A Short Term Study of the Sedimentation of Haha Cove

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Abstract

Sedimentation data was collected for a tidal mudflat in Abingdon, Maryland from June-August 2011. Data was collected using poles, tile traps, and funnel traps. They gave the following rates of sedimentation: -0.12cm/day, 0.09cm/day, and 0.03cm/day, respectively. The funnel traps probably gave the most reliable of the results and provide us with a rough estimate of the summer sedimentation rate at this site.

Introduction

Sedimentation is the process of sediment being deposited by and building up in bodies of water (Jiyu et al. 1990). It is generally most pronounced at the mouths of rivers where the transition from moving water to still water allows the sediment to settle to the bottom. Sedimentation always occurs naturally, but anthropogenic factors such as deforestation, impervious surfaces, and construction often greatly increase its rate by causing more sediment to enter the water ways. The goal of this research project was to asses the rate of sedimentation of Haha Cove, a tidal mudflat.

Materials and Methods

Study Site

Haha Cove is a tidal mud flat located in Abingdon, Maryland. It is fed by Haha Branch to the north, and it empties into Otter Point Creek to the east. During high tides, the entire cove is under water. During low tides, however, a large section of the cove (the area at the mouth of Haha Branch) drains and becomes a large mudflat. This mudflat is frequently visited by foraging shore birds, and is an important part of the marsh.

Experimental Design

The rate of sedimentation was measured using three methods: poles, tile traps, and funnel traps (Gardner 1980). Poles were made of ½ inch PVC and were marked in 15 centimeter (cm) increments. At the start of the study, the poles were driven into the mud such that 30cm was sticking out (e.g. the second 15cm mark was flush with the surface of the mudflat). The tile traps were 10.8x10.8cm ceramic tiles that were laid on the surface of the mudflat (Morse et al. 2004). Funnel traps consisted of a plastic funnel (13.0 cm diameter) with a screw on collection bottle attached to the bottom (Lund-Hansen 1991). To keep the funnel traps in place, large pieces of PVC were embedded in the mud so that the bottle could fit down inside the pipe with the funnel protruding out of the top. The funnels were attached to the pipes using thin wire. The pipes were embedded such that the lip of the funnels were 3-4cm above the surface of the mud.

Nine stations were established in the cove (Figure 1). The center station (C) was placed in the center of the area that fully drained. A magnetic compass was used to place four of the other stations 20 meters (m) from C. They were place 20m north (N), 20m east (E), 20m south (S), and 20m west (W). The remaining four were place 10m from C. They were placed 10m northeast (NE), 10m southeast (SE), 10m southwest (SW), and 10m northwest (NW). Each station consisted of one funnel trap in the center, two tile traps 0.5m from the funnel trap in the direction of the station (e.g. station N hat a tile trap 0.5m north of the funnel trap and 0.5m south of the funnel trap), and one pole 0.25m right of the funnel trap when facing the direction of the station (Figure 1).

Traps were checked weekly at low tide from June-August 2011. To check the poles, the height of the sediment immediately around each pole was measured on the north, east, south, and west sides using a meter stick and the 15cm marks (e.g. if the sediment was 28cm from the top, then it had risen 2cm from the start of the study). To collect the sediment on the tile traps, the tiles were carefully lifted and the sediment on top of them was carefully scraped into a clean, labeled collection jar. Distilled water was used to rinse the top of the tile. After removing the sediment, the tile was place back in its previous location. Five weeks into the study, a large *Hydrilla* bloom coated the study site and prevented us from continuing to use the tile method, so only 4 weeks of data was collected from that method. To collect the sediment trapped in the funnels, any water and sediment that was still in the funnel itself was carefully pored and rinsed into a clean, labeled collection bottle (distilled water was used), then, the bottle that was currently attached to the funnel was unscrewed and a clean bottle was put in its place. If there was vegetation in the funnel, then the sediment on it was carefully rinsed into a bottle and the plant was discarded.

