INTERNATIONAL JOURNAL OF RESEARCH AND INNOVATION IN APPLIED SCIENCE (IJRIAS)
ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

Impact of Street Greenery on Outdoor Thermal Comfort in the Context of Urban Microclimate of Dhaka City

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DOI: https://doi.org/10.51584/IJRIAS.2025.10060007

Received: 11 May 2025; Accepted: 23 May 2025; Published: 27 June 2025

ABSTRACT

Urban street vegetation influences several aspects such as environmental, aesthetic and thermal comfort of the users. This study focuses on the effect of street side flora on outdoor human thermal comfort (HTC). For this purpose, an experiment was conducted at four streets with similar geometrical configurations but different amounts of street vegetation and orientation in BUET campus, Dhaka, Bangladesh. The onsite climatic data were collected using data logger. Additionally, a qualitative study was conducted by semi-structured interviews with pedestrians to explore their perceptions of thermal comfort and aesthetic appreciation of street greenery. Finally, the thermal comfort level of those four streets were compared. The result shows that street greenery can reduce temperature and provide thermal comfort depending on the percentage of greenery, their geometry, coverage, canopy size placement and the current meteorological circumstances. According to the interviews, the amount of street vegetation seemed to be correlated with the instantaneous subjective thermal comfort. People placed a high aesthetic value on the presence of street plants. Lastly, some critical overviews and planning policies are recommended to enhance the applicability of this work practically. The study concludes that street vegetation functions as a feasible adaptation technique to provide aesthetically pleasing and thermally comfortable streetscapes in moderate climates.

Keywords: street vegetation, thermal perception, outdoor thermal comfort, aesthetic appreciation, urban microclimate

INTRODUCTION

The thermal comfort of urban street space is correlated to individual's comfort experience of outdoor activities (Lee et al. 2018, Zhu et al. 2020). This is more evident in the pedestrian walkway area where people walk, stay or socialize through various street side activities which prolong people's stay time in the pedestrian pathway. Street greeneries are an important feature of the urban landscape, with the potential to improve environmental condition as well as human thermal comfort (HTC) (Coccolo et al., 2018; Teshnehdel et al., 2020).

Urban regions are facing excessive heat condition due to rapid urbanization and global climate change (Ullah et al. 2023). One of the primary extreme weather occurrences caused by climate change is the heatwave (World Health Organization, 2023). According to World Health Organization 2024, about 125 million people were exposed to heatwaves in between 2000 and 2016. Heat waves possess a threat to human health, well-being and thermal comfort causing heat-related illnesses (HRI) and chronic diseases (Menghan Li, 2024). Also, Heat-related fatalities may rise during heatwaves.

Because of the urban heat island effect, urban areas are more susceptible to heat waves. One significant factor contributing to the urban heat island effect is urban pavements (Anand and Sailor, 2021). Due to the high heat retention of urban pavement, urban street canyon areas can become one of the city's primary hot spots throughout the summer. Urban street greening has the potential to significantly reduce the harmful effects of urban heat islands and urban heat waves. Street trees can reduce high urban temperature through the processes of shading and evapotranspiration (Samira et al. 2016). Also, vegetation can alter urban microclimates as well as assist to reduce the effects of the urban heat island (UHI) (Yaşlı et al. 2023). Moreover, it is found that, streets with high tree covering are thermally more comfortable than streets with less tree cover (Ren et al., 2022). So, street side vegetation may help create a better atmosphere in the street canyon providing thermal comfort.

The sky view factor, building height-to-width ratios, and street orientation are some of the street geometries that can significantly influence the urban thermal climate (Chatzidimitriou and Yannas 2017; Sharmin et al. 2017; Qaid et al. 2018). Street trees provide shade on the roadways, block direct sunlight from people and buildings, and lower the amount of energy needed for air conditioning during the sweltering summer months (Lee and Mayer 2018; Qaid et al. 2018). So, implementation of green infrastructure can be an adaptive method that can be deemed beneficial to reduce urban heat and thermal discomfort (Revelli and Porporato 2018; Gebert et al. 2019).

Again, aesthetic appreciation of the green, natural environment is one of the psychological aspects that influence perceived thermal comfort (Lenzholzer et al., 2010; Wang et al., 2017). Green infrastructure and naturalness are related because people prefer naturally vegetated urban areas over those that are not (Klemm et al., 2015; Smardon, 1988; Ulrich, 1986). By implementing green infrastructure, urban planners and designers can alter the naturalness and aesthetic appeal of the surrounding area while also enhancing people's perception of thermal comfort.

