

## ALBEDOMAPS: PROPOSAL OF A DIGITAL PLATFORM FOR MONITORING URBAN HEAT ISLANDS IN THE CUIABÁ METROPOLITAN REGION

## ALBEDOMAPS: PROPOSIÇÃO DE UMA PLATAFORMA DIGITAL PARA MONITORAMENTO DE ILHAS DE CALOR URBANAS NA BAIXADA CUIABANA

## ALBEDOMAPS: PROPUESTA DE UNA PLATAFORMA DIGITAL PARA EL MONITOREO DE ISLAS DE CALOR URBANAS EN LA REGIÓN METROPOLITANA DE CUIABÁ



<https://doi.org/10.56238/sevened2026.008-201>

**Matheus Nunes dos Santos<sup>1</sup>, Luiz Carlos de Almeida<sup>2</sup>, Mario Marcos Morel<sup>3</sup>, Nayara Gomes de Oliveira<sup>4</sup>, Olivia Fernandes Boretti<sup>5</sup>, Paulo Ricardo dos Santos Silva<sup>6</sup>, Phelipe Matheus Sales Kinack<sup>7</sup>, Quedna Brito dos Reis<sup>8</sup>, Rander Teixeira Barros<sup>9</sup>, Regis Alves Dourado<sup>10</sup>, Gracyeli Santos Souza Guarienti<sup>11</sup>, Lidia Martins da Silva<sup>12</sup>**

### ABSTRACT

Tropical cities have experienced increasing urban heat island intensification due to rapid urban expansion, soil sealing, and the reduction of vegetative cover, factors that negatively affect public health, energy consumption, and overall quality of life. In the Cuiabá metropolitan region, characterized by persistently high temperatures, there is a lack of accessible digital platforms capable of integrating climate data and supporting urban planning strategies. In response to this gap, this study proposes the development of AlbedoMaps, a collaborative digital platform designed to monitor urban heat islands using remote sensing data. The

<sup>1</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: Matheus.nunesufg@gmail.com

<sup>2</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: lucadealmeida@gmail.com

<sup>3</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: morel.tsi@gmail.com

<sup>4</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: oliveiragnayara@gmail.com

<sup>5</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: oliviaboretti@gmail.com

<sup>6</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: pauloshutt@gmail.com

<sup>7</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: phellipem19@gmail.com

<sup>8</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: quedna71@hotmail.com

<sup>9</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: randernet@hotmail.com

<sup>10</sup> Undergraduate Student in Science and Technology. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: regis@rg.com.br

<sup>11</sup> Dr. in Environmental Physics. Universidade Federal de Mato Grosso (UFMT). Mato Grosso, Brazil. E-mail: gracyeli.guarienti@ufmt.br

<sup>12</sup> Dr. in Applied Computing. Universidade do Vale do Rio dos Sinos (UNISINOS). Mato Grosso, Brazil. E-mail: lidiamartins10@gmail.com

methodological approach is based on the conceptual modeling of the system, integrating Landsat 8/9 satellite data and Land Surface Temperature (LST) estimates obtained through the Split-Window technique into a web-based architecture developed in Python. The outcome of this proposal was the structuring of a Minimum Viable Product (MVP) capable of generating interactive thermal maps while incorporating principles of citizen science and corporate environmental governance (ESG). The results indicate that the proposed platform presents significant potential as a tool to support local climate governance, democratize environmental information, and contribute to sustainable urban planning initiatives.

**Keywords:** Urban Heat Islands. Remote Sensing. Urban Albedo. Citizen Science. Sustainable Urban Planning.

## RESUMO

As cidades de clima tropical enfrentam intensificação das ilhas de calor urbanas em decorrência da expansão urbana desordenada, da impermeabilização do solo e da redução da cobertura vegetal, fatores que impactam a saúde pública, o consumo energético e a qualidade de vida. Na região da Baixada Cuiabana, caracterizada por temperaturas elevadas ao longo do ano, observa-se a ausência de plataformas acessíveis que integrem dados climáticos e ferramentas de visualização voltadas ao planejamento urbano. Diante desse cenário, o presente estudo propõe o desenvolvimento do AlbedoMaps, uma plataforma digital colaborativa destinada ao monitoramento de ilhas de calor urbanas por meio de dados de sensoriamento remoto. A metodologia fundamenta-se na modelagem conceitual da solução, utilizando dados dos satélites Landsat 8/9 e estimativas de Temperatura da Superfície Terrestre (LST), processadas por técnica Split-Window, integradas a uma arquitetura web desenvolvida em Python. Como resultado, estruturou-se um Produto Mínimo Viável (MVP) capaz de gerar mapas térmicos interativos e de incorporar princípios de ciência cidadã e sustentabilidade corporativa (ESG). Conclui-se que a proposta apresenta potencial como instrumento de apoio à governança climática local, contribuindo para a democratização do acesso à informação ambiental e para o planejamento urbano sustentável.

