CASA0025: Building Spatial Applications with Big Data

Los Angeles Geography Infographics

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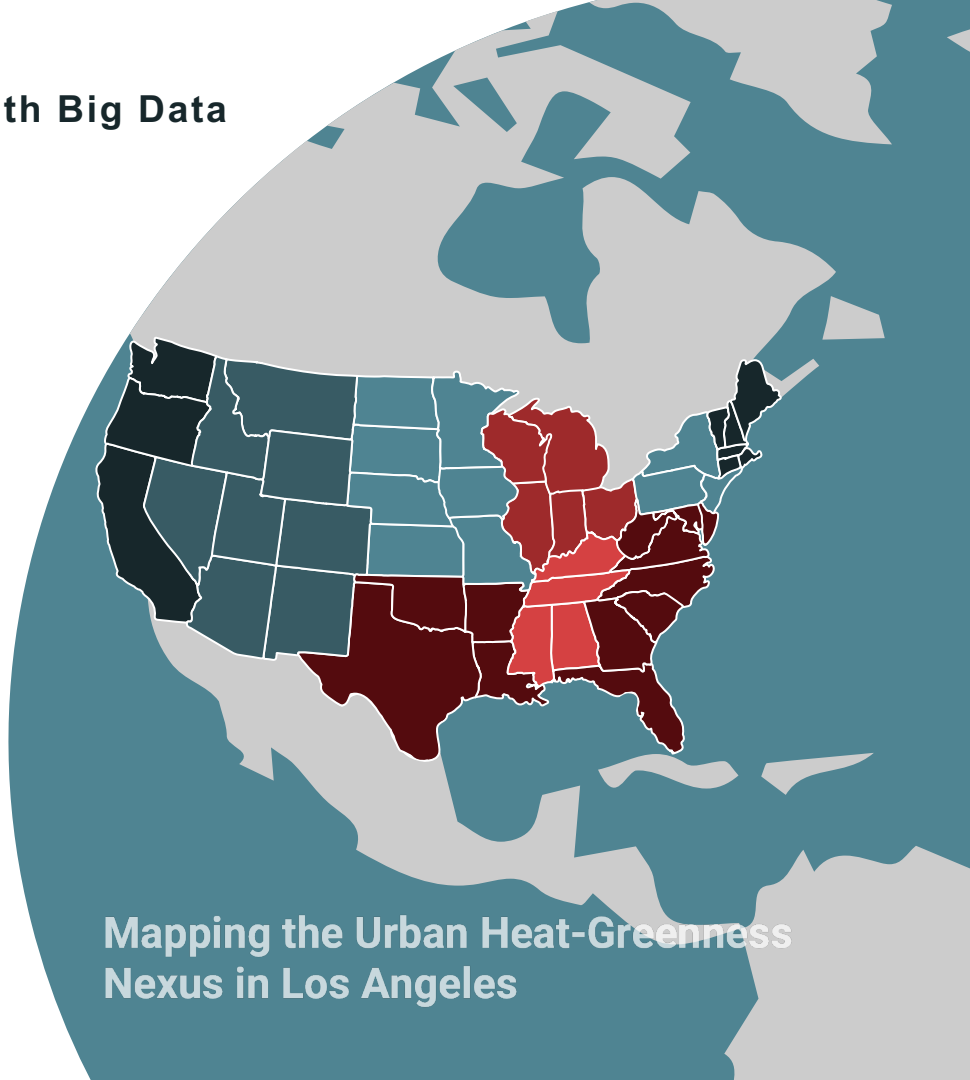

Urban Heat Island (UHI) Issue

In 2012, California passed Assembly Bill 296, which established clear goals for urban emission reduction and heat mitigation.

CHALLENGES IN LA :

APPLICATION GOALS

- Utilize **Google Earth Engine** to provide interactive spatial analysis tools.
- Enable urban planners and community organizations to accurately identify “hot and green-deficient” zones.
- Support data-driven planning of green infrastructure interventions, promoting **health equity** and compliance with AB 296.

“

TO INFORM EQUITABLE GREEN INFRASTRUCTURE PLANNING IN LOS ANGELES THROUGH INTERACTIVE VISUALIZATION OF URBAN HEAT AND VEGETATION PATTERNS USING GOOGLE EARTH ENGINE

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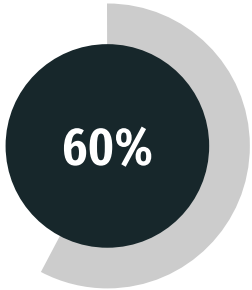
Los Angeles Geography Infographics

TARGET USERS

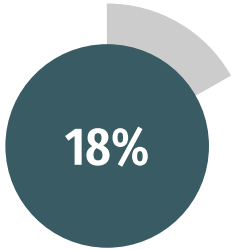
Urban Planners

Use data to prioritize greening in heat-prone areas



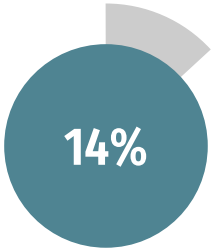
Public Health Officials

Identify vulnerable groups at risk from extreme heat



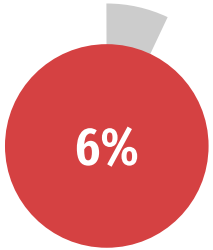
Environmental Scientists

Analyze LST/NDVI patterns using geospatial tools



Community Organizations

Advocate for green justice and participatory planning



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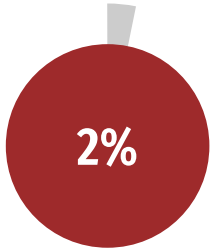
Other reasons.....



