Coastal Geotools 2009

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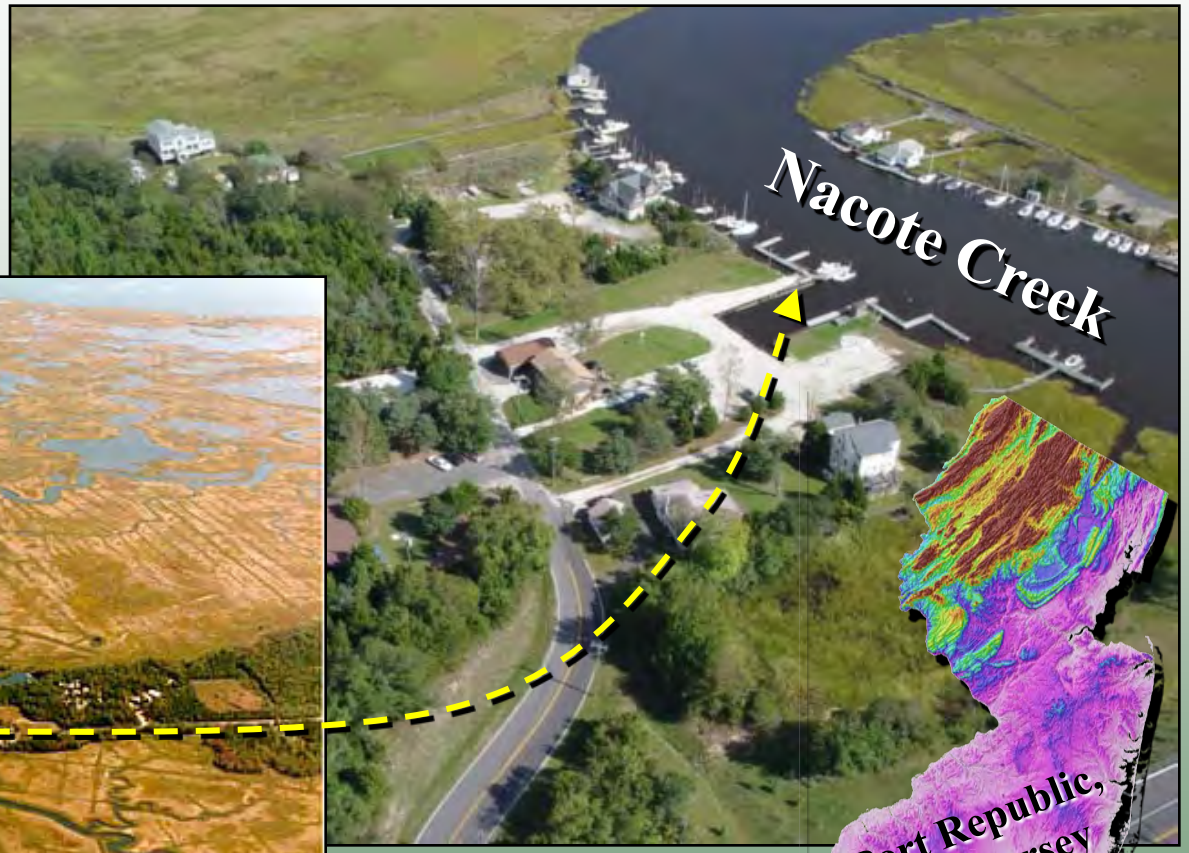
Thursday, March 5, 2009

Coastal Research Center



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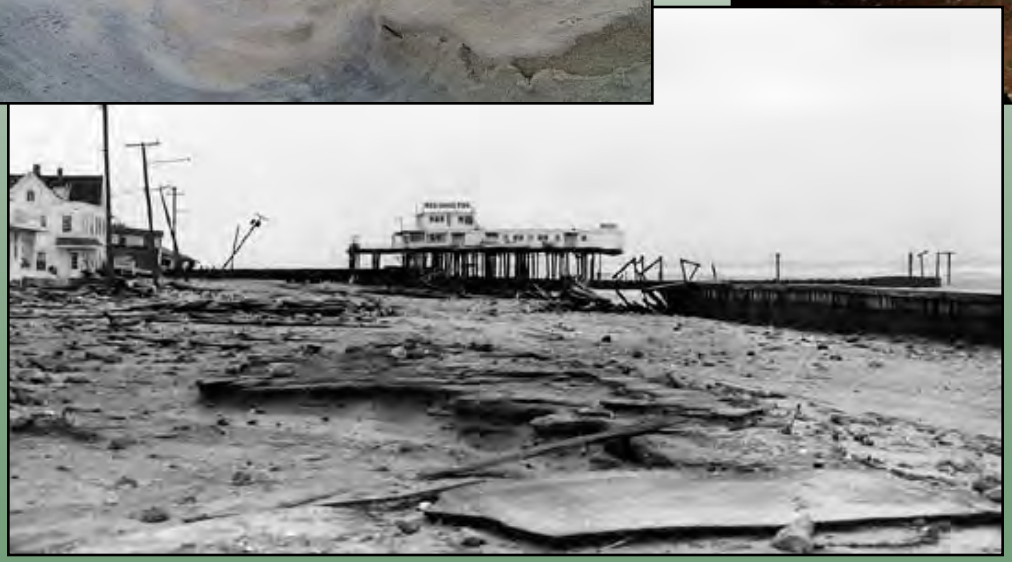
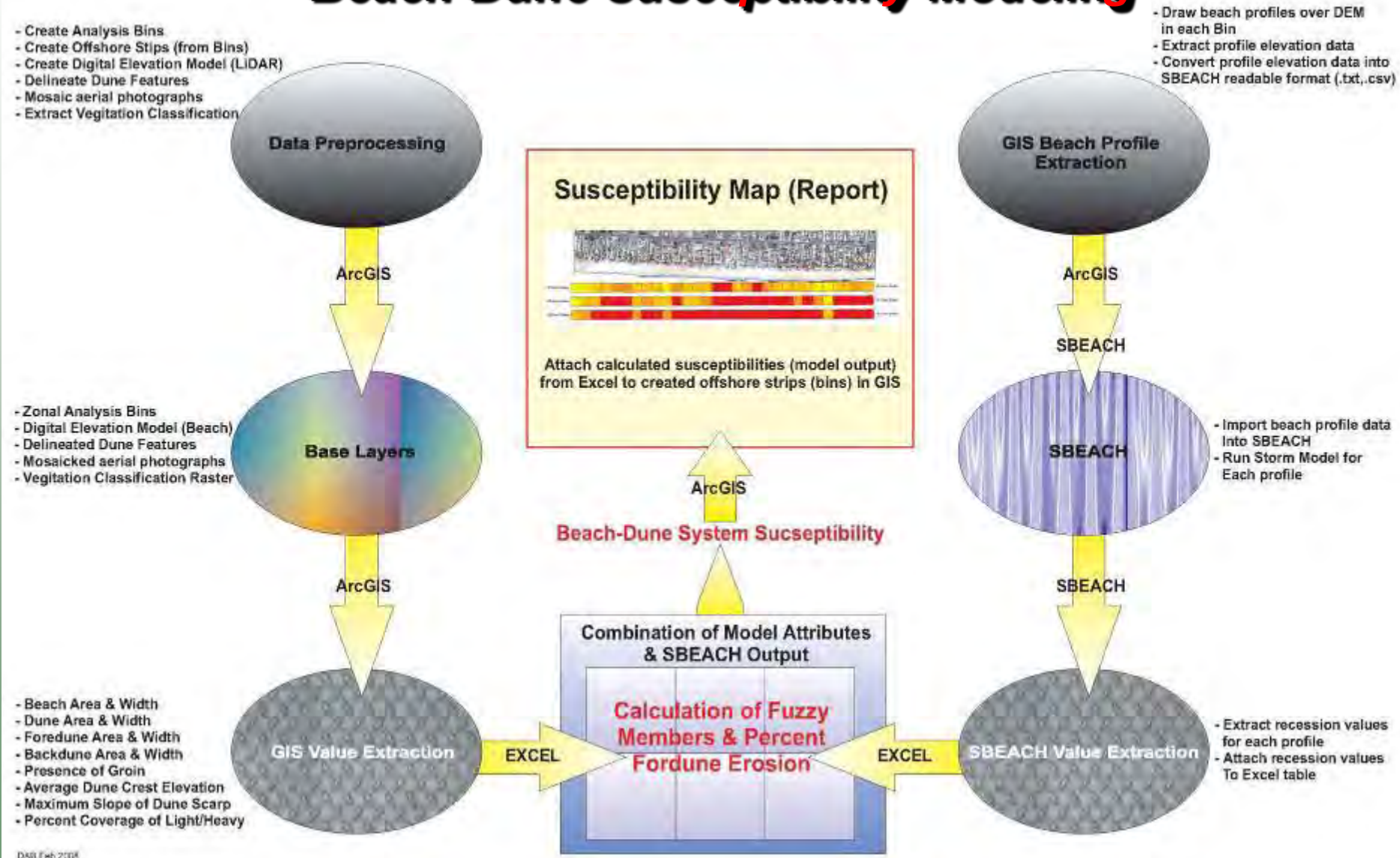
Beach-Dune Susceptibility Assessment & Software Application



