Contaminated Sediment and Climate Change – Sediment Desiccation, The Unthought About Hazard for Caps and MNR

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Introduction: Climate change poses an increasing threat to remedy effectiveness at contaminated sediment sites, especially those sites located in rivers, coasts, and inland waterways. Contaminated sediment sites are some of the nation's most contaminated sites, often acting as a reservoir for persistent pollutants that pose a risk to human health and the environment. Many of the contemporary remedies were designed and/or constructed decades ago without considering the effects of climate changes. While many events are associated with climate change, this evaluation focuses on how increasing air temperatures and increased drought potential may affect climate resiliency at contaminated sediment sites. Surface temperatures are projected to rise over the 21st century with heat waves predicted to occur more often and last longer. Record-setting hot years are projected to become more common, leading to the possibility of chronic, long-duration droughts. In some regions, the combination of climate change and increased withdrawal of water from aquifers are causing surface water levels to drop, resulting in exposed and desiccated sediment. Our objective was to evaluate the effect of sediment desiccation on existing and future sediment remedies such as subaqueous sediment caps, monitored natural recovery (MNR), and enhanced monitored natural recovery (EMNR).

Methods: We reviewed the well-established body of literature evaluating sediment characteristics and properties, including the effects of sediment desiccation. Then, we evaluated how that could affect contaminated sediment sites in the context of climate change, specifically focusing on increasing air temperatures, drought, and sediment desiccation. We focused on physical and chemical changes to contaminated sediment and the performance of subaqueous sediment caps and MNR/EMNR during drying and rewetting cycles. We also evaluated unanticipated risks, such as shifting exposure pathways from desiccated contaminated sediment from inhalation, dermal contact, and impacts to new receptors.

Results: Damage to remedies at contaminated sediment sites can lead to releases of contamination. Existing and future remedies will need to account for the effects of climate change, including the focus of this evaluation—increased temperatures and increased drought risk. Regions at risk for increased drought may have lowering surface water levels and increased sediment desiccation. As water levels drop, sediment caps can be exposed to the atmosphere, causing desiccation and cracking, ultimately decreasing the cap's ability to cover or sequester contamination. This can result in migration of the previously contained contamination to ground or surface water and/or resuspension of contaminated sediment. Sediment desiccation can also change the biodegradation potential as contaminants shift from anaerobic conditions to aerobic conditions.

Discussion: Lower water levels also could impact the suitability of caps in working river and harbors if additional dredging is required to allow for a deeper navigational channel. The success of MNR/EMNR depends on an assumed sedimentation rate of new uncontaminated material. Decreased water flow due to drought could decrease the deposition rate of new material and impact the success of MNR/EMNR as a remedy. Desiccation can also change exposure pathways, such as exacerbating the exposure and inhalation risk posed by wind-blow contaminated particles. Higher temperatures, increased drought risk, and associated desiccation of sediment are an important consideration of climate resiliency and contaminated sediment sites.

References: [1] EPA (2019) *Climate Resilience Technical Fact Sheet: Contaminated Sediment Sites*; [2] EPA (2021) *Climate Adaption Action Plan*; [3] ASTSWMO (2022) *Planning for Resiliency and Sustainability in a Changing Climate*; [4] Ecology (2017) *Adaptation Strategies for Resilient Cleanup Remedies.*