A Socioecological Approach to Identify Coastal Protection Zones for Vulnerable Coastal Communities - Sayreville South River

RUTGERS
Aresty Research Center for Undergraduates

Ryan Hutton, Johnny Quispe, Jean Marie Hartman, PhD

Department of Landscape Architecture, Rutgers University, Piscataway, New Jersey 08854

Abstract

Many of New Jersey's most vulnerable communities live on low-lying floodplains which are subject to flooding events and sea-level rise. Human caused climate change is accelerating this rise due to thermal expansion of ocean water and ice loss, increasing the potential risk of coastal storms. As a result, these communities may face severe impacts from flooding hazards within the coming decades. Current coastal vulnerability assessments are mostly based solely on environmental criteria such as soil data and geomorphology to determine the most at-risk locations, but do not take into account issues of environmental justice. They often do not consider the socioeconomic factors within these communities like income,race, and age that disproportionately affect their ability to prepare for and react to these climate change scenarios. Using geospatial mapping tools such as ArcGIS, I planned to create a combined socioecological approach to better identify these marginalized communities, primarily in the Sayreville-South River area. Having a more extensive analysis can help prioritize the areas which are the most susceptible to these risks and show local governments and environmental agencies where to take action. In doing so, we can better equip these watershed and coastal communities to deal with sea-level rise and the resulting flood risks as well as enhancing environmental resilience.

How Much Will Sea-Level Rise in New Jersey?

Table 3. New Jersey Sea-Level Rise above the year 2000 (1991-2009 average) baseline (ft)*

		2030	2050	2070			2100			2150		
				Emissions								
	Chance SLR Exceeds			Low	Mod.	High	Low	Mod.	High	Low	Mod.	High
Low End	> 95% chance	0.3	0.7	0.9	1	1.1	1.0	1.3	1.5	1.3	2.1	2.9
Likely Range	> 83% chance	0.5	0.9	1.3	1.4	1.5	1.7	2.0	2.3	2.4	3.1	3.8
	~50 % chance	0.8	1.4	1.9	2.2	2.4	2.8	3.3	3.9	4.2	5.2	6.2
	<17% chance	1.1	2.1	2.7	3.1	3.5	3.9	5.1	6.3	6.3	8.3	10.3
High End	< 5% chance	1.3	2.6	3.2	3.8	4.4	5.0	6.9	8.8	8.0	13.8	19.6

*2010 (2001-2019 average) Observed = 0.2 ft

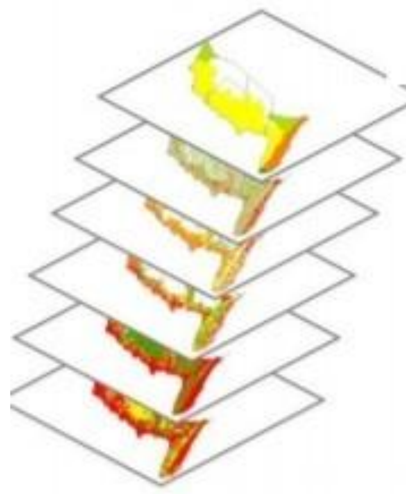
Background

The 2019 Science and Technical Advisory Panel (STAP) report estimates that with moderate emissions there is a likely (~50%) chance sea-level rise (SLR) will increase by 1.4 ft. by 2050 and by 3.3 ft. by 2100. Future preparations need to consider not only physical exposure but also the socioeconomic factors that determine response effectiveness and resilience. To do this, I wanted to combine a Coastal Vulnerability Index (CVI) with a Social Vulnerability Index (SVI) for Sayreville-South River.

- The CVI is a composite of geospatial hazard indicators including geomorphology, slope, flood prone areas, storm surge inundation scenarios, poorly drained soils, erosion-prone areas, and 2050 and 2100 SLR scenarios
- The SVI was based on the CDC model which ranks each census tract on social factors and groups them into four related themes: Socioeconomic Status, Household Composition & Disability, Minority Status & Language, and Housing & Transportation

Combining the two creates an informative socioecological index that can better identify communities vulnerable to future flooding scenarios and help local governments take preventative action.

