The Urban Heat Island and Soil Degradation

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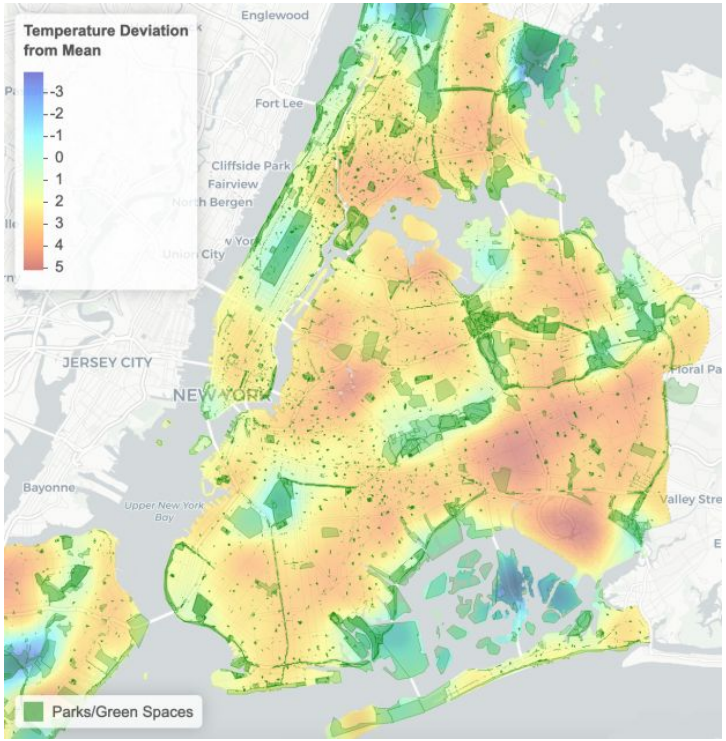
What is a Urban Heat Island (UHI)

- A UHI is an urban area that has increasingly higher temperatures compared to its surrounding rural areas.
- Heat created through heavy industrialization and emissions builds up overtime and is usually is able to be dispersed.
- In UHIs due to the dense proximity of buildings and surfaces like asphalt metal and glass those materials act as insulators for heat and paired with lack of greenspace creating UHIs.

How soil is impacted by UHI and Industrialization

- Extreme Heat
  - Higher temperatures leads to higher rate of evapotranspiration(the cycle in which water is taken from land to the atmosphere) creating drier soil overall.
  - Dry soil can leads to low nutrients.
- Runoff
  - When it rains water is heated on hot surfaces like asphalt and metals allowing toxic debris particles to flake making a toxic runoff.
  - Additionally due to the majority of land usage being made up of impermeable surfaces, toxic runoff from industry seeps into the few green spaces.
  - Concrete particles that get caught in runoff can affect soil pH increasing levels dramatically.



Green Space Mitigation.

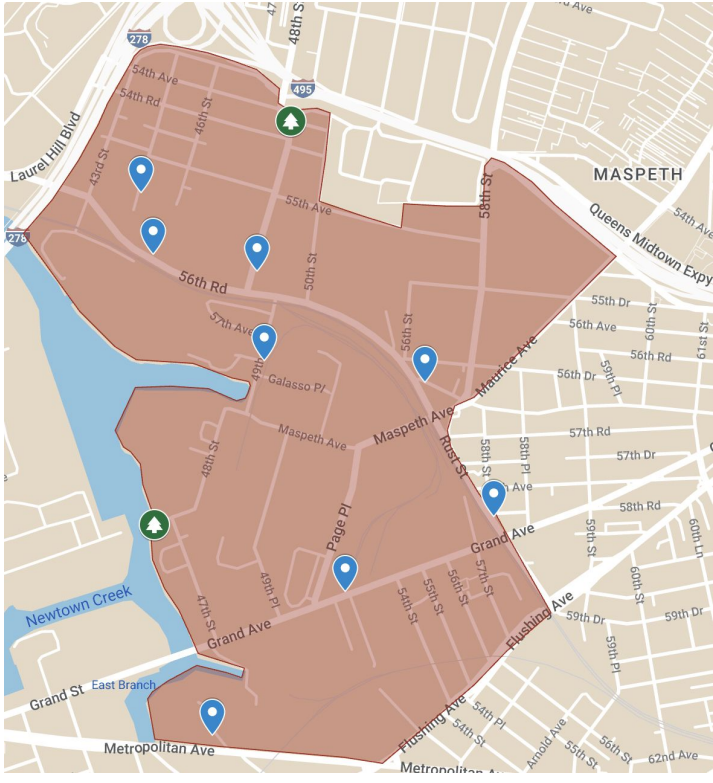
- Green infrastructure is an essential way to mitigate UHI.
  - Trees act as green canopies providing shade and protection to soil.
  - Plants take in heat and release moisture into the air through evapotranspiration creating a cooling effect.
  - Plants absorb air pollution and seculude Co2.
  - Ability to hold stormwater runoff and filter out contamination.

