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ASLI 2018

E-B Environment - Behaviour Proceedings Journal

AicQoL2018PerhentianIsland

http://www.amerabra.org; *https://fspu.uitm.edu.my/cebs*
6th AMER International Conference on Quality of Life
Pulau Perhentian Resort, Malaysia, 03-04 March 2018
"Quality of Life in the Built & Natural Environment 6"

e-IPH e-International Publishing House Ltd., United Kingdom

Vegetation Design as User's Thermal Modifier at Urban Park

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Abstract
The study aims to investigate the potential of vegetation design as a microclimatic modifier at KLCC park. The scope of the study is to determine the impact of vegetation types towards thermal comfort. The different morphological characteristics of trees, shrubs and groundcover, and its planting configurations could be the best indicator to determine the outdoor thermal satisfaction among users. The results indicate the sampling points with various types of vegetation including hardy canopied trees, dense shrubs and groundcovers recorded lowest air temperature, and more visitors were comfortable doing activities in that area compared to points with fewer layers of vegetation.

Keywords: Planting design; vegetative cooling; user's thermal comfort; urban public park

DOI: https://doi.org/10.21834/e-bpj.v3i7.1243

1.0 Introduction

Among the challenges we face in the 21st century is to make the city more resilient to future climate change. There is an urgent need to tackle issues like Urban Heat Island (UHI), heat stress and outdoor discomfort to ensure the habitability of the city, and to enhance the quality of life to the inhabitants. Imposing more green network and infrastructure could help in improving the urban thermal environment, and promote outdoor comfort to the dwellers. Vegetation plays a significant role in modifying urban temperature where it serves as passive tools to reduce solar radiation and lower ambience temperature. Thermal comfort is a necessary element for an individual to sitting outside which gives influence to the activities in the streets, playgrounds, and public parks in the city. It focuses on the perception and use of outdoor thermal comfort in outdoor spaces that are relevant to thermal adaptation. Outdoor areas are significant to the sustainability of a city which connects the public with built-in urban context while providing facilities for pedestrian and many outdoor activities (Marc Aurel Schnabel, 2015; Thani et al., 2017).

The quality of an outdoor space is very dependent on the user's comfort. The user's feeling against thermal comfort very affected by the local microclimate and makes it as an essential factor when choosing a place to be utilised (Wan Aman, 2016). The number of people who sit in shaded spots and open sunny area both has a significant impact on people's desire to continue to sit there or move to other sites. Studies show the proper planning arrangement of trees and wind direction can improve the pedestrian thermal comfort around buildings and public areas (Derkzen et al., 2017). Urban trees have a variety of ecological function. It also provides environmental relationships and buffer zone within the built environment and supports the ecosystem in the city (Tan et al., 2015; Rashid et al.; 2014).

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DOI: https://doi.org/10.21834/e-bpj.v3i7.1243

The vital function of vegetation design is to provide shading along streets in urban areas which could be adaptive potentials to combat climate change.

Residential areas and cities that are almost covered by buildings have their thermal systems. There are combinations of many human-made and natural elements that contribute to modify climatic conditions that will simultaneously form outdoor thermal system (Jamaluddin et al., 2014). Besides, a part of buildings, vegetation, road and pavement, water bodies and earth ground also contribute to the alteration of thermal condition (Sharifah Khalizah et al., 2012). To reduce heat impact onto our environment, the objectives of design should be planned to meet the needs where all the heat sources could be reduced. Therefore, the components of the thermal system should be arranged and well managed, so that accumulated heat is at the minimum level. Improvements of outdoor space in the urban area help to prevent the increasing climatic stresses around buildings and public areas to make these areas comfortable to live for a long time. Plants act as a shield to the sun, sound and wind and also as a source of humidity which can reduce air temperature in surrounding surfaces (Rashid et al., 2014). Trees can reduce the level of incoming solar radiation in the open space using shadowing and minimise the amount of sunlight that reaches the ground. Among improvements which are the most efficient and widespread use is the incorporation of water bodies and vegetation in an urban environment (Tan et al., 2015). Both play an essential role in creating a more comfortable microclimate in the outdoor space and around buildings.

The outdoor thermal comfort is majorly influenced by the built environment, for example, anthropogenic heat, evaporation and evapotranspiration of plants, shading by trees and human-made objects, and ground surface cover such as natural grass and artificial paving. People get the different experience of thermal sensation while carrying out the outdoor activities in streets, plazas, playgrounds and urban parks (Palliwoda et al., 2017). Thermal comfort is defined by ASHRAE as the psychological approach as the condition of mind, which expresses the satisfaction with the thermal environment.

