Sediment Transport by Mean Near-Bottom Currents During the SandyDuck Storm

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ABSTRACT

This study examines sedimentation processes during a northeaster storm that passed over the U. S. Army Corps of Engineers Field Research Facility at Duck, North Carolina, in October 1997. Observations of seabed elevation and currents were made on the shoreface at water depths of 5.5 m, 8 m, and 13 m. Sediment cores were collected before and after the storm at these same locations. All three stations showed erosion on the order of 0.1 m followed by deposition. The net seabed elevation change increased across the shoreface from nil at 5.5 m to greater than 0.2 m at the deepest site. These measurements were in agreement with the stratigraphy seen in the cores.

Sediment suspension, erosion, and deposition by mean near-bottom flow were simulated using a numerical sedimentation model, TRANS98. The model is used in conjunction with the observations to examine two hypotheses:

(1) Sediment is transported offshore by mean currents during a storm and is deposited on the inner shelf, seaward of the 13 m isobath.

(2) Alongshore gradients in the alongshore sediment flux contribute to recovery of the shoreface after a storm.

The model results show that sediment was probably lost to the inner shelf throughout the study period and replaced by sediment carried by the along-shore currents from up the coast. If this effect is not accounted for, there will be an apparent across-shore sediment flux from the shoreface to the beach face. However, an unequivocal test of these hypotheses requires measurements of the alongshore sediment transport field on the shoreface and inner shelf.

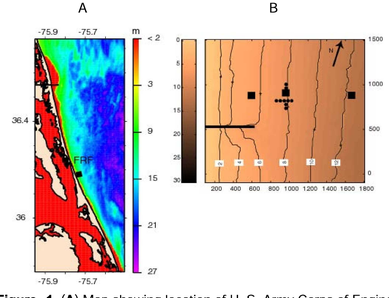

Figure 1. (**A**) Map showing location of U. S. Army Corps of Engineers Field Research Facility (FRF) at Duck, North Carolina. (**B**) Depth contours of the study area and location of data collection sites. The squares indicate location of bipod arrays and circles indicate the directional wave measurement arrays. Depth contours in meters. The x and y axes are measured in meters. The heavy line to right of (B) indicates location of the pier.

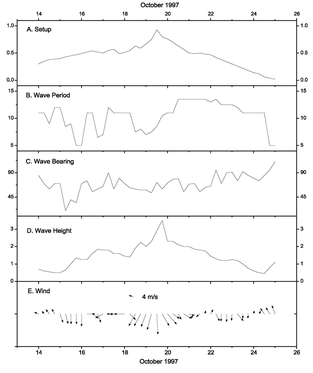

Figure 2. Time series of environmental conditions at the Field Research Facility during the SandyDuck experiment in October 1997: (**A**) coastal setup (m); (**B**) peak wave period (sec); (**C**) wave direction using nautical convention; (**D**) significant wave height (m); and (**E**) wind vectors (m/s).

Figure 3. Photograph of bipod assembly installed at each site during the SandyDuck97 field experiment.

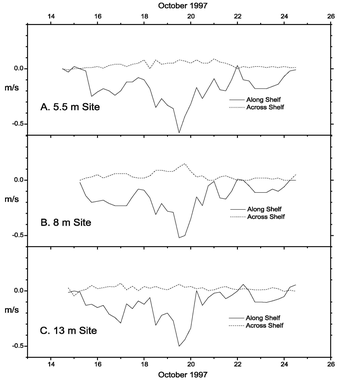

Figure 4. Currents (m/s) measured at (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m sites. Negative values are southward (along-shore) and onshore (across-shore).

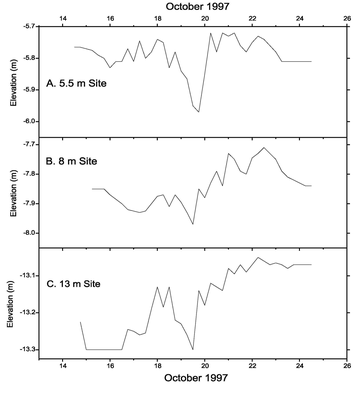

Figure 5. Bed elevation (m) time series at (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m sites relative to mean sea level measured at the bipods.

