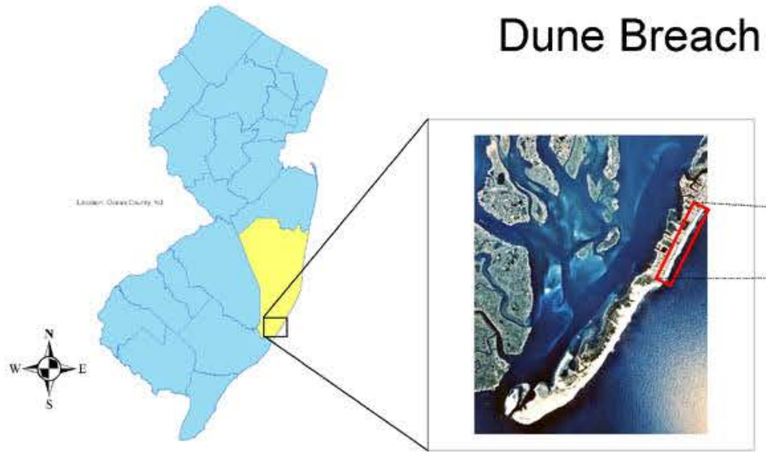
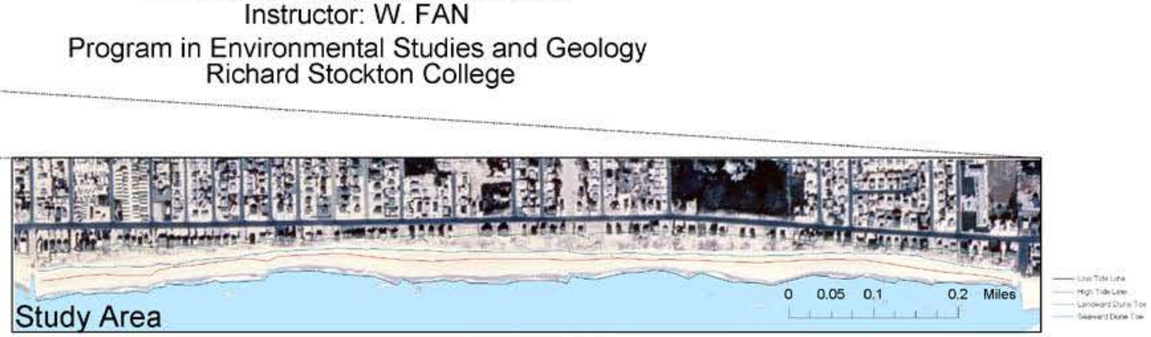
Dune Breach Susceptibility in Holgate, Long Beach Island, New Jersey

Tonya Del Sontro
ENVL 3303: Advanced GIS Course
Instructor: W. FAN
Program in Environmental Studies and Geology
Richard Stockton College



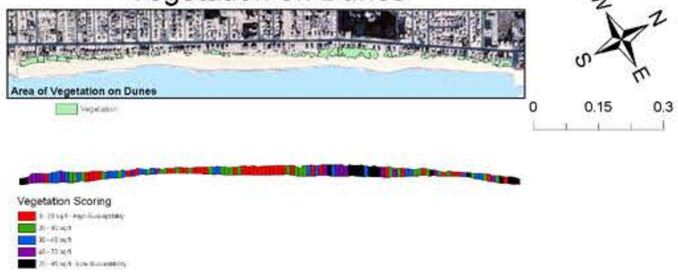


ABSTRACT

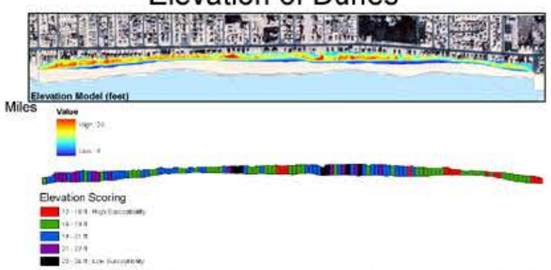
Long Beach Island (LBI), NJ is a low-lying barrier island frequented by storms annually. The dunes on a barrier island are extremely valuable safeguards against storms for the island and the main-land. A 1.2 mile stretch of beach in Holgate of LBI was divided into 122 "sampling" bins, 100ft wide, and was surveyed for four variables: 1) dune width, 2) vegetation upon the dunes, 3) dune height, and 4) slope of the foredune. The values of these four variables were placed into 5 categories ranging from most susceptible to dune breach to least susceptible to dune breach. The values for each variable per bin were then combined into an equation in order to determine the overall susceptibility from very high to very low of each bin to overwash. The scoring of each variable and the ranking of each bin are shown, as well as the overall susceptibility of each bin. The aim of this project is that coastal residents use this knowledge to better manage the dunes that they unknowingly depend upon.

Width of Dunes

Vegetation on Dunes



Elevation of Dunes



Slope of Foredunes

INTRODUCTION

In the spring of 2002, an analysis of dune stability was carried out for a 1.2 mile stretch of beach in Holgate, on southern Long Beach Island, New Jersey. Several variables relating to dune stability were collected and examined in order to assess the vulnerability of dunes to overwash and erosion from storm activity. These variables include: (1) dune width, (2) dune height, (3) dune slope, and (4) presence/absence of dune-stabilizing vegetation. The combined influence of these variables was used to determine which sections of dune are most susceptible to breaching. GIS was used to visually compare, analyze, and weigh the importance of each variable, and to mathematically integrate the variables across "sampling bins" along the length of the dune field.

OBJECTIVE

The purpose of this project was to determine and quantify the susceptibility of dunes to overwash and erosion. The goal was to produce a "dune susceptibility map" that indicates where residential areas, particularly beach-front homes and property, may be at risk and exposed to dune overwash and flooding.

METHODOLOGY

Data were collected in the field as part of the larger Marine Geology (MARS-3310) class project, and acquired from several federal and state agencies, including the National Oceanic and Atmospheric Administration (NOAA) and the New Jersey Department of Environmental Protection (NJEPA). In the field, dune profile measurements were taken perpendicular to the beach face every 100ft. Dune measurements included (1) distance from seaward toe to crest, (2) distance from crest to landward toe, and (3) slope of fore- and backdune. Trigonometry was used to calculate the true dune width from the slope and toe-to-crest measurements. Vegetation was field mapped as either "present" or "absent." Both the dune and vegetation data were digitized from the field maps into the GIS.

The base map image and related data are from NJDEP. Elevation data are from NOAA LIDAR, flown in September, 2000. The LIDAR were edited to remove the effects of houses and related structures, as well as anomalous elevation points. The revised elevation data were used to (1) constrain the locations of the seaward and landward dune toes, (2) create a dune elevation/topography map, and (3) create a foredune slope map.

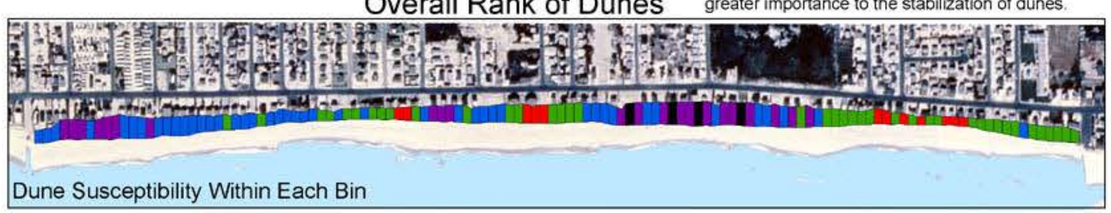
In order to measure the variables in a consistent manner, the study area was subdivided into 122 uniform "sampling bins", measuring 100ft in width, 1000ft in length, and centered on a dune profile. For each bin, summary statistics or area ratios were calculated individually for the four dune stability variables.

Dune width and vegetation were measured as area-percent within a given bin. Average dune width (measured perpendicular to the beach strike) was determined using the following estimation:
Dune Width = (bin length) / ((dune area) / (bin area)).
The dune heights and slopes were measured for each bin and the maximum values were determined using summary statistics. All accessways were masked out from the slope map so as not to disrupt the maximum slope statistics of the foredune for each bin.

Each variable was further grouped using a scoring system of 1 to 5, where 1 is the most susceptible to dune breach and 5 is the least susceptible. Scoring was done using histograms and visually determining natural breaks in the data distribution. The overall susceptibility "rank" of a given bin was calculated by combining the variable scores using the following equation:

(3 Elevation + 2 Slope + Width + Vegetation) / 7
Elevation and slope were given more weight because of their greater importance to the stabilization of dunes.

Overall Rank of Dunes



RESULTS

Each of the four dune stability variables are shown as overlays on the base map image. The variables, scored according to bin, are shown below the base map image. For presentation, the bins were clipped to the width of the dunes. Red bins are the most susceptible to dune breach, and are characterized by narrow dune widths, low dune elevations, shallow foredune slopes, and absence of vegetation.

The dune susceptibility map shows the overall rank of the bins, which is based on all four variables. Red bins are very high overall susceptibility and black bins are very low. There are 12 bins that have very high susceptibility and only 4 bins with very low susceptibility.

CONCLUSION

The final map shows the vulnerability of individual dunes in this 1.2 mile stretch of beach. It is obvious by performing fieldwork that the vulnerability of some of these areas are due to anthropogenic modifications. Some dunes were leveled off to create a view of the beach, a walk-way or a backyard. Dunes are natural beach features that serve as safeguards against storm activity in order to protect the island and mainland. These features need to also be protected and preserved, not manually altered for the selfish benefit of beach-front homeowners. Perhaps this project will give coastal residents new insight into how their actions affect the beach front and the consequences they are promoting.