REFERENCE

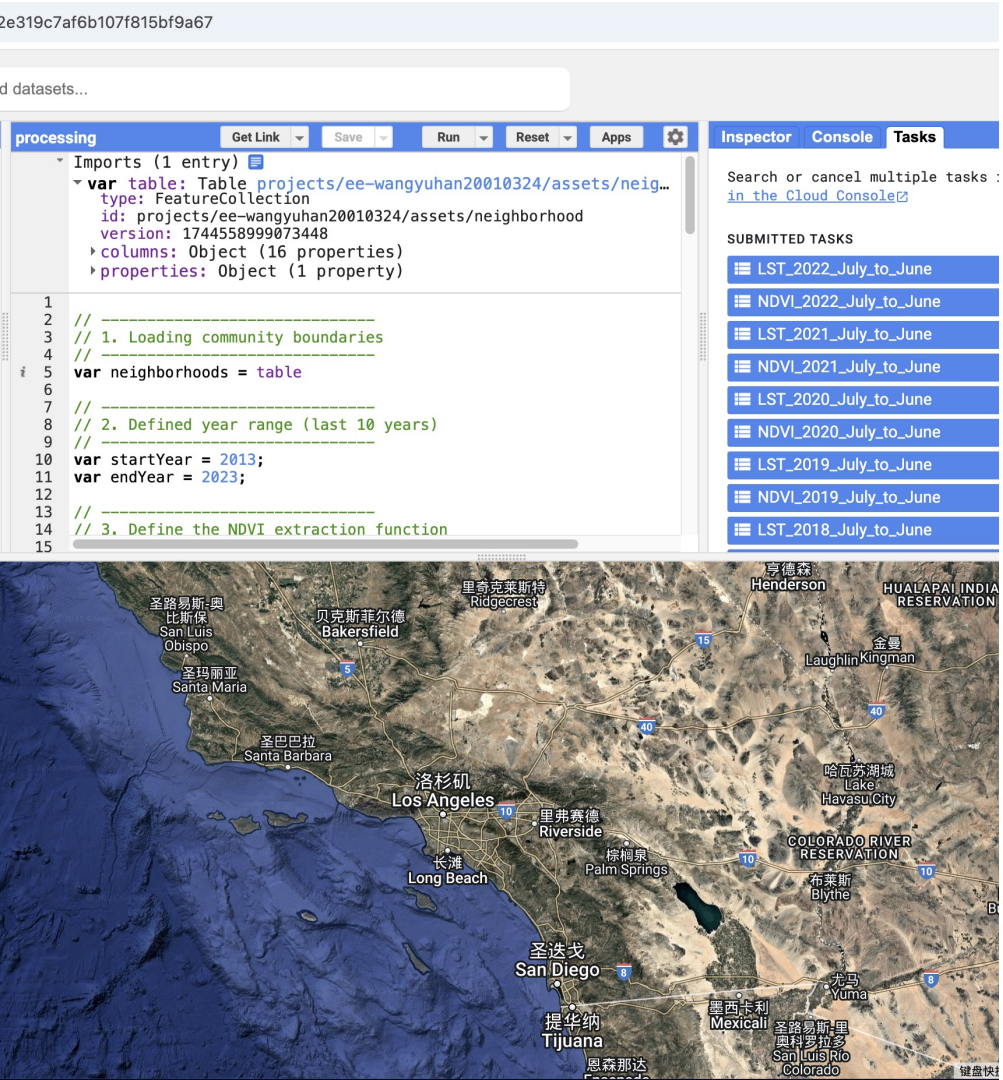
TITLE	SOURCE	YEAR	APPLICATION
Neighborhood Council Boundaries (2018)	Los Angeles Geohub	2018	GeoJSON Data
USGS Landsat 8 Level 2, Collection 2, Tier 1	GEE Datasets	2013-2023	Main Data
MOD13Q1.061 Terra Vegetation Indices 16-Day Global 250m	GEE Datasets	2013-2023	Main Data
MODIS/Terra Land Surface Temperature/Emissivity 8-Day L3 Global 1 km SIN	USGS	2013-2023	Main Data
California Environmental Protection Agency	CalEPA	2012	GOVERNMENT POLICY
Variation in the urban vegetation, surface temperature, air temperature nexus	Science of The Total Environment	2016	Journal articles
Estimation of land surface temperature–vegetation abundance relationship for urban heat island studies	Remote Sensing of Environment	2003	Journal articles

1
PROCESSING

2
ANALYSIS

3
VIRSUALIZATION

4
LIMITATIONS&
CONCLUSION



P1.

HOW TO PROCESSING THE DATA?

Data Preprocessing

1. Tools: Google Earth Engine （Code Processing）
2. Focus: Extract spatial statistics for **Normalised Vegetation Index (NDVI)** and **Land Surface Temperature(LST)**.
3. Time scale: annual (10-year trend)
4. Unit: communities in Los Angeles (City Council ward shapefiles）
5. Goal: Provide clear, structured datasets for mapping and analysis

DATA	SOURCE	YEAR	DATATYPES	APPLICATION	exports
Neighborhood Council Boundaries (2018)	Los Angeles Geohub	2018	GeoJSON Data	Los Angeles Community shapefile	CSV files of average NDVI and LST per community. There are 20 csv files in total.
USGS Landsat 8 Level 2, Collection 2, Tier 1	GEE Datasets	2013-2023	Main Data	This is the **Normalised Vegetation Index (NDVI)**, calculated by (B5 - B4)/(B5 + B4).	
MODIS/Terra Land Surface Temperature/ Emissivity 8-Day L3 Global 1 km SIN	USGS	2013-2023	Main Data	This is the **Land Surface Temperature (LST)**, converted by LST × 0.02 - 273.15.	

Data Preprocessing

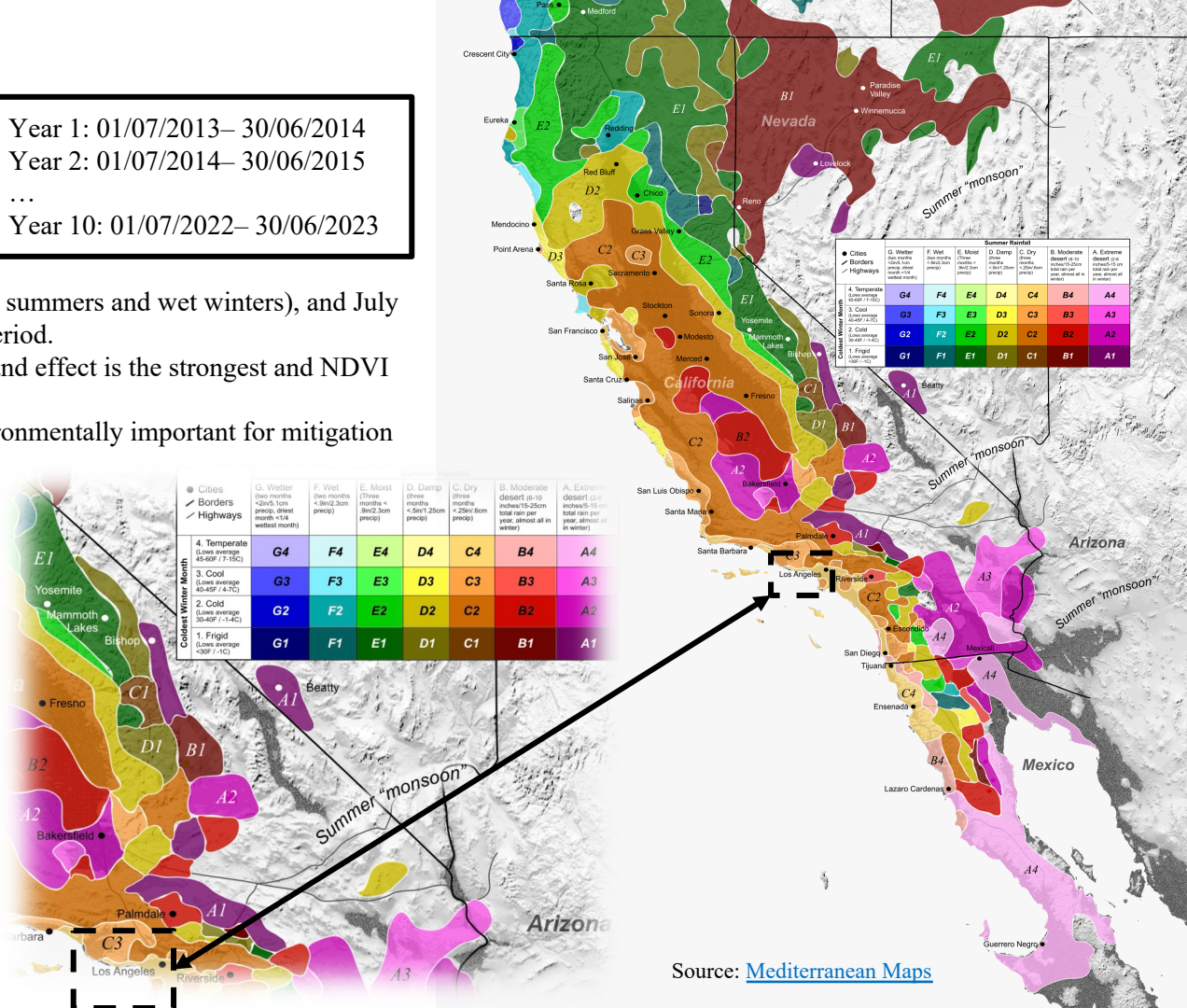
Time scale: annual (10-year trend)

Selection of July to June as the monitoring year

Year 1: 01/07/2013– 30/06/2014
Year 2: 01/07/2014– 30/06/2015
…
Year 10: 01/07/2022– 30/06/2023

- Los Angeles has a Mediterranean climate (dry summers and wet winters), and July marks the beginning of the hot and dry heat period.
- Summer is the period when the urban heat island effect is the strongest and NDVI changes are the most significant.
- Vegetation status (NDVI) is clearest and environmentally important for mitigation during the summer period.

