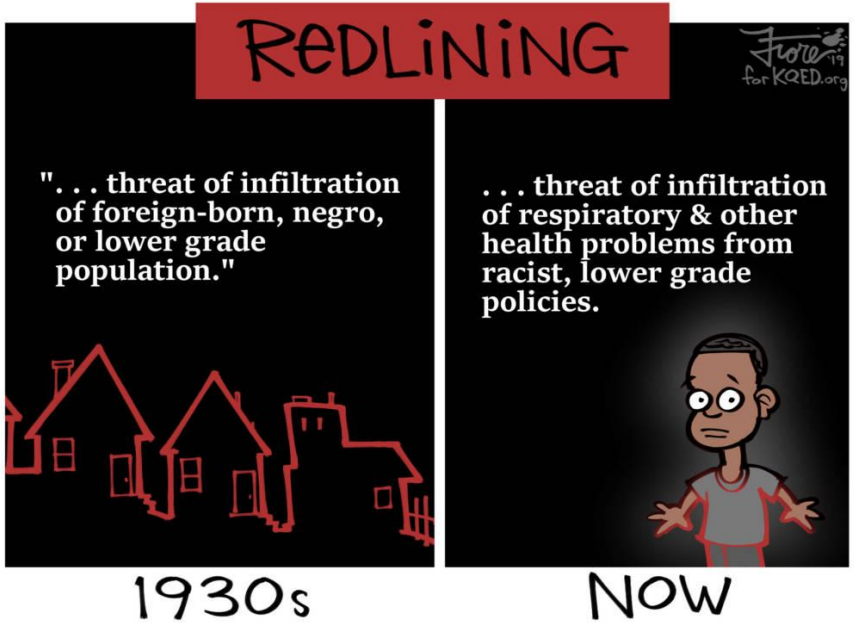
Plant a Tree, Save A Life?

The Effects of Historical Redlining on Urban Tree Canopy Coverage & Community Health in Los Angeles County

DS4A Team 101
Anakaren Cervantes, Dana Kraus, Erika Wingfield, Oritseweyinmi "Henry" Ajagbawa, Yiu Ho Au

Background

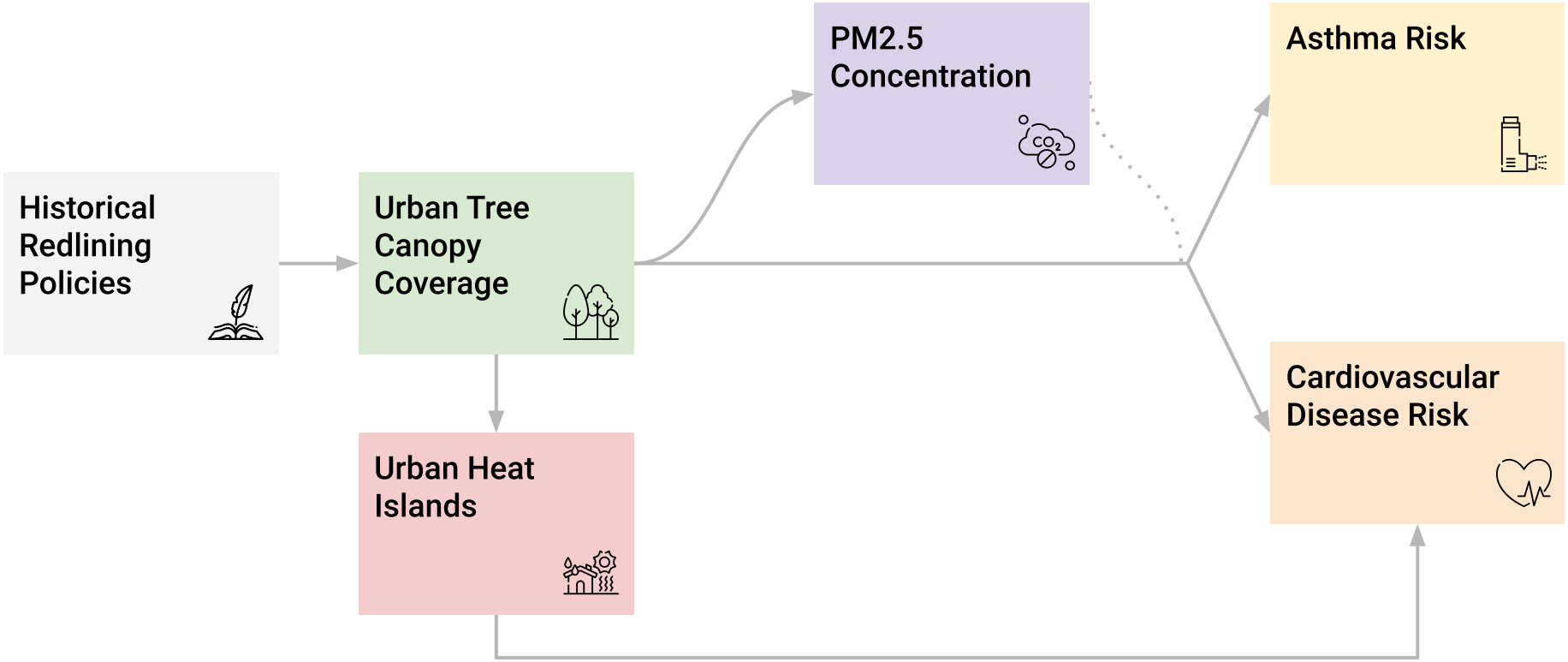
What Was Redlining?



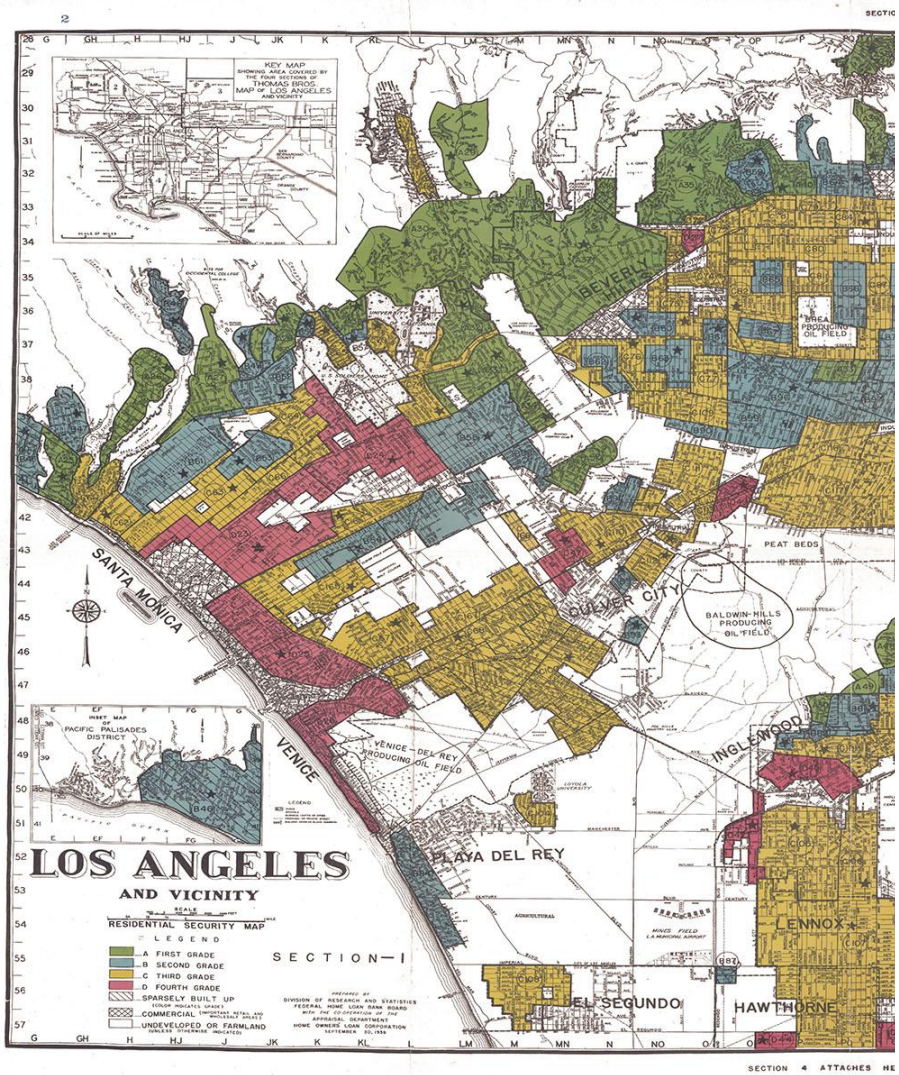
- Home Owners' Loan Corporation (HOLC)
- 1930s-40s: developed neighborhood appraisal maps for over 200 urban areas across the United States
- Assigned letter grades to neighborhoods (A to D) according to perceived risk for mortgage lenders
- Grading based largely on race + other demographic factors
- Areas graded A were considered "desirable"
- Areas graded D were considered "hazardous," shaded red on maps, and ineligible for federally-backed mortgages
- **Essentially a tool for segregation and preventing Black Americans and immigrants from accessing homeownership**

Source: https://www.npr.org/sections/thetwo-way/2016/10/19/498536077/interactive-redlining-map-zooms-in-on-americas-history-of-discrimination

