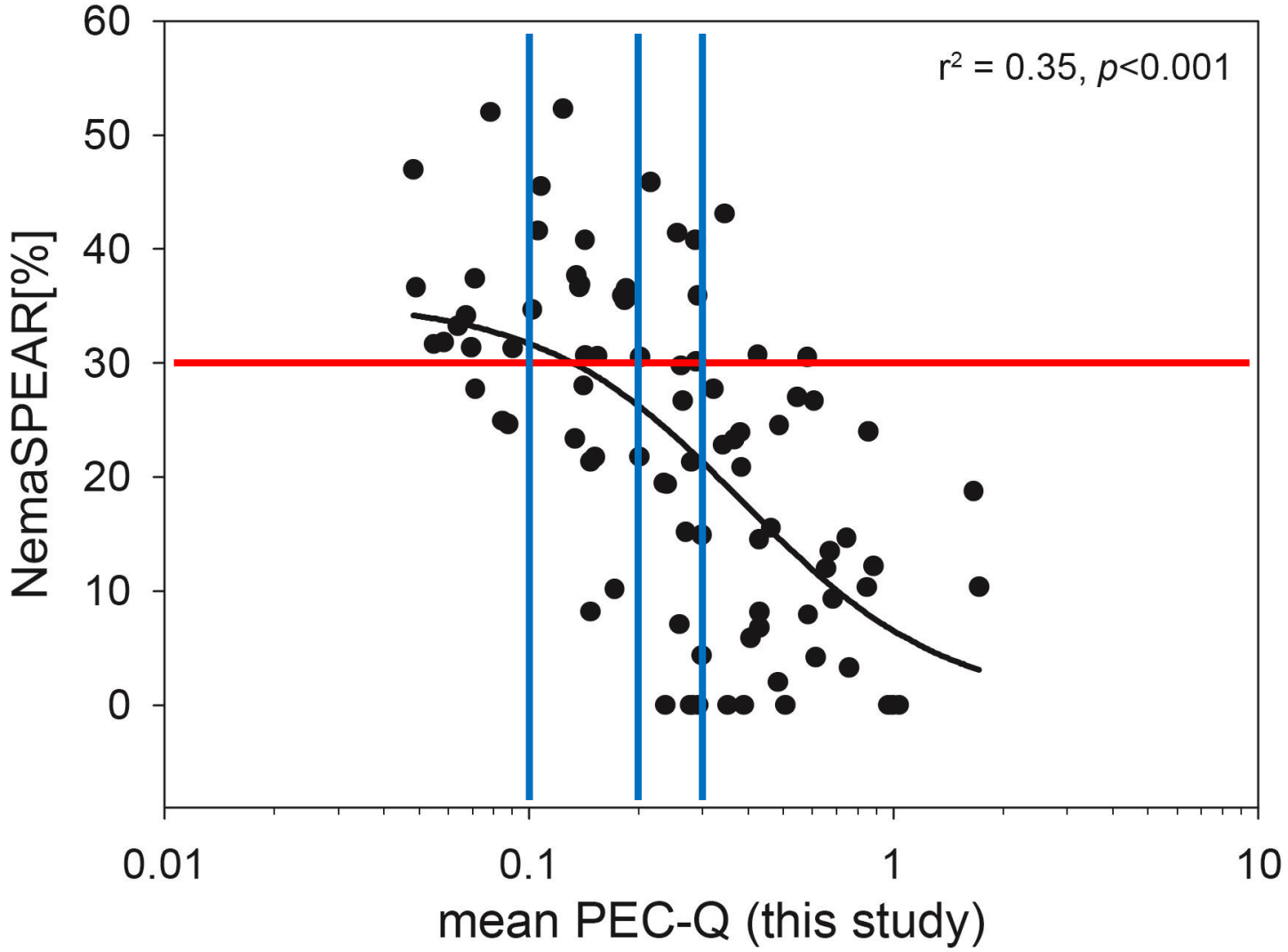
NemaSPEAR[%]: a pollution-sensitive ecological index



Index recently validated and updated: Höss et al. (2017): Ecol. Indic. 73, 52–60.

