Use of Unmanned Aerial Systems to Assess Development of Living Shorelines

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Introduction

The application of Unmanned Aerial Systems (UAS) to assess a wide range of environmental conditions has dramatically increased as diversity and accuracy of aircraft and sensors improve. UAS also facilitates quick and frequent mapping and virtual sampling of a location with limited field personnel. For these reasons, an UAS was recently used to assess sediment accretion behind several different living shoreline wave attenuation elements at a demonstration living shoreline.

Goffinsville Park, the project site, is a county park on the Nassau River in northeast, FL where four wave attenuation devices have been deployed as a public demonstration of various living shoreline elements, and a means to help stabilize the shoreline from waves and currents. The site is also investigating plastic-free wave attenuation alternatives. Four elements deployed at the site are bagged oyster shell deployed in 2016, Community Oyster Reef Enhancement modules (COREs) deployed in 2019, Oyster Reef Balls deployed in spring 2020 and Reef Prisms deployed in early fall 2020 (Figure 1).

Figure 1. Aerial view of the Goffinsville Park Living Shoreline demonstration site with example and location of various wave attenuation elements.

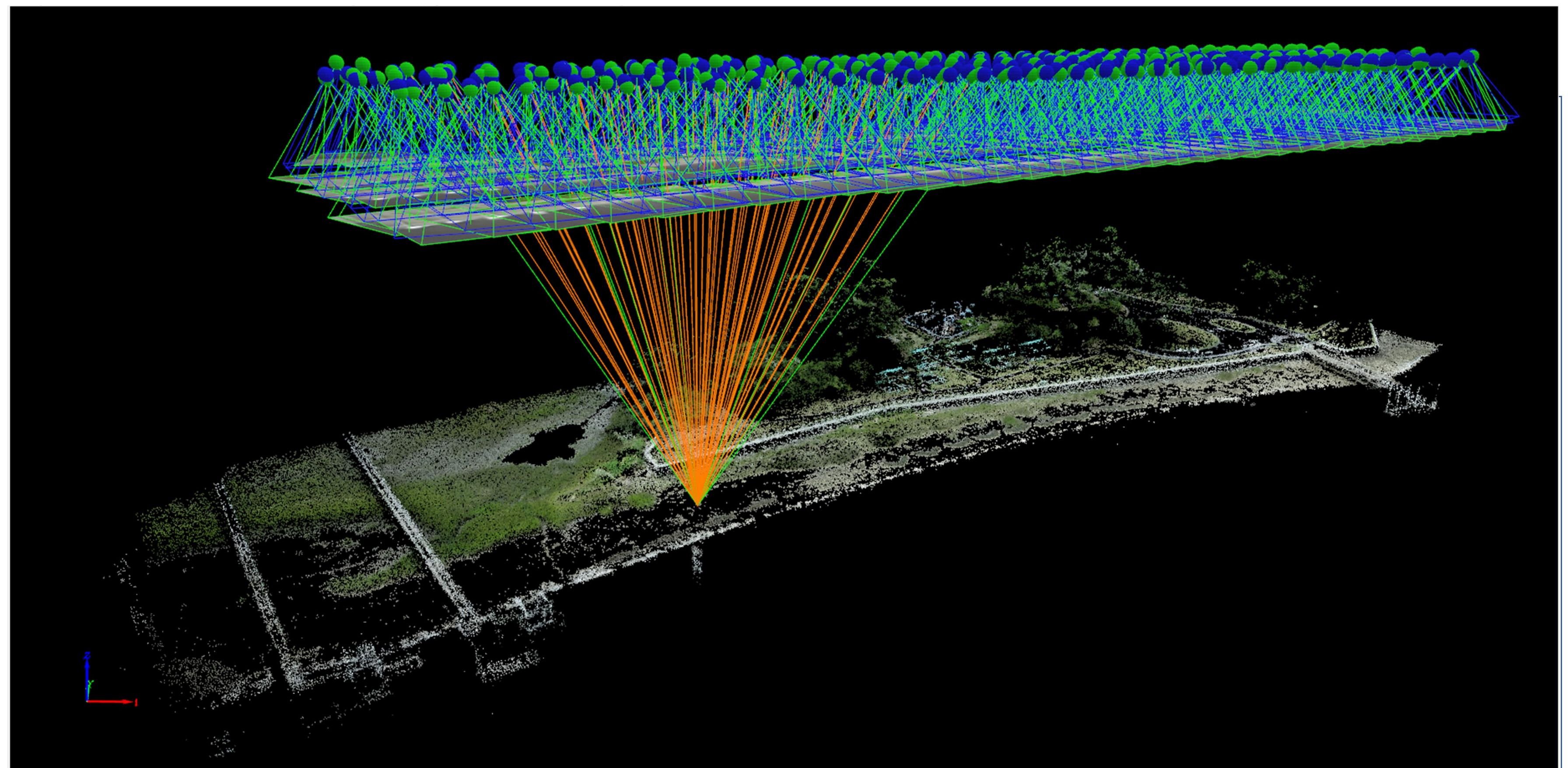

Figure 2. Visualization of image postprocessing in Pix4D with collected images and projections (green and blue pyramids at top), a common tie point connection found among multiple images, in this case 72 photos had a common tie point (orange rays), and the resulting point map (pixelated image at bottom) identifying all tie points used to create the digital surface model.

