

## Article

# Recovery Strategies of Contaminated Marine Sediments: A Life Cycle Assessment

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**Abstract:** This study performed a Life Cycle Assessment (LCA) on recovery strategies of dredged contaminated marine sediments in a large Mediterranean port located in central Italy (Tuscany) in order to find the most environmentally sound solution. The study considered marine sediments polluted by potentially toxic elements (PTEs) and/or organic compounds, two different sediment particle sizes and the combined use of three soil remediation technologies: soil washing, electrokinetic treatment and enhanced landfarming. The analyzed scenarios depended on the sediment properties and characteristics of the treatment technologies investigated, and were compared with the corresponding reference scenarios, consisting of the landfilling of dredged contaminated sediments. The LCA results show that scenarios associated with sediment recovery generated potential environmental impacts lower than the corresponding reference scenarios. Almost all the impact categories considered in the CML-IA baseline method showed an environmental convenience in the recovery of contaminated sediments, especially for abiotic depletion and global warming. Future studies should focus on optimizing the combined use of multiple technologies and reducing the resource consumptions related to their implementation in order to achieve both environmental and economic benefits.

**Keywords:** LCA; marine sediments; contamination; recovery; remediation; soil washing; electrokinetic; enhanced landfarming; PTEs; hydrocarbons



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## 1. Introduction

Nowadays, resource scarcity and climate changes are growing issues all around the world that researchers and practitioners will have to address in the near future [1]. Adopting “zero waste” thinking seems to be the right way for sustainable development [2]. These matters are part of the objectives of the circular economy, which calls for the resource recovery by considering waste as a product to be reused in order to achieve environmental and economic benefits without compromising the next generations [3,4].

In view of this, the recovery of dredged contaminated marine sediments represents a viable way to contribute to the ongoing paradigm shift. Indeed, marine sediments are often affected by pollution due to industrial, civil and port activities, and their removal is strictly necessary, involving very expensive operations in several aspects [5].

This study compared the potential environmental impacts due to the recovery or landfilling of contaminated marine sediments located in a large port of central Italy (Tuscany). Generally, management of marine sediments is governed by Italian Legislative Decree 152/2006, which provides guidelines for dredging activities, aimed at the maintenance of river and coastal areas, and for the reuse of decontaminated fractions after appropriate treatments. Until the recent past, the most common management strategy of contaminated marine sediments was landfill disposal; however, this option is considered a potential risk

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**Congressional Record** United States. Congress,2001 Assessment and Remediation of Contaminated Sediments in the Great Lakes United States. Congress. House. Committee on Public Works and Transportation. Subcommittee on Water Resources,1992 *Monthly Catalog of United States Government Publications* United States. Superintendent of Documents,1991 Interior, Environment, and Related Agencies Appropriations for 2013 United States. Congress. House. Committee on Appropriations. Subcommittee on Interior, Environment, and Related Agencies,2012 **Interior, Environment, and Related Agencies Appropriations for 2014** United States. Congress. House. Committee on Appropriations. Subcommittee on Interior, Environment, and Related Agencies,2013 **Monthly Catalogue, United States Public Documents** ,1990-07 Energy and Water Development Appropriations for Fiscal Year 2000 United States. Congress. Senate. Committee on Appropriations. Subcommittee on Energy and Water Development,2000 Acid Precipitation ,1983 *Reauthorization of the Federal Water Pollution Control Act* United States. Congress. House. Committee on Public Works and Transportation. Subcommittee on Water Resources,1991

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