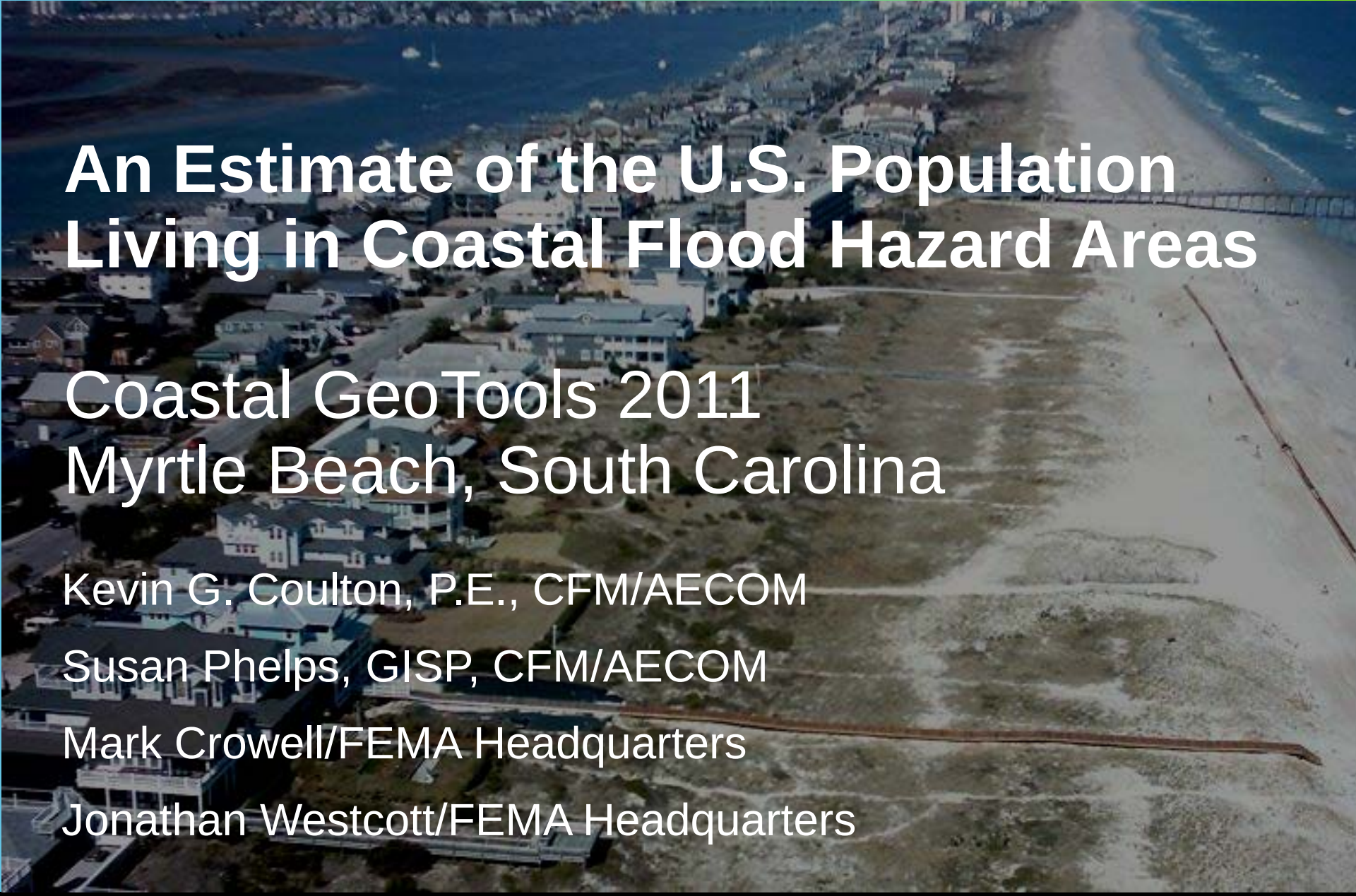

An Estimate of the U.S. Population Living in Coastal Flood Hazard Areas

Coastal GeoTools 2011
Myrtle Beach, South Carolina

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March 22, 2011

AECOM

Agenda

- Goals and Objectives
- Key Definitions
- Study Approach
- Results

Goals and Objectives

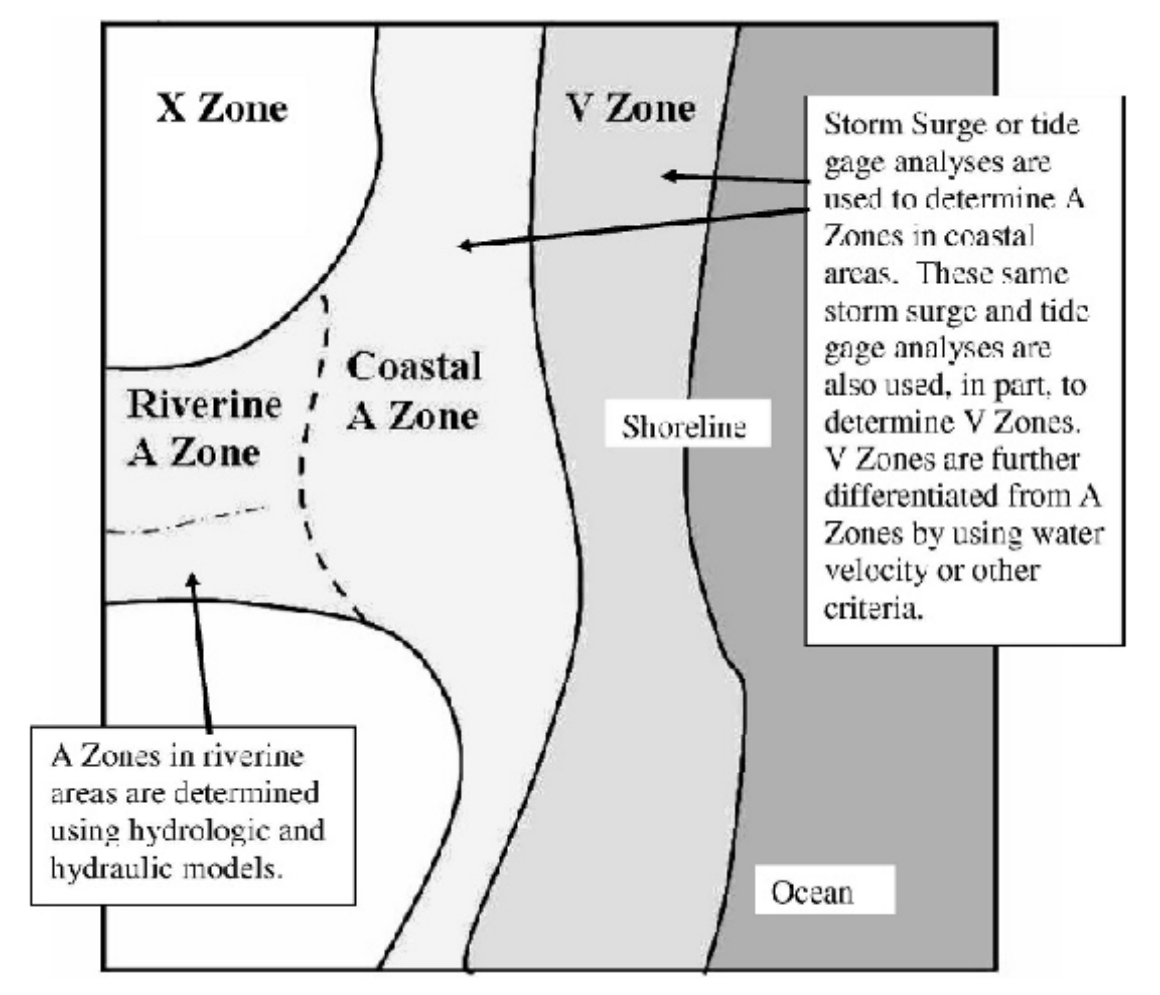
- The primary goal of the study was to provide useful information to FEMA that can be used to support future decisions about identifying, mapping, and managing Coastal AE Zones and shaded X Zones through the NFIP.
- The primary objectives of the study were to:
  - Respond to a 2006 NFIP evaluation comment that FEMA begin to delineate Coastal AE Zones.
  - Prepare datasets useful for an eventual response to GAO recommendations to evaluate long-term fiscal implications of climate change on the NFIP.
  - Estimate population and housing demographics and NFIP claims and policy distributions in “coastal” flood hazard zones.