Comprehending the impact of street trees on microclimate and their effect on HTC is crucial in order to suggest recommendations for their placement, preservation, and upkeep. Depending on the quantity and composition of vegetation, urban greenspace can provide cool zones and reduce the impact of urban heat islands. (Roeland et al. 2019; Lo Piccolo and Landi 2021). Another study has shown that enhancing the landscape layout of road green spaces has a more substantial impact on the daytime thermal comfort of street canyons with the maximum difference in UTCI between models being 0.76 °C (Liu et al., 2024). The benefits of street side vegetation on HTC can help to convince authorities to invest in street trees. So, to enhance the urban thermal environment, developing an understanding of urban greenspace design is essential for the city planners.

But most thermal comfort researches focus on the developing countries with temperate and cold climates. There is a shortcoming in the study of the tropical climate context even though people in those cold climatic areas spend more time in indoors than in tropical climates. Another reason for the knowledge gap has been created from the fact that Architects are primarily concerned about achieving a better indoor thermal environment rather than outdoors. However, in tropical places like Dhaka, outdoor conditions are equally vital. Also, people's perception of thermal comfort is not clearly measured or understood in this climatic context. As a result, more research is needed on the thermal comfort of people in pedestrian walkways of Dhaka city.

This study aims to explore the effect of street vegetation on the outdoor human thermal comfort in the urban microclimate of Dhaka, Bangladesh so that the benefits of greenery and its usefulness can be explored and it can further contribute to design guidelines for street greenery for thermally comfortable streetscapes within moderate climates. To comprehensively understand the impact of street greenery and how street side vegetation is associated with thermal comfort of outdoor environment, a literature review is conducted.

A three-step mixed methodology is implemented to conduct the research. The study involves quantitative analysis of environmental parameters associated with thermal comfort in the four selected road with different amount of greenery. Also, questionnaire survey of the four different road types was conducted to understand the perception of thermal comfort of the pedestrians and users. Finally, an analysis is given according to the findings representing the importance of street side greenery and their crucial impact on outdoor thermal comfort.

LITERATURE REVIEW

There exists positive correlation between roadside greenery and the comfort of pedestrians in various climatic zones including temperate, continental, arid, and tropical regions (De Quadros, B. M., & Mizgier, M. G. O.

2023). Some observational studies suggest that the air temperature under trees is significantly cooler than in open areas during the day (Du et al. 2024, Klemm et al. 2015; Coutts et al.,2015). Studies show that increasing the amount of vegetation cover is a frequently suggested feasible solution for alleviating urban heat (Schwaab et al 2021, Iungman et al 2023, Zhang et al 2023).

Factors like tree species, size, height of tree and crown base, tree trunk circumference and traits affect cooling effects (Helletsgruber et al., 2020). While trees in open areas may result in a discernable temperature reduction, their cooling potential is influenced not only by the characteristics of the trees but also by the surrounding urban context, including surface materials, spatial geometry, building height, and urban density (Shashua-Bar et al. 2010a). So, over the last decade, a number of research projects have been conducted in various climates to investigate the detailed relationship between urban vegetation, geometry, climate and human thermal comfort.

In a study conducted in the nine different streets of same geometric configuration with different types and amount of greenery in the city of Utrecht, Netherlands, it is found that the mean radiant temperature (Tmrt) in streets with tree covers of 39% were up to 4.8K lower than in streets without trees. It is also found that, 10% tree coverage lowers Tmrt by about 1K within a street canyon (Klemm et al., 2015). Another study in Melbourne, Australia shows that trees were very effective at lowering daytime Universal Thermal Climate Index (UTCI) in summer through a reduction in mean radiant temperature lowering thermal stress from very strong (UTCI>38 °C) down to strong (UTCI> 32 °C) (Coutts et al.,2015).

An experiment in Biskara of Algeria showed that green spaces can significantly lower the surface temperature with a value exceeding 12°C which influences the reduction of air temperature and ensures the outdoor thermal comfort of the wayfarers. (Khadraoui et al., 2022). Studies also found that the presence of greenery provide the users a sense of thermal comfort through an aesthetic ambience rendering a positive impact on their behavior and psychological condition (Klemm et al., 2015; Khadraoui et al., 2022).

Some other studies observed how trees affected the thermal comfort of the neighborhood and in street canyon both during the day and at night (Morakinyo et al. 2017; Locke et al., 2024). In a study, Locke et al. observed the cooling benefits from tree canopy cover at different time period of the day where the cooling benefits from tree canopy were strongest in the midday, afternoon, and morning on clear days. The cooling effect was comparatively smaller on cloudy atmosphere. Morakinyo et al. (2017) discovered that key elements for enhancing thermal comfort are leaf area index, tree and trunk height. They also found that, during the day, trees' ability to improve thermal comfort dropped as urban density increased, and at night, the opposite scenario was prominent.