To actually measure the sediment, the sediment and water in the collection bottles were allowed to settle for several days until the sediment hat settled out of solution. The water was then carefully pored off, and the sediment was pored into tared drying trays (preliminary tests showed that the residual amount of sediment in the water that was pored off was <0.1 grams (g) per bottle, and therefore insignificant). A minimal amount of distilled water was used to rinse the remaining sediment into the trays. The trays were then allowed to completely dry in a greenhouse. Once dry, the trays with sediment were weighed to the nearest 0.1g and the mass of the trays was subtracted, providing us with the mas of the sediment.

Calculations/Statistical Analysis

Because we were interested in the height of sediment accumulation, it was necessary to convert from grams to centimeters. To do this, two sediment samples were collected from each station on the day that the stations were established. They were collected from roughly the positions on the tiles. The samples were taken to the lab and suspended in distilled water. They were then pored into tared containers of a known volume and allowed to dry in a greenhouse (this simulated the natural deposition of sediments by moving water). Once dry, the excess sediment was scraped off and the outside of the containers were thoroughly cleaned. The sediment samples were then weighed and averaged proving us with a mean of 1.27g/cm^3. This mean was used for all subsequent calculations.

To convert the results of the tile traps and funnel traps into centimeters, the mass of the sediment was converted to cm^3 by multiplying by 1.27g/cm^3. This volume was then divided by the area of either the tile or the funnel (depending on the sample) resulting in a linear measurement of sediment height. Finally, the measurements for each week were averaged and divided by the number of days since the last time that the traps were checked, resulting in a mean cm/day of sediment accumulation. For the poles, it was only necessary to average and divide by the number of days since the raw data was already in cm.

Because of the accuracy of the data, statistical test were only performed on the data from the funnel traps. The data was analyzed in two ways. First, a Kruskal-Wallis test ($\alpha = 0.05$) followed by a post-hoc analysis of the least significant difference between mean ranks was used to compare the results from each of the nine stations (this was (Figures 2-3). Second, a Spearman rank correlation ($\alpha = 0.05$) was used to look for a correlation between the rate of sedimentation and daily rainfall (Figure 4).

Results

Each collection method gave a very different result. The mean rate of sedimentation for the poles, tile traps, and funnel traps were -0.12cm/day, 0.09cm/day, and 0.03cm/day respectively. The Kruskal-Wallis test (H = 29.687, d.f. = 8, P = 0.001) showed that there were significant differences between some of the stations (Figures 2-3). The Spearman rank test (r_s = 0.782, P = 0.008) showed that there was a positive linear correlation between rainfall and sediment accumulation (Figure 4). The critical value was taken from Ramsey (1989).

Discussion

The disparity among the methods is disturbing, but plausible explanations exist. Moving water has a tendency to cut out the sediment around a rounded object such as a stone or a pole. Thus, the poles likely gave a negative result (e.g. sediment was lost rather than gained) because the flowing water eroded the sediment immediately around the pole. The tiles suffered the flaw of being small and heavy which would give them the tendency to sink into the mud and accumulate an unrealistically high amount of sediment (Morse et al. 2004). The funnel traps, however, did not suffer either of these flaws and should have been the most reliable of our methods. Also, the fact that the results of the funnel traps correlated closely with the rainfall gives strong support for the reliability of this method. Rainfall greatly increases the amount of sediment that washes into waterways, so we would expect sedimentation to correlate closely with rainfall (Stumpf 1988). The differences noted in the Kruskal-Wallis test are probably do to the pattern of drainage caused by water flowing from Haha Branch. This should be taken into account when considering management options.

This study provides excellent preliminary data, however, it suffers several handicaps. First, it was very short term. Data should be collected over a longer period of time for increased accuracy. Second, all of the data was collected during “normal” weather, but events such as droughts and storms can cause major changes in rates of sedimentation (Yang et al. 2007). Also, data was only collected during the summer, but sedimentation rates often vary with season (Childers et al. 1993). Despite these limitations, our results still provide valuable baseline data that will help guide research in future years.

