



M.Sc. Degree in Environmental Science

ECOLOGICAL ASSESSMENT OF BLUE CARBON ECOSYSTEMS IN  
NORTHERN NEGOMBO ESTUARY USING GIS AND FIELD BASED  
APPROACHES

A dissertation submitted

by

S.H. UDESHIKA CHATHURANI

to

The Centre for Environmental Studies and Sustainable Development

in partial fulfillment of the requirements

for the degree of

Master of Science in Environmental Science

of

THE OPEN UNIVERSITY OF SRI LANKA

NAWALA, NUGEGODA

May, 2025



076015

CK/CC  
5

## Abstract

Blue carbon ecosystems like mangroves and seagrasses play a vital role in climate change mitigation through their high carbon sequestration and storage capacity. The Negombo estuary in Sri Lanka is a key blue carbon hotspot but faces growing threats from urbanization, land reclamation, and pollution. This study aimed to assess the spatial extent, species composition, and blue carbon stocks of mangrove and seagrass habitats in the northern part of the estuary using GIS mapping and field-based ecological and biogeochemical methods, to support sustainable management and conservation efforts.

Field assessments were carried out from August to December 2024 across five mangrove islands (Mirissanduwa, Mahauppalama, Wedikanda, Mandagasalamba, and Kaakaduwa) in the northern Negombo stuary. Vegetation structure and floristic composition were quantified using 5×5 m quadrates, and biodiversity was evaluated using Shannon-Wiener and Simpson indices. Above- and below-ground biomass was estimated via species-specific allometric equations, while sediment organic carbon (SOC) was derived from 0–30 cm soil cores based on bulk density and total organic carbon (TOC) determined by Loss on Ignition. Seagrass meadows were surveyed using 0.5×0.5 m quadrates along 50 m transect. Physicochemical parameters (salinity, pH, turbidity) were recorded. Spatial analyses utilized ANOVA and GIS integration. Results showed that *Rhizophora mucronata* dominated all mangrove islands, particularly in Mahauppalama, Mirissanduwa, and Wedikanda, accounting for over 80% of vegetation cover. In contrast, Mandagasalamba and Kaakaduwa hosted more diverse, mixed species stands, including *Sonneratia alba*, *Avicennia marina*, *Bruguiera gymnorhiza*, and *Lumnitzera racemosa*. Shannon-Wiener Index values ranged from 0.48 to 0.90, indicating spatial heterogeneity in species diversity, though no statistically significant differences were found ( $p > 0.05$ ). The highest blue carbon stock was recorded at Mirissanduwa (1,533.34 Mg C ha<sup>-1</sup>), with progressively lower values observed at Mahauppalama, Wedikanda, Mandagasalamba, and Kaakaduwa.

Soil pH ranged from 6.68 to 8.14 and salinity from 16 to 22 ppt, both showing limited spatial variability and suggesting stable edaphic conditions.

Seagrass assessments revealed two species: *Halodule pinifolia* (dominant) and *Halophila ovalis* (restricted to Basiyawaththa). The most extensive meadows occurred at Basiyawaththa (~800 × 200 m), followed by Munnakkara and Kadolkele. Shoot densities were highest at Munnakkara (up to 9,248 shoots m<sup>-2</sup>), with *H. pinifolia* generally showing higher densities than *H. ovalis*. Above ground and below-ground biomass was greatest at Munnakkara. Sediment organic carbon (SOC) content was higher in deeper layers (15–30 cm), indicating longer-term carbon accumulation. Total seagrass blue carbon stocks ranged from 13.45 to 24.15 Mg C ha<sup>-1</sup>, with sediments contributing over 90% of the total. Statistically, no significant differences in biomass or SOC were observed between sites ( $p > 0.05$ ). Water quality parameters showed significant spatiotemporal variation ( $p < 0.05$ ), and land use analysis from 2000 to 2024 revealed a 4.70% decline in vegetation cover and a 4.24% increase in built-up area, emphasizing the growing anthropogenic stress on the ecosystem.

The study recommends prioritizing the conservation and restoration of high-carbon mangrove areas such as Mirissanduwa and Mahauppalama through buffer zones and community-based management. Restoration of degraded, mixed-species sites like Kaakaduwa and Mandagasalamba is advised to improve biodiversity and resilience. Site-specific seagrass conservation, particularly at Munnakkara, is essential due to its high biomass and sediment organic carbon (SOC) content. Given the predominance of sediment carbon in both ecosystems, minimizing sediment disturbance via sustainable land use and shoreline protection is critical. Integrating blue carbon values into policy, developing carbon offset mechanisms, and establishing long-term monitoring and stakeholder engagement programs are key strategies for effective blue carbon conservation and climate resilience.