FEMA

Coastal Flood Risk: Today and Tomorrow

October 2019
Lauren Schmied, PE
Engineering Resources Branch, FEMA

RiskMAP
Increasing Resilience Together

FEMA

Today

October 12, 2019

RiskMAP
Increasing Resilience Together

Risk MAP Vision and Goals

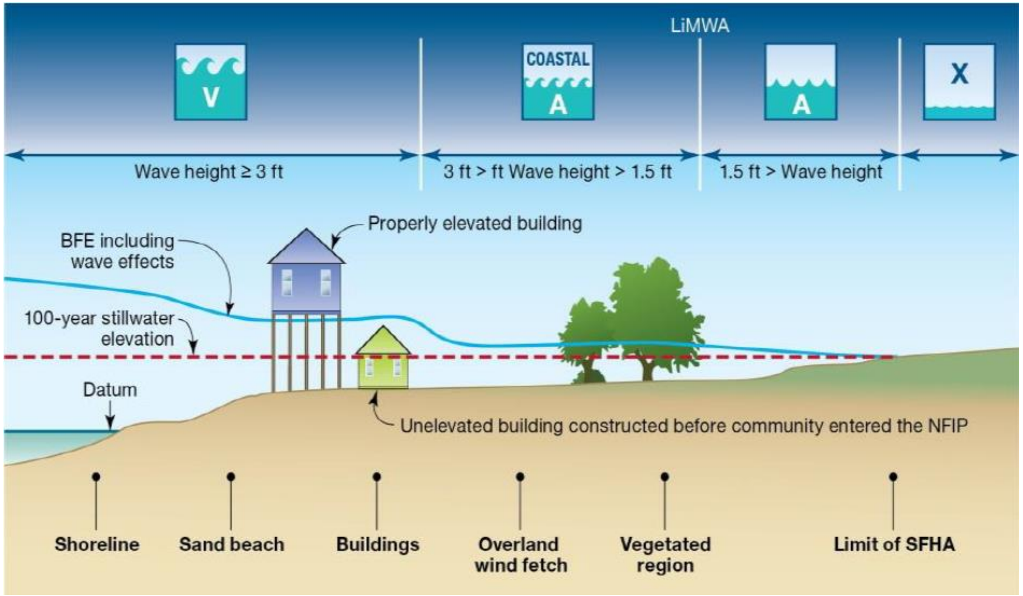
1 Address gaps in data

2 Align increased awareness with reductions in vulnerability

3 Support community-level mitigation planning

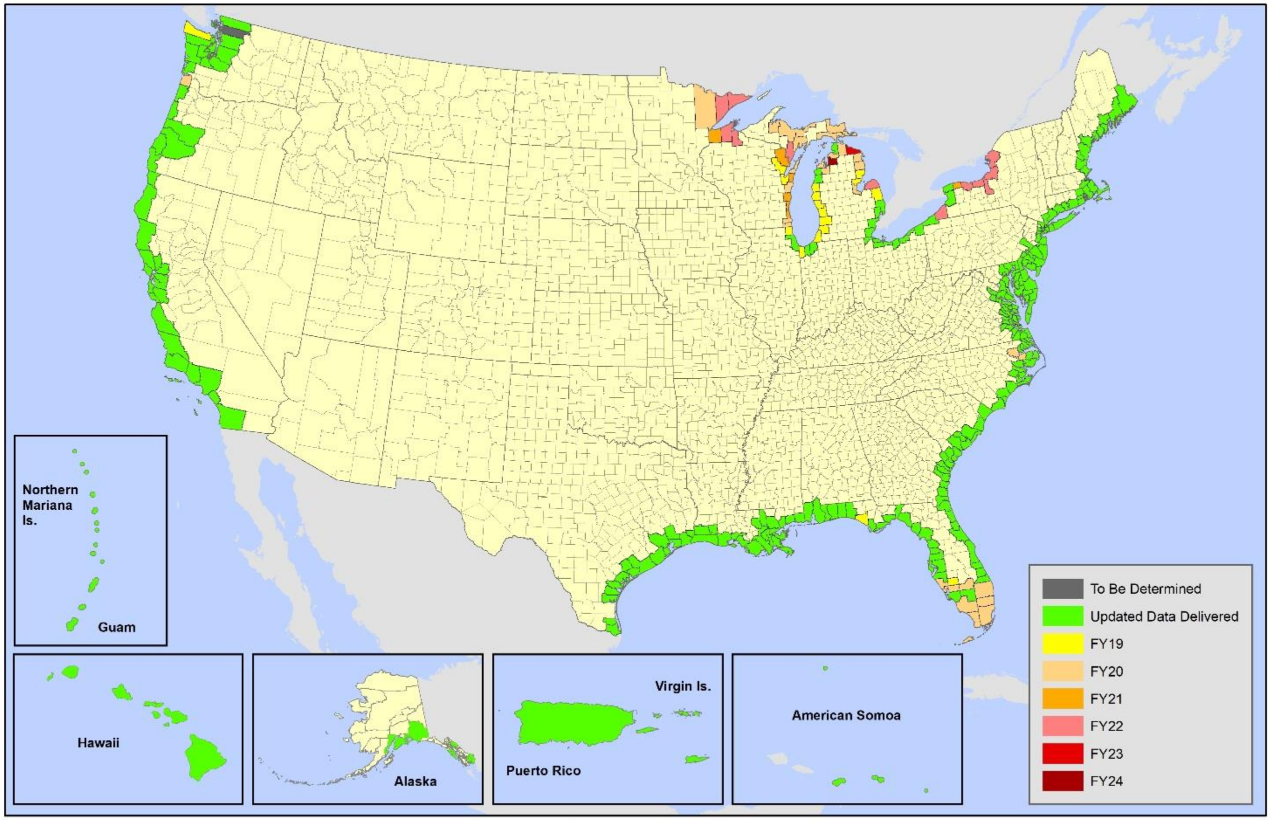
4 Improve management of Risk MAP resources through tech

5 Improve information sharing between programs



FEMA’s Investment in Coastal Mapping

Schedule of Coastal Counties Receiving Updated Mapping Data as of July 2019



FEMA

A preliminary FIRM is a National Flood Insurance Program (NFIP) map that reflects the initial results of a flood risk project that is performed by or for FEMA. FIRMS are tracked by fiscal year (FY), which is October through September. Data is updated quarterly and therefore subject to change.
For more information, please call 1-877-FEMA MAP (1-877-336-2627), email FEMAMapSpecialist@riskmapcds.com, or visit https://www.fema.gov/coastal-flood-risks

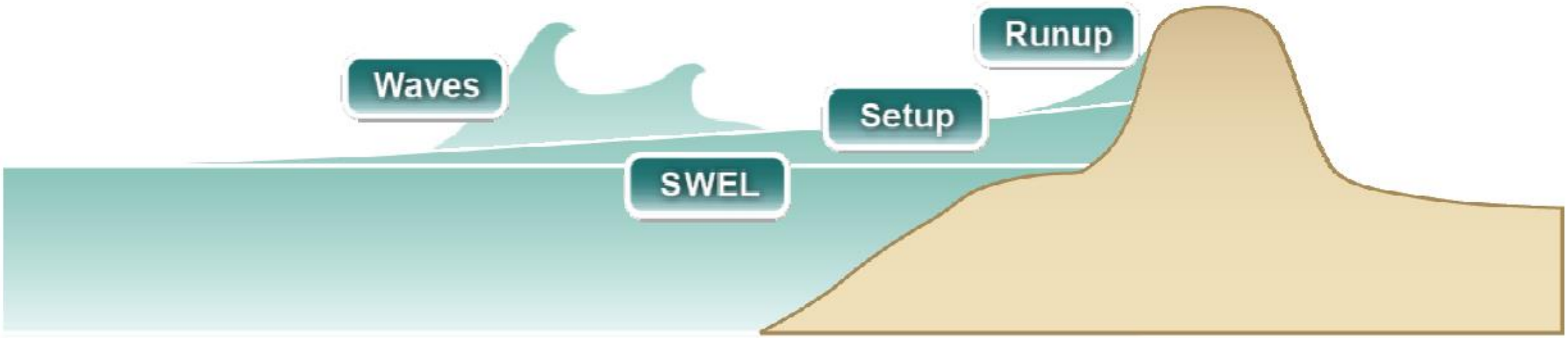
RiskMAP
Increasing Resilience Together

Basic Elements of a Coastal Flood Risk Study

Base Flood Elevation (BFE) on Flood Insurance Rate Map (FIRM) includes four components:

1. Storm surge stillwater elevation (SWEL)
2. Amount of wave setup
3. Wave height above storm surge elevation
4. Wave runup above storm surge elevation (where present)

Determined from storm surge model

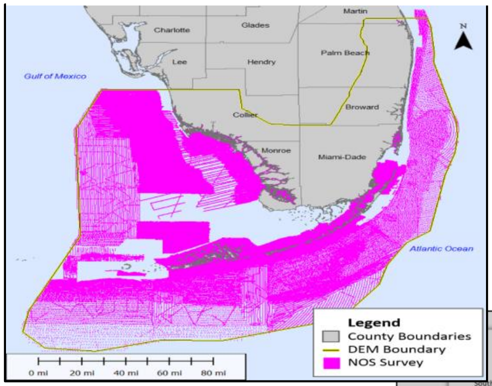


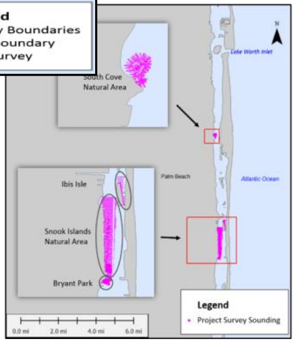
Gather Field Data

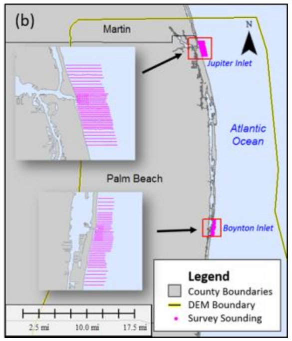
- Coordinated with community officials and stakeholders regarding available data
- Conducted thorough data investigation
- Conducted field investigations for storm surge, dune erosion, and overland wave modeling efforts.

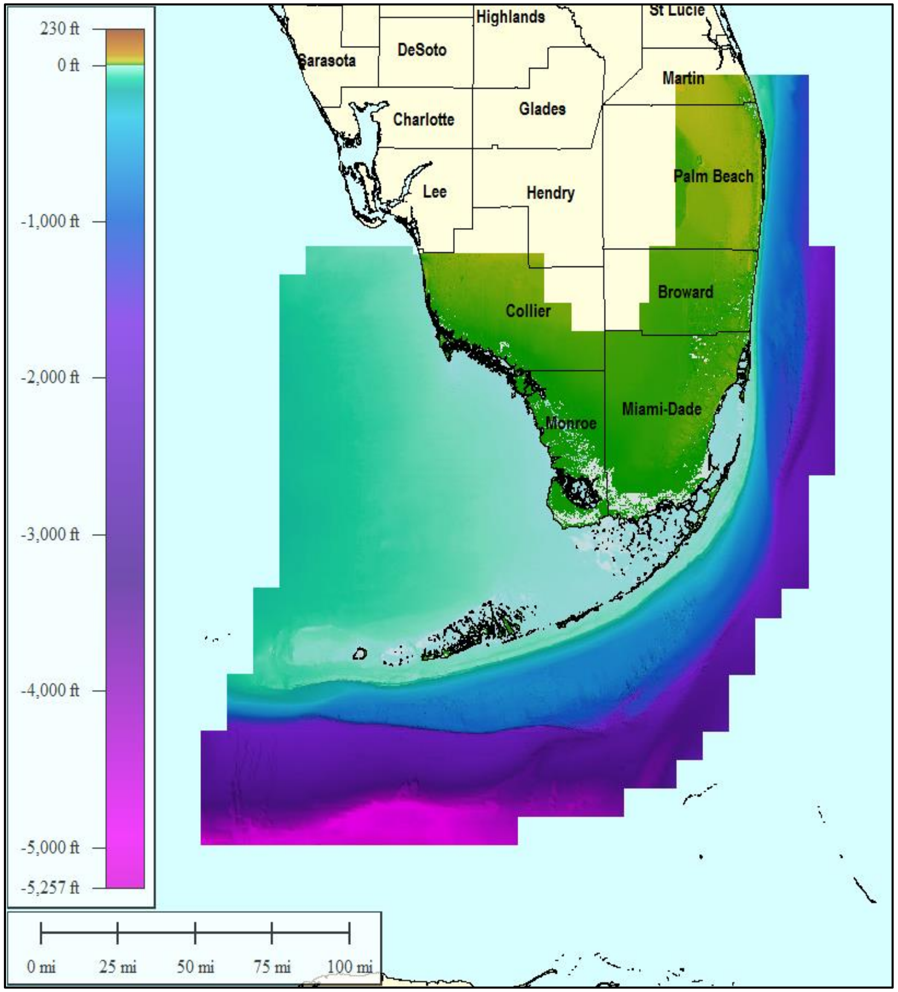
Topographic LIDAR and Bathymetric Data

Year	Description	Data Type	Source/Owner
2007	St. Lucie and Martin Counties, FL LIDAR	Airborne LIDAR	FDEM
2007	Palm Beach County, FL LIDAR	Airborne LIDAR	FDEM
2007	Herbert Hoover Dike Project, FL LIDAR	Airborne LIDAR	FDEM
2001	Palm Beach County, FL LIDAR (DEM)	Airborne LIDAR	SFWMD
2007	Broward County, FL LIDAR	Airborne LIDAR	FDEM
2007	MiamiDade County, FL LIDAR	Airborne LIDAR	FDEM
2008	Florida Keys Project, FL LIDAR	Airborne LIDAR	FDEM
2007	Monroe County, FL LIDAR	Airborne LIDAR	FDEM
2007	Collier County, FL LIDAR	Airborne LIDAR	FDEM
Various	USGS National Elevation Data (10 meter DEMs)	Digital Elevation Model	USGS
2014	South FL Composite Topography	Digital Elevation Model	SFWMD

