



HAZUS 2014

7th Annual Conference

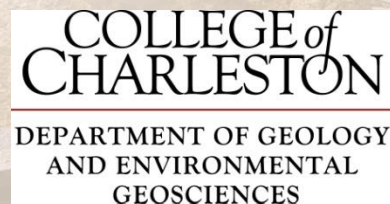
HAZUS Comparison of Storm Surge Levels from Different Hurricanes to the Newest SLOSH Models for Berkeley, Charleston, & Dorchester Counties Along the SC Coastline.

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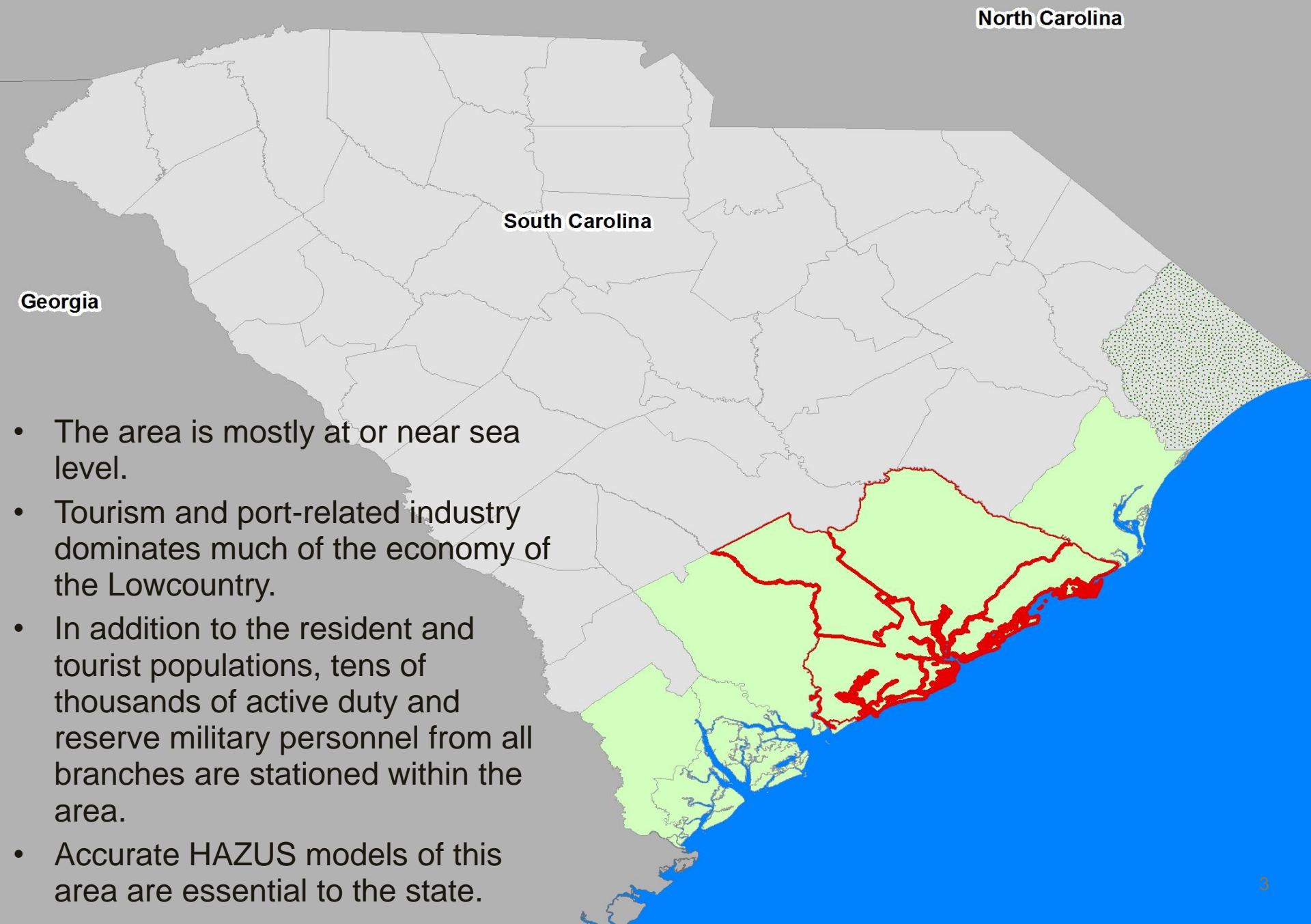
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Background

- In 2011 South Carolina completed a new Hurricane Evacuation Study (HES) of all the coastal counties in the state.
- The HES looked at multiple factors regarding hurricane evacuations including population, infrastructure networks, vulnerable areas, evacuation timing, and storm surge impacts.
- Charleston, Berkeley, and Dorchester counties are in what is called the “central conglomerate” of the SC coastline.
 - These counties are also in the heart of what the locals call “The Lowcountry”.



North Carolina

South Carolina

Georgia

- The area is mostly at or near sea level.
- Tourism and port-related industry dominates much of the economy of the Lowcountry.
- In addition to the resident and tourist populations, tens of thousands of active duty and reserve military personnel from all branches are stationed within the area.
- Accurate HAZUS models of this area are essential to the state.

Background

- A main part of the HES is the new NOAA Sea, Lake and Overland Surges from Hurricanes (SLOSH) model.
 - GIS mapping of storm surge inundation was completed by the Baltimore District US Army Corps of Engineers (USACE).
- Storm surge inundation maps produced for the HES are based on the high tide Maximum of Maximum (MOM) output for the SC coastline.

SLOSH - MOMs

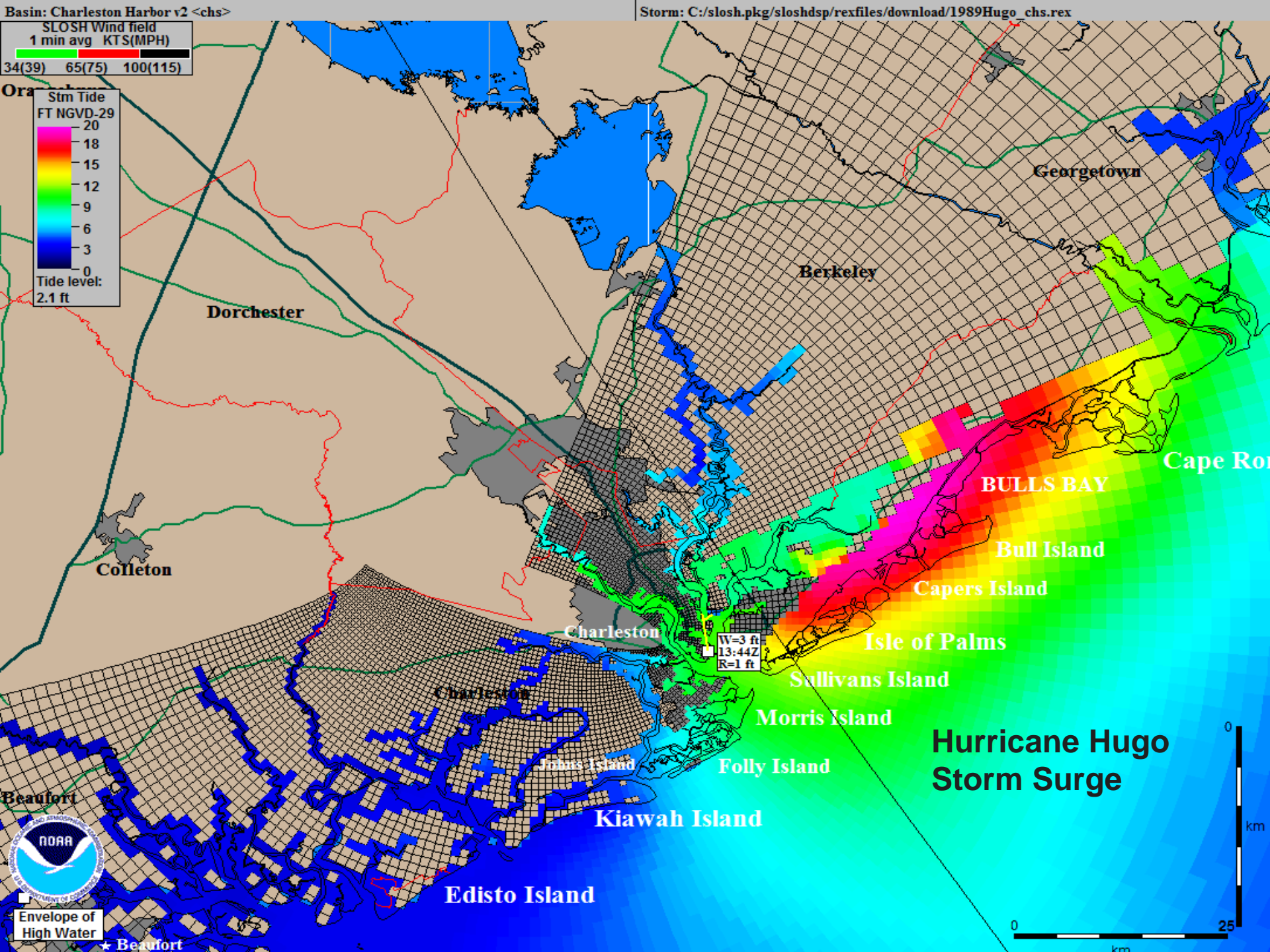
- SLOSH – MOM datasets do not show the impacts of a single storm, but a combination of 1,000s of different types of hurricanes at different speeds, strengths, tracks, and tide levels.
- These outputs create a “worst case scenario” of potential impacts and evacuation planning.
- The results of these models on the SC coastline have storm surge inundation reaching as far as 30 – 40 miles inland.