Key Definitions – FEMA Flood Hazard Zones

- The land area covered by the floodwaters of the base flood (1.0% annual chance [100-yr] flood) is the Special Flood Hazard Area (SFHA) on NFIP maps.
- The SFHA is the area where the NFIP's floodplain management regulations must be enforced and the area where the mandatory purchase of flood insurance applies.
- The SFHA includes A and V Zones (A, AO, AH, VE, and V).
- Current FEMA regulations do not distinguish between riverine and coastal A Zones.
- The 0.2% annual chance [500-yr] flood zone, the shaded X Zone, is not a SFHA and is delineated by the inland extent of the 0.2% annual chance stillwater elevation.

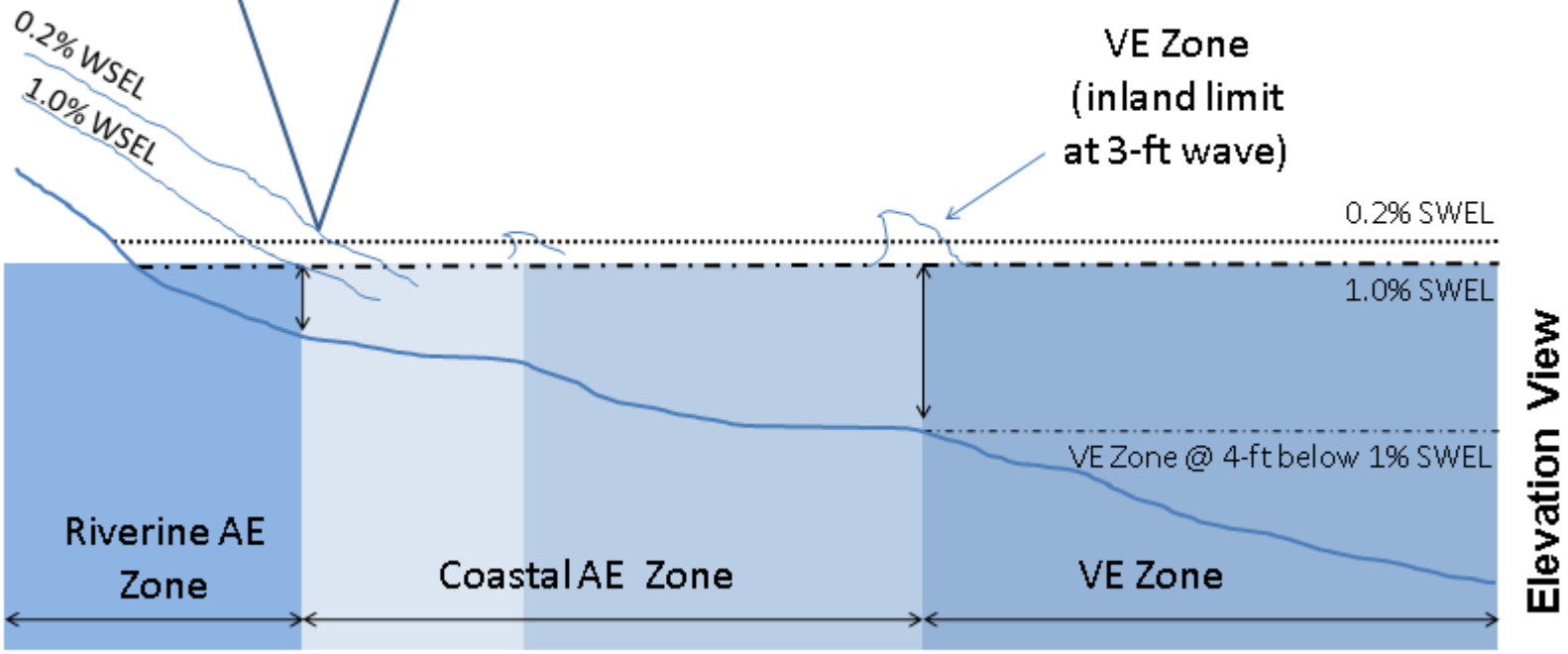
Key Definitions – Flood Hazard Mapping Along Coastlines

- Flood hazard zones along coastlines can be attributed to "pure" coastal flood sources; e.g., storm surge, wave runup.
- However, zones at river confluences are a combination of coastal and fluvial flood sources.



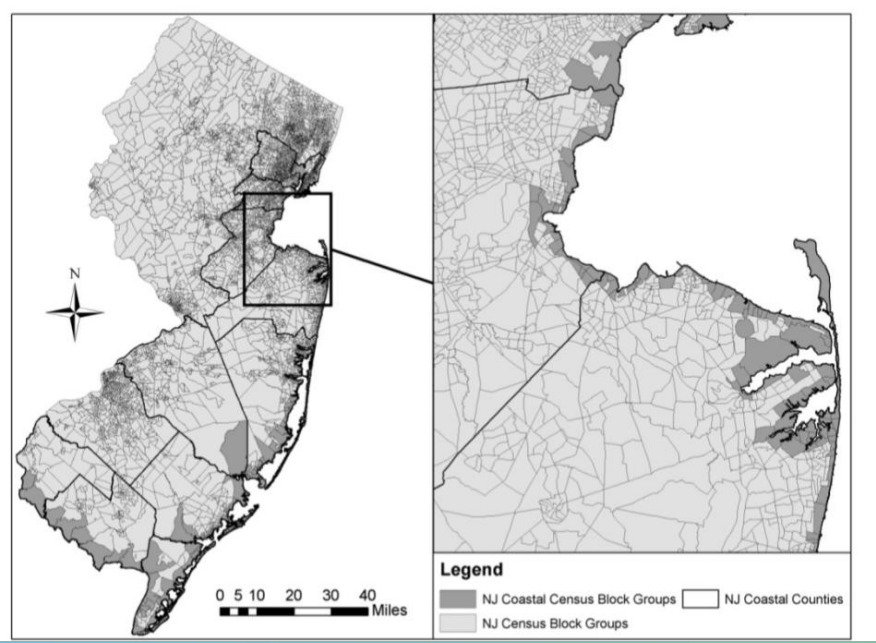
Key Definitions – Flood Hazard Mapping at River Confluences