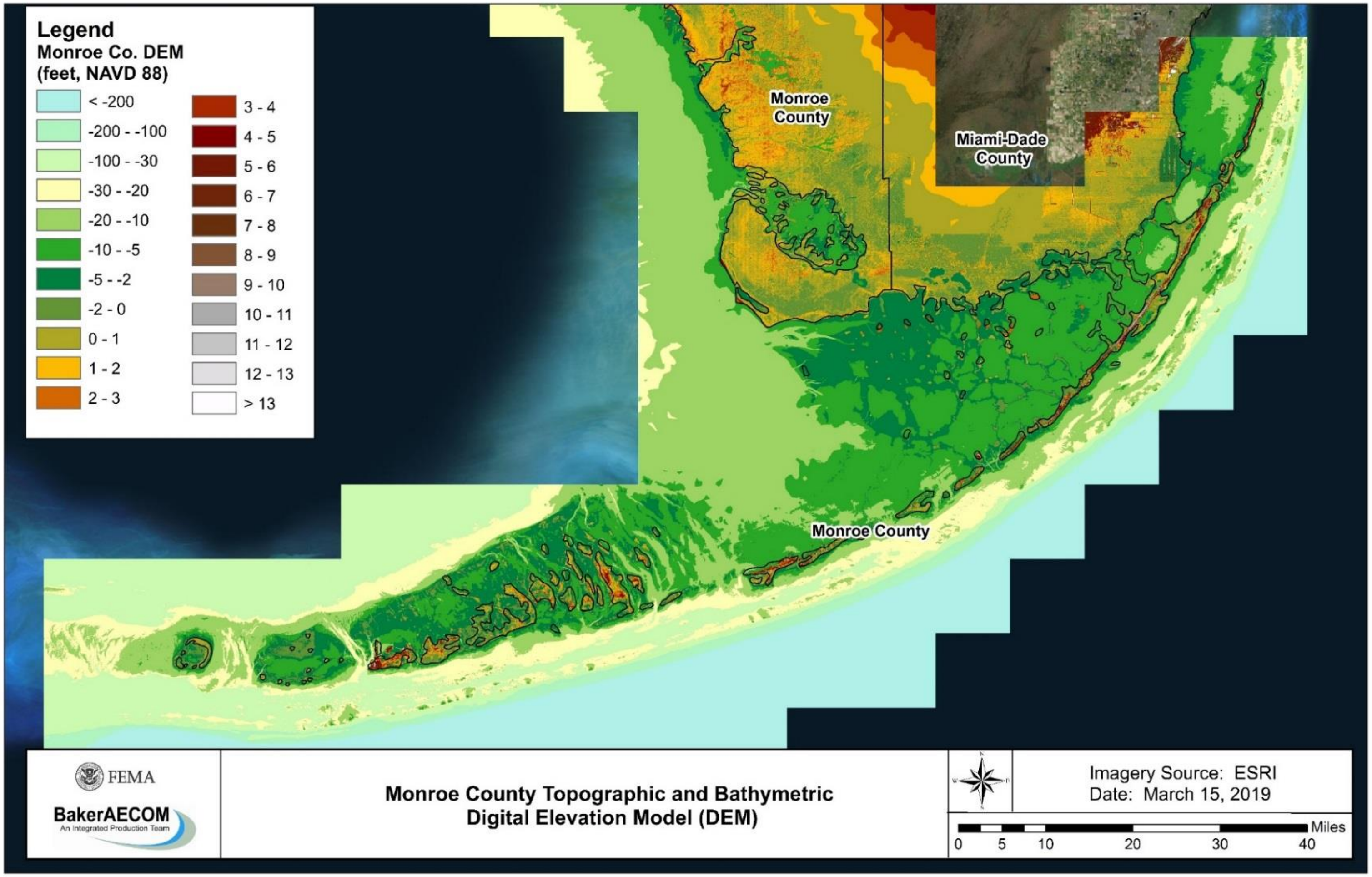




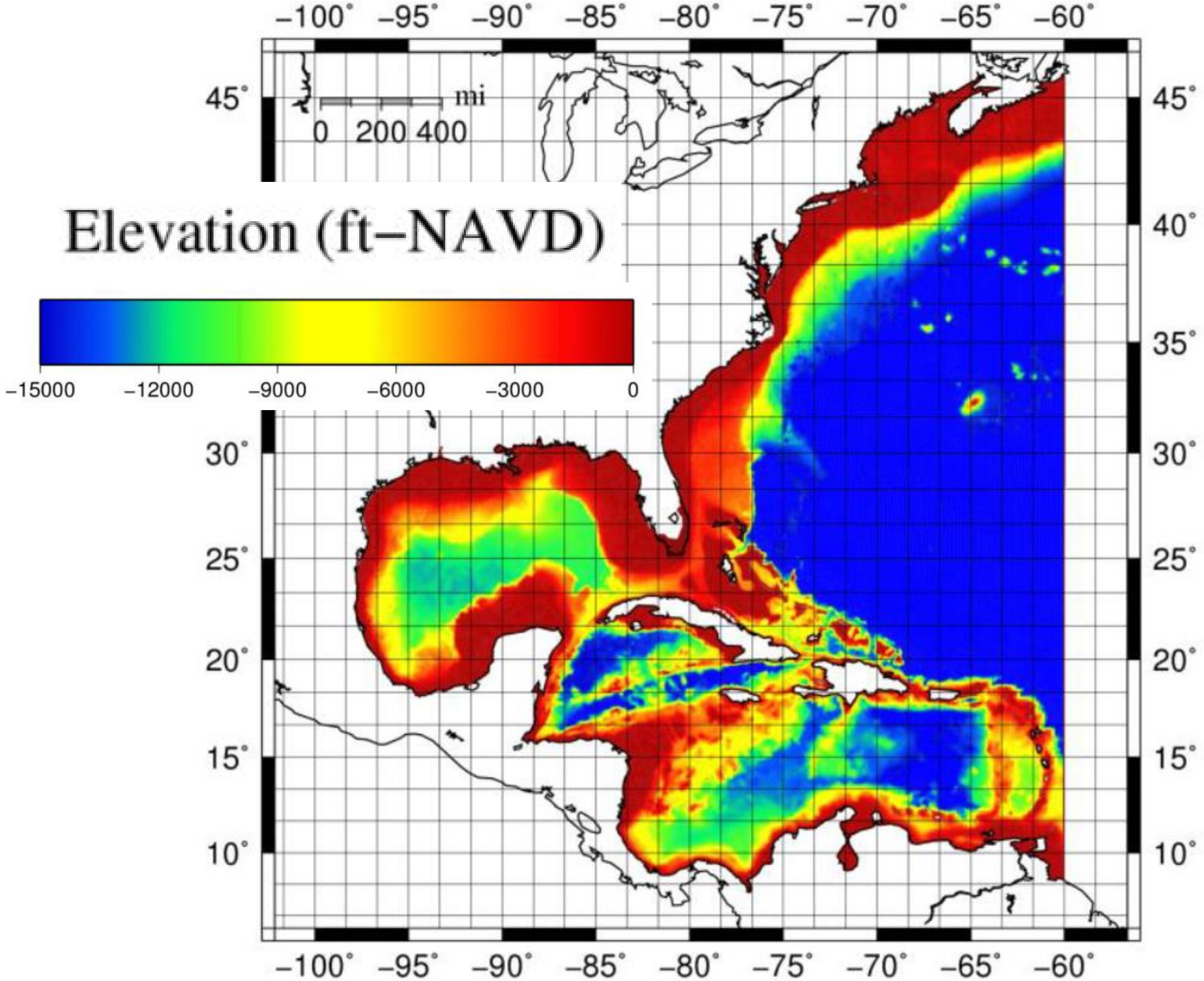




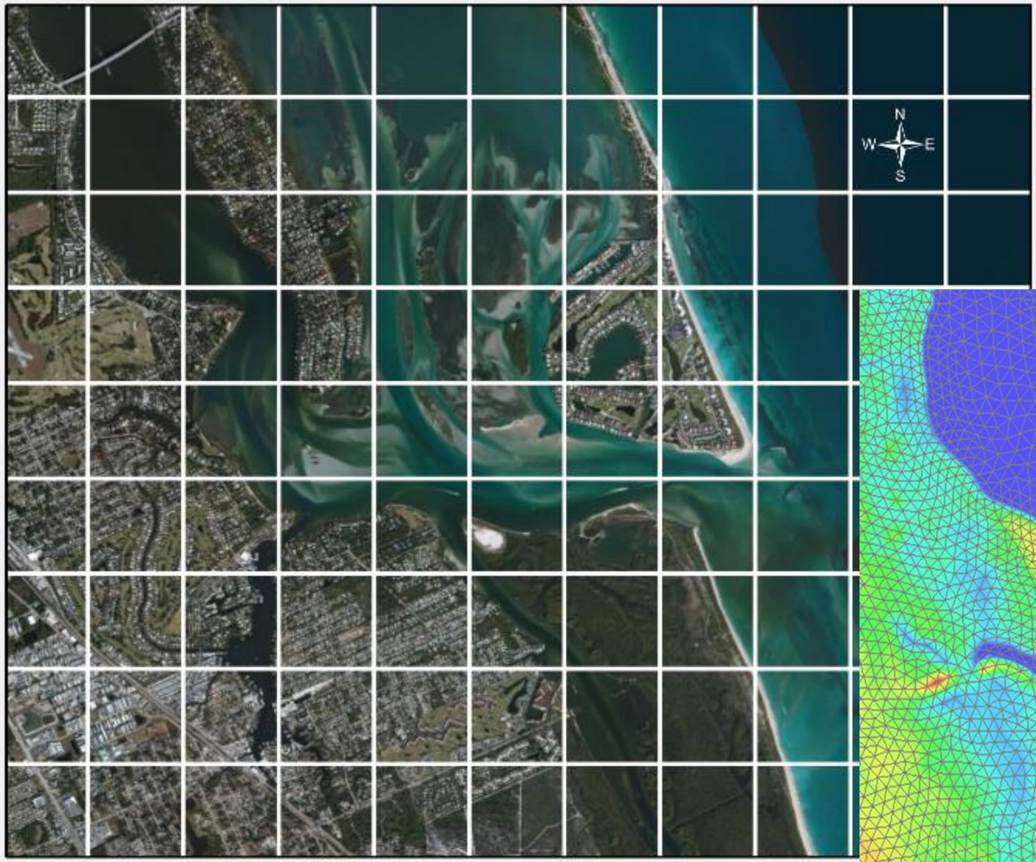
Seamless Digital Elevation Model



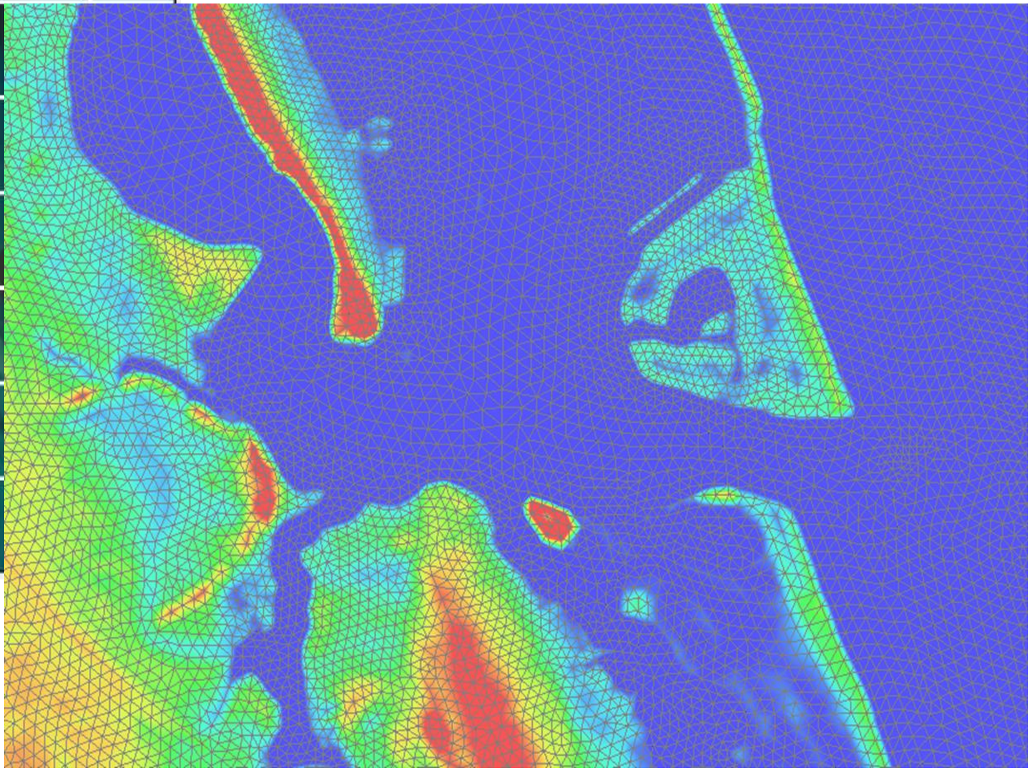
Hurricane Model Mesh Development



Mesh Development (cont'd)

