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Characterization of Current and Historical Variations in Sediment Accretion and Carbon Dynamics at the Rice Rivers Center Kimages Creek Wetland Restoration

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Introduction

Current research of freshwater wetland soils have assessed and reported smaller stocks of soil organic carbon in restored wetlands compared to reference natural wetlands[1]. However, a majority of these studies focus on sites restored from agricultural draining of non-tidal depressional wetlands [2,4,5],whereas carbon and accretion dynamics in tidal freshwater wetlands restored via dam removal is poorly understood. The U.S. Army Corps of Engineers estimates over 80,000 dams greater than 6 feet and tens of thousands of smaller dams pepper the U.S., of which the majority are unsafe, old or no longer serve their intended purpose[3].

Damming disrupts the natural flow of sediment to adjoining water bodies resulting in the accumulation of what are commonly referred to as Legacy Sediments (LS). These sediments have the ability to alter the biology, hydrology, geomorphology, and biogeochemistry of their river corridors and adjacent riparian ecosystems[6]. While the effect of these sediment inputs on ecosystem function has been well investigated in non-tidal regions, particularly in the form of milldam removal[7,8,9,10], there has been little-to-no inquiry on how LS exist within and affect tidal wetlands and their biotic and abiotic processes.

History

The VCU Rice Rivers Center, located on the lower James River in Charles City County, Virginia, houses one of the largest wetland and stream restorations in the mid-Atlantic region. Running through the site is Kimages Creek (KC), which was dammed in 1927 at its confluence with the James River. This resulted in a 70 acre impoundment known as Lake Charles. Prior to damming, the KC basin was a forested tidal freshwater wetland (TFW) that was logged once before the civil war and once prior to the dam establishment. In 2007, the dam was partially breached and in 2010 a portion of the dam was removed, restoring tidal communication.

Figure 1. KC Wetland Restoration. Pre-restoration (upper left): Impoundment of KC, former Lake Charles. Transitional (upper right): partial breach in 2007. Restored (lower): partial removal of dam in 2010. By Bukaveckas & Wood, 2014

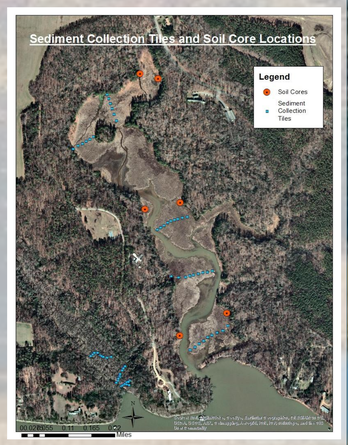
Research Objectives

- Quantify the current temporal and spatial variation in sediment deposition and soil carbon dynamics within KC and Harris Creek (HC) wetlands via sediment collection tiles (SCTs).
- Assess the differences in LS characteristics along the tidal to non-tidal gradient and between different depositional areas through soil core sampling and radiocarbon dating.
- Compare carbon sequestration and sediment accretion rates between the two historical environments; the pre-impoundment forested freshwater wetland & the Lake Charles environment (LS).

Methods

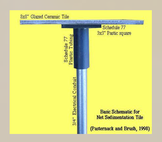
Legacy Sediment Characterization:

- Using the standard penetration test coupled with current stratigraphic information of the site, a series of 5', 10', 15', and 20' 2" diameter PVC cores are driven down until the bedrock layer is located.
- Cores extracted from locations ranging the tidal to non-tidal gradient as well as between point bars and cut banks.
- The cores are then split and segmented into 10cm intervals. Each interval is then analyzed for bulk density, organic and carbon content, texture, and color.
- Two samples are collected below the LS barrier for radiocarbon dating in both a tidal and a non-tidal core (n=4).



Contemporary Sediment Accretion :

- Sediment collection tile (SCT) transects arranged in a random block design spanning elevational and tidal to non-tidal gradients.
- Tiles are sampled bi-monthly for the growing season and monthly thereafter.
- Simultaneously, shallow surface cores are taken to calculate bulk density while tile samples are analyzed for organic matter content.



Acknowledgements

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Preliminary Findings

Legacy Sediment Characterization:

- 3 preliminary cores have been taken at this site and the barrier between the end of LS and beginning of historic creek bank has been determined via texture analysis.
- O.M. content was lower in the non-tidal core with a higher proportion of sand.

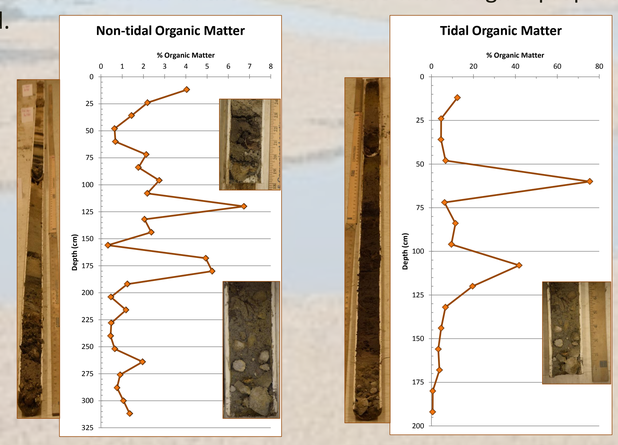


Table 1. Soil profiles characteristics between tidal and non-tidal cores

Core	Developing LS A Horizon (cm)	LS B Horizon (cm)	Relict Hydric Soil (cm)	Bed Rock Basal Gravels (cm)
Non-tidal	25	150	25	-
Tidal	20	150	140	15

Contemporary Sediment Accretion:

- Samples from the SCTs that have been gathered since deployment have shown higher deposition in tidal areas and in areas closest to primary sediment sources (creek banks or seeps).

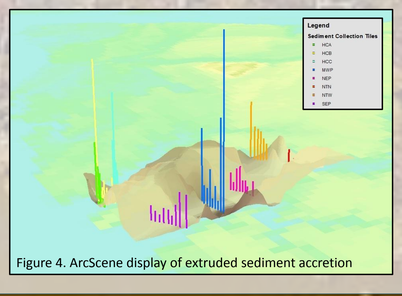
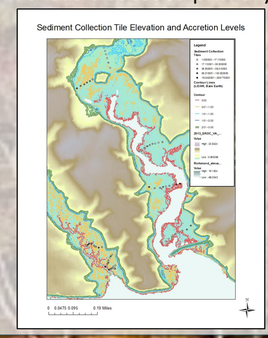


Figure 4. ArcScene display of extruded sediment accretion



Future Work

- In order to further define the LS barrier across the site, 8 to 10 more cores will be taken along the tidal to non-tidal gradient, as well as in different depositional areas to quantify how much LS has been lost following dam removal.
- Cesium[137] dating will be conducted within KC and HC to gain a more accurate estimate of decadal scale vertical accretion and carbon accumulation.
- Surface Elevation Tables (SETs) and feldspar marker horizons will be established in both sites and in two neighboring forested TFWs to understand how this restoration site compares to natural reference wetlands.