**Palavras-chave:** Ilhas de Calor Urbanas. Sensoriamento Remoto. Albedo Urbano. Ciência Cidadã. Planejamento Urbano Sustentável.

## RESUMEN

Las ciudades de clima tropical han experimentado una intensificación de las islas de calor urbanas debido a la expansión urbana acelerada, la impermeabilización del suelo y la reducción de la cobertura vegetal, factores que impactan negativamente la salud pública, el consumo energético y la calidad de vida. En la región metropolitana de Cuiabá, caracterizada por altas temperaturas a lo largo del año, se observa la ausencia de plataformas digitales accesibles que integren datos climáticos y apoyen la planificación urbana. Frente a esta problemática, el presente estudio propone el desarrollo de AlbedoMaps, una plataforma digital colaborativa orientada al monitoreo de islas de calor urbanas mediante el uso de datos de teledetección. La metodología se fundamenta en la modelación conceptual del sistema, integrando datos de los satélites Landsat 8/9 y estimaciones de Temperatura de la Superficie Terrestre (LST) obtenidas mediante la técnica Split-Window, incorporadas en una arquitectura web desarrollada en Python. Como resultado, se estructuró un Producto Mínimo Viable (MVP) capaz de generar mapas térmicos interactivos e integrar principios de ciencia ciudadana y gobernanza ambiental corporativa (ESG). Se concluye que la propuesta presenta potencial como herramienta de apoyo a la gobernanza climática local y al desarrollo de estrategias de planificación urbana sostenible.

**Palabras clave:** Islas de Calor Urbanas. Teledetección. Albedo Urbano. Ciencia Ciudadana. Planificación Urbana Sostenible.

## 1 INTRODUCTION

The process of intensive urbanization in recent decades has caused significant changes in the energy balance of cities, contributing to the emergence and intensification of the so-called urban heat islands. This phenomenon is mainly due to the replacement of natural surfaces by impermeable and low-reflectance materials, such as asphalt and concrete, which alter the local thermal dynamics and increase heat retention (Oke, 1987). According to Landsberg (1981), cities profoundly modify the fluxes of radiation, ventilation and humidity, configuring their own microclimates that differ substantially from the surrounding rural areas. In tropical regions, such effects tend to be more expressive due to the high solar incidence throughout the year.

In the Brazilian context, studies have shown that cities with hot climates are more vulnerable to the impacts of heat islands, with direct repercussions on public health, energy consumption, and the thermal comfort of the population (Amorim, 2019). In an investigation on urban thermal dynamics, Morais et al. (2013) highlight that heat islands occur mainly in cities with a high degree of urbanization and result in an increase in average temperatures in urban areas compared to rural areas. In the Baixada Cuiabana, especially in the conurbation between Cuiabá and Várzea Grande, the high average annual temperatures associated with disorderly urban growth reinforce the need for technical instruments that support mitigation and urban planning strategies (Souza et al., 2025).

The advancement of remote sensing technologies has significantly expanded the possibilities of urban environmental monitoring. The estimation of Land Surface Temperature (LST) by means of thermal images from Landsat satellites has been consolidated as a method widely used in the scientific literature (Sobrino; Jiménez-Muñoz; Paolini, 2004). According to Jiménez-Muñoz et al. (2014), split-window algorithms allow the recovery of surface temperature with greater accuracy, becoming strategic tools for spatio-temporal analysis in urban contexts. However, despite the methodological robustness of these approaches, the results produced remain, in many cases, restricted to the academic environment, with low public accessibility and limited integration with local governance instruments.

