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Spatial Variability of Soil Organic Carbon Stocks in the Mangrove Ecosystem of Koggala Lagoon, Sri Lanka

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Mangroves in Sri Lanka serve as critical blue carbon sinks, yet their sediment carbon storage remains understudied, limiting their incorporation into national climate change mitigation strategies. This study presents the first quantitative assessment of soil organic carbon (SOC) stocks in the mangrove ecosystem of Koggala Lagoon, located in the southern province of Sri Lanka. Soil samples were collected from ten sites using cylindrical corers at depths of 0–15 cm and 15–30 cm. Samples were processed using standard procedures including oven-drying, the Loss on Ignition (LOI) method for organic matter determination, and conversion to SOC stocks expressed in Mg C ha^{-1}. Results revealed substantial spatial variability in SOC stocks across the lagoon, ranging from 14.74 to 66.93 Mg/ha in the topsoil layer. High-performing sites (Site 02: 66.93 Mg/ha; Site 07: 59.16 Mg/ha) demonstrated carbon storage potential more than 4.5 times greater than low-performing sites (Site 03: 14.74 Mg/ha). Unexpectedly, several sites exhibited atypical vertical carbon distribution patterns, with Site 10 showing higher subsoil carbon content (72.55 Mg/ha) than topsoil (47.19 Mg/ha), suggesting complex sediment dynamics potentially influenced by deep-rooted vegetation or historical land use. These findings have critical implications for blue carbon accounting and conservation strategy. The heterogeneous distribution of SOC stocks indicates that national carbon inventories and credit schemes must avoid generalized assumptions to prevent overestimation. The study confirms Koggala Lagoon mangroves as significant carbon reservoirs and emphasizes the necessity of their conservation as natural climate solutions. This baseline data provides essential evidence for incorporating mangrove ecosystems into Sri Lanka's climate change mitigation frameworks and highlights their underappreciated role in global carbon sequestration efforts.

Keywords: Blue carbon, Carbon sequestration, Koggala Lagoon, Mangrove sediments, Soil organic carbon