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COMMUNITY DEVELOPMENT

FLOOD RISK AND BASEMENT HOUSING IN NEW YORK CITY: The Impact of Extreme Weather on Vulnerable Housing Stock

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Key Takeaways

- Approximately 10 percent of low-income and immigrant New Yorkers live in census tracts with high concentrations of basement apartments at high risk of flooding.
- Both traditional (FEMA) and newer measures of flood risk (First Street Foundation), the latter of which incorporates intense rainfall, indicate that the highest flood risk to basement housing is concentrated in South and East Brooklyn, South Queens, the East Coast of Staten Island, and East Bronx.
- New measures of flood risk indicate that inland areas in Brooklyn and Queens face major to severe risk of flooding, including areas outside the 100-year floodplain.
- We estimate potentially 4,078 basement units that are likely to house LMI renters in areas at risk of major to severe flooding.
- Our estimates of the viable versus flood-prone housing stock suggest that adjacent and nearby neighborhoods that are affordable and less vulnerable to storms could be developed as future sites of safe dwellings.
- This future development of viable housing is especially salient because we estimate that 40 percent of low-and-moderate income and immigrant New Yorkers live in areas that are at low risk of future flooding and may face gentrification pressures.

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Introduction

Hurricane Ida, which struck New York in early September 2021, exposed the region's vulnerability to extreme rainfall and inland flooding. The storm caused $7.5 billion in damage to homes and vital infrastructure in New York state.[1] Most acutely, it was responsible for the deaths of eleven people in their basement homes, highlighting specific risks to inhabitants of low-lying units.

Severe rainstorm events like Ida are becoming more intense and more likely to overwhelm existing infrastructure and threaten low-lying housing stock. A recent analysis of the nation's housing vulnerabilities indicates that more than 18 million rental units in the United States face climate- and weather-related hazards.[2] Estimates of expected precipitation from the First Street Foundation suggest that "one in nine residents of the lower 48 states, largely in populous regions including the Mid-Atlantic and the Texas Gulf Coast, is at significant risk of downpours that deliver at least 50 percent more rain per hour" than can be drained by local infrastructure, including pipes and sewage systems.[3]

The intersection of natural hazards, severe housing shortages, and public safety raises the importance of identifying which neighborhoods contain the highest shares of flood-prone dwellings. The findings have significant practical value as municipalities assess where to encourage future housing density. This report measures the importance of basement housing in New York City, particularly for low-income and immigrant populations who may be priced out of above-ground units. It examines the flood exposure of basements using new data that incorporates risk from river-driven (fluvial) and rainfall-driven (pluvial) flooding, in addition to coastal flooding risk. We find that basements in select census tracts are at high risk of flooding, affecting an estimated 10 percent of low-income and immigrant New Yorkers. However, our estimates of the viable versus flood-prone housing stock indicate that adjacent and nearby neighborhoods that are affordable and less vulnerable to storms could be developed as future sites of safe dwellings.

1 New York State Office of the Governor. August 29, 2022. *Governor Hochul Announces Hurricane Ida Recovery Action Plan To Assist New Yorkers Impacted by Deadly Storm* (Press Release). Available at: Disaster Declaration and Latest News | Governor Kathy Hochul (ny.gov)
2 Joint Center for Housing Studies of Harvard University. (2024). *America's Rental Housing 2024*. Available at: America's Rental Housing 2024 (harvard.edu)
3 First Street Foundation. (2023). *The 8th National Risk Assessment: The Precipitation Problem.* Available at: National-Risk-Assessment-The-Precipitation-Problem-1.pdf (firststreet.org)

About the Data

Basement dwellings are among the most vulnerable to flooding. We focus on the basement structures most likely to be in residential buildings using the PLUTO (Primary Land Use Tax Lot Output) Database, which contains information about NYC properties and land at the tax-lot level. We adopt and modify a data-filtering process from Citizens' Housing and Planning Council's (CHPC) Hidden Housing report and divide basements into flood-prone and viable categories using flood-risk metrics from FEMA and First Street Foundation. In this brief, we define basements as below-grade and above-grade units in areas zoned for single- or two-family residential housing with two or more units.[4]

For our analysis of basement flood vulnerability, we combine data on flood risk from the FEMA 100-year floodplain and First Street Foundation. FEMA's data, which primarily relies on coastal flooding brought on by storm surges and rising sea levels, uses the 100-year return period (the likelihood of a one-in-100-year flood event happening) to determine a neighborhood's flood risk. We also use data from the First Street Foundation, which measures river and precipitation-driven flooding in addition to coastal flooding, to identify areas that are prone to flooding.

