

# Using Satellite Imagery to Map Floods in NYC

Remote Sensing

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Nov. 9<sup>th</sup>, 2021

# *Disclaimer*

- Preliminary research, not finished completely yet

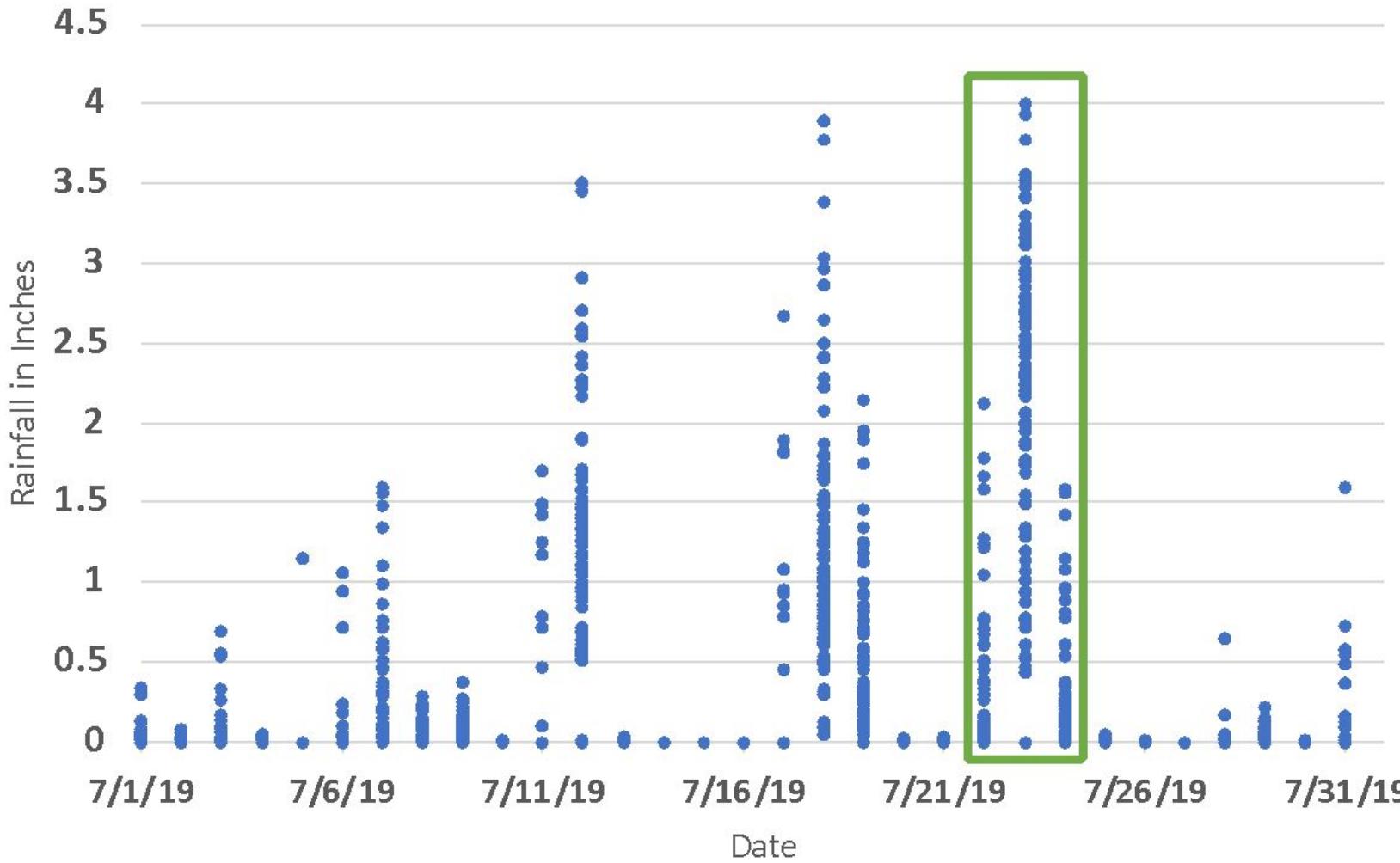
# Sentinel-1 Satellite

- According to Clement et al., (2018) and Manjusree et al., (2012), VV polarized bands are best to detect inundation
- Orbital period of 12 days



<https://sentinels.copernicus.eu/web/sentinel/missions/sentinel-1/overview>

## Recorded Precipitation for New York City in July, 2019



It rained 3-4 inches across all of NYC rain gauges on July 23<sup>rd</sup>  
The sentinel took an image on July 25th

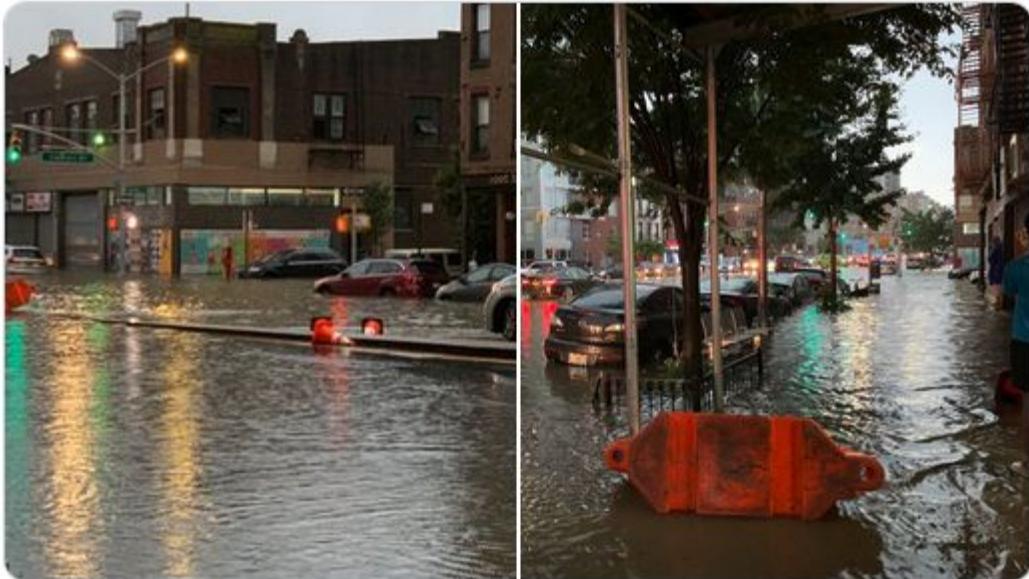
# Flash Flood on July 23<sup>rd</sup>, 2019



Tim Sachs  
@TimSachs



Flooding in Gowanus at 4th and Carroll, even after 3 summers of work to replace the sewer on Carroll.  
#nycheatwave #flooding @bradlander