In this scenario, initiatives based on citizen science emerge as promising alternatives to bring scientific production and society closer together. Bonney et al. (2009) highlight that collaborative projects expand community engagement and strengthen scientific literacy, contributing to more participatory decision-making processes. At the same time, the incorporation of environmental impact metrics and corporate sustainability practices has been pointed out as a relevant mechanism for the viability and continuity of socio-environmental

projects, especially when articulated with international reporting and transparency benchmarks (GRI, 2021).

It is in this context that AlbedoMaps is inserted, whose conception originated in the Bachelor of Science and Technology course at the Federal University of Mato Grosso (UFMT), within the scope of the discipline Integrator Seminar IV. Structured by academics of the course as an extension action aimed at real problems of society, the project articulated knowledge of thermal physics, remote sensing and development of web systems, proposing a digital platform for interactive visualization of urban thermal patterns in the Baixada Cuiabana. Although born in an academic environment, the project was conceived with the potential for practical applicability and scalability.

In view of the gap identified — not in the absence of thermal analysis methods, but in the lack of accessible digital tools that integrate data, visualization, and social participation — the following research question is formulated: how can a digital platform based on Landsat data contribute to the monitoring of urban heat islands and support climate governance strategies in the Baixada Cuiabana?

Thus, the general objective of this work is to propose and describe AlbedoMaps as an interactive web platform structured in the format of Minimum Viable Product (MVP) for visualization of urban thermal patterns. Specifically, it seeks to: (i) integrate LST estimates derived from Landsat 8/9 data through the split-window technique; (ii) develop web architecture capable of providing interactive thermal maps; (iii) outline engagement mechanisms based on citizen science; and (iv) propose a sustainability model based on environmental impact metrics aligned with international benchmarks. By delimiting these objectives, it is intended to contribute to the debate on digital innovation applied to the urban climate, offering a technological proposal applicable to cities with a tropical climate.

## **2 THEORETICAL FRAMEWORK**

### **2.1 URBAN HEAT ISLANDS AND TRANSFORMATIONS IN THE CLIMATE OF CITIES**

Initially, it is important to understand that Urban Heat Islands (ICU) are defined as a horizontal thermal anomaly, characterized by the increase in temperature in the built environment compared to its rural surroundings (Amorim, 2019). This phenomenon is mainly due to the replacement of the natural soil cover by impermeable surfaces, such as asphalt and concrete, which significantly alter the urban energy balance by increasing the flow of sensible heat and reducing the evaporative cooling provided by vegetation (Sales; Sales; Mendonça, 2022). As a result, there is greater thermal storage during the daytime and gradual release of heat throughout the night, intensifying thermal discomfort in urbanized areas.

From a theoretical point of view, heat islands can be classified into three distinct levels: surface, related to the temperature of the earth's surface; the urban canopy layer, associated with the air between buildings; and the urban border layer, which surrounds the atmospheric portion above the city (Amorim, 2019). This distinction is particularly relevant, as it guides both analysis methodologies and mitigation strategies, especially when remote sensing techniques are employed to estimate the Earth's Surface Temperature (LST).

In addition, although heat islands are often associated with large metropolises, recent research shows that small and medium-sized cities also have significant thermal differences in relation to rural areas. Amorim (2019, p. 23) highlights that the urban climate problem is not restricted to large centers, stating that:

It is evident that problems related to the urban climate, such as the generation of heat islands, the impacts triggered by precipitation events or the problems resulting from atmospheric pollution are more visible and perceived by the population in large urban agglomerations. However, in the various studies carried out in Brazilian climatology, and at the international level, it has been verified that as well as in large urban centers, medium and small cities have also undergone strong transformations in the natural landscape, materialized through different forms of air, water, soil and subsoil pollution, in addition to transformations in the morphology and structure of the urban environment. Rivers and streams are channeled or have their courses altered; the morphology is modified through embankments and constructions; The vegetation is removed. (Amorim, 2019, p. 23)

From this perspective, the understanding that heat islands are an expression of the socio-spatial transformations promoted by the urbanization process, regardless of the demographic scale of the city, is expanded. Studies carried out in Brazilian municipalities indicate thermal differences of more than 6 °C between urban and rural areas (Amorim, 2020), showing that the phenomenon is not restricted to large capitals. In addition, a strong correlation is observed between surface water stress and temperature increase, reaching rates of up to 96% between soil moisture reduction and thermal intensification (Sales; Sales; Mendonça, 2022). These data consolidate the scientific consensus regarding the central role of vegetation cover and water availability in urban climate regulation.

