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Locations: Austin (TX), Sandy (UT), Bernardsville (NJ), Dublin (CA), Frisco (TX), Detroit (MI), San Diego (CA)

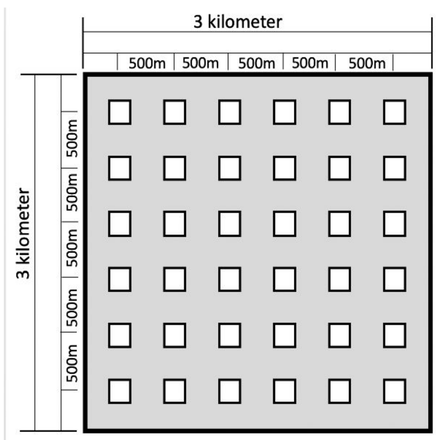
Understanding the Effects of Urbanization on Plant Ecosystems in Selected Areas of Interest

Aarav Awasthi, Vineeth Erram, Sophie Humer, Boone Macon, Jeannelyn Newsome, Charles Quinn, Zimraan Shamrao, Charles Quinn, Claire Tagalog, Aadhi Umamageswaran

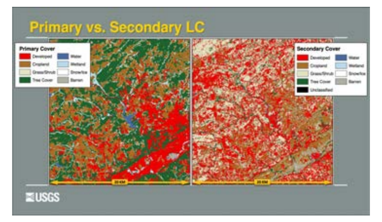
Abstract

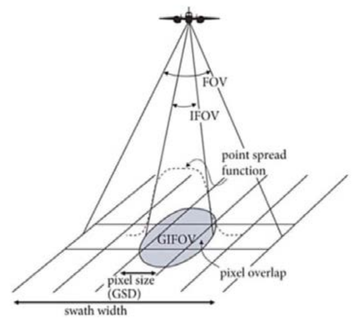
Over the last two decades, the world population has increased by approximately 1.5 billion, representing a staggering 15% rise. Subsequently, land cover has undergone significant changes, resulting in an increase in impervious surfaces in the form of buildings, sidewalks, roads, etc. How does this urban development affect plant ecosystems? Looking backwards helps us understand the changes arising from urban sprawl. Each case study location can be analyzed before, during, and after periods of urban growth. The progression of urbanization can be measured and monitored using several tools, including the Multi-Resolution Land Characteristics (MRLC) National Land Cover Database (NLCD) Viewer, various layers available in Earthmap digital software, and Landsat satellite imagery supplemented by ground observations collected through GLOBE Observer. A 9 km^2 kernel is divided into 36 evenly spaced 100 m^2 areas of interest (AOI) and 1 centroid location. The geometry is converted into a GeoJSON file, allowing for repeatable operations within each dataset. The United States population is projected to increase by roughly 40 million people in the next 30 years, indicating urbanization will continue. It is essential to investigate sustainable approaches to create a balance between urban development and the ecosystems it displaces. By utilizing investigated approaches and materials that prioritize sustainability, we can harmonize the relationship between urban development and the plant ecosystems that we aim to protect.

Methods

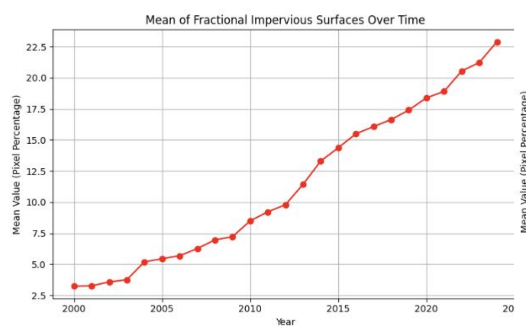


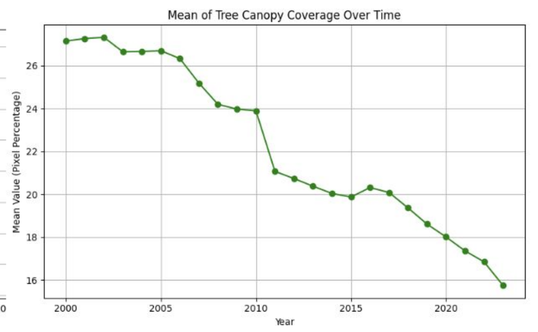
AaP3Km Sampling Techniques for an Area on Earth