8:12 PM · Jul 22, 2019



30 6 Copy link to Tweet

Tweet your reply



Julie Chang ✓  
@BayAreaJulie

At 4th Ave and Carroll Street in Brooklyn. Courtesy of Adrienne Zhao

▶ 733.7K views 0:03 / 0:09 🔍 ↗

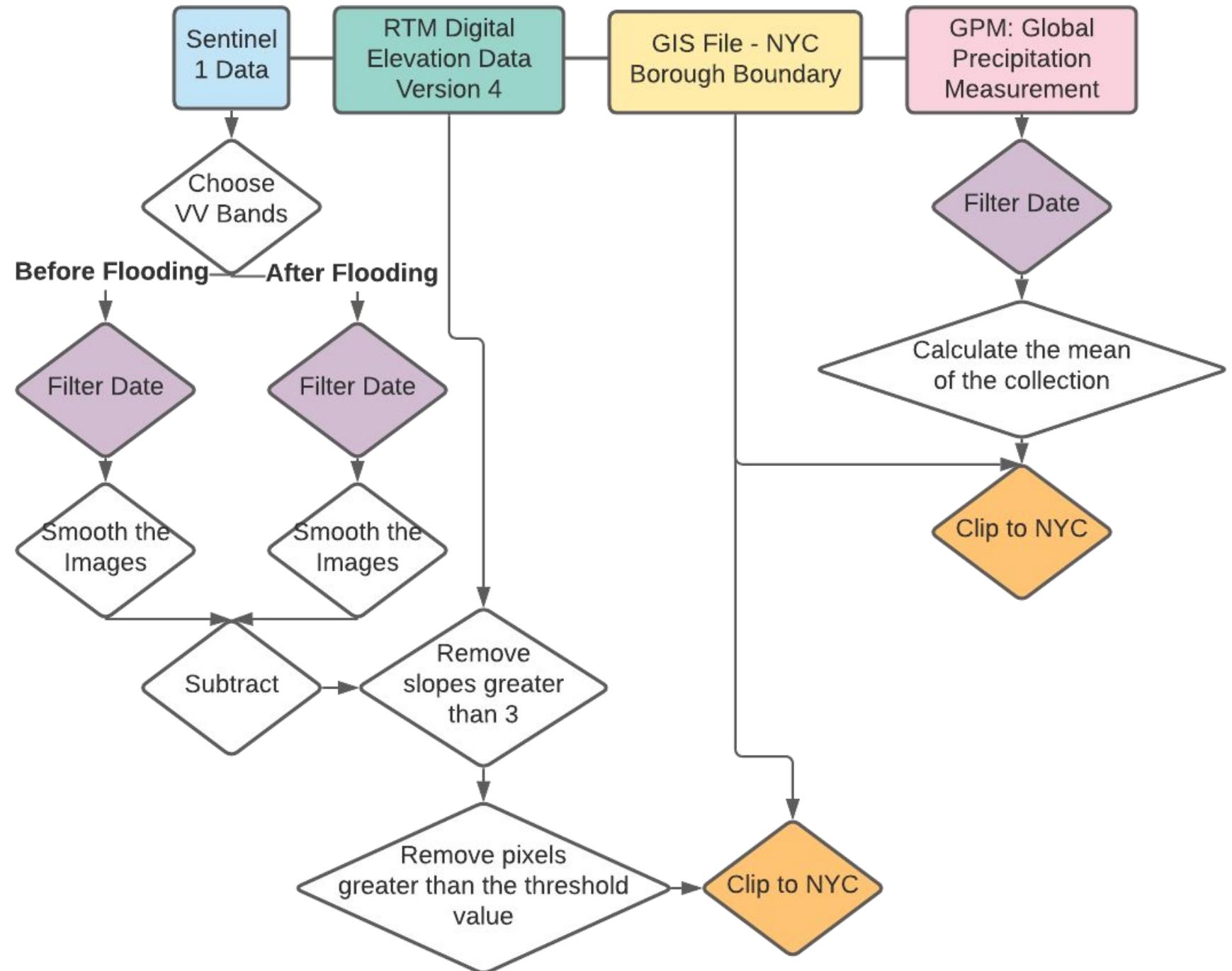
# Before – July 13th, 2019



# After – July 25<sup>th</sup>, 2019



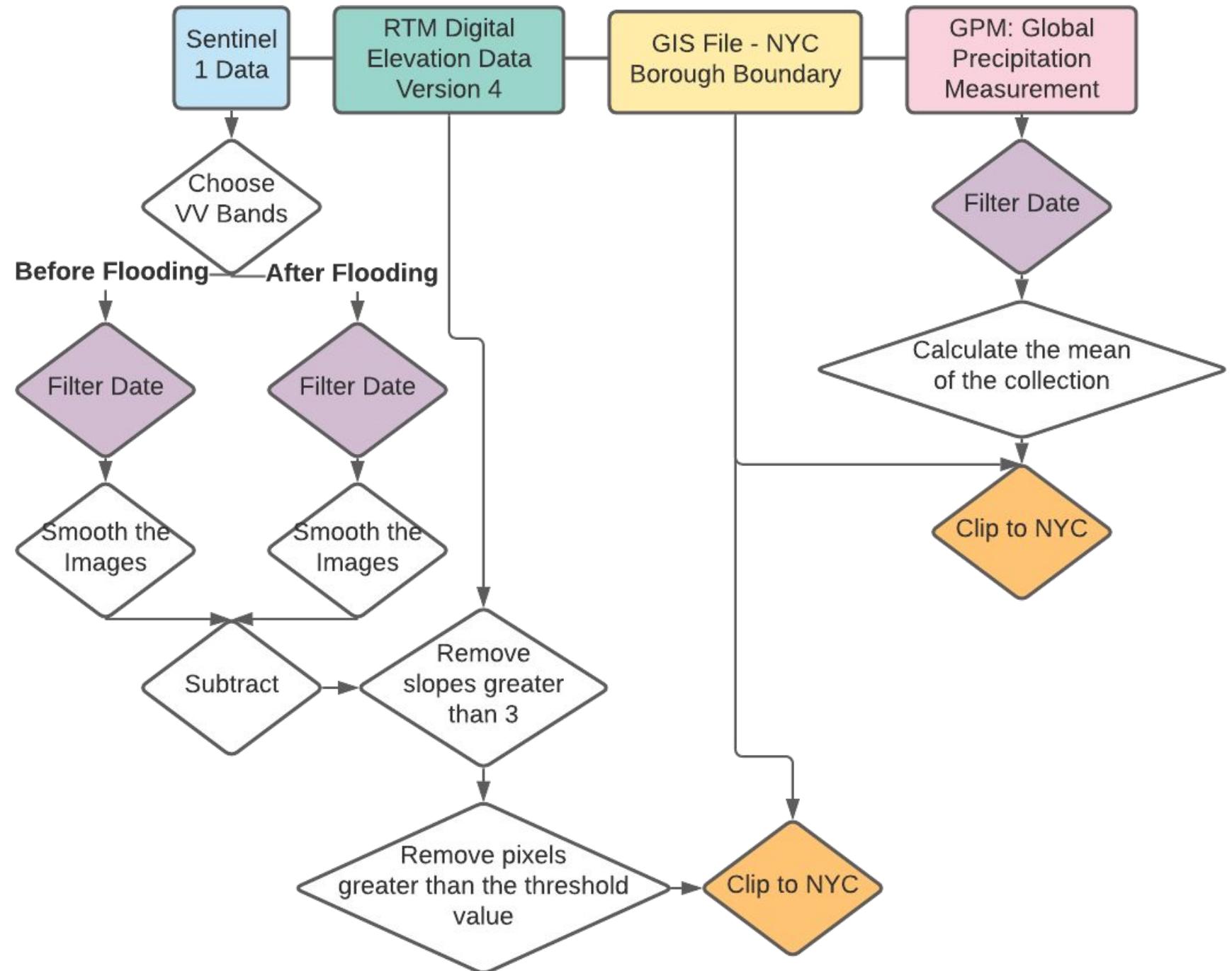
# Graph of Workflow – *Calculating Inundation*