- 1.0% Coastal and Riverine A/AE Zones separated to define inland limit of Coastal AE Zone at: 1) first riverine BFE or 2) downstream end of floodway or 3) AE to A Zone transition or 4) 1% stillwater elevation (SWEL)—depending on available mapping.
- 0.2% Coastal and Riverine A/AE Zones separated at same location as 1.0% A/AE Zones.



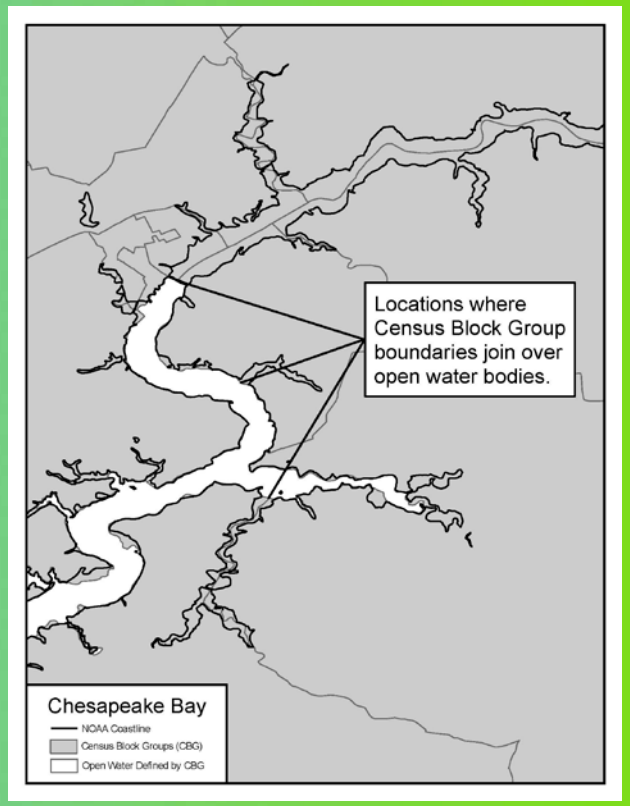
(Note: The proposed limits in Figure 4-2 neglect any potential effects of vegetation and obstructions, and reflect the maximum inland extent of wave action effects.)

Key Definitions – Census Block Groups/Coastlines



< Shaded census block groups are adjacent to open coast or sheltered waters or contain V/VE Zones.)

Coastlines were delineated along the seaward edges of census block group boundaries and where census block group boundaries join across NOAA-defined water boundaries. >



Study Approach

The estimation of the population located in coastal flood zones followed a three step procedure:

- Step1 - Create a national database by compiling the best available coastal-proximate digital flood hazard data showing the location and extent of coastal and riverine SFHAs.
- Step 2 - Develop a systematic method to separate the coastal and riverine AE and shaded X Zones and delineate this new boundary line onto the digital flood hazard database.
- Step 3 - Combine 2000 census data with the national digital flood hazard database and the VE Zone and coastal AE and shaded X Zone areas using a Geographic Information System.

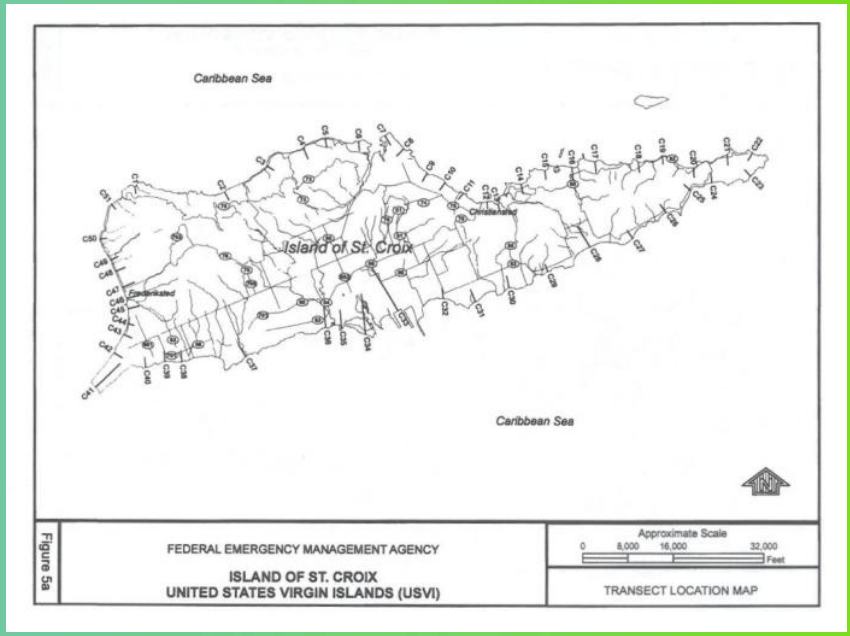
Step 1: Digital Base Data Compilation

Three digital data sources were used to compile the base coastal dataset used for this analysis:

- National Flood Hazard Layer (NFHL) data.
- Q3/First American - Effective flood zone data scanned from hardcopy flood maps
- National Elevation Data (NED) Terrain Data combined with estimates of 1.0% and 0.2% annual chance stillwater elevations. The stillwater elevation is defined by FEMA as the surface of the water resulting from astronomical tides, storm surge, and freshwater inputs, but excluding wave setup contributions

Approximated Flood Zones

- NED Terrain Data combined with estimates of 1.0% and 0.2% annual chance stillwater elevations.
- Stillwater elevations obtained from FIS reports and DFIRM datasets.
- Datum conversions done using on-line tools.
- For the Great Lakes, IGLD55 > IGLD85 > NAVD88; for all other coasts, NGVD29 > NAVD88, as necessary.