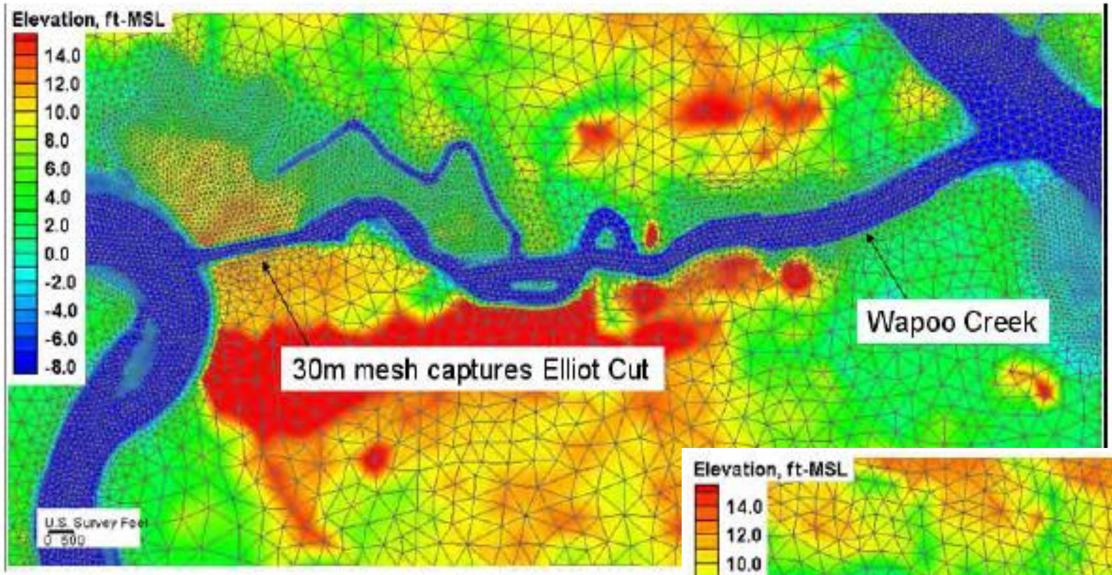


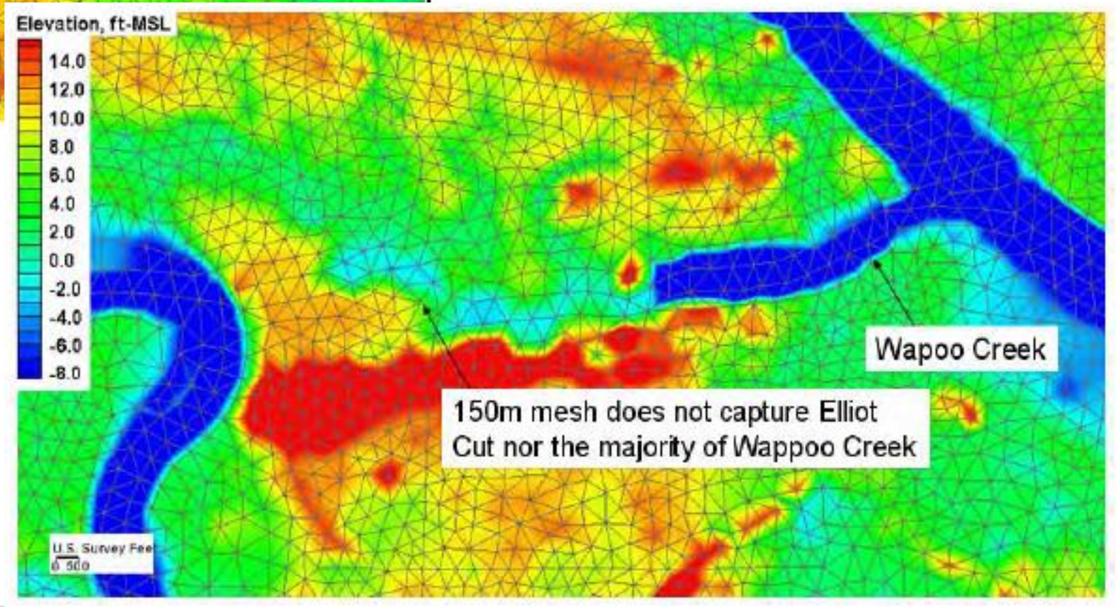
Old Mesh



New Mesh

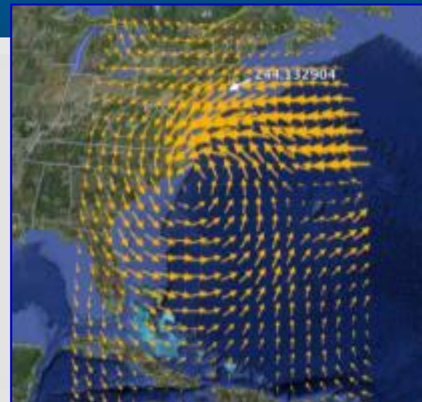
Mesh Development (cont'd)





Storm Surge Modeling System

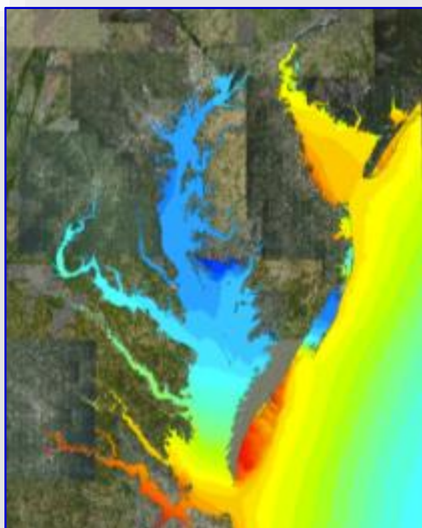
Model Components



Atmospheric Forcing
- Wind and Pressure Fields

HBL Hurricane Boundary Layer Model
Extratropical Storm Reconstructions

Circulation Model
- Tides, - Currents



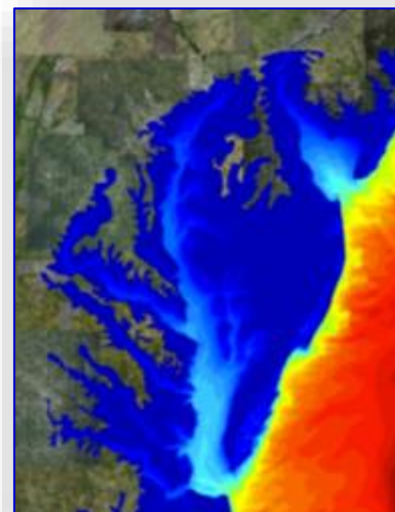
ADCIRC
Advanced CIRCulation model

Coupling

Water Levels

Wave Stress

Wave Model
- Surface waves



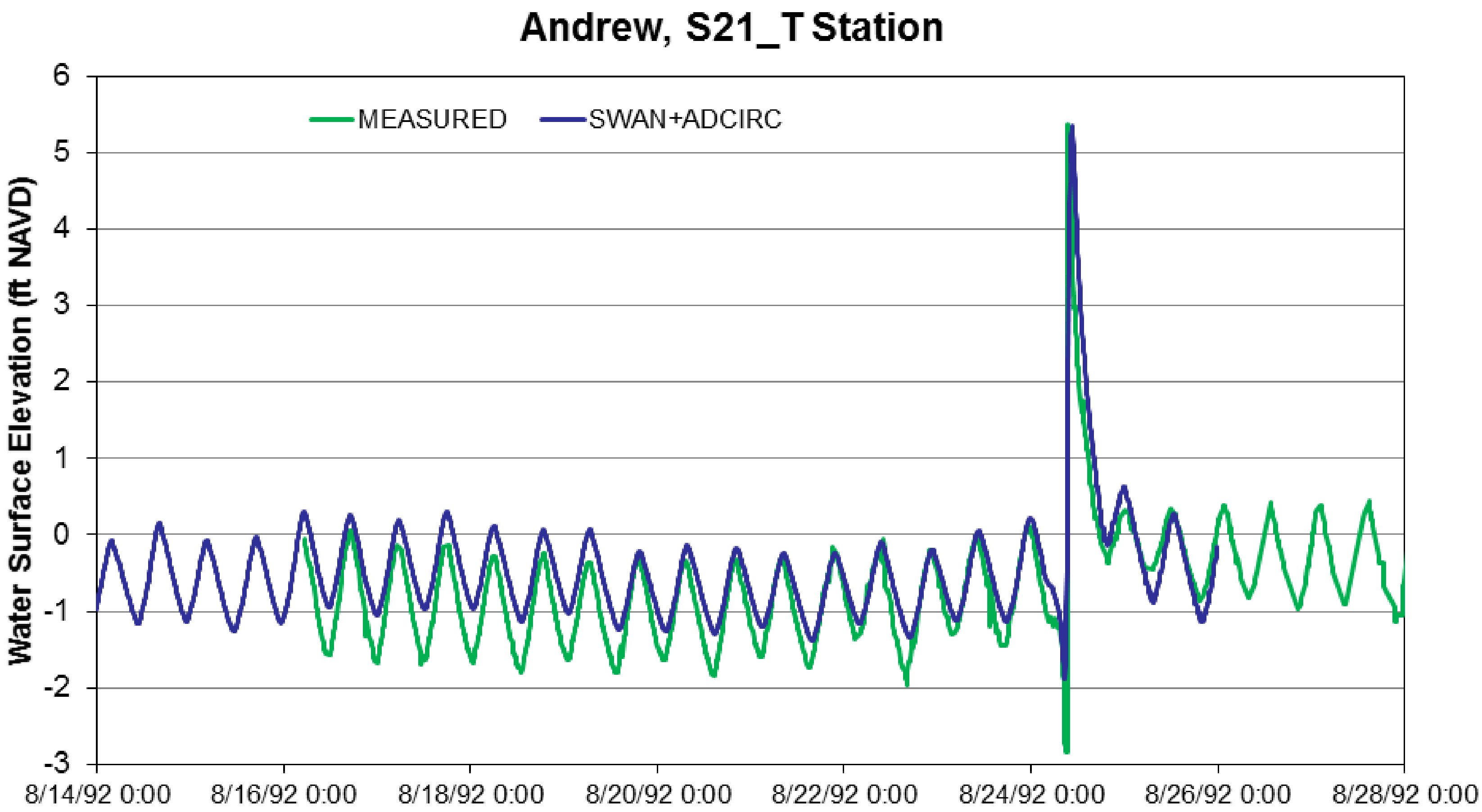
unSWAN
un-structured Simulating WAves Nearshore model

Slide from USACE Research and Development Center

Model Validation

- Makes sure that the model “works”
- Do this by checking that it is able to reproduce storm surge that occurred during historical events given the appropriate inputs (wind and tides)
- Run a known storm and compare model results to actual measured storm surge from that event—measured at tide gages (NOAA) and from collected High Water Marks (HWM)
- If available, compare to wave data
- Storm specific datasets if available.

Example: Model Validation



Two Types of Frequency Analysis

High Frequency

- **50-, 20-, 10, 4-percent-annual-chance water surface elevations**
- **Tide Gage Analysis**
  - L-moments-type regional frequency analysis
  - Calculate growth factors that can be used to determine x-percent-annual-chance Stillwater elevations

Low Frequency

- **2-, 1, 0.2-percent-annual-chance water surface elevations**
- **Coupled 2-D wave and surge modeling**
  - Joint Probability Method – Optimized Sampling (JPM-OS)
  - Highly defined modeling grid

