

Determining Focus Areas to Promote Solar
Development

by: Paul Jarymowycz

ROOFTOP SOLAR POTENTIAL IN NYC

Objective

- NYC is a very dense urban area
- Large rooftop area potentially suitable for solar panel installations
- However, shading from buildings may lower total amount of solar radiation
- Determine locations where solar energy can be incentivized to reach a total electrical production goal.

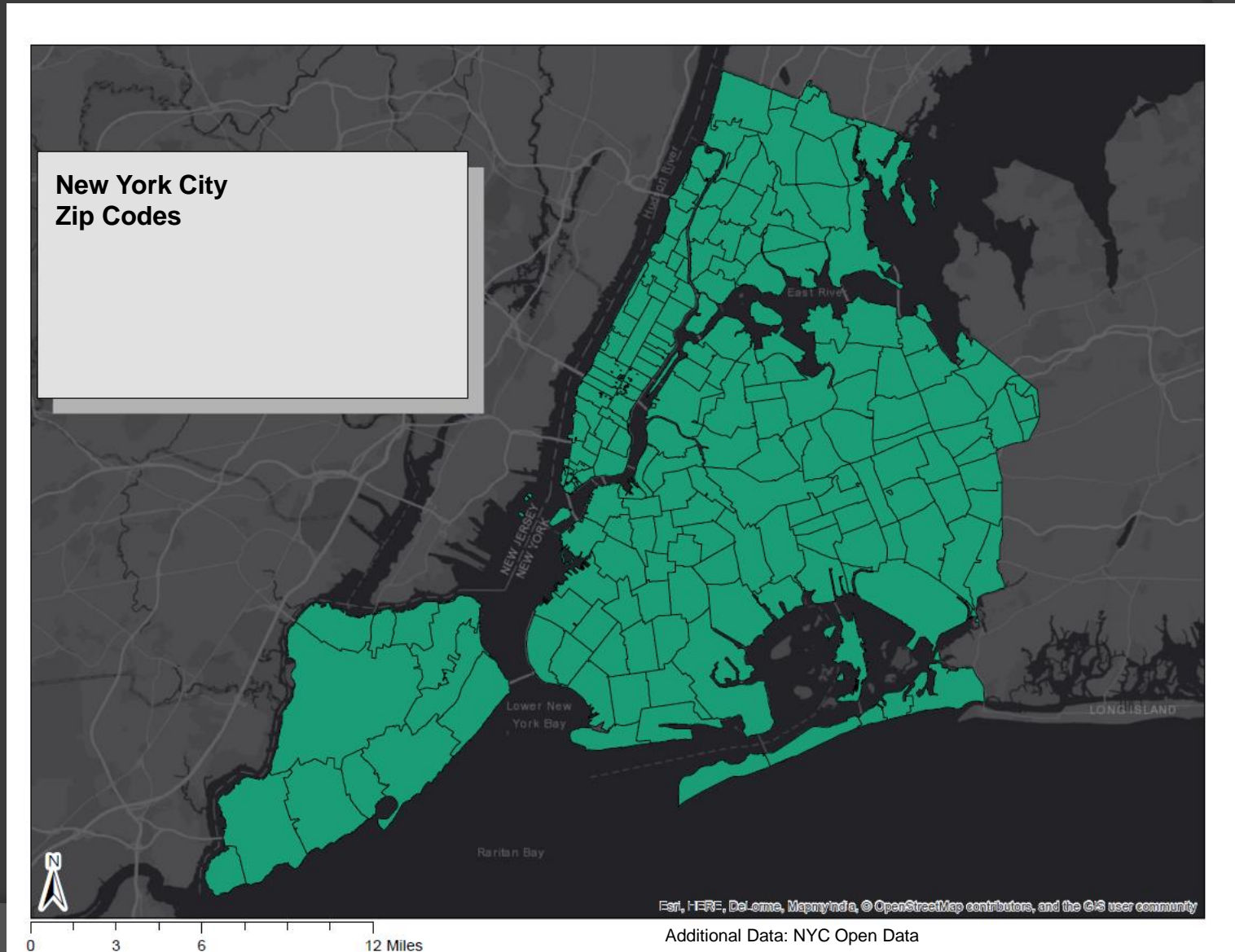
Data Collection

- ◎ Several online sources offer rooftop solar irradiation measurements, including NY Solar Map (originally a CUNY project), Mapdwell (an MIT project), and Project Sunroof (Google).
 - Most sources primarily focused on providing building-level data and supplementary pricing, incentive, and regulatory information to assist owners who may be considering a solar installation.
 - Although there are some variations in the methodologies, each source attempts to determine usable rooftop area, shading, and average solar radiation to calculate total solar irradiation.

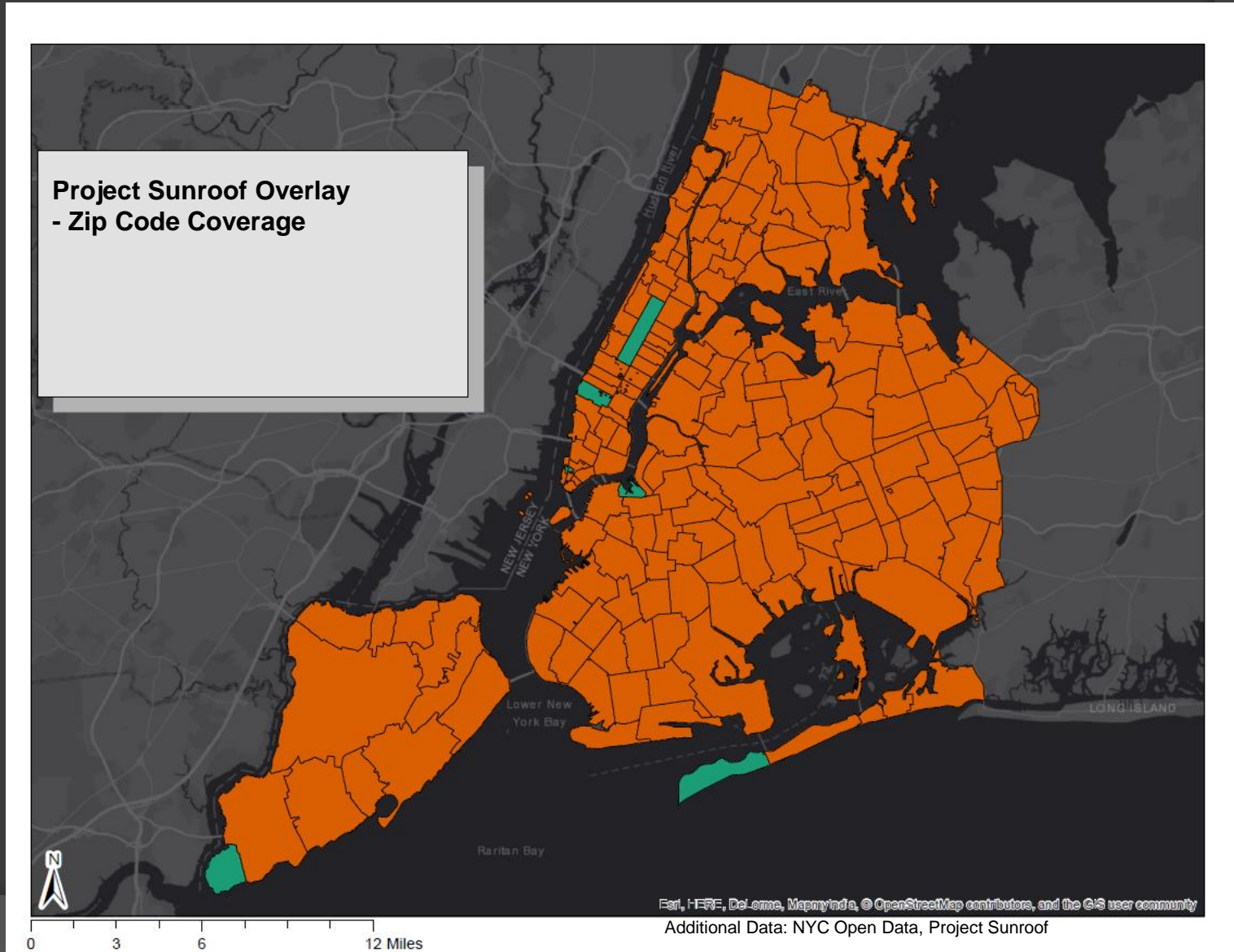
Data Collection

- ◎ Project Sunroof data was chosen for this project since it allows Census Tract and Zip Code level aggregate data exports.
 - Project Sunroof uses Google's 3D building models, regional solar radiation data, and machine learning algorithms to compute solar irradiance on each facet of a building's rooftop, accounting for shading from surrounding buildings and other features.
 - However, Google's dataset is not complete, which creates issues in some aggregated regions.