Talking Points

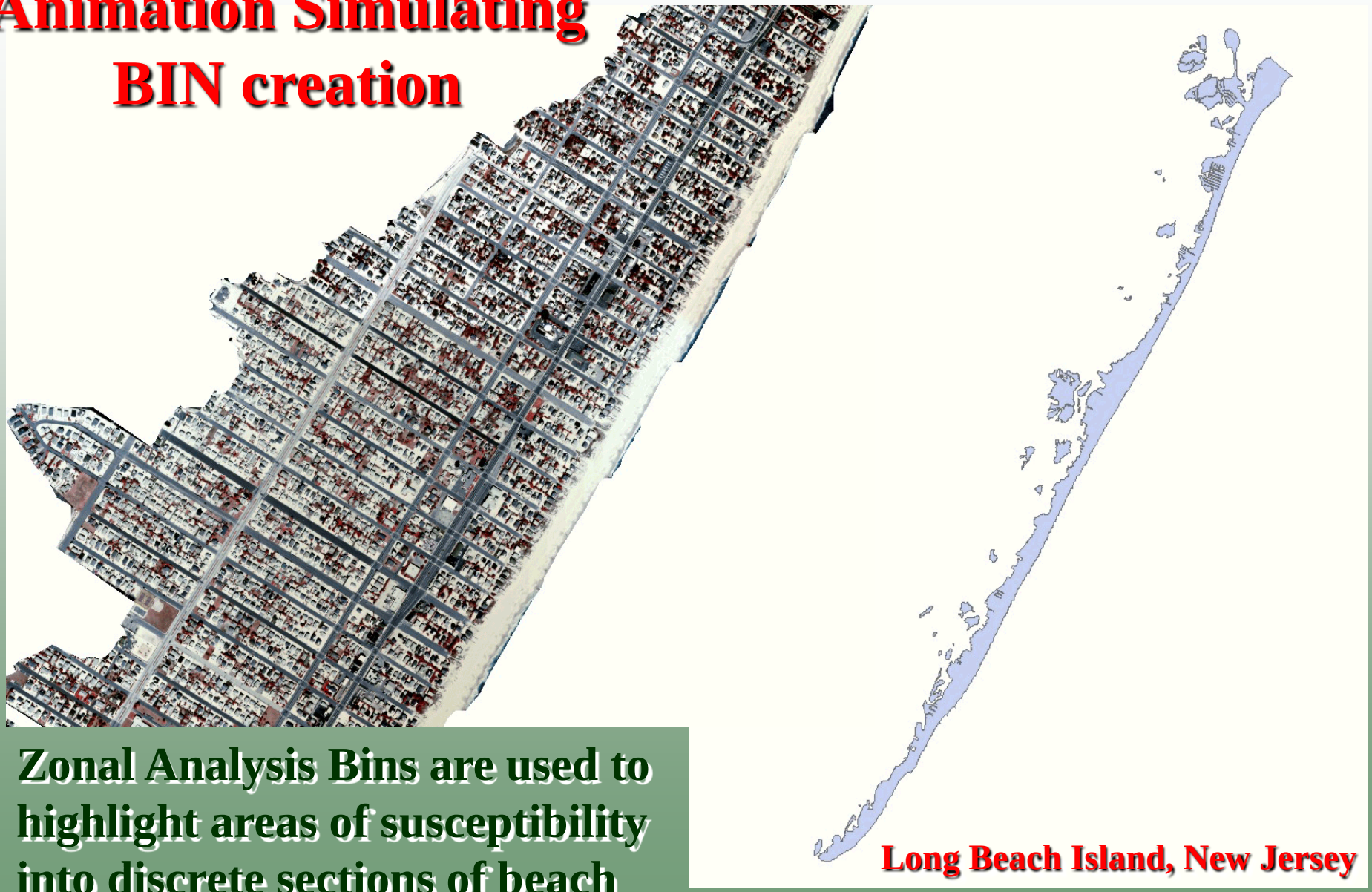
- GIS and Analysis & Modeling
- LiDAR
  - Simple Dune System LiDAR Analyses, Examples…
- Beach-Dune System Susceptibility
  - Overview
  - Regional Assessments – NJ Statewide
- Software Application - Photo Science

Beach-Dune Susceptibility Modeling



Bin Creation

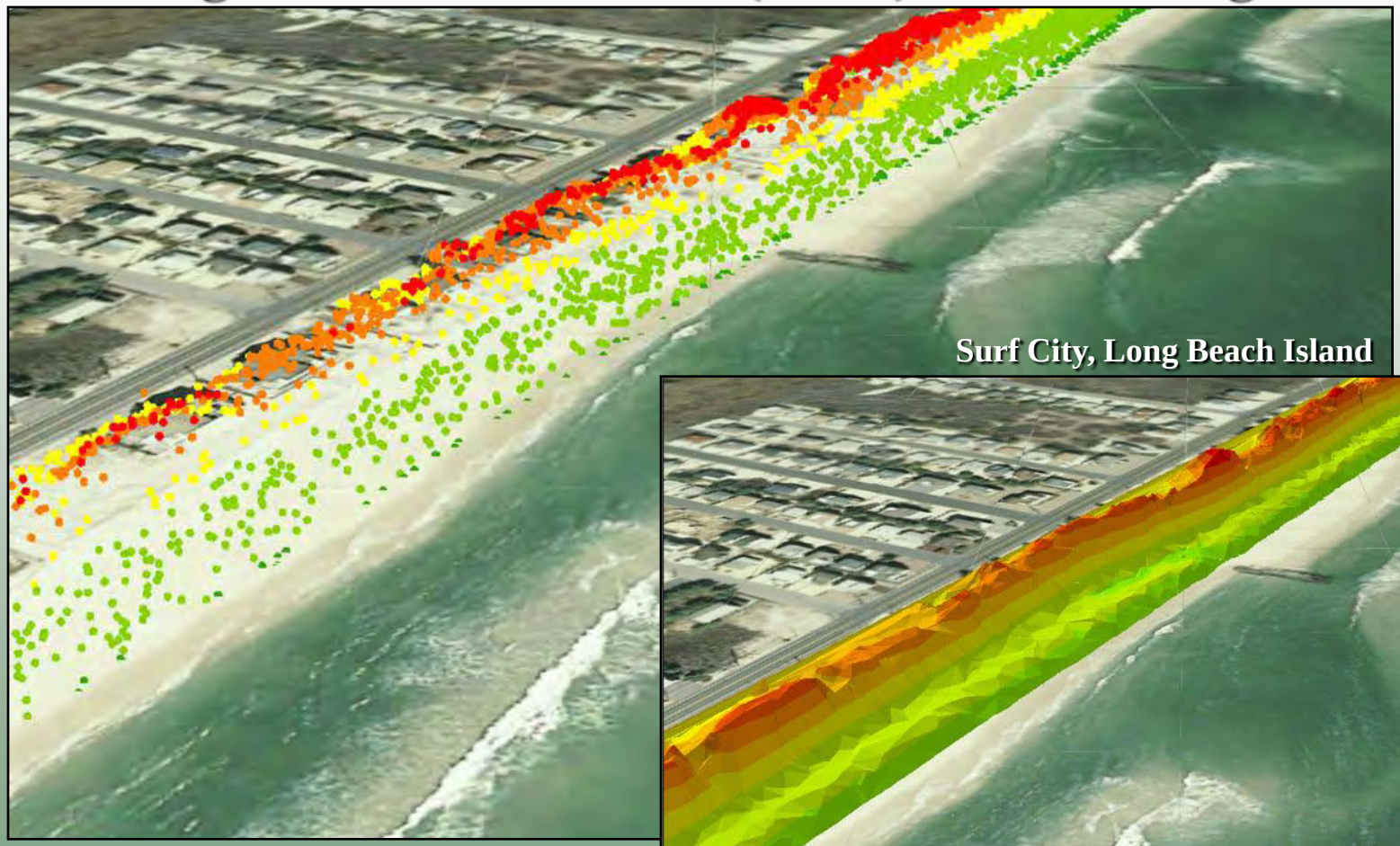
Animation Simulating BIN creation

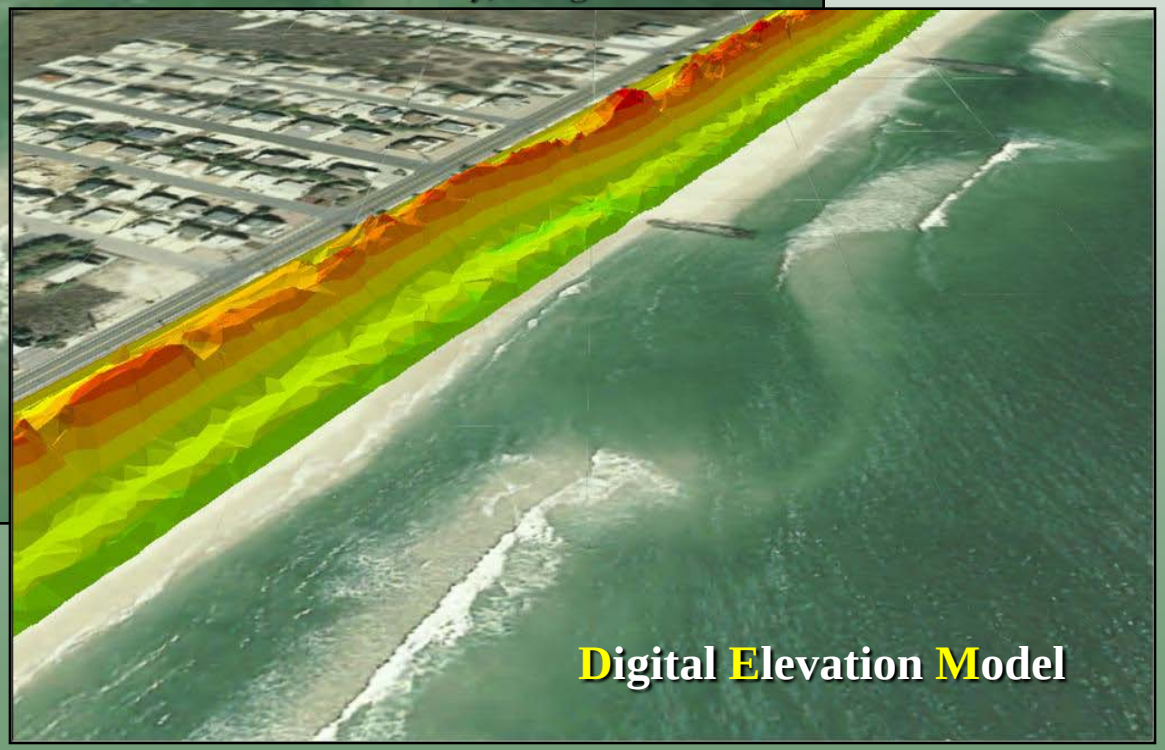


Zonal Analysis Bins are used to highlight areas of susceptibility into discrete sections of beach

LiDAR & Photogammetry

Digital Elevation Model (DEM) created using LiDAR data



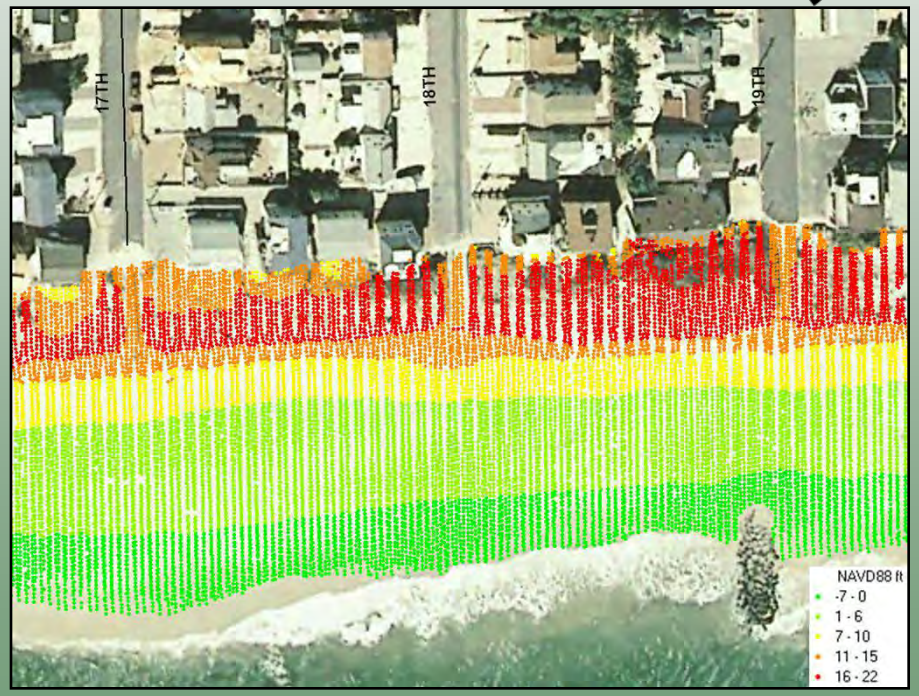


"Raw", Unprocessed
LIDAR Point Elevations

Digital Elevation Model

Spatial Distribution and Resolution

- LiDAR data, combined with photogrammetry allows for creation of baseline datasets to perform delineations
  - Dune Crest
  - Landward and Seaward Dune Toes
  - Shoreline
  - 10 ft. Waterline



