Supplementary Materials: Transformation of infragravity waves during hurricane overwash

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This supplementary materials document is comprised of two sections. Section 1 details the surveying of pressure transducers (PTs) and bed-level changes on either side of Matagorda Peninsula before and after Hurricane Harvey. Section 2 outlines the procedure used in this paper for generating a digital elevation map (DEM) using an unmanned aerial vehicle (UAV) and stereo photogrammetry.

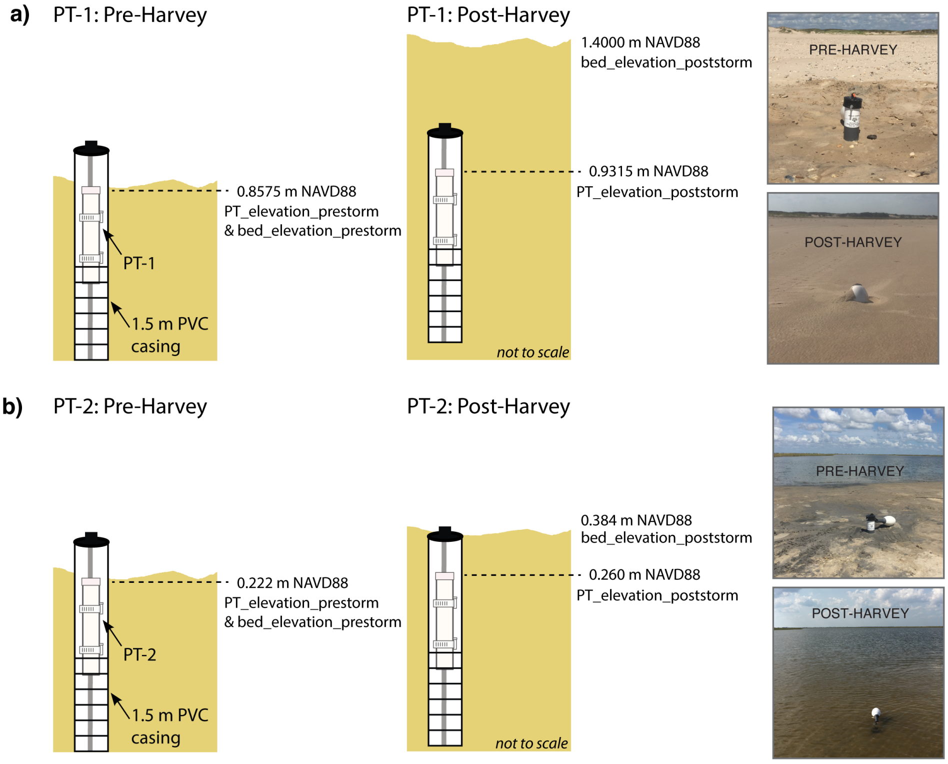

Figure S1. Schematics and photographs depicting the vertical placement of pressure transducers (PTs) at Matagorda Peninsula pre- and post-storm as well as storm-induced sedimentation. An RTK-GPS system was used to survey the bed and well cap elevations in (**a**) the backshore (PT-1) and (**b**) back-barrier environment (PT-2). All elevations were surveyed relative to North American Vertical Datum 1988 (NAVD88). Schematics are not to scale. Note that the back-barrier bay remained elevated for several weeks following the storm. Photos were all taken facing North. Although not utilized in this paper, a buoyant tilt-current meter was tethered atop both wells and is visible in the pre- and post-storm photographs.

1. Bed-level change and surveying of PT-1 and PT-2

Well cap elevations at PT-1 and PT-2 were surveyed using a real-time kinematic global positioning system (RTK-GPS) with a horizontal accuracy of 0.005 m and vertical accuracy of 0.01 m. Comparison of pre- and post-storm elevations measurements revealed small differences in GPS vertical elevations at both instrument locations, measuring 7.4 cm at PT-1 and 3.8 cm at PT-2 (Figure S1). Review of the pressure time records at both instrument locations did not reveal sudden decreases of pressure which would be associated with rapid vertical motion of the monitoring well due to buoyancy or spurious actions by humans (i.e., pulling on the well). The slotted PVC wells are not inherently buoyant, so while progressive upward motion cannot be ruled out, it is unlikely. We therefore interpret this vertical displacement to be related to GPS error associated with the pre-storm GPS measurements at this remote field site. As shown in Figure 2d and Figure 3b-e, the post-storm GPS measurements at PT-1 are in good agreement with interpreted bed-level changes from measurements of pressure head at PT-1, lending support to the interpretation of pre-storm GPS error as the source of these differences in measured vertical elevation.

