



Analyzing Severe Weather Risk with Geographic Information Systems

Severe Weather Workshop CAS RPM 2016

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March 14, 2016

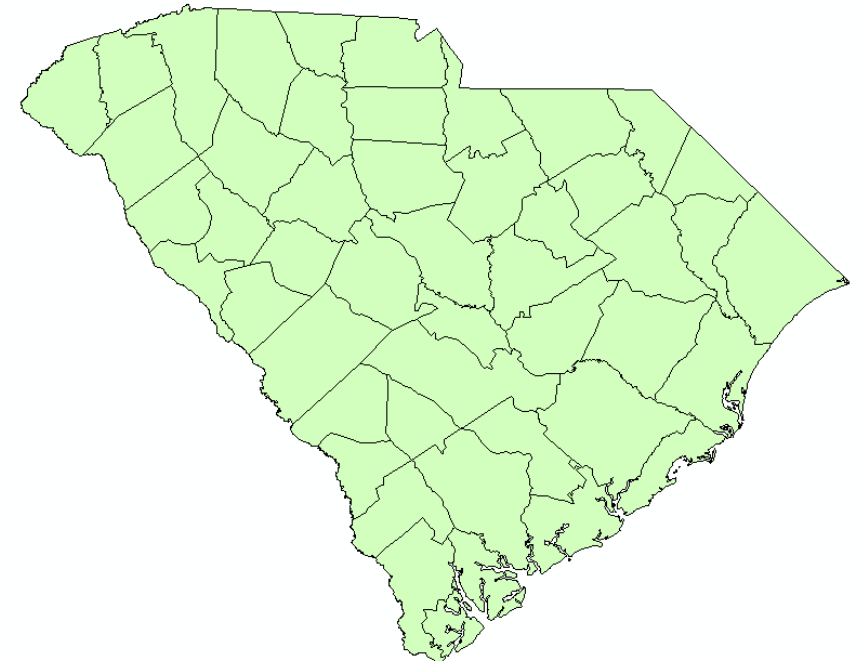
Analyzing Severe Weather Risk with Geographic Information Systems

- I. GIS basics
- II. Geocoding and Uncertainty
- III. Data sources and workflows
- IV. Visualization
- V. Clustering Analysis

Geographic Information Systems (GIS)

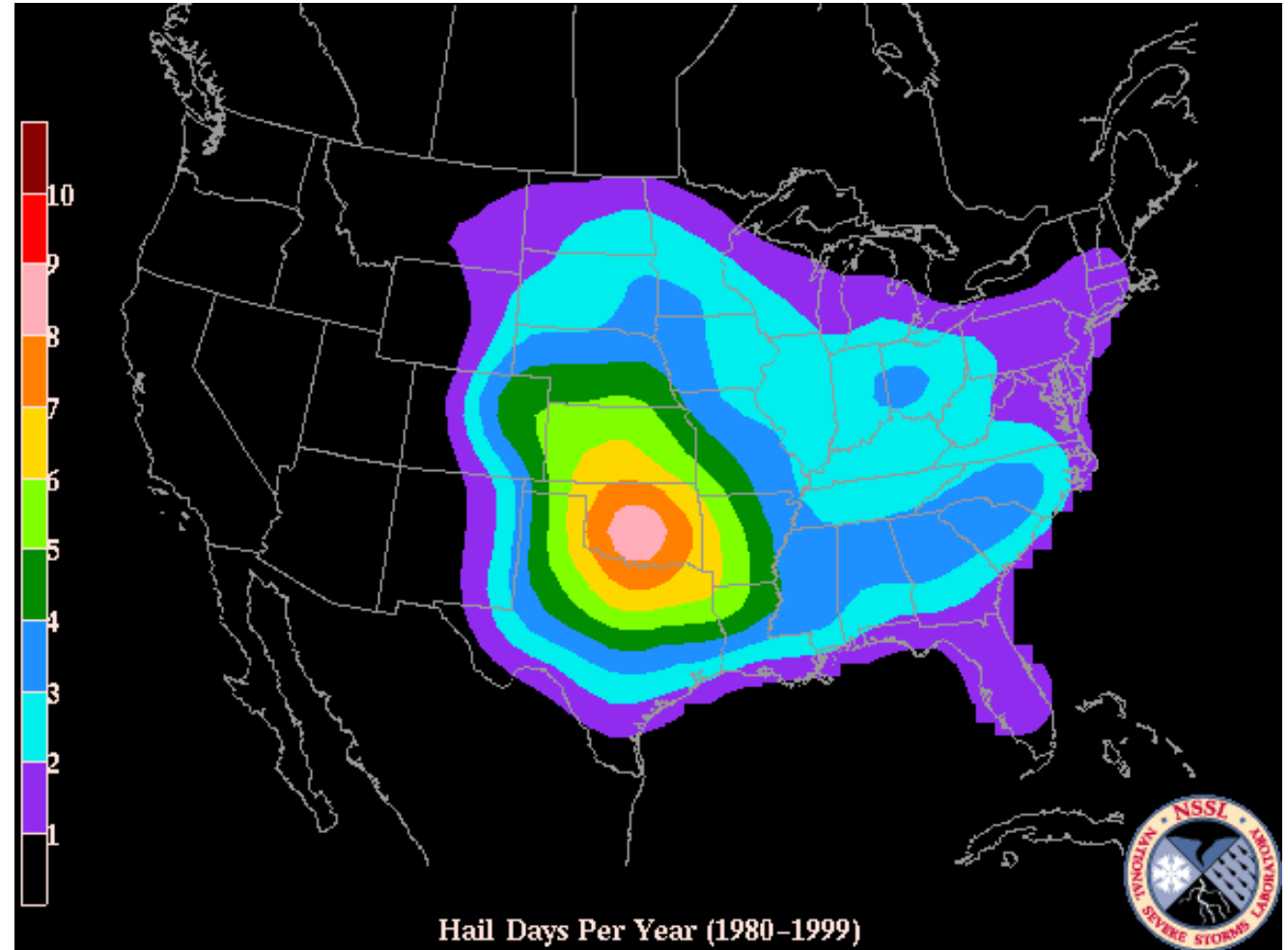
- GIScience: “the science behind the systems”
- GISystems are used to capture, store, edit, analyze, and present geographic data
- A lot of insurance data is already geographic:
 - Policy Location, territory, zip code, etc.

OBJECTID *	county *	Owner_SF_detached	policies	quotes
1	ABBEVILLE	5859	1	19
2	AIKEN	35926	37	174
3	ALLENDALE	1610	1	14
4	ANDERSON	43918	30	141
5	BAMBERG	3125	7	56
6	BARNWELL	3911	8	29
7	BEAUFORT	36393	629	11633
8	BERKELEY	35246	198	3427
9	CALHOUN	3317	29	170
10	CHARLESTO	71596	743	11770
11	CHEROKEE	9926	146	571
12	CHESTER	7047	45	142
13	CHESTERFIE	8191	6	37
14	CLARENDON	5575	54	350



GIS and Severe Weather Risk

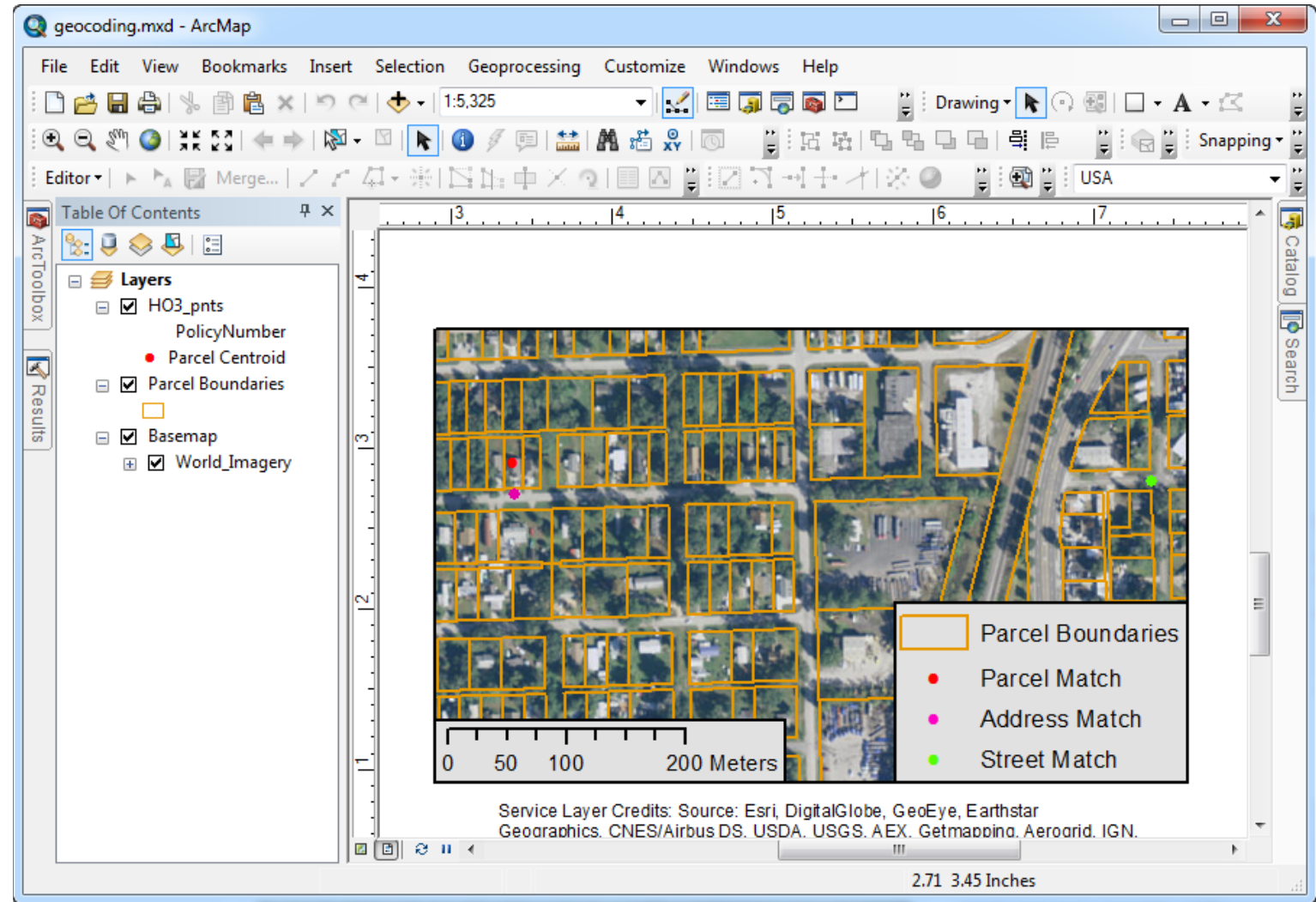
- Severe weather risks vary greatly by geography
- Mapping allows for visualization and analysis of geographic relationships
- GIS can be used to bring spatial data into underwriting and pricing analysis
- Geoprocessing tools can provide additional spatial statistical analysis



Source: Severe Thunderstorm Climatology, NSSL, NOAA
<http://www.nssl.noaa.gov/projects/hazard/totalthreat.html>

