Analysis of New York City’s Flood Vulnerability Index

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Abstract

The Flood Vulnerability Index (FVI) assesses the distribution of vulnerability to flooding across New York City to guide flood resilience policies. This study analyzed six hazard-specific FVIs covering different flood scenarios. Using a combination of exposure indices and the Flood Susceptibility to Harm and Recovery Index (FSHRI), we evaluated the socio-economic factors contributing to flood vulnerability. Results indicate that low-income neighborhoods are disproportionately affected by future storm surge scenarios, highlighting the need for targeted resilience programs. Statistical analysis confirms significant disparities in vulnerability across socio-economic groups

Introduction

Flooding poses a significant threat to urban areas, particularly in cities like New York, where diverse socio-economic factors influence vulnerability. The Flood Vulnerability Index (FVI) was developed to assess the distribution of flood vulnerability across NYC, guiding resilience policies and programs. Vulnerability, as defined by Cutter et al. (2009), consists of three components: exposure to hazards, susceptibility to harm, and capacity to recover.

This study aims to analyze the FVI across six different flood scenarios: current and future storm surge scenarios, as well as current and future tidal flooding scenarios. Each scenario considers both the exposure index, which varies to capture different exposures, and the Flood Susceptibility to Harm and Recovery Index (FSHRI), which remains constant and aggregates 12 socio-economic indicators. These indicators are correlated with various types of hardships and recovery capacities.

The primary objectives of this study are to:

1. Evaluate the distribution of flood vulnerability across different neighborhoods in NYC.

2. Identify socio-economic factors that contribute to increased vulnerability.

3. Assess how future flood scenarios might impact the vulnerability landscape.

4. Provide insights that can inform targeted interventions and resilience programs to mitigate flood risks, particularly for high-risk communities.

Understanding these components is crucial for developing effective flood resilience policies and programs that can protect vulnerable populations. This research seeks to contribute to this understanding by providing detailed analysis and insights based on the latest FVI data.

Methods

Data Source: Data.gov.

Metadata Updated: April 12, 2024.

Publisher: data.cityofnewyork.us

Six hazard-specific FVIs for different flood scenarios: current and future storm surge scenarios, current and future tidal flooding scenarios.

Data Cleaning and Preprocessing:

1. **Data Cleaning:** Missing values in the dataset were identified and imputed using the median value for each socio-economic indicator. Outliers were detected using the interquartile range (IQR) method and were either removed or transformed to reduce their impact on the analysis.
2. **Normalization:** All socio-economic indicators were normalized using min-max scaling to ensure they were on a comparable scale between 0 and 1. This normalization was crucial for accurately calculating the exposure index and the Flood Susceptibility to Harm and Recovery Index (FSHRI).
3. **Transformation:** Variables with skewed distributions, such as income levels, were log-transformed to approximate a normal distribution. Categorical variables, such as flood zone classifications, were converted into numerical format using one-hot encoding.
4. **Data Integration:** Data from multiple sources, including socio-economic data and geospatial flood maps, were integrated to form a comprehensive dataset. Geospatial data were processed to convert addresses into coordinates, ensuring accurate mapping of vulnerability indices.
5. **Quality Assurance:** Consistency checks were performed to ensure data accuracy. This included validating data ranges, checking for duplicate entries, and ensuring proper data types. All preprocessing steps were thoroughly documented to ensure reproducibility.

Analysis Techniques:

1. **Descriptive Statistics:** Summary statistics were computed using the `summary()` function to understand the basic characteristics of the data. Distribution analysis was performed using `ggplot2` to create histograms and density plots, revealing the spread and central tendency of the Flood Vulnerability Index (FVI) and its components.
2. **Correlation Analysis:** A correlation matrix was generated using the `cor()` function to examine the relationships between socio-economic indicators and the FVI. Heatmaps were created with the `ggcorrplot` package to visualize these correlations, identifying strong associations between certain indicators and flood vulnerability.
3. **Geospatial Analysis:** The spatial distribution of FVI across New York City was mapped using the `sf` and `ggplot2` packages. These maps highlighted areas of high and low vulnerability. Spatial clustering analysis was conducted using the `spdep` package to detect clusters of high and low vulnerability.
4. **Comparative Analysis:** Comparative analysis was conducted using `dplyr` to filter and compare FVI values under different flood scenarios. `ggplot2` was employed to visualize the differences, while box plots and other comparative visualizations were used to examine vulnerability across different socio-economic groups.
5. **Statistical Testing:** T-tests and ANOVA were performed using `t.test()` and `aov()` functions to test for significant differences in FVI between different groups. Linear regression analysis was conducted using the `lm()` function to model the relationship between FVI and socio-economic indicators, identifying significant predictors of flood vulnerability.
6. **Visualization:** Various visualizations were created using `ggplot2`, including bar charts, scatter plots, and box plots, to present the results clearly. Interactive dashboards were developed with `shiny`, allowing dynamic exploration of the data and results.

