COLUMBIA
GSAPP

PRIORITIZING ENERGY INVESTMENTS IN NEW YORK CITY

GEOGRAPHIC INFORMATION SYSTEMS
FINAL PROJECT FALL 2022

NIEW HOLMES
GARRYTH HOAL
KAVYAA RIZAL

PROF. LEAH MEISTERLIN
& PROF. DANIEL FROEHLICH

“All the cities of the world are going to expand. We need to have a better understanding of what makes good urban habitat for homo sapiens. We have an obligation to make the new places more livable, more sustainable, more healthy. We have the tools.”

- Jan Gehl

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INTRODUCTION

New York City is considered one of the great financial capitals of the world. Throughout New York's storied history large capital projects have been financed by wealthy private citizens such as the Morgan family as well as through governmental investment (Chernow, 2022). Largely these investments have been driven through the prioritization of economic growth. However, New York City is now one of the largest cities in the world and is struggling to maintain its public infrastructure (Lehewych, 2022).

Due to its presence as a large population center the city has struggled to combat its negative role in the climate crisis. As with many coastal urban centers, the city is especially vulnerable to acute climate events and climate change over time (Climate Check, 2022). This vulnerability in combination with struggling a public infrastructure system has created an environment ripe for energy based investments.

It is our hope that this report can be of use to those working to identify investment opportunities in clean energy for the City of New York.

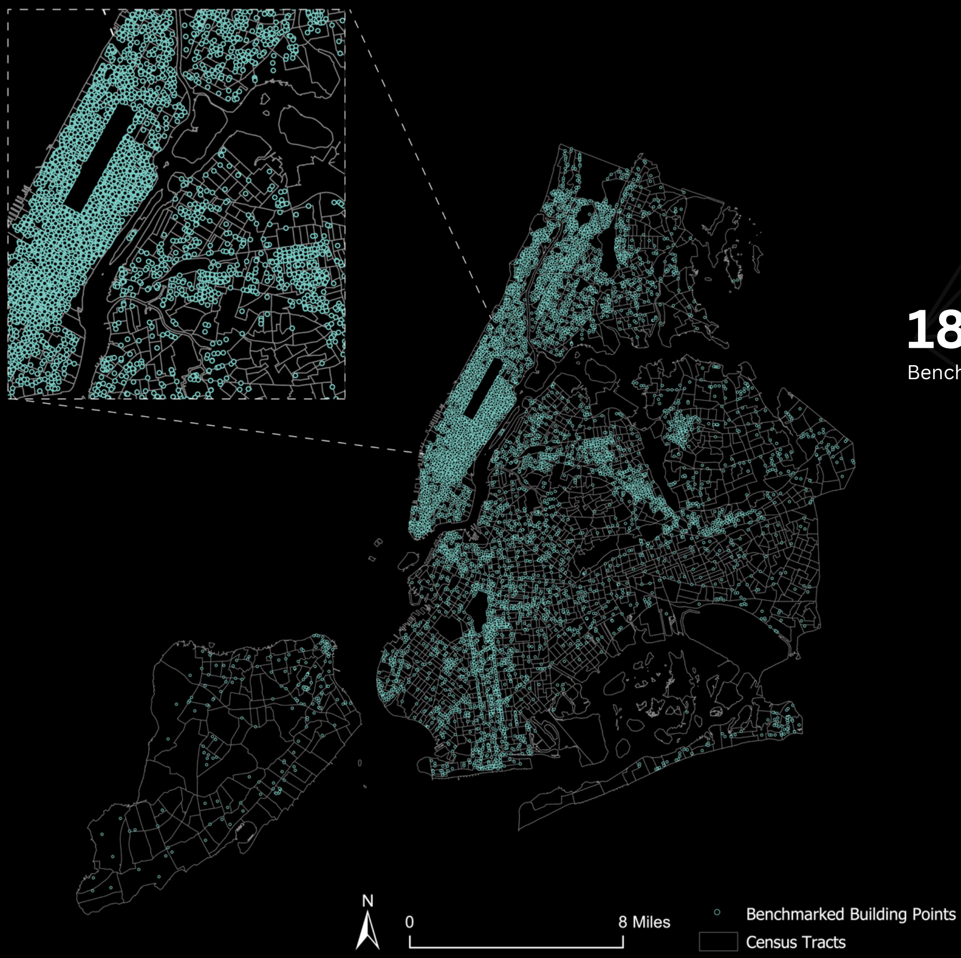
Source: New York Public Library

BACKGROUND

With the urgency for climate mitigation in cities increasing, a lot of the attention has shifted to enhancing building energy efficiency in New York City this past decade. Under the Climate Mobilization Act, NYC has committed to achieving carbon neutrality by 2050 in a just and equitable way (OneNYC, 2022). Specifically, under Local Law 97, NYC has set the ambitious goal of reducing building carbon emissions by 80% by 2050, starting with stringent regulations for energy efficiency in buildings over 25,000 sq ft from 2024. Building energy use at the moment, roughly accounts for 66% of total citywide GHG emissions (OneNYC, 2017).

In an effort to create transparency around building energy use and energy efficiency, NYC has also enacted Local Law 33, which requires benchmarked buildings (most buildings over 25,000 sq ft.) to report and display their energy efficiency scores.

The Justice40 Initiative, signed 2022, on the other hand, cites that 40% of the overall benefits of federal investments should flow to “disadvantaged communities that are marginalized, underserved, and overburdened by pollution” (The White House, 2022). “Clean Energy and Energy Efficiency” is one of the 7 categories of investment under this initiative.



185,660
Benchmarked Buildings

RESEARCH QUESTIONS

What are the most suitable [1] neighborhoods [2] for investments in building energy efficiency in New York City?

What is the current land use and demographic composition of those neighborhoods?

HYPOTHESIS

Historically disadvantaged communities will be concentrated in areas that have not received quality green infrastructure investment, and therefore, also where building energy efficiency is the most poor.

1 | Suitability is determined through the Justice40 and additional building performance indicators.
2 | Neighborhoods are operationalized as a group of 4-6 census tracts.

SCOPE

The scope of this study focuses on building energy efficiency as a category of investment under the Justice 40 Initiative and its implications for the City of New York. The study begins with identifying areas with the highest concentration of disadvantaged communities as defined by the initiative along with building energy efficiency scores for residential buildings of over 25,000 sq ft. reported over the last 5 years.

Our study will utilize the Multi-Criterion Decision Analysis (MCDA) process to make recommendations regarding the allocation of the 40% of investments towards promoting equitable building energy efficiency transitions in the city.

LIMITATIONS

The scope of this study falls within the last five years of building energy use and demographic distribution. This temporal restriction may not be enough to adequately assess the historic relationship between green energy transition and marginalized groups.

Our analysis focuses on the allocation of resources from the Justice 40 Initiative and does not include analysis of other means of investment. Our work is also focused solely on the investment of these resources in the five boroughs of New York City and does not address the needs of the surrounding areas. "Disadvantaged communities" are defined according to the Justice40 parameters, therefore, only includes 3 out of many possible socio-economic and environmental vulnerabilities communities might face.

Data regarding current/past investments towards building energy efficiency improvements are not available and therefore cannot be factored into our analysis. This study focuses on the last five years of data and does not extend into years prior. This study also does not include analysis of future private investment potential for green energy.

In addition, in our MCDA approach, our method of weighing factors affects the outcome of our analysis, differently applied weights may result in a change in findings.

Finally, it should be noted that much of the assessment includes building energy use data and may not address other infrastructure needs in the City of New York.

OUR BIRDHOUSE

USERS

Our team is comprised of 3 MSUP students with backgrounds in real estate development, finance, environmental sciences, international development and entrepreneurship.

METHODS

We utilized our data to conduct a Multi Criterion Decision Analysis based on three factors from the Justice 40 Initiative and three factors introduced by our team.

DATA

Publicly available datasets used covered household-level income, energy expenditure, exposure to air pollution and benchmarked building performances from 2015-2020.

SOFTWARE

For our analysis we utilized Microsoft Excel, R Studio, Arc GIS Pro, Adobe Illustrator, and Python 3.11

HARDWARE

The majority of our project utilized the Columbia Urban Planning Lab in Fayerweather Hall on the Columbia University Campus

