Sea Level Rise Alters Salt Marshes' Carbon Storage Capacity

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Accelerating sea level rise (SLR) is reshaping coastal salt marshes, vital ecosystems for long-term carbon sequestration. The Great Sippewissett Marsh in Cape Cod, Massachusetts, experiences an SLR rate nearly twice the global average, making it an ideal model to study SLR impacts on marsh vegetation and below-ground carbon storage in Northeast U.S. salt marshes. As SLR progresses, *Spartina alterniflora*, a low marsh species, increasingly encroaches upon high marsh zones historically dominated by *Spartina patens*. This shift creates a transition zone where high marsh vegetation is progressively supplanted by low marsh species. Although this vegetation replacement is evident, its implications for long-term carbon storage remain unclear.

This study assessed the carbon storage capacity along a transect extending from the low marsh across the transition zone to the high marsh. Below-ground biomass and soil organic carbon (SOC), as well as sediment accretion rates, were measured in replicated 30 cm sediment cores collected from each marsh zone. Our findings demonstrate that high marsh zones retain more stable sedimentary carbon than low marsh zones. Transition zone profiles of SOC revealed distinct stratification, with an upper layer (0-15cm), newly colonized by *S. alterniflora* resembling the low marsh, which had a lower SOC content. In contrast, the lower layer (15-30cm) retained the former high marsh traits, including higher SOC content. Estimates of the carbon burial rates varied significantly, with high marsh zones sequestering 116 $gC/m^2/yr$, considerably exceeding the 76 $gC/m^2/yr$ of the low marsh.

The significant carbon storage gap between high and low marsh zones suggests that transition zones act less as intermediaries and more as discrete zones, decreasing carbon storage efficiency as they shift toward low marsh characteristics. These findings reveal a decline in carbon storage capacity as high marsh converts to low marsh under SLR, emphasizing the importance of considering plant zonation shifts when assessing salt marsh resilience and their role in climate mitigation amid accelerating sea level rise.