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**URBAN GEOPOLITICS
AND ITS IMPACT ON
THE HEAT ISLAND
EFFECT IN THE
MUNICIPALITY OF SÃO
PAULO - SP, BRAZIL**

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Abstract: Legislation can influence the Heat Island effect of cities. Urban geopolitics addresses questions about plans and projects for the city, as well as direct action on the territory. Considering the territorial extension and population density of the city of São Paulo, the climate impact on urban plans is paramount for the inhabitant. This study seeks to systematize information obtained from research that allows identifying the state of the art related to planning and the urban heat island of the city of São Paulo, including the area where the Mirante de Santana Meteorological Station is installed, due to its historical and to the threat of interference in their physical space. The bibliometric mapping and organization of sample research data made it possible to understand the relevance of legislation in the form and use of urban land while also suggesting the carrying out of more studies on the topic.

Keywords: Urban Policy, Heat Island, São Paulo.

INTRODUCTION

The municipality of São Paulo (SP, Brazil) has a population of 11,253,503 people distributed unevenly across 1.521,202 km² in length, with an average demographic density of 7,398.26 inhabitants/km² (IBGE, 2017). Brazilian legislation provides for the creation of a master plan for cities with more than twenty thousand inhabitants, according to the City Statute, in the Public Policy chapter (BRASIL, 2008). This way, the Strategic Master Plan (PDE) of the municipality of São Paulo, published in 2014 (SÃO PAULO, 2015), allows organizing the city's growth and the urban instruments that act on the urban form from 2014 to 2029.

The review of the PDE for São Paulo, which was supposed to take place in 2021 to align goals, was postponed to 2022-2023 due to the Covid-19 pandemic, and the Plan was

approved by the City Council on June 26, 2023, on Monday voting. The 2023 review aims at greater verticalization of the city and the expansion of the radii of the Urban Structuring Axes, opposing the incentive for walkability/active mobility, threatening, in particular, the main meteorological measurement point located in the north of the municipality, Mirante de Santana Station, belonging to INMET (CALEJO, 2023; HONÓRIO, 2023).

The utilization coefficient defines the potential built area on each lot and is established by the PDE and Municipal Zoning (SÃO PAULO, 2015). The current fiscal and urban incentive (updated PDE) for the verticalization of areas up to one kilometer away from subway stations and those located up to 450 meters from bus lanes will promote the change of all urban canyons served by transport in an area larger than planned for a walkable city (GEHL, 2013; SANTORO et al., 2023), thus intensifying the use of cars, as the distance between housing and public transport was increased, and the emission of greenhouse gases into the atmosphere.

This idea also implodes the linking of the axis to the incentive of active modes of mobility, since the smaller radii (up to 450m or 600m depending on the mode) kept a logic of travel possible on foot or by bicycle to the stations. (SANTORO et al., 2023, s/p.).

The PDE review also addresses changing the height of buildings around Mirante de Santana with a view to verticalizing the region. Castelani (2023) mentions that such an initiative will result in the loss of historical parameters and will influence urban planning, which depends on climate monitoring, according to experts in the field. The station follows international parameters, making it part of the UN global meteorological agency network. According to Castelani (2023), municipal legislation from 1971 defines the height of the viewpoint as the maximum

gauge (maximum height of buildings) around the measuring point.

This issue shows the geopolitical nature of the topic, influencing not only data and plans for São Paulo, but also the reading of global data due to the international nature of the measurement center. Another point that raises this relationship is highlighted by Santoro et al. (2023) when reporting the absence of the topic of expanding the radius of influence of the Axes of Transformation in the public hearings on the review. Therefore, the criticism about the production of urban space is supported by Carlos's (2004) description:

[...] The space production process reveals ways of approaching social reality, a product modified by the experience of the place, and from there in its relationship with the world, a multiple relationship of sensation and action, but also of desire, as a consequence of identification with the projection onto the other. [...] These are places, that man lives within the city that relate to his daily life and way of life [...] (CARLOS, 2004, p.51).

The urban heat island, generated by human action, is intensified by built density and population concentration, and corresponds to the difference in temperature between urban and rural areas (OKE, 1973). The Climate Action Plan of the city of São Paulo (SÃO PAULO, 2022) – Plan Climate was prepared in response to the city's commitment to the Paris Agreement and the C40 group.

Although it foresees actions to eliminate carbon emissions, raise awareness about climate change and qualify green areas, there are no specific measures for the Urban Transformation Axes in the Plan. This fact raises a geopolitical discussion (MATTOS, 1975; CARLOS, 2004). Based on the above, this study aims to systematize scientific information that demonstrates the need to consider the effects of the São Paulo heat island on the PDE.

The method used to verify the state of the

art on the urban heat island and the planning of the city of São Paulo corresponds to the list of articles on Web of Science and Google Scholar, with the creation of bibliometric maps to identify the correspondence between the articles. After this stage, articles aligned with the theme were read and selected and organized into a table summarizing the information obtained in each study. A survey of studies covering the Mirante de Santana Meteorological Station was also carried out.