Acknowledgments

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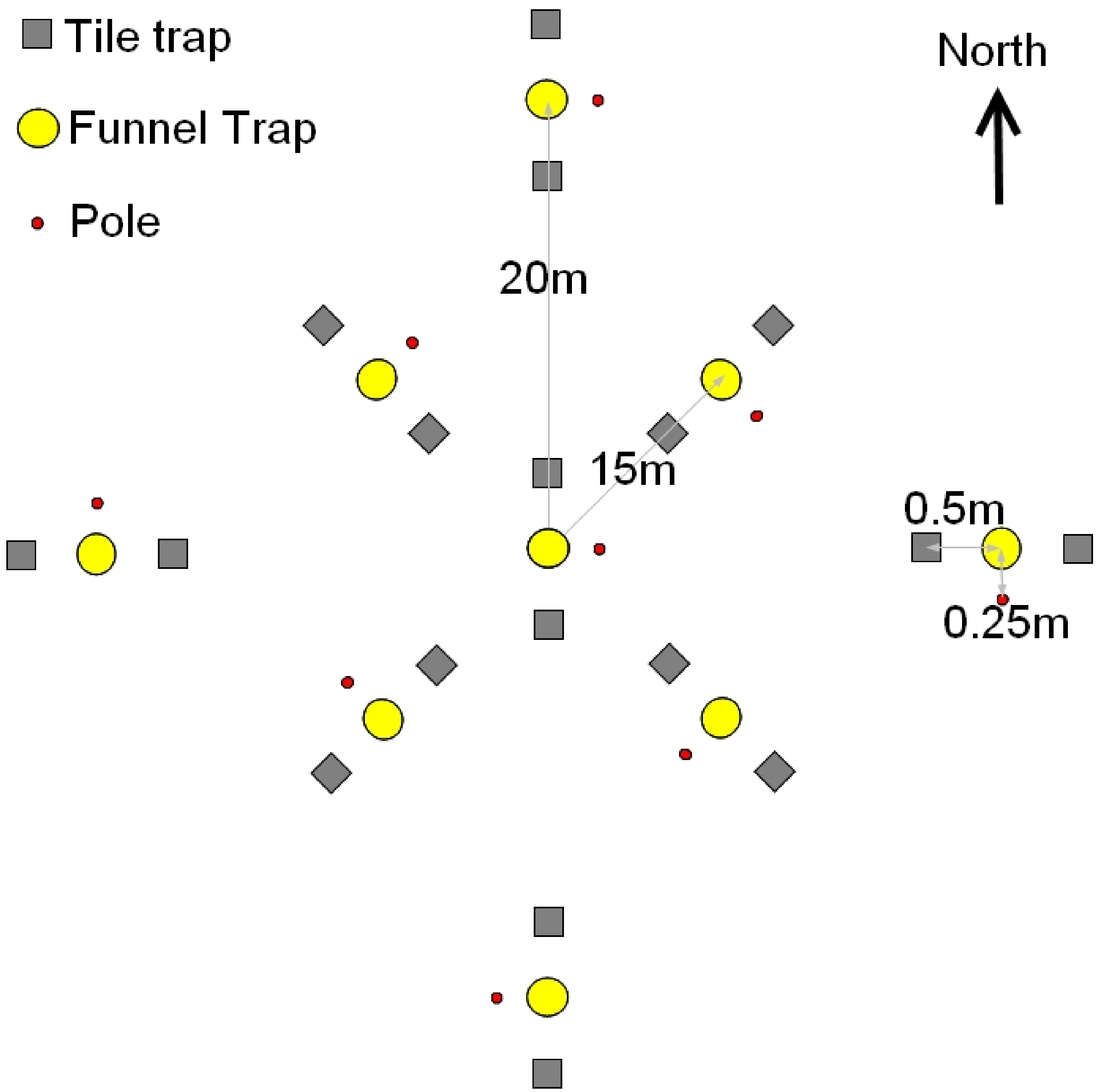

Figure 1. Nine stations were setup on HaHa Cove. Each station consisted of a funnel trap, pole, and two tile traps.