At the same time, the impacts of heat islands go beyond the environmental dimension, reaching the sphere of public health. Technical reports indicate that heat waves are associated with increased mortality from cardiovascular, respiratory, and kidney diseases (Brasil, 2025). In this context, vulnerable groups, such as the elderly – due to their lower capacity for thermoregulation – and children – due to physiological immaturity – become particularly susceptible to the extreme effects of district heating.

Given this scenario, the literature points to different mitigation strategies. Bioclimatic Urbanism proposes the use of natural ventilation through urban parameters, such as the coefficient of use and progressive setbacks between vertical buildings (Brandão; Barbosa; Barbirato, 2019). In a complementary way, the implementation of green infrastructure and the use of high reflectivity materials, associated with the increase in urban albedo, are recognized as effective measures in reducing the accumulation of sensible heat (Cutieru, 2021; Brandão; Barbosa; Barbirato, 2019).

## 2.2 URBAN ALBEDO AND RADIATIVE BALANCE OF BUILT SURFACES

In the context of urban climate change, urban albedo — understood as the ability of city surfaces to reflect incident solar radiation — is a fundamental variable in the thermal regulation of the built environment. In physical terms, the greater the reflectance of a surface, the lower the amount of energy absorbed and converted into sensible heat. However, the urbanization process has promoted the replacement of natural surfaces by artificial materials, such as asphalt and concrete, whose radioactive properties favor greater energy absorption, directly contributing to the intensification of heat islands.

In this context, mitigation strategies based on the modification of the optical properties of materials have been widely discussed in the literature. It is recommended to use cold materials, characterized by high solar reflectance and high thermal emittance, attributes that make it possible to maintain lower surface temperatures. As demonstrated by Muniz-Gäal et al. (2018), the thermal efficiency of roofs is directly related to their ability to reflect solar radiation and emit accumulated heat. The authors show that light colors have higher reflectance values; however, they point out that surface roughness can increase absorptance due to the greater number of interreflections of the incident radiation. Thus, the relationship between reflectance and thermal performance proves to be more complex than a simple association between color and temperature.

To measure this solar heat rejection capacity, the Solar Reflectance Index (SRI) is used, which incorporates both the reflectance and the emissivity of the material. Comparative studies indicate that glazed ceramic tiles, especially in light shades, have superior thermal performance when compared to concrete tiles (Muniz-Gäal et al., 2018). Thus, the choice of construction materials plays a strategic role in urban thermal mitigation, particularly in cities located in regions with a hot climate.

However, the analysis of albedo cannot be dissociated from urban morphology. The radiative balance in cities is profoundly influenced by the configuration of so-called urban canyons, where multiple internal reflections of solar radiation produce the so-called "cavity

effect". Pereira and Marinoski (2022) demonstrate that increasing solar reflectance on facades and pavements can reduce surface temperatures; however, simultaneously, it can raise the radiation incident inside the canyon due to the successive reflections between the vertical surfaces. Therefore, interventions based exclusively on increasing albedo must consider the geometric complexity of urban space.

In addition, the distribution of radiative flux in long waves is a central element to understand urban thermal behavior. Machado (2009) demonstrates that urban morphology directly influences the redistribution of nocturnal thermal radiation, especially in vertical areas, where there is greater heat trapping. The relationship between the height of the buildings and the width of the roads — expressed by the H/W ratio — proves to be decisive in this process, since deeper canyons tend to reduce thermal dissipation and intensify energy storage.