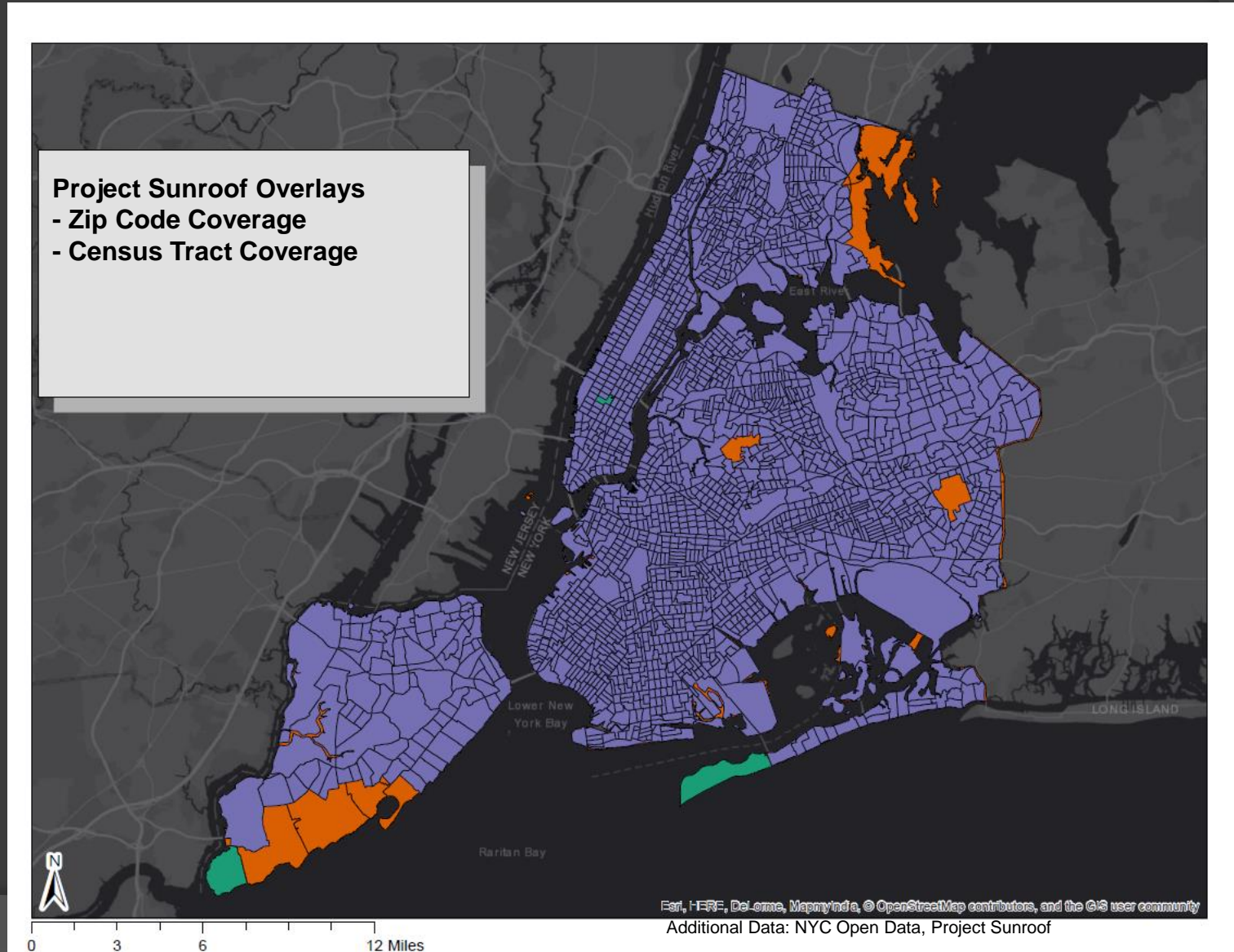
Map – NYC Zip Codes



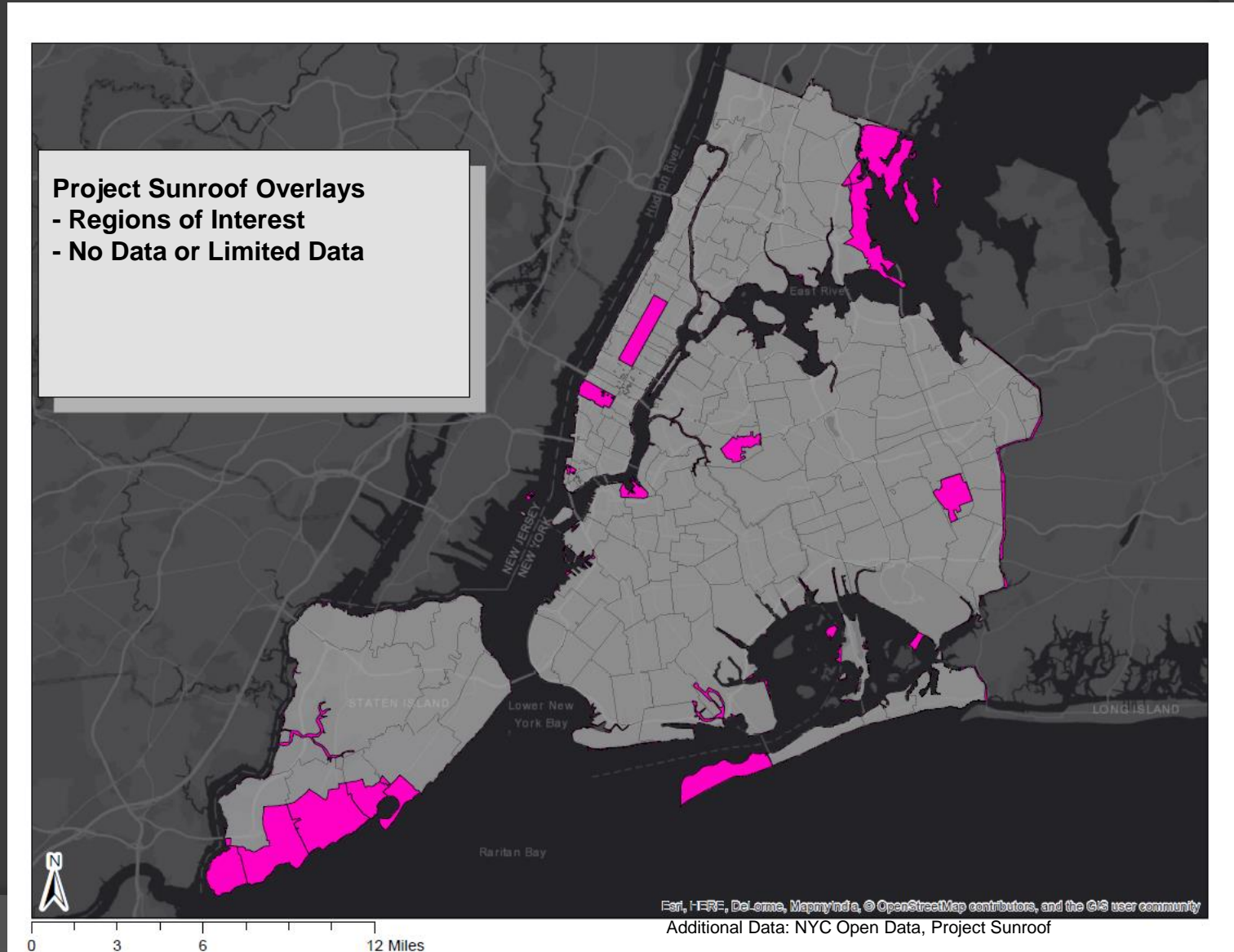
Map – Data Analysis



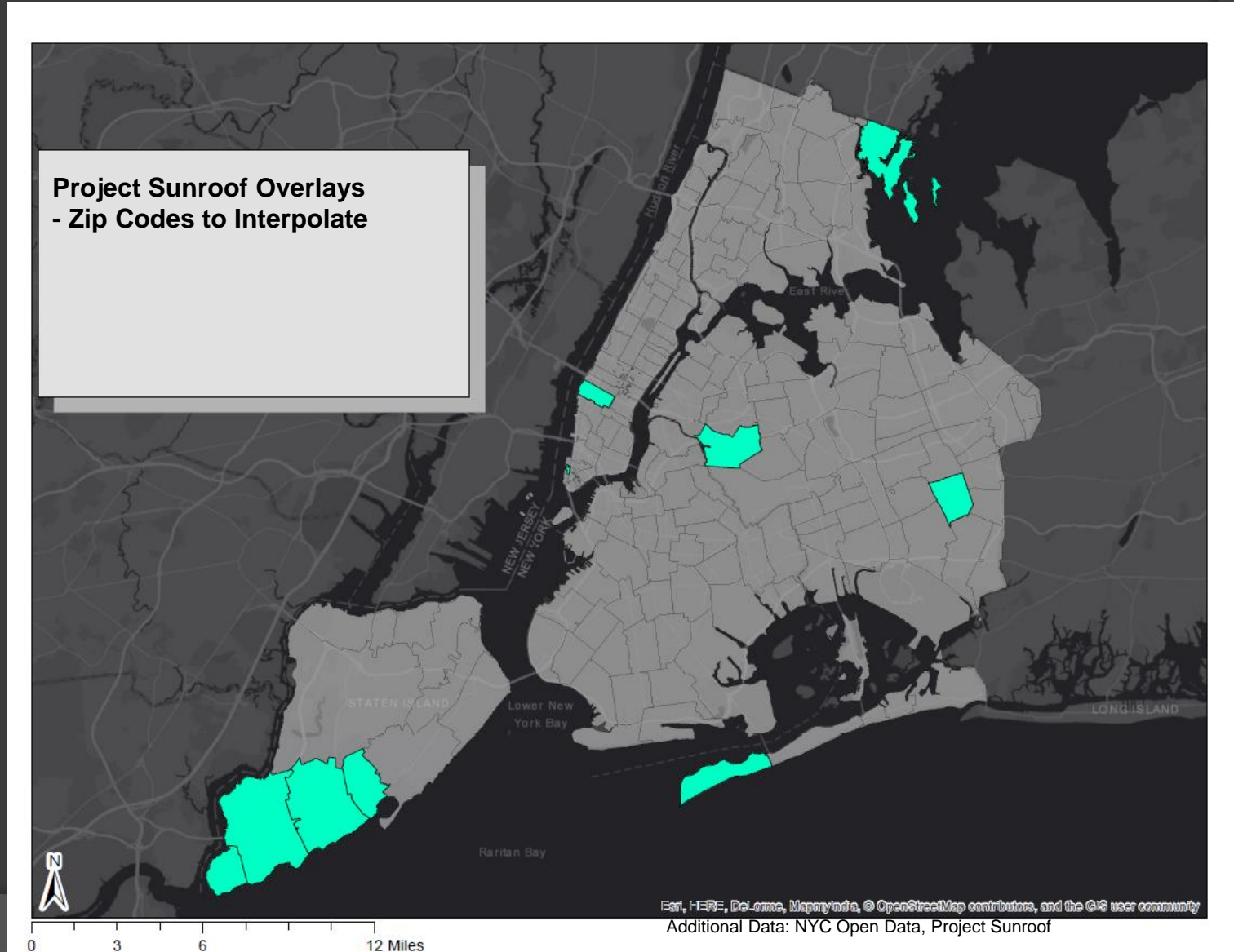
Map – Data Analysis



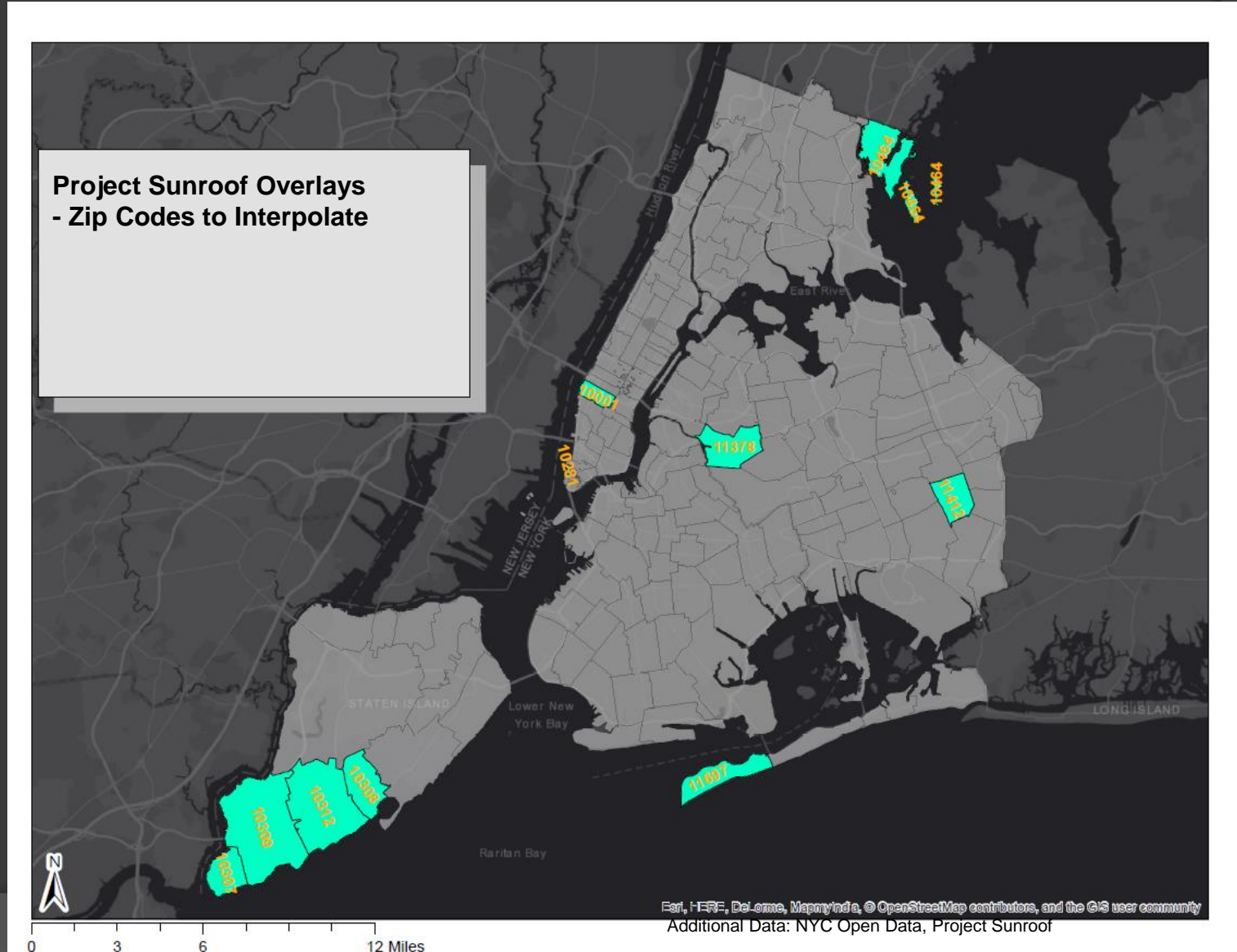
Map – Data Analysis



Map – Data Analysis



Map – Data Analysis



Data Interpolation

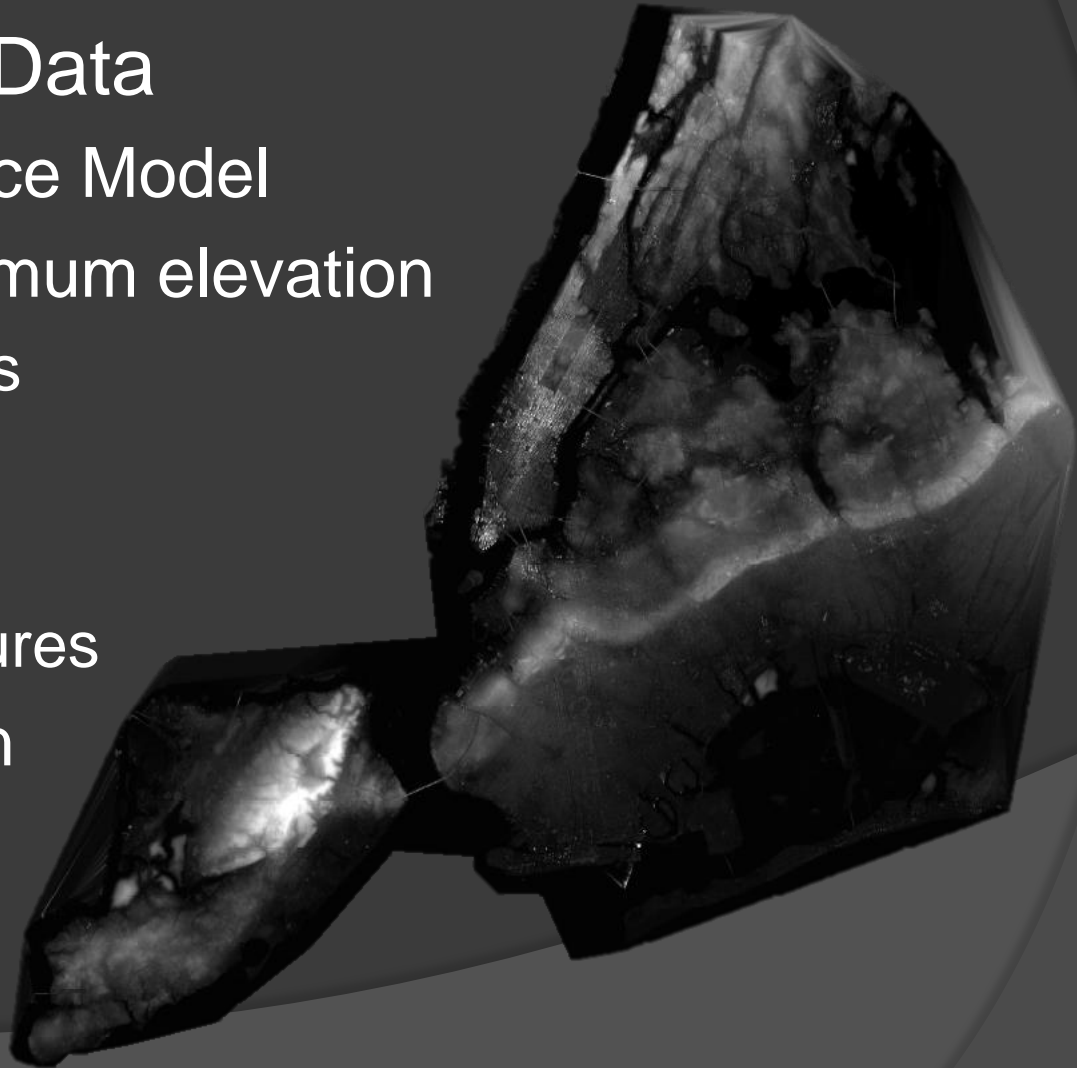
- Zip Codes with large amounts of excluded area were manually assessed in several ways to determine adequate data
 - Zip Codes were manually entered into the Project Sunroof Data Explorer online interface to see if an error message was generated (most were screened this way).
 - These regions were visually assessed in the Project Sunroof Data Explorer map layer to determine if large numbers of buildings were missing rooftop solar data imagery.
 - Currently installed solar panel projected electrical output was subtracted from rooftop solar radiation data to see whether this produced suspiciously low or negative results.

Data Collection

- ◉ Additional rooftop data was obtained from the National Renewable Energy Laboratory (NREL)
 - Used to interpolate Zip Code level data in regions where Project Sunroof data was incomplete.
 - NREL methodology uses LiDAR data and raster analyses to determine suitable rooftop areas for solar panel installations.