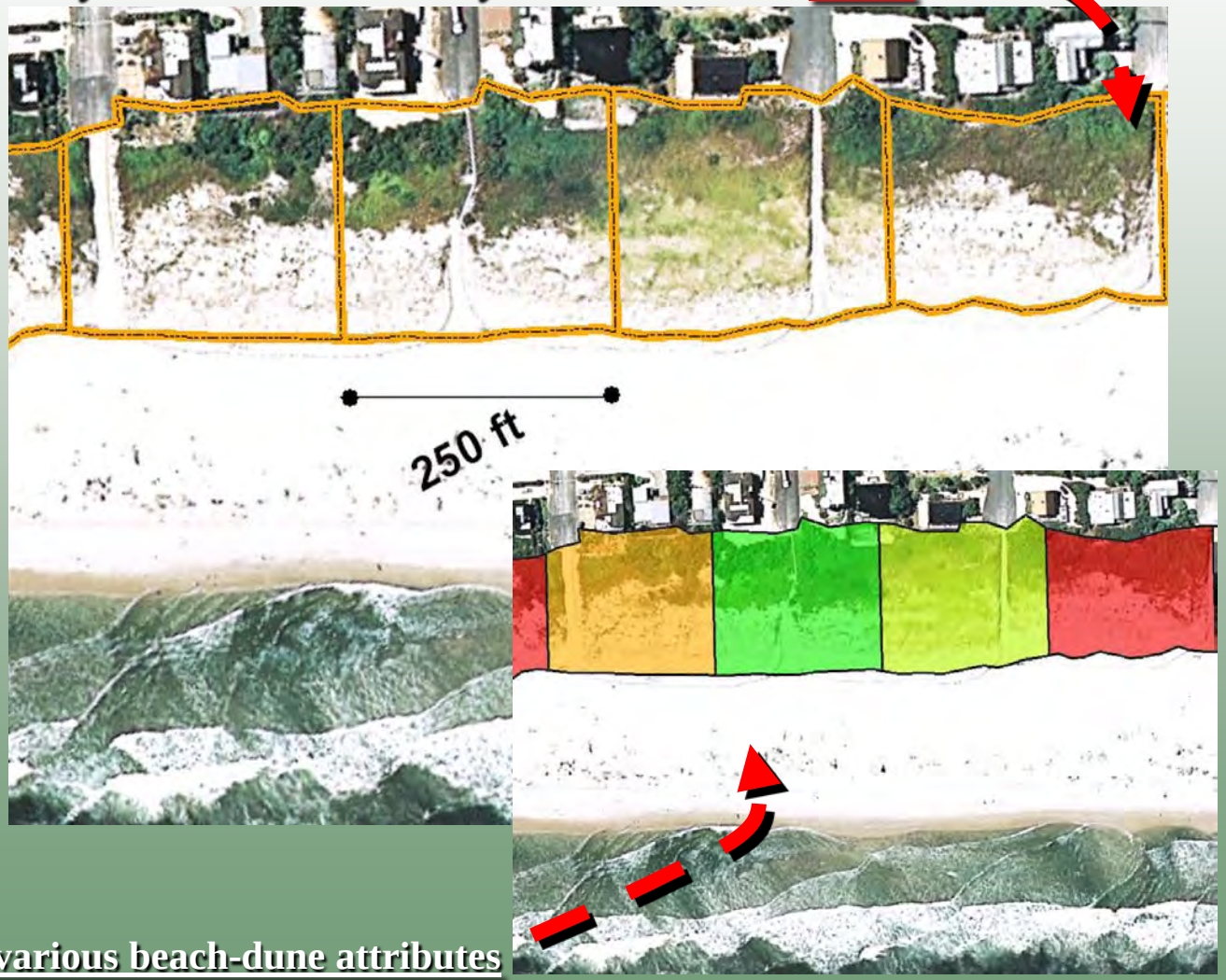
LiDAR Point Distribution

LiDAR Extracted Dune Delineations

Analysis bins

- The GIS-based beach-dune assessment integrates several geospatial datasets into weights of susceptibility within zonal analysis areas call "**bins**"

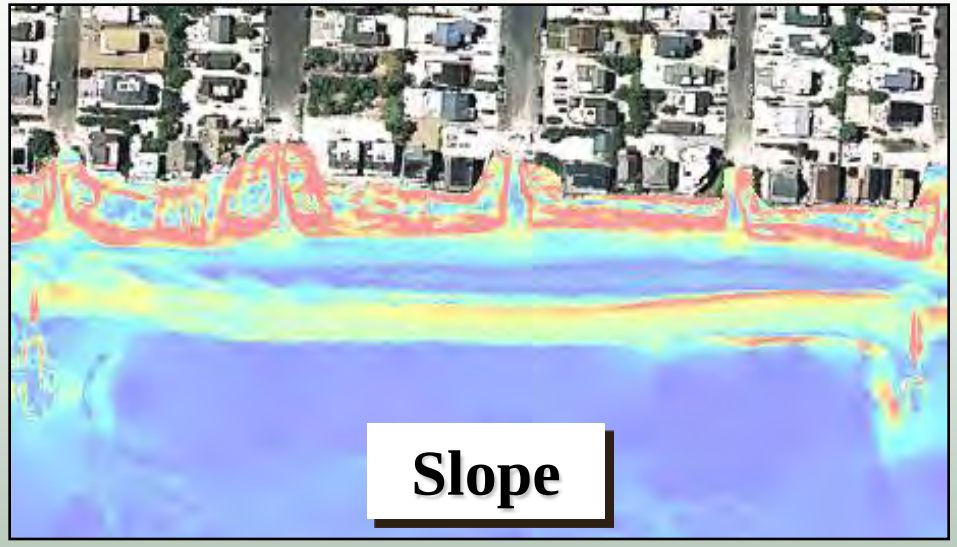
  - Bins run long-shore parallel to shoreline
  - Each bin divides the beach into 250-foot sections
  - Within each zonal analysis bin, geospatial calculations are performed to extract beach-dune characteristics based on base data such as LiDAR elevation data and Photogrammetric data.

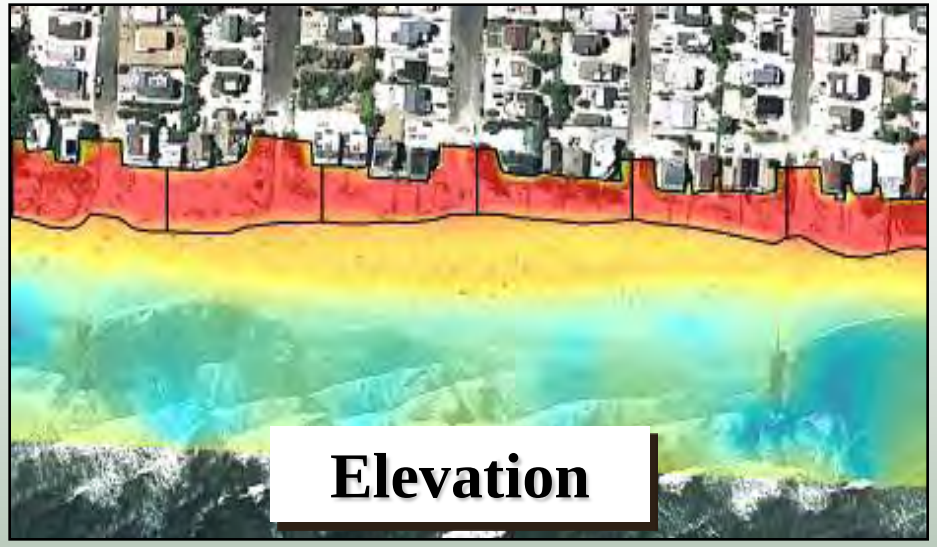


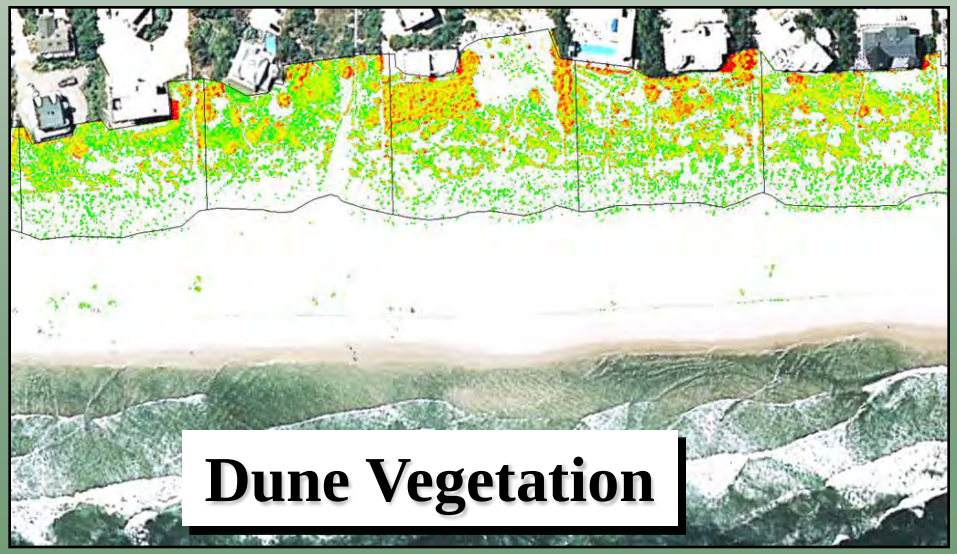
Bins are also used to symbolize various beach-dune attributes