What were my goals in this study?

- Assess
  - Research and understand soil quality of Maspeth IBZ
  - Observe how UHI effects soil quality.
- Compare
  - Look for trends and differences between soil plots.
  - Is there a difference in rate of soil degradation between these spaces?
- Hypothesis
  - Maintained green spaces experience lower rates of soil degradation and therefore by creating more maintained spaces, we can help mitigate UHI in Maspeth IBZ.

Where did I Sample?

- 10 sites around Maspeth IBZ.
  - Providing diverse range of soil in Maspeth IBZ.
  - Maintained sites and Unmaintained sites.



Difference In Soil Plots

Unmaintained

Maintained

Maintained Soil Plots

- Developed green spaces with green infrastructure
- Native flowers and plants.
- Green canopies and shade.
- Some maintenance, trash clean up, planting etc.

Unmaintained Soil plots.

- Overgrown with invasive weeds/plants
- Little to no Green canopies or shading
- No maintenance, often littered with trash.

Data collection Process

- Sampled each of the 10 plots twice digging different soil holes each time.
  - Dug around 6-10” deep
  - Bagged an labeled with date and location.
  - Took note weather conditions.
- Data collection day one 7/19/23
  - Humid and partly cloudy
  - Previous rain during night and briefly midday.
  - Soil collected was partially damp but mostly dry.
- Data Collected 7/20/23
  - Dry hot and Sunny.
  - Soil collected was dry.

Testing Process.

What was I testing for?

