Coastal Inundation Products: Applications and Limitations

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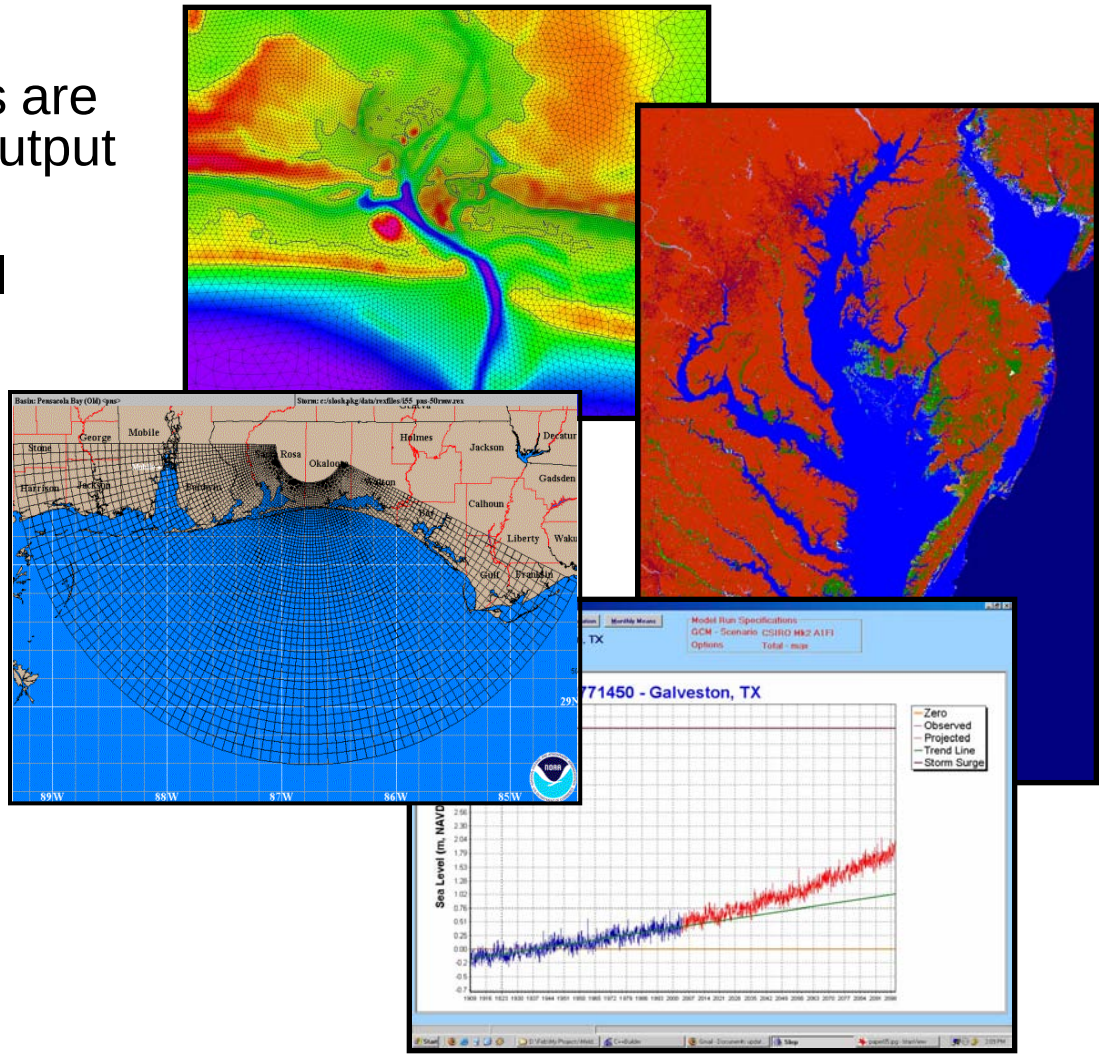
LINKING PEOPLE, INFORMATION, AND TECHNOLOGY

Coastal Inundation Models

- Most inundation products are the result of a modeled output
- Types of physical coastal models:
  - Storm surge
  - Circulation
  - Wave height
  - Wave run-up
  - Wave set-up
- Operational versus hypothetical modeling



Coastal Inundation Products

Risk-Based: Depict results of probabilistic modeling

Example: Flood Insurance Rate Maps

Event-Based: Depict observed flooding, other impacts

Example: Post-hurricane recovery maps

Scenario-Based: Depict output from predictive models

Examples: Storm surge zones

What about future conditions?

Coastal Inundation Products

Risk-Based Inundation Products

Maps that characterize an event that has a specific probability of occurring over a specific time frame

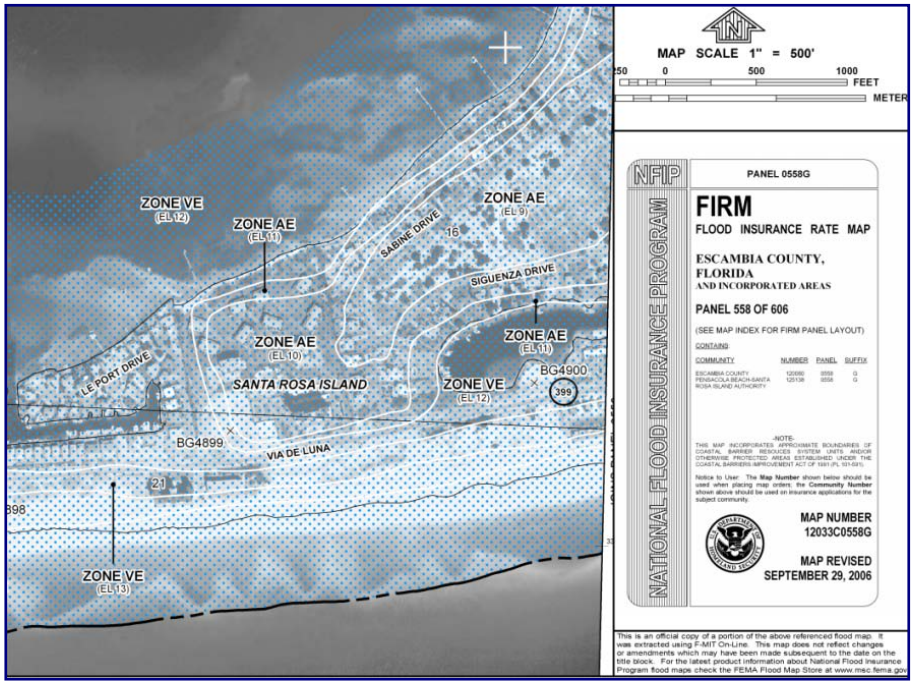
Risk-Based Products

Flood Insurance Rate Maps (FIRMs)

