

Anna Carl

Kelly Eta

Zachary Rosman

Erma Swartz

Environmental Justice in the South Bronx:

The Intersection of Industrial Zoning, Race, and Climate-Driven Flood Risk

Abstract

The South Bronx, officially designated as a Significant Maritime Industrial Area (SMIA), is uniquely vulnerable to hazardous waste contamination from waterways due to the history of racist zoning practices that concentrate the South Bronx waterfront with heavy manufacturing. As the legacy of environmental racism persists and the climate crisis intensifies, communities along the South Bronx waterfront are at significant risk of climate change-induced flooding and subsequent heavy industry water contamination given the neighborhood's concentration of hazardous waste sites along the waterfront. To determine how exactly the neighborhood is at risk, our research deploys quantitative data from secondary sources to evaluate the scope of the issue, which is then supplemented with firsthand qualitative data from site visits to the South Bronx waterfront and the Community Land Act-Meeting led by South Bronx Unite. Our findings conclude that we see a relationship between flood risk, racial demographics, and heavy industry presence in the South Bronx. Additionally, site visits to the waterfront conclude that rezoning for mixed-use development along the waterfront is underway, but the residential buildings incorporated are market rate and built to encourage gentrification and threaten the displacement of current residents, undermining the goals of South Bronx Unite and the community for a public waterfront. The lack of information on the threat of water contamination from heavy industry waste highlights the neglect the South Bronx residents continue to face, where they are ill-prepared in the event of flooding.

History and Background

Land Acknowledgement

Before European colonization, the Lenape First People inhabited and managed the land we now call Mott Haven (Mott Haven History).

Neighborhood Demographics

Mott Haven is a neighborhood in the South Bronx, just north of Manhattan, bordered by the Harlem and East Rivers (Figure 1). As of the 2020 census, it has a population of 40,232 that is predominantly Hispanic (67.9%) and Black (27.2%), and a smaller population of Asian and White residents (Furman Center, 2024; U.S. Census Bureau, 2020).

In 2022, the median household income in the South Bronx was around \$32,860, significantly lower than New York City's \$77,550. Mott Haven's poverty rate is 32.7%, while New York City's is 18.3%, showing that the neighborhood is far more impoverished than the city at large (Furman Center 2024).

Overall, Mott Haven is among New York City's poorest neighborhoods. The concentration of lower-income Black, Hispanic, and immigrant populations, combined with its history of systemic racism, makes it vulnerable to environmental racism.

Neighborhood History

In 1828, Jordan Mott formed Mott Haven to build an ironworks. Over the coming decades, he and others expanded the settlement, building more industry and residences on the riverfront (Historic Districts Council; Landmarks Preservation Commission, 1973; Museum of the City of New York, 2012).

In the late 19th and early 20th centuries, Mott Haven became a bustling industrial hub for piano factories, also manufacturing “clothes, stuffed animals, sausages,” showing the diversity of the industry in the area (Historic Districts Council; Mott Haven History).

Redlining in the 1930s built a systematic economic and social barrier stopping people of color from gaining access to opportunities. Mott Haven was given the lowest grade possible of “D” and barred from federal assistance in home loans (Ortigas et al.) (Figure 2). Thus began the vicious divestment cycle,

which has continued until today. After World War II, Puerto Ricans and African Americans began to move to the area, while whites left for the suburbs (Mott Haven History).

Deindustrialization hit Mott Haven hard, bringing about some of the most severe urban decay in the nation (Historic Districts Council). In the 1970s, neglect worsened urban decay. Meanwhile, the crack epidemic led to a dramatic rise in crime (Bronx River Alliance, 2020). However, limited revitalization efforts began after 2000 (Mott Haven History; Samuels, 2023). In conclusion, Mott Haven's history is marked by a long and complex trajectory, including its meteoric rise and sharp decline, albeit with a hopeful future.

Environmental History in the South Bronx

The South Bronx has long been home to industrial activity which harms the environment and public health. It is currently under threat of worsening conditions in the event of a natural disaster(South Bronx Unite). While this impacts the health and well-being of the population, it also makes the waterfront much more vulnerable to flooding, endangering the people who call the South Bronx home(Mott Haven History).

The communities of Mott Haven and the South Bronx have routinely protested further industrial development, yet the expansion of such industry has continued unimpeded. An example of the dangers these facilities pose to Mott Haven is the Con Edison explosion in 1980. Despite the explosion killing 14 people and a jury declaring the company and the state responsible for the explosion, no further action was taken, and the responsible actors were accountable (New York Times, 1981). Despite this well-documented history, in addition to another wave of significant community resistance, the 1991 state government entered into a 99-year lease agreement with River Yards Ventures/The Galesi Brothers, continuing this pollution (Office of the Comptroller, 1996).