Graphs and Heatmaps from MRLC Data





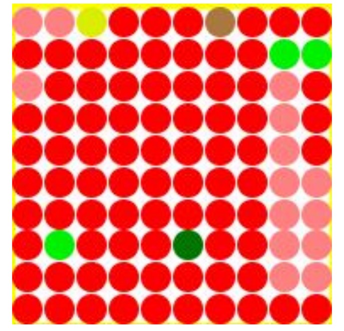
Earthmap Data Sets Used

Collect Earth Online Data Example Grid (After Classification)

- Meta 1m Tree Canopy
- 10m World Cover
- 10m Dynamic World
- 10m ESRI

Yellow highlight indicates Worldview-4 satellite

Cyan indicates from Sentinel 1 and 2 satellites



Results: Remote Sensing, Globe Observer, Collect Earth Online

Platform	Landsat s 5-9	WorldView-4	Sentinel-1/2			GLOBE Observer						Collect Earth Online
AOI	Landsat Time Series Graph	1m Tree Canopy Meta	World Cover 10m	Dynamic World 10m	ESRI 10m	Up	Down	west	south	east	north	high resolution image interpretation
1												
2												
3												
4												
5												
6												
7												

Discussions

- Relationship between urban growth and plant life depend on local planning & development patterns
- Several AOI locations portrayed trend where urban development displaced or replaced plant life due to a surge in impervious surfaces
  - Ex: Frisco, Texas & Austin, Texas showcases original plant ecosystems displaced or replaced with almost entirely with impervious surfaces, with little new vegetation added. impervious surfaces like buildings and roads.
- Other locations demonstrated a direct relation where urban development paired with high vegetation
  - Ex: Dublin, California displayed common trend of intentional green space retention, Tree canopy preservation which demonstrated a positive effect for plant life
  - Due to community organizations such as the HOA placing landscape requirements on certain neighborhoods
  - Neighborhoods have consistent vegetation that is determined before construction, such as in-built gardens or pine trees integrated in between each doorstep.
- A middle ground can be seen in places like Bernardsville, New Jersey, where both impervious surfaces and greenery (canopy) do not drastically increase or decrease yearly, showing retention and harmony
- In both scenarios, community priorities and maintenance played a key role. In areas where communities desired to cultivate plant life with growth projects and landscape requirements, increased vegetation was observed.
- Combined Utilizing of ground-truth Globe Observer images, Cloud Earth Online's manual land cover identification & Remote Sensing data helped provide full outlook on environmental patterns & revealed discrepancies, such as overestimates of built-up urban areas & underestimates of integrated vegetation in satellite data
- Variation between different cities supports insight that resources such as citizen science & remote sensing datasets can function together to allow local governments and policymakers to make informed decisions toward land use, canopy preservation, and urbanization strategies. Sustainable urban development is an imperative step cities must take toward a prolonged future.

Similarities

- Each member on the team utilized the same methodology when gathering their Area Of Interest data.
- Each member utilized satellite tools such as Landsat time-series plus WorldCover 10 m, Dynamic World 10 m, ESRI 10 m and Meta 1 m Tree-Canopy layers to gather remote sensing data of their area.
- These tools combined with land cover ground photos taken using the Globe Observer app allowed each team member to analyze there 3kmx3km area of interest and view how it changed from 1984-2025.

Differences

- The results vary by their location and aren't necessarily always consistent with the expected outcome. -
- Detroit had a rise of urban greenery because of their implemented means to improve it.
- San Diego had an increase in urbanization (impervious surfaces) and a decrease in concentration of greenery.
- Austin's canopy has decreased in concentration near the urban part.
- Bernardsville has remained mostly relatively unchanged over the years, resulting in maintained greenery.
- Differences can lie within data collection as issues such as lost data can reduce precision.

Conclusion

The relationship between plant ecosystems and urban development depends on a variety of factors where community type and guidelines play a key role.

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