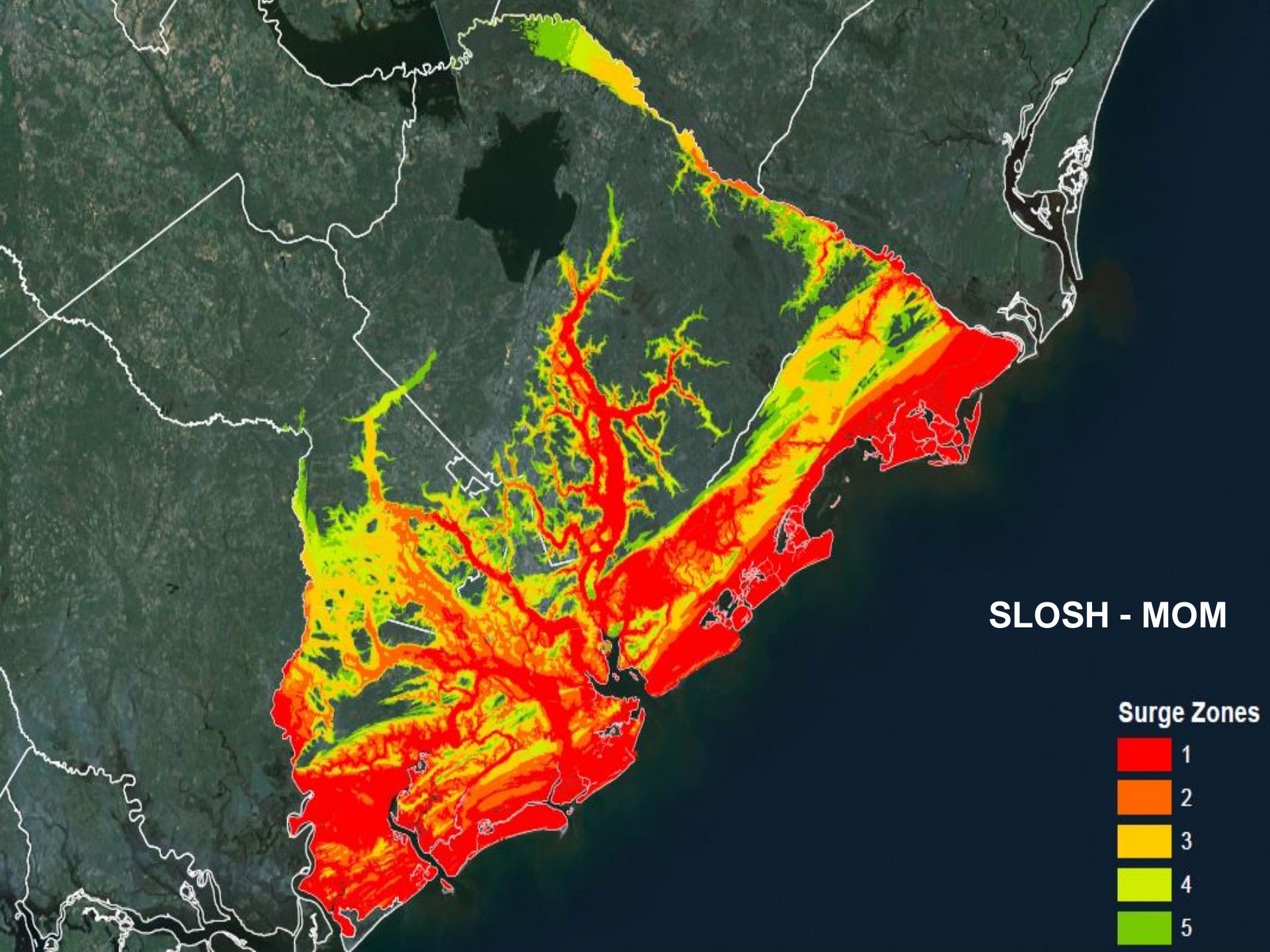
Basin: Charleston Harbor v2 <chs>

Storm: C:/slosh.pkg/sloshdsp/rexfiles/download/1989Hugo_chs.rex

SLOSH Wind field
1 min avg KTS(MPH)
34(39) 65(75) 100(115)

Or
Stm Tide
FT NGVD-29
20
18
15
12
9
6
3
0
Tide level:
2.1 ft





SLOSH - MOM

Surge Zones

- 1
- 2
- 3
- 4
- 5

Study

- Dorchester County Emergency Management together with the College of Charleston's Lowcountry Hazard Center performed a series of HAZUS hurricane storm surge models.
- The objective was to see if HAZUS' storm surge model for a specific storm could mirror the inundation estimated by the SLOSH – MOM.
 - The two models were compared to determine the variability from product to product.

Study

- This study looks at three storms of varying strengths and landfall locations.
- Hurricane Hugo making landfall south of his original location.
- Hurricane Sandy had she made landfall in the Charleston region.
- The Governor's Table Top Storm (GTTS) nicknamed "Dean" that was used in the 2013 statewide hurricane exercise.

Scenario

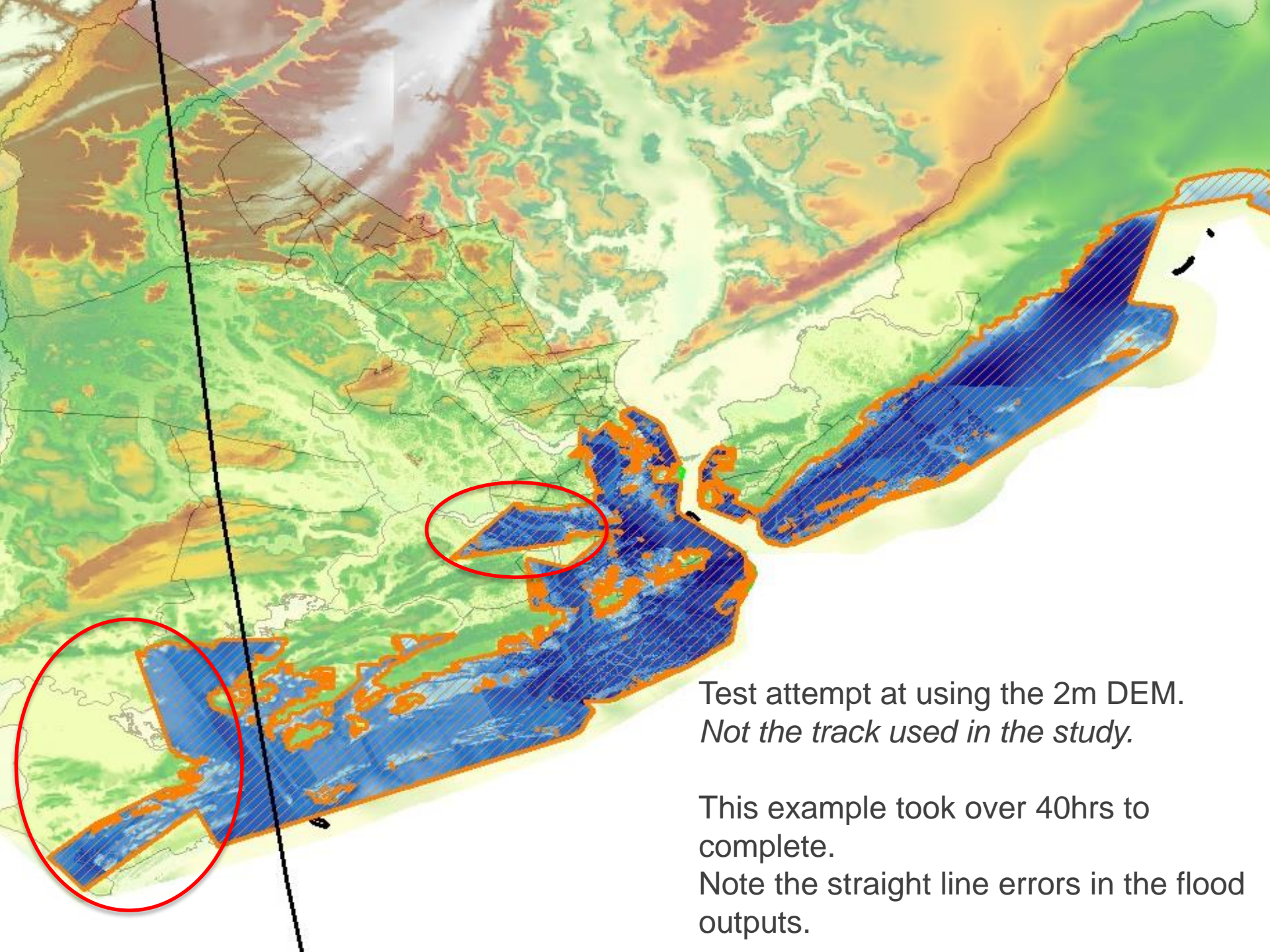
- The College of Charleston has been working on collecting high resolution DEMs of the SC coastline from several LiDAR sources and combining them into one master file.
 - The DEM for the basins needed for the flood module was clipped from this file.
- The study region was set for the tract level, with the storm surge model set for no-waves with a 6' tidal range.
- The entire Charleston County coastline / Barrier Island system was selected for the shoreline reach.

Scenario

- Unfortunately, the size of the DEM at 2m spacing was just over 60G in size. HAZUS either crashed repeatedly while calculating the surge or produced faulty straight line outputs.
- Using the 2m DEM to try to inundate 3 counties, actually filled up the C:// drive of the College's GIS computers; causing Windows to shut down and the model to crash.
- Once the HAZUS study regions and data were pathed to alternate drives for the model to have enough space to run, we started to get the faulty outputs.

Scenario

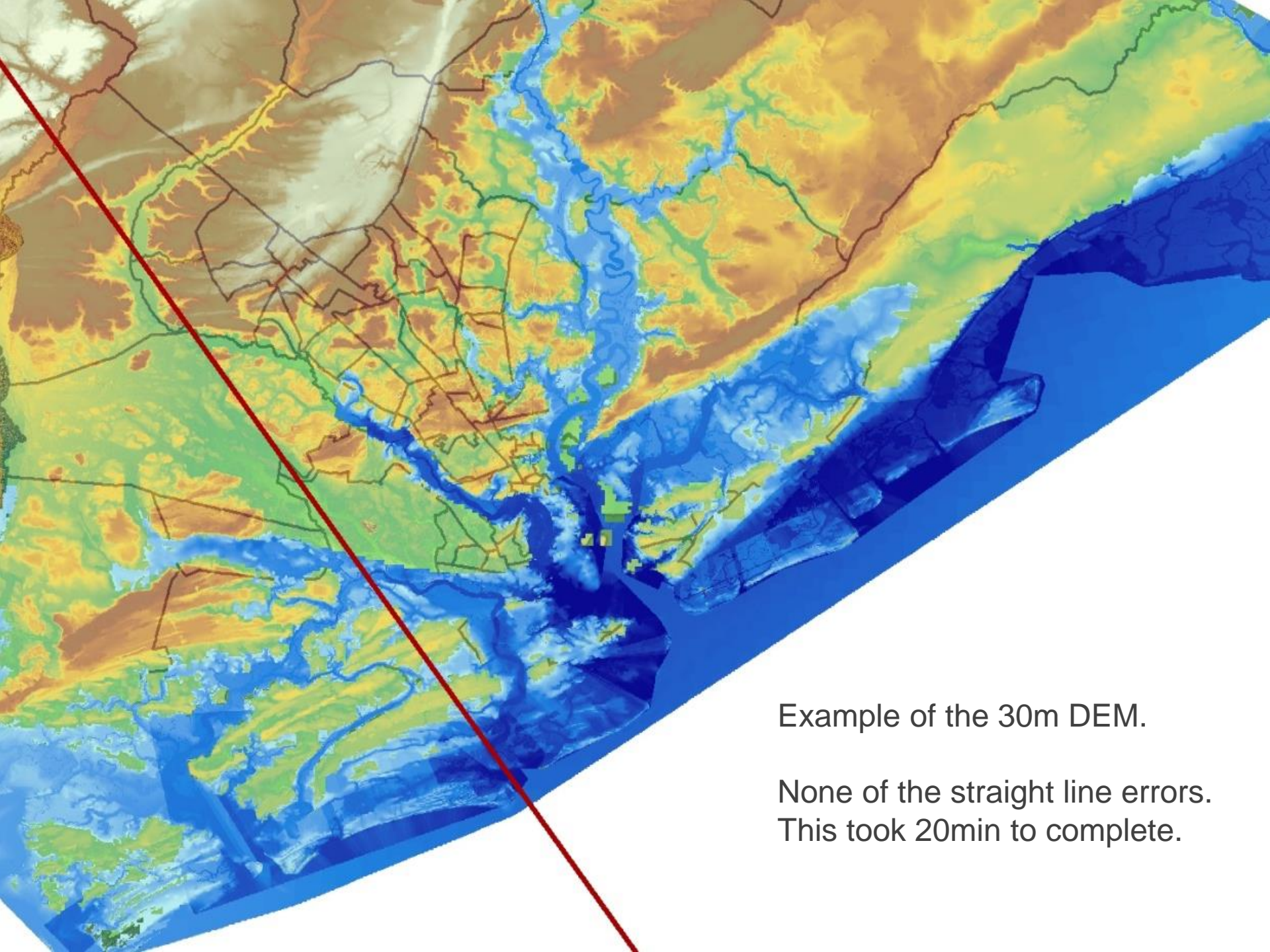
- If the computer did not crash, the storm surge runs on the 2m dataset took about 41 – 59 hours to complete.
- A decision was made to use the prepackaged 30m DEM available from the USGS through the HAZUS portal download
 - Runs on this dataset only took 20mins to complete.