The history of Mott Haven is a reminder of how industrialization, environmental neglect, and systemic racism have disproportionately impacted marginalized communities (South Bronx Unite). During the area's long history, it has been exploited repeatedly, prioritizing industrial development over

its residents' wants, needs, and desires. However, the community continues to fight for a future in which this history of exploitation can be transformed into one of justice and equity.

The issue of Flooding and Climate Change in the South Bronx

The South Bronx faces an extreme risk of flooding over the next 30 years, with heavy rainstorms and the lack of marshlands to absorb the floodwaters significantly contributing to this risk(Bronx River Alliance, 2023 First Street Foundation, 2023).

Floodwaters damage properties and pose serious health risks, particularly due to the city's outdated sewer system. When heavy rainfall overwhelms these systems, untreated wastewater is often redirected into local waterways, exposing residents to harmful bacteria (Bronx River Alliance, 2023). Additionally, floodwaters can carry toxic chemicals, industrial waste, and other pollutants. This pollution is another looming hazard to the health of the South Bronx.

Unless awareness is raised and funding is allocated towards climate resilience in the South Bronx, it is guaranteed that the issues in waste management will not be addressed in time for the next flood, and disaster will occur.

To prevent this disaster and ensure justice in the community at large, we ask how the history of racially motivated zoning and heavy industry disposal in the South Bronx interact with the contemporary threat of climate-change-driven flooding along the South Bronx waterfront. Once we answer this question, we will suggest solutions to this crisis on the waterfront (Figure 1).

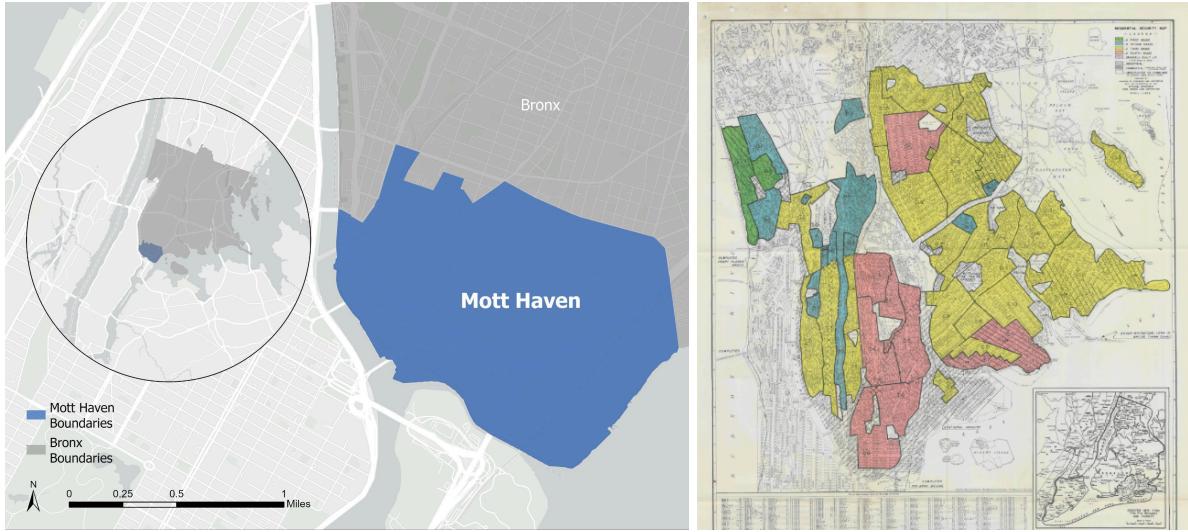


Figure 1 (left): Mott Haven is a neighborhood in the South Bronx, just north of Manhattan, bordered by the Harlem and East Rivers.

Figure 2 (right): The Bronx redlining map, Mott Haven/Port Morris is in the far south, and has the lowest grade (Ortigas et. al)

Literature Review

Historical Context of Environmental Inequities in the South Bronx

Julie Sze's *Noxious New York* (2007) provides a foundation for understanding the systemic inequities in waste management and industrial zoning in the South Bronx. She highlights how racially motivated zoning policies and the disproportionate siting of waste facilities have burdened marginalized communities with significant environmental hazards. Sze emphasizes how race and class intersect with policy decisions, creating persistent environmental injustices, particularly in neighborhoods like the South Bronx. Gonzalez Samot (2020) expands on this by exploring the effects of waste transfer stations, which are overwhelmingly concentrated in low-income communities of color. He documents the South Bronx's role as New York City's hub for waste processing and its heightened exposure to industrial waste, noise pollution, and truck traffic compared to similar neighborhoods.