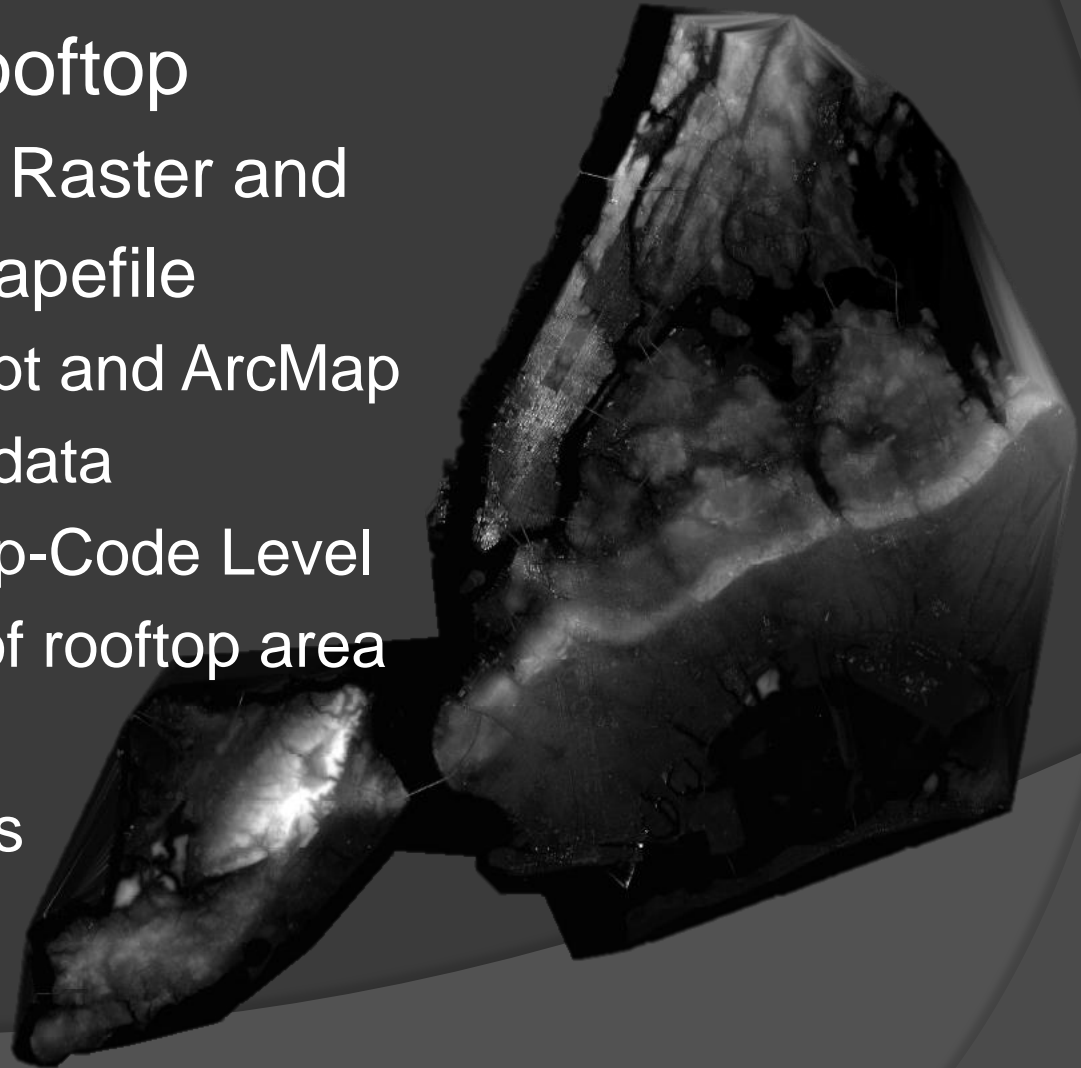
Sample Rasterized LiDAR

- First Return Data
 - Digital Surface Model
 - Shows maximum elevation for all features
 - Terrain
 - Buildings
 - Other Features
 - Rasterized in ArcMap



Sample Rasterized LiDAR

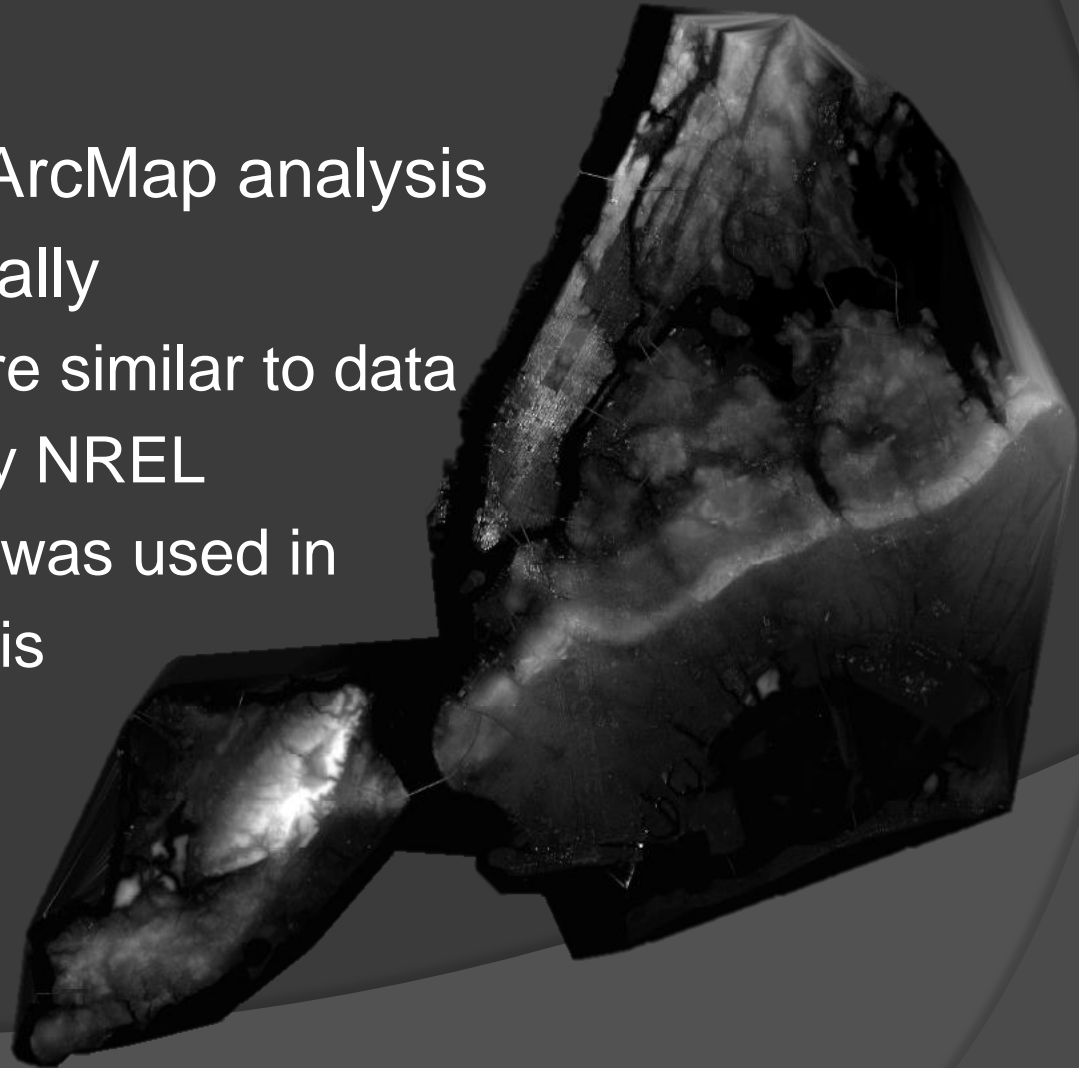
- NREL PV-Rooftop
 - Uses LiDAR Raster and Buildings shapefile
 - Python script and ArcMap to analyze data
 - Provides Zip-Code Level Summary of rooftop area suitable for solar panels



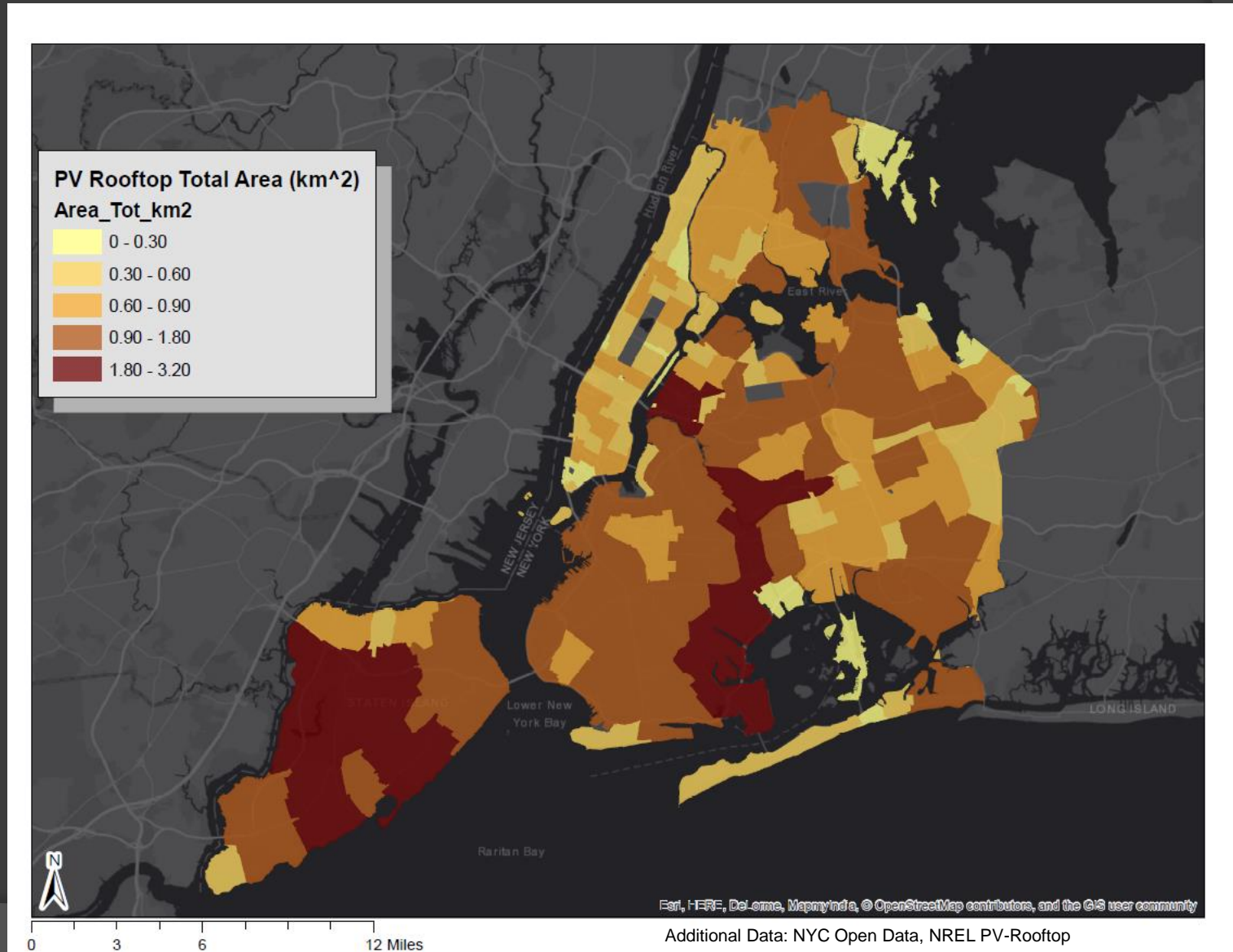
Sample Rasterized LiDAR

● Analysis

- Python and ArcMap analysis were run locally
 - Results were similar to data Provided by NREL
 - NREL data was used in final analysis



