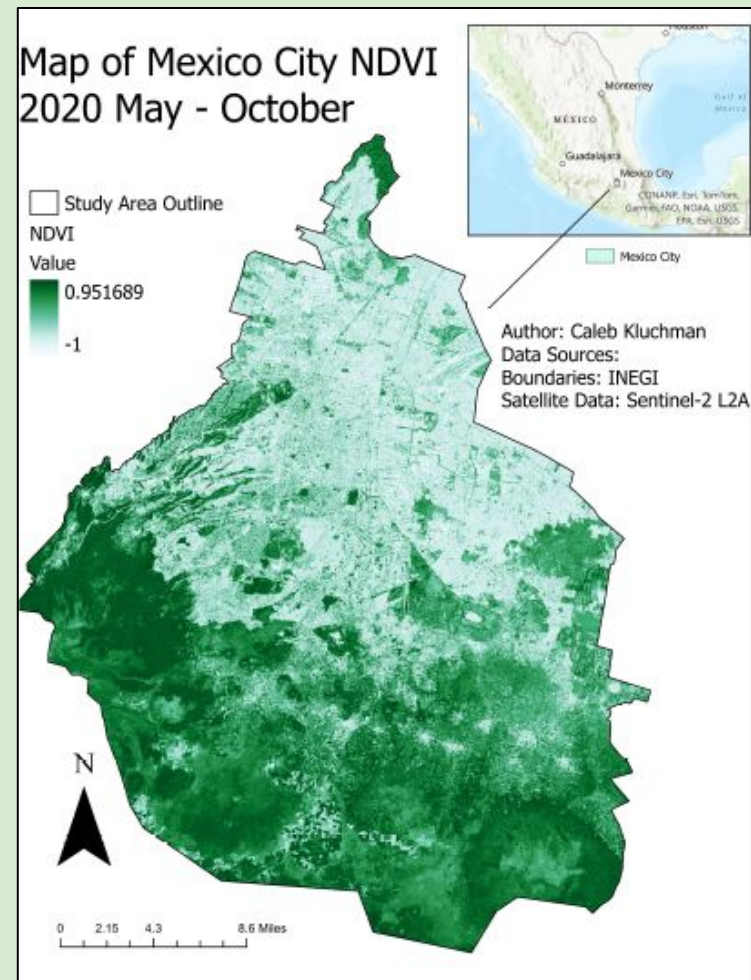# Mapping Proximity to Green Spaces in Mexico City

A Final Project by Caleb Kluchman

Background

Population: 9,209,944 (as of 2020)

Air pollution causes about one in seventeen (5.9%) of all deaths in the country, elevated in the city
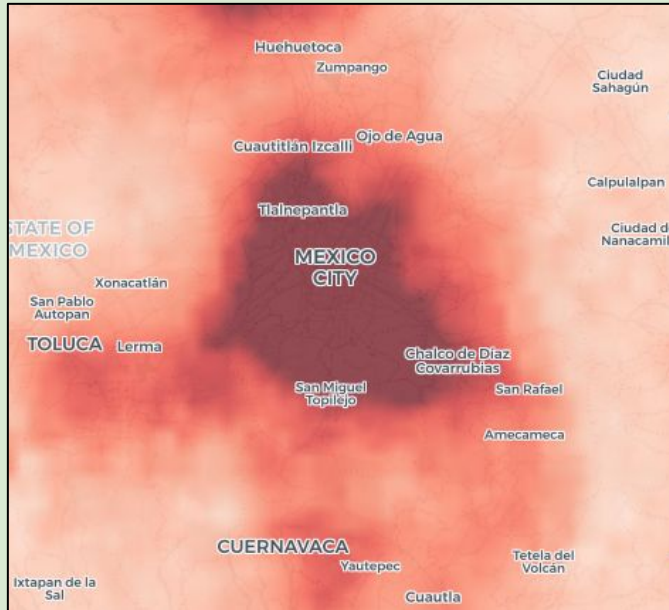
Causes:
- Rapid Industrial Growth
- Poor Controls on Vehicle carbon outputs
- High altitude → Low Oxygen

(Initial) Research Objective

Objective: examine environmental injustice through air quality in Mexico City with remote sensing
- Problem: (freely accessible) remote sensing air quality not suitable for this task

(New) Research Objective

Objective: Find proportion of population living in benefits presence of green spaces

Why green spaces?