The Contemporary Threat of Climate-Change-Driven Flooding

The risk of flooding exacerbates the environmental vulnerabilities in the South Bronx. Laner et al. (2009) explore how flooding of municipal solid waste (MSW) landfills can mobilize hazardous pollutants, posing risks to nearby ecosystems and communities. These findings are particularly concerning for areas like the South Bronx, where industrial waste sites remain poorly managed and are susceptible to flooding. Shannon's (2014) evaluation of New York City's post-Superstorm Sandy resiliency efforts underscores the inequitable allocation of resources for flood mitigation in low-income neighborhoods. Her analysis reveals that the South Bronx has been systematically neglected in favor of wealthier, gentrifying areas, leaving it increasingly vulnerable to storm surges and rising sea levels.

Resilience and Infrastructure Challenges

Karamouz et al. (2019) propose frameworks for improving flood resilience in urban infrastructure, such as wastewater treatment plants, which are critical in neighborhoods like the South Bronx. Their resilience index identifies disparities in preparedness across New York City and suggests best practices for flood mitigation, including redundancies in infrastructure and strategies for resisting and delaying flood impacts. Despite these recommendations, the South Bronx has seen limited implementation of such measures, as noted in reports by the Natural Resources Defense Council (NRDC) and other advocacy groups (Chaisson, 2017).

Implications for Environmental Justice and Policy

The persistence of waste-related hazards in the South Bronx highlights broader issues of environmental racism and policy neglect. Gonzalez Samot (2020) critiques the lack of federal superfund designations for the South Bronx, which contrasts with similar sites in Brooklyn and Queens that have received remediation efforts. This disparity suggests that gentrification and political will have influenced the prioritization of cleanup projects, leaving the South Bronx at heightened risk of waste leakage during climate-induced flooding.

Data Collection

In order to more accurately analyze the intersection of climate-change-induced flooding, waste management, and environmental racism in the South Bronx Community, we must employ a mixed methods approach of both qualitative and quantitative data analysis. Our data collection reflects our mixed methods approach, with primarily quantitative, secondary data sources that are supplemented with qualitative, primary data sources.

Quantitative Data

In our research, we utilized a mix of geospatial, demographic, and environmental datasets to conduct a comprehensive analysis. The PLUTO database provided detailed zoning and industrial land use data, while Census data gave us insights into racial demographics and population distributions. We used FSHRI, or Flood Susceptibility Hazard Risk Index, to quantify flood vulnerability. Our methodological approach involved cleaning, normalizing, and joining these datasets on common geographic identifiers such as NTAs and GEOIDs. This allowed us to aggregate data at the neighborhood level, identifying relationships between industrial zoning proportions, racial demographics, and flood risks. For the South Bronx, we focused on NTAs specific to this region. This sub-analysis highlighted the intersection of industrial zoning, racially diverse populations, and flood risks, further emphasizing the region's vulnerability. Regression analysis helped us uncover significant correlations and provided a quantitative foundation for our conclusions about environmental injustice and systemic disparities in climate resilience. In our research, we determined that it was essential to conduct primary data collection in order to flesh out the primarily quantitative data from secondary sources with qualitative, firsthand information of the current situation of the South Bronx waterfront. We conducted both a site visit to the South Bronx waterfront along with attending a community meeting led by the community advocacy group South Bronx Unite (SBU). To determine which locations along the waterfront to conduct our research, we used data from EJNYC Mapper for current floodplains, zoning for residential and manufacturing lots, and Google Maps to identify notable waste management facilities in the area (Mayor's Office of Climate and Environmental Justice, n.d.; NYC Department of City Planning, n.d.). These data were intersected to

identify locations that pointed to the relationship between flooding, heavy industry and which residents are at risk of flooding and waste contamination.

Qualitative Data

Attending a South Bronx Alliance meeting will provide a source of qualitative data through community feedback and discussion. We will document community perspectives on environmental risks, waste management, and resilience initiatives, allowing us to contextualize our quantitative findings. This data will enrich our analysis by providing insight into the social impacts of environmental issues within the community. That being said, this data may be specifically vulnerable to bias, as it will be skewed by those who have the time and resources to attend the meeting and may not accurately represent the beliefs of the entire community and thus cannot be overstated in our report. Our site visit will provide necessary qualitative data such as photographs and descriptive observations of the nature of the South Bronx, as well as identify qualitative data like residential, industrial, and waste management locations along the waterfront that are essential to understanding how environmental racism has impacted Mott Haven residents.