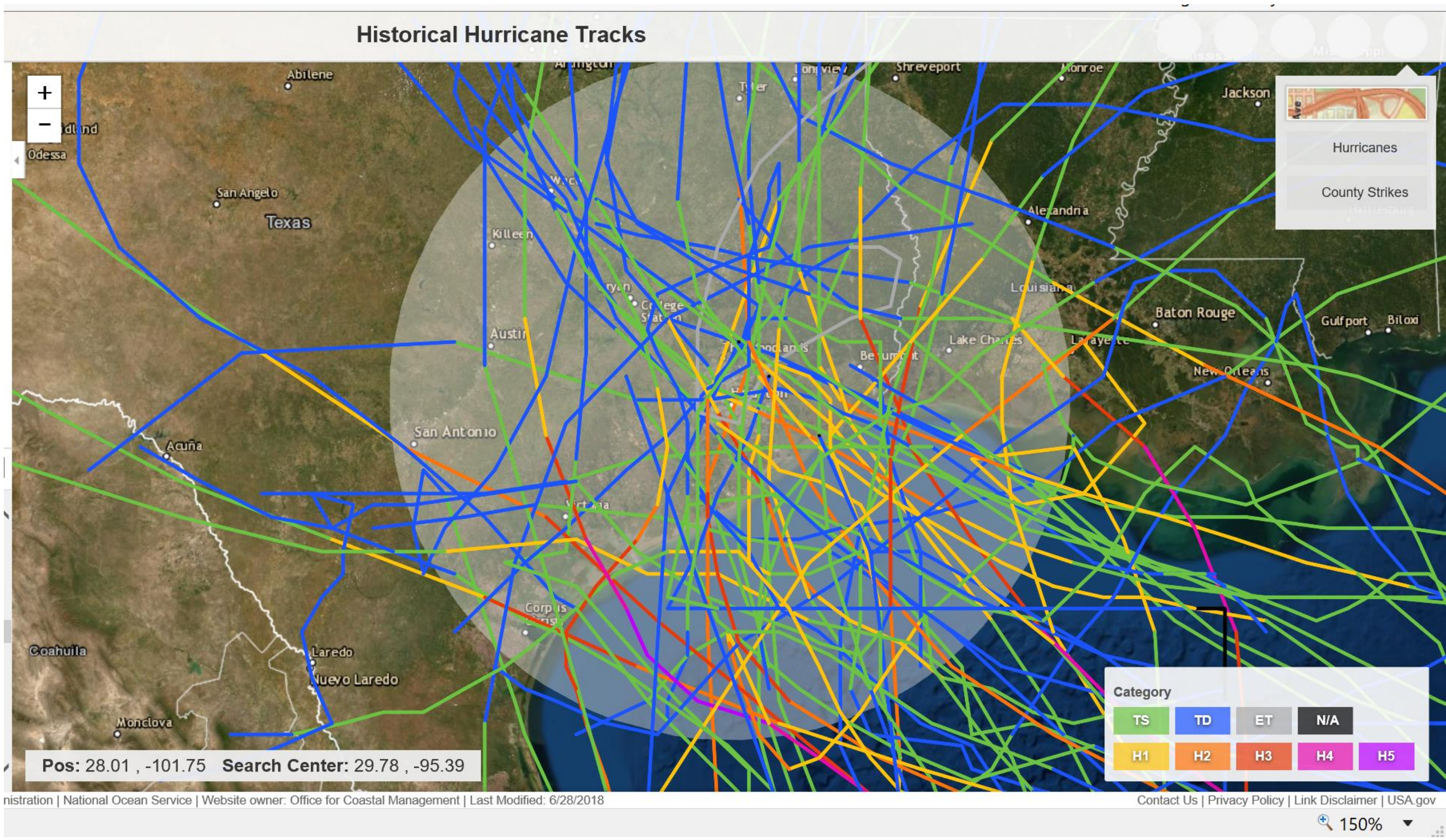
Storm Climatology: in Study Area

Tropical Storms:

1940 - 2010

Passing within 175 nm of Houston

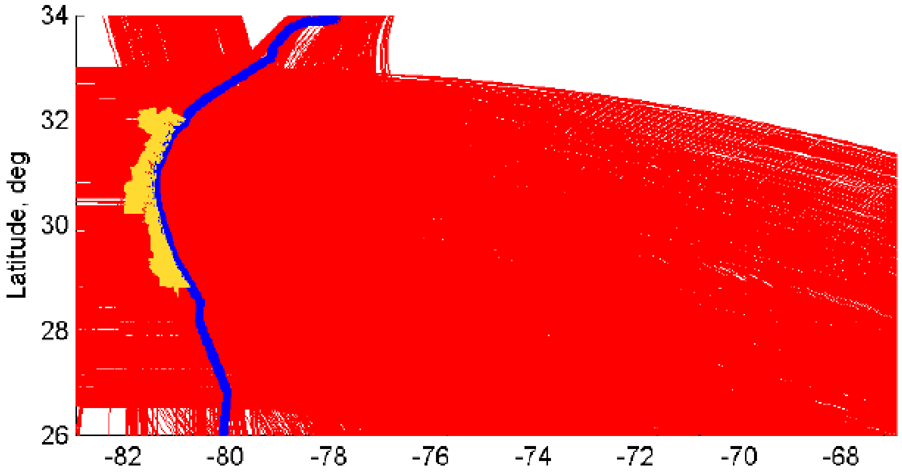
Limited data before 1940



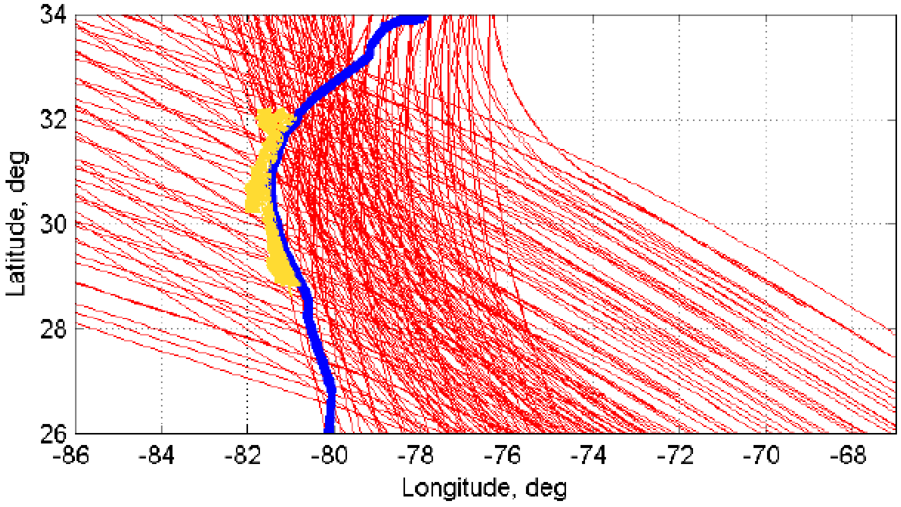
Hypothetical Storms

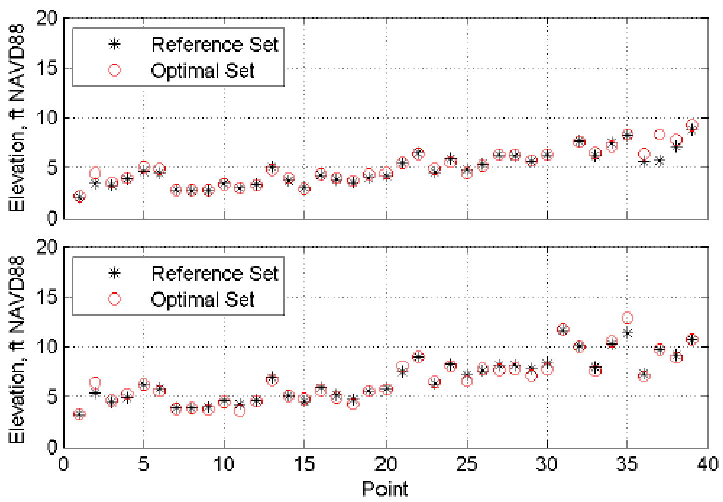
- Using 5 parameters
  - Central pressure (intensity), Radius to maximum winds (size), Forward speed, Storm heading (location), Holland's B (pressure shape parameter)
- Ensure covers whole range of possible storms for the study area
  - Based on historic data for the area

JPM-OS



- **Reduces needed storm runs from tens of thousands to a few hundred**
- **Focuses on storms that impact the 2-, 1-, 0.2% annual chance return periods at reference locations**
-

