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ASSESSING THE RISK OF SOIL CONTAMINATION USING COMPUTATIONAL MODELS

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Abstract

Serious global challenges such as soil degradation, declining biodiversity, and escalating environmental pollution present urgent issues that demand the implementation of advanced and effective strategies for pollution prevention, control, and remediation. This study addresses these critical problems by proposing a comprehensive approach to mitigating soil pollution, emphasizing both ecological sustainability and regulatory compliance. Guided by the general principles of contaminated soil risk management and the legislative frameworks of both the European Union and national authorities, the research aimed to evaluate potential pollution sources within a targeted farm area and propose a scientifically robust remediation solution. The research involved the systematic identification and quantification of pollution hotspots and sources in the selected agricultural zone. Subsequently, an innovative bioremediation framework, referred to as the BIOF&T model, was developed and tailored to the specific environmental conditions of the contaminated area. The model integrates biological, organic, and physicochemical processes to enhance soil quality, reduce pollutant concentrations, and restore ecological balance. BIOF&T's strength lies in its adaptive design, making it suitable for real-world applications across varying environmental conditions, and it demonstrates a clear potential for high-performance outcomes in large-scale soil remediation projects. In addition to presenting the rationale for selecting the BIOF&T model, the study highlights its compatibility with other advanced biotechnological and soil conservation techniques. Initial implementation results indicate that BIOF&T is capable of significantly reducing contaminant loads, promoting soil health, and supporting plant biodiversity, thus offering a promising solution for long-term environmental sustainability.
By extending the list of available tools for soil pollution control and biodiversity protection, the BIOF&T model contributes to advancing current knowledge and practice in environmental remediation. The outcomes of this research serve as a foundation for future studies aimed at optimizing soil health restoration techniques, including their integration with digital monitoring technologies and precision agriculture approaches. Moreover, this study underscores the importance of continuous evaluation and adaptation of bioremediation models to meet the dynamic needs of diverse ecosystems under varying pollution stressors. Future research directions include expanding the model's application across different soil types and climatic conditions, assessing long-term ecological impacts, and exploring its potential for synergistic use with microbial consortia engineered for heavy metal detoxification. The findings presented herein provide practical and scalable solutions for policymakers, environmental managers, and agricultural stakeholders seeking sustainable pathways for soil restoration and pollution mitigation.

Key words: bioremediation, environment, computational models, pollution, sustainable soil

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