Test attempt at using the 2m DEM.
Not the track used in the study.

This example took over 40hrs to
complete.

Note the straight line errors in the flood
outputs.

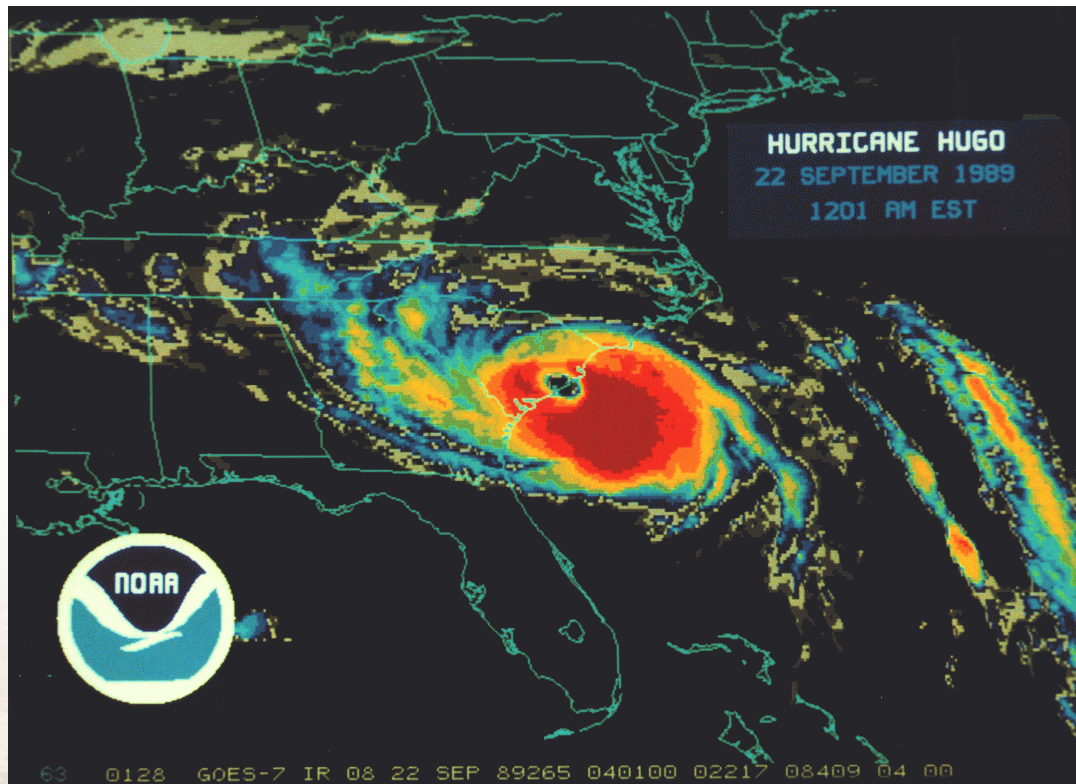


Example of the 30m DEM.

None of the straight line errors.
This took 20min to complete.

Hurricane Hugo

- Hugo made landfall September 1989 just north of Charleston, SC. The impacts could have been worse as the strongest part of the storm impacted a rural area along with the Francis Marion National Forest.

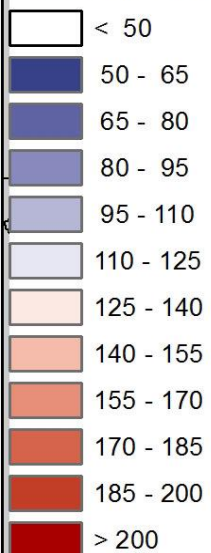


Potential Hugo Impacts

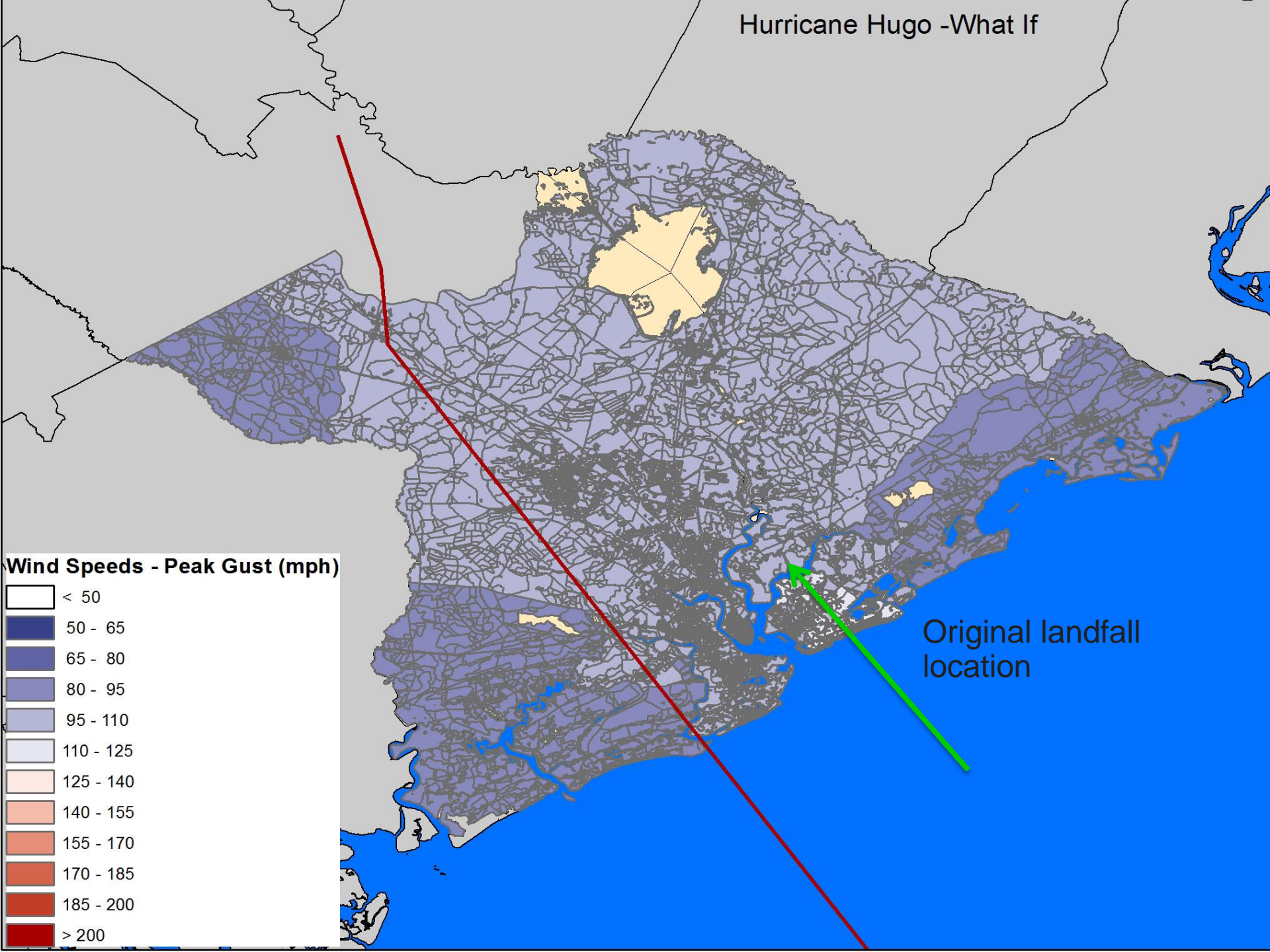
- Had Hurricane Hugo come ashore near Folly Beach, SC; the combined wind and surge impacts to Charleston, Berkeley, and Dorchester counties would be:
 - Maximum Peak Wind Speed Gust: 113 mph
 - 21,289 buildings would be at least moderately damaged.
 - 3,069 buildings completely destroyed.
 - 2,039,805 tons of debris would be generated.
 - Total economic loss of 4 billion dollars.
 - 40,973 people would seek temporary shelter.

