INTEGRATED APPROACHES TO SUSTAINABLE SEDIMENT MANAGEMENT - THE PARADOX OF HAVING IT ALL

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Abstract

The desired outcome of integrated sediment management approaches – *in a perfect sediment world* - is a solution that is protective of human and ecological health and includes source controls to prevent recontamination. The outcome should succeed in reducing liability and should be designed and constructed at the least cost being economically efficient to the public, government and business sectors. Additionally, technical and management solutions should be transferable to between environments such as estuaries, lakes, fjords, as well as to complex urban environments.

Decision-making and associated project timeframes in remediation/restoration usually center on political, social, and stakeholder acceptability. Furthermore, the concept of developing dredged material and remediation project designs/construction in a sustainable manner in synergy with long-term maintenance of the ecosystem components for future generations and to proceed to project construction within your lifetime, continues to be a challenge to having it all. With a well-designed Regional Sediment Management structure that balances physical, natural and human systems and encompasses a sustainability driver, perhaps then you can have it all.

Introduction

Sediments travelling through a watershed system can become compartmentalized by political, regulatory, regional and programmatic boundaries. A major impediment to a sustainable approach to the restoration of contaminated sediment impacted waterways, particularly in urban environments, is the fragmented, non-integrated nature of the various regulatory processes and agency programs which often overlap and have competing objectives. Remediation, economic development, port maintenance, source control and habitat restoration are typically assessed, planned and managed separately. The resulting challenges to balancing remediation and dredged material management programs can have economic repercussions to ports and municipalities. Globally, challenges are evidenced by changes in ocean/aquatic placement criteria, the difficulty of siting new structures such as confined disposal facilities, the difficulty of extinguishing long-term liability, the costs required for long-term monitoring associated with climate change adaptation and the great distances that sediments are often hauled for final placement which in one sense is a paradox to green remediation.

Ongoing contamination from legacy sediments, runoff from urban, industrial and legacy sites, point and non-point sources (including municipal storm water) can directly affect commerce, economic development and contribute to long-term corporate liabilities, degrading the overall vitality (environmental, social and economic) of the watershed. Restoring impacted waterways and water quality is critical for economic development in urban communities and can offer significant social benefits. However, because of the different individual agency missions, the regulatory environment in both the European Union (EU) and the United States, does not fully consider social, economic, and sustainability factors and instead, focuses exclusively on the environmental drivers without balancing perceived risk and sustainability. This is partially the result of the regulatory system not recognizing the link between sustainability and integrated sediment management. Since much of this work philosophically has focused on soil remediation within artificial, not natural, boundaries, it has been generally difficult to make that linkage because economics is usually the sole driver.