The research results demonstrate, through bibliometric mapping, the 20 keywords and the 23 most representative references within the sample of 47 articles, making it possible to understand the choice of terms and the overview of the theoretical and methodological bases used by the authors. Fifteen selected articles report that urban form and the height of buildings influence the Urban Heat Island in São Paulo, which can be intensified by anthropogenic heat and the energy source used. Urban planning, (SÃO PAULO, 2022), has the function of adapting urban growth and the heat island effect. With this, we consider the arguments presented by Carlos (2004) about urban space being a condition, means and product of human action, exposing the need to discuss this topic. The research results present the need to consider the territorial relationship surrounding Mirante de Santana and its influence on climate studies in urban planning.

MATERIALS AND METHODS

The method applied consists of verifying the state of the art regarding the socio-environmental impacts of the heat island in São Paulo, through bibliometric mapping and recording research results. The search for articles published on the study topic was carried out on the Web of Science page, using the terms “heat island”, “São Paulo” and “plan*”, resulting in the initial selection of 47

articles. The same terms were also searched on the Google Scholar page in order to consider the national panorama, resulting in a sample of 3,750 articles, demonstrating the relevance of the topic in texts written in Portuguese.

The search for studies that use the Mirante de Santana station to collect meteorological data was carried out on Google Scholar. The bibliographic survey using the name “Mirante de Santana” resulted in 273 articles, the low number (three) of results found in the Web of Science about this meteorological station made statistical analysis of the data and bibliometric mapping unfeasible.

The bibliometric mapping carried out by the free VOSViewer program for manipulating data (scientific publications) allows the analysis of the co-occurrence of keywords and the co-citation of references cited in studies collected on the Web of Science page. The analysis of these relationships makes it possible to understand the quality of the sample’s basic bibliography and its relevance.

After creating the bibliometric maps, a refinement was carried out within the sample already selected. Due to the fact that the city and state of São Paulo are homonymous, some selected studies do not present data about the municipality. Four articles were discarded because it was not possible to access them or because they did not belong to the topic. The final selection resulted in the identification of 15 studies related to geopolitics and the heat island in the city of São Paulo. This selection was organized in a table containing author, article title, year of publication, magazine and main results related to the topic studied. The synthesis of information obtained in the selected studies aims to understand the state of the art regarding the socio-environmental impacts of the heat island in São Paulo.

RESULTS AND DISCUSSION

The search on Web of Science resulted

in 47 articles related to the research topic, which were analyzed through bibliometric mapping carried out with the free VOSViewer program. The co-occurrence of keywords in the articles demonstrates that studies added new terminologies over the years, as indicated in Figure 1. The use of the term “local climate zones” stands out in the period 2020, and this definition was established in the literature by Stewart and Oke (2012). Other study techniques on the topic, such as “simulation” and “model”, are part of the keyword sample.

Terms such as “urbanization”, “urban” and “city” are present throughout the analyzed period, however, terms related to urban planning are not found, which raises the discussion proposed by Carlos (2004) about the need for criticism and questioning relating to the geopolitics of the city of São Paulo, through strategic plans and legislation.

Issues relating to the Urban Climate System – S.C.U. (MONTEIRO, 2021) are associated with the terms “sea breeze”, “heat island” and “urban climate”. More specific issues of the study site, such as “temperature”, “cover”, “surface temperature” and “climate” are highlighted in different years. The incorporation of the term “vegetation” as a keyword is more recent, dating from 2021, according to the mapping carried out.

The analysis of the co-citation of references cited in studies allows us to understand which authors are most important for the discussion of the topic. Figure 2 summarizes this information and allows us to identify four lines of study established through the difference in colors. Line 1 – pink – comprises eight articles published from 1987 to 2020. Line 2 – green – presents six studies from 1978 to 2017, some of which address specific municipalities. Line 3 – purple – is marked by the study of Local Climate Zones between 1973 and 2014, with five articles. Line 4 – lilac – has four articles from 1982 to 2010 that address the mesoscale

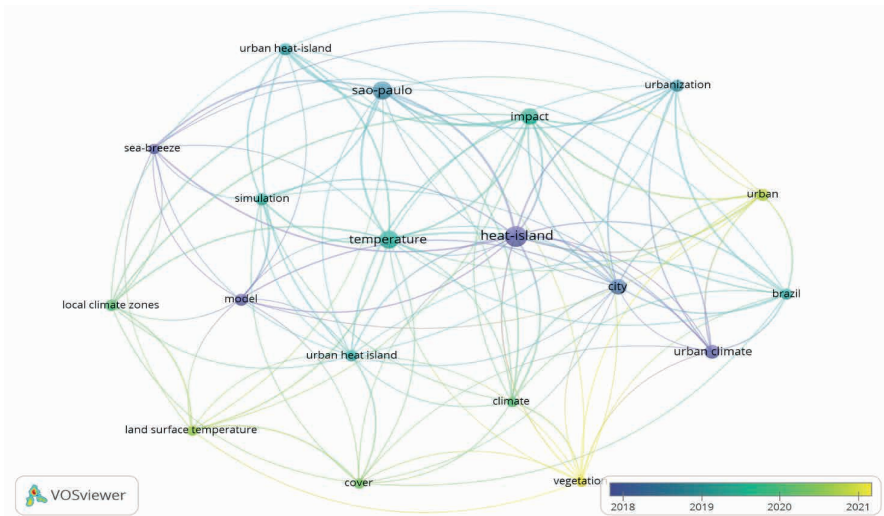


Figure 1: Bibliometric mapping of keyword co-occurrence between 2017 and 2022. Source: Own authors, 2023.

