Hurricane Katrina, Race, and Wealth: Using GIS to Assess Environmental Justice

By Willow Campbell, Heather Hartunian, and Barbara Van Ness

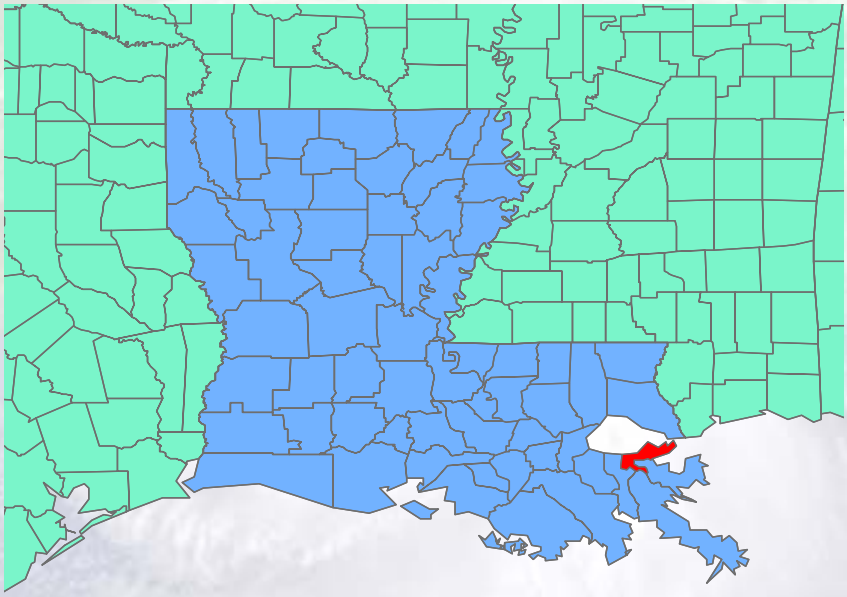
Problem Statement

- What groups of people, both racially and economically, were most affected by Hurricane Katrina and its aftermath?
- Identify possible evacuation routes

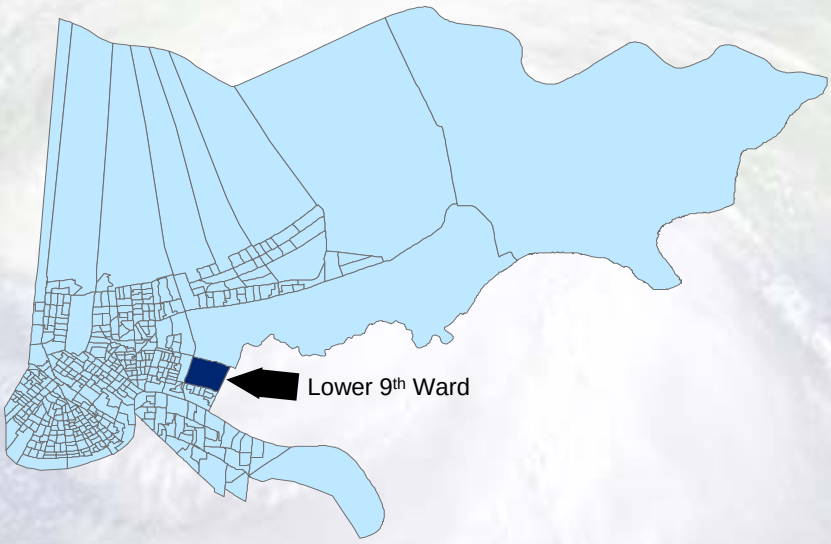
Data Layers

- ESRI
  - Census Block Group data
  - Roads and Highways
- USGS Seamless
  - DEM
- US Census Bureau
  - Income
- FEMA
  - Extent of Flood Damage

