Comparing Piermont Marsh Blue Carbon Storage Capacity to Our Carbon Footprint

Columbia University Earth Institute Spring 2020 Research Showcase

Research Summary: *Tidal marshes play crucial roles in carbon capture and storage. With climate change and rising sea level, it is important that we preserve them to the greatest extent given their huge carbon storage potential. This study investigates carbon storage capacity of Piermont Marsh (Figure 1), one of the tidal marshes along the Hudson River, and compares its capacity to our carbon footprint. By analyzing a sediment core taken at Piermont Marsh, we were able to determine its carbon content (g/cm³) at each depth layer (Figure 2) (Peteet et al., 2020), which we then took an average of to use as a reference for estimating the total carbon storage at Piermont Marsh (as shown on the right). Knowing the average depth of Piermont is roughly 10 m and the marsh area is approximately 109 ha, we determine the total carbon content in Piermont to be roughly 353,000 tons.*

- **Carbon (g) per core per depth** = LOI * dry weight (g) * 0.5
- **Organic matter (OM) (g)** = Carbon (g) * 2
- **OM (% of dry weight)** = OM (g) / dry weight (g)
- **Bulk density (bd) (g/cc)** = dry weight (g) / 2
- **Organic matter content (g/cm^3)** = OM (% of dry weight) * bd
- **Carbon Content (g/cm³)** = Organic matter content * 0.52

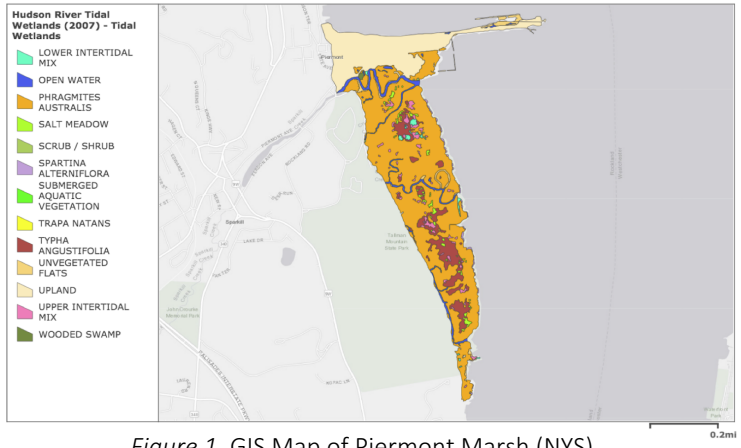

Figure 1. GIS Map of Piermont Marsh (NYS).

Piermont stores **353,000 tons of carbon,**
*which is equivalent to **annual emissions** of*

280,000 vehicles
217,000 NYC residents
3% of annual NYC emissions

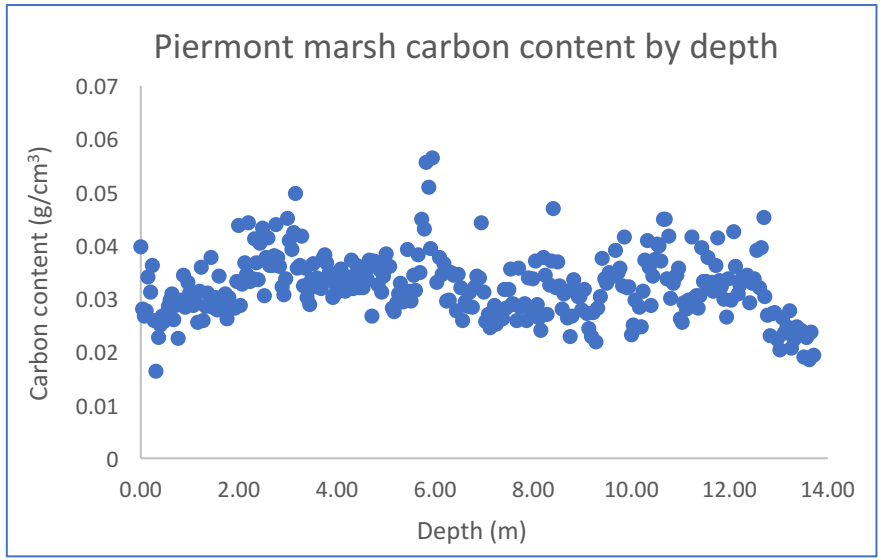

Figure 2. Piermont marsh carbon content by depth.

Piermont average depth (cm)	1,000
Piermont area (cm²)	1.09E+10
Piermont volume (V) (cm³)	*1.09E+13*
Average carbon content per cm³ (avg cc) (g/cm³)	*0.0323*
Total carbon content in Piermont (tons) = avg cc * V * 10E-6	**352,987**

CO_2 atomic mass	44.009
Carbon atomic mass	12.011
Oxygen atomic mass	15.999
Weight % of carbon per CO_2 molecule	**27.29%**

NYC total emission in 2017 (tCO_2e) (nyu.edu)	50,692,925
Carbon in NYC 2017 total emission (tons)	*1.38E+07*
# of Piermonts to store annual NYC emissions	**39**
Carbon stored in Piermont as a % of annual NYC emissions	**3%**

NYC population (appoximate average of recent 5 years)	8,500,000
NYC per capita emission in 2017 (tCO_2e)	5.96
Carbon in NYC per capita emission in 2017 (tons)	*1.63*
# of NYC residents Piermont can store annual emissions for	**216,867**

Average vehicle emission per year (tCO_2e/vehicle) (epa.gov)	4.63
Carbon in per average vehicle emission in 2017 (tons)	*1.26*
# of registered vehicles in the U.S. in 2017 (bts.gov)	272,480,899
Total emissions from vehicles in 2017 (tCO_2e)	1.26E+09
Carbon in all U.S. vehicle emissions in 2017 (tons)	*3.44E+08*
# of Piermonts to store all annual U.S. vehicle emissions	**975**
# of vehicles Piermont can store annual emissions for	**279,344**

Select References:

1. Craft, C. B., Seneca, E. D., & Broome, S. W. (1991). Loss on ignition and Kjeldahl digestion for estimating organic carbon and total nitrogen in estuarine marsh soils: calibration with dry combustion. *Estuaries*, *14*(2), 175-179.
2. Kauffman, J. B., Heider, C., Cole, T. G., Dwire, K. A., & Donato, D. C. (2011). Ecosystem carbon stocks of Micronesian mangrove forests. *Wetlands*, *31*(2), 343-352.
3. Pendleton, L., Donato, D. C., Murray, B. C., Crooks, S., Jenkins, W. A., Sifleet, S., ... & Megonigal, P. (2012). Estimating global "blue carbon" emissions from conversion and degradation of vegetated coastal ecosystems. *PloS one*, *7*(9).
4. Peteet, D. M., Nichols, J., Kenna, T., Chang, C., Browne, J., Reza, M., ... & Stern-Protz, S. (2018). Sediment starvation destroys New York City marshes' resistance to sea level rise. *Proceedings of the National Academy of Sciences*, *115*(41), 10281-10286.
5. Peteet, D., et al. (2020). Climate and Anthropogenic Controls on Blue Carbon Sequestration in Hudson River Tidal Marsh, Piermont, New York. *Environmental Research Letters.*

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