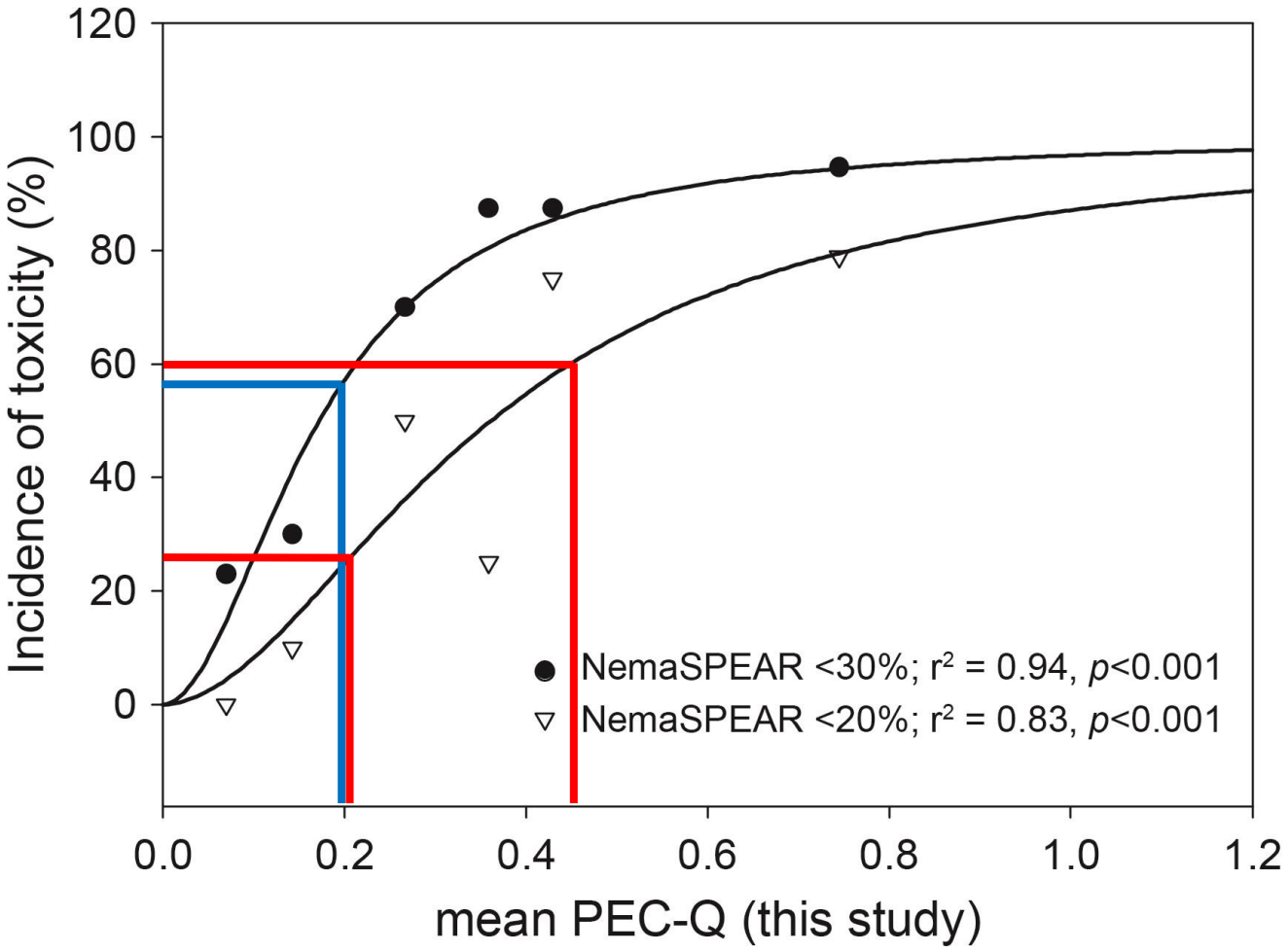
- Toxic Potential: mean PEC-Q based on SQGs from de Deckere et al. (2011): J. Soils Sediments 11, 504-517.

NemaSPEAR[%] vs. mean PEC-Quotient



Predictive ability

following MacDonald et al. (2000): Arch Environ Con Tox 39, 20-31



NemaSPEAR <30%:

- toxic effects likely
- likely „no good ecological status“ achieved

NemaSPEAR <20%:

- more severe toxic effects likely
- likely „no moderate ecological status“ achieved

Probability of toxicity!

Ecological relevance of SQGs?