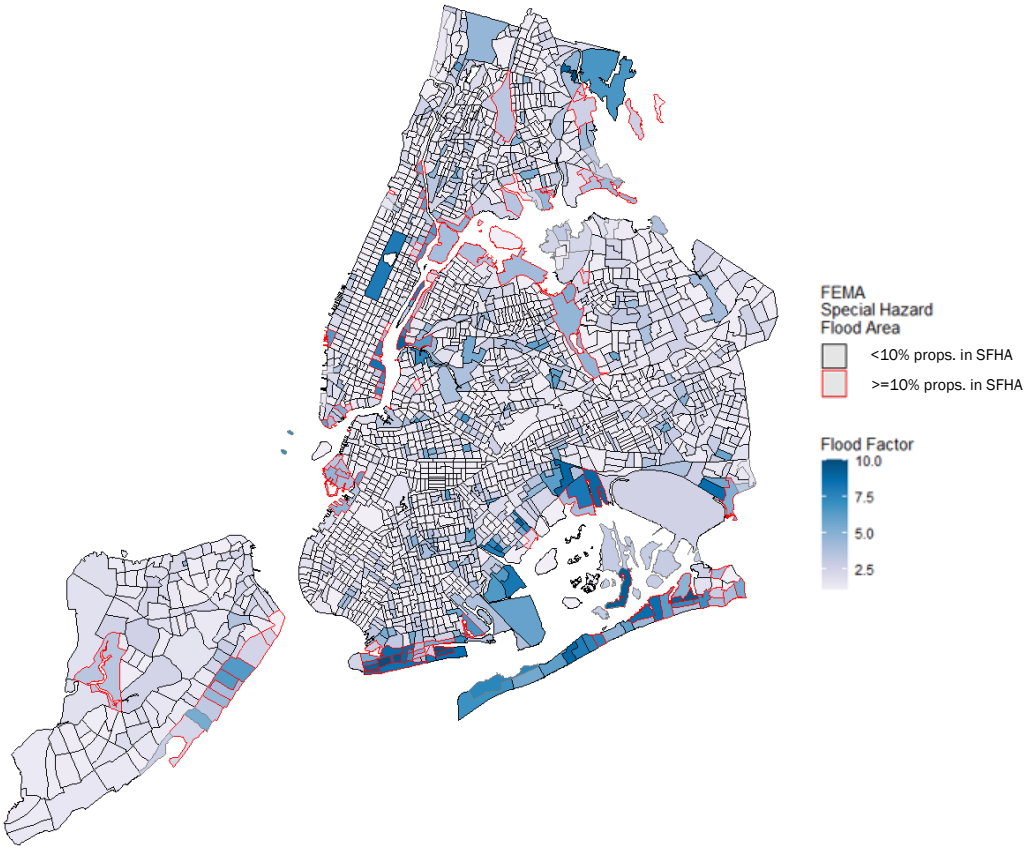
For demographic information, we use the 2021 American Community Survey (ACS) 5-year Estimates from the Census Bureau, specifically data from ACS Table B25118.

4 This includes all basements considered below-grade (basement walls are fully submerged or are less than 4 feet on at least three sides) and above-grade (basement walls are at least 4 feet high on at least two sides), as well as basements that are full (basement is 75 percent or more of the area of the first floor) and partial (basements that are between 25 percent and 75 percent of the area of the first floor) basements.

NYC Neighborhoods at Highest Flood Risk

New York City experiences tidal, coastal, inland, and riverine flooding throughout all five boroughs, given its uniquely expansive coastal geography and its vulnerability to hurricanes, thunderstorms, and cloudbursts. The increasing frequency of these flood events has tested the capacity of the city's stormwater-drainage infrastructure, resulting in flood loss that damages residential and commercial properties as well as community infrastructure. The New York City Panel on Climate Change (NPCC) estimates that by 2100 New York City could experience as much as 25 percent more rainfall every year.[5]

Figure 1: Flood Risk in New York City by Census Tract



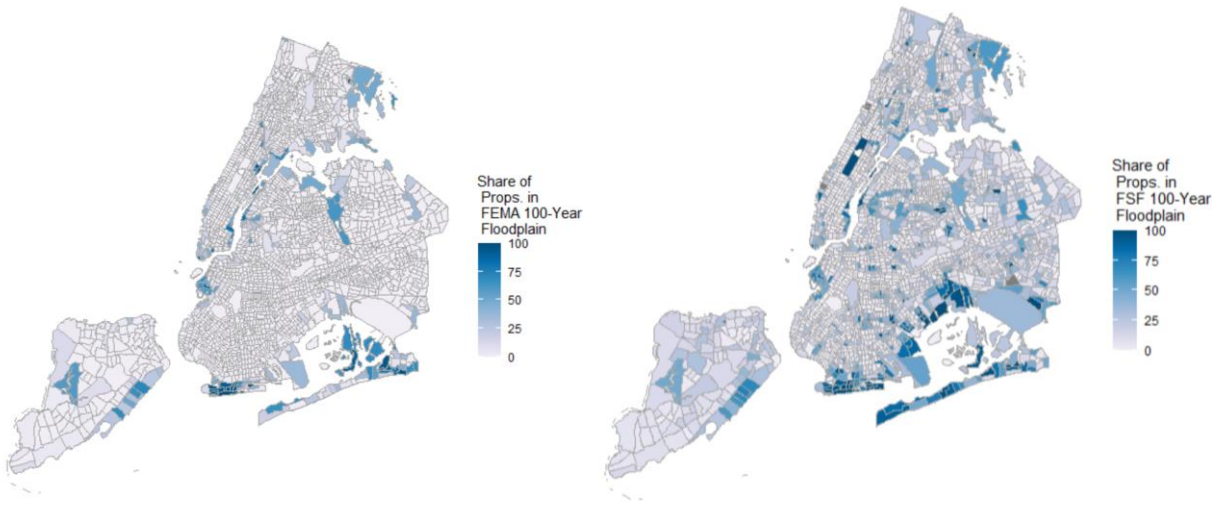
Data: First Street Foundation (2021); FEMA
Note: First Street Foundation's Flood Factor is measured on a 1 to 10 scale, with 1-2 indicating Minimal/Minor Flooding, 3-4 indicating Moderate Flooding, 5-6 indicating Major Flooding, 7-8 indicating Severe Flooding, and 9-10 indicating Extreme Flooding.