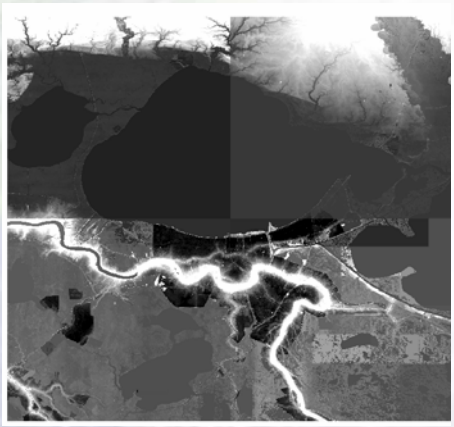
Orleans Parish



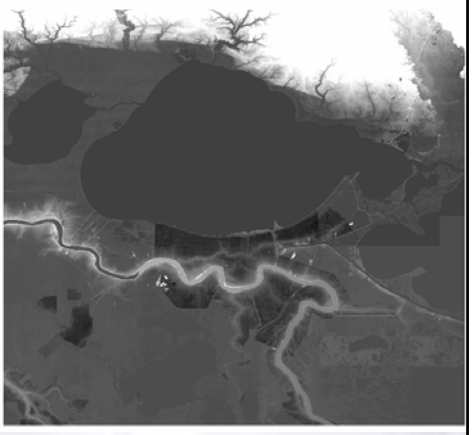
Lower 9th Ward



Mosaics of DEMs

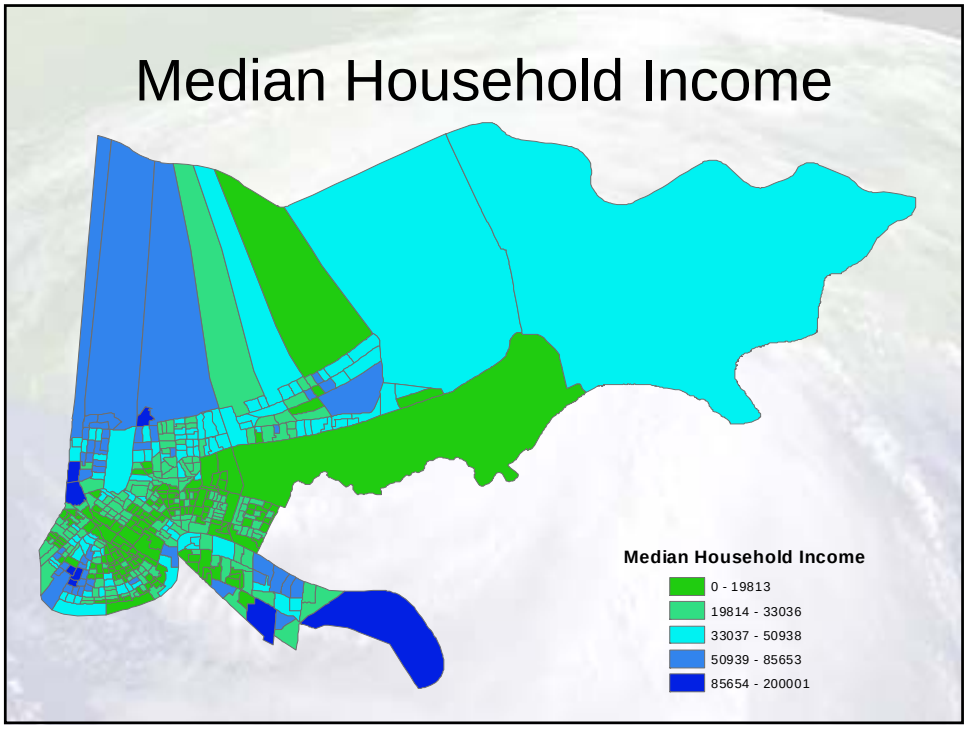


Original four DEMs

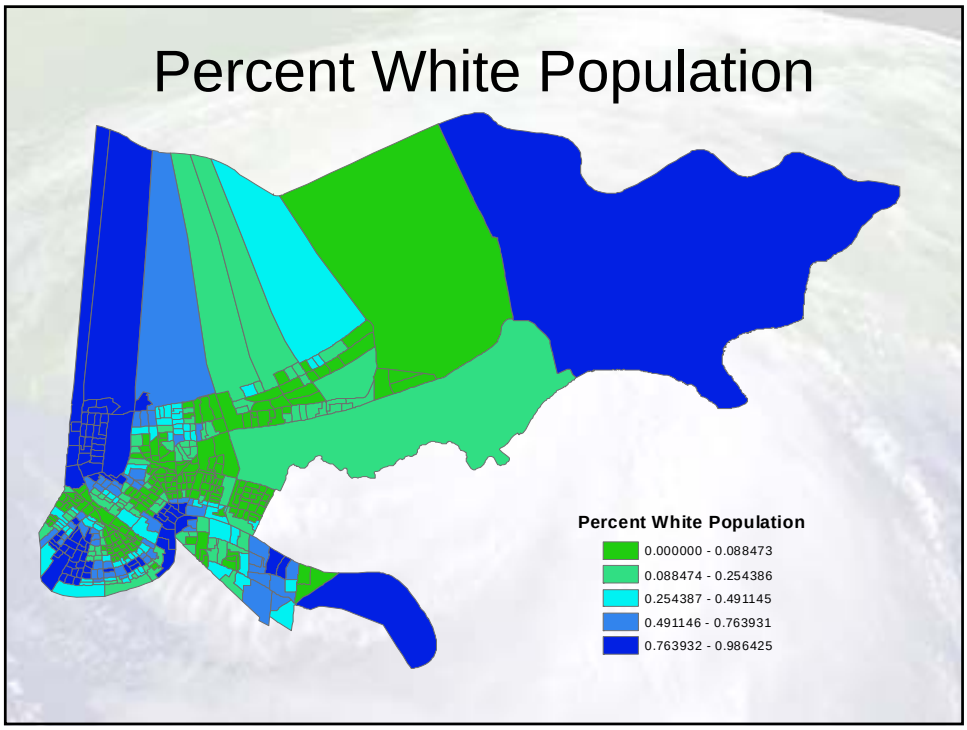


Final Mosaic

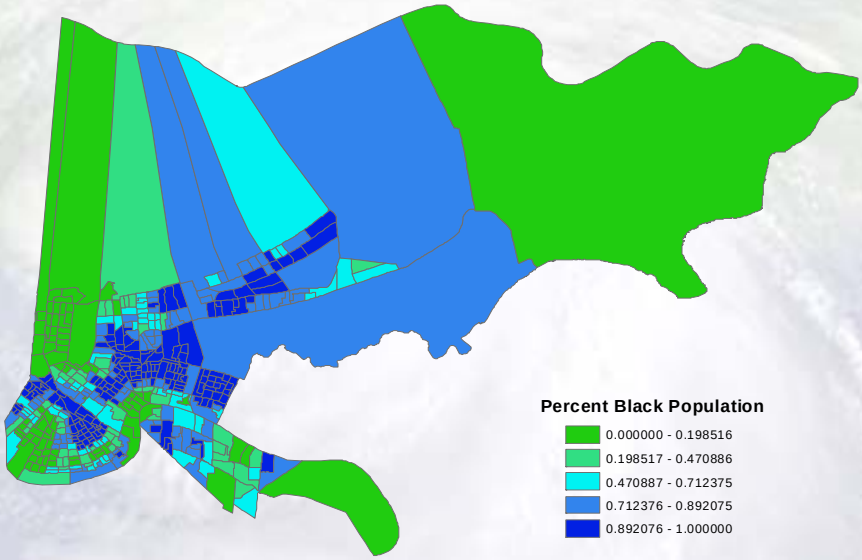
Median Household Income



Percent White Population



Percent Black Population



Moran's I for Median Household Income

