Modeling and Mapping Coastal Flood Risk in the Mid-Atlantic

September 16, 2015

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Increasing Resilience Together

Agenda for Today

- FEMA's Risk MAP Program overview

- Why was a new FEMA coastal study needed?

- Elements of the Region III Coastal Flood Insurance Study

  - Storm surge model

  - Overland wave analysis

- Overview of non-regulatory Flood Risk Products and datasets

- What data are available

- Where to find the data

FEMA's Risk MAP Program

- Risk **M**apping, **A**ssessment and **P**lanning

- Builds on Map Mod digitized Flood Insurance Rate Map (FIRM) successes

- Will deliver quality data that increase public awareness and lead to action that reduces risk to life and property.

- Watershed approach

- Regulatory Products: Flood Insurance Study (FIS) and FIRM (Coastal re-mapping)

- New Non-Regulatory Products and Datasets

Mapping **Assessment** **Planning**

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Risk**MAP**
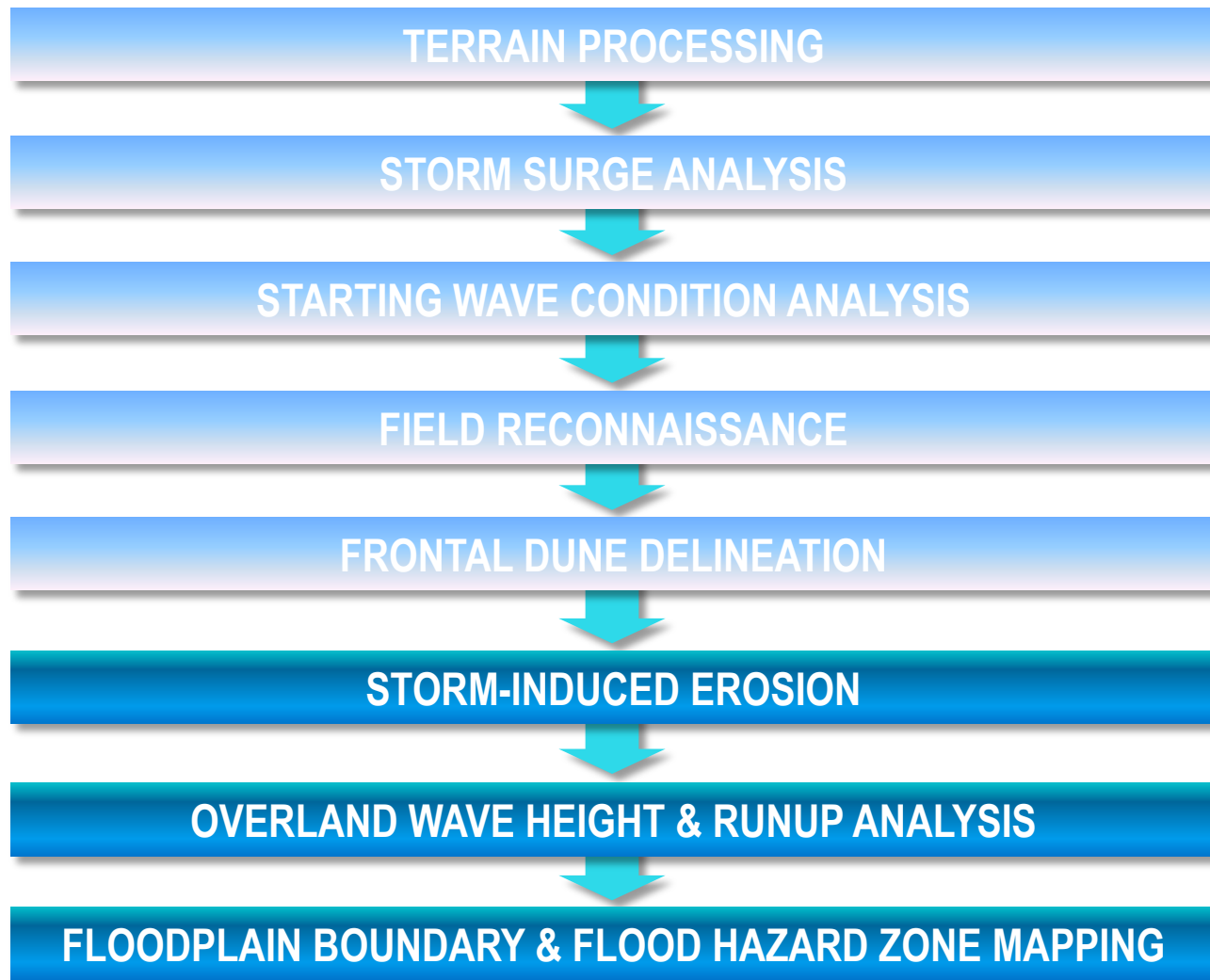Increasing Resilience Together

Why was a new FEMA coastal study needed?

- **New Guidelines need to be implemented**
  - Atlantic Ocean and Gulf of Mexico Guidelines Update (2007)
  - Sheltered Water Report (2008)
  - PM 50 Limit of Moderate Wave Action (LiMWA) (2008)

- **To update base data such as topographic datasets and aerial imagery to high resolution products and seamless Digital Elevation Model (DEM)**

- **To utilize newer coastal hazard methodologies developed during the FEMA Mississippi Coastal Restudy**

- **To take advantage of higher performance numerical modeling**

- **To take advantage of improvement in GIS technologies to allow for more accurate FIRMs**

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Effective vs. New Region III Coastal Study

Coastal Study Component	Previous Effective Studies (1980's-2010's)	New Study
Topographic data	USGS topo maps or Lidar (1950's-2000's)	2003-2014 detailed LiDAR data
SWELs	Studies from the 1970's-1990's (tidal gage analysis or VIMS model)	2012 USACE study
Modeled transects	Limited	Greatly increased
Dune erosion	Some	Yes
Wave setup	Some	Yes
Wave runup	Some	Yes
LiMWA	No	Yes

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Coastal Study Process

TERRAIN PROCESSING

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STORM SURGE ANALYSIS

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STARTING WAVE CONDITION ANALYSIS

↓

FIELD RECONNAISSANCE

↓

FRONTAL DUNE DELINEATION

↓

STORM-INDUCED EROSION

↓

OVERLAND WAVE HEIGHT & RUNUP ANALYSIS

↓

FLOODPLAIN BOUNDARY & FLOOD HAZARD ZONE MAPPING

Basic Elements of a Coastal Floodplain Study

Base Flood Elevation on FIRM includes 4 components:

1. Storm surge stillwater elevation (SWEL)
2. Amount of wave setup
3. Wave height above storm surge (stillwater) elevation
4. Wave runup above storm surge elevation   (where present)
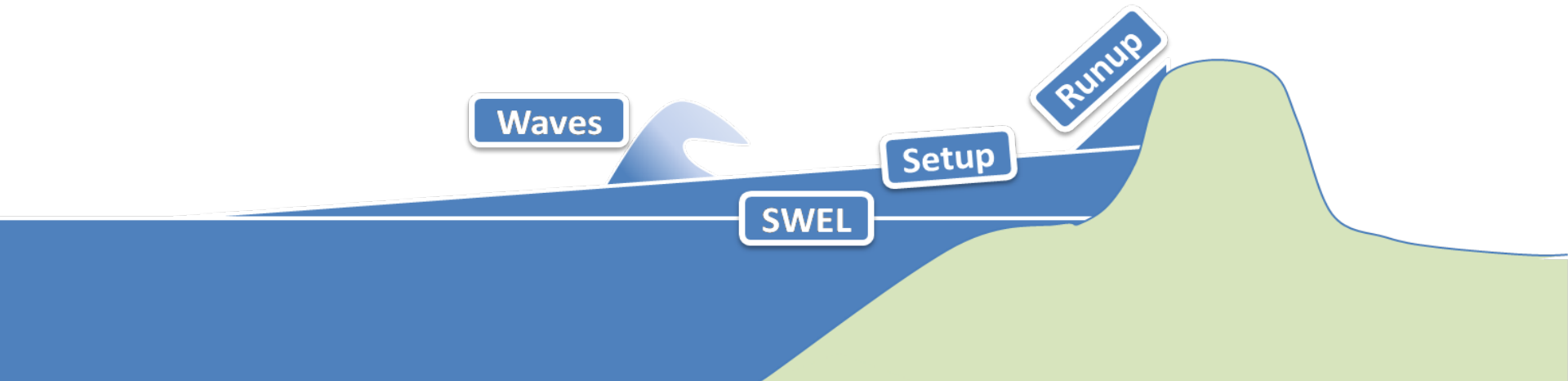
Scope of USACE Coastal Surge Analysis Study