- **Carbon sequestration from vegetation has both local and city-wide benefits on air quality**

- **Green space research has broad applications, and is therefore useful and reusable**

Overall Methodology

| Create Vegetation Raster | — | Find Vegetated Areas > 1 Acre | — | Find Air Quality increasing effects of Vegetated Areas | — | Find Effect on Population |

Data

Name	Source	Resolution	Date
Mexican Population	Humanitarian Data Exchange	100x100ft	2018 October
Mexican Population Under 5	Humanitarian Data Exchange	100x100ft	2019 June
Mexican Population Over 60	Humanitarian Data Exchange	100x100ft	2019 June
NDVI	Sentinel 2 L2A	85x80 ft	May-October 2020

Methods - Green Space Creation

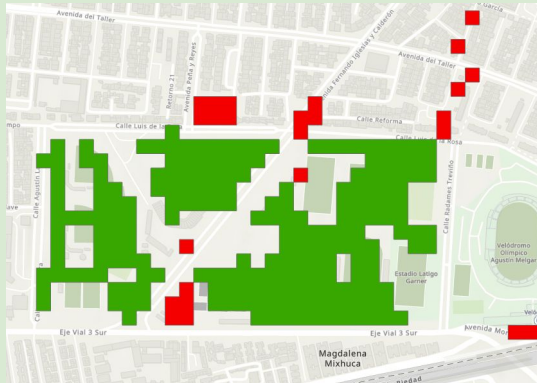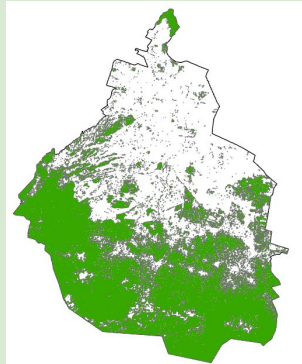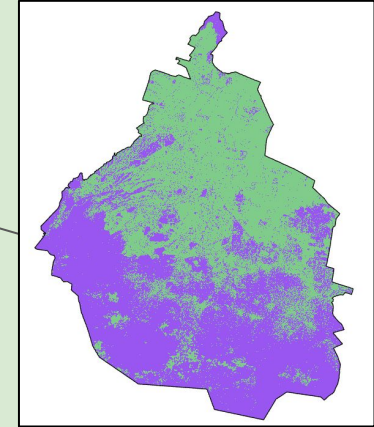Satellite data from Copernicus (roughly 80x85 ft) May - October

Calculate NDVI with Raster Calculator

Clip to study area and reclassify to threshold

(NIR - Red)/(NIR + Red)

Threshold set to .5 NDVI

Remove Green Spaces Under 1 Acre

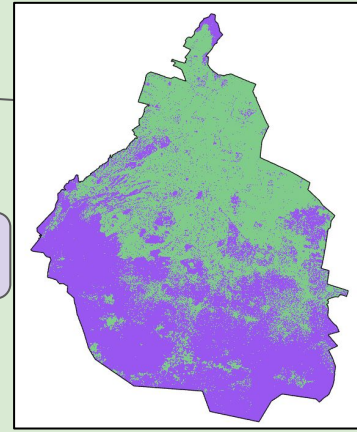Convert to Polygon, create Area field, Calculate Geometry

Satellite data from Copernicus (roughly 80x85 ft) May - October

Calculate NDVI with Raster Calculator

Clip to study area and reclassify to threshold

Threshold set to .5 NDVI

Convert to Polygon, create Area field, Calculate Geometry

Create a new field based on area of park

Merge and clip buffers

Create a buffer based on area of park (65m, 100m, 300m)

