Sustainable Sediment Management and Implications of Climate Change

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Introduction: Sediment serves as a critical resource for beach and shoreline protection and provides nutrients and material for creating and sustaining wetland and coastal habitat. Annually, approximately one billion cubic meters of sediment is removed from waterways throughout the world to support navigation, commerce, environmental clean-up, habitat restoration, flood control, and other purposes at a cost between $15 to 30 billion US. In the Europe, the challenges are particularly difficult because of challenges posed by urban and port development in coastal and major river areas, as well as differences in environmental regulations among countries.

With rising sea level and increasing frequency and intensity of storm events, rivers and coastlines continue to naturally realign and alter sediment budgets. These changes impact long-term costs of maintenance dredging and shoreline preservation. Similar concerns apply to the restoration of habitat and construction of new ecological habitat for mitigation or offsets of coastal infrastructure projects. The ecological goals for such work (e.g., supporting native vegetation) may not be achievable or sustainable in the face of climate change and the anticipated sea level changes. In some regions, it may not be possible to overcome the forces of sea level rise, increasing sea surface temperatures, ocean acidification, or frequency and magnitude of storms to preserve, protect, or restore certain systems.

The profound influence of human activities on natural processes and the associated consequences of climate change begs the question: can regional sediment management strategies accommodate the need to maintain and preserve the beneficial uses that society has identified for a particular system? Are long-term projects sustainable? As engineers and scientists, how should we respond to these challenges?

Methods: Net Environmental Benefit Analysis (NEBA) provides a framework for balancing multiple competing interests and engaging stakeholders to inform the planning process. NEBA accommodates consideration of future scenarios, and can guide the development of management plans that provide pragmatic, sustainable solutions. A critical first step is problem formulation, where information is gathered to characterise the system of interest and develop, with stakeholder input, appropriate assessment and measurement endpoints for evaluating potential alternative scenarios. Characterisation of both current and potential future conditions of the system, given planned/anticipated land-use, changes, and projected vulnerabilities associated with climate change are used to inform development of relevant, alternative strategies for evaluation via the NEBA process.

NEBA is then applied to alternative management strategies. Strategies may be ranked according to the net environmental benefit they derive based on comparison to the current condition or some other defined reference state. Alternative strategies are then evaluated further by dividing the net environmental benefit by the projected implementation cost to develop a final ranking. The framework is intended to be iterative with opportunities to refine and improve upon the alternative strategies throughout the process.

Results: This paper summarizes a conceptual approach to sediment management, and discusses the work needed to develop sediment budgets for future commercial port, urban, and environmental protection planning purposes. Sustainable sediment management practices are needed that address current and future human use services while balancing broader environmental, economic, and societal concerns. Sustainable sediment management plans must, by necessity, be both pragmatic and adaptive. This is especially true when the effects of climate change and anthropogenic impacts on the environment and society are uncertain.

Discussion: Sediment management strategies must seek to affect practical solutions in the face of a changing coastal environment by supporting and enhancing the attributes of systems valued by society and balancing multiple, often competing interests to ensure long-term sustainability. Comprehensive sediment management strategies should:

- Facilitate natural transport processes
- Reduce contaminant loads (i.e., enabling a higher level of beneficial use moving into the future)
- Provide for storage/treatment of contaminated sediments for potential beneficial use
- Support desired beneficial uses in the system.