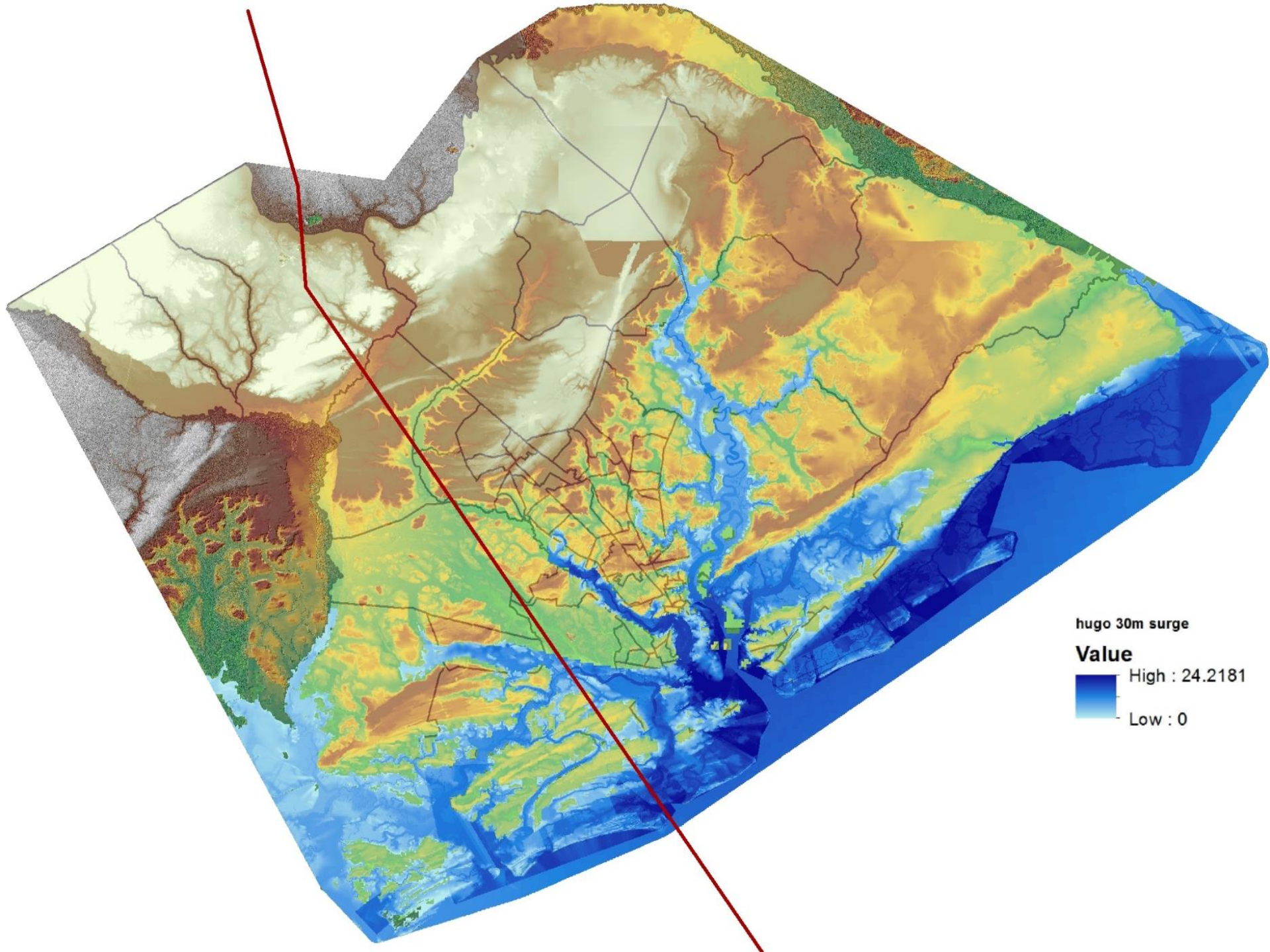
Hurricane Hugo -What If

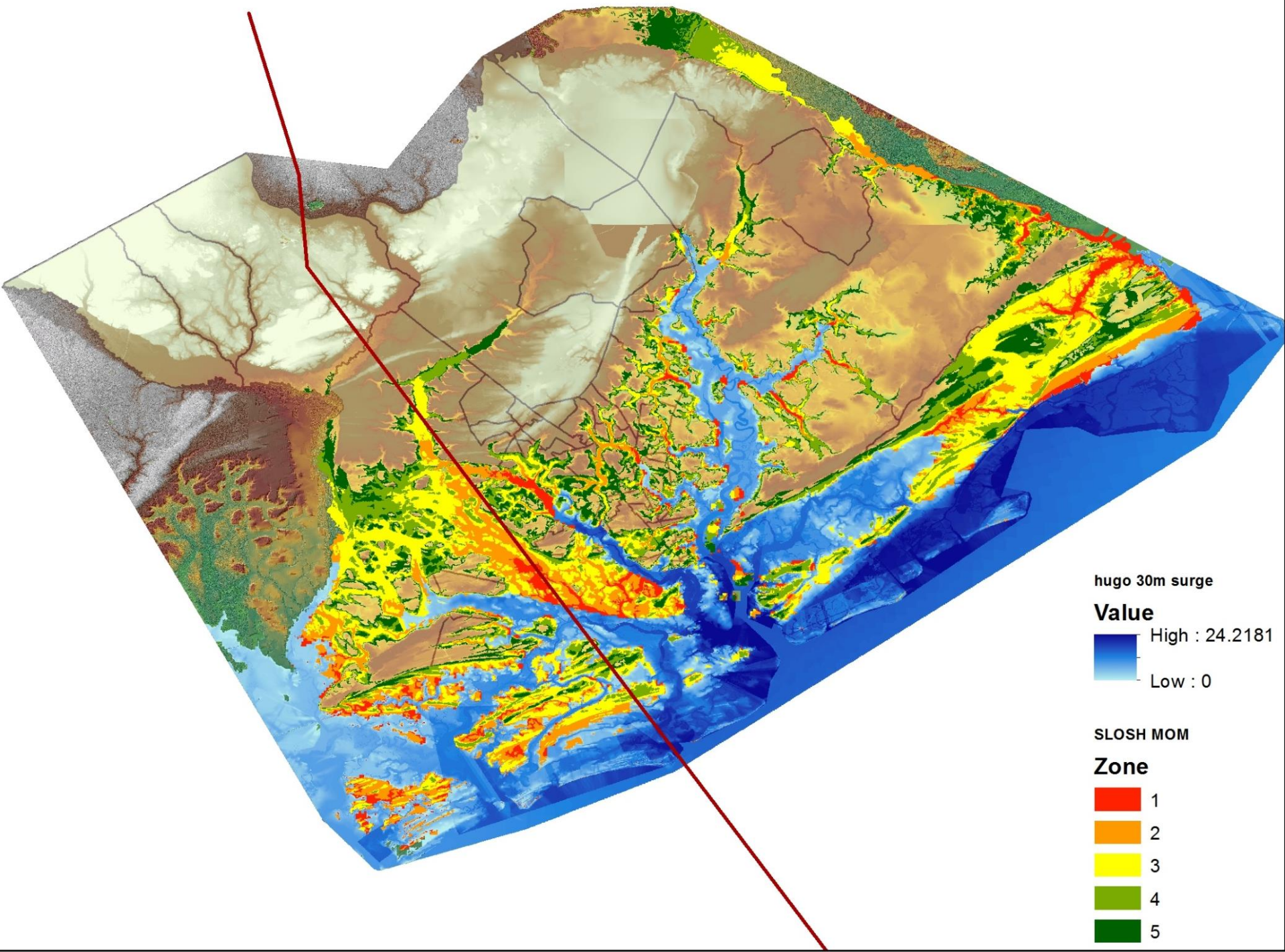
Wind Speeds - Peak Gust (mph)



Original landfall
location







hugo 30m surge

Value



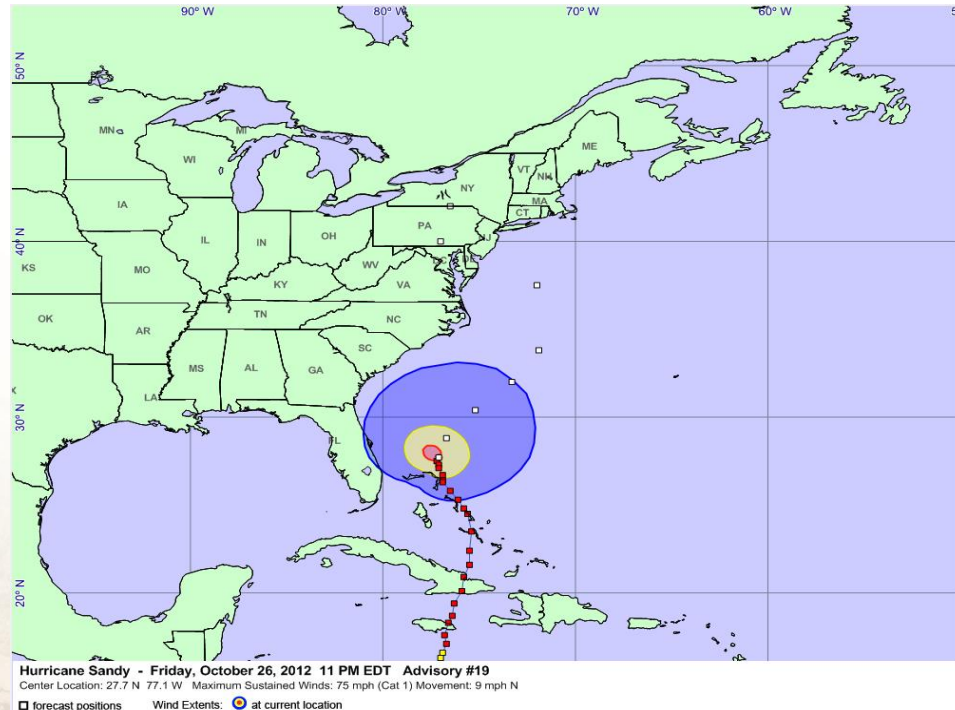
SLOSH MOM

Zone



Hurricane Sandy

- At one time Sandy had the potential to impact SC. The issues the northern states are continuing to deal with could have occurred in SC. The HURREVAC tool was used to provide storm data to HAZUS so the track could be manipulated into the Charleston area.

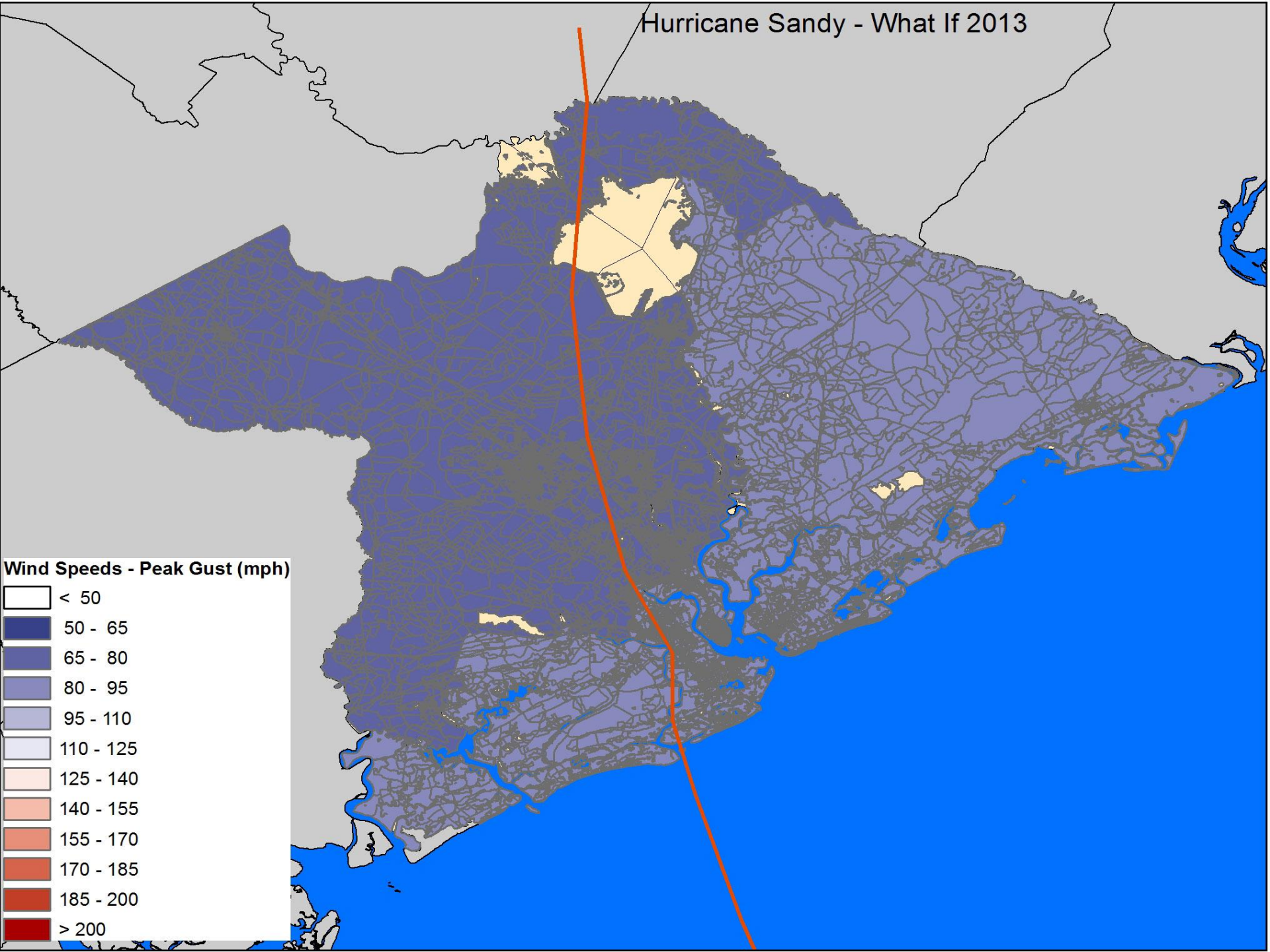
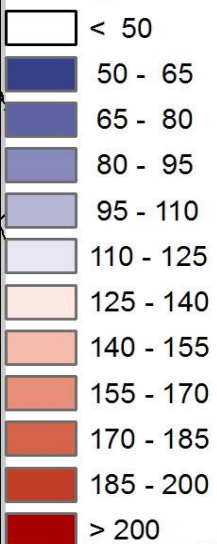