Several studies were conducted in different cities of China focusing the impact of street greenery on the thermal comfort during both in hot and cold days (Cao et al., 2022; Liu et al., 2023). Cao et al., (2022) observed that thermal comfort is affected by the orientation and aspect ratio of the streets where plantation layout had no significant effect. On the other hand, Liu et al., (2023) discovered that tall trees with high tree canopy density and large crowns can increase the street canyon's thermal comfort on hot days and decrease it on cold days where the average PET was 31.1 ◦C and 13.3 ◦C respectively.

The effects of varying levels of street tree coverage on the thermal comfort was explored in Changchun city, China. It is observed that the street with the highest tree cover had significantly lower physiological equivalent temperature (PET) and more comfortable than the other two streets with medium and low amount of vegetation. The frequency of strong heat stress (PET>35 °C) was 64%, 11%, and 0%, respectively, for streets with low, medium, and high tree coverage. With less tree cover, there was an increase in pulse rate, diastolic blood pressure, and systolic blood pressure (Ren et al., 2022). Another observation in Wuhan, China showed a reduction of afternoon air temperature and mean radiant temperature by up to 3.3 °C and 13.9 °C respectively in streets with a high-amount of tree canopy, compared to a similar street with no tree shade (Huang et al., 2020). Narimani et al. (2022) discovered that the influence of tree cover on thermal comfort was greater than that of street orientation.

METHODOLOGY

In this study the impacts of street greenery on human thermal comfort are explored using a three-step mixed

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

methodology. Four different roads of same geometric configuration and diverse amounts of greenery are selected for the study. First, environmental parameters associated with thermal comfort are measured. Then a questionnaire survey was conducted to understand pedestrians' perception of thermal comfort and preferences according to aesthetic appreciation. Finally, an analysis is represented based on the findings highlighting the significance of streetside vegetation in case of ensuring thermal comfort.

Study area

The study area is located within the BUET campus in Dhaka, Bangladesh, encompassing two distinct zones characterized by different landscape settings. Microclimate A corresponds to the Electrical and Computer Science Engineering (ECE) campus, which features a relatively sparse amount of greenery, while Microclimate B refers to the Dormitory Hall premises, noted for its extensive vegetation cover. The selected sample streets lie within a 90-meter radius, ensuring effective surveying and facilitating comparative analysis. From each microclimate, two streets were chosen, maintaining similar geometric configurations but different orientation and the quantity of street vegetation. Specifically, Road 1 and 2 are located in the ECE campus with north-south and east-west orientation, respectively, whereas Road 3 and 4 are situated within the Hall premises, also oriented north-south and east-west, respectively. Fig. 1 shows the selected study area with proper annotations.

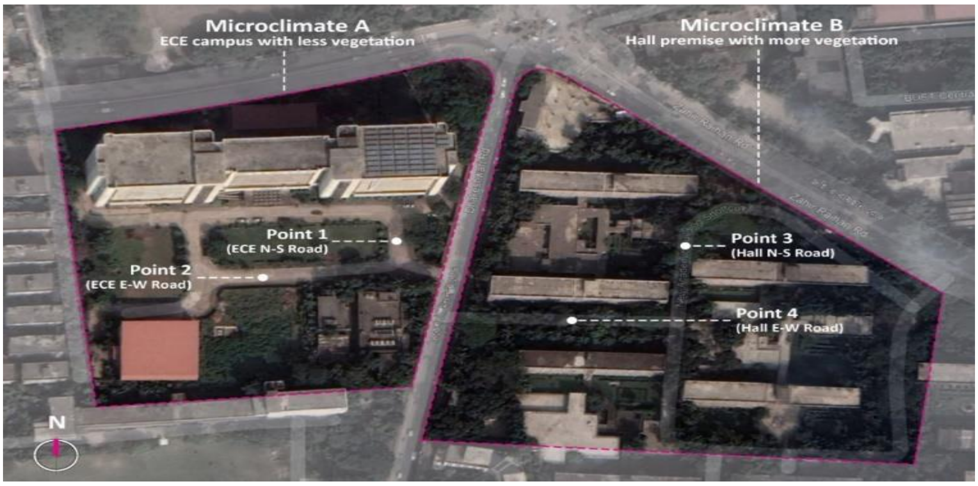

Fig. 1: Selected area of BUET campus, Dhaka.

(Measurement points are annotated)

Fig. 2 shows the selected study and four different street views of the Microclimates.

Fig. 2: Four different street views of Microclimate A (a), (b) and Microclimate B (c) and (d).