- The use of a July start allows for complete coverage of dry periods and lush green spaces, capturing the full range of environmental changes on the surface.
- This method of dividing the year by climatic characteristics rather than calendar year is widely used in urban heat island, ecological monitoring and growing season studies.
- This division helps to more accurately assess the impact of green space construction on the cooling effect of the following summer.



Source: [Mediterranean Maps]

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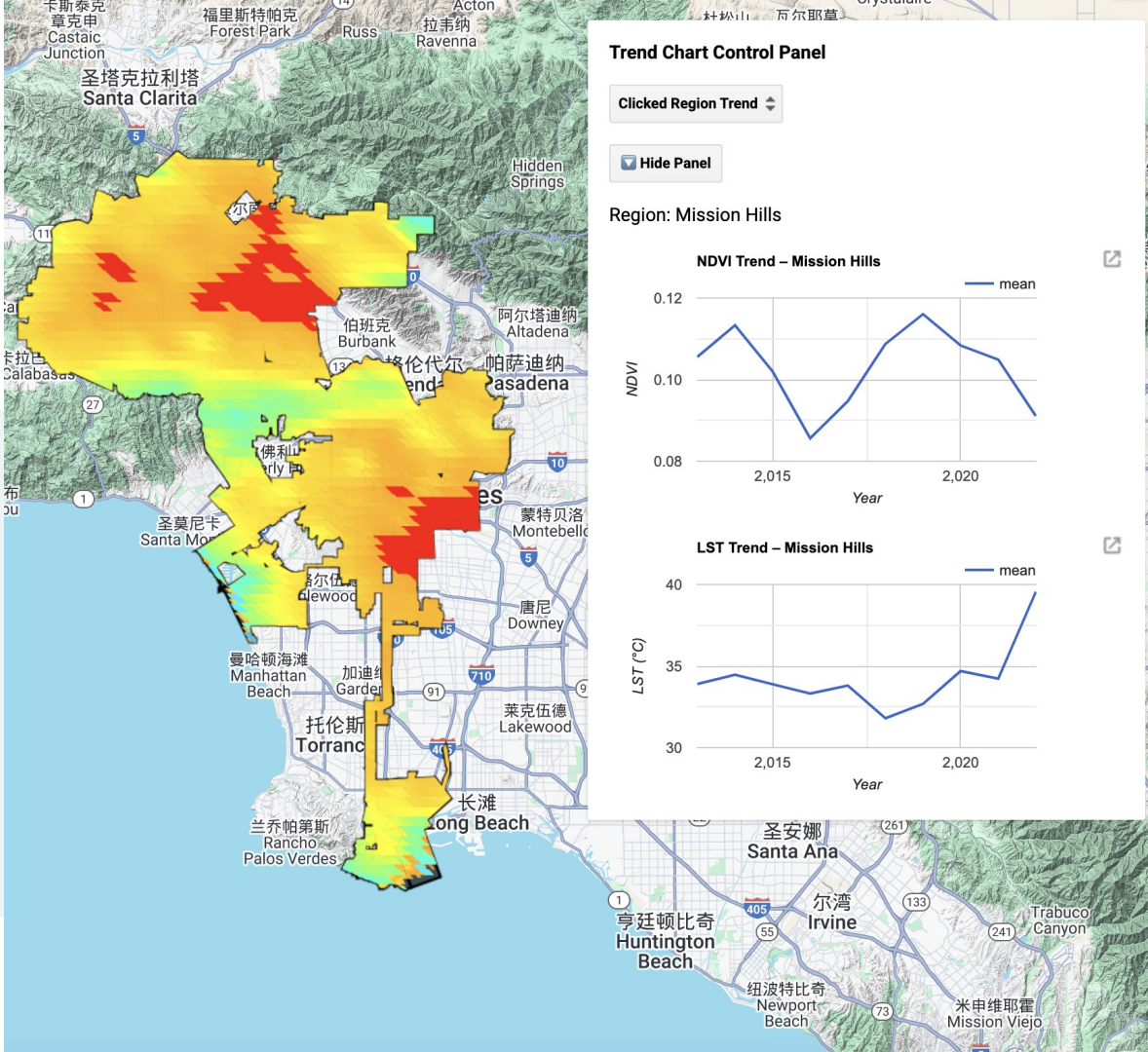
FINDING IN ANALYSIS



Load data

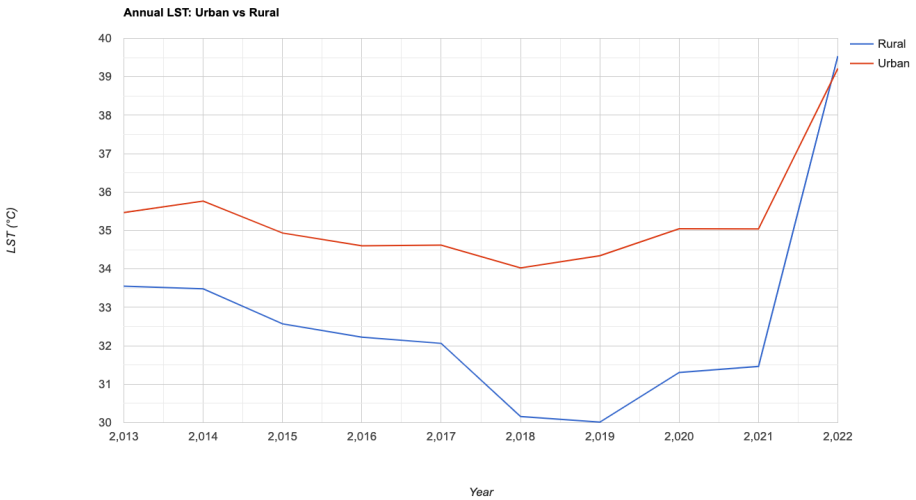
DATASET	SOURCE	YEAR	APPLICATION
Neighborhood Council Boundaries (2018)	Los Angeles Geohub	2018	GeoJSON Data
USGS Landsat 8 Level 2, Collection 2, Tier 1	GEE Datasets	2013-2023	Main Data
MOD13Q1.061 Terra Vegetation Indices 16-Day Global 250m	GEE Datasets	2013-2023	Main Data
MODIS/Terra Land Surface Temperature/Emissivity 8-Day L3 Global 1 km SIN	USGS	2013-2023	Main Data