While previous studies have established the great significance of urban trees in modifying the thermal environment, some critical understanding gaps remain. It is regarding the relative importance of vegetation layers, plant area index and planting composition – and of gathering plants in particular – compared to other activities pursued by people in urban green spaces (Palliwoda et al., 2017). This study aims to observe the characteristics of vegetation design and urban park typologies that could be the best indicator to serve as microclimatic modifier towards user's comfort at KLCC Park. By examining the vegetation layers concerning user's thermal convenience, it is hoped that the findings of this study could suggest landscape design improvements in designing urban parks. A better consciousness of effective climate adaptation is required to see how the connections of vegetation design influence user's behaviour in the area of interest.

2.0 Methodology

This research combines both quantitative and qualitative approaches to understand a research problem. In this study, a quantitative research approach is used to obtain primary data where a field measurement was conducted to collect temperature (ºC) and wind speed (ms^{-1}) readings at KLCC Park. First, the study observed the vegetation design and its microclimatic effects through field measurements. Second, the study found the influence of vegetation design to user's comfort through secondary data obtained from another researcher that conduct a similar survey at KLCC Park.

The study involved both qualitative and quantitative methodology where it divides into two different observations. For ground measurements, 15 sampling stations were identified within KLCC Park that comprises of various urban park typologies and vegetation characteristics. For determining the user's thermal comfort, the researcher has selected eight sampling points with different layers of vegetation around the KLCC Park. The perception of user's thermal comfort among 30 respondents was obtained through guided interview and questionnaire survey. The results of both observations and ground measurements were then analysed thoroughly to get the empirical findings for this study.

2.1 Selection of case study

The study is carried out at KLCC Park (Lat. 3.156° N, Long. 101.7140° E), located at the heart of Kuala Lumpur City and midst of a busy city, KLCC Park has chosen as a case study for several reasons. Firstly, it has specific land uses and land covers that determine various urban surface characteristics and give different types of human activities. The KLCC Park has become a famous public park and green lung providing a recreational retreat for the city's residents and visitors since its opening in 1998. Located in the heart of Kuala Lumpur's commercial and business district, the 50-acre park is an integral part of the overall 100-acre KLCC Development. These include a two-acre child-safe playground, children's wading pool, jogging track, gazebo, benches, patterned footpaths, sculptures, as well as other necessary facilities. Designed public amenities for visitors of all ages also well equipped. More than 1,900 trees and palms representing 66 species have planted in the park, each carefully selected for indigenous relevance to the climate of Malaysia. Besides to promote biodiversity, the trees were chosen to attract local and migratory birds.

2.2 Sampling method

For this research, 15 sampling stations selected throughout the KLCC Park. These locations were chosen to represent the diverse characteristics of landscape typologies at KLCC Park. The sampling stations were located at different kinds of features to cover all types of area, trees and specific landscape characteristics. The number of the sampling stations considered sufficient for this research because it represents the distinctive landscape in the park (e.g. built-up, water area and green area) of KLCC Park, and provides enough number of readings to investigate the climatic parameter distribution throughout the park. Figure 1 shows the macro view and boundary of KLLC Park as well as all the sampling points through satellite imagery.

The Garmin GPS was used to navigate the location of the sampling points for ground measurement. A digital camera was used to photograph the landscape characteristics of each selected sampling locations. The chosen sampling stations and its features are shown in Figure 1.

