

Spatial Variability of Soil Organic Carbon and Nutrient Dynamics in Disturbed and Undisturbed Riverine Mangrove Sites in Mannar

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Abstract

The reclamation of coastal blue carbon ecosystems for agricultural or industrial land uses has resulted in declination of soil carbon storage. These disruptions to riverine mangroves in the Mannar region were location-specific and varied in intensity. This study examines soil spatial variability in soil organic carbon (SOC) and nutrient availability due to disturbances in riverine mangrove sites in the Mannar region. It identifies an inland strip of mangroves at Mendakal Aru, Methanvely near Kalimondai beach, and Achchankulam, revealing spawning activities, water flow diversion, and exploitation at the top two sites. Random soil sampling and analysis to examine the variation of SOC, carbon fractions, and nutrient contents at the upper soil layer of 0-15 cm were conducted at disturbed mangrove sites (n=19) at Methanvely and Mendakal Aru and were compared with the undisturbed sites (n=3) at Achchankulam. Three clusters were identified following principal component analysis and cluster analysis, with one cluster having the highest concentrations of phosphorous and manganese ($58.3 \pm 9.4 \text{ mg kg}^{-1}$; $86.6 \pm 32.4 \text{ mg kg}^{-1}$), while the other two clusters had the highest SOC, sodium, and zinc concentrations ($3.12 \pm 0.44 \%$; 10.3 g kg^{-1} ; $49.5 \pm 49.5 \text{ mg kg}^{-1}$) and lowest contents of SOC and permanganate oxidizable carbon ($0.68 \pm 0.28 \%$; $296.3 \pm 152.2 \text{ mg kg}^{-1}$). A mixed model ANOVA was used to determine the significance of the sites and vegetation communities. Accordingly, Achchankulam had significantly ($P < 0.05$) higher concentrations of SOC and ammonium ($2.2 \pm 0.5\%$ and $25.0 \pm 4.3 \text{ mg kg}^{-1}$) yet the lowest calcium concentration ($3.1 \times 10^3 \pm 9.1 \times 10^3 \text{ mg kg}^{-1}$) compared to disturbed riverine mangroves. SOC were low as $0.97\% \pm 0.25$ and $0.97\% \pm 0.20$ at Mendakal Aru and Methanvely, respectively. Mendakal Aru was found with the lowest ammonium levels ($0.5 \pm 2.1 \text{ mg kg}^{-1}$), while Methanvely had the highest calcium content ($18.1 \times 10^3 \pm 4.0 \times 10^3 \text{ mg kg}^{-1}$) and pH (8.4 ± 0.2). Thus, the vegetation communities alone did not have a notable variability in SOC, yet significant variability was caused at specific sites. The study reveals an underline correlation of high SOC and ammonium levels and lower calcium concentrations. Significant variations exist in SOC and nutrients between disturbed and undisturbed riverine mangrove areas in the region. The findings emphasize the need for site specific management for recovering the disturbed coastal ecosystems.

Keywords: *Blue carbon sequestration, Cluster analysis, Gulf of Mannar, Mangrove ecosystem Disturbance, Principal component analysis*