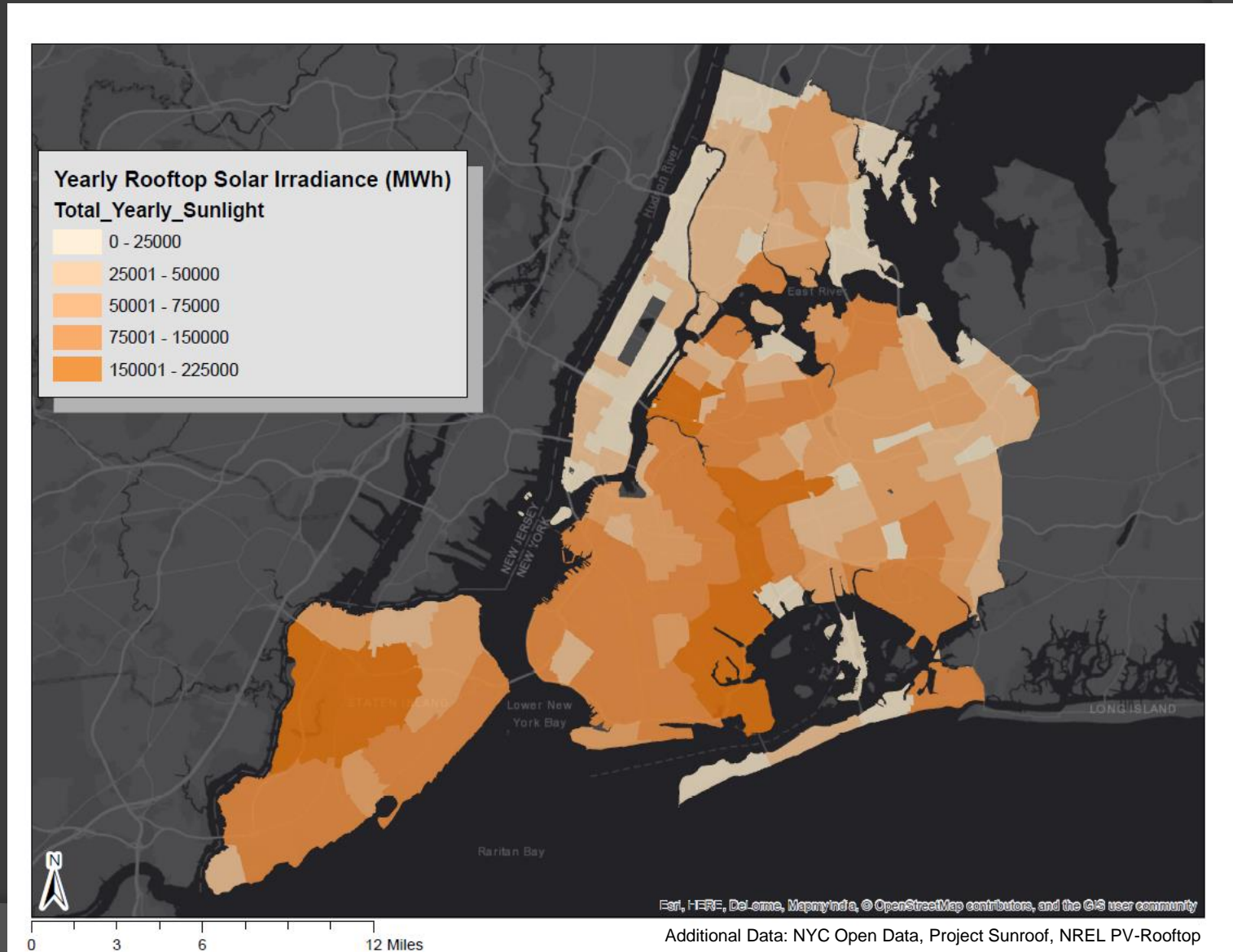
Map – Data Analysis



Data Interpolation

- Once Zip Codes with missing or bad data were determined, an interpolated value for yearly rooftop solar irradiation was found using data from nearby Zip Codes
 - A spreadsheet program was used to perform the interpolation.
 - Two nearby Zip Codes were chosen to account for similar building styles and overall solar radiation.
 - The Project Sunroof total yearly solar irradiation value was divided by the NREL rooftop area of each target zip code, and then multiplied by the NREL rooftop area of the excluded zip code.
 - The average of these two values provides an estimated total yearly solar irradiation value for the zip codes excluded from the Project Sunroof dataset.

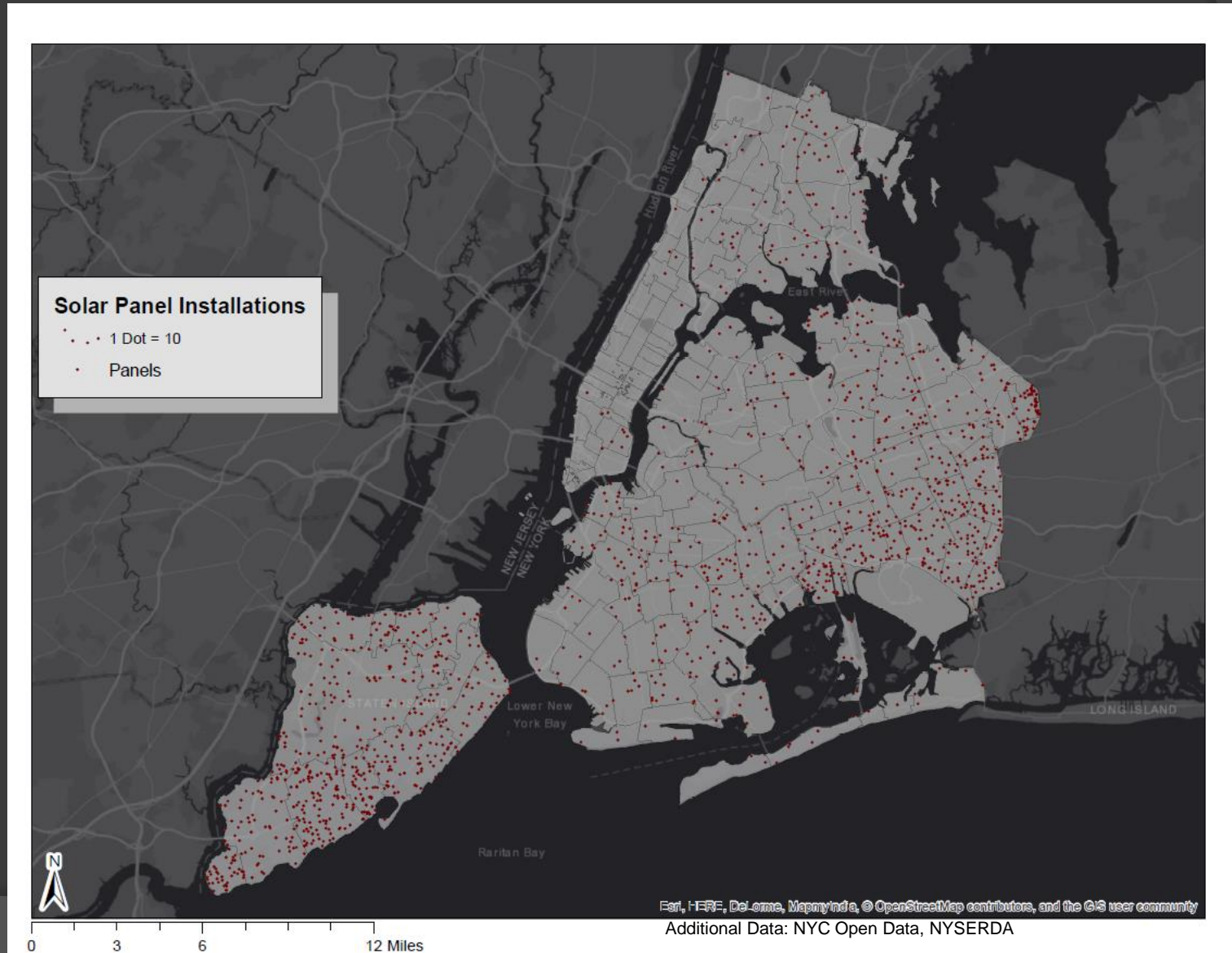
Map – NYC Sunlight



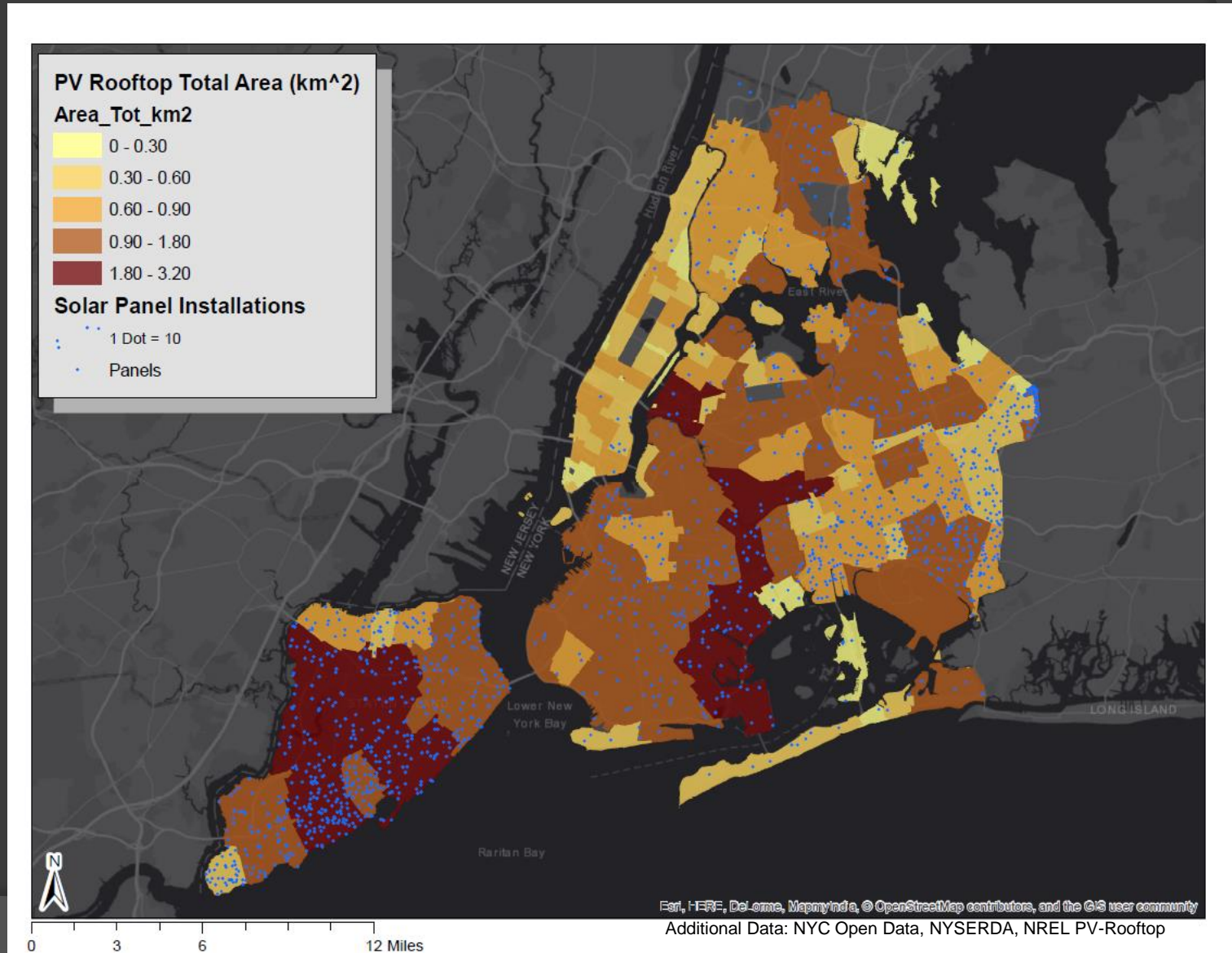
Data Collection

- ◎ Current solar panel installation data was obtained from the New York State Energy Research and Development Authority (NYSERDA)
 - Provide Zip Code level data on all individual solar panel installations since year 2000.

