Using UAV Technology to Monitor Shoreline Change and Beach Stabilization, Montauk Beach, Long Island, New York

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Due to an apparent increase in high energy coastal storms and increasing sea levels in recent years, severe beach erosion is being observed around the world. Monitoring the ever-changing shoreline and beach erosion is important for environmental management, to maintain the aesthetic appeal of the beaches and for the management of properties around the shoreline. Use of Unmanned Aerial Vehicles (UAV) and modeling software in monitoring changes in shorelines and beach elevations is a quick and efficient tool in documenting current and changing conditions at these critical sites. This paper will detail the shoreline and backshore elevations observed, using a UAV both before and after a beach stabilization project in Montauk beach, Long Island, New York in 2019.

For the data collection, a low-cost DJI Phantom Pro 4 2.0 UAV equipped with a 20-megapixel RGB camera was utilized to collect the high-resolution nadir images. To perform in-field elevation corrections, 10 Propeller Aeropoints were utilized as Ground Control Points (GCP) to collect real-time elevation data. The first set of data was collected in April 2019 before the start of the restoration project, a total of 427 nadir images were collected from approximately 26.5 acres of beach and property along the shoreline of Montauk beach. The collected images and the elevation data were then imported to photogrammetric processing software (Pix4D) to further process all the individual nadir images and to prepare a 3D point cloud model. The point cloud model was then improved using the elevation data. Utilizing the improved data, a Digital Surface Model (DSM), Digital Terrain Model (DTM) and 1 ft. elevation contours were generated. Using the elevation correction data from the ground control points, the Root Mean Square (RMS) error for the data was reduced down to 0.009 ft. The RMS error for the data is acceptable for shoreline monitoring projects.

After the completion of the 2019 $1.1. million beach restoration project, which involved the importation and grading of locally sourced sands, the second data collection event was performed in June 2019. A total of 530 nadir images and 10 GCPs using the Propeller Aeropoints were collected from approximately 28.5 acres of the shoreline and surrounding properties. The data was processed using Pix4D to prepare a 3D point cloud model, DSM, DTM, and 1 ft. elevation contours. Using the elevation correction data from the ground control points, the RMS error for the data was reduced down to 0.007 ft. Further, the 3D point cloud model and elevation contours were utilized to visually observe and make cross-sections to document the changes in the beach elevation and shoreline, before and after the beach restoration project. In the cross-sections, it was observed that after the beach restoration, the average elevation of the beach was raised ranging from 1 ft. to 2.5 ft. over the study area.

In conclusion, the usage of UAV technology for beach restoration and shoreline monitoring projects provide a high quality, cost-effective, quick and acceptable alternative to the traditional methods of data collection. The use of routine UAV modeling over susceptible coastlines could provide critical information about vulnerable areas where early maintenance could provide a reduction in long term stabilization costs and damage from storm events.