- All of Region III coastal counties/cities (Atlantic Ocean Chesapeake Bay, Delaware Bay and their tributaries)
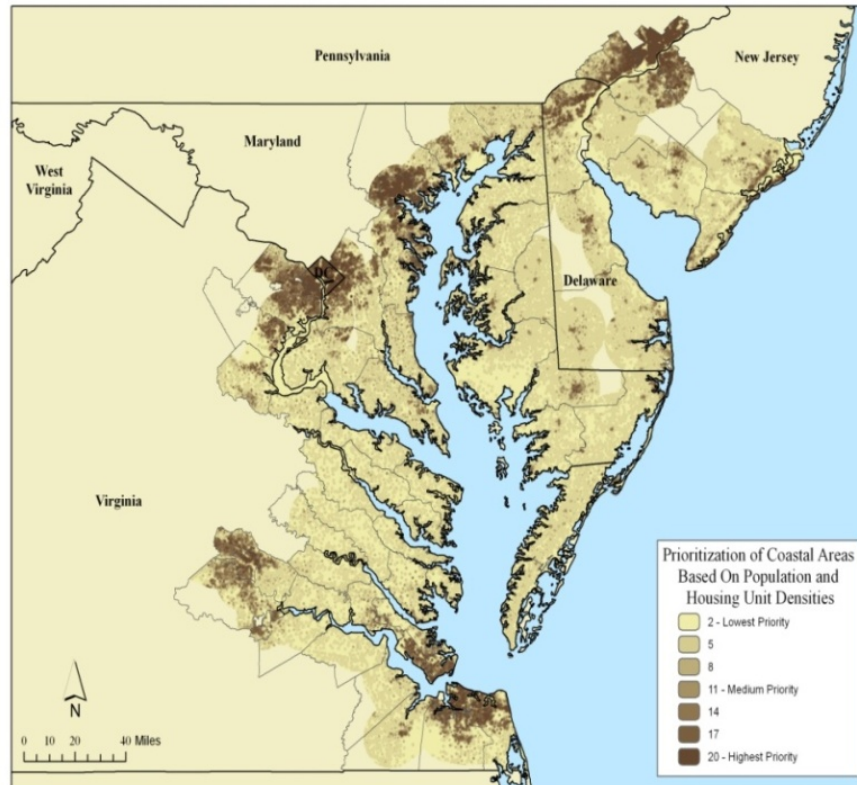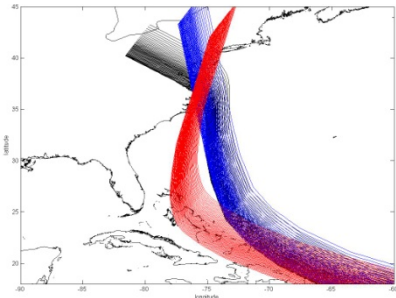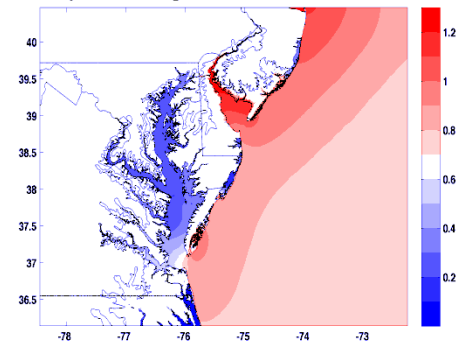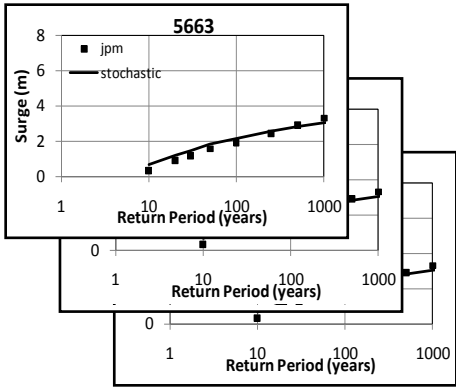
Storm Surge Modeling Approach

Storm Forcing
-Extratropical Wind Fields
- Hurricane Tracks

Storm Surge Modeling
ADCIRC   SWAN   WAVEWATCH III®

Winds

Waves ⟷ Water Levels
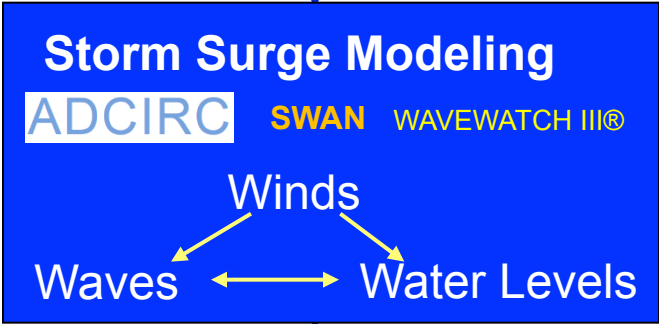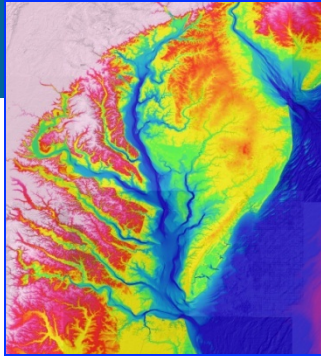
High-Resolution Bathy / Topo Mesh