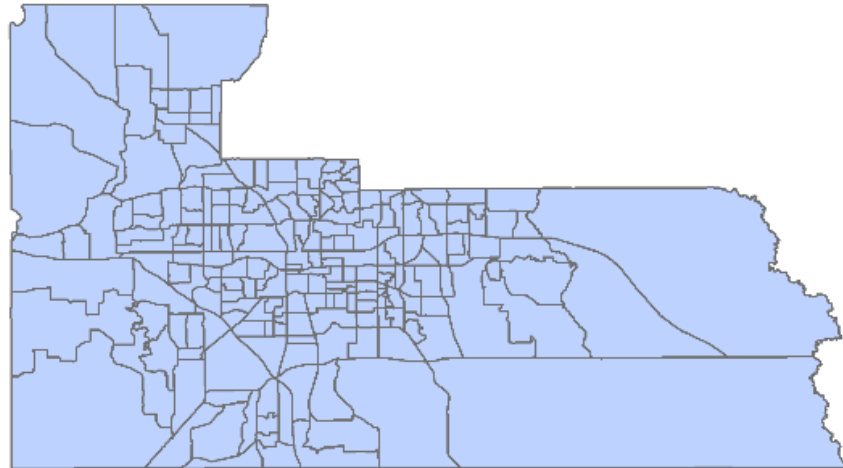
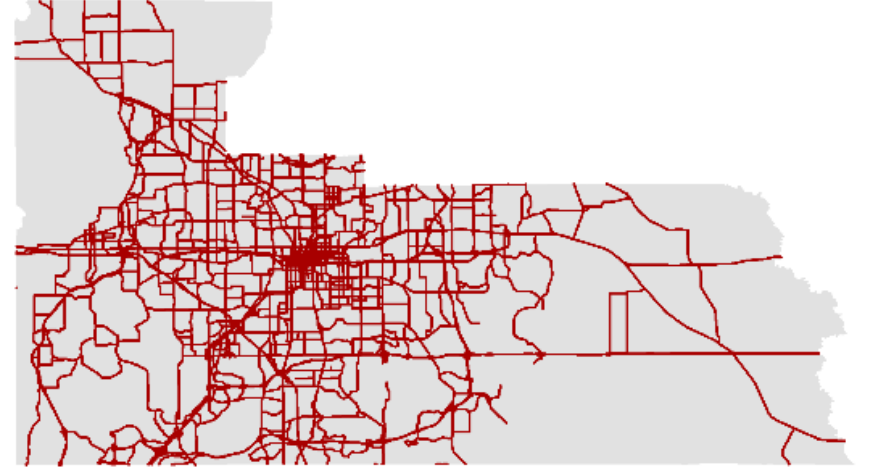
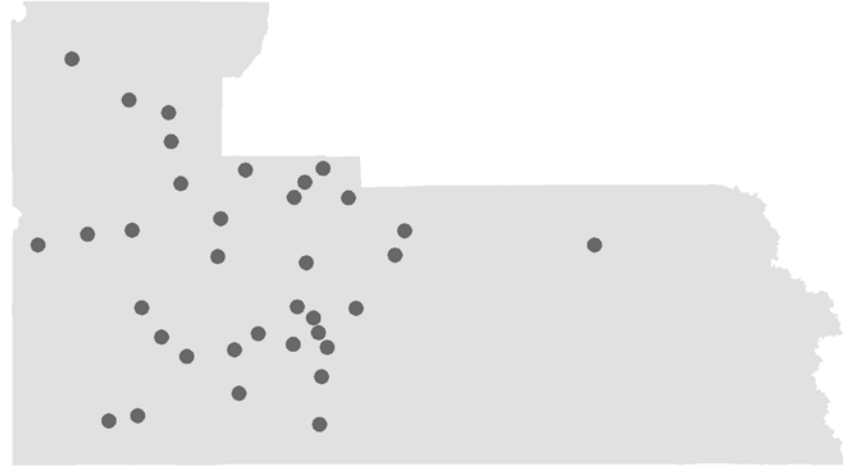
GIS Applications

- Desktop GIS applications:
 - **ESRI's ArcMap**
 - GRASS, QGIS, ERDAS...
 - R, SAS, SQL
- Web applications:
 - ArcGIS Online
 - CartoDB
 - Leaflet



Data Types

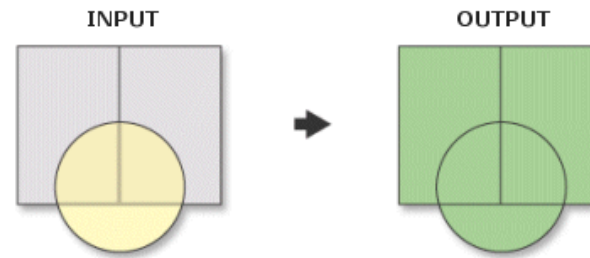
- Point
- Line
- Polygon
- Raster



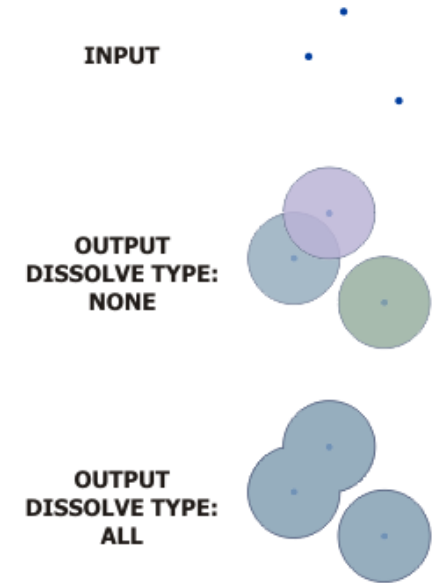
GIS Operations

- Create, manage, and maintain geographic features, datasets, and layers
- Geocode addresses
- Projections and transformations
- Aggregate or split areas
- Calculate distances or areas
- Overlays and spatial joins

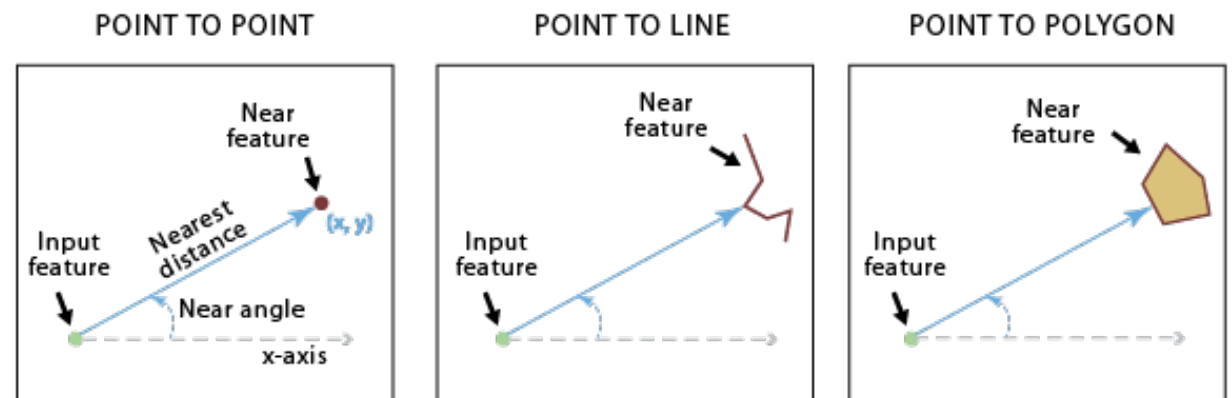
Union (overlay)



Buffer (distance)



Near (distance)



Source: ArcGIS for Desktop Online Help
<http://desktop.arcgis.com/en/arcmap/>

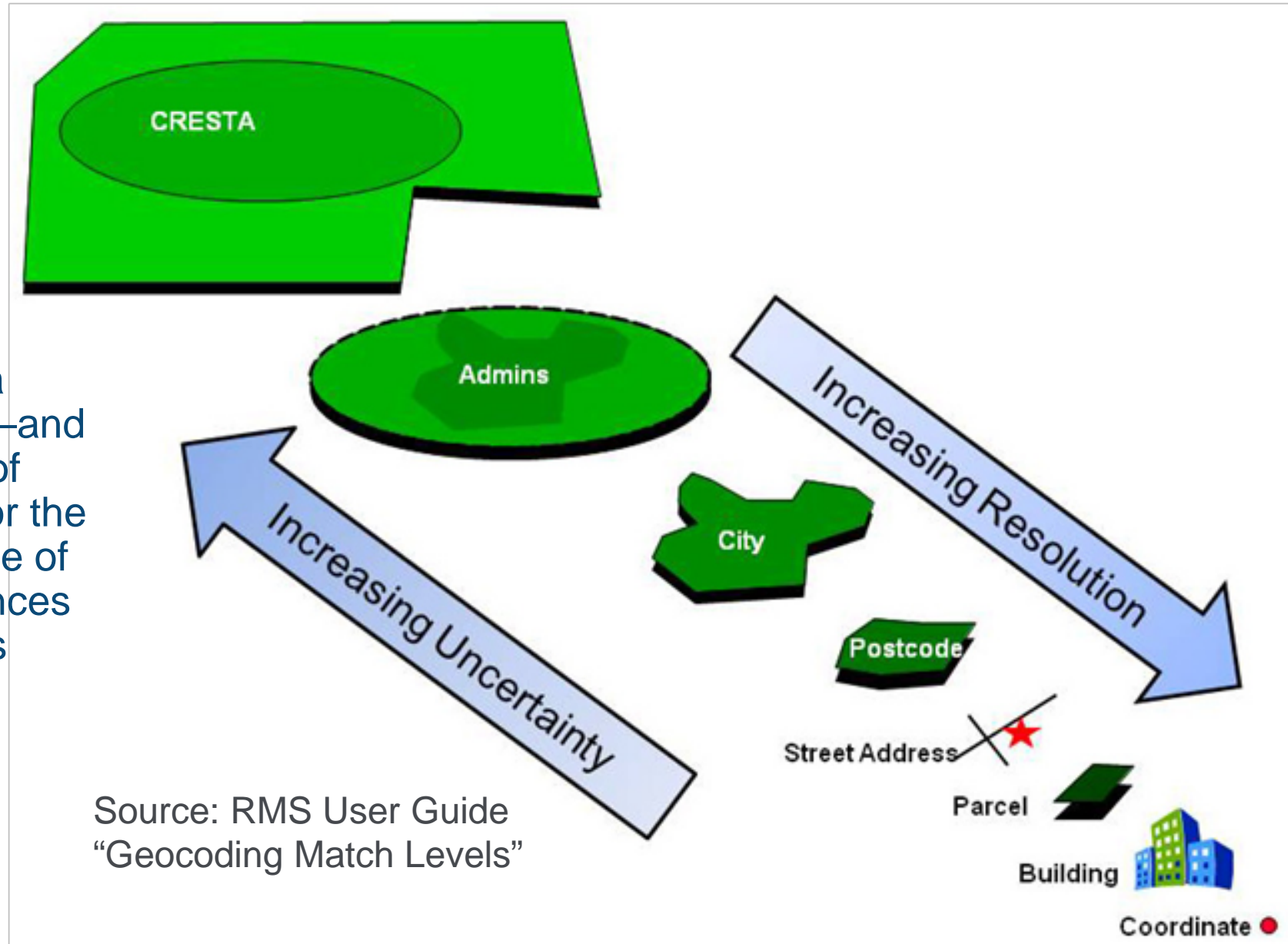
Geocoding and Location Level Data

- Geocoding: attaching a location or lat/lon to a record
- Often occurs in the catastrophe modeling process
- Every geocoder should also provide a match score and/or match type
 - Examples:
 - Parcel Point
 - Address Point
 - Address Range
 - Street Name
 - Postal Code