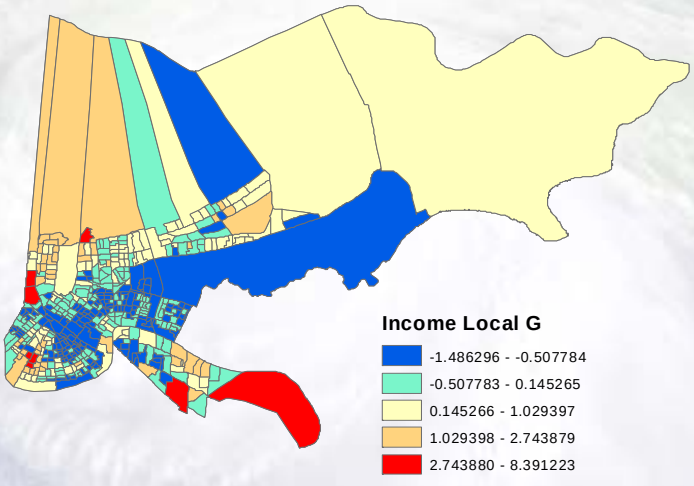
Moran's I Index = 0.09

- Z Score = 28.6 standard deviation
- There is less than 1% likelihood that this clustered pattern could be the result of random chance.

Getis –Ord General for Median Household Income

- General G Index = 21.59
- Z Score = -6.1 standard deviation
- There is a less than 1% likelihood that the clustering of low values could be the result of random chance.