Methods & Results

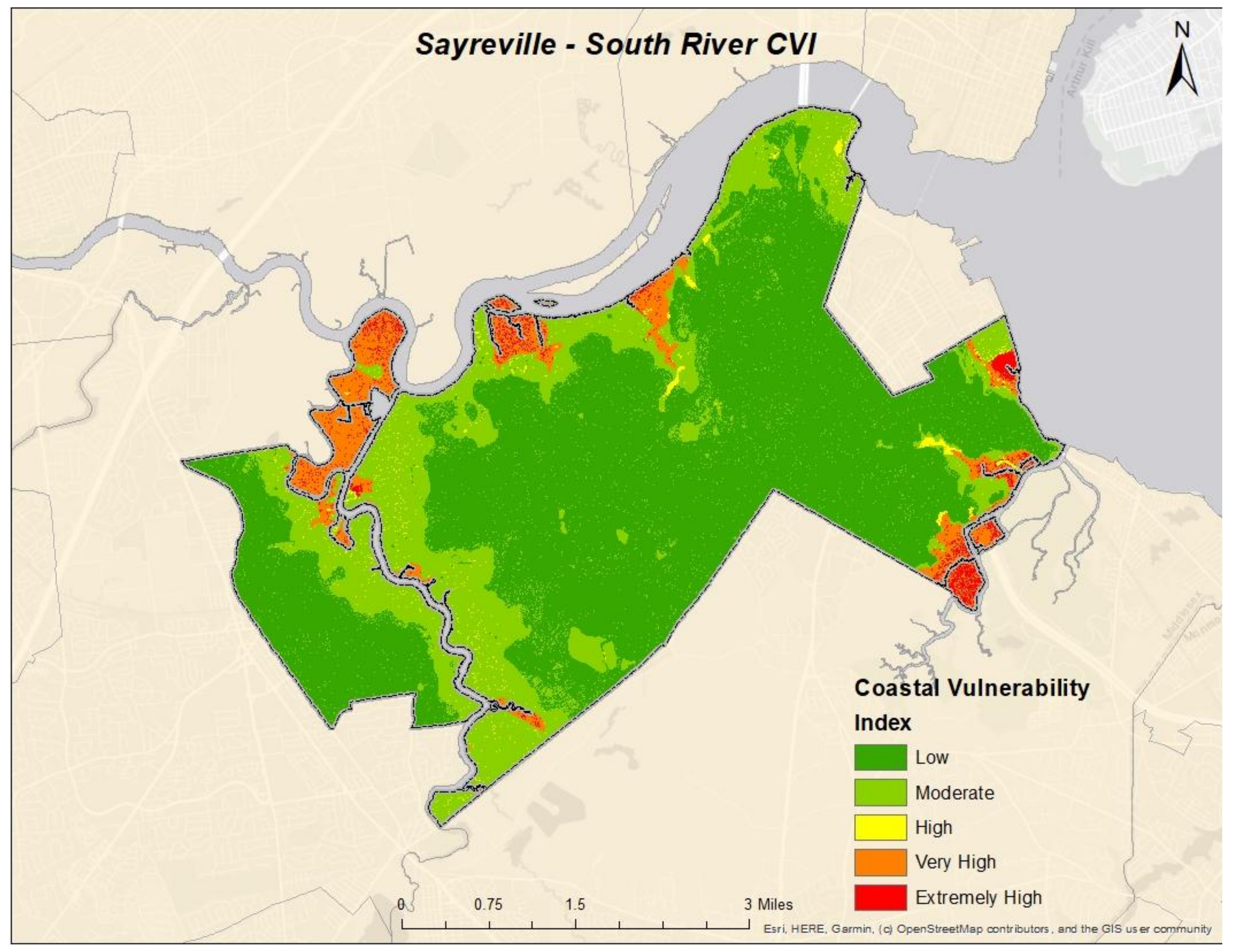


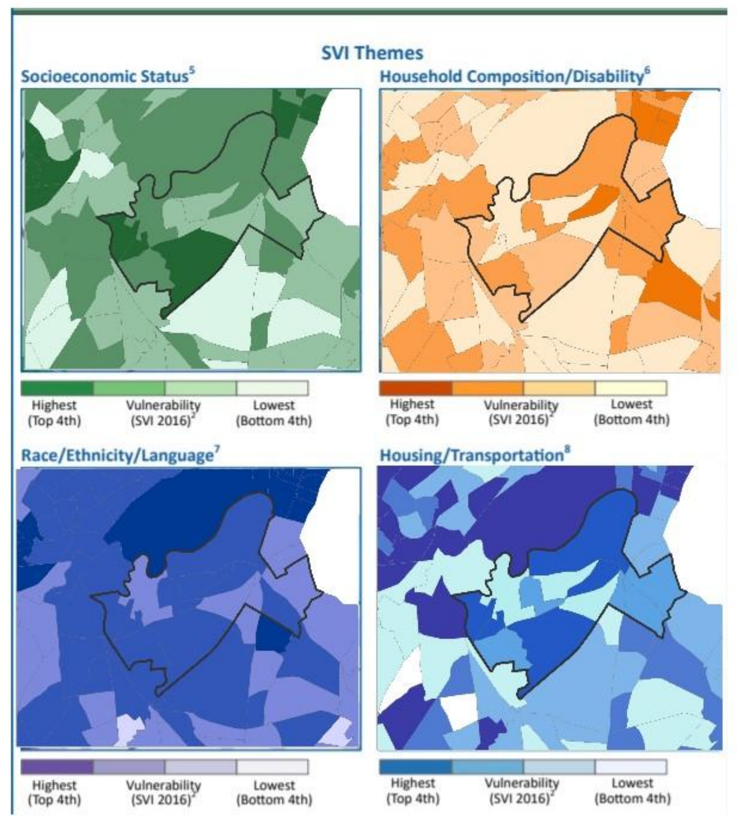
$$CVI = a + b + c + d + e + f$$

Where CVI =

