Climate Change Vulnerability Analysis in Bangladesh:

Mapping Geographical and Social Risk Factors

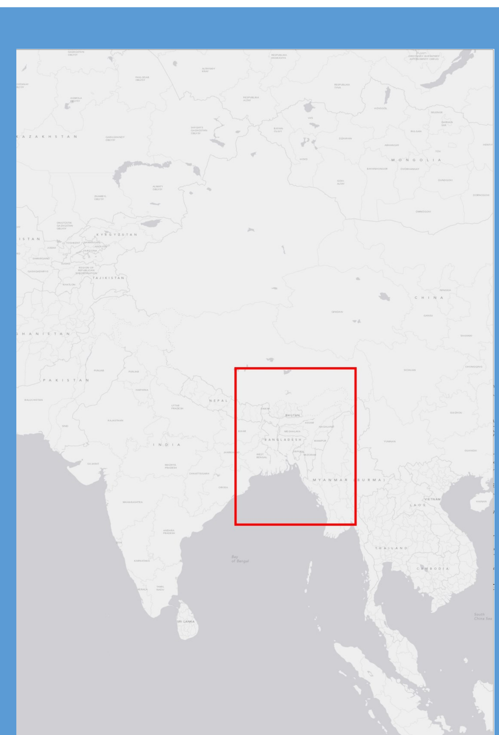
Background

According to the Sixth Annual Climate Change Vulnerability Index, Bangladesh is the most vulnerable country to climate change, and it's capital, Dhaka, is one of the top five most vulnerable cities in the world. Located on one of the world's largest river deltas, Bangladesh experiences annual monsoon floods, which, on average, cover 20% of the country's landmass. The increasing threat of climate change will make these floods, and other natural disasters, even more deadly.

Bangladesh's vulnerability stems not only from its geographical location on the Bay of Bengal, but also from the nation's social and economic vulnerabilities. These socio-economic issues, such as poverty, lack of health care, and inequality, are compounded by climate change and put already marginalized populations at risk.

During a storm or natural disaster, privileged members of society have an advantage. They have adequate shelter, safe water, money to repair any damages to their homes or belongings, and the ability to leave if necessary. Low-income groups often live in poor-quality housing and lack access to adequate health care and infrastructure. For farmers and fisherman, salinity intrusion and damages from cyclones can destroy their livelihoods.

While there are many global vulnerability analyses, there are very few that exist on the sub-national level (excluding the United States). The purpose of this analysis is to determine the districts in Bangladesh that are the most vulnerable to climate change.



Methodology

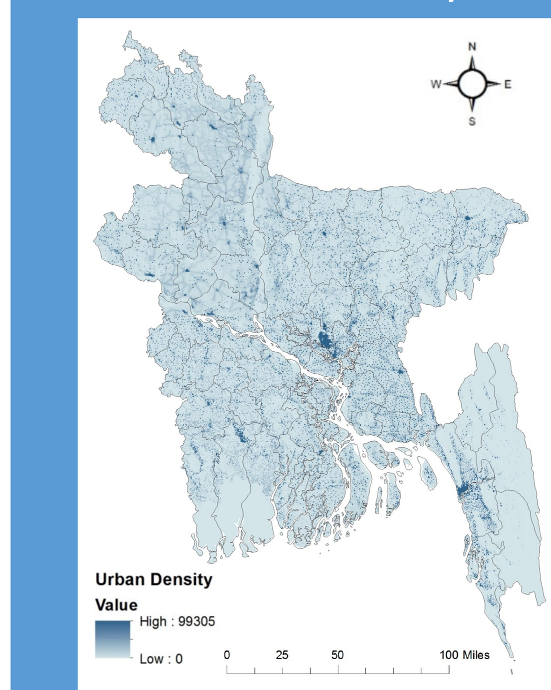
The initial data came from tabular data from several different sources. In order to view it in ArcMap, I joined this data with a district-level vector data set. The poverty data was initially for individual sub districts, so I used the dissolve tool in ArcMap to combine the sub districts into districts and find the mean squared poverty gap index by weighting each sub district by population.

