# Spatial Representation of the Potential Impacts of Hurricanes on Vulnerable Population Groups

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## Motivation

- The colossal impacts of Hurricanes and the domino effects, including floods, infrastructure damages, and loss of lives are well known.
- Recent hurricane events such as Hurricanes Matthew, Irma, and Florence have had tremendous impacts on infrastructure and more importantly, lives.
- The disproportionate effects of hurricanes on the aging population and low-income neighborhoods in terms of both infrastructure damage and recovery are reported[1,2].


## Study Objectives

- Investigating areas most impacted by hurricanes, and how elderly population groups are affected.
- ArcGIS spatial analysis techniques for representing census data, and the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model[3] are leveraged for evaluating areas of increased storm surge heights.
- Identifying and spatially representing infrastructure, i.e. roads and bridges at risk of closure due to flooding or overtopping.
- Identifying which infrastructures are spatially connected to elderly-dense areas.

## Methodology

Identify areas of high elderly population density using ArcGIS spatial analyst tools

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Identify critical infrastructure important to vulnerable population using kernel density

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Analyze storm surge heights based on selected basins, historical data and storm surge maximum envelop of water (MEOW) using SLOSH Display

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Extract storm surge height data for specific storm (wind direction and speed) as shapefile for further analyses in ArcMap

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Identify elderly-dense areas affected by categorical storms and at-risk infrastructure of interest to the identified areas. Identified areas and infrastructure (bridges) are further investigated.

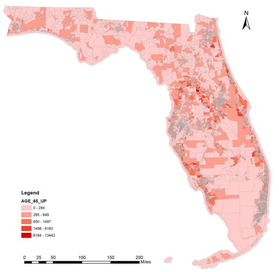
### Data Sources

Data obtained from Florida Geographic Data Library (FGDL):

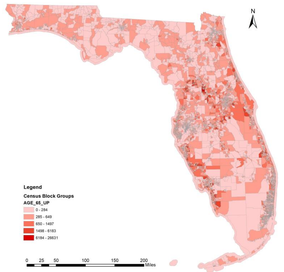
- Florida Census Block Groups, 2016
- National Bridge Inventory Data
- Florida Roadways (Tiger files)

Slosh Model Data and Slosh Display from National Oceanic and Atmospheric Administration (NOAA) – United States Department of Commerce

## Analysis

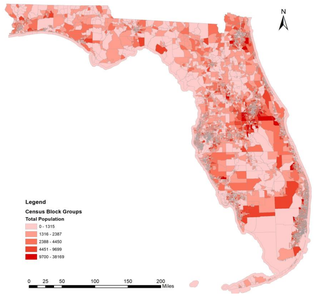



Map of Florida's Elderly Population (2011)

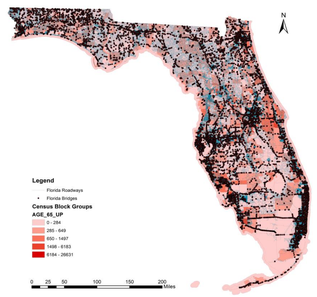



Map of Florida's Elderly Population (2016)