Maps created following a detailed flood insurance study (FIS) to illustrate flood risk.

- **Model Input:**
  - Riverine Flood Studies
  - Transition Zone
  - Coastal Flood Studies
- **Output:**
  - Base Flood Elevations
  - Flood Hazard Areas
  - Coastal Flood Hazard Areas

The 100 year flood:
A flood having a 1% chance of being reached in any single year



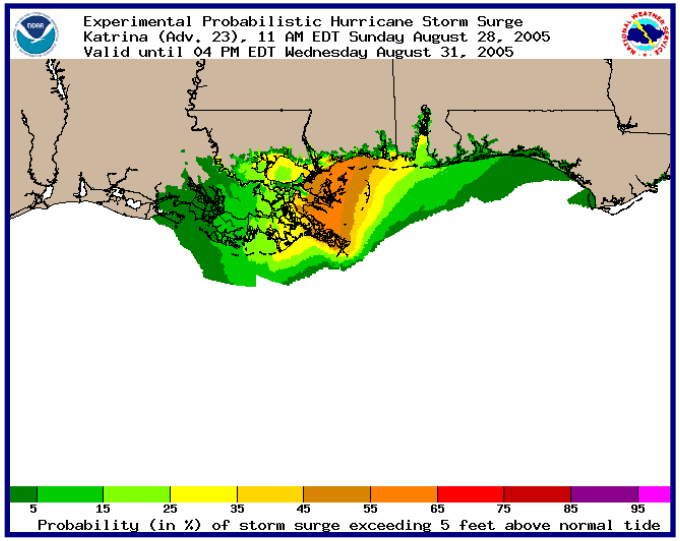
Example of a Flood Insurance Rate Map for a portion of Escambia County, Florida.

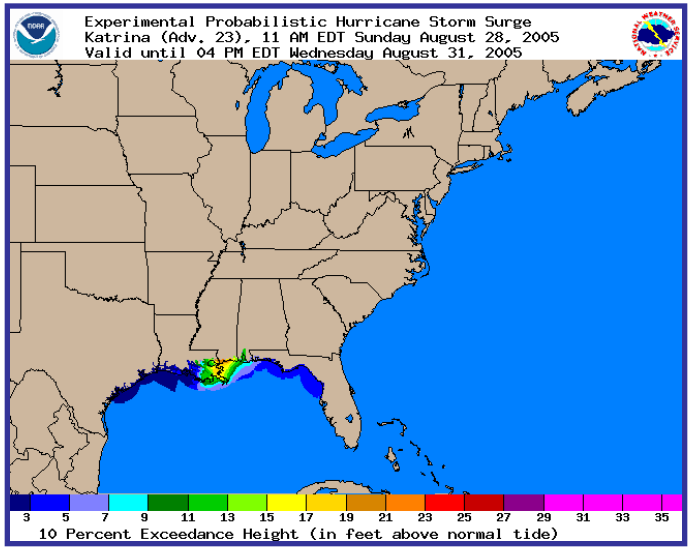
www.msc.fema.gov

Risk-Based Products

Probabilistic Hurricane Storm Surge Mapping

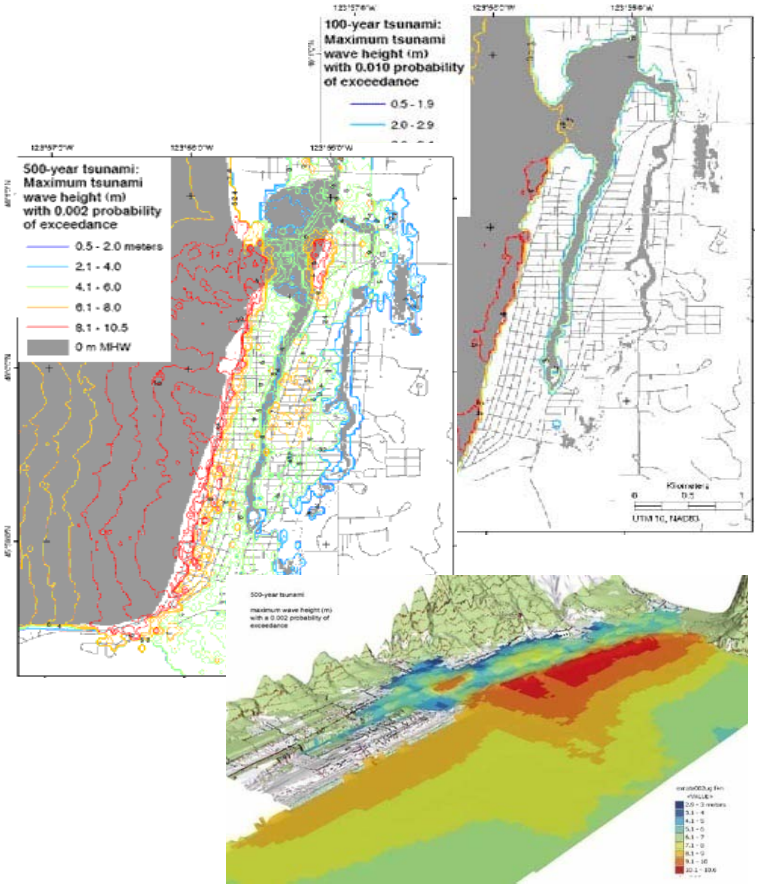
- **Model Input:**
  - Combination of SLOSH model runs based on current tropical activity
  - Historical error characteristics are taken into account
- **Output:**
  - Cumulative probabilities
  - Exceedance probabilities





