CURRENT STATUS, GAPS AND NEEDS IN SUSTAINABLE TREATMENT AND MANAGEMENT OF METAL CONTAMINATED SEDIMENTS

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Introduction

Contaminated sediment site management requires lowering chemical risks to ecological receptors and human health via the removal, elimination, or reduction of contaminant release and uptake (USEPA, 2005). Currently the most commonly used methods to remediate metal contaminated sediments are environmental dredging (85%), followed by monitored natural recovery (6%) and capping (6%). Combinations of technologies are often emphasized for the management of contaminated sediments. Logical progression should start with dredging of hot spots and source control. After source control, the most appropriate action is often monitored natural recovery (MNR). If more than MNR is required, additional engineering such as active capping can be incrementally added (Figure 1 A). Future sustainable management of contaminated sediments should include a broader application of passive samplers to assess the bioavailable pool of metals and new approaches to amended caps and in situ treatment.

Sustainable Remediation of Contaminated Sediments

Consideration of the state-of-the-art suggests that there is a need for new remediation technologies or modification of existing ones; e.g., capping technologies that can sequester sediment contaminants and create a reliable, stable, and long-lasting cap in a range of aquatic environments. Also, the application of in-situ remediation methods such as reactive amendment mats, mixing of amendments in the sediment, and mixing or layering of amendments within sand caps should be emphasized when selecting remedial technologies for contaminated sediments. Further, more field evaluations of these in-situ methods are needed. However, a challenge to all remedial approaches is the continued influx of contaminants from uncontrolled sources following remediation. This can produce a polluted habitat zone that overlies the remediated sediments, thereby negating the benefits accrued by the remedial action. Ultimately, these re-contaminated sediments may once again become a contaminant source. The severity of the problem posed by the influx of contaminants on remediated sediments may be affected by the type of remediation that has been undertaken. Influxes of contaminants on sediments remediated by environmental dredging or by passive capping with inert materials can be expected to degrade the remediated sediments at a rate proportional to the rate of contaminant influx. Remedial effectiveness will be largely negated when sediments become re-contaminated to a depth that encompasses the habitat zone for most benthic organisms. In contrast, the environmental impacts of contaminants that are deposited over sediments remediated with chemically active sequestering agents may be reduced by these agents (Figure 1B).

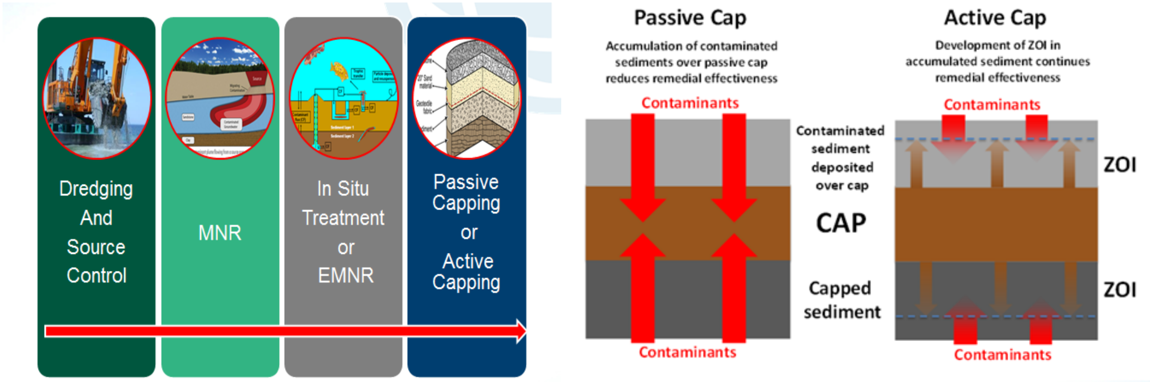
A B


Figure 1. A - Remediation technologies for contaminated sediments (Bridges et al., 2012); MNR- monitored natural recovery (MRN), EMNR – enhanced MNR. B - Recontamination of remediated sediment; ZOI – zone of influence.

Management of Contaminated Sediments and Bioavailability

Bioavailability controls the transfer of metals from sediments to ecological receptors and humans. It can rarely be predicted from total metal concentrations because it is affected by metal geochemistry in sediments as well as the biochemistry, physiology, and behavior of benthic organisms. There is no single approach for including bioavailability in risk assessments because of variability in site specific conditions and the difficulty of validating methods. Successful evaluation of bioavailability will result from the selection of analytical methods that are suitable for the organisms and sediment environments under consideration. A weight-of-evidence approach can maximize the likelihood of incorporating bioavailability measurements into remedial decisions by helping to overcome skepticism by the regulatory community and public. Such an approach will incorporate multiple lines of evidence to address the technical uncertainty associated with individual methods.

Conclusion

Although problems remain, contaminated sediment management is improving due to the control and elimination of contaminant sources, development of new remedial technologies, and selection of analytical methods to evaluate metal bioavailability.

References

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