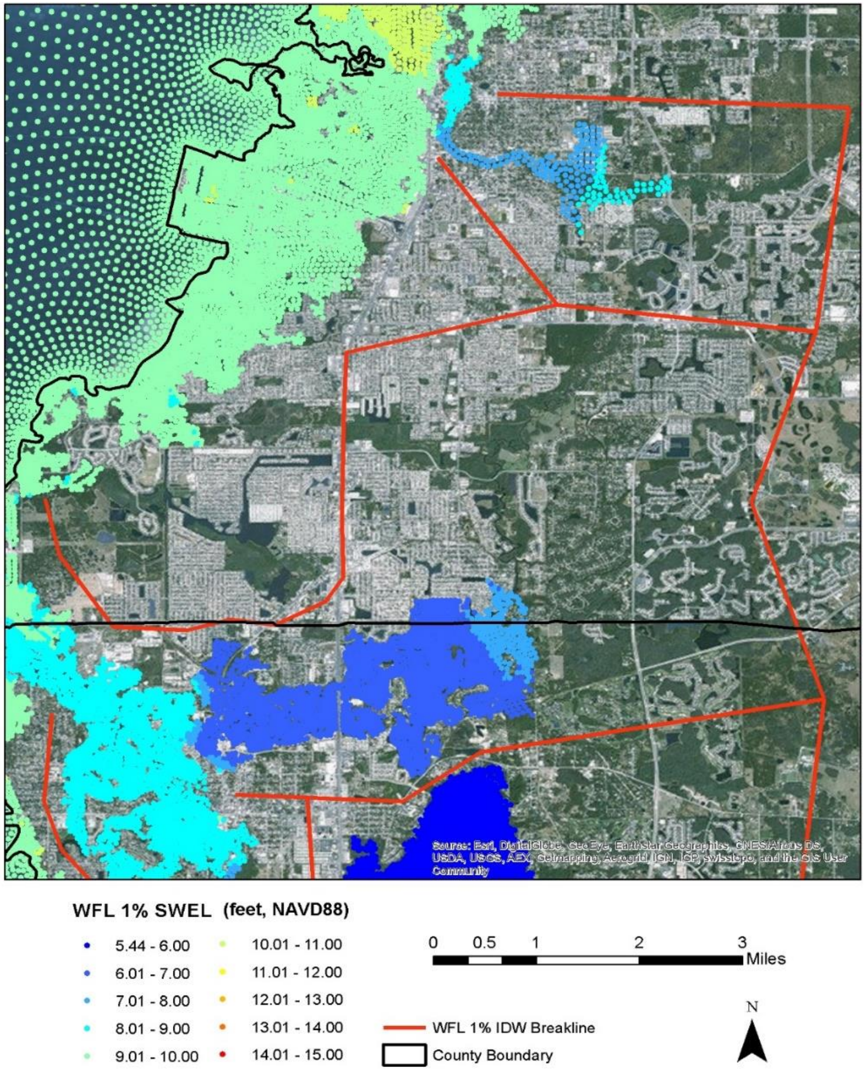




2% annual chance event

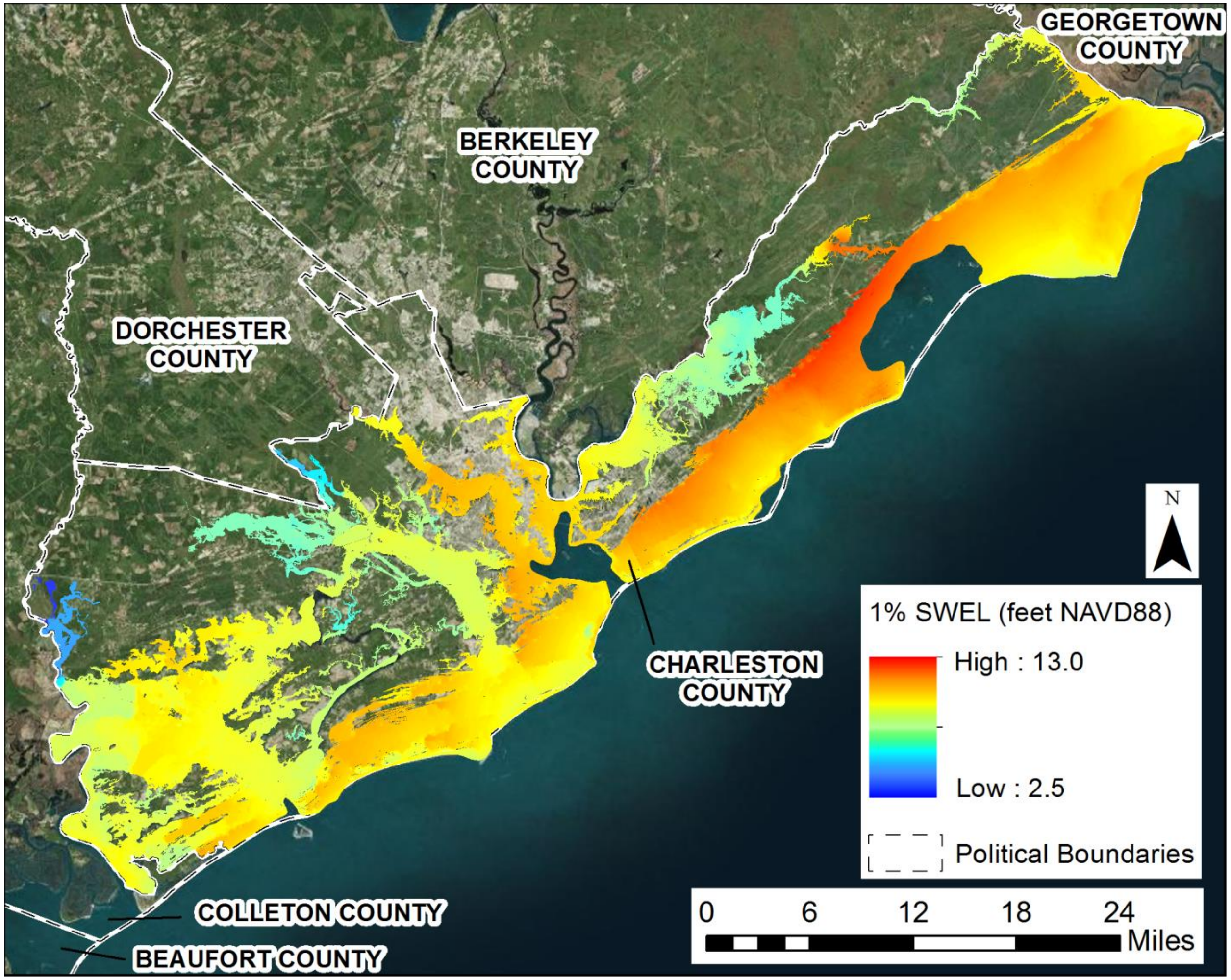
1% annual chance event

Return Period Analysis and Surface Creation

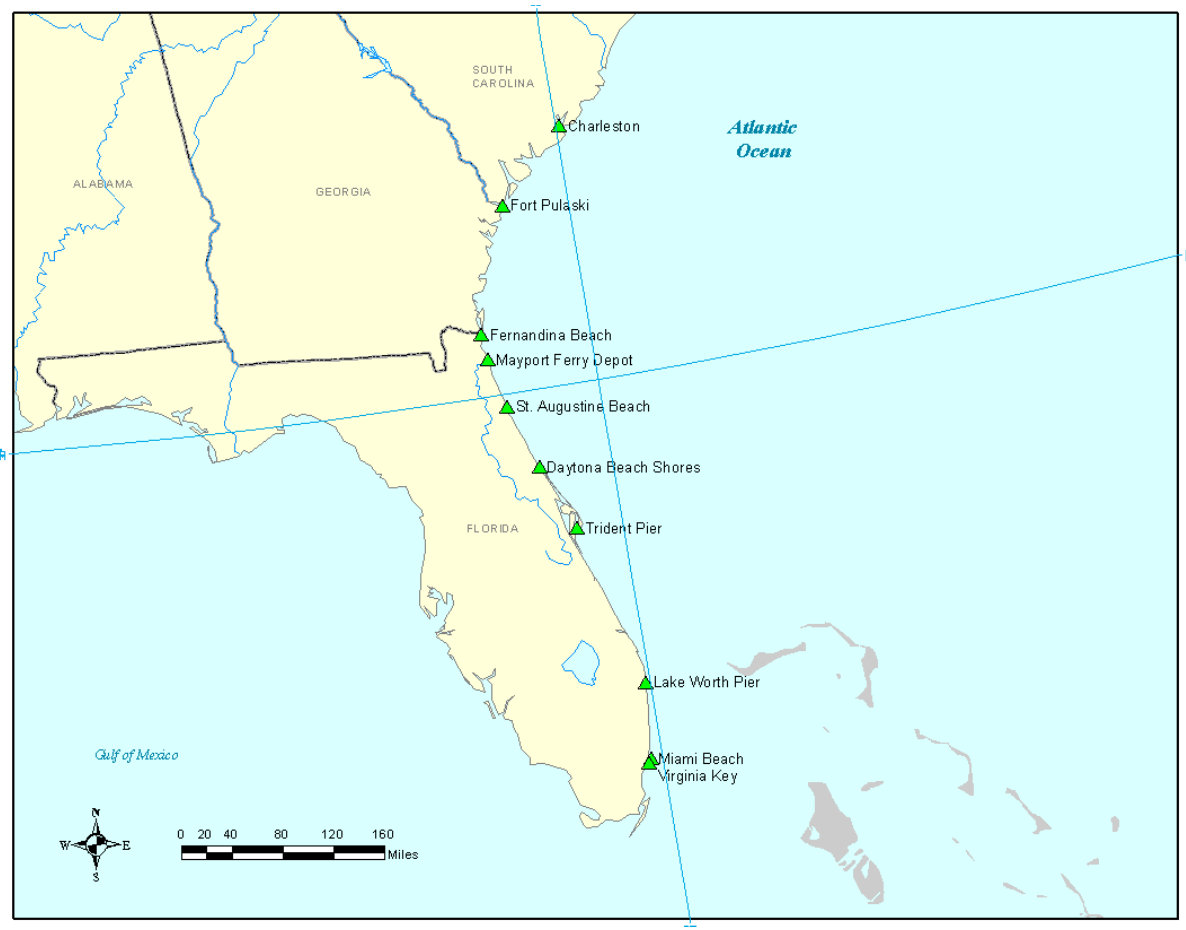


- For each storm, maximum water elevation is extracted at each node
  - SURGE_STAT
  - Peak surges; surge-frequency curves at each node
- SWEL is extrapolated inland along nodes with breaklines
  - What direction would surge propagate from
  - Significant features that may impede propagation of surge
  - Rasters developed
  - Clipping optional

Stillwater Development

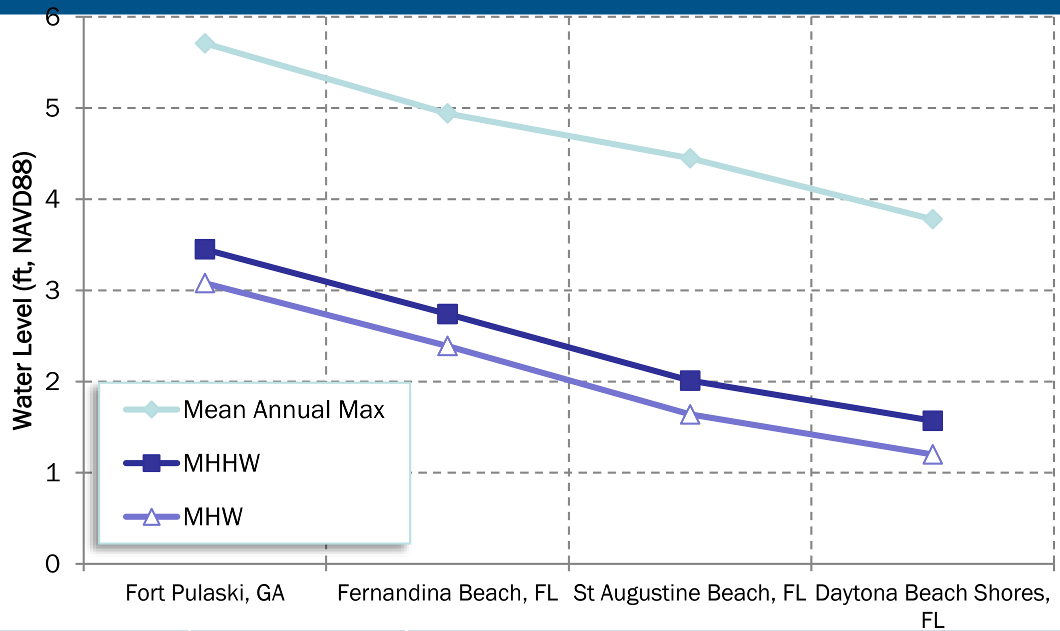


High Frequency - Regional Frequency Analysis



- Regional frequency analysis
  - Based on geographic setting, physical characteristics, data distributions
- Three steps for analysis
  - Compilation and screening of data
  - Segregation of data into homogenous regions
  - Fitting probability distributions

Estimates of High Frequency WLs



Site Name	Mean Annual Maximum water level (feet above NAVD88)	x% Annual Chance Water level (feet above NAVD88)			
		50%	20%	10%	4%
Georgia – Northeast Florida Region		Regional Growth Curve Factors			
		0.981	**1.049**	**1.101**	**1.181**
Fort Pulaski, GA	5.71	5.60	5.99	6.29	6.74
Fernandina Beach, FL	4.94	4.85	5.18	5.44	5.83
St Augustine Beach	4.45	4.37	4.67	4.90	5.26
Daytona Beach Shores	4.79	3.71	3.97	4.16	4.46

$$z = z_0 + \frac{y - y_0}{y_1 - y_0}(z_1 - z_0)$$

z = x-percent annual chance flood level at the interim location between long-term gage sites (value to be estimated)

z_0, z_1 = x-percent annual chance flood levels at long-term gage sites (known values)

y = latitude at the interim location between long-term gage sites (known values)

y_0, y_1 = latitudes at the long-term gage sites (known values)

- Regional frequency analysis
  - Based on geographic setting, physical characteristics, data distributions
- Monthly Maximum WLs retrieved
  - Calculate annual maximum water levels

RiskMAP
Increasing Resilience Together

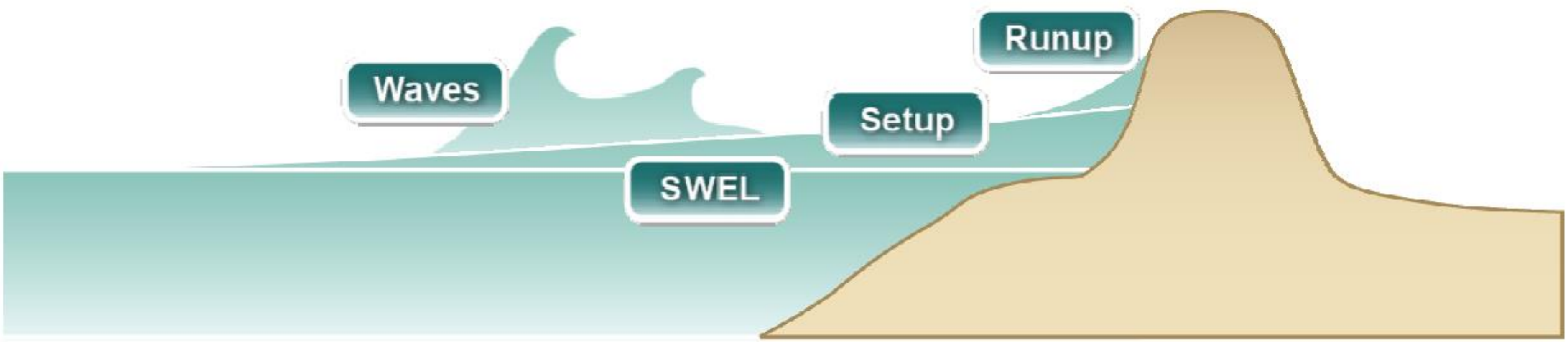
Basic Elements of a Coastal Flood Risk Study

Base Flood Elevation (BFE) on FIRM includes 4 components:

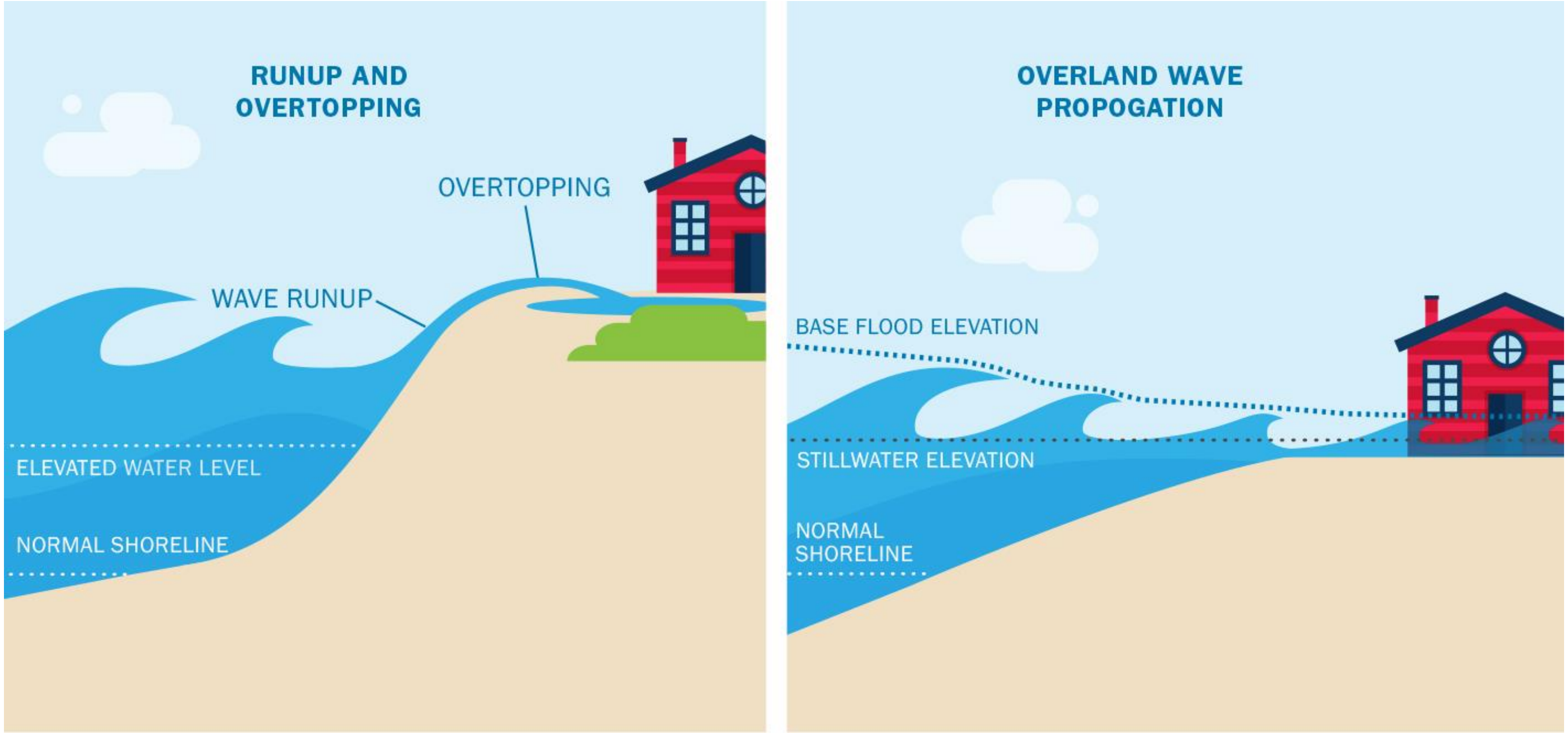
1. Storm surge stillwater elevation (SWEL)
2. Amount of wave setup
3. Wave height above storm surge (SWEL) elevation
4. Wave runup above storm surge elevation (where present)

Determined from storm surge model (1–2)