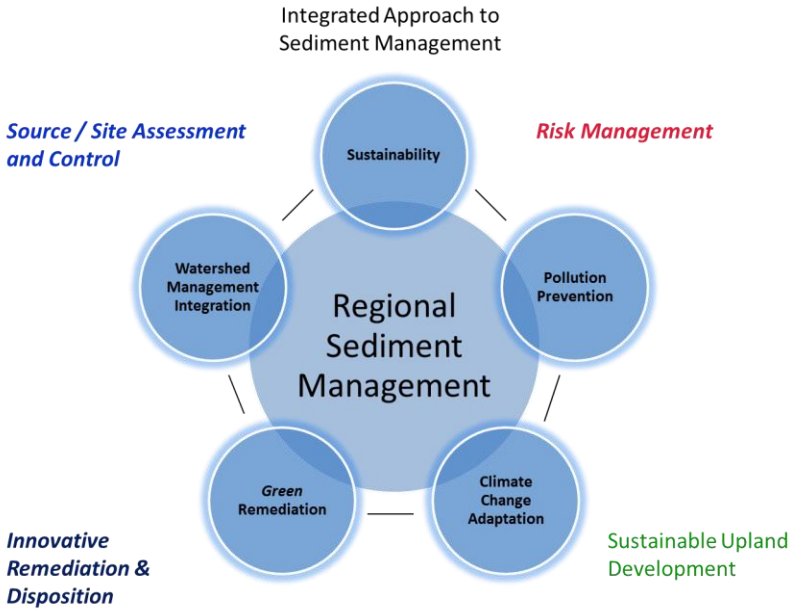

Figure 1: Conceptual Structure for Regional Sediment Management

Structuring Regional Sediment Management

Regional Sediment Management (RSM) requires the holistic assessment of the remediation site as an integrated system that accounts for social and economic factors when creating strategies for long-term sustainability. An example of a RSM planning approach focused on remediation is presented in Figure 1. The outer shell is comprised of the four major objectives of a remediation strategy, while inside the shell are five integrated foundation components that provide the sustainable platform critical in maintaining the overall long-term vitality of the watershed. Furthermore, the *Sustainable Upland Development* linkage takes into account upland sustainable design (*e.g.* green construction and water capture systems), and engineering for source control management, as well as the promotion of sediment beneficial use such as confined disposal facilities for port expansion or marketable products (e.g. manufactured soils, construction grade cement, light weight aggregate, and fill material) from innovative sediment treatment technologies. Controlling continuing contaminant sources is usually the most contentious challenge in moving forward with remediation, especially in complex, multi-contaminant urban environments. Effects of climate change and future land use development within the watershed also should be taken into account by planning and design functions formulating the long-term sustainable goals of the watershed system.

The general overlap of non-integrated regulatory sediment programs tends to complicate movement towards implementing sustainable solutions where remediation is necessary, especially in urban aquatic environments and communities where re-development and restoration becomes an economic driver. Much of this progress is related to the "*polluter pays",* or for that matter, "*who pays"* principle. Allocation of responsibility and restoration costs typically is a long-term negotiation involving legal, as

well as passionate stakeholder and environmental advocacy input. This translates to lost time, money and opportunity. Since timeframes to implementation can be on the order of a decade or more, the allocation process desensitizes the development of innovative integrated approaches and technology, thus innovative technology development firms move on or lose interest.

Many of the industries that produced legacy contaminants are no longer in business and/or produced and discharged contaminants before there were regulatory agencies, laws, enforcement or understanding of contaminant toxicity to human and ecological health. Additionally, many of these industries are well-regarded for having employed many in the directly affected community. With this in perspective, cost sharing strategies and other incentives should be considered to encourage participation by all stakeholders, especially when RSM is to be considered and long-term sustainability of the watershed system becomes a driver. To be successful, costs and benefits should be shared among the stakeholders; industry, government, municipalities, and foundations.

Programs such as the United States Environmental Protection Agency's Great Lakes Legacy Act and the Canadian Great Lakes Sustainability Fund are examples of such an approach. These programs balance the long-term community and industrial use of the *built* urban environment within an implementable regional/urban sediment management plan. Since the disposition of excavated sediments is a critical component to remediation and navigational dredged material management programs, the development of a centralized regional processing facility to integrate dredged material and remediation programs with beneficial use applications could be considered within an RSM approach.

Complex sediment remediation projects can be cost prohibitive and take decades to complete. Integrating hybrid solutions that cut across competing regulatory programs should be considered and be advanced within the framework of an RSM program. RSM management programs have been in development over the last several years. The EU Sediment Network Research (SedNet) continues to be a major influence in setting strategy for implementation of RSM globally. SedNet focused on sediment quality and quantity challenges on a river basin scale – from freshwater, estuarine to marine environments. RSM involves making individual project or program decisions within the context of the basin's physical, natural and human systems and forecasting the long-range implications of actions within an adaptive management framework. To achieve long-term, balanced and sustainable solutions all aspects of these systems need consideration, including the legacies of past actions and events. Effective RSM needs to engage the participation of stakeholders whose activities may have system-wide effects.

Case Study

Utilizing a case study in Norway for implementation of RSM, contamination of marine sediment has been found in more than 120 areas that have resulted in restrictions on the consumption of fish and fishery products in 24 fjords and harbors covering an area of 820 km^2. A national sediment policy has been put in place under the Norwegian Parliamentary Document – *Clean and Rich Oceans* which outlines, the Norwegian Government's list of priority sites which are part of a national initiative for national sea floor remediation.