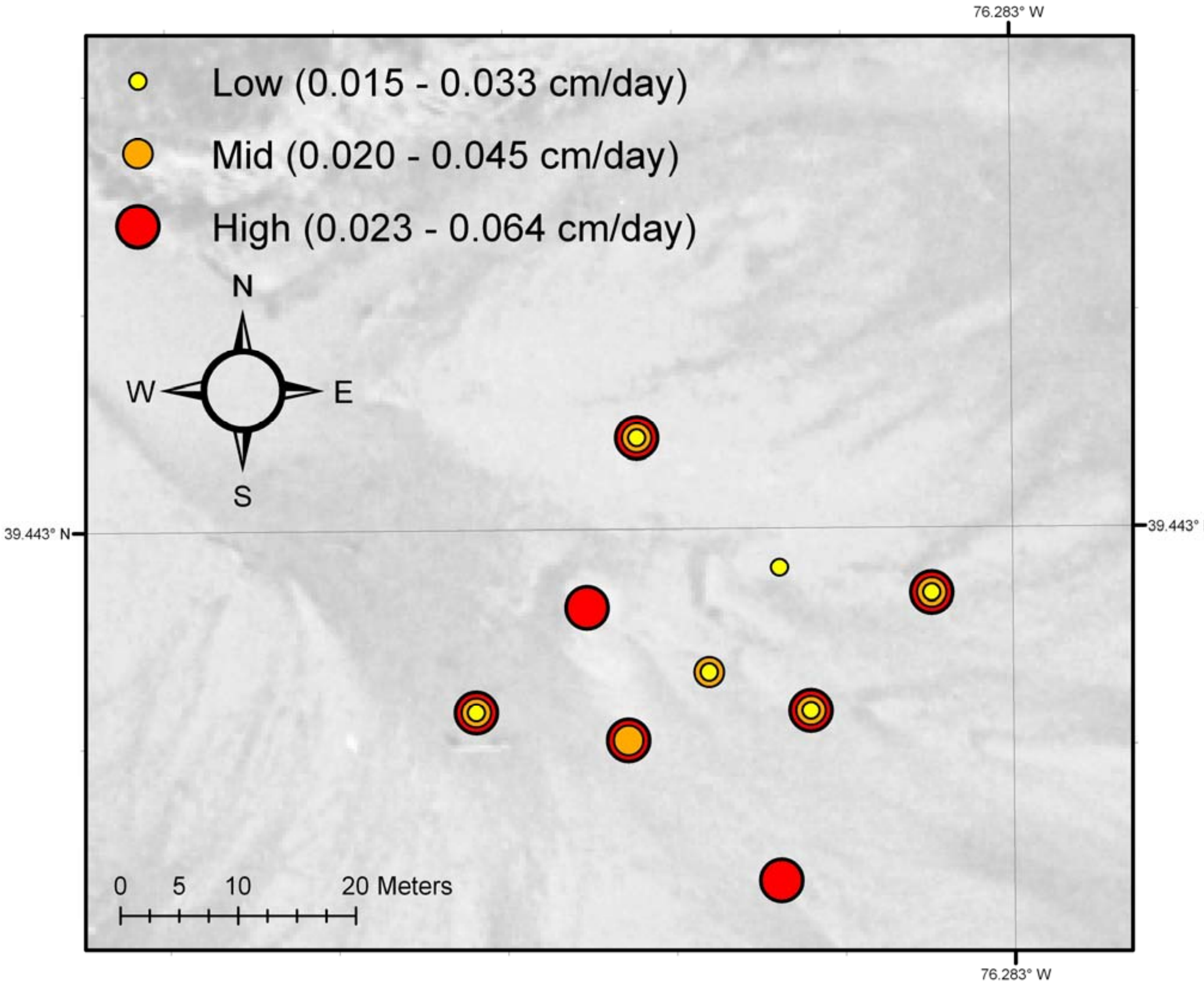

Figure 2. A map of the study site showing the results of the Kruskal-Wallis test (α = 0.05). Stations which share a color are statistically equivalent. The sites ate tilted slightly off of north because of either a gps or compass malfunction. The map was made in ArcGIS 10.