Hot Spot Analysis (Getis-Ord Gi*)



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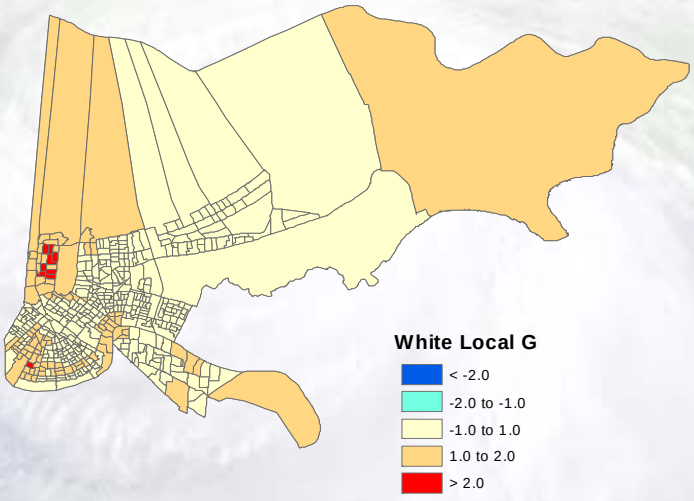

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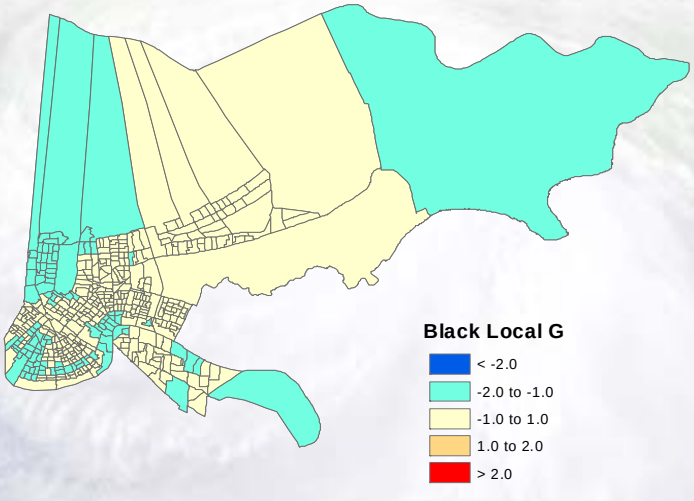
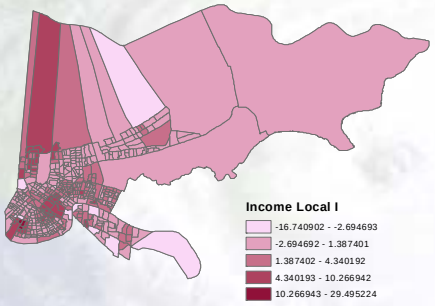
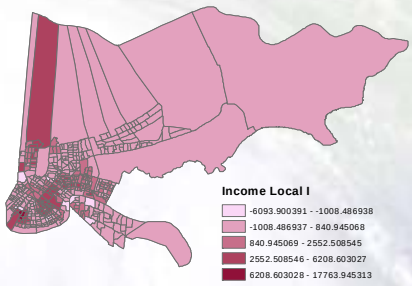


Local Moran's I Index

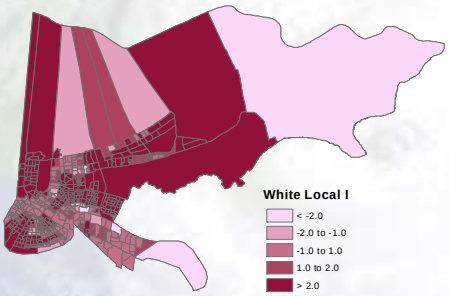


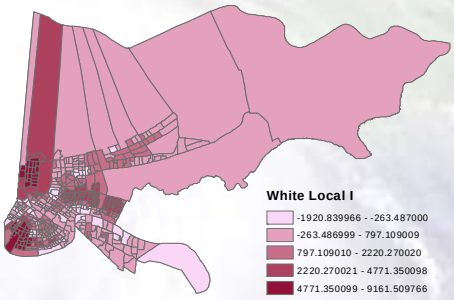


Z Score

Local Moran's I Index

Local Moran's I Index





Z Score

Local Moran's I Index

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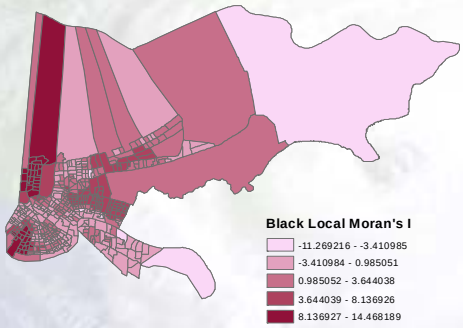
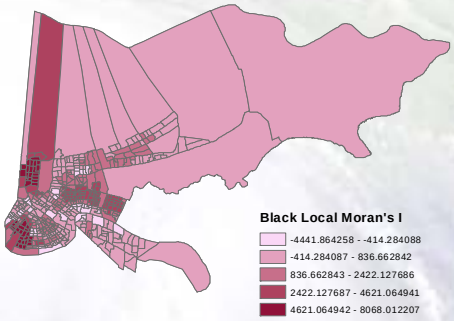