Operational Conceptual Model




Data



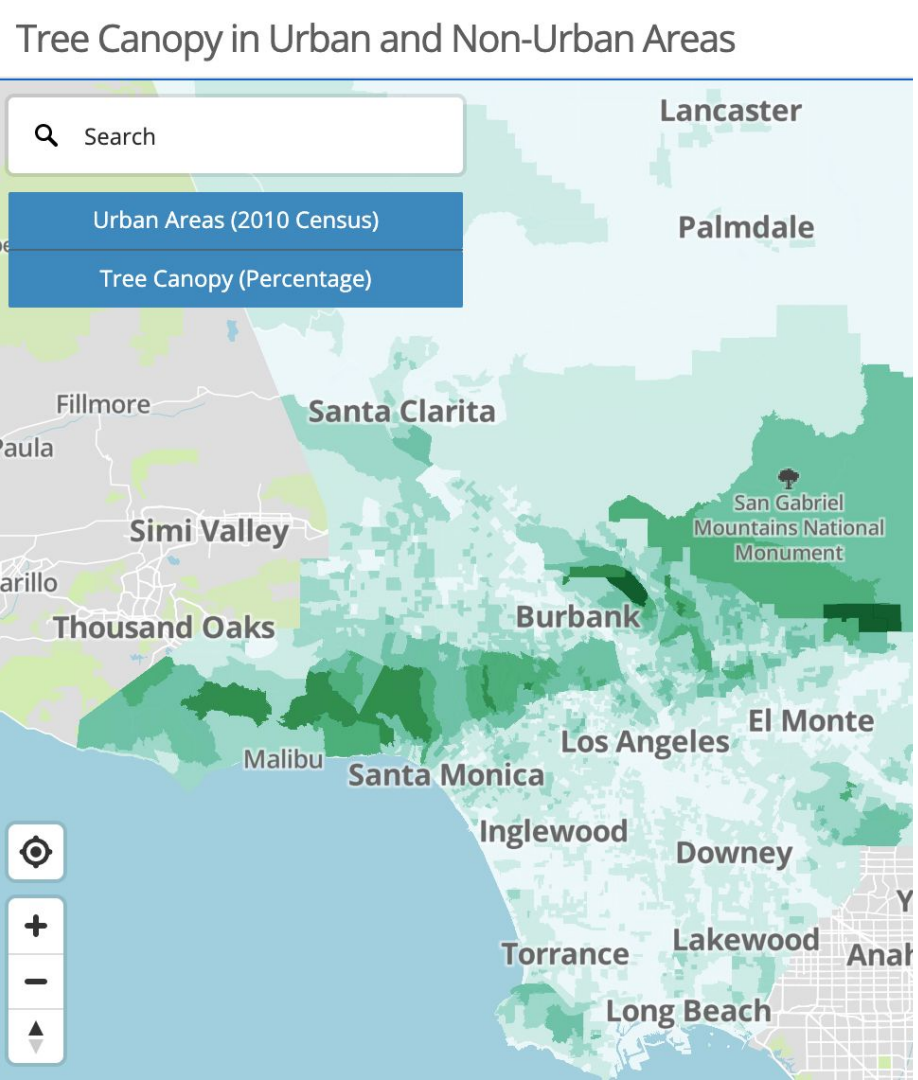
Mapping Inequality: Redlining in New Deal America

Mapping Inequality brings one of the country's most important archives to the public. Agents of the federal government's Home Owners' Loan Corporation created thousands of area descriptions between 1935 and 1940; HOLC documents contain a wealth of information about how government officials, lenders, and real estate interests surveyed and ensured the economic health of American cities.

Format: GeoJSON

Variables: HOLC grading over a multi-polygonal area

Source: https://dsl.richmond.edu/panorama/redlining/



Tree Canopy in Urban and Non-Urban LA County (2014)

This is a combination of two datasets:
(1) LA County tree canopy data from TreePeople/University of Vermont Spatial Analysis Lab
(2) LA County land cover data (2014 imagery) from the Los Angeles Regional Imagery Acquisition Consortium (LARIAC)

This dataset contains urban and rural tree canopy areas and percentages by census block group in Los Angeles County. Urban areas are defined as those census block groups whose centroids are within the Census' "Urban Areas" shapefile.

Format: Shapefile

Variables: present-day tree canopy coverage percentage by census block group

Source: https://data.lacounty.gov/Sustainability/Tree-Canopy-in-Urban-and-Non-Urban-LA-County-2014-/kf6c-hxgf

Residential housing segregation and urban tree canopy in 37 US Cities.

Dexter H. Locke*[1], Billy Hall[2], J. Morgan Grove[1], Steward T.A. Pickett[3], Laura A. Ogden[4], Carissa Aoki[5], Christopher G. Boone[6], Jarlath PM O'Neil-Dunne[7]

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Locke et al: Residential housing segregation and urban tree canopy in 37 US Cities

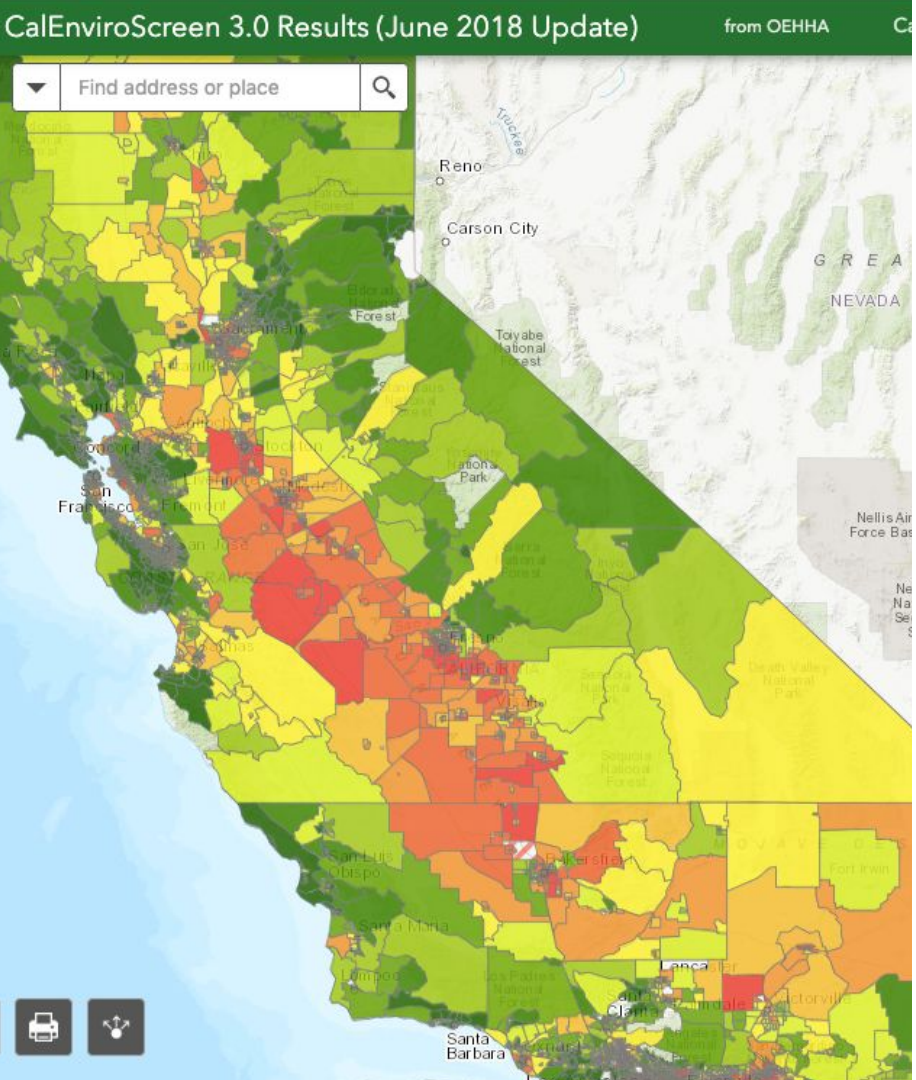
City-specific file geodatabases which features classes of the HOLC polygons obtained from the Mapping Inequality Project and tables summarizing tree canopy for each HOLC polygon (neighborhood)

The University of Vermont Spatial Analysis Lab and LARIAC were also the source of the tree canopy and land cover data for Los Angeles in this paper.

Format: Geodatabase

Variables: present-day tree canopy coverage percentage by HOLC-graded neighborhood

Source: https://portal.edirepository.org/nis/metadataviewer?packageid=knb-lter-bes.5008.1