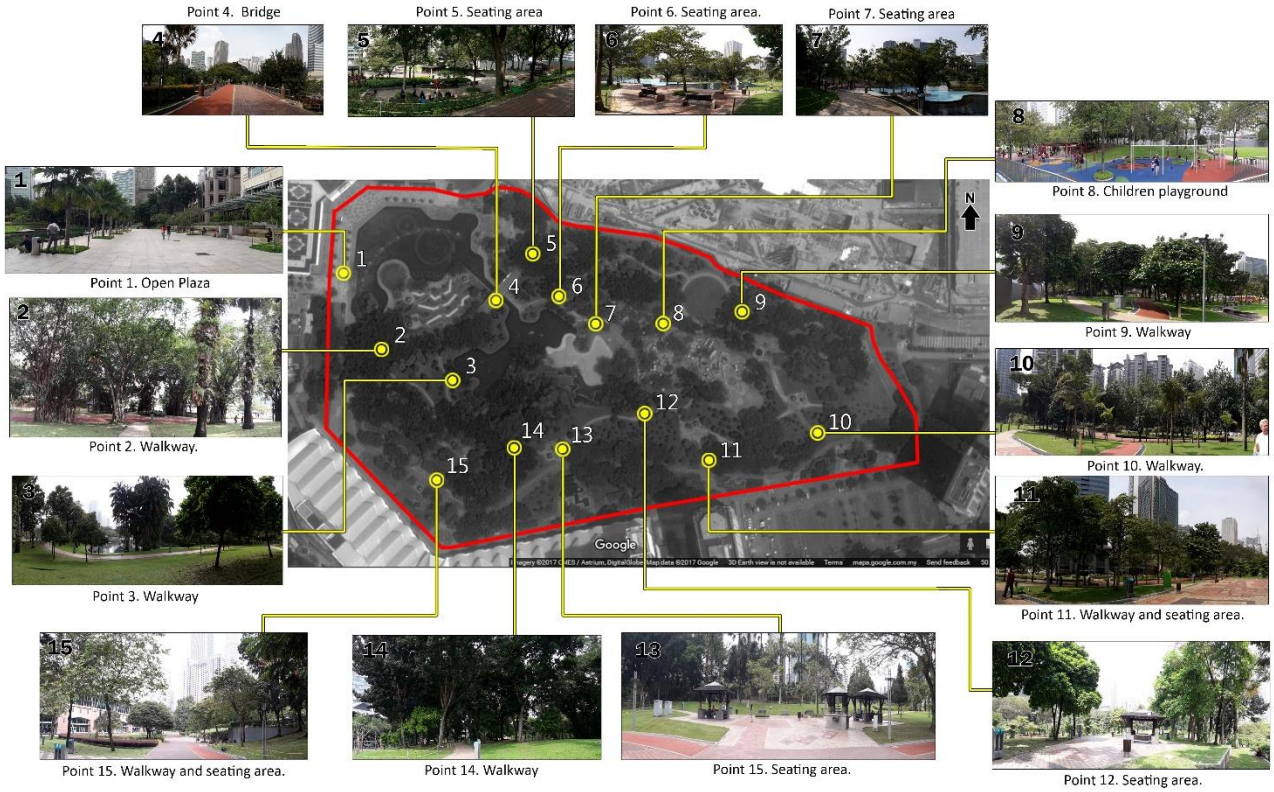


Fig. 1. Selected 15 sampling points at KLCC park

For user's thermal comfort survey, a study by Wan Aman (2016) was referred as secondary data to obtain information on thermal comfort of visitors at KLCC Park. In her research, non-probability sampling techniques were conducted to represents the various background of KLCC Park's users and visitors. The target respondent is among the visitor who comes to KLCC Park for visiting, having leisure activity and sight-seeing. The guided questionnaire survey includes the survey of thermal comfort acceptance among users and visitors at KLCC Park. The questionnaire also considers the clothing and activity of human at the park, followed by the section involve the Predicted Mean Value (PMV) scale from +3 hot which is discomfort situation until -3 the coldest position. The part of the questionnaire also consists of the effect of vegetation design towards the thermal comfort. The variety of vegetation design and planting hierarchy such as tree, shrub and groundcover give the different satisfaction towards the environment. The thermal comfort sensation can be recorded in any one of the thermal comfort scales as shown in Table 1.

Table 1. The ASHRAE Scale

ASHRAE Scale	Indicator
Hot	+3
Warm	+2
Slightly warm	+1
Neutral	0
Slightly cool	-1
Cool	-2
Cold	-3

(Source: ASHRAE)

2.3 Microclimatic measurements

The field measurements of air temperature and wind speed were taken from 29th March to 8th April 2017 for two to three times a week within two weeks including four days on weekdays and two days on the weekend. The field measurements were taken on the calm and clear weather. This number of observation provided sufficient information to determine the highest and lowest temperature consistently recorded at the study area and to examine the influence of vegetation design (layers) towards outdoor thermal comfort in various park typologies.