DATASETS & SOURCES

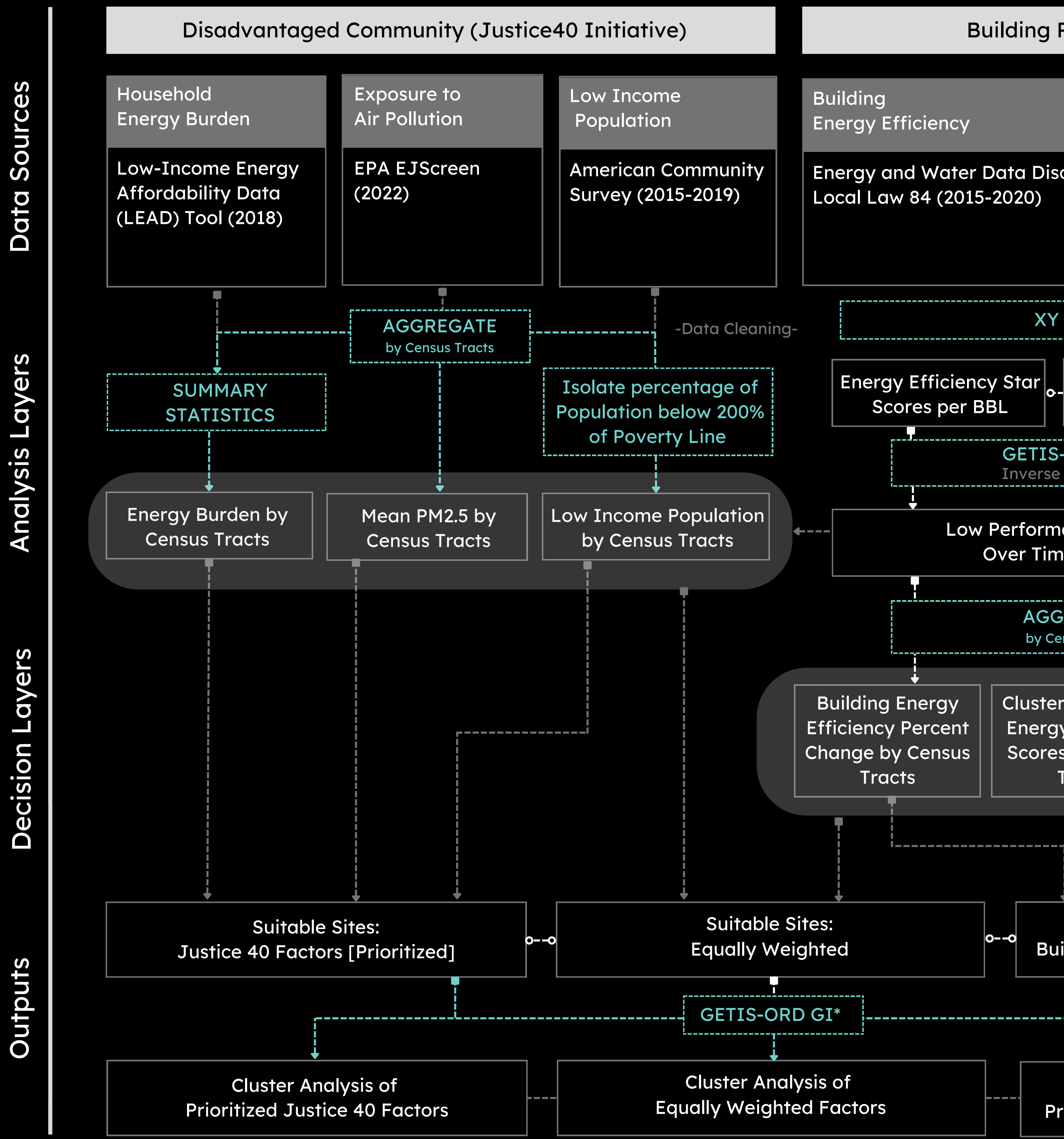
As the Justice40 Initiative is the basis of our work, it is relevant and necessary to incorporate decision making layers based on the evaluation done by the policy makers. To that end we have incorporated data used in the Justice40 Initiative to determine where disadvantaged communities are located. As we also wanted to focus on investment in poor performing buildings in NYC, we decided to include three factors from external to the Justice40 requirements. These factors assist us with understanding the temporal/geographical relationship between demographic, environmental and energy efficiency indicators.

ANALYTICAL DATASETS

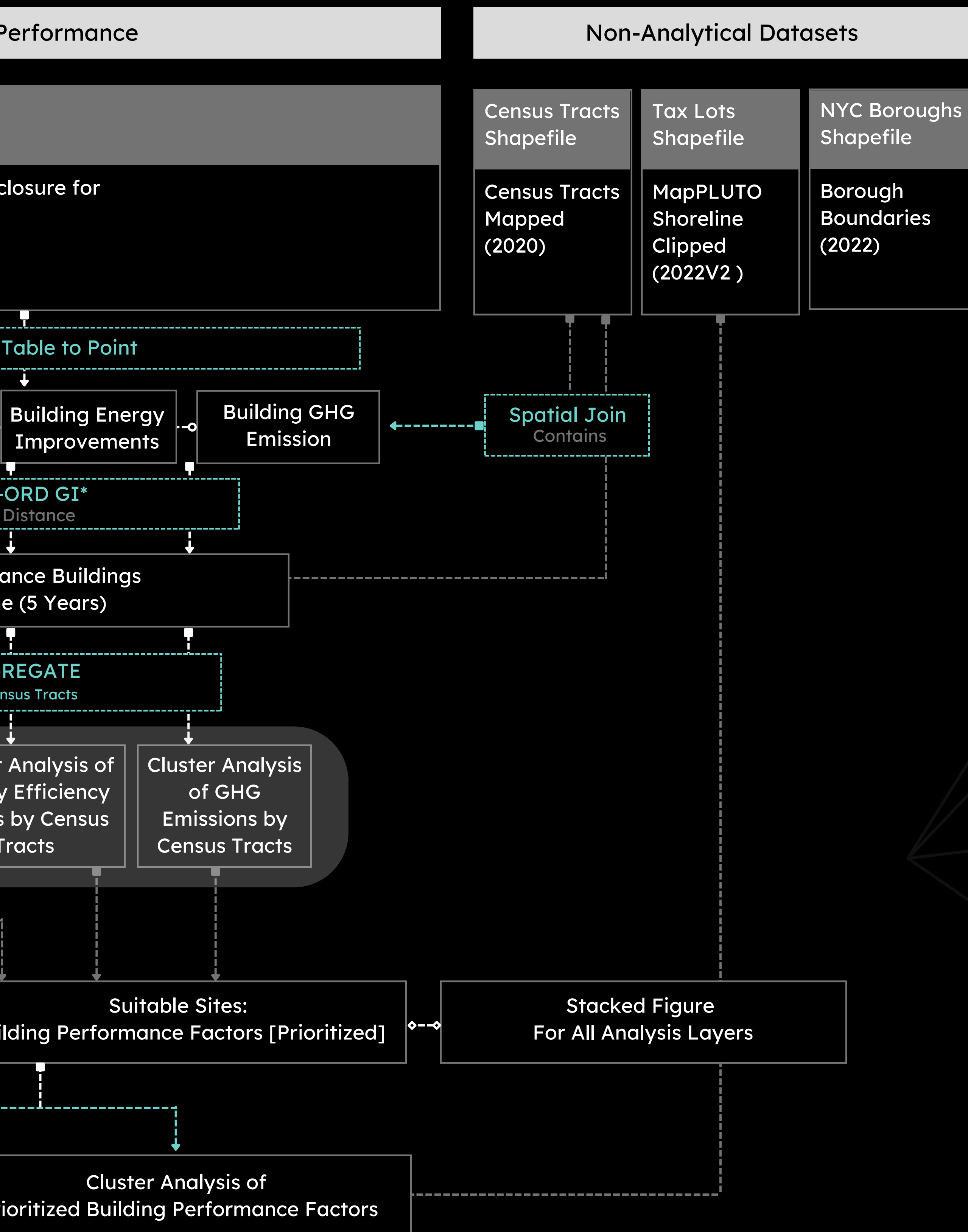
DATASET	DESCRIPTION	SOURCE
LOW-INCOME ENERGY AFFORDABILITY DATA (LEAD)	Energy burden calculated as the percentage of total household income spent on energy.	OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY (2018)
ENVIRONMENTAL JUSTICE SCREENING RAW DATA	Particulate matter found in the census tract compared to national averages sourced from the EPA.	UNITED STATES ENVIRONMENTAL PROTECTION AGENCY (2020)
AMERICAN COMMUNITY SURVEY 5-YEAR ESTIMATES 2015-2019	Low income as defined by the percentage of households in the census tract 200% under the poverty line.	UNITED STATES CENSUS BUREAU (2020)
ENERGY AND WATER DISCLOSURE FOR LOCAL LAW 84 2015-2020	Total GHG Emissions (Metric Tons CO2e) and Energy STAR Score per BoroughBlockLot.	NYC MAYOR'S OFFICE OF CLIMATE AND SUSTAINABILITY (2021)

REFERENCE DATASETS

DATASET	SOURCE
2020 TIGER/LINE SHAPEFILE	U.S. CENSUS BUREAU (2020)
MAPPLUTO RELEASE 2022v2 SHAPEFILE	NEW YORK CITY DEPARTMENT OF CITY PLANNING (2022)
NEW YORK CITY BOROUGH BOUNDARIES - WATER EXCLUDED	NEW YORK CITY DEPARTMENT OF CITY PLANNING (2022)



Data Sources
Analysis Layers
Decision Layers
Outputs
Disadvantaged Community (Justice40 Initiative)
Building P
Household Energy Burden
Low-Income Energy Affordability Data (LEAD) Tool (2018)
Exposure to Air Pollution
EPA EJScreen (2022)
Low Income Population
American Community Survey (2015-2019)
Building Energy Efficiency
Energy and Water Data Disc
Local Law 84 (2015-2020)
AGGREGATE
by Census Tracts
-Data Cleaning-
XY
SUMMARY STATISTICS
Isolate percentage of Population below 200% of Poverty Line
Energy Efficiency Star Scores per BBL
GETIS-
Inverse
Energy Burden by Census Tracts
Mean PM2.5 by Census Tracts
Low Income Population by Census Tracts
Low Perform
Over Tim
AGG
by Ce
Building Energy Efficiency Percent Change by Census Tracts
Cluster
Energy
Scores
T
Suitable Sites: Justice 40 Factors [Prioritized]
Suitable Sites: Equally Weighted
Bui
GETIS-ORD GI*
Cluster Analysis of Prioritized Justice 40 Factors
Cluster Analysis of Equally Weighted Factors
Pr

