CHAPTER 70

Overwash Processes on Assateague Island

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Abstract

The primary barrier dune on the northern portion of Assateague Island, Maryland is presently being scarped on its seaward face and breached by storm-generated surges. During storms, sediment-ladened water moves across the dune line onto the barrier flats as overwash. The objective of this project is to determine the role overwash plays in barrier island sedimentary dynamics.

An overwash model has been suggested. The nonvegetated overwash fan serves as a reservoir for the eventual distribution of the storm-deposited sand. Eolian processes, after the storm, determine the net contribution of overwash sand to each of the different morphological features, i.e., dunes, marsh, beach, etc.

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Introduction

Overwash in this discussion refers to the flow of swash and associated transported sediment across the frontal dune line onto the barrier flats during a storm or an unusually high tide. This process results in the characteristic breaching of the primary dune line, a feature apparent in field reconnaissance as well as identifiable from aerial photography. Relatively small-scale overwash deposits (the subject of this paper) have been monitored in which the breach in the dune is on the order of 40 ft (12 m). Much larger breaches have been observed, e.g., the March 1962 storm destroyed over 1000 ft (305 m) of primary dune at Cape Hatteras, N. C. The former features result in a fan-like deposit, while the latter are much more broad in character.

Overwash processes are of interest because of their role in the overall sediment budget of the barrier island. The temporal and spatial frequency of these events, as well as the storm parameters causing them, are poorly understood at present. From a coastal engineering viewpoint, an understanding of overwash dynamics is necessary for the evaluation of shoreline management alternatives. In particular, the policy of barrier dune construction and sand fencing projects precludes some understanding of overwash dynamics (Dolan, 1972).

This study was designed to observe and quantify the discrete overwash events, in order to begin to address the issues cited above.

Previous Investigations

With the present eustatic rise in sea level (Hicks, 1972), barrier islands are being encroached upon by the sea, and in many cases eroded, National Shoreline Study (1971). Kraft (1973), working on the Delaware coastline, concluded that the washover sands migrate landward across marsh and lagoonal sediments at the leading edge of the Holocene transgression. Dillon (1970) and Swift (1968) investigated the migration of the Rhode Island barrier and the process of coastal erosion and transgressive stratigraphy in the Bay of Fundy, respectively. These authors concluded that shore face erosion and washover was the dominant process responsible for landward migration.

Pierce (1970) investigated the dynamics of the overwash process suggesting that the velocity of the surge slows after it "overtops" the barrier. Deposition of the entrained sediment occurs on the tidal flats and near the bayside of the barrier. Concerning the sediment moved by overwash, Pierce (1973) concluded that the amount of material transported by this process is difficult to evaluate due to the lack of accurate periodic surveys, but that the size of the overwash fans in this area suggests a significant amount of sediment transport. Hayes (1967) and Perkins and Enos (1968) studied hurricane deposition. Aerial photography and field reconnaissance indicated that large volumes of sediment were washed onto and sometimes over the barrier by the hurricane surge.

Site Description

The northern end of Assateague Island, Maryland, was chosen as the field site for this study. This location overwashes several times each year, with the deposits characterized by the small fan-shape feature described above. The relatively small scale of these deposits makes a control volume approach to the computation of the sediment budget feasible. In addition, this area is relatively accessible during a storm with a reasonable degree of safety for the field crew. An analysis of historical charts and photography by several investigators, particularly Slaughter (1949) and Gawne (1966), indicates that the trend for Assateague has been seaside erosion and thus landward migration.

Figure 1 is a schematic of the study area. This section of Assateague Island contains many closely-spaced overwashes. The throat widths are about 40 ft (12 m), and the fans extend toward the bay for an average of 150 ft (46 m). Many of these fans are connected to the bay and thus drained by well-defined sluiceways or channels.

The sediment consists primarily of quartz sand with mean diameters of .25 mm on the fan, .20 in the dunes, and .30 mm on the beach, as determined by sieving. The overwash sediment is characterized by a high percentage of heavy minerals, chiefly ilmenite, rutile, and garnet.

