The Neighborhood Population data set provided the number of residents in the city, which can be used to prepare the most vulnerable neighborhoods for adaptation strategies. This information can be used to identify neighborhoods most vulnerable to sea level rise by considering population density and distance to major roadways. This analysis can be performed to identify neighborhoods most vulnerable to sea level rise by considering neighborhood population density and distance to major roadways. This information can be used to prepare the most vulnerable neighborhoods for adaptation strategies and other protective measures.

**Data**

This analysis is based on the Predicted Sea Level Rise, Neighborhood Population, and NYC Highways data layers. The Sea Level Rise and Neighborhood Population data layers came from the NYC Department of City Planning and the Highway data was digitized from an image showing major highways in NYC, consisting of bridges, tunnels, expressways, and tunnels. The Sea Level Rise data set provided a geodatabase of 10th, 25th, 75th, and 90th percentile sea level rise predictions for the decades of 2020, 2050, 2080, and 2100. Each feature class contained a polygon of the coverage of potential flooding, but does not account for erosion, rapid subsidence, or future construction. Areas where sea level rise was predicted was assigned a value of 1. The neighborhood population raster was reclassified based on population density to values from 1 (low) to 5 (high) and highways were reclassified based on highway type to values from 1 (expressways) to 4 (parkways). Tunnels and parkways being more at risk to sea level rise since they are at lower elevations. The raster calculator was used to calculate the intersection between highways with each sea level rise scenario and the same was done with the highway buffer and neighborhood population rasters. To calculate vulnerability, a weighted overlay of these three rasters was performed for each decade, assigning a weight of 50% to population and 25% to both highways and the buffer. Evaluation of vulnerability was on a scale from 1 to 4, 1 being low and 4 being high vulnerability.

**Methodology**

For each sea level rise scenario, neighborhood vulnerability was assessed through neighborhood population density and if a major highway ran through the neighborhood or was 0.25 miles from a highway. A buffer of 0.25 miles was created around each major highway to account for additional sea level rise. All the data layers were clipped to the Neighborhood Boundaries layer and converted into rasters. Areas where sea level rise was predicted was assigned a value of 1. The neighborhood population raster was reclassified based on population density to values from 1 (low) to 5 (high) and highways were reclassified based on highway type to values from 1 (expressways) to 4 (parkways). Tunnels and parkways being more at risk to sea level rise since they are at lower elevations. The raster calculator was used to calculate the intersection between highways with each sea level rise scenario and the same was done with the highway buffer and neighborhood population rasters. To calculate vulnerability, a weighted overlay of these three rasters was performed for each decade, assigning a weight of 50% to population and 25% to both highways and the buffer. Evaluation of vulnerability was on a scale from 1 to 4, 1 being low and 4 being high vulnerability.

Vulnerability maps for each decade are shown in Figures 4 through 7. For the purpose of this analysis, the 90th percentile predictions from the Predicted Sea Level Rise dataset were used to provide worse case scenarios. The sea level rise projections for 2020, 2050, 2080, and 2100 are 10 in, 30 in, 58 in, and 75 in, respectively. As expected, as the years progressed and sea level rise projections increased, more parts of the city received high vulnerability scores of either 3 or 4, especially around the coast. Although the areas that received low vulnerability scores may not be directly impacted by sea level rise, they may still be vulnerable to flooding due to the low elevation of NYC. The boroughs with the most change between the four decades are Manhattan and Brooklyn. This is likely due to how much of the land is exposed to the coast and the elevation of these areas. Most of the areas in Manhattan that received a high vulnerability score by 2100 are also areas with dense populations, therefore, more people will be impacted by sea level rise. In the 2020 vulnerability map, the areas that received high vulnerability scores in Brooklyn and Queens mainly consisted of parks and cemeteries, so these areas are of little concern. Adaptation strategies and evacuation plans can be implemented in areas of high vulnerability to reduce the risk of damage to populations and the infrastructure in these areas.

**Results**

In the United States, the major concern is for the East Coast and its coastal cities where thousands of businesses and resources are located, and millions of people live. New York City is the most densely populated city in the United States and is comprised of five boroughs that are surrounded by water. Not only does NYC have the densest population, but it is a major location for trade, along with infrastructure necessary for people to live. A city like New York holds many assets and sea level rise due to climate change could have a huge impact on the city both socially and economically. A risk analysis on NYC was performed to identify neighborhoods most vulnerable to sea level rise by considering neighborhood population density and distance to major roadways. This information can be used to prepare the most vulnerable neighborhoods for adaptation strategies and other protective measures.

**Recommendations**

To Protect Populations:
- Create evacuation plans for high vulnerability neighborhoods
- Educate high vulnerability neighborhood populations of evacuation plans and what to do in case of a flood

To Protect Infrastructure:
- Implement sea walls along highways that lie along coastline
- Elevate roadways that currently lie below sea level
- Ensure stormwater drainage systems can withstand larger thresholds of water
- Elevate building utility systems in high vulnerability neighborhoods

Table 1 consists of neighborhoods that will be the most vulnerable by 2100 since they consist of high density populations. All of these neighborhoods are located in Manhattan. Additional attention should be paid to these neighborhoods because so many more people are at risk.

<table>
<thead>
<tr>
<th>Neighborhoods</th>
<th>Chinatown</th>
<th>East Harlem</th>
<th>Hamilton Heights</th>
<th>Lenox Hill</th>
<th>Murray Hill/Kips Bay</th>
<th>Stuyvesant Town</th>
<th>West Village</th>
<th>Yorkshire</th>
</tr>
</thead>
</table>

**References**

Data Source: NYC Department of City Planning
Cartographer: Stephanie Pon
CEE-187: Geographical Information Systems
May 3, 2019