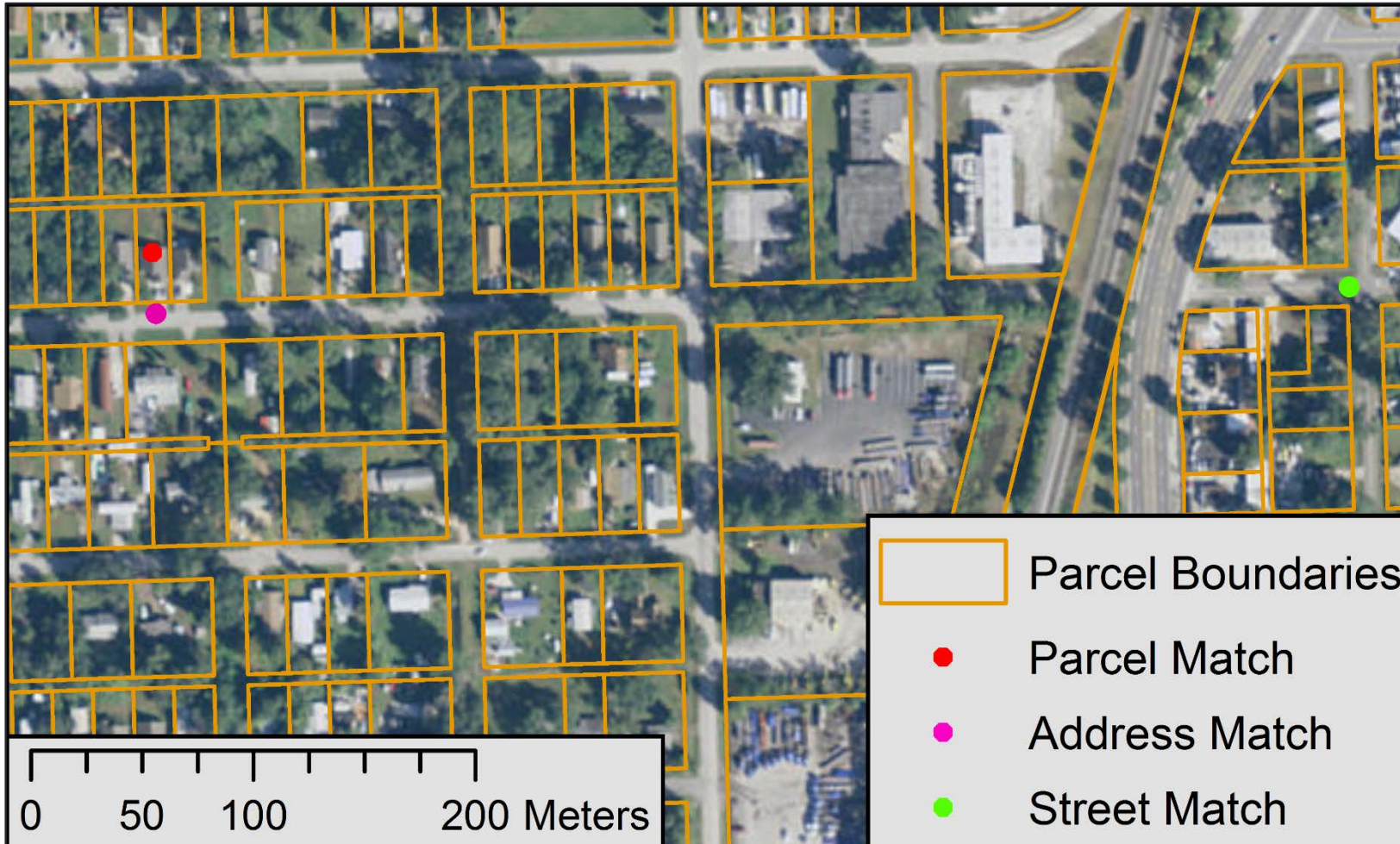
PHYADDR1	221 CORNER TREE CT	5319 HANSEL AVE APT E5	752 RIDENHOUR CIR	Input Fields
PHYCITY	ORLANDO	ORLANDO	ORLANDO	
PHYST	FL	FL	FL	
PHYZIP	32820	32809	32809	
LOC_NAME	StreetName	StreetAddress	PointAddress	Output Fields
MATCH_ADDR	Corner Tree Ct, Orlando, Florida, 32820	5319 Hansel Ave, Orlando, Florida, 32809	752 Ridenhour Cir, Orlando, Florida, 32809	
LAT	28.571006	28.482046	28.453134	
LON	-81.131031	-81.37137	-81.38701	

Geocoding and Location Level Data

“...the precision of a geocoded address—and hence the retrieval of hazard conditions for the location—can be one of the strongest influences on damage and loss results.”



Geocoding and Location Level Data



Distance from Parcel Centroid:

- Address Point:
25 m
- Street Point:
550 m
- Postal Point (not shown):
4 km

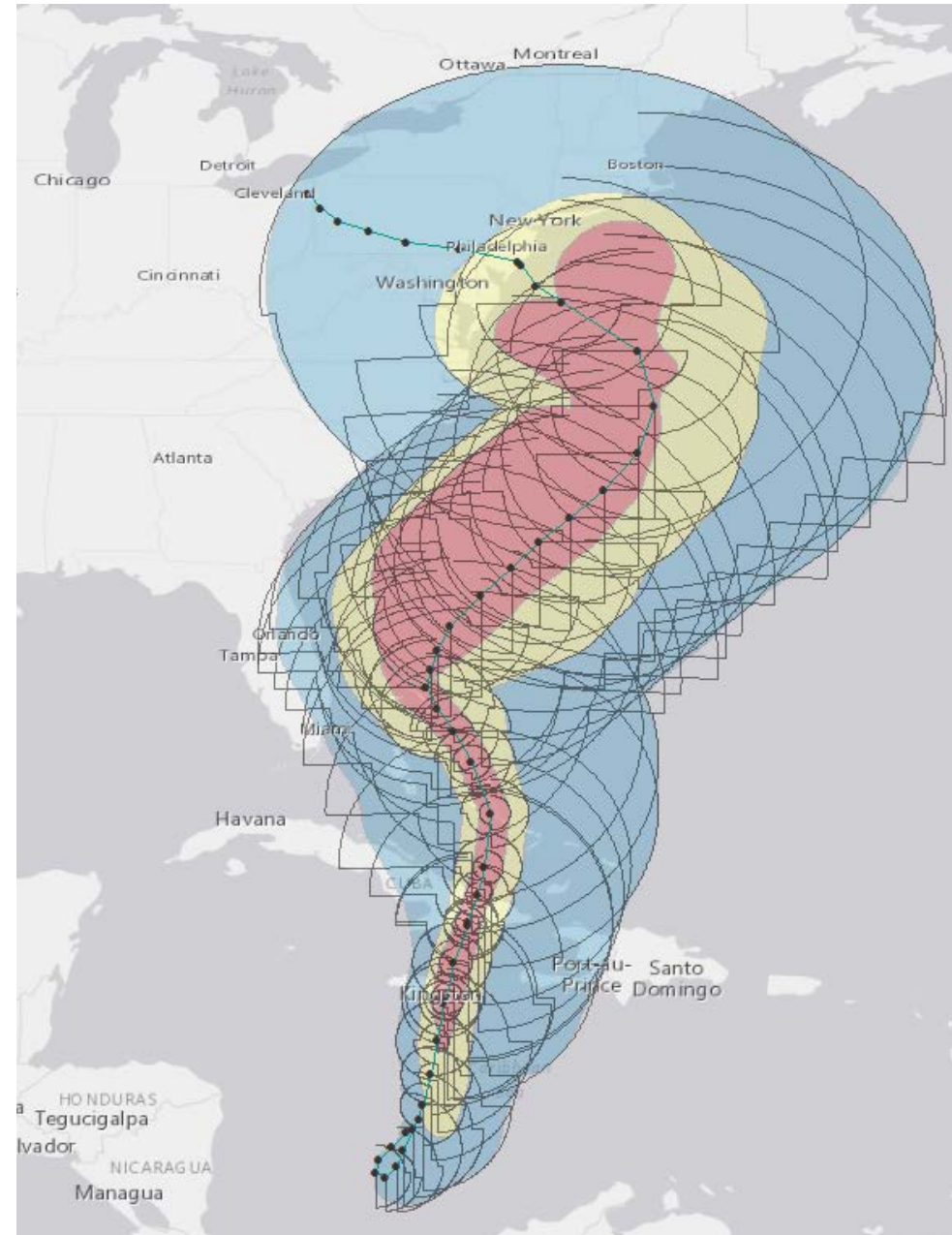


Geocoding and Location Level Data

Location	County	City	Match Type	Hurricane AAL
1	ORANGE	ORLANDO	Parcel	\$ 392.04
1	ORANGE	ORLANDO	Street	399.73
1	ORANGE	ORLANDO	City	384.88
2	BREVARD	MELBOURNE	Parcel	553.21
2	BREVARD	MELBOURNE	Street	603.85
2	BREVARD	MELBOURNE	City	650.16

Data Sources

- U.S. Geological Survey
 - National Hydrology Dataset (NHD)
<http://nhd.usgs.gov/>
 - National Elevation Dataset (NED)
<http://nationalmap.gov/elevation.html>
 - National Land Cover Database (NLCD)
<http://www.mrlc.gov/>
- NOAA
 - Coastlines
<https://www.ngdc.noaa.gov/mgg/shorelines/>
 - National Weather Service
<http://www.nws.noaa.gov/gis>
 - National Hurricane Center
<http://www.nhc.noaa.gov/gis/>
- State and local agencies
 - Ex. Parcels and land records from county assessors