Methods

This study used a mixed-methods approach, combining quantitative and qualitative methods to analyze the intersection of industrial zoning, racial demographics, and climate-driven flood risks in the South Bronx. Quantitatively, spatial and demographic data were analyzed using tools like EJNYC Mapper and MapPLUTO. Key variables included industrial zoning, flood risk, and socioeconomic indicators such as income and racial composition, drawn from Census and ACS data. These datasets were normalized and aggregated at the Neighborhood Tabulation Area level. Regression analysis was conducted to identify correlations between industrial land use, racially diverse populations, and flood susceptibility.

Qualitative methods complemented the statistical analysis with community-level insights and field observations. Site visits documented the spatial relationship between industrial zones and floodplains, using ArcGIS to map critical areas. Observations captured the lived reality of environmental challenges in affected neighborhoods. Additionally, engagement with local advocacy groups, including

South Bronx Unite, provided a deeper understanding of community concerns and priorities, further contextualizing the analysis. Together, these methods highlighted systemic disparities and informed recommendations for equitable zoning and climate resilience strategies.

Quantitative Methods: OLS Regression Analysis

The data collection process began with obtaining several key datasets. Flood risk data were sourced from multiple metrics, including the Flood Hazard Surface Risk Index (FSHRI), and storm surge/tidal risk scores for different time horizons (present, 2050s, and 2080s). Demographic information was extracted from neighborhood-level statistics provided through the Neighborhood Tabulation Areas (NTA) American Community Survey found on the Census Website. This included race/ethnicity composition, age distribution, and poverty indicators across NTAs. Additional datasets included land-use information from the NYC PLUTO dataset, which offered zoning and land-use characteristics to supplement the flood risk and demographic analyses. All datasets were systematically cleaned, integrated, and filtered to include only relevant records for New York City, with particular emphasis on the South Bronx, as indicated by the “Neighborhood” and “NTA2020” identifiers.

This mixed-methods research study investigates the relationship between racially motivated zoning, heavy industrial activity, and contemporary climate-change-driven flood risks in the South Bronx. To conduct the quantitative analysis, we employed a multifaceted methodological approach involving data acquisition, cleaning, integration, and statistical regression modeling, supported by a range of visual analyses.

To ensure consistency, datasets underwent a standardized cleaning process: duplicates and unnecessary columns (e.g., “Unnamed”) were removed, column names were harmonized, and NTA2020 identifiers aligned. Flood risk scores were consolidated using the FSHRI metric, while neighborhood-level demographic data, including racial composition, were merged with flood risk scores. Once integrated, statistical and visual analyses were conducted. Descriptive statistics examined average flood risk across NTAs, particularly in the South Bronx, where flood risk scores were analyzed alongside

racial and demographic data. Stacked bar charts illustrated how flood risks varied among population groups, highlighting disproportionate exposure.

For a broader context, neighborhoods with measurable flood risk were analyzed city-wide. Comparative charts displayed aggregate flood risks across racial and ethnic groups, revealing systemic disparities and situating South Bronx-specific findings within the larger urban landscape.

To further test the relationship between racial composition and flood risk, we performed a multiple linear regression analysis. In this model, the dependent variable was the flood risk score (FSHRI), while independent variables included the proportion of key racial and ethnic groups (% Hispanic/Latino, % Black/African American, % White, % Asian, and % Other). This regression allowed us to evaluate which demographic factors most significantly predicted exposure to flooding.

The methodological framework combines robust data cleaning and integration processes, statistical modeling, and impactful visual analysis to elucidate the intersection of environmental vulnerability and social inequities. By merging flood risk and demographic data at the neighborhood level, the study reveals critical insights into the disproportionate exposure of marginalized populations to flood hazards, particularly in historically underserved areas like the South Bronx. For more information on the written code please visit: github.com/ErmaSwartz/Flood

Quantitative Methods: Limitations within the Regression Analysis

The regression analysis revealed several limitations that may have impacted the robustness of the findings. A key issue is multicollinearity, indicated by an extremely high condition number, which suggests overlapping influences among variables. This makes it difficult to isolate the individual effects of each variable. Additionally, the R-squared value of 0.298 shows that the model explains only a portion of the variation in flood risk, highlighting the need for additional predictors, such as socioeconomic variables or housing density, to improve explanatory power. The analysis also lacks interaction effects, which could capture compounded vulnerabilities, and it operates at the neighborhood level (NTAs), potentially masking finer-scale disparities within neighborhoods. Several coefficients, including those for

Black/African American and Native Hawaiian groups, were not statistically significant, underscoring the importance of emphasizing significant results while acknowledging data limitations.

