Valuing Mangrove Oxygen Production as a Co-benefit in the Blue Carbon Market: A Case Study from Negombo, Sri Lanka, 2010 vs 2025

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Current blue carbon frameworks emphasise carbon sequestration and under-evaluate the oxygen-releasing role, and hence capture only half of the biogeochemical contribution of mangrove ecosystems. The current study evaluates the oxygen-releasing amount of existing mangrove biomass and its temporal change over 2010 – 2025. The study was conducted at the Kadolkele Mangrove Reserve in the Negombo Lagoon, Sri Lanka. Three random belt transects (10 m width) were laid perpendicular to the shoreline and subdivided into 10m × 10m (100 m²) sampling units (12). Biomass (total above- and belowground) of mangroves was estimated using allometric methods. The estimated amount of oxygen released from the existing biomass was calculated by converting biomass into carbon stocks (applying a carbon conversion factor of 0.47), then converting into molecular oxygen using the stoichiometric relationships inherent to photosynthesis. The economic value of oxygen released by mangrove biomass was estimated using a cylinder-based (medical oxygen cylinder) replacement approach. From 2010 to 2025, 18.8% of biomass increment and 16.5% of total organic carbon (TOC) level increment were observed, resulting in a 21.1% of raise of oxygen release from 171.10 to 207.73 million L ha^{-1}. The economic value of the amount of oxygen released from the total mangrove area of 14 ha reveals a proportional increment, rising from approximately LKR 10.06 billion (USD 30.5 million) in 2010 to LKR 12.18 billion (USD 36.9 million) in 2025. Representing a theoretical ecosystem magnitude, the estimated oxygen release from mangrove biomass per hectare corresponds to the annual oxygen requirement of approximately 946 individuals in 2025 and 781 in 2010, based on the standard per capita oxygen consumption. This study highlights the substantial ecological and economic value of mangrove ecosystems through their role in oxygen production. Integrating oxygen-releasing ecosystem services into policy frameworks will strengthen conservation strategies, highlighting the tangible benefits. This quantification and economic valuation provide a novel and tangible metric for integrating ecological functions into the blue economy framework.

Keywords: *Oxygen production, Ecosystem valuation, Biogeochemical cycling, Blue economy, ecological service*