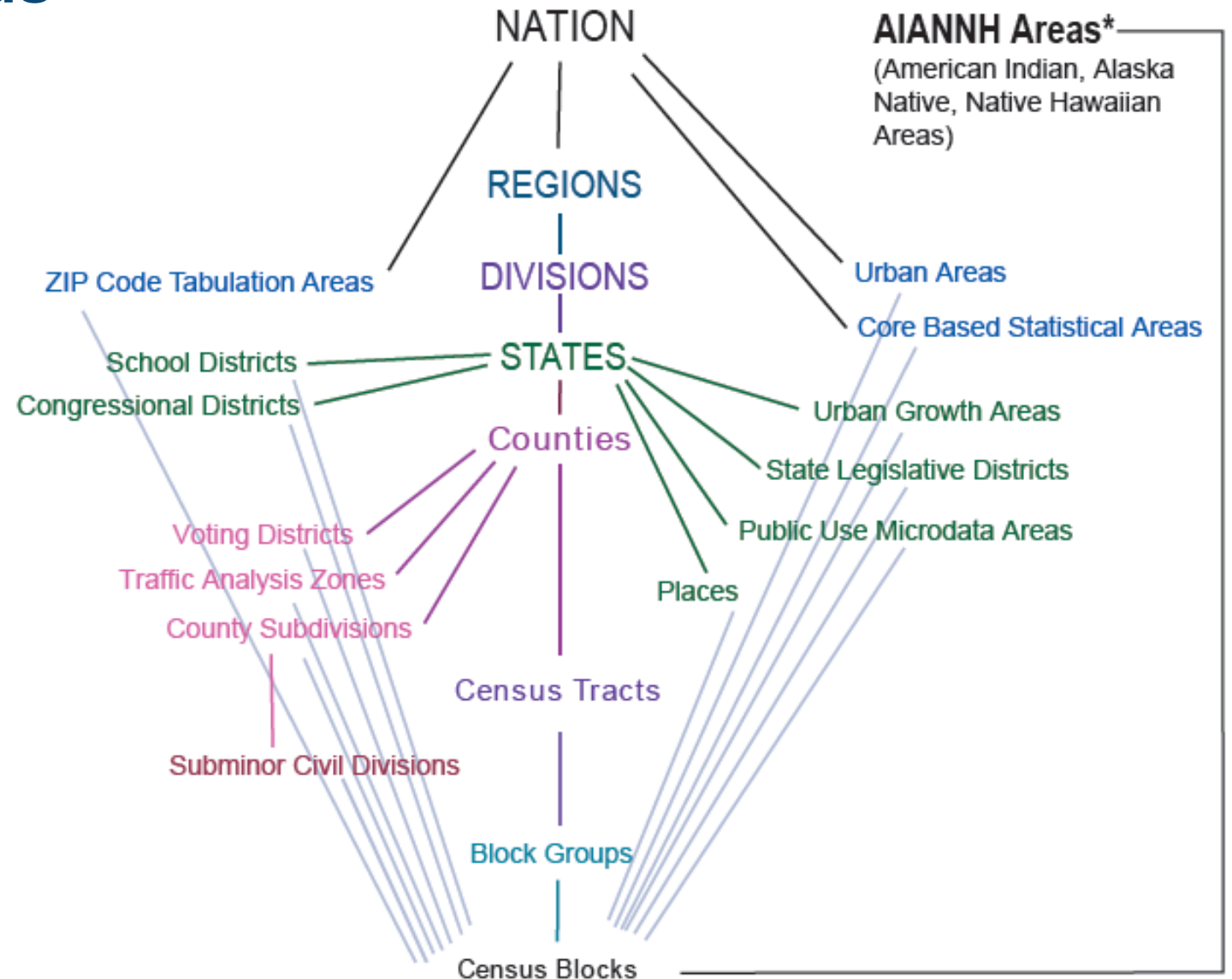
Data Sources – U.S. Census

- Census geographies
 - Source for political boundaries and base map information including hydrology and road networks

<https://www.census.gov/geo/maps-data/data/tiger-line.html>

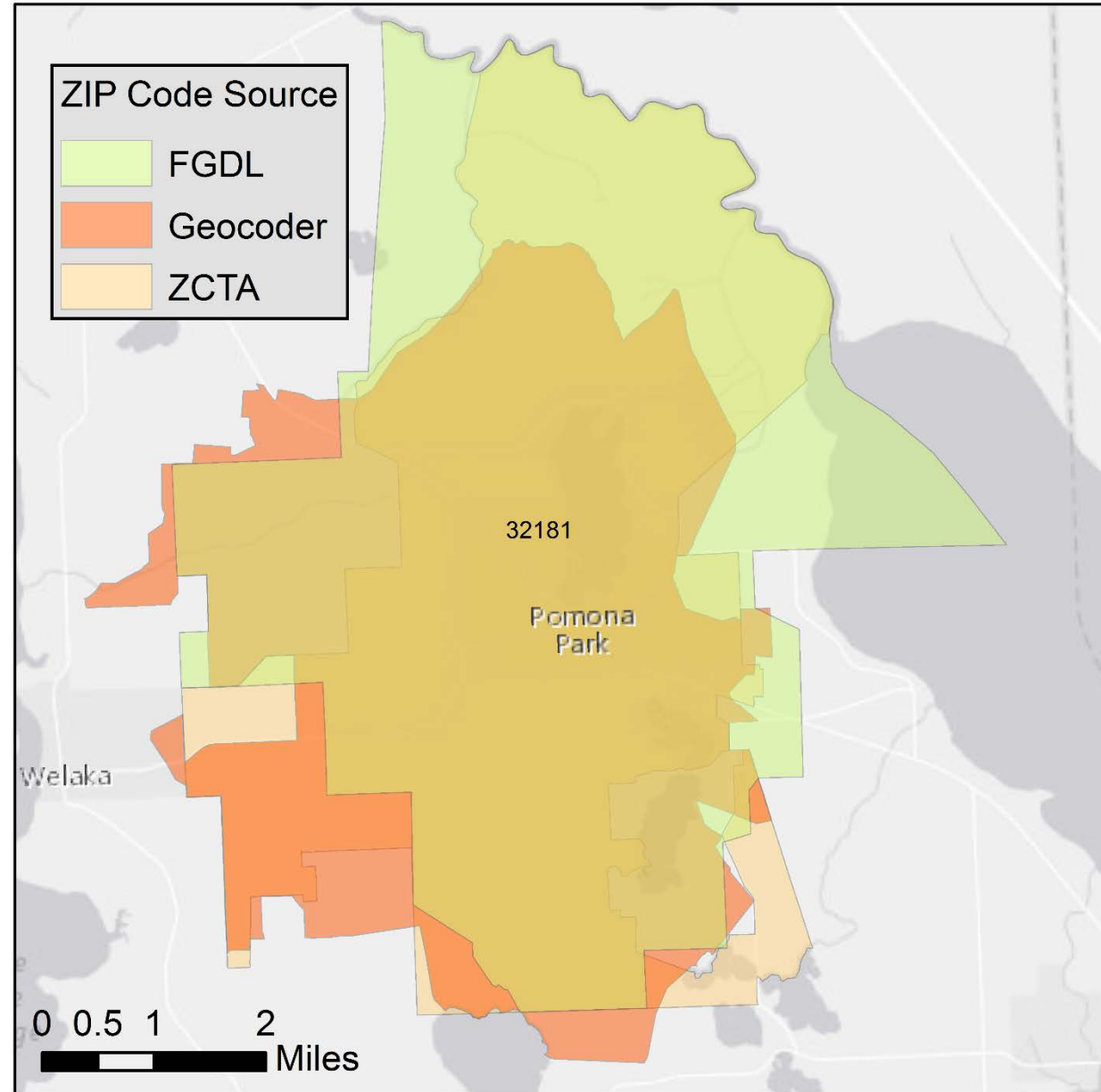
- Census data
 - Source for estimates of population, housing stock, available automobiles

<http://factfinder.census.gov/>



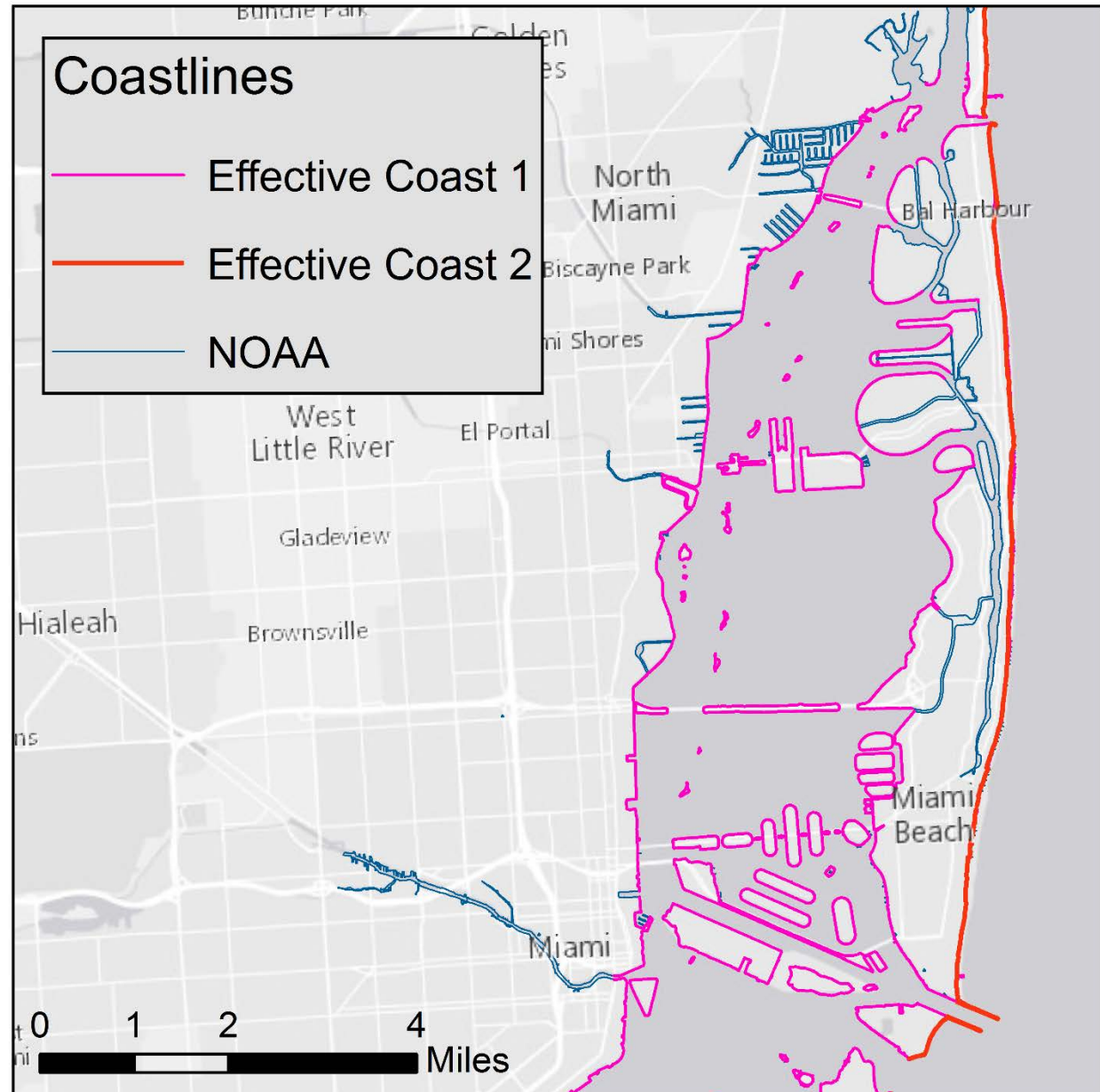
Data Sources – ZIP Codes

- Defined by USPS as address ranges
- Continually updated
- ZIP Codes are discrete data (points)
 - Defined at the delivery address
- Often do not coincide with county or city boundaries
- Census ZIP Code tabulation areas (ZCTA)
 - Statistical areas that approximate ZIP codes



