Chapter 6
Understanding Natural Bioremediation for Soil and Water Sustainability: Case Studies From Barreiro and Tagus Riverbanks

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ABSTRACT

The chapter highlights Europe's proactive approach to environmental recovery and underscores the importance of educational initiatives in enhancing public literacy on these critical issues. Real-world data from two case studies conducted in Barreiro and along both banks of the Tagus River illustrate the effectiveness of natural bioremediation in tackling hydrocarbon pollution and restoring ecosystems. These examples underscore the ability of native microorganisms from potentially contaminated sites to effectively metabolize the pollutants present due to their natural adaptation to the local environmental conditions. Additionally, three versatile protocols are presented to improve the practical application of bioremediation studies. By incorporating

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Social-Emotional Learning (SEL), hypothetical case studies, and local cultural and natural heritage as educational resources, this chapter aims to empower learners and promote essential literacy in bioremediation and sustainability for addressing environmental challenges and ensuring ecosystem health for future generations.

1. INTRODUCTION

Ecological systems are complex and dynamic, adapting to both natural variations and human-induced stressors. These systems strive for equilibrium through intricate biological, chemical, and physical interactions. Gaining insight into how ecosystems function and maintain balance is essential for understanding their potential to recover from environmental degradation. In the context of bioremediation, this knowledge is particularly relevant, as successful recovery strategies rely on the interplay between abiotic and biotic components.

Bioremediation relies on the natural ability of living organisms, particularly microorganisms, plants, and fungi, to detoxify or eliminate pollutants from contaminated environments. The efficiency of these biological processes depends on various environmental parameters. For example, temperature has been identified as a critical abiotic factor influencing microbial degradation. Studies indicate that optimal thermal and moisture conditions significantly enhance microbial activity and the breakdown of organic contaminants (Moxley et al., 2019; Verardo et al., 2021). Furthermore, factors such as pH, oxygen levels, and the availability of nutrients like nitrogen and phosphorus play key roles in determining the effectiveness of bioremediation (Alori et al., 2022). While technical knowledge of these parameters supports tailored interventions, translating this knowledge into impactful action depends on public awareness and environmental education.

The interconnectedness of organisms and their habitats must be considered in the development of bioremediation strategies. Recognizing that all components of an ecosystem, from microbes to plants and animals, contribute to environmental health enables more effective and sustainable remediation approaches. This holistic perspective supports nature-based recovery and reduces the risk of additional environmental harm.

Raising awareness of these ecological relationships requires strong environmental literacy, which forms the foundation for responsible environmental behavior (Serralha & Coelho, 2024; Thompson et al., 2016). Environmental literacy encompasses the ability to understand ecological principles and to make informed decisions regarding environmental issues. Promoting understanding of bioremediation helps bridge the gap between scientific research and community action, fostering sustainable practices that align with ecosystems' regenerative capacities.

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