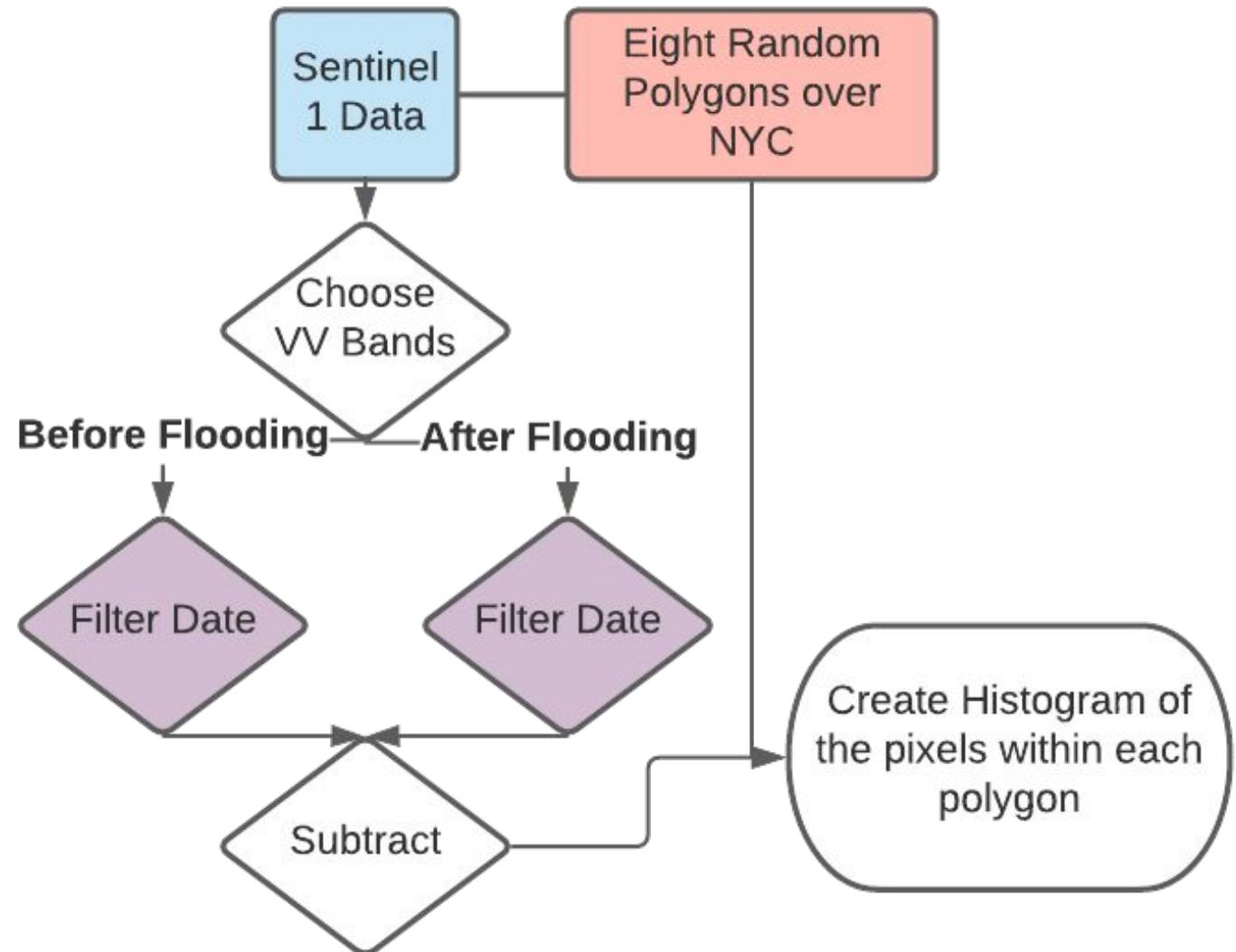
# Differenced Image Smoothed



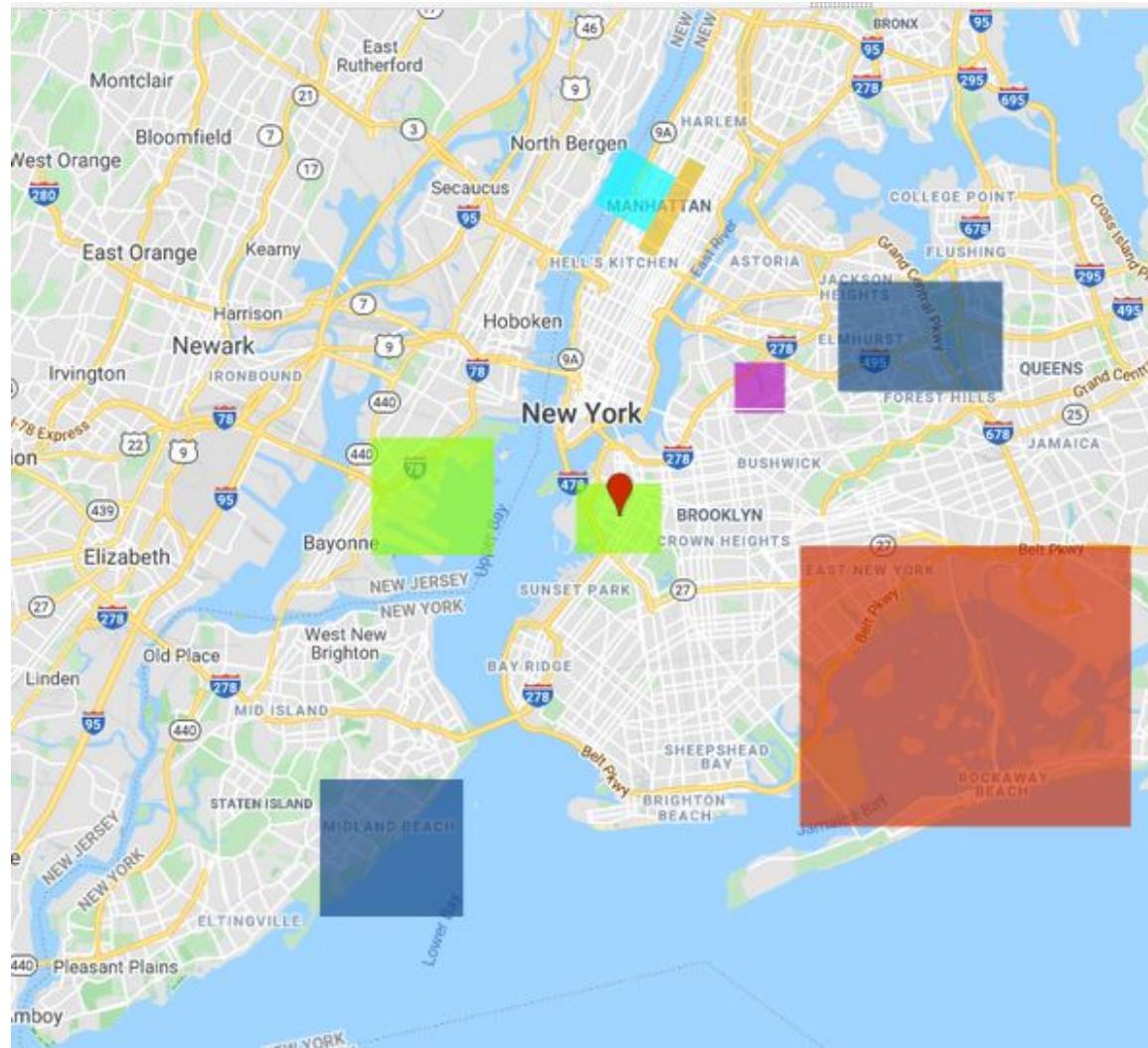
# Graph of Workflow – *Calculating Inundation*