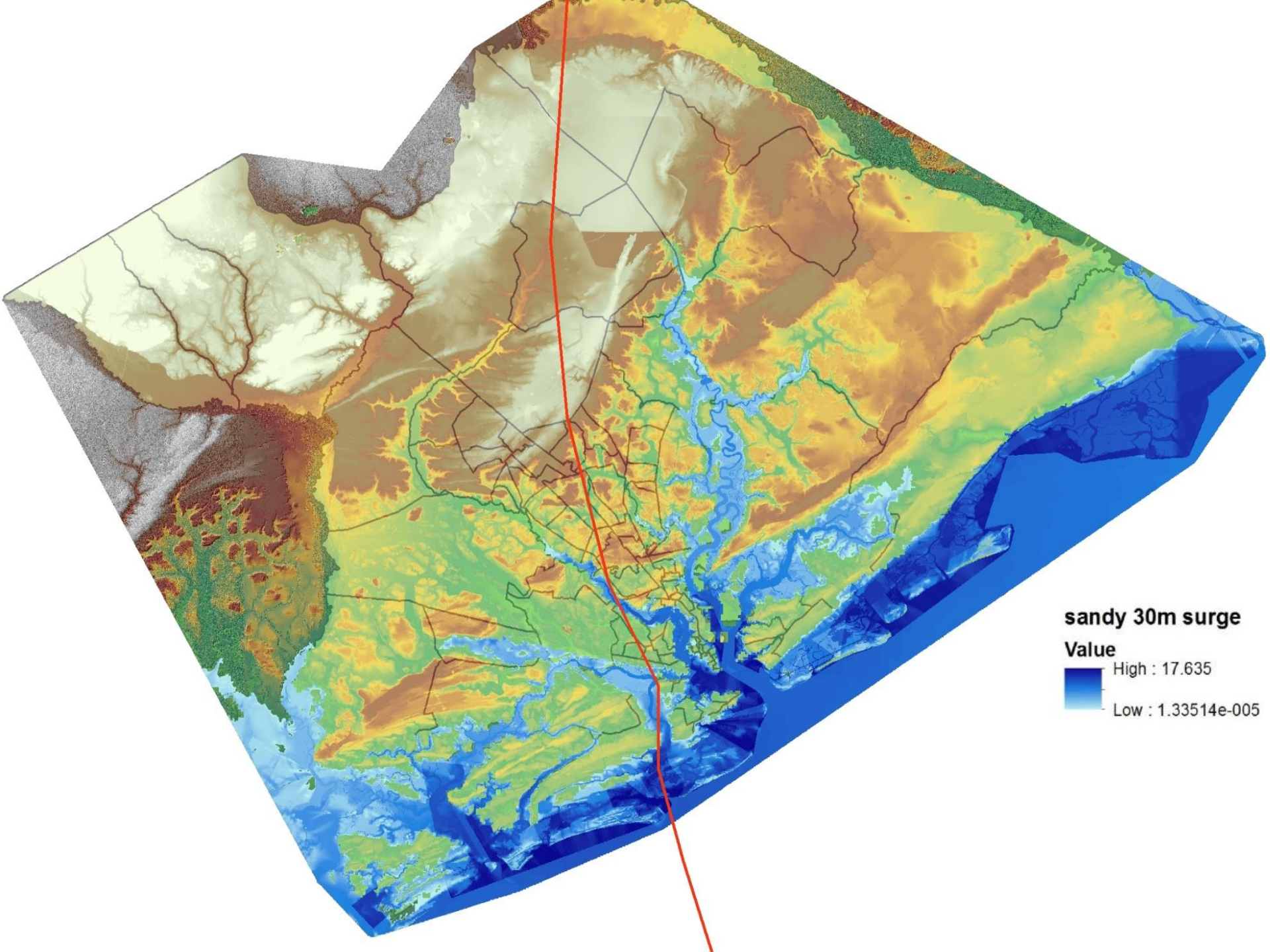
Potential Sandy Impacts

- Had Hurricane Sandy come ashore near Folly Beach, SC; the combined wind and surge impacts to Charleston, Berkeley, and Dorchester counties would be:
 - Maximum Peak Wind Speed Gust: 87 mph
 - 15,964 buildings would be at least moderately damaged.
 - 1,063 buildings completely destroyed.
 - 580,010 tons of debris would be generated.
 - Total economic loss of 3 billion dollars.
 - 52,936 people would seek temporary shelter.

Hurricane Sandy - What If 2013

Wind Speeds - Peak Gust (mph)

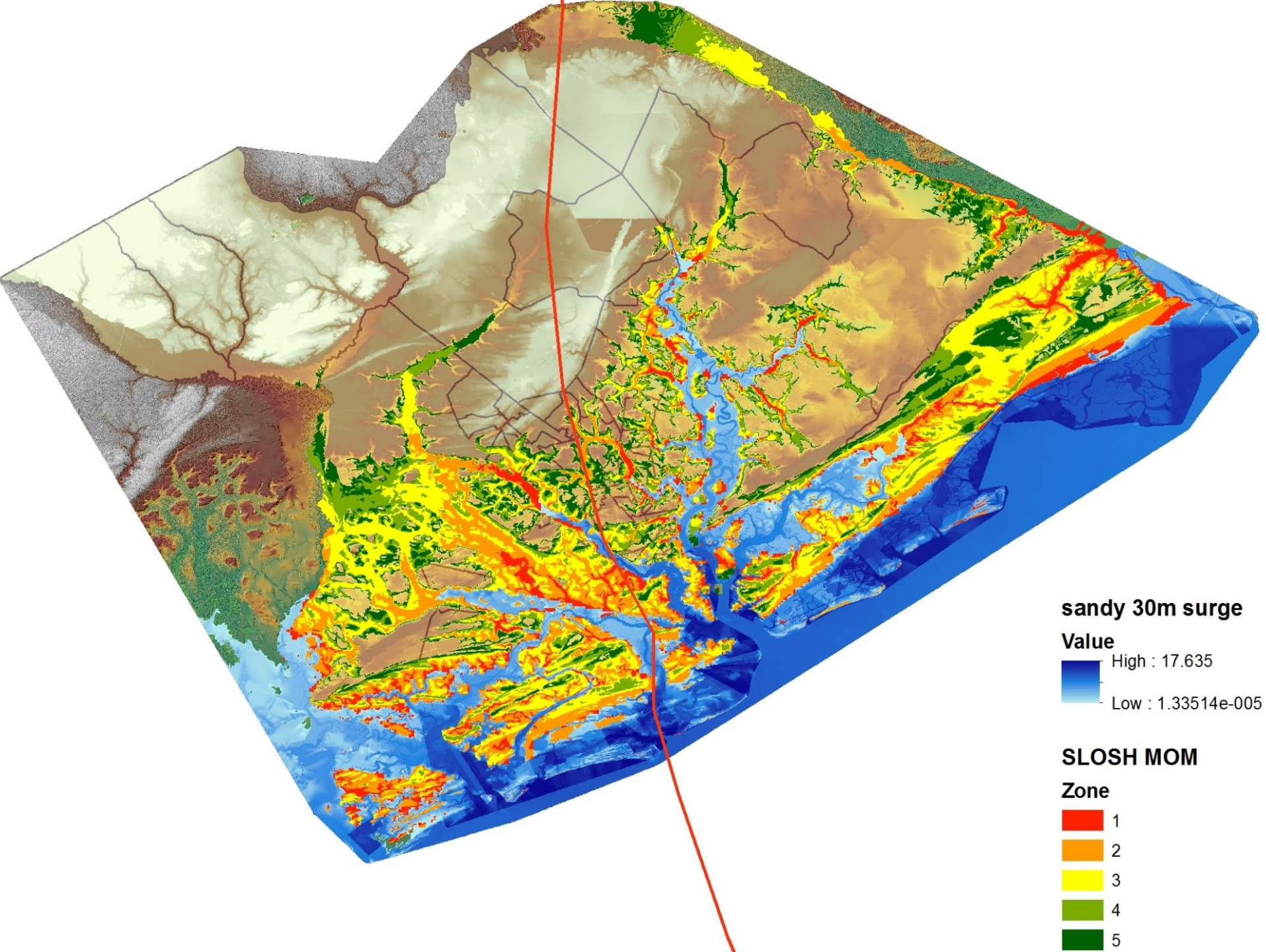




sandy 30m surge

Value

High : 17.635
Low : 1.33514e-005



GTTS Hurricane “Dean”