The measurements of all sampling points were conducted during the day by afternoon in between 12.00 pm to 3.00 pm (Malaysia Local Time). The measurements were taken around that time in the daytime because; the amount of solar radiation received is at the maximum rate with the low amount of silhouettes produced. The measurements were conducted in end of March and early of April 2017

to represent the distribution of climatic parameter of dry season, and to observe the temperature distribution in the study area. The solar noon measurements were conducted in the afternoon to see the patterns of daily temperature where the peak of the warmest hour.

The measurements conducted at 1.0 m above ground. Few researchers suggest that the ideal position in taking the ground measurement is as close to pedestrian height as possible. A similar approach has been applied earlier by several urban climate researchers to study the relationship of urban characteristics (land use, land cover and urban structures) with the climatic parameters (Thani et al., 2013). The measurement at each selected sampling stations was obtained by using a handheld Surfing LCD Digital Anemometer Thermometer Wind Speed Gauge Meter. The instrument had temperature and air velocity accuracy of ± 2ºC and +/-5%. The resolution was 0.2ºC and 0.1ms^{-1} respectively. Before beginning the field work, the devices were calibrated to ensure it is in excellent condition and does not affect the measurement taken. Furthermore, the surveyors also waited about 20 seconds to stabilise the sensor before taking the measures at each sampling points.

3.0 Findings and Discussion

Both studies demonstrated results as follows:-

3.1 Influence of landscape typologies towards microclimatic effects

Based on the field measurements that conducted within 15 selected sampling points in KLCC park, there was a noticeable influence on temperature distributions where each park typologies recorded various microclimatic event depending on the specific characteristics of each location. The different microclimatic readings indicate that although all measurements were taken within the park vicinity, however, the temperature readings much likely to be influenced by vegetation types, landscape elements and basic amenities that surround the locations.

Figure 2 shows the variance of microclimatic readings for 15 sampling locations. The temperature and air velocity readings were averaged to get the mean value. In general, the temperature distribution was quite uniform as they were not much difference of temperature readings within each sampling points, and the air velocity that was recorded in KLCC Park ranging from 0.0 to 0.6ms^{-1}. In general, the influence of air velocity towards minimising temperature distribution does not significantly affect each other as the speed were deficient in the area, below 1ms^{-1}.

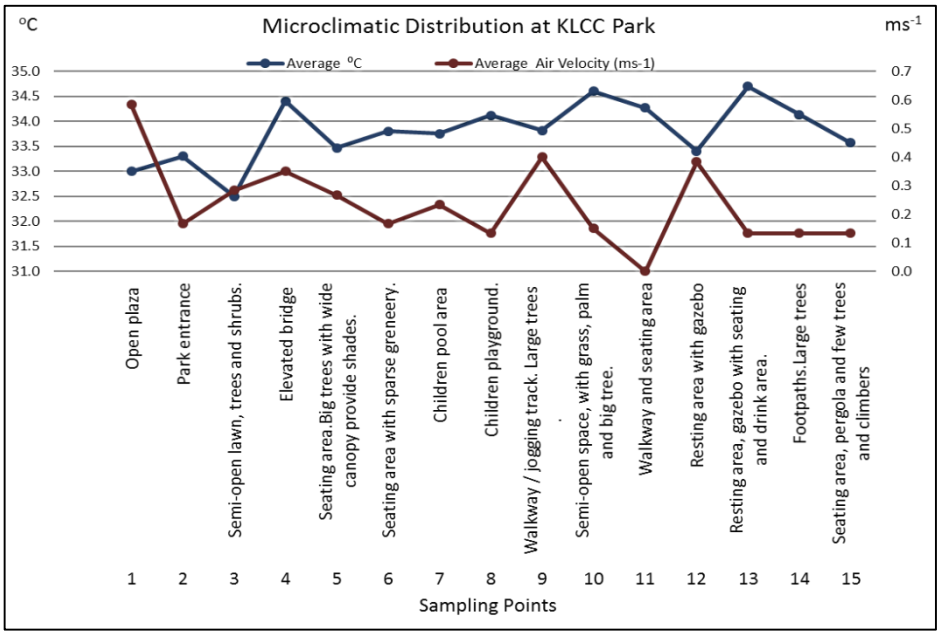


Fig. 2. Microclimatic distribution at KLCC Park

The highest temperature recorded at Point 13 (resting area with gazebo, benches and few trees) which is 34.7ºC. The lowest temperature recorded at Point 3 (semi-open lawn, trees and shrubs) which is 32.5ºC. From the temperature and air velocity distribution that have been presented in a graph (Figure 2), it could be concluded that the temperature distribution slightly higher at the area with more landscape structures like a gazebo, street furniture, playground and others that are believed to attract more people to do activities in that area. This indicates the presence of anthropogenic activities that could influence the microclimate of the area. On the other hand, the landscape typologies for area which recorded lower temperature distribution observed the characteristics of more soft landscape elements like the lawn with trees and few vegetation layers. Although not all areas with soft landscape elements found lower temperature than human-made elements in KLCC park, it could be seen that landscape typologies which impose more plants exhibit a slightly lower temperature within the sampling locations. This indicates that each landscape elements have their thermal properties that could influence