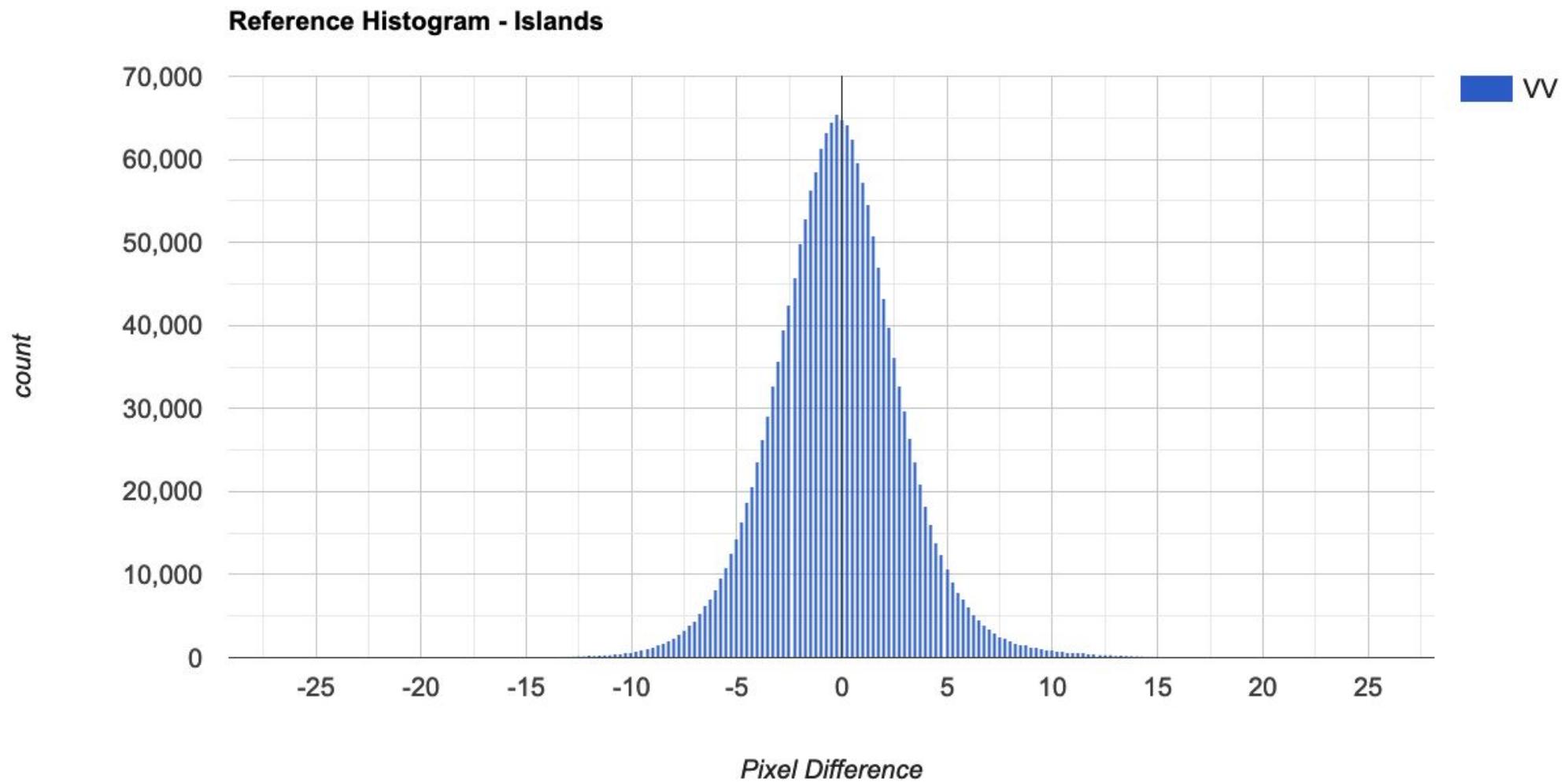
# First Step – Calculate Threshold Value



# 8 Various Polygons



# Calculating the Threshold Value



$$P_D < (\{lmean[D]\} - k_f * \{lstdev[D]\})$$

From Long et al., (2014).

# Calculating the Threshold Value

	A	B	C	D	E	F	G	H
1								
2								
3	Island	Known Flood	Half Water	Central Park	Hudson River	Channel	Bay	Land
4	-4.8985008	-3.821009	-6.9607806	-4.2639514	-4.8881933	-4.761851	-5.3982947	-3.6488532
5	-4.8985008	-3.821009	-6.9607806	-4.2639514	-4.8881933	-4.761851	-5.3982947	-3.6488532
6								
7								
8								
9	Average		<b>-4.83</b>					
10								
11								
12								
13								