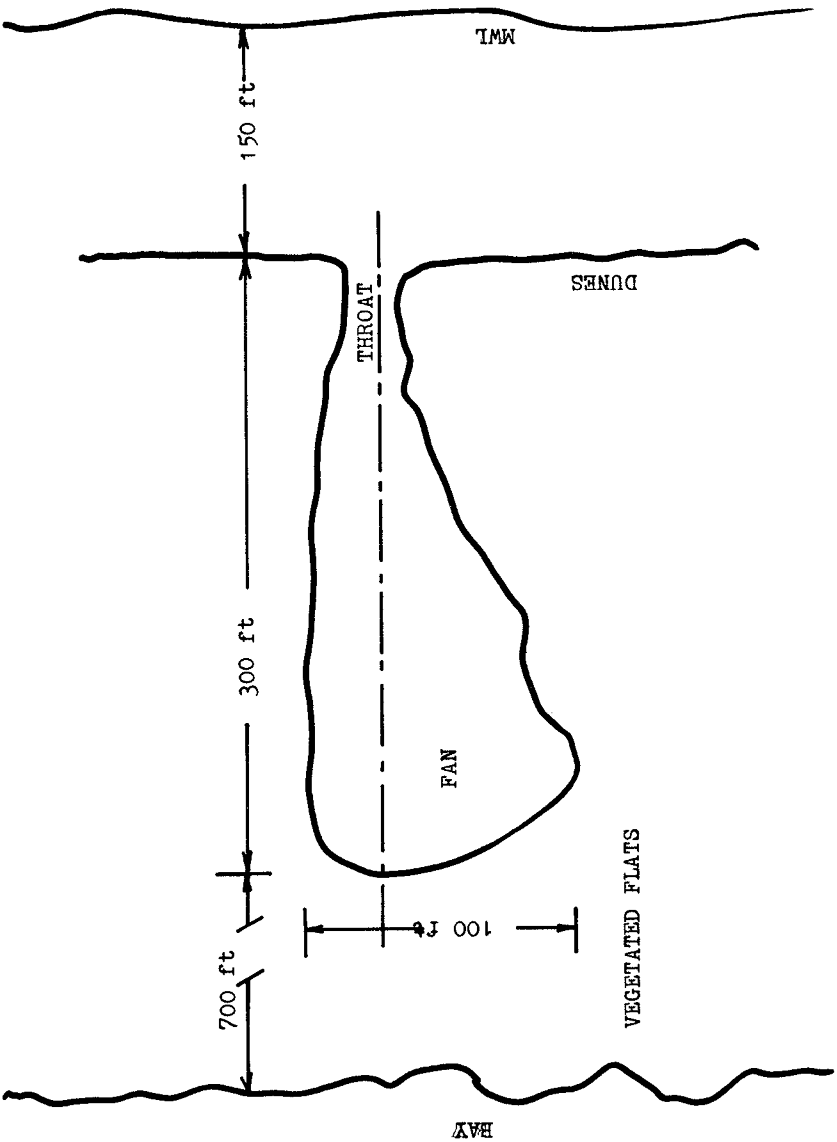

Figure 1, Schematic of Overwash Area

Details of the Present Study

The present study began in February of 1973 with the initiation of a monthly surveying program. A rectangular grid has been superimposed on a transverse slice of the island from the vegetated barrier flats seaward to the mean water line so as to include a single overwash fan and adjacent barrier dunes. Elevations are surveyed at each point along seven lines with an accuracy of .05 ft (1.52 cm). Fixed markers are located only along the baseline, in order to avoid artificial scour or fill within the boundaries of the active fan.

In addition to the systematic measurement of the elevation changes, a technique is employed to monitor the depth of erosion and thus the gross deposition, Figure 2. Plugs of painted sand are placed level with the surface along the survey lines. After an overwash, these plugs are sectioned such that the amount of erosion, as well as the depth of post storm fill, can be determined.

During storm conditions, quantification of overwash hydraulics are attempted. The velocity of the surge through the throat and the temporal frequency of the surges are recorded. Suspended sediment samples are also collected.

Analysis of Data

The field program outlined above has made possible the detailed study of individual overwash events. Ideally, the field site would be surveyed just before and immediately after the storm-overwash period. In practice, there is often an interval of several days before or after the storm, and thus the analysis of data must consider the additional factor of eolian transport of material.

The first storm to be monitored in detail occurred on March 22, 1973. This northeaster had deep water wave heights reported greater than 30 ft (9 m) with surface winds of 65 knots (33 m/sec) at sea, NOAA (1973). At Ocean City, Maryland, COSOP observations reported 6 ft (2 m) breaking waves, with periods of 8 to 12 seconds out of the northeast, CERC (1973). Figure 3 illustrates the sediment deposition pattern for this storm. The maximum depth of erosion can be seen from the elevation of the colored sand plugs. This erosion was concentrated in the forward or throat section of the overwash feature. The net change after the storm was a deposition of