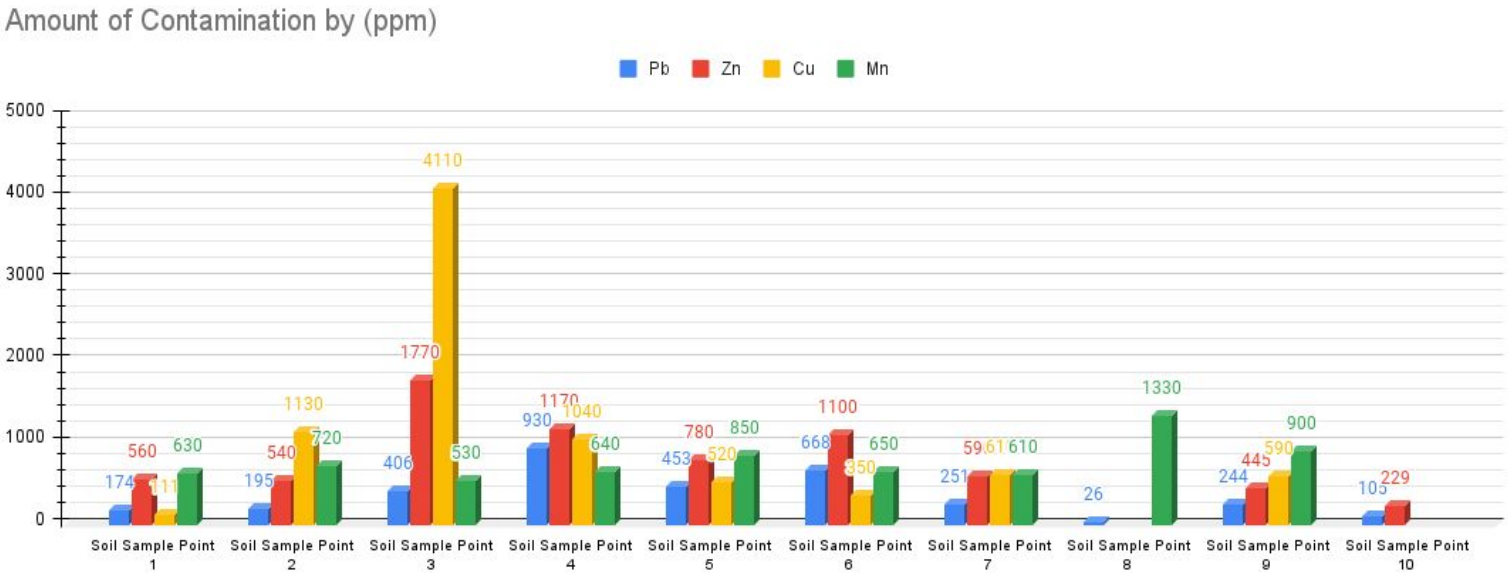
- Heavy Metal contamination→ XRF (X-Ray Fluorescence) Testing Gun
- General Soil Nutrients Nitrate, Phosphorous, and Potassium → NPK Soil Kit.
- Soil Acidity → Soil pH test

Heavy Metal XRF testing.

- Goals of this test!
  - Identify what specific metals are present in soil.
  - Is there a difference in contamination between maintained and unmaintained plots?

- What are we looking for?
  - Pb (Lead)>400 ppm Zn (Zinc)>100 ppm Cu (Copper) 50-150 ppm Mn (Magneses)>400ppm As (Arsenic)>16 ppm