Return Period Analysis
-JPM-OS Hurricanes
-EST Extratropicals

Flood Levels
25-, 50-, 100-, & 500-year

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Advancements in Mesh Resolution
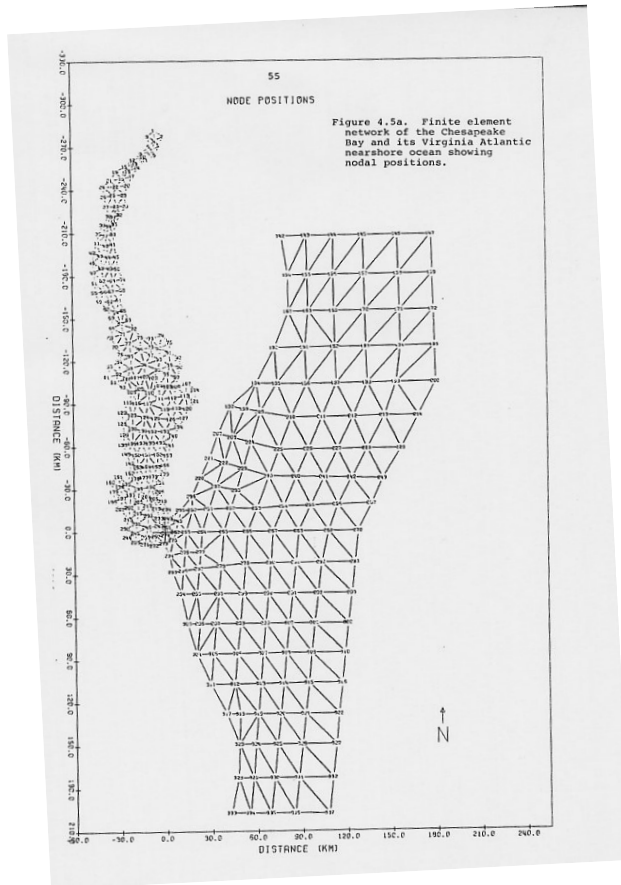
1978 VIMS Mesh (3-6 mile resolution)
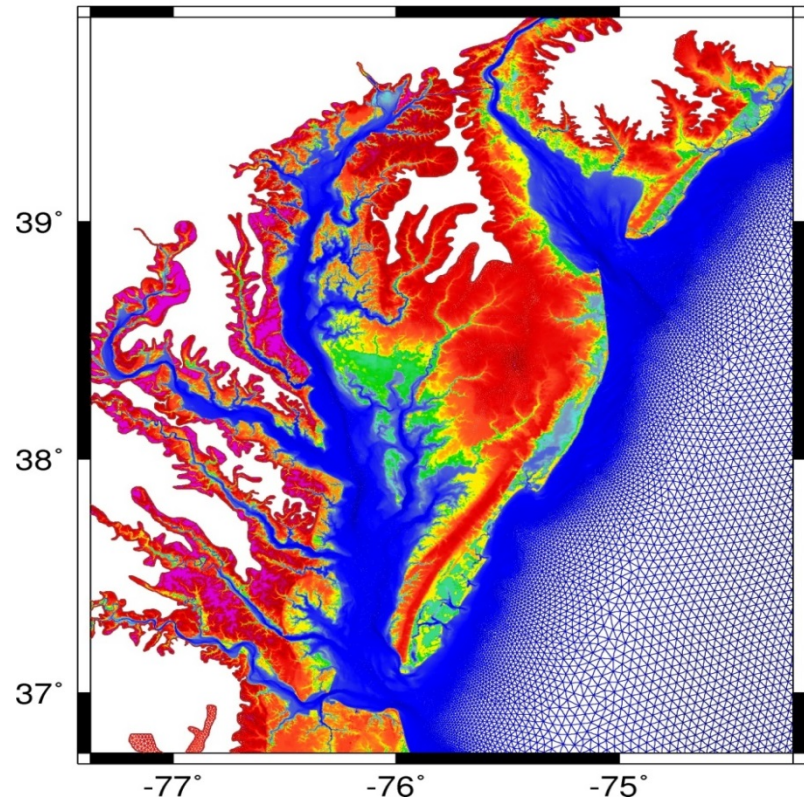
2011 USACE Mesh (100 ft resolution)
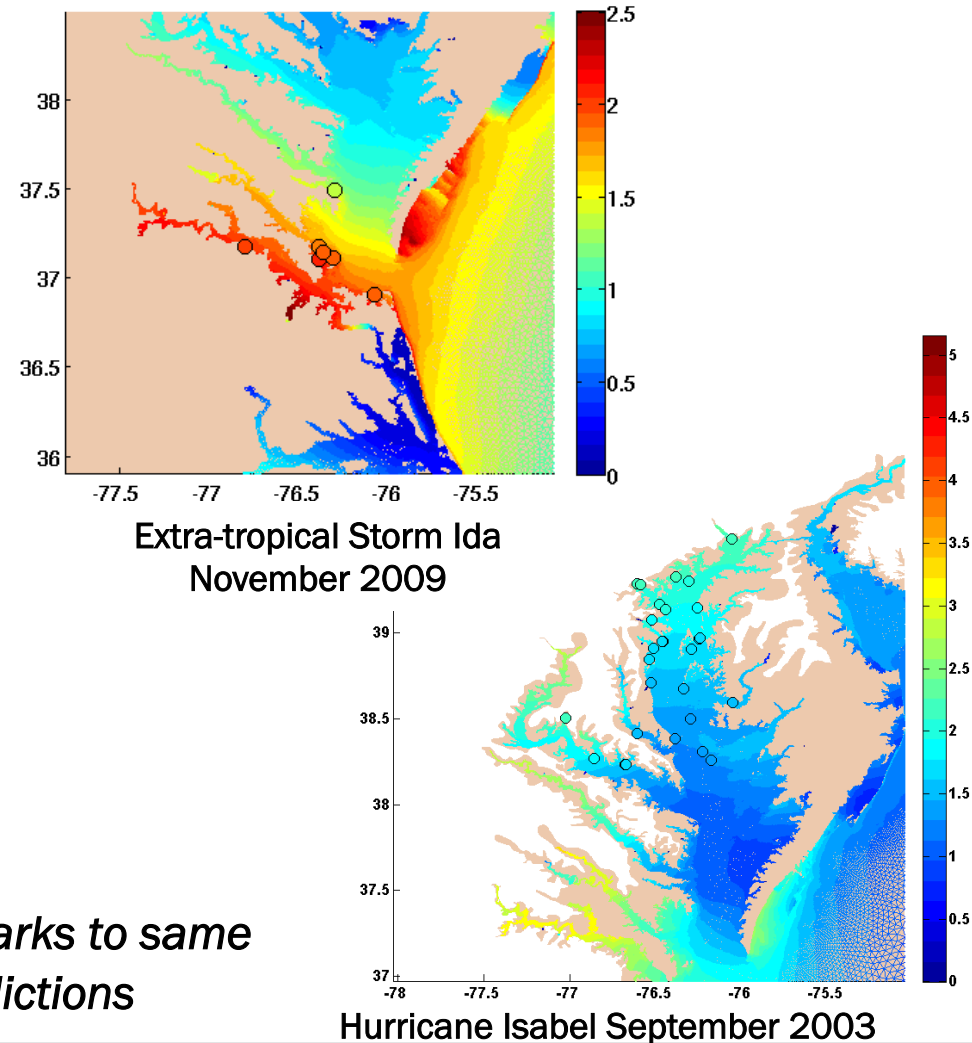
Modeling System Validation

- **Validation Storms**
  - Hurricane Isabel (SEP 03)
  - Hurricane Ernesto (AUG 06)
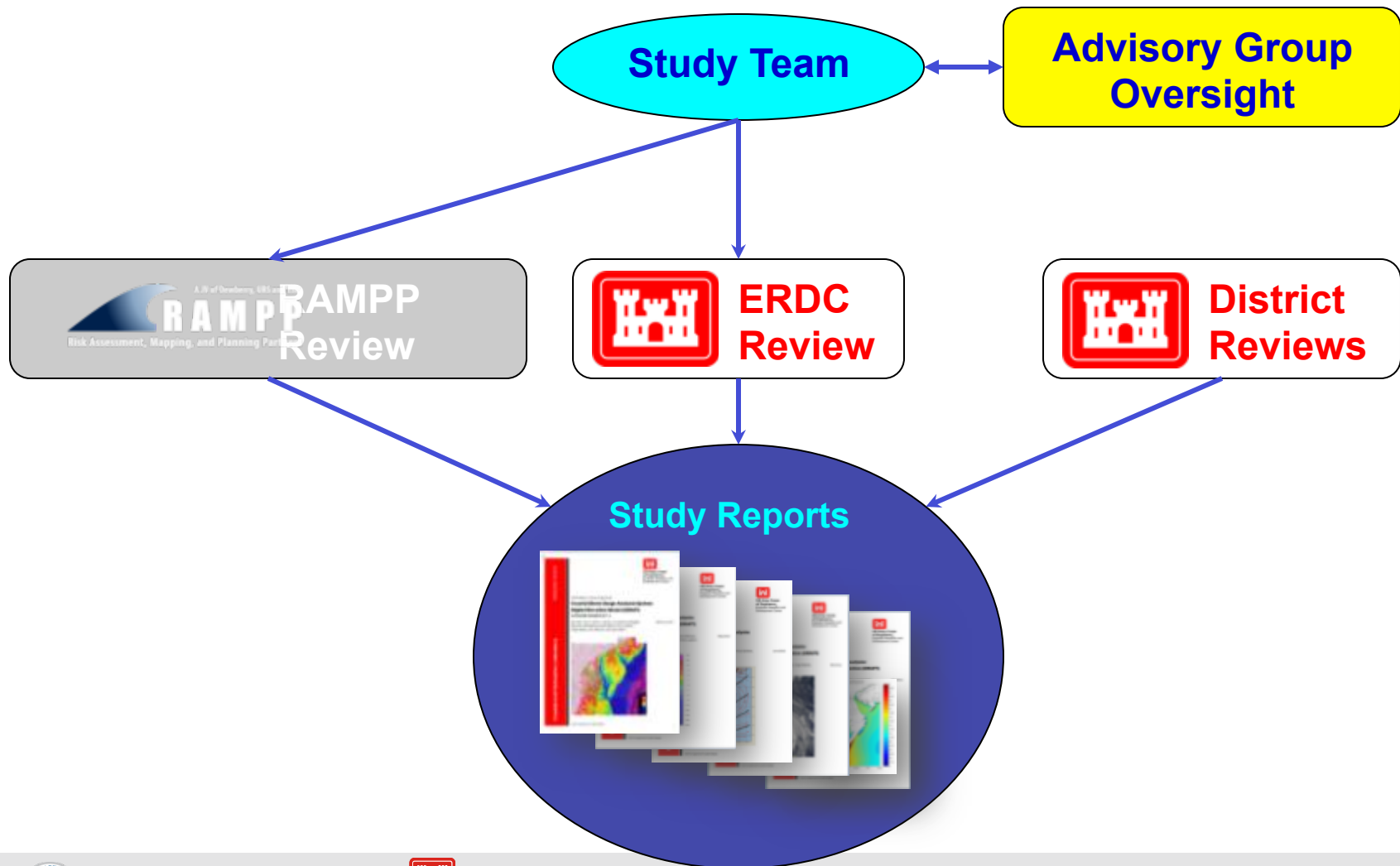 - Extratropical Storm Ida (Nov 09)

- **Validation Parameters**
  - Tides
  - Wind speed and direction
  - Wave height, period and direction
  - Water levels
  - High water marks

- *Circles depict observed high water marks to same color scale as background surge predictions*


