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Tree planting as a health promotion strategy on cycle paths in a municipality with unfavorable weather conditions for active transport

Marla Simone Bueno Ribeiro
Mestre em Promoção da Saúde, PPGPS, Universidade Cesumar, Brazil
marlaribeiroarquiteta@gmail.com

Barbara Peixoto de Araujo
Mestranda em Tecnologias Limpas, PPGTL, Universidade Cesumar, Brazil
barbarap_peixoto@hotmail.com

Rute Grossi-Milani
Professora Doutora, PPGPS e PPGTL, Universidade Cesumar, Brazil
Bolsista do Programa Produtividade em Pesquisa do ICETI Instituto Cesumar de Ciência, Tecnologia e Inovação.
rute.milani@unicesumar.edu.br

ABSTRACT

Improving conditions and encouraging active mobility has become a necessity in the current parameters of urbanization in Brazil. Using active transport, through cycling, provides a sustainable characteristic to the urban environment, integrating environmental, social and economic improvements. The present study aims to analyze the influence of afforestation on cycling structures' comfort condition in a Brazilian municipality in a region with extreme climate conditions: high temperatures and humidity unfavorable to active transport. Temperature and relative humidity data were collected using an HTR-157 thermo-hygrometer in 7 urban cycling structures in the municipality of Sinop, State of Mato Grosso, Brazil, from March to July 2020. Temperature and humidity were used to determine the Temperature and Humidity Index (THI). The analysis using a dendrogram, carried out using the hierarchical grouping method, for the tree-lined and non-tree-lined cycle paths, showed that cycle path 7, the only one with the presence of continuous and contiguous trees on both sides of the road, showed different behavior from all the others, with more favorable temperature and relative humidity indicators for the entire analyzed period (dry and rainy). It is concluded that afforestation constitutes an important strategy for promoting health in the urban environment, providing better thermal comfort and environmental quality conditions, especially when there are low values of relative air humidity, positively supporting aspects related to afforestation such as aesthetics, safety and microclimate.

KEY WORDS: Active Mobility. Thermal Comfort. Urban Green Spaces.

1 INTRODUCTION

Urban mobility is a basic component of the population's quality of life and has been one of the greatest challenges to urban structures in cities, largely due to increased use of motor vehicles. The impacts of this behavior go beyond urban mobility, affecting the environment with an increase in atmospheric pollution as well as physical and mental health, with an increase in respiratory diseases, obesity, a sedentary lifestyle and stress (NETTO; RAMOS, 2017).

In recent decades, the problem of urban growth has become the target of several studies (SILVA et al., 2019; CASTRO; KANASHIRO, 2015; CAPALONGO et al., 2020; VALE, 2016; SOUSA; PENHA-SANCHES, 2019; NETTO; RAMOS, 2017; SIQUEIRA-GAY et al., 2017; XIMENES et al., 2020; FIALHO; DE ALVAREZ, 2017), focusing on urban planning, urban mobility, health promotion and urban afforestation. Such studies contribute to developing initiatives that improve citizen well-being, proposing a more harmonious integration of public spaces with individual demands.

As an alternative to mobility problems, using bicycles and implementing cycle paths have gained strength in urban planning. Using this active mode of transport provides a more sustainable characteristic to the urban environment, integrating improvements from an environmental, social and even economic point of view. The health benefits of using a bicycle are notable as well as reducing costs of living, due to the low maintenance of the mode (VALE, 2016; MENESES; SALES, 2018).

The decision to use bicycles as a means of transport in cities involves a series of issues, with emphasis on the available infrastructure. Aspects such as safety, direct routes and comfort are essential for potential users of this mode to make use of it, contributing to the reduction of motor vehicles on the streets (BARBERAN et al., 2017; VANSTEENKISTE et al., 2017; MENESES; SALES, 2018; FRATER; KINGHAM, 2020). As for comfort, especially when considering the tropical climate that predominates in Brazil, the heat and high temperatures hinder the use of bicycles for activities of daily living. Strategies that improve such characteristics must be taken into consideration during projects to implement cycling structures (MENESES; SALES, 2018; FRATER; KINGHAM, 2020).