- Using a pollution-sensitive ecological indicator to assess the predictive ability of Sediment Quality Guidelines (SQGs) for fine sediments underpins the ecotoxicological impact (toxic potential) and ecological relevance associated with the guidelines

- Pollution-sensitive ecological indices (e.g. NemaSPEAR[%]) and effect-based chemical indices (e.g. mean PEC-Q) help to identify potential impact of pollutants and thus also to distinguish between environmental stressors

Every test system, every index, ... will be producing false-negative and false-positive results!

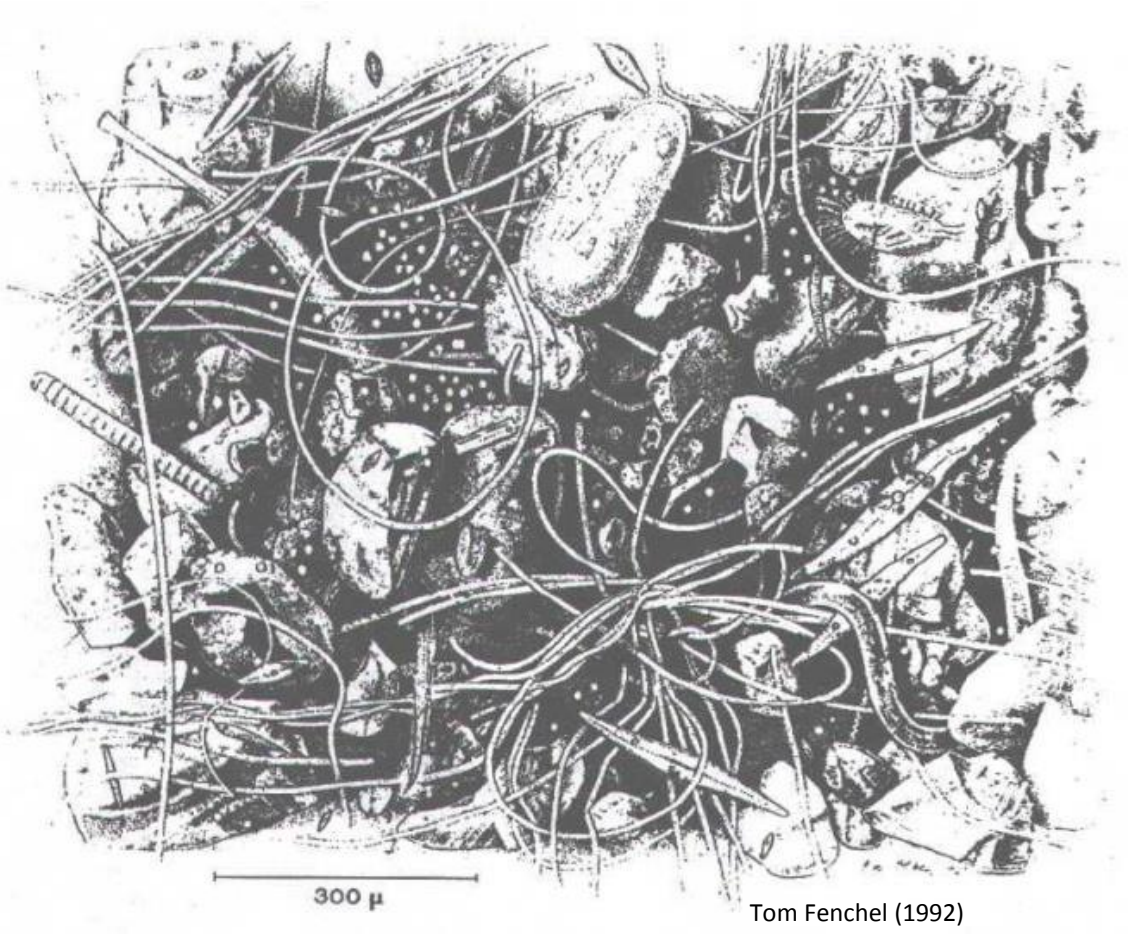
What are the reasons?

- other stressors (e.g. O_2-deficit, habitat structure) -> NemaSPEAR[%]
- increased or decreased bioavailability of contaminants -> mean PEC-Q

The aim should be to reduce uncertainty – can be done by

- improving the assessment tool
- using additional Lines of Evidence (Weight of Evidence)

Specifying the probability of toxicity that is associated with a sediment contamination instead of only determining the exceedance or not exceedance of fixed threshold values **likely will be a straightforward approach to deal with uncertainty and to communicate uncertainty**!



Tom Fenchel (1992)

Thank you for your attention!