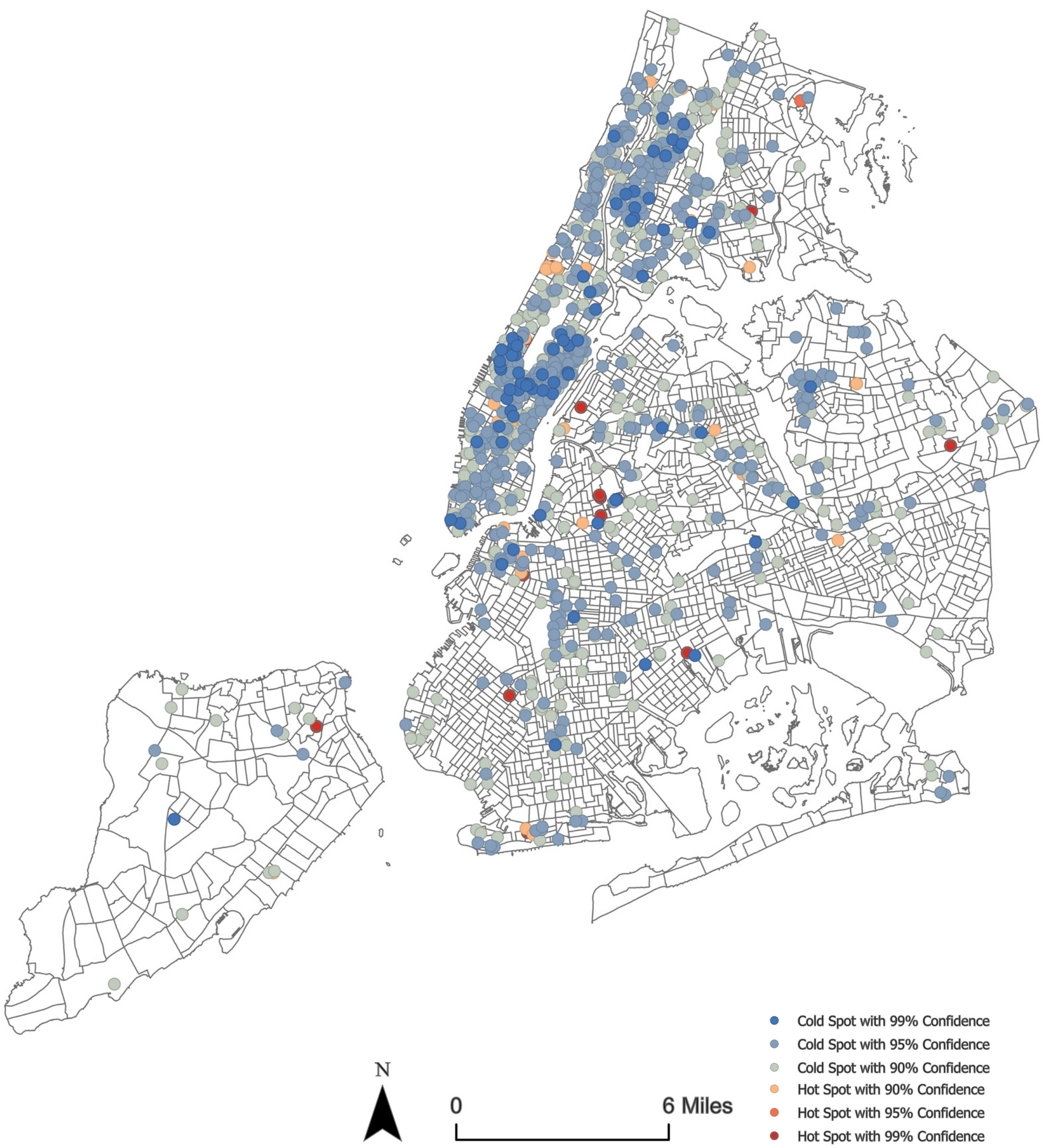


Performance
Non-Analytical Datasets
Census Tracts Shapefile
Census Tracts Mapped (2020)
Tax Lots Shapefile
MapPLUTO Shoreline Clipped (2022V2)
NYC Boroughs Shapefile
Borough Boundaries (2022)
closure for
Table to Point
Building Energy Improvements
Building GHG Emission
Spatial Join
Contains
-ORD GI*
Distance
ance Buildings
e (5 Years)
REGATE
nsus Tracts
Analysis of
y Efficiency
s by Census
Tracts
Cluster Analysis of GHG Emissions by Census Tracts
Suitable Sites:
ilding Performance Factors [Prioritized]
Stacked Figure
For All Analysis Layers
Cluster Analysis of
ioritized Building Performance Factors

JUST CHECKING!

Our initial assumption that low performing buildings are spatially related needed to be affirmed before we began our analysis. We used a GETIS-ORD* cluster map to ensure that low performing buildings were in fact clustered together.

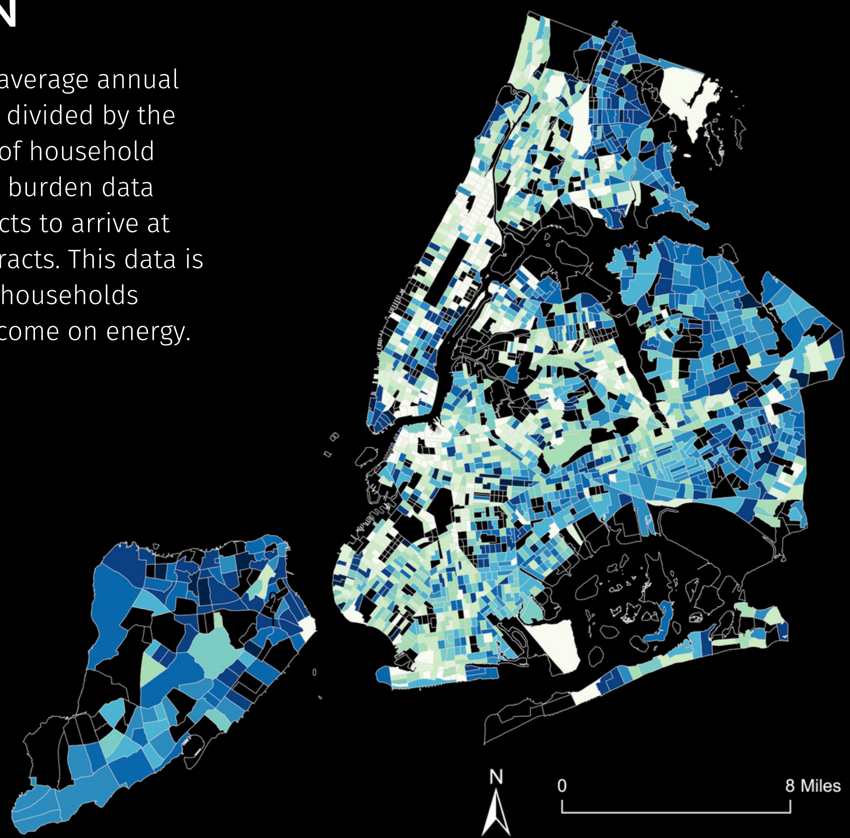
Using individual building performance data in (X,Y) format we created this map to identify cold spots of low Energy Star Scores. This process validated our approach to focus on the neighborhood scale for building energy efficiency investments.



JUSTICE-40 INDICATORS

ENERGY BURDEN

Energy Burden is determined by the average annual household spending on energy costs divided by the average household income (percent of household income spent on energy). The energy burden data acquired is aggregated by census tracts to arrive at the mean energy burden by census tracts. This data is used to identify census tracts where households spend the highest portion of their income on energy.



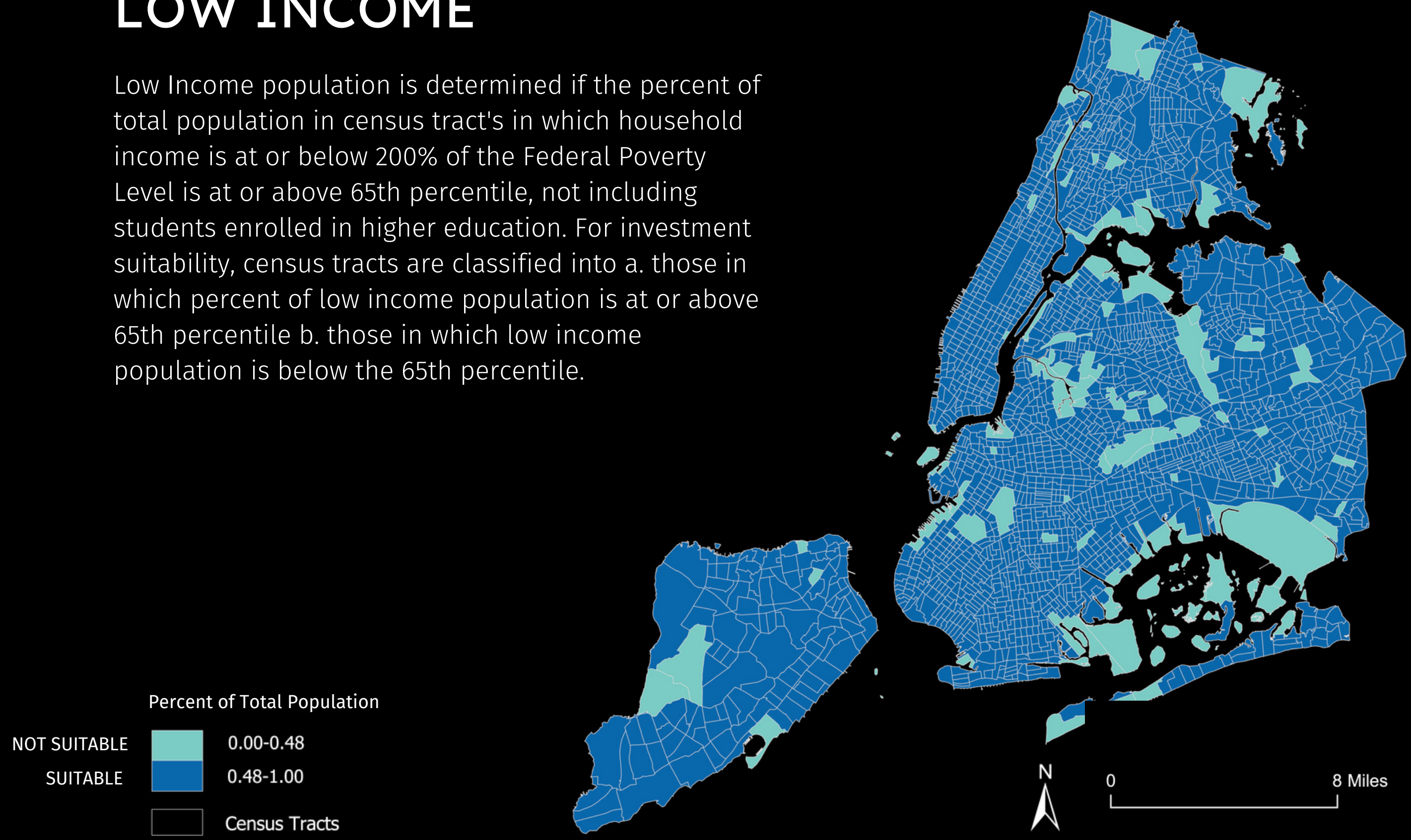
AIR POLLUTION

Air pollution is identified as exposure to fine inhalable particles with 2.5 or smaller micrometer diameters (PM 2.5). The weight of the particles per cubic meter is aggregated by census tracts to arrive at exposure to air pollution.