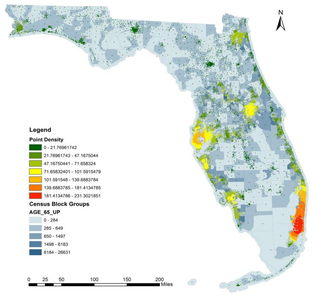
## Analysis



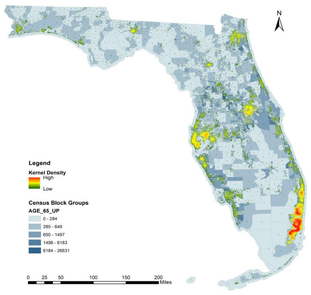

Map of Florida's Total Population



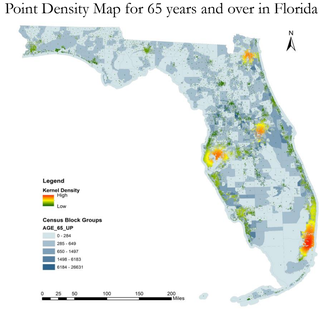

Map Indicating Roadways and Bridges



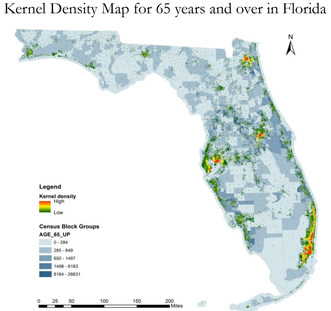

Point Density Map for 65 years and over in Florida



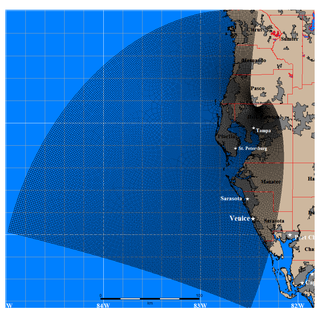

Kernel Density Map for 65 years and over in Florida



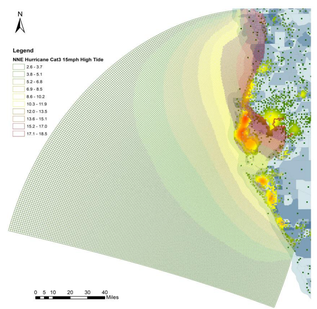

Kernel Density Map for Florida Bridges




Kernel Density Map for Florida Bridges weighted by ADT

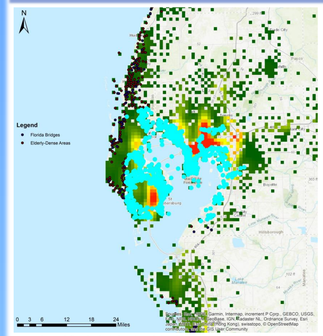



Tampa Bay Basin Identification Using Slosh Display



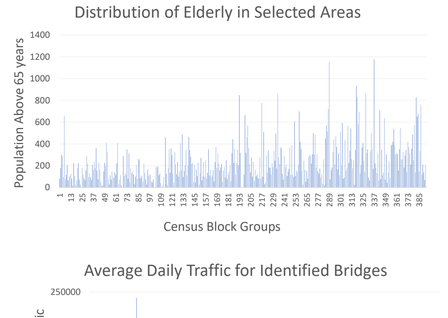

Further Analyses SSH in the Tampa Bay Area

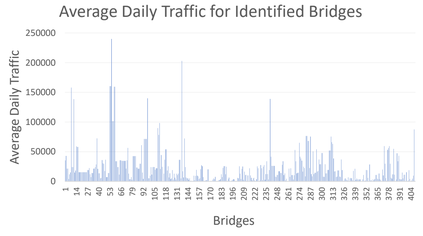
## Results

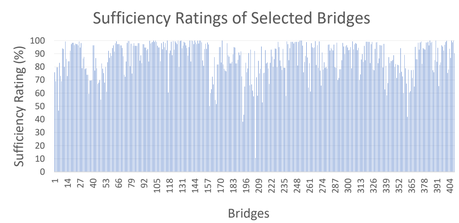



Identified Critical Elderly Areas and Bridges

- Results indicate that 402 out of 501 selected bridges are of interest to elderly commute within the Bay Area.
- Based on high SSH (>12 ft) 393 out of 601 selected census block groups within elderly dense areas are identified as important in the event of an NNE Category 3 Hurricane with 15mph High Tides.
- Further analyses indicated the mean age among those 65 years and above was 74 years and about 20% of the total population are 65 and above.




## Conclusions

- This study investigated areas most impacted by hurricanes, and how elderly population groups are affected by using ArcGIS spatial analysis techniques and leveraging SSH data from SLOSH Model
- The schematic framework utilized here can be used to identify critical infrastructure affected by hurricanes and tropical storms.
- Identified infrastructures and their relevance to vulnerable age groups can serve as basis to take proactive measures in the case of storm events.
- Identifying affected infrastructure through simulated storms can help responsible agencies to evaluate infrastructure health conditions for maintenance, repair and rehabilitation activities when needed.

## Sample References

[1]Brunkard, J., Namulanda, G., & Ratard, R. (2008). Hurricane katrina deaths, louisiana, 2005. *Disaster medicine and public health preparedness, 2*(4), 215-223.

[2]Prasad, S. (2018). Measuring and Comparing Hospital Accessibility for Palm Beach County's Elderly and Nonelderly Populations During a Hurricane. *Disaster Medicine and Public Health Preparedness, 12*(3), 296-300. doi:10.1017/dmp.2017.89

[3]Jelesnianski, C., Chen, J., Shaffer, W., & Gilad, A. (1984). SLOSH-a Hurricane Storm Surge Forecast Model. In *OCEANS 1984* (pp. 314-317). IEEE.