Nematode-related criteria for sediment quality assessment

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Introduction: Sediment management needs cost-efficient tools for sediment quality assessment that help to prioritize management or further assessment options. Sediment quality guidelines (SQGs) are chemical (threshold) concentrations that can be used as predictors of the toxic potential of sediments or the probability of the incidence of toxicity. Moreover, their advantage is that they were effect-based derived and thus, the SQGs are directly related to biological effects. Once derived, they can be cost-efficiently applied as a screening tool or, if required, taken for a chemical line of evidence in a comprehensive weight-of-evidence framework.

Here, SQGs are presented that were derived based on chemical and nematode community analysis of freshwater sediment samples from several river basins across Germany (e.g., Elbe, Rhine, Danube). Nematodes were chosen because they are frequently the most abundant and diverse taxonomic group in sediments and they fulfill key positions in benthic food webs due to their various feeding types. In addition, as endobenthic organisms, they are subjected via various pathways to any noxious substances in sediments throughout their whole life-cycle. Moreover, nematodes are often more dominant than macroinvertebrates in fine sediments, which are of particular interest in terms of water quality due to their high potential to accumulate pollutants.

The aim of this study was to develop SQGs that also protect meiobenthic organisms, such as nematodes, which have been rather neglected so far despite their high ecological relevance. Moreover, this study wants to gather more information about how meiobenthic organisms, as exclusively endobenthic organisms, may complement existing sediment quality assessments with special respect to fine sediments.

Methods: SQGs (threshold effect concentrations, TECs and probable effect concentrations, PECs) were derived with two approaches based on co-occurrence of specific substances (e.g., metals, PAHs, PCBs) and biological effects (nematode community level) in environmental sediment samples. A first set of SQGs was derived according to Neff et al. [1] and de Deckere et al. [2] using the screening level concentration approach (SLCA). A second set of SQGs was calculated according to Field et al. [3,4] using a logistic regression modeling approach (LRMA). In the latter approach, we designated sediment samples as toxic for benthic organisms if a calculated NemaSPEAR[%] index [5] was below 30 for these samples.

Results and Discussion: TECs based on the SLCA were, for example, 0.6, 36, 26, 38, 0.19, 46, and 100 mg/kg dw for cadmium, copper, lead, chromium, mercury, nickel, and zinc, respectively. TECs derived by using the LRMA yielded similar values. For example, at an incidence of toxicity of 5%, TECs for cadmium and lead were designated to be 0.7 and 33 mg/kg dw, respectively. The results show that SQGs can be derived on the basis of nematode communities and that TECs are for a group of substances similar to existing ones based on macrobenthic organisms (e.g., [2]). However, calculated PECs were for several substances higher compared to existing ones, indicating a high tolerance range of nematode communities. Additionally, the results from the LRMA provide further evidence that the NemaSPEAR[%] index is a feasible indicator of sediment toxicity.

Conclusion: On the one hand, this study demonstrates that the protection of ecologically important meiobenthic organisms is at least to some extent already covered by existing SQGs, but that vice versa nematode-based SQGs (particularly TECs) might also protect sediment-dwelling macroinvertebrates. On the other hand, this study underlines the value and applicability of nematode-related criteria for sediment quality assessment in general.

References: [1] Neff et al. (1986) *Report prepared for US EPA*; [2] de Deckere et al. (2011) *J Soils Sediments* **11**:504-517; [3] Field et al. (1999) *Environ Toxicol Chem* **18**:1311-1322; [4] Field et al. (2002) *Environ Toxicol Chem* **21**:1993-2005; [5] Höss et al. (2011) *Environ Int* **37**:940-949.