One of the widely disseminated strategies for improving the urban microclimate is afforestation, which plays a fundamental role in cycling structures. More wooded areas are influenced by the evapotranspiration process, allowing the absorption of heat and the release of water into the atmosphere (RAMOS et al., 2019). Trees act as a shading agent for surfaces, preventing direct sunlight, making cycling more pleasant (SIQUEIRA-GAY; DIBO; GIANNOTTI, 2017; XIAO et al., 2018).

Based on the above, the present study seeks to analyze the influence of afforestation on the comfort condition of cycling structures in a region with extreme climate conditions: high temperatures and humidity unfavorable to active transport.

2. THEORETICAL REFERENCE

2.1 Afforestation as a resource for microclimate and active mobility

Much has been studied about the changes suffered in the microclimate of cities due to accelerated urban expansion, such as the formation of heat islands, which highlights the need for urban planning and greater care for the environment (CANDIDO et al., 2020; RAMOS et al., 2019; ALVES, 2017; ALMEIDA; NUNES, 2018; XIAO et al., 2018).

Using green environments in city spaces, whether through street trees or urban green spaces, represents an effective strategy. Using vegetation (understand trees) in cities allows for more shading, contributing with characteristics that enhance the existence of new microclimates, reducing wind speed, greater solar protection, both for passersby and for buildings. Furthermore, it contributes to evapotranspiration, temperature reduction and moisture retention in the soil and air, providing better health conditions for individuals and the urban environment as well as a more beautiful and welcoming city (ALMEIDA; NUNES, 2018; MARTINI et al., 2018; GONÇALVES; MENEGUETTI. 2015; MENESES; SALES, 2018). Even in light of evidence, it is observed that there are still problems related to urban landscape management and its consequent lack of planning and control, promoting interference with the distribution and preservation of green areas, damaging the quality of spaces in the city (KUHNEN et al., 2018; ALMEIDA; NUNES, 2018; GONÇALVES; MENEGUETTI, 2015).

The repopulation of vegetation cover, through more wooded environments, becomes an important strategy for urban planning, enabling better environmental and health conditions for the population. Urban greenery contributes to the sustainability of human life, being an indication of aesthetic quality and allowing the existence of biodiversity in urban ecosystems (GONÇALVES; MENEGUETTI, 2015; XIAO et al., 2018).

Therefore, the afforestation of cycle paths is provided as a way of contributing to the repopulation of vegetation in cities, encouraging active transport and promoting the health of users of this mode, whether by encouraging the use of bicycles or by the possibility of breathing more purified air with the presence of the arboreal element. The development of more wooded spaces becomes important for environmental sustainability, making it possible to provide a better quality of life for the population (ALMEIDA; NUNES, 2018; MENESES; SALES, 2018).

2.2 Encouraging active mobility

The need to reduce atmospheric pollutants, derived from individual motorized transport, and the encouragement of modes that enable more sustainable travel allow greater openness to using active transport through bicycles, promoting more economical and healthy conditions for moving around the urban environment (MENESES; SALES, 2018).

It should be noted that the choice of mode is not only linked to the route, but also to factors related to the physical effort required for the cycling activity, interaction with other modes and environment quality (SEGADILHA; PENHA-SANCHES, 2014). Therefore, creating situations that favor using active transport is contributing to a healthier choice for individuals and the environment (XIAO et al., 2018).

At a time when climate change, global warming and environment devastation are at the critical point of the environmental discussion, the importance of resuming protectionist standards for more wooded spaces is observed, contributing to the more democratic use of urban environment and favoring active transport over motorized transport, providing improvements in urban environment quality (GOUVEIA; KANAI, 2020; BARBIERO, 2020).