Qualitative Methods: South Bronx Unite Visit

As part of our qualitative methods, on the 23rd of October 2024, our professor, Hugo Sarmiento, invited South Bronx Unite (SBU) Senior Organizer Matthew Shore to discuss how the local community is reacting to Waste Facilities in the South Bronx. According to Shore, South Bronx United is an organization that wants to provide justice to the members of the South Bronx community, halting and reversing the ongoing gentrification in the area. One of their projects is to build a “community waterfront” (South Bronx Unite) (Figure 3).

Qualitative Methods: Community Land Act Meeting (10/29)

Matthew Shore suggested we attend a meeting regarding the Community Land Act on 10/29; his organization was present at (South Bronx Unite) (Figure 4). While the main presentation on the Bill was irrelevant to our research, I discussed the waterfront right before the main presentation with an SBU organizer who was ratcheting up support for the project.

Qualitative Methods: Limitations

While South Bronx Unite is a crucial resource to understand the issue of environmental racism along the South Bronx Waterfront, they are only one source of information and do not represent the entirety of the South Bronx population. Contacting other groups involved with the community, like the Department of City Planning, the NYC Parks team in charge of the Harlem River Watershed and Natural Resources Management Plan for the Bronx, and conducting primary data collection methods like resident surveys, we can address the limitations faced in this research project. While a complete qualitative analysis on any area is impossible, incorporating multiple sources of information at varying degrees of intervention would help us to better understand the experiences of South Bronx residents and to more effectively identify solutions to environmental racism along the waterfront.

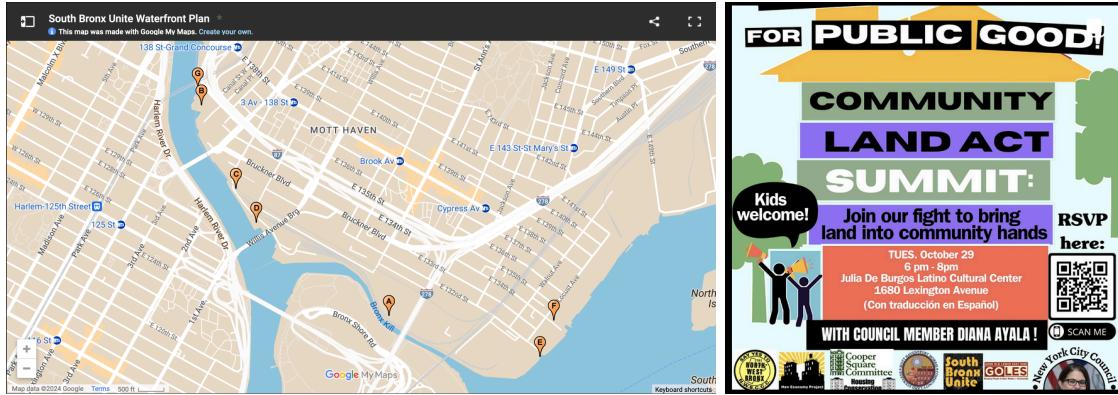


Figure 3: South Bronx Unite Community Waterfront Plan Locations (South Bronx Unite)

Figure 4: Community Land Act Summit Poster. (South Bronx Unite)

Findings and Analysis

Table 1: Quantitative Findings and Analysis: OLS Regression Results

Dep. Variable:	FSHRI	R-squared:	0.298
Model:	OLS	Adj. R-squared:	0.296
Method:	Least Squares	F-statistic:	155.0
Date:	Sat, 30 Nov 2024	Prob (F-statistic):	2.46e-164
Time:	12:49:28	Log-Likelihood:	-3491.0
No. Observations:	2196	AIC:	6996.
Df Residuals:	2189	BIC:	7036.
Df Model:	6		
Covariance Type:	nonrobust		