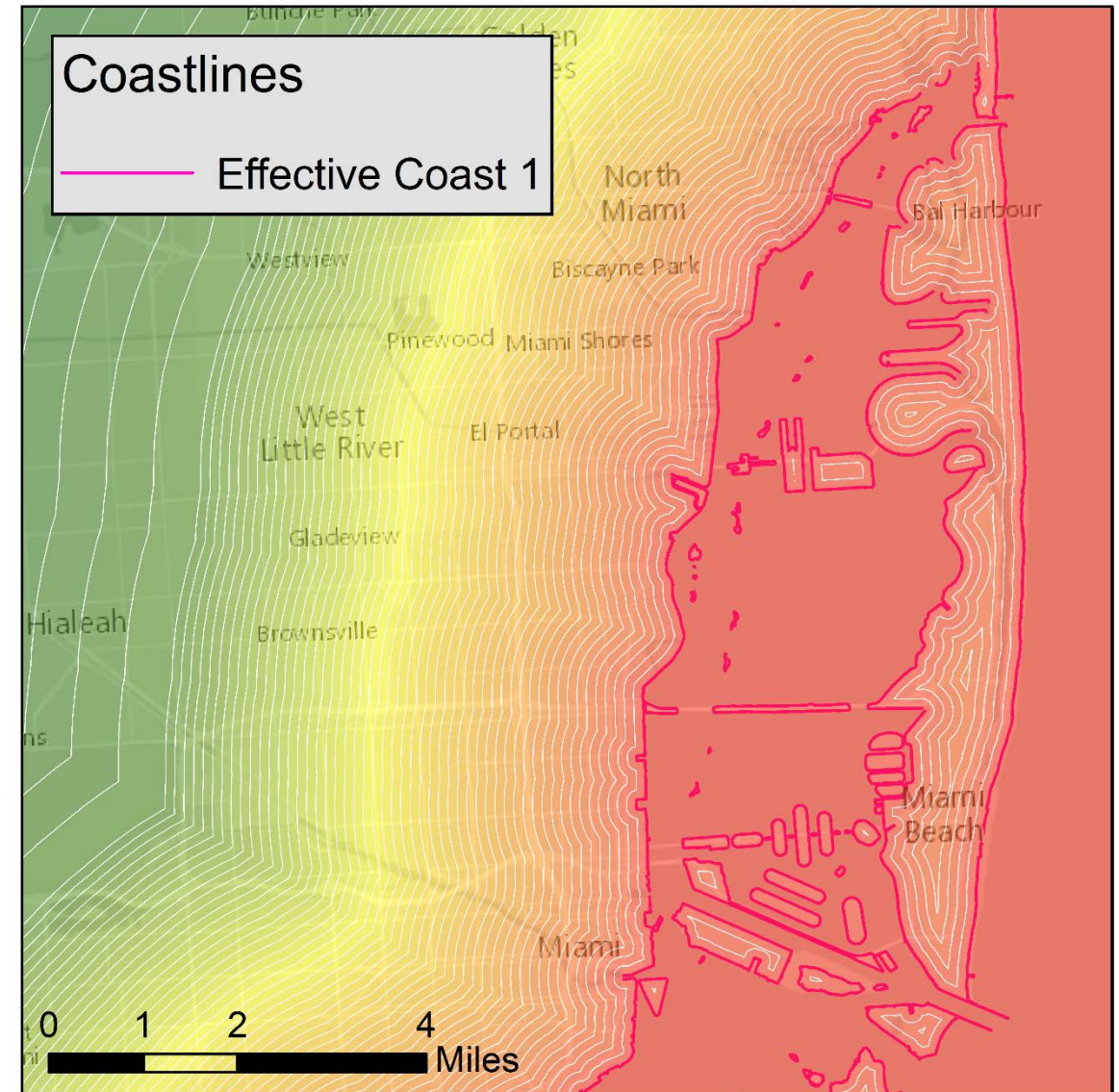
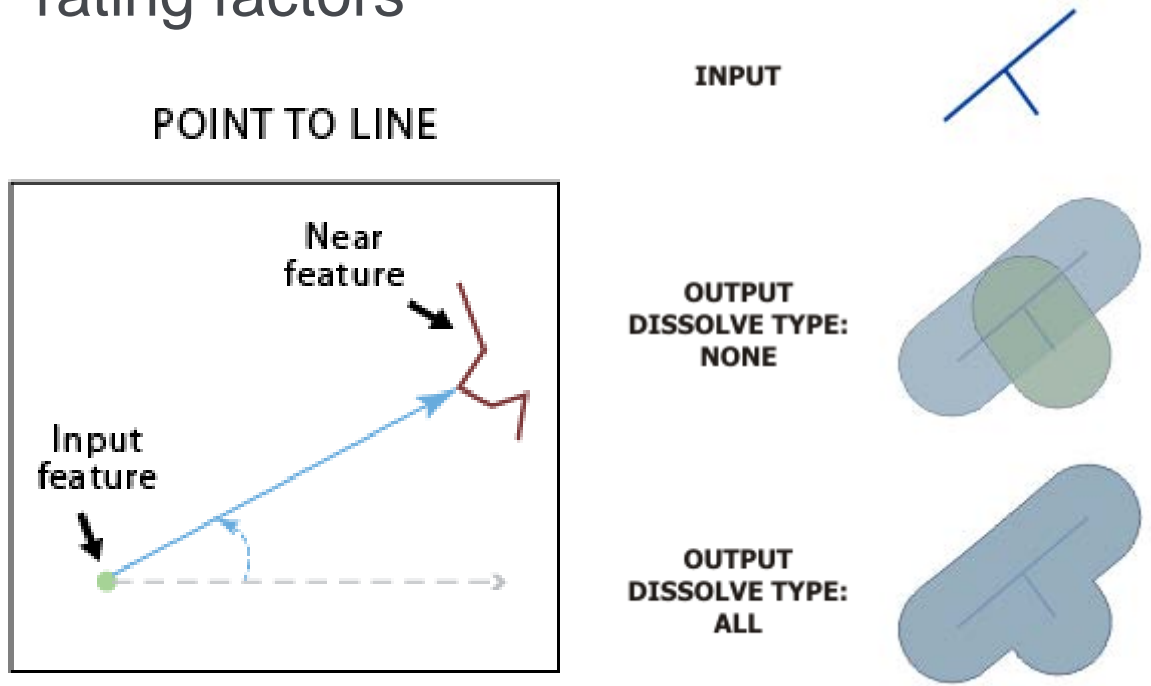
Distance to Coast

- Possible Input data sources:
 - NOAA Shorelines
 - National Hydrology Dataset
- Distance to salt water versus distance to effective coastline
- GIS software necessary to edit third-party data sources to create desired layers



Distance to Coast

- Calculate exact distance for each location
- Create distance bands for rating factors



Source: ArcGIS for Desktop Online Help

Elevation Data

- National Elevation Dataset (NED)
 - Seamless coverage for the U.S.
 - 1/3 arc-second, 1 arc-second, 2 arc-second (~10 m, 30 m, 60 m)
 - Continuous updates with better data
 - 1/9 arc-second (~ 3 m) available in limited areas
 - 1 m dataset introduced in 2015