the microclimate of particular spaces. The findings agree with some researchers that observed the existence of thermal properties in different tree species and landscape characteristics (Thani et al., 2013; Rashid et al., 2014).

3.2 Influence of vegetation layers towards user's comfort

The percentage of user's comfort level when stay at the different layer of vegetation was observed by Wan Aman (2016) in KLCC Park. Table 2 tabulated the user's comfort level in response to various vegetation layers that have identified in KLCC Park. The level of comfortable towards the different layer of vegetation is based from the ASHRAE scale that divides into seven thermal acceptance level namely cold, cool, slightly cool, neutral, slightly warm, warm and hot. The respondents at each vegetation layers were asked the comfort level in doing an outdoor activity at KLCC park. Respondents were selected randomly in eight different vegetation layers and were requested to response their comfort (thermal) level while being outdoors.

Table 2. The percentage level of user's comfort towards eight combination layers of vegetation
(** show the highest % that represent each vegetation layer)

Vegetation Layers	Cold (%)	Cool (%)	Slightly Cool (%)	Neutral (%)	Slightly Warm (%)	Warm (%)	Hot (%)
(a) Tree only	8.7	14.7	**19.0	24.7	16.3	10.0	6.7
(b) Shrub only	2.0	8.0	15.7	31.7	**22.7	13.7	6.3
(c) Groundcover only	3.3	6.3	13.3	32.3	**19.0	14.3	11.3
(d) Tree and shrub	4.3	14.7	**22.0	31.7	16.3	7.7	3.3
(e) Tree and groundcover	4.0	15.3	**23.7	32.0	13.0	9.0	3.0
(f) Shrub and groundcover	3.0	10.7	**23.7	35.7	15.0	8.7	3.3
(g) Tree, shrub and groundcover	19.7	**22.7	17.7	19.3	12.0	7.3	*1.3
(h) Pavement only	2.7	5.3	5.7	23.7	21.0	**23.3	18.3

(Source: Modified from Wan Aman, 2016)

In the analysis, although the neutral % recorded highest value, however, it could not be considered to represent the user's comfort because it indicates 0 value in ASHRAE Comfort Scale where it could be interpreted as the visitors just accept any kind of thermal condition, thus, it is not really contributing to measure comfort level. The different layer of vegetation design effects the level of comfort of the respondent when visiting the KLCC Park. Based on the results, most respondents answered "slightly cool" while they were outdoor in KLCC Park. The highest percentage (23.7%) observed at vegetation layers that comprise of tree and groundcover, and a combination of tree, shrub and groundcover. From the result, most respondents (23.3%) found that the warmest area spotted at pavement only, and the slightly warm areas were observed at areas with shrub (22.7%) or just groundcover (19.0%). The percentage show respondent feels warm when staying at the outdoor environment without vegetation. Its mean, the vegetation design influenced the user's comfort level when staying in an area that has a different layer of vegetation design compare to an environment without vegetation design such as pavement only. Therefore, the level of comfort is increased when staying at the three combination layer containing trees, shrub and groundcovers compared to when staying at the environment with fewer vegetation layers or with pavement only.

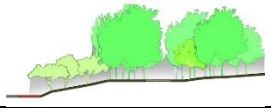
This indicates that the vegetation layers and planting hierarchy plays important roles to influence user's perception when staying in an outdoor environment. This finding agreed with the previous study by Shahidan (2015) that investigates the potential of individual and cluster tree cooling effect performances in improving urban microclimate through the evaluation of urban trees canopy density. The study by Shahidan (2015) found that each tree has different capabilities in modifying each microclimate variables. The vegetation design is important in influencing the thermal comfort which is the satisfaction when staying the certain environment. The different layer of vegetation design gives the different level of thermal comfort either it comforts or uncomfortable.