Methods

Using Structure from Motion (SfM) analysis, a Digital Surface Model was developed from aerial images using DroneDeploy version 2.132.0 and Pix4Dmapper version 4.7.3 (Figure 2). A DJI Phantom 4 Pro V2 drone was used with Post Processing Kinematics (BAAM.Tech PPK) and one ground control point to improve accuracy. Field time allocated to UAS site assessment was approximately 2 hours to optimize PPK positioning; however, the actual flight time was only 13:15 min. The assessment flight was flown September 9, 2021.

Using the output orthomosaic and DSM (Figure 3), virtual elevation transects and sediment volume landward of the different wave attenuation elements were estimated and compared. A linear fit model was used to establish the base plane when determining accreted volume. Volume was then divided by assessed area to normalize the comparison between elements (Figure 4).

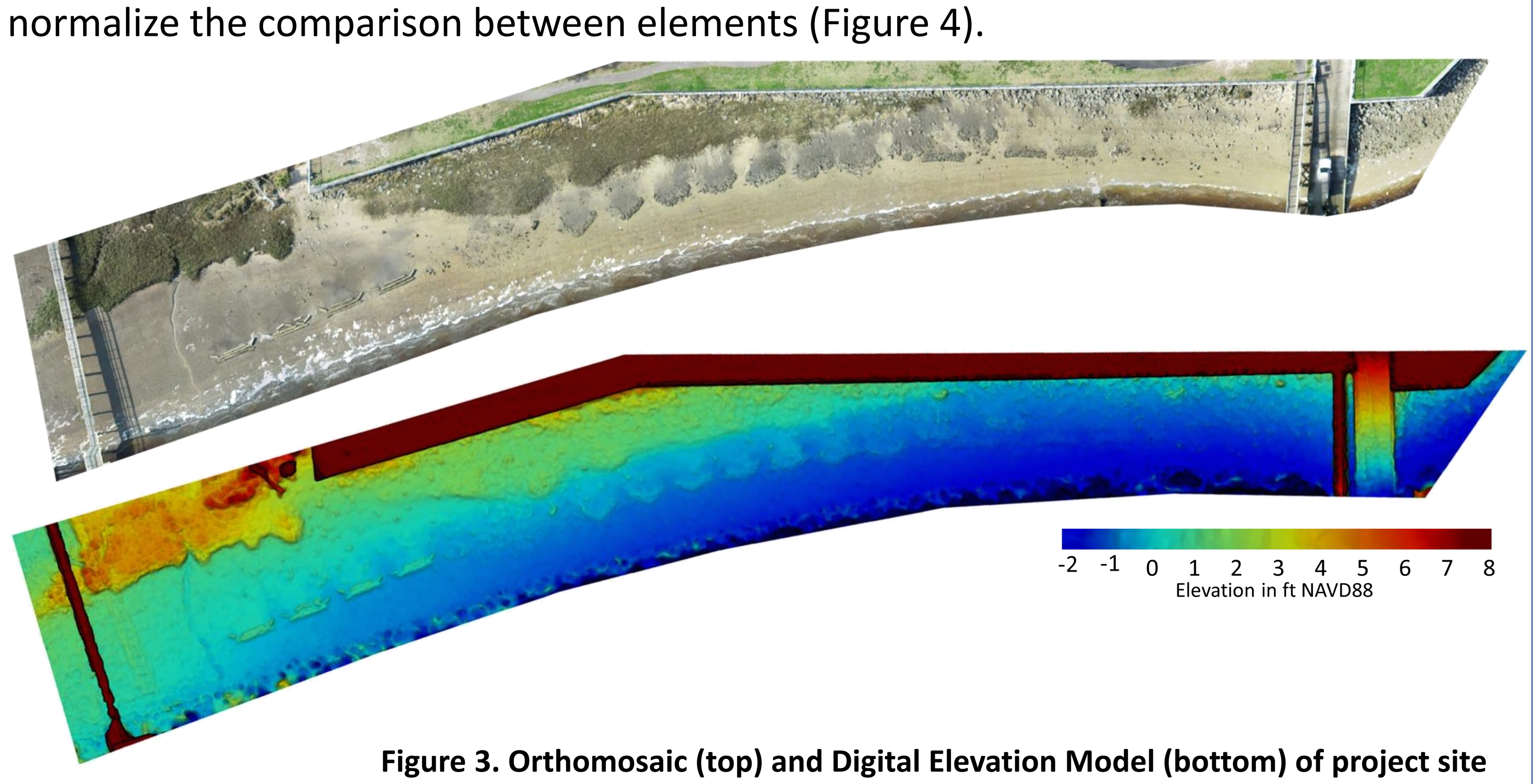

Figure 3. Orthomosaic (top) and Digital Elevation Model (bottom) of project site

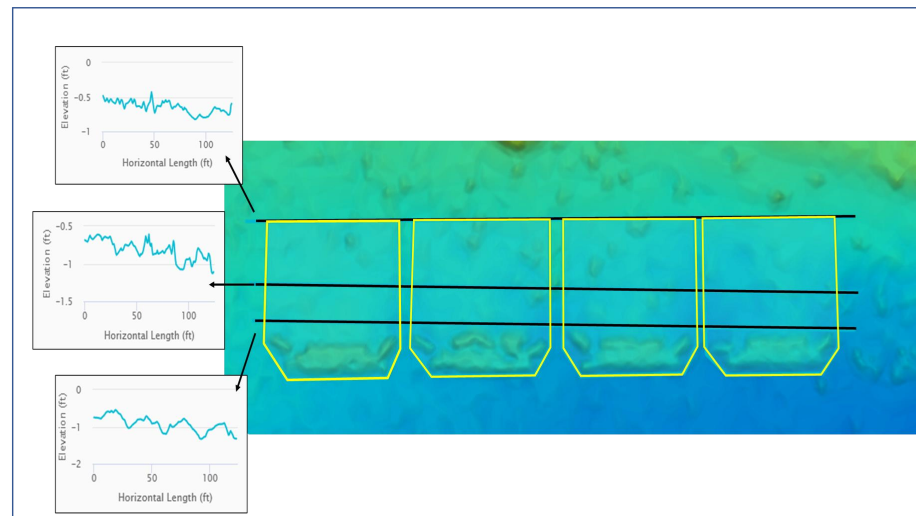

Figure 4. Example of where volume base plane was set relative to wave attenuation element and contour elevation behind element. Black lines and elevation profile figures at left show contour change behind wave attenuation feature. Yellow polygons show placement of volume base plan.

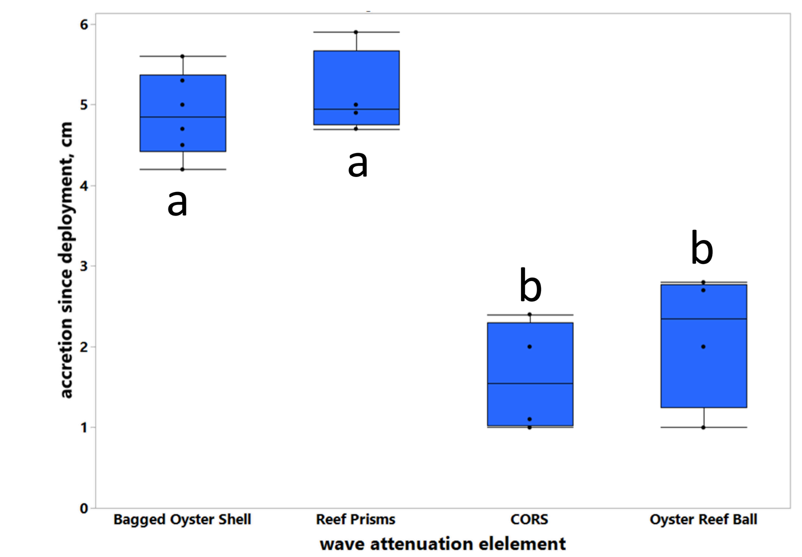

Figure 5. Results of sediment accretion among the four wave attenuation elements. Accretion value represents average sediment accretion within the base plane since element deployment. Letters represent statistically different accretion (α=0.05)

Results & Discussion

A comparison of sediment accretion among the four wave attenuation devices showed significant differences with sediment accretion falling into two groups; CORE and Oyster Reef Balls with accretion ranging from 1.0 to 2.8 cm, and Bagged Oyster Shell and Reef Prisms with accretion ranging from 4.2 to 5.9 cm. These values do account for duration of deployment and therefore accretion is not reported as a rate only a cumulative amount.

The more practical result of this investigation is that the comparison could be conducted in a fraction of the time it would have taken to spatially survey the 18 sampling locations for each of the four element types. In addition to the 2 hours allocated to facilitate PPK position and collect imagery, approximately 2 hours was used to layout the base plane at each sampling unit and compile data. Assessing a similar spatial resolution using traditional surveying techniques would likely take more than a day and been constrained to low tide resulting in the need to spread a traditional survey over at least two days.

Although some degree of accuracy is sacrificed when using remote vs. direct ground measurements, use of PPK and or ground control points can significantly reduce that error. When field collection time is considered along with increased spatial sampling resolution, UAS provides a valuable resource when assessing the development of living shorelines.

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