www.weather.gov/mdl/psurge/

Risk-Based Products



FEMA/NOAA/USGS pilot project in Seaside, Oregon

Probabilistic Tsunami Inundation Modeling and Mapping

- **Model Inputs:**
  - Historic data from two major tsunamis
  - Method of Splitting Tsunami (MOST) model for simulating tsunamis
- **Output:**
  - 100-year and 500-year tsunami inundation zones

pubs.usgs.gov/ds/2006/236/index.shtml

Risk-Based Products

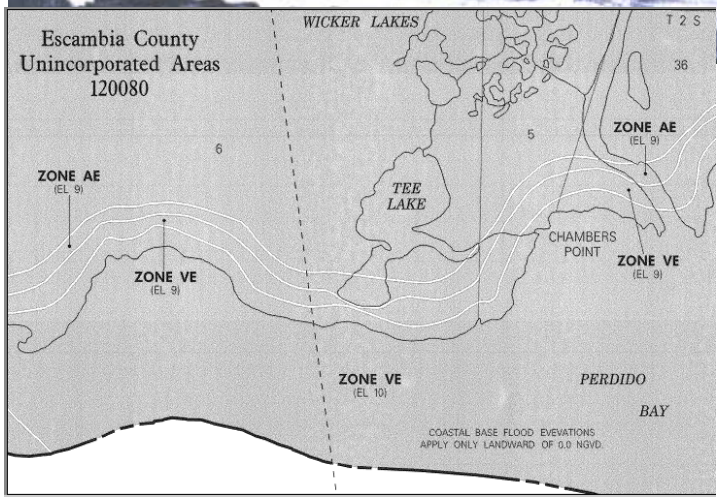
Applications and Limitations

Applications:

- Floodplain management
- Hazard mitigation planning
- Post-storm damage assessments
- Public outreach / education

Limitations:

- Lack of understanding of risk and what flooding is possible
- Updates to maps
- Period of recorded events
- Future conditions?



Coastal Hazard Zones: 100-year coastal floodplains that have additional hazards associated with storm surge

