Investigation of the Impact of Beach Raking on Beach Accretion/Erosion: West End Beaches of Galveston Island, Texas 2007/ 2008

By

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Abstract

The impact of beach scraping of beach cast material and the raking or grooming of the beach face were measured along the beaches on the west end of Galveston Island, Texas, between August 2007 and August 2008. Twelve monthly cross sectional profiles were obtained by using survey grade global positioning systems that measured latitude, longitude, and elevation from the toe of the dune or other limiting structure to the maximum wading depth. During the 12-month study period, the average elevation change for all study sites was -2 cm and ranged from an independent site change of +18 cm to -20 cm. Monthly monitoring at the twelve beach sites revealed that there were significant differences in elevation between the raked and unraked beaches' lower section of the beach, where typically the sand is wet and compacted from tidal influxes. The upper section of the beach or the dry beach elevations remained relatively constant over the study period.

Keywords: Beach cast; *Sargassum*; Galveston; Theodolite; Wetline; Geomorphology; Temporal; Accretion

Introduction

Historically, beach profiles have been a onetime snapshot of the beach contour during a specific surveying period. Although accurate, these surveys fail to take into account the varying seasons and recent weather patterns. Galveston Island's beaches are shaped by a set of complex natural and anthropogenic influences that are in a constant influx. During the last several decades, several different methods have been used to collect and record beach profiles from using the transit and pole methods to using RTK technology with the combination of a sled and Jet Ski. These methods have proven to be either extremely time consuming or too costly to be considered for temporal analytical techniques for beach profiling. In order to facilitate informed decision making regarding the management of Galveston's beaches, the Coastal Geology Laboratory at Texas A&M University at Galveston have developed and implemented a monthly system of time series measurements of 12 beach profiles sites using post processing survey grade GPS units. These profile lines are measured from the toe of the dune or other limiting structure to the

maximum wading depth. The continued accumulation of beach profile data will be available to the numerous stakeholders involved and will be used to assist in effective management of the island's beaches. This study is a continuation of the study on the effects of the management practices involving anthropogenic efforts such as beach raking and scraping that affect beach morphology.

This project was initiated during the 2006 Summer Field Season, and results from the preliminary study have been used to direct the current and proposed study. During the 2007 study, analyses of beach raking and/or grooming to remove debris from the beach appear to have the potential of being significant factors in beach erosion. Pirates Beach, which experienced frequent raking of the beach during the summer months, lost approximately 15% of its dry beach from February 2006 to January 2007. During the same period, the adjacent Pirates Beach West Beach, where raking was not conducted, lost approximately 12% of its dry beach. Although this difference appears to be small and may be within the margin of error within this study, at the cost of beach nourishment, such differences can add up to significant dollars.

Beach Raking vs. Scraping

There appears to be some confusion between the difference of raking and scraping of Galveston's beaches. Scraping is the process of gathering *sargassum* into large piles and then picking up these masses of material so as to place them further up the beach slope. This process does not change the volume of beach material on the beach. As the summer temperatures decompose the Sargassum, the subsequent high tides then redistribute any sand that was incorporated with the movement of the sargassum. Raking or grooming is a process designed to smooth out irregularities in the beach surface and loosen up wet, compacted sand so as to be more inviting to beachgoers.

Figure 1. Beach Scraping vs. Beach raking

Study Site

The Homeowners Associations of the beach communities of Pirates Beach and Pirates Beach West provided the funding and are therefore important sites in the study. Further, these locations are representative of the subdivision density along the west end of the island and, as such, are valid locations for study (Figure 2). Galveston Island State Park, The Dunes, and Beachside were chosen because of the absence of beach raking or scraping. The additional sites all have some level of raking throughout the year. They typically bracket the non-raked sites and are used for comparative purposes.

Figure 2. West End of Galveston Island

Methods

The permanent benchmark, located on the Galveston Seawall at 61st Street, was selected for a primary base station. The primary base station serves as a point of reference elevation datum for the study. The horizontal coordinates of the benchmark were established by traditional geodetic methods (Ground speak Incorporated 2006; National Geodetic Survey 2006) and adjusted by the National Geodetic Survey in February 1996. The orthometric height was determined by differential leveling and adjusted by the National Geodetic Survey in March 1997. The Laplace correction (National Geodetic Survey 2006) was computed from DEFLEC99 derived deflections. The geoid height was determined by GEOID99. The dynamic height was computed by dividing the NAVD 88 geopotential number by the normal gravity value computed on the Geodetic Reference System of 1980 (GRS 80) ellipsoid at 45 degrees latitude (G = 980.6199 gals.). The

modeled gravity was interpolated from observed gravity values. The benchmarks located on the Seawall have historically held a true position and elevation (Groundspeak Incorporated 2006).