JUSTICE-40 INDICATORS

LOW INCOME

Low Income population is determined if the percent of total population in census tract's in which household income is at or below 200% of the Federal Poverty Level is at or above 65th percentile, not including students enrolled in higher education. For investment suitability, census tracts are classified into a. those in which percent of low income population is at or above 65th percentile b. those in which low income population is below the 65th percentile.



JUSTICE-40 INDEX

The Justice-40 Index prioritizes the three factors from the Justice-40 initiative: high levels of energy burden, high exposure to air pollution, and high percentage of low income populations.

Energy burden was indexed into 10 classes for us to prioritize census tracts at the 90th percentile, and capped at 100% of income due to our assumption that no households were able to spend more than their full income on energy expenses.
Air pollution was also indexed into 10 classes for us to prioritize census tracts at the 90th percentile.
Low income was indexed into binary values as the census tracts either fit the definition of low income or did not.

SCORE	ENERGY BURDEN CLASS (% of income)	AIR POLLUTION CLASS (PM2.5 exposure)	LOW INCOME CLASS (% of population)
0	N/A	N/A	0.0 - 0.48
1	-0.21 - 0.05	7.47 - 7.79	N/A
2	0.05 - 0.06	7.791 - 7.98	
3	0.06 - 0.07	7.981 - 8.12	
4	0.07 - 0.078	8.129 - 8.24	
5	0.079 - 0.08	8.24 - 8.357	
6	0.08 - 0.10	8.357 - 8.46	
7	0.10 - 0.11	8.461 - 8.55	
8	0.11 - 0.14	8.558 - 8.65	
9	0.14 - 0.38	8.655 - 8.74	
10	0.38 - 1.00	8.741 - 8.92	0.48 - 1

BUILDING PERFORMANCE

BUILDING ENERGY EFFICIENCY

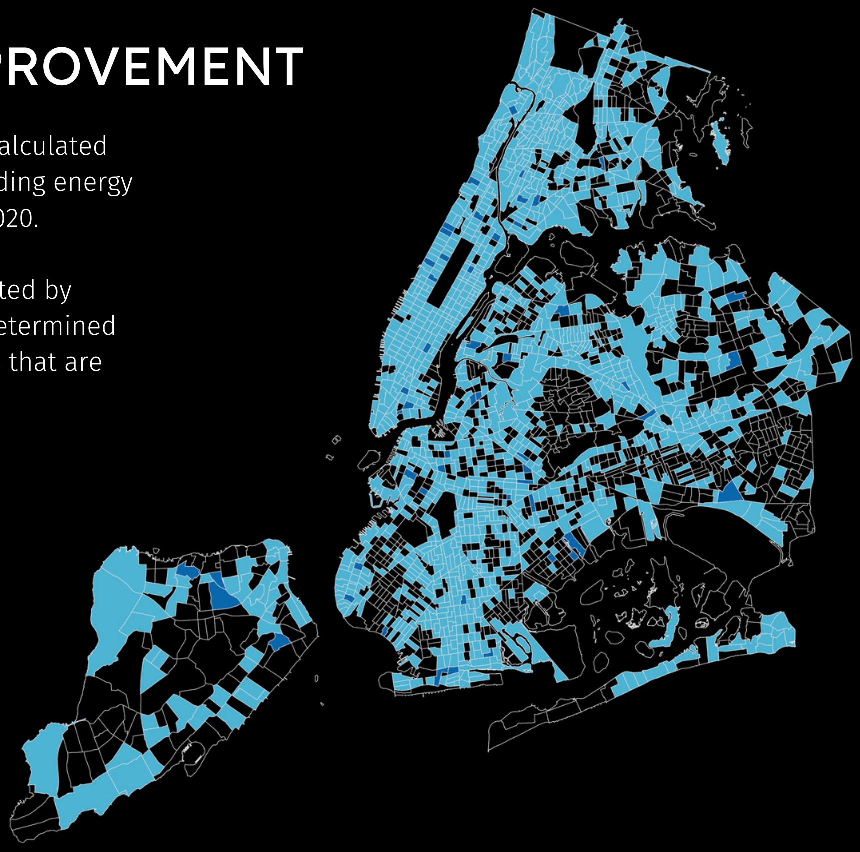
Building Energy Efficiency is determined by the building energy star scores per building. Buildings can receive scores from 1-100 Energy Star, which determines how the building performs, taking into account the physical attributes, operations, and how energy is used by users.

This individual building data was aggregated by census tracts to determine the average building efficiency by census tracts.

EFFICIENCY IMPROVEMENT

Energy Efficiency Improvements are calculated based on the changes individual building energy efficiency scores between 2015 and 2020.

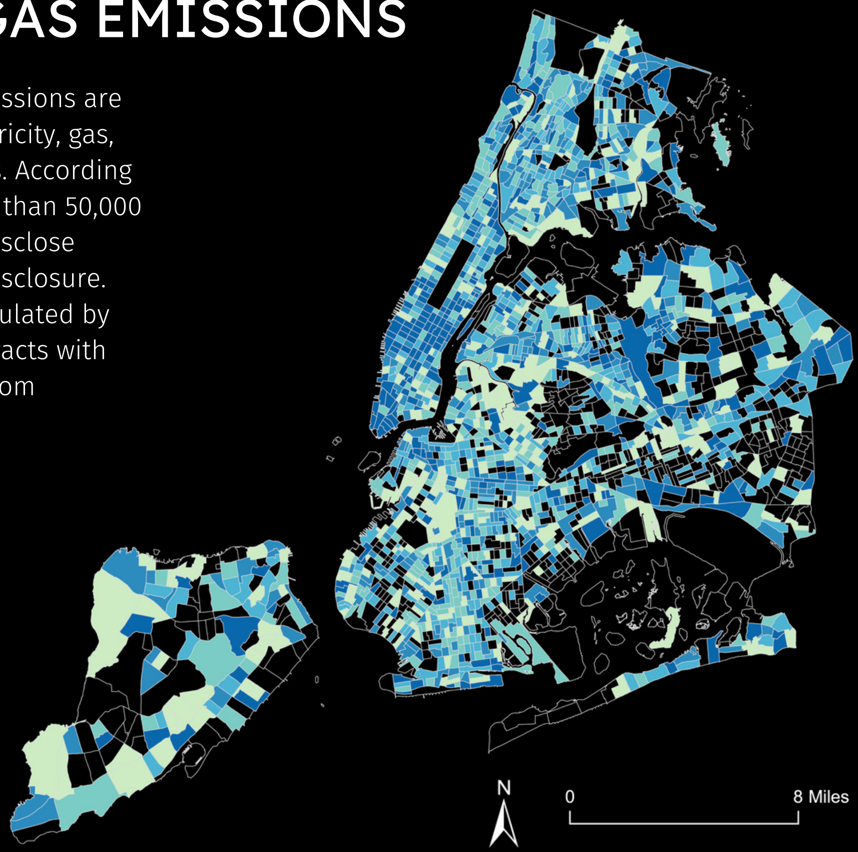
These individual scores were aggregated by census tract. This was then used to determined which census tracts contain buildings that are performing poorly and had the least improvements in energy scores.



BUILDING PERFORMANCE

GREEN HOUSE GAS EMISSIONS

Building Green House Gas (GHG) emissions are estimated based on how much electricity, gas, and other fuels a building consumes. According to Local Law 87, buildings with more than 50,000 square feet in size are required to disclose energy and water usage for public disclosure. The building GHG emissions are calculated by census tracts to determine census tracts with the highest average GHG emission from buildings.