Extra-tropical Storm Ida
November 2009

Hurricane Isabel September 2003

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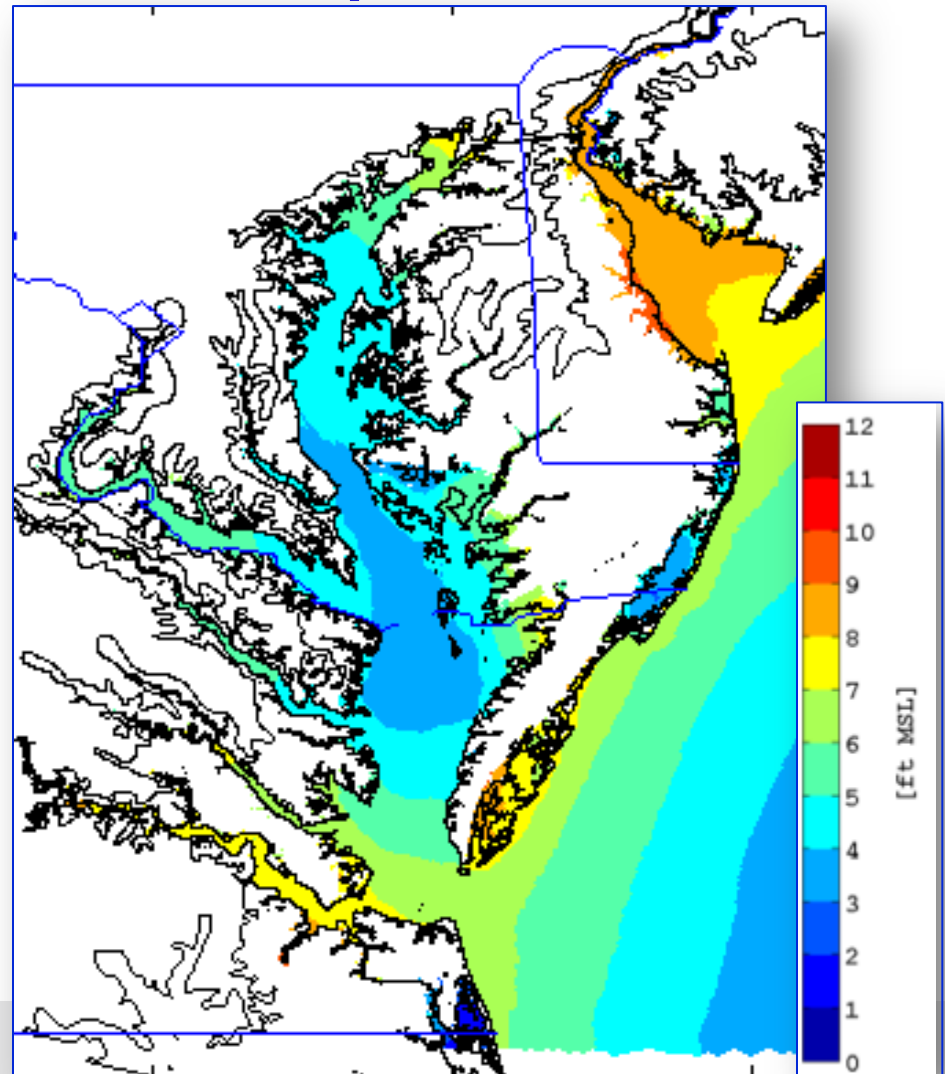# National and Regional Expert Review of Study Results

Comparison of 1% Still Water Elevations (SWELs)
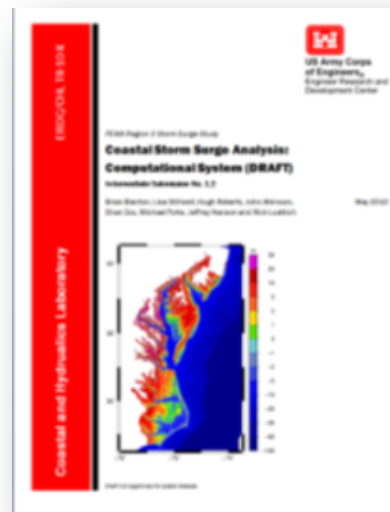
Previously Published
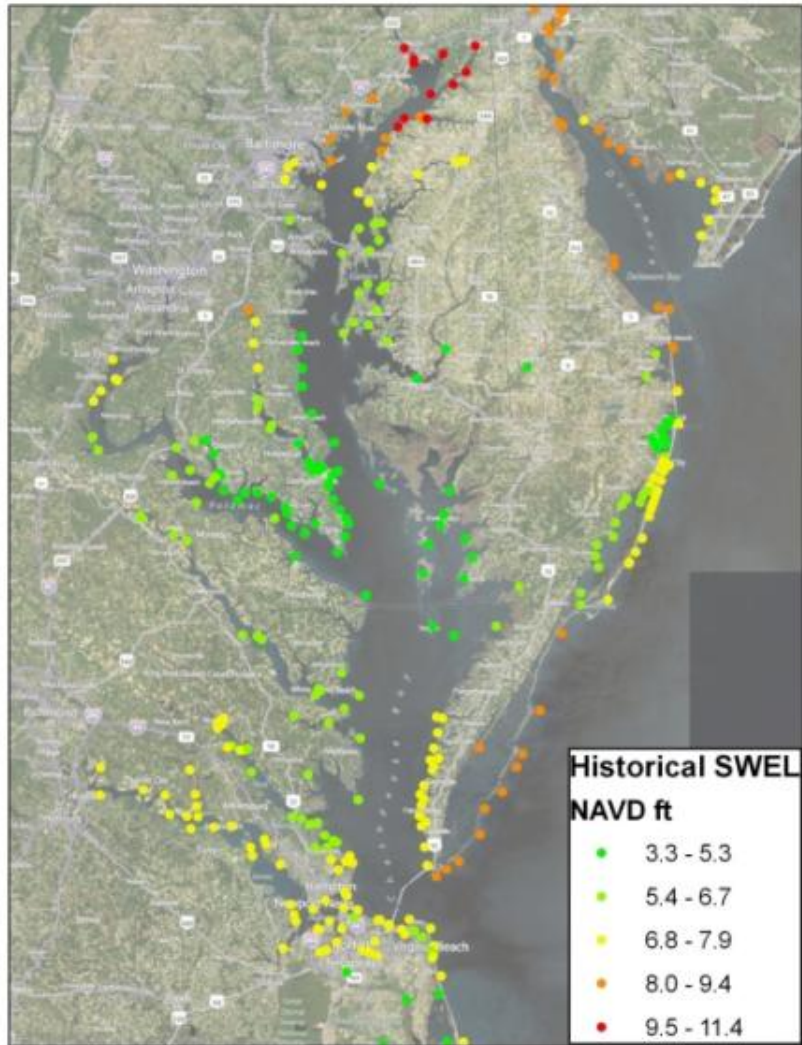
Updated

USACE Storm Surge Study Results

1.1 DEM

1.2 Modeling System

1.3 Storm Forcing

2. Model Validation
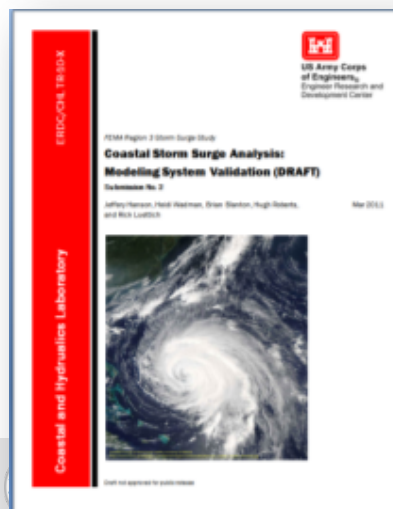
3. Final Analysis
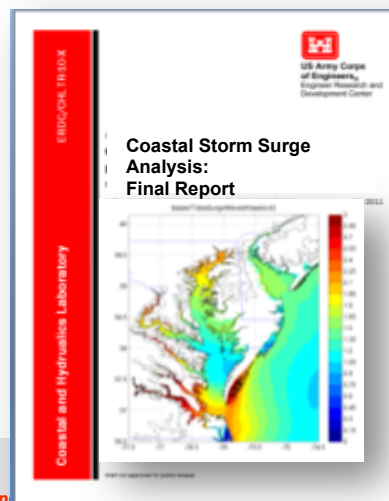
- **Methods and results**