I combined these layers so they could be compared against each other by transforming them from vector data sets into raster data sets and reclassifying them on a 1-10 scale (10 being the most vulnerable, 1 being the least). I then used the raster calculator to add up the total vulnerability of the four data sets. This created a vulnerability index ranging from 0 to 40. The highest rating was 39 for socio-economic vulnerability.

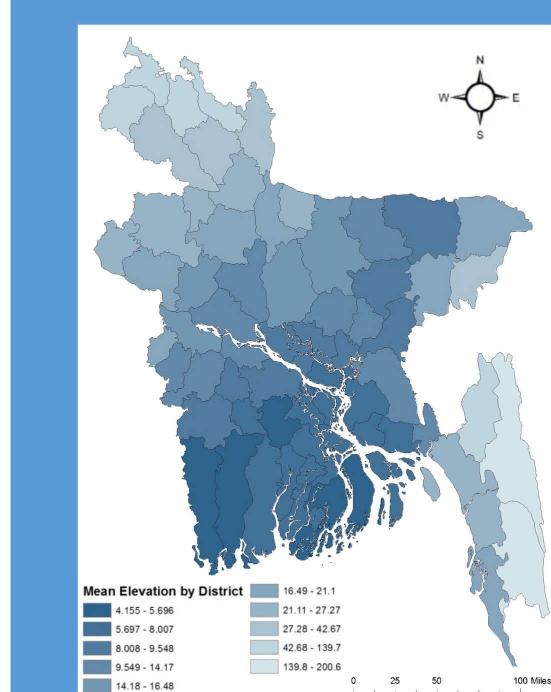
There is very little sub-national climate change data, so in order to simulate geographical vulnerability I used an elevation raster data set from the USGS. This data set is a good way to represent vulnerability to sea level rise and flooding. I could not find subnational precipitation models, so my analysis does not consider changes in rainfall or heat.

I ran a zonal statistics tool on the elevation data set to determine the average elevation for each district, and then reclassified it on a scale of 1-10. I did the same thing with a global Landsat data set, which represents population and human density. My final vulnerability map represents the combined reclassified vulnerability scores from the socio-economic data set, the elevation data set, and the Landsat data set.

Urban Density



Elevation



Results

According to my analysis, the two most vulnerable districts are Cox Bazaar, located on the southeast coast, and Netrokona, located in the Northeast. These districts are vulnerable largely due to socioeconomic factors, as they are not located in areas of extremely low elevation or density.

I was very surprised by the low vulnerability rating for the districts located within Bangladesh's low coastal elevation zone. If I did the analysis again, I would have considered weighting factors based on their importance, specifically weighting elevation as more important than the socio-economic factors.