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Research workflow

A mixed-methods approach was employed to gain comprehensive insights into the impact of streetside greenery on human thermal comfort. Environmental parameters related to thermal environments such as air temperature, relative humidity, and dew point—were measured in natural settings using data loggers. Using these measurements, the Temperature Humidity Index (THI) was calculated to quantify thermal conditions. Additionally, semi-structured interviews were conducted with pedestrians to capture their subjective perceptions of thermal sensation and comfort. The quantitative and qualitative analyses of the data as well as survey findings are represented in the charts and graphs in the following sections. Fig. 3 presents the methodology in a flowchart as research workflow.

(a) Point 1: ECE north-south road (b) Point 4: Hall east-west road

Fig. 3: Flowchart of the methodology used in research

Data Collection

To measure environmental parameters such as air temperature, relative humidity, and dew point, four data loggers (model: EL-USB-1-LCD) were individually installed by the authors along four separate roads on October 26th, 2023 (Figure 4). October in Dhaka represents the transitional period from the monsoon season to the post-monsoon/autumn season, characterized by moderate to high temperatures and a noticeable reduction in heavy rainfall. These conditions make October particularly suitable for outdoor thermal comfort measurements. Compared to the peak summer months (April to June), which can be excessively hot, October typically offers stable weather with clear skies and moderate humidity. This period also coincides with increased outdoor activity as residents begin resuming more frequent movement after the monsoon. Therefore, conducting the survey in October provides an optimal balance between sufficient heat load for meaningful thermal comfort analysis and practical feasibility for pedestrian data collection. The data collection was carried out between 10 a.m. and 5 p.m., with measurements recorded at one-minute intervals. Fig. 4 shows all the data loggers that are installed.

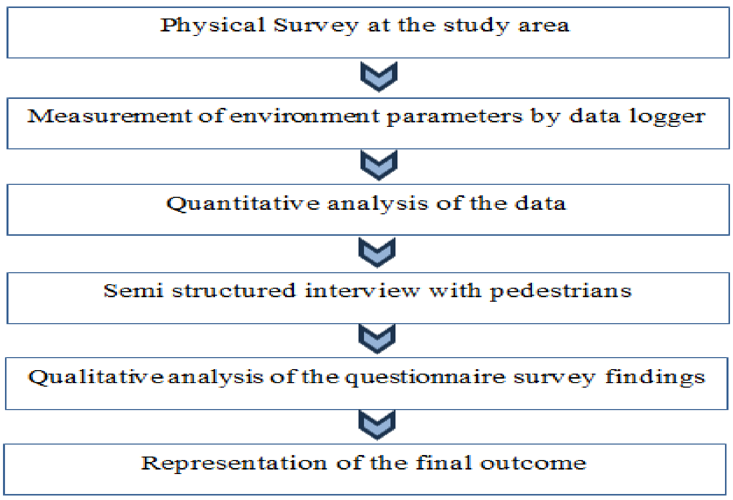

Figure 4: Data loggers installed at different roads for taking measurements

Fig. 5 represents the air temperature, relative humidity and dew point of all four different roads that was experimented in this research.