In Norway, the nature of urban watersheds with adjacent port infrastructure, where ongoing sources such as stormwater and legacy contamination from military installations impact fjords and their fishery resources, perhaps justifies evolving the national environmental management policy to regional sediment management framework. To take into account urban systems, special consideration within an

urban sediment management environment is presented in Figure 2. In these situations, industrial/municipal discharges, legacy deposits of pollutants and urbanization may have far greater influence than upstream inputs. Solutions here are likely to depend on the integration of several remediation approaches and technologies (e.g. sediment capping, dredging, enhanced Monitored Natural Attenuation, stabilization, treatment technologies) while integrating sustainability – a somewhat difficult concept in remediation project design. To implement RSM as illustrated in Figure 2, national sediment strategies have broad policy elements pertaining to watershed approaches. RSM has components addressing sustainable sediment management within riverine, coastal and urban aquatic environments.

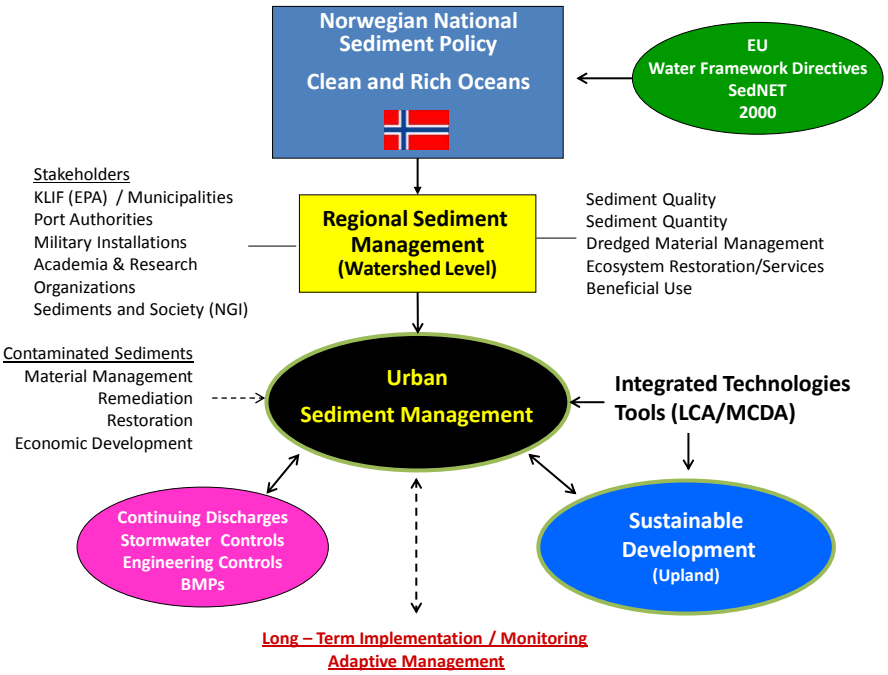

Figure 2: Conceptual Structure for RSM Planning Focused on Urban Sediment Management

Conclusion

While a National Strategy is important for acknowledging and creating ownership of sediment problems, a well-designed Regional Sediment Management structure that balances physical, natural and human systems provides the framework for implementation. Stakeholder engagement is one component of sediment management decision-making. In addition to knowledge of the physical and natural systems and their dynamics, other components concentrate on upland source control measures and sustainable urban development will reduce source loading. Such measures can include green and sustainable designs in storm water management, emissions control, wetland filtration systems, green roofs, and so forth coupled with Best Management Practices (BMPs). Beneficial use and the capacity for creating marketable products from sediment are also important components. Integrated technology decision making can be facilitated by applying sustainability metric tools such as Life Cycle and Multi-Criteria Decision Analysis.

Multi-agency/regulatory programs, along with industry users and other stakeholders that have an environmental, economic, political and social bearing should not be operating independently based on their individual missions. A catalyst is required that integrates RSM holistically in an adaptive

management framework that can implement the program with cost-share. Most of the time the pieces are there, but the eco-psychology of putting it together to enact a real behavioral change or shift in sediment management thinking lags behind or relies on past practices without innovation (i.e., *if it's not broken don't fix it*). Thus perhaps by implementing an RSM strategy you may begin to move in a direction of having it all.