5 Rosenzweig, Cynthia and Willam Solecki. New York City Panel on Climate Change 2019 Report, Chapter 1: Introduction. Annals of the New York Academy of Sciences, Vol 1439: 22-29. Available at: https://www.unisdr.org/preventionweb/files/64738_nyas.14004.pdf

Figure 1 shows the degree of flood risk across NYC census tracts. We use Flood Factor as the risk metric, where scores range from 1 to 10 and increase as the 30-year cumulative flood likelihood and/or the projected depth of flooding increase. Properties with a higher Flood Factor are more likely to flood. In this map, we have computed a mean of Flood Factor scores across all buildings within a census tract. Flood Factor is shown in blue, with deeper shades depicting greater risk. These are contrasted with data on FEMA Special Flood Hazard Areas (SFHA), outlined in red. We code as red any census tract in which FEMA designates 25 percent or more of buildings existing in a Special Flood Hazard Area.

Inland areas in Brooklyn and Queens experiencing major flood risk reflect the impact of rainfall's increased activity and intensity. The National Climate Assessment found that the heaviest 1 percent of daily rainfall increased by 70 percent in the Northeastern United States. Stormwater management in New York City has not yet adapted to this increase in rainfall, making it imperative to identify the non-coastal areas that face as much flood risk as coastal areas.[6]

Figure 2: Comparing Flood Exposures in 100-year Floodplains



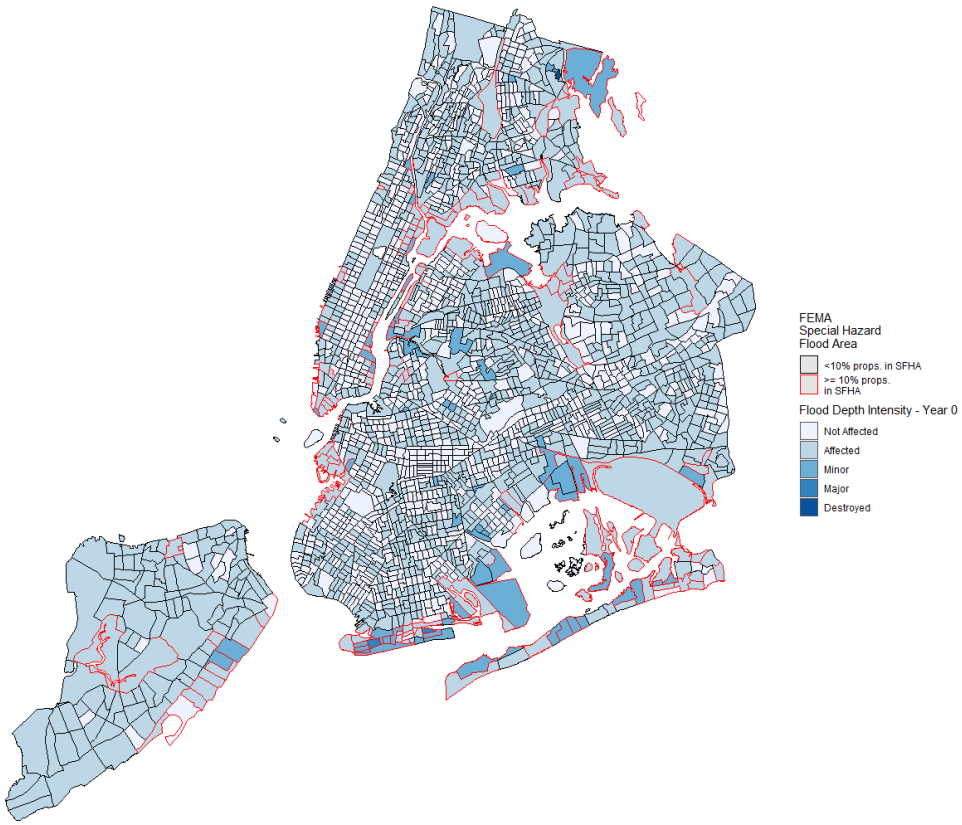
Data: First Street Foundation (2021); FEMA
Note: The 100-year floodplain using First Street Foundation data was found by calculating the share of properties experiencing greater than zero inches of flooding in the 100-year return period.

6 USGCRP, 2023: *Fifth National Climate Assessment*. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. Available at: https://doi.org/10.7930/NCA5.2023

Figure 2 captures the 100-year floodplains measured by FEMA and First Street Foundation, highlighting the areas not captured by FEMA's Special Flood Hazard Areas that likely experience pluvial flooding.