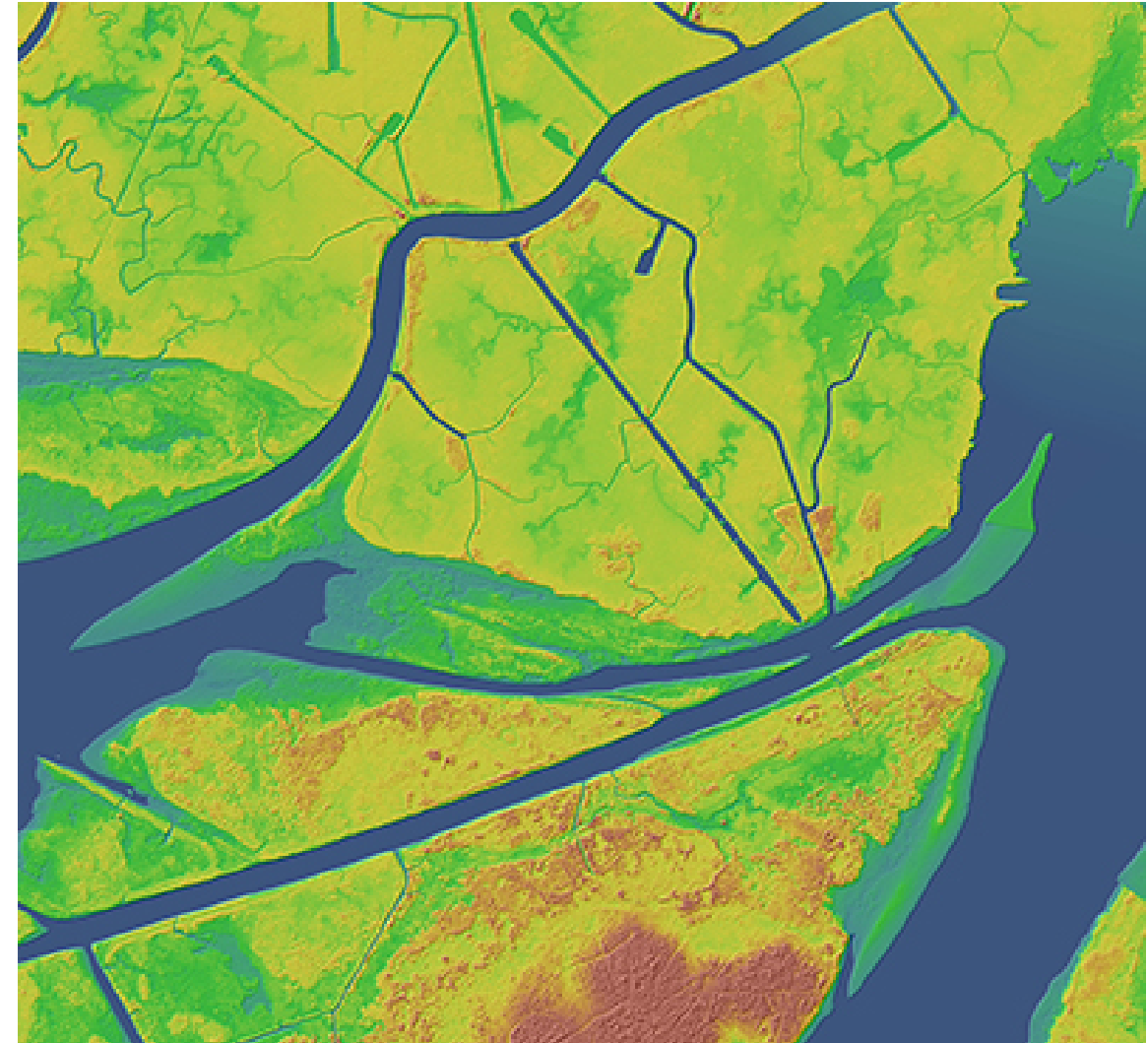
- Downloads

<http://nationalmap.gov/elevation.html>

- Query service

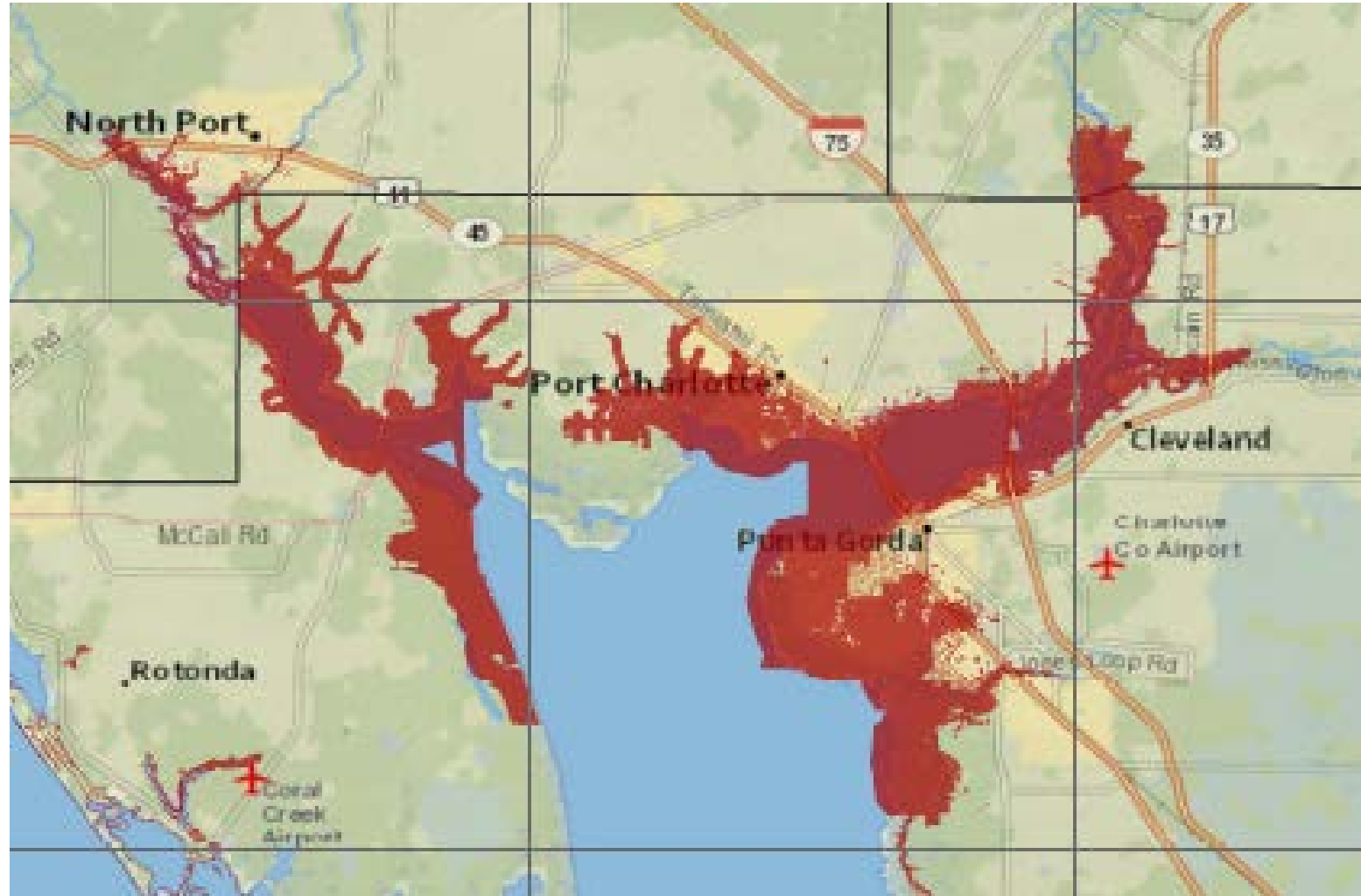
<http://ned.usgs.gov/epqs/>

Parameter	Value
X:	<input type="text"/>
Y:	<input type="text"/>
Units	Feet ▼
Output	JSON ▼
<input type="button" value="Get Elevation"/>	



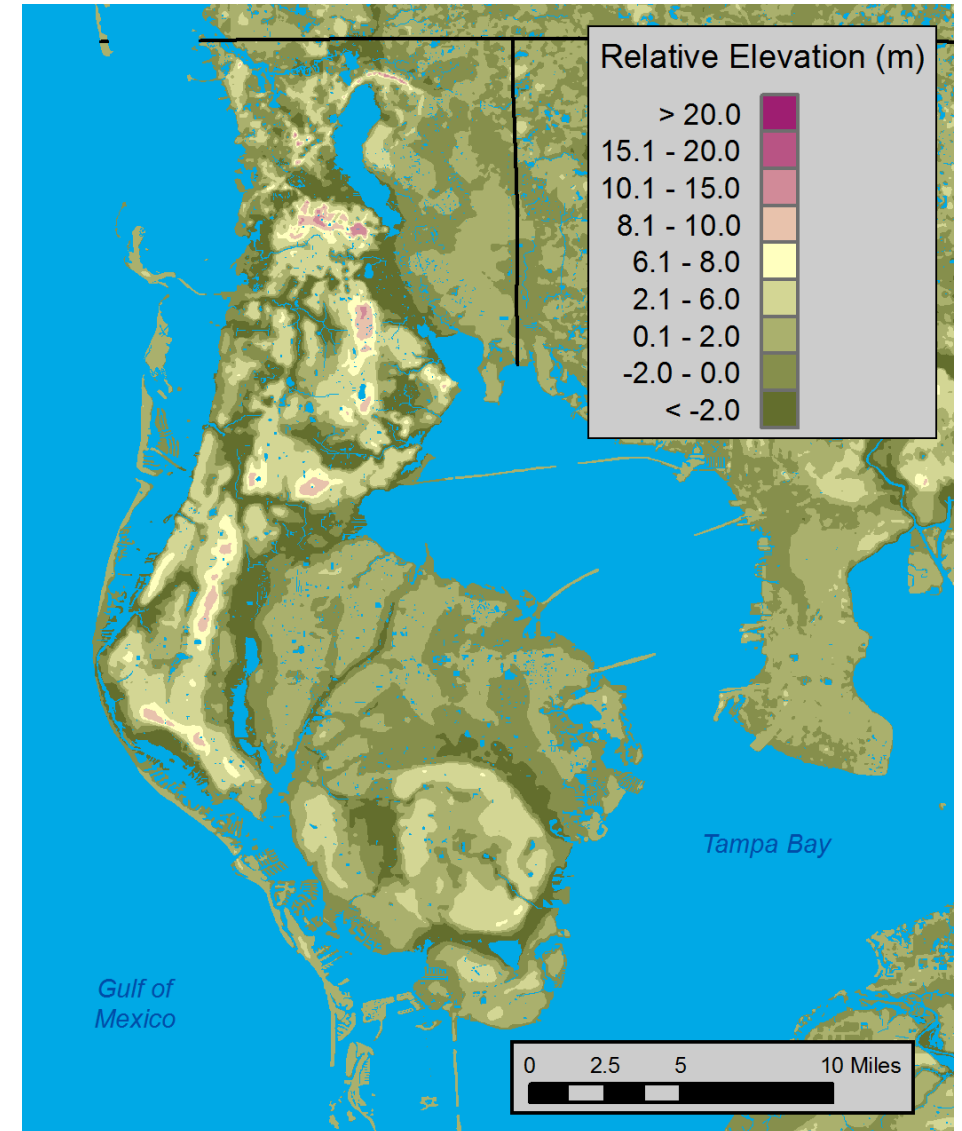
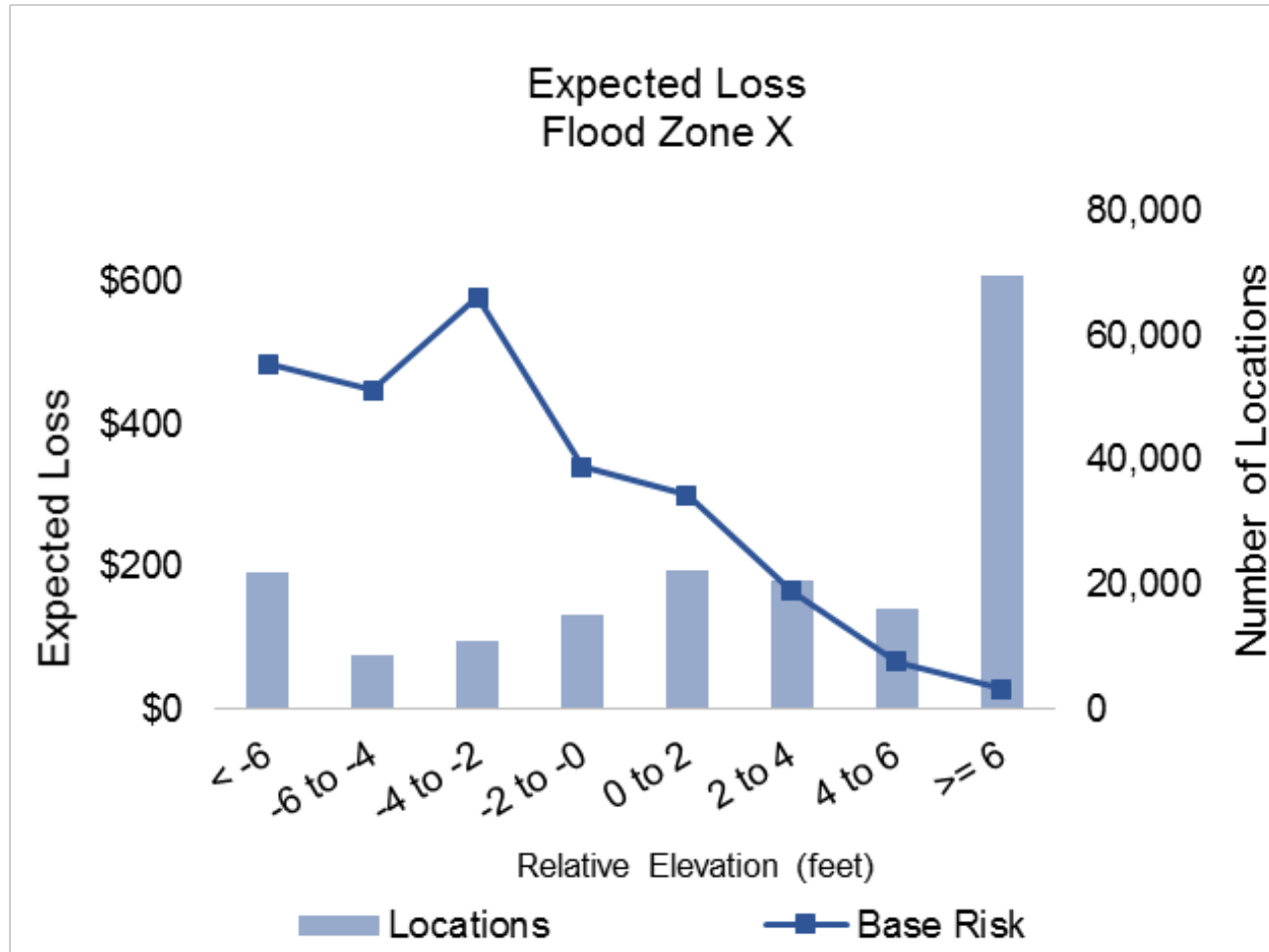
1 meter bare earth DEM, Atchafalaya basin, Louisiana
Source: USGS National Map