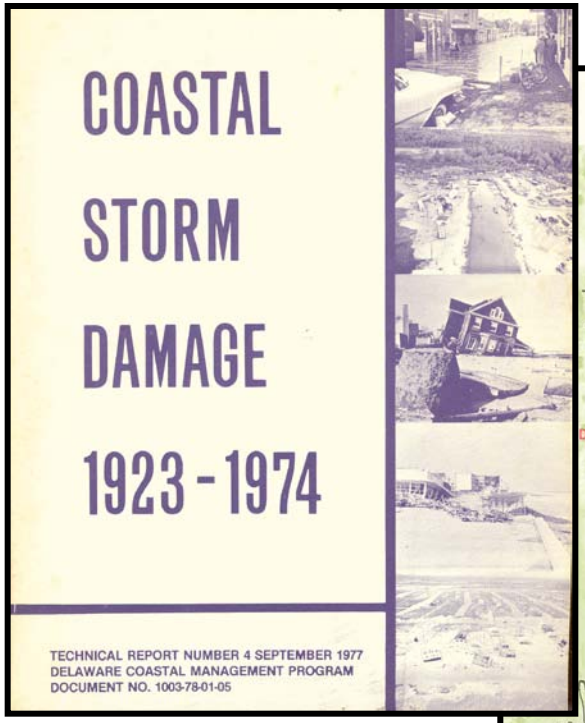
Coastal Inundation Products

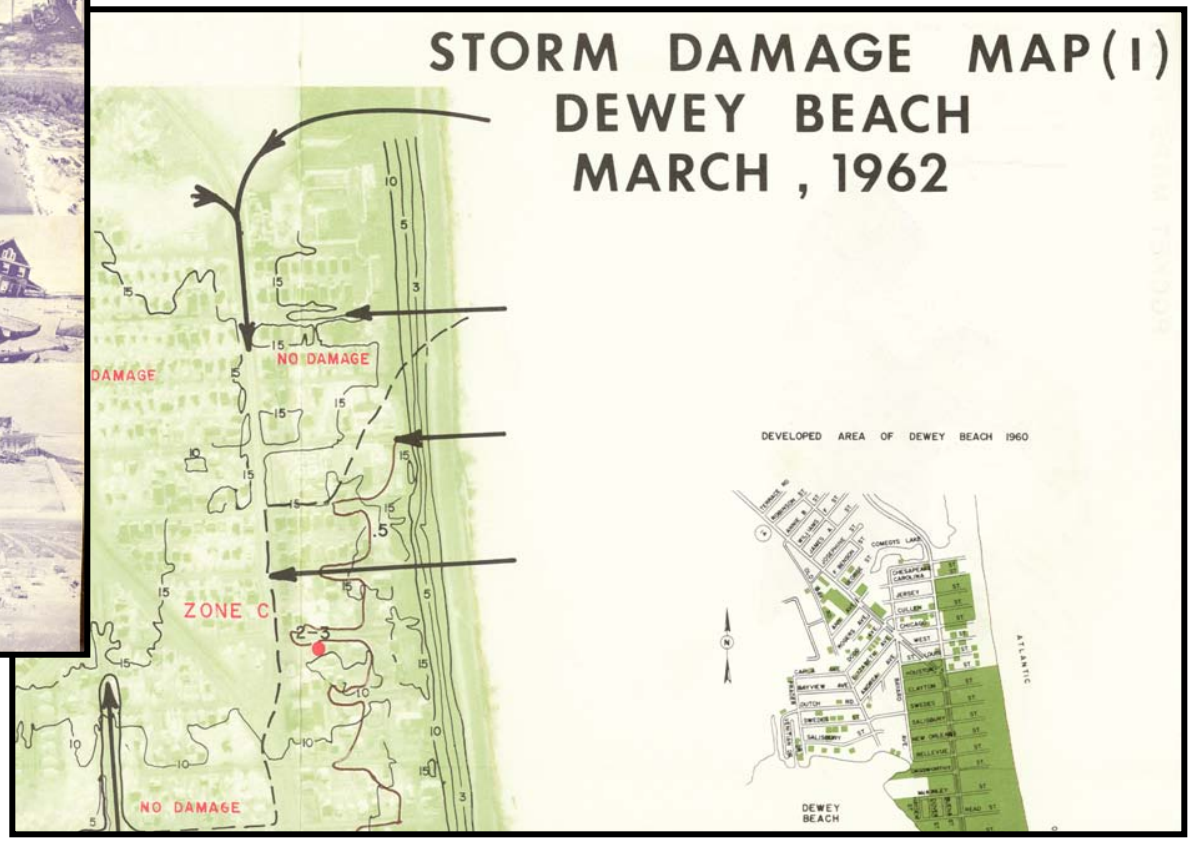
Event-Based Products

Maps that characterize an event that has already occurred

Event-Based Inundation Maps

Recovery mapping isn't all that new…





Delaware CZMP (1977)

Event-Based Products

FEMA Post-Hurricane Coastal Recovery Maps

- Identify the inland limits of surge inundation
- Identify the Advisory Base Flood Elevation (ABFE) inland limit
- Identify the inland limit of the V-zone and coastal A-zone

www.fema.gov/hazard/flood/recoverydata/

Event-Based Products

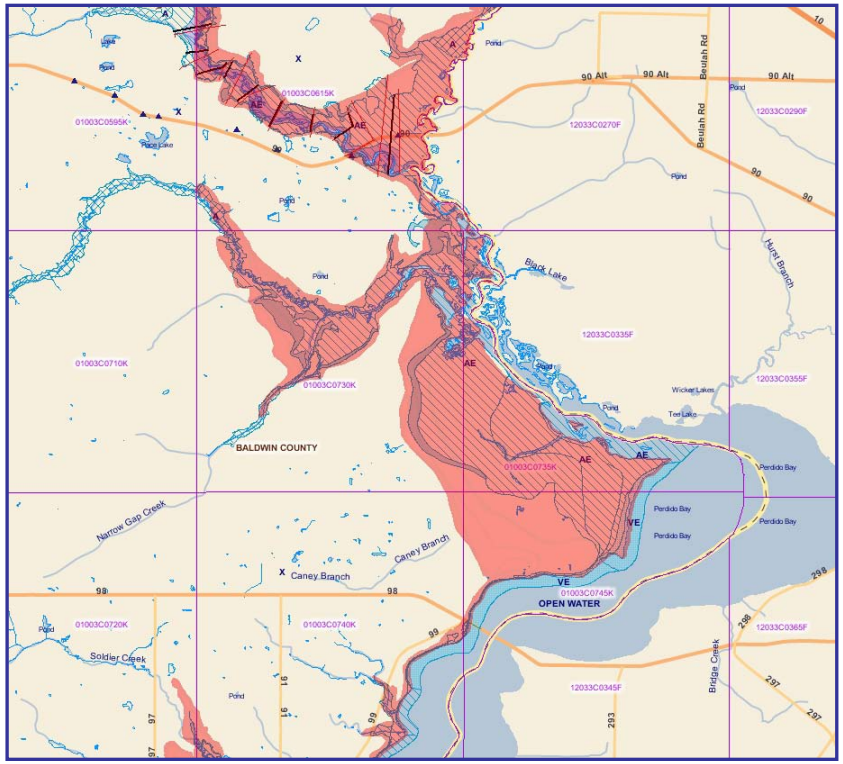
Applications and Limitations

Applications:

- Document a storm's impact
- Post-disaster recovery
- Update hazard mitigation plans
- Public Awareness

Limitations:

- Accelerated timeline
- Accuracy of data
- False sense of security



An overlay of the inundation limits from Hurricane Ivan (shown in red) and FEMA FIRM flood boundaries (blue hatched boundaries)