- **Multi-tiered review**

- **Released as formal reports**

- **Available at http://dodreports.com/ and www.riskmap3.com/coastal**

NY/NJ Storm Surge Study
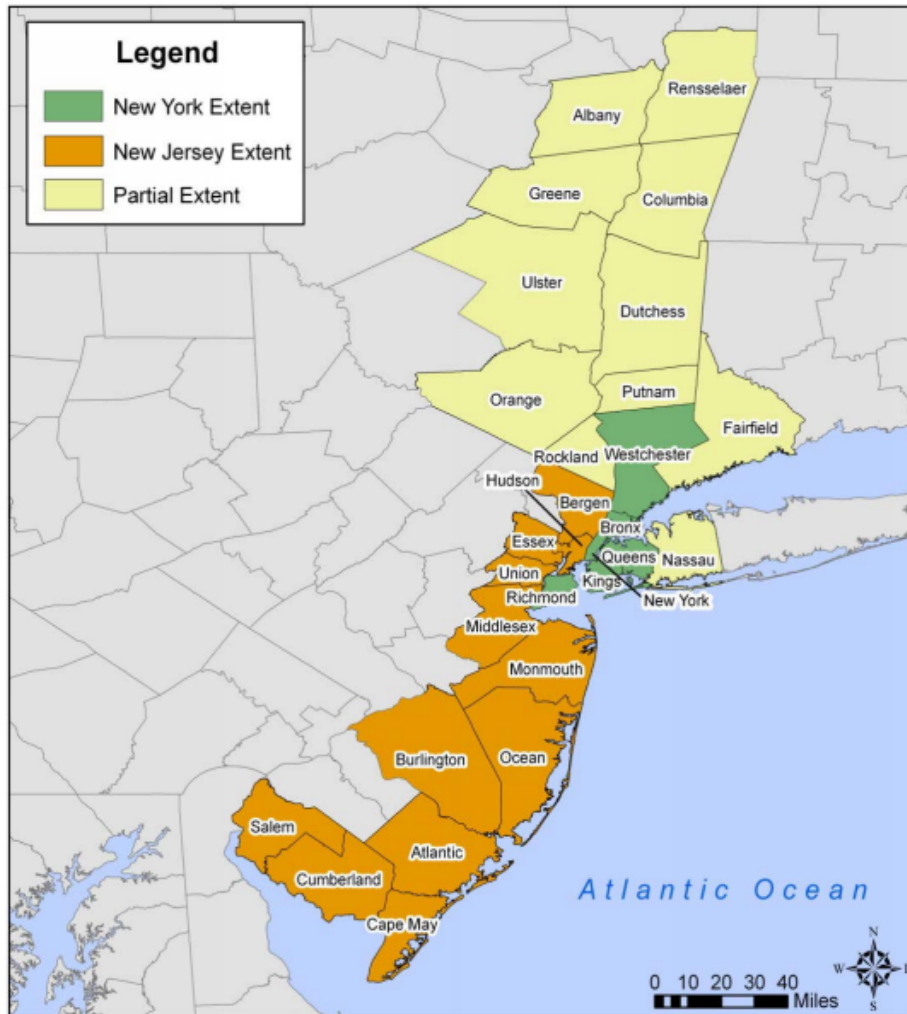
- **Separate study performed by RAMPP**

- **Similar methodology to the USACE Storm Surge Study**
  - Coupled ADCIRC+UnSWAN
  - Tropical and Extratropical forcing
  - Combined statistics of the results
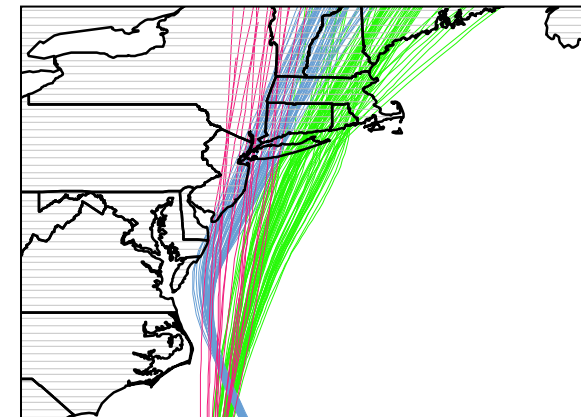
Coastal Hazard 1D Analyses Components

- Transect layout

- Field Reconnaissance (land use, obstructions, shoreline conditions, structures)

- Starting wave conditions (wave height and period) from 2D wave modeling eliminates the need for limited fetch analysis

- Wave setup from 2D wave modeling

- Bluffs: non standard erosion based on historic data

- Dune erosion: 540 sqft rule

- WHAFIS modeling for overland wave height computation

- 2% Wave Runup computed using various models

- All above analyses performed with the proprietary GIS-based Coastal GeoFIRM toolset

Transect Placement

High Density Shoreline: 41 mile

Low Density Shoreline: 46 miles

Layers
- ☑ sussex_transects
- ☑ Classified_Shoreline
  - Density
  - — High
  - — Low
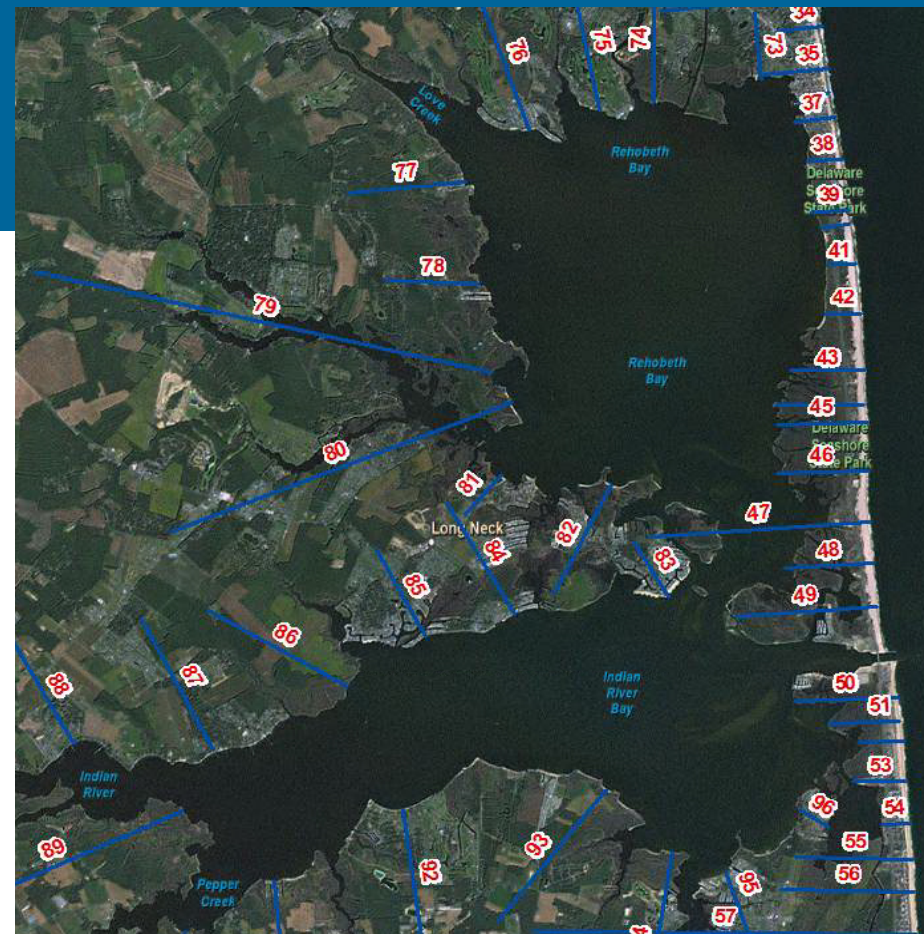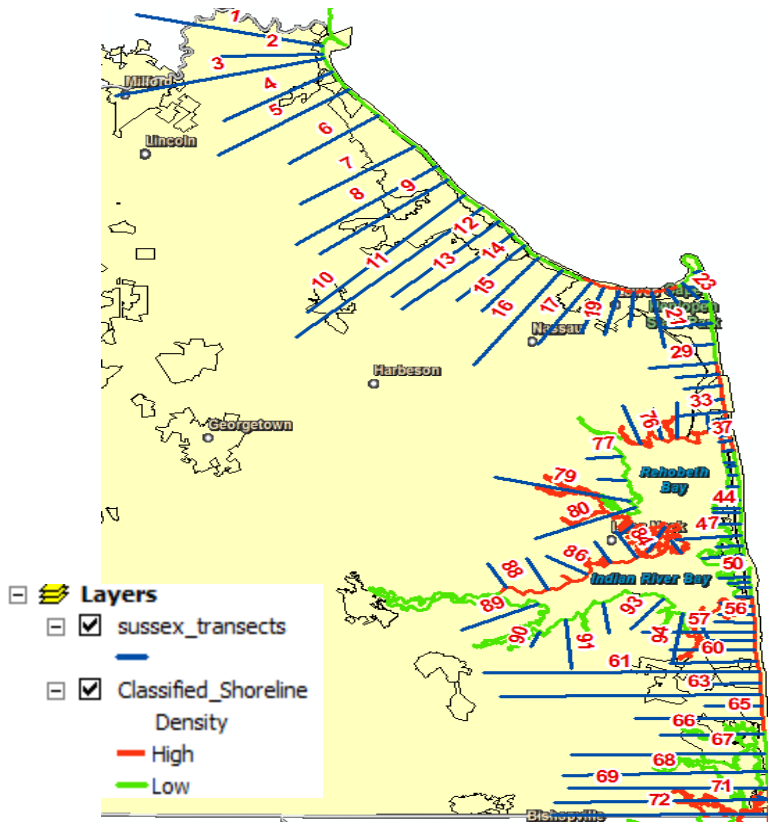
Transect Layout at Rehoboth Bay
and Indian River Bay

Field Reconnaissance

Sussex County, DE
Transect No. 208 - Point No. 001
Team 001 (Emily Dhingra, Joe Faries)
11/24/2009

Location Description : Beach along Shore Dr. The coast could be exposed to open fetch but is likely sheltered by New Jersey and Cape Henlope. The shoreline is straight and sandy. The beach is about 30-40' wide. The dune is small and eroded at the time of collection. The first row of houses is on top or just behind dune.