Remove Green Spaces Under 1 Acre

Select by location for each population type, divide within buffer by total

Perform Chi-Squared Tests

Clip to study area, Turn to integer, convert to polygon

Clip to study area, Turn to integer, convert to polygon

Population data from Humanitarian Data Exchange
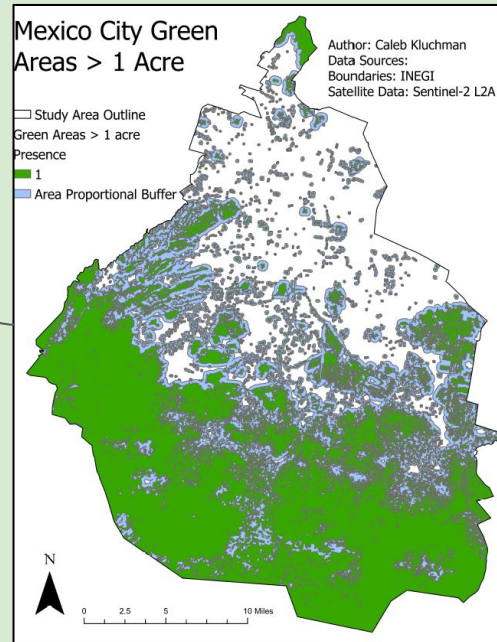
Methods - Combing Demographic and Park Data

Population data from Humanitarian Data Exchange

Clip to study area, Turn to integer, convert to polygon

Clip to study area, Turn to integer, convert to polygon

Create a new field based on area of park

Create a buffer based on area of park (65m, 100m, 300m)

Merge and clip buffers

Select by location for each population type, divide within buffer by total

Mexico City Green Areas > 1 Acre

Author: Caleb Kluchman
Data Sources:
Boundaries: INEGI
Satellite Data: Sentinel-2 L2A

☐ Study Area Outline
Green Areas > 1 acre
Presence
■ 1
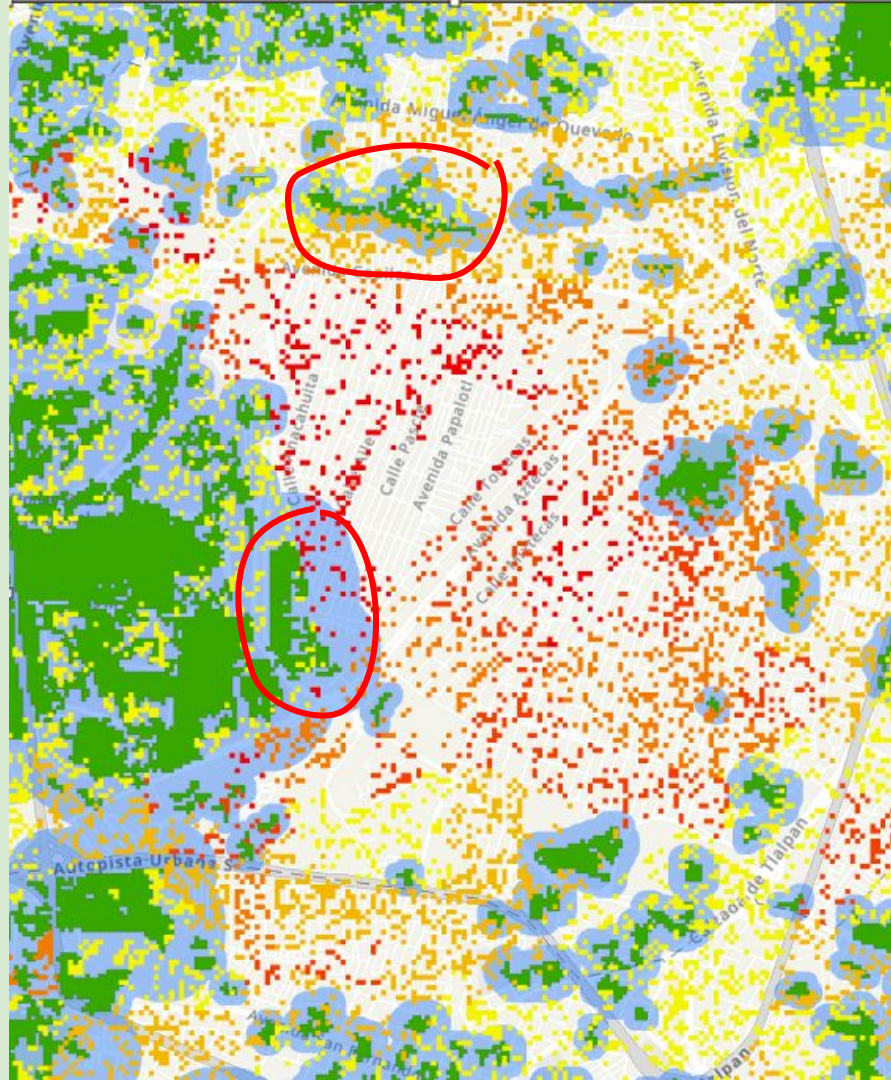■ Area Proportional Buffer