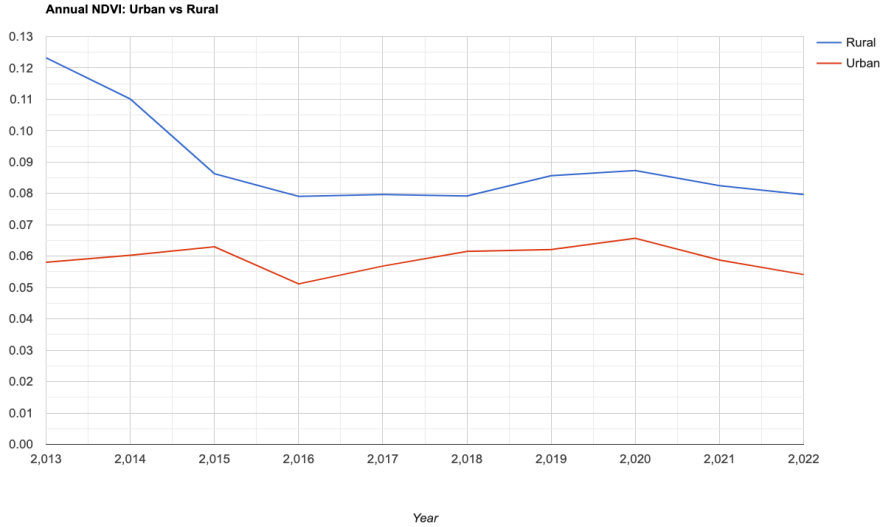
Brief Description of Preprocessing

1. NDVI: Normalized by 0.0001; Add the year attribute
2. LST: Multiply by 0.02 and subtract 273.15 to obtain degrees Celsius
3. All images extract the "year" attribute for subsequent aggregation and analysis

Methodology

1 We calculate the annual mean NDVI and LST to assess overall trends in vegetation and surface temperature.





Methodology

❷ Count Regions with Heat Islands

Identifies neighborhoods repeatedly in the hottest 10% (persistent heat islands), helping target mitigation.

Regions with UHI ≥ 5 years
North Hollywood Northeast: 10 years
Central Alameda: 9 years
Boyle Heights: 8 years
CANNDU: 8 years
Zapata King: 8 years
Downtown Los Angeles: 7 year
North Hollywood West: 7 years
Panorama City: 6 years
South Central: 6 years

Methodology

3 Linear regression between NDVI and LST values

Fit NDVI-LST regression model for a year, allow users to simulate NDVI increase effects