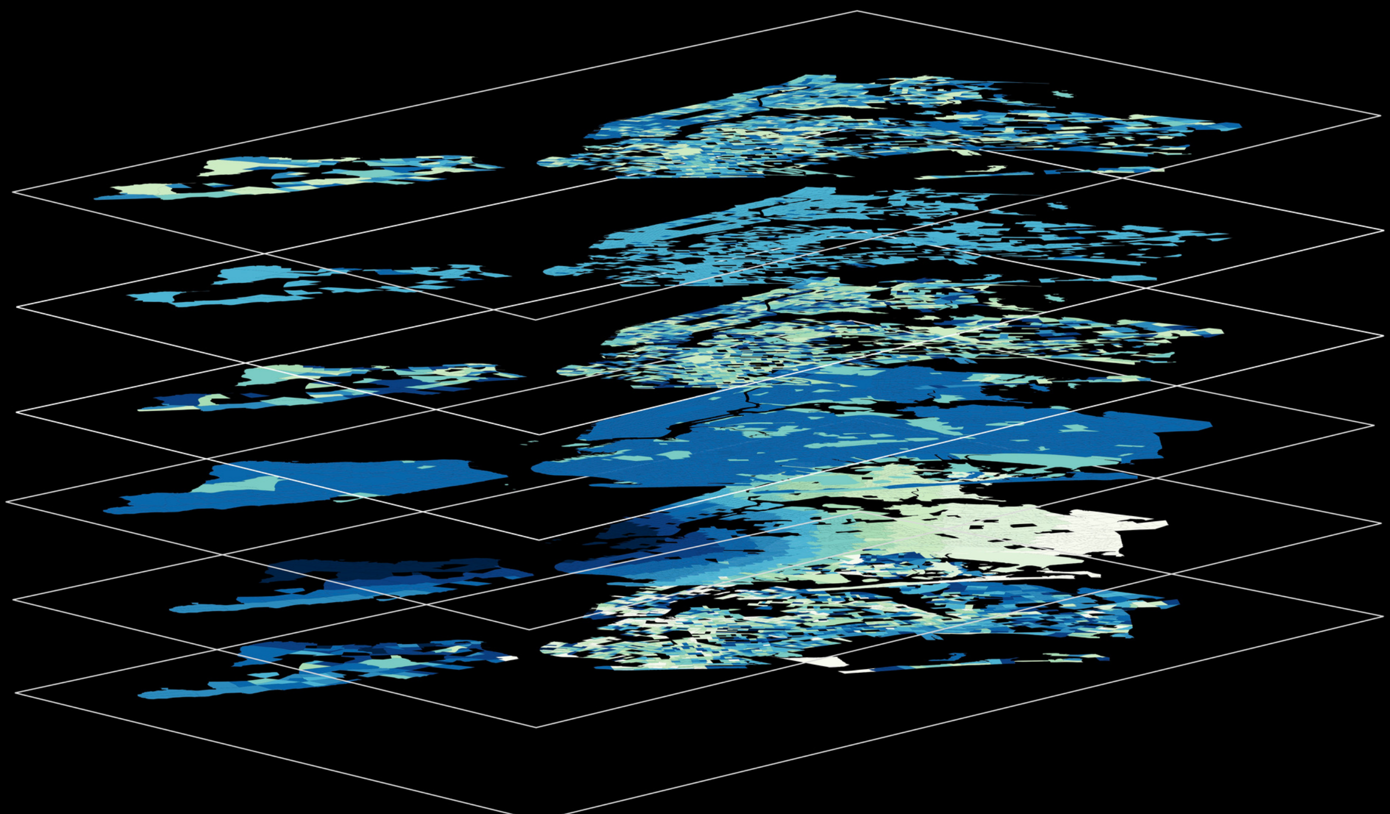
BUILDING PERFORMANCE INDEX

Three factors were considered to assess building energy efficiency performance: most recent building energy efficiency scores, most recent building GHG emissions, and building energy efficiency improvement over time.

Building energy efficiency scores were indexed into 5 classes to ensure the legibility of the produced maps as it was unnecessary to evaluate percentiles for this factor.
Building GHG emissions were also indexed into 5 classes to preserve legibility for the produced maps.
Energy improvement over time was indexed into binary scores based on a decrease or increase in efficiency over time.

<table>
<tr><th>SCORE</th><th>BUILDING ENERGY EFFICIENCY CLASS (Energy Star Score)</th><th>EFFICIENCY IMPROVEMENT CLASS (% change over time)</th><th>GHG EMISSIONS CLASS (Metric Tons)</th></tr>
<tr><td>1</td><td>N/A</td><td rowspan="4">N/A</td><td>N/A</td></tr>
<tr><td>2</td><td>1.00 - 44.00</td><td>0.00 - 265.60</td></tr>
<tr><td>3</td><td>N/A</td><td>N/A</td></tr>
<tr><td>4</td><td>44.01 - 66.00</td><td>265.01 - 364.80</td></tr>
<tr><td>5</td><td>N/A</td><td>0.01 - 0.015</td><td>N/A</td></tr>
<tr><td>6</td><td>66.01 - 80.00</td><td rowspan="4">N/A</td><td>364.01 - 479.10</td></tr>
<tr><td>7</td><td>N/A</td><td>N/A</td></tr>
<tr><td>8</td><td>80.01 - 91.00</td><td>479.11 - 692.90</td></tr>
<tr><td>9</td><td>N/A</td><td>N/A</td></tr>
<tr><td>10</td><td>90.01 - 100</td><td>-0.99 - 0</td><td>692.90 - 69640.70</td></tr>
</table>

FINDINGS

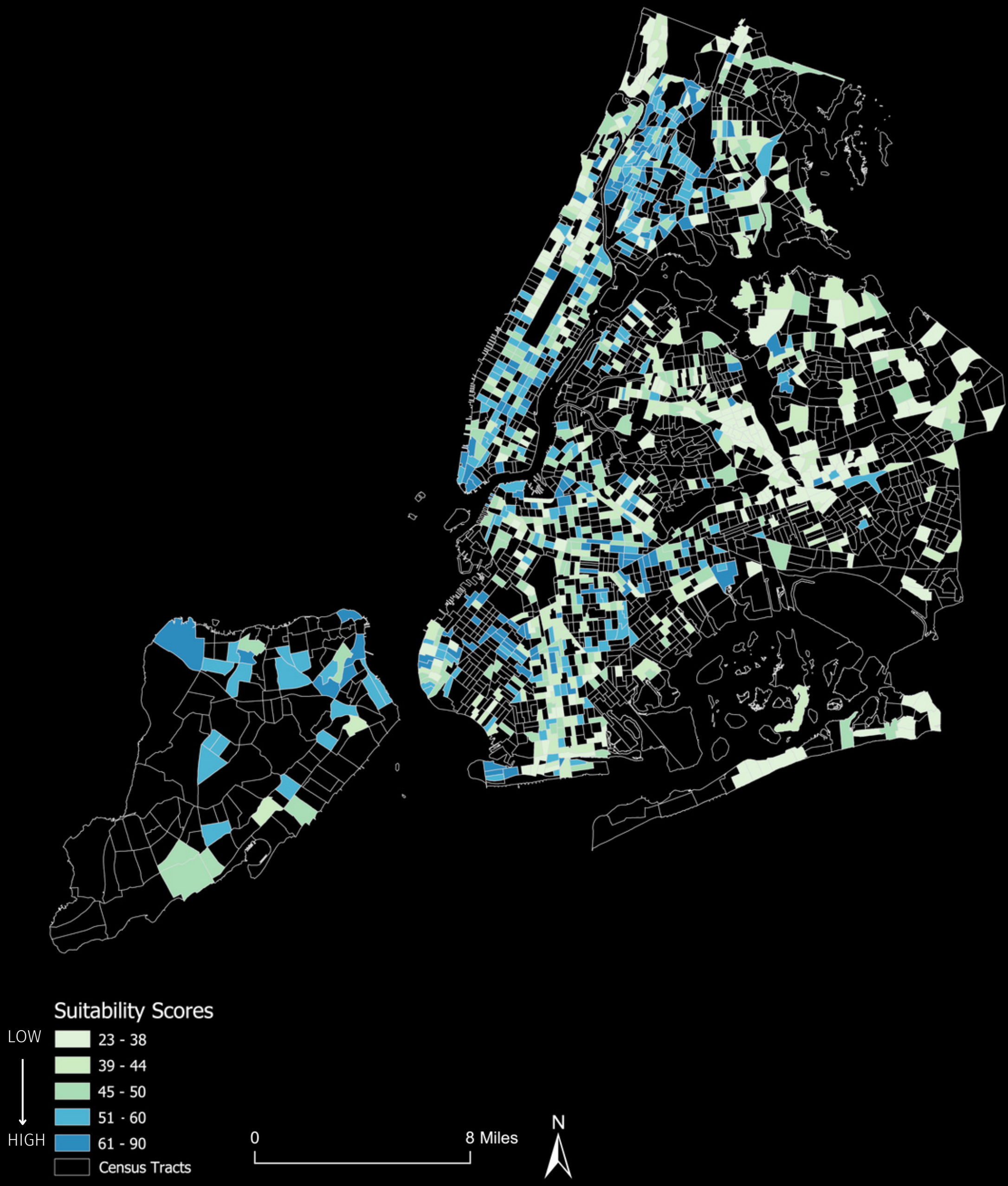


JUSTICE-40 PRIORITIZED

[Energy Burden Score x 2 + Air Pollution Score x 2 + Low Income Score x 2] + [Energy Efficiency Score + Efficiency Improvement Score + GHG Emissions Score]

JUSTICE-40 INDICATORS

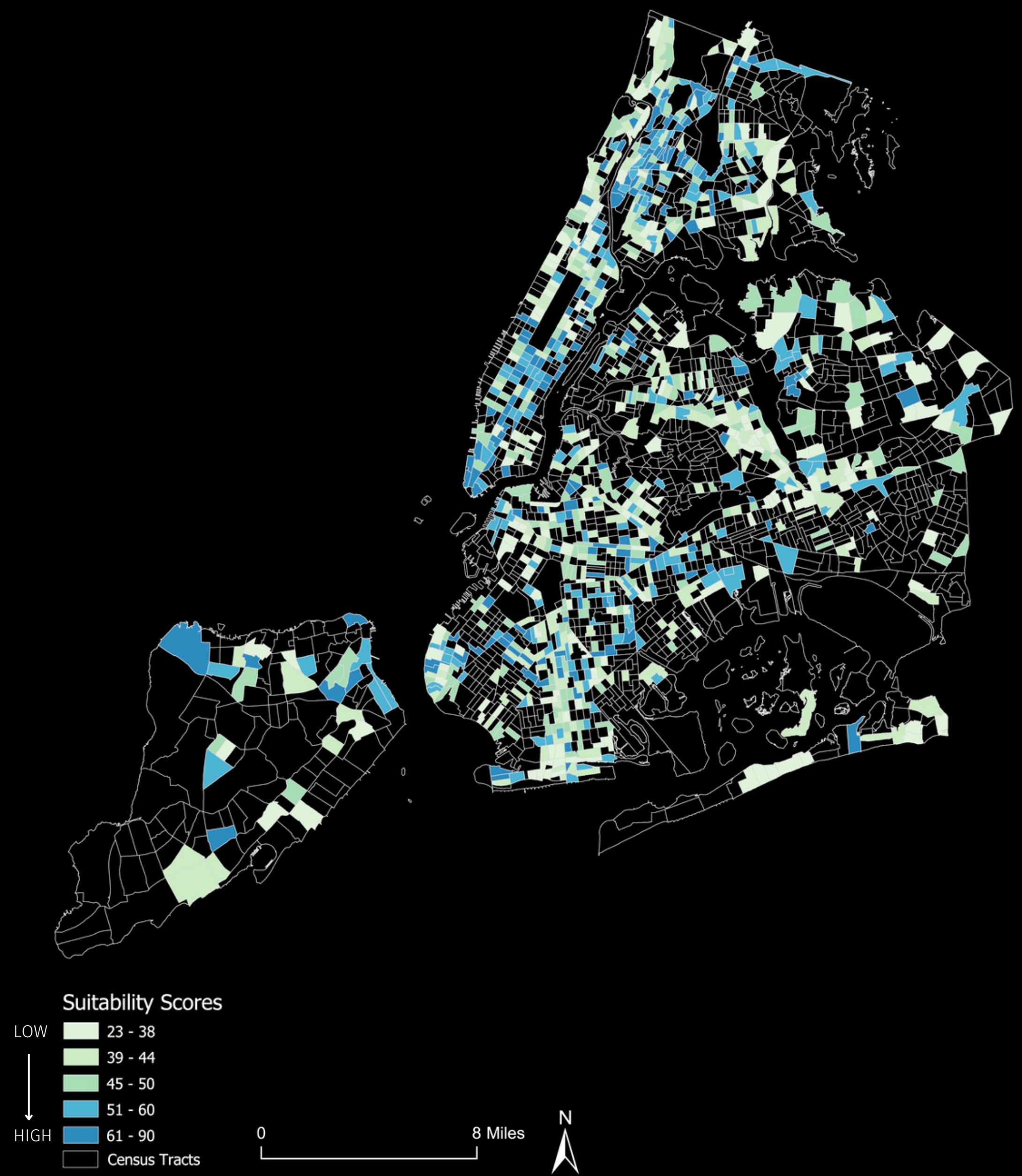
BUILDING PERFORMANCE INDICATORS



BUILDING PERFORMANCE PRIORITIZED

[Energy Burden Score + Air Pollution Score + Low Income Score] + [Energy Efficiency Score x 2 + Efficiency Improvement Score x 2 + GHG Emissions Score x 2]