Tool Kit: NAVD88 - IGLD85 Height Conversion

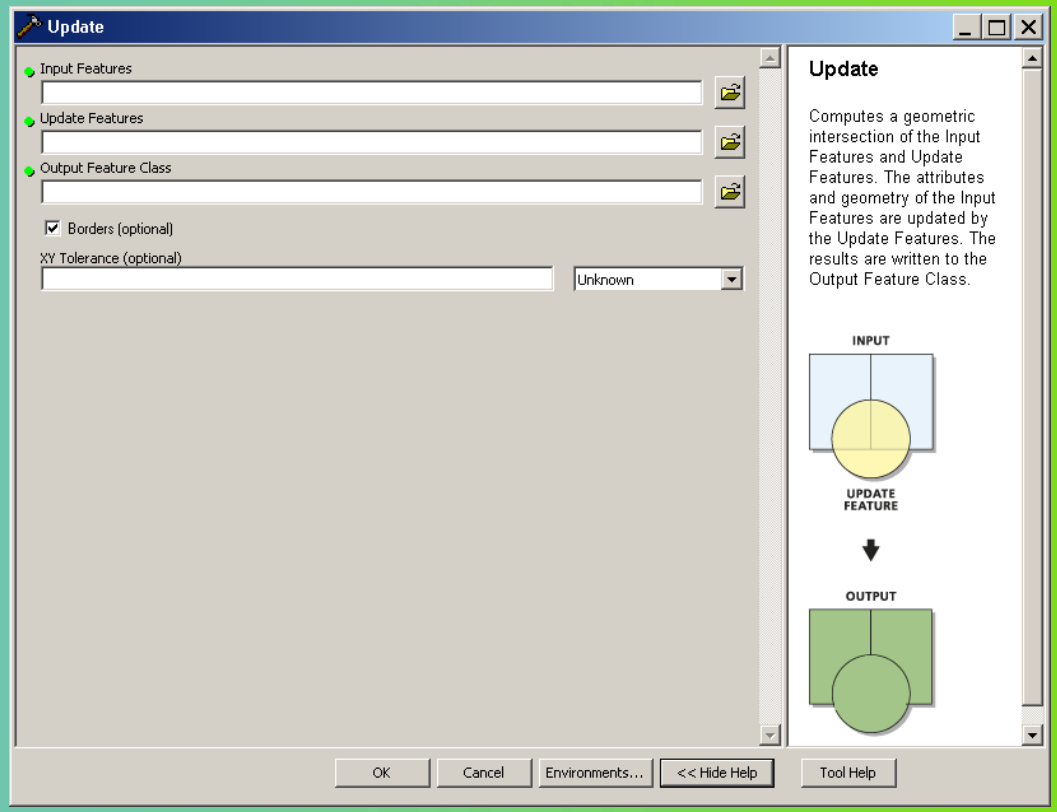
International Great Lakes Datum of 1985

The North American Vertical Datum (NAVD) 1988 is based on orthometric height. Informally, this could be considered as a height above mean sea level. NAVD 88 is based on an adopted elevation at Point Rimouski/Father's Point. And NAVD 88 is realized as Helmert orthometric heights, which are a good approximation to true orthometric heights. The NAVD 88 was affirmed as the official vertical datum for the United States by a notice in the Federal Register (Vol. 58, No. 120, page 34325) on June 24, 1993. For more information on NAVD 88, please check the NAVD 88 report.

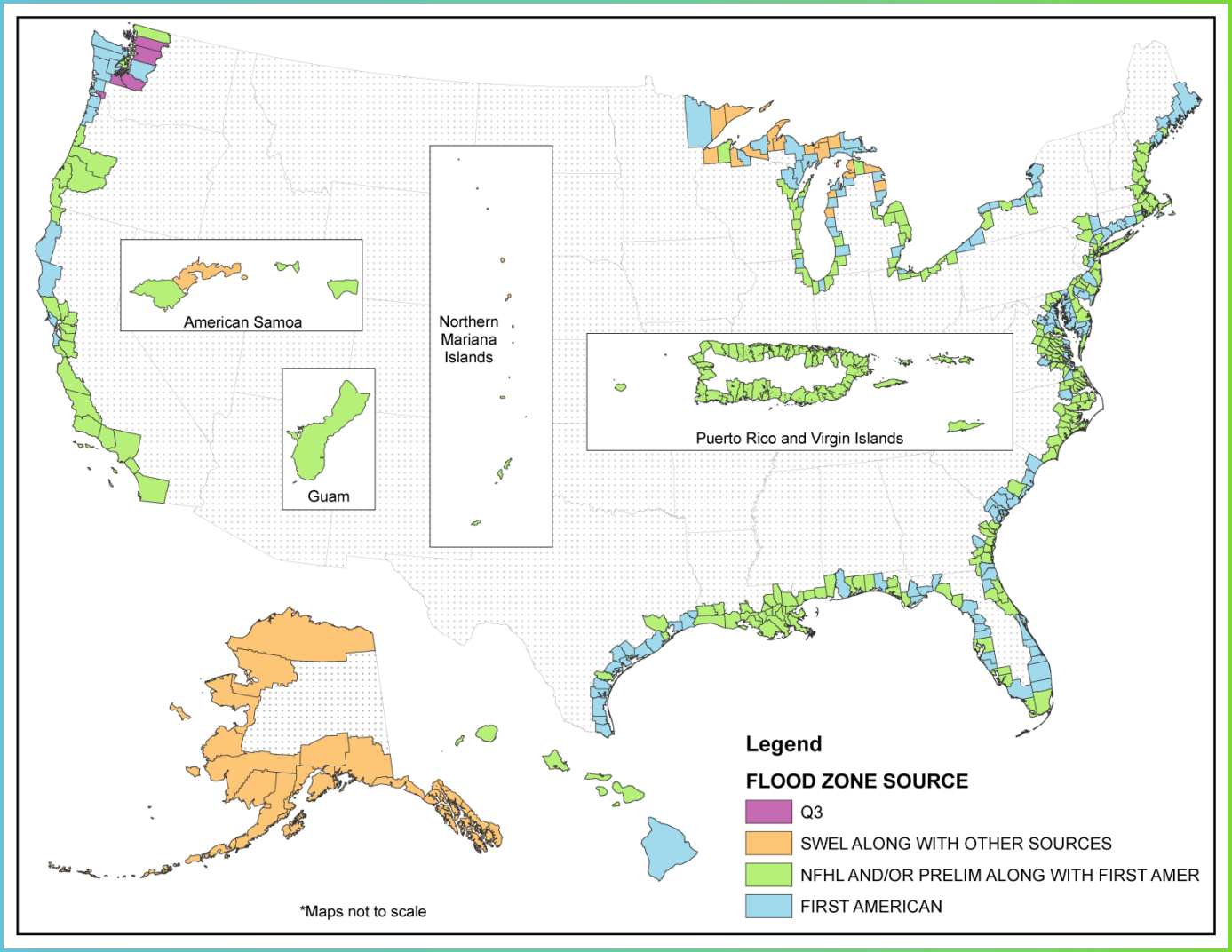
The International Great Lakes Datum (IGLD) 1985 is expressed as dynamic height. Informally, this could also be considered as a height equivalent (based on work to raise a unit mass) above mean sea level. IGLD 85 is also based on an adopted elevation at Point Rimouski/Father's Point. And, IGLD 85 is realized as mean water levels at a set of master water level stations on the Great Lakes. Due to various observational, dynamical, and steric effects, there will be slight departures between a dynamic height and an IGLD 85 height. These departures are known as hydraulic correctors, and are part of the NAVD 88/IGLD 85 datum transformation.