LiDAR - Photogammetry

Other Geospatial Datasets Derived from LiDAR Data







Beach-Dune Profiling Animation

Beach-Dune Profiling

2D Beach Profiles extracted from DEM surfaces

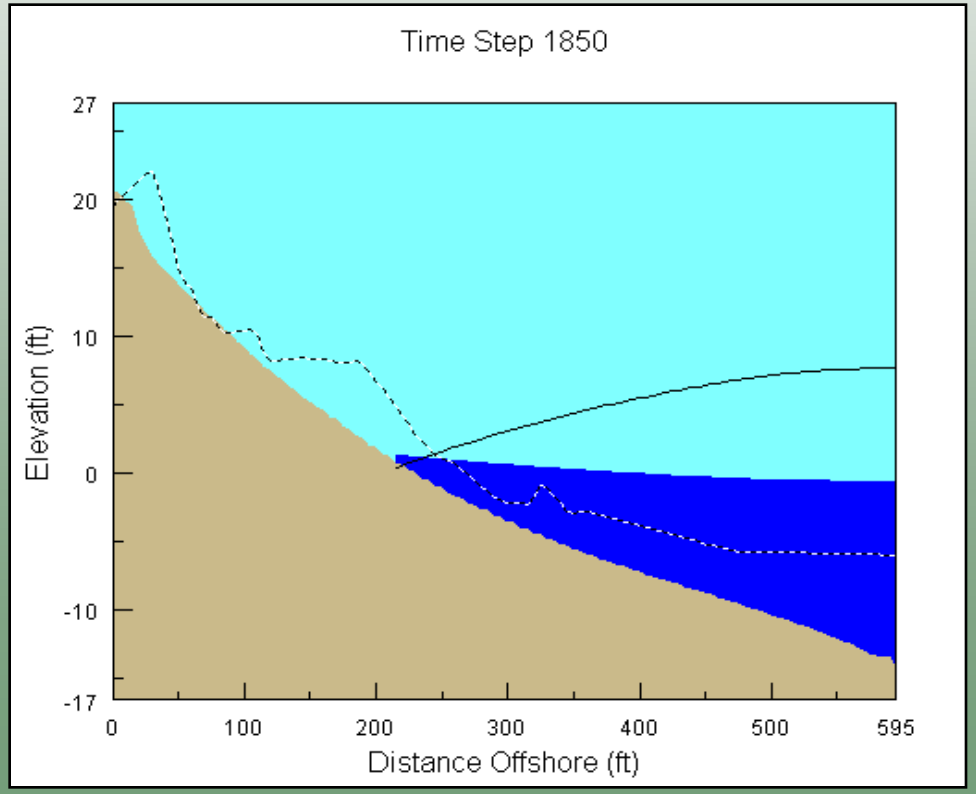
- Provide cross-sectional beach profiles run cross-shore, from the landward extent of the dune to the nearshore zone (extent of LiDAR elevation data).

- Beach profiles are extracted from center of each zonal analysis bin based on LiDAR elevation data.

Beach-Dune Profiling

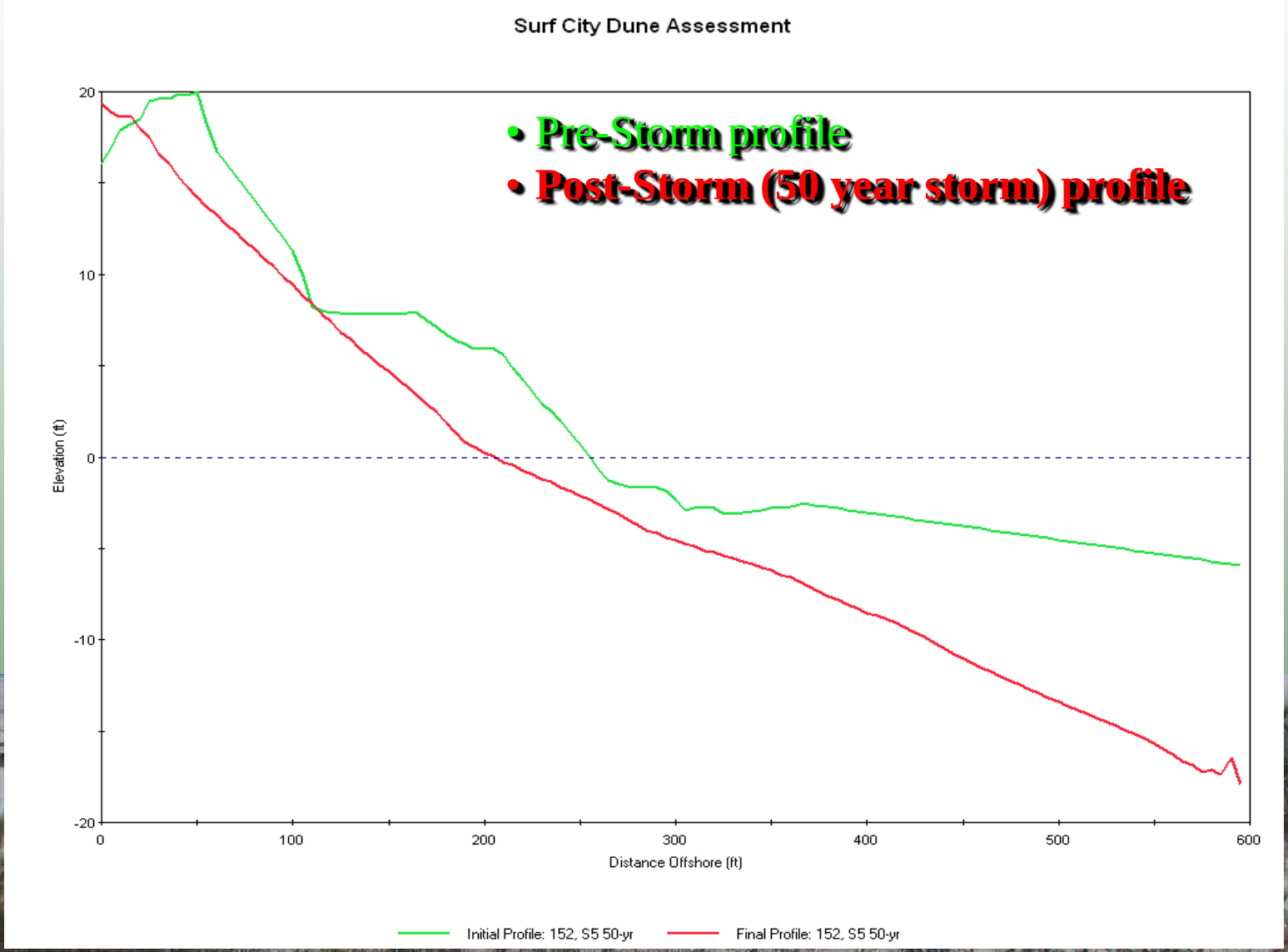
- **LiDAR generated profiles combined with a U.S Army Corps storm simulation model CEDAS (Storm-induced BEAch CHange) SBEACH …**
  - **Simulates 2D beach profiles for 2-year, 5-year, 10-year, 20-year, 50-year storm events using Federal Emergency Management Association (FEMA) based storm parameters**

Coastal Engineering Design & Analysis System Version 4.0

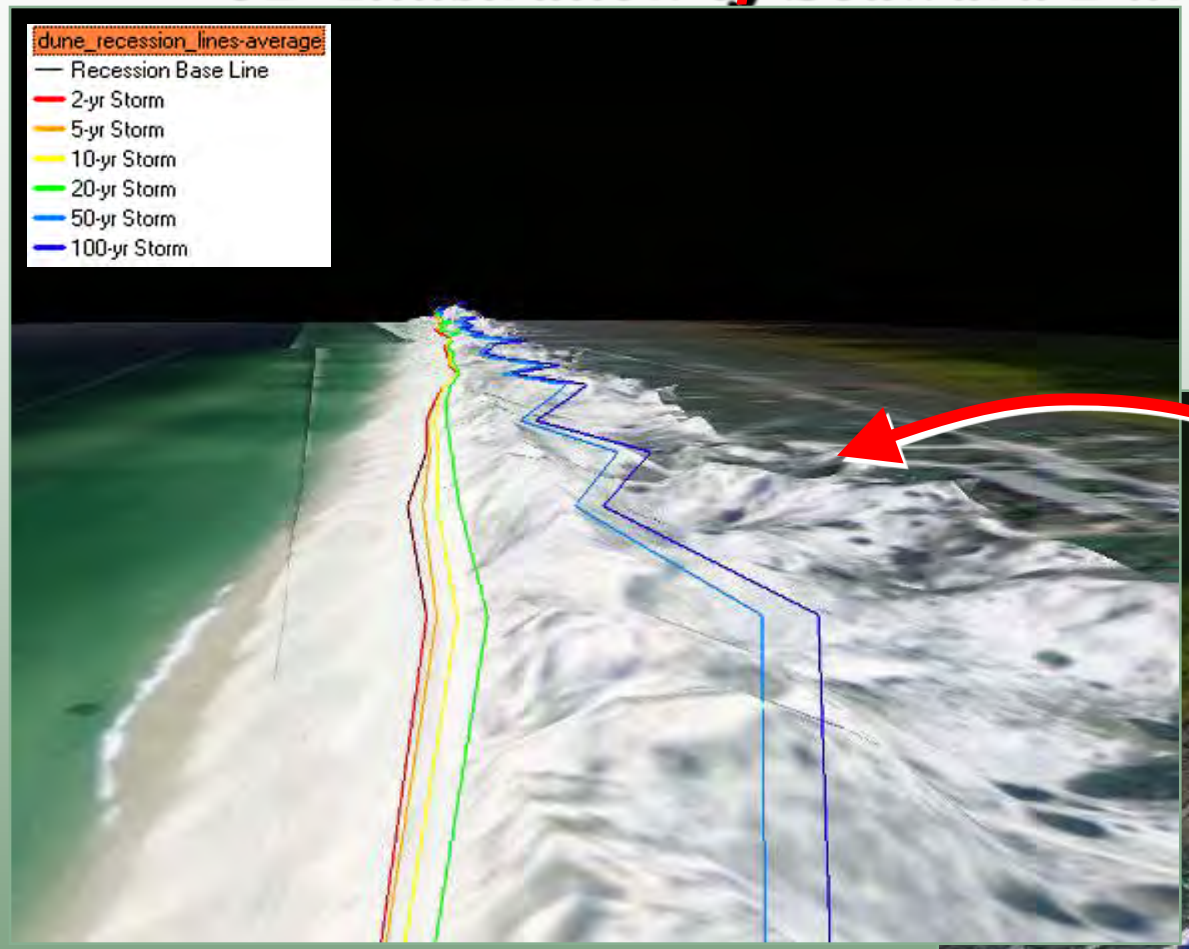


- **SBEACH storm simulations provide…**
  - **Dune recession analysis**
  - **Volume change analysis**
  - **Dune breach vulnerability points**