Coastal Inundation Products

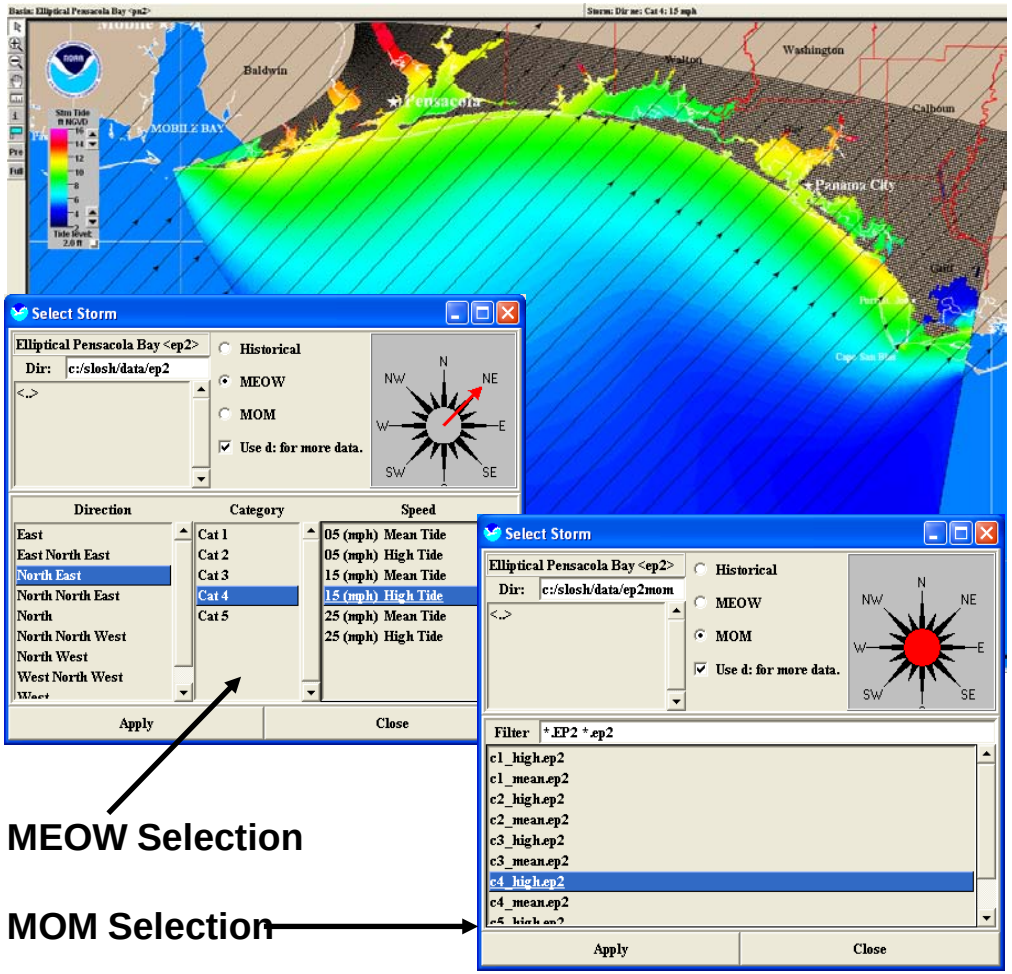
Scenario-Based Products

Models and maps that characterize a hypothetical event or composite of events

Scenario-Based Products

SLOSH: Sea, Lake, and Overland Surges from Hurricanes

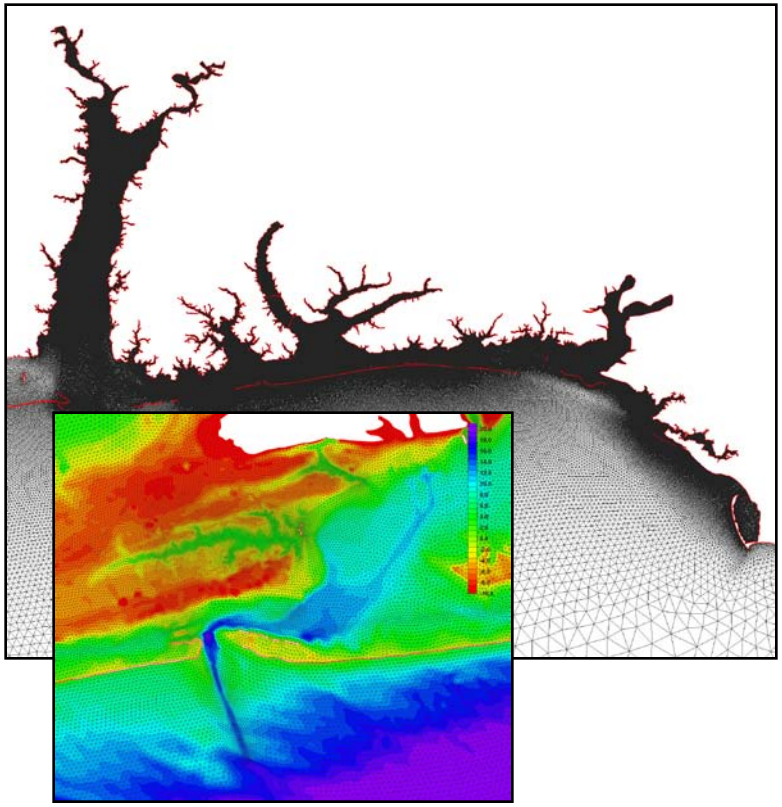
- Maximum Envelope of Water (MEOW):
  - Maximum surge heights for a given hypothetical event
- The Maximum of the MEOWs (MOM):
  - Maximum surge height for all hurricanes of a given category



Scenario-Based Products

ADCIRC: Advanced Circulation Model

- Hydrodynamic model used to calculate the motion of water
- Widely used to compute water surface elevation fluctuations at a high resolution
  - Driven by astronomic tides and winds (including tropical cyclones)
- Uses unstructured grids
  - Represent complex coastal shoreline features with element size less than 100m
  - Balance computational cost by reducing resolution where interest is lower and dynamics allow

