GLOBE VS Research Proposal Template

Preserving Urban Vegetation and Identifying Urban Heat Islands

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Abstract

The loss of urban vegetation has intensified the formation of heat islands, raising temperatures and exacerbating environmental and social problems in cities. This project aims to analyze the relationship between vegetation cover and thermal variation in urban environments, comparing areas with a large presence of concrete and little tree cover with regions that have extensive vegetation cover.

Data collection is carried out at different points in the city and in rural areas, using the GLOBE Observer application to record thermal information, environmental characteristics, and images of the observed locations. In addition, satellite data, terrestrial sensors, and geoprocessing tools are used for mapping and analyzing urban heat islands.

The data obtained are organized and analyzed with the aid of Geographic Information System (GIS) software and environmental indices, allowing the identification of areas more susceptible to heat accumulation and understanding the influence of vegetation on the regulation of the urban microclimate.

The study results contribute to the understanding of urban heat islands and provide input for sustainable urban planning, reinforcing the importance of preserving and expanding green areas as a strategy for reducing temperatures and improving the quality of life for the population.

Why?

The advance of urbanization has led to a reduction in vegetation in urban areas, intensifying the heat island effect and aggravating environmental and social problems in cities, especially in the interior of the state of São Paulo. This process makes the urban environment hotter, drier, and unhealthy, directly affecting the health, well-being, and quality of life of the population, especially during periods of extreme heat.
The development of this project is justified because the loss of urban vegetation cover compromises one of the main natural mechanisms for regulating the local climate. The absence of trees reduces evapotranspiration and the availability of shade, favoring the accumulation of heat on urban surfaces, raising temperatures, worsening air quality, and intensifying the effects of climate change in cities.
In addition, many cities still lack reliable and systematized local data that objectively prove the direct relationship between the presence of vegetation and the reduction of urban temperature. The lack of this scientific basis hinders environmental planning, causing urban afforestation and land use actions to be sporadic, inefficient, or poorly targeted.
By integrating the Biosphere Protocol, focused on the analysis of vegetation cover and the presence of trees, with the Atmosphere Protocol, responsible for recording climate data such as temperature and humidity, the project allows this relationship to be scientifically proven, transforming the environmental problem into measurable and comparable information. This data is fundamental to guiding public policies, urban afforestation projects, territorial planning, and adaptation strategies to climate change.
Therefore, the project is justified as an essential tool for:

- Understanding and quantifying urban heat islands;
- Supporting technical and political decisions in sustainable urban planning;
- Reducing environmental and social impacts, improving thermal comfort and the health of the population;
- Strengthening environmental preservation and the adaptation of cities to climate change.

How?

The project will be developed through integrated environmental monitoring, combining vegetation cover data and climate information to identify and analyze urban heat islands.

Initially, urban areas with different levels of vegetation will be selected, including regions with little tree cover and greener areas, such as squares and parks, allowing for comparison between the environments.

The vegetation analysis will be carried out using the Biosphere Protocol, utilizing satellite images and indices such as NDVI, which make it possible to measure the density of urban vegetation cover. In parallel, built-up areas will be identified with the aid of NDBI, highlighting regions with a higher concentration of concrete and asphalt.

Next, the Atmosphere Protocol will be applied to record
local climate data, such as air temperature and humidity, using ground-based sensors and data from meteorological stations, as well as thermal information obtained by orbital sensors.

The collected data will be processed using Geographic Information System (GIS) software, such as QGIS or ArcGIS, allowing for the cross-referencing of temperature, land use, and vegetation cover. From this integration, indices such as UTFVI and simulation tools, such as THIS and UHeat, will be used to identify, map, and analyze the intensity of heat islands.

Finally, the results obtained will be compared between more and less wooded areas, clearly demonstrating the relationship between the presence of vegetation and the reduction of urban temperature, providing support for proposals for afforestation and environmental planning.

When?

The project will be developed over a continuous monitoring period, allowing the collection and analysis of environmental data in different climatic conditions. Measurements will be taken monthly, with greater attention to periods of high temperatures, especially during spring and summer, when urban heat islands tend to intensify.

The collection of vegetation cover and temperature data will be done systematically and comparatively, enabling the analysis of thermal variation over time and the identification of critical areas. Whenever possible, the data obtained in the field will be compared with satellite images and historical records, ensuring greater reliability of the results.