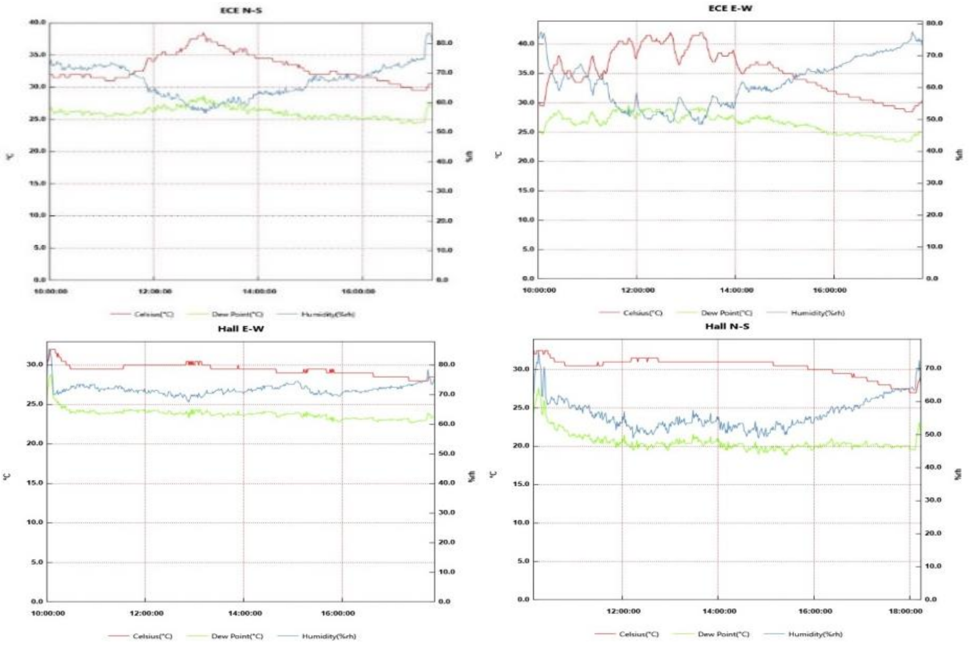

Fig. 5: Air temperature, Relative humidity and dew point graphs of the sample roads from 10 am to 5 pm.

Questionnaire survey and Interview with pedestrians

To assess pedestrians' thermal sensation, a semi-structured questionnaire survey was conducted along each of the four roads. A total of 80 participants were surveyed, with 20 individuals on each street, who were asked about their thermal sensation while walking through the respective roads. The survey also aimed to capture participants' aesthetic appreciation of the streetside greenery and their preferences regarding the vegetation. Data collection was carried out simultaneously on all four roads at three different times of the day: 10 a.m., 12 p.m., and 3 p.m. A modified version of the ASHRAE Thermal Sensation Scale (ASHRAE, 2005), as shown in Table 1, was employed to gauge thermal sensation by asking participants the question: "How are you feeling (thermal sensation) while passing through this road?"

The voting scale, as presented in Table 1, was utilized to assess thermal comfort and answered the question: **How does this road feel like to you in terms of thermal comfort?**

Table I Comfort voting of air temperature and relative humidity

Comfort voting						
Uncomfortable			**Neutral**	**Comfortable**		
-3	**-2**	**-1**	**0**	**+1**	**+2**	**+3**

RESULT AND DISCUSSION

This section discusses the potential physiological and psychological effects of streetside flora that ensures thermal comfort and environmental benefit. It is found that air temperature, relative humidity and dew point varied due to different amount of greenery, their configuration and orientation of the roads. Hence the thermal comfort level and perception of the pedestrians also varied in different roads. It was observed that streets with higher vegetation coverage and wind-parallel orientation (e.g., Road 3: Hall north-south road) yielded THI values in the comfortable range (24–26), while areas with less greenery and non-aligned orientation (e.g., Road 2: ECE east–west road) experienced extreme thermal stress (THI up to 37). The questionnaire survey also shows that people feel thermally comfortable in the Hall Roads and uncomfortable in the ECE campus roads. People also prefer more street side flora in terms of aesthetic and psychological perspective of thermal comfort. The maximum, minimum and average value of the data are given in the table 2 below.

Table II Maximum, minimum and average value of air temperature, relative humidity and dew point

Road name	Temperature (°C)			Humidity (%rh)			Dew point (°C)		
	Min	max	Avg	Min	max	Avg	Min	max	Avg
ECE north-south	29.5	38.5	33.04	56.5	83.5	67.2	24.4	28.7	26.1
ECE east-west	28.5	42.0	35.3	48.5	77.5	61.7	23.4	29.7	26.6
Hall north-south	27.0	32.5	30.3	49	75.5	56.3	18.9	27.6	20.6
Hall east-west	28	32	29.4	67.5	85.5	71.9	22.7	28.8	23.8

Impacts on Air temperature (Ta)

Fig. 6 presents a comparative graph illustrating the air temperature variations across the four roads. The graph highlights the differences in temperature based on the amount of greenery and road orientation. The highest average air temperature of 35.3°C was recorded on Road 2 (ECE campus east-west road) due to minimal greenery and maximum sun exposure from its east-west orientation. The street trees here are comparatively short with small canopies. Road 1 (ECE campus north-south road) has a lower average temperature of 33.04°C because of slightly more greenery. Road 4 (Hall east-west road), despite its east-west orientation, shows the lowest average temperature of 29.4°C due to extensive greenery, taller trees, and larger canopies. Road 3 (Hall north-south road) has an average temperature of 32.5°C, higher than Road 4, because it has less greenery despite better wind flow. So according to this quantitative analysis, Hall east-west road is comfortable and discomfort occurs most in the ECE campus east-west road due to the less amount of street side vegetation, small canopy and height