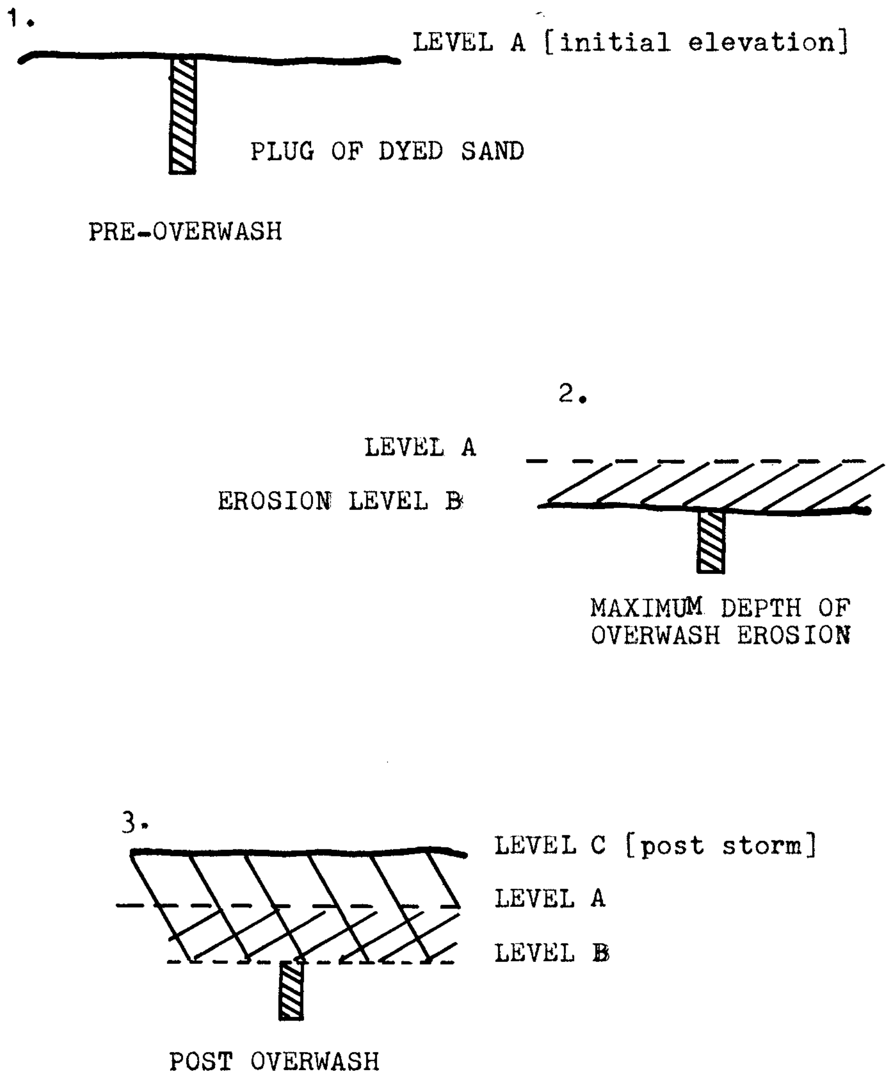

Figure 2, Method for Determining Erosion Depth

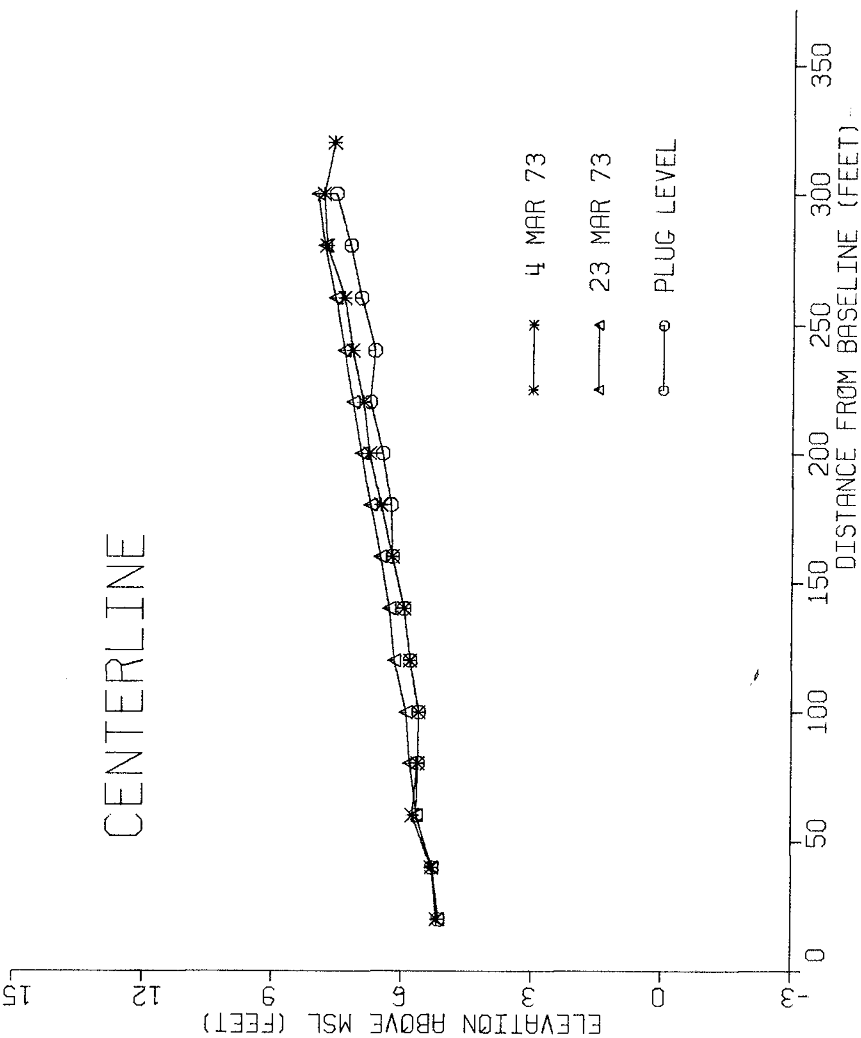

Figure 3, Centerline Profile Change, Northeaster, March 22, 1973 material over the fan, tapering off towards the marsh. This wedge-shaped deposit is typical of the overwashes observed on the island.