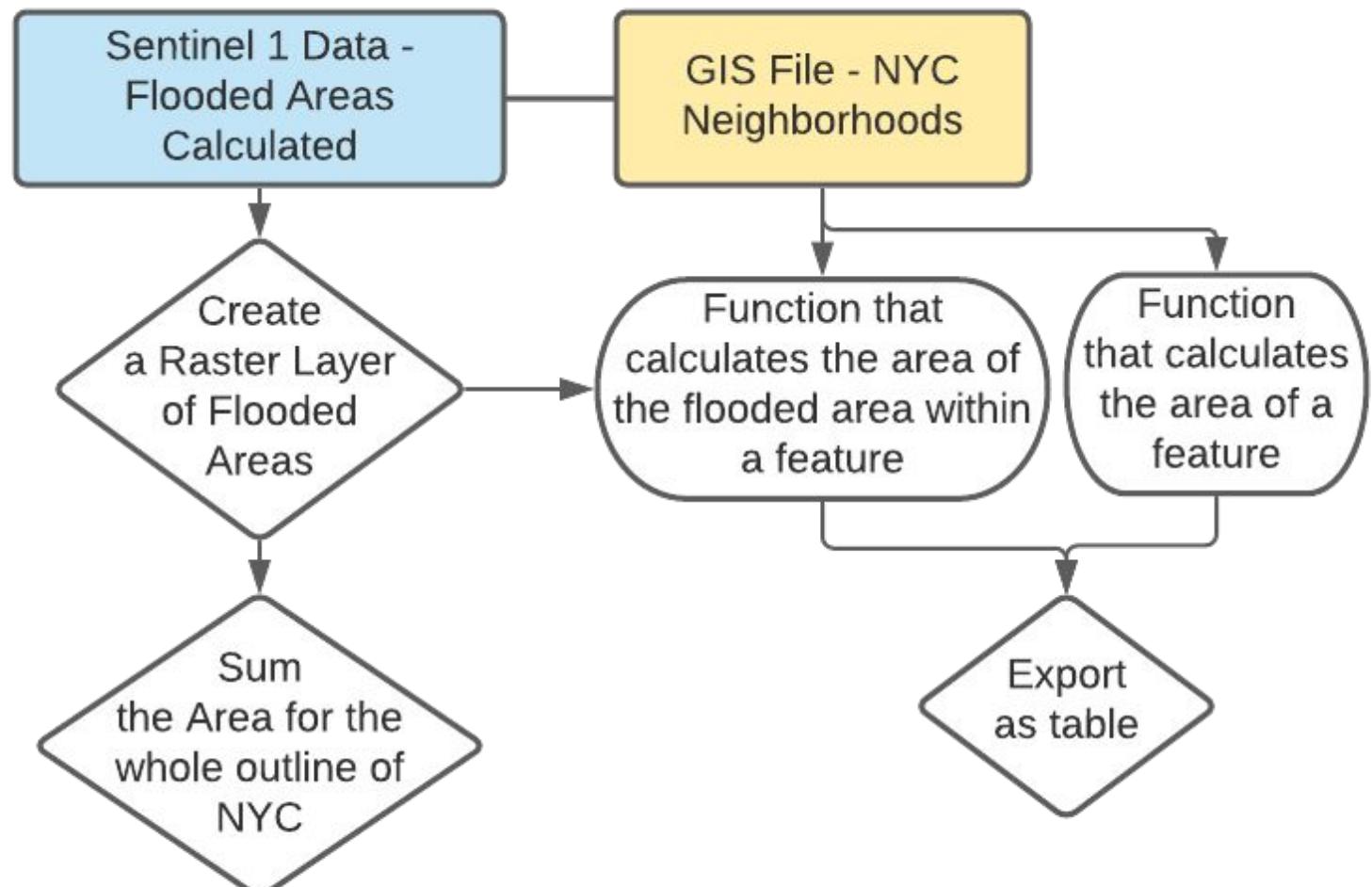
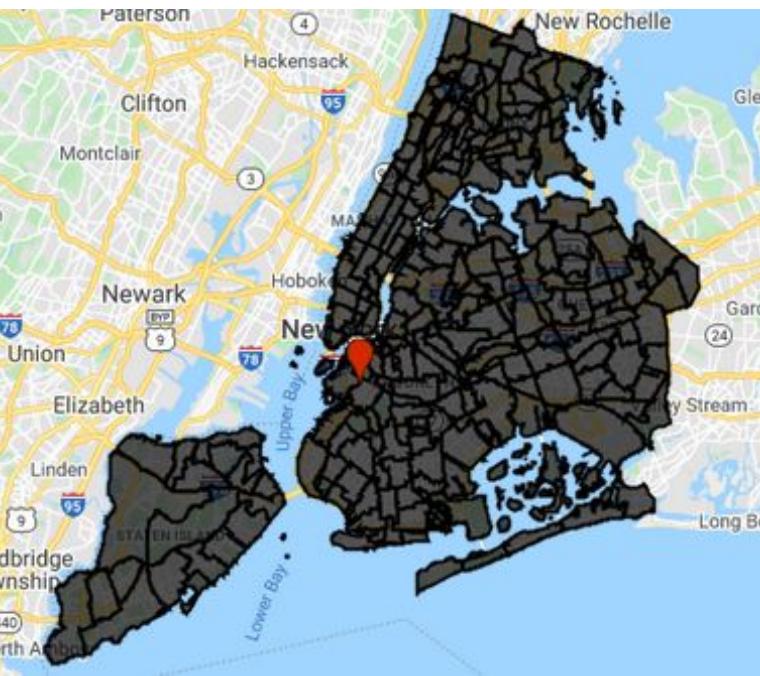
# Result

Total Precipitation  
from satellite data:  
6.3 meters

Total Precipitation  
from Rain Gages:  
5.2 meters



# Graph of Workflow – *Quantifying Inundated Areas*



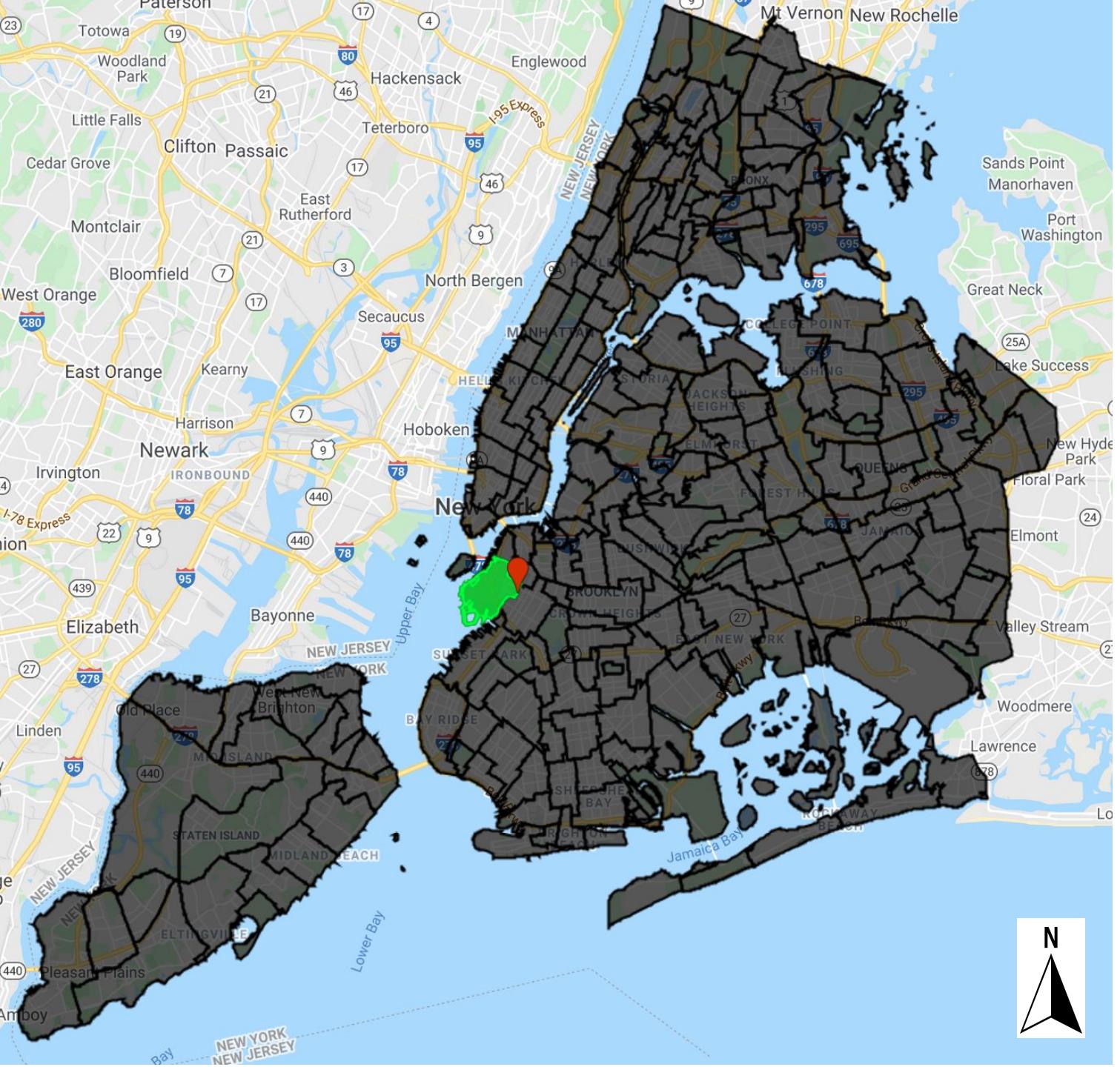
# Calculating Area

```
105 // This function computes the feature's geometry area and adds it as a property.  
106 var addArea = function(feature) {  
107   return feature.set({area: feature.geometry().area()});  
108 };  
109  
110 // This function computes the feature's geometry area for specifically flooded areas and adds it as a property.  
111 var addFloodArea = function(feature2) {  
112   var flood_pixelarea = flooded.select('VV')  
113     .multiply(ee.Image.pixelArea());  
114   var floodedArea = flood_pixelarea.reduceRegion({  
115     reducer: ee.Reducer.sum(),  
116     geometry: feature2.geometry(),  
117     scale: 10, // native resolution  
118     maxPixels: 1e9,  
119     bestEffort: false  
120   })  
121   return feature2.set({floodedArea: floodedArea});  
122 };  
123  
124 // Map the area getting function over the FeatureCollection of all NYC Neighborhoods.  
125 var areaAdded = neighborhoods.map(addArea);  
126 var areaFloodAdded = neighborhoods.map(addFloodArea);
```