From wave height analyses (3–4)



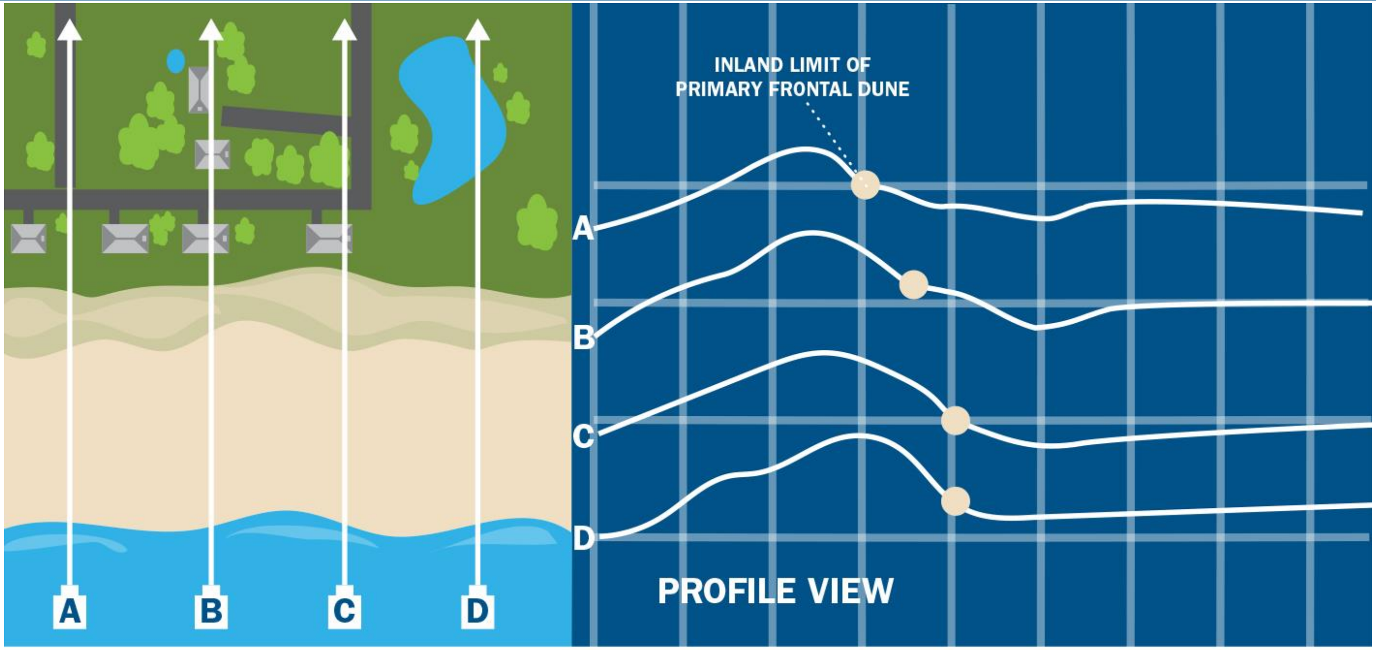
Modeling Part 2 – Waves



WAVE HAZARD MODELING

During a flood, waves ride on elevated water levels and can impact buildings located on land that is normally high and dry. FEMA conducts wave hazard modeling to evaluate the risks from overland wave propagation, runup, and overtopping and to determine base flood elevations (BFEs).

Transect-Based Modeling



DEFINE CROSS-SHORE TRANSECTS AND IDENTIFY THE PRIMARY FRONTAL DUNE

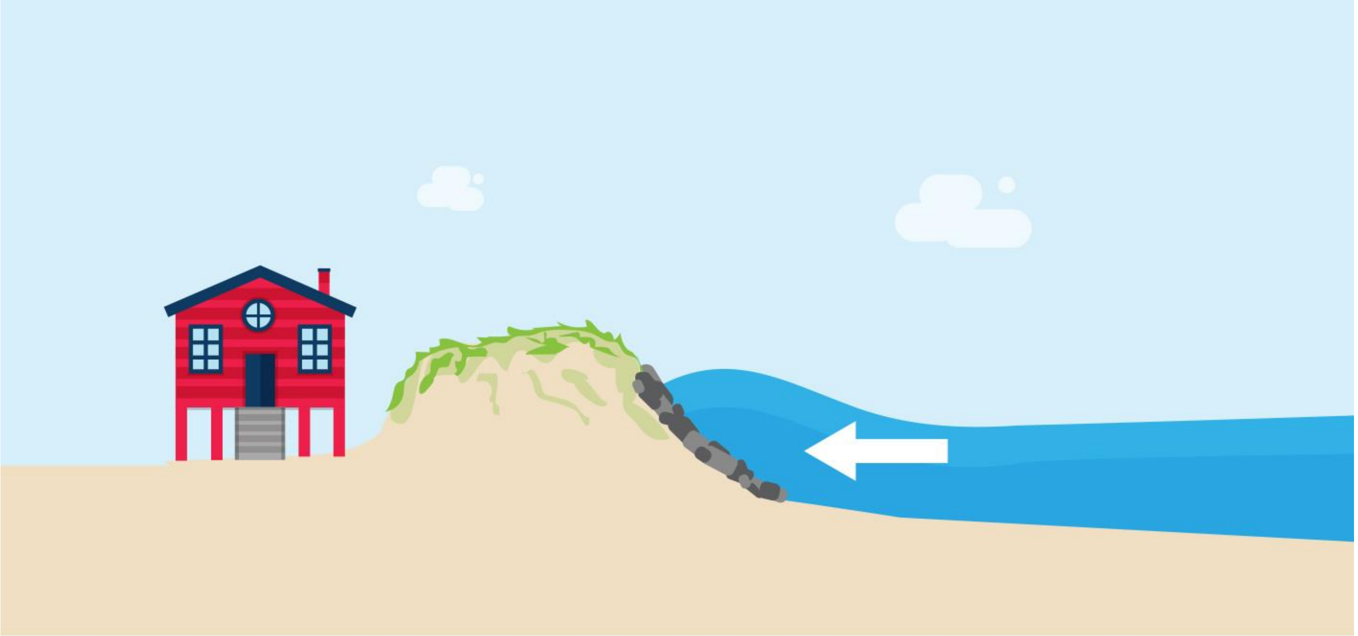
Engineers and surveyors divide the shoreline into segments and represent each segment with a cross-shore transect to characterize the study area's topography, development, and land use. The Primary Frontal Dune (PFD), defined as a continuous or nearly continuous ridge of sand with relatively steep seaward and landward slopes immediately landward of and adjacent to the beach, is identified for each shoreline segment.

Primary Frontal Dune (PFD)

"*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*"

–NFIP regulations

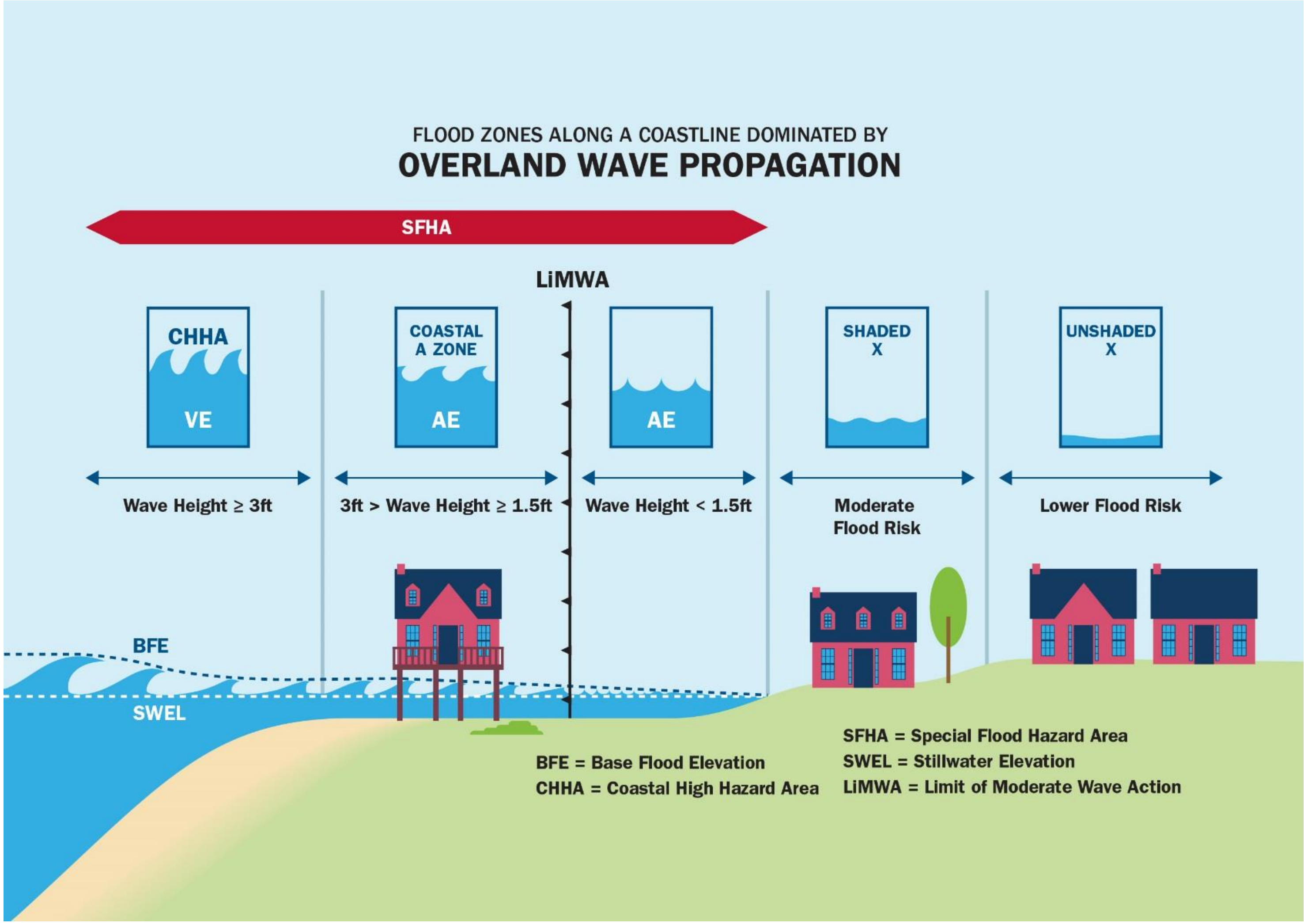
Erosion & Structures



EVALUATE STORM-INDUCED EROSION AND SHORE PROTECTION STRUCTURES

FEMA evaluates natural features, such as dunes and bluffs, and man-made features, such as seawalls, revetments (rock armoring), and beach nourishment for their ability to protect upland areas from flood hazards. Man-made dunes that are well-established with long-standing vegetative cover are included in the erosion analysis.

WHAFIS Models Waves Overland

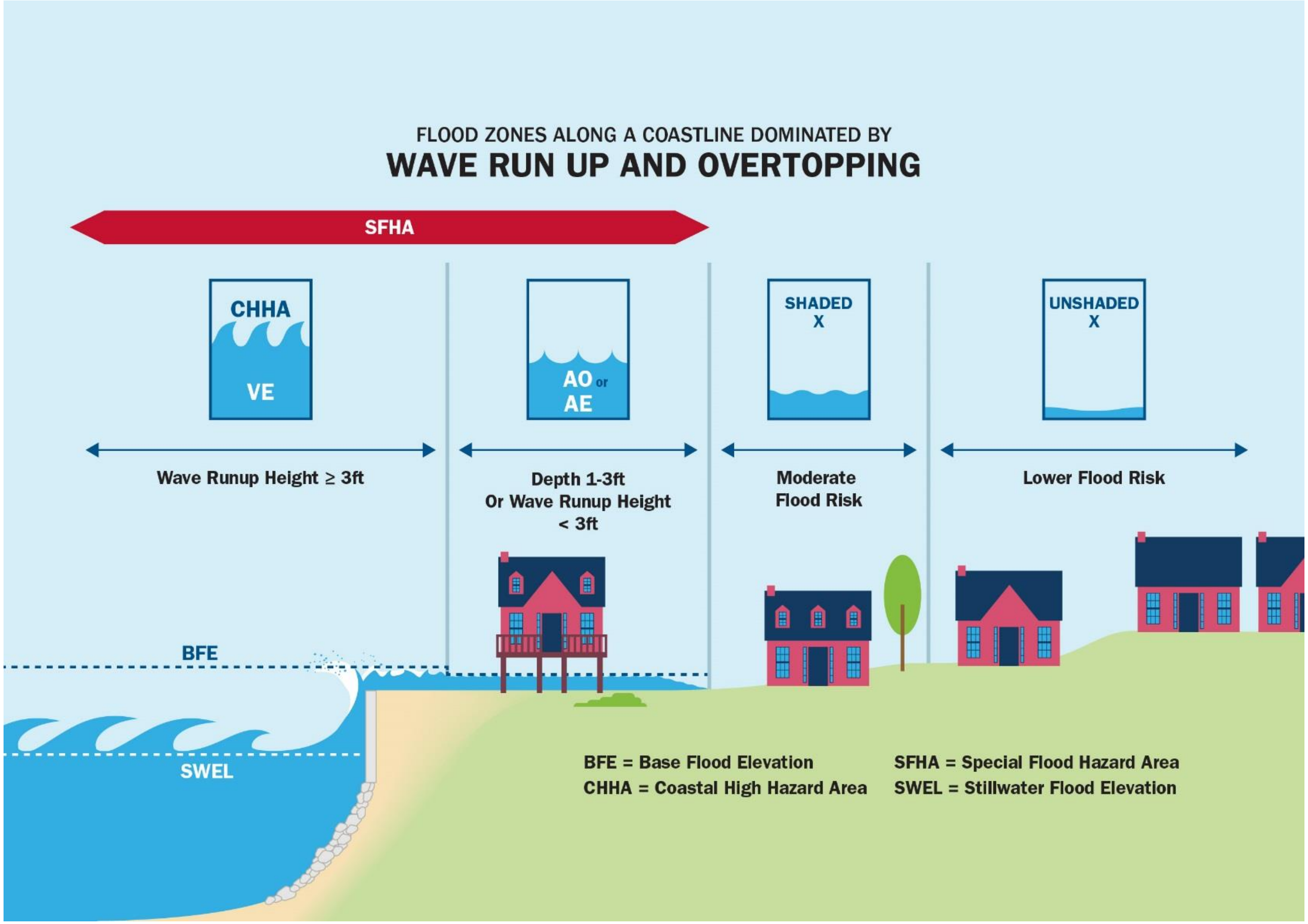


WHAFIS Models Waves Overland

- 1D transect approach based on limited water depth
- Accounts for wave dissipation/regeneration overland
- Buildings and vegetation (e.g. trees, mangroves, bushes) sources of wave dissipation
- Open area (e.g. golf courses, water) allow wave regeneration
- Wave crest elevations => Base Flood Elevations