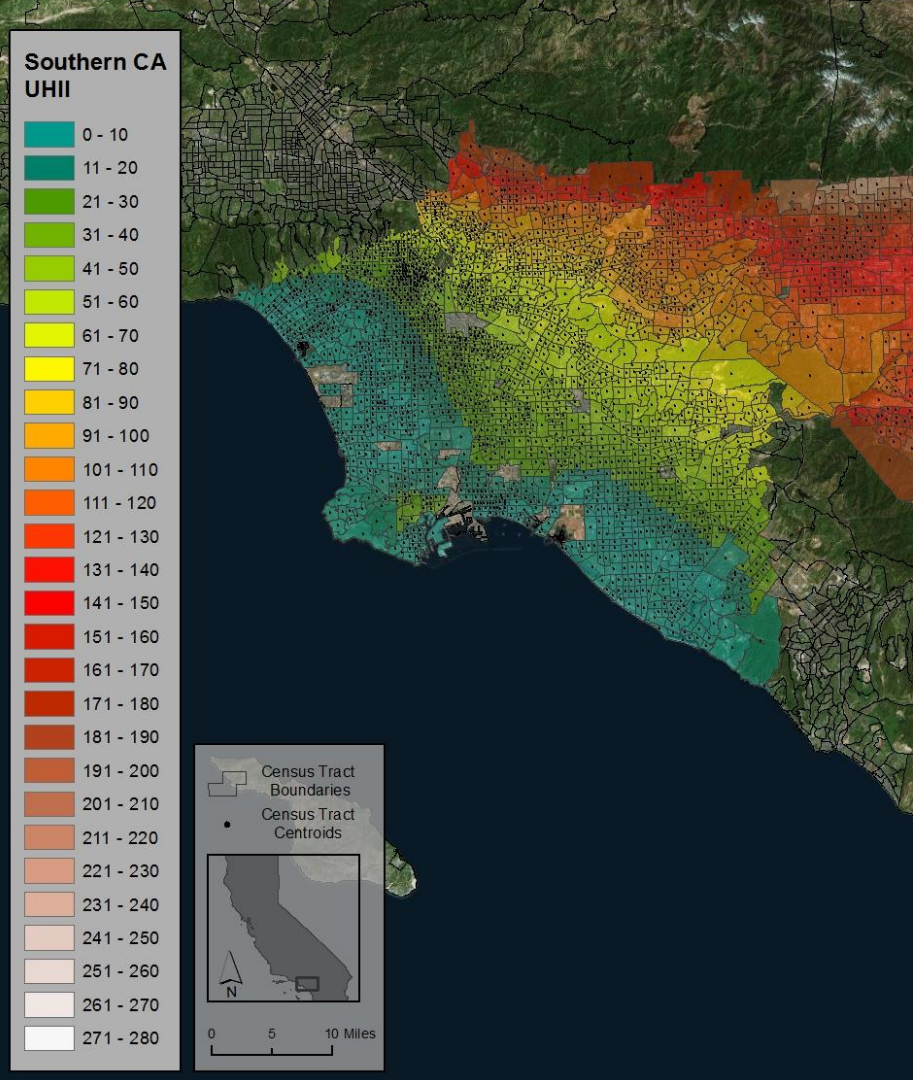
CalEnviroScreen 3.0 from OEHHA

CalEnviroScreen identifies California communities by census tract that are disproportionately burdened by, and vulnerable to, multiple sources of pollution. Data is available as Excel spreadsheet, Google Earth file, ArcGIS geodatabase, and shapefile.

Format: Shapefile

Variables: CI score, pollution, ozone, PM2.5 levels, asthma risk, and cardiovascular risk over a multi-polygonal area (census tract)

Source: https://oehha.ca.gov/calenviroscreen/report/calenviroscreen-30



CalEPA Urban Heat Island Index for California

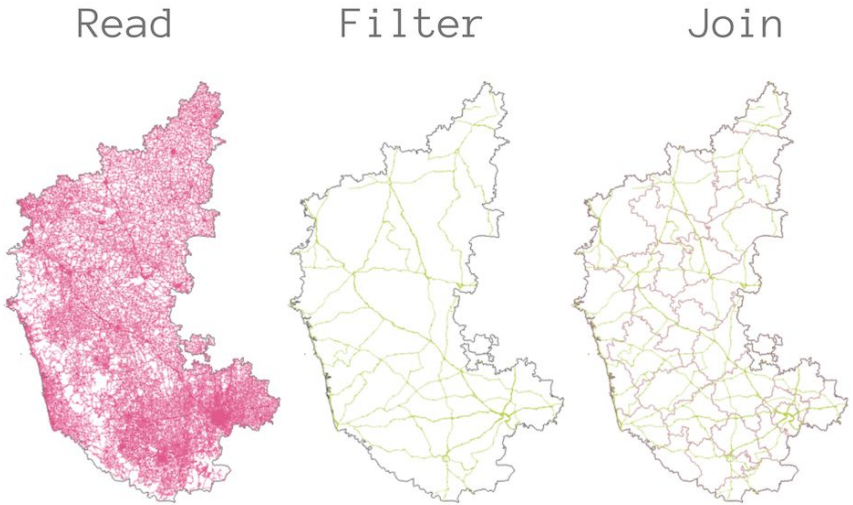
In 2015, CalEPA released a study entitled, “Creating and Mapping an Urban Heat Island Index for California. ” It defines and examines the characteristics of the urban heat island and creates an Urban Heat Island Index (UHII) to quantify the extent and severity of urban heat islands for individual California cities. The index assigns a score for each census tract in and around most urban areas throughout the state.

Format: Excel file

Variables: UHII score by census tract

Source: https://calepa.ca.gov/climate/urban-heat-island-index-for-california/

Methods



Package
GeoPandas

The goal of GeoPandas is to make working with geospatial data in python easier. It combines the capabilities of pandas and shapely, providing geospatial operations in pandas and a high-level interface to multiple geometries to shapely. GeoPandas enables you to easily do operations in python that would otherwise require a spatial database such as PostGIS.

To combine the various datasets, we utilized GeoPandas to:

- harmonize different Coordinate Reference Systems (CRS)
- overlay different datasets to enable analysis according to our operational model

Source: https://geopandas.org/

CalEnviroScreen 3.0

∩

intersect

Residential Housing Segregation and Urban Tree Canopy in 37 US Cities (Locke et al., 2020)