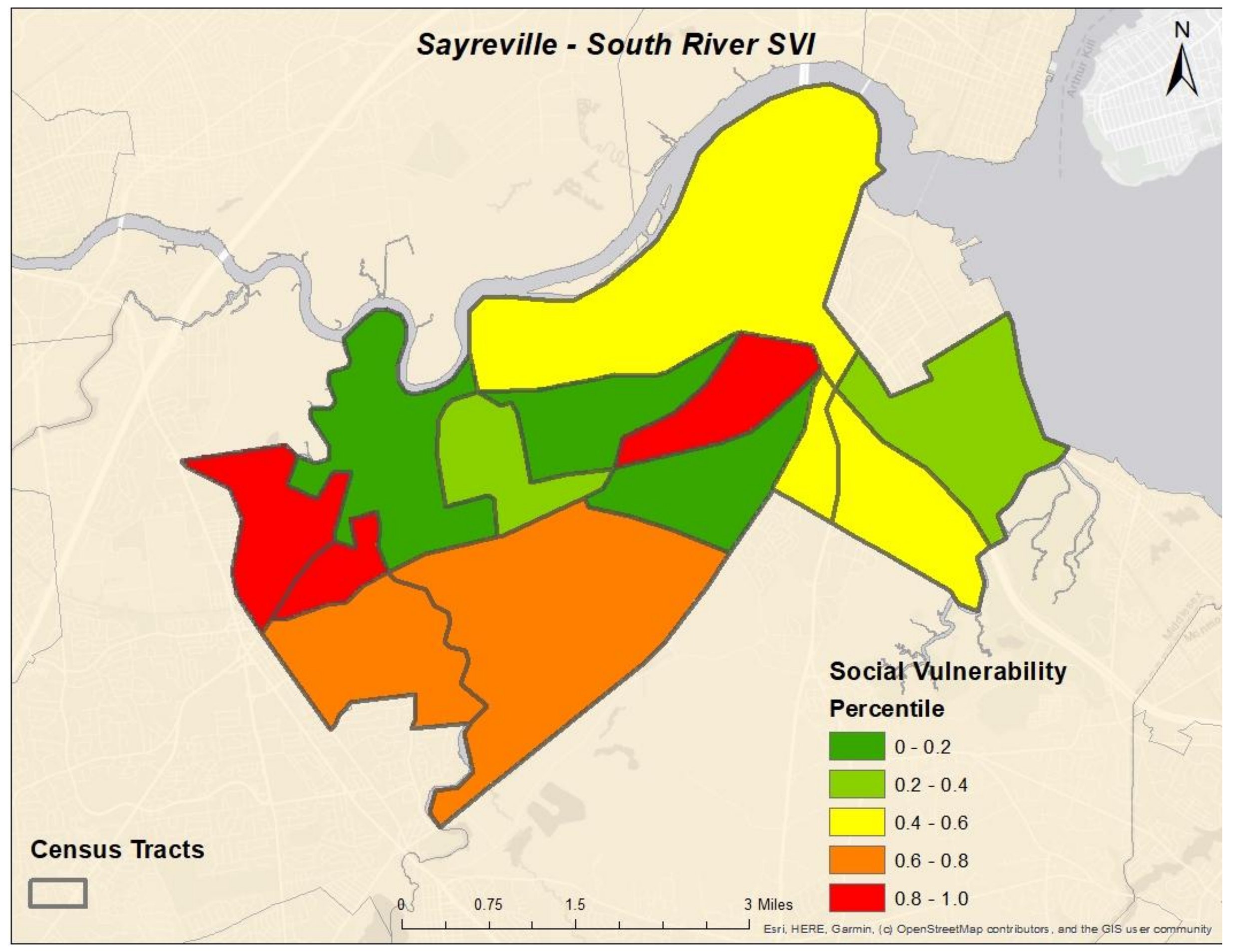
(a) SLR Scenarios
(b) Slope (% Rise)
(c) Flood Prone Areas
(d) Storm Surge (SLOSH)
(e) Drainage
(f) Erosion