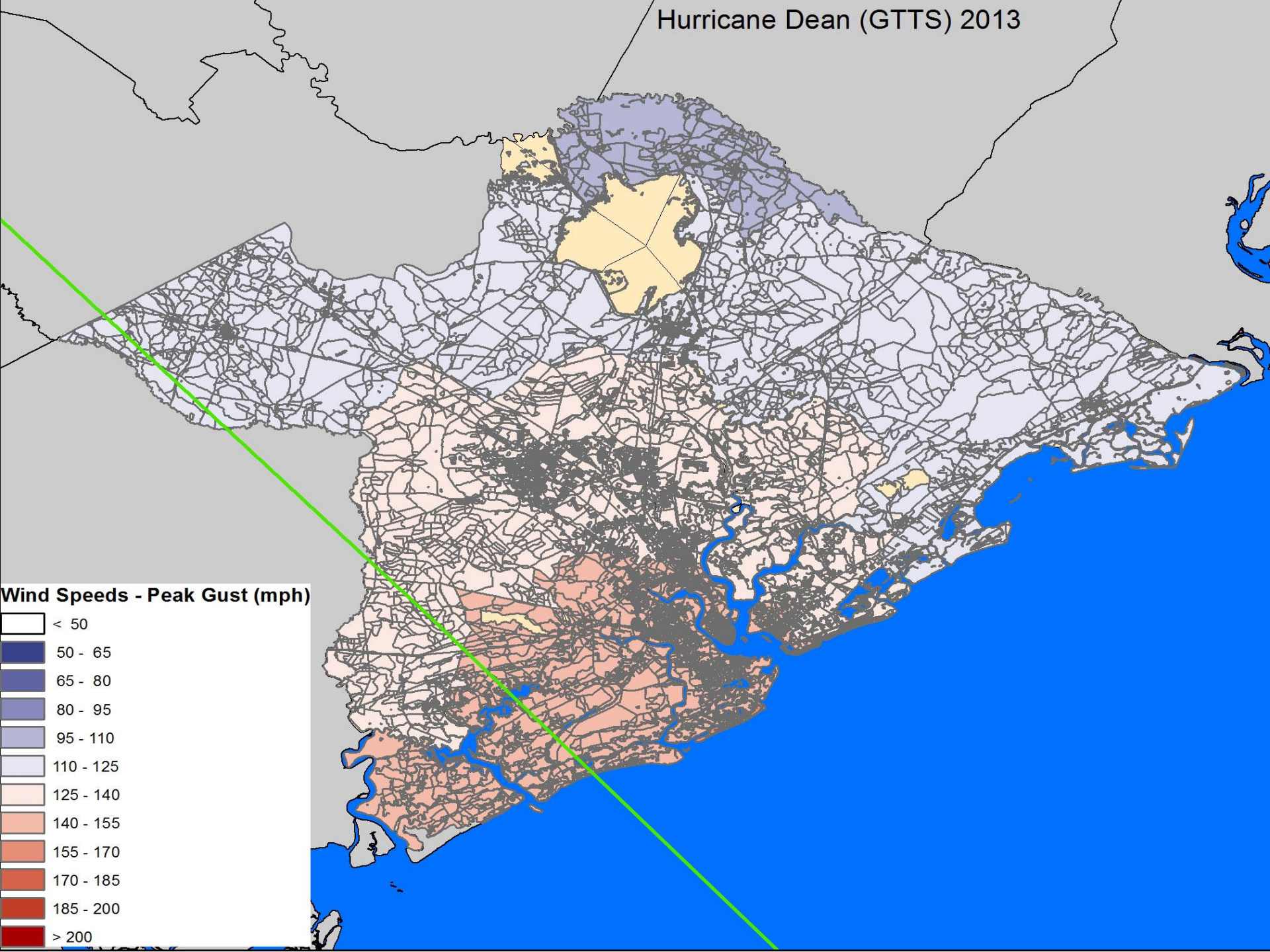
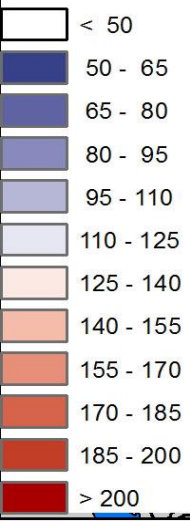
- Hurricane Dean was created by the SC Emergency Management Department for the 2013 Governors' Tabletop Statewide Hurricane Exercise.
- The storm was created in HAZUS and the outputs were sent to each participating county to use during the exercise.
- SC Emergency Management graciously gave Dorchester County the .hpr file to use in this study.

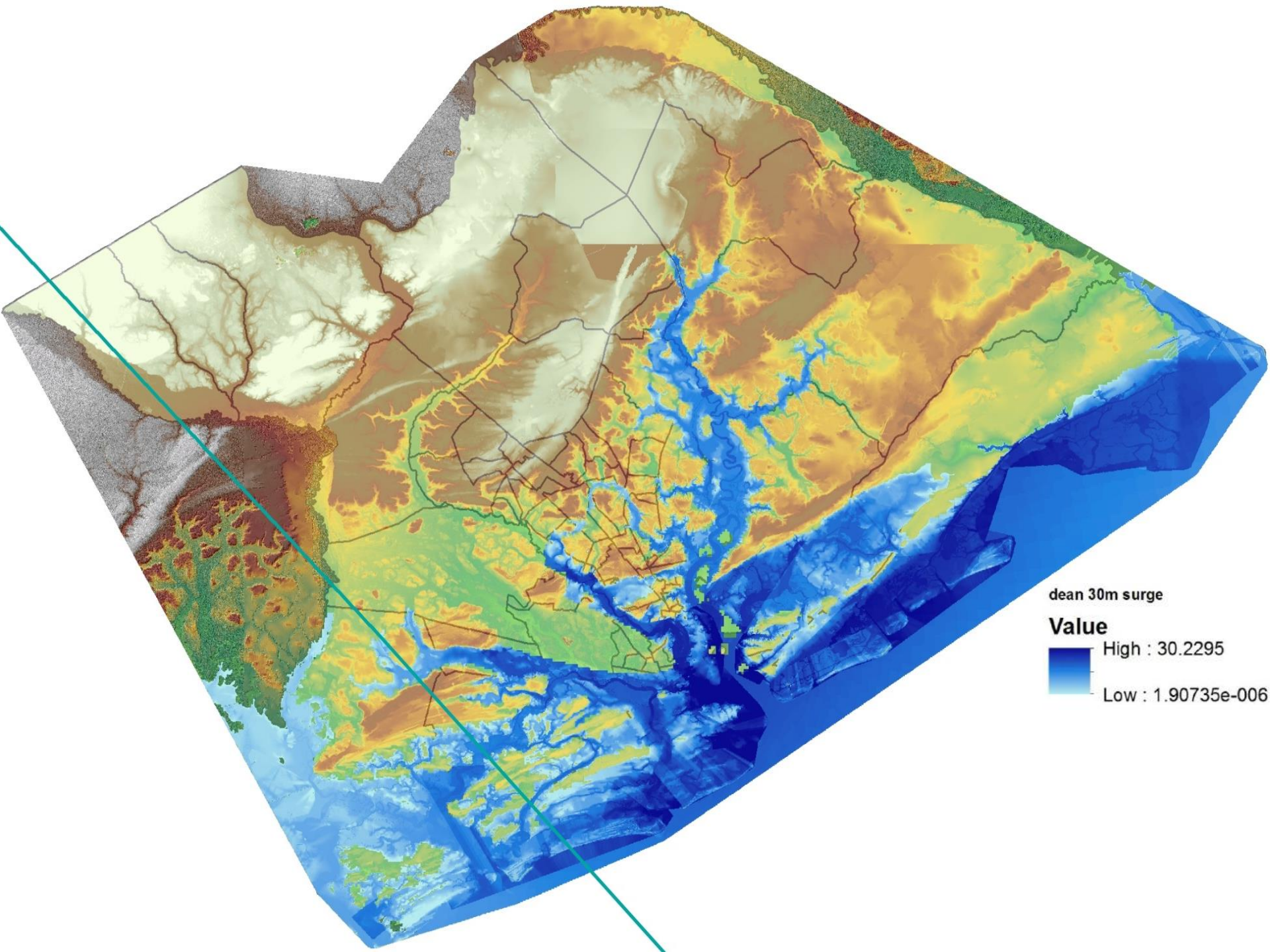
Potential Dean Impacts

- Had Hurricane Dean come ashore near Kiawah Island, SC; the combined wind and surge impacts to Charleston, Berkeley, and Dorchester counties would be:
 - Maximum Peak Wind Speed Gust: 165 mph
 - 135,088 buildings would be at least moderately damaged.
 - 26,586 buildings completely destroyed.
 - 8,122,837 tons of debris would be generated.
 - Total economic loss of 14 billion dollars.
 - 165,887 people would seek temporary shelter.

Hurricane Dean (GTTS) 2013

Wind Speeds - Peak Gust (mph)



