

Impact of Sea-Level Rise on Arsenic Biogeochemistry in Contaminated Coastal Soils

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Arsenic (As) contamination in drinking water is a major global concern, with elevated levels detected in groundwater wells across 25 U.S. states, affecting 2.1 million people. This issue is particularly critical in coastal regions, where a quarter of the global population resides and where sea-level rise (SLR) is expected to alter hydrological and biogeochemical conditions, potentially increasing As mobility and human exposure risks. Understanding the stability of As in contaminated coastal soils and its response to SLR is essential for predicting future contamination risks and informing mitigation strategies. Previous research has primarily focused on abiotic As transformations under relatively stable conditions, with limited attention given to the role of microbial processes in dynamic coastal environments. However, microbial activity plays a crucial role in As cycling, influencing its speciation, solubility, and bioavailability. As rising sea levels introduce saltwater into previously unaffected soils, shifts in microbial community composition and activity could significantly impact As release and transport. Despite the increasing urgency of this issue, the coupled effects of SLR-driven hydrological changes and microbial processes on As fate remain poorly understood. This study aims to bridge this knowledge gap by investigating the impacts of SLR and saltwater intrusion on As biogeochemistry and speciation. We assess the influence of environmental stressors associated with SLR—such as increased salinity, redox fluctuations, and organic matter changes—on microbial communities and their role in As transformation. Using an integrated approach combining laboratory experiments, spectroscopic and geochemical analyses, and microbial assessments, we seek to unravel the complex interactions governing As stability in submerged coastal soils. The findings of this research will provide critical insights into the risks associated with As mobilization in coastal environments affected by SLR. These insights will support the development of targeted remediation and management strategies to protect drinking water quality and safeguard public health in vulnerable coastal regions worldwide.