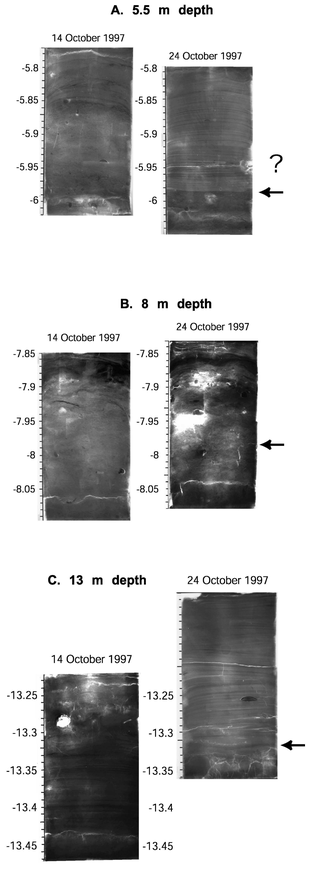

Figure 6. Box core x-ray profiles collected on 14 October (left panels) and 24 October (right panesl) at (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m sites. Seaward is to the right. The arrows indicate maximum erosion depth from Figure 5. The question mark in (A) indicates uncertainty in maximum erosion depth.

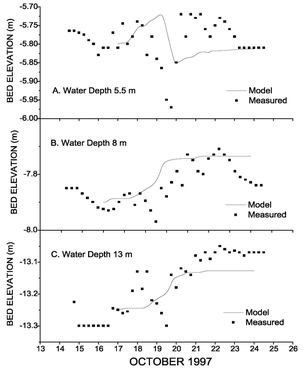

Figure 7. Time series of bed elevation (m) predicted by TRANS98 with no along-shore change in currents: (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m . The solid squares are the observations. A closed boundary at the sea-ward margin was used.

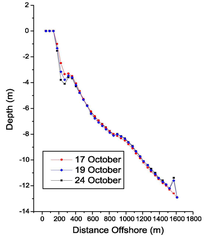

Figure 8. Model-predicted depth profiles before, during, and after the storm, with no along-shore change in currents and a closed seaward boundary.

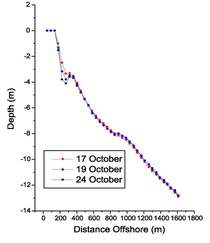

Figure 9. Model-predicted depth profiles before, during, and after the storm, with no along-shore change in currents and an open seaward boundary.

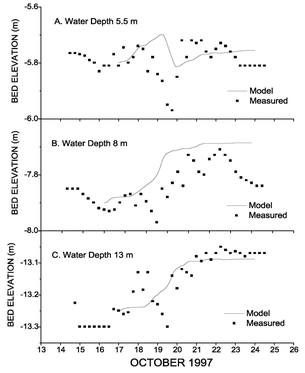

Figure 10 Time series of bed elevation predicted by TRANS98 using currents that decrease southward (depositional currents) at (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m sites. The solid squares are the observations.

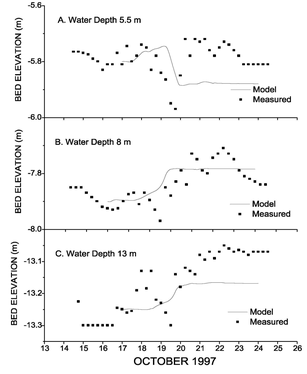

Figure 11. Time series of bed elevation predicted by TRANS98 using currents that increase southward (erosional currents) at (**A**) 5.5 m, (**B**) 8 m, and (**C**)13 m sites. The solid squares are the observations.

CONCLUSIONS.

Sediment suspension, erosion, and deposition by mean near-bottom flow were simulated using a numerical sedimentation model, TRANS98. The model is used in conjunction with the observations to examine two hypotheses: (1) Sediment is transported offshore by mean currents during a storm and is deposited on the inner shelf, seaward of the 13 m isobath. (2) Alongshore gradients in the alongshore sediment flux contribute to recovery of the shoreface after a storm. The model results show that sediment was probably lost to the inner shelf throughout the study period and replaced by sediment carried by the along-shore currents from up the coast. If this effect is not accounted for, there will be an apparent across-shore sediment flux from the shoreface to the beach face. However, an unequivocal test of these hypotheses requires measurements of the alongshore sediment transport field on the shoreface and inner shelf.