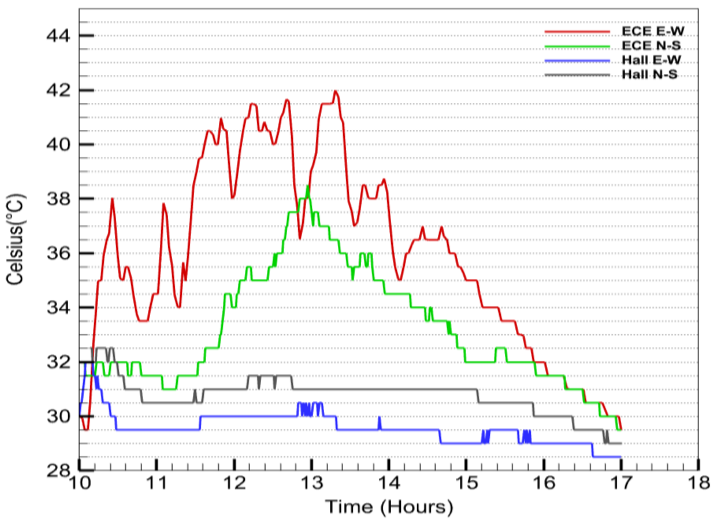

Figure 6: Comparative graph of air temperature of the sample roads.

Impacts on Relative humidity (%rh)

Fig. 7 represents a comparative graph illustrating the relative humidity variations across the four roads. The graph highlights the differences in relative humidity based on the amount of greenery, road orientation and wind factor. Maximum average relative humidity of 71.9% was recorded on Road 4 (Hall east-west road) due to the extensive amount of greenery. In contrast, despite its north-south orientation, the minimum average relative humidity of 56.3% was found on Road 3 (Hall north-south road) because of the lower amount of greenery

ISSN No. 2454-6194 | DOI: 10.51584/IJRIAS |Volume X Issue VI June 2025

compared to Road 4. The average relative humidity on Road 1 (ECE campus north-south road) and Road 2 (ECE campus east-west road) were moderate due to the smaller amount of greenery compared to the Hall premise roads.

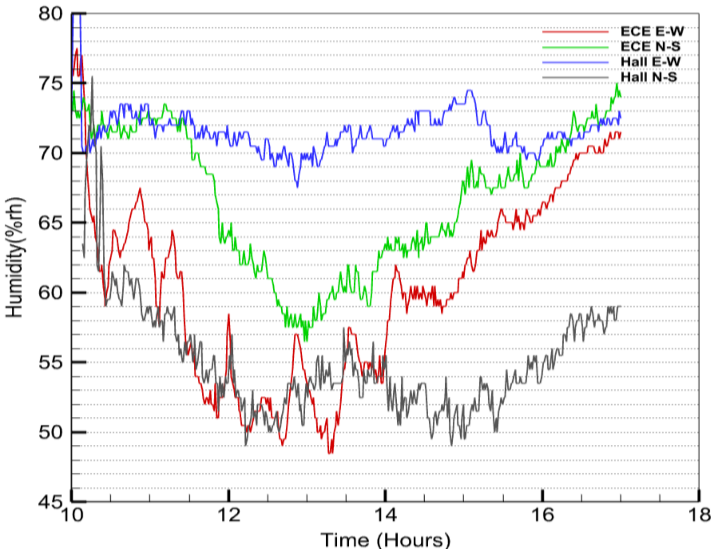

Fig.7: Comparative graph of relative humidity of the sample roads.

Impacts Temperature Humidity Index (THI)

Temperature humidity index (THI) also referred to as the discomfort index (DI) is one of the versions of effective temperature (ET), developed by Thom (1959).

Air temperature and relative humidity is used to derive the thermal humidity index and the following equation is used:

$$THI = 0.8Ta + \frac{RH \times Ta}{500}$$

where Ta is the air temperature (°C) and RH is the relative humidity (%). The THI values are empirically tested on human objects, and the comfort limits are determined as

$21 \leq THI \leq 24$ = 100% of the subjects felt comfortable

$24 < THI \leq 26$ = 50% of the subjects felt comfortable

$THI > 26$ = 100% of the subjects felt uncomfortably hot

It is important to note that the aforementioned ranges originated in the mid-latitudes. Residents of tropical regions are likely to withstand higher levels of THI due to acclimatization as well as variations in food, habitats, and clothing etc. (Emmanuel 2005).

Assessment of Thermal Humidity Index (THI)

According to the air temperature and relative humidity of the all four roads the THI value is derived separately. Fig. 8 demonstrates that the maximum THI value is found for the Road 2 (ECE campus east-west road) as the air temperature is relatively high and relative humidity is comparatively low due to less amount of greenery. The THI of this road ranges from 28 to 37 and maximum value occurs at around 1pm. Hence the ECE campus east-west road is thermally discomfortable.