Monitoring will occur throughout the project execution period, allowing the observation of seasonal changes, evaluating the impact of vegetation on urban thermal regulation, and generating consistent information to support environmental planning actions.

Where?

Thermal data collection is carried out in different types of environments, with the aim of comparing temperature variations and analyzing the formation of heat islands.

Data is collected in urban neighborhoods with little vegetation and a large presence of concrete, such as paved streets, areas with many buildings, residences, and low tree cover, places more prone to heat accumulation.

Information is also collected in areas with extensive vegetation cover, such as parks, farms, rural areas, and places with a large presence of trees and natural vegetation. These areas

generally have lower temperatures due to the presence
of shade and the evapotranspiration process of plants.

The collection is carried out using the GLOBE Observer application, in which the local temperatures, environmental characteristics, and photographs of the observed areas are recorded. The information is entered at different points in the city and in rural areas, allowing for thermal comparison between the different locations studied.

The collected data are organized and analyzed to understand the influence of vegetation and impermeable surfaces on temperature.

The results obtained contribute to the study of urban heat islands and can assist in urban planning, highlighting the importance of green areas for reducing temperatures and improving the quality of life of the population.

How were the collection sites chosen?

The collection sites were chosen based on direct observation of the environment, prioritizing clear differences in land use. The selection followed two main criteria:

a) Urbanized areas (without vegetation)
Sites were chosen that presented:
- Paved streets;
- Intense presence of concrete and buildings;
- Little or no tree cover;
- High sun exposure during the day.

Examples: central streets, neighborhoods with many buildings, residential areas with few trees.

b) Vegetated areas
Sites were chosen that presented:
- Significant presence of trees;
- Permeable soil;
- Natural shade;
- Continuous vegetation.

Examples: parks, farms, rural areas, and regions with natural vegetation cover.
The choice of these sites allowed for the comparison of environments with contrasting thermal conditions, essential for the study of heat islands.

Preparation for Data Collection
Before starting the data collection, the following steps were performed:
- Installation of the GLOBE Observer application on the mobile phone;
- Verification of GPS functionality;
- Selection of days with stable weather conditions (no rain at the time of collection);
- Setting similar times for measurements, avoiding large variations throughout the day.

How Temperature Measurements Were Taken
Measurements were taken on-site, using the mobile phone as a recording tool, always following the same procedure to ensure data standardization.

1. Step-by-step measurement in GLOBE Observer:
2. Open the GLOBE Observer application.
3. Select the type of observation related to temperature/environment.
4. Allow the application to automatically record the location (GPS).
5. Measure the air temperature on-site, keeping the mobile phone:

    - In the shade whenever possible;
    - Approximately 1.5 meters from the ground;
    - Away from very hot surfaces, such as walls or cars.

6. Record in the application:
    - Type of surface (asphalt, concrete, soil, vegetation);
    - Presence or absence of trees;
    - Existence of shade in the location;
    - Characteristics of the surroundings (buildings, houses, open areas).

7. Take photographs of the location, as requested by the application, showing:
    - The surrounding area;
    - The type of ground cover;
    - The presence or absence of vegetation.

8. Send the data through the application itself.

Repetition of measurements
The same procedure was repeated:

- At different points in urban areas;
- At different points in vegetated areas.

This allowed for comparison of temperatures within the city itself and between urban and rural environments.

Organization of collected data
After collection, the data recorded in the application were organized to:

- Compare temperatures between areas with and without vegetation;
- Relate thermal values to environmental characteristics;
- Identify patterns associated with the formation of urban heat islands.

Data collected

Brazil Citizen Science

Site: 22KGB260114

Measurements | Data Counts | Site Info | Photos

Next Site

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Site Information

Site ID	402351
Name	22KGB260114
Latitude	-21.586104°
Longitude	-48.817186°
Elevation	515.6m
Location Source	gps

Atmosphere Site

Activated At	2025-10-26 18:32:23.099053
Thermometer Type	other: soil or air

Image 1 – Coordenadas de Aferição - Itápolis/SP. Janeiro 2026.

Brazil Citizen Science

Site: 22KGB265113

Measurements | Data Counts | Site Info | Photos

Next Site

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Site Information

Site ID	408414
Name	22KGB265113
Latitude	-21.586944°
Longitude	-48.812346°
Elevation	507.8m
Location Source	gps

Atmosphere Site

Activated At	2026-01-17 20:09:25.211944
Thermometer Type	other: soil or air

Image 2 – Coordenadas de Aferição - Itápolis/SP. Janeiro 2026.