Step 1: Digital Base Data Compilation

- Update function in ArcGIS toolbox utilized to combine 3 flood zone layers
  - First update process run to replace effective flood zone data with NFHL
  - Second update process run for inclusion of NED/stillwater flood zones



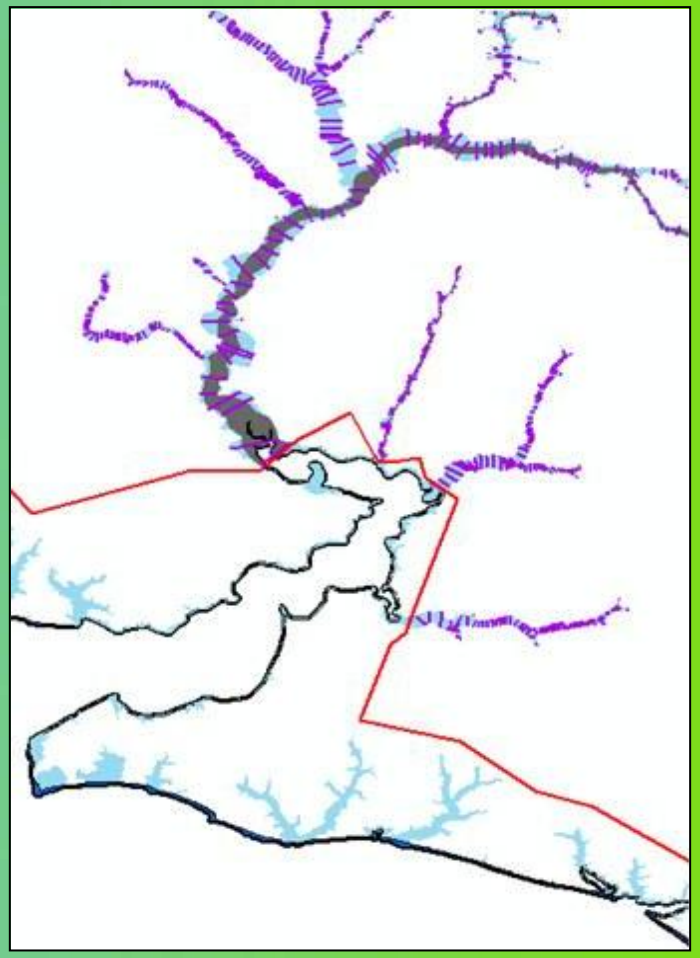
Summary of Flood Zone Source Data by Coastal County



Step 2: Riverine and Coastal AE and Shaded X Zone Separation

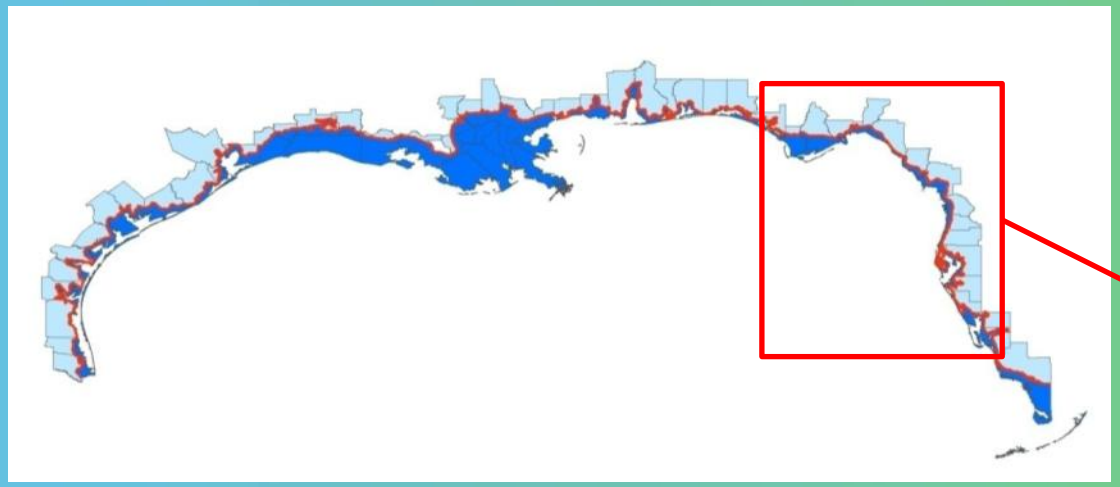
- The AE and shaded X Zones were manually separated into riverine and coastal portions based on the available data.

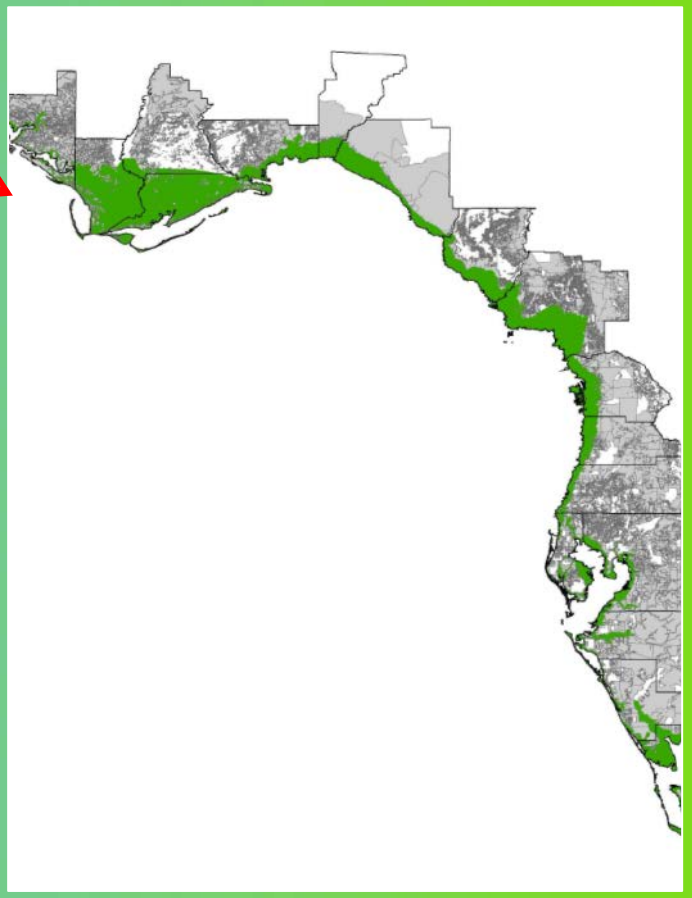
Data Source	Separation Location	Comment
NFHL Data	First riverine BFE	Most definitive method
Q3Data	At downstream limit of floodway (used infrequently)	No BFEs available in Q3 data
Q3Data	At transition from AE to A Zone (used infrequently)	Use if no Q3 floodways exist; assumes A Zones are riverine
Q3 Data	At point where the Zone A/AE floodplain begins to widen in upstream direction (used infrequently)	Use if no Q3 floodways or AE to A Zone transitions exist
NED Terrain Data	At point where SWEL minus 1-ft polygon edge crosses streams	Use if no Q3 or NFHL data are available



(Separation occurs at most downstream BFE in NFHL datasets.)