On the other hand, minimum THI value is found for the Road 3 (Hall north-south road) as the air temperature and relative humidity is comparatively low due to vast amount of greenery. The THI of this road ranges from 24 to 26. Therefore, Road 3 (Hall north-south road) is thermally more comfortable.

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Though the average air temperature of Road 4 (Hall east-west road) is lowest among the four roads but its THI ranges from 27 to 31 for a bit higher relative humidity compared to Road 3 (Hall north-south road). As residents of tropical regions can withstand higher levels of THI than other climatic region (Emmanuel 2005) the THI range of Road 4 (Hall east-west road) may exist in the tolerable level for the people of this region.

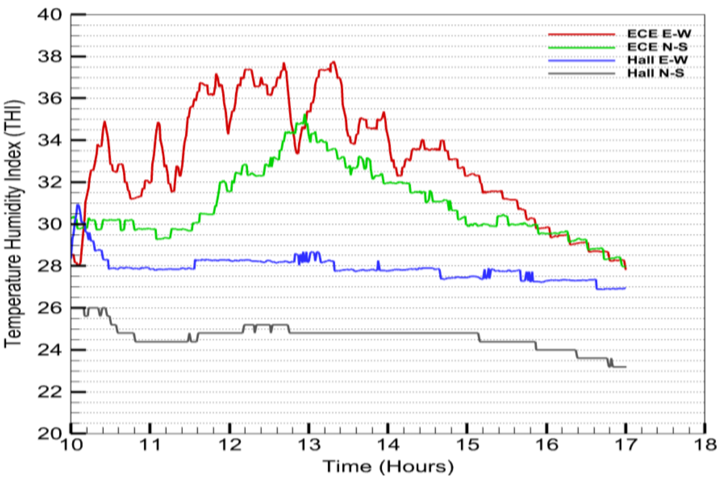

Figure 8: Comparative Thermal Humidity Index (THI) of the sample roads.

Assessment of Semi structure interview

To understand pedestrians' thermal perception, a semi-structured questionnaire survey was conducted on each of the four roads. Furthermore, the survey aimed to ascertain pedestrians' preferences and aesthetic appreciation of streetside flora. 80 people in total participated in this study. 20 people were questioned regarding their thermal perception along each of the four roads. Figure 9 shows the feedback of pedestrians according to thermal sensation vote. Following the feedback of the people it is found that Road 4 (Hall east-west road) is more comfortable, and discomfort occurs most in Road 2 (ECE campus east-west road). The pedestrians also preferred greenery, and they suggested more greenery on the ECE campus road as shown in Fig.9.

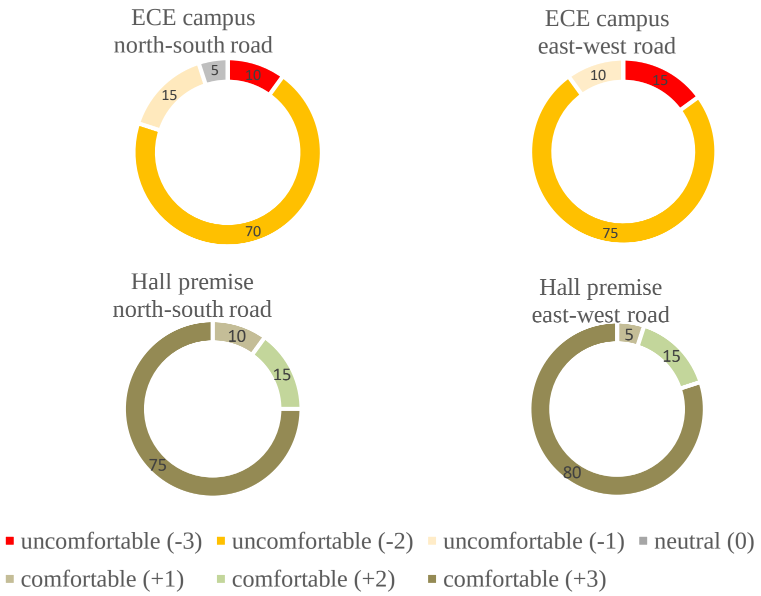

Fig. 9: Pedestrians' perception of thermal comfort on each different road according to thermal sensation vote.

Recommendations and planning policy

Streets with better thermal comfort are naturally more inviting, safer, and healthier as they encourage physical activity and reduce the risk of heat-related illnesses, particularly in Dhaka's hot, humid climate. Selecting tree species that offer shade, purify air, and block UV rays further improves environmental quality. Achieving

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thermal comfort in Dhaka and in similar tropical cities through street vegetation and plantation requires careful planning due to the city's climatic context, population density and urban heat island effect. Vegetation zoning maps may guide the planners to select suitable tree species matching to each microclimate zone based on streets morphology, sun exposure, street width, canyon geometry, and usage. Here's a breakdown of recommendations by category shown in table 3.