What we found in Data sample 7/19/23



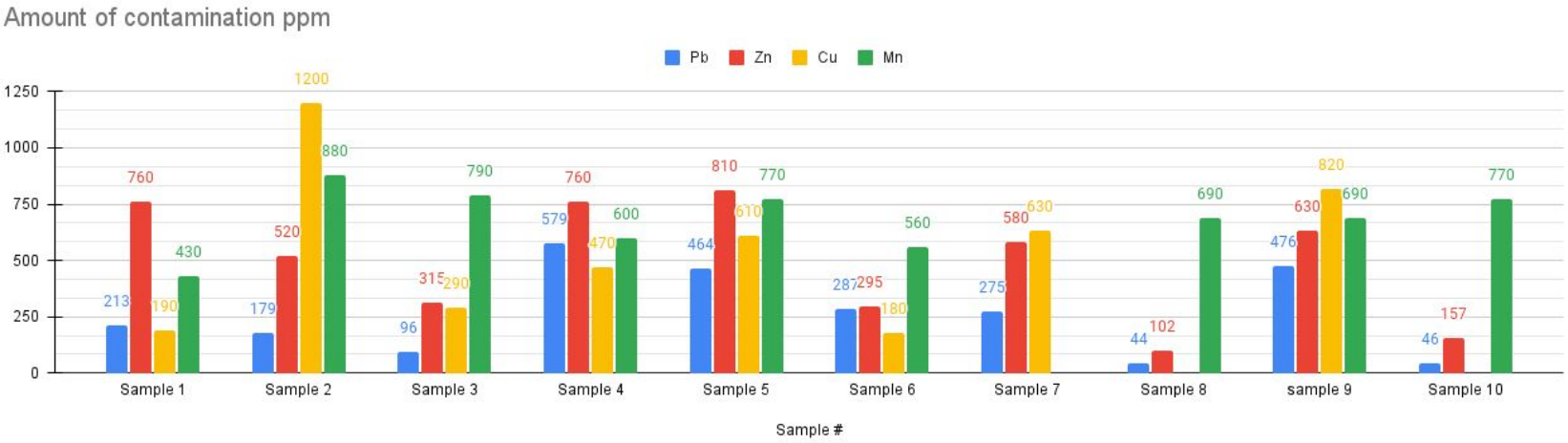
Pb >400 in sample 3,4,5,6

Zn>100 in all. Extreme in 3,4,6

Cu>50-150 in samples 2,3,4,5,6,7,9 Extreme in 3.

Mn>400 in samples 1,2,3,4,5,6,7,8,9

Data from 7/20/23



Pb>400 In samples 4,5,9

Zn>100 In all

Cu>50-150 in samples 1,2,3,5,6,7,9

Mn>400 1,2,3,4,5,6,8,9,10

Historical Context for contamination.

Phelps Dodge Copper refinery 1920-1983.

Huge copper refinery plant that through nearly 60 years of dumping is responsible for heavy contamination of the area of Maspeth Queens.

Sites then and now.

