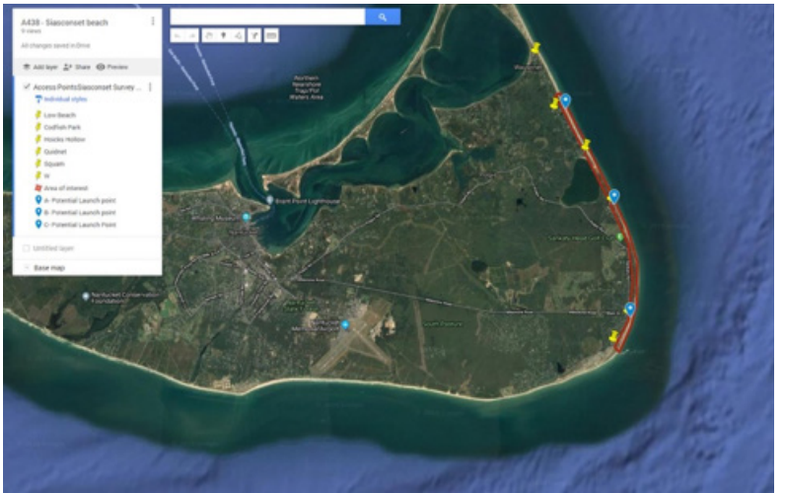
SIASCONSET BLUFF EROSION

A Case Study | 2019



The six mile stretch of the Island and the bluff being scanned.

INTRODUCTION

Siasconset is located on the eastern side of Nantucket, Massachusetts tucked against the Atlantic shoreline. This village includes an 80-foot-high coastal bluff that is of concern due to significant erosion that has threatened residences at the top of the bluff. The focus of this project case study is on the bluff that contains a geotube, a series of geotextile tubes filled with sand, that was installed in 2013. The geotube was installed at the base of the bluff by the Siasconset Beach Preservation Fund (SBPF) to provide protection for the bluff. SBPF is a privately funded homeowners association with the goal of preserving the bluff and properties that are along it. The geotube is 800 feet long and consists of four individual 14 foot diameter sections that rest 7 ft high and are stacked in a terrace. The Order of Conditions of the project permit requires that the client conduct quarterly monitoring surveys and submit monitoring reports.

The monitoring program for this area has been ongoing since 1994 for various shoreline protection projects, and more than 78 surveys have been completed. The monitoring area includes 46 transects over approximately six miles of coastline. Woods Hole Group (WHG) uses a survey grade RTK GPS to collect topographic survey data along each transect and then uses an electronic total station and prism to collect shallow bathymetry shots in the surf zone. The survey data is processed into a 2D cross-shore profile that is then compared with historic survey data to calculate beach profile and shoreline change relative to previous surveys. The results of each survey are published in a monitoring report showing profile changes and shoreline position relative to different time periods.

WHG enlisted the help of ARE and their UAS (drone) technologies. ARE acquired AirShark, a leading New England UAS services company, in January 2018. The technologies used throughout the missions from 2017 and 2018 include Photogrammetry and LiDAR (Light Detection and Ranging). Photogrammetry is the process of meshing NADIR or oblique images to build 2D and 3D models, orthomosaics, elevation models, contours and 3D point clouds. Photogrammetry was flown in 2017 along with LiDAR in conjunction with the ground survey by WHG.

THE CHALLENGE

Wind, fog and access were the three primary challenges. Incorporating ground control and working in the vicinity of the shoreline presented challenges as well. ARE was augmenting traditional topographic methods in order to assist with the data collection. Drones can accurately, safely and quickly collect data. 57 ground control targets were set out at the same time as the traditional survey and used to verify and compare the data collection methods and outputs.

It is difficult to set up ground control close to water lines because of the ever-changing tide and wave action. The customers needed to have detailed elevation data all the way down to the waterline. With photogrammetric methods, cameras cannot 'see thru' vegetation. However, LiDAR is an active sensor and can penetrate vegetation which can be useful in measuring topographic change that may be hidden with traditional methods. In 2018, LiDAR was the technique used to collect data.

THE PARTNER

Woods Hole Group, Inc. is a worldwide leader for Ecological, Coastal and Oceanographic consulting services, providing related products for collection of ocean measurements, ocean forecasting, wildlife, tracking, and fisheries vessel monitoring systems (VMS). The environmental business unit and coastal services have worked extensively with ARE on various coastal projects.