Therefore, it is appropriate to highlight that the city must provide comfort and attract people to socialize in public spaces, providing aesthetic experiences and causing pleasant sensory impressions, as the city must be planned for people, not for cars (GEHL, 2017).

2.3 Possibility of environmental restoration in the city of Sinop

Sinop is a city located in the northern region of the state of Mato Grosso, with an estimated population of 142,996 thousand inhabitants in 2019. According to the Brazilian Institute of Geography and Statistics (IBGE - *Instituto Brasileiro de Geografia e Estatística*) (2020), it is considered the main city in northern state. It has a regular urban layout, with flat topography in most of the city. With adverse population growth and the consequent disorderly city expansion, longer routes emerged, with many intersections (SANCHES, 2015; SANCHES et al., 2020; CANDIDO et al., 2020).

Studies show that the relationship between the hot climate and deforestation that has occurred in recent years, due to the process of city growth and rural urbanization, has generated changes in the local and regional climate, having direct and indirect consequences for the population of these areas (CANDIDO et al., 2020; XIMENES et al., 2020).

The city has undergone changes to the landscape composition in some regions, contributing to the maintenance of green areas and reducing vehicle traffic, reducing the negative effects of climate change in these regions (SANCHES et al., 2018). On the other hand, the replacement of native vegetation with impermeable areas, whether as a result of urban settlement or agriculture implementation, the suppression of arboreal vegetation along the BR-163 route, which cuts through the city, and the implementation of parking lots in other regions of the urban layout impacted the change in the system of winds, rain, sun exposure and heat accumulation on surfaces (SANCHES et al., 2018; MENESES; SALES, 2018; CANDIDO et al., 2020). Considering the above, green and wooded areas are seen as a resource for individuals' well-being, comfort and protection in their routine with the urban environment and represent an alternative in maintaining the microclimate, and can contribute to citizens' appropriation of the city's dynamics (RAMOS et al., 2019).

Given the important facilitators that the city of Sinop has, achieving a basically flat characteristic (SEGADILHA; PENHA-SANCHES, 2014), there is a need to analyze existing cycle paths, aligning the relationship between physical and spatial qualities, with incentives for urban afforestation implementation, providing a more pleasant environment (MARTINI et al., 2018) and the increase in the effective number of cycle path users.

3 METHODOLOGY

This is an exploratory, descriptive and observational study, carried out by surveying temperature and relative humidity data on cycle paths in the city of Sinop, ending with a comparative analysis of the values obtained to diagnose the influence of the presence of urban trees in the given environment.

Study area

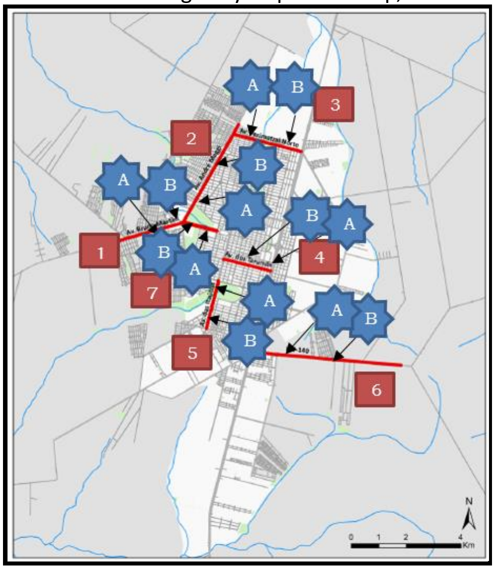
The municipality of Sinop is located in the northern region of the state of Mato Grosso, Brazil, a place of transition between the Amazon and *Cerrado* (open pasture with patches of stunted vegetation in Brazil) biomes. The city is 372 m above sea level in a tropical climate region. The climate, according to the Köppen classification, is Aw, that is, a savannah climate, with a drier season in winter, with the driest month having less than 60 mm of precipitation, equivalent to less than 4% of total annual precipitation. The average annual temperature in Sinop is 25.0°C, and the rainfall accumulated over the year has an average of 1,818 mm (SANCHES et al., 2020).

