Comparing conventional and integrated sediment-quality assessment of three North Sea region waterways

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Introduction: Proper and realistic assessment of sediment quality is essential in areas where dredging operations are executed (1,2). The challenge is to reduce uncertainties in environmental management and the economic costs of dredged material (DM) management, while maintaining environmental safety. Traditionally, only chemical analyses were used in regulations for sediment-quality assessment (SQA), but many specialists recommend integrating data from different lines of evidence (LOE), such as toxicity tests and benthic community structure surveys (1,3-5). To investigate whether integrative approaches improve SQA with regard to the above mentioned challenges, conventional and integrated SQA approaches were applied to sediments from three North Sea region waterways.

Methods/Results: In the project "Sullied Sediments" (Interreg NSR, http://northsearegion.eu/sullied-sediments), six sampling campaigns at three sites each at rivers in Belgium (Scheldt), Germany (Elbe) and the United Kingdom (Humber) were conducted between 2017 and 2019. Samples were analysed in three lines of evidence (LOEs): Sediment chemistry (127 metals and organic contaminants), sediment toxicity (9 biotests covering different trophic levels, end points and exposure phases) and benthic community structure (bacterial, meio- and macrofaunal abundance, diversity and dominance).
Subsequently, this data was applied in conventional and integrated SQA schemes. This was carried out in three parts, each addressing particular aspects of interest in detail.

1. Assessment based solely on chemical analyses
Chemical-based SQA according to two European regulations, the Dutch Soil Quality Decree based on chemical threshold values derived from background concentrations and the Flemish framework VLAREM applying environmental quality standards based on the deviation of measured concentrations from a reference sediment, was carried out.
The contaminant profiles of the sampling sites were described and compared to each other. The contaminant sets monitored in this project and those in the above regulations were critically compared.

2. Ecotoxicological assessment of samples
First, results of the biotests were evaluated to identify the optimal combination of biotests for this data set. Considered aspects were efficiency (most time-, effort- and cost-wise battery), non-redundancy and flexibility (which combinations of biotests deliver the same results for the SQA and could be removed from the battery or exchanged between laboratories?).
Then, ecotoxicological sediment classifications according to the pT-value method (6) and based on effect classes (7) were compared.
In addition, the suitability of the toxic unit (TU) approach (8,9) to predict ecotoxicity was tested. For each sample, a sum TU based on the quotient of measured contaminant concentrations and database-derived effect concentrations (EC_{50}) of the crustacean *D. magna* and green algae were calculated. The outcome was compared to the biotests results of the sampled sediments.

3. Integrative assessment using all three LOEs
An integrated assessment following the Flemish TRIAD approach (10) was applied to the data set. The obtained sediment quality classes were compared to integrating only two LOEs, sediment chemistry and toxicity, as in the Italian regulation M.D. 173/2016 for DM from brackish and marine waters.

Discussion: The sediment classifications and resulting handling requirements for DM obtained by applying the different assessment schemes were compared and critically discussed. The aim is to develop a SQA that avoids overprotective measures in DM assessment while maintaining environmental safety.

References [1] Choueri et al. (2009) *Ecotoxicol Environ Saf* **72**:1824-1831; [2] de Castro-Català et al. (2016) *Sci Total Environ* **540**:297-306; [3] Chapman (2007) Environ Int **33**:492-501; [4] Hollert et al. (2005) Ecotoxicology 11:311-21; [5] den Besten et al. (2003) *J Soils Sediments* **3**:144 1462; [6] Krebs et al. (2000), *Small-scale Freshwater Toxicity Investigations* **2**:281-304; [7] Ahlf and Heise (2005) *J Soils & Sediments* 5 (1) 16 – 20 [8] Sprague (1970) *Water Res* **4**:3-32; [9] Von der Ohe et al. (2009) Integr Environ Assess Manage **5**:50-61; [10] Flemish Environment Agency (2000).