# Analysis

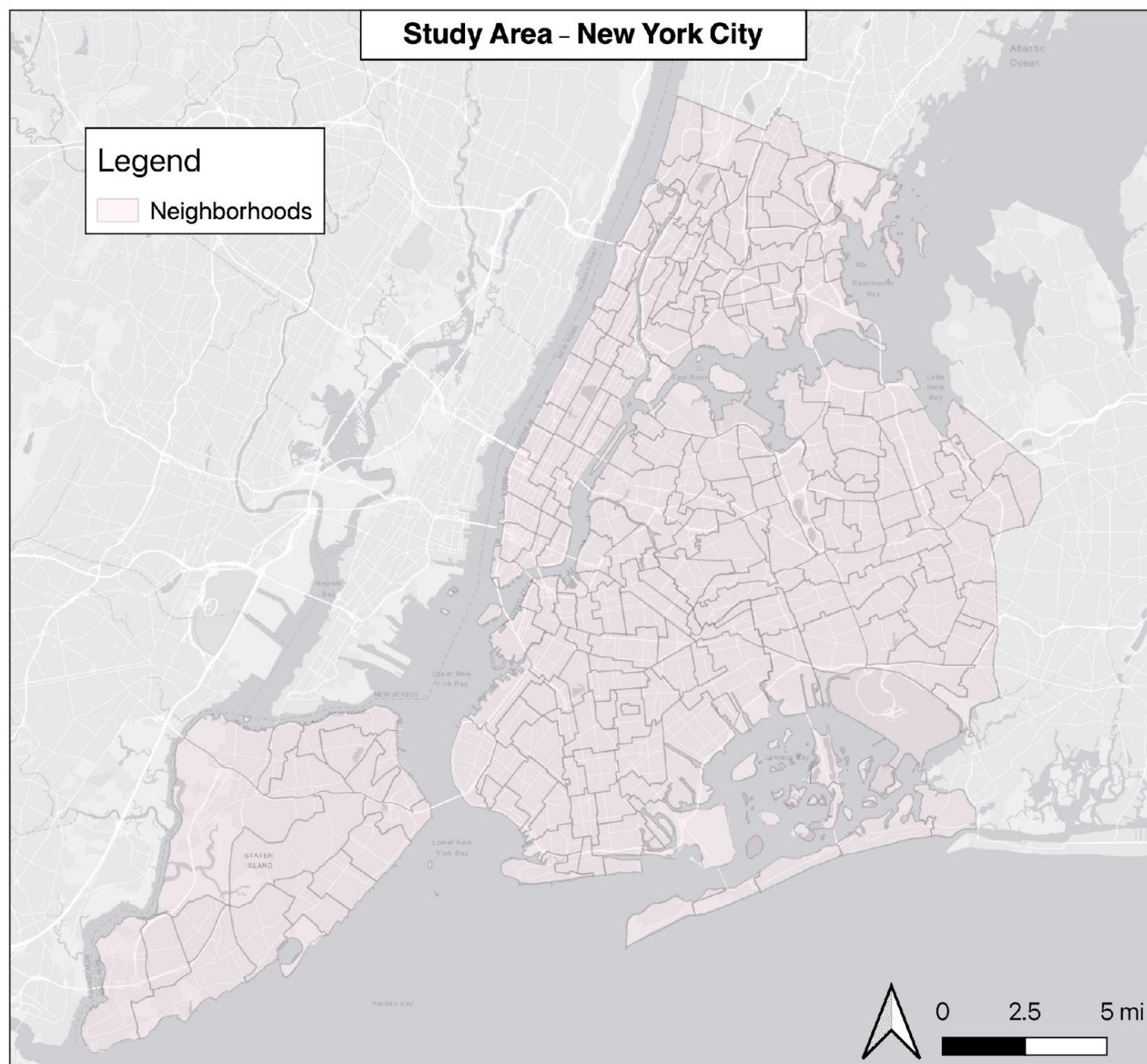
Neighborhood Name	Borough	Area of Neighborhood (m2)	Total Flooded Area (m2)	Percent of Flooded Area
Carroll Gardens-Columbia Street-Red Hook	Brooklyn	4,138,563	30,981	0.749%
Mariner's Harbor-Arlington-Port Ivory-Graniteville	Staten Island	8,300,588	22,212	0.268%
park-cemetery-etc-Queens	Queens	28,480,136	49,401	0.173%
New Dorp-Midland Beach	Staten Island	5,145,284	4,963	0.096%
Turtle Bay-East Midtown	Manhattan	1,613,686	1,514	0.094%
park-cemetery-etc-Bronx	Bronx	20,544,573	18,813	0.092%
park-cemetery-etc-Brooklyn	Brooklyn	20,914,593	17,943	0.086%
West New Brighton-New Brighton-St. George	Staten Island	5,199,082	2,880	0.055%
New Springville-Bloomfield-Travis	Staten Island	30,361,103	12,895	0.042%
Rosedale	Queens	5,713,115	1,440	0.025%
College Point	Queens	4,690,854	1,135	0.024%
Old Town-Dongan Hills-South Beach	Staten Island	6,218,198	1,181	0.019%
Airport	Queens	21,176,469	1,667	0.008%
Seagate-Coney Island	Brooklyn	3,597,651	152	0.004%
Hunts Point	Bronx	4,610,935	151	0.003%
Gravesend	Brooklyn	2,908,078	76	0.003%