3.1 Data collection and analysis procedure

Temperature and relative humidity data were collected using an HTR-157 thermo-hygrometer (INSTRUTERM brand) in 7 urban cycling structures in the municipality, between the months of March and July 2020. This period includes the rainy and dry seasons in region (SANCHES et al., 2020), allowing an analysis for the two distinct periods.

The cycling structures were selected as follows: one with trees on both sides of the road and the other six with trees, spaced only on one side of the road and/or without trees. The selected cycle paths are installed throughout the urban perimeter of the municipality, in order to represent the maximum diversity of conditions and surroundings that the local urban structure offers. The cycle paths were numbered from 1 to 7 (Figure 1), and temperature and humidity data were obtained at two different points on the road, named A and B, as shown in Figure 1. In Figure 2, it is possible to observe the analyzed cycle paths' different conditions. The photos were taken about 10 days before data collection, on 03/08/2020, using a semi-professional camera with high resolution (NIKON P-510).

Figure 1 – A/B points and numbering of cycle paths. Sinop, Mato Grosso, Brazil, 2020



Source: research data.

Figure 2 – Cycle paths in the city of Sinop, Mato Grosso, Brazil, representing the existing typology

Source: research data, 2020.

Scattered occasional trees can be observed on cycle paths 01, 04 and 05, on cycle paths 02, 03 and 06 there is no afforestation and cycle path 07 is the most forested.

Table 1 presents the characteristics of each point (A and B), relating the presence of afforestation, type (trees or palm trees), size (tall, medium-sized or small) and population density.

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Table 1 – Situation of each cycle path related to the proximity of green areas, afforestation and population density. Sinop, Mato Grosso, Brazil, 2020

Behavior of afforestation and urban densification on cycle paths														
Cycle path	1		2		3		4		5		6		7	
Afforestation	A	B	A	B	A	B	A	B	A	B	A	B	A	B
Close to green areas		X	X			X			X				X	X
Spaced trees	X	X					X	X	X	X				
Contiguous trees													X	X
Irregular afforestation	X	X												
Regular afforestation							X	X	X	X			X	X
Presence of palm trees				X		X			X	X				
Tall													X	X
Medium-sized/small	X						X	X	X	X				
Population density – High		X		X	X	X	X	X	X	X				
Population density – Little/regular	X		X								X	X	X	

Source: research data, 2020.

Establishing a relationship between the data in Table 1 and Figure 2, it is noted that cycle paths 2, 3 and 6 are those with the least or no presence of tree species. The existing trees are isolated and/or palm trees, not allowing a positive influence on the arboreal surroundings. Cycle paths 1, 4 and 5 have low or medium-sized tree species. It is noted that the trees on these cycle paths are concentrated only on one side of the road. Cycle path 7 has the best spatial and afforestation quality, with continuous and contiguous afforestation on both sides of the road.

Data were collected at two times of the day from 11:00 am to 12:30 pm (considered to have the greatest solar interference) and from 4:30 pm to 6:00 pm, observing times with a large movement of cyclists in function of returning to work and school activities.

The temperature and humidity data were used to determine the Temperature and Humidity Index (THI), according to equation 1 (FRANÇA et al., 2015).

$$THI = 0.8.At + \left[\frac{RH.At}{500}\right] \quad \text{Eq. 1}$$

Caption:

THI = Temperature Humidity Index (ºC);

At = Ambient temperature (ºC);

RH: Relative humidity (%)

The thermal comfort index expressed by the THI establishes 3 levels: comfortable (THI between 21º C to 24º C); slightly uncomfortable (THI between 24º C to 26º C); and highly uncomfortable (THI above 26º C) (BARBIRATO et al., 2007).

