Future of Sediment Management in Europe: The Perspective From Industry

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- **NICOLE** is a network of “traditional” problem holders who:
  - wish to protect human health and the environment
  - target limited funds at significant issues
  - aim to make a difference

- PS is an hydrogeologist with Shell Global Solutions
- Working in contaminated soil and groundwater

Format of Industrial Perspective

- Current practices in Europe – measuring harm
- Uses and application
- Drawing parallels from land based management of contamination

This lead to a number of questions ……………….

  - What is the end point?
  - Achievable and/or desirable?

- Conclusions

Current Practice in Europe

Soil Quality Guidelines (SQG) in most countries, but basis for deriving SQGs varies from:

- Arbitrary (not based on risk)
- Toxicity incidence among large (field) datasets
- Laboratory toxicity and equilibrium partitioning model

SQGs limited for following reasons:

- Only address a small proportion of potential COCs
- Don’t address synergistic or antagonistic chemical interactions
- Don’t address actual characteristics of receptor populations
- Have no relevance for other environments (e.g., aquatic SQGs for upland disposal sites)

Current Practice in Europe (cont'd)

In limited number of countries, biological effects used in decision-making frameworks, however:

- Even biological effects often can't pinpoint source of toxicity due to confounding factors such as grain size, ammonia, pH, chlorine, other trace contaminants with synergistic effects, etc…

Some countries TRIAD approach applied:

- Considers various lines of evidence to assess whether the sediment poses unacceptable risk:
  1. Ecological effects/bioaccumulation from field studies
  2. Adverse effects/bioaccumulation from bioassays
  3. Chemical concentrations

Applications using Current Practice

- Current approaches in Europe are used primarily to determine how to manage sediments dredged for navigational purposes
- Generally not intended to trace a toxic effect back to a specific source(s) as this is very difficult and costly

However, sources need to be controlled to prevent re-contamination of sediments

- Improved industrial practices
- New legislation e.g. IPPC, reduced discharges

Measureable improvements BUT not there yet !

Remediation Goals

- Range of remedial options should be carefully evaluated and should have a specific goal(s) in mind
- Goals need to be clearly identified, and remediation targets need to have a clear link with achievement of these goals, for example:
  - Goal: to reduce PCB levels so fish can be eaten
  - Target: remove PCBs in sediments to a level that will allow levels in fish to recover to <2mg/kg

Goal should NOT simply be 'mass removal'

Remediation Targets

Setting targets is a complex task:

- Often no direct human risk pathway
- More often, the only identifiable target and intended benefit is to reduce contamination levels in fish to below levels safe for human consumption (May not be needed check fish eaten in the area)
- Inter-relationship between contamination levels in fish and those in sediment and water is complex and difficult to define (via worms etc)

Despite the complexities, remediation targets must be consistent with reducing the identified risks, otherwise:

- Remediation likely to be ineffective and costly
- Could do more harm than good

Conceptual Site Model (CSM)

CSM critical for developing targets that are related to actual risk reduction

Need to characterise key dynamics of the sediment site:

- Sources and sinks
- Contaminant fate and transport
- Exposure pathways and receptors

CSM should consider bioavailability:

- Contaminants not within the bioavailable zone not a source of risk
- Contaminants within the bioavailable zone but not biologically available also not a source of risk

CSM should also consider bed stability and the potential impact of rare (storm) events

Evaluation of Remediation Options

Hierarchical approach should progress from:

- Source control
- Natural recovery
- Engineered burial (capping)
- Removal/disposal methods

Chosen method should fulfil the following criteria:

1. Not result in more harm than good (particularly removal methods)
2. Withstand scrutiny from a cost-benefit standpoint
3. Achieve identified goals

Remediation Options

Source control

- The obvious first step since any remediation effort will be pointless if sediments become re-contaminated

Natural recovery

- Involves leaving contaminated sediments in place and allowing ongoing aquatic processes to contain, destroy or reduce bioavailability
- Viable if contaminants are being buried under cleaner sediments

Remediation Options (cont'd)

Engineered Capping

- Where there is not a net deposition of clean over contaminated sediments
- Accurate placement of clean, isolating material cover over contaminated sediments without relocating or causing major disruption to the original bed

Removal/Disposal Methods

- May be appropriate where other methods are not
- Removes high percentage of contaminant mass
- However, may produce little observable long-term benefit or risk reduction
- May result in more harm that benefit

Remediation Options (cont'd)

Removal/Disposal Methods (cont'd)

- Removal of sediments is logistically difficult and ecologically destructive
- May bring deeper, more contaminated sediments to surface making them again bioavailable
- Water environment mobilises and transports re-suspended contaminated sediments away from target area during removal
- Requires extensive land-based area for managing dredged materials
- Requires siting, land acquisition, permitting and construction of disposal facilities

Conclusions

- An approach that considers multiple lines of evidence (eg, TRIAD) to assess sediment toxicity is most appropriate for evaluating sediment management options
- Difficult to identify specific sources that give rise to sediment toxicity,
    - maintain emphasis on source control, and
    - appropriate discharge consents
- Sediments that don’t need to be dredged, but require remediation to reduce risk levels should have remediation targets based on clearly defined goals

Conclusions (cont'd)

- Remediation targets should be based on a CSM that considers:
  - relevant receptors
  - exposure pathways, and
  - contaminant bioavailability
- Historic contamination managed within risk framework
- On-going sources reduced/controlled
- Non-intrusive remedial methods (natural recovery and engineered capping) should be given preference over removal/disposal methods, which can cause more harm than good