Point Type : Coastal

Latitude, Longitude (decimal degrees) : 38.865, -75.25091

Coast Type : Sandy

Fetch Description : Open Fetch

Building Description : Coastal Community, very small amount are on stilts. Most

Vegetation Description :

Marsh Description :

Photo Type & ID : Offshore
Direction & Description : Offshore at Prime Hook Beach,
Direction: 70 degrees

Photo Type & ID : Right
Direction & Description : Along Prime Hook Beach,
Direction: 330 degrees

Photo Type & ID : Left
Direction & Description : Along Prime Hook Beach,
Direction: 165 degrees

Photo Type & ID : Onshore
Direction & Description : Onshore at Prime Hook Beach,
Direction: 265 degrees

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Erosion Analysis

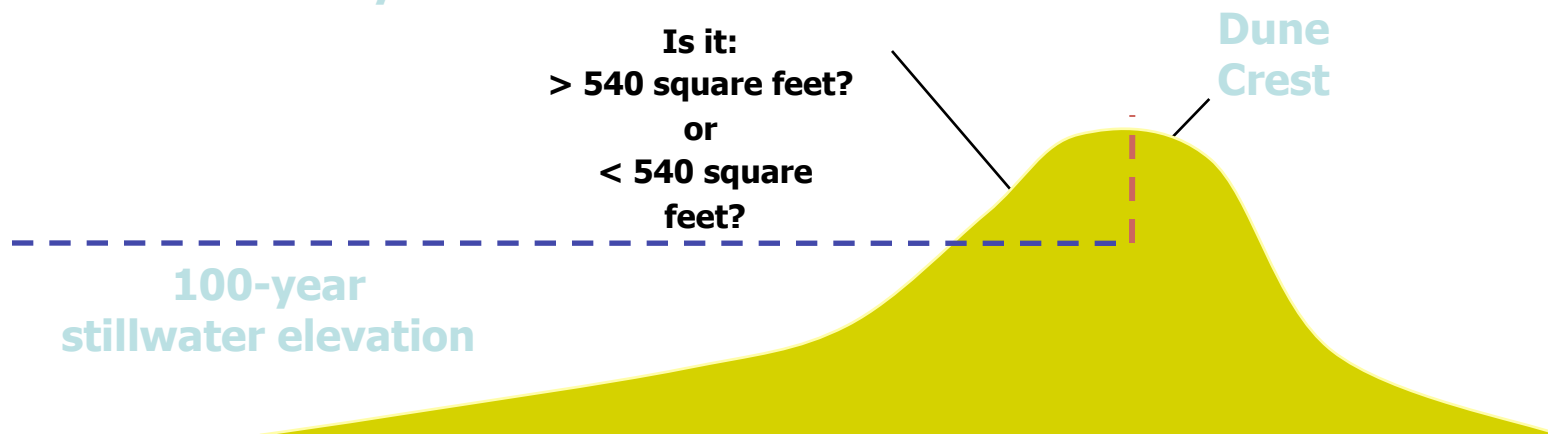PFD in Sussex County near Rehobeth Bay

- **Dunes:**
  - Dune erosion based on the 540 ft^2 rule
    - >540ft^2 → Dune retreat
    - <540ft^2 → Dune removal
  - Primary Frontal Dune (PFD) delineation

Primary Frontal Dune Reservoir

Is it:
> 540 square feet?
or
< 540 square feet?

Dune Crest

100-year stillwater elevation

Overland Wave Hazard Modeling

WHAFIS 4.0

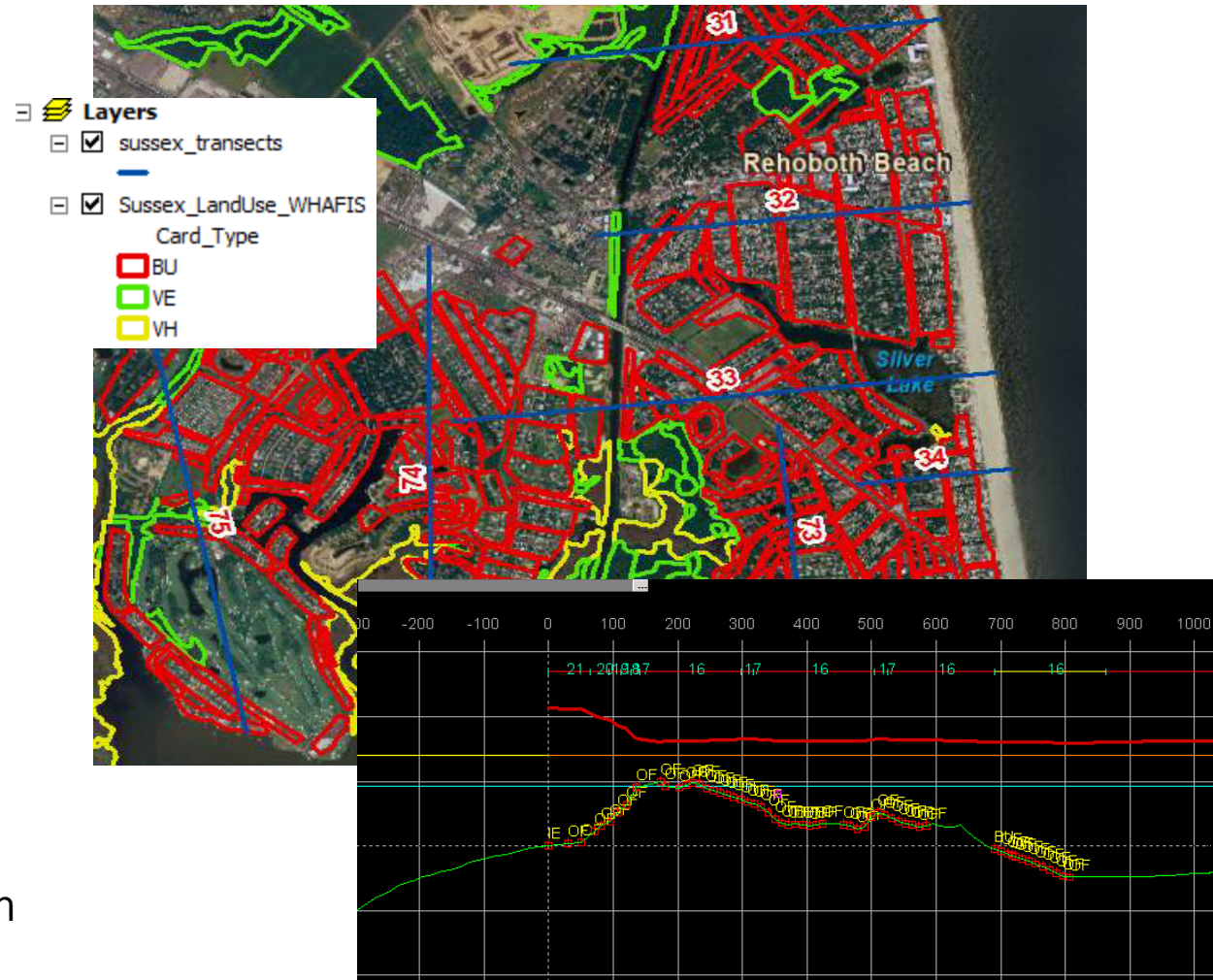- Inputs
  - Ground profile elevation
  - 1% SWELs
  - Starting wave conditions
  - Wave Setup
  - Obstruction cards (OF, IF, BU, VE, MG)