# Carroll Gardens - Columbia Street - Red Hook

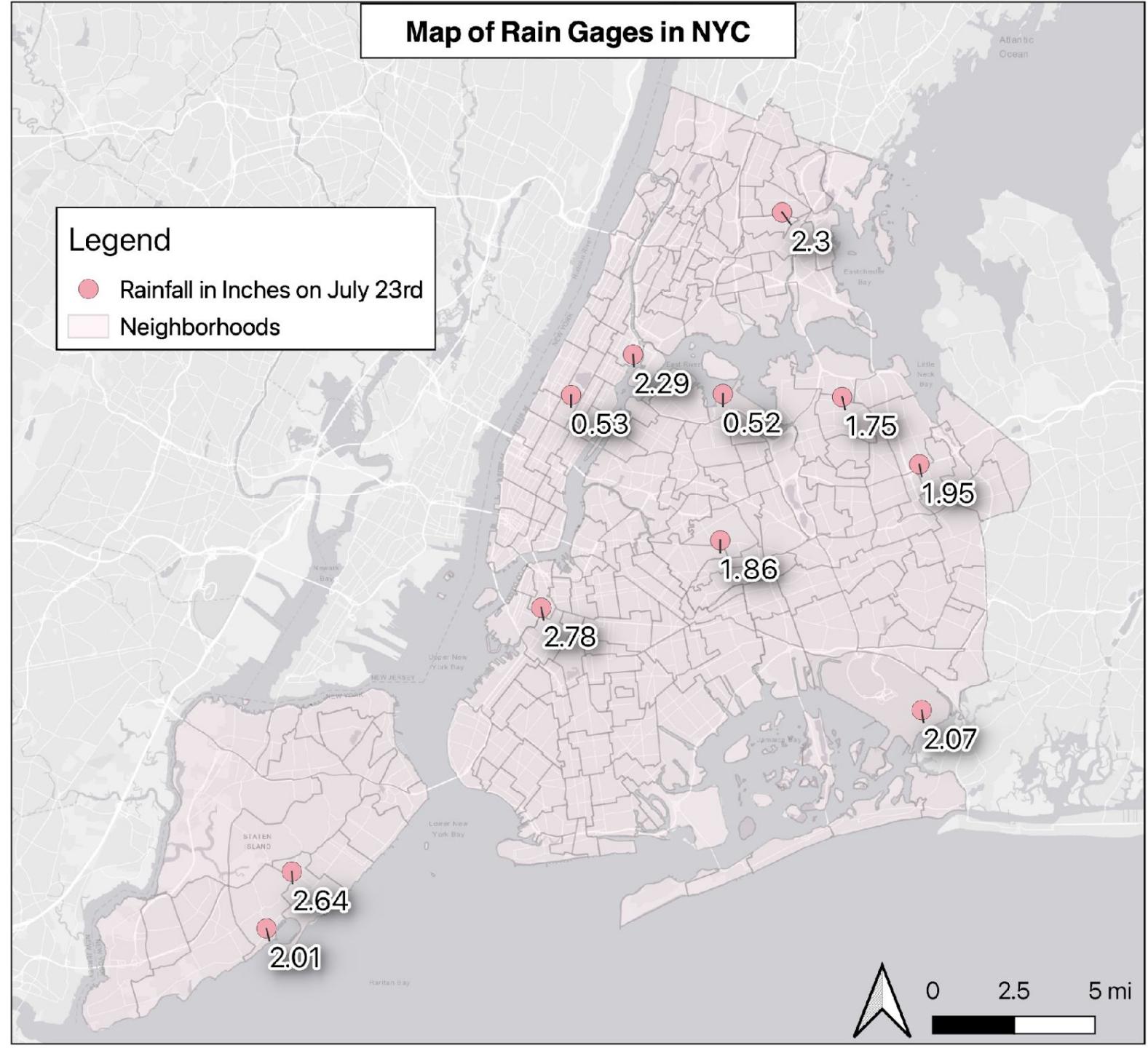


# Study Area

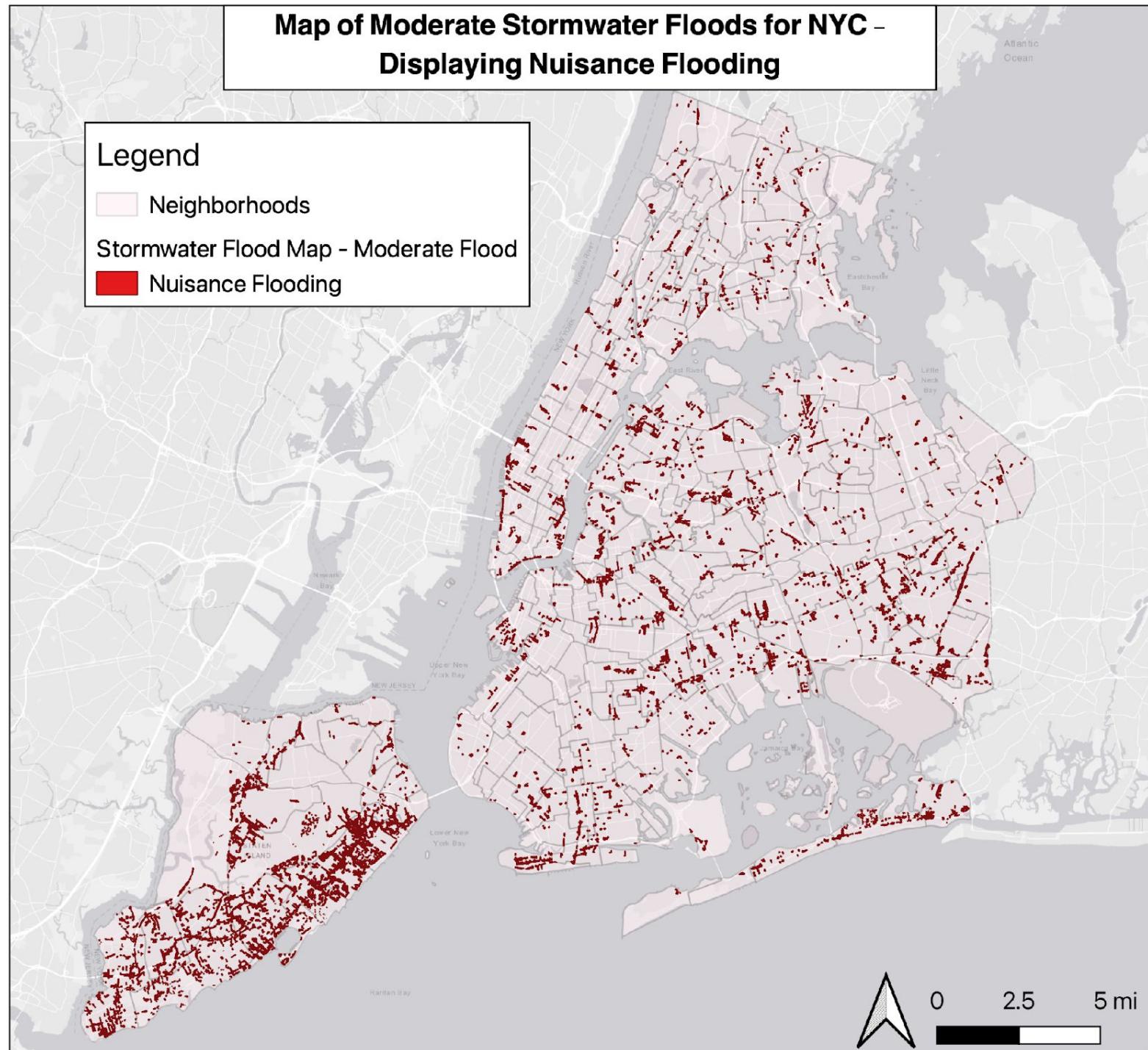
**Study Area - New York City**



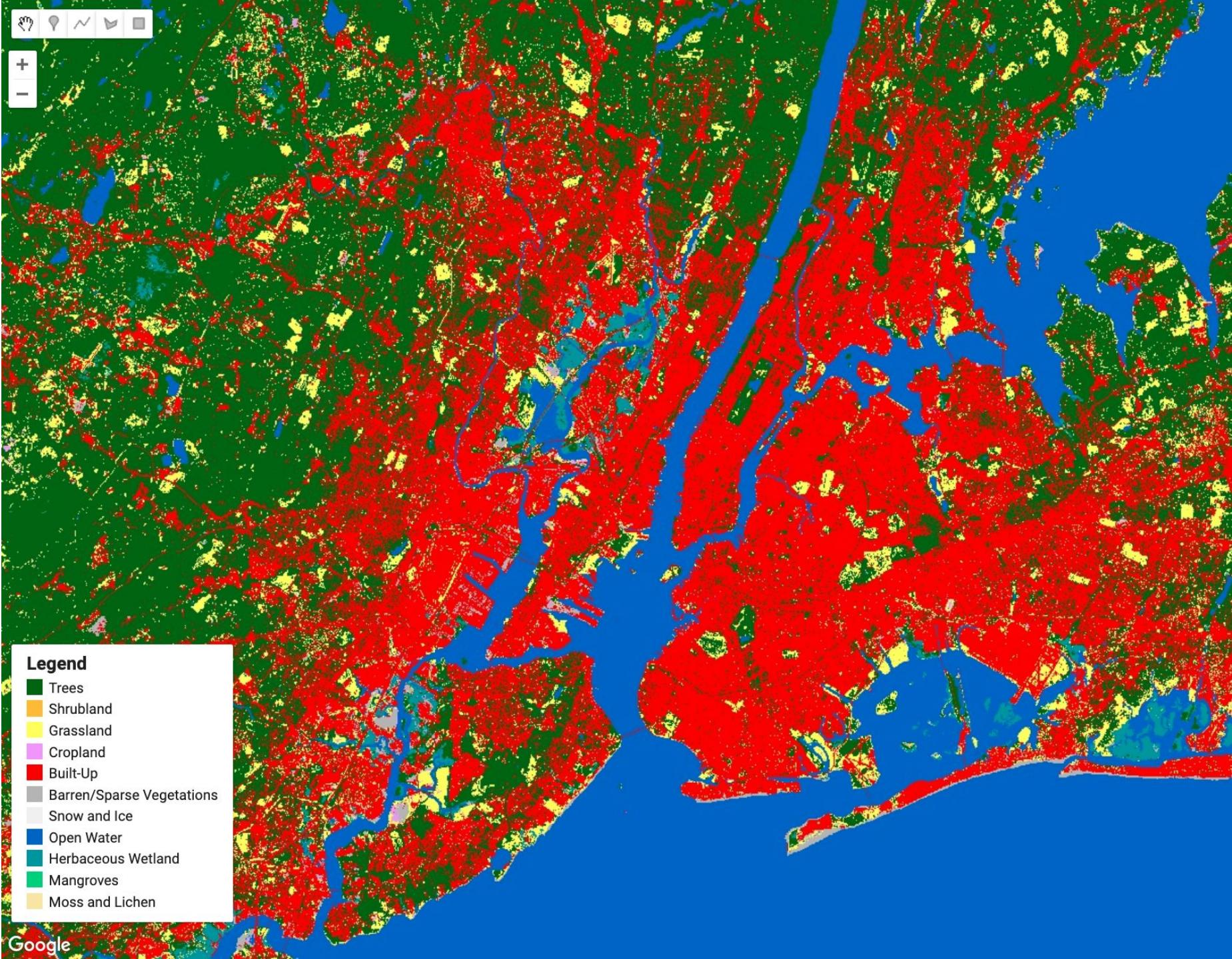