More recently, the literature has broadened the discussion by incorporating albedo as an indicator of urban resilience. Ferreira and Vieira (2025, p. 3), when relating surface reflectance and climate adaptation, state that:

The albedo or hemispheric reflectance — which represents the fraction of solar radiation reflected by a surface — plays a crucial role in urban thermal regulation, influencing the urban climate, energy consumption in buildings, and greenhouse gas emissions [...] Given the relevance of albedo for urban resilience and mitigation of climate impacts, this article presents the methodology used to calculate the percentage of urban areas with high albedo (AAA), devoid of vegetation cover. The measurement of this indicator, described in ABNT NBR ISO 37123:2021, contributes to monitoring and promoting resilience to heat in urban areas, supporting strategies to mitigate greenhouse gas emissions, and promoting adaptations, contributing to sustainable urban development. This process requires a systemic approach, with integration of multidisciplinary data, where data collection and systematization of information is essential for the consolidation of integrated municipal management plans in parallel with the development of public policies. (Ferreira; Vieira, 2025, p. 3)

From this approach, it is observed that albedo is no longer just a physical-radiative variable and starts to assume a strategic role in sustainable urban planning. The need for multidisciplinary data integration and information systematization reinforces the importance of digital tools capable of translating technical metrics into accessible spatial representations.

### 3 METHODOLOGY

The present study is characterized as an applied research, of exploratory and descriptive nature, oriented to the development of a technological solution aimed at the monitoring of urban heat islands. It is the conception and modeling of a digital artifact — AlbedoMaps — structured from the perspective of design science research, a methodological approach aimed at the creation and evaluation of artifacts intended to solve real problems

(Hevner et al., 2004). Unlike purely empirical research, this approach prioritizes the construction of technological solutions that are theoretically grounded and validated for their technical feasibility.

The delimited study area corresponds to the Baixada Cuiabana, covering mainly the municipalities of Cuiabá and Várzea Grande, in the state of Mato Grosso. The choice of this region is based on its tropical continental climate condition, marked by high temperatures throughout the year and prolonged periods of drought, factors that favor the intensification of heat islands. In addition, the dynamics of urban expansion and the scarcity of public thermal visualization platforms reinforce the relevance of the proposal.

To estimate the Land Surface Temperature (LST), data from the Landsat 8 and Landsat 9 satellites were used, especially the thermal bands of the TIRS (Thermal Infrared Sensor) sensor. The use of Landsat images is widely consolidated in the scientific literature for urban thermal analysis, due to its adequate spatial resolution and free availability (Sobrino; Jiménez-Muñoz; Paolini, 2004). The processing of the images followed standardized steps: conversion of digital values (Digital Numbers – DN) into spectral radiance; conversion of radiance to brightness temperature; and application of the split-window technique for atmospheric correction and obtaining the LST.

The split-window technique was adopted for its efficiency in recovering surface temperature from thermal bands, considering atmospheric variations and surface emissivity (Jiménez-Muñoz et al., 2014). As the authors point out, the application of algorithms based on the difference between thermal bands allows reducing errors associated with atmospheric interference, increasing the reliability of thermal estimates. The processing was carried out through scripts developed in Python language, using libraries aimed at the manipulation of geospatial data, which ensures replicability and methodological transparency.

As far as the development of the platform is concerned, the architecture was structured into two main components: backend and frontend. The backend was responsible for the organization, storage and treatment of geospatial data, while the frontend was designed as an interactive interface for cartographic visualization of thermal patterns. This modular structure favors scalability and future integration with new indicators, such as metrics related to urban albedo and climate resilience.

The conceptual modeling of the platform also considered the possibility of integration with normative indicators, such as the percentage of urban areas with high albedo (AAA), described in ABNT NBR ISO 37123:2021, as discussed by Ferreira and Vieira (2025). Although the complete calculation of this indicator has not been operationalized at this stage, its methodological forecast reinforces the systemic character of the proposal and its

compatibility with sustainable urban planning strategies.

From an ethical point of view, the research used exclusively public remote sensing data made available by international space agencies, not involving the collection of personal data or sensitive information, which does not require submission to a research ethics committee.

Finally, limitations inherent to the study are recognized, especially those related to the spatial resolution of the Landsat data and the dependence on adequate atmospheric conditions for image acquisition. In addition, as it is a Minimum Viable Product (MVP), the platform still requires improvements in terms of automatic data updating and integration with local sensors. However, such limitations do not compromise the conceptual validity of the proposal, but indicate paths for future development.

#### **4 RESULTS AND DISCUSSIONS**

Based on the methodology adopted, a Minimum Viable Product (MVP) of the AlbedoMaps platform was structured, capable of integrating remote sensing data and providing interactive thermal maps referring to the Baixada Cuiabana. The processing of Landsat 8 and 9 images allowed the estimation of the Earth's Surface Temperature (LST), evidencing spatial patterns compatible with the literature on urban heat islands. The areas with higher building density and lower vegetation cover had higher surface temperatures than the less urbanized peripheral regions, corroborating findings previously described by Amorim (2019) and Morais et al. (2013).