↓

Define mask for valid NDVI and LST range

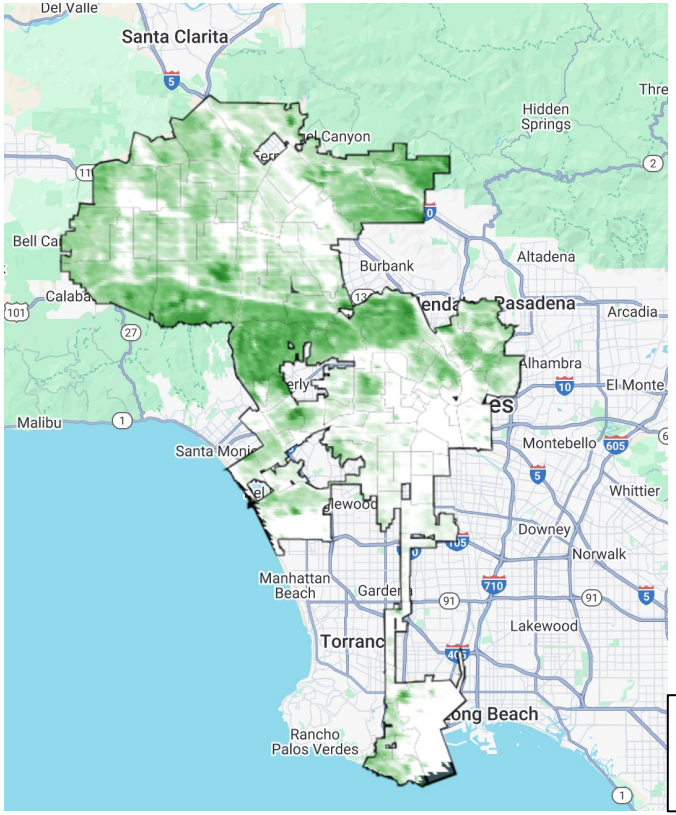
↓

Calculate linear

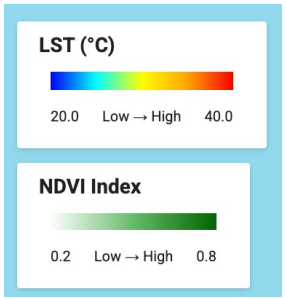
↓

Evaluate regression and provide interactive simulation for NDVI increase

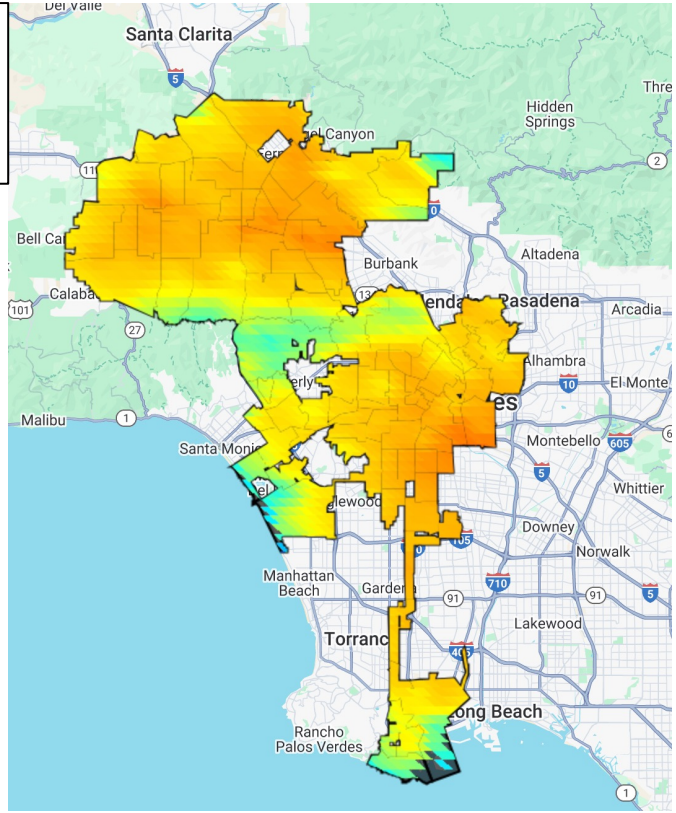
NDVI and LST Spatial Distribution



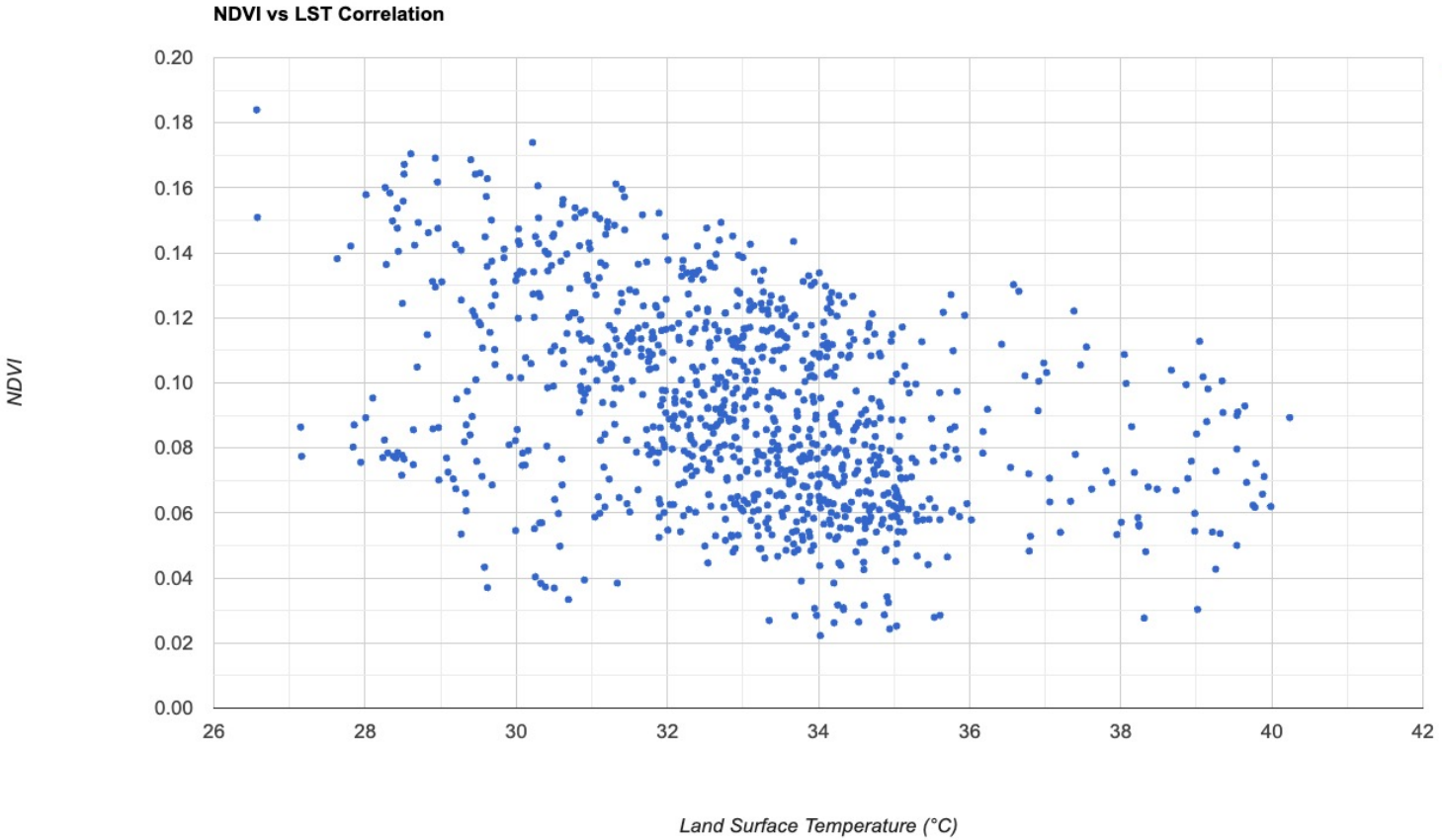
•**LST Layer**: Red areas represent high-temperature heat island effect zones, while blue areas represent cooler regions.



•**NDVI Layer**: Green areas represent regions with higher vegetation cover.



NDVI vs LST Correlation



Negative correlation:

As NDVI (vegetation cover) increases, indicating denser vegetation cover, the corresponding LST LST (land surface temperature) tends to decrease.

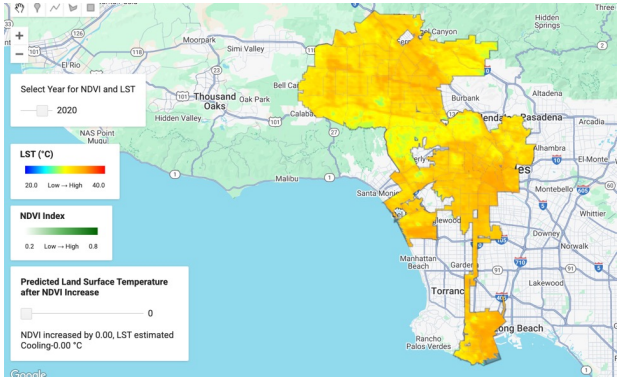
Predicted Land Surface Temperature after NDVI Increase

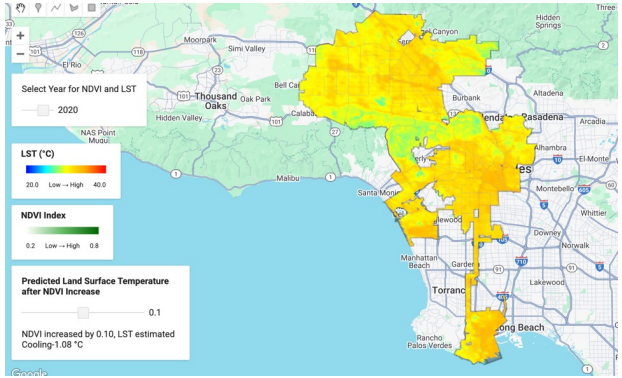
The regression analysis reveals a significant negative correlation between NDVI and LST: as NDVI (vegetation cover) increases, LST (land surface temperature) decreases. This suggests that increasing urban greenery can effectively mitigate the heat island effect and lower surface temperatures.

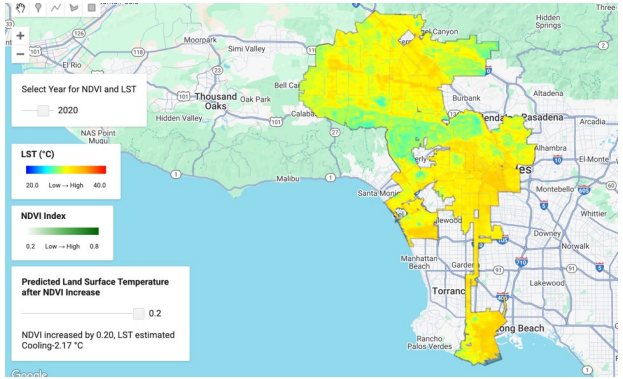
Predicted Land Surface Temperature after NDVI Increase