Results

Data Description: The New York City Flood Vulnerability Index dataset provides a comprehensive assessment of flood vulnerability across NYC. It includes Flood Vulnerability Indices (FVI) for multiple scenarios: storm surge (present, 2050s, 2080s) and tidal flooding (2020s, 2050s, 2080s). The dataset incorporates a Flood

Susceptibility to Harm and Recovery Index (FSHRI), which aggregates 12 socio-economic indicators related to flood impact and recovery capacity. Each entry likely represents a geographic unit (e.g., census tract), identified by GEOID, and includes geometric data for spatial analysis. The FVIs combine physical exposure to flooding with socio-economic vulnerability, allowing for comparative analysis across different NYC areas, flood types, and future projections. This structure enables researchers to investigate spatial patterns, temporal trends, and the relationship between socio-economic factors and flood vulnerability in New York City.

Key Findings:

Flood Vulnerability Distribution in New York City (Figure 1): The first chart shows the spatial distribution of the Flood Vulnerability Index (FVI) in NYC under the current storm surge scenario, with FVI ranging from 1 (lowest) to 5 (highest). Different colors represent varying levels of vulnerability.

- **Coastal Areas:** Higher flood vulnerability indices (yellow and orange regions, representing FVI values of 4 and 5) are prominently observed along the southern and eastern shores of New York City. These areas include parts of Staten Island, southern Brooklyn, and Queens.
- **Inner City Areas:** Lower flood vulnerability indices (purple and blue regions, representing FVI values of 1 and 2) are generally observed in inner city areas, indicating lower susceptibility to flooding in these regions.
- **Hotspots:** Notable hotspots of high vulnerability are evident in specific coastal neighborhoods, highlighting the need for targeted flood resilience strategies in these areas.

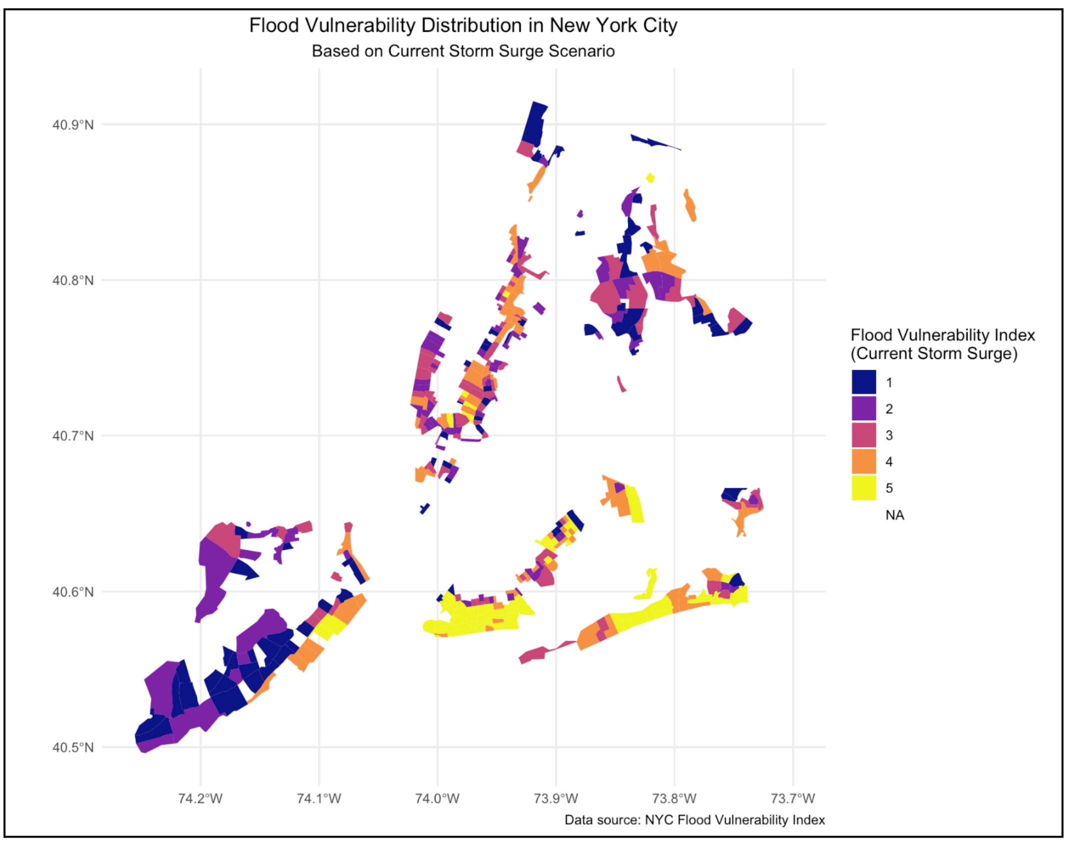

Figure 1

Average Flood Vulnerability Index by NYC Borough (Figure 2): The second chart presents the average Flood Vulnerability Index (FVI) for different boroughs in New York City under current storm surge conditions.

- **Brooklyn:** Exhibits the highest average FVI, slightly above 3, indicating the greatest flood vulnerability among the boroughs.
- **Queens and Manhattan:** Follow Brooklyn, with average FVI values just under 3, indicating moderate flood vulnerability.
- **Bronx and Staten Island:** Show lower average FVI values, with the Bronx having a moderately lower FVI and Staten Island having the lowest average FVI at around 2.

