COPING WITH CONTAMINATED SEDIMENTS AND SOILS IN THE URBAN ENVIRONMENT*

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The functioning of mega-scale urban conglomerates is dependent on the interaction of numerous entities that provide government, food, electricity, transportation and all the other goods and services needed by its human population. But, as Empedocles proposed almost 2500 years ago, the world is composed of the four elements of fire, water, air, and earth. Today, we may consider that these elements are the foundations for our urban cultures with fire equated to energy sources and air, water, and earth being the veritable bases of our lives. Unfortunately, human activities can cause contamination of our surroundings with toxic organic and inorganic compounds that harm the environment and human health. The pathways for the compounds in the environment are complex and involve multi-directional interactions between the air, water, and earth on both a micro and macro scale. While working to ensure that urban regions have clean air, water, and earth, we need to also pay attention to processes occurring on regional or global scales.

The New York/New Jersey Harbor is a good illustrative example of the transport and fate of contaminants in an urban system. Anthropogenic contaminants have entered and continue to enter the system through a variety of pathways including both point and non-point sources from throughout the 35,000 square kilometer watershed. For example, atmospheric deposition contributes perhaps 20% of the total contaminant input to the Harbor region. Historically poor waste management practices in the production of industrial chemicals, polychlorinated biphenyls (PCBs) and herbicides, resulted in releases of these materials. These contaminants, particularly lipophilic polar compounds and organometals like mercury, became bound to the organically rich sediments of the harbor. Over time, these sediments have been transported via the dynamic estuarine hydrodynamics to various locations resulting in “toxic hot spots”. These sediments, rather than being removed from the system through burial, are continually disturbed by normal tidal action, storm water scour, and dredging activities making the associated chemicals available for exposure to benthic communities, and the estuarine food chain. Recent changes in US law that have been successful at reducing pollutant discharges into the system have dramatically improved surface water quality, increasing the pressure for multiple uses of the estuary. While this is hailed as an environmental victory, it has also raised the visibility of the legacy of contaminated sediments. As fisheries and recreational uses increase in the harbor, the potential risk associated with the contaminants in the sediments increases.

There is also a direct practical aspect resulting from the sediment contamination. Maintenance of efficient operation of the Port of New York/New Jersey requires dredging of the navigational channels in the Port on a regular basis. The amounts vary from year-to-year, but average around 1,500,000 m^3 /year, and better than half of that material is considered too contaminated for unrestricted disposal in the ocean. Stringent regulations govern the ways in which this material can be managed. Over the past decade, the region has invested considerable resources to develop innovative yet environmentally responsible ways for managing this material since Port operations are vital to the economic viability of the NY/NJ urban region.

We summarize here work relevant to the development of methods that can be used to economically process/ decontaminate sediments and soils to create environmentally acceptable beneficial use products. The decontamination technology is part of an overall treatment train that includes dredging, transport to a processing site, decontamination, creation of a beneficial use product, and shipment to the site of the end use. The costs for operation of the treatment train are paid for by a combination of tipping fees paid by the beneficiaries of the dredging or remediation operation and the sale of the beneficial use product.

Technologies investigated included solidification/stabilization, manufactured soil creation from untreated sediments, sediment/soil washing, solvent extraction, thermal desorption, and very high temperature treatments that destroy the organic compounds and incorporate the metals into a solid matrix. Successful technologies include cement production using a rotary kiln facility and sediment washing for creation of a manufactured soil. They are applicable to sediments or soils that are lightly (washing) or heavily (thermal) contaminated and combined are the basis for a treatment train that can be used to effectively manage the contaminated sediments and soils found in urban regions.

The practical demonstrations have been supported by other activities. We are developing a computational capability that uses open source software to provide interactive modeling and visualization resources that can be delivered to regulators, researchers, educators, and the concerned public. Additionally, research and development efforts are carried out to improve our understanding of the biological, chemical, and physical interactions that govern the interactions of the contaminants with the sediments. This effort is integrated with the large-scale demonstrations and with the computational modeling work.

We believe that our project approach to contaminated soils/sediments in New York and

New Jersey is also generally applicable to urban sites around the world with similar problems. Specifically, consideration could be given to how the lessons we have learned might benefit projects in Shanghai and other regions of China.

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