0.060

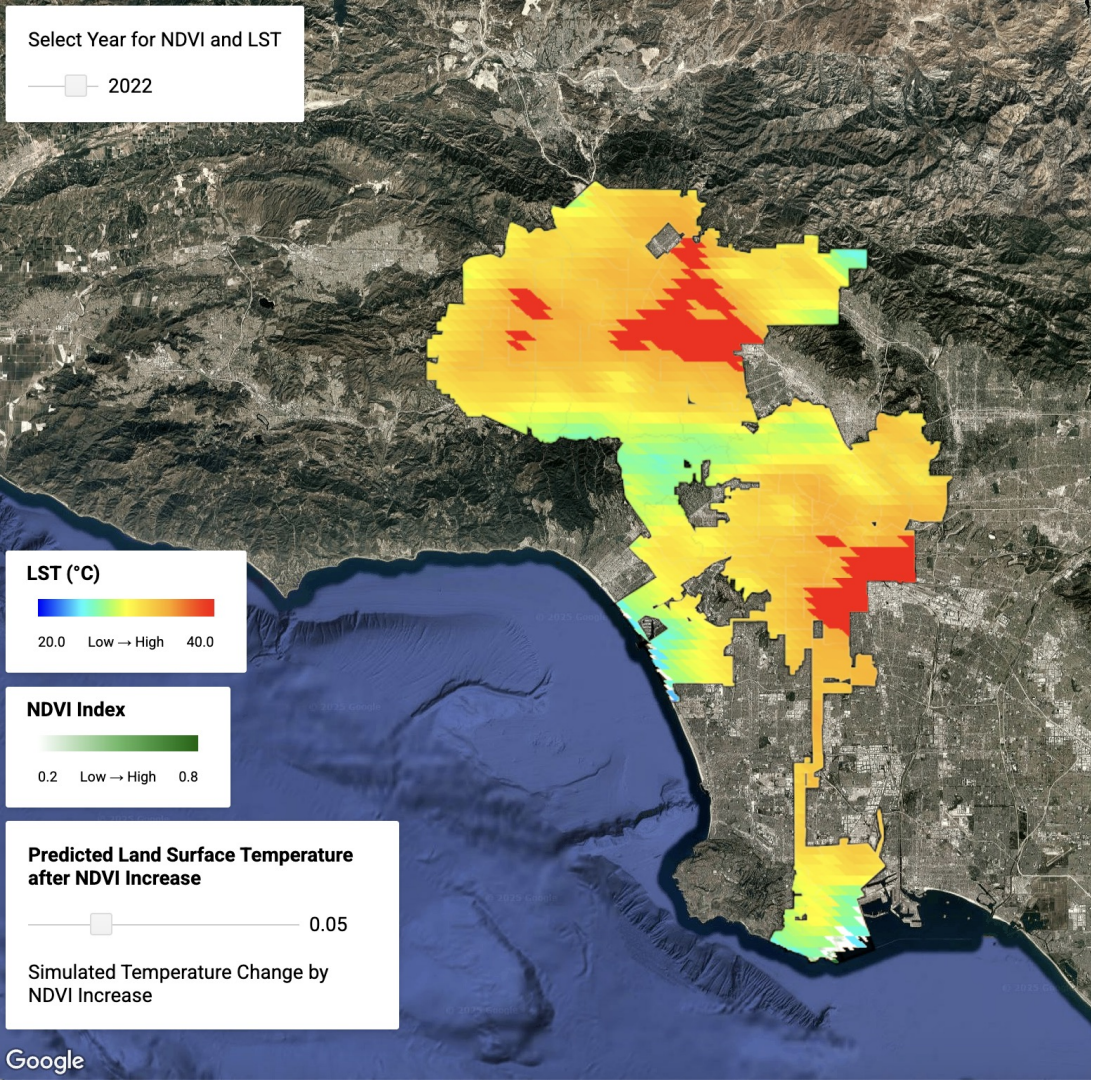
NDVI increased by 0.06, LST estimated Cooling-0.65 °C







As NDVI increases, it is expected that LST will gradually decrease.



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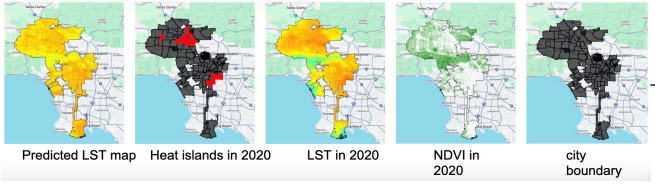
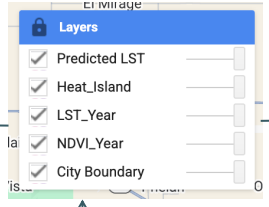
VIRSUALIZATION VIA GOOGLE EARTH ENGINE

Introduction to the Interactive Interface

APP: [Los Angeles Heat Island Effect]





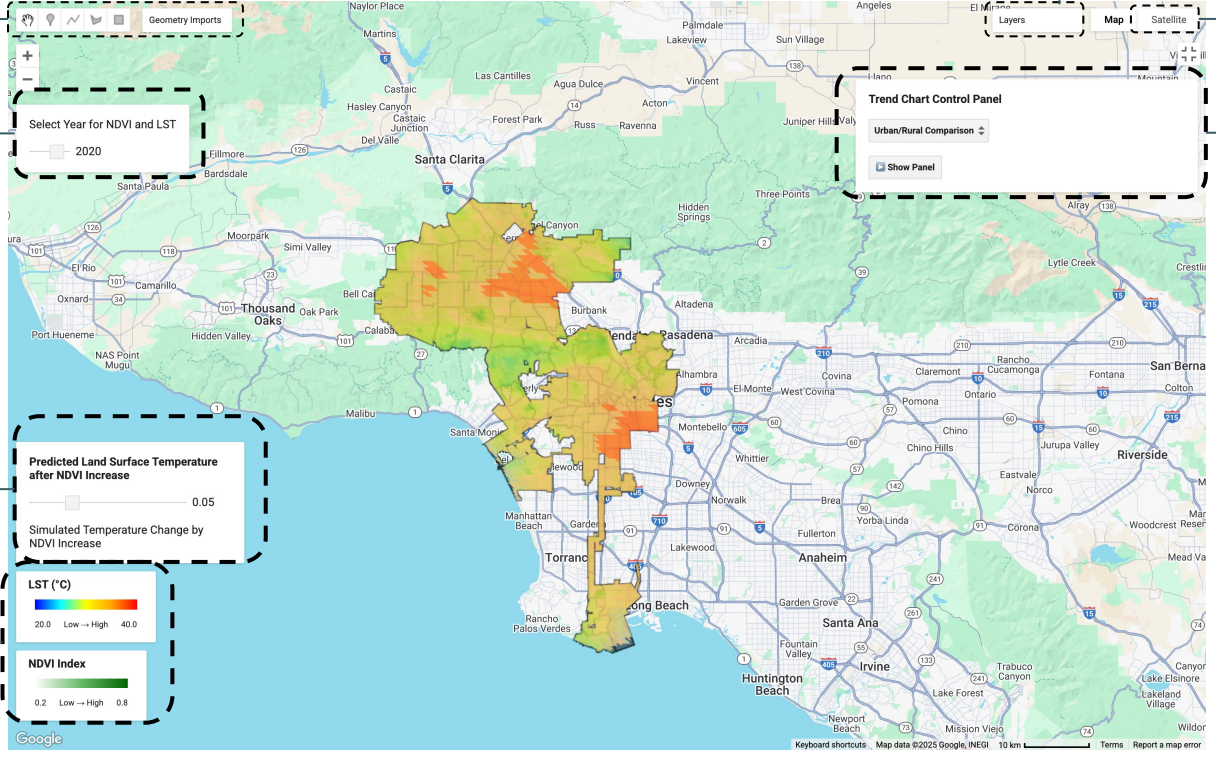
Multiple layers can be switched, transparency can be adjusted to superimpose different layers for comparison.

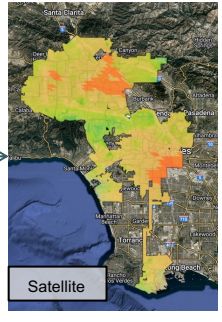
Toolbox
- point drawing
- line drawing
- polygon drawing
- rectangle drawing

A year slider allows switching between NDVI and LST layers from 2013 to 2022, with automatic legend and color scale updates.