Image 3 – Data Counts - Itápolis/SP. Janeiro 2026.

Biosphere

Biometry - Tree Heights

Data Date Range: 2026-01-17 to 2026-01-17

Data Source: **GLOBE Observer App**
Measured At: **2026-01-17 20:03:00**
Tree Height: **9.18 m**
Circumference (cm): **170.00**
Genus: **Swietenia**
Species: **macrophylla**
Common Name: **Mógno**
Source Of Knowledge: **personal**
Location Method: **automatic**
Location Accuracy M: **39**
Mv Updated At: **2026-01-20 15:41:39.558011+00**
Elevation: **508.10 m**

Image 4 – Measurements - Itápolis/SP. Janeiro 2026.

Biosphere

Biometry - Tree Heights

Data Date Range: 2026-01-18 to 2026-01-18

Data Source: **GLOBE Observer App**
Measured At: **2026-01-18 13:37:00**
Tree Height: **7.38 m**
Circumference (cm): **118.00**
Common Name: **Mandioqueiro**
Source Of Knowledge: **personal**
Location Method: **automatic**
Location Accuracy M: **4214**
Mv Updated At: **2026-01-18 13:45:02.228218+00**
Elevation: **540.20 m**

Brazil Citizen Science
Site: 22KGA300995

Next Site
1/2

Measurements | Data Counts | Site Info | Photos

Site Information

Site ID	408448
Name	22KGA300995
Latitude	-21.693028°
Longitude	-48.77693°
Elevation	541.9m
Location Source	gps

Atmosphere Site

Activated At	2026-01-18 13:40:32.914534
Thermometer Type	other: soil or air

Image 5 – Measurements and coordenadas de aferição– Itápolis/SP. Janeiro 2026

Data relationship

Biosphere

Biometry - Tree Heights

Data Date Range: 2026-01-20 to 2026-01-20

Measurement: 1

Data Source: **GLOBE Observer App**
Measured At: **2026-01-20 21:53:00**
Tree Height: **0.19 m**
Location Method: **automatic**
Location Accuracy M: **7**
Mv Updated At: **2026-01-23 12:45:17.867717+00**
Elevation: **922.20 m**

Biosphere

Biometry - Tree Heights

Tree Height
Tree Photos

Data Date Range: 2026-01-20 to 2026-01-20

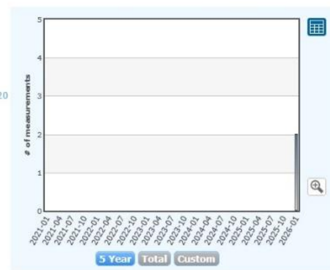

Image 7 – Measurements and Data Counts - Uberlândia/MG. Janeiro 2026

Biosphere

Biometry - Tree Heights

Data Date Range: 2026-01-24 to 2026-01-24

Data Source: **GLOBE Observer App**
Measured At: **2026-01-24 18:01:00**
Tree Height: **1.95 m**
Circumference (cm): **9.00**
Common Name: **Tento**
Source Of Knowledge: **personal**
Location Method: **manual**
Mv Updated At: **2026-01-24 18:20:01.975377+00**
Elevation: **789.40 m**

Site Information

Site ID	408984
Name	23KQS552789
Latitude	-20.972848°
Longitude	-42.545479°
Elevation	795.5m
Location Source	gps

Atmosphere Site

Activated At	2026-01-24 18:18:03.864967
Thermometer Type	other: soil or air

Image 8 – Measurements and Coordenadas – Rosário da Limeira/MG. Janeiro 2026

Differential Innovation

The innovation of this project lies in the integrated use of advanced technologies for monitoring urban heat islands, allowing for precise detection, detailed mapping, and continuous analysis of areas where the temperature is significantly higher than in surrounding rural regions.

The combination of remote sensing, ground sensors, Artificial Intelligence, and geospatial analysis makes it possible to understand the thermal behavior of cities at different scales, contributing to the management of urban thermal comfort and the construction of cities more resilient to climate change.

Main ways in which technology contributes to monitoring heat islands:

1. Remote sensing and satellites

- Satellites provide a macro-spatial and historical view, essential for identifying thermal patterns and long-term climate trends.

- Thermal satellite images: Satellites from agencies such as NASA and ESA capture longwave infrared radiation, allowing the calculation of Continental Surface Temperature (LST) and the mapping of critical heat areas with high spatial resolution.