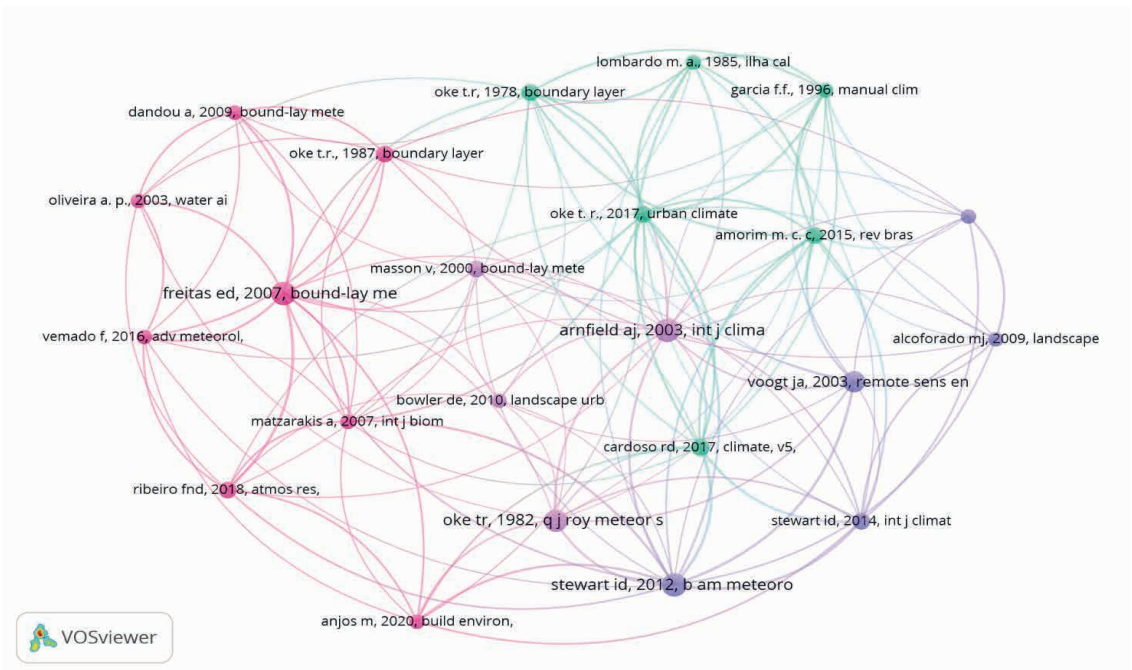


Figure 2: Bibliometric mapping of co-citation of cited references. Source: Own authors, 2023.

and the energy issue associated with the heat island.

The bibliometric map in Figure 2 indicates the presence of common references in the 47 selected articles, such as studies by Lombardo (1985), Freitas (2007) and Amorim, Dubreuil and Cardoso (2015), which deal with the urban climate in specific municipalities. Arnfield (2003) reviews aspects related to the heat island, including energy, and Masson (2000) analyzes the urban form of mesoscale models and flow. Stewart and Oke (2012) address a classification system to study the heat island according to urban configuration. This way, such studies address the anthropogenic influence on the climate and the need to adapt the urban form to obtain the energy balance appropriate to thermal comfort.

The refinement of the article review, selecting only studies focusing on the city of São Paulo, made it possible to record the results of 15 studies. At this stage, articles that did not focus on the metropolitan region of São Paulo were discarded. The information regarding the publication of the articles and the main scientific results obtained in each study were organized and are shown in Table 1. Such data enable the identification of bibliographic references used in the discussion of the planning of the city of São Paulo in relation to the urban heat island.

The analysis of the state of the art regarding studies on urban heat island in the city of São Paulo allows us to visualize the scenario of publications related to the topic in several aspects. Of the selected articles, the oldest dates back to 2009, a fact that may be related to the absence of digitalized and, therefore, older physical articles on the topic. There is a greater number of publications in 2019 (four articles) and 2021 (three articles). The publications are not concentrated in a specific journal, with scientific journals being associated with the methodology used in each study. Graph

1 shows this relationship between year of publication and number of articles published.

In Graph 2, when comparing the main theme of each study, we identified that 34% of the sample (five studies) address aspects of urban form, urban growth or land use to study the Heat Island. Vegetation is addressed in 27% of the sample, in four studies. The other topics raised, such as urban infrastructure planning, sea breeze and identification of pollution and surface temperature, each represent 13% of the total.