=

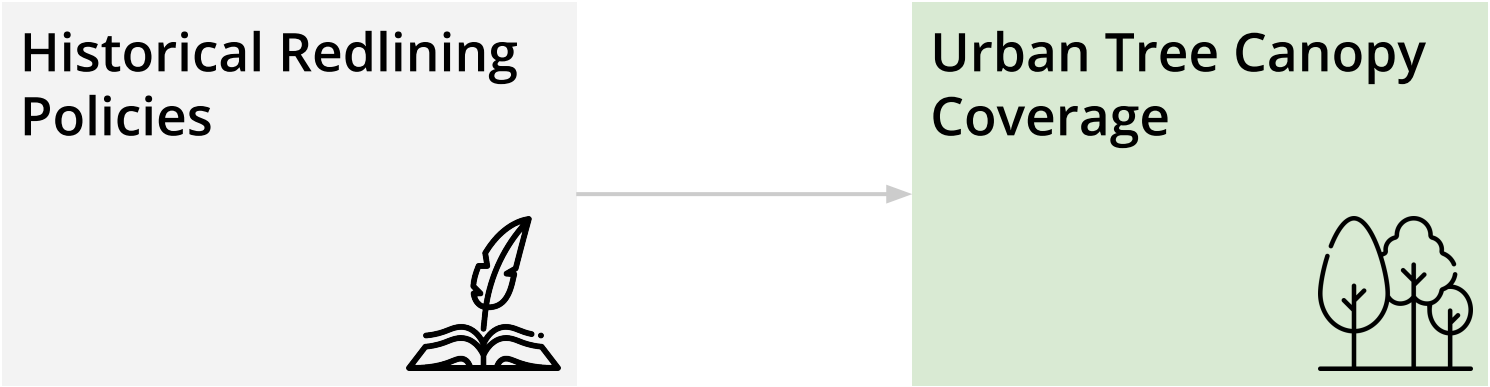
result

Resulting GeoPandas Dataframe

Results

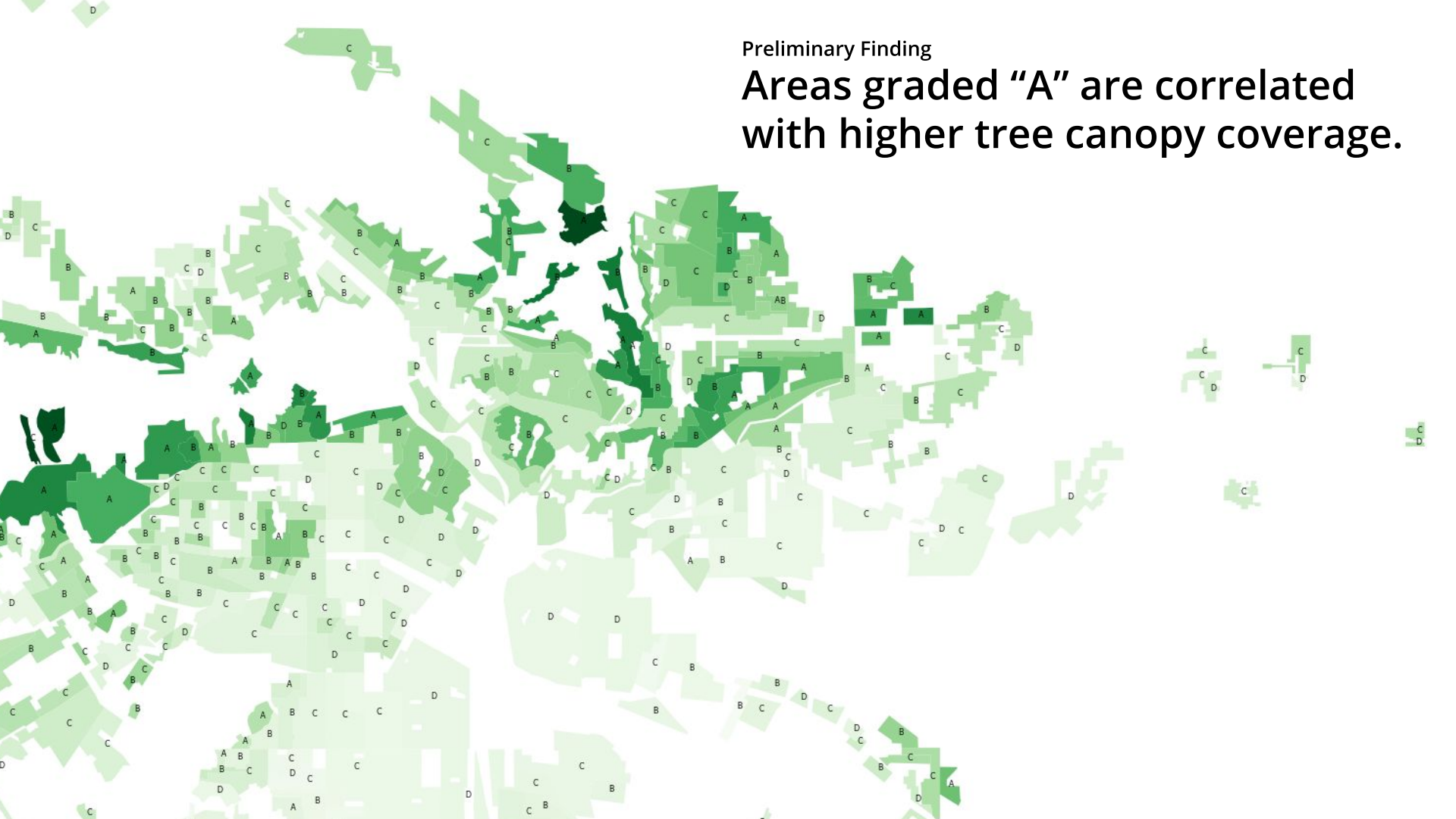
Part 1

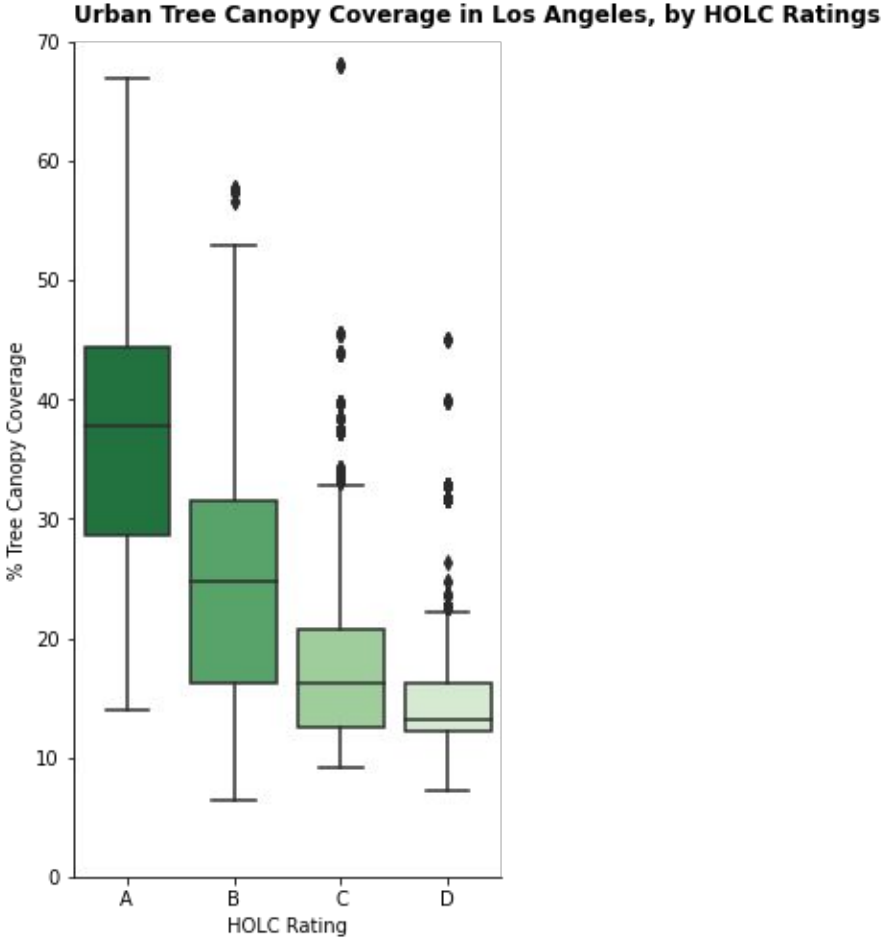
Exploring the relationship between historical redlining policies and urban tree canopy coverage



Preliminary Finding

Areas graded “A” are correlated with higher tree canopy coverage.





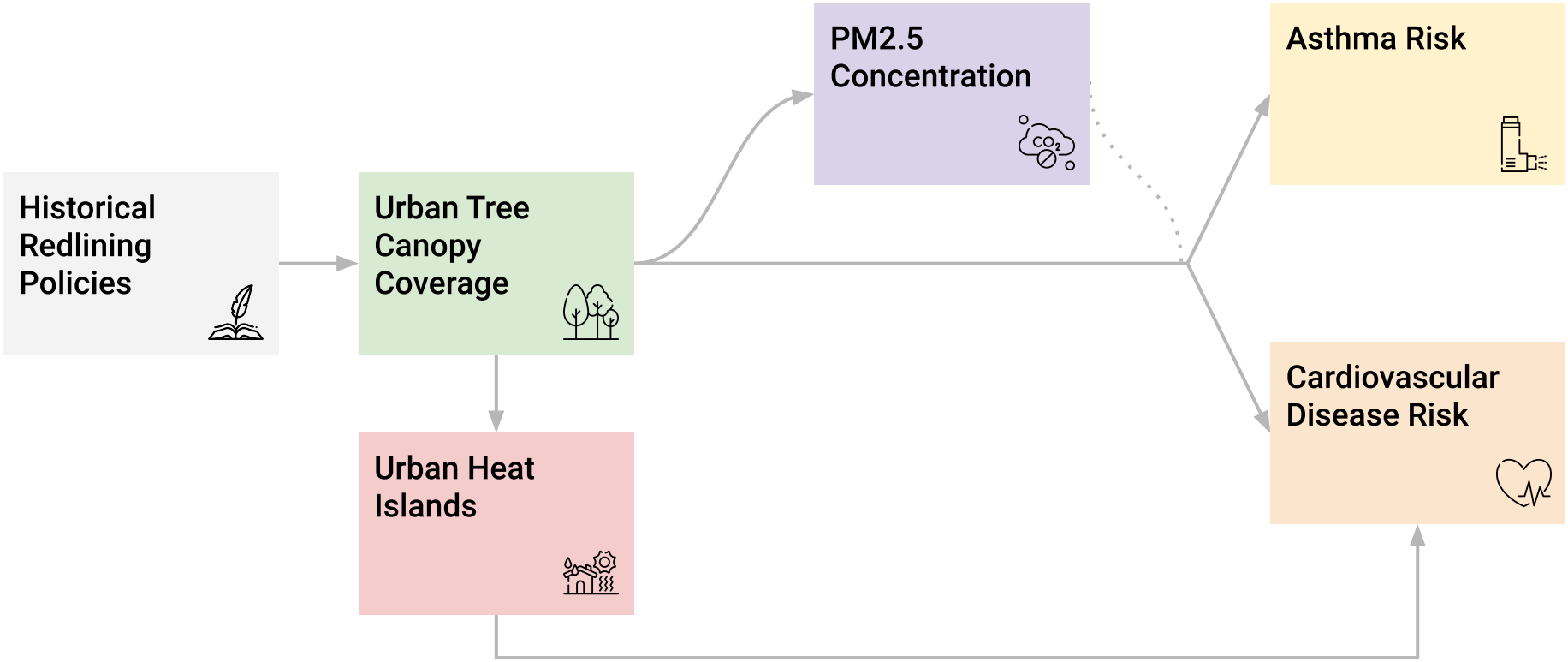
Simple Model

A D-graded neighborhood is expected to have 20% less urban tree canopy coverage, compared to an A-graded neighborhood.

Takeaway

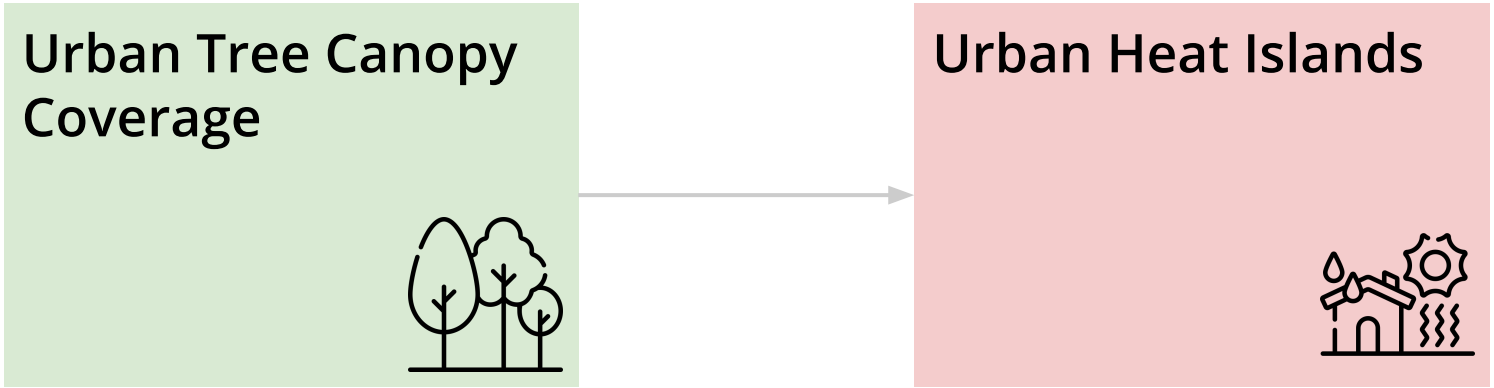
Results suggest that historical redlining policies affected contemporary tree canopy coverage.