Z Score

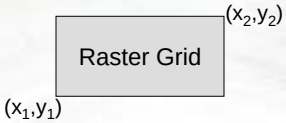


Local Moran's I Index

Converted to Grid

- Use of Spatial Analyst tool Convert Features to Raster
  - Percent Black
  - Percent White
  - Median Household Income

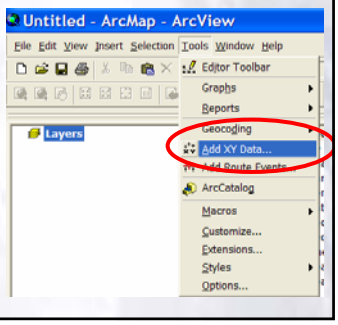
Random Locations



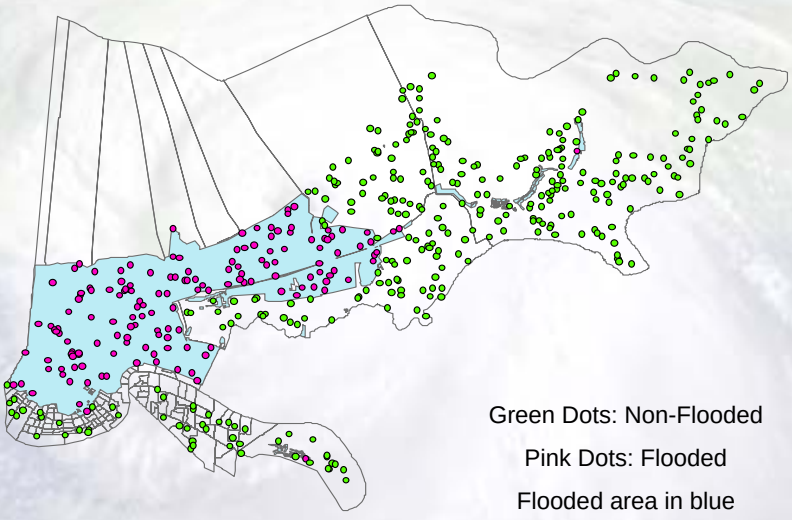
- To generate a random point, (x', y') in Excel:

  $x' = x_1 - (x_1 - x_2) * RAND()$

  $y' = y_1 - (y_1\ y_2) * RAND()$
- Saved as a DBF file
- In ArcMap:
  - Added points with Toolx / Add X,Y
  - Three data sets made from these points
    - Orleans Parish
    - Flooded areas
    - Non-Flooded areas