Minimum Permissible Elevation Model



Example case of ineligible areas near Punta Gorda, Florida

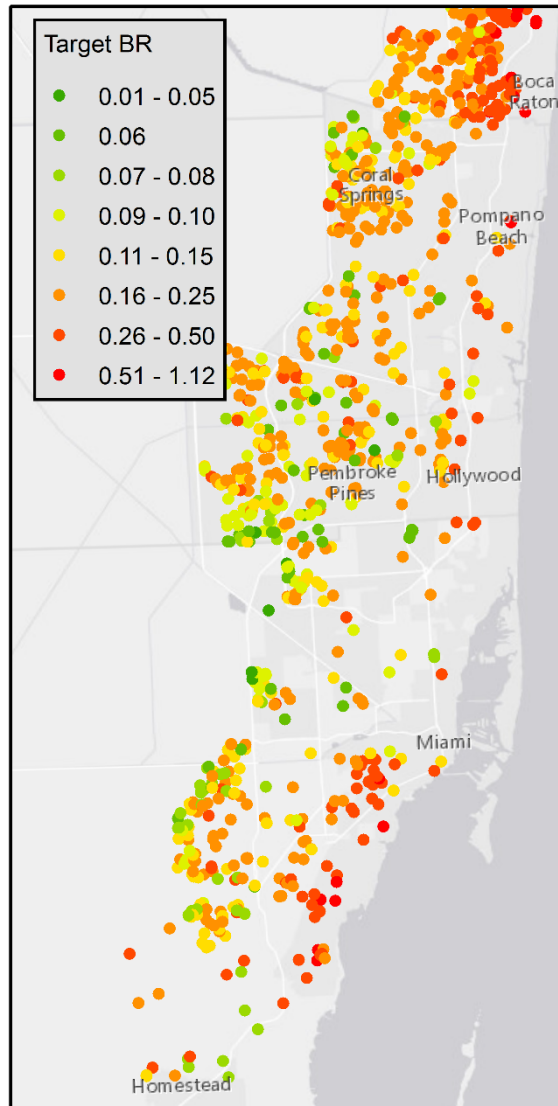
Elevation Data – Relative Elevation



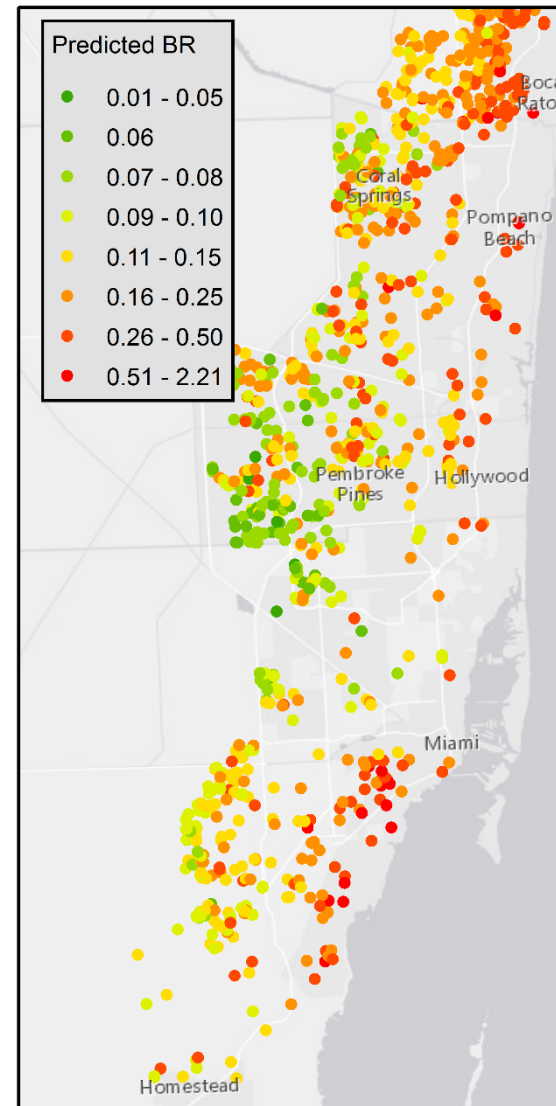
Example raster showing relative elevation in Pinellas County, Florida

Visualizing CAT model output

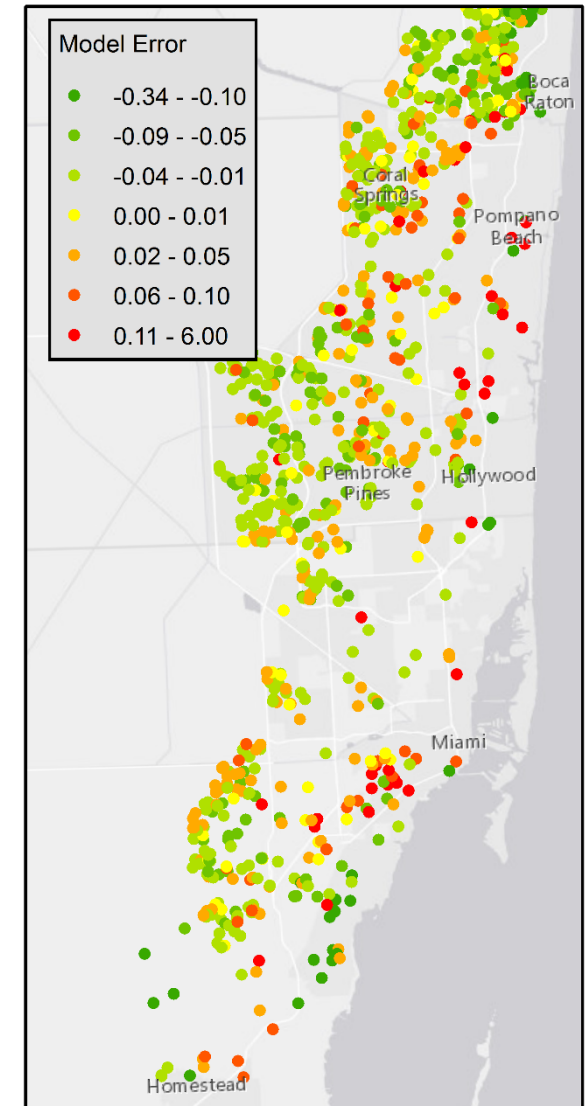
- Comparison of expected CAT model loss to GLM output