Limitations and Future Research

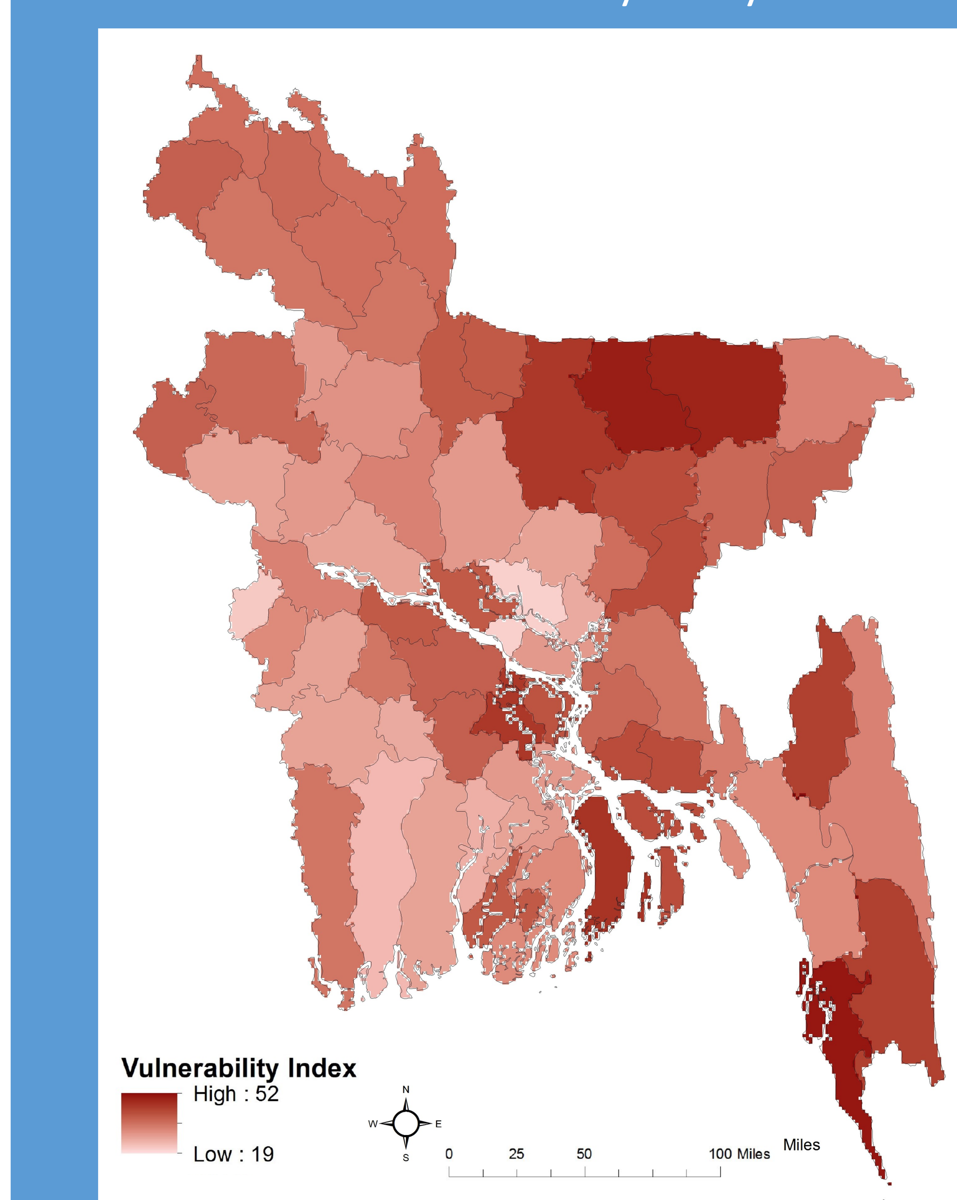
A major setback to my analysis is the lack of data on slum populations, which exist in huge numbers in the outskirts of Bangladesh's major cities. As flooding and salinity intrusion destroys homes and livelihoods in coastal areas, people migrate to Dhaka and other urban areas to find work. This migration has caused a boom in population over the last 40 years. These migrants cannot afford proper housing, so they settle in the slums.

In my analysis, Dhaka is one of the least vulnerable districts. However, I believe this is only because of lack of proper data on Dhaka's slum populations. The government does not officially recognize these populations, making it very difficult to obtain data on Bangladeshi slums.

Additionally, another factor that is important in determining vulnerability is occupation, specifically the percent of the district populations that are work in agriculture, a livelihood that is dependent on natural resources and weather patterns.

Other factors I could have considered are soil type, local government spending on adaptation, international aid, number of storm shelters per district, historical flood and cyclone data, migration, gender, and distance from rivers. There are obviously a plethora of factors that contribute to climate change vulnerability, which was the largest limitation to this study.