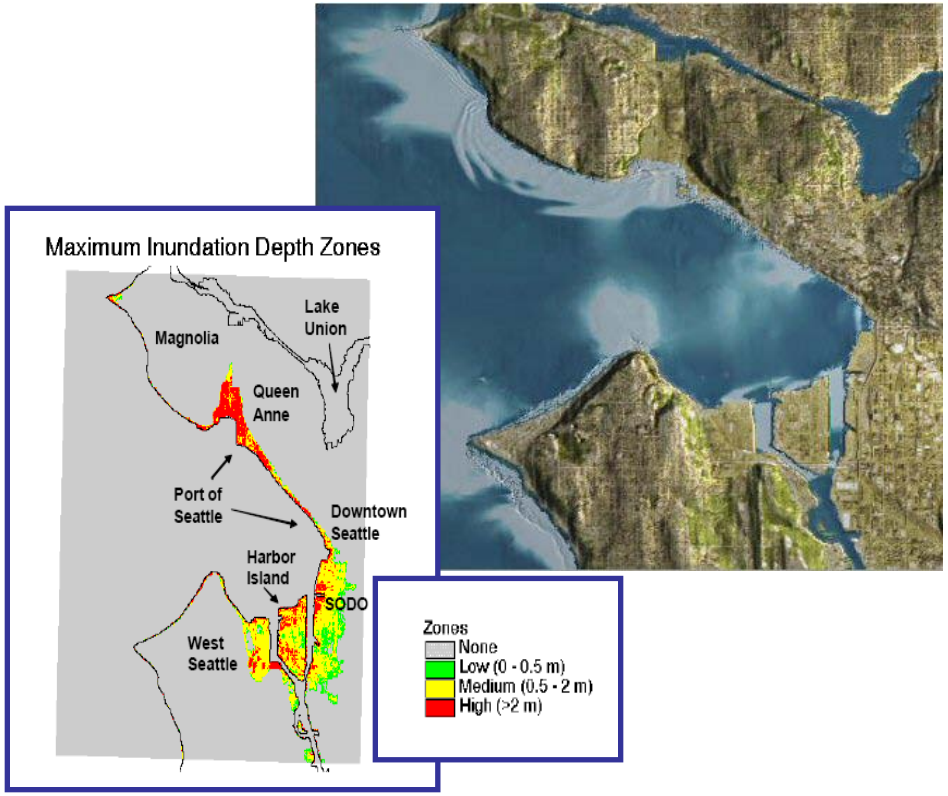


ADCIRC grid of Florida Panhandle and entrance to Pensacola Bay. Source: created by NOAA Office of Coast Survey Development Laboratory

Scenario-Based Products

Method of Splitting Tsunami (MOST) Model

- A suite of numerical simulation codes for tsunami development
- Operationally, model utilizes pre-computed tsunami scenarios
- Output combine with topo/bathy data to derive inundation maps for planning



Inundation model for Elliot Bay in Seattle based on a magnitude 7.3 earthquake on the Seattle Fault. Source: Washington State Hazard Mitigation Plan; NOAA Center for Tsunami Research

Scenario-Based Products

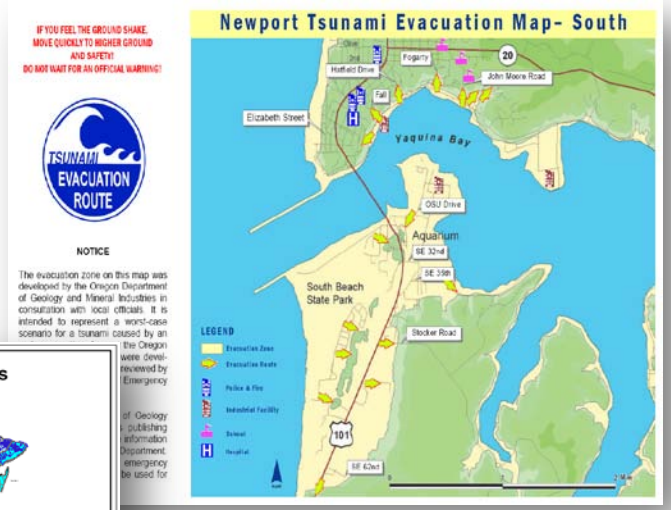
Applications and Limitations

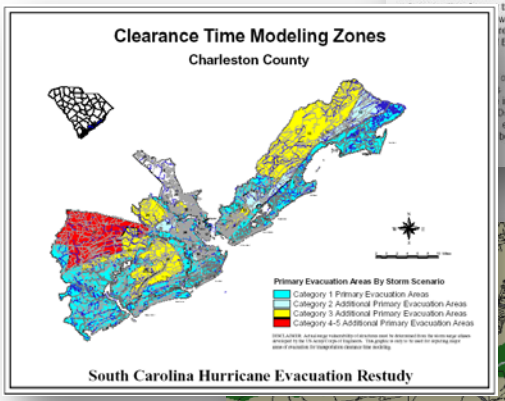
Applications:

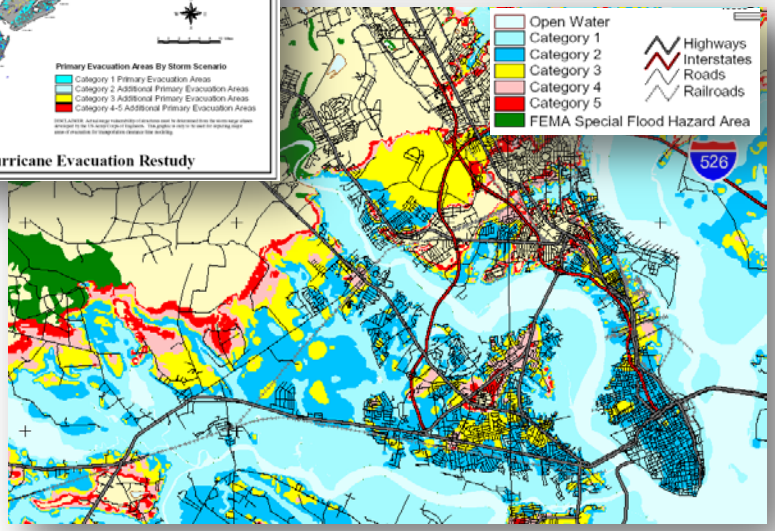
- Operational forecasting
- Hypothetical scenario tool
- Mitigation and evacuation planning

Limitations:

- Resolution/Model sensitivity
- Computational resources
- Currentness of topographic and bathymetric data data