- Temporal analysis: Comparing images over the years makes it possible to assess the spatiotemporal evolution of heat islands, associating them with urban growth and vegetation loss.

2. Internet of Things (IoT) and ground sensors

- While satellites offer a global view, IoT sensors allow real-time monitoring on a local scale, at street level.

- Fixed sensors: Low-cost devices installed on poles, buildings, and strategic points monitor variables such as air temperature, relative humidity, atmospheric pressure, and solar radiation.

- LoRaWAN networks: Long-range, low-energy wireless networks connect multiple sensors, enabling detailed mapping of urban microclimates. - Mobile sensors: Equipment installed in vehicles, such as buses or bicycles, collects thermal data in motion, generating dynamic urban heat maps.

3. Artificial Intelligence (AI) and Machine Learning

- Artificial Intelligence is fundamental for processing the large volume of data generated by satellites and sensors.

- Predictive modeling: Machine Learning and Deep Learning algorithms allow predicting

future thermal patterns and simulating urbanization and tree planting scenarios.

- Data fusion: AI integrates information from different sources (satellite, ground sensors, and climate data), creating highly accurate thermal maps.

4. Drones (UAVs)

- Monitoring of hard-to-reach areas: Drones equipped with thermal cameras make it possible to identify hotspots of extreme heat in specific locations, offering very high spatial resolution for urban microclimate studies.

Materials and Methods

Materials

The following materials and tools will be used to carry out the project:

- **Satellite images** with thermal and spectral data, for analysis of urban surface temperature;

- **Geographic Information System (GIS)** software, such as QGIS or ArcGIS, for processing, analysis and cross-referencing of spatial data;

- **Spectral indices:**

    - NDVI (Normalized Difference Vegetation Index), for evaluating vegetation cover; ○ NDBI (Normalized Difference Built-up Index), for identifying built-up areas;

    - UTFVI (Urban Thermal Field Variance Index), for analyzing the intensity of heat islands;

- **Urban simulation and analysis tools**, such as THIS (Tool for Heat Island Simulation) and UHeat (Arup);

- **Temperature sensors and weather stations** (e.g., MeteoBlue) for monitoring air temperature and other climatic variables;

- **Computer with internet access** for data processing and storage.

Methods

The project development will follow these methodological steps:

- **Delineation of the study area**

Selection of urban areas with different levels of vegetation cover, including regions with low tree cover and areas with greater vegetation presence, such as squares and parks.

- **Collection of vegetation cover data (Biosphere Protocol)**

Use of satellite images for NDVI calculation and analysis of urban vegetation distribution. When possible, field measurements will be carried out to complement the data.

- **Collection of climate data (Atmosphere Protocol)**

Monitoring of air temperature and humidity through sensors and weather stations, in addition to obtaining surface thermal data from orbital sensors.

- **Data processing and analysis**

The collected data will be processed in a GIS environment, allowing the cross-referencing of temperature, land use, and vegetation cover. The NDBI and UTFVI indices will be applied to identify and quantify urban heat islands.

- **Simulation and interpretation of results**

Tools such as THIS and UHeat will be used to simulate urban thermal behavior and visualize critical areas of heating.

- **Comparison and validation**

The results obtained in different areas of the city will be compared, allowing the evaluation of the relationship between the presence of vegetation and the reduction of urban temperature**.**

Tools

The mapping and analysis of urban heat islands are carried out through the integration of different technological tools, which allow the collection, processing, and interpretation of environmental and climatic data. The main tools used in this project are:

- **Satellites**: used due to the presence of thermal sensors, which allow measuring the temperature of the Earth's surface and identifying areas with greater heat accumulation.

- **GIS (Geographic Information System):** software such as QGIS or ArcGIS enable the storage, editing, and analysis of spatial information, allowing the cross-referencing of temperature data with land use and land cover.

- **Vegetation and Construction Indices:**

    - **NDVI (Normalized Difference Vegetation Index):** used to measure the density and distribution of urban vegetation.

    - **NDBI (Normalized Difference Built-up Index):** used to map built-up areas, such as regions with a predominance of concrete and asphalt.

    - **UTFVI (Urban Thermal Field Variance Index):** used to assess the intensity and distribution of heat in the urban environment.

- **THIS (Tool for Heat Island Simulation):** specific software to simulate and analyze the behavior of heat islands, assisting in understanding urban thermal patterns.