Data collection to verify the state of the art regarding Mirante de Santana included 273 articles, some of which were related to the local effect of climate change, which was carried out by analyzing the historical air temperature series observed at the meteorological station. One of these articles corresponds to the bibliographic review carried out by Marengo et al. (2020) on the trend of extreme rainfall in the metropolitan region of São Paulo since the beginning of observations at the station, in 1945, at Mirante de Santana. The authors also present projections of hydrological disasters and report the increased risk in vulnerable areas, thus assisting urban planning based on a historical series.

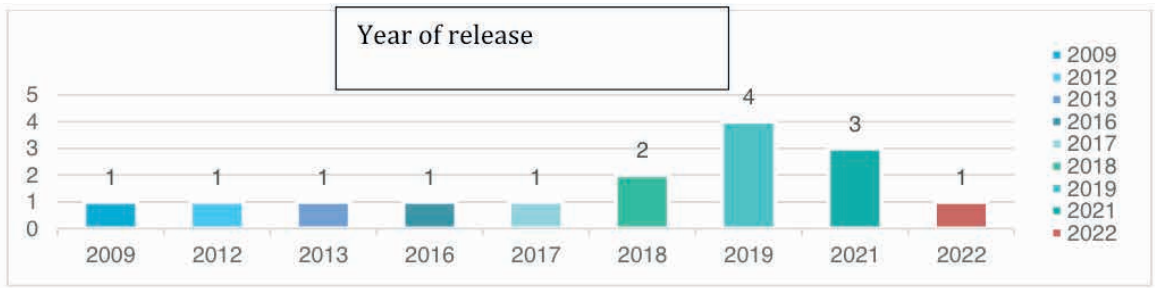
FINAL CONSIDERATIONS

The research results show that current legislation superficially addresses the issue of the urban heat island effect in the city of São Paulo. According to the bibliography consulted, the effect of the urban heat island may intensify if mitigation and adaptation policies are not applied in the urban area of São Paulo. The little association between politics and the urban environment harms the population's quality of life. Based on the studies analyzed, there is additionally a need to preserve the urban conditions of the area surrounding Mirante de Santana, with the height of buildings lower than the height of