Operational Conceptual Model



Part 2.0

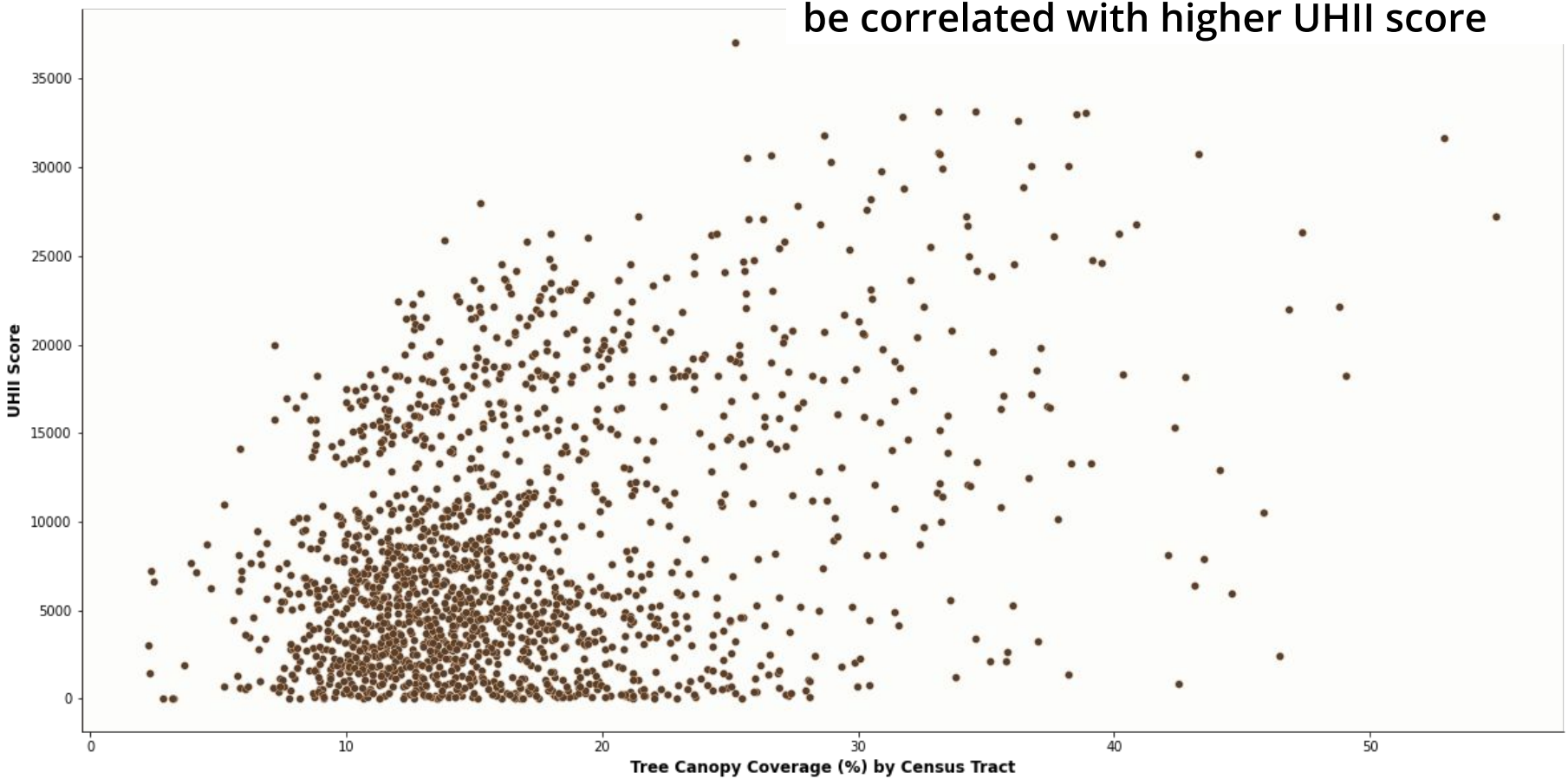
Exploring the relationship between urban tree canopy coverage and prevalence of urban heat islands



Large urbanized areas can experience higher temperatures, greater pollution and more negative health impacts during hot summer months when compared to more rural communities. This phenomenon is known as an urban heat island. Heat islands are created by a combination of heat-absorptive surfaces (such as dark pavement and roofing), heat-generating activities (such as engines and generators) and the absence of vegetation such as urban trees (which provides evaporative cooling).

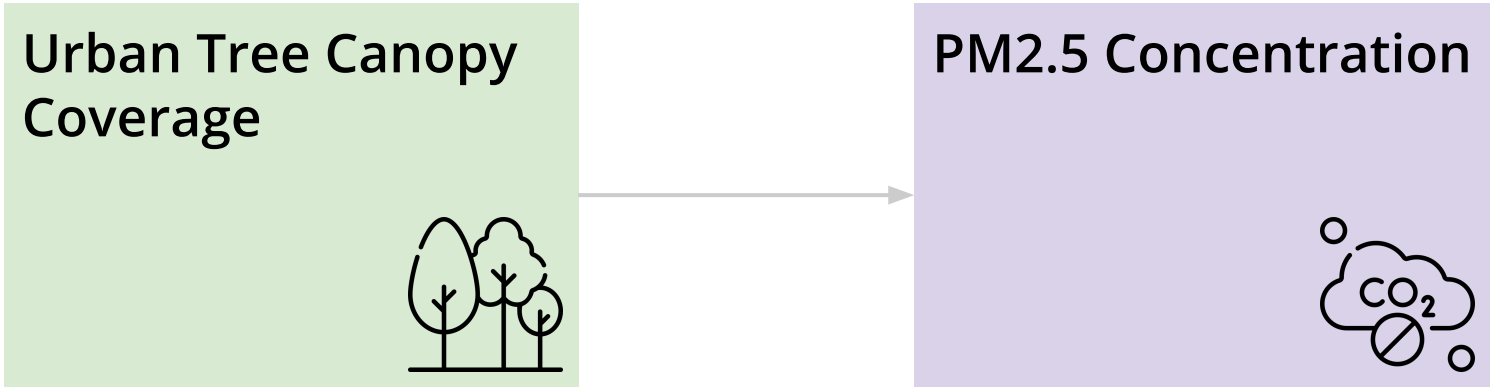
Preliminary Finding

Higher tree canopy coverage appears to be correlated with higher UHII score



Part 2.1

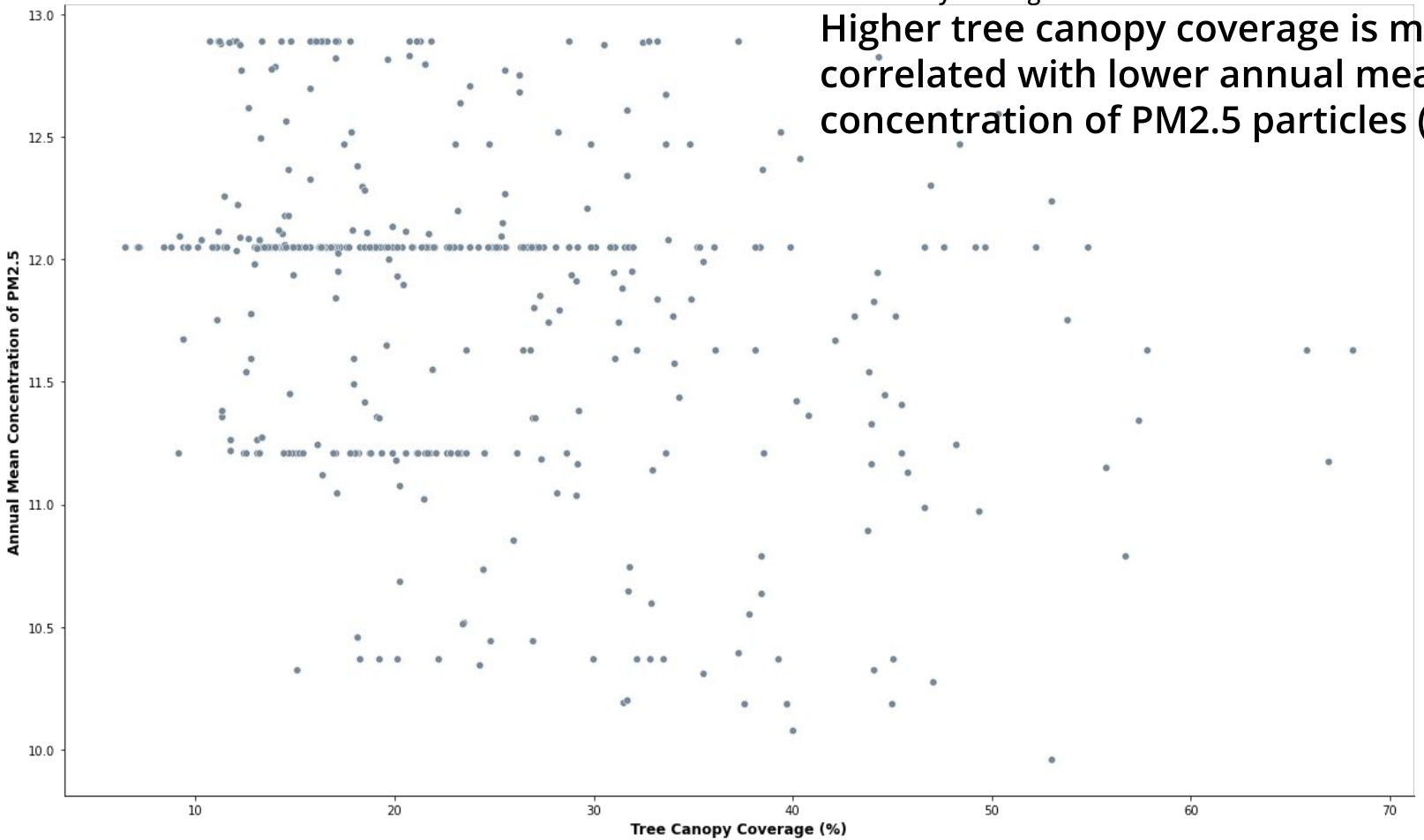
Exploring the relationship between urban tree canopy coverage and PM



Particulate matter pollution, and fine particle (PM2.5) pollution in particular, has been shown to cause numerous adverse health effects, including heart and lung disease. PM2.5 contributes to substantial mortality across California. The health impacts of PM2.5 and other criteria air pollutants (ozone, nitrogen dioxide, carbon monoxide, sulfur dioxide, and lead) have been considered in the development of health-based standards. Of the six criteria air pollutants, particle pollution and ozone pose the most widespread and significant health threats.

