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Effectiveness of Assisted Natural Regeneration in Revitalizing Soil Carbon Stocks in Former Chena Lands

Wijsekara, P.A.N.U.^{1*}, Ratnayake, R.R.², Wijesundara, D.S.A.², Dayawansa, P.N.¹

¹*Department of Zoology and Environment Sciences, Faculty of Science,
University of Colombo, Colombo 03, Sri Lanka*

²*National Institute of Fundamental Studies, Kandy, Sri Lanka*

**renuka.ra@nifs.ac.lk*

Abstract

The global climate crisis highlights the critical role of forests as vital carbon sinks, with deforestation being a major driver of climate change. In Sri Lanka, a significant reduction in forest cover has threatened biodiversity and ecological stability, prompting the government to increase forest coverage. Assisted Natural Regeneration (ANR) has been promoted as a cost-effective, sustainable technique to restore degraded ecosystems, such as abandoned Chena cultivation, by facilitating natural succession. However, the long-term effectiveness of ANR in restoring key ecosystem functions, particularly carbon sequestration and soil carbon storage (SCS), compared to natural forests, remains inadequately studied. This research aimed to address this gap by investigating whether forest carbon dynamics differ across various restoration stages of ANR at IFS-Pophum Arboretum, Dambulla, and adjacent natural dry mixed evergreen forests. The study assessed how forest maturity influences carbon sequestration and compared the carbon sequestration capacity of natural forests with ANR plots (representing partial restoration and rehabilitation of abandoned chena cultivation) and naturally regenerated forests (no action). The study tested two null hypotheses that stated there is no difference in soil carbon content and sequestration capacity across different forest types: Natural Forest, old-growth restored forest, mid-growth restored forest, and naturally restored forest. Soil samples were collected from two depths (0-0.15 m and 0.15-0.30 m), and Total Organic Carbon was determined using a CHN elemental analyzer. SCS was calculated incorporating the Bulk density measurements obtained by Soil Core method. The results demonstrated that the natural forest had a significantly higher (One-way ANOVA: $p < 0.05$) mean soil carbon stock ($305.9 \pm 103.6 \text{ Mgha}^{-1}$) than all restored forest types, confirming its superior role as a carbon sink. Contrary to expectations, ANR forests ($172.93 \pm 42.69 \text{ Mgha}^{-1}$) did not show a significant advantage in carbon storage over naturally regenerated forests ($188.6 \pm 35.9 \text{ Mgha}^{-1}$); this suggests that human-assisted restoration in this dry zone context has not yet augmented carbon sequestration beyond natural recovery. Results have explained no significant difference between soil layers. Though the upper layer has a higher stock ($218.3 \pm 73.3 \text{ Mgha}^{-1}$) than the below layer ($187.0 \pm 80.3 \text{ Mgha}^{-1}$). Among the restored forests, old-growth stands ($196.3 \pm 58.5 \text{ Mgha}^{-1}$) had higher carbon storage than mid-growth stands ($164.09 \pm 28.05 \text{ Mgha}^{-1}$), indicating that maturity within restored plots positively influences carbon accumulation. These findings are crucial for informing Sri Lanka's forest policy and restoration strategies, highlighting that while ANR is a valuable tool, natural forests remain irreplaceable carbon reservoirs.

Keywords: *Carbon sequestration, Assisted natural regeneration, Soil carbon stock, Forest restoration, CHN analyzer*