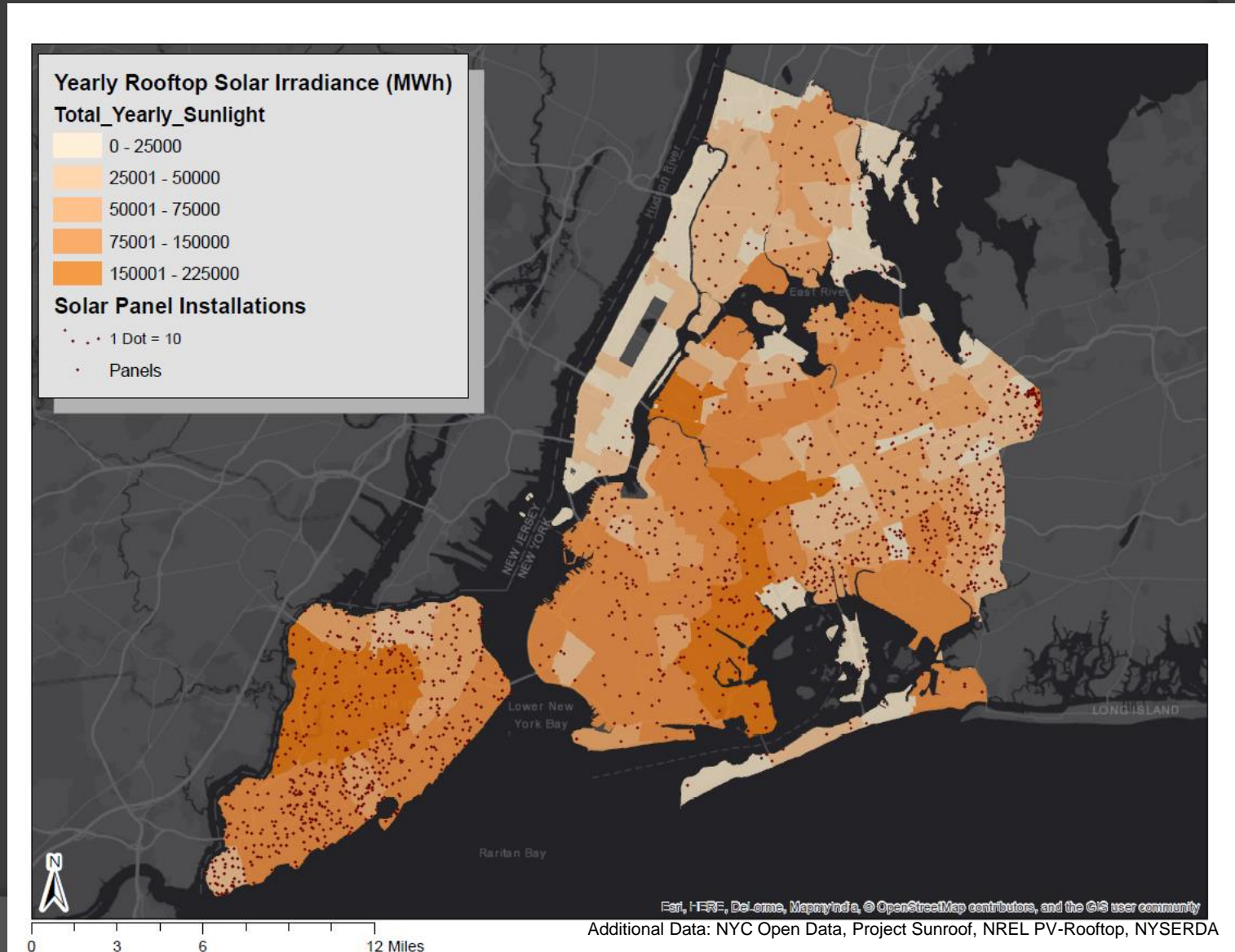
Map – Solar Installations



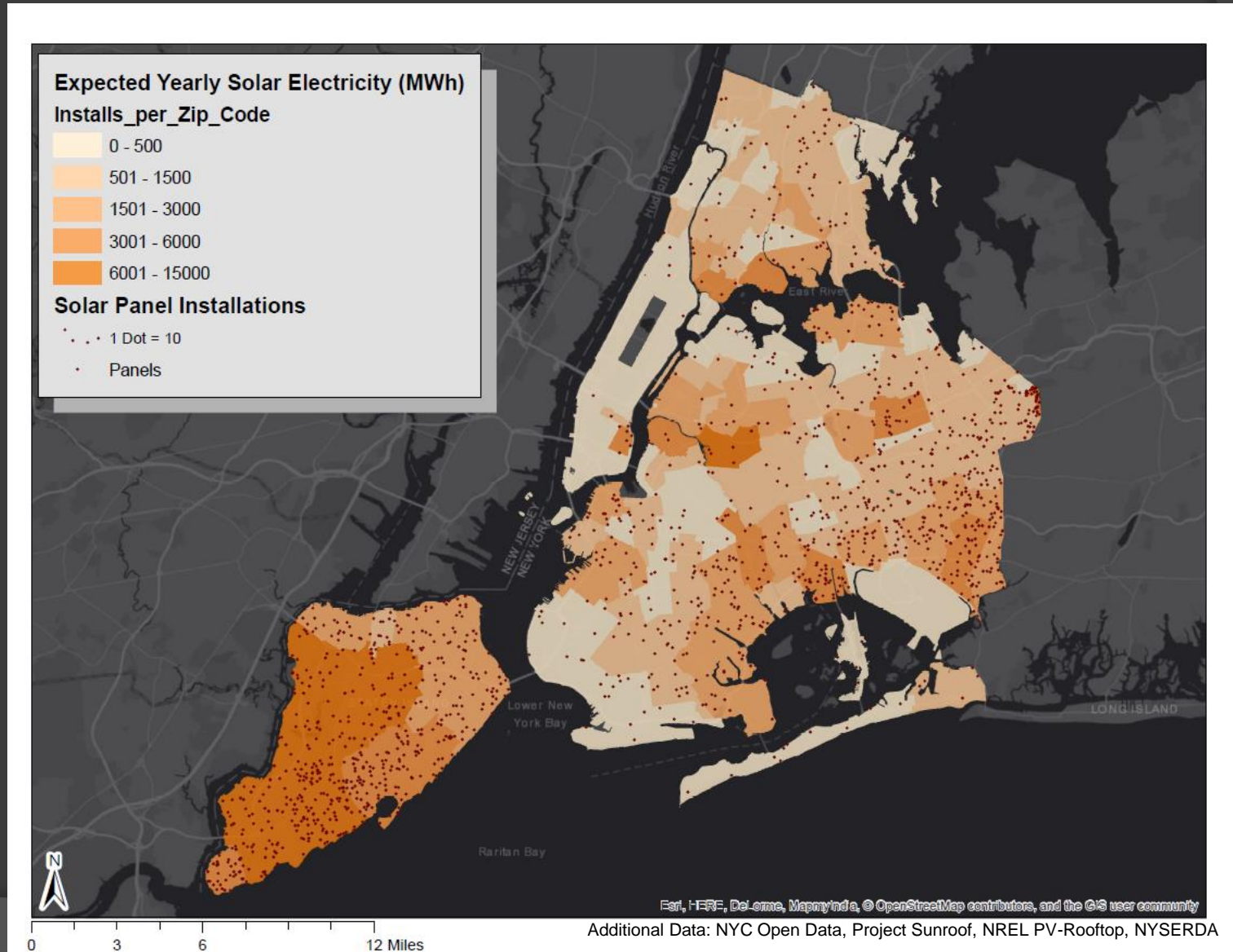
Map – Data Analysis



Map – Solar Potential



Map – Current Solar Production



Production Goal Analysis

- ⦿ Set a solar electricity production goal
 - Solar goal vs. total NYC electricity use
 - 10% chosen for this analysis
 - Reasonable goal
 - Higher than any current zip-code production
 - Simple comparative analysis
 - Changing percentage yields similar comparative results