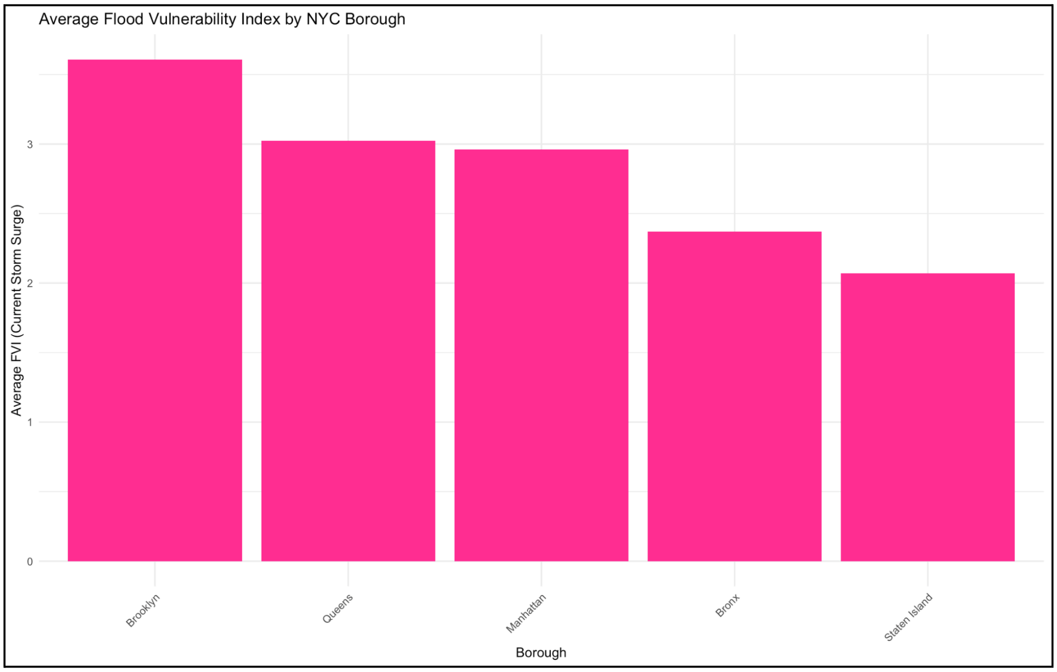

Figure 2

Relationship between FSHRI and FVI across Different Scenarios(Figure 3): The scatter plots show the relationship between the Flood Susceptibility to Harm and Recovery Index (FSHRI) and the Flood Vulnerability Index (FVI) across storm surge and tidal flooding scenarios for the present, 2050s, and 2080s.

1. **Storm Surge 2050s, 2080s, and Present:**
    - All three storm surge scenarios (2050s, 2080s, and present) display a positive correlation between FSHRI and FVI. This indicates that as the susceptibility to harm and difficulty in recovery increase (higher FSHRI), the flood vulnerability index also increases.
    - The trend is more pronounced in the future scenarios (2050s and 2080s), suggesting that future storm surges may exacerbate the impact on areas already susceptible to harm and slow to recover.
2. **Tidal Flooding 2020s, 2050s, and 2080s:**
    - Similar to the storm surge scenarios, tidal flooding scenarios for the 2020s, 2050s, and 2080s show a positive correlation between FSHRI and FVI.
    - The correlation is slightly weaker compared to storm surge scenarios but still indicates that higher susceptibility and lower recovery capacity (higher FSHRI) lead to increased flood vulnerability.