Velocities in the throat section were measured during the storm using a Gurley current meter. Maximum surge velocities were 8 ft/sec (2 m/sec) at 1 ft (.3 m) above the bottom of a 3 ft (1 m) deep surge. During a two hour period which corresponded to the peak of the storm, 130 surges were observed to cross the dune line with some surges penetrating the entire width of the island. Thus, approximately one surge per minute was recorded.

During this same period of observation, suspended sediment samples were obtained by hand-held collection bottles. These samples, collected at mid-depth in the overwash surge, had concentrations of about 50% sediment by weight.

A second overwash resulting in a significant volume of sediment transported onto the study site occurred on October 26-27, 1973. Tropical Storm Gilda generated 10 second, 6 ft (2 m) waves as observed on Assateague Island (BEP, 1974). Figure 4 shows the net sediment transport along the centerline from this storm. In this case, the area of erosion extended further back onto the fan, although in general the pattern is similar to the previous example. By integrating all seven survey lines over the entire deposit, the net volume change can be computed. For this storm, 83 cubic yards (64 m^3) were deposited.

Overwash Hypothesis

Based upon the analysis of data and observations made, a basic model of overwash on Assateague Island has been proposed. The storm parameters needed for overwash appear to include breaking waves in excess of 6 ft (2 m) with a storm tide of 1 ft (.3 m) or greater. Figures 5, 6, 7, and 8 illustrate the probable sequence of erosion and deposition during an overwash.

The initial stages of overwash are primarily erosional in nature, in the throat section of the fan. Sand is transported to the fan itself or flushed to the marsh via the sluiceway depending on the magnitude of the surge. Later, as the surge velocities decrease, during the later stages of the storm, new