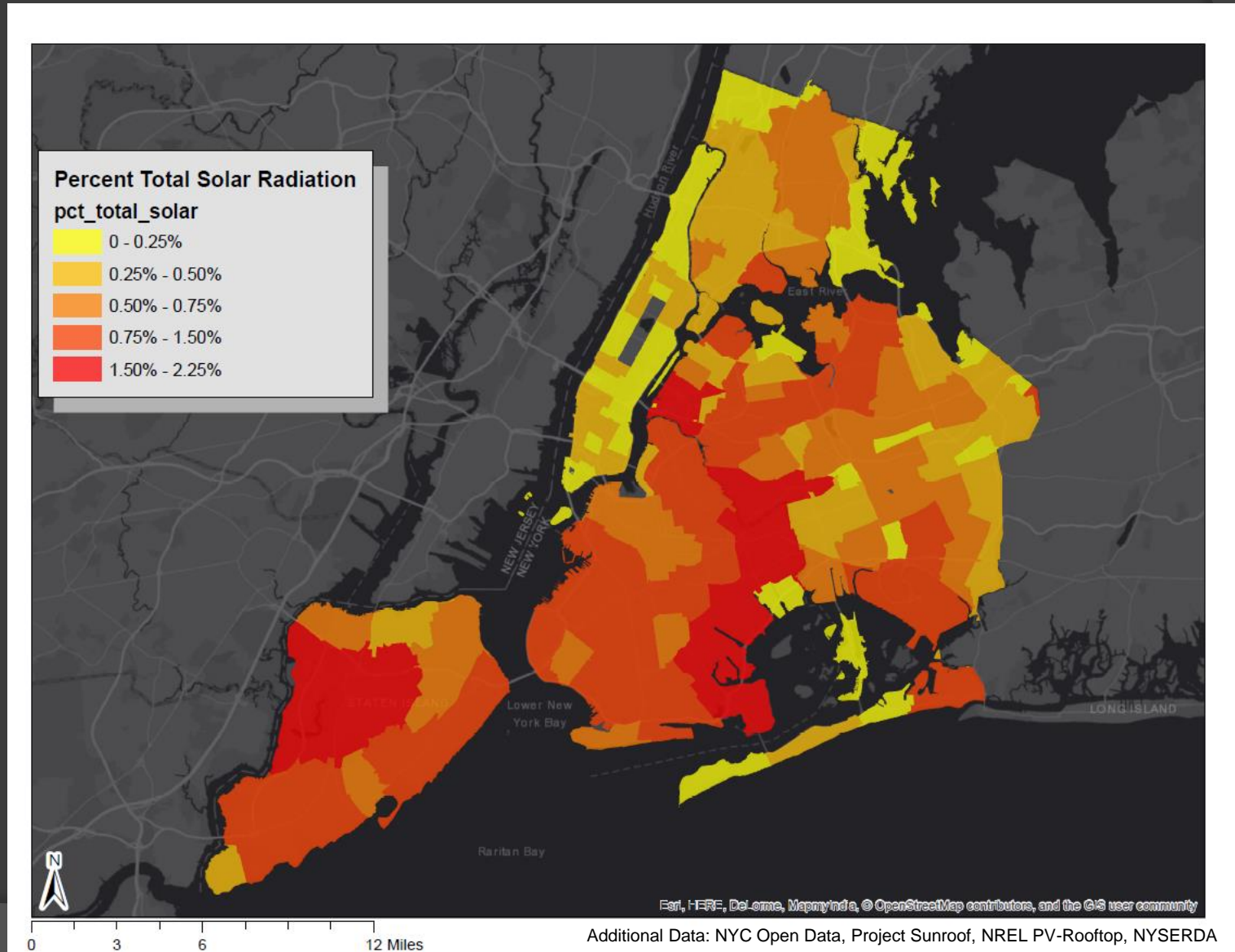
Data Collection

- ◎ Yearly electrical consumption data for NYC was obtained from the U.S. Energy Information Administration (EIA)
 - Lists total energy quantity sales for power companies in the U.S. for 2016.
- ◎ 2016 Utility Bundled Retail Sales
 - Consolidated Edison Co-NY Inc.
 - 19,885,764 MWh
- ◎ 10% Goal = 1,988,576 MWh

Production Goal Analysis

- ◎ The total yearly solar potential for each zip code was normalized by the total solar potential of the entire city
 - Percent rooftop sunlight received by each zip code

Map - % Sunlight by Zip Code

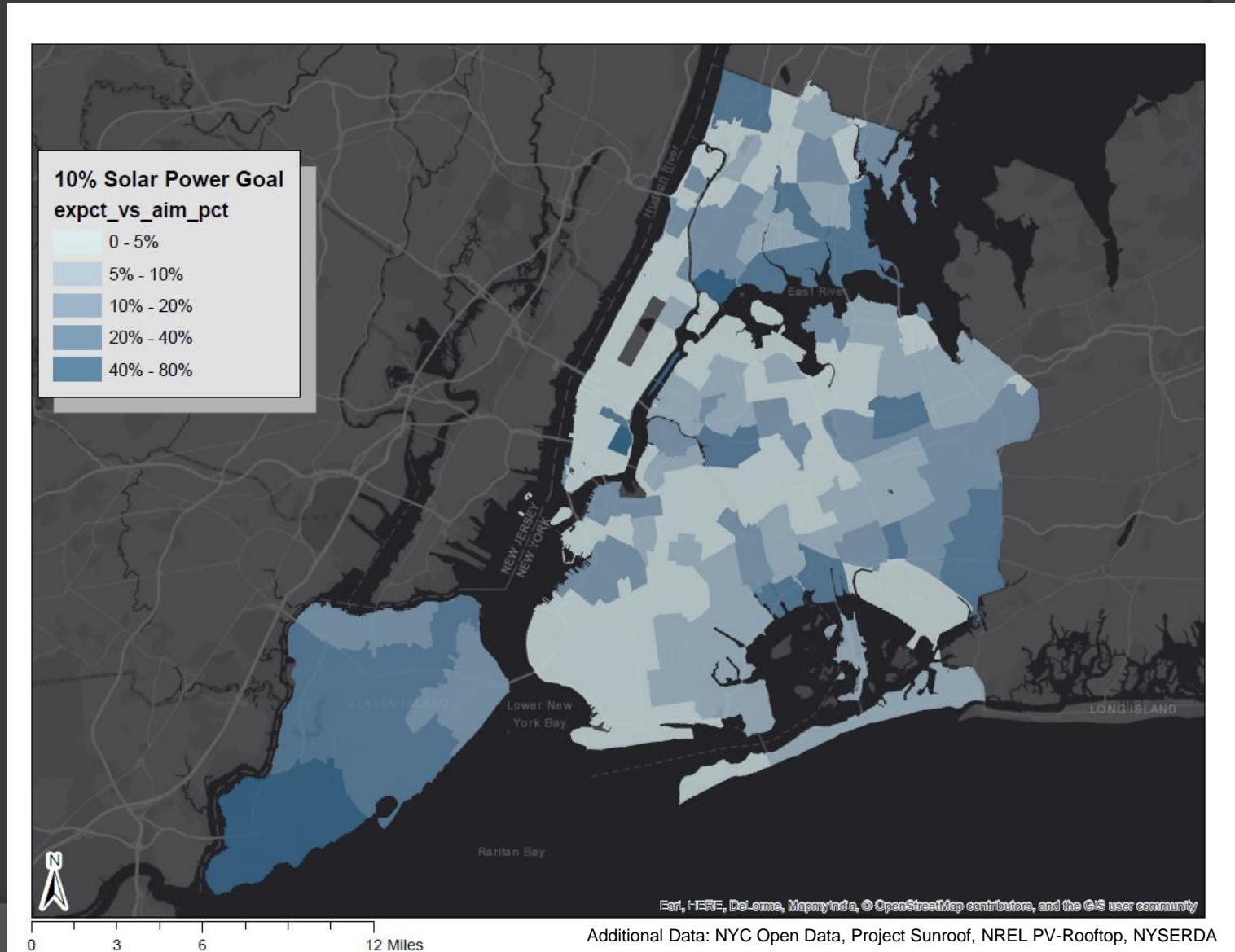


Production Goal Analysis

Distance-to-goal analysis

- The 10% solar goal was adjusted based on the percent solar potential of each zip code
 - (Total goal proportionally divided among all zip codes)
- The yearly solar production for current installations was compared to the 10% goal
- A percent value was found for current production vs. the proportional goal

