Carbon storage in Piermont Marsh, Hudson River Estuary

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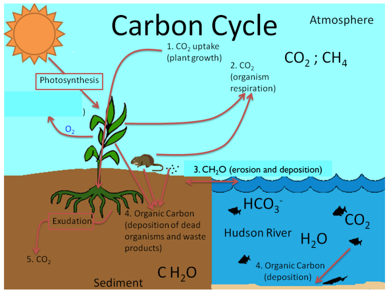
Abstract:

The carbon storage potential of coastal wetlands is high due to rapid sediment accumulation rates and high plant productivity. We explored the spatial variability of sediment carbon content in brackish Piermont Marsh (73°54'W, 41°02'N), located ~ 40 km above the mouth of New York's Hudson River Estuary. We measured organic content of sediments from the marsh surface and 1-2 meter sediment cores by the Loss-On-Ignition method (LOI). By comparing LOI results with % carbon measured by an Elemental Analyzer (30 samples), we determined that organic matter in Piermont Marsh is approximately 62% carbon. Estimated %C increases from 5% near depositional stream banks up to 34% near stable pools within the central marsh. Carbon density ranges from 0.01 – 0.04 g C cm^{-3}. When coupled with accumulation rates, this information will improve our understanding of modern carbon cycle dynamics in the Hudson River Estuary. Core samples show that carbon and nitrogen shifted during the past 1,000 years in response to human impact due to farming, manure, introduction of invasive species, and erosion.

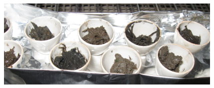
Introduction:

Carbon dioxide is a greenhouse gas that contributes to global warming. Carbon is also found in organic remains. Although removed from the atmosphere through photosynthesis, it can be returned via microbial metabolism or fossil fuel combustion. The modern increase of atmospheric CO_2 is influencing global average temperature, which can cause changes within ecosystems. Piermont marsh is home to the native *Spartina alterniflora* and *Schoenplectus americanus* as well as the invasive *Phragmites australis* and *Typha angustifolia*. Piermont undergoes tidal fluctuations and the salinity ranges from 5 to 18 ppt (brackish). During spring tides and storm surges, the marsh is partially flooded and creeks overflow their boundaries.

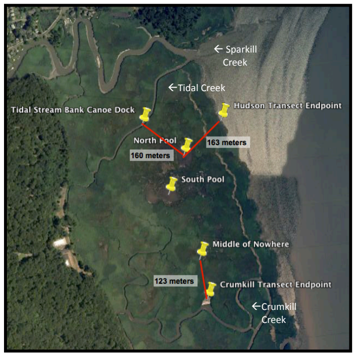


Methods:

- •Transects were made from Tidal to Pool One and from Pool One to the Hudson River; each 160 meters.
- •Samples were taken approximately 15-20 meters apart.
- •A Russian Peat corer was buried two meters into the marsh, and cores were placed on meter long cut PVC pipes.
- •Down core samples were analyzed using a Munsell soil color chart and were sent to Cornell for isotope analysis: an elemental analyzer and a mass spectrometer were used there.
- •Combustion was used to determine both LOI and carbon percentage. Final carbon percentage was determined through the formula: Carbon (%) = (.635)xLOI+(.0000435)xLOI^2.

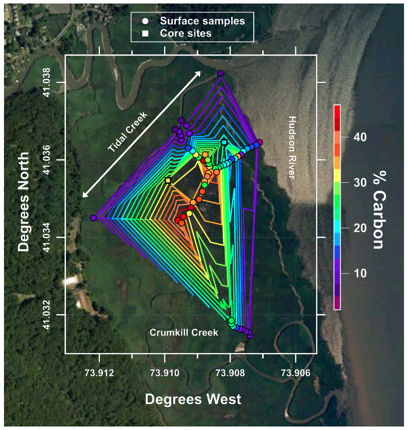


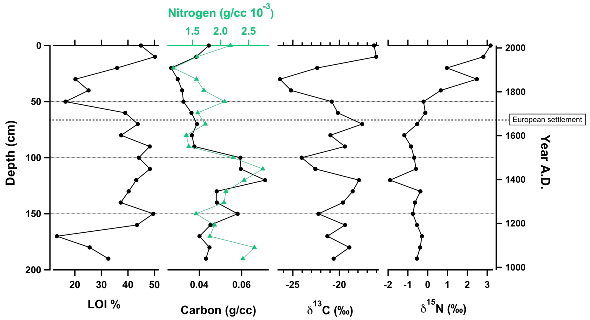
Results:



Above: Map sample transects and major features in Piermont Marsh.