3.3 Vegetation design in relation to user's comfort

The findings could be summarised as follow (refer Table 3):

Table 3. Summary of the findings – user's comfort level in relation to various landscape typologies and vegetation layers

Points	Landscape Typologies and Vegetation Characteristics	Vegetation layers	Microclimatic Variance (Mean Value)	User's Comfort Level
P1	Open plaza. Covered with wide area of pavement. Combination of palm and trees.	Tree and groundcover 	33.0 °C / 0.6 ms^{-1}	Slightly Cool
P2	First entrance to the park. Big tree and wide canopy of *Ficus* sp. tree. Planted beside walkway and jogging track, giving perfect shade to stop by.	Matured tree and groundcover 	33.3 °C / 0.2 ms^{-1}	Slightly Cool

P3	Semi-open lawn area with scattered trees. Walkways and grass area to walk and leisure. Lawn area used by visitor to sit and picnic facing the man-made lake.	Tree, shrub and groundcover 	32.5 °C / 0.3 ms-1	Cool
P4	The elevated bridge cut across the park. Open space to ease people to take photo of KLCC Tower. Equipped with pavement and jogging track.	Pavement only 	34.4 °C / 0.4 ms-1	Warm
P5	Seating area. Covered with pavement. Big trees with wide canopy provide shades and giving comfort to the user.	Tree and shrub 	33.5 °C / 0.3 ms-1	Slightly cool
P6	Seating area. Small area provided with bench, covered with pavement, groundcovers and some trees.	Tree and groundcover 	33.8 °C / 0.2 ms-1	Slightly cool
P7	Children wading pool area. Equipped with seating area, and planted with trees to give shade. Covered with pavement, cement and interlocking.	Tree only 	33.9 °C / 0.2 ms-1	Slightly cool
P8	Children playground. Surface mostly covered by EPDM (Ethylene Propylene Deine Modified) Rubber. Some trees.	Tree only 	34.1 °C / 0.1 ms-1	Slightly cool
P9	Walkway equipped with jogging track. Big trees provide shade.	Tree and groundcover 	33.8 °C / 0.4 ms-1	Slightly cool
P10	Walkway and jogging track. Semi-open space, with grass, palm and big trees.	Tree and groundcover 	34.6 °C / 0.2 ms-1	Slightly cool
P11	Walkway and seating area, patterned footpaths and jogging track, covered with trees.	Tree only 	34.3 °C / 0.0 ms-1	Slightly cool
P12	Resting area with gazebo, bench and some shades from trees. Quite breezy area as located at higher point of park.	Tree, shrub and groundcover 	33.4 °C / 0.4 ms-1	Cool
P13	Resting area. Few benches provided, gazebo with seating and drink area. Mostly covered with pavement and few trees.	Tree and groundcover 	34.7 °C / 0.1 ms-1	Slightly cool
P14	Footpaths. Shade area from big trees with compact and wide canopy.	Tree and shrub 	34.1 °C / 0.1 ms-1	Slightly cool

P15	Seat area. Wide pattern pavement of walkway with jogging track. There are more than 2m heights trees, shrub and groundcover. A structured pergola equipped with seating area.	Tree, shrub and climber 	33.6 ^{o}C / 0.1 ms^{-1}	Slightly cool

The table above summarised both results where it could be seen that the outdoor setting with different landscape typologies and vegetation design have resulted in variation to the microclimate. It could be observed in KLCC Park where most people found landscape typologies with a combination of more than one vegetation layers gives many thermal benefits compared to barren or least vegetated spaces. Mostly user's at KLCC Park found it is cold or slightly cool when staying or doing recreational activities in the areas with more of one vegetation layers. It could also be seen people noticed it was slightly cool too at areas with only least or few layers of vegetation (P1, P2, P5, P6, P7, P8, P11, P13 and P14). The results also showed even though some areas have landscape typologies of ample greenery and more vegetation layers (P3, P9, P12 and P15), but the temperature recorded somewhat higher than areas with least vegetation layers. However, the user's comfort perception was inverted with the microclimatic variances at these areas where they still consider that these areas were slightly cool and contribute to the thermal comfort. This indicates that vegetation also has influenced in the psychological perception of the users where it could be presumed that users found it is more cooling when there is vegetation rather than sparse areas. User's opinion also influenced by many factors, from the results, it could be seen that areas equipped with landscape amenities like benches, pergola or seating area could attract more enjoyment among users to use the space.