JUSTICE-40 INDICATORS — BUILDING PERFORMANCE INDICATORS

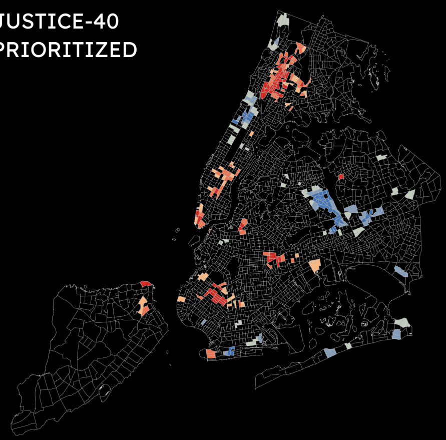


CLUSTER ANALYSIS OF SUITABLE SITES

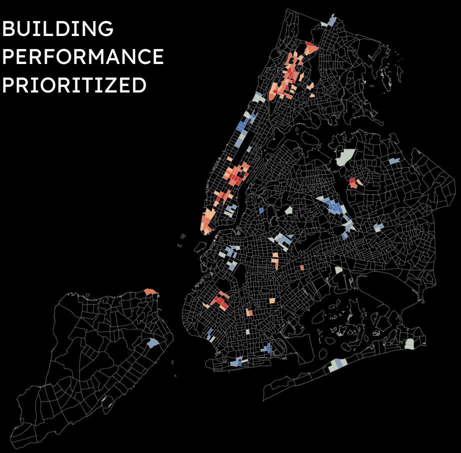
The GETIS-ord GI* test reveals clusters of poor performing buildings, based on differently weighted indices. The findings reveal that clusters of suitable sites for investments are in similar locations when Justice-40 parameters and building performance parameters are prioritized.

This result confirms our hypothesis that neighborhoods with disadvantaged communities are also where buildings are performing the most poorly in terms of energy efficiency.