	coef	std err	t	P> t	[0.025	0.975]
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const	2.4982	0.349	7.166	0.000	1.815	3.182
Estimate Total: White alone			-1.0644	0.362	-2.942	0.003
	-0.355					-1.774
Estimate Total: Black or African American alone			0.2583	0.364	0.710	0.478
	-0.455	0.971				
Estimate Total: American Indian and Alaska Native alone			0.9742	1.652	0.590	0.555
	-2.266	4.214				
Estimate Total: Asian alone			3.0629	0.377	8.131	0.000
	3.802					2.324
Estimate Total: Native Hawaiian and Other Pacific Islander alone			-3.1290	2.044	-1.531	0.126
	-7.138	0.880				
Estimate Total: Some Other Race alone			2.6895	0.413	6.505	0.000
	3.500					1.879
Estimate Total: Two or More Races:			-0.2933	0.519	-0.565	0.572
	0.725					-1.311
<hr/>						
Omnibus:	51.317	Durbin-Watson:		1.755		
Prob(Omnibus):	0.000	Jarque-Bera (JB):		26.795		
Skew:	-0.015	Prob(JB):		1.52e-06		
Kurtosis:	2.460	Cond. No.		4.82e+15		
Notes:						

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

[2] The smallest eigenvalue is 1.18e-28. This might indicate that there are strong multicollinearity problems or that the design matrix is singular.

Quantitative Findings: Zoning and Environmental Vulnerability

To further contextualize these relationships, the study examined the role of industrial zoning using data from the NYC PLUTO dataset. Industrially zoned areas (indicated by zonedist1 starting with “M”) were normalized and aggregated at the neighborhood level to compute the proportion of industrial land use.

Preliminary regression results showed a significant positive correlation between industrial zoning and flood risk, particularly in neighborhoods with higher Asian and Other race populations. This reinforces the historical link between racially motivated zoning practices and environmental vulnerability, where marginalized groups were disproportionately exposed to industrial land uses and their associated risks.

Quantitative Findings: Bronx vs. City-Wide Trends

The analysis separated neighborhoods in the Bronx from the rest of New York City to uncover localized patterns. In the South Bronx, flood risks were particularly acute in areas with significant industrial zoning, where neighborhoods such as Hunts Point and Mott Haven-Port Morris demonstrated higher FSHRI values. These neighborhoods also have a disproportionately high concentration of Hispanic/Latino populations, as visualized in stacked bar charts.

City-wide, flood risks were more variable, but the trends remained consistent: neighborhoods with higher proportions of Asian and Other race populations faced greater flood risks. The negative correlation for White populations persisted across the broader dataset, highlighting systemic disparities in exposure to environmental hazards.

Figures 5a-5d:

Correlation Matrices. Figures 5a-5b are matrices between zoning and race in NTA outside and inside the Bronx, respectively, while Figures 5c and 5d are matrices between race and flood risk in NYC outside and inside the Bronx, respectively.

Figure 5a:

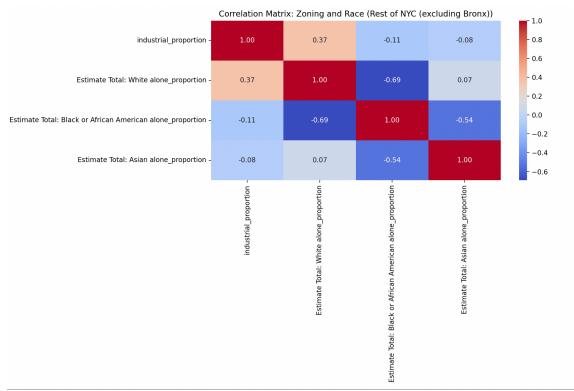


Figure 5c:

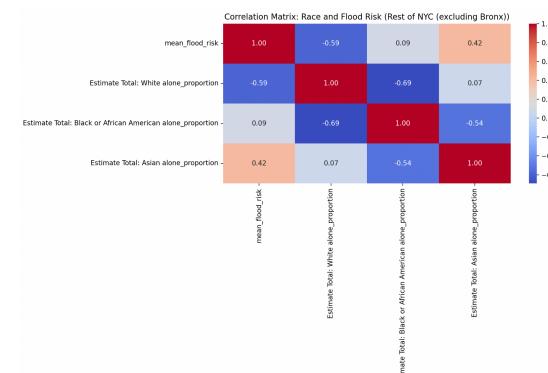


Figure 5b:

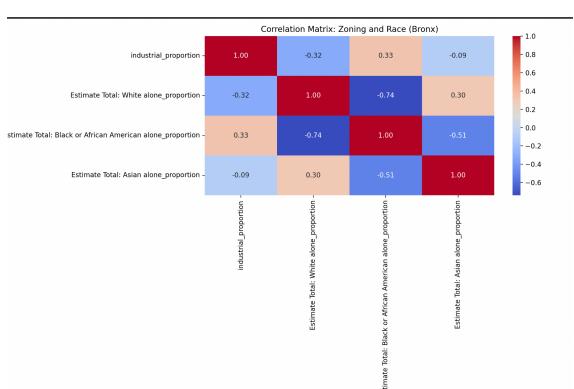
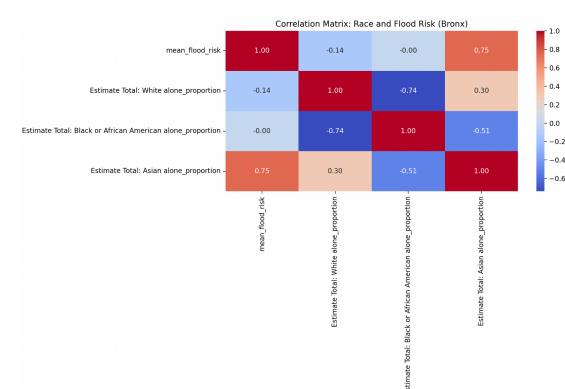


Figure 5d:



Qualitative Findings and Analysis

Qualitative Findings and Analysis: Guest Speaker Matthew Shore, South Bronx Unite Meeting (10/23)

Shore provided valuable context pertaining to the South Bronx Waterfront. For example, the waterfront, despite being public property, has been leased by the city to the Galesi brothers for 99 years, which subleases it to waste management; in turn, this waste management processes 100 percent of the waste in the Bronx. The subsequent fallout and lawsuits from this and other controversial decisions led to the creation of SBU.

Shore stated that the waterfront is also inaccessible, with few routes towards the waterfront, most of them reserved for the trucks and the industrial sites occupying the water. Moreover, he stated this area has few greenspaces and is in the poorest congressional district in the country

To solve these crises of inaccessibility and pollution, as well as to ameliorate the effects of poverty they want to open the South Bronx waterfront in seven sites between Bronx Kill and Harlem River, in a project called the “community waterfront” (Figure 3). There is strong political support for the waterfront, and it would cost 125 million dollars while producing over twice that in benefit. It would also provide a buffer to flooding that industry would not provide, reducing the risk of flooding (South Bronx Unite). The plan is in motion, with technical assistance and partnerships under the Inflation Reduction Act, to the tune of 20 million dollars.

In sum, Matthew Shore discussed how the South Bronx Waterfront is very industrial, with plenty of waste facilities on the coast, which already puts the area at risk for coastal flooding and subsequent waste leakage. Moreover, there is very little, if any, greenspace to absorb the flooding on the coast or pollutants that leak from the flooding, further amplifying the flood risk and subsequent risk of leakage. There is, however, community and organizational action to fix these crises. To stop this flooding crisis, more money and investment must be put towards SBU’s community waterfront, not only completing the project but also providing provisions for its expansion.

Qualitative Findings and Analysis: South Bronx Unite Community Land Act Meeting (10/29)

Overall, the organizer discussed the waterfront project in terms similar to Shore; unfortunately, she did not go into much deeper detail than he did and just gave me some literature when I asked more questions. She primarily discussed how industry has dominated the waterfront for so long, rendering it inaccessible, and that the community wants to build up a “community waterfront” free from corporate influence so they can get land denied to them for so long by industrial interests. There was not much regarding flood protection, although she did imply that such greenspaces would help to prevent flooding when I asked her about the topic.

Overall, discussions with Matt Shore on the 23rd of October and the SBU organizer on 10/29,, were quite useful, as the speaker's passion was clear. The fact that they reached out to meetings shows that they are engaging in community activities for such a valuable piece of infrastructure.

Qualitative Findings and Analysis: Waterfront Site Visit

In ArcGIS, we found the intersection between floodplains and zoning for manufacturing and residential and discovered the existence of a mixed residential-manufacturing zoning designation that was concentrated on the South Bronx waterfront. We focused our site visit on these locations, theorizing the mixed residential and manufacturing zoning would be particularly vulnerable to waste contamination in the event of a flood (Mayor's Office of Climate and Environmental Justice, n.d.; NYC Department of City Planning, n.d.).