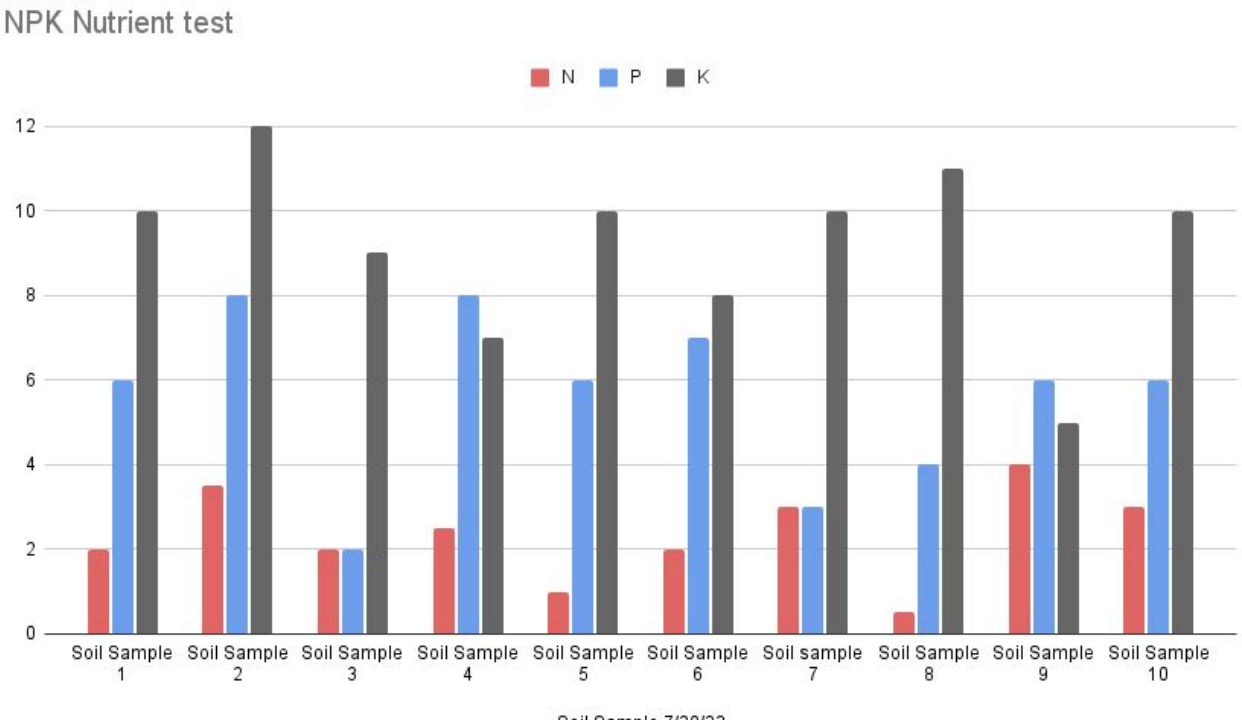
Nutrient NPK testing

- (N)Nitrate (P)Phosphorous (K) Potassium testing.
  - Determine nutrient levels in soil.
  - Do we see an increase in soil nutrient quality in maintained and developed green spaces?
- What are we looking for
  - Nitrogen levels are essentials for developing plant structures.
  - Phosphorus is important for cell division and plant growth
  - Potassium help build roots and drought resistance.
  - Too much of any nutrients can inhibit the intake of other nutrients.
  - Excessive Potassium (K) can lead to clogged pore space inhibiting water distribution.

NPK results.

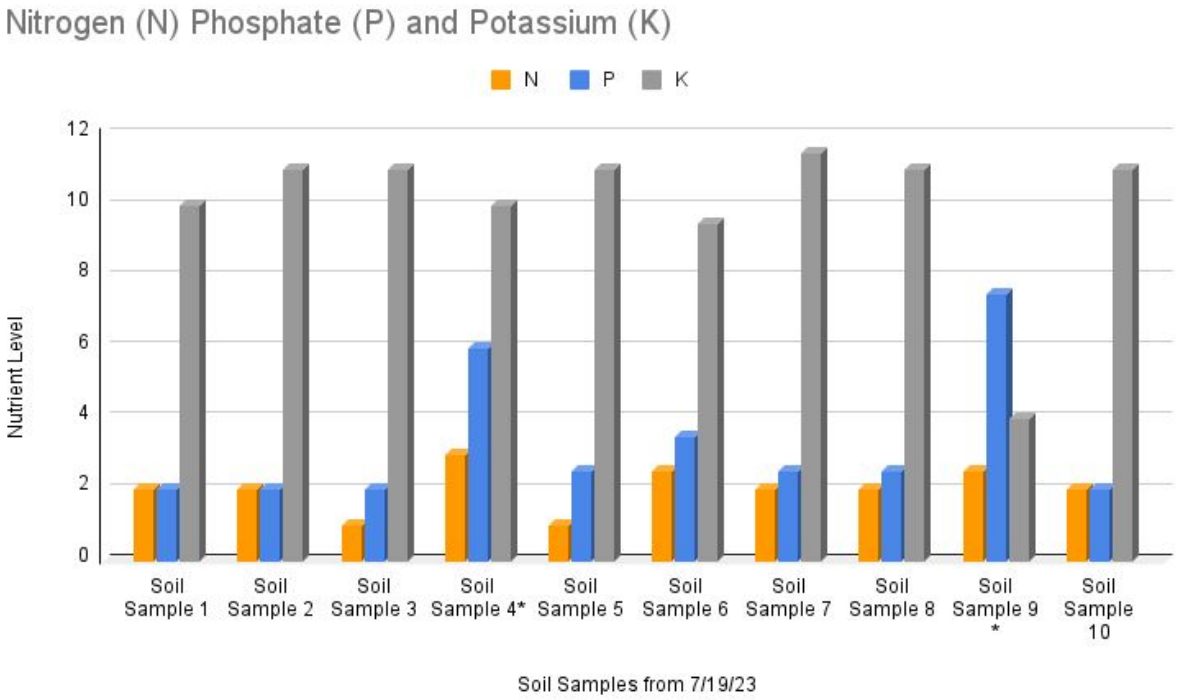
On a scale of 0-12 with 3 being Low, 6 being medium and high being 9 anything under or above those values is depleted or excessive.

- Most samples had depleted to low levels of Nitrogen. With the highest in soil sample 9 at just above “low”
- Phosphorus registered mostly above medium with samples 2 and 4 registering 8
- Potassium found excessive peeking high as 12 in sample 2 and was lower for the rest of samples.



NPK testing continued.