From this permanent benchmark, a local control monument was established prior to the start of the project. The monument is located at Bermuda Beach on an elevated deck to provide maximum accuracy during the survey period. Each line begins at the toe of the dune or some type of geo-structure and stops at the maximum wading depth.marked with 1 m long rebar driven into the ground so the top of the rebar was at ground level. These surveys were established by the survey grade GPS receivers set in static / kinematic mode to establish new survey lines with an accuracy level of Horizontal: 0.012 m + 2.5 ppm, Vertical: 0.015 m + 2.5 ppm, Azimuth: <1 arcsecond. Observation Time: Ranges from 180 to 360 minutes depending on distance between GPS receivers and other environmental factors. The survey grade GPS Surveying System utilizes integrated WAAS/EGNOS aided navigation to locate the survey point and collect GPS data with the receiver's on-board software systems.

The beach profile survey produced a monthly set of data-points on the twelve specified cross section beach surveys established along the shore at specified sites. The elevation was measured with reference to a benchmark with a known vertical datum. These surveying data sets were plotted on GIS to provide a complete bathymetric profile of the beach.

Each profile was 90 to 140 m long with data points set at approximately 1 m intervals. The distance was measured from a control point located on the toe of the dune or other limiting structure to beyond the wetline in the seaward direction. The data was edited to remove spurious data points, entered into Microsoft Excel©, and combined with the elevation data from the survey grade GPS. Using Microsoft Excel, graphs were prepared for analysis.

Each beach profile was dissected into three sections based on elevation. The upper section or the dry beach is from the toe of the dune or other limiting structure to a mean sea level elevation of .75 meters. Under normal conditions, this area remains dry and loose. The middle section is the aerial part of the beach that is above sea level but within normal tidal range, which keeps the sand wet and compacted. The lower section of the beach face comprises the shallow surf zone to maximum wading depth.

Discussion

There is much debate on the benefits or harm of beach raking and scraping along Galveston Island's beach faces. The beach scraping of large volumes of *Sargassum* mats failed to materialize in 2008, redirecting our study to focus on changes in elevation between raked and non-raked sites. Each non-raked site was bracketed with raked sites, allowing multiple comparisons. The study monitored changes in elevation at all twelve sites including detailed investigations of different sections of each beach profile. These sections included the dry beach, the wet beach, and the surf zone. The 12 months of short-term fluctuations in the elevations of the profiles recorded on Galveston Island suggest that a variety of physical processes, such as raking, *Sargassum* casting, and flooding, were responsible for variations to the beach elevation. There was evidence of accelerated elevation loss on the wet beach raked sites in comparison to

the wet beach non-raked sites. These changes were evident in all profiles with the exception of Spanish Grant, which experienced a beach replenishment project during the survey period.

There were multiple high tide flooding events throughout the survey period. The profile elevations would decrease then recover during normal tidal ranges. The maximum flood height during the 2007/2008 survey period was recorded at the Galveston Pleasure Pier tidal gauge at 25th Street and Sea Wall Blvd. on November 21, 2008. The gauge recorded a .994 m above mean sea level at 21.54 hours (NOAA, 2007). Surveys were conducted one week after this event with minimal erosion measured at each site. All areas experienced partial recovery through the December 2007 profiles.

Conclusions

At this point in our study, the analysis of the temporal dataset profiles does support a direct connection between beach raking of the wet sections of beach and long-term (annual) influences on beach geomorphology. The erosion of sand on the raked sites outpaced the non-raked sites throughout the time period that raking efforts occurred.

Analysis suggests that anthropogenic methods, such as raking and/or grooming to remove debris from the beach, do contribute to beach erosion. The raked Sea Isle and the un-raked Dunes sub-divisions were compared for changes in beach elevation. The dry beach at both sites lost approximately 5 cm. in elevation. The wet beach at Sea Isle lost approximately 20 cm. in elevation while the Dunes gained 10 cm. in elevation during the study period. The dry beach at the raked Jamaica Beach lost approximately 8 cm. in elevation while the adjacent profile of the unraked Galveston State Park gained 13 cm. in elevation. The wet beach at Jamaica Beach lost approximately 12 cm. of elevation while the State Park gained 18 cm. in elevation. Other profile sites produced similar results with the exception of Spanish Grant profile site that received additional sand through a beach replenishing project. The antidotal evidence suggests that the raking of the beach broke the hard crust and substantially decreased the critical shear stress of the sand, making it more susceptible to erosion.

As with most short-term studies, the initial data set generates a base for more detailed studies over an increased survey area. The Coastal Geology Laboratory has continued to collect data at the twelve survey sites, even through the devastation of Hurricane Ike. After the storm, a new set of questions are in need of answers. Three questions beg from these preliminary conclusions. They are: 1) what percentage of recovery will the study sites recover post Hurricane Ike, 2) what impact will the beach replenishment of the seawall on the west end beaches, and 3) With the majority of the sand socks destroyed, how will the new beach faces respond to anthropogenic influences? We propose to refine our field and research methods to address these questions during the 2009 field season.

References

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