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Assessing Soil Carbon Recovery: Evidence of Progressive Restoration at a Lowland Wet Zone Site in Sri Lanka

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Abstract

Diyakothakanda forest in the Kalutara district (6° 45' N - 80° 31' E) is a 2-hectare restoration site that was initiated in 2009. The restoration project, which used the relay floristic method (2016 onwards), demarcated the degraded forest area into three zones (A, B, and C) from lower to higher elevations. The main objective of the present study was to compare soil characteristics and soil carbon stock with an adjacent reference forest to determine the success of initial restoration efforts in terms of soil. A stratified random sampling approach was used. From each zone of the restoration site (RS) and the corresponding zones of the adjacent natural forest (NF), five topsoil samples (0 to 25 cm depth) per zone were collected, and soil pH, electrical conductivity, moisture, bulk density, and organic carbon content were measured. Hierarchical clustering was performed based on soil parameters using RStudio (version: 4.4.1). A heat map was generated (ArcGIS Pro 3.0.1) using soil carbon stock data. No significant difference was observed in soil pH (5.4 -5.6) and electrical conductivity (45.7mS/m) between the two sites. A significant difference was observed between the natural forest and the restoration site in soil moisture (RS: 1.1%, NF: 9.1%) and organic carbon content (RS: 4.5%, NF: 6.1%). Soil carbon stocks were 10573 t ha^{-1} and 4334 t ha^{-1} in the natural forest and restoration site, respectively. This significant difference shows that the restoration effort would require further time for carbon stocks to recover to levels seen in natural forests. However, out of the three zones of the restoration site, zones A and B, which are the older plots, showed a higher value for soil carbon stock compared to zone C. Under hierarchical clustering, five main clusters were formed, with most of the RS plots in the first cluster, while the last cluster showed only NF plots. In the other clusters, plots from both sites were seen, suggesting that these RS plots share similarities with the NF plots regarding soil parameters. This can be considered a positive early outcome for the restoration effort as it shows that the mature areas of RS have reached the NF level in terms of selected soil parameters. The current study lays a foundation for gathering further insights into the restoration process at this site and thereby suggesting optimized restoration strategies for the lowland wet zone of Sri Lanka.

Keywords: *Soil carbon stock, Restoration site, Hierarchical clustering, Soil characteristics*