Using a Soil Survey Approach to Quantify and Understand the Fate of Blue Carbon: A Case Study of the Albemarle-Pamlico Estuary, North Carolina - Andrew Reuben Wilson

A national cooperative effort is underway to map coastal zone areas due to their importance in carbon storage. The Albemarle-Pamlico Estuary (APE) is the second largest estuarine system in the United States and covers approximately 809,000 hectares of North Carolina and Virginia. We examined 12 wetland sites in the APE peninsula consisting of the 3 major ecosystems in the region: tidal forested (average salinity, 0.16–1.64 ppt); degraded oligohaline tidal forests (4.32–8.32 ppt); and established mesohaline tidal marshes (12.0–15.5 ppt). A nearshore-offshore sampling design was implemented. The design encompassed historical terrestrial soils being lost to submergence (nearshore) and subaqueous soils older than the 1980s soil survey map boundaries (offshore). At each site, data was gathered on subaqueous and terrestrial peat depth and morphology to understand the fate of peat upon submergence. When nearshore, subaqueous total carbon (C) pools (Mg C/ ha) were compared to terrestrial ecosystem equivalents tidal forests lost 730±343, ghost forests lost 564±315, and marshes lost 471±206 of their respective C pools upon submersion. None of the 3 types of ecosystems were found to be significantly different ($p = 0.2252$). Pb-210 radiometric dating was also used to determine terrestrial accretion and carbon sequestration rates. When comparing carbon sequestration rates between ecosystems (kg*C/m2 yr), tidal forests sequestered (0.15 ± 0.03) significantly more ($p = 0.0263$) than tidal marshes (0.06±0.02). These data will be used to direct land management decisions and better understand the effects of sea-level rise induced submersion and erosion on soil C stocks.

USDA - NRCS Coastal Zone Soil Survey and Quantifing Blue Carbon Stocks - David Steinmann

As the scientific community continues to value blue carbon studies to quantify carbon sequestration rates, the USDA’s Natural Resources Conservation Service recognizes the significant role Coastal Zone Soil Survey (CZSS) will play in this effort. As the nation’s lead in mapping and evaluating soil resources, studying and quantifying carbon values will continue in the coastal zone. CZSS inventories describe soils to 2 meters, allowing for a deeper understanding of blue carbon stocks. A detailed look into how CZSS mapping can assist with quantifying blue carbon stocks.

Strategies for re-establishing carbon storage in restored blue carbon ecosystems - Judith Drexler

Restoration of blue carbon ecosystems (BCEs), including mangroves, tidal marshes, and seagrasses, is increasingly being used as a nature-based climate solution. Research on sites along the U.S. Pacific coast and Hawai‘i has shown that hydrologic alteration, elevation of the wetland surface within the tidal frame, and presence of invasive plants can reduce the capacity of BCEs to store carbon after restoration. For example, hydrologic alteration can result in surface desiccation and hyper-saline conditions in BCEs. This has occurred along the southern shore of Moloka‘i, Hawai‘i, resulting in low vegetative cover, which limits carbon accumulation. In addition, improper site grading can lead to stunted and/or sparse vegetation or even marsh drowning. In the Nisqually National Wildlife Refuge (Washington), low initial surface elevation of restored marshes has resulted in slow recolonization of vegetation. Soon after restoration, this did not affect carbon accumulation rates due to subsidies from neighboring marshes, but it could ultimately reduce carbon storage because erosion is typically greater on mudflats than marshes. Finally, in marshes in the San Francisco Estuary, invasive water primrose (Ludwigia hexapetala) is displacing native Schoenoplectus species (bulrushes). Major differences in root structure between water primrose and native vegetation will likely lead to decreased carbon storage in infested marshes. The main lessons learned from these examples are that current and projected future surface elevations of restored BCEs must be well understood, hydrology needs to closely resemble reference sites, and early eradication of invasive flora are critical for re-establishing durable carbon storage.

Using Pedogeomorphic Units and Soil Morphology to Model Soil Carbon Stocks in Southern New England's Tidal Marshes - Joe Manetta

Managing coastal ecosystems requires an inventory of the soils and associated resources. In this study, we addressed the challenges of quantifying soil carbon stocks in tidal marsh ecosystems in Southern New England (SNE) and modeling those stocks at both the regional and pedon level. Soils from 32 SNE marshes were described and sampled along transects in four different pedogeomorphic units: back barrier, cove, tidal creek, and tidal river. Pedon-level carbon stocks were modeled by grouping soil materials based on soil morphological properties and PGUs to develop soil material groups (SMGs). The final grouping of SMGs included 2 organic material SMGs, and 3 mineral SMGs. Soil material groups were found to accurately model carbon stocks of previously described soils ($p<0.0001$). Our findings revealed significant differences ($p<0.001$) in carbon stocks among the pedogeomorphic units (PGUs), with cove marshes exhibiting the highest mean carbon stock at 100 cm (46 kg m-2) and 200 cm (83 kg m-2) depths and back barriers holding the least amount of carbon at 100 cm (20 kg m-2) and 200 cm (27 kg m-2). All PGUs, except back barriers, held more carbon than when applying a previously suggested universal single value for the contiguous United States (27.0 kg m-3), suggesting that a regional-based pedogeomorphic approach is more effective than a broad-scale carbon density value. Coastal managers interested in coastal blue carbon, carbon credits, and marsh restoration should consider inventorying tidal marsh resources using a pedogeomorphic units approach.

An improved approach for estimating blue carbon stocks in Mid-Atlantic tidal marsh soils - Jordan Kim

Sound estimations of blue carbon (C) stocks are critical in tidal marshes because the marshes store a disproportionately large quantity of blue C despite their small areal extent. Previous research has suggested that the most accurate approach for estimating C stocks in tidal wetlands was to use a fixed C density value. However, this method neglects the dramatic heterogeneity found in marsh soils, which vary based on the particular geomorphic setting in which a marsh has formed. In this study, we collected and analyzed 454 samples from 72 pedons across the Mid-Atlantic region. Carbon stocks to 200 cm were calculated for these pedons. Additionally, nine types of marsh soil materials were distinguished based upon their morphological characteristics and pedogeomorphic setting. The mean C density of each material group was calculated, and significant differences were found between the means of some types. An approach for estimating C stocks (in the absence of lab data) was developed by joining these mean C densities with a standard soil morphological description. Our analysis demonstrates that this approach generates reasonable and reliable estimates compared to using a single C density value. It is also a more efficient way of acquiring data without sacrificing accuracy because it only requires that one obtain a morphological description. The mean C density method should continue to be applied in the Mid-Atlantic and possibly adapted and refined for use in other regions. This approach to estimation may be developed in additional coastal zone ecosystems (like subaqueous soils) that store significant amounts of blue C.