Assessing Landscape Cumulative Impacts of Natural and Human Disturbances on Mangrove Carbon Storage in Puerto Rico (Jobos Bay)

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Mangrove wetlands are considered one of the most efficient global carbon sinks due to their carbon storage capacity (i.e., Blue Carbon, BC). Yet, they are negatively impacted by the increasing interaction of human and natural disturbances, triggering a significant global reduction. If BC markets are broadly implemented as a climate change mitigation measure, potential funding from these markets might be available to advance mangrove rehabilitation and restoration (R/R) projects. Yet, accurate carbon inventories are needed to monetize these inventories with reduced uncertainty at different spatial scales—especially to identify potential BC recovery and loss trajectories as financial systems develop in the following decades. Here, we analyze the spatial distribution of mangrove BC stocks in different sites across the Jobos Bay National Estuarine Research Reserve (JBNERR) in Puerto Rico's south coastal plain. Local and watershed-level hydrological alterations due to agriculture expansion, road construction, and urban development have historically impacted these areas (A, B, C, D). In addition, these areas were affected by hurricanes Maria and Irma in 2017. Two types of surveys were performed in each region to determine the spatial variability of total organic carbon (TOC) along transects ranging from 5-25 (stratified survey) to up to 900 (systematic survey) meters; the sampling occurred in the period 2022-2023. The TOC stock includes values for the soil, aboveground biomass, dead wood, pneumatophores, and litterfall compartments. All areas showed soil hypersalinity (pore-water) conditions (>60 ppt), particularly in inland areas (range 70- 140 ppt) at lower elevations and where extensive mangrove dieback was evident. TOC ranged from 217 to 455 MgC/ha, where the soil compartment contributed >90% of the total TOC; the higher values were measured in area B, followed by D, A, and C. These TOC values are less than half the mangrove global mean, underscoring the current and cumulative negative impact affecting mangrove spatial distribution and productivity in the JBNERR. The net difference in TOC densities among sites and within transects at each site helped delineate a timeline of sequential and cumulative adverse impacts in the JBNERR (site D), the Bosque Estatal de Aguirre (site B), and sites A and C. Despite the low value of aboveground TOC in site D, the mean soil TOC is higher (398 ± 40 MgC/ha) than in sites A (304 ± 29 MgC/ha) and C (153 ± 15 MgC/ha), where human impacts) are extensive (road construction). A regional TOC loss was estimated at ~419 MgC/ha, equivalent to an emission (CO_2 equivalent units) of 1537 Mg/ha CO_2eq. This is the first landscape-level blue carbon storage capacity study in heavily impacted forests in southern Puerto Rico. This study also underscores the need for holistic conservation approaches to ensure mangrove wetland resilience under significant human impacts interacting with climate change in the Caribbean region.