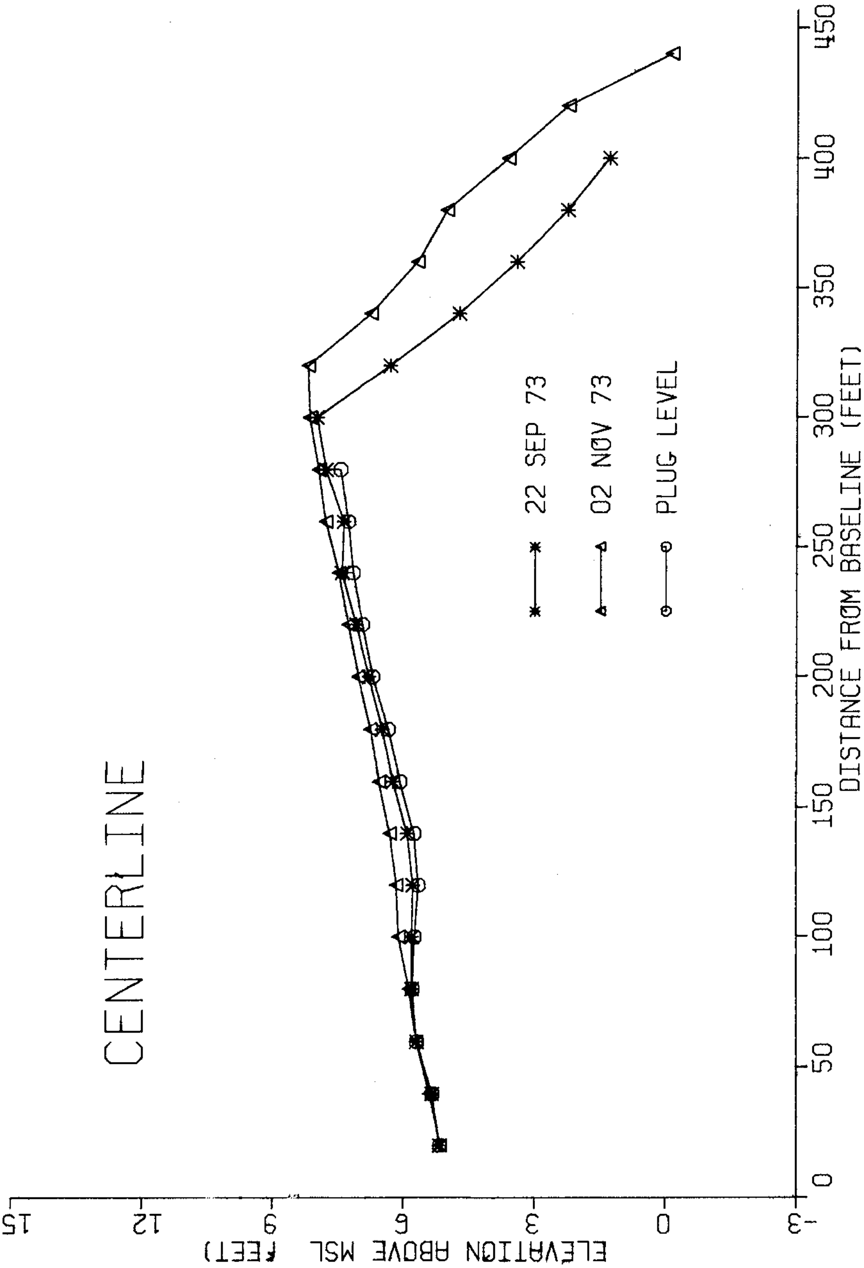

Figure 4, Centerline Profile Change, Tropical Storm Gilda, October 26, 1973

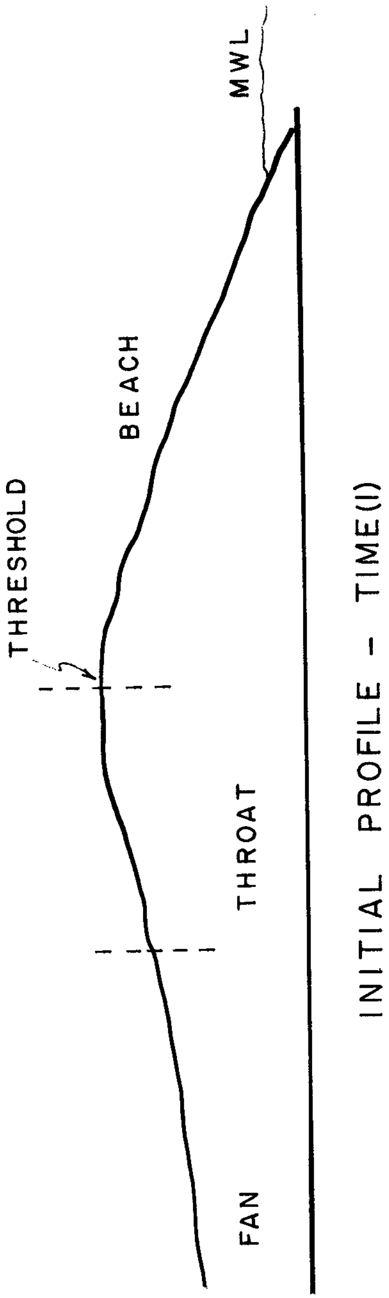

Figure 5, Overwash Model, Initial Conditions

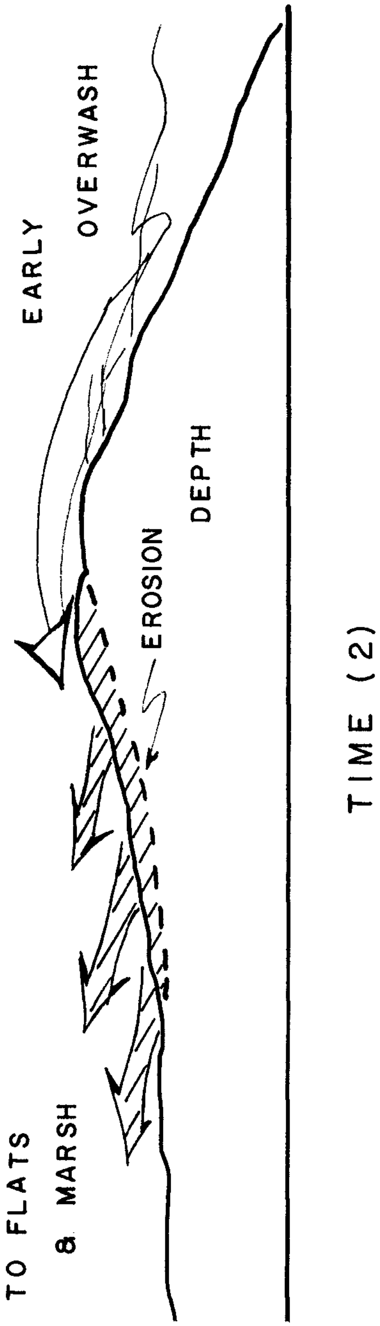

Figure 6, Overwash Model, Early Overwash Surges

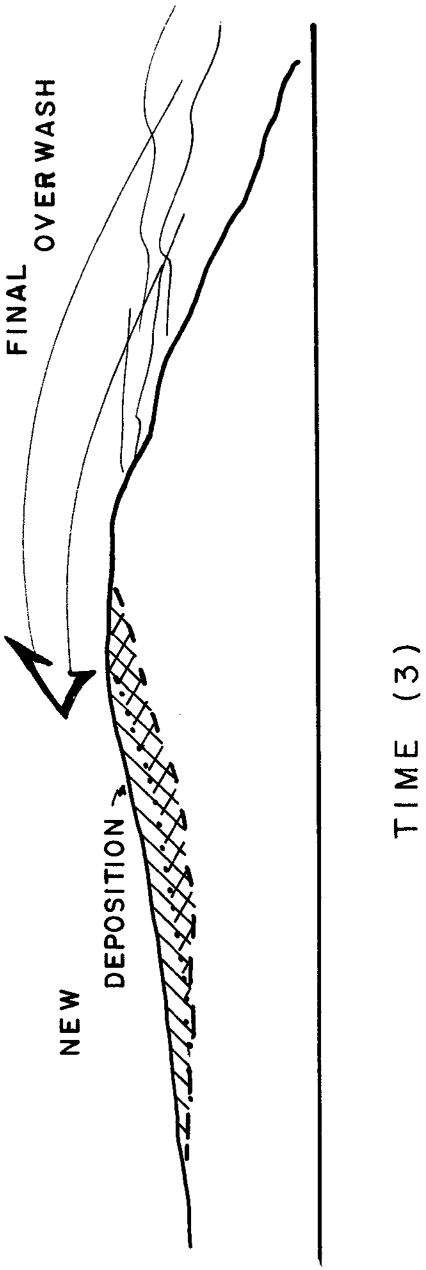

Figure 7, Overwash Model, Net Storm Deposition

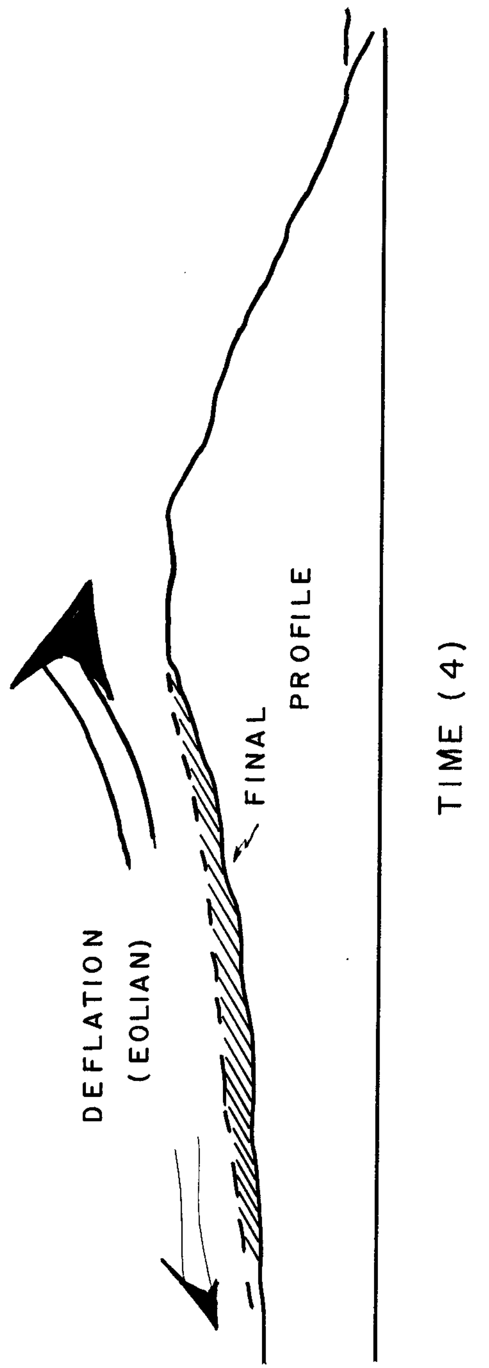

Figure 8, Overwash Model, Eolian Deflation of Fan and Throat material is deposited over both the throat and fan sections. Finally, after the storm has abated, the wind reworks the newly deposited material. The net contribution of sand to each of the morphological features, i.e., the dunes, marsh, flats or beach depends on wind direction and magnitude.

Summary and Conclusions

After two years of continuous study of this transverse slice of the island, some surprising initial conclusions can be drawn. At least 4 storms are known to have caused overwash at this site during the past two years. Our surveys, which include the last two of these storms, indicate approximately 36 cubic meters or an average of 3.8 cm over the fan area of net loss of sand at this site (Figure 9). Considering the transient nature of this environment, this loss can be essentially neglected, and the fan elevation considered stable.
The dune line has receded slightly by seaward scarping, consistent with an eroding beach. Survey profiles for Northline 4 (Figure 10) and Southline 4 (Figure 11) over the same 14 month period show that the backside of the dunes are accreting. This sediment has been derived from the overwash fan. The elevation of the vegetated barrier flats and marsh have remained essentially unchanged with respect to eolian action. This analysis indicates that the beach is the chief recipient of the overwash material.

The throat width has been reduced 5 to 10 ft (1.5 to 3 m) during the period of study. This latter figure suggests that the overwash process at this level of storm intensity is not competent to self-maintain the breaches in the dune line. Further evidence supporting this conclusion can be obtained from an analysis of historical photography.

In March 1962 a severe northeaster struck this area. Aerial photographs of Assateague Island immediately after the storm show that the overwash throat at the present research site was approximately 100 ft (30 m) in width. The throat has subsequently been reduced to 40 ft (12 m) which is consistent with the five foot reduction per year calculated from the field data.

The program outlined above is being continued with the addition of tide and wave gage data, as well as refinements in the measurement program during the storms. This new data should greatly improve the quantification of these overwash processes.

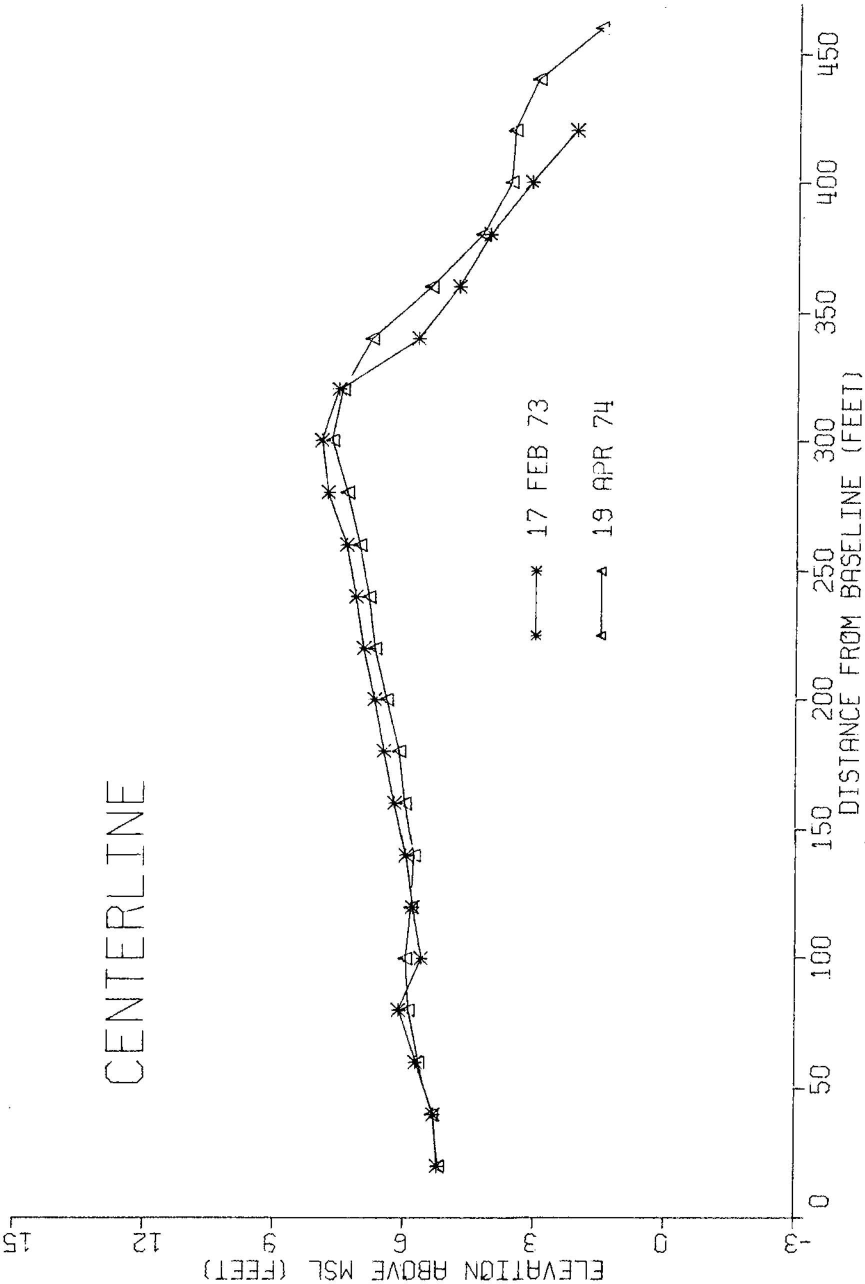

Figure 9, Net 2-year Change, Centerline

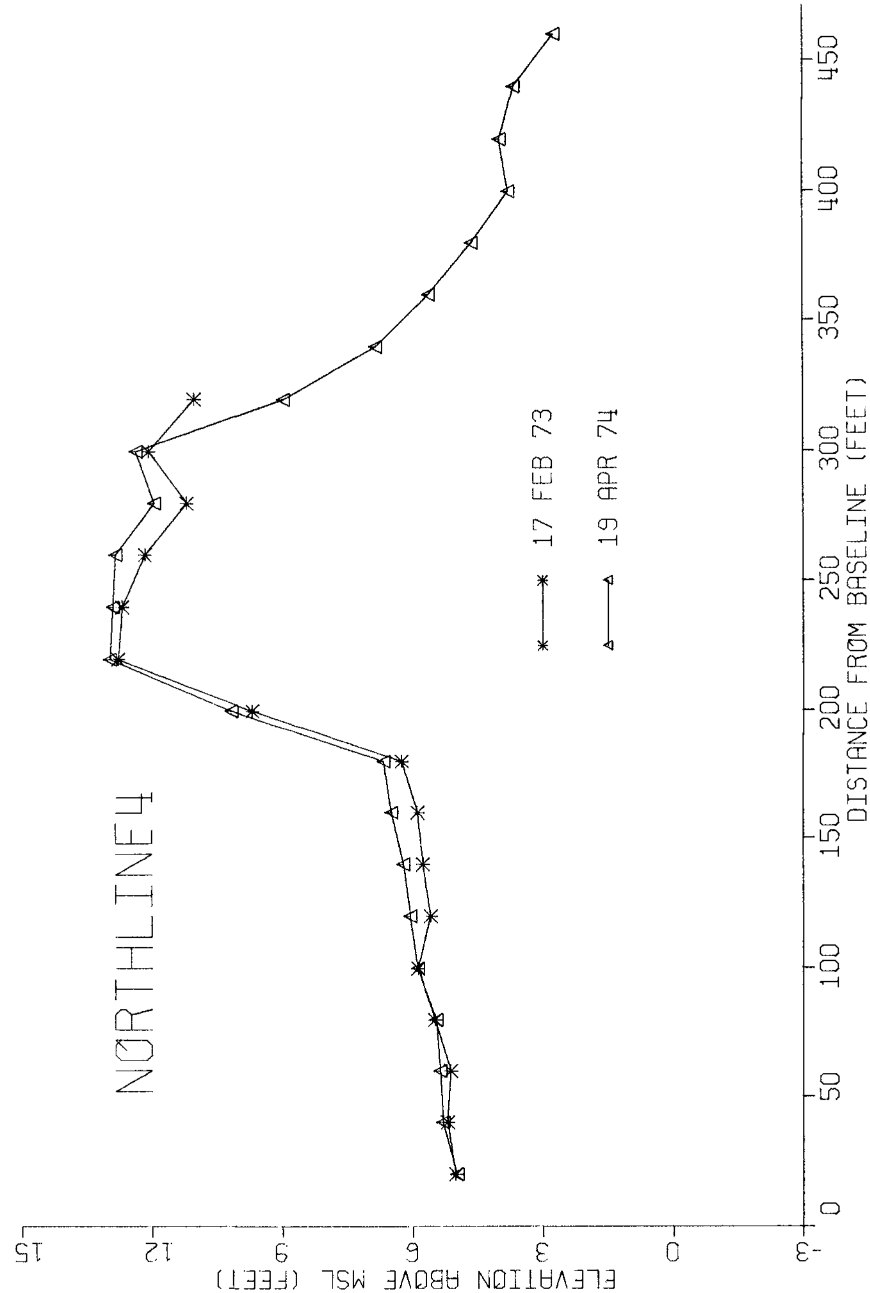

Figure 10, Net 2-year Change, 40 ft. north of Centerline

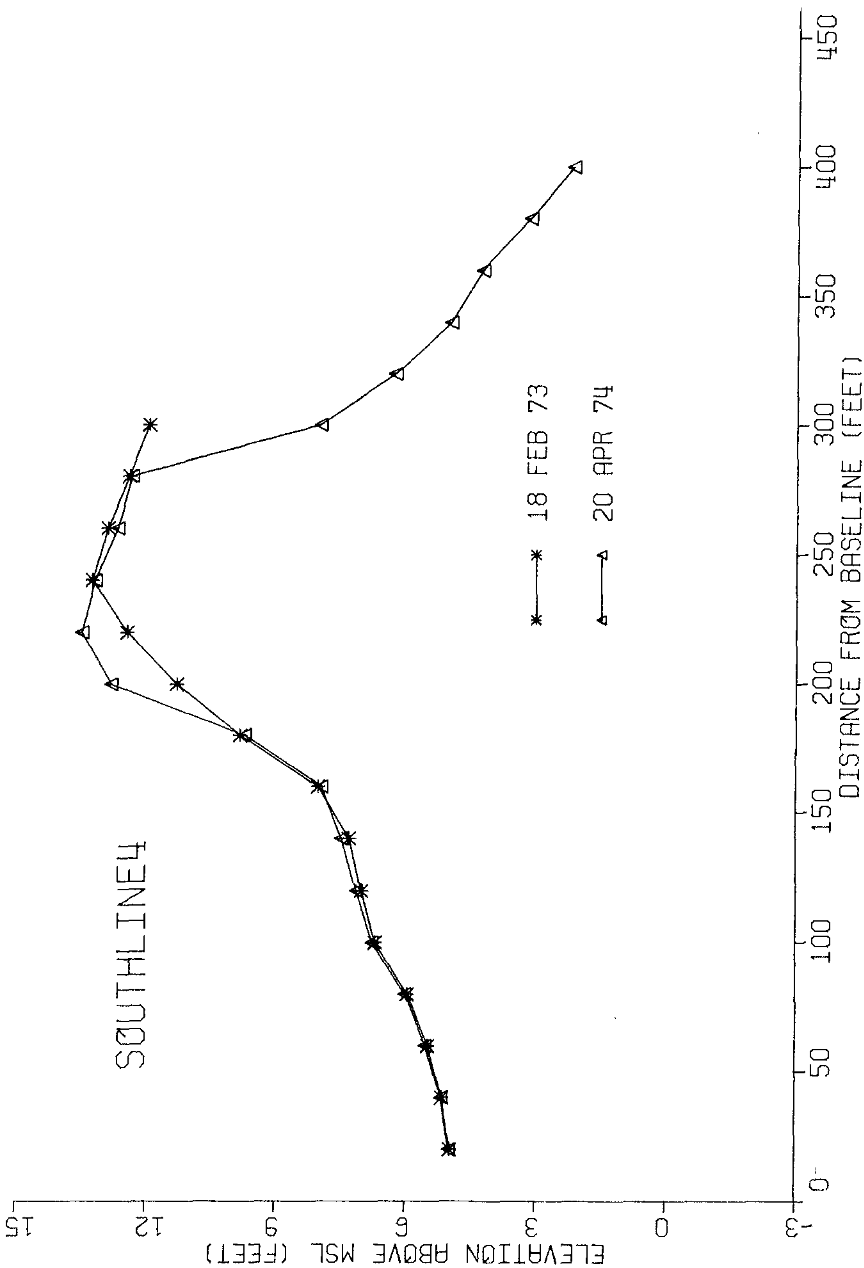

Figure 11, Net 2-year Change, 40 ft. south of Centerline

Acknowledgements

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