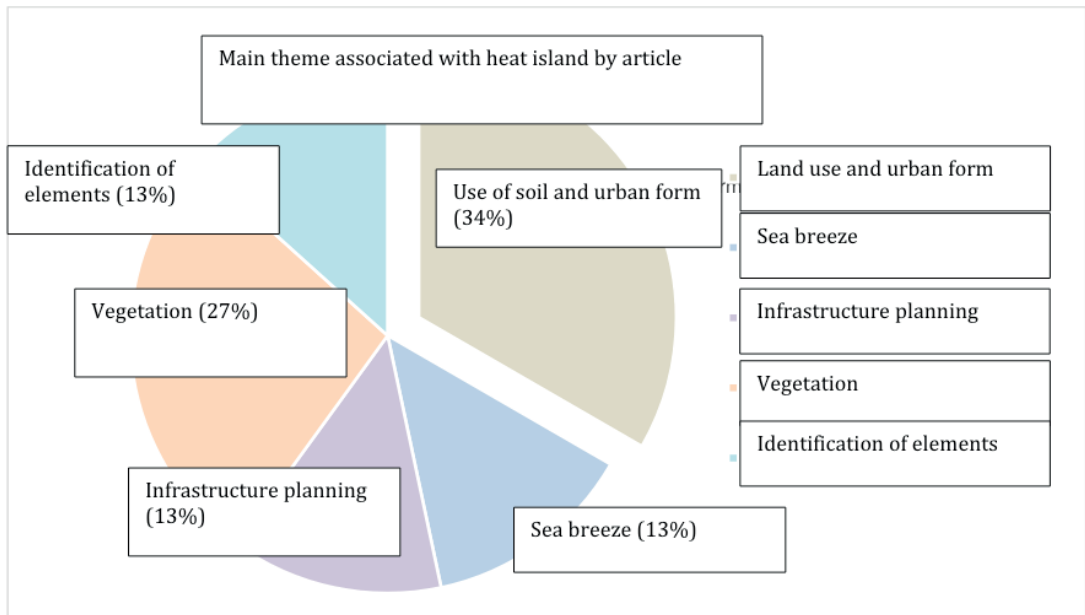
2009
<p>Authors: Mendonça, Magaly; Lombardo, Magda A. Periodical: ``REVISTA DE GEOGRAFIA NORTE GRANDE`` Title: Urban climate of subtropical coastal Atlantic cities: the case of the Florianópolis conurbation Results: The authors carry out a comparison between the cities of Florianópolis and São Paulo. As a reflection of the urbanized area and the different land uses in the city of São Paulo, the horizontal temperature gradient between urban and rural areas is greater than 10 °C, in stable weather conditions.</p>
2012
<p>Authors: Backman, J.; Rizzo, L. V.; Hakala, J.; Nieminen, T.; Manninen, H. E.; Morais, F.; Aalto, P. P.; Siivola, E.; Carbone, S.; Hillamo, R.; Artaxo, P.; Virkkula, A.; Petaja, T.; Kulmala, M. Periodical: ATMOSPHERIC CHEMISTRY AND PHYSICS Title: On the diurnal cycle of urban aerosols, black carbon and the occurrence of new particle formation events in springtime São Paulo, Brazil Results: The authors analyze the diurnal cycle of particulate pollution in the spring in the city of São Paulo. The conclusions demonstrate that the air mass is more stagnant in the early hours of the morning, according to the PBL model. This fact worsens the air quality during this period. During clear sky conditions the heat island effect affects the measurement and there is a change in wind direction towards the edge of the city. According to the survey, the RMSP can be compared with Mexico City in terms of population density and particle concentration.</p>
2013
<p>Authors: Monsalves-Gavilan, P.; Pincheira-Ulbrich, J.; Rojo Mendoza, F. Periodical: ATMOSPHERE Title: Climate change and its effects on urban spaces in Chile: A summary of research carried out in the period 2000-2012 Results: The study includes a literature review on urban climate studies. The city of São Paulo is reported in five referenced works. The conclusions of the survey make it possible to affirm that the incorporation of vegetation can mitigate heat waves and that urban land use and urban planning must be more adaptable to climate change.</p>
2016
<p>Authors: Vemado, Felipe; Pereira Filho, Augusto José Periodical: ADVANCES IN METEOROLOGY Title: Severe Weather Caused by Heat Island and Sea Breeze Effects in the Metropolitan Area of Sao Paulo, Brazil Results: The authors highlight the effect of sea breezes in the metropolitan area of São Paulo. With the constant growth of the urban area over the decades, urban heat intensified precipitation and accumulated rain.</p>
2017
<p>Authors: Morais, Marcos Vinicius Bueno de; Marciotto, Edson R.; Urbina Guerrero, Viviana Vanesa; de Freitas, Edmilson Dias. Periodical: URBAN CLIMATE Title: Effective albedo estimates for the Metropolitan Area of Sao Paulo using empirical sky-view factors Results: The authors study the Sky View Factor (SVF) of the city of São Paulo. Albedo, related to the emissivity of materials, can contribute to intensifying or mitigating the Urban Heat Island. The height of buildings and materiality can influence these factors.</p>
2018
<p>Authors: Flores Rojas, Jose L.; Pereira Filho, Augusto J.; Karam, Hugo A.; Vemado, Felipe; Masson, Valery. Periodical: BOUNDARY-LAYER METEOROLOGY Title: Effects of Explicit Urban-Canopy Representation on Local Circulations Above a Tropical Mega-City Results: The authors analyze the effect of sea breezes in the metropolis of São Paulo. They conclude that wind speed is reduced by the urban roughness of the São Paulo metropolis. In specific cases, the decrease in wind results in increased transport of moisture to upper layers of the atmosphere through sea breezes. The authors compare the city of São Paulo to a semi-desert canopy due to the suppression of rainfall.</p>
<p>Authors: Prata Shimomura, Alessandra Rodrigues; Ferreira, Anderson Targino. Periodical: PLEA Title: LCZ in Metropolitan Regions: Surface Temperature in Urban and Rural Areas Results: The study carried out in the macro-region of the city of São Paulo presents the mapping of Local Climate Zones, identifies the Surface Heat Island (LST) and classifies the heat island. The authors conclude that the LST is 2.5°C higher in the RMSP than in the rural area due to urban area.</p>