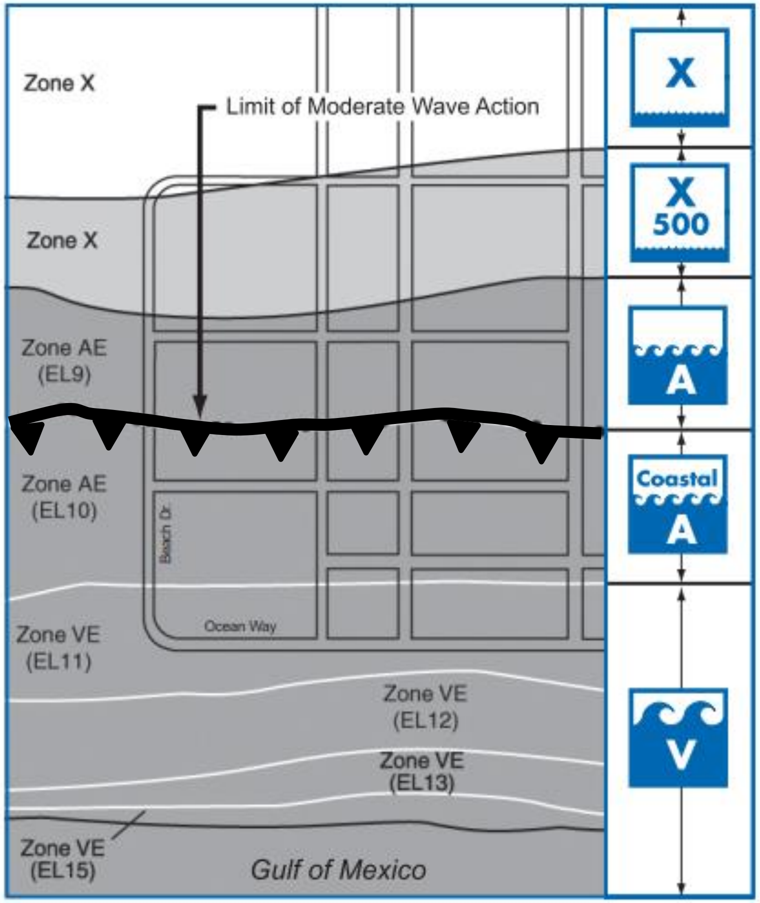
Wave Runup and Overtopping

Wave Runup Modeling and Mapping



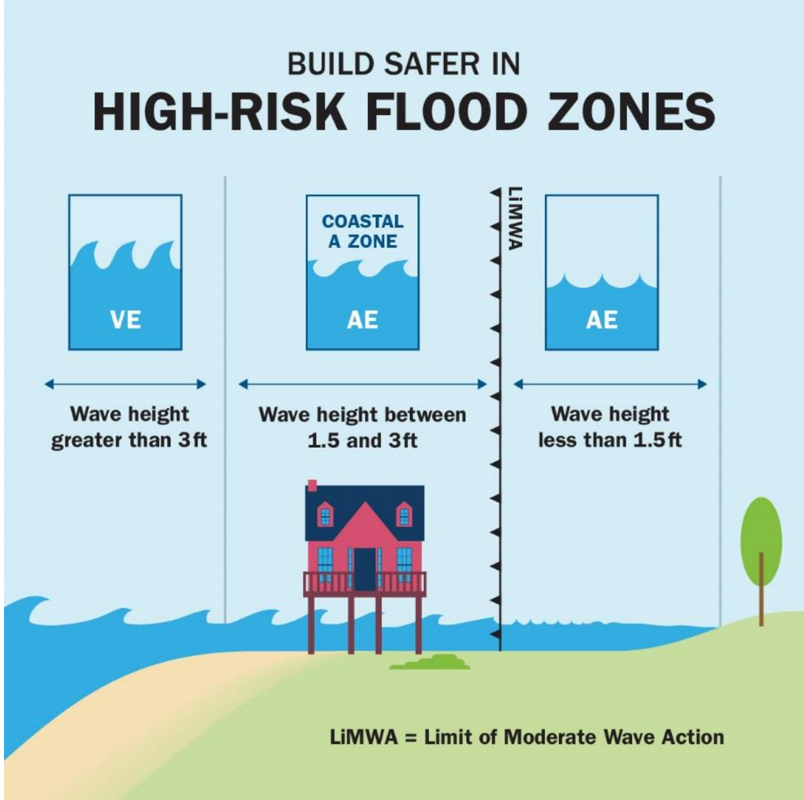
Limit of Moderate Wave Action (LiMWA)

- After many years of conducting post-storm damage surveys, FEMA has found that **structures exposed to wave heights as small as 1.5 feet can experience significant damage**.
- The Limit of Moderate Wave Action (LiMWA) represents the landward limit of the 1.5 feet breaking wave and appears within Zone AE thereby defining the Coastal A Zone (CAZ).
- Structures located within the CAZ (between Zone VE and the LiMWA) are vulnerable to damage from waves of 1.5 to 3 feet.



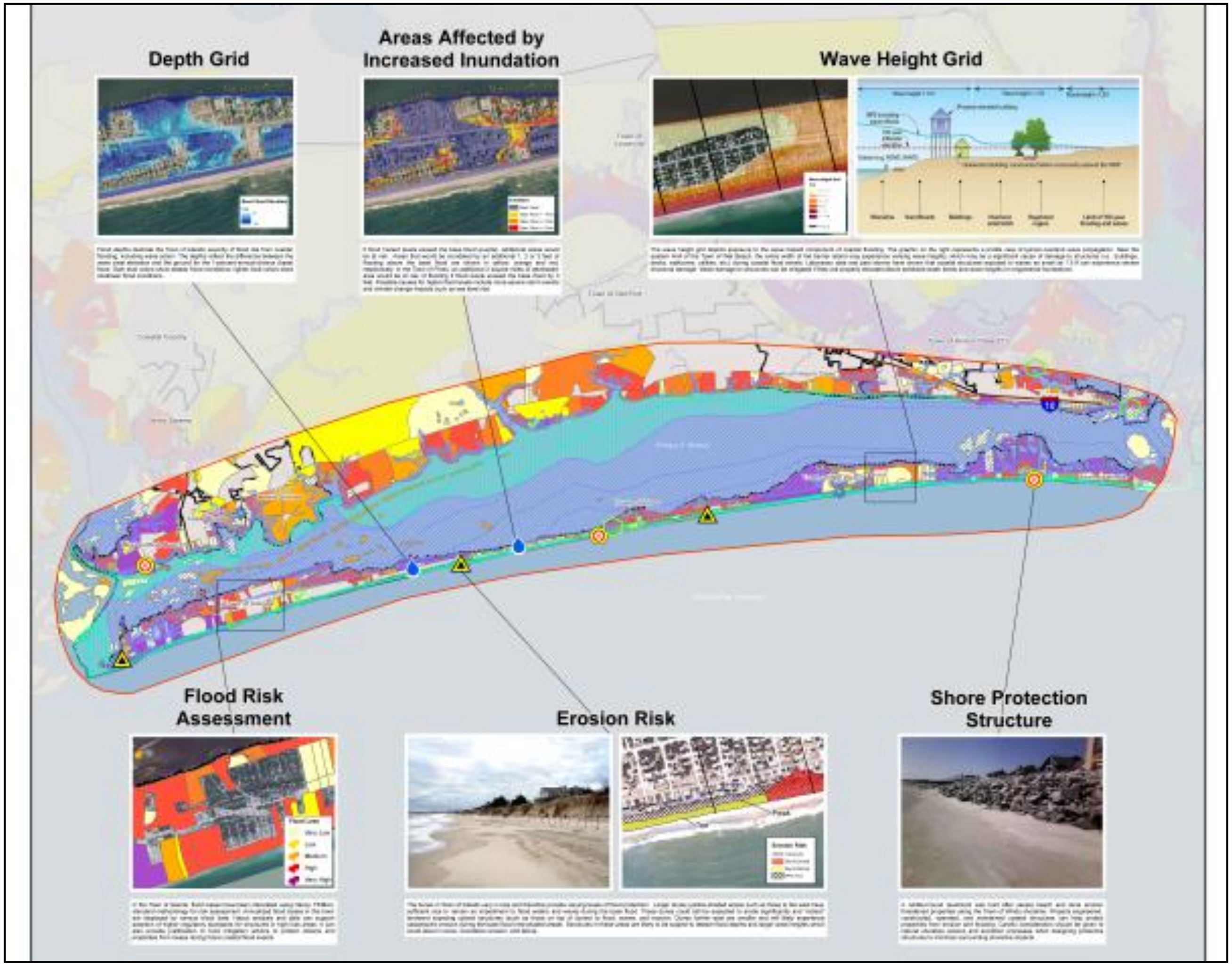
Why Map the LiMWA?

- By adopting higher building codes and standards in the CAZ similar to those used in the VE zone, communities can mitigate damages caused by waves and erosion and may also earn Community Rating System (CRS) credits.
- Although the risk of damage is higher in the CAZ than in other Zone A areas, the National Flood Insurance Program (NFIP) uses the same insurance rates for buildings in both areas.



Flood Risk Products

- Flood Risk Report
- Flood Risk Map
- Flood Risk Database



FEMA

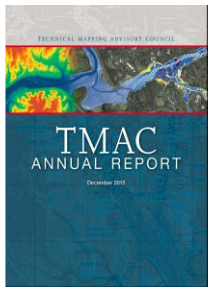
Tomorrow

October 12, 2019

RiskMAP
Increasing Resilience Together

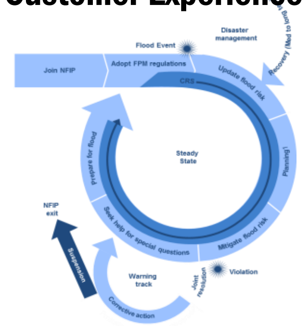
Strategic Drivers, Influencers, and Priorities

TMAC Recommendations



RMD Priorities

Customer Experience



Federal Mission Space

NOAA
USGS

Reauthorization

NATIONAL FLOOD INSURANCE PROGRAM

Moonshots

FEMA Strategic Goals

STRATEGIC GOALS

I.
BUILD A CULTURE OF PREPAREDNESS

OBJECTIVES

1.1 Incentivize investments that reduce risk, including pre-disaster mitigation, and reduce disaster costs at all levels

1.2 Close the insurance gap

1.3 Help people prepare for disasters

1.4 Better learn from past disasters, improve continuously, and innovate

Risk Rating 2.0

DELIVERING RATES THAT:	USING POLICY FORMS THAT:
ARE FAIR	ARE SIMPLE
ARE CLEAR	ALIGN WITH INDUSTRY
USE CURRENT TECHNOLOGY & DATA	PROVIDE CHOICE

Future of Flood Risk Data

1. Address gaps in data
2. Align increased awareness with reductions in vulnerability
3. Support community-level mitigation planning
4. Improve management of Risk MAP resources through tech
5. Improve information sharing between programs

Recalibrating to Meet Strategic Goals

FEMA and FIMA have set bold strategic goals over the course of the past year and Risk MAP must evolve to meet the mission

2018–2022

Strategic Plan

Helping People. Together.