- Outputs
  - Wave height profile
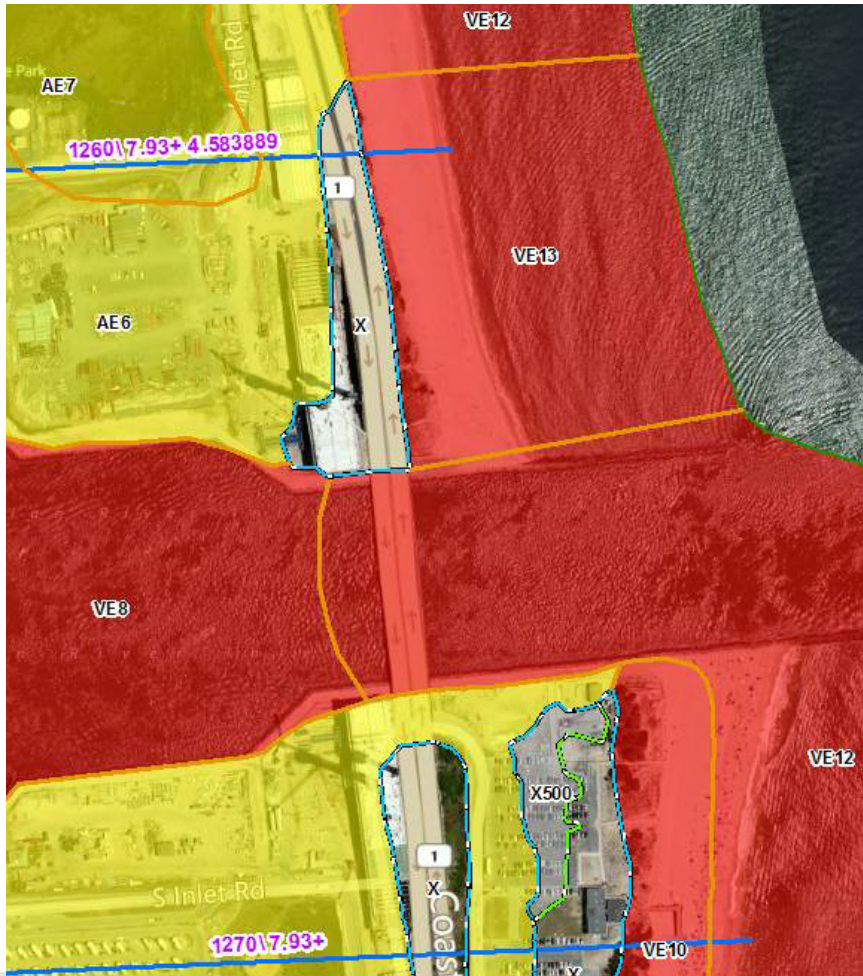 - Base Flood Elevation profile

Wave Runup

- Runup modeled for beaches, bluffs, cliffs and coastal structures
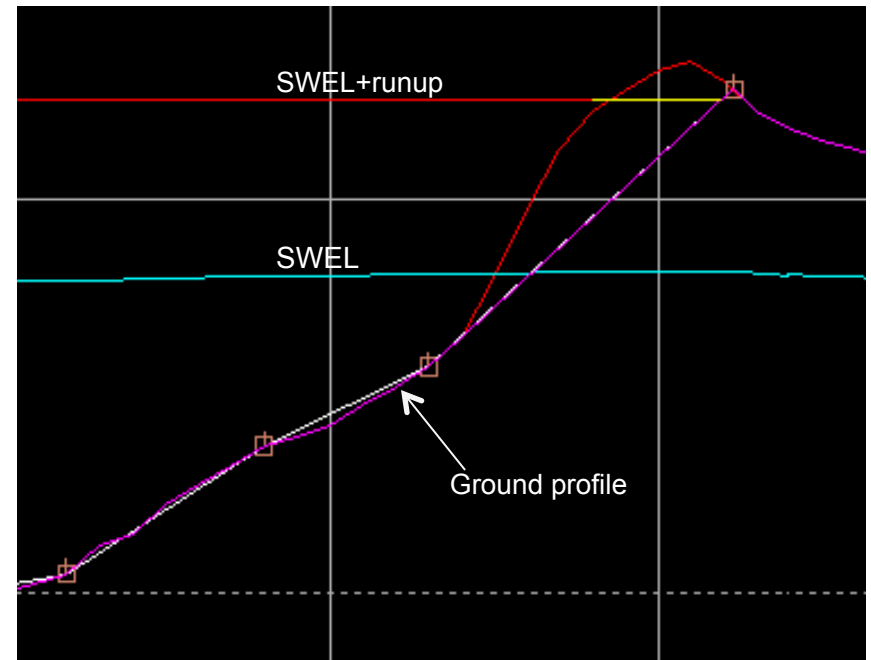
- Methods:

  Runup 2.0, TAW, ACES, SPM

Wave Runup

How runup is mapped?

Profile view of Transect 1260

Mapping

- <u>Base Flood Elevation (BFE)</u>: The height in feet above a certain datum, in this case North American Vertical Datum of 1988 (NAVD 88), that flood waters have a 1 percent annual chance of reaching or exceeding in any given year

- <u>Primary Frontal Dune (PFD)</u>: A continuous or nearly continuous mound or ridge of sand with relatively steep seaward and landward slopes immediately landward and adjacent to the beach and subject to erosion and overtopping from high tides and waves during major coastal storms

- <u>Zone VE</u>: Defined by wave heights of 3 ft. or greater, or by the PFD

- <u>Zone AE</u>: Defined by wave heights ranging from 0-3 ft.

- <u>Limit of Moderate Wave Action (LiMWA)</u>: Defined by the area subject to wave action with waves greater than 1.5 ft. in height
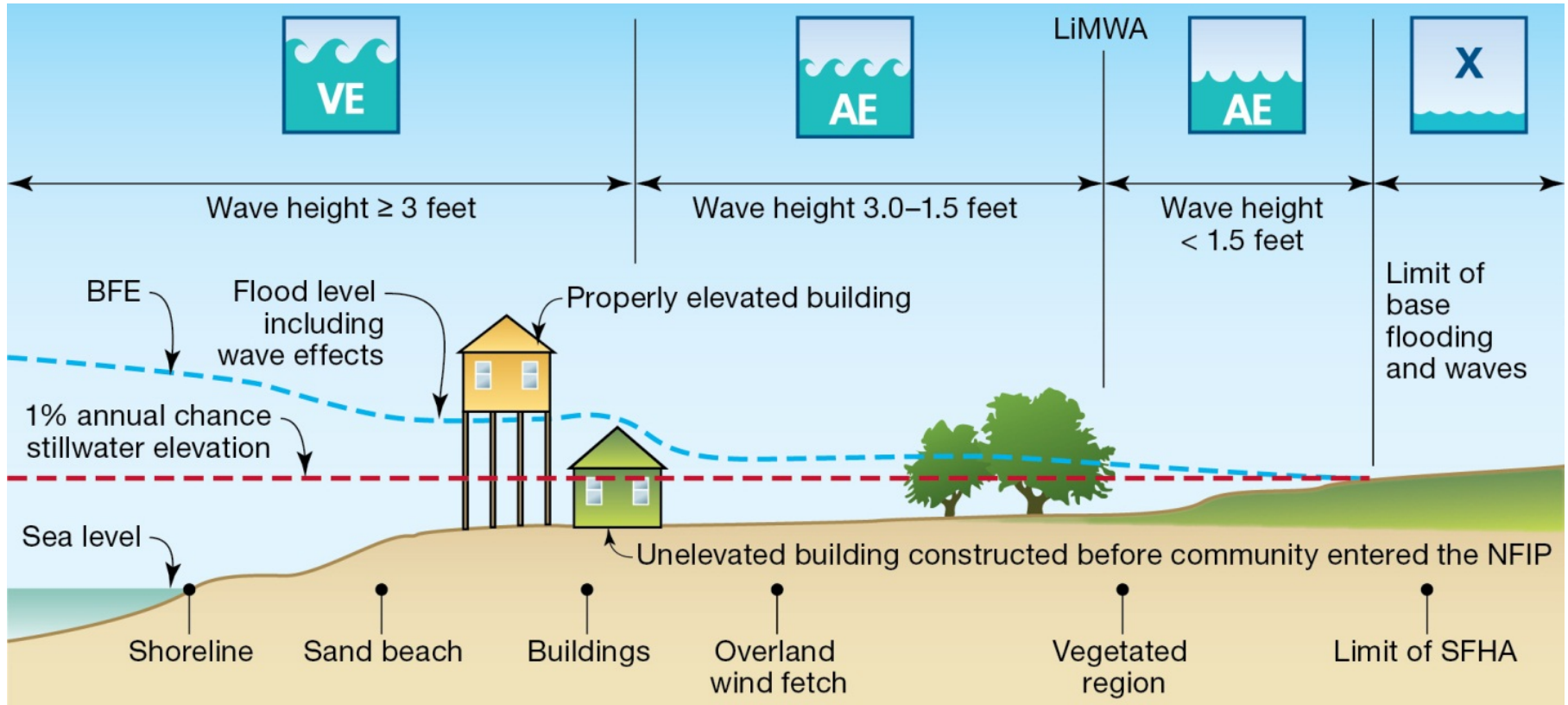
Non-Regulatory Coastal Flood Risk Products and Datasets

