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Analysis of Carbon Sequestration Capacity in Land Remediation Projects

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Abstract

This article aims to explore the carbon sequestration capacity in land remediation projects and study how to effectively increase soil and biological carbon sequestration through these projects to address the challenges of global climate change. It introduces the basic concept of carbon sequestration and its influencing factors, with particular attention to the impact of key factors such as soil quality and water resource management on carbon sequestration capacity. It assesses the potential of soil carbon sequestration in land remediation projects and emphasizes the significance of rational land use planning in enhancing carbon sequestration capacity. The strategies and measures to enhance carbon sequestration capacity in land remediation projects are discussed, including ecological engineering construction, wetland conservation and restoration, soil quality improvement, promotion of organic agriculture, soil conservation, and carbon incentive policies and social participation. By promoting the simultaneous development of carbon neutrality and ecological protection, the article aims to achieve a win-win situation for the economy and the environment, and drive sustainable rural development.

Keywords

Land Remediation; Carbon Sink; Ecological Function; Sustainable Development.

1. Basic Concepts and Influencing Factors of Carbon Sequestration

Carbon sequestration is the process of absorbing and storing a significant amount of carbon dioxide (CO2) in natural or artificial systems. These systems can capture CO2 from the atmosphere and convert it into organic carbon, which is then stored in living organisms or in the soil[1, 2, 3]. This process plays a crucial role in reducing the concentration of greenhouse gases in the atmosphere and mitigating global climate change. Carbon sequestration is a vital element in maintaining ecological balance and climate stability.

Soil carbon sequestration, on the other hand, refers to the storage of both organic carbon and inorganic carbon in the soil. Organic carbon primarily originates from plant residues, animal waste, and microbial decomposition, while inorganic carbon includes compounds such as carbonates. Soil organic carbon gradually accumulates in the soil through the decomposition of plant litter and microbial activities, creating a soil carbon reservoir[4, 5].

Soil quality plays a vital role in determining the carbon storage capacity of the soil. High-quality soils generally have higher organic matter content, which enables them to retain and store carbon more effectively (Figure 1). Therefore, improving soil quality and implementing soil improvement measures, such as organic fertilizer application and soil conservation, are essential for increasing soil carbon sequestration. Proper water resource management also has a significant impact on carbon sequestration capacity. Adequate water resources facilitate vegetation growth and maintain soil moisture, enhancing the efficiency of CO2 absorption by plants and increasing biological carbon sequestration. Moreover, conserving water resources

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and avoiding excessive water use can reduce greenhouse gas emissions from irrigation, further promoting soil carbon sequestration.

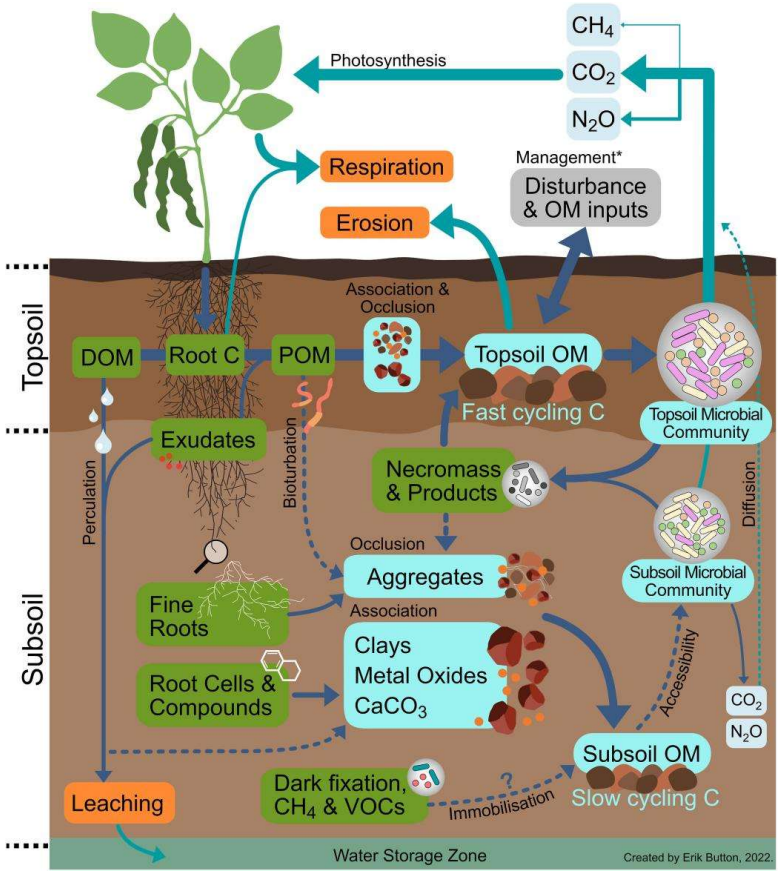

Figure 1. Conceptual diagram of the top- and sub-soil C cycles [7]

2. Carbon Sequestration Potential Assessment in Land Remediation Projects

In land remediation projects, soil improvement measures and the application of organic fertilizers play a crucial role in increasing the soil's organic matter content and improving its carbon storage capacity[6]. By using organic fertilizers, the soil's organic carbon content can be boosted, leading to improved soil structure and enhanced stability of organic carbon. As a result, the carbon sequestration capacity of the land remediation area is significantly increased.