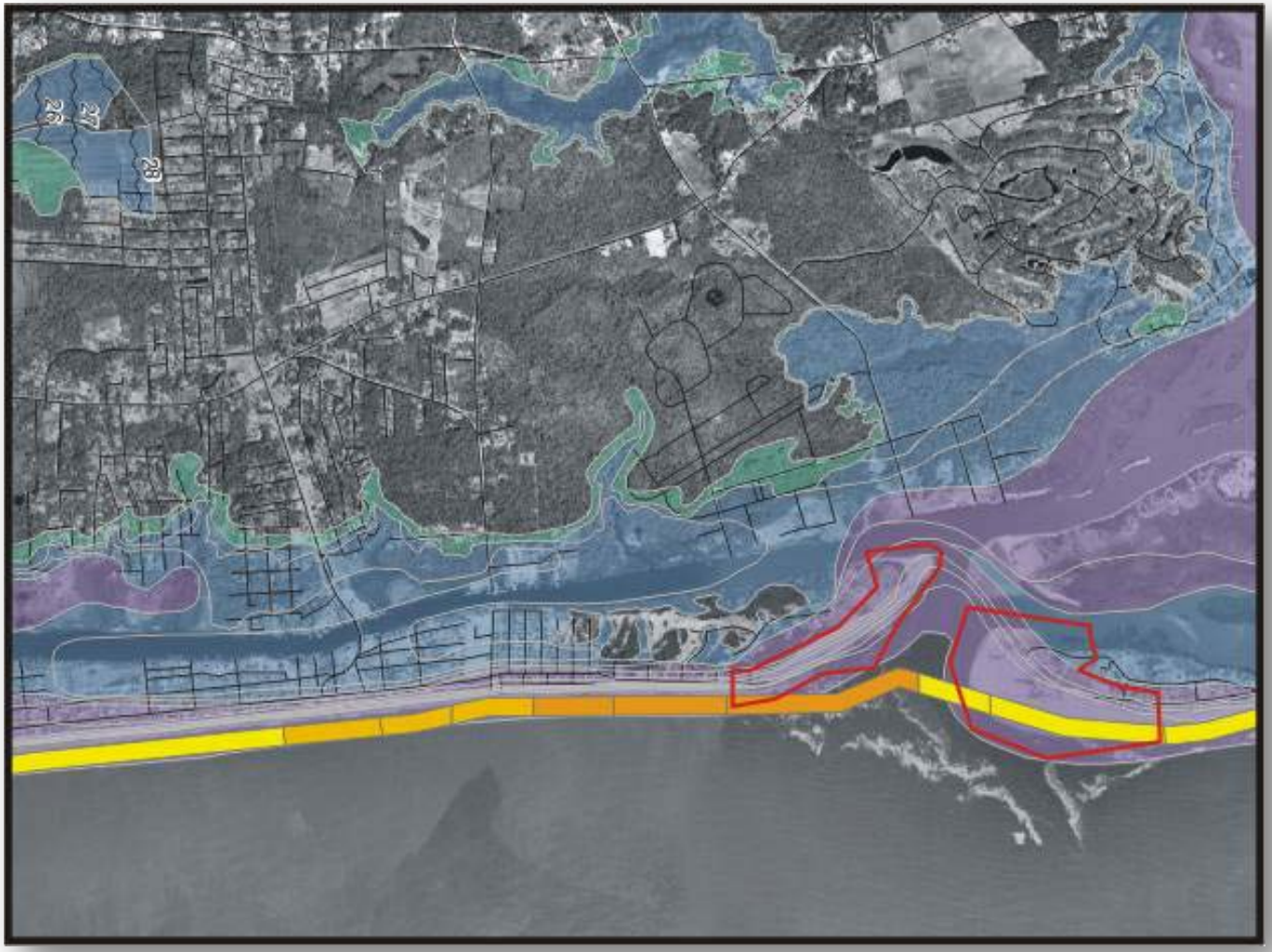






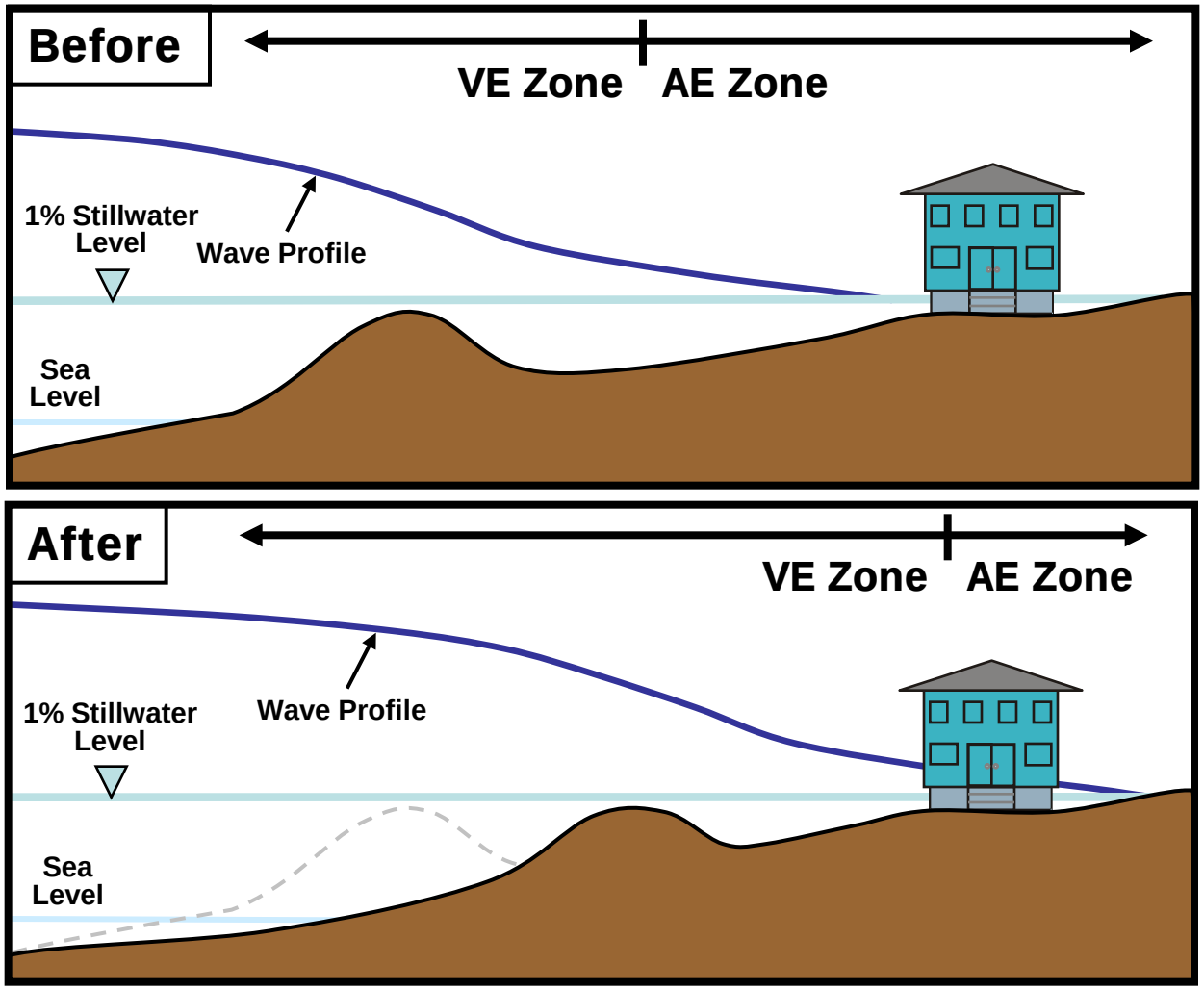
Combined Map Products

- View multiple inundation products as overlays (DFIRMs and Surge Zones)
- Incorporate future conditions (shoreline change, chronic erosion zones)



Future Conditions

- Shoreline change has an effect on validity of all coastal inundation map products
- Move the shoreline . . . flood hazards change
- Products need to take into account future conditions based on erosion rates, sea level rise



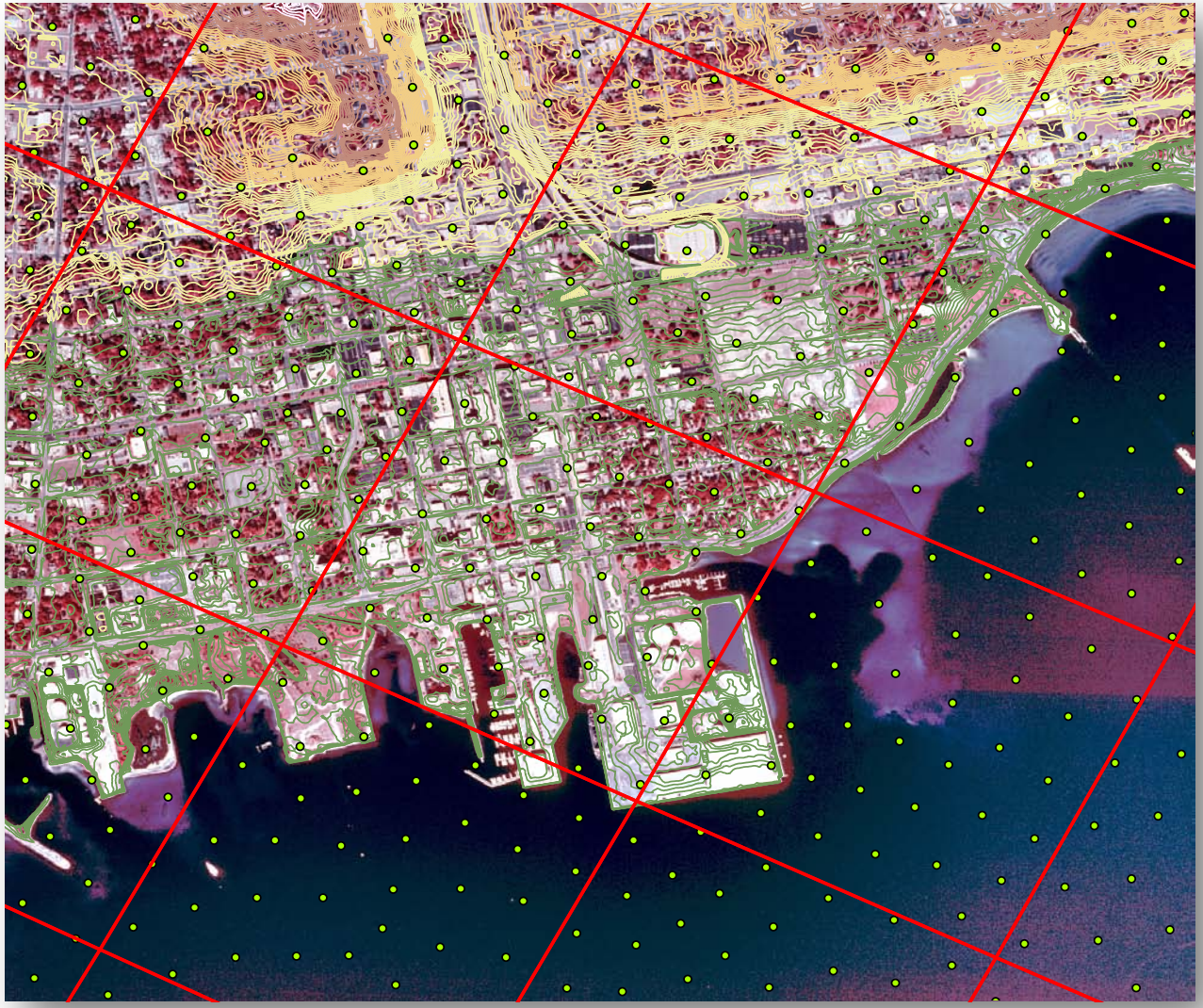
Parcel / Street Level Maps for Pensacola

>1 km SLOSH grid

>100m ADCIRC grid

1 foot contours – Escambia County

We can map the inundation to this detail, but should we?



Summary and Food for Thought

- Different products have different applications and every product has limitations
- Migrating products to GIS enables overlays and comparisons for multiple-objective management
- Easy to use wrong product for wrong application if both are digital (GIS)
- Mapping future conditions is necessary
- Resolution of models and elevation data are crucial elements to the validity of the final inundation map products

Questions?