Step 2: Riverine and Coastal AE and Shaded X Zone Separation

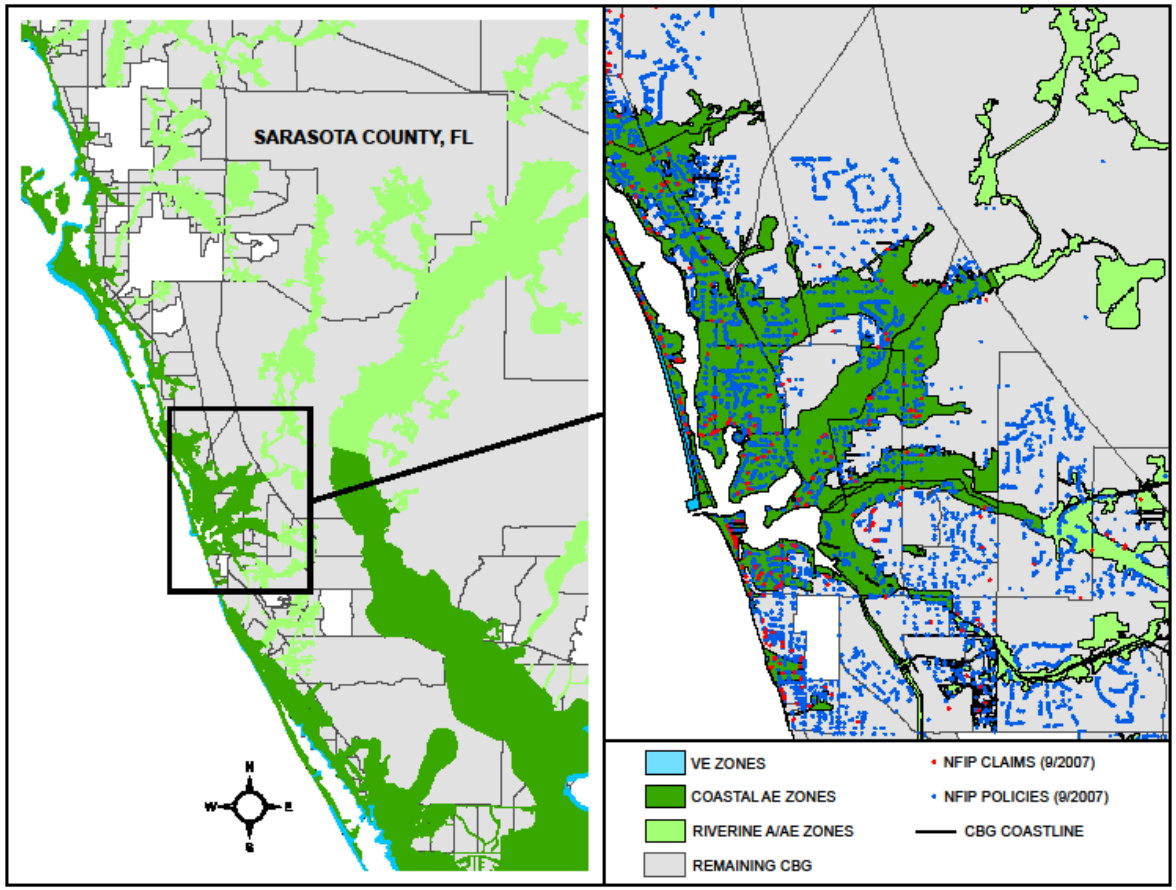




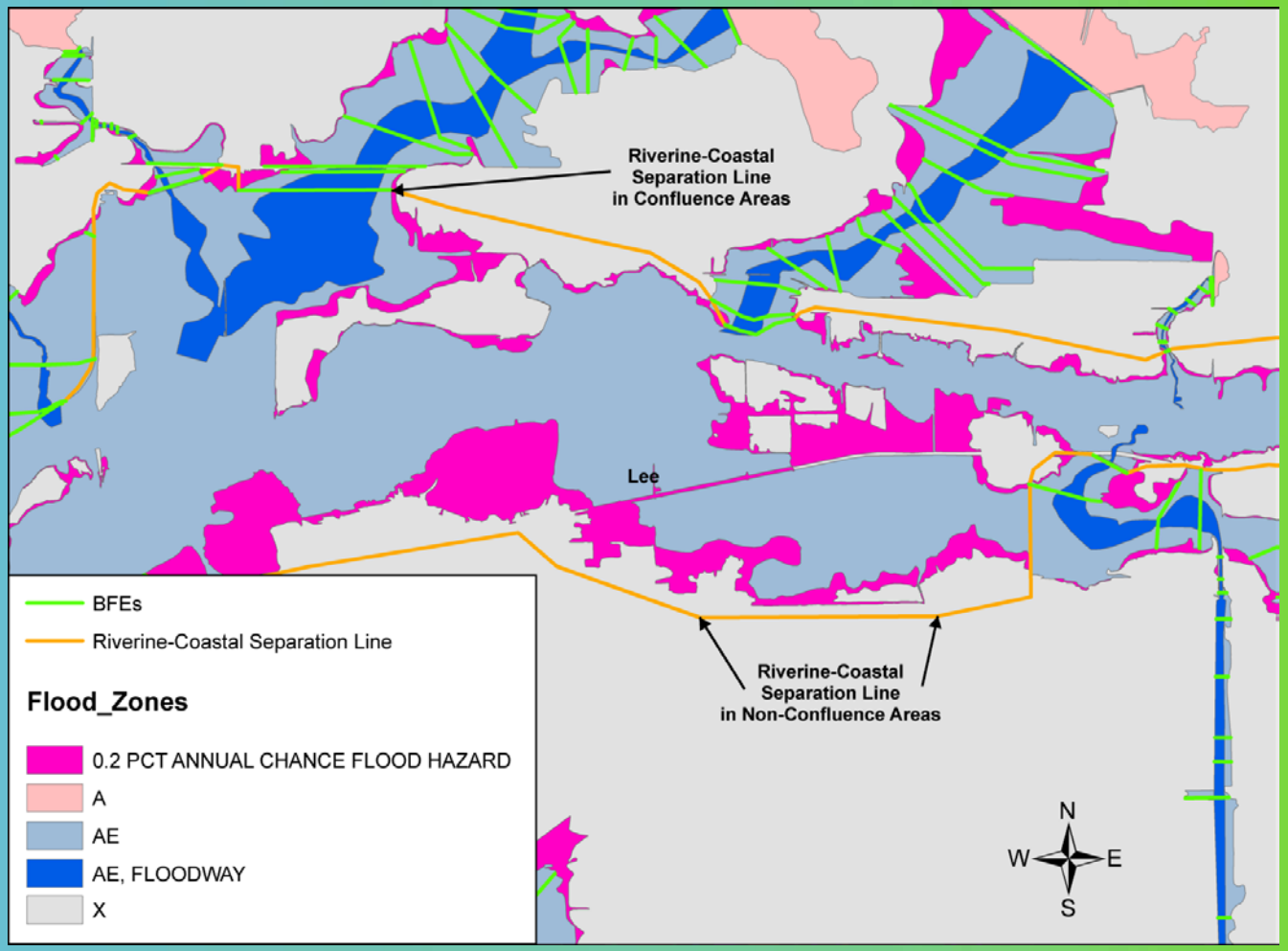
The riverine-coastal separation line generally defines “coastal” land area; Coastal AE and shaded X Zones may make up a large or small portion of this area.