All data were subjected to descriptive statistical analysis, with determination of averages and standard deviations. The temperature and relative humidity values on the studied cycle paths were subjected to the Kolmogorov-Smirnov normality test, at a significance level of 0.05.

Based on temperature and humidity data, the cycle paths were compared using multivariate analysis such as grouping by Euclidean distance. All statistical analyzes were performed using Action Stat (ESTATCAMP, 2019).

4 RESULTS AND DISCUSSION

Table 2 shows temperature and humidity data for the seven cycle paths analyzed.

Table 2 – Temperature and relative humidity data (average ± standard deviation) for dry and rainy periods per cycle path. Sinop, Mato Grosso, Brazil, 2020

Cycle path	Rain	Dry
	Temperature (º C)	
1	30,97±1.68 a	30.57±2.55 a
2	30.99±2.29 a	30.66±3.49 a
3	31.18±2.37 a	30.90±2.59 a
4	31.24±2.54 a	31.14±3.41 a
5	30.73±2.78 a	30.32±3.43 a
6	30.58±3.02 a	30.55±3.31 a
7	28.97±2.37 a	28.70±3.00 a
	Relative humidity (%)	
1	65.63±5.56 A	52.97±15.39 B
2	67.12±6.14 A	55.20±17.00 B
3	64.72±9.87 A	52.67±14.13 B
4	63.73±10.50 A	52.05±15.34 B
5	67.87±12.12 A	54.01±16.84 B
6	67.90±14.99 A	52.49±15.81 B
7	76.31±13.97 A	61.14±17.90 B

Source: research data, 2020.

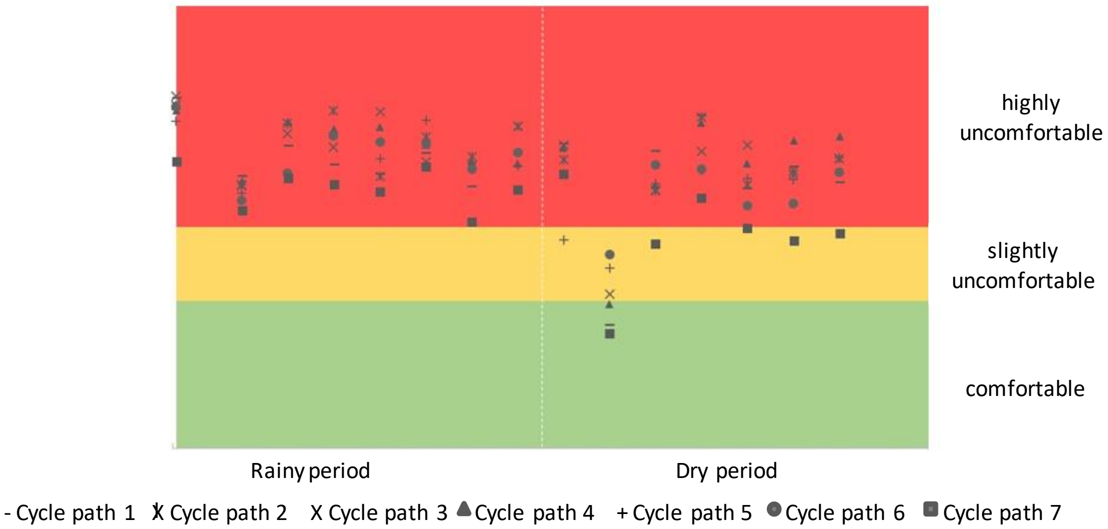
* Averages followed by the same letters in the line do not differ from each other using the Tukey test at a 5% significance level.

Average temperature values for the cycle paths studied show that there was no difference between their values for dry and rainy periods, however, for humidity values, it was found that they were different between the periods. The values for standard deviation demonstrate less variation in the rainy period compared to the dry period.

The humidity values presented in the analyzed cycle paths, during the rainy season, remained within the range recommended by the World Health Organization (WHO) (GOMES et al., 2015; CGESP, 2020), above 60%. However, for the dry period, only cycle path 7 presented a humidity value within this range.