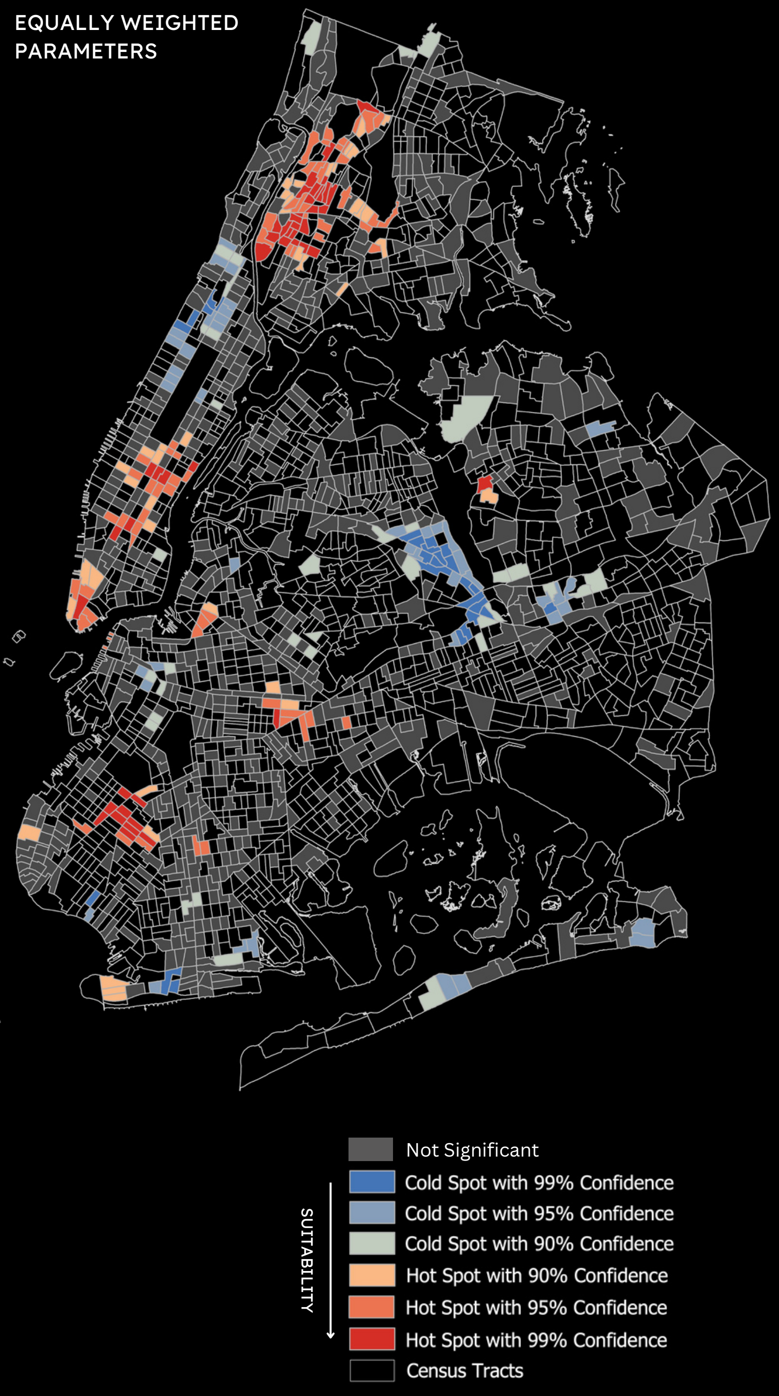
JUSTICE-40 PRIORITIZED

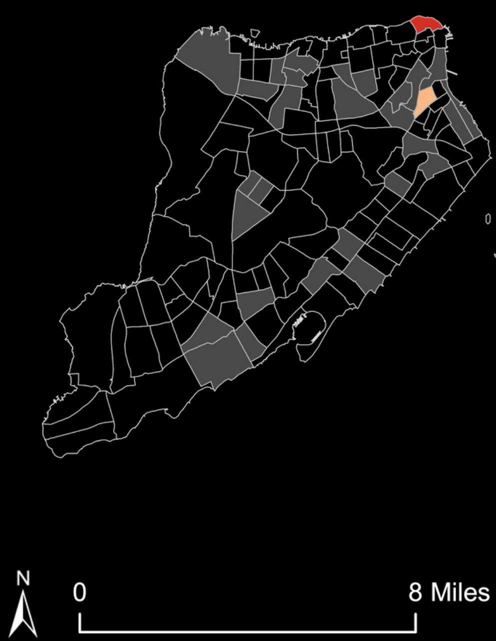


BUILDING PERFORMANCE PRIORITIZED

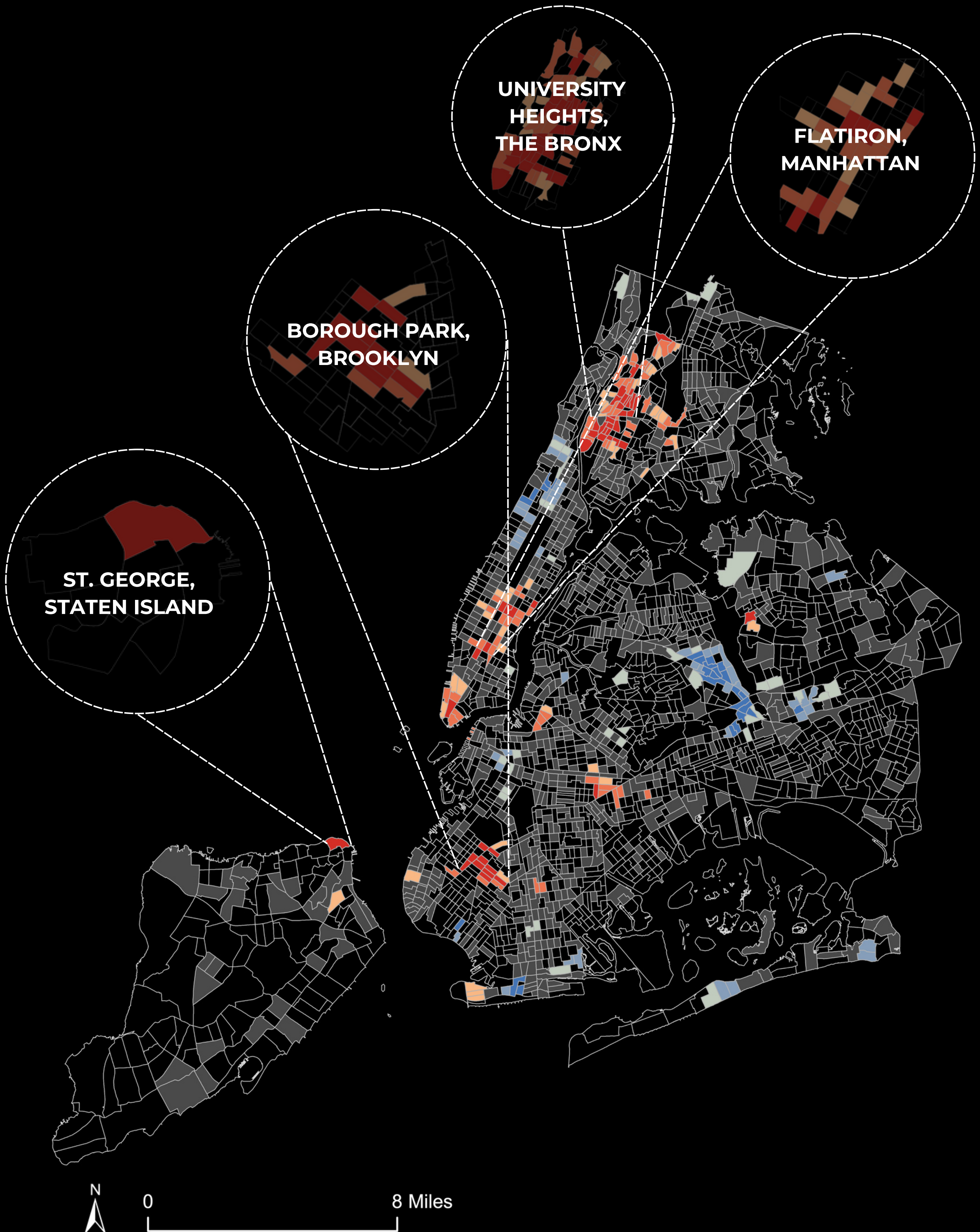


EQUALLY WEIGHTED PARAMETERS

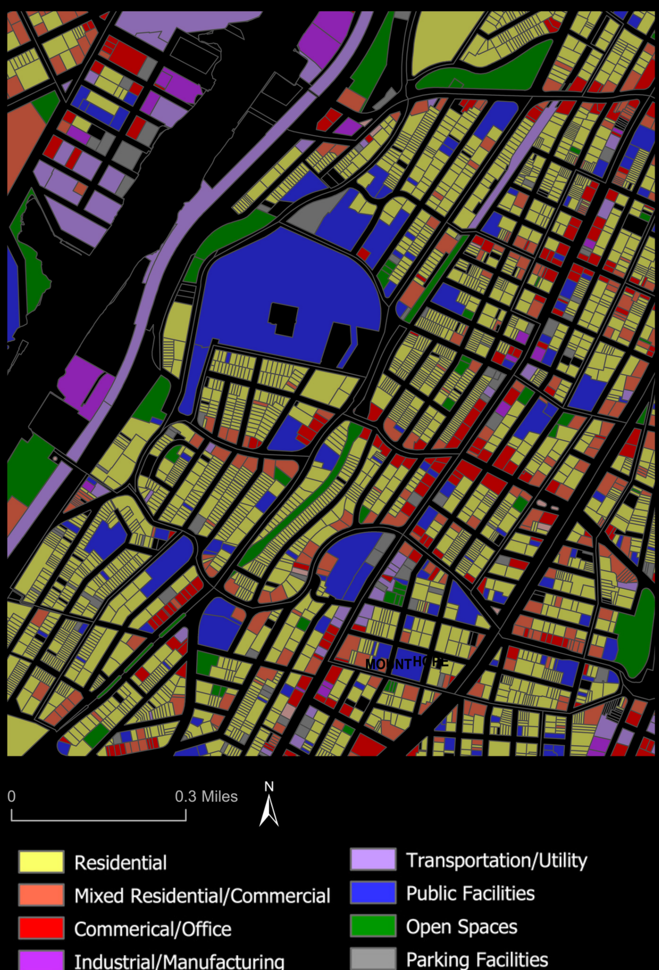




SELECTED NEIGHBORHOODS



NEIGHBORHOOD 1: UNIVERSITY HEIGHTS, THE BRONX



Source: Google Earth

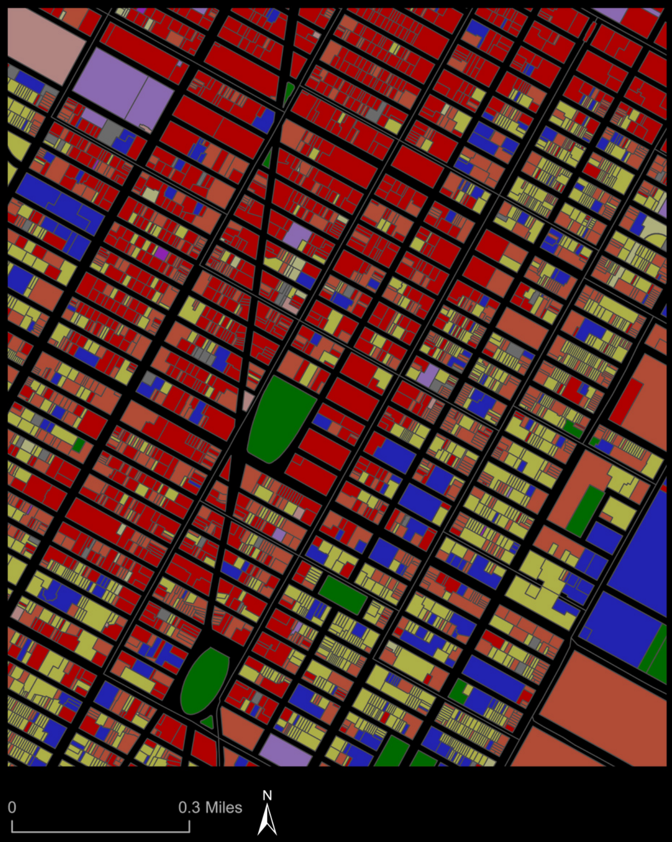
University Heights gets its name from the historic presence that NYU had in the neighborhood. In 1973 NYU sold its campus to The Bronx Community College which now dominates the neighborhood. Many of the residents are students and many of the housing units serve as dormitories. The total population of the area is 31,865 with the total households at 11,007.

The percentage of the population with a bachelors degree is 9.83% and the median household income is $29,651. The median year built for buildings is 1941 (ACS, 2020).

SUITABILITY SCORE

SUITABILITY SCORES BASED ON INDIVIDUAL PARAMETERS

NEIGHBORHOOD 2: FLATIRON, MANHATTAN



Source: Google Earth

- Residential
- Mixed Residential/Commercial
- Commerical/Office
- Industrial/Manufacturing
- Transportation/Utility
- Public Facilities
- Open Spaces
- Parking Facilities

The Flatiron neighborhood gets its name from the legendary flatiron building that dominates the streetscape near Madison Square Park. Before becoming an iconic neighborhood the area was primarily a commercial and manufacturing area with many toy, clothing, and furniture manufactories on site. Today the neighborhood is considered a "trendy" area with many publishers and photographers moving their offices to Flatiron.

Although the area appears to be well off based on the demographic breakdown, the surrounding areas scored badly based on their energy efficiency. The results were more skewed when looking at the energy efficiency index where the surrounding areas scored around 75/90. This allows us to understand that although the area may not be the most disadvantaged based on Justice40 factors but the area performs very poorly in terms of energy efficiency