N

0   2.5   5   10 Miles
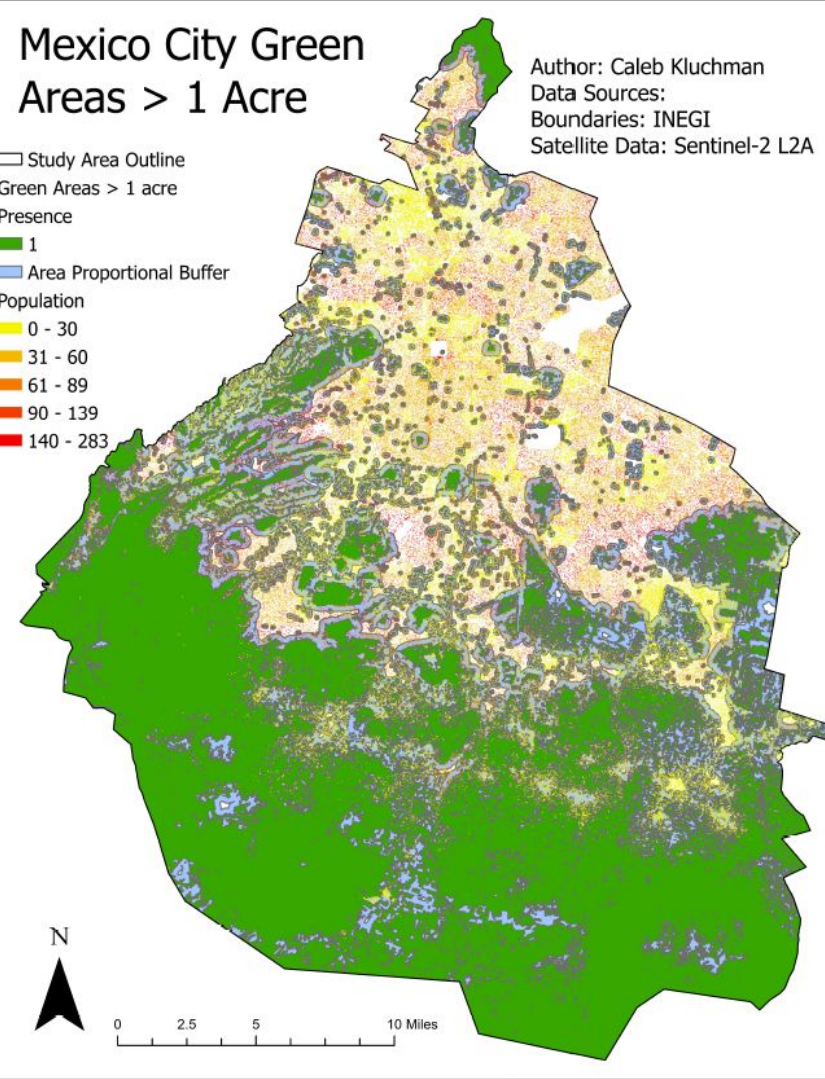
Results (Susceptible)

260,223/748,541 = ~35% of elderly and young children live within the positive effects of vegetated areas

Results (Total Pop)

1,656,297/4,444,581= ~37% of the total population live within the positive effects of vegetated areas

Conclusions and Future Work

Conclusions:
- This population dataset shows no strong pattern between where susceptible populations and the general population live
- A majority people live away from vegetated areas, and therefore most people do not receive the positive cooling and air quality benefits of urban greenery.