Both data sources indicate that the highest flood risk is concentrated in South and East Brooklyn, South Queens, the East Coast of Staten Island, and East Bronx. Given that Flood Factor also considers rainfall-driven flooding, there are some inland census tracts without coastal flooding in Brooklyn and Queens with Flood Factors of 5 or above. These inland areas, while not captured by SFHAs, still face major to severe risk of flooding. Given that these areas also sit outside of the 100-year floodplain, the frequency and severity of the risk of flood loss may not be adequately captured in assistance programs informed by the 100-year floodplain, such as federal emergency assistance benefits or the National Flood Insurance Program.

Figure 3: Flood Depth in New York City by Census Tract



Data: First Street Foundation (2021); FEMA
Note: Flood depth is measured in centimeters by First Street Foundation, then converted to inches and cross-referenced with a depth-to-damage scale defined by FEMA.

Figure 3 shows average flood depth across census tracts in New York, categorically defining depth by the intensity of the damage it can cause to properties. The map shows that most census tracts in New York City are at least "affected" by flood-related property loss, indicating that most of the city is experiencing flood depths inconvenient enough to cause some level of loss to property or even disruptions in access to public services like transit. Here, areas experiencing minor or major levels of flood-depth-related damage tend to be situated in and around coastal areas, though some notable exceptions in inland Brooklyn and Queens are not captured by SFHAs.

Inland flooding is typically marked by short-term, high-intensity localized rainfall, usually due to the density of impervious areas and the saturation of stormwater management systems. While coastal flood inundation can often be forecast with some accuracy, it is much harder to anticipate inland flood inundation, rendering residents less prepared for flood management and adaptation.

LMI Renters Face Elevated Risk from Floods

New York City's rental housing market is notoriously tight. A recent report suggests the city is facing its worst affordability crisis in two decades.[7] Half of households lack the means to cover monthly costs of an apartment, food, health care, and transportation, creating challenges for low- and moderate-income (LMI) populations seeking affordable housing. In addition to these general challenges, low-income renters are particularly vulnerable to natural hazards.[8] Standard renters' insurance does not cover flood damage,[9] and federal relief programs, in the event of a federal disaster declaration, offer renters only basic coverage.

Figure 4 examines the intersection of flood risk and the share of LMI renters by census tract using a bivariate choropleth map—a map that uses differences in shading or coloring to describe low and high values of a condition. Deeper shades of blue characterize the tracts with the highest flood risk and share of low-income renters. Tracts colored gold describe areas that house dense populations of low- and moderate-income renters but are less flood prone.

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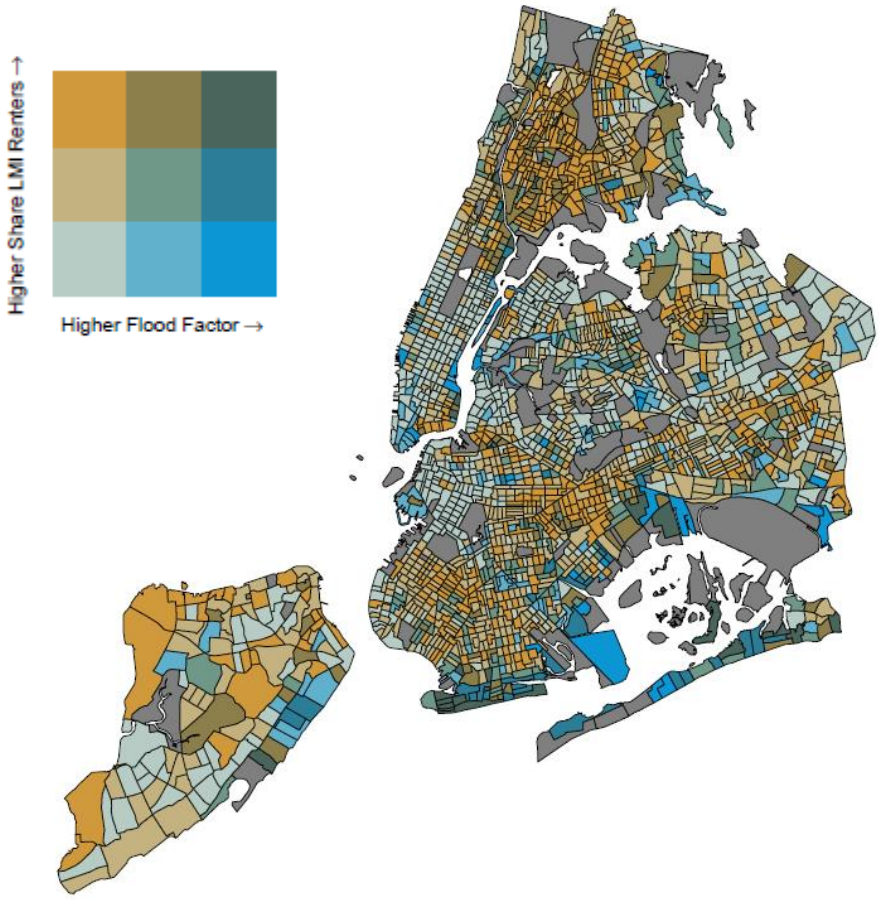
7 Center for Women's Welfare. (2023) *Overlooked & Undercounted: Struggling to Make Ends Meet in New York City 2023*. (New York: The Fund for the City of New York & United Way of New York City). Available at: https://unitedwaynyc.docsend.com/view/dh9h3h7q9478bzf9