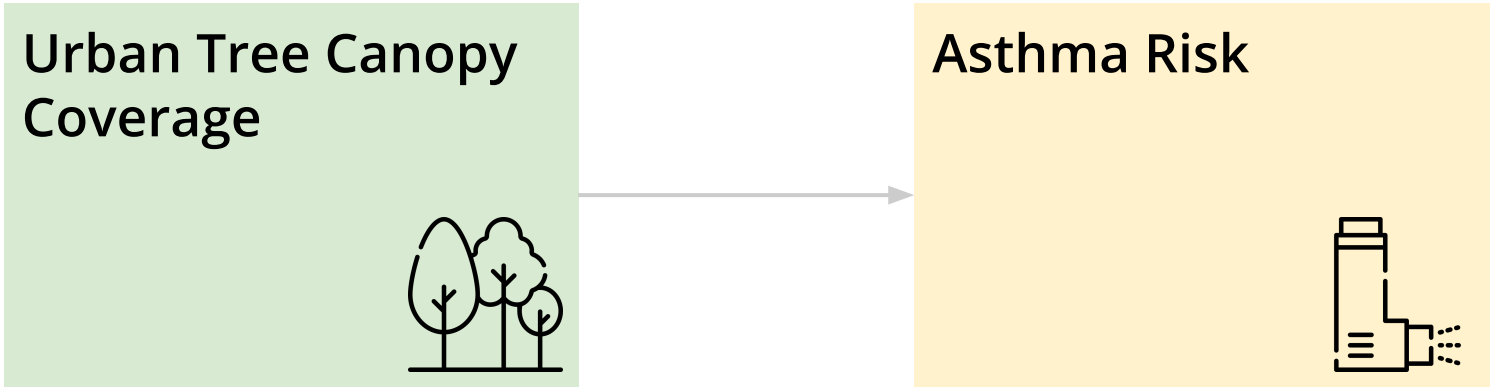
Preliminary Finding

Higher tree canopy coverage is mildly correlated with lower annual mean concentration of PM2.5 particles (μg/m³).



Part 2.2

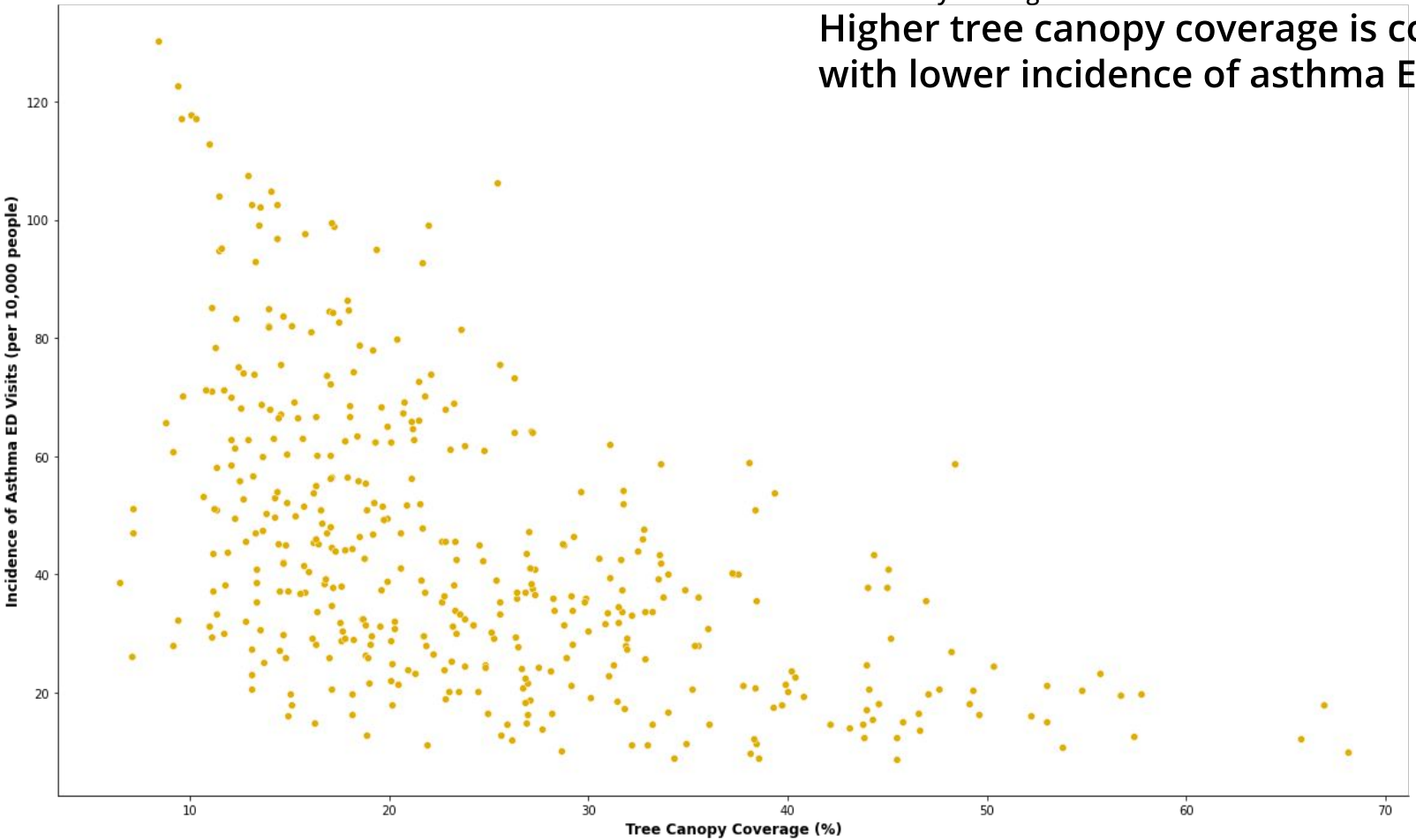
Exploring the relationship between urban tree canopy coverage and asthma risk



Asthma is a chronic lung disease characterized by episodic breathlessness, wheezing, coughing, and chest tightness. While the causes of asthma are poorly understood, it is well established that exposure to traffic and outdoor air pollutants, including particulate matter, ozone, and diesel exhaust, can trigger asthma attacks. Nearly three million Californians currently have asthma and about five million have had it at some point in their lives. Children, the elderly and low-income Californians suffer disproportionately from asthma (California Health Interview Survey, 2009).

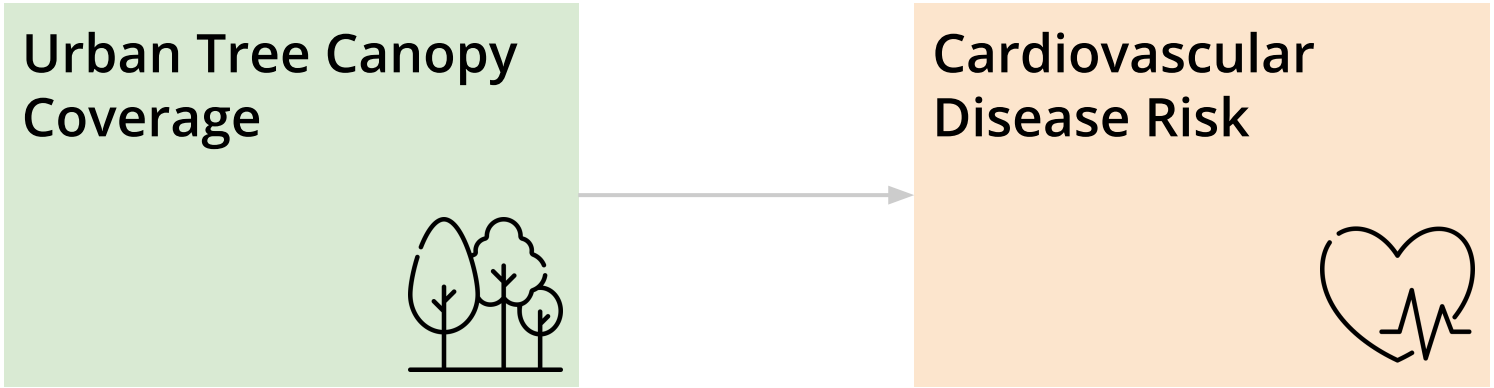
Preliminary Finding

Higher tree canopy coverage is correlated with lower incidence of asthma ED visits.



