水庫沉積物應用於沙地植生與碳吸存成效探討

A Study on the Effectiveness of Reservoir Sediment Application for Vegetation Establishment and Carbon Sequestration in Sandy Soils

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摘　要

台灣西部濱海地區長期因河川沙源補充不足及水庫攔沙效應，導致沙丘地乾涸貧瘠，易受季節風揚塵影響且難以植生。另水庫沉積物淤積嚴重，削弱蓄洪功能並縮短壽命，需尋求有效之去化與再利用對策。本研究由經濟部水利署南區水資源分署委託，針對阿公店水庫沉積物進行資源化再利用，於高雄市阿公店溪出海口北岸沙灘區辦理綠化試驗，期望達成沉積物去化、沙地改良、植生綠化與碳吸存等多重目標，作為兼顧減碳與環境治理之永續應用示範。

本試驗區共分兩期建置，總面積約 7,300 平方公尺，去化沉積物 6,417 立方公尺，栽植濱海防風樹種共 1,088 株。前期(110~111 年)採設置三道沉積物牆方式進行，面積約 4,400 平方公尺，堆置沉積物 4,074 立方公尺，植栽樹種包含木麻黃、草海桐與黃槿；後期(112 年)於 2,900 平方公尺區域設置不同高度之地表堆置區，去化沉積物 2,343 立方公尺，另設對照組，主要植栽黃槿與水黃皮，並搭配建置防塵網、草覆、澆灌等配套設施。試驗區後續亦導入 NDVI 植生分析、UAV 航測地形、土壤與地下水監測等方法，以追蹤試驗效益。

土壤監測結果顯示，沉積物堆置區之含水量約為 30%至 60%，顯著高於原沙地之 13%至 30%，顯示其具有良好保水性與有機質，有助提升植栽初期成活率。113 年度進行土壤碳分析結果顯示，堆置區 TOC 濃度為 1.01%至 1.30%，明顯優於對照區（<0.45%），具碳吸存潛力。然而，114 年度檢測值下降至 0.45%至 0.50%，初步研判可能與降雨沖蝕、有機質礦化速率偏高、採樣誤差或植栽旺盛生長期吸收碳源有關。

為提升土壤碳穩定性與促進植栽後續生長，建議後續管理導入綠肥作物以補充有機質，並施用根瘤菌或促生菌促進固氮及微生物活性，搭配腐植質液肥或堆肥茶，以維持土壤碳氮平衡與保水保肥能力，並持續進行植生與碳含量監測。綜上所述，本研究顯示水庫沉積物應用於濱海沙地具高效去化、土壤改良與促進植生成效，並兼具碳吸存潛力，為兼顧工程實務與永續環境治理之具體應用模式。

關鍵詞：水庫沉積物再利用，淤泥去化，濱海沙地改良，碳吸存與植生效益

Abstract

The western coastal region of Taiwan has experienced long-term degradation due to reduced fluvial sediment supply and sediment retention by upstream reservoirs. This has led to barren, wind-eroded sand dunes with limited vegetation potential. Meanwhile, excessive reservoir sedimentation has reduced flood storage capacity and service life, highlighting the urgent need for sustainable sediment reuse strategies.

Commissioned by the Southern Region Water Resources Office, this study explored the reuse of sediments from Agongdian Reservoir in a coastal greening pilot project at the northern shore of the Agongdian River estuary in Kaohsiung. The project aimed to achieve multiple goals including sediment removal, coastal soil improvement, vegetation establishment, and carbon sequestration.

The site was developed in two phases, covering 7,300 m^2 and using 6,417 m^3 of sediments to plant 1,088 windbreak trees. Phase I (2021–2022) involved three subsurface sediment berms over 4,400 m^2, while Phase II (2023) established three surface mounds of different heights across 2,900 m^2, along with a control plot. Supporting measures included dust control netting, mulching, irrigation, NDVI analysis, UAV terrain surveys, and groundwater and soil monitoring.

Soil moisture in the sediment-treated zones reached 30–60%, significantly higher than untreated sandy areas (13–30%), improving plant survival rates. TOC levels in 2024 ranged from 1.01% to 1.30%, compared to below 0.45% in control areas, indicating enhanced carbon sequestration potential. However, TOC values dropped to 0.45–0.50% in 2025, possibly due to rainfall erosion, rapid organic matter mineralization, or nutrient uptake during active plant growth.

To stabilize carbon levels and support plant development, it is recommended to introduce green manure crops, apply rhizobial or plant growth-promoting bacteria, and use humic acid solutions or compost tea. These practices, combined with ground cover management and ongoing monitoring, can enhance soil quality, plant performance, and environmental resilience.

This study demonstrates that reusing reservoir sediment for coastal greening provides a viable model for sediment management, soil restoration, and long-term carbon sequestration.

Keywords: Reservoir Sediment Reuse, Silt Removal, Coastal Soil Improvement, Carbon Sequestration and Vegetation Benefits