8 Regional Plan Association. (2022). *Preventing Another Ida: Stormwater Management and Basement Apartments in Central Queens*. Available at: https://rpa.org/work/reports/hurricane-ida-stormwater-management-queens

9 New York State Department of Financial Services. *Help for Homeowners: Renter's Insurance Coverage.* Available at: https://www.dfs.ny.gov/consumers/help_for_homeowners/renters_tenants/renters_insurance#:~:text=a%20standard%20renters%20insurance%20policy,of%20damage%20when%20they%20do

The tracts with the highest flood risk for low-income renters include East Bronx, East Harlem, the East Coast of Staten Island, Southern and Eastern Brooklyn, the Lower East Side of Manhattan, and Southern Queens. The census tracts at highest risk tend to be located on coastlines, but there are several census tracts in Brooklyn, Queens, and the Bronx that are located more inland and show a moderate to high risk of flooding for LMI renters (shaded dark green). This is notably risky, as rainfall-induced flooding is not captured in the flood information used to qualify households for disaster assistance and insurance. Accordingly, asymmetric information on flood risk may put certain LMI renter households at increased risk of property damage and broader harm from inland flooding.

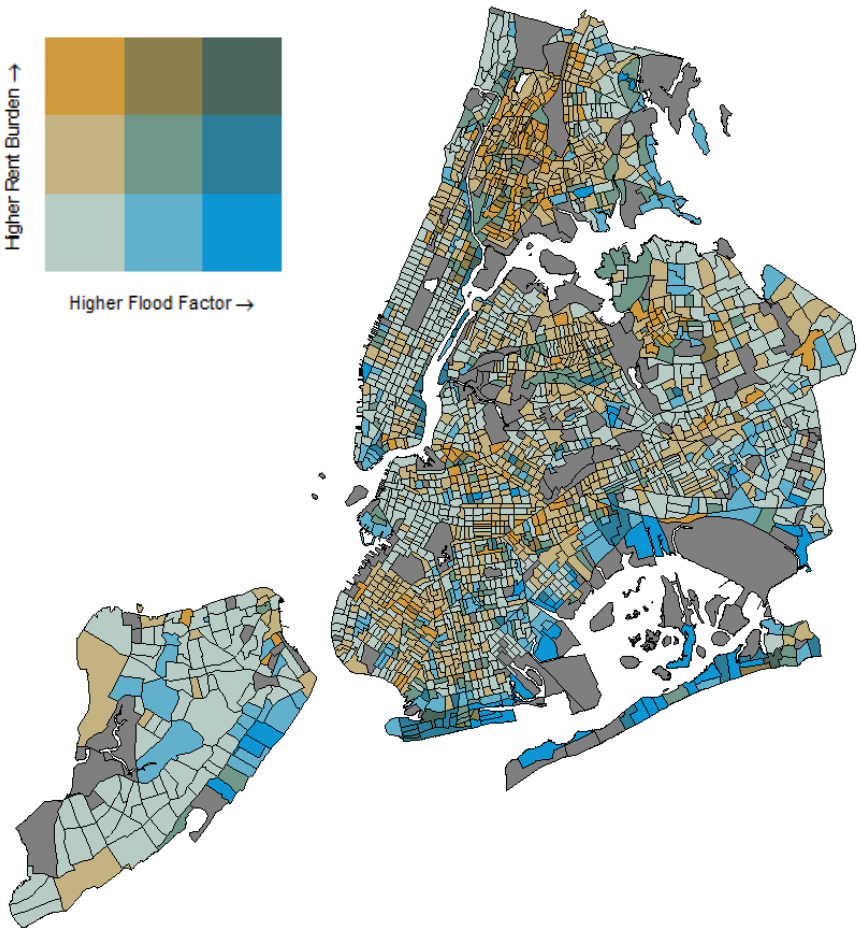
Figure 4: Flood Risk and LMI Renter Populations in NYC



Data: American Community Survey (5-year, 2017-2021); First Street Foundation (2021)
Note: Dark gray census tracts indicate data are not available. The numeric buckets for the share of LMI renters axis are 0-31 percent, 31-64 percent, and 64-100 percent.

The Connection Between Rental Burden and Flood Risk

Figure 5: Bivariate Map of Flood Risk and Rent Burden in NYC



Data: American Community Survey (5-year, 2017-2021); First Street Foundation (2021); FEMA
Note: Dark gray census tracts indicate data are not available.