# Rain Gages NYC



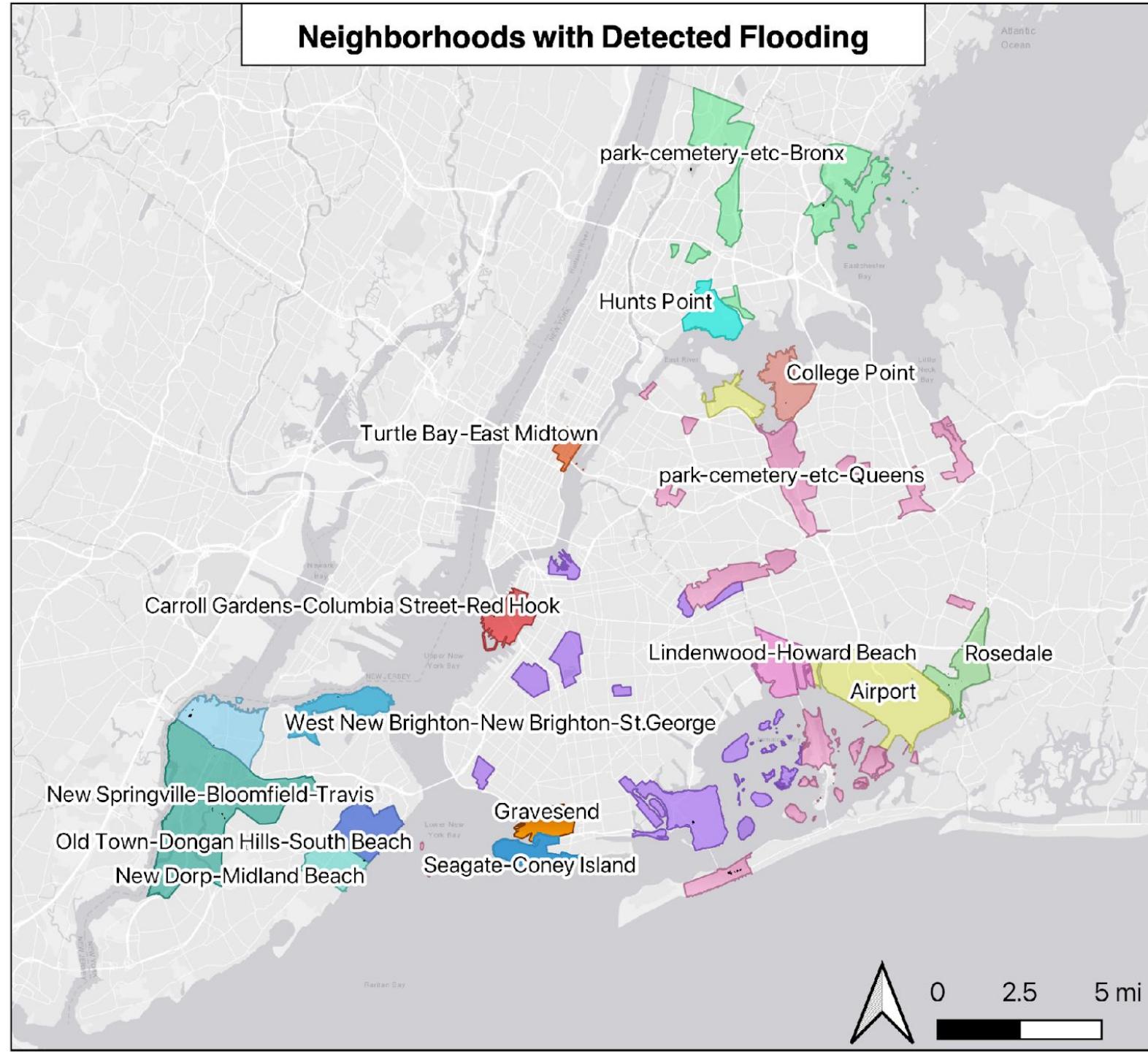
# Flooding



# Land Use



# Flooded Neighborhoods



# Top 5 Flooded Neighborhoods

**Neighborhoods with Detected Flooding**  
**Top 5 by percentage flooded to total area of the neighborhoods**