- **UHeat (Arup):** a digital tool that uses satellite imagery and open-source climate data to analyze and visualize urban areas affected by heat islands.

- **Ground sensors and weather stations (e.g., MeteoBlue):** used for continuous monitoring of air temperature and other climatic variables, allowing for the analysis of the atmospheric heat island.

Results

The results obtained from data collection and analysis indicate a clear thermal contrast between urbanized areas with low vegetation cover and areas with a greater presence of vegetation. Measurements recorded in densely built environments, characterized by asphalt, concrete surfaces, buildings, and limited tree cover, consistently showed higher temperatures when compared to vegetated areas.

Data collected in parks, rural areas, and locations with significant tree cover showed lower temperatures and greater thermal stability. These differences are associated with the presence of vegetation, which promotes shading and evapotranspiration, reducing heat accumulation on the surface.

Spatial comparison of the collected data allowed the identification of urban heat islands, especially in central and highly impermeable areas. The relationship between land use and temperature became evident when comparing measurement points with similar climatic conditions but different surface characteristics.

The records obtained through the GLOBE Observer application, including temperature measurements, environmental descriptions, geographic coordinates, and photographic documentation, allowed the visualization and comparison of thermal patterns in different locations. The organization of this data demonstrated that areas with reduced vegetation are more susceptible to heat accumulation, while environments with vegetation contribute to lower temperatures and greater thermal comfort.

The results confirm the strong influence of vegetation cover on the regulation of the urban microclimate and reinforce the importance of green areas as a mitigating factor for urban heat islands.

Conclusion

The development of this project allowed for a clear understanding of the relationship between the loss of urban vegetation and the intensification of heat islands in cities. The comparative analysis between areas with a large presence of concrete and low tree cover and regions with extensive vegetation cover showed that vegetation plays a fundamental role in the thermal regulation of the urban environment, contributing to the reduction of temperatures and the improvement of thermal comfort.

The data collected through the GLOBE Observer application, combined with the use of satellite images, terrestrial sensors, and geoprocessing tools, made it possible to identify areas more susceptible to heat accumulation and demonstrate the direct influence of impermeable surfaces on the increase in urban temperature. Thus, the study confirmed that locations with greater vegetation cover have milder temperatures due to the presence of shade and the process of evapotranspiration.

The results obtained reinforce the importance of environmental monitoring and the use of technologies in urban planning, highlighting the need to preserve and expand green areas as an effective strategy to mitigate the effects of heat islands. Thus, the project contributes to the development of more sustainable cities, resilient to climate change and with a better quality of life for the population.

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Badges

For this project, the badges "I am a Data Scientist" and "I am a Problem Solver" were selected, as both directly represent the steps developed during the research.

The badge "I am a Data Scientist" applies to the project because the investigation was based on the collection, organization, and analysis of environmental data. Thermal information was obtained through the GLOBE Observer application, in addition to observations made by the research team itself. The collected data was compared between different types of environments, such as urban areas with a large presence of concrete and areas with greater vegetation cover. From this analysis, it was possible to identify patterns, understand temperature variations, and make inferences about the formation of urban heat islands, also considering the limitations of the data used.

The "I am a Problem Solver" badge was chosen because the project goes beyond identifying the problem of heat islands, seeking to understand their causes and possible solutions. The results obtained demonstrate that areas with a greater presence of vegetation have lower temperatures, highlighting the importance of green areas in urban planning. Thus, the study uses Earth system science to contribute to reflections and proposals that can help reduce heat islands and improve the quality of life of the population.

These two badges represent the use of data-driven science and the commitment to applying scientific knowledge to address real environmental problems.

This project makes direct use of satellite data to investigate the formation of urban heat islands and the relationship between vegetation cover and surface temperature. Images and information from NASA satellite missions allow for the identification of largescale thermal variations, as well as mapping areas with greater vegetation and highly urbanized regions.

Remote sensing data were fundamental for the analysis of Earth's surface temperature and for the application of indices such as NDVI, enabling the identification of spatial and temporal patterns of heat islands. This information was integrated with data collected in the field using the GLOBE Observer application, allowing for comparison between local observations and orbital data.

In this way, the use of satellite data contributed to a broader and more scientific understanding of the phenomenon studied, strengthening the analyses, validating the results obtained, and assisting in answering research questions related to the impact of urban vegetation on the microclimate of cities.