Higher Nitrogen and Phosphorus and Potassium nutrients found in soil plots 4 and 5 with the rest of samples showing depletion and/or excessive nutrients.



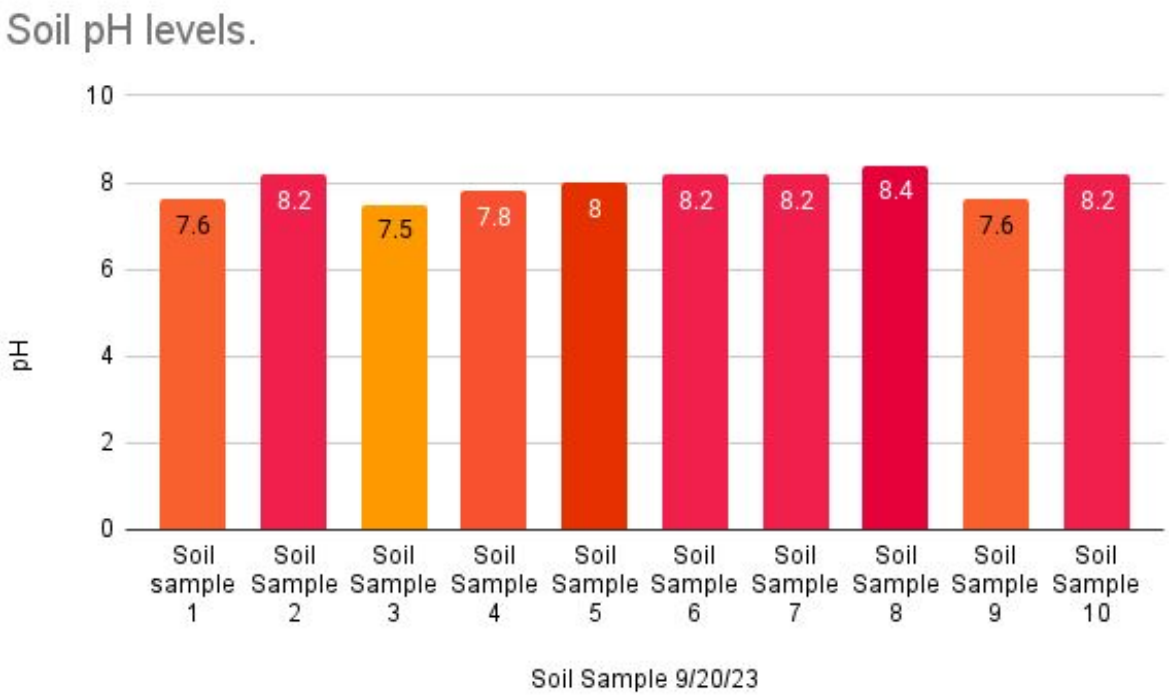
pH testing.

- Soil pH testing
  - Identifying where we see elevated pH levels
  - Compare pH levels of maintained points with unmaintained.
- What does low/ high soil pH indicate?
  - Low Soil pH under 6.5 pH indicates high acidity in soil.
  - Optimal pH ranges from 6.5pH to 7.5 pH.
  - High and excessive soil pH above 7.6pH indicated strongly alkaline soil. Which is notable in soils that receive little rainfall or have poor water distribution making it hard to intake essential soil nutrients.

Soil pH Results

Neutral to mild alkaline levels in soil sample 1,3,9.

High pH and alkaline level in soil sample 2, 5, 6, 7, 8, 10



Conclusion

- Soil Nutrients quality is overall poor and toxic in IBZ because of UHI.
- However when Looking at soil nutrients and pH tests we observed better results in our maintained soil plots (4 and 9).
- When it comes to heavy metal contamination it is hard to pinpoint the source for contamination and we must take into account historical use of the industry.
- We can use this data to get a general understanding of soil degradation in the IBZ and promote green infrastructure projects.
- This data may suggest that by developing green spaces they will perform better and become more prosperous in an IBZ and can help to mitigate UHI.

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