Right: Figure 1 illustrates the surface samples' carbon percentages throughout the marsh. Carbon percentages are higher in the interior, near the pools, and lower near the streams and Hudson River.





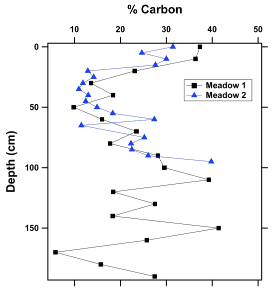
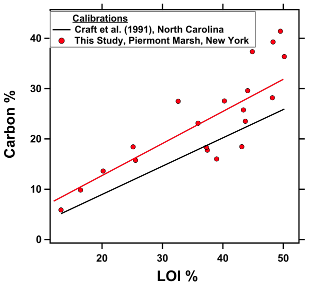
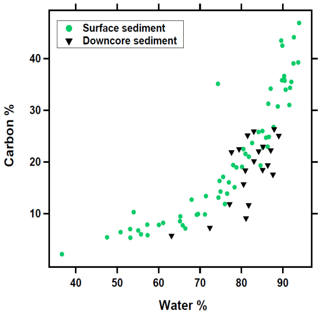


Figure 3 is a comparison of nitrogen and carbon percentages, and nitrogen and carbon isotopes throughout the last ~1400 years. The age model is based on Pederson et al. (2005), who used AMS radiocarbon dates on identified macrofossils to determine sedimentation rate. Figure 4 shows carbon percentages of the two sediment cores taken from Meadow 1 and Meadow 2. The fact that we see similar down-core patterns at both sites and the previous core suggests that these sediments are influenced by broad, marsh-wide processes.



Left: A comparison of carbon percentages estimated from two different LOI to carbon formulas. The red circles represent our own calibration based on %C measurements done by elemental analyzer at Cornell University, and %LOI measurements performed at Lamont Doherty Earth Observatory.

Right: Carbon and water are positively correlated in both surface and down-core samples.



Left: *Spartina* meadow
Right: Taking a sediment core

Conclusions:

- •Sediment within the interior of the marsh contains more carbon (up to ~50% by weight) than on the stream and river banks (~5%).
- • The concentration of organic matter in near-bank sediments may be lower due to dilution with inorganic sediment – clays and silts.
- •It is also possible that organic matter concentrations are higher towards the marsh interior because conditions there are wetter and thus more anoxic, creating more favorable conditions for organic matter preservation. Our results show that carbon storage in marshes is heterogeneous, and imply that it is the deep marsh interior that is the most important sequestration area.
- •Reducing the size of marshes (converting them to small, "near-bank" environments) may thus drastically decrease their capacity for carbon storage.
- •European settlement led to greater watershed erosion, which may have increased silt and clay delivery to the marsh and led to lower %C. Nitrogen isotopes may have increased because of manure; decreases may be due to modern fertilizers (isotopically lighter than manure). The introduction of *Phragmites* may have led to an increase in carbon.

Future Work:

- •Analyze more areas within the marsh to get a clear spatial understanding of carbon distribution.
- •Test vegetation and vegetation density impacts on carbon sequestration keeping in mind native and invasive species in the marsh.

Acknowledgments:

We would like to acknowledge Katherine Allen for her guidance and assistance throughout the course of the project. We would also like to thank Dr. Robert Newton, Susan Vincent, Dr. Dorothy Peteet, and the services provided by Lamont-Doherty Earth Observatory. A special thanks is extended to Bill Herguth, owner of Paradise Boats, for logistical support.

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