Using a pollution-sensitive biotic indicator to assess the predictive ability of Sediment Quality Guidelines (SQGs) for fine sediments

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Introduction: Fine sediments are often associated with pollution because they are a major binding phase for many substances inside waterbodies. The appropriate management of polluted fine sediments, whether concerning, for example, dredging activities or river management plans, is hence an important issue. Therefore, tools for classification of fine sediments according to their toxic potential are needed for prioritization of further assessment or management options. Many studies have derived Sediment Quality Guidelines (SQGs) and/or calculated indices using SQGs, such as mean PEC-Quotients, to indicate the toxic potential of sediment samples based on measured chemical concentrations [e.g. 1, 2, 3]. However, it is important to assess the predictive ability of SQGs and their respective indices. This has been usually done by using bioassays, such as the *Hyalella azteca* toxicity test, to compare the prediction of toxicity for a sediment sample to the toxicity as indicated by a bioassay for the same sample [e.g. 1, 2]. In the present study, SQGs were developed that are based on endobenthic organisms living between fine sediment particles throughout their whole life cycle (Nematoda). Moreover, instead of using bioassays, the predictive ability of these SQGs was assessed by using the NemaSPEAR[%]-index [4, 5], which indicates pollution-induced nematode community alteration.

Methods: Based on concurrent chemical and nematode community analysis of freshwater sediment samples from several river basins across Germany (e.g., Elbe, Rhine, Danube), Threshold Effect Concentrations (TECs) and Probable Effect Concentrations (PECs) were derived for 40 single substances and 4 sum parameters according to the Screening Level Concentration Approach (SLCA; [2, 6]). Then, the mean PEC-Quotient (mean PEC-Q; e.g. [1]) and the NemaSPEAR[%]-index [5] were calculated for each sample of an independent data set. Subsequently, assessment of the predictive ability of the mean PEC-Qs was done by calculating the percentage of samples with a NemaSPEAR[%] below 30% and 20%, respectively, within specific ranges of mean PEC-Qs. A NemaSPEAR[%] <30% indicates chemical stress to nematode communities and that thus no good ecological status is achieved; an index <20% indicates that the sample even fails to achieve a moderate ecological status due to more severe pollution [5].

Results and Discussion: The results showed a decrease of the NemaSPEAR[%]-index, i.e. a loss of pollution-sensitive species, with increasing mean PEC-Q. Long et al. [3] defined four ranges of chemical exposure relating to mean Quotients: Minimum (<0.1), Low (0.1–<0.3), Moderate (0.3–<0.5), and Maximum (0.5). Within these ranges, the predictive ability of the mean PEC-Q to indicate failure of achieving a good ecological status was 23, 50, 88 and 95%, respectively, and to indicate failure of achieving a moderate ecological status was 0, 30, 50 and 79%, respectively. These results confirm the applicability of the nematode-based mean PEC-Q as an index for the toxic potential of a fine sediment sample and show that the chemical exposure ranges of Long et al. [3] can be used for classification of samples. Plotting the predictive ability of several mean PEC-Q classes against the median of the mean PEC-Qs of each class and fitting a regression (see [1]), would allow to deduce the probability of toxicity for any mean PEC-Q. Specifying the probability of toxicity for a sample, including the probability of toxicity of different magnitudes (here based on different NemaSPEAR[%] threshold values), likely yields valuable information for risk managers and regulators.

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