Target



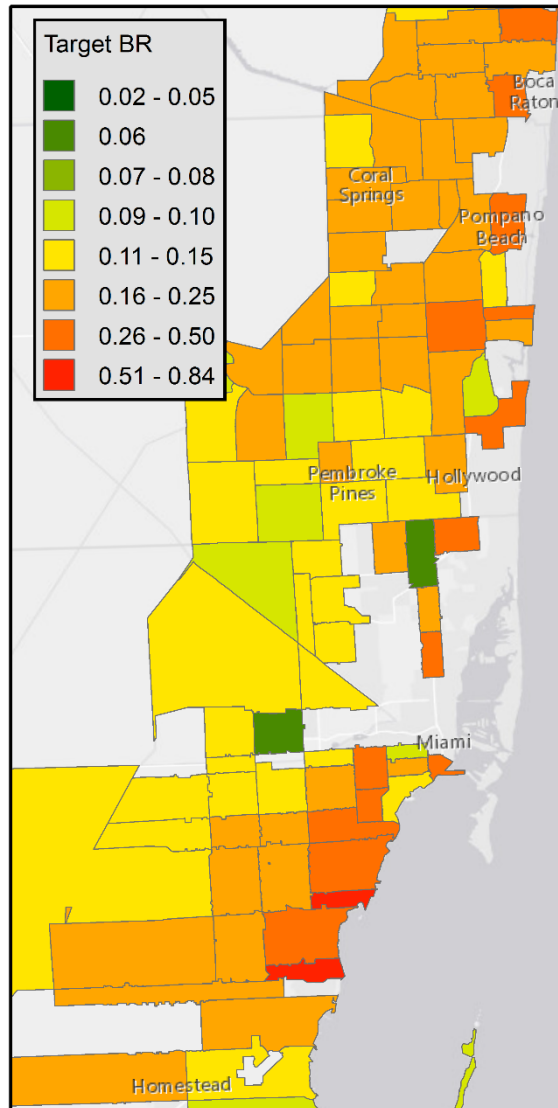
Predicted



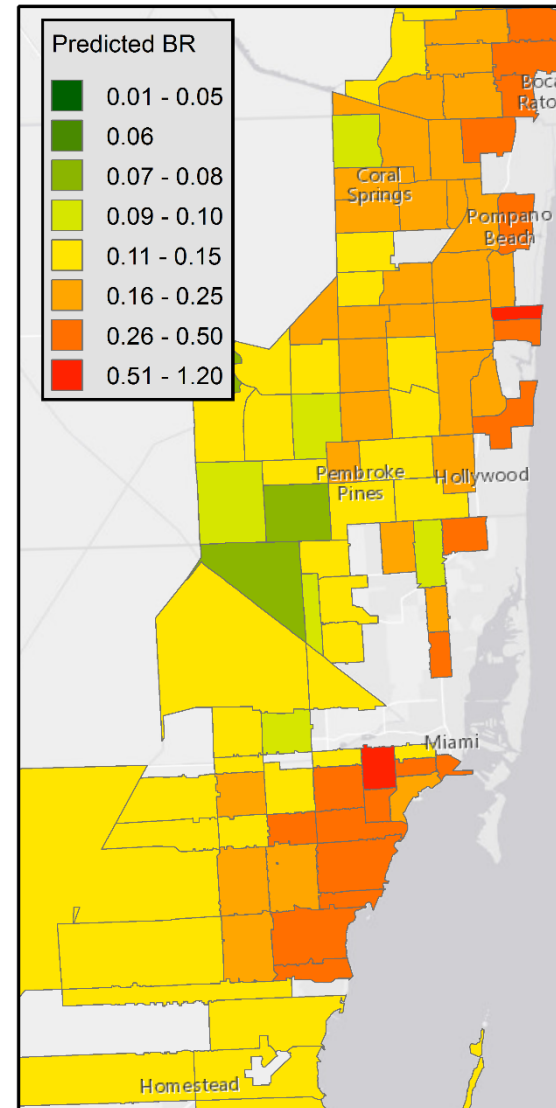
Error

Visualizing CAT model output

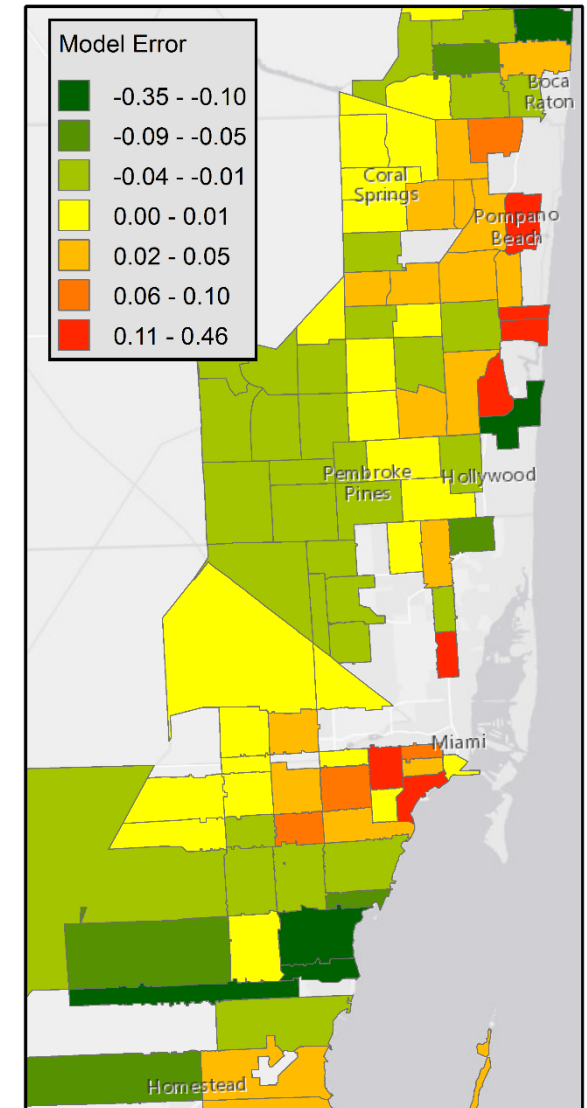
- Summarized by polygon areas



Target



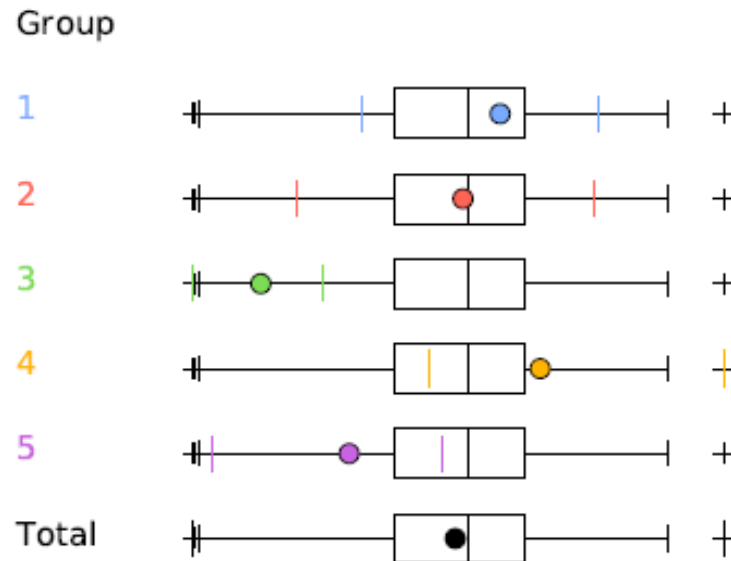
Predicted



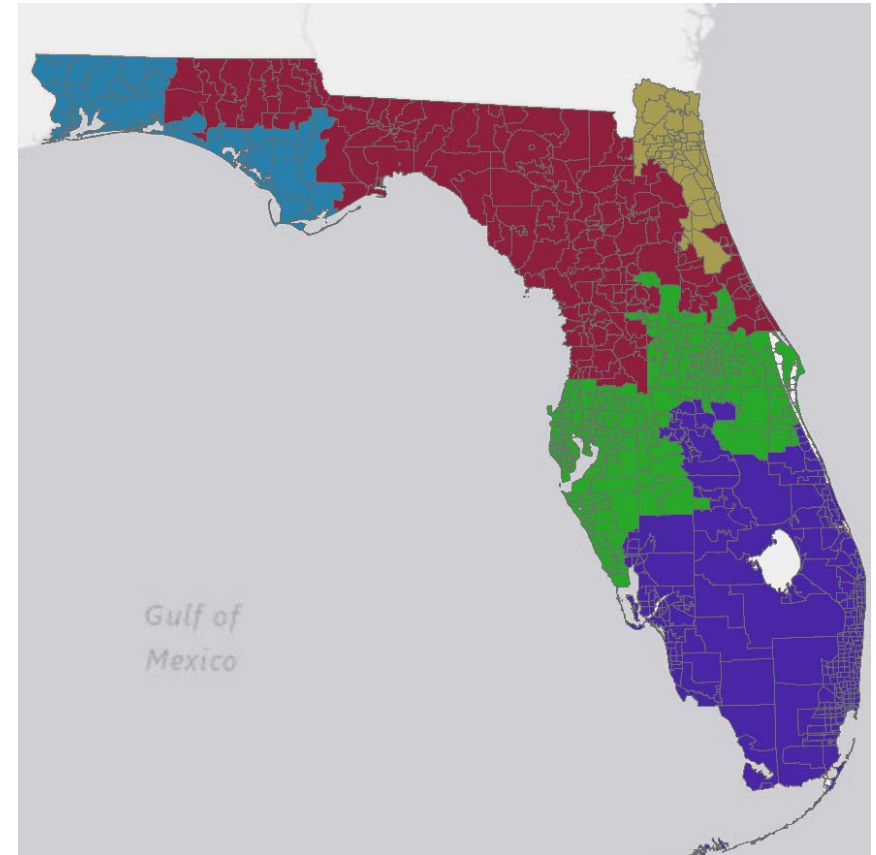
Error

Clustering and Territory Creation

- Grouping Analysis tool in ArcGIS
- Attempts to identify natural clusters
- Can use spatial relationships to define neighbors
 - Nearest neighbor
 - Contiguity
 - Triangulation
 - Custom Weights

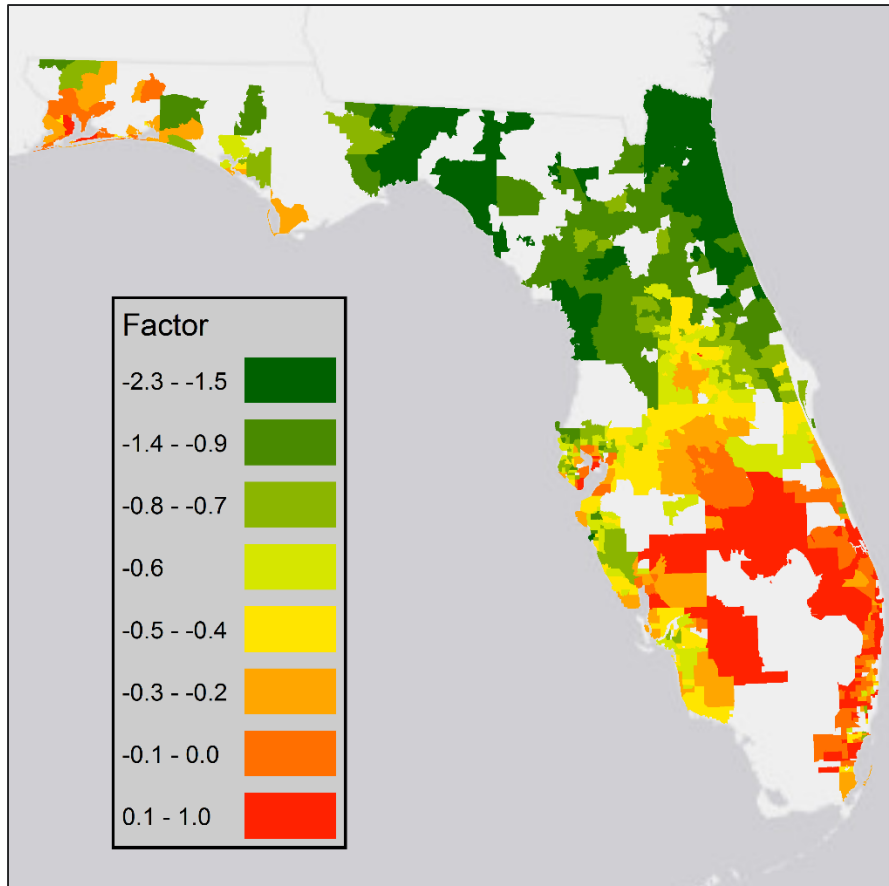


Box-and-whisker plots of each output group relative to the total.

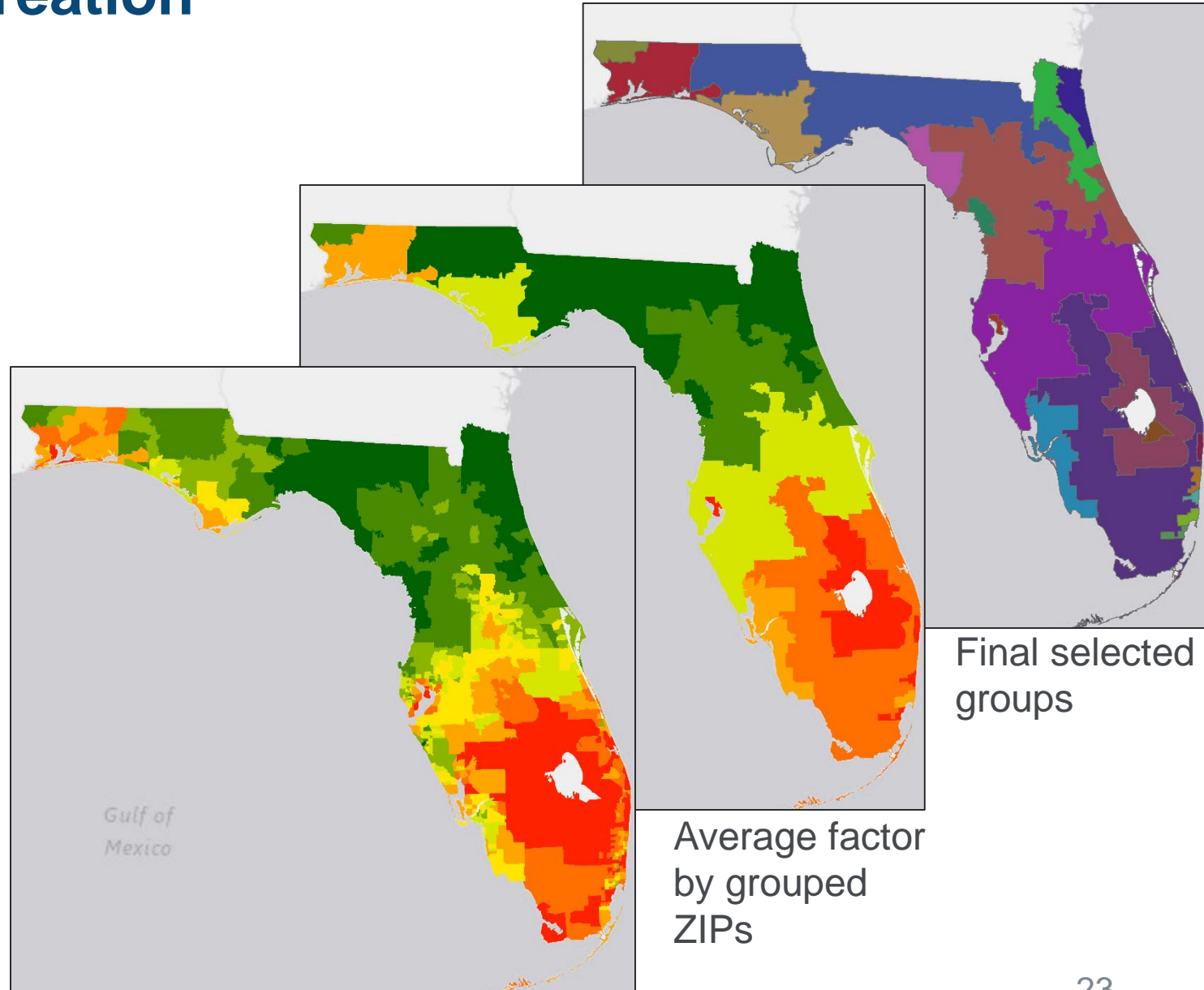


Example Grouping Analysis Output using Florida ZIP Codes with 5 output groups.

Clustering and Territory Creation



Modeled factors by ZIP Code



Interpolated factors

Average factor by grouped ZIPs

Final selected groups



Thank you

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