Generated Random Points



Green Dots: Non-Flooded

Pink Dots: Flooded

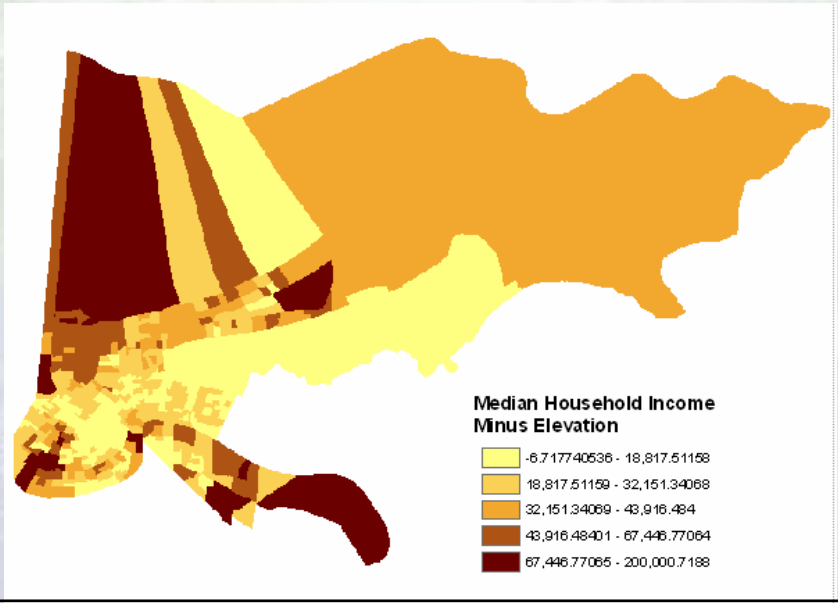
Flooded area in blue

Mississippi

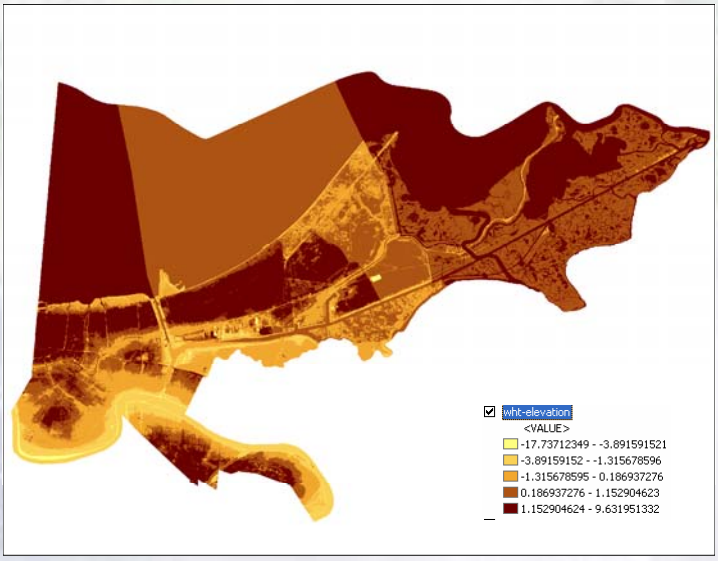
Raster Calculator

- Three new grids made:
  - Income grid – Orleans mosaic
  - Percent White – Orleans mosaic
  - Percent Black – Orleans mosaic