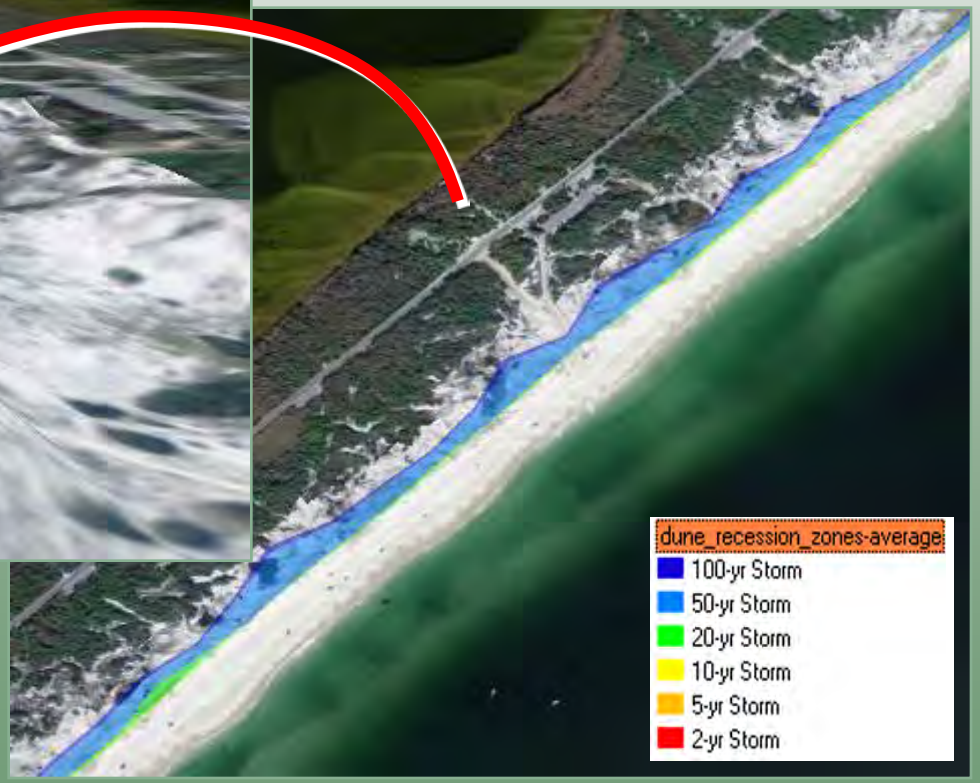
SBEACH Pre and post storm profile output



3D Illustration of Seaward Dune Toe Recession

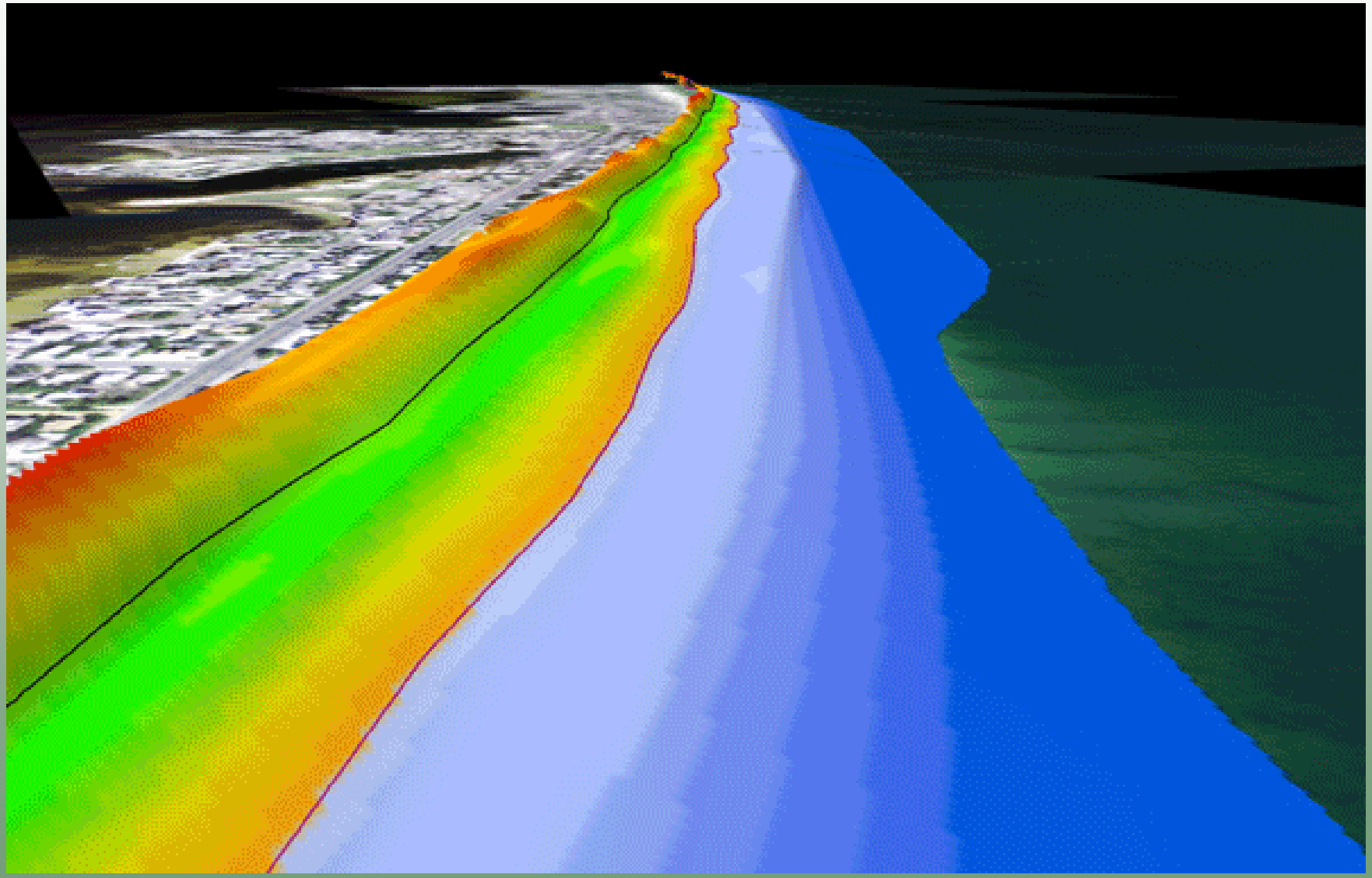


Island Beach State Park



3D Illustration Showing Recession Lines Draped on the Foredune

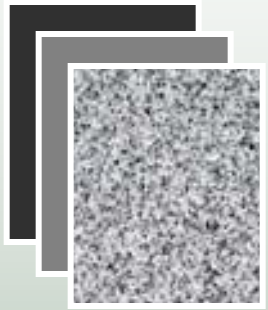
3D Animation of 2,5,10,20 and 50 year storm events



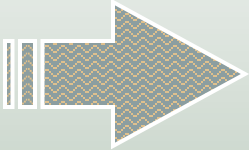
Integration of Geospatial Datasets

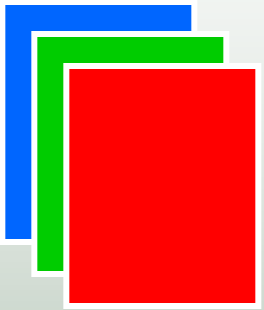
Basic Approach to Geospatial Modeling

Raw Datasets



Data Processing





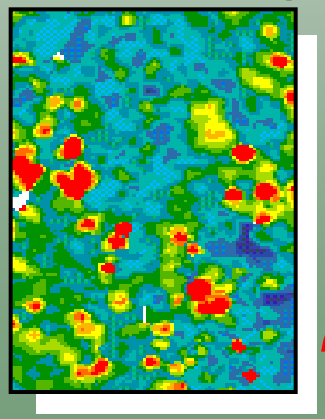
Maps

Weighting

Optimize

Integration

Map of Correlation, Suitability, Favorability, Probability, Susceptibility, etc.



The

" Model "