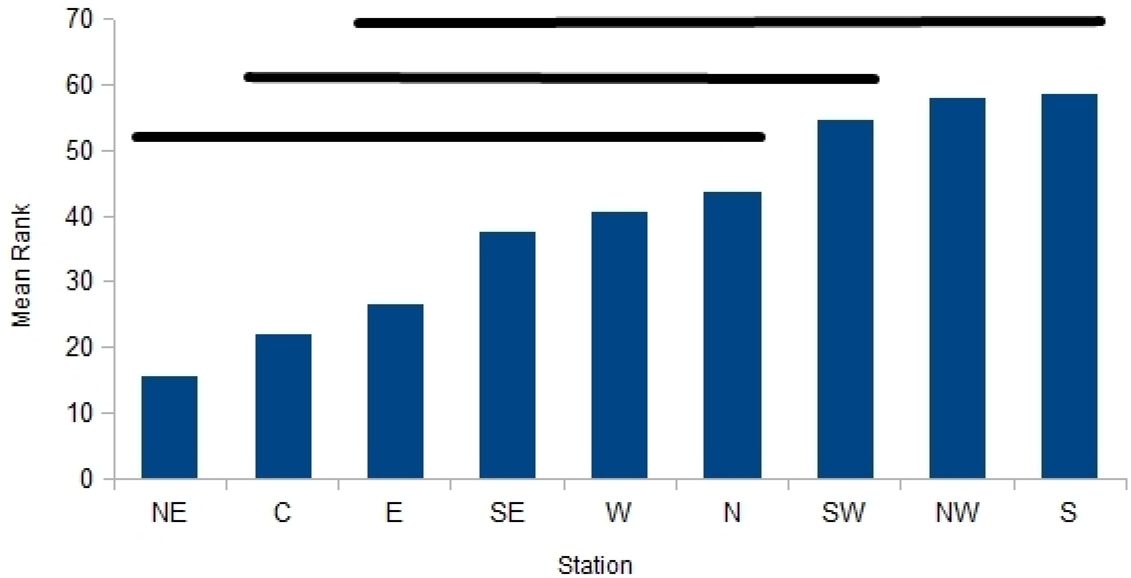

Figure 3: The results of the Kruskal-Wallis test are shown (α = 0.05). Stations connected by a dark horizontal line are statistically different equivalent.

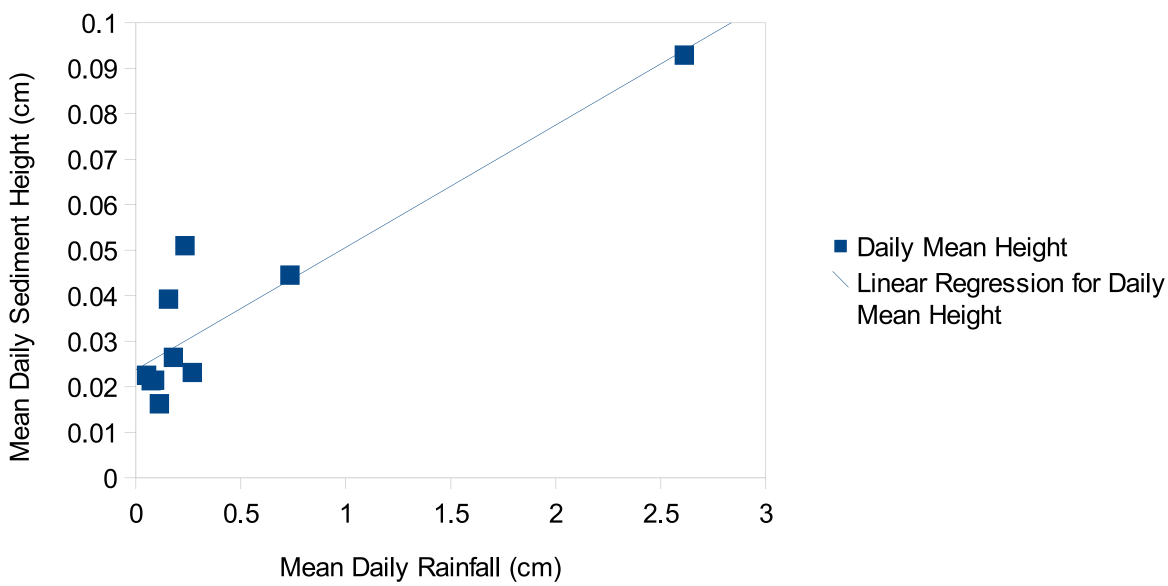

Figure 4: The Spearman rank test (r_s = 0.782, P = 0.008) showed that there was a positive linear correlation between rainfall and sediment accumulation.