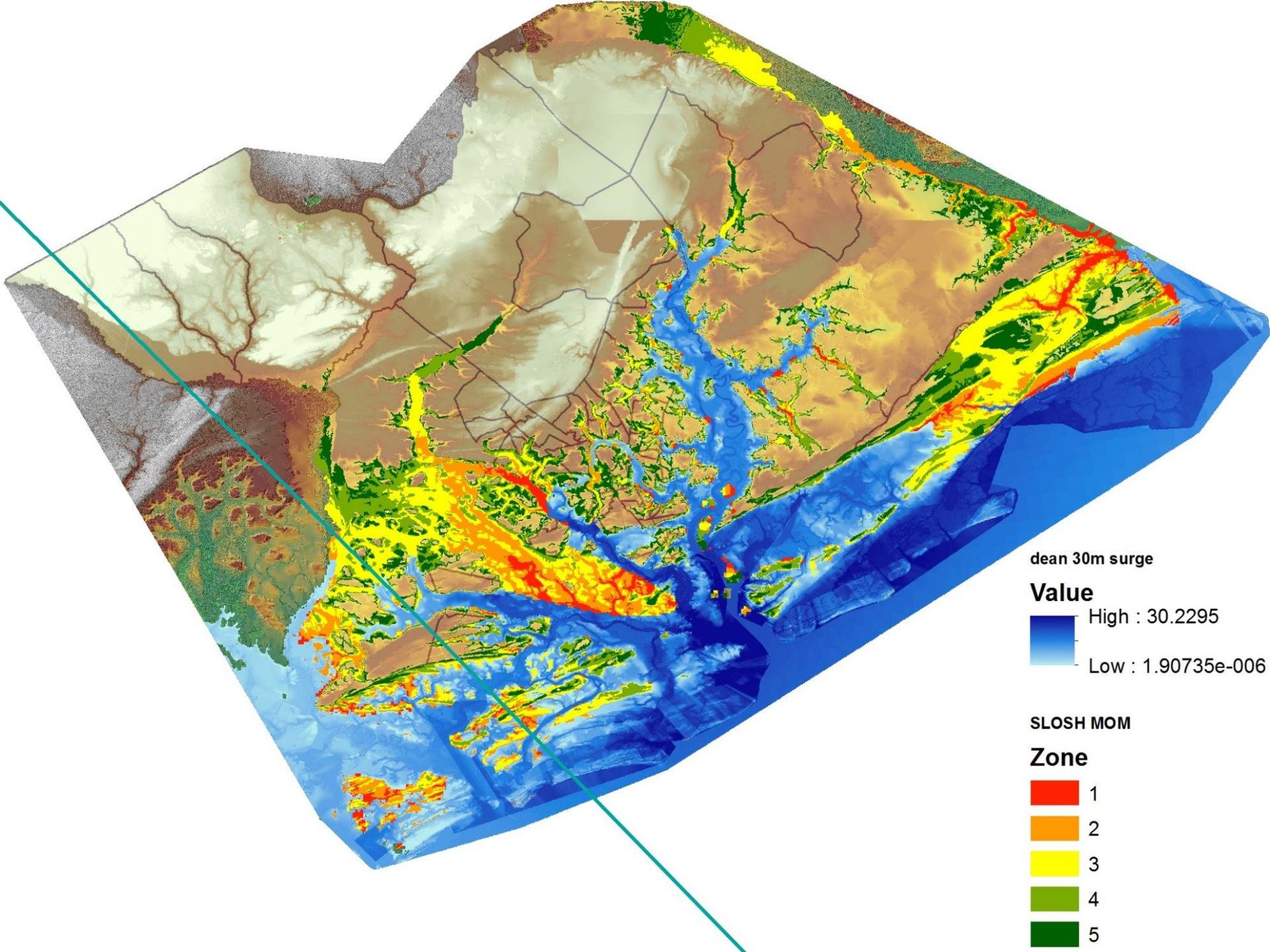


dean 30m surge

Value

High : 30.2295

Low : 1.90735e-006



dean 30m surge

Value

High : 30.2295

Low : 1.90735e-006

SLOSH MOM

Zone

1

2

3

4

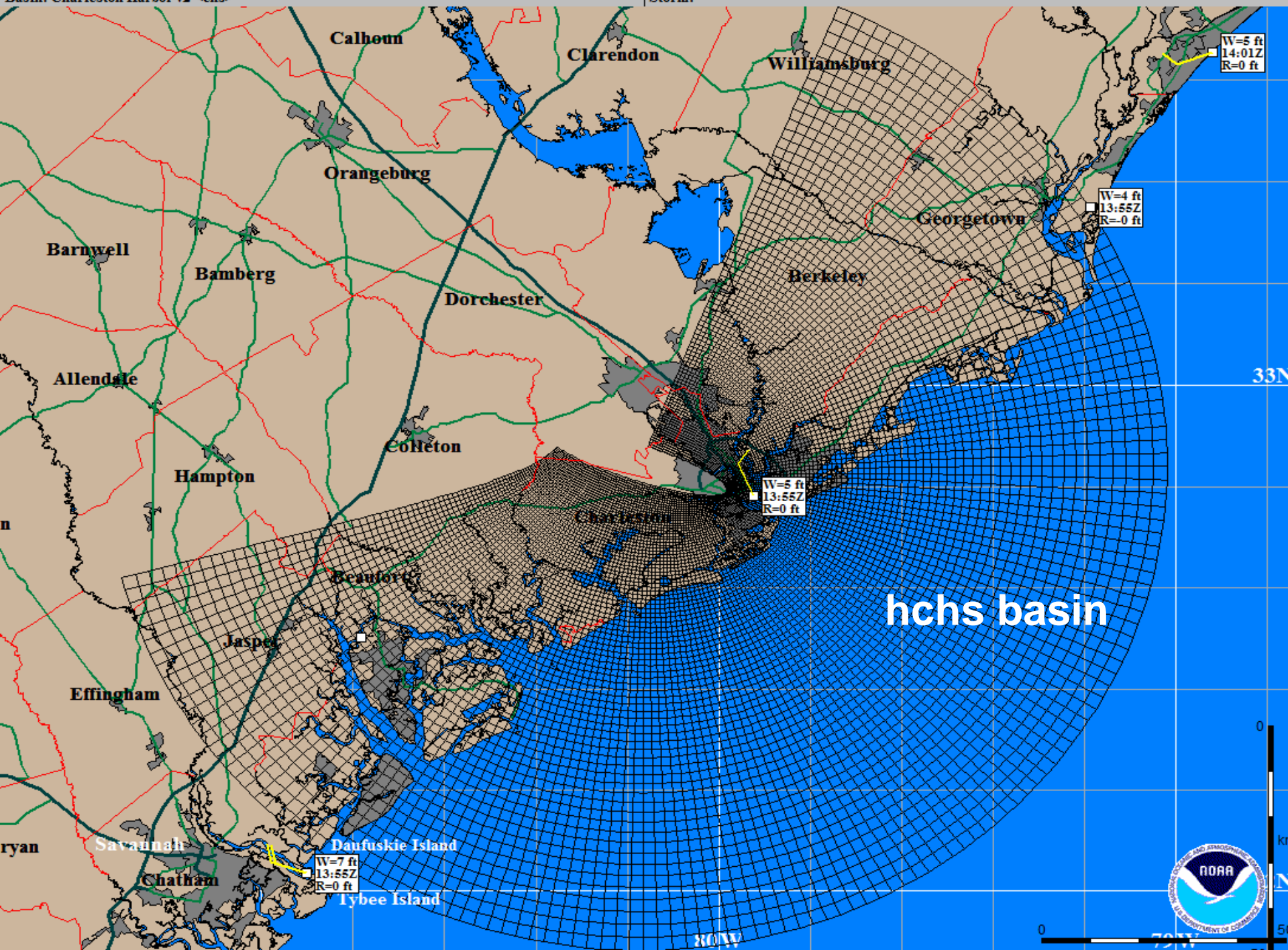
5

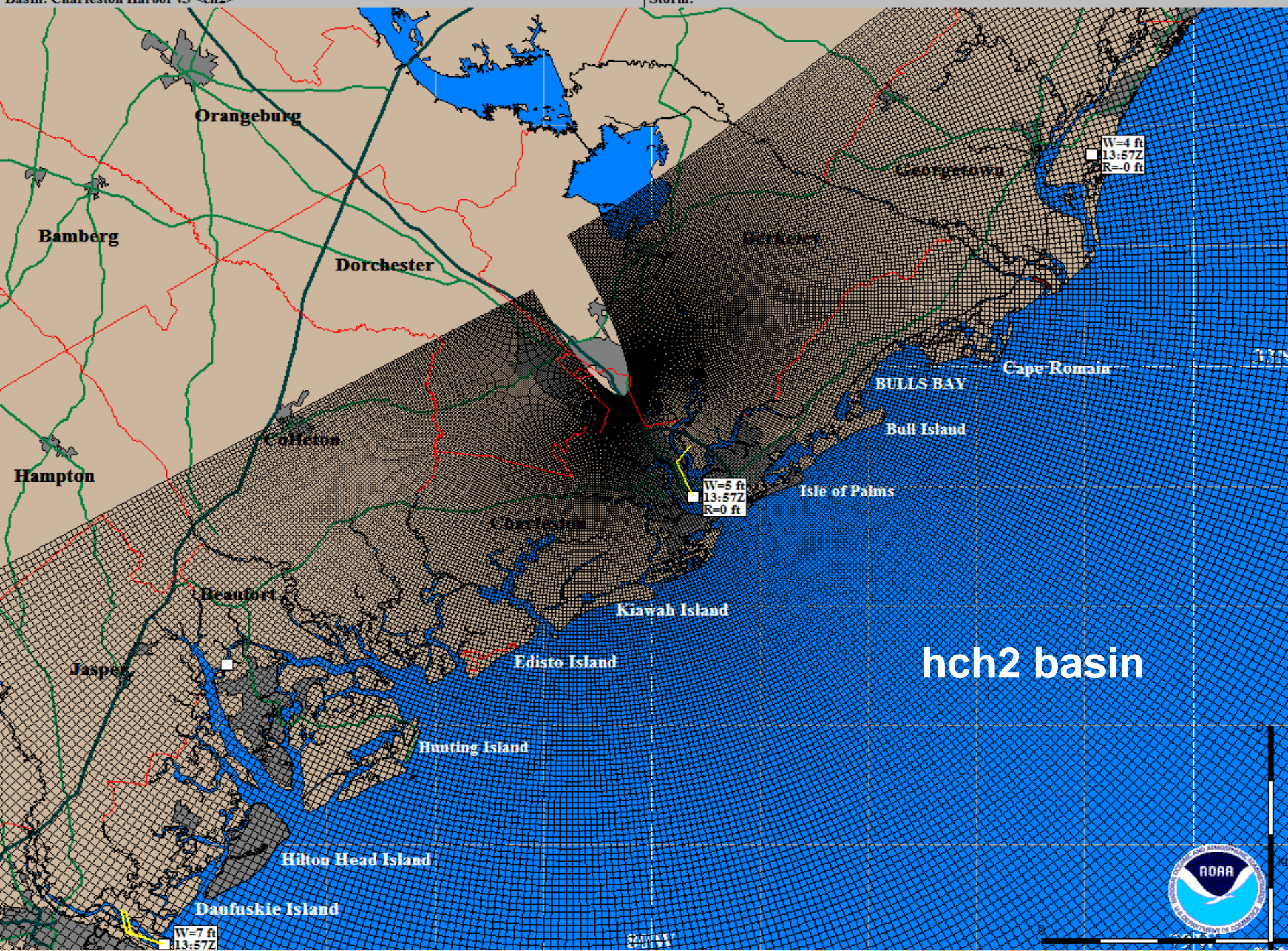
Outputs

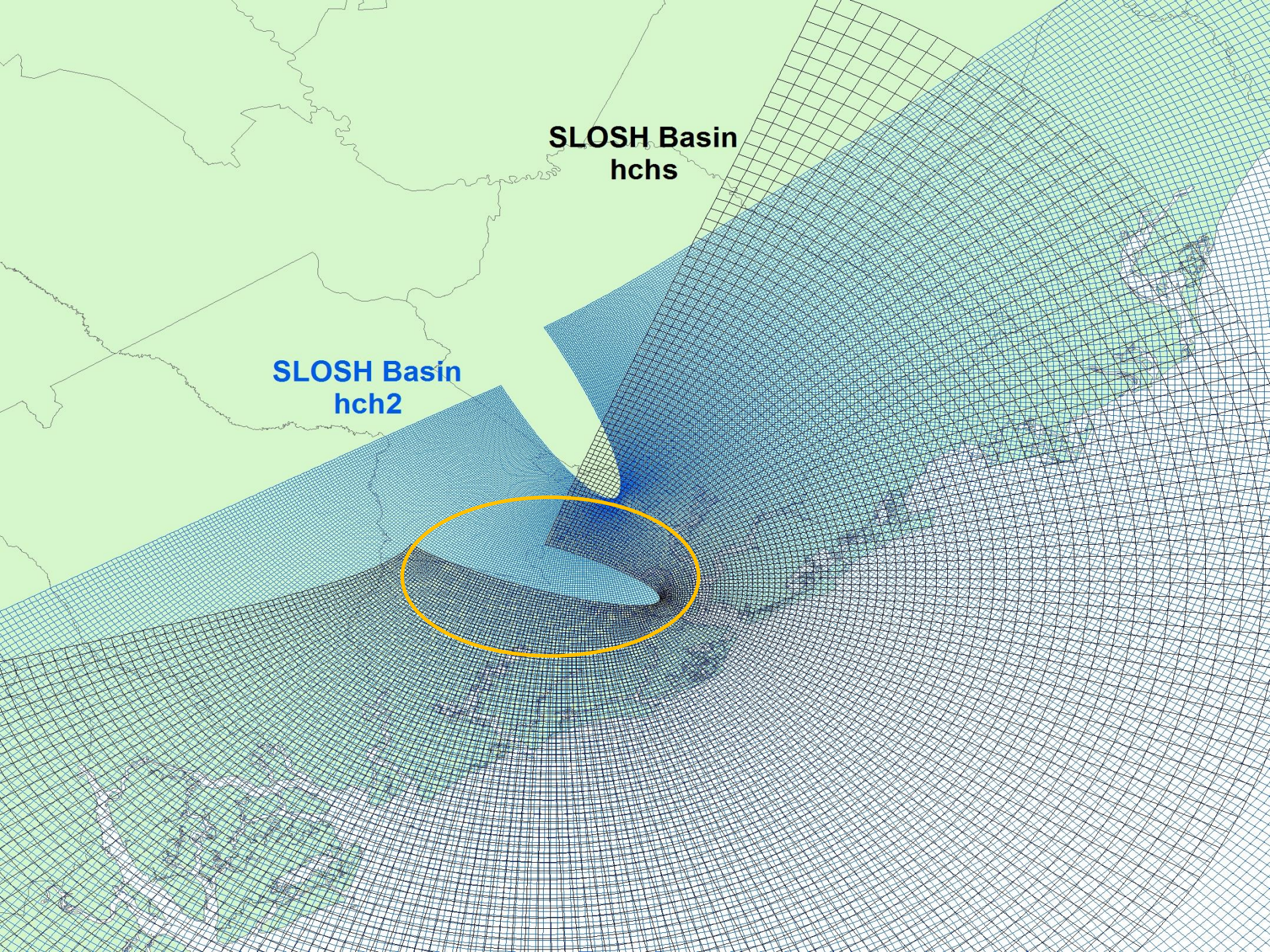
- **Important to Note** – The damage / population figures are from the 2000 Census data and may actually be a lower estimate that one would expect today.
- Complete CDMS data is not yet available for all 3 counties in the study area.