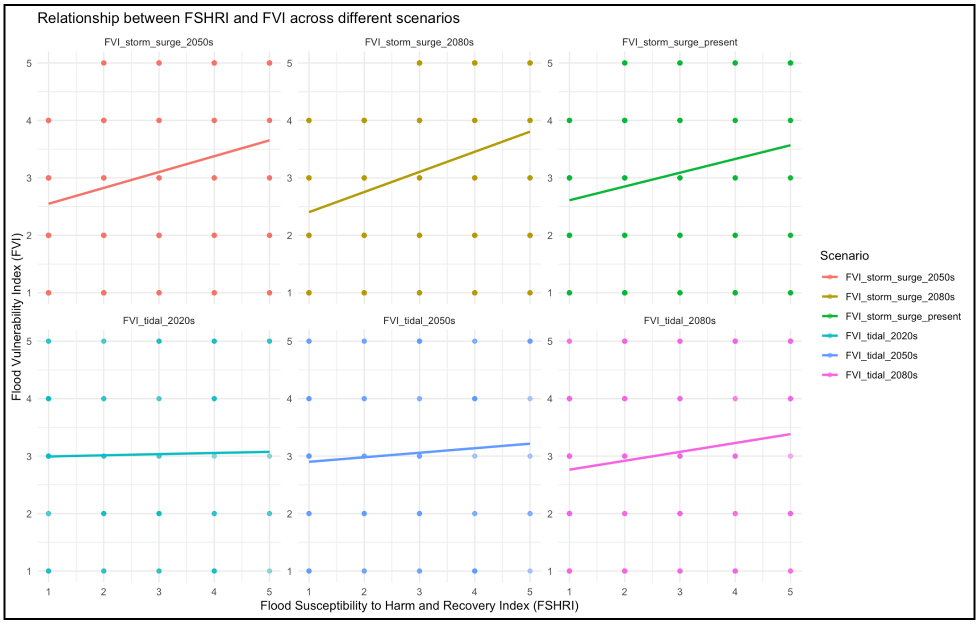

Figure 3

Distribution of FVI across Different Scenarios (Figure 4): The scatter plots illustrate the relationship between the Flood Susceptibility to Harm and Recovery Index (FSHRI) and the Flood Vulnerability Index (FVI) across storm surge and tidal flooding scenarios for the present, 2050s, and 2080s.

1. **Storm Surge Scenarios:**
    - The box plots for storm surge scenarios (present, 2050s, and 2080s) reveal similar distributions of FVI, with median values around 3 and a range extending from 2 to 4.
    - This consistency across scenarios suggests that while the overall flood vulnerability remains relatively stable, the extent of vulnerability might slightly increase in the future.
2. **Tidal Flooding Scenarios:**
    - The tidal flooding scenarios (2020s, 2050s, and 2080s) also display consistent distributions, with median FVI values around 3.
    - Like the storm surge scenarios, the range is from 2 to 4, showing consistent vulnerability levels over time across future scenarios.

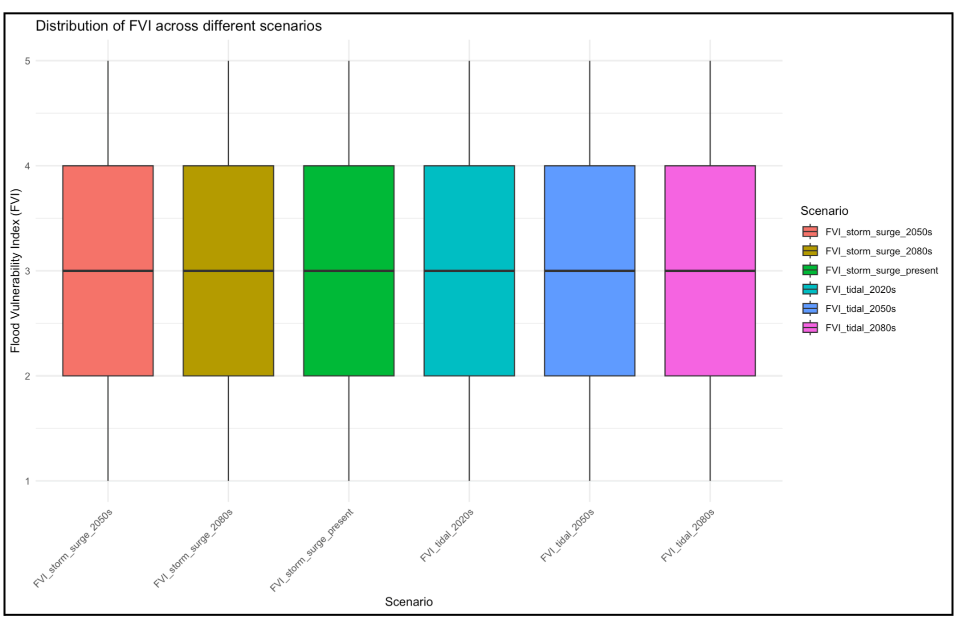

Figure 4

Temporal Trends in Flood Vulnerability (Figure 5):

1. **Mean Flood Vulnerability Index (FVI) Over Time:**
   - The line graph shows the mean FVI for storm surge and tidal flooding scenarios from the present to the 2080s.
   - **Storm Surge:**
     - The mean FVI for storm surge remains relatively stable, with a slight decline from around 3.005 in the present to just below 3.005 in the 2080s.
   - **Tidal Flooding:**
     - The mean FVI for tidal flooding starts at around 3.025 in the present, decreases slightly in the 2020s, and continues to drop significantly, reaching below 3.015 in the 2080s.
   - This indicates that tidal flooding vulnerability decreases more noticeably over time compared to storm surge vulnerability, which remains relatively constant.