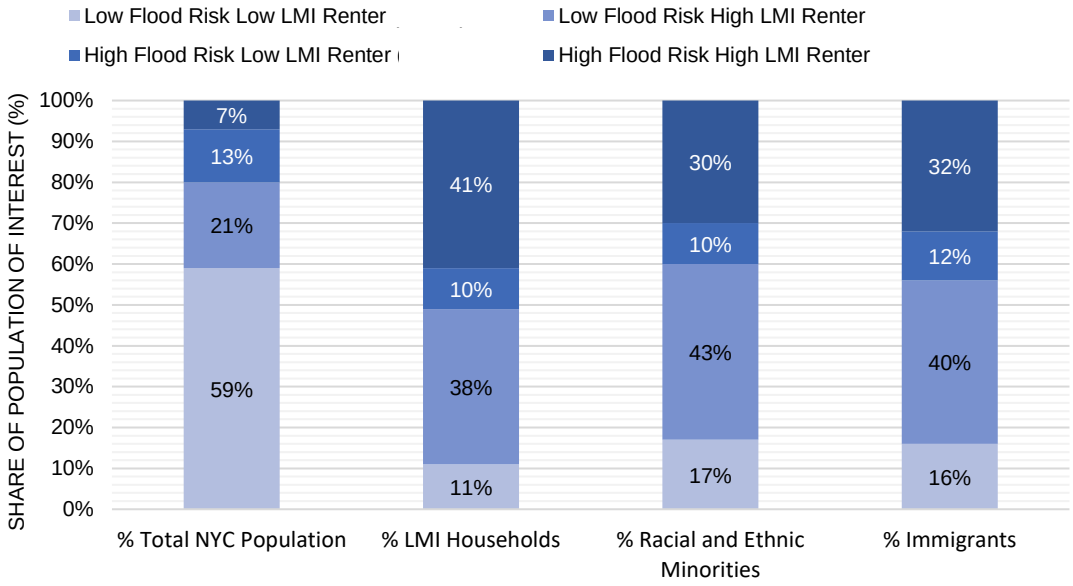
To convey more precisely where renters may face both financial and physical risk, Figure 5 shows rent burden and flood risk by neighborhood. Households are commonly defined as rent burdened when they spend 30 or more percent of monthly household income on rent. Severely burdened households spend 50 percent or more of their monthly income on housing.[10] Large areas of New York City, highlighted in gold, stand out as relatively rent burdened. Clusters of these neighborhoods

[10] Larrimore, Jeff and Jenny Schuetz (2017). *Assessing the Severity of Rent Burden on Low-Income Families*. FEDS Notes: Board of Governors of the Federal Reserve System. Available at: https://www.federalreserve.gov/econres/notes/feds-notes/assessing-the-severity-of-rent-burden-on-low-income-families-20171222.html

include large portions of the Bronx; East Harlem; sections of Eastern Queens, including Flushing; southern Queens, including part of the Rockaways; central Brooklyn near Flatbush and Canarsie; Western Brooklyn near Borough Park; and parts of the north coast of Staten Island. We expect legal and non-legal basement apartments to be in high demand in these neighborhoods.

While the gold-shaded neighborhoods have comparatively little flood risk, neighborhoods shaded in dark green are facing both high rent burdens and significant flood risk. We also anticipate elevated demand for more affordable housing, including both legal and non-legal basements, in these neighborhoods. However, these are also areas where basement apartment residents face the greatest physical risk. Dark green neighborhoods highlight areas where lack of broader housing choice could potentially motivate LMI renters to opt for formal or informal basement housing at higher risk of flood inundation, making these residents more vulnerable to frequent flood losses.

Figure 6: Demographics of Census Tracts with Varying Flood Risk and LMI Renter Density



Data: American Community Survey (5-year, 2017-2021); First Street Foundation (2021); FEMA

Low-income renters in New York include racial minorities and immigrant populations, who face acute vulnerabilities from climate risk. In Figure 6, four categories of flood risk and LMI renter density are used to assign shares of the total population as well as LMI households, racial minorities, and immigrant populations. Although 59 percent of New York City's population resides in census tracts

that have low flood risk and low-density LMI renter populations, over 50 percent of LMI households and approximately 40 percent of racial minorities and immigrants largely live in areas that are at high flood risk.

Additionally, LMI households, racial minorities, and immigrants are seen to have approximately 40 percent of their respective populations living in areas with low flood risk and high-density LMI renter populations. These areas are characterized by slightly more affordable housing in relation to other areas of the city; however, they are also vulnerable to climate displacement or the pricing out of low-income residents by newer, higher-priced development. The New York City population with the financial bandwidth to leave high flood-risk areas may opt to move to these low-risk areas that are currently home to a large share of LMI residents.

Profiling Flood-Prone Basement Housing

For neighborhoods with higher rent burdens and in those with limited housing supply, basement housing can serve as an important part of the housing stock. Average rental costs of basement dwellings are lower than those for above-ground apartments, saving renters an estimated 20 percent or more.[11] These economics make basement apartments attractive to thousands of New Yorkers, particularly working-class immigrants and people of color.[12] Table 1 categorizes the potential basement housing stock at low- or major- to high- flood risk.

Table 1: Sizing Flood-Prone Basement Housing Stock

NYC Census Tracts	***Low Share of LMI Renters (<30%)***	***Moderate to High Share of LMI Renters (>30%)***
Low Flood Risk (< 5 FF)	*44,753 basements (19% of all basements)*	*168,668 basements (72% of all basements)*
Major to High Flood Risk (>= 5 FF)	*506 basements (<1% of all basements)*	*4,078 basements (2% of all basements)*

Data: American Community Survey (5-year, 2021); First Street Foundation (2021); PLUTO NYC Database version 23.1; FEMA

[11] Myers, Emily. (2018, November 20). *What are the pros and cons of living in a basement apartment in NYC?* Brick Underground. Available at: https://www.brickunderground.com/rent/the-rules-on-basement-apartments-in-new-york-city

[12] Afridi, Lena and Rebekah Morris. (2021). *New York's Housing Underground: 13 Years Later*. Pratt Center. Available at: https://prattcenter.net/uploads/1021/1634833975615756/Pratt_Center_New_Yorks_Housing_Undergound_13_Years_Later_102121.pdf

The most vulnerable census tracts are those with higher shares of LMI renters and higher flood risk. An estimated 4,078 basement units are likely to house LMI renters in areas at risk of major to severe flooding. This is eight times the number of basement units (506) located in high-flood-risk census tracts with smaller populations of LMI renters, where there is a smaller likelihood of basement-unit residents.