> *"The ARE flight team provided excellent service when asked to perform the flights on Nantucket in a challenging terrain in the marine environment. They managed every step in the process and provided quick and accurate imaging and data products. We always look forward to working with them."*
>
> *— Mitch Buck, Woods Hole Group*

2018 LiDAR FLIGHT OPERATIONS & SOLUTION

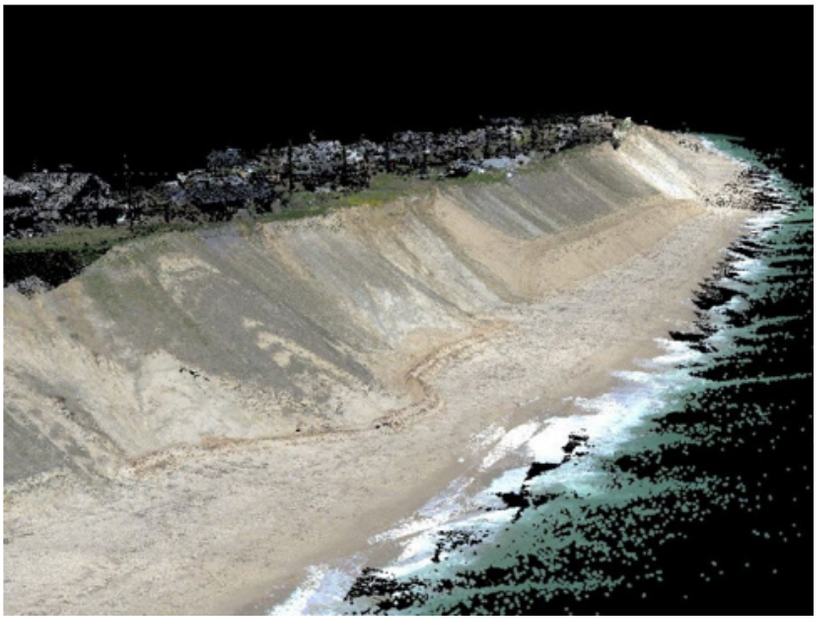
Using a flight planning software, ARE was able to input the project area boundary and make an accurate estimate of how many flights it would take to complete the project. In total, six 10-15 minute flights were flown down the six mile stretch of the bluff. Using the method of an out and back flight pattern, the LiDAR sensor was able to capture an 800ft swath of not only accurate data (3-5cm RMSEz), but with a point density of 100 points per square meter. With a base station set up on site while the LiDAR system was flying, the data processing team corrected the original flight trajectory using NOAA OPUS and Inertial Explorer. The data processing team then joined the corrected trajectory data with the raw LiDAR data captured and

Aerial view of the bluff and the geotubes holding the bluff from erosion

created an industry standard. The LAS point cloud has an accuracy of 3-5cm RMSEz. From there, an automated and manual LiDAR classification routine was run to create clean Digital Elevation Models and contours. This data was then delivered to the client to perform further analysis and compare the data to previous surveys conducted in past years.

THE RESULTS

Woods Hole Group integrated the drone data into their survey results. Woods Hole compared the 2017 and 2018 data. In 2017, three methods of collection were used: traditional survey, photogrammetry from a drone, LiDAR from a drone. When lined up on a graph all three maintain good correlation from the water/wave line to the beginning of the bluff. While waves breaking on the beach interfered with the accuracy of the photogrammetry and the LiDAR, the ground survey team was able to maintain accurate samples far into the water using a total station and rod shots along with bathymetry data collected by boat. The ground survey team could not access the steep sections of the bluff for safety reasons and the sensitivity of the vegetation on the bluff. The photogrammetry and LiDAR were able to accurately capture these areas and fill in the gaps where the surveyors could not go. On the graph with all 3 methods, the ground survey needed to interpolate from the bottom of the bluff to the top, which was roughly 50 feet horizontally and 40 feet vertically where there was not data. In 2018 after analyzing the 2017 survey, WHG decided to just use the LiDAR collection method, therefore saving time not having to set up 10's of control points needed for photogrammetry and being able to capture the steep sections of the bluff without disturbing it.



LiDAR point cloud of a section of the bluff, highlighting the steep elevation.

The UAS solution was deemed equivalent or superior to traditional methods to go where people can't, the bluff's face. The scan LiDAR can capture the lower portion of the beach and is a shorter flight time than photogrammetry which means less time on site reducing labor costs and air time. ARE is continually working in conjunction with Woods Hole Group to complete future scans and monitoring of the bluff.