Overall, in determining user's thermal comfort, the landscape typologies and vegetation layers do have a vast influenced where all sampling points that user's found it was cool or slightly cool were sharing specific similar characteristics. Firstly, most of the areas have the presence of mature or trees with a large canopy, a combination of both hard and soft landscape elements, and lastly have some park amenities like gazebo, play area, seating areas and other that make people find it is comfortable to stay and doing outdoor activities in these areas.

4.0 Conclusion

The findings suggest a preliminary strategy to design with plants in improving urban microclimate. This research indicates the landscape design improvements as follows:

- From the results, it could be concluded that the critical factor that should be considered in designing for outdoor thermal comfort is to provide shading (both from vegetation and human-made structures). From the questionnaire survey, most user's found that it is quite comfortable to stay outdoor and doing recreational activities in the area with large tree canopies and provide ample shading.
- In an urban park setting, because people acceptance level is hugely depending on their perception, it is essential to ensure that people will enjoy the space. Although trees and vegetation could be core source that provides thermal benefits, however, landscape elements should also be provided as most user's still considered the area that equipped with park facilities are slightly more relaxed than areas with vegetation only (even though the temperature is lower at this area). Therefore, all factors must be considered in designing an urban park for user's comfort.
- All types of vegetation have their thermal properties and could be modified to promote outdoor thermal comfort.
- Further research specifically on vegetation thermal properties according to native tropical species are suggested. The focus should be given on the Plant Area Index and canopy densities that contribute to thermal benefits. Wind infiltration through canopy layers also should be observed.

Thermal comfort is a necessary element for an individual to sitting outside which gives influence to the outdoor activities. Therefore, to secure social sustainability in future, the aspects of environmental resilience should be taken proactively from time to time.

Acknowledgements

This research paper is supported by a grant of Research Acculturation Grant Scheme (RAGS) from Ministry of Higher Education, Malaysia and Institute of Research Management and Innovation (IRMI), Universiti Teknologi MARA (600-RMI/RAGS 5/3 (64/2015)).

References

Derkzen, M.L., Teeffelen, A.J.A.V., Verburg, P.H. (2017). Green infrastructure for urban climate adaptation: How do residents' views on climate impacts and green infrastructure shape adaptation preferences?. *Landscape and Urban Planning* 157. 106–130

Jamaludin, S.N., Nik Mohamad, N.H., Thani S.K.S.O. (2014). Designing Conducive Residential Outdoor Environment for Community: Klang Valley, Malaysia. *Procedia-Social and Behavioral Sciences* 153, 370-383

Palliwoda, J., Kowarik, I., Lippe, M. V. D. (2017). Human-biodiversity interactions in urban parks: The species level matters. *Landscape and Urban Planning* 157. 394–406

Rashid, Z.A., Al Junid, S.A.M., Thani, S.K.S.O. (2014). Trees' cooling effect on surrounding air temperature monitoring system: Implementation and observation. *International Journal of Simulation: Systems, Science and Technology* 15 (2). 70 – 77

Shahidan, M.F. (2015). Potential of individual and cluster tree cooling effect performances through tree canopy density model evaluation in improving urban microclimate. *Journal of Current World Environment* 10 (2), 398-413

Sharifah Khalizah, S.O.T., Nik Hanita, N.M., Sabrina, I. (2012). Modification of urban temperature in hot-humid climate through landscape design approach: A review. *Procedia-Social and Behavioural Sciences,* 68, 439 – 450.

Tan, Z., Lau, K.K.L., Ng, E. (2015). Urban tree design approaches for mitigating daytime urban heat island effects in a high-density urban environment. *Energy and Buildings*, 114 , 265-274

Thani, S.K.S.O., Nik Mohamad, N.H., Syed Abdullah, S.M. (2017). Influence of Urban Landscapes to Microclimatic Variances in a Tropical City. *Asian Journal of Behavioural Studies 2* (7), 31-41

Thani, S.K.S.O., Nik Mohamad, N.H., Jamaludin, S.N. (2013). Outdoor thermal comfort: the effects of urban landscape morphology on microclimatic conditions in a hot-humid city. *WIT Transactions on Ecology and the Environment* 179. 651-662

Wan Aman, W. A. (2016). *The Impact of Vegetation Design towards Thermal Comfort at KLCC Park.* Unpublished Thesis. Universiti Teknologi MARA, Malaysia