Figure 3 shows the calculated THI values for the cycle paths studied.

Figure 3 – Temperature and Humidity Index values for the cycle paths studied during the rainy and dry seasons. Sinop, Mato Grosso, Brazil, 2020



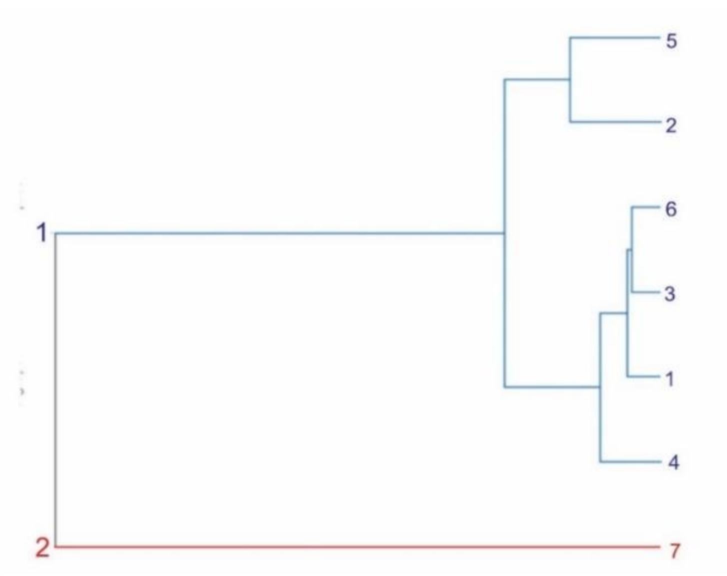
Source: research data.

The comfort rating of cycle paths is related to THI, following parameters determined by Barbirato (2007). The parameters used to assess THI determine that values between 21 and 24º C characterize a comfortable level, between 24 and 26º C, slightly uncomfortable, and above 26º C, extremely uncomfortable. THI values for cycle paths numbered 1 to 6 showed, on most days during the period determined for the research, that the calculated index was in the highly uncomfortable range. However, for cycle path 7, a different behavior was observed: in the dry period, in almost all measurements, it remained at a slightly uncomfortable level.

It is noted, in the dry period, that in one measurement, all calculated THI values were between comfortable and slightly uncomfortable. This is the presence of a cold front in the region, with temperatures milder than annual average. The behavior of cycle path 7 stands out, which remained in the best situation, with a general average of 24º C, reaching a comfortable level.

Figure 4 presents an analysis using a dendrogram, carried out using the Hierarchical Grouping Method, for tree-lined and non-tree-lined cycle paths.

Figure 4 - Grouping of cycle paths according to temperature and relative humidity conditions in the dry period, obtained using the hierarchical method. Sinop, Mato Grosso, Brazil, 2020



Source: research data.

Based on Figure 4, it is possible to observe that cycle path 7 was different from all the others in terms of its temperature and relative humidity characteristics, for the entire period analyzed (dry and rainy). In group 1, represented by the blue line, there are all the cycle paths with little or no trees, and in group 2, represented by the red line, there is the cycle path with the most distinct behavior in terms of the presence of trees.

Based on the distance presented by the dendrogram for the grouped cycle paths, it is possible to infer that cycle paths 5 and 2 have similar behavior. Cycle paths 1, 3 and 6 also form a group with closer values. And cycle path 4, although it has a similar behavior to the cycle paths in group 1, has a different behavior.

The comparative analysis of data obtained from the survey of temperature and humidity values on cycle paths in the city of Sinop demonstrated that temperatures remained in the highly uncomfortable range in most measurements (BARBIRATO et al., 2007), a result of the region's climate, whose characteristic is the predominance of high temperatures. The results indicate that including more trees on cycle paths becomes a favorable action to control relative air humidity.