A built-in simulator adjusts NDVI increments and visualizes predicted cooling.

Users can select any location to view historical trends in vegetation (NDVI) and surface temperature (LST).



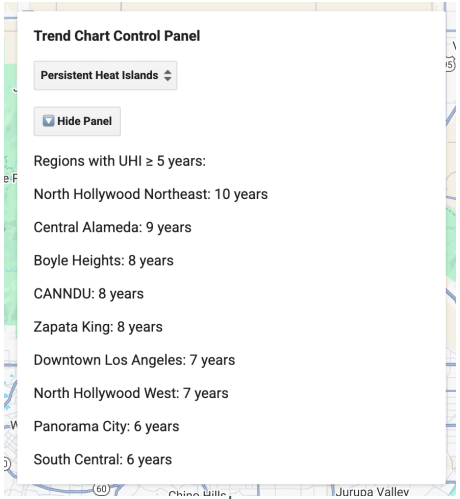


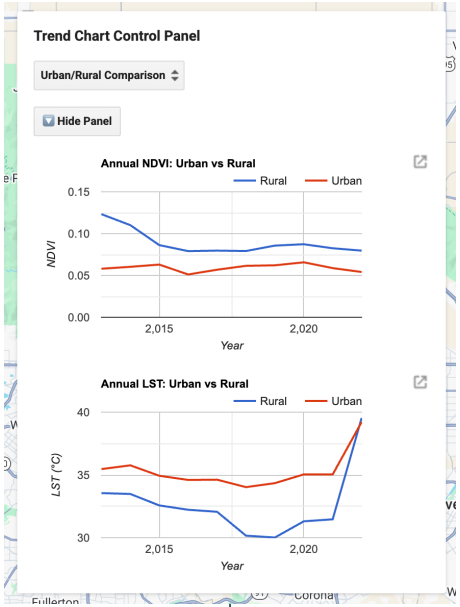
Trend Chart Control Panel

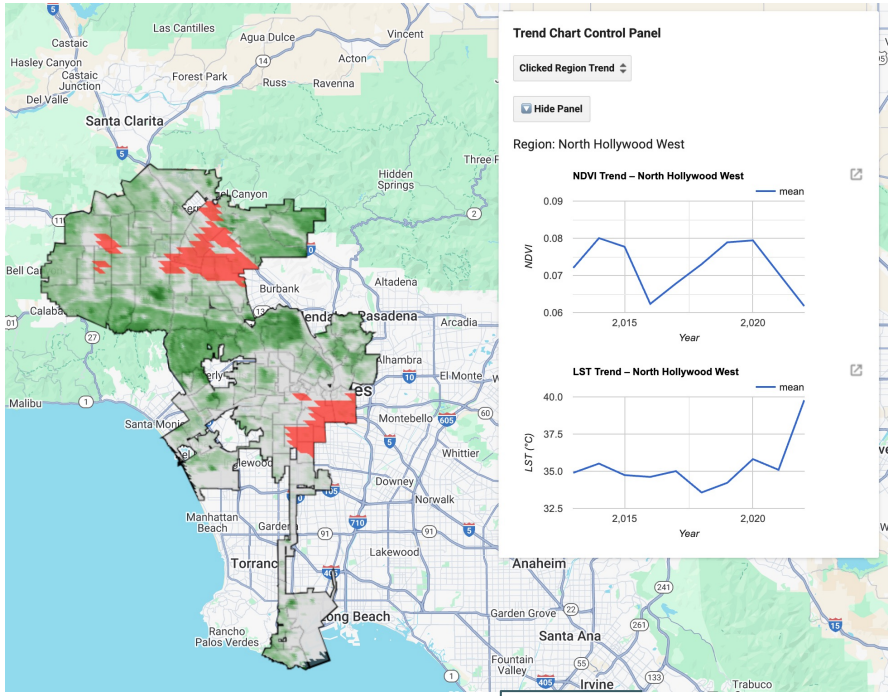
- Urban/Rural Comparison
- Persistent Heat Islands
- Clicked Region Trend

Users can choose to view different charts.

Introduction to the Interactive Interface – trend chart control panel







Trend Chart Control Panel

- Urban/Rural Comparison
- Persistent Heat Islands
- Clicked Region Trend

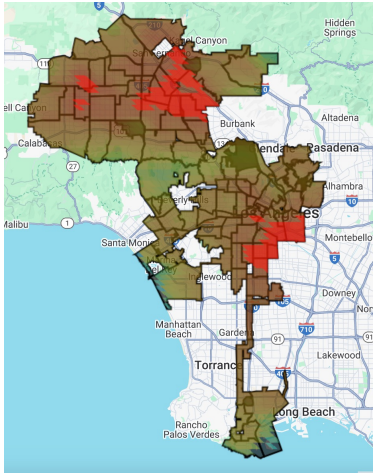
P4

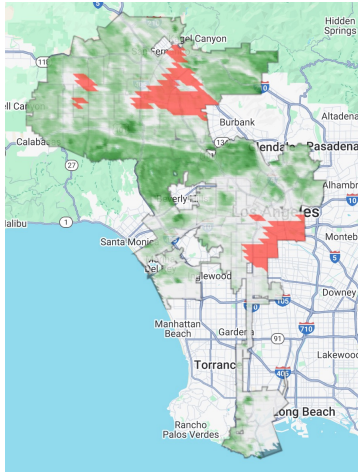
LIMITATIONS & CONCLUSION

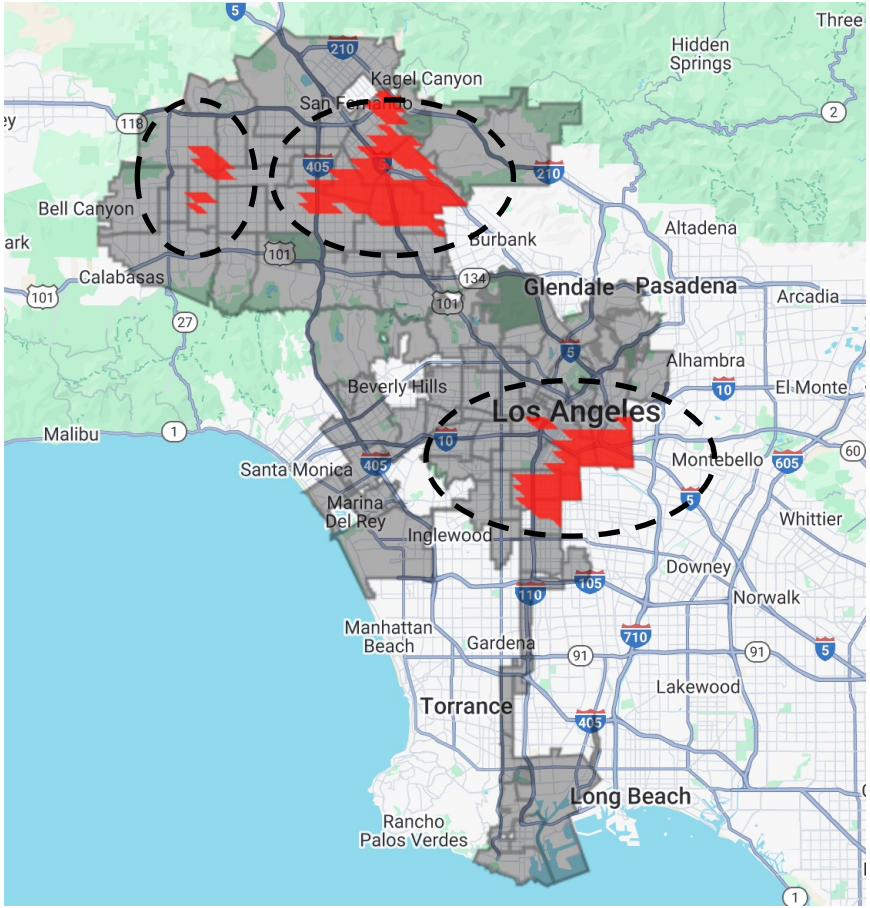
Result

Heat Island Area Statistics

- **Consistently Affected Regions**: Westlake, Pacoima, Downtown Los Angeles identified with persistent high temperatures over 5+ years.
- **Land Use Characteristics**: Commercial, industrial, and traffic-heavy zones show stronger heat island effects.
- **Vegetation Cover**: These areas typically have low greenery, intensifying surface heating.