- Flood Risk Products
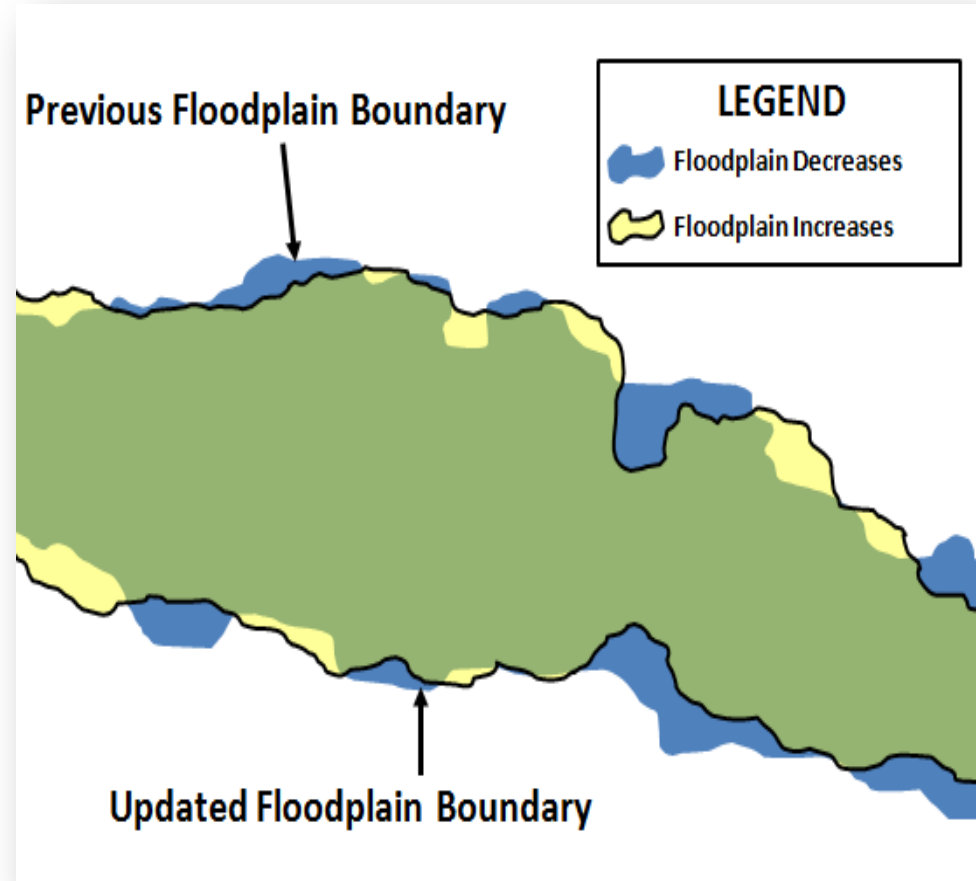 - Flood Risk Report
  - Flood Risk Database
  - Flood Risk Map
- Flood Risk Datasets
  - Changes Since Last FIRM
  - Coastal Depth Grids
  - Flood Risk Assessment (refined Hazus analysis)
- Flood Risk Products help communities:
  - Gain a better understanding of flood risk and its potential impact on communities and individuals
  - Take proper mitigation actions to reduce this risk

Using Changes Since Last FIRM for Identifying Actions

Changes Since Last FIRM

- Communities and homeowners can use this to identify the impacts of new maps on the regulatory Special Flood Hazard Area (SFHA)

- Also reveals new areas that may need mitigation actions – either for existing assets or for future planning

Previous Floodplain Boundary

LEGEND
- Floodplain Decreases
- Floodplain Increases

Updated Floodplain Boundary

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Using Depth and Analysis Grids for Identifying Actions

Depth Analysis Grids

- Better information on depth and velocity of flooding

- More information on higher probability (10 & 25 year) flood events

- These provide enhanced data to develop a more accurate Benefit Cost Analysis (BCA) for mitigation projects, a big step towards implementation

1% Depth Grid

	0 - 2
	3 - 4
	5 - 6
	7 - 8
	9 - 10
	11 - 12

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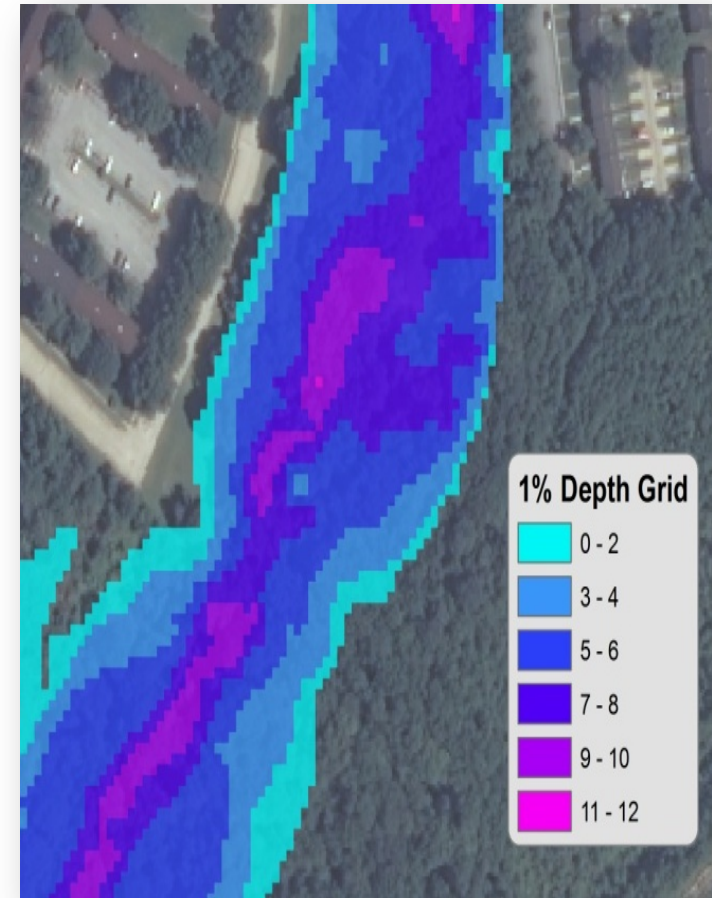
# Using Flood Risk Assessment for Identifying Actions

Flood Risk Assessment

- Identifies areas of higher flood risk by census block

- Quantifies potential future flood losses to existing structures

- Improves ability to identify areas requiring higher building code requirements

- Supports mitigation plan updates and disaster recovery planning through improved risk quantification

1% Chance Risk (100-yr)
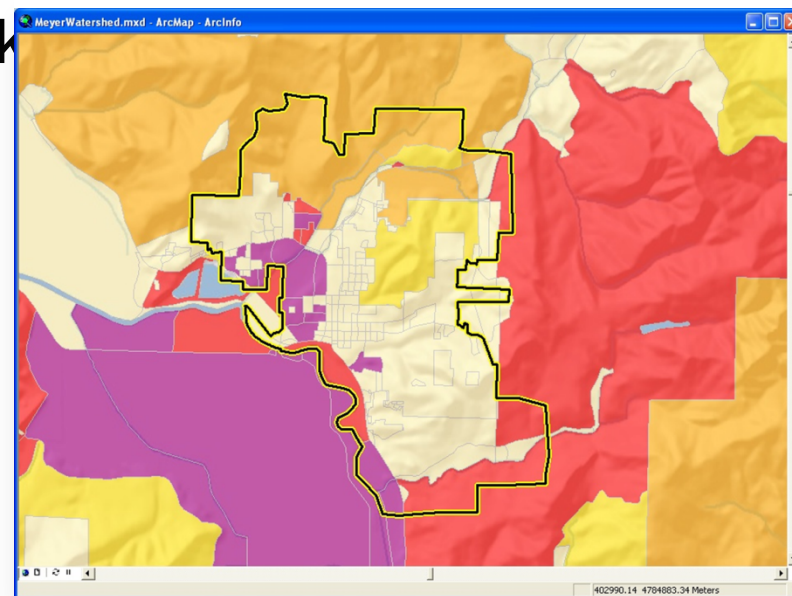
What data are available?

- **USACE Storm Surge Model and NY/NJ Storm Surge Model**
  - Stillwater raster grid files for the 10, 2, 1, 0.2% annual chance storm events
  - Starting wave conditions
  - Region-wide bathy/topo mesh
  - Reports

- **Coastal Hazard Analysis**
  - CHAMP databases
    - GIS Transects
    - WHAFIS input and output
  - Erosion analysis
  - Runup analysis
  - Seamless high resolution bathy/ topo DEMs

- **Regulatory Flood Insurance Products**
  - Flood Insurance Rate Maps (FIRMs)
  - Flood Insurance Study (FIS) Report
  - FIRM Database
  - TSDN

- **Flood Risk Products and Datasets**
  - Report, Map and Database
  - Depth Grids
  - Risk Assessment
  - Changes Since Last FIRM

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Where can the data be downloaded?

- **USACE Storm Surge Model**
  - Contact RAMPP with data requests, christine.worley@aecom.com
  - SWEL rasters will be on www.riskmap3.com soon
  - Reports available at www.riskmap3.com

- **NY/NJ Storm Surge Model**
  - Contact RAMPP with data requests, David.Rubenstein@aecom.com
  - Data and reports: www.region2coastal.com

- **Coastal Hazard Analyses**
  - All data is available on FEMA's Mapping Information Platform (MIP)
  - Contact RAMPP with data requests if no access to the MIP

- **Regulatory Flood Insurance Products**
  - All available data can be downloaded for free on FEMA's Map Service Center (MSC): https://msc.fema.gov

- **Flood Risk Products and Datasets**
  - All available data can be downloaded for free on FEMA's MSC: https://msc.fema.gov

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