2.1. Relationship between Land Use Types and Soil Carbon Storage

The impact of different land use types in land remediation projects on soil carbon storage varies significantly. Forest soils, for instance, tend to store higher organic carbon content due to the slow decomposition of plant litter and woody debris, resulting in a more stable organic carbon pool. Conversely, agricultural and urban lands often exhibit lower soil carbon storage due to vegetation destruction and reduced organic matter content. Hence, implementing a well-thought-out land use plan in land remediation projects, with an emphasis on increasing forest and wetland areas, can effectively enhance carbon sequestration capacity.

2.2. Impact of Agricultural Management Measures on Carbon Sequestration

Agricultural land plays a critical role as a soil carbon sink, and implementing effective agricultural management measures can significantly increase the carbon sequestration capacity of land remediation areas[7, 8]. For instance, adopting proper cropping systems and

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efficient irrigation facilities can improve soil quality and enhance organic carbon content, thus leading to increased soil carbon storage. Additionally, practices such as crop rotation and straw incorporation help maintain the stability of soil organic matter, fostering carbon accumulation and storage.

3. Empirical Studies of Carbon Sequestration Capacity in Land Remediation Projects

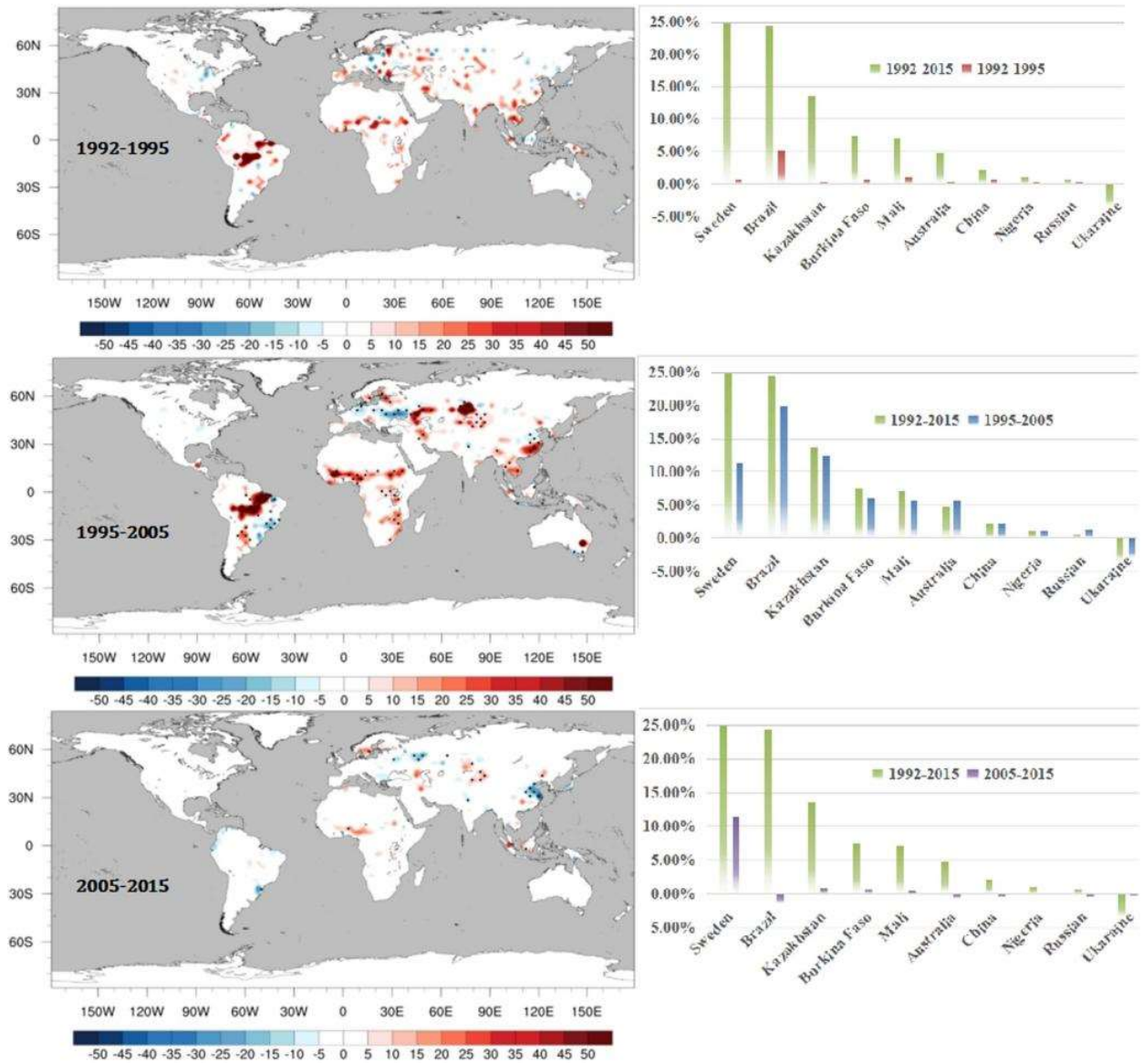

Figure 2. Hotspots of cultivated land area change (the 10 countries with the most significant changes) in terms of percentage change in area over time[5].

Accurately assessing the carbon sequestration capacity of land remediation projects requires comprehensive field investigations and data collection. This entails detailed surveys and continuous monitoring of various types of land remediation projects, including site selection, project implementation, and subsequent outcomes. Field investigations should encompass critical indicators such as vegetation coverage, soil quality, and water resource management. Data collection involves the sampling of plants and soil, along with monitoring climate factors, to acquire comprehensive and unbiased data on carbon sequestration capacity.

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Rural ecological restoration projects are pivotal components of land remediation efforts, aiming to improve rural ecological environments and enhance carbon sequestration capacity (Figure 2). By implementing vegetation restoration and protection measures like windbreak belts, fruit tree forests, and bamboo forests, these projects effectively increase vegetation coverage and promote biological carbon sequestration in rural areas[9, 10, 11]. Furthermore, they prioritize soil improvement and the application of organic fertilizers to boost soil carbon storage capacity. Empirical research demonstrates that rural ecological restoration projects have a significantly positive impact on enhancing carbon sequestration in rural areas, providing robust support for rural carbon neutrality and climate change adaptation.

4. Strategies and Measures to Enhance Carbon Sequestration Capacity in Land Remediation Projects

4.1. Ecological Engineering and Vegetation Restoration