Step 2: Riverine and Coastal AE and Shaded X Zone Separation

Example of resulting Coastal AE Zones (dark green) and riverine AE Zones (light green).



Step 2: Riverine and Coastal AE and Shaded X Zone Separation



Step 3: Tallying Coastal Population

- Once coastal AE and shaded X Zones were separated from riverine AE Zones, the zones seaward of this separation line were classified as “coastal flood hazard zones”, consisting of coastal AE Zones and VE Zones, as well as coastal shaded X zones.
- The union tool in ArcGIS Toolbox was used to spatially combine the coastal flood hazard areas with census block groups (CBGs).

Step 3: Tallying Coastal Population

- Square mile area calculations from the GIS unions provided estimates of the portion of each census block group located within the coastal flood hazard zones.
- Census block group populations were assumed to be uniformly distributed across each block group and the population within a coastal flood zone was estimated in a spreadsheet calculation by multiplying the block group population per square mile by the square mile area of the coastal flood zone.

Results – "Coastal" Counties
(Counties with VE Zones, Coastal AE, and/or Coastal Shaded X Zones)

ATLANTIC	174
Connecticut	4
Delaware	3
District of Columbia	1
Florida	14
Georgia	9
Maine	8
Maryland	18
Massachusetts	9
New Hampshire	2
New Jersey	15
New York	13
North Carolina	22
Pennsylvania	2
Rhode Island	5
South Carolina	9
Virginia	40

GREAT LAKES	82
Illinois	2
Indiana	3
Michigan	41
Minnesota	3
New York	9
Ohio	8
Pennsylvania	1
Wisconsin	15

PACIFIC TERRITORIES	8
American Samoa	3
Guam	1
Northern Mariana Islands	4

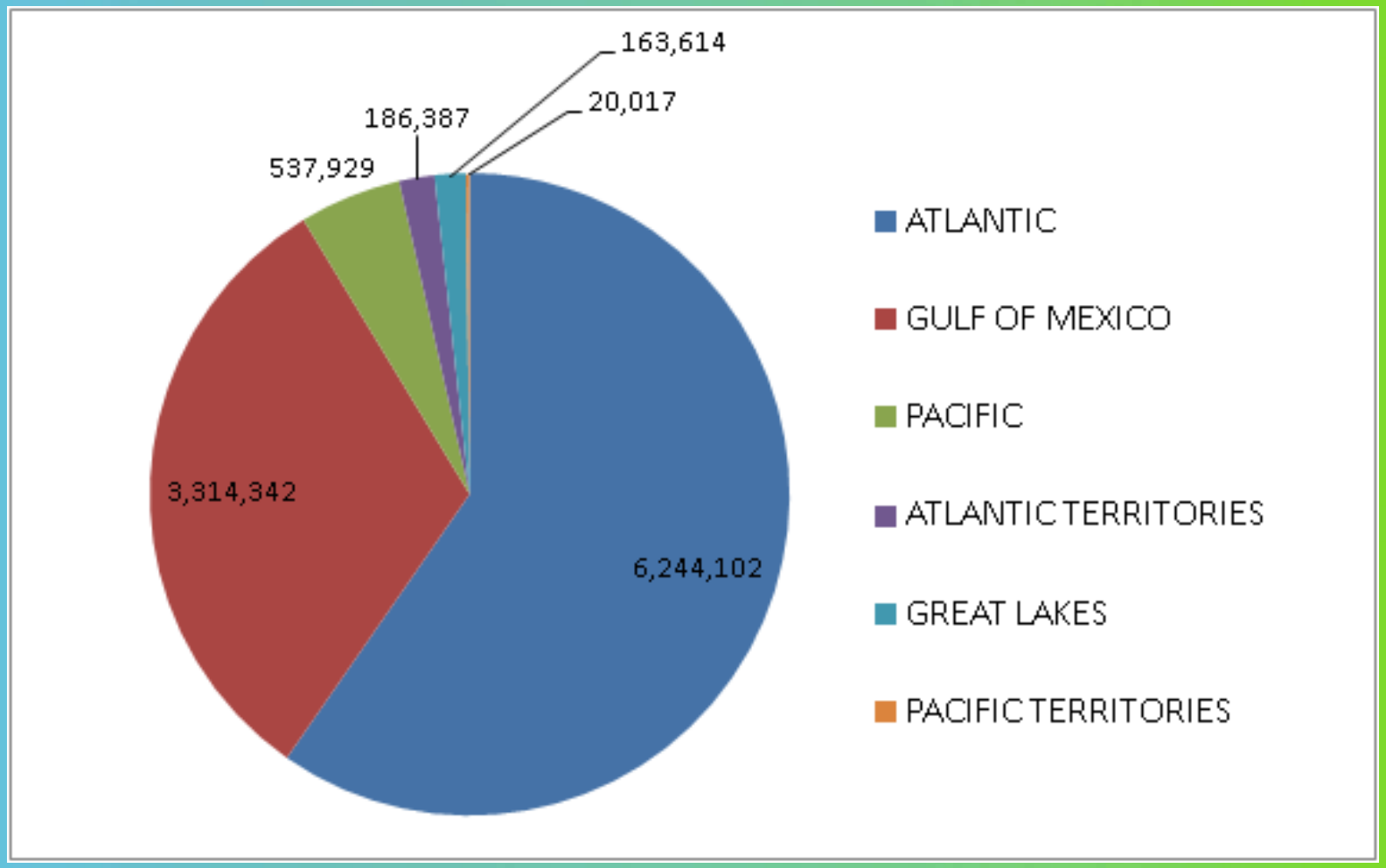
451 Counties

GULF	69
Alabama	2
Florida	25
Louisiana	21
Mississippi	3
Texas	18

PACIFIC	70
Alaska	23
California	20
Hawaii	5
Oregon	7
Washington	15

ATLANTIC TERRITORIES	48
Puerto Rico	45
US Virgin Islands	3

Results – National Population Summary by Coastline



Results – National Demographics Summary by Coastline

GEOGRAPHY	ALL COASTAL A, V and SHADED X ZONES			
COAST	2000 POPULATION	2000 HOUSING UNITS	AREA (SQ MI)	POLICIES-IN-FORCE (2009)
ATLANTIC	6,244,102	3,005,855	12,224	1,002,016
ATLANTIC TERRITORIES	186,387	80,354	104	6,502
GULF	3,314,342	1,193,618	18,536	769,421
PACIFIC	537,929	257,385	22,213	34,910
PACIFIC TERRITORIES	20,017	5,279	77	NA
GREAT LAKES	163,614	82,111	622	9,989
Coastal Totals (U.S. Only)	10,259,987	4,538,969	53,595	1,816,336
Coastal Totals (U.S. and Territories)	10,466,391	4,624,602	53,776	1,822,838
National Totals (U.S. Only)	281,421,899	115,903,837	3,594,434	4,374,134
National Totals (U.S. and Territories)	285,643,295	117,458,300	3,598,458	4,427,625
% Coastal (U.S. Only)	3.6%	3.9%	1.5%	41.5%
% Coastal (U.S. and Territories)	3.7%	3.9%	1.5%	41.2%