FEMA Mission: **Helping people before, during, and after disasters.**

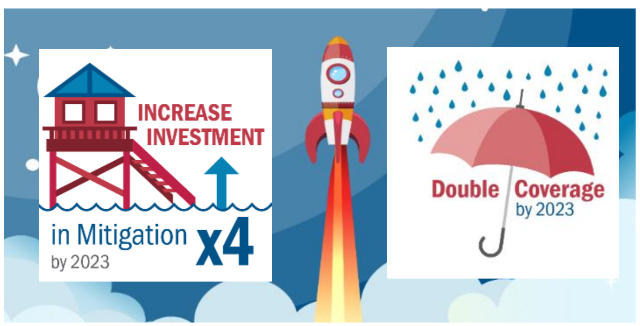
STRATEGIC GOALS

I. BUILD A CULTURE OF PREPAREDNESS

OBJECTIVES

- 1.1 Incentivize investments that reduce risk, including pre-disaster mitigation, and reduce disaster costs at all levels
- 1.2 Close the insurance gap
- 1.3 Help people prepare for disasters
- 1.4 Better learn from past disasters, improve continuously, and innovate

Moonshots



Risk Rating 2.0

DELIVERING RATES THAT:

- ARE FAIR
- ARE CLEAR
- USE CURRENT TECHNOLOGY & DATA

USING POLICY FORMS THAT:

- ARE SIMPLE
- ALIGN WITH INDUSTRY
- PROVIDE CHOICE

Coastal Opportunities and Challenges

Ensuring Technically Credible Models and Methodologies

- Address the Disconnects across Study Areas with Differing Levels of Detail/Credibility
- Choosing and Using the Most Credible Models
- Landing Our Erosion Methodology
- Shifting to Hazard-Based Risk Identification

Striking the Balance between Meeting User Needs & Maintaining Technical Credibility

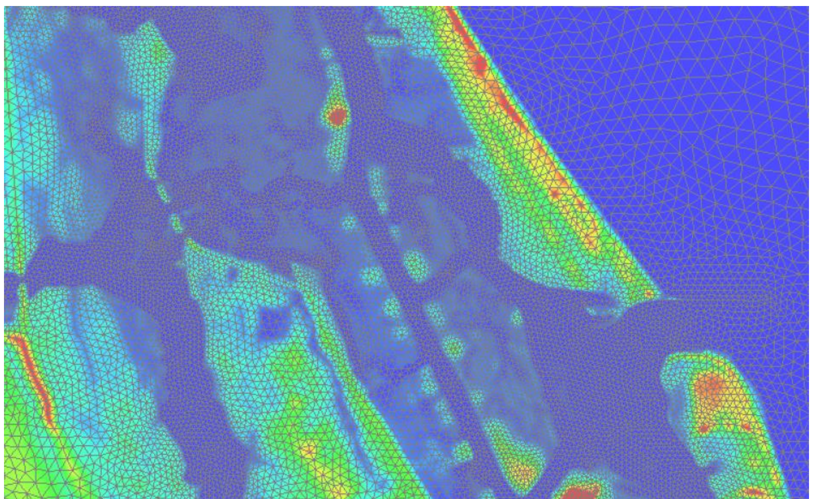
- Provide more consistent, continuous, and customized communications to communities and individuals
- Increasing Speed and Cost Effectiveness of Flood Insurance Studies
- Providing an Easier Avenue for Flood Hazard Map Updates

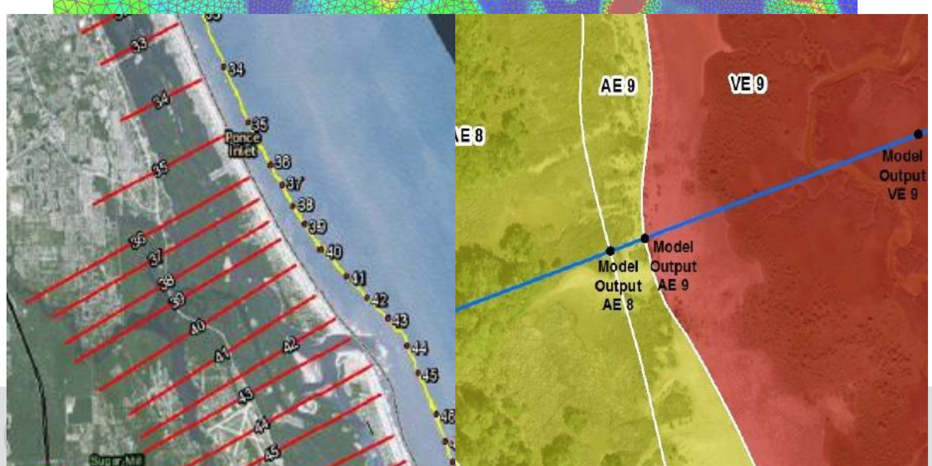
Moving Beyond the 1%

- Accounting for All Coastal Hazards
- Move beyond hazard awareness and into providing risk assessments
- Enabling Structure-Specific Depiction of Risk

Better Connections across Study Areas with Differing Levels of Detail

Opportunity Summary: Address the perceived disconnects in accuracy and precision along our study process (e.g., sophisticated 2D nearshore models with less detailed and credible 1D overland models)





Strategic Alignment:

FEMA-WIDE

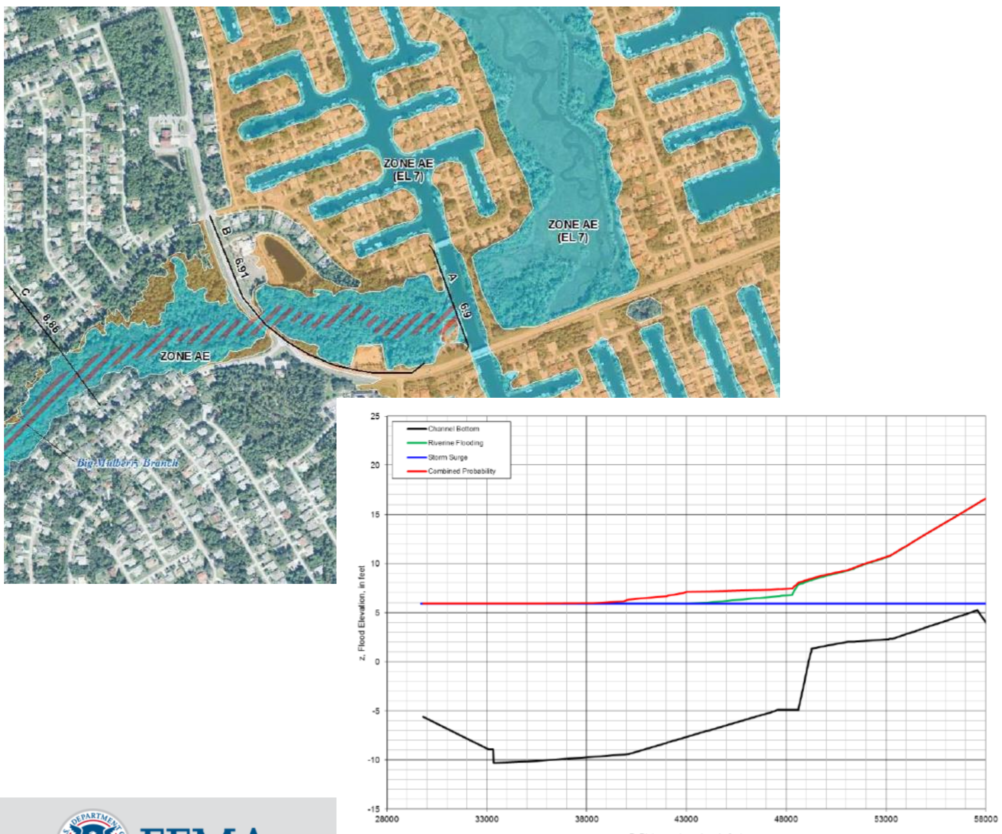
	Mitigation Moonshot
	Insurance Moonshot
✓	Improve the Customer Experience

RISK MANAGEMENT DIRECTORATE

✓	Improve Flood Risk Data
✓	Risk Rating 2.0
	Products Address Future Conditions or Structure Level Risk
	Transform Risk Communications

Accounting for All Coastal Hazards

Opportunity Summary: Storm surge & wave modeling have been found appropriate for the 1% for most of the US. As we move towards more robust hazard information, we need to take into account tsunamis, stormwater run-off, tidal flooding, combined riverine etc.



Strategic Alignment:

FIMA-WIDE

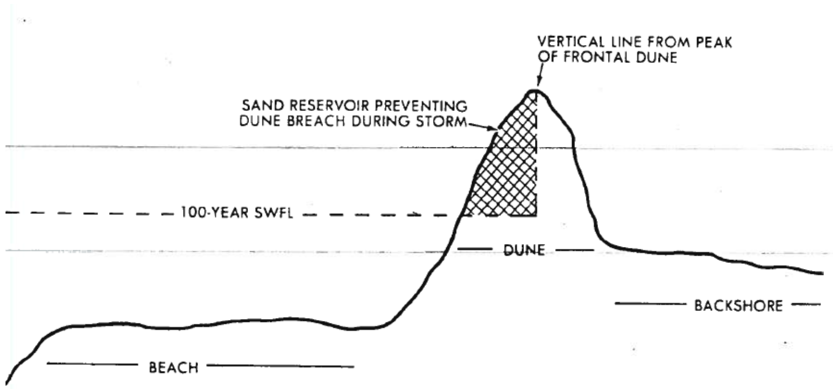
- ✓ Mitigation Moonshot
- ✓ Insurance Moonshot
- ✓ Improve the Customer Experience

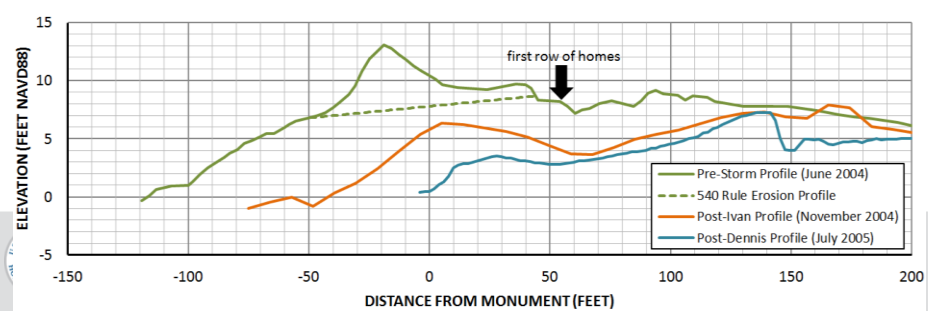
RISK MANAGEMENT DIRECTORATE

- ✓ Improve Flood Risk Data
- ✓ Risk Rating 2.0
- ✓ Products Address Future Conditions or Structure Level Risk
- ✓ Transform Risk Communications

Landing Our Erosion Methodology

Opportunity Summary: We need to address the fact that the there is room for improvement in the erosion methodology





Strategic Alignment:

FIMA-WIDE

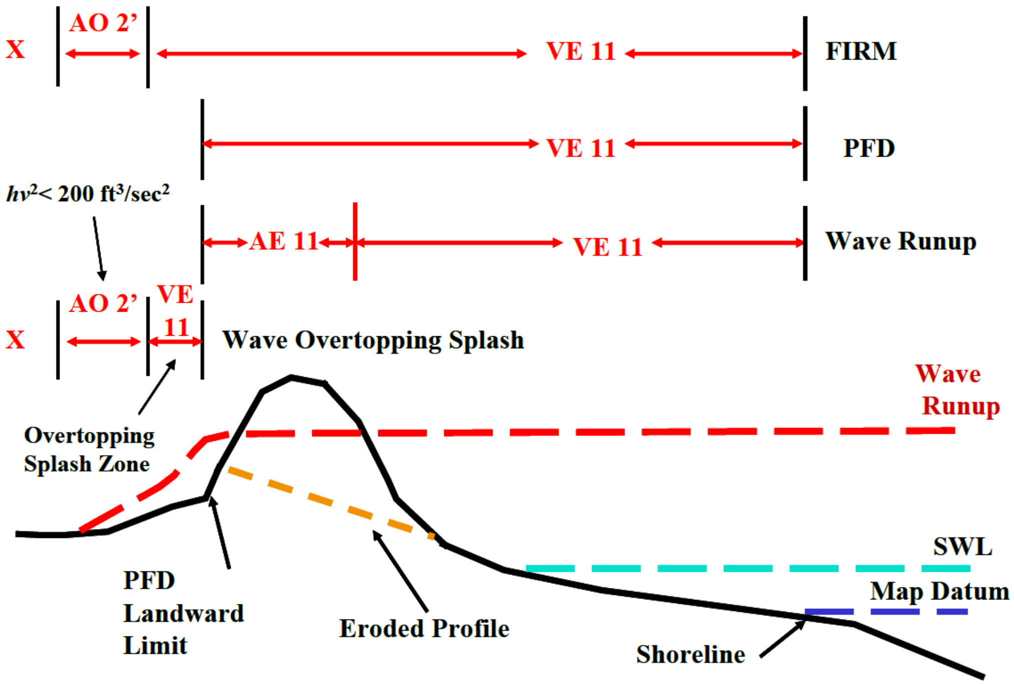
- ✓ Mitigation Moonshot
- Insurance Moonshot
- ✓ Improve the Customer Experience

RISK MANAGEMENT DIRECTORATE

- ✓ Improve Flood Risk Data
- ✓ Risk Rating 2.0
- Products Address Future Conditions or Structure Level Risk
- ✓ Transform Risk Communications

Shifting to Hazard-Based Risk Identification

Opportunity Summary: The coastal program uses non-hazard based risk identification where the present methodology did not fully capture the risk (e.g. PFDs, 30 ft splash zones)



Strategic Alignment:

FIMA-WIDE

- Mitigation Moonshot
- Insurance Moonshot
- ✓ Improve the Customer Experience

RISK MANAGEMENT DIRECTORATE

- ✓ Improve Flood Risk Data
- ✓ Risk Rating 2.0
- Products Address Future Conditions or Structure Level Risk
- ✓ Transform Risk Communications

Open Discussion

- **Larry Voice, FEMA RVI Engineer**
  - Larry.Voice@fema.dhs.gov

- **Lauren Schmied, FEMA HQ Coastal Engineer**
  - Lauren.Schmied@fema.dhs.gov