The cartographic visualization revealed more intense thermal concentrations in areas characterized by high soil impermeabilization, which reinforces the understanding that the replacement of vegetation cover by artificial surfaces contributes significantly to the increase of sensible heat flux (Sales; Sales; Mendonça, 2022). Such spatial patterns confirm the scientific consensus that urban morphology and land use exert a determining influence on the thermal dynamics of cities (Oke, 1987).

From a technological point of view, the platform demonstrated functional feasibility by allowing interactive navigation, identification of critical areas, and potential future integration with normative indicators, such as the percentage of urban areas with high albedo (AAA), as discussed by Ferreira and Vieira (2025). The modular structure adopted, with Python backend and interactive frontend, proved to be adequate for the organization and presentation of geospatial data, ensuring transparency and methodological replicability.

When comparing the results obtained with the literature, there is convergence regarding the relevance of remote sensing as a tool for urban thermal diagnosis. According

to Sobrino, Jiménez-Muñoz and Paolini (2004), the estimation of the LST by means of Landsat data is a robust method for spatial analysis of heat islands. In addition, the application of the split-window technique, as systematized by Jiménez-Muñoz et al. (2014), proved to be adequate to reduce atmospheric interference, increasing the reliability of thermal estimates.

However, unlike most of the studies analyzed, which focus exclusively on the technical analysis of data, this proposal advances by structuring a digital instrument aimed at democratizing access to climate information. In this sense, AlbedoMaps is close to the perspective of citizen science discussed by Bonney et al. (2009), by enabling technical data to be translated into representations understandable to the non-specialized public, expanding the potential for social engagement and support for urban governance.

However, it is necessary to recognize limitations inherent to the study. The spatial resolution of Landsat images (30 meters) may not capture thermal microvariations at a very local scale, especially in areas of complex urban morphology. In addition, the absence of in situ validation by means of meteorological stations or urban sensors constitutes a methodological limitation, restricting the comparative analysis between surface temperature and air temperature. Such aspects point to the need for future integration with local weather data and urban IoT sensors.

Another limitation refers to the fact that the system is in the MVP stage, requiring improvements related to the automatic updating of images and the incorporation of additional metrics, such as vegetation indices and formal indicators of urban resilience described in ABNT NBR ISO 37123:2021. Despite this, the results obtained indicate technical feasibility and practical relevance of the proposal.

Thus, the results not only confirm patterns already described in the literature on heat islands, but also contribute by proposing a model of integration between climate diagnosis, interactive visualization and potential articulation with public policies. By combining remote sensing, digital architecture, and an environmental governance perspective, AlbedoMaps positions itself as a promising tool to support sustainable urban planning in tropical cities.

## **5 CONCLUSION**

This article presented AlbedoMaps as a proposal for an experimental application developed within the scope of the Integrator Seminar III discipline of the Bachelor's Degree in Science and Technology at the Federal University of Mato Grosso (UFMT). The initiative emerged as an extension action aimed at the practical application of interdisciplinary

knowledge acquired throughout the training, articulating fundamentals of urban climatology, remote sensing and development of web systems.

By proposing a digital platform for viewing urban thermal patterns in the Baixada Cuiabana, the study sought to respond to the gap between scientific production on heat islands and the accessible availability of this information to public managers and civil society. In this sense, the work reinforces the importance of integrating environmental data, technological tools and urban planning, contributing to the strengthening of local climate governance.

Although the application is in the experimental phase and structured as a Minimum Viable Product (MVP), its conception demonstrates technical feasibility and potential for expansion. More than presenting consolidated results, the study offers a replicable methodological and technological model, which can be improved through the incorporation of new metrics, empirical validations, and integration with urban sensors.

Thus, the main contribution of the work lies in the articulation between teaching, extension and technological innovation, showing that academic projects can transcend the university environment and be configured as instruments to support urban sustainability. By emerging from a curricular component aimed at solving real problems, AlbedoMaps reaffirms the role of interdisciplinary training in the construction of digital solutions applied to contemporary climate challenges.

