Assessment of Total Ecosystem Carbon Stocks in Natural and Restored Mangroves and Degraded areas at Anawilundawa Wetland Sanctuary, Sri Lanka

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Mangrove forests are globally recognized as highly efficient blue carbon ecosystems due to their capacity to capture and store exceptionally large quantities of carbon. The aim of this study was to quantify and compare total ecosystem carbon stocks (TECS) across natural, restored, and degraded mangrove habitats in the Anawilundawa Wetland Sanctuary, Sri Lanka, and to evaluate site-level variation in ecosystem carbon storage. Nine representative sites were surveyed, including one natural stand, three restored mangrove stands representing approximately 5, 3, and 1 years old (established in 2021, 2023, and 2024), and five degraded sites with secondary vegetation. At each site, TECS were quantified following standardized blue carbon protocols by measuring aboveground biomass carbon, belowground biomass carbon, downed wood carbon, and soil organic carbon from soil cores collected to 100cm depth. Differences among sites were evaluated using one-way analysis of variance (ANOVA). TECS differed significantly among sites, ranging from 103.37±15.03 Mg C ha^{-1} in the 2024 restored site to 270.56±15.96 Mg C ha^{-1} in a degraded site. The natural stand stored 212.81±26.91 Mg C ha^{-1}, while restored sites exhibited progressive increases in TECS with stand age, ranging from 103.37±15.03 Mg C ha^{-1} in the 1-year stand to 231.63±13.79 Mg C ha^{-1} in the 5-year stand. Degraded sites displayed heterogeneous outcomes, with stocks spanning 108.05±14.14 Mg C ha^{-1} to 270.56±15.96 Mg C ha^{-1}, in some cases exceeding both natural and restored stands. Soil carbon represented the dominant ecosystem carbon pool, accounting for 80-99% of TECS across all sites. These findings provide critical site-specific insights into blue carbon dynamics in Sri Lankan mangroves, establishing baseline information for mangrove restoration planning, blue carbon accounting, and climate change mitigation initiatives in Sri Lanka.

Keywords: *Blue carbon, Mangrove restoration, TECS, Anawilundawa Wetland Sanctuary*