Sediment quality assessment at small streams affected by different types of anthropogenic pressures

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Introduction: Under the Water Framework Directive, a tiered approach is recommended for sediment quality assessment [1]. A first tier consists of chemical analyses and the evaluation against sediment quality standards (EQS). EQS are recommended as a screening tool, triggering additional investigations to refine potential risks or verify the possibility of observing poor ecological quality at the sites. The use of bioassays for sediment quality assessment have been already tested within different national and EU projects [2,3]. A pilot project was carried out to test a battery of bioassays at small streams affected by different levels and types of contamination.

Methods: Thirteen sites were studied; five sites influenced by agricultural activities, four sites subject to mixed sources of pollution (agricultural and urban), and four sites with less anthropogenic influence. The tested battery included three standardized bioassays: the crustacean ostracod *Heterocypris incongruens*, the nematode *Caenorhabditis elegans*, and the insect *Chironomus riparius*. The sediment samples were analyzed for traditional sediment properties, metals and major elements, and organic contaminants (PAHs, PCBs and pesticides among others). The ecotoxicological quality of sediments was assessed by means of existing toxicity thresholds. Measured concentrations were compared with EQS derived according to the WFD Technical Guidance [1].

Results and discussion: Sediments from less impacted sites were less toxic than those from agricultural or mixed watersheds and chemical analyses also showed less chemical contamination. However, three out of four sites cause medium sublethal effects in ostracods together with slight exceedances of the EQS for some metals, PCBs and pesticides. Three out of five sites from agricultural watersheds showed unsatisfactory ecotoxicological quality with severe effects in the ostracod and medium effects in the chironomid tests. At these sites, several pesticides exceeded the EQS, sometimes by more than a factor 10. Traditional sediment contaminants (metals, PAHs and PCBs) only showed slight exceedances of the EQS at few agricultural sites. Sites affected by mixed pollution sources showed the highest risk according to chemical analyses for all substance types. Medium or severe effects in the ostracod and chironomid tests were also shown, with two sites of medium ecotoxicological quality and two of unsatisfactory ecotoxicological quality. Despite of statistically significant effects in the nematode test compared to the controls at several sites, none of the sites exceeded existing toxicity thresholds.

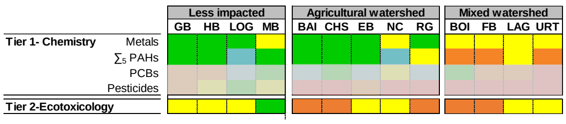

Fig. 1: Summary of risk assessment based on chemical analyses and bioassays. Colours are shaded when EQS are preliminary. Colour code attributed for a given substance type is the worst class among the individual substances except for PAHs (cumulated risk).

Conclusions: The ostracod test was the most sensitive among the bioassays, indicating good potential as screening tool. The high number of exceedances of the toxicity threshold for the endpoint growth should be considered with caution because the sensitivity of this species to specific contaminants remains unexplored. Moreover, sediment properties could be confounding factors in the interpretation of the results. The chironomid test showed complementary results to the ostracod test, supporting the use of both bioassays within a test battery. The toxicity thresholds should be further validated at less impacted sites to minimize the number of false positives in the ostracod test and false negatives in the nematode test.

References: [1] European Commission (2018). European Technical Guidance document (TGD) for Deriving Environmental Quality Standards. [2] Feiler et al. (2013) Environ.Toxicol. Chem. 32,144-155. [3] Tuikka et al. (2011). Ecotoxicol. Environ. Saf. 74,123-131.