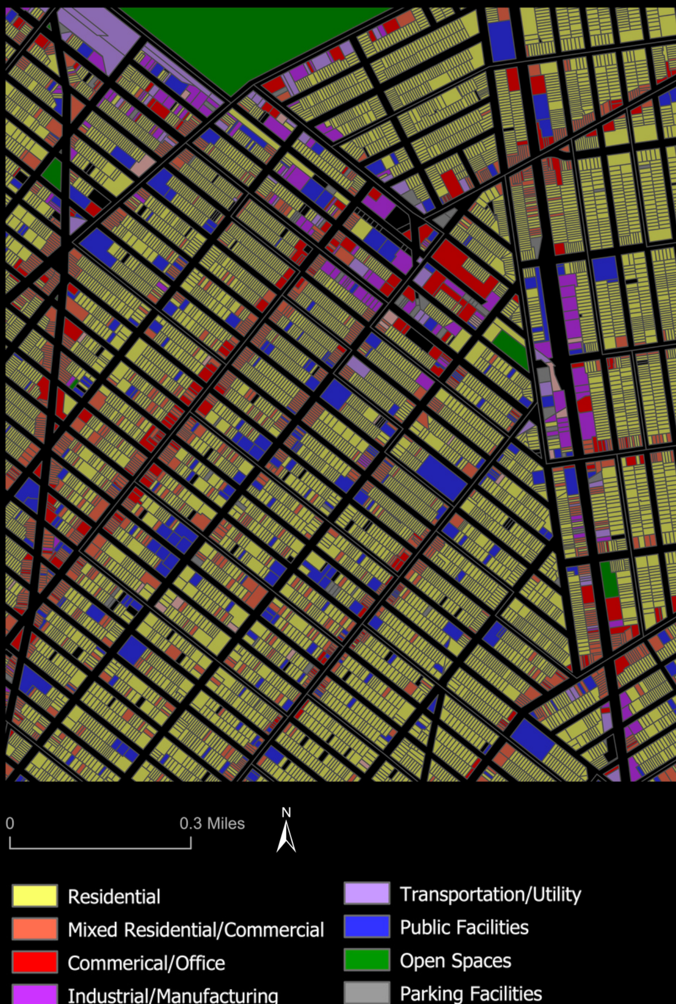
SUITABILITY SCORE

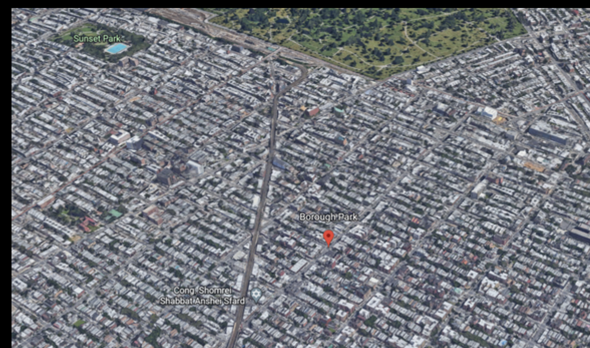
71%

76%	94%	0%	100%	72%	88%
ENERGY BURDEN	AIR POLLUTION	LOW INCOME	ENERGY EFFICIENCY	EFFICIENCY IMRPOVEMENT	GHG EMISSIONS

SUITABILITY SCORES BASED ON INDIVIDUAL PARAMETERS

NEIGHBORHOOD 3: BOROUGH PARK, BROOKLYN





Source: Google Earth

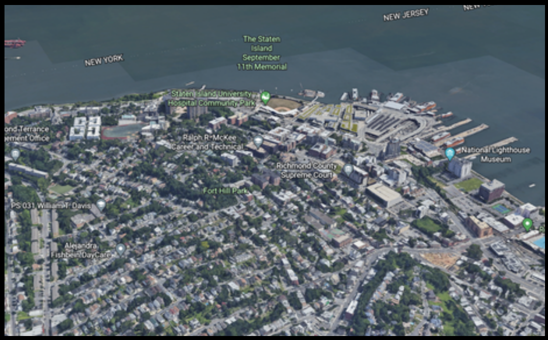
SUITABILITY SCORE

Originally called Blythebourne, Borough Park was established as a group of small cottages in the late 1880's. The area would eventually be absorbed as development continued and the neighborhood became a large Jewish immigrant center. In recent years Borough Park has experienced a large increase in commercial growth. The total population of the area is 132,355 with 38,581 total households.

This neighborhood was selected for investment due to the surrounding tracts scores in the equally weighted index. The results were skewed towards the Justice 40 factors with the weighted index producing scores in the high 70's and low 80's with 90 being the maximum score.

SUITABILITY SCORES BASED ON INDIVIDUAL PARAMETERS

NEIGHBORHOOD 4: ST. GEORGE, STATEN ISLAND



Source: Google Earth

Originally home to the Lenape people, St. George was colonized by the British and Dutch during the colonial era. The land was eventually ceded to the United States where little development happened in the area until the 1880's. The area gradually shifted from a summer resort into the residential heavy community that it is today. The neighborhood has a total population of 38,001 with 14,466 households.

Although this area is relatively well off when income and education are considered, the area experiences a significant amount of air pollution. This neighborhood was chosen partly due to its interesting presence as an outlier in Staten Island. It can be interpreted as the are suffering from a large disadvantaged population and poor energy efficiency.

SUITABILITY SCORE

SUITABILITY SCORES BASED ON INDIVIDUAL PARAMETERS

CONCLUSION

Our results have found that areas with more disadvantaged communities are also areas with low-performing buildings in terms of energy efficiency. Several reasons could be attributed to this, including the lack of green energy and infrastructure made in impoverished areas. However, our results show that it is those very areas that are most in need of green infrastructure investments pertaining to building energy efficiency.

Additionally, we found that areas that were most suitable more investment did not have singular forms or tends in land-use composition. While neighborhoods such as Flatiron are predominantly commercial, land in neighborhoods such as Borough Park and St. George was mostly used for residential purposes.

Source: dream.ai

APPENDIX

STEP-BY-STEP APPROACH

Step 1: Collect and Prepare Datasets & Analysis Layers

Datasets on parameters of Justice 40 Initiatives

- Household Energy Burden (2018)
- Exposure to Air Pollution (2020)
- Low Income Population (2020)

Export GEOID that contains census tract information in New York City

1. Perform Summary Statistics on Household energy burden dataset to achieve energy burden data by census tracts.
2. Aggregate Exposure to Air pollution dataset to achieve Mean PM2.5 by census tracts.
3. Isolate percentage of population below 200% the poverty line for Low Income Population dataset to achieve data for low income population by census tracts

Dataset on Building Energy Efficiency

1. Download Energy & Water Data Disclosure for Local Law 84 (2015 - 2020).
2. Conduct XY Table to Point.
3. Spatial Join Census tracts shapefile to Building Energy Efficiency data.
4. Isolate data points on Total GHG Emissions, and Energy STAR Score per building.
5. Calculate for building energy change between 2015 and 2020.
6. Aggregate Data by census tracts.
7. Perform GETIS-Ord GI* for with inverse distance on 3 different data types to achieve clusters of building for building energy efficiency percent change by census tracts, cluster analysis of energy efficiency scores by census tracts, and cluster analysis of GHG emissions by census tracts.

Non-Analytical Datasets:

1. Download the 2020 Census Tracts shapefile of NYC, 2020 MapPLUTO Tax Lots shapefile, and 2022 NYC Borough Boundaries Shapefile.
2. Set the Coordinate Reference System to *NAD1983 StatePlane New York Long Island FIPS*

STEP-BY-STEP APPROACH

Step 2: Create Decision Layers

1. **Suitable Site #1** (Prioritizing Justice 40 Factors):

X2 Weight		X1 Weight
Energy Burden by census tracts Mean PM2.5 by census tracts Low Income population by census tracts	+	Building energy efficiency percent change Energy efficiency star scores GHG Emissions

2. **Suitable Site #2** (Equally weighted):

X1 Weight		X1 Weight
Energy Burden by census tracts Mean PM2.5 by census tracts Low Income population by census tracts	+	Building energy efficiency percent change Energy efficiency star scores GHG Emissions

3. **Suitable Site #3** (Prioritizing Building Parameters):

X1 Weight		X2 Weight
Energy Burden by census tracts Mean PM2.5 by census tracts Low Income population by census tracts	+	Building energy efficiency percent change Energy efficiency star scores GHG Emissions

Step 3: Final Outputs

1. Perform Getis-Ord GI* to each Suitable Sites defined above to achieve 3 final cluster layers

=	=	=
Cluster Analysis of Prioritized Justice 40 Factors	Cluster Analysis of Equally Weighted Factors	Cluster Analysis of Prioritized Building Performance Factors

CODE SCRIPT: CLASSIFICATION & SCORING

CLASSIFY ENERGY BURDEN:

```
def reclass(MEAN_EnergyBurden):
    if (MEAN_EnergyBurden < 0.055175):
        return 1
    elif(MEAN_EnergyBurden > 0.055176 and MEAN_EnergyBurden < 0.064201):
        return 2
    elif(MEAN_EnergyBurden > 0.064202 and MEAN_EnergyBurden < 0.071960):
        return 3
    elif(MEAN_EnergyBurden > 0.071961 and MEAN_EnergyBurden < 0.079990):
        return 4
    elif(MEAN_EnergyBurden > 0.079991 and MEAN_EnergyBurden < 0.088725):
        return 5
    elif(MEAN_EnergyBurden > 0.088726 and MEAN_EnergyBurden < 0.100811):
        return 6
    elif(MEAN_EnergyBurden > 0.100812 and MEAN_EnergyBurden < 0.116884):
        return 7
    elif(MEAN_EnergyBurden > 0.116885 and MEAN_EnergyBurden < 0.148293):
        return 8
    elif(MEAN_EnergyBurden > 0.148294 and MEAN_EnergyBurden < 0.382354):
        return 9
    elif(MEAN_EnergyBurden > 0.382355 and MEAN_EnergyBurden < 1.00):
        return 10
```

CLASSIFY AIR POLLUTION:

```
def reclass(MEAN_PM25):
    if (MEAN_PM25 < 7.796204):
        return 1
    elif(MEAN_PM25 > 7.796205 and MEAN_PM25 < 7.981679):
        return 2
    elif(MEAN_PM25 > 7.981680 and MEAN_PM25 < 8.129570):
        return 3
    elif(MEAN_PM25 > 8.129571 and MEAN_PM25 < 8.247212):
        return 4
    elif(MEAN_PM25 > 8.247213 and MEAN_PM25 < 8.357942):
        return 5
    elif(MEAN_PM25 > 8.357943 and MEAN_PM25 < 8.461038):
        return 6
    elif(MEAN_PM25 > 8.461039 and MEAN_PM25 < 8.558484):
        return 7
    elif(MEAN_PM25 > 8.558485 and MEAN_PM25 < 8.655523):
        return 8
    elif(MEAN_PM25 > 8.655524 and MEAN_PM25 < 8.748235):
        return 9
    elif(MEAN_PM25 > 8.748236 and MEAN_PM25 < 8.920011):
        return 10
```

CLASSIFY LOW INCOME:

```
def reclass(LOW_INCOME_DOUBLE):
 if (LOW_INCOME_DOUBLE < 0.485957):
 return 0
 elif(LOW_INCOME_DOUBLE > 0.485957):
 return 10
```

Classify ES Percent Change

```
def reclass(ES_Percent):
 if (ES_Percent < 0):
 return 10
 elif(ES_Percent > 0):
 return 5
```

CLASSIFY ENERGY STAR 2020

```
def reclass(ENERGY_STAR_Score_2020):
 if (ENERGY_STAR_Score_2020 < 44):
    return 10
 elif(ENERGY_STAR_Score_2020 > 44.000001 and ENERGY_STAR_Score_2020 <
66):
    return 8
 elif(ENERGY_STAR_Score_2020 > 66.000001 and ENERGY_STAR_Score_2020 <
80):
    return 6
 elif(ENERGY_STAR_Score_2020 > 80.000001 and ENERGY_STAR_Score_2020 <
91):
    return 4
 elif(ENERGY_STAR_Score_2020 > 91.000001 and ENERGY_STAR_Score_2020 <
101):
    return 2
```

CLASSIFY GHG 2020

```
def reclass(Total_GHG_2020_Num):
 if (Total_GHG_2020_Num < 265.6):
    return 2
 elif(Total_GHG_2020_Num > 265.6000001 and Total_GHG_2020_Num < 364.8):
    return 4
 elif(Total_GHG_2020_Num > 364.8000001 and Total_GHG_2020_Num < 479.1):
    return 6
 elif(Total_GHG_2020_Num > 479.1000001 and Total_GHG_2020_Num < 692.9):
    return 8
 elif(Total_GHG_2020_Num > 692.9000001 and Total_GHG_2020_Num <
69640.7):
    return 10
```

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