NJ Northern Ocean County Barrier-Spit

Pilot Study - Conducted Over 2005-2007

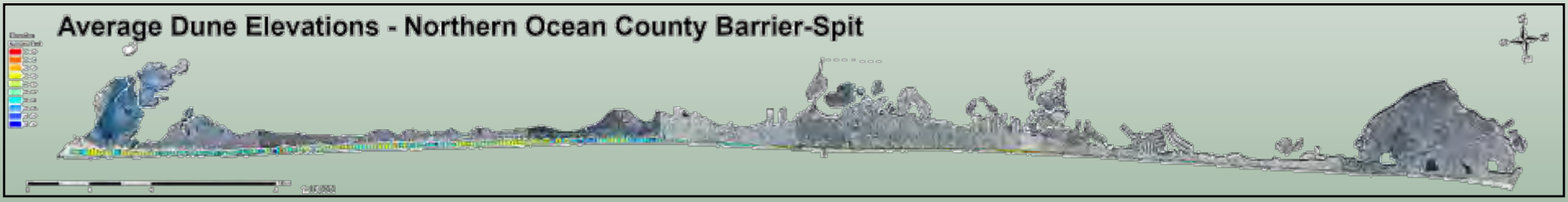
Regional Scale Assessment…

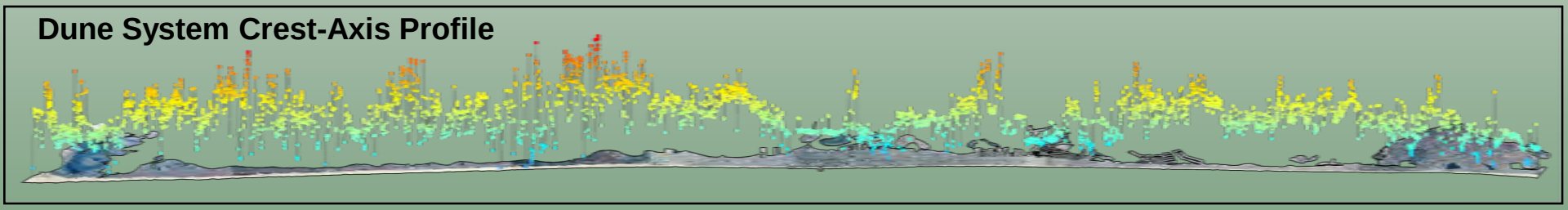
Rapid Analysis Generated from LIDAR

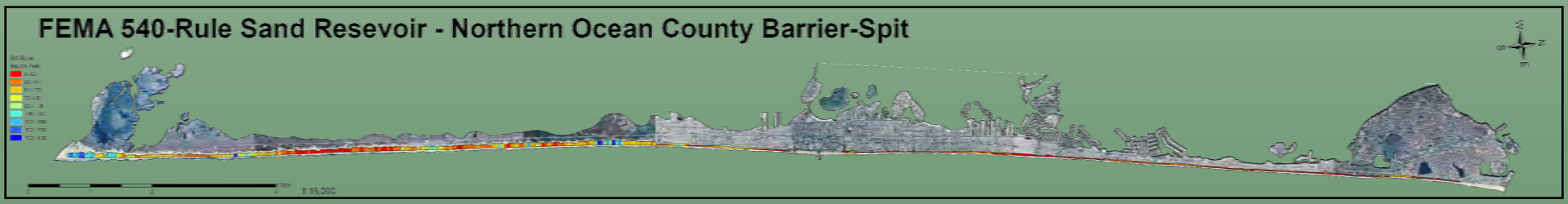
Barnegat Inlet

Manasquan Inlet

490 Bins, Equal-Interval, 250-Foot Wide





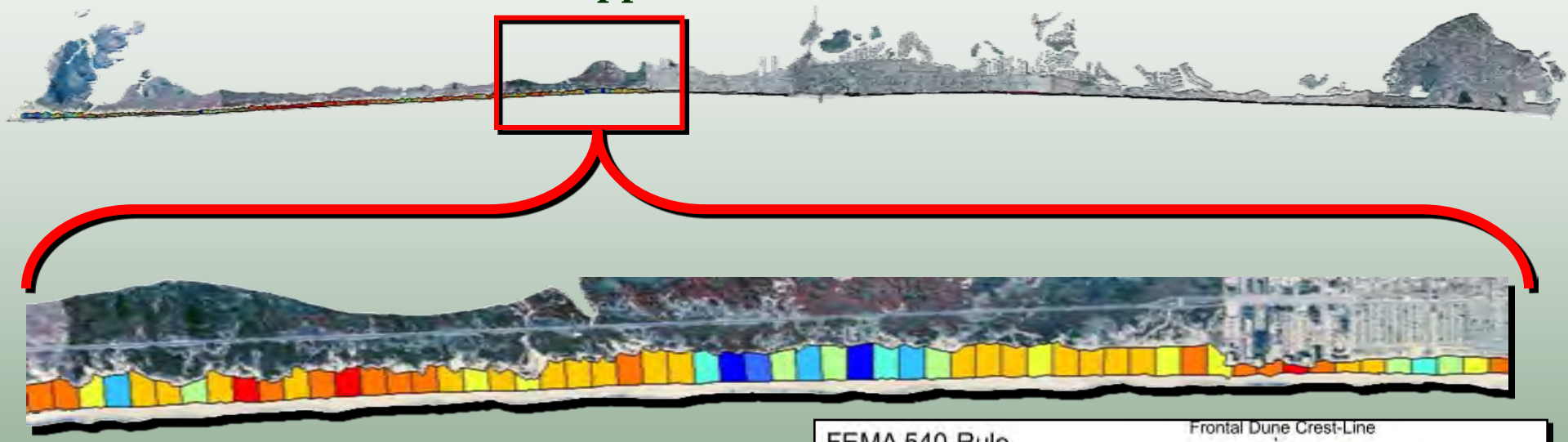


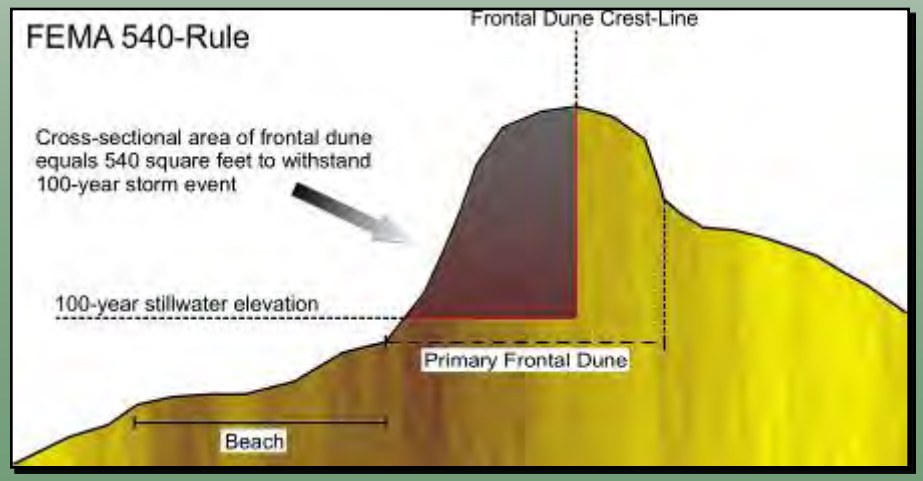
FEMA 540-Rule: Frontal Dune, Average Cross-Sectional Area

Barnegat Inlet

490 Bins, Equal-Interval, 250-Foot Wide
Clipped to Dune Width

Manasquan Inlet





Beach-Dune Susceptibility Modeling

Weighting of Beach-Dune System Attributes

Variables Calculated on a Per Bin Basis

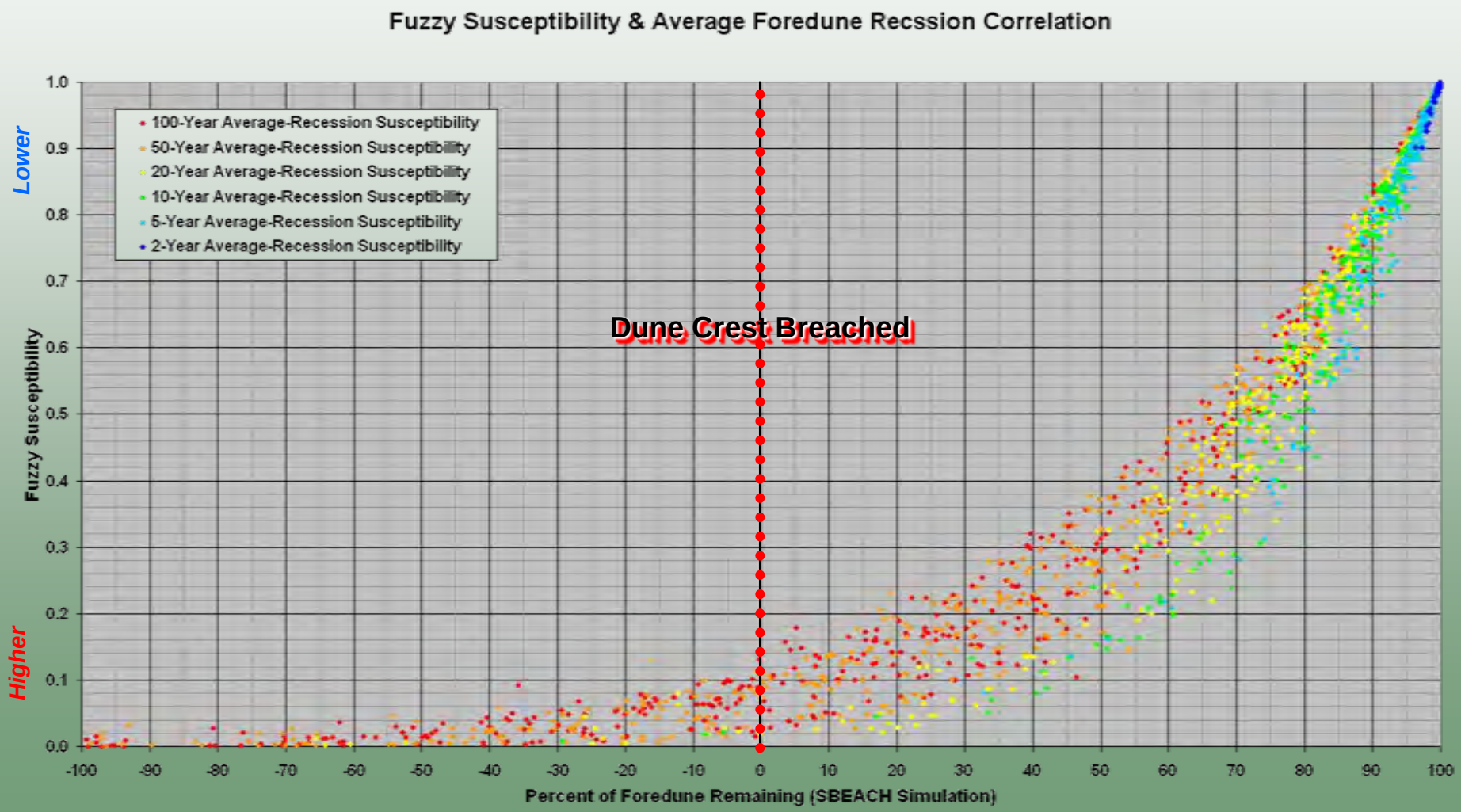
- Average Dune-Crest Elevations
- Dune Width
- Beach Width
- Percent Vegetation Coverage
- Presence of Groins
- Foredune Slope

→ **Values Normalized Between 0 and 1**

↓ **Values Combined Together**

Weighted Susceptibility Value Per Bin

In Relation to Storm Intensities with Respect to Dune Toe Recession



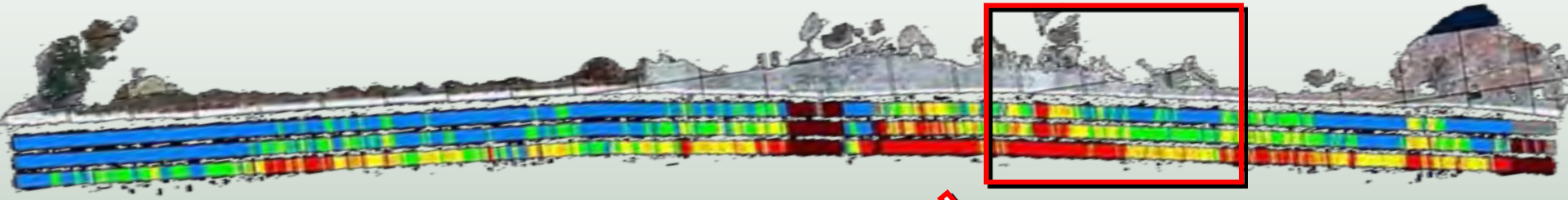
Susceptibility Map

Minimum Impact Scenario Showing Only 10-, 20-, and 50-Year Storms

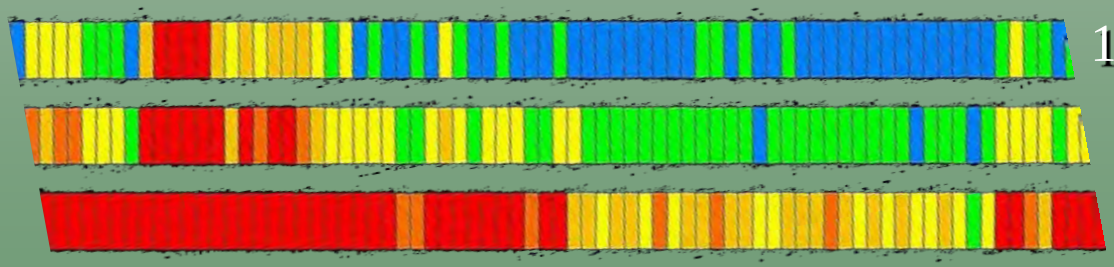
Barnegat Inlet

Manasquan Inlet

490 Bins, Equal-Interval, 250-Foot Wide



- 0% - 10% Foredune Removed
- 10% - 25% Foredune Removed
- 25% - 50% Foredune Removed
- 50% - 75% Foredune Removed
- 75% - 90% Foredune Removed
- > 90% Foredune Removed
- Surge at Structure
- Surge not at Structure