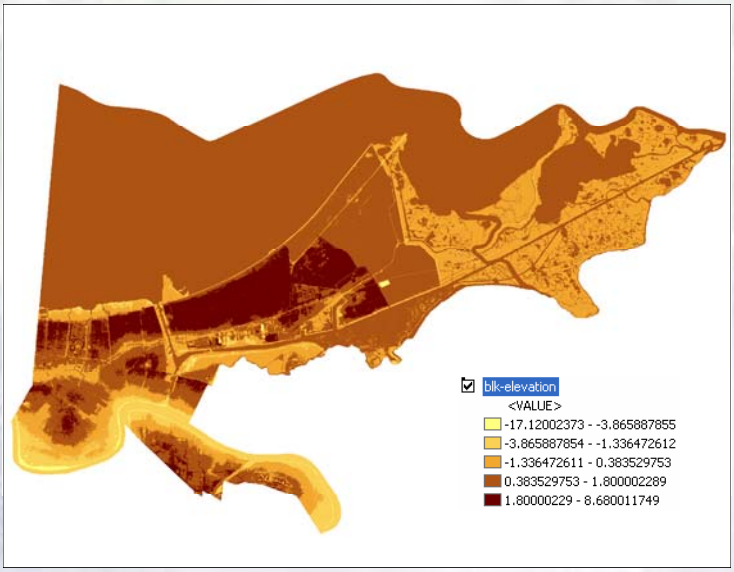
Median Household Income Minus Elevation



% White Population Minus Elevation



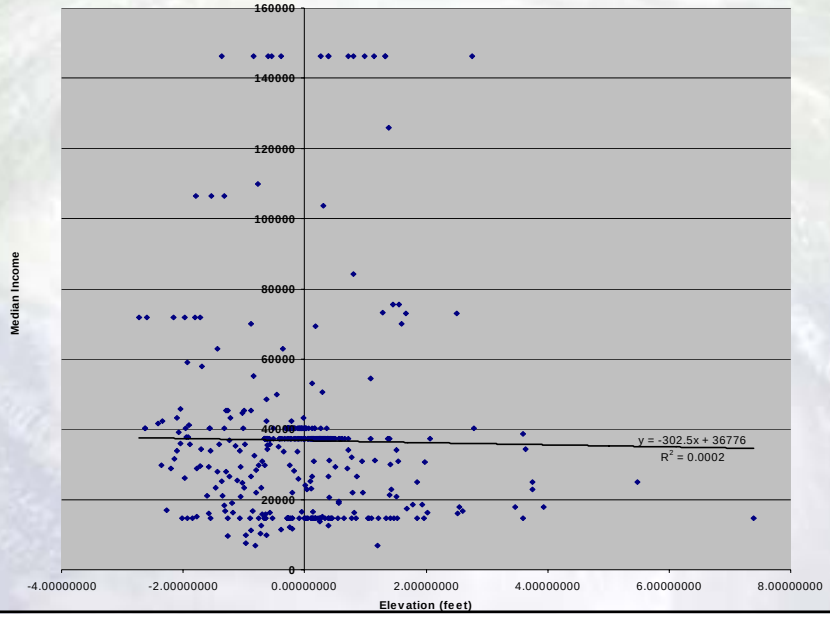
% Black Population Minus Elevation



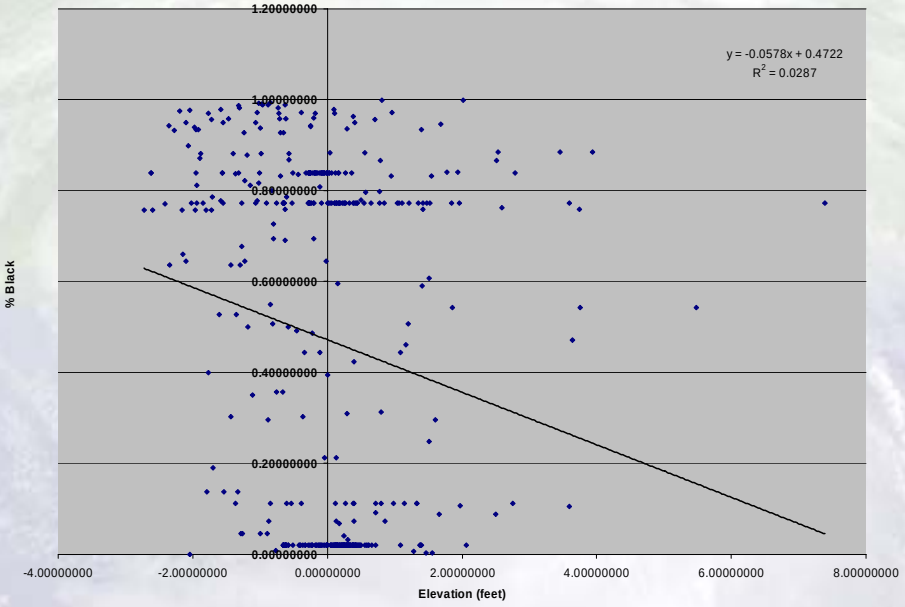
Regression Analysis

- Investigate Correlation between Elevation and Socioeconomic Factors
- Extract Value to Point
  - Elevation
  - Median Household Income
  - Percent White
  - Percent Black

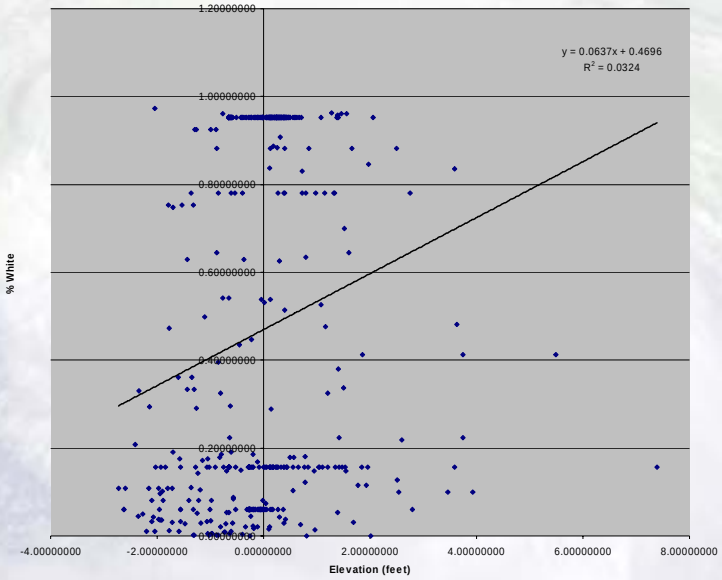
Relationship of Income to Elevation



Relationship of % Black Population to Elevation



Relationship of % White Population to Elevation



Comparing Flooded Areas with Non-Flooded Areas

- Used the Chi-Square test to see if there was a difference in the median household income or racial composition of the two areas
- The random points were used to categorized the data
  - Income categorized two ways:
    - Above/below poverty line for family of four
    - Above/below average median income
  - Percent White and percent Black categorized as to high, medium, or low proportion in the population