Upon visiting the South Bronx waterfront, we observed the streets and sidewalks were devoid of people but populated heavily with cars and broken glass. Attempts at improving the accessibility of the waterfront were seen with designated bike lanes, but in the three hours, we saw only a couple of cyclists on the poorly maintained roads [insert pic of bike lanes]. The waterfront, as we anticipated, was largely inaccessible, and the closest we could get to the water from the South Bronx was the bridge to Randall's Island that went over the water but not up to it. An approximately 800-foot buffer of large manufacturing facilities like FreshDirect and FedEx surrounded the waterfront and blocked it from the public. There were streets that were lined with manufacturing on one side, and residential homes on the other. Fortunately, these lots were zoned as residential-only and existed outside the floodplains, but the

manufacturing buildings remained at risk of floods. When inspecting the mixed residential-manufacturing zoning lots, however, we saw the lots were newly renovated or constructed market-rate residential buildings, not the site for heightened flood water and contamination risk as we had predicted. Further research uncovered the NYC Economic Development Corporation (EDC) had launched the Lower Concourse Infrastructure Investment Strategy in 2017 which paved the way for the rezoning of previously manufacturing-only lots to include residential in order to create a mixed-use, economically revitalized South Bronx waterfront. While our initial hypothesis of neglected residents in these buildings is false, it does prove that environmental racism is present here. These newly developed apartment units near the waterfront are priced at market rate, where a one-bedroom, one-bathroom apartment starts at \$3,500. Compared to South Bronx's average rent of \$954 and a 58% rent-burdened population, this pricing is outlandish and encourages gentrification and displacement of current residents by pricing them out of their own neighborhoods. This is a neighborhood that has a long history of industrialization and has been advocating for the return of the waterfront to its community, and yet the only significant changes to the waterfront from heavy industry to more people-centered is when wealthier developers cast their sight on the South Bronx waterfront that the city responds with substantial support. Now that public and private stakeholders are interested in the waterfront, climate change-induced flood resiliency plans may begin to take root. But had they looked elsewhere, what would have happened to the South Bronx in the result of a flood? Environmental racism is clear and present in the South Bronx, and vulnerable communities would be increasingly at risk of waste contamination as the floodplains expand if left unchecked.



Figure 6 (left): Manufacturing and residential buildings, split by 133rd street (image from site visit)

Figure 7 (right): Mixed residential and manufacturing zoned new construction on 138th street and Rider Ave. (image from site visit)

Conclusion

Planning Suggestions and Next Steps

To implement the findings in our study, we have two primary suggestions. First, on the Mott Haven shoreline, there needs to be a prioritization of community initiatives like the South Bronx United's Community Waterfront Proposal, which would put the agency back into the hands of the community to determine how they can use the waterfront, rather than it continuing to be run by large manufacturing companies. Figure 3 shows the current South Bronx plans that are underway and being implemented in NYC Park's Harlem River Watershed and Natural Resources Management Plan. But with the imminent risk of climate-driven flooding in the neighborhood, waterfront resiliency infrastructure plans need not only to be included in plans like these but prioritized and even expanded as a neighborhood under immediate climate change threat

Secondly, the Mott Haven shoreline, when built, needs to implement NYC Parks' policies for resilient urban planning emphasizing designing adaptable waterfronts to mitigate flood risks and climate impacts. The Flood Resiliency Guidelines advocate for tailored site-specific solutions, including resilient materials, flood-adapted edges, and dual-purpose designs for everyday use and storm protection. The East

Side Coastal Resiliency Project exemplifies integrating elevated park structures, floodwalls, and enhanced drainage to safeguard communities while maintaining public access. Similarly, the Vision Plan for Resilient East Harlem highlights community-informed strategies to reduce stormwater flooding, adapt public spaces, and integrate urban ecosystems with city infrastructure, ensuring equity in resilience planning (NYC Department of Parks & Recreation).

The findings underscore the enduring legacy of racially motivated zoning and industrial land use policies, particularly in the South Bronx, where marginalized populations face heightened exposure to flood risks. While flood vulnerabilities are increasingly driven by climate change, the systemic inequities observed in this study point to a need for targeted resilience planning. Specifically:

- Mitigation Strategies: Policies must address flood vulnerabilities in racially and socioeconomically marginalized neighborhoods, particularly those with high FSHRI scores.
- Equity in Resilience Planning: Planners and policymakers should prioritize investments in flood mitigation infrastructure in areas like Hunts Point and Mott Haven-Port Morris.
- Environmental Justice Advocacy: The disproportionate risk borne by Asian, Hispanic/Latino, and Other race populations highlights the importance of environmental justice frameworks in urban planning.

The statistical significance and visual clarity of these findings contribute to a growing body of research on environmental justice and climate resilience. By integrating flood risk scores with demographic data, this study offers a robust methodology for identifying vulnerable populations and advocating for equitable urban planning solutions.

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