## **ACKNOWLEDGMENTS**

We would like to thank the Faculty of Science and Technology (FCT), an academic unit of the University Campus of Várzea Grande (CUVG) of the Federal University of Mato Grosso (UFMT), for the institutional support and the academic environment that enabled the development of this work within the scope of the Bachelor's Degree in Science and Technology. Also recognizing the importance of the curricular component Integrator Seminar III as a training space that encouraged the articulation between teaching, extension and technological innovation applied to real problems.

## **REFERENCES**

- Amorim, M. C. C. T. (2019). Ilhas de calor urbanas: Métodos e técnicas de análise. *Revista Brasileira de Climatologia*.
- Amorim, M. C. C. T. (2020). Ilhas de calor urbano em cidades de pequeno e médio porte no Brasil e o contexto das mudanças climáticas. *Confins*, (46).

- Bonney, R., et al. (2009). Citizen science: A developing tool for expanding science knowledge and scientific literacy. *BioScience*, 59(11), 977–984.
- Brandão, L. K. V., Barbosa, R. V. R., & Barbirato, G. M. (2019). Verticalização e ambiente térmico urbano: Estudo de parâmetros urbanísticos em fração urbana na cidade de Arapiraca/AL. In 15º Encontro Nacional de Conforto no Ambiente Construído. ANTAC.
- Brasil. Ministério da Ciência, Tecnologia e Inovação. (2025). Clima em síntese: Estudos sobre saúde e ondas de calor no Brasil (2015–2025). MCTI.
- Cutieru, A. (2021, 26 de setembro). Cidades do mundo todo começam a implementar novas estratégias de combate às ilhas de calor. ArchDaily Brasil.
- Ferreira, F. L. S., & Vieira, R. M. S. P. (2025). O albedo das superfícies como indicador de resiliência urbana. In 18º Encontro Nacional de Conforto no Ambiente Construído. ANTAC.
- Global Reporting Initiative. (2021). Consolidated set of GRI sustainability reporting standards 2021. GRI.
- Hevner, A. R., et al. (2004). Design science in information systems research. *MIS Quarterly*, 28(1), 75–105.
- Jiménez-Muñoz, J. C., et al. (2014). Land surface temperature retrieval methods from Landsat-8 thermal infrared sensor data. *IEEE Geoscience and Remote Sensing Letters*, 11(10), 1840–1843.
- Landsberg, H. E. (1981). *The urban climate*. Academic Press.
- Machado, A. J. (2009). Distribuição espacial do fluxo radiativo em ondas longas na Região Metropolitana de São Paulo (Tese de doutorado). Universidade de São Paulo.
- Morais, H. F., Albuquerque, E. M., Andrade, S. C., & Santos, C. A. C. (2013). Identificação do fenômeno de ilhas de calor urbano em Belo Horizonte – MG. In XVI Simpósio Brasileiro de Sensoriamento Remoto (pp. 7423–7430). INPE.
- Muniz-Gäal, L. P., et al. (2018). Eficiência térmica de materiais de cobertura. *Ambiente Construído*, 18(1), 7–22.
- Oke, T. R. (1987). *Boundary layer climates* (2nd ed.). Routledge.
- Pereira, N. H. G., & Marinoski, D. L. (2022). Análise do impacto da refletância solar das superfícies no fluxo de radiação de onda curta em cânions urbanos. In 19º Encontro Nacional de Tecnologia do Ambiente Construído (pp. 1–11). ANTAC.
- Sales, R. S. B., Sales, D. S., & Mendonça, J. C. (2022). Balanço de energia e ilhas de calor no perímetro urbano de Campos dos Goytacazes, RJ: Um estudo de caso. *Revista Brasileira de Geografia Física*, 15(6), 3093–3105.
- Sobrino, J. A., Jiménez-Muñoz, J. C., & Paolini, L. (2004). Land surface temperature retrieval from Landsat TM 5. *Remote Sensing of Environment*, 90, 434–440.



Souza, N. S., Nogueira, M. C. J. A., Santos, F. M. M., & Sanches, L. (2025). Urban heat and cool island dynamics in a rapidly growing tropical city: Land-use implications for the built environment of Cuiabá, Brazil. *Journal of Housing and the Built Environment*.