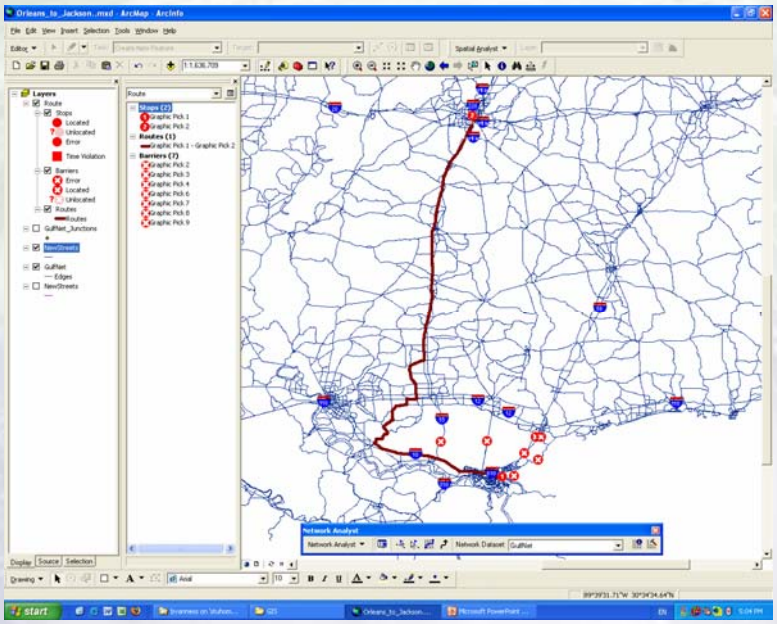
Chi-Square Test Results

Chi-Square Results Comparing Inside and Outside Flooded Area				
	Average Value for			
Test	Flooded Area	Non-Flooded Area	p-value	
Median household income	$32,195	$39,074	0.11 *	8.169E-19 **
% white	23.8%	57.8%	7.222E-16	
% black	69.6%	36.7%	1.288E-12	

* test with categories above and below poverty level for a household of four

** test with categories above and below the average for all the random points

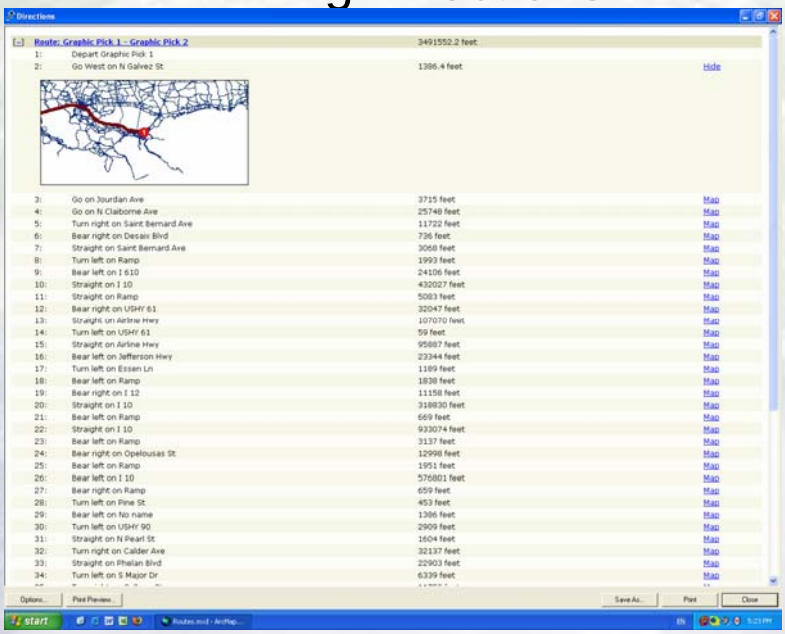
Network Analyst



Bay St. Louis bridge

Evacuation Route to Houston

Driving Directions



Conclusion

- No correlation between
  - Elevation and median household income
  - Elevation and where different racial groups live
- Significant differences in the median household income between the flooded and dry areas
  - Lower median household income found in the flooded area
- Significant differences in the racial demographics of the flooded and dry area
  - Higher percentage of black residents in the flooded area
  - Higher percentage of white residents in the dry areas

Future Analysis

- Age Demographics
- Proximity to the Levees
- Operational Emergency Facilities
- Access to Transportation
- Dasymetric Mapping
- Travel Times in Network Analyst