2019
<p>Authors: Bender, Andreia; Freitas, Edmilson Dias; Toledo Machado, Luiz Augusto. Periodical: CLIMATIC CHANGE Title: The impact of future urban scenarios on a severe weather case in the metropolitan area of São Paulo Results: The urban structure functions as a heat reservoir. The authors consider the Strategic Master Plan of São Paulo to estimate the projected growth of the urban area of the metropolitan region for 2030. And, based on the projected urban area, they verify the impacts on the atmosphere through the use of a numerical model (BRAMS). The results show increased atmospheric instability and wind shear. The urban area and building height are also associated with an increase in storms.</p>
<p>Authors: Collaço, Flavia Mendes de Almeida; Simoes, Sofia G.; Dias, Luis Pereira; Duic, Neven; Seixas, Julia; Bermann, Celio. Periodical: JOURNAL OF CLEANER PRODUCTION Title: The dawn of urban energy planning - Synergies between energy and urban planning for Sao Paulo (Brazil) megacity. Results: The authors talk about planning energy sources in the city of São Paulo. Alternatives for reducing the impact of the Urban Heat Island (UHI) are addressed in the text, demonstrating the alignment of the study with the urban issue. Green areas are highlighted as an effective alternative for reducing UHI.</p>
<p>Authors: Ferreira, Luciana Schwandner; Silva Duarte, Denise Helena. Periodical: URBAN CLIMATE Title: Exploring the relationship between urban form, land surface temperature and vegetation indices in a subtropical megacity Results: The authors seek to define the Local Climate Zone - LCZ based on the study by Stewart and Oke (2012) for the metropolitan region of São Paulo. With this, they compare the Urban Heat Island with the presence of vegetation, through NDVI, in the study region</p>
<p>Authors: Shinzato, Paula; Simon, Helge; Silva Duarte, Denise Helena; Bruse, Michael. Periodical: ARCHITECTURAL SCIENCE REVIEW Title: Calibration process and parameterization of tropical plants using ENVI-met V4-Sao Paulo case study Results: The study was carried out for the city of São Paulo using ENVI-met V4 to define the model calibration process. The Urban Heat Island (UHI) presents a regional nighttime variation of 6°C to 8°C, in the coldest months (May to August). The authors indicate urban vegetation as one of the alternatives to mitigate UHI and benefit the microclimate.</p>
2021
<p>Authors: Ribeiro, Flavia Noronha Dutra; Umezaki, Arissa Sary; Chiquetto, Julio Barboza; Santos, Isabel; Machado, Pedro Gerber; Miranda, Regina Maura; Almeida, Paulo Santos; Simoes, Andre Felipe; Mouette, Dominique; Leichsenring, Alexandre Ribeiro; Ueno, Helene Mariko. Journal: SCIENCE OF THE TOTAL ENVIRONMENT Title: Impact of different transportation planning scenarios on air pollutants, greenhouse gases and heat emission abatement Results: The study shows that changes in transport planning can reduce GHG emissions and, therefore, anthropogenic heat.</p>
<p>Authors: Wei, Chunzhu; Chen, Wei; Lu, Yang; Blaschke, Thomas; Peng, Jian; Xue, Desheng. Periodical: REMOTE SENSING Title: Synergies between Urban Heat Island and Urban Heat Wave Effects in 9 Global Mega-Regions from 2003 to 2020 Results: The study addresses the magnitude of the UHI (Urban Heat Island) and heat waves in mega regions such as the cities of São Paulo and Rio de Janeiro. The authors argue that built density and urban growth in both urban areas are associated with the intensity of heat waves.</p>
<p>Authors: Yamasoe, Marcia Akemi; Rosario, Nilton Manuel; Santos Martins Almeida, Samantha Novaes; Wild, Martin. Periodical: ATMOSPHERIC CHEMISTRY AND PHYSICS Title: Fifty-six years of surface solar radiation and sunshine duration over Sao Paulo, Brazil: 1961-2016 Results: The analyzed period of clear days and cloudy days in the city of São Paulo had a significant change in the spatial domain, which contributed to intensifying the Urban Heat Island from 1980 to 2010.</p>
2022
<p>Authors: Nascimento, Augusto Cezar Lima do; Galvani, Emerson; Assis Gobo, Joao Paulo; Wollmann, Cassio Arthur. Periodical: ATMOSPHERE Title: Comparison between Air Temperature and Land Surface Temperature for the City of São Paulo, Brazil Results: The authors compare surface temperature with air temperature to identify the Urban Heat Island</p>

Table 1: Summary of selected studies. Source: Own authors, 2023.



Graph 1: Year of publication of articles. Source: Own Authors, 2023.



Graph 2: Percentage of the 15 studies that analyzed the São Paulo Heat Island and were associated with the themes land use and urban form, sea breeze, infrastructure planning, vegetation and identification of elements. Source: Own Authors, 2023.

the viewpoint, so that climate studies do not show changes resulting from the new urban planning.

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REFERENCES

- AMORIM, Margarete C. de C. T.; DUBREUIL, Vincent; CARDOSO, Renata dos S.. MODELAGEM ESPACIAL DA ILHA DE CALOR URBANA EM PRESIDENTE PRUDENTE (SP) – BRASIL. **Revista Brasileira de Climatologia**, [S.L.], v. 16, n. 1, p. 29-45, 30 jun. 2015. ABClima (Brazilian Association of Climatology). <http://dx.doi.org/10.5380/abclima.v16i0.40585>.
- ARNFIELD, A. John. Two decades of Urban Climate Research: A review of Turbulence, Exchange of Energy and Water, and the Urban Heat Island. **Int. J. Climatol**, v. 23, n. 1, p. 1–26, jan. 2003.
- BACKMAN, John; RIZZO, Luciana V.; HAKALA, Jani; NIEMINEN, Tuomo; MANNINEN, Hanna E.; MORAIS, Fernando G.; AALTO, Pasi P.; SIIVOLA, Erkki; CARBONE, Samara; HILLAMO, Risto; ARTAXO, Paulo; VIRKKULA, Aki; PETÄJÄ, Tuukka; KULMALA, Markku. On the diurnal cycle of urban aerosols, black carbon and the occurrence of new particle formation events in springtime São Paulo, Brazil. **Atmospheric Chemistry And Physics**, [S.L.], v. 12, n. 23, p. 11733-11751, 11 dez. 2012.
- BENDER, Andréia; FREITAS, Edmilson D.; MACHADO, Luiz A. T. The impact of future urban scenarios on a severe weather case in the metropolitan area of São Paulo. **Climatic Change**, [S.L.], v. 156, n. 4, p. 471-488, ago. 2019.
- BRASIL. **Estatuto da Cidade**. – 3. ed. – Brasília : Senado Federal, Subsecretaria de Edições Técnicas, 2008. 102 p.
- CALEJO, Marco. **Revisão do PDE**: Câmara aprova revisão do Plano Diretor. 2023. Câmara Municipal de São Paulo. Disponível em: <https://www.saopaulo.sp.leg.br/blog/revisao-do-pde-camara-aprova-revisao-do-plano-diretor/>. Acesso em: 07 dez. 2023.
- CARLOS, Ana Fani A.. **Espaço Urbano**: Novos escritos sobre a cidade. São Paulo: Contexto, 2004, 154 p.
- CASTELANI, Clayton. Folha de São Paulo. **Plano Diretor ameaça estação referência para o clima em SP**: Artigo aprovado pela Câmara libera prédios no entorno do Mirante de Santana. 2023. Mudança Climática. Disponível em: <https://www1.folha.uol.com.br/cotidiano/2023/06/plano-diretor-ameaca-estacao-referencia-para-o-clima-em-sp.shtml>. Acesso em: 15 jun. 2023.
- COLLAÇO, Flávia M. de A.; SIMOES, Sofia G.; DIAS, Luís P.; DUCIC, Neven; SEIXAS, Júlia; BERMANN, Célio. The dawn of urban energy planning – Synergies between energy and urban planning for São Paulo (Brazil) megacity. **Journal Of Cleaner Production**, [S.L.], v. 215, p. 458-479, abr. 2019. Elsevier BV. <http://dx.doi.org/10.1016/j.jclepro.2019.01.013>.
- FERREIRA, Luciana S.; DUARTE, Denise H. S.. Exploring the relationship between urban form, land surface temperature and vegetation indices in a subtropical megacity. **Urban Climate**, v. 27, p. 105-123, 2019.
- FLORES ROJAS, José .L.; PEREIRA FILHO, Augusto J.; KARAM, Hugo A.; VEMADO, Felipe; MASSON, Valéry. Effects of Explicit Urban-Canopy Representation on Local Circulations Above a Tropical Mega-City. **Boundary-Layer Meteorol** 166, 83–111 , 2018. <https://doi.org/10.1007/s10546-017-0292-8>.