Hot and humid climate characteristics, constant high temperatures in the legal Amazon region, in which the study environment is located, present concern for vulnerability in the face of accelerated urban growth, interference with the environment and climate changes that have been observed in the last years (SANTOS, 2014; SANCHES et al., 2018; CANDIDO et al., 2020; XIMENES et al., 2020).

It was observed that temperatures on cycle paths were not significantly influenced by conditions related to the local microclimate for the periods analyzed, with most measurements remaining in the highly uncomfortable range (BARBIRATO et al., 2007), a result of the region's climate, whose characteristic is high temperatures throughout the year. The THI classification proposed by Barbirato *et al.* (2007) is widely used in the tropics to assess "stress" in the urban environment. Thermal comfort is directly related to factors beyond climate, being related to human activities, from the clothing used to interference with the environment. Thus, several conditions can interfere with temperature and humidity values (NÓBREGA; LEMOS, 2011). It should be noted that the behavior of standard deviation for temperature and humidity data in the period determined by the dry climate in the region establishes greater sensitivity to "stress" caused by human actions (BARBIRATO, 2007; NÓBREGA; LEMOS, 2011).

In the present study, the rainy period showed a smaller variation in standard deviation compared to the dry period, showing homogeneity in temperature and humidity values. During the dry period, there was a slight increase in the standard deviation of temperature values and a considerable increase in humidity values, proposing the action of greater interference related to urban environment particularities such as urban densification, the existence of water flows and the presence of areas greens (CANDIDO et al., 2020).

Nóbrega and Lemos (2011) found in a study carried out in the city of Recife that the transformations of urban space drive thermal discomfort, given the variations in urban growth and individual behavior, suggesting caution when practicing physical or work activities in open environments. The authors observed throughout the study that, on days with more cloudiness, the feeling of thermal comfort was better, even if the temperature remained high. The aforementioned authors point out that the process of growth and development of cities increases concerns regarding inhabitants' quality of life in the future, and highlight that the maintenance of islands of freshness through actions by public authorities (maintenance of public squares and parks, restoration of mangroves and coastal areas) becomes a viable alternative to improving quality of life and the urban environment.

Thus, it is noted that the results obtained with temperature and humidity research in Sinop's cycle paths corroborate the fact that the presence of trees presents itself as an effective alternative that favors the thermal comfort of street users and by correlation of cycle paths, explaining the differences found between cycle paths with little or no trees (1 to 6) and the tree-lined cycle path (LEAL et al., 2014; MARTINI et al., 2018). Shading contributes, resulting in improved climate indices, filtering solar radiation and minimizing thermal discomfort (NOVAIS et al., 2018). The continuous and contiguous arrangement of trees proves capable of alleviating the climate, especially given the significant number of buildings and soil impermeability due to asphalt (AGUIRRE JUNIOR; LIMA, 2007; CANDIDO et al., 2020).

The temperature and humidity values found in this study indicate that the afforestation, present in the studied cycle paths, was not able to improve the comfort condition during the rainy season, with the region's predominant climate being decisive for this characteristic, but the opposite behavior is observed for the dry period, in which the afforestation present on cycle path 7 puts this space at an advantage in relation to the thermal comfort of the other six cycle paths analyzed. Temperature and humidity values were in the "highly uncomfortable" parameter for most of the data collection period, due to the predominant characteristic of the region's climate (BARBIRATO et al., 2007, SANCHES et al., 2018; SANCHES, 2015). However, when comparing cycle paths, especially during the dry climate period, the influence of tree evapotranspiration process on thermal comfort index for cycle path 7 is evidenced (NOVAIS et al., 2018).