Of all potential basement housing stock. 72 percent is found in census tracts with a moderate to high share of LMI renters and lower flood risk, suggesting a substantial stock of basement housing that could provide affordable options for LMI renters in flood-prone areas.

Flood depth is a categorically important measure to consider when determining risk of flooding to basement properties, as any level of flood inundation could be enough to cause significant damage to below-grade units. Basement dwellings and their inhabitants situated in areas more inland in Brooklyn and Queens face the added risk of flash flooding in an area not covered by the 100-year floodplain.

Who Resides in Basement Housing? Understanding the Residential Composition of Viable Versus Flood-Prone Basement Housing in NYC

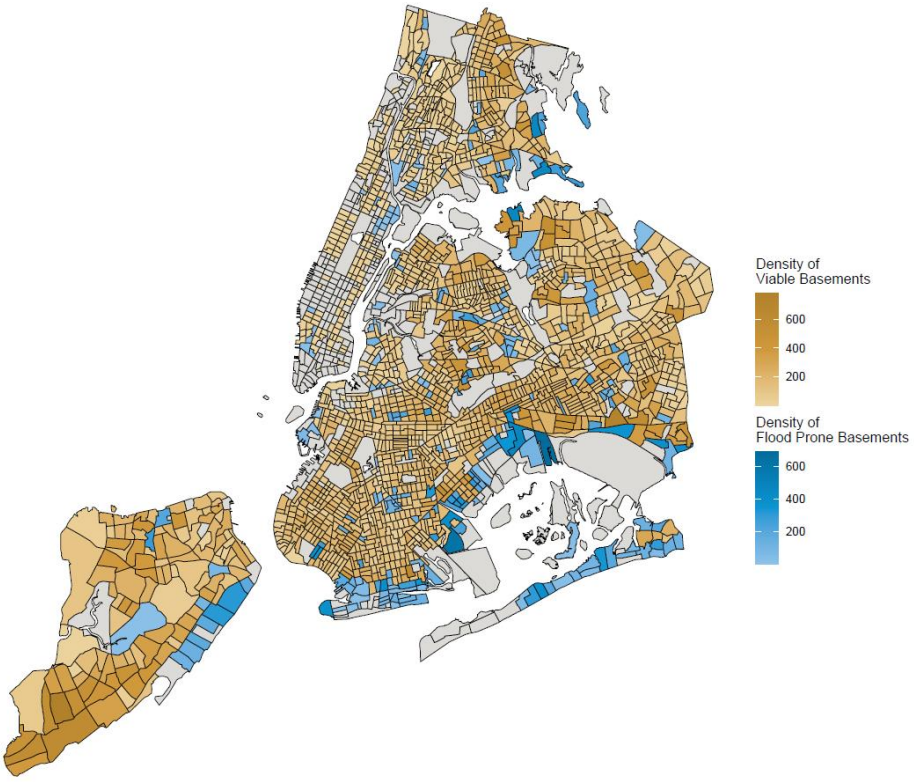
We categorize census tracts (and the basements in them) as flood-prone if they have a Flood Factor score of 3 or above (moderate to extreme flood risk) and/or if more than 10 percent of the properties in the census tract fall in a Special Flood Hazard Area. Viable basements are in census tracts that have a Flood Factor score of below 3 and less than 10 percent of properties in a SFHA. Census tracts defined as having viable basement housing are intended to be broad estimates of less flood-prone below-ground dwellings but may still include some dwellings that are flood-prone.

Figure 7 indicates that most census tracts in New York City are viable but vary in the density of basements. High concentrations of viable basements are in southern Staten Island, southern Brooklyn, southern Queens, and Flushing, while higher concentrations of flood-prone basements are in East Harlem, eastern Staten Island, eastern and southern Bronx, and notably, parts of southern Brooklyn, southern Queens, and Flushing. The proximity of flood-prone basement dwellings in southern Brooklyn, southern Queens, and Flushing to neighborhoods with viable basements indicates that alternative options (if vacant) are nearby. For inland census tracts with flood-prone

basements, the density of viable basements in adjacent census tracts varies, suggesting that alternative housing options may be scarce for those in basement housing at risk of inland flooding.

The highest densities of flood-prone basement housing are still found along the coastlines of the city, particularly Canarsie, Coney Island, Howard Beach, and East New York. These basement units are also in census tracts with severe to extreme flood-risk scores. However, the rent burden in adjacent, viable census tracts is lower than in other parts of the city, suggesting there may be affordable basement housing options nearby. Many of the census tracts with viable basement housing align with the areas in Figures 4 and 5 showing locations with higher populations of LMI renters and low flood risk. As mentioned, these areas are potential hotspots for climate displacement and rising housing costs. While rent burden may be lower in these areas right now, it is important to consider the role that relocation and subsequent housing costs play in the future viability of these areas.