FREITAS, Edmilson Dias de. Effective albedo estimates for the Metropolitan Area of São Paulo using empirical sky-view factors. **Urban Climate**, [S.L.], v. 21, p. 183-194, set. 2017. Elsevier BV. <http://dx.doi.org/10.1016/j.uclim.2017.06.007>.

GEHL, Jan. Cidades para pessoas. Tradução Anita Di Marco. Editora: Perspectiva, 2013.

HONÓRIO, Gustavo. **Novo Plano Diretor: veja o que muda na cidade de SP com revisão de lei**. 2023. G1 SP e TV Globo - São Paulo. Disponível em: <https://g1.globo.com/sp/sao-paulo/noticia/2023/06/27/novo-plano-diretor-veja-o-que-muda-na-cidade-de-sp-com-revisao-de-lei.ghtml>. Acesso em: 07 dez. 2023.

IBGE - Instituto Brasileiro de Geografia e Estatística (org.). **Cidade de São Paulo**. 2017. Disponível em: <https://cidades.ibge.gov.br/brasil/sp/sao-paulo/panorama>. Acesso em: 02 nov. 2022.

LOMBARDO, Magda A.. Ilha de calor nas metrópoles: o exemplo de São Paulo. São Paulo: Hucitec, 1985.

MARENGO, Jose A.; ALVES, Lincoln M.; AMBRIZZI, Tercio; YOUNG, Andrea; BARRETO, Naurinete J. C.; RAMOS, Andrea M.. Trends in extreme rainfall and hydrogeometeorological disasters in the Metropolitan Area of São Paulo: a review. **Annals Of The New York Academy Of Sciences**, [S.L.], v. 1472, n. 1, p. 5-20, 13 fev. 2020. Wiley. <http://dx.doi.org/10.1111/nyas.14307>

MASSON, Valéry. A physically-based scheme for the urban energy budget in atmospheric models. **Boundary-layer meteorology**, v. 94, p. 357-397, 2000.

MATTOS, Meira. **Brasil: Geopolítica e Destino**. Rio de Janeiro: Biblioteca do Exército, 1975.

MENDONÇA, Magaly; LOMBARDO, Magda A. El clima urbano de ciudades subtropicales costeras atlánticas: el caso de la conurbación de Florianópolis. **Rev. geogr. Norte Gd.**, Santiago, n. 44, p. 129-141, Dec. 2009. Disponível em: <http://www.scielo.cl/scielo.php?script=sci_arttext&pid=S071834022009000300007&lng=en&nrm=iso>. Acesso em: 07 Nov. 2023. <http://dx.doi.org/10.4067/S0718-34022009000300007>.

MONTEIRO, Carlos Augusto de Figueiredo. Teoria e Clima Urbano. In: MONTEIRO, Carlos Augusto de Figueiredo; MENDONÇA, Francisco (org.). **Clima Urbano**. 2. ed. São Paulo: Contexto, 2021. p. 9-68.