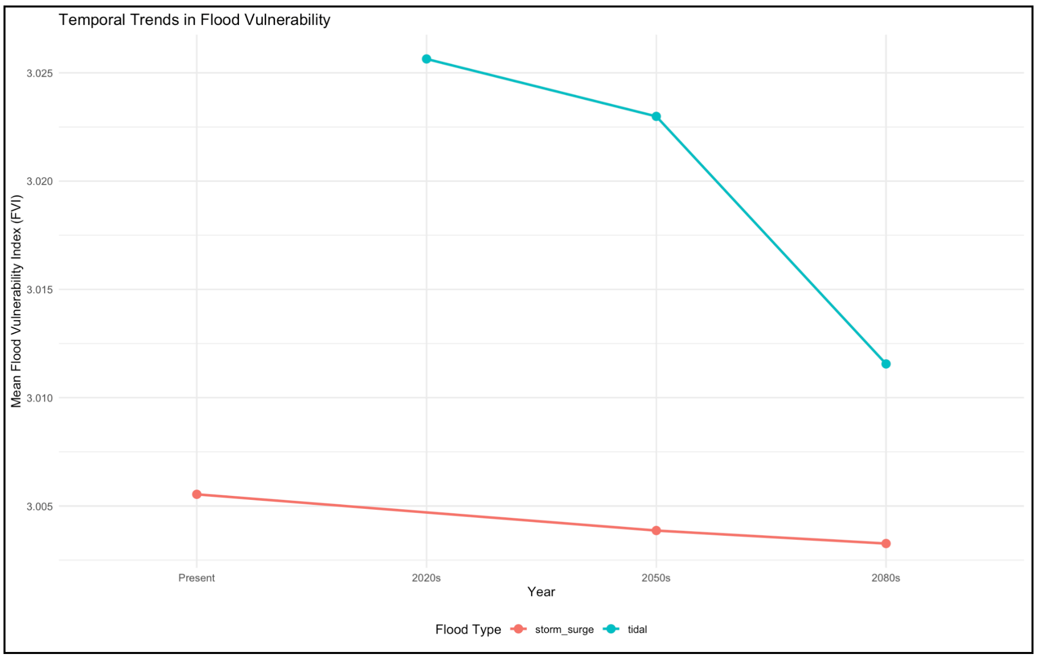

Figure 5

1. **Distribution of FVI Over Time(Figure 6):**
   - The box plot shows the distribution of the Flood Vulnerability Index (FVI) for both storm surge and tidal flooding scenarios across different time periods (present, 2020s, 2050s, 2080s).
   - **Storm Surge:**
     - The distribution of FVI for storm surge is fairly consistent over time, with median values remaining around 3 and a range extending from 2 to 4.
   - **Tidal Flooding:**
     - The distribution of FVI for tidal flooding also shows a consistent pattern over time, with median values around 3 and a range from 2 to 4.
   - The stable distribution for both flood types suggests that the overall flood vulnerability does not change drastically over time, although there is a slight downward trend in the mean FVI for tidal flooding.

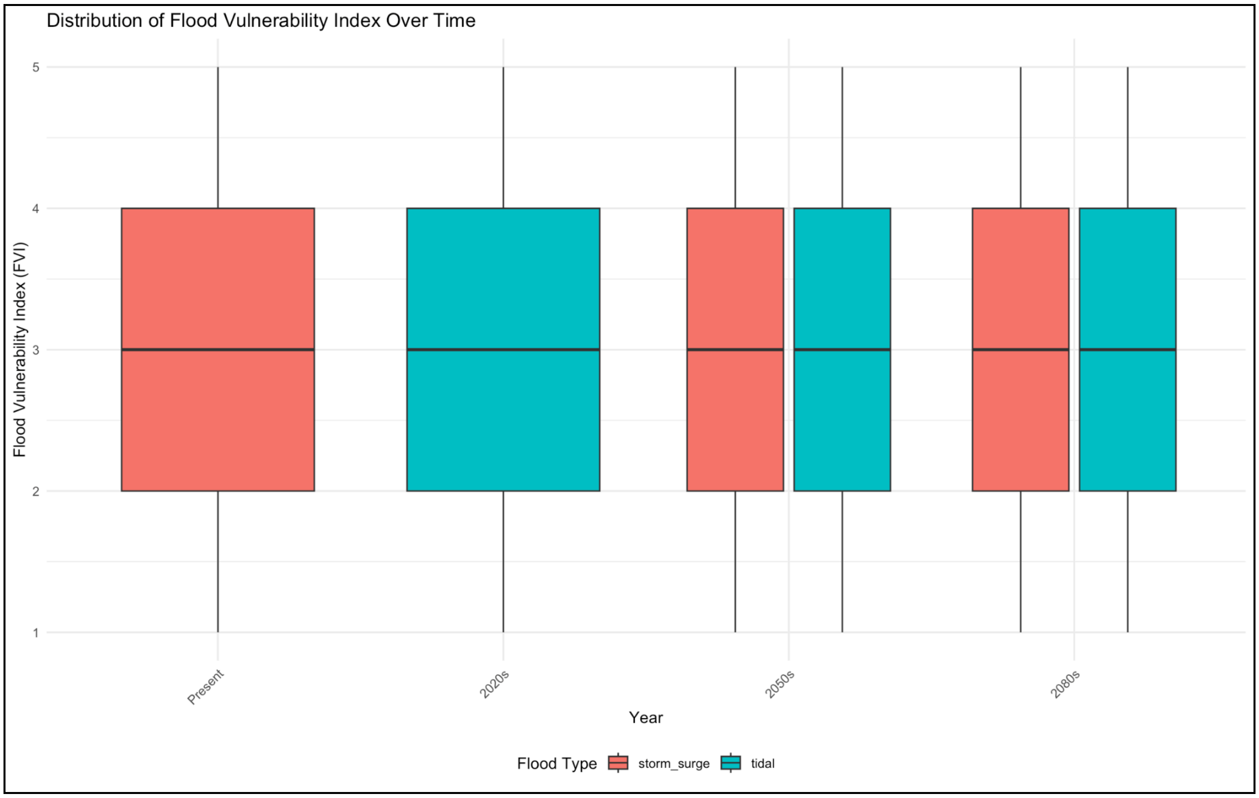

Figure 6

Statistical Analysis

The table below provides the summary statistics for the Flood Vulnerability Index (FVI) across different flood scenarios:

Scenario	Mean_FVI	Median_FVI	SD_FVI
FVI_storm_surge_2050s	3.00	3	1.42
FVI_storm_surge_2080s	3.00	3	1.42
FVI_storm_surge_present	3.01	3	1.42
FVI_tidal_2020s	3.03	3	1.42
FVI_tidal_2050s	3.02	3	1.42
FVI_tidal_2080s	3.01	3	1.42

1. Mean and Median FVI:

- The mean FVI values for all scenarios are remarkably similar, ranging from 3.00 to 3.03. This indicates a consistent level of flood vulnerability across different time periods and flood types.
- The median FVI value is consistently 3 across all scenarios, further confirming the stability of flood vulnerability over time and across flood types.

2. Standard Deviation (SD_FVI):

- The standard deviation for all scenarios is 1.42, indicating a consistent spread or variability around the mean FVI. This suggests that the distribution of FVI scores is similar across all scenarios.

Interpretation

The statistical data indicates that the Flood Susceptibility to Harm and Recovery Index (FSHRI) does not vary significantly across different flood scenarios. The mean and median FVI values are consistent, and the standard deviation remains unchanged at 1.42 for all scenarios. This uniformity suggests that the socio-economic factors contributing to flood vulnerability are stable over time and do not significantly differ between storm surge and tidal flooding scenarios.

The lack of significant variation in FVI across different scenarios implies that the socio-economic characteristics influencing flood vulnerability are persistent. Consequently, resilience and mitigation efforts should focus on addressing these underlying socio-economic vulnerabilities, as they remain constant regardless of the type of flood or the projected future scenario. This emphasizes the importance of targeted interventions to enhance the resilience of communities, particularly those identified as highly vulnerable based on the consistent FVI values across scenarios.

Temporal Trends in Flood Vulnerability

The table below presents the summary statistics for the Flood Vulnerability Index (FVI) across different flood types (storm surge vs. tidal) and scenarios (present, 2050s, 2080s):

Flood Type	Year	Mean_FVI	Median_FVI	SD_FVI
storm_surge	Present	3.01	3	1.42
storm_surge	2050s	3.00	3	1.42
storm_surge	2080s	3.00	3	1.42
tidal	2020s	3.03	3	1.42
tidal	2050s	3.02	3	1.42
tidal	2080s	3.01	3	1.42

1. **Mean FVI:**
   - **Storm Surge:**
     - The mean FVI for storm surge scenarios shows a very slight decline from 3.01 in the present to 3.00 in both the 2050s and 2080s. This suggests a stable trend in flood vulnerability due to storm surge over time.
   - **Tidal Flooding:**
     - The mean FVI for tidal flooding starts at 3.03 in the 2020s and gradually decreases to 3.01 by the 2080s. This indicates a slight decrease in flood vulnerability due to tidal flooding over time.
2. **Median FVI:**
   - The median FVI remains constant at 3 for both storm surge and tidal flooding scenarios across all time periods, indicating a consistent central tendency in flood vulnerability.
3. **Standard Deviation (SD_FVI):**

    - The standard deviation remains consistent at 1.42 for all scenarios and flood types, suggesting a stable variability in flood vulnerability across different time periods and flood types.

Interpretation of Temporal Trends

The statistical analysis indicates that flood vulnerability, as measured by the Flood Vulnerability Index (FVI), remains relatively stable over time for both storm surge and tidal flooding scenarios. The mean FVI shows minimal variation, with a slight decrease observed in tidal flooding scenarios from the 2020s to the 2080s. The median FVI remains constant at 3 across all scenarios, and the standard deviation also remains unchanged at 1.42, indicating consistent variability.

These findings suggest that the temporal trends in flood vulnerability do not exhibit significant changes, highlighting the persistent nature of flood vulnerability across different flood types and future scenarios. This stability underscores the importance of implementing long-term and adaptive flood resilience strategies that address the underlying socio-economic factors contributing to flood vulnerability, ensuring that communities remain resilient to both current and future flood risks.