Figure 7: Density of Potential Basement Dwellings by Census Tract (Viable Versus Flood-Prone)



Data: PLUTO NYC Database version 23.1; First Street Foundation (2021); FEMA
Note: Dark gray areas indicate that there are no identifiable potential basement dwellings in the census tract, given the data-filtering process used here.

We calculated the share of low and moderate-income people, immigrants, and racial/ethnic minorities living in a flood-prone census tract. Approximately one in ten LMI individuals, immigrants, and racial/ethnic minorities in NYC live in a flood-prone census tract, a significant share of each of these populations, as shown in Table 3. The informality of basement housing often means that the city's most vulnerable communities are likely to take up residence in these dwellings.[13]

Table 3: Flood Prone Census Tracts by Demographics

Basement Type	***LMI***	***Immigrants***	***Racial/ethnic minorities***	***Monthly Median Rent ($)***
Census Tracts with Flood-Prone Basements	9%	9%	10%	$1494.36

Data: American Community Survey (5-year, 2021); First Street Foundation (2021); PLUTO NYC Database version 23.1; FEMA
Note: The first three data columns reflect the percentage of the total population in tracts with moderate to high flood risk (Flood Factor of 3 or above and/or > 10 percent of properties in a Special Flood Hazard Area). The final column shows the mean of median rents across census tracts.

Additionally, sizable shares of these populations living in census tracts with flood-prone basements, are prone to pluvial (rainfall and stormwater related) flooding. Some 4 to 6 percent of LMI, immigrant, and racial minority populations in NYC live in areas experiencing pluvial flooding, and many of these areas are outside the 100-year floodplain. Nearly equal shares of these populations are vulnerable to coastal and pluvial flooding alike, but those living in areas prone to pluvial flooding face the added vulnerability of unanticipated flash floods and lack of access to emergency financial assistance.[14]

[13] Afridi, Lena and Rebekah Morris. (2021). *New York's Housing Underground: 13 Years Later*. Pratt Center. Available at: https://prattcenter.net/uploads/1021/1634833975615756/Pratt_Center_New_Yorks_Housing_Undergound_13_Years_Later_102121.pdf

[14] Sources of financial assistance for flood-related losses, such as the National Flood Insurance Program, rely on the FEMA 100-year floodplain to determine qualification for financial assistance which may not always encompass areas exclusively impacted by pluvial flooding and not coastal or riverine flooding. As a result, these neighborhoods are more limited in their access to emergency aid.

Table 4: Coastal vs. Pluvial Flood-Prone Census Tracts by Demographics

Basement Type	*LMI*	*Immigrants*	*Racial/ethnic minorities*	*Average Monthly Median Rent ($)*	*Average Annual Median Income ($)*
Census Tracts with Coastal Flood-Prone Basements	4%	5%	4%	$1325.41	$91,405
Census Tracts with Pluvial Flood-Prone Basements	5%	4%	6%	$1510.34	$67,821

Data: American Community Survey (5-year, 2021); First Street Foundation (2021); PLUTO NYC Database version 23.1; FEMA
Note: The first three data columns reflect the percentage of the total population in tracts with moderate to high flood risk (Flood Factor of 3 or above and/or > 10 percent of properties in a Special Flood Hazard Area). The fifth column shows the mean of median rents across census tracts. The final column shows the average annual median income across census tracts.

Median rents in census tracts with basement housing also differ based on flood type. The median monthly rent in areas with pluvial flooding is about $200 higher per month than in areas with coastal flooding. This could suggest that the costs associated with experiencing pluvial flooding have not necessarily been priced into housing costs, in contrast to areas that experience coastal flooding and sit squarely within the 100-year floodplain.

While average monthly median rent in tracts with pluvial flood-prone basements is higher than in coastal flood-prone basements, annual median income is lower by approximately $24,000. This indicates that residents in areas with more rainfall-induced flood inundation must manage not only the vulnerability associated with flash flooding, but also higher rent burdens and less income liquidity to overcome unanticipated costs associated with flooding.

Conclusion

This brief introduces new data to estimate with greater precision the flood risk to basement apartments in New York City. We show that flood risks potentially impact roughly ten percent of LMI individuals, immigrants, and racial and ethnic minorities. However, we also show that census tracts adjacent to some flood-prone areas could provide additional viable basement housing.

As the formalization of basement housing stock in NYC is debated, it is important to account for both inland and coastal flooding, the degree of rent burden, and the vulnerability of LMI, immigrant, and minority populations in assessing viable basement housing stock and future housing development.

APPENDIX

Basement Housing Identification Methodology

First, we removed all tax lots with no basements indicated and retained both above-grade and below-grade basements. Second, we filtered the data down to one- and two-family homes, because the basement units in these buildings are the most likely and able to be converted into basement units, informal or formal. Basements in multifamily housing are subject to stricter regulations and oversight and are often smaller in area. Third, we filtered down to the dwellings zoned for two or more units, ensuring that the homes in our data can viably fit a separate housing unit in their basement. Fourth, we label basements as flood-prone if they are in a census tract in a SFHA and/or have a Flood Factor score of 5 or above.

The total number of basements in the data is about 233,203. It is likely that a significant portion of this count is not being used for basement dwelling units. However, these data are important in identifying the share of basements that are at highest risk for flooding and therefore not viable as a residence.