Part 2.3

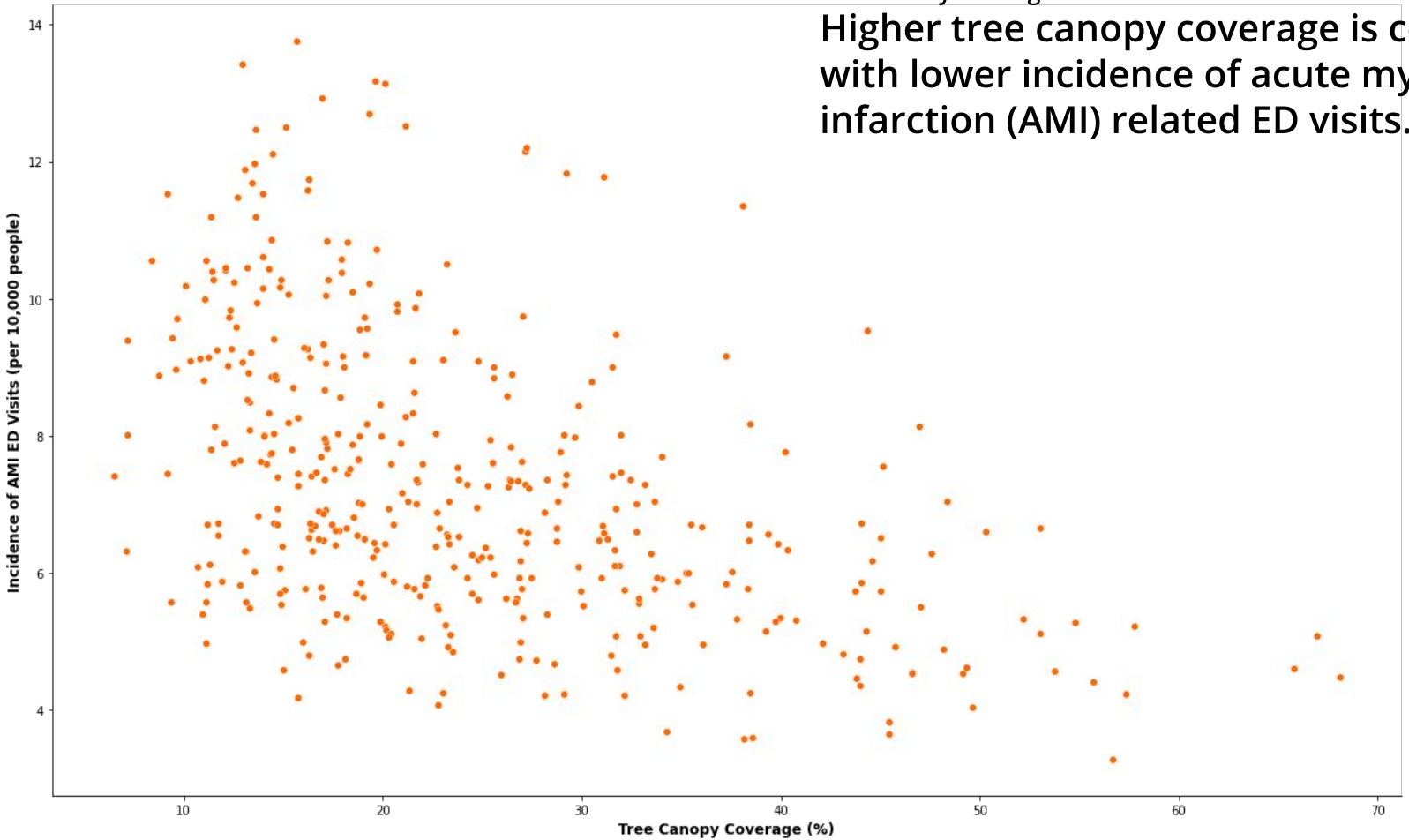
Exploring the relationship between urban tree canopy coverage and cardiovascular disease risk



Short term exposure to air pollution, and specifically particulate matter, has been shown to increase the risk of cardiovascular mortality shortly following a heart attack. There is also growing evidence that long term exposure to air pollution may result in premature death for people that have had a heart attack. In addition to people with a previous AMI, the effects of pollution on cardiovascular disease may be more pronounced in the elderly and people with other preexisting health conditions.

Preliminary Finding

Higher tree canopy coverage is correlated with lower incidence of acute myocardial infarction (AMI) related ED visits.



Discussion

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- Historical redlining policies are a **statistically significant factor behind current tree canopy coverage** in our data set even controlling for race.

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- Based on our data, **tree canopy coverage can help mitigate asthma events and cardiovascular events**, controlling for age and race.

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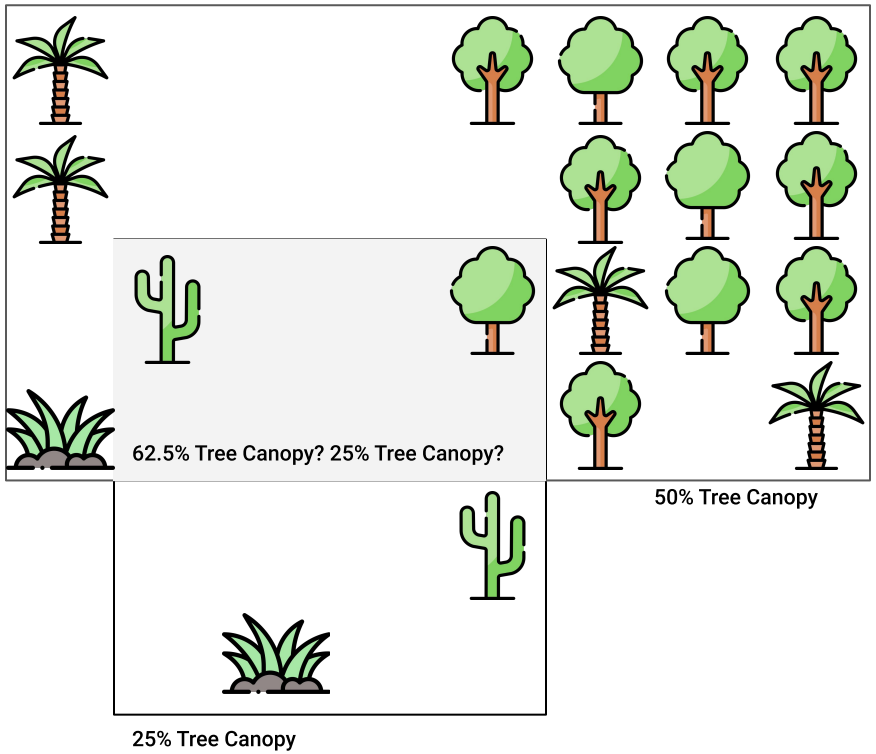
- Historical redlining policies are a **statistically significant factor behind current tree canopy coverage** in our data set even controlling for race.
- Based on our data, **tree canopy coverage can help mitigate asthma events and cardiovascular events**, controlling for age and race.
- Relationship between tree canopy coverage and Urban Heat Island Index was **not as expected** in the data that we analyzed. Could be an area of further study.

Limitations

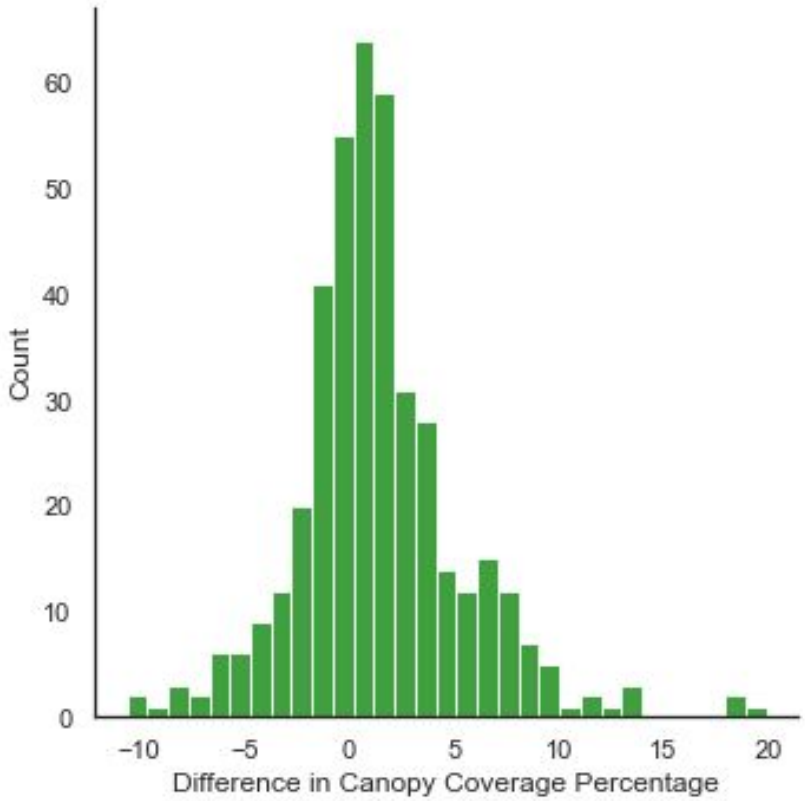


Assumption of Even Distribution of Tree Canopy Coverage

Based on available datasets, we took the average of tree canopy coverage percentages for an intersection of an area.

However, it might not be entirely accurate for a given area (see grey intersection).

Outside of re-running tree canopy estimation analyses at a more granular level, the current analysis represents the next best option for visualizing trends over an area.



Incongruence between LA Canopy & Locke Dataset

The methodologies used to estimate urban tree canopy cover was different between the LA Canopy and Locke dataset; understandably there would a difference in the reported values.

Majority of the values are within ±5% of the other value, and appear to be normally distributed, so we assert that the differences are acceptable.

To ensure uniformity of results, we used the lowest common denominator of Locke's dataset for analyses.

Limitations

- Some data incongruence between our tree canopy data sources
- Establishing direct causality between redlining-era neighborhood grade and community health outcomes