Future Work:
- More susceptibility mapping
- Green space by neighborhood, and income
- Including hospitalization or respiratory mortality data
- Question for you all: What types of facilities would be useful to map in analysis like this? Hospitals?
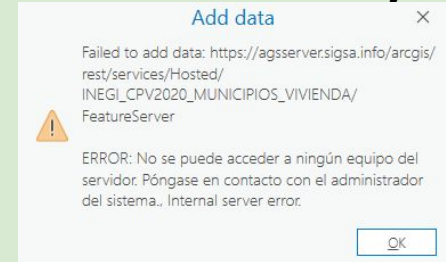
Limitations

Data:

- All INEGI data in the Living Atlas stopped working recently, which limited my demographic analysis
- Other demographic data was in spanish, which took time to translate

Methods:

- Not enough time to test which NDVI values were best for Parks.
- Processing time stopped me from having individualized buffer distances for each park
- Literature is unclear about localized air quality effect based on park size
- The larger the buffer created, the longer it takes, not necessarily how many different buffers are made, particularly geodesic buffers
- Population Data underestimated population significantly

Add data ✕

Failed to add data: https://agsserver.sigsa.info/arcgis/rest/services/Hosted/INEGI_CPV2020_MUNICIPIOS_VIVIENDA/FeatureServer

⚠ ERROR: No se puede acceder a ningún equipo del servidor. Póngase en contacto con el administrador del sistema., Internal server error.

OK

References

Nowak, David, and Gordon Heisler. "Air quality effects of urban trees and parks." Research Series Monograph. Ashburn, VA: National Recreation and Parks Association Research Series Monograph. 44 p. (2010): 1-44.

Lome-Hurtado, A., Touza-Montero, J., & White, P. C. (2019). Environmental injustice in Mexico City: A spatial quantile approach. Exposure and Health, 12(2), 265–279. https://doi.org/10.1007/s12403-019-00310-2

Moreno-Jiménez, A., Cañada-Torrecilla, R., Vidal-Domínguez, M. J., Palacios-García, A., & Martínez-Suárez, P. (2016a). Assessing environmental justice through potential exposure to air pollution: A socio-spatial analysis in Madrid and Barcelona, Spain. Geoforum, 69, 117–131. https://doi.org/10.1016/j.geoforum.2015.12.008

Moreno-Jiménez, A., Cañada-Torrecilla, R., Vidal-Domínguez, M. J., Palacios-García, A., & Martínez-Suárez, P. (2016b). Assessing environmental justice through potential exposure to air pollution: A socio-spatial analysis in Madrid and Barcelona, Spain. Geoforum, 69, 117–131. https://doi.org/10.1016/j.geoforum.2015.12.008

Ressl, R., Luz Martínez, C., Piña Camacho, M. E., Hruby, F., Dávila Rosas, J. M., Rodríguez Huesca, M. E., & Jimenez-Rosenberg, R. (2020). Mapping Mexican covid-19 vulnerability at Municipal Scale. Terra Digitalis. https://doi.org/10.22201/igg.25940694e.2020.2.79

Rogers, M. Z., Zeng, Y., Marx, A., Poynor, M., & Lu, M. (2021). Inequality in risk-taking: Evidence from location tracking in Mexican cities during COVID 19. Frontiers in Political Science, 3. https://doi.org/10.3389/fpos.2021.631826

Mamkhezri, J., Bohara, A. K., & Camargo, A. I. (2019). Air pollution and daily mortality in the Mexico City Metropolitan Area. Atmósfera. https://doi.org/10.20937/atm.52557

Mexico: High resolution Population density Maps + Demographic Estimates - Humanitarian Data Exchange. (n.d.). https://data.humdata.org/dataset/mexico-high-resolution-population-density-maps-demographic-estimates?

Thank you!