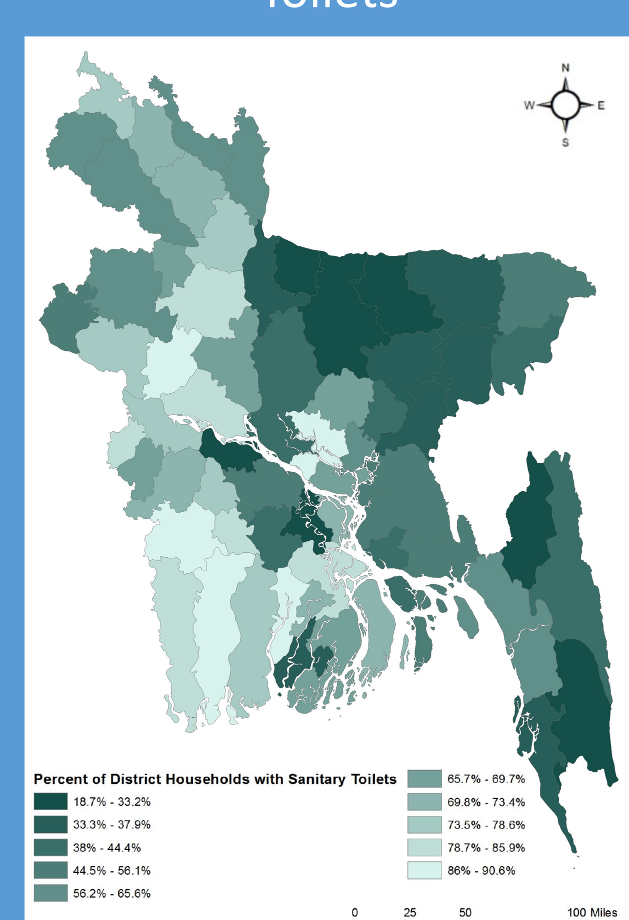
Total Vulnerability Analysis



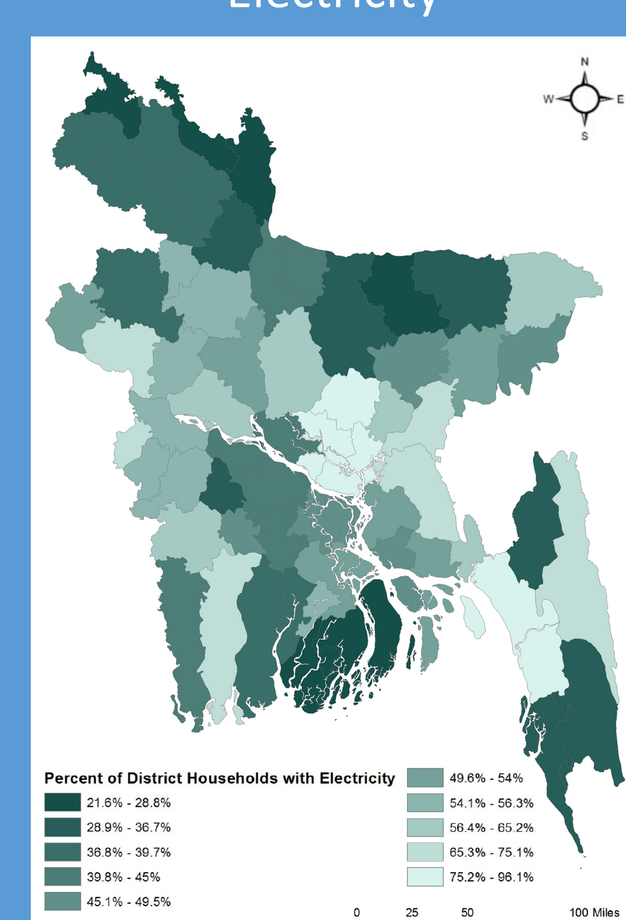
Socio-Economic Factors

In order to determine socio-economic vulnerability, I compared four factors: access to a sanitary toilet, improved housing, electricity, and the squared poverty gap index. Access to a sanitary toilet is a critical indicator of public health and can help determine the level of sanitation and overall wealth. During a flood, lack of sanitary latrines can become a large health risk. Improved housing is defined as houses with finished roofs (tin, wood, cement, and tiles) and finished walls (tin, wood, and cement). This is an indicator of wealth and the ability to withstand storms. Electricity is another indicator of wealth as well as an indicator of access to information (evacuation warnings, weather forecasts, etc.). The squared poverty gap index is a measure of the degree of poverty in an area, weighting households by their distance below the poverty line.

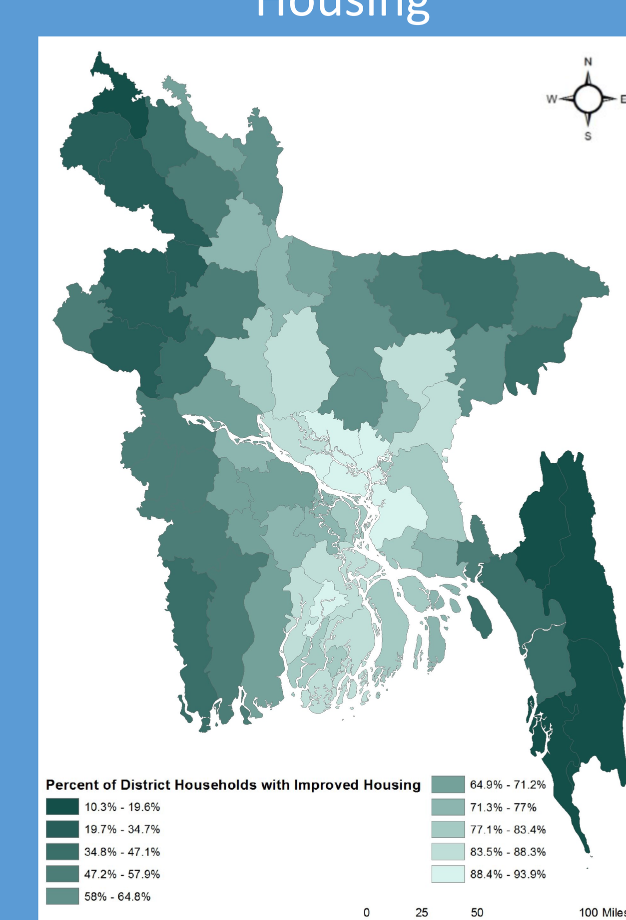
Toilets



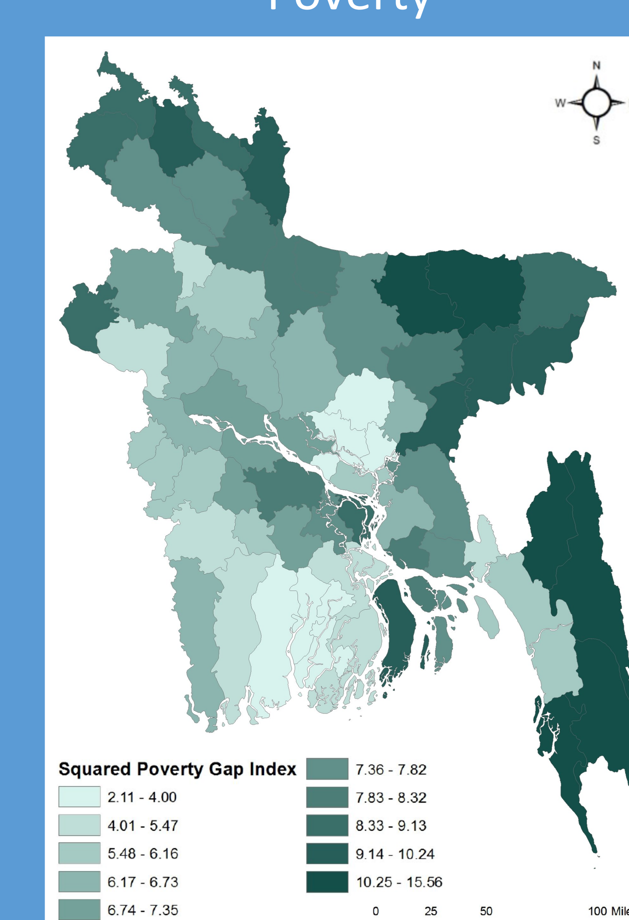
Electricity



Housing



Poverty



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Course: GIS 101

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Data Sources: Bangladesh Bureau of Statistics, USGS, University of North Carolina Population Center Measure Evaluation, DIVA GIS

Projection: WGS 1984 Mercator Auxiliary Sphere

Scale: 1:3,350,000

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