Tiers, Triads and Priority Lists: Are We Protecting What We Value?

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Introduction: The objectives of many countries' sediment assessment programs, and of related national and international legislation, are to protect and preserve aquatic environments from sources of pollution and to take effective measures, according to scientific, technical, and economic capabilities, to prevent, reduce, and where practicable eliminate the impacts of contaminated sediments on ecosystems and their services. The development of sediment assessment frameworks can involve almost endless possible permutations of chemical and biological measures and decision rules. Both individual choices about these parameters, and how they are combined can affect outcomes and the efficacy and fitness for purpose of a framework. Frameworks tend to either be tiered (i.e., starting with simple, conservative measures to assess risk, followed by more detailed assessment if there is a need to reduce uncertainty) or simultaneously consider multiple lines of evidence (e.g., triads); but in most cases, short lists of priority pollutants, and limited bioassays are used.

Methods: Although the literature is rich with documents on how such approaches should be designed, there are few datasets that are extensive, diverse and representative enough to evaluate how various decision scenarios actually perform when evaluating a broad range of sediment types. A database was developed containing co-located sediment chemical and toxicological analytical results that were representative of the range of marine, coastal and estuarine sediment types, and contaminant combinations and levels that might be encountered by a program. After validation and processing, the final database containing 2196 records (for chemistry) and 1081 (for co-located chemistry and toxicity) was designed to enable each record to be "challenged" by a range of decision scenarios, and the results to be analysed; the relative effectiveness and fitness for purpose of these scenarios was evaluated.

Results and discussion: Although there are a potentially infinite number of permutations and scenarios, a systematic approach was used to test the potential implications of some key questions, including [1,2]:

- How effectively does a short chemical action list predict the presence (or absence) of other chemicals? Is this effective in a tiered approach?
- What is the relative importance of chemical action levels (SQGs) vs action lists (type and number of analytes)?
- How effectively do various chemical action lists predict toxicity?
- What is the effect of different chemical decision rules (e.g., one out, all out; hazard quotients, etc.)
- Are tiered approaches effective, ecologically or economically?
- What is the effect of a screening bioassay?
- Are confounding factors affecting toxicity assessment?
- Are upper action levels effective in identifying acutely toxic sediments?
- How do a range of international approaches compare? What does this tell us about trade-offs?

With ever increasing pressure to do more with less, there is a need to balance protectiveness with cost-effectiveness in any assessment framework, but growing concern about emerging contaminants, increasing intentional releases of proprietary chemical mixtures and extensive demands on land- and water-scapes, an understanding of the costs, risks and benefits of various assessment frameworks is essential.

With an emphasis on dredged material management frameworks, key findings of these studies will be summarized, and the economic and ecological implications of various frameworks and approaches will be discussed.

References: [1] Apitz and Agius (2013) *Mar Poll Bull* **69**:76-90; [2] Apitz and Agius (submitted to *Mar Poll Bull*).