Promoting ecological engineering construction and enhancing vegetation restoration and protection are essential for increasing vegetation coverage and biological carbon sequestration capacity in land remediation areas[3, 12, 13]. Scientifically rational plans for forest and grassland vegetation restoration should be developed, with the implementation of afforestation, greenery, and protective forest projects. Moreover, the restoration of degraded vegetation should be prioritized, and efforts to establish and protect plant diversity must be undertaken to enhance the carbon sequestration capacity of ecosystems.

4.2. Wetland Conservation and Restoration

Strengthening wetland conservation and restoration is crucial for maintaining the ecological integrity and stability of wetlands while increasing their carbon storage capacity. By establishing wetland conservation areas and implementing wetland ecological restoration projects, aquatic vegetation can be restored, promoting the functionality of wetland ecosystems as efficient carbon sinks.

4.3. Soil Quality Improvement and Promotion of Organic Agriculture

Improving soil quality and promoting organic agriculture are key to increasing soil carbon sequestration capacity in land remediation areas. The application of organic fertilizers can enhance soil organic matter content, improve soil structure, and contribute to increased soil carbon storage capacity[14].

4.4. Soil Conservation and Soil Improvement Techniques

Implementing soil conservation and soil improvement techniques is vital to prevent over-cultivation and soil erosion, maintain the stability of soil organic matter, and increase the soil carbon sequestration capacity in land remediation areas[15]. By adopting sustainable agricultural practices such as reduced tillage, contour plowing, and terracing, soil erosion can be minimized, and the organic matter content in the soil can be preserved, thereby enhancing carbon sequestration.

4.5. Carbon Incentive Policies and Social Participation

Establishing carbon incentive policies is instrumental in encouraging businesses and social organizations to participate in carbon trading and carbon sequestration incentive mechanisms. Through carbon trading, the carbon sequestration capacity of land remediation projects can be incentivized and enhanced. Additionally, encouraging public participation in ecological protection and restoration within land remediation projects fosters collective efforts in environmental conservation across society.

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5. Conclusion

Land remediation projects play a crucial role in enhancing carbon sequestration capacity while promoting the strategic goal of carbon neutrality and harmonious development with the environment. Carbon neutrality is a significant means of addressing climate change, and land remediation projects serve as an effective approach to increasing carbon sequestration. They provide practical support for achieving carbon neutrality objectives. Simultaneously, the ecological restoration and protection measures in land remediation projects contribute to enhancing the stability and resilience of ecosystems, reinforcing their ability to withstand disturbances. By fostering the synergy between carbon neutrality and environmental conservation, we can achieve a win-win situation between the economy and the environment, promote sustainable rural development, and leave a more beautiful home for future generations.

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