10-Year Storm Event

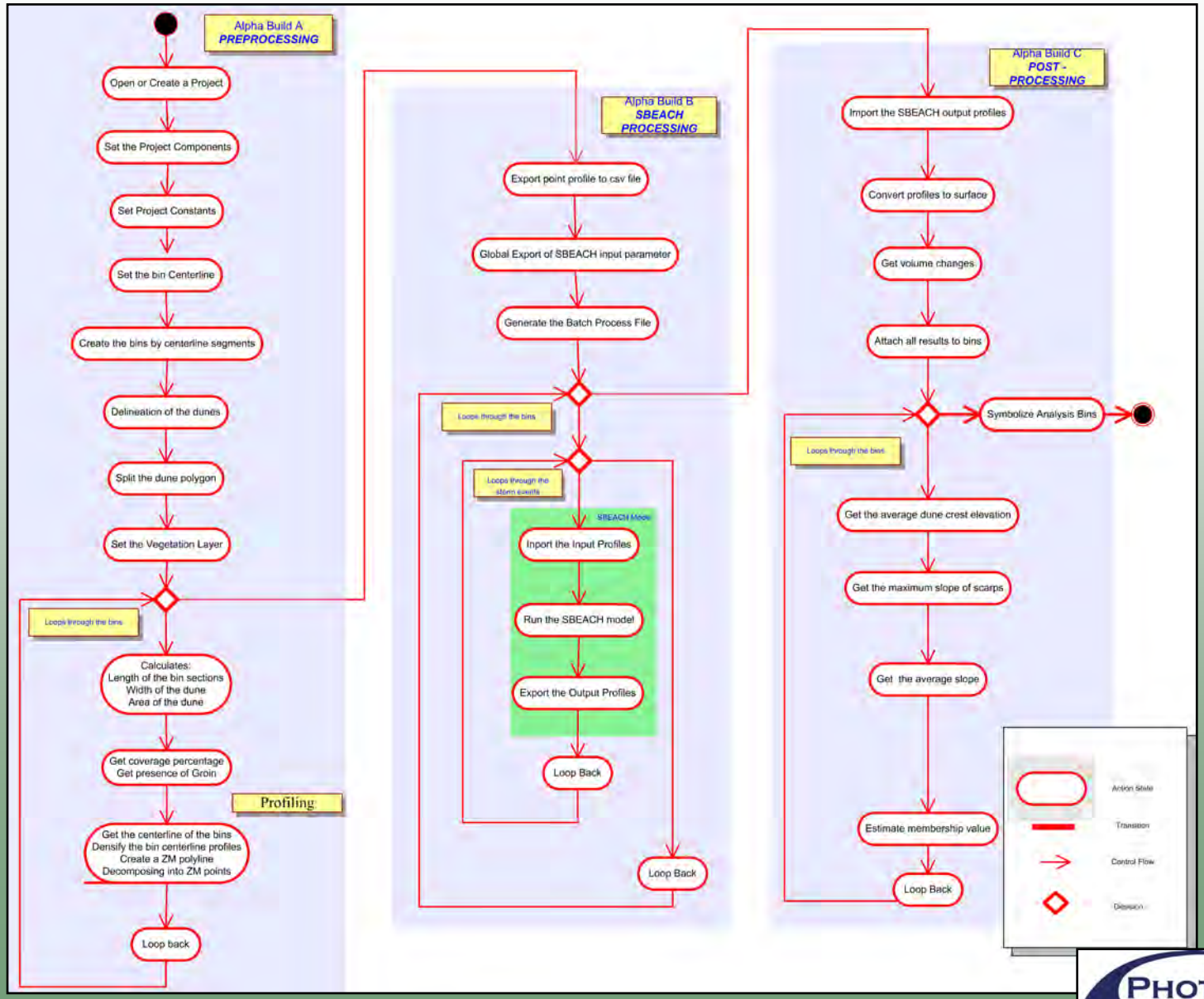
20-Year Storm Event

50-Year Storm Event

Beach-Dune Analyst

- Automates Pre-processing & Analysis
  - Desktop Application
  - Sophisticated User Interface
- System Requirements
  - ESRI ArcGIS Desktop 9.3
  - ESRI 3D Analyst & Spatial Analyst
  - USACE SBEACH 4.03
  - Microsoft Excel 2003
  - Microsoft .NET 3.5 Framework

Automation Process



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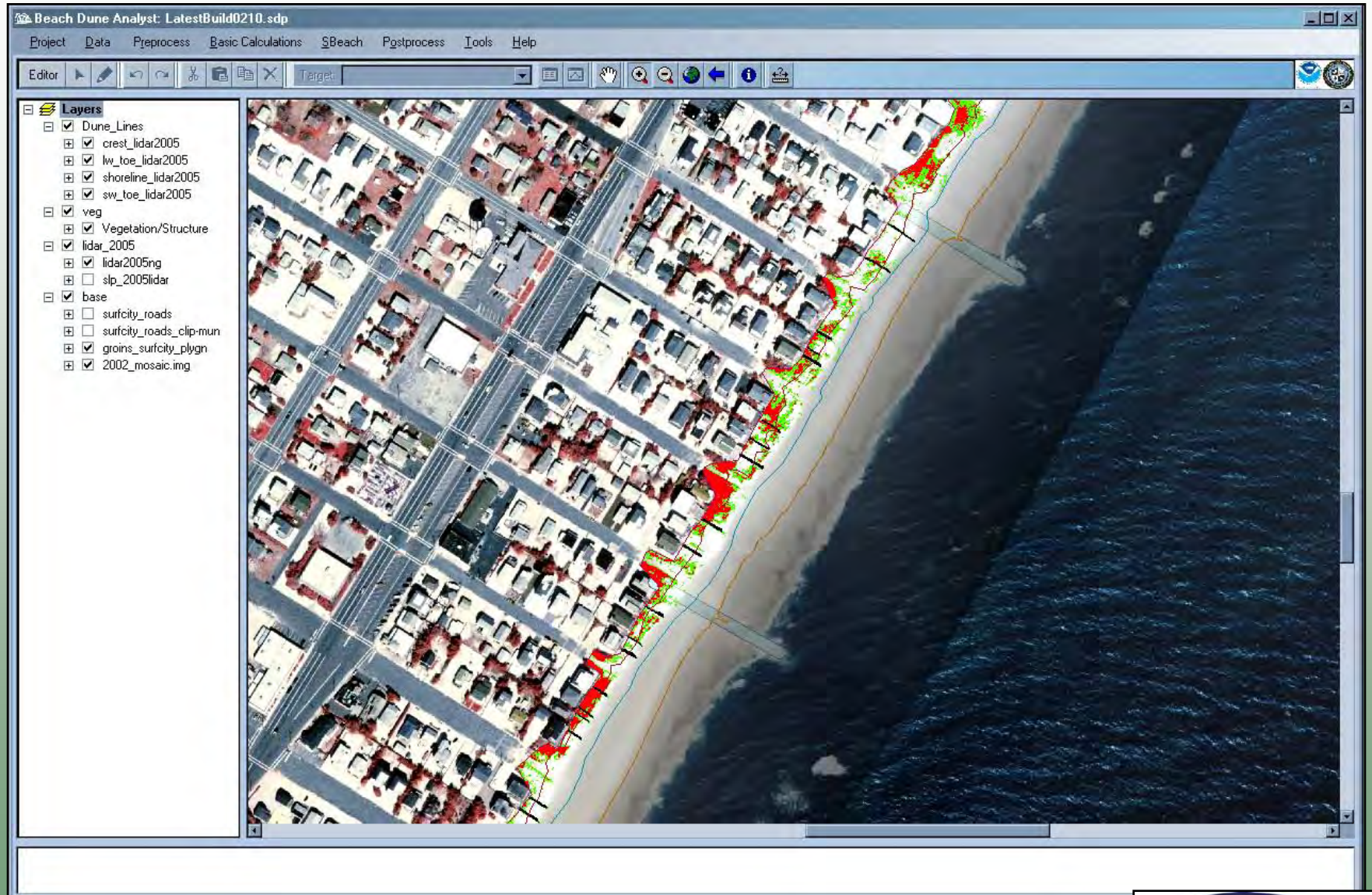
Geospatial Solutions