Results – National Summary by Individual Coastal Flood Hazard Zones

- There is an estimated total population of 2,089,000 in coastal shaded X Zones compared to 7,760,000 and 617,000 in coastal SFHAs (coastal A and V Zones), respectively.
- There is an estimated total of 891,000 housing units in coastal shaded X Zones compared to 3,392,000 and 342,000 housing units in coastal SFHAs (coastal A and V Zones), respectively.
- There is an estimated total of 6,400 square miles of coastline in coastal shaded X Zones compared to 38,900 and 8,500 square miles for coastal SFHAs (coastal A and V Zones), respectively.

Results – National Summary by Combined Flood Hazard Zones Coastal vs. Riverine

GEOGRAPHY	2000 POPULATION	2000 HOUSING UNITS	AREA (SQ MI)	POLICIES-IN-FORCE (2009)	CUMULATIVE CLAIMS (AS OF DEC. 31, 2009)
COASTAL A, V AND SHADED X ZONES	10,466,391	4,624,602	53,776	1,822,838	783,940
COASTAL AND RIVERINE A, V AND SHADED X ZONES	40,069,607	17,000,002	258,681	2,450,204	920,620
% OF TOTAL A, V AND SHADED X ZONE DEMOGRAPHICS OCCURING IN COASTAL AREAS	26%	27%	21%	74%	85%

Data Limitations and Accuracy of the Results

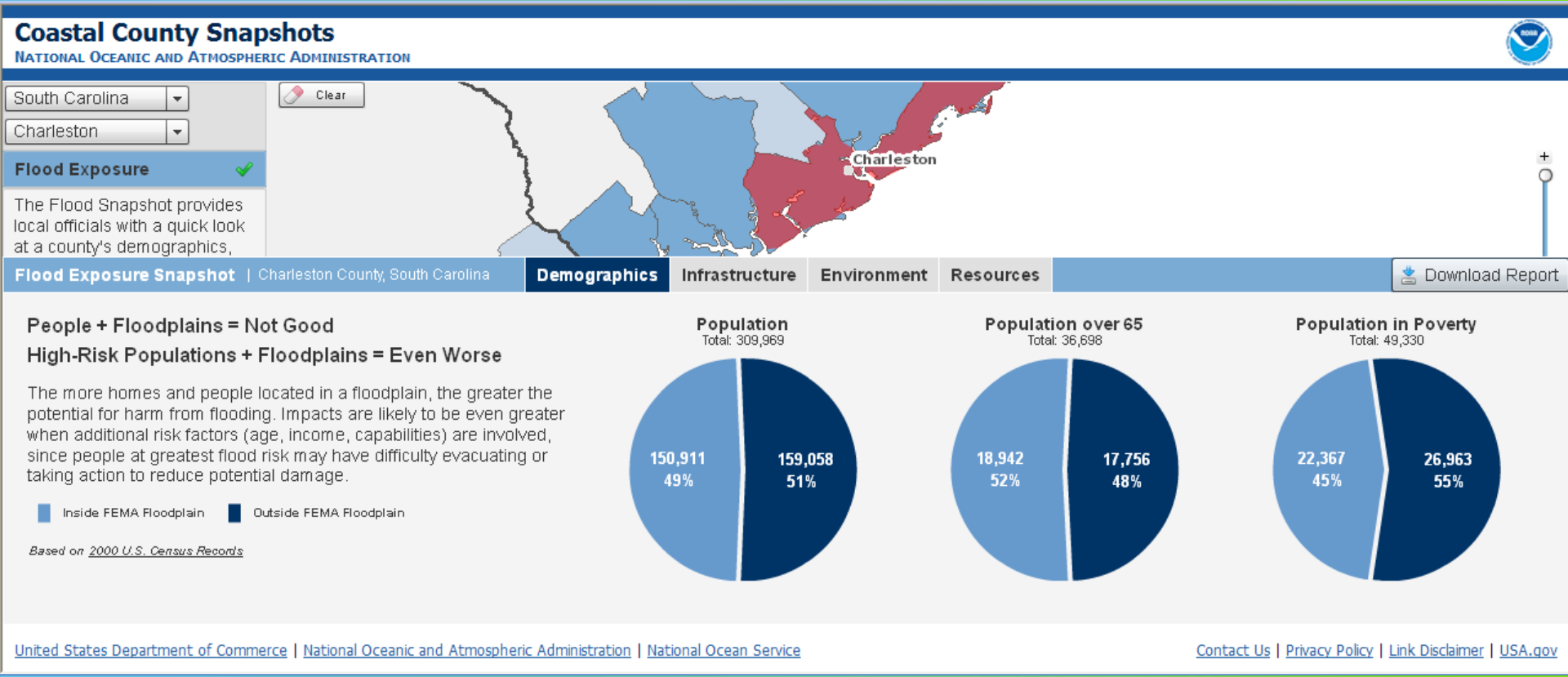
- Absence of Mapped Shaded X Zones
  - There is not a consistently mapped transition from a 1.0% to 0.2% annual-chance flood hazard along all coastlines; i.e., shaded X Zones are not immediately inland of AE and VE Zones in all coastal areas.
  - The 1.0% surge or runup/overtopping may extend inland over the 0.2% SWEL inland limit.
  - PFD VE Zones may extend inland over the 0.2% SWEL inland limit.
  - The shaded X Zones may not be mapped due to map scale limitations.
  - The FIS may have been limited to a study of the 1.0% annual chance flood and the 0.2% annual chance flood was not studied.

Data Limitations and Accuracy of the Results

- Flood Zone Data Limitations
  - Flood zone data truly represent “snapshots” in time; for this study the flood zone data were not all derived at the same point in time nor with similar methods and this imposes limitations on the use of the data.
  - Much of the flood zone GIS data provided for use in this study contains inherent topological errors, such as gaps in the flood zones. QC efforts were focused on finding and removing overlapping polygons and large gaps in the data.
  - The highest quality flood zone data are represented by the more recent effective Digital Flood Insurance Rate Map (DFIRM) data, archived in the National Flood Hazard Layer (NFHL) and preliminary DFIRM data, those data not yet archived in the NFHL.

Data Use in NOAA Products

NOAA Coastal County Snapshots – Charleston, SC



Thank You!

Questions?

Kevin.Coulton@aecom.com