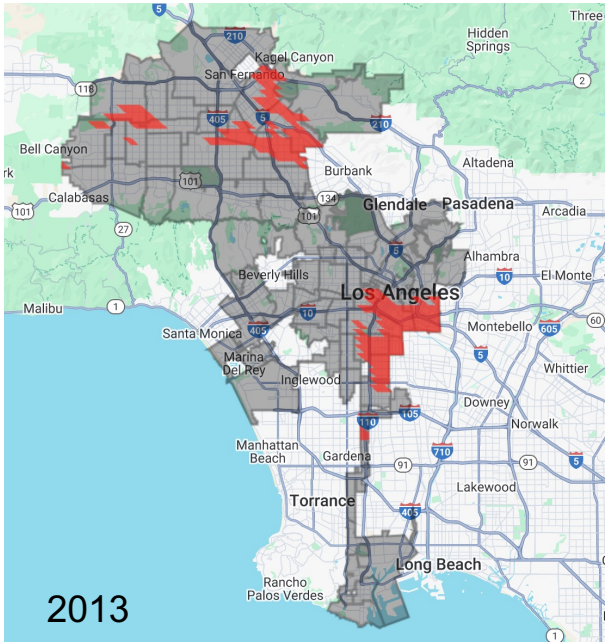


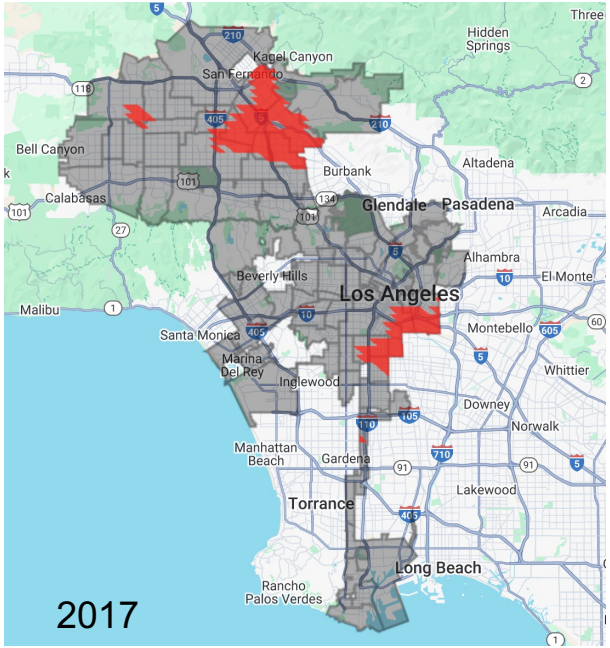


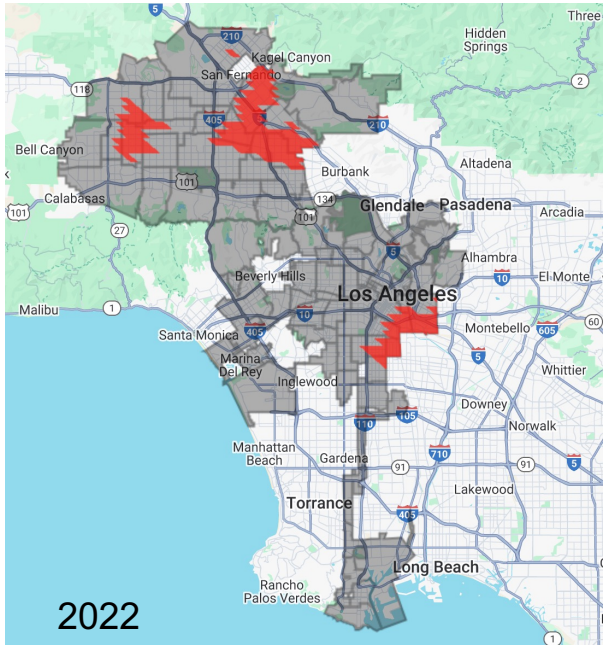


Result

Heat Island Effect Area Changes Over Time







•**Heat Island Effect Change Map**: Shows the change in heat island effect areas from 2013 to 2022, comparing the expansion of the heat island effect.

Limitation

1. Time-frequency and missing data issues:

- Landsat and MODIS images are limited by cloud cover and missing images, and there may be insufficient data for some months even if monthly averages are taken.
- While the seasonal dynamics of NDVI and LST are largely complete, the short-term effects of extreme weather events (e.g., heat waves) may be smoothed out by monthly averaging.

→ Implications: Subtle time-scale trends may be underestimated.

2. Functional diversity of cities is not sufficiently taken into account:

- Different Neighborhoods have very different population densities, land use (e.g., industrial, commercial, residential) characteristics.
- Current analyses are mainly based on geographic boundary-averaged NDVI/LST, without further breakdown of urban functional types.

→ Implications: Functional differences lead to possible 'internal heterogeneity' in the relationship between heat islands and green spaces, which is not well captured.Urban vegetation was identified as critical for climate resilience and mitigating the UHI effect.

3. Simplified heat island-green space scoring model

- Although the scoring model (e.g. NDVI/LST weighted average) is simple and intuitive, the actual urban thermal environment is also affected by multiple factors such as building materials, road coverage, wind field, water bodies and so on.
- Predictive models for green space enhancement (e.g., 'NDVI+0.1 → 3°C decrease in temperature') are based on linear assumptions and may ignore complex non-linear feedback mechanisms.

→ Implications: Predictions may overestimate or underestimate actual improvements.

Conclusion

1. Methodological Approach:

- Data were systematically processed in Google Earth Engine to create neighborhood-level datasets.
- NDVI and LST were selected as core indicators to examine spatial patterns of greenness and heat.
- The analysis year was redefined (July to June) to better capture peak summer temperature dynamics.

2. Key Findings:

- Areas with lower NDVI consistently exhibited higher surface temperatures, confirming a negative spatial correlation.
- Urban vegetation was identified as critical for climate resilience and mitigating the UHI effect.
- The study offers a foundation for future mapping, prediction, and planning strategies to enhance urban environmental equity.

For more information about Urban Heat-Greenness Nexus in Los Angeles, please follow these links:
Github: https://SkyGarry.github.io/CASA0025
Google Earth Engine: https://ygzhang5112.users.earthengine.app/view/casa0025

Mapping the Urban Heat-Greenness Nexus in Los Angeles

CASA0025: Building Spatial Applications with Big Data