The environmental factors are added together along with 2050 & 2100 SLR scenarios (assuming moderate emissions)





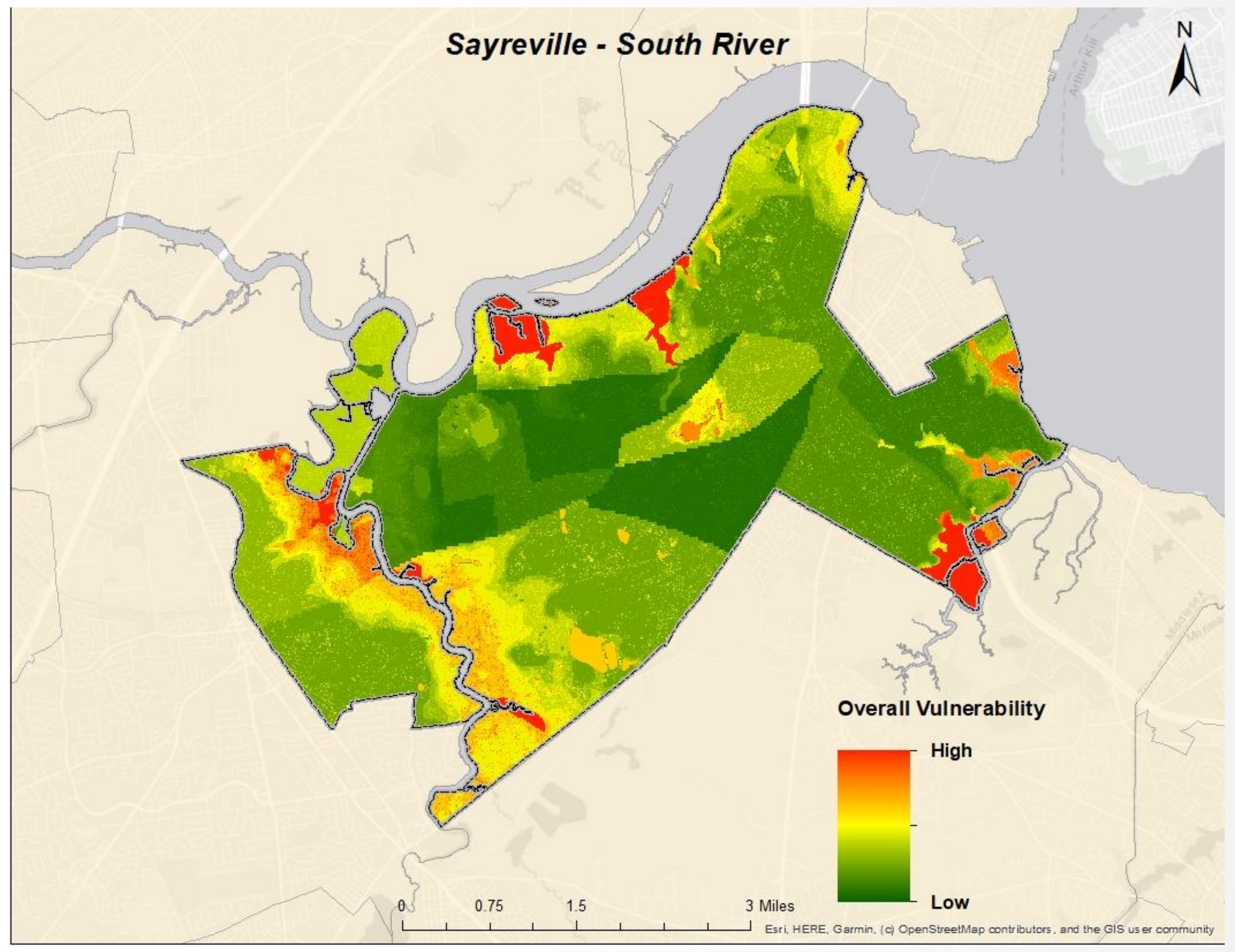
The four socioeconomic themes ranked by percentile