About HAZUS Storm Surge

- We did discover one issue with HAZUS' storm surge model for our area regarding the use of the SLOSH Basin grids.
- HAZUS uses the SLOSH Basin grid “hchs” for the Charleston Harbor area.
- The HES used the newer SLOSH Basin grid “hch2” for the Charleston Harbor area. This grid covers more area than the older “hchs” grid.
- Looking at storm surge flooding with the “hchs” grid would give the artificial impression that some areas would escape inundation from a storm surge.

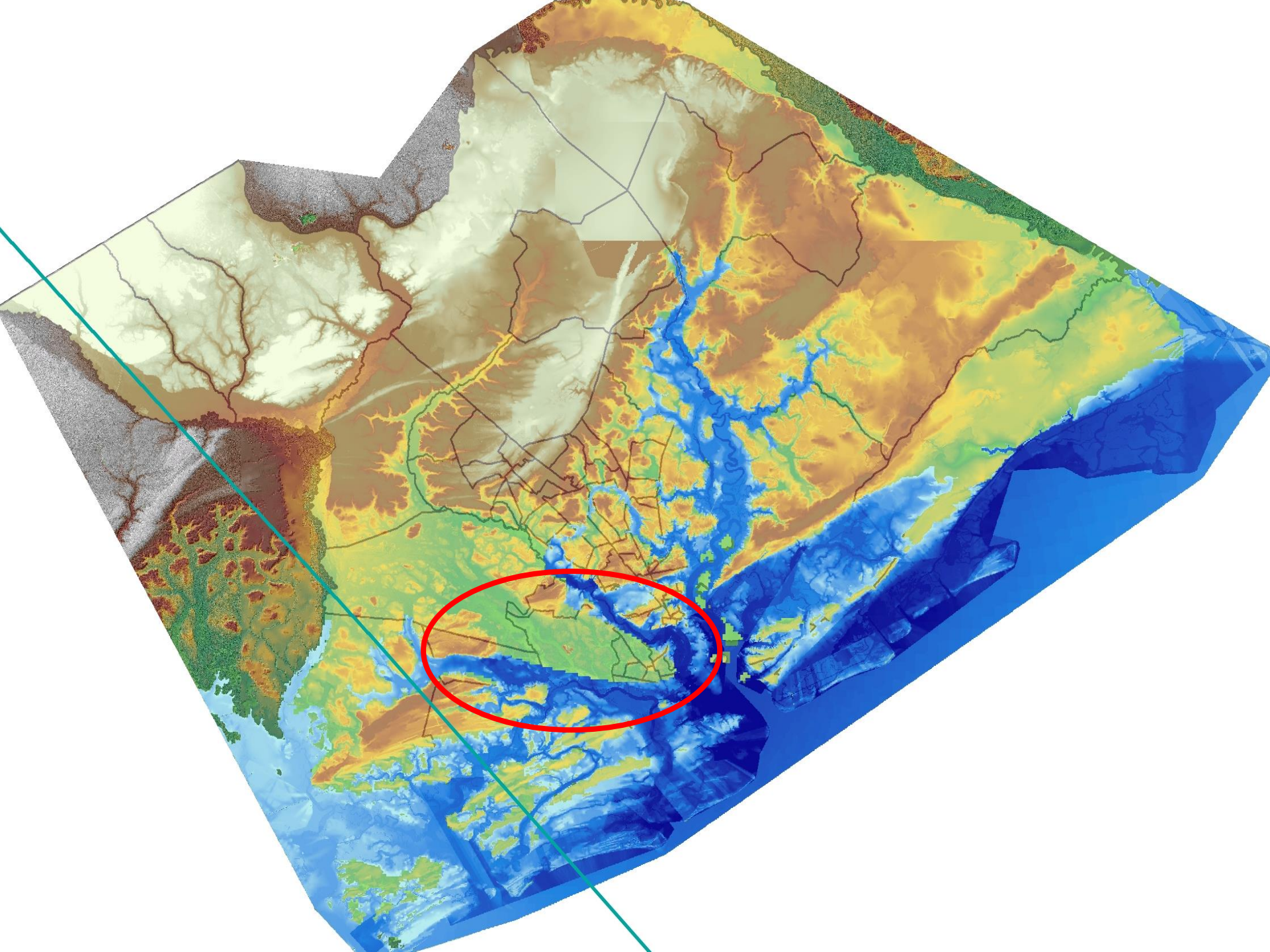






**SLOSH Basin
hchs**

**SLOSH Basin
hch2**



SLOSH Basin Grids Issues

- Grid size:
 - Grids are developed at finite sizes each grid is then used to provide a surge height for that cell.
 - The surge map is developed by then intersecting the surge height with the elevations on the DEM
 - The effective resolution of the Grids are:

hch2 (km2)

0.35

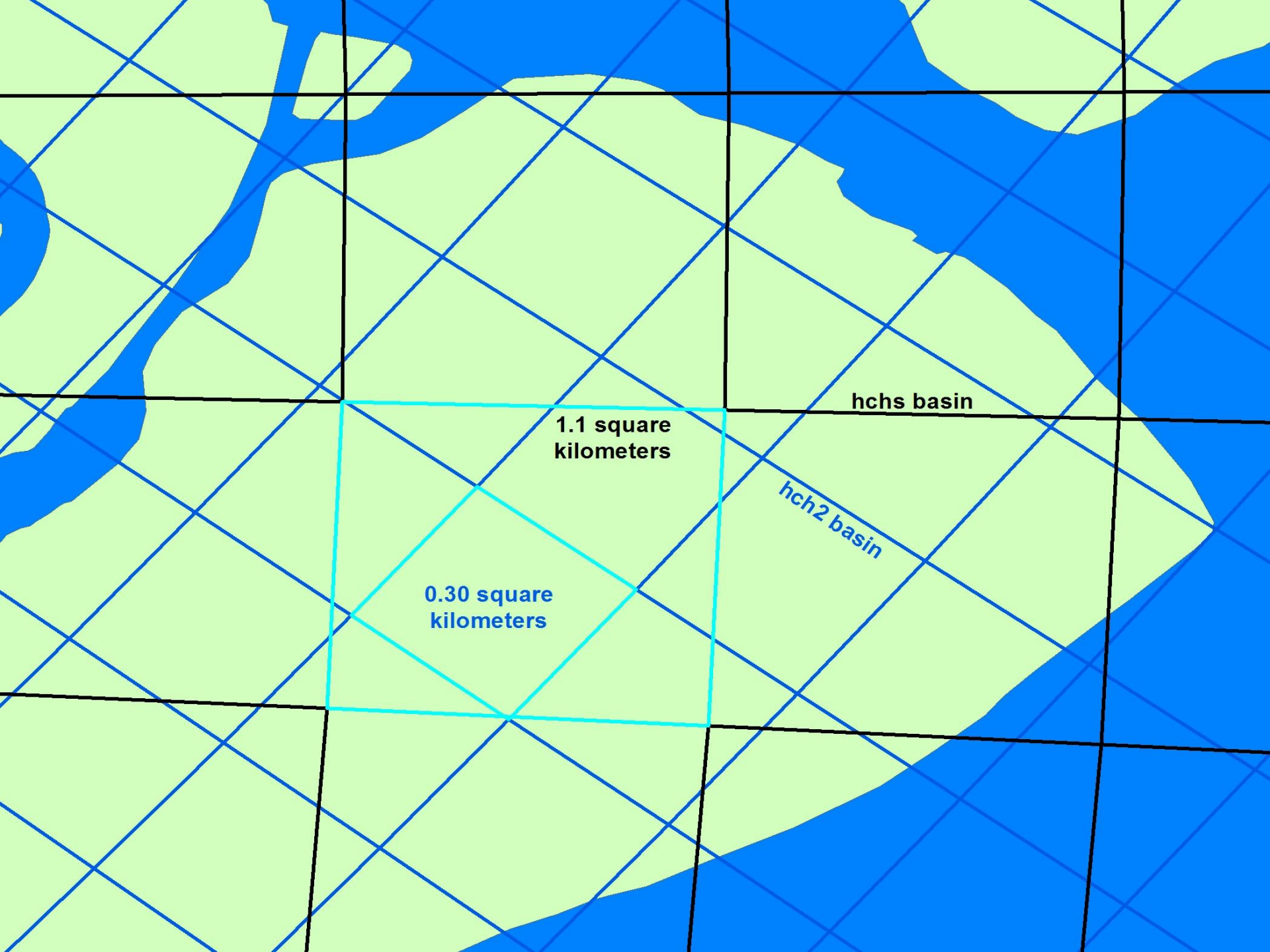
Ratio ~1:70 Mil

hchs (km2)

0.83

Ratio ~1:1.7 Bil

- This suggests that enhancing the DEM will only result in prettier maps not more accurate ones unless the grids can be enhanced as well.



Study Limitations

- HAZUS does have some limitations in using the coastal surge model.
- As previously mentioned, either HAZUS or the computer system's inability to handle larger size DEMs limits the accuracy of the storm surge model.
- With HAZUS using the older "hchs" grid for the SLOSH model, it complicates the comparisons between the new SLOSH – MOMs.
 - This issue was sent to the HAZUS help desk
 - Resolution from the help desk: Agree with suggestion, SLOSH basins should be updated periodically.

HUGS

- The HAZUS User Groups have been a great resource on how to deal with the issues we are having with the 2m DEM.
- Several of the users suggested that our LiDAR might have been “too good” and was causing the road networks to act as artificial blockages to the water flow.
 - Road networks were found not to be an error, the SLOSH basin grid differences seem to be the issue.
- HUG members have also suggested using a computer with a solid state drive to increase performance.

Next Steps

- Dorchester County and the College of Charleston will continue to look at enhancing this model so it can use the 2m DEM as the elevation base.
- We may still need an even more powerful computer to handle a DEM that is 60G in size.
- We look forward to the next HAZUS versions in hopes that the SLOSH basins will be updated.

Next Steps

- We will also be looking at incorporating our high resolution flood models into the surge to increase the accuracy water damage estimates to get a more complete picture of what would happen should a hurricane make landfall along the SC coastline.
- In the Lowcountry, flooding can end up accounting for more total damage than the wind.

Next Steps

- The data, outputs, and reports of the completed study will be shared with the local county Emergency Management Departments, the South Carolina Emergency Management Department, interested HAZUS User Groups, and interested Federal agencies (USCG, USACE).
- The information gathered in this study will hopefully provide statewide and local emergency managers / coastal planners better tools for making evacuation decisions and mitigation recommendations for future hurricane events in SC.

Thanks



ATKINS



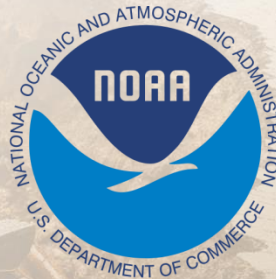
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US Army Corps
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Questions

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