Correlation Analysis

Correlation Between Socio-Economic Indicators and Flood Vulnerability

The table below shows the correlation values between the Flood Susceptibility to Harm and Recovery Index (FSHRI) and the Flood Vulnerability Index (FVI) across different flood scenarios:

Indicator	Correlation	Scenario
FSHRI	0.23936499	FVI_storm_surge_present
FSHRI	0.27411123	FVI_storm_surge_2050s
FSHRI	0.35052827	FVI_storm_surge_2080s
FSHRI	0.01919105	FVI_tidal_2020s
FSHRI	0.07646709	FVI_tidal_2050s
FSHRI	0.15360625	FVI_tidal_2080s

1. **Strongest Correlations:**
    - **FVI_storm_surge_2080s:** The highest correlation is observed between FSHRI and FVI_storm_surge_2080s with a correlation value of 0.35052827. This indicates a moderate positive relationship, meaning that as socio-economic vulnerability (as measured by FSHRI) increases, flood vulnerability due to storm surges in the 2080s also increases.
    - **FVI_storm_surge_2050s:** The second-highest correlation is for FVI_storm_surge_2050s with a correlation value of 0.27411123. This also shows a moderate positive relationship.
    - **FVI_storm_surge_present:** The present storm surge scenario shows a moderate positive correlation with FSHRI, with a correlation value of 0.23936499.
2. **Weaker Correlations:**

- **FVI_tidal_2080s:** The correlation for tidal flooding in the 2080s is weaker, with a value of 0.15360625.
- **FVI_tidal_2050s:** The correlation for tidal flooding in the 2050s is very weak, with a value of 0.07646709.
- **FVI_tidal_2020s:** The weakest correlation is observed for tidal flooding in the 2020s with a value of 0.01919105, indicating almost no relationship between FSHRI and FVI in this scenario.

Discussion

The analysis of flood vulnerability in New York City highlights significant spatial and temporal variations in flood risk across different regions and scenarios. The mean Flood Vulnerability Index (FVI) across different boroughs and scenarios shows a relatively stable trend, with slight variations between storm surge and tidal flooding scenarios.

Spatial Distribution: Coastal areas, particularly the southern and eastern shores, exhibit higher vulnerability indices, reflecting the increased exposure to flood hazards. Notable hotspots of high vulnerability are evident in parts of Staten Island, southern Brooklyn, and areas of Queens. Inner city areas generally show lower vulnerability, suggesting the influence of local factors such as topography, infrastructure, or socio-economic conditions.

Borough Analysis: Brooklyn exhibits the highest flood vulnerability under current storm surge conditions, followed by Queens and Manhattan. The Bronx and Staten Island show lower average FVI values, indicating relatively lower vulnerability. This distribution underscores the need for targeted resilience programs, particularly in Brooklyn and Queens, to mitigate flood risks effectively.

Temporal Trends: The mean FVI for storm surge scenarios remains relatively stable over time, with minimal fluctuations. However, the mean FVI for tidal flooding shows a slight decrease from the 2020s to the 2080s, indicating a potential reduction in vulnerability over time. This stability in flood vulnerability emphasizes the importance of continuous and adaptive resilience strategies.

Analysis of High-Risk Areas and Contributing Factors: High-risk areas, identified by higher FVI values, are primarily located in coastal regions, including parts of Staten Island, southern Brooklyn, and Queens. These areas are more susceptible to flooding due to their proximity to water bodies and lower elevation levels. Socio-economic factors, such as income levels, housing quality, and access to resources, further exacerbate vulnerability in these regions.

The strong correlation between the Flood Susceptibility to Harm and Recovery Index (FSHRI) and FVI in storm surge scenarios indicates that socio-economic vulnerabilities significantly contribute to flood risk. Areas with higher FSHRI values, reflecting greater susceptibility to harm and lower recovery capacity, tend to have higher FVI values. This correlation underscores the need for interventions that address both physical and socio-economic vulnerabilities.

Comparison with Previous Studies: The findings of this study are consistent with existing literature on flood vulnerability in urban areas. Previous studies have highlighted the disproportionate impact of flood hazards on low-income communities and the importance of addressing socio-economic factors in resilience planning. Similar to this study, other research has identified coastal areas as high-risk zones due to their exposure to storm surges and tidal flooding.

However, this study's detailed spatial analysis, based on census tract data, provides a more granular understanding of flood vulnerability in New York City. The identification of specific hotspots and the consistent trends across different scenarios offer valuable insights for targeted resilience strategies.

Limitations

Data Limitations: The analysis relies on available flood vulnerability and socio-economic data, which may not capture all relevant variables. Data quality and accuracy can vary, potentially affecting the results.

Methodological Constraints: The study uses specific indicators and correlation analyses to assess flood vulnerability. Other methodological approaches or indicators might yield different insights.

Scenario Projections: Future flood scenarios are based on projections that carry inherent uncertainties. Changes in climate patterns, urban development, and mitigation efforts can alter the actual flood risks.

Granularity: While the study provides a detailed spatial analysis, further granularity at a neighborhood or block level could offer more precise insights for localized interventions.

ates most strongly with flood vulnerability in storm surge scenarios, particularly in the 2080s. The correlation is weaker for tidal flooding scenarios, especially in the 2020s. This suggests that socio-economic factors have a more pronounced impact on flood vulnerability in the context of future storm surges compared to tidal flooding. The findings highlight the need for targeted interventions to address socio-economic vulnerabilities, particularly in areas prone to future storm surges, to enhance flood resilience

Conclusion

The analysis of flood vulnerability in New York City reveals several important insights that have significant implications for flood resilience policies:

Spatial Distribution of Vulnerability: Coastal areas, particularly the southern and eastern shores, exhibit higher flood vulnerability indices, with notable hotspots in Staten Island, southern Brooklyn, and parts of Queens. Inner city areas generally show lower vulnerability. Brooklyn has the highest average Flood Vulnerability Index (FVI) under current storm surge conditions, followed by Queens and Manhattan. The Bronx and Staten Island have lower average FVI values.