The grouping obtained by the multivariate analysis of temperature and relative humidity data on cycle paths shows that the presence of effective afforestation, composed not only of shrubs, makes a marked difference in cycling structure comfort, whether through direct sun protection or temperature softening in urban areas (AGUIRRE JUNIOR; LIMA, 2007; MARUYAMA; SIMÕES, 2014; XIMENES et al., 2020). In this way, the choice of tree species is extremely important to obtain the expected comfort results in the city scenario, also related to the benefits they provide to the environment and population's health (XIMENES et al., 2020). Comparing the data from cycle paths 4 and 7, it is observed that the presence of shrub vegetation or trees, even of short stature, do not provide the same effect as trees of greater size and height (AGUIRRE JUNIOR; LIMA, 2007).

In addition to thermal comfort factors, it is worth highlighting the importance of afforestation as a factor in protecting soil and vegetation, providing visual comfort and a feeling of care for the environment and urban environment. Afforestation, by forming tunnels where the treetops meet, provides an effect of guiding observers' gaze, providing visual comfort. The combination of tree tops also contributes to a pleasant microclimate in the environment and surroundings (AGUIRRE JUNIOR; LIMA, 2007; MARUYAMA; SIMÕES, 2014).

On the other hand, the lack of afforestation, which is so necessary for cities with a hot climate, harms not only bicycle travel, but also pedestrian travel. The lack of urban afforestation on cycle paths presents a characteristic of local aridity and harm to users' quality of life (AGUIRRE JUNIOR; LIMA, 2007).

Afforestation is a viable alternative for maintaining a more pleasant microclimate in the region, contributing to air purification, increasing soil permeability, and beautifying cities, providing aesthetic values, psychological well-being, physical and mental health to residents of urban centers (LUZ, 2012; RAMOS et al., 2019).

All the cycle paths analyzed are part of Sinop's urban layout and, in general, have paved roads alongside them, thus suffering the action that soil impermeability brings to the climate. Soil impermeability by asphalting, in conjunction with the large number of buildings, causes a negative influence on the environment, as it reflects solar radiation, unlike afforestation, which absorbs this radiation to convert photosynthesis (LEAL et al., 2014; MARTINI et al., 2018; RAMOS et al., 2019). Cycle path 7 stands out among all, because, even in this scenario, it behaves in a more positive way for individuals' and the environment's health.

It is believed that the preparation of this study will contribute to new strategies for urban planning, the development of awareness-raising policies and awareness of environmental preservation, centered on health promotion, contributing to encouraging active mobility and thus providing better health conditions and quality of life for citizens.

It should be noted that the survey carried out individually and the reduced amount of equipment, concomitantly, present themselves as limitations of this study, and could have been prepared with greater accuracy with simultaneous data collection, enabling a real-time analysis of all points listed in the search. Another limiting factor in the study was taking measurements exclusively on Sundays, a day with reduced movement on the cycle paths. Therefore, there is an opportunity to suggest the continuation of new studies, expanding the range of future investigations, taking into account the importance of information involving the public afforestation of cycle paths as a participant in urban and environmental planning, observing an important role in health promotion.

5 CONCLUSION

Considering the data analyzed, it was found that the presence of urban afforestation in the environment of cycle paths is of great importance, contributing to better conditions in the urban environment, especially given the extreme conditions of temperature and humidity experienced in the region studied. It is reinforced that, in cities with extreme occurrences of temperature and humidity, at values indicated as unhealthy by the WHO, solar radiation acts as an influential parameter, and must be considered in the planning of spaces for public use, creating a more environmentally favorable scenario for citizens.

The vegetation included in the cycle path environment, in addition to softening the temperature and improving air humidity levels, contributes to encouraging active mobility, providing better health conditions and quality of life for citizens. The need for afforestation was identified, forming a type of arboreal tunnel. The need for large trees that allow greater surface coverage, through shading, has proven to be effective, creating a more efficient and pleasant microclimate for active transport users, encouraging using cycle paths as a healthy and safe route of travel.

Thus, it is concluded that afforestation is an effective strategy for promoting health in the urban environment, contributing to thermal comfort conditions on cycle paths and environmental quality, especially when there are low relative humidity values, positively supporting aspects related to urbanization, such as aesthetics, safety and microclimate.

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