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Influence of Trees and Greens in Open Spaces on Meteorological variables

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Abstract

This Vegetation in open spaces has been identified to contribute to its microclimate and comfort conditions. This paper assesses the influence of trees and open spaces (lawn and tarred) for environmental performance and thermal conditions. The influence of trees, open spaces (lawn) and open space (tarred) on the microclimate of the Federal University of technology, Akure was considered at nine (9) selected sites with several species of trees and greens within the University campus. Measurements of some meteorological variables (wind speed, temperature, relative humidity, light intensity, radiation) were carried out for this purpose. Data were collected in the first fourteen days of August when monsoon type (vortex) rainfall was predominant due to the northernmost position of the Inter-tropical discontinuity (ITD) at about 22^0N (Lele and Lamb, 2008). Temperature behaviour from the findings shows that besides the daytime cooling effect, trees with dense canopies tend to have warmer temperature than trees with less dense canopy at late evenings and early mornings.

Key word: Tree, Greens, Open space, Thermal comfort and Meteorological variable

1. Introduction

Environmental variables that are important for human thermal comfort include solar radiation, temperatures of surrounding surfaces, air temperature, and humidity and wind speed (Akbari and Taha, 1992) and reduce the need to use air-conditioning systems (Dimoudi and Nikolopoulou, 2003). Urban trees can ameliorate these environmental variables by preventing solar radiation from heating the surrounding buildings and surfaces, cooling the air by evapotranspiration, and reducing wind speed (Akbari et al., 2001). Trees function as natural 'air conditioners', at least with regards to the microclimate of the city. However, due to the reduction of vegetation in urban areas, the problem of the thermal island is continuously increasing. The cool climate conditions that occur in small areas depends on how shaded these areas are. According to Ferrante and Mihalakakou (2001), plants have a large effect on the microclimate. Trees and green areas help to cool cities and to save energy. The evapotranspiration that results from vegetation foliage reduces the temperature in urban areas. An important change in temperature (heat tolerance) occurs as a result of the trees' foliage, in combination with the direct solar radiation (Shashua–Bar & Hoffman, 2003).Since thermal comfort has been suggested to relate more to higher exposure than higher temperature (Emmanuel, 2005), the importance of tree shading as shelter from direct sun exposure cannot be over emphasized.

2. Materials and Methodology

The study was carried out within the university campus of the Federal University of Technology Akure (FUTA), Ondo State Nigeria. The campus which harbours virtually all administrative blocks, departments, student hostels and the staff quarters lies between longitudes 7^0E and 7^045^1E and latitudes 6^0N and 7^0N of the equator. A reconnaissance survey was carried out to assess the number of open spaces (lawn and tarred) and locations with trees within the campus. With the aid of a GPS (Global Positioning System), the coordinates of the nine selected sites were taken, as well as the pictures of the exact position where the measurements and other necessary observations were taken. The locations are positioned as presented in the figure 1.