1.1. Structure-from-motion photogrammetry

An UAV was utilized in combination with structure-from-motion (SfM) photogrammetry to generate a post-storm DEM one week following Hurricane Harvey. A DJI Matrice 600 Pro was used to capture multispectral imagery in discrete narrow bands for the near infared spectrum. Images were collected at altitudes of 60 m with an overlap of 60-70% along each flight line. UAV-SfM DEMs were supplemented with subaerial and wading-depth RTK-GPS beach profile transects, which also served as check points for the horizontal and vertical accuracy of the UAV-SfM derived DEM, which resulted in a root-mean-square error of 12 cm in the vertical and 11 cm in the horizontal.

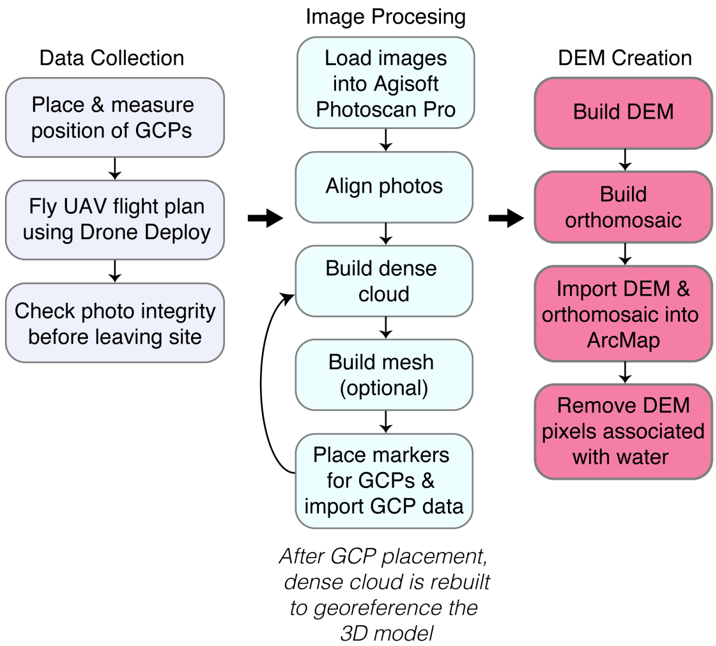

Figure S2. Flow diagram highlighting the procedures used in this study to produce high resolution digital elevation maps (DEMs) from imagery collected using an unmanned aerial vehicle (UAV) and structure-from-motion (SfM) photogrammetry.

Figure S2 summarizes the procedures involved in production of the high resolution UAV-SfM DEMs discussed in this study. Image alignment and point cloud processing was executed using the software Agisoft Photoscan version 1.3.4. Optimization of the SfM sparse point cloud was conducted by removing tie points with high reprojection errors (weak geometry) and by adjusting the camera alignment [as in e.g., 1,2]. Ground control points (24-34) were evenly placed throughout the study domain and surveyed using a RTK-GPS for georeference of SfM point clouds. The georeferenced SfM dense point clouds were constructed in Photoscan using the high-density setting and aggressive depth-filtering algorithm resulting in more than 500 million data points. Derivative products, including DEMs and orthomosaics, were exported at 0.02 m resolution.

References

1. Warrick, J.A.; Ritchie, A.C.; Adelman, G.; Adelman, K.; Limber, P.W. New techniques to measure cliff change from historical oblique aerial photographs and structure-from-motion photogrammetry. *Journal of Coastal Research* **2016**, *33*, 39–55.

2. Sherwood, C.R.; Warrick, J.A.; Hill, A.D.; Ritchie, A.C.; Andrews, B.D.; Plant, N.G. Rapid, Remote Assessment of Hurricane Matthew Impacts Using Four-Dimensional Structure-from-Motion Photogrammetry. *Journal of Coastal Research* **2018**, *34*, 1303–1316.