To obtain the overall vulnerability the CVI raster was multiplied by the SVI raster based on a weighted scaling:

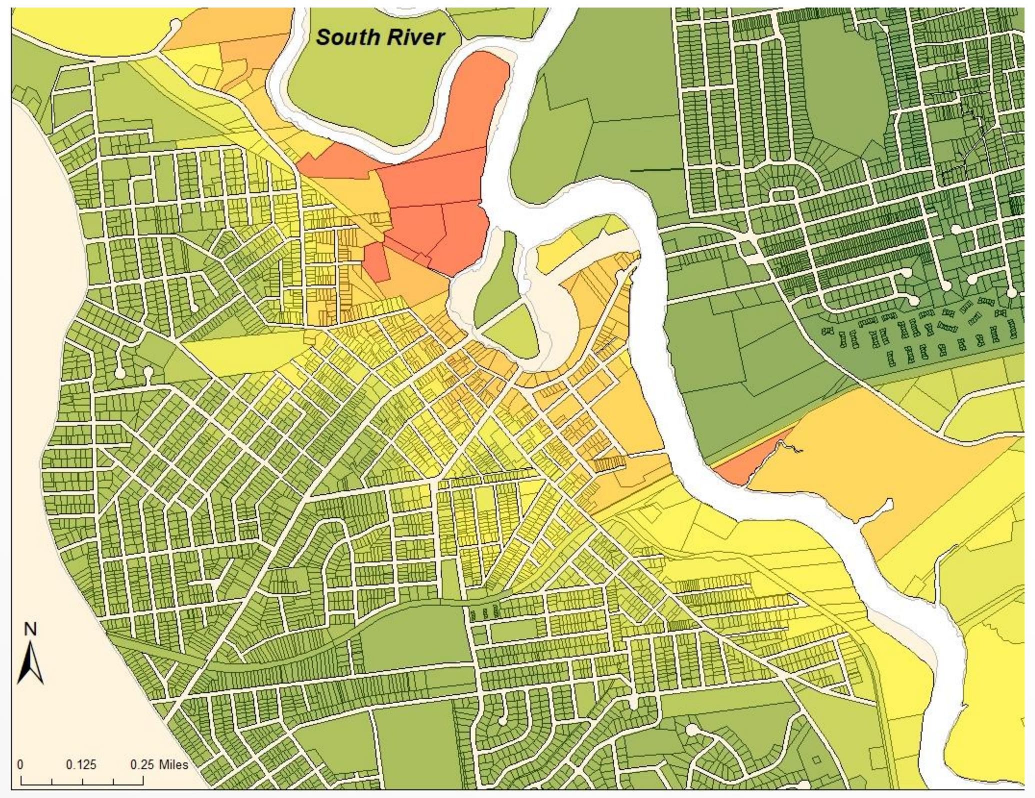
i.e. If the corresponding SVI percentile cell value was 0.5, then the CVI cell value was multiplied by 3