Beach-Dune Analyst Interface



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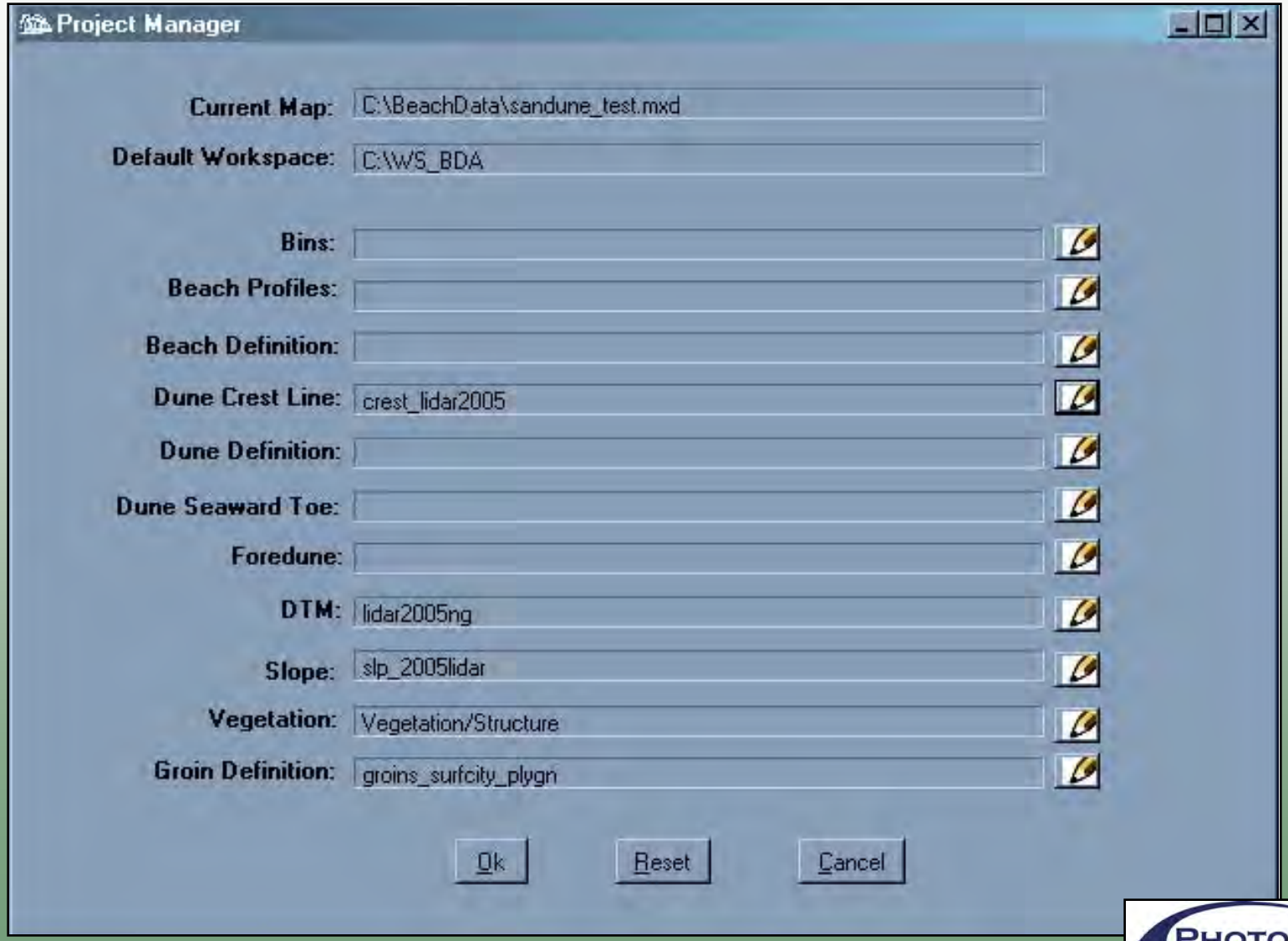
Project Management Window



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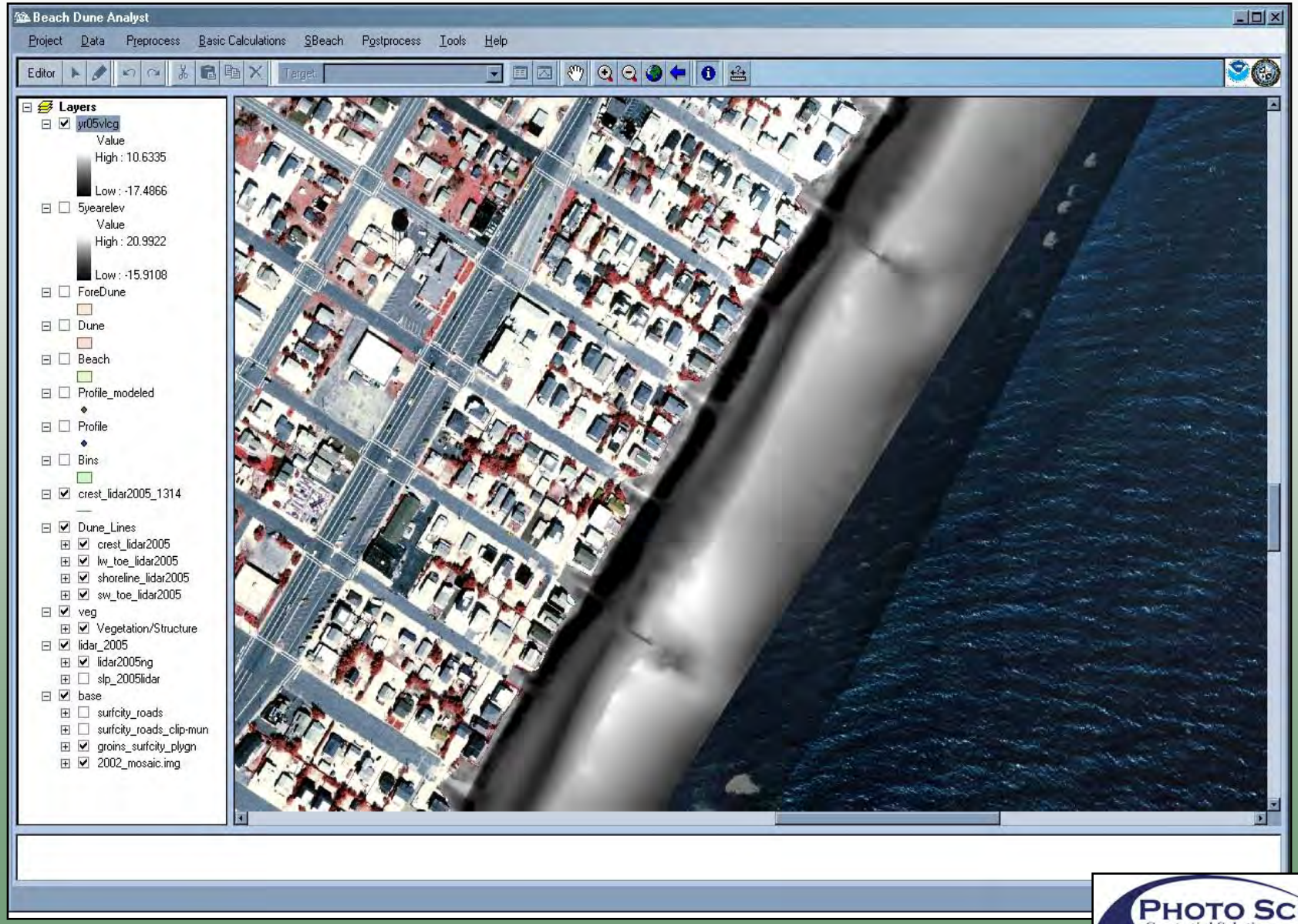
Post-Storm Elevation Surfaces



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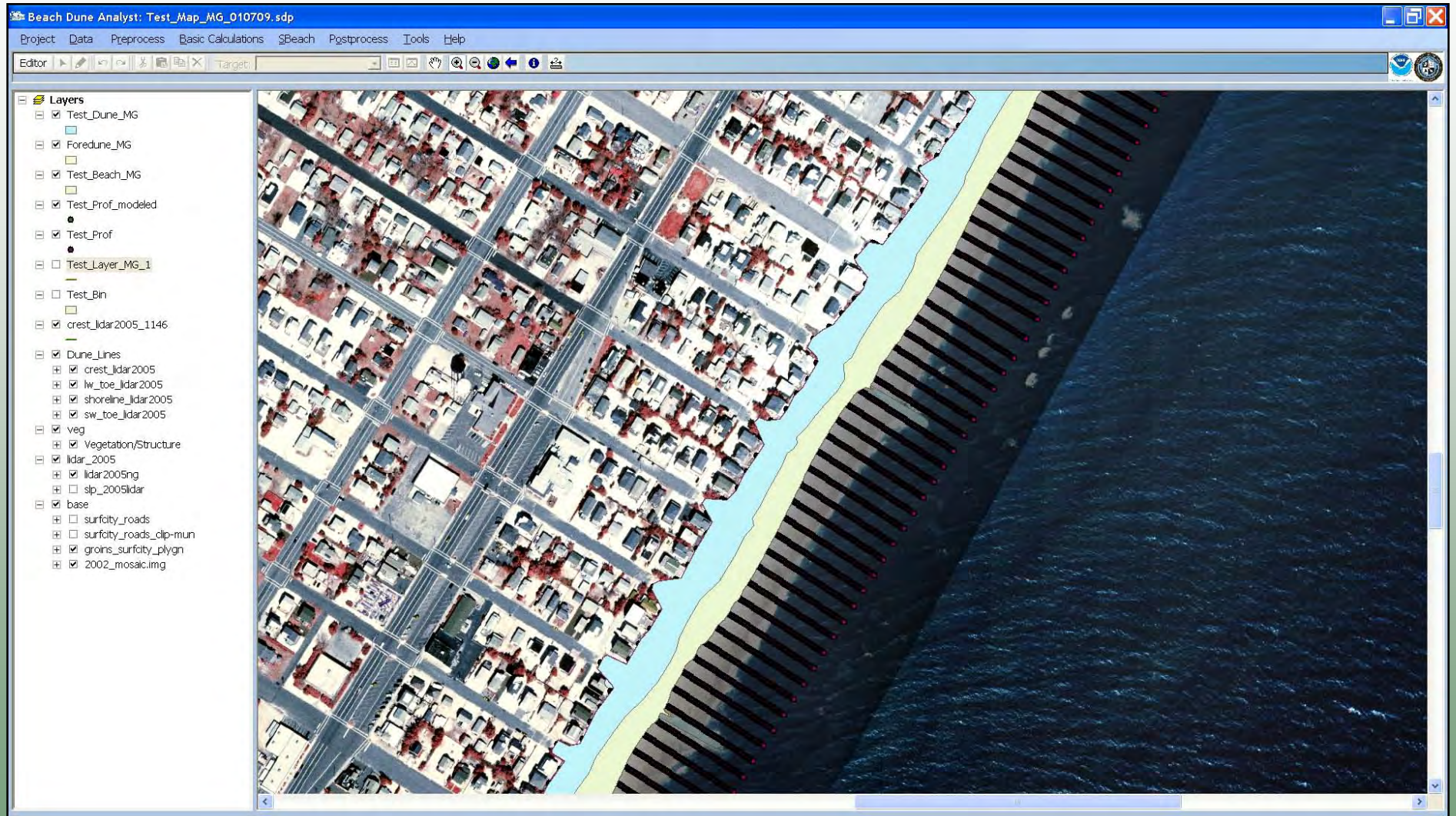
Viewing Final Results



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Potential Future Research Analyses Stemming from Beach-Dune Assessment

- Post-Storm Comparative Analysis
  - Model Testing After Actual Storm Event
- Potential Socio-Economic Impacts
  - Combine Storm Susceptibilities with Storm Related Economic Impacts
- Flood Mapping
  - Combine Beach-Dune Failure Points with Flood Prone Areas

Thank You…

Questions?
Comments?

The Richard Stockton College of New Jersey
Coastal Research Center
www.stockton.edu/crc