Table III Tree Morphology and Planning Policies

Street Morphology	Policy Considerations for planning
Street Orientation	Streets should be aligned with prevailing wind direction where possible. East-west oriented streets need denser canopy than north-south oriented streets in tropical climate.
Canyon Aspect Ratio	Balance between height and width to maximize shade and airflow should be ensured.
Sky View Factor (SVF)	Low SVF should be maintained by planting trees with larger canopy in open streets.
Canopy Layout Strategy	Canopy coverage goals may be defined as: 60% for pedestrian priority streets, 40% for mixed-use streets, and 20% for vehicular arterial roads. Preferable distance should be maintained according to street scale and tree species.
Zoning and Layout	Vegetation zoning maps should be implemented to match species with land-use zoning, soil, sunlight, and water availability across the city.

Furthermore, urban microclimate control requires synergistic design of street form and green elements. Table 4 represents some considerations concerning the street morphology and urban microclimate.

Table Iv Street Morphology And Planning Policies

Tree Morphology	Policy Considerations for planning
Tree Species	Native or tropical species like Siris tree, Rain tree, Neem, Krishnachura, Golden Trumpet, Peacock Flower, banyan tree Acacia etc.
Height layering	Large trees for upper layering to block the sun, shrubs for pedestrian comfort and groundcover or turf to reduce surface temperature.
Water Needs	Moderate to drought-tolerant species due to infrequent watering
Growth Characteristics	Fast-growing, low maintenance, upright with moderate-to-large canopies, minimal lateral root spread
Ecological & Cultural Value	Should offer ornamental appeal, fragrance, edible or medicinal uses, and shade performance
Climate Benefit	Effective at evaporative cooling, UV filtering, urban heat island mitigation, and air purification.s

Dhaka can showcase the impact of green infrastructure through "Cool Street" pilot projects in high-pedestrian zones, such as near student residences or transit corridors. These should be reinforced by urban greening mandates requiring tree plantation in all new street designs, with legal safeguards.

Sustaining these efforts will require community involvement—through maintenance programs, "adopt-a-tree" initiatives, and awareness campaigns highlighting the cultural and environmental value of greenery.

CONCLUSION

The impact of street vegetation on thermal comfort from a physical and psychological standpoint is examined in this study. From the experiment conducted on four different roads with same geometrical configuration but varying amount of street side flora, it's been found that street side vegetation has impact on street average air temperature and humidity and hence it has impact on human thermal comfort (HTC).The amount and placement of vegetation, canopy, radius and height of the trees are also some factors which affects the shading, air temperature, humidity, air velocity as well as other thermal parameters.

This study shows that despite being in the east west direction, the Hall east west road (Road 4) is thermally more comfortable because air temperature is reduced and humidity is also in moderate range due to extensive amount of greenery. Hall north south road (Road 3) with vast amount of greenery can also be referred to as comfortable in the context of Bangladesh being in the tropical climatic zone. On the other hand, ECE campus roads (Road 1 and 2) lack roadside greenery and not thermally comfortable because of high air temperature.

The questionnaire survey also shows that people feel thermally comfortable in the Hall Road and uncomfortable in the ECE campus roads. People also prefer more street side flora in terms of aesthetic and psychological perspective of thermal comfort.

To sum up, street vegetation is a practical adaptive method for designing aesthetically pleasing and thermally comfortable spaces in the outdoor living environment. The findings of this study indicate that street side tree canopy contributes to urban microclimate by reducing daytime average air temperature and thereby improve HTC during hot conditions. The magnitude of tree cooling depends on the amount of shading, the layout of the streets, and the local climate which affect the differences in air temperature in the street canyons. So, it is important to place the trees effectively to maximize the benefits. In Dhaka or other cities with similar dense tropical context, street vegetation must be treated as an essential infrastructure. When integrated with smart orientation and design, it becomes a key solution for heat mitigation, enhancing public health, and creating a more livable, climate-resilient city to maximize the benefits.

ACKNOWLEDGEMENT

The author acknowledges Atiqur Rahman, Assistant professor from the Department of Architecture, Bangladesh University of Engineering and Technology for guidance and use of materials from the MSc Arch Course Thermal Environment and Built Form (Arch 6101)

Ethical approval

All participants provided informed verbal consent prior to data collection. The study followed ethical guidelines for research involving human subjects and was approved by the appropriate institutional review board.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this study. No financial or personal relationships have influenced the research, data interpretation, or writing of this paper.

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