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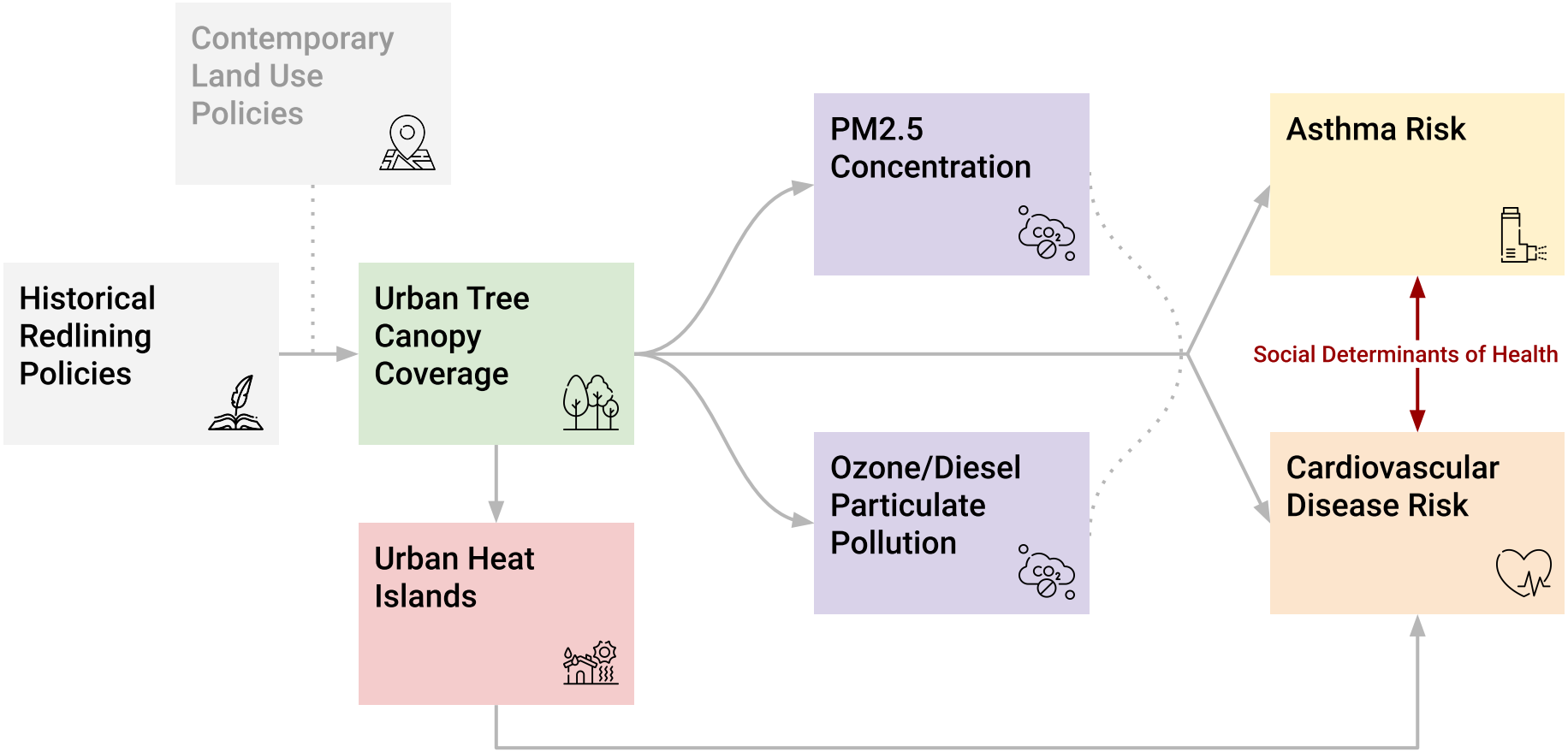
- Establishing direct causality between redlining-era neighborhood grade and community health outcomes
- Exploring interactions with additional variables such as median household income

Future Directions

Full Conceptual Model



Examination of Contemporary Land Use Policies

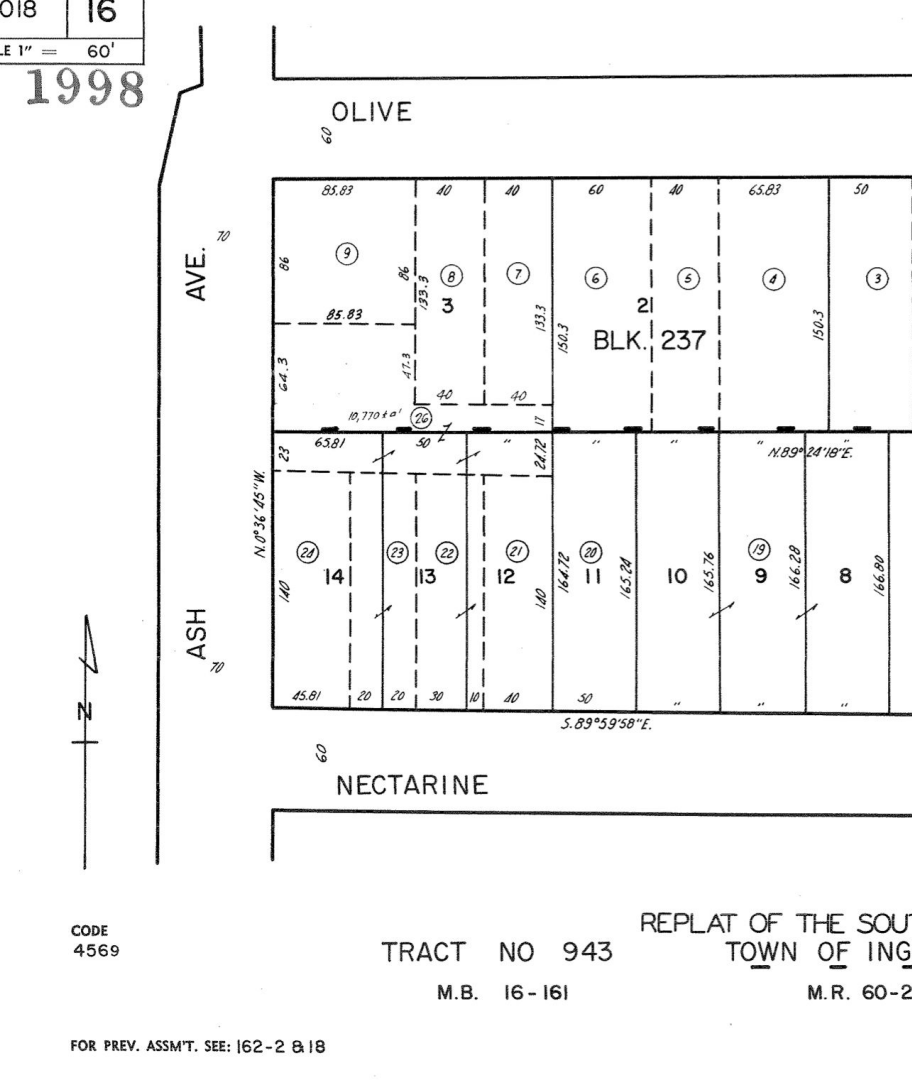
Our analysis focused primarily on quantifying the effects of historical redlining policies on contemporary urban tree canopy coverage; we did not have the capacity to systematically analyze how land use policies have affected the phenomenon between 1930's to 2020's.

Preliminary Explorations

Terner California Residential Land Use Survey

A survey collected responses from 252 cities and 19 unincorporated county areas in the state, and included insights on a range of questions on local zoning, development approval processes, affordable housing policies, and rental regulations.

Source: https://californialanduse.org/



Examination of Building Augmentations

Similarly, additional analysis on building augmentations throughout 1930's - 2020's may be insightful. For example, if a large proportion of single family housing was subsequently converted to multi-family housing, it would imply a loss in potential space for greenery.

Preliminary Explorations

Los Angeles County Assessor Parcel Data

Data provided from the County of Los Angeles Open Data initiative, containing valuation and property description for parcels on the Assessor's annual secured assessment roll for 2019.

Source: https://data.lacounty.gov/Parcel-/Assessor-Parcels-Data-2019/csig-gtr7
https://hub.arcgis.com/datasets/lahub::la-county-parcels

Examination of Social Determinants of Health

Although our models included race as covariate, we did not fully explore other factors such as median household income (as a measure for socioeconomic status), or ease of access to healthcare facilities.

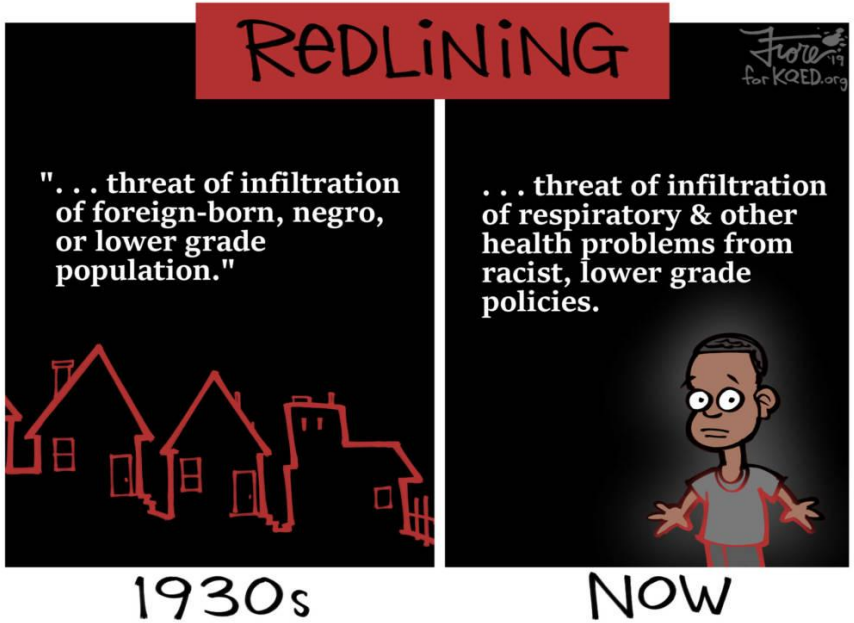
Preliminary Explorations

Southern California Association of Governments (SCAG) Active Transportation Program (ATP) Data

A demographic shapefile that contains Census tract level population, race, employment, English speaking, income, and elderly data of the SCAG region.

Source: https://hub.arcgis.com/datasets/865f2509d5d4450ea6bfd527596ef502_0

Conclusion



Takeaways

Historical redlining policies affected contemporary urban tree canopy coverage. **Areas graded worse** have **lower tree canopy coverage**.

Since **higher tree canopy coverage** is associated with **lower incidence of asthma and cardiovascular emergency department visits**, it suggests that areas with low tree canopy coverage would not have the same buffering effects that tree canopy cover provides.

This implies that persons living in **neighbourhoods with low tree canopy cover** are at **greater risk for asthma-related and cardiovascular-related incidents**.

Thank You!

Expressed Appreciation for:

Alex Aronov, PhD | Mentor, Thought-Leader

Peyton Runyan | Spiritual Pillar, ASMR Influencer

Lai Jiang | Economics Wunderkind 天才/天菜

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