

Dynamics of blue carbon in mangroves in the Rekawa Lagoon, Sri Lanka: Integrating remote sensing and the InVEST model for coastal ecosystem management

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Coastal blue carbon ecosystems store significant carbon, but are increasingly threatened by land-use changes, habitat degradation, and climate change. By measuring blue carbon, the hidden climate value of mangroves can be recognized, helping to prioritize conservation efforts and develop nature-based solutions that enhance both biodiversity and carbon storage. This study aimed to quantify the spatiotemporal changes of mangrove carbon storage in the Rekawa Lagoon, Sri Lanka, over a two-decade period (2001–2021), by integrating Land Use/Land Cover (LULC) maps with the InVEST model (Integrated Valuation of Ecosystem Services and Tradeoffs). Field assessments were conducted to estimate four carbon pools: above-ground biomass, below-ground biomass, soil organic carbon, and dead organic carbon across the sampling sites according to the Blue Carbon Manual. LULC maps for 2001, 2007, 2014, and 2021 were developed using the unsupervised classification technique in ArcGIS 10.6.1 to detect changes in mangrove extent. The recorded mangrove extents were 109, 92, 97, and 100 ha, respectively, in the four years considered. These LULC maps and carbon pool data were then used as inputs in the InVEST model to estimate above-ground, below-ground, soil, and total carbon stocks over a two-decade period. Results indicated that the mangrove extent of the Rekawa Lagoon showed an 8% loss over the study period, with a declining trend (16%) from 2001–2007, and a partial recovery from 2007–2014 (6%) and 2014–2021 (3%). The resulting carbon maps showed notable trends in both carbon sequestration and carbon emissions over the 20 years. The total carbon storage in mangroves was 75,949 MgC in 2001, declining to 63,888 MgC in 2007, followed by a gradual recovery to 67,783 MgC in 2014 and 69,730 MgC in 2021. The initial degradation of carbon stocks may be attributed to settlement expansion, habitat destruction, and the tsunami catastrophe, whereas the observed recovery trend suggests regeneration and conservation efforts. Therefore, the present study highlights the importance of integrating field data, remote sensing, and spatial modelling in assessing blue carbon dynamics. Further, this approach gives a robust scientific basis to develop evidence-based policy, carbon offset planning, and sustainable coastal zone management in Sri Lanka.

Keywords: *Blue carbon, InVEST model, Land use change, Mangroves, Rekawa Lagoon*