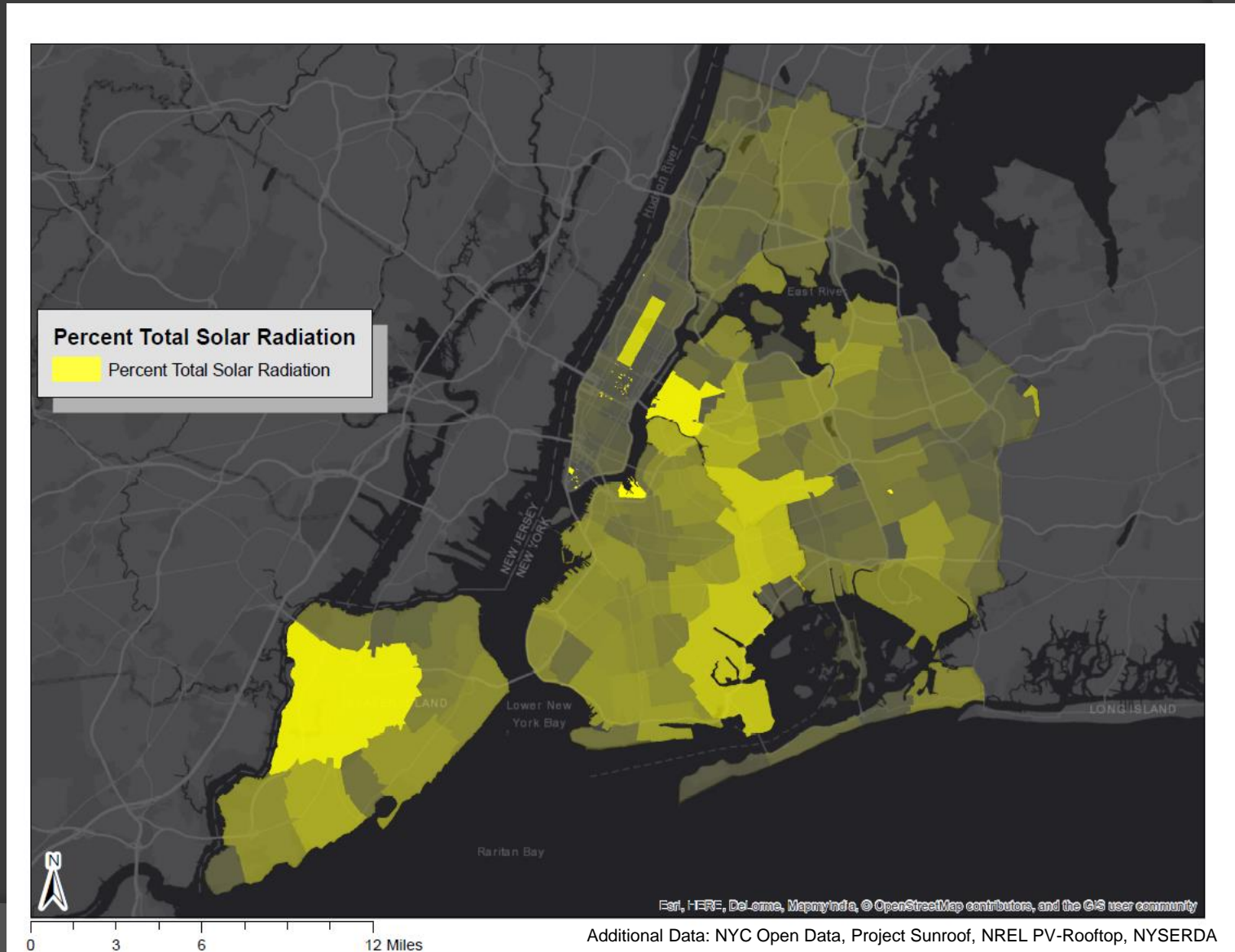
Map – Distance to Goal



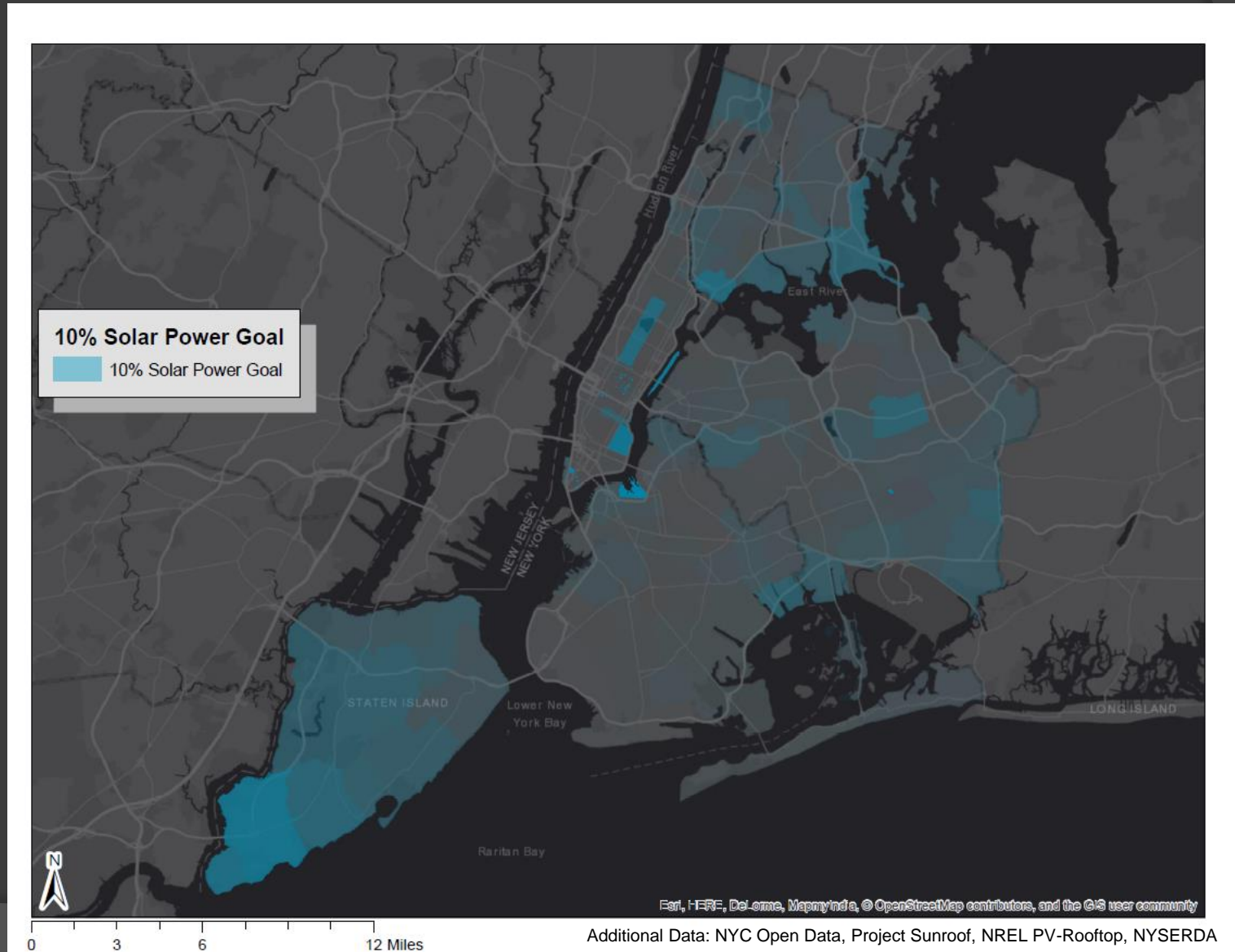
Visual Data Analysis

- In order to simultaneously analyze the previous two maps, the choropleth coloration was adjusted to base transparency of a single color on the percent sunlight or percent distance to goal
 - The two resulting maps were overlayed to produce a new color scheme signifying solar development by zip code

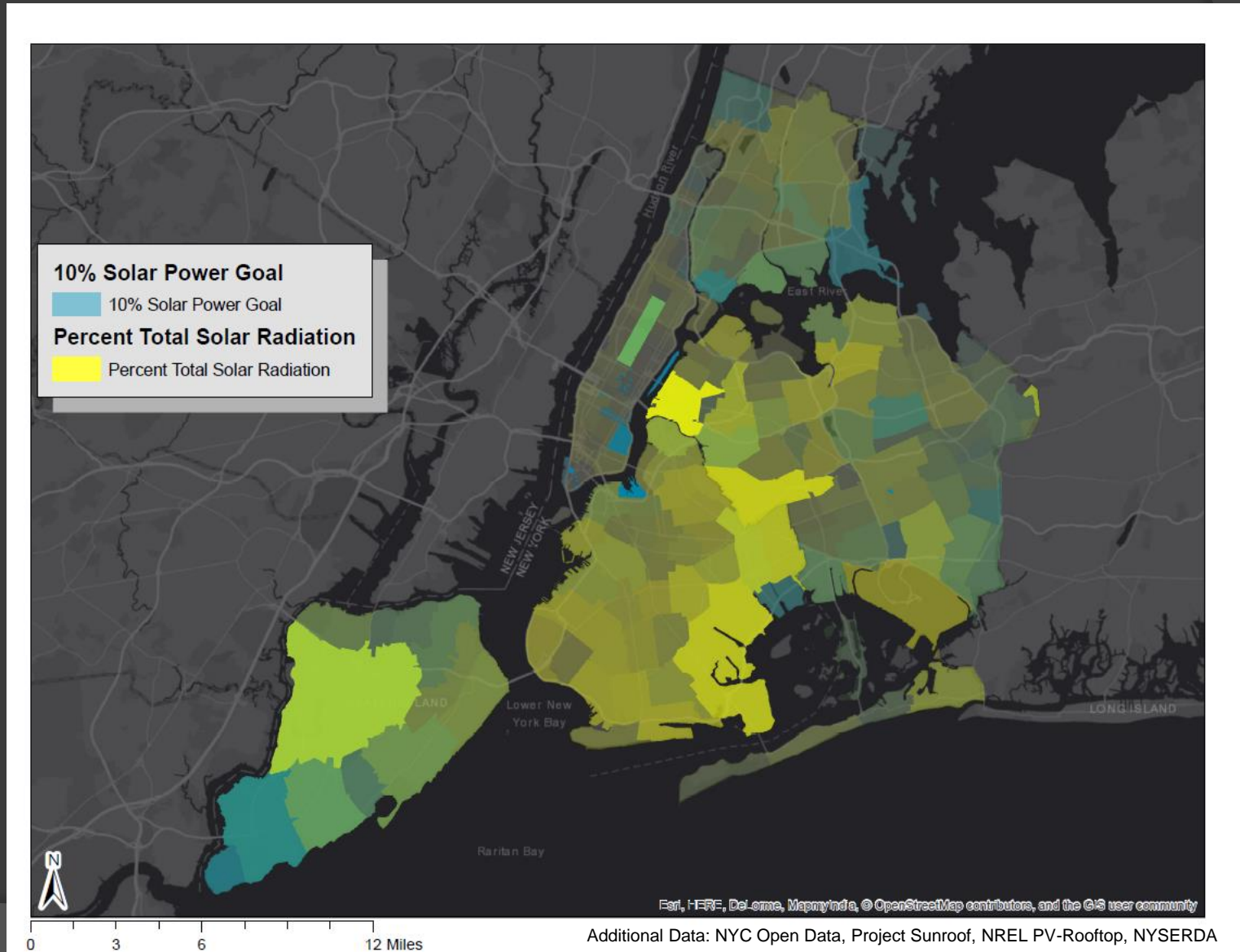
Map - % Sunlight by Zip Code



Map – Distance to Goal



Map – 10% Goal Analysis



Conclusion

- Most solar potential in NYC lies in Staten Island, Brooklyn, and Queens
- Staten Island has highest solar development
- Eastern Queens and the Bronx have some solar development, but less potential
- Manhattan has low solar development potential

Conclusion

- ⦿ Much of Brooklyn and the bordering areas of Queens have good solar potential, but are underdeveloped
- ⦿ Specific focus regions
 - JFK – medium potential (low building count), but no current development and large rooftops
 - Long Island City – high potential and low development

References

- ◉ Project Sunroof: <https://www.google.com/get/sunroof#p=0>
- ◉ Mapdwell: <https://www.mapdwell.com/en/solar>
- ◉ NY Solar Map: <https://nysolarmap.com/>
- ◉ National Renewable Energy Laboratory: <https://www.nrel.gov/>
- ◉ NREL National Solar Radiation Database (NSRDB) Data Viewer -> Infrastructure -> PV Rooftop: <https://maps.nrel.gov/nsrdb-viewer/>
- ◉ NYS Energy Research and Development Authority: <https://www.nyserda.ny.gov/>
- ◉ U.S. Energy Information Administration – Utility Bundled Retail Sales: www.eia.gov/electricity/sales_revenue_price/pdf/table10.pdf
- ◉ NYS GIS Clearinghouse: <https://gis.ny.gov/>