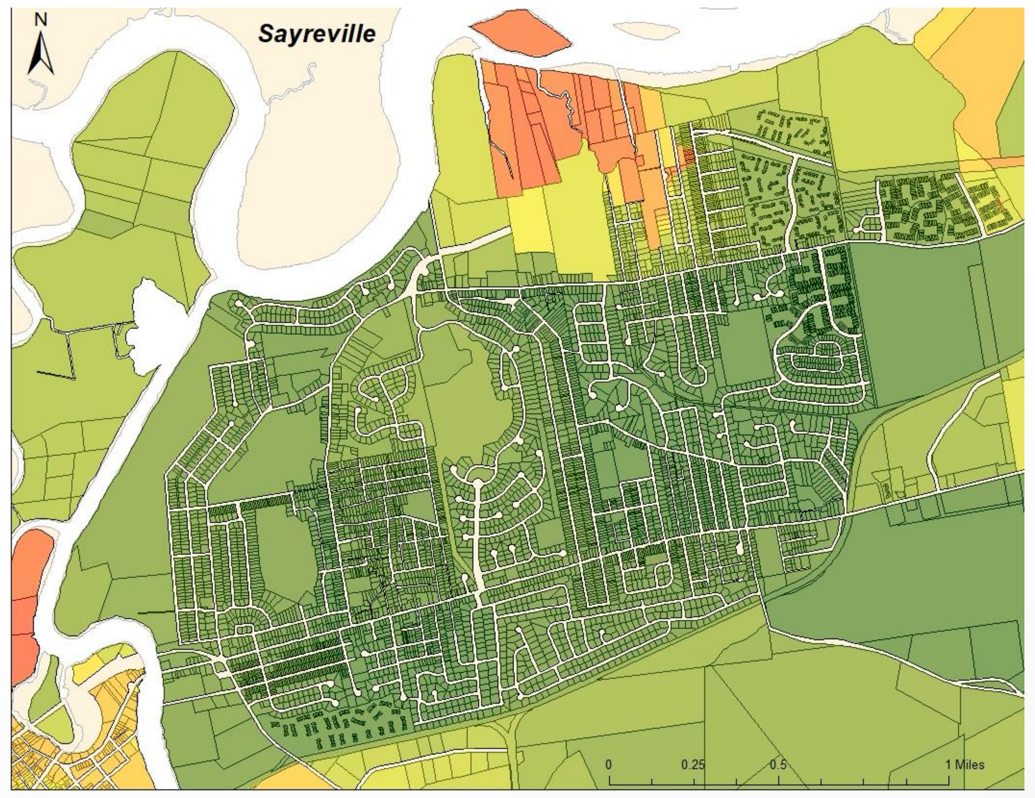
SVI Percentile	Scaling Factor
0 - 0.2	X 1
0.2 - 0.4	X 2
0.4 - 0.6	X 3
0.6 - 0.8	X 4
0.8 - 1.0	X 5



The Combined Vulnerability Index was then averaged over MOD-IV and parcel data to visualize vulnerability over individual houses, buildings, and local neighborhoods. See Parcel Map Representations for examples.

Parcel Map Representations





Conclusion & Future Direction

This research can help Identify communities that are especially vulnerable to flood risks. Going forward, these maps can assist local governments and environmental agencies in prioritizing areas that will struggle the most as sea-level and flood hazards continue to increase over the coming decades. This is especially helpful for smaller scale analysis on the level of local communities and neighborhoods. Future work on this project can work on SLR scenario modifiability as well as Digital Shoreline Analysis implementation.

Acknowledgments

I would like to thank Hartman Lab and Johnny Quispe for this educational opportunity and all of the help provided over the year.
Credit to NOAA, FEMA, NJDEP, USDA, the CDC, and the US Census Bureau for source data