MORAIS, Marcos Vinícius Bueno de; MARCIOTTO, Edson R.; GUERRERO, Viviana V. U.; MONSALVES-GAVILAN, Pablo.; PINCHEIRA-ULBRICH, Jimmy; ROJO MENDOZA, Félix.. Climate change and its effects on urban spaces in Chile: A summary of research carried out in the period 2000-2012. **Atmósfera** [online], vol.26, n.4, pp.547-566, 2013. ISSN 0187-6236.

RIBEIRO, Flávia N. D.; UMEZAKI, Arissa S.; CHIQUETTO, Júlio B.; SANTOS, Isabel; MACHADO, Pedro G.; MIRANDA, Regina M.; ALMEIDA, Paulo S.; SIMÕES, André F.; MOUETTE, Dominique; LEICHSENRING, Alexandre R.; UENO, Helene M.. Impact of different transportation planning scenarios on air pollutants, greenhouse gases and heat emission abatement. **Science Of The Total Environment**, [S.L.], v.781 p.146708, ago.2021. Elsevier BV. <http://dx.doi.org/10.1016/j.scitotenv.2021.146708>.

NASCIMENTO, Augusto C. L. do; GALVANI, Emerson; GOBO, João P. A.; WOLLMANN, Cássio A.. Comparison between Air Temperature and Land Surface Temperature for the City of São Paulo, Brazil. **Atmosphere**, [S.L.], v. 13, n. 3, p. 491, 18 mar. 2022. MDPI AG. <http://dx.doi.org/10.3390/atmos13030491>.

OKE, Timothy R. City size and urban heat island. In: **Atmospheric Environment**. Oxford. 1973, p. 769-779.

PRATA-SHIMOMURA, Alessandra R.; FERREIRA, Anderson T. LCZ in metropolitan regions: surface temperature in urban and rural areas. **34TH INTERNATIONAL CONFERENCE ON PASSIVE AND LOW ENERGY ARCHITECTURE (PLEA 2018)**, Hong Kong, China: Smart and Healthy within the 2-degree limit. V. II, p. 796-801, 2018.

SANTORO, Paula F.; STROHER, Laisa; COSTA, Deiny; SOUZA, Paula V. S.; AZZOLINI, Gabriela. **Substituto do Plano Diretor de São Paulo propõe verticalização generalizada. Veja como seu bairro será afetado**. 2023. LabCidade – Laboratório Espaço Público e Direito à Cidade – é um laboratório da Faculdade de Arquitetura e Urbanismo da Universidade de São Paulo. Disponível em: <http://www.labcidade.fau.usp.br/entenda-a-proposta-de-verticalizacao-generalizada-do-substituto-do-plano-diretor-de-sao-paulo/>. Acesso em: 15 jun. 2023.

SÃO PAULO (Município). Prefeitura do Município de São Paulo – PMSP. **Plano Diretor Estratégico do Município de São Paulo**: lei municipal nº 16.050, de 31 de julho de 2014; texto da lei ilustrado. São Paulo: PMSP, 2015.

SÃO PAULO (Município). Secretaria Municipal do Verde e do Meio Ambiente. **Plano de Ação Climática**. 2022. Disponível em: https://www.prefeitura.sp.gov.br/cidade/secretarias/meio_ambiente/comite_do_clima/index.php?p=284394. Acesso em: 03 nov. 2022.

SHINZATO, Paula; SIMON, Helge; DUARTE, Denise H. S.; BRUSE, Michael. Calibration process and parametrization of tropical plants using ENVI-met V4 – Sao Paulo case study. **Architectural Science Review**, [S.L.],v.62,n.2,p.112-125, jan.2019. Informa UK Limited. <http://dx.doi.org/10.1080/00038628.2018.1563522>.

STEWART, Iain D.; OKE, Timothy R., 2012. Local climate zones for urban temperature studies. **Bull. Am. Meteorol. Soc.** 93, 1879–1900, 2012. <https://doi.org/10.1175/bams-d-11-00019.1>.

VEMADO, Felipe; PEREIRA FILHO, Augusto J.. Severe Weather Caused by Heat Island and Sea Breeze Effects in the Metropolitan Area of São Paulo, Brazil. *Advances In Meteorology*, [S.L.], v. 2016, p. 1-13, 2016. Hindawi Limited. <http://dx.doi.org/10.1155/2016/8364134>.

YAMASOE, Marcia A.; ROSÁRIO, Nilton M. É.; ALMEIDA, Samantha N. S. M.; WILD, Martin. Fifty-six years of surface solar radiation and sunshine duration over São Paulo, Brazil: 1961–2016. **Atmospheric Chemistry And Physics**, [S.L.], v. 21, n. 9, p. 6593-6603, 3 maio 2021. Copernicus GmbH. <http://dx.doi.org/10.5194/acp-21-6593-2021>.

WEI, Chunzhu; CHEN, Wei; LU, Yang; BLASCHKE, Thomas; PENG, Jian; XUE, Desheng. Synergies between Urban Heat Island and Urban Heat Wave Effects in 9 Global Mega-Regions from 2003 to 2020. **Remote Sensing**, [S.L.], v. 14, n. 1, p. 70, 24 dez. 2021. MDPI AG. <http://dx.doi.org/10.3390/rs14010070>.