Socio-Economic Factors: There is a strong correlation between the Flood Susceptibility to Harm and Recovery Index (FSHRI) and the FVI in storm surge scenarios. Areas with higher socio-economic vulnerabilities are more susceptible to flood risks. Targeted interventions addressing socio-economic factors, such as improving housing quality and access to resources, are essential for enhancing flood resilience.

Temporal Stability: The mean FVI remains relatively stable across different flood scenarios and time periods, indicating persistent flood vulnerability levels. While there is a slight decrease in the mean FVI for tidal flooding over time, storm surge vulnerability remains constant. Continuous and adaptive resilience strategies are necessary to address the enduring nature of flood vulnerability.

Future Work

Enhanced Granular Analysis: Conduct more detailed spatial analyses at the neighborhood or block level to identify specific areas requiring targeted interventions. This can help in developing localized resilience strategies.

Incorporate Additional Data: Integrate more comprehensive socio-economic and environmental data to capture a broader range of factors influencing flood vulnerability. This could include data on infrastructure quality, emergency response capabilities, and historical flood impacts.

Climate Change Projections: Incorporate updated climate change projections to refine future flood scenarios. This will help in understanding potential changes in flood risks and inform long-term resilience planning.

Community Engagement: Engage with local communities to gather insights and feedback on flood risks and resilience measures. Community participation can enhance the effectiveness and acceptance of resilience strategies.

Policy Evaluation: Assess the effectiveness of current flood resilience policies and programs in mitigating flood risks. Identify gaps and areas for improvement to ensure that policies are responsive to the evolving nature of flood vulnerability.

Interdisciplinary Approaches: Foster interdisciplinary research collaborations to develop holistic flood resilience solutions. Combining expertise from urban planning, engineering, social sciences, and environmental studies can lead to more robust and sustainable resilience strategies.

Policy Implications

- **High Risk Coastal Areas:**
  - **Southern and Eastern Shores:** Coastal regions along the southern and eastern shores of New York City exhibit the highest flood vulnerability indices. These areas are particularly susceptible to storm surges and tidal flooding.
  - **Specific Hotspots:** Parts of Staten Island, southern Brooklyn, and areas of Queens are identified as notable hotspots with high flood vulnerability. Policies should prioritize these areas for flood mitigation measures.
- **Borough-Specific Interventions:**
  - **Brooklyn:** As the borough with the highest average Flood Vulnerability Index (FVI) under current storm surge conditions, Brooklyn should be a primary focus for resilience efforts. Enhancing infrastructure, improving drainage systems, and implementing community-based adaptation measures can help reduce flood risks.
  - **Queens:** With a high average FVI, particularly in coastal areas, Queens requires targeted interventions to address both physical and socio-economic vulnerabilities. Flood barriers, wetland restoration, and resilient housing initiatives are recommended.
  - **Manhattan:** Although Manhattan shows a lower average FVI compared to Brooklyn and Queens, its dense population and economic significance necessitate robust flood resilience measures. Protecting critical infrastructure and ensuring rapid recovery capabilities are essential.
- **Socio-Economic Vulnerability:**
  - **Low-Income Neighborhoods:** Areas with high Flood Susceptibility to Harm and Recovery Index (FSHRI) values, reflecting greater socio-economic vulnerability, should be prioritized. Policies aimed at improving housing quality, increasing access to emergency resources, and providing financial support for recovery can significantly reduce flood risks in these communities.
  - Community Resilience Programs: Implementing community-based resilience programs that involve local residents in planning and decision-making processes can enhance the effectiveness of flood resilience measures. Education and awareness campaigns can also empower communities to take proactive steps in mitigating flood risks.
- **Infrastructure and Environmental Enhancements:**
  - **Green Infrastructure:** Investing in green infrastructure, such as permeable pavements, green roofs, and urban green spaces, can reduce surface runoff and improve flood management. These measures are particularly effective in densely populated urban areas.

    - **Flood Barriers and Wetlands:** Constructing flood barriers and restoring wetlands along vulnerable coastlines can provide natural protection against storm surges and tidal flooding. These measures can be integrated with urban development plans to create a sustainable and resilient urban environment.
- **Adaptive and Flexible Policies:**
    - **Future Climate Scenarios:** Policies should be adaptive and flexible to account for future climate change projections and evolving flood risks. Regular updates to flood risk assessments and resilience plans are necessary to ensure their continued relevance and effectiveness.
    - **Cross-Sector Collaboration:** Collaboration between government agencies, non-profit organizations, academic institutions, and the private sector can enhance the implementation and sustainability of flood resilience policies. Leveraging diverse expertise and resources can lead to more comprehensive and innovative solutions.

By focusing on these areas, flood resilience policies can be more effectively targeted to reduce vulnerability, protect communities, and enhance the overall resilience of New York City to future flood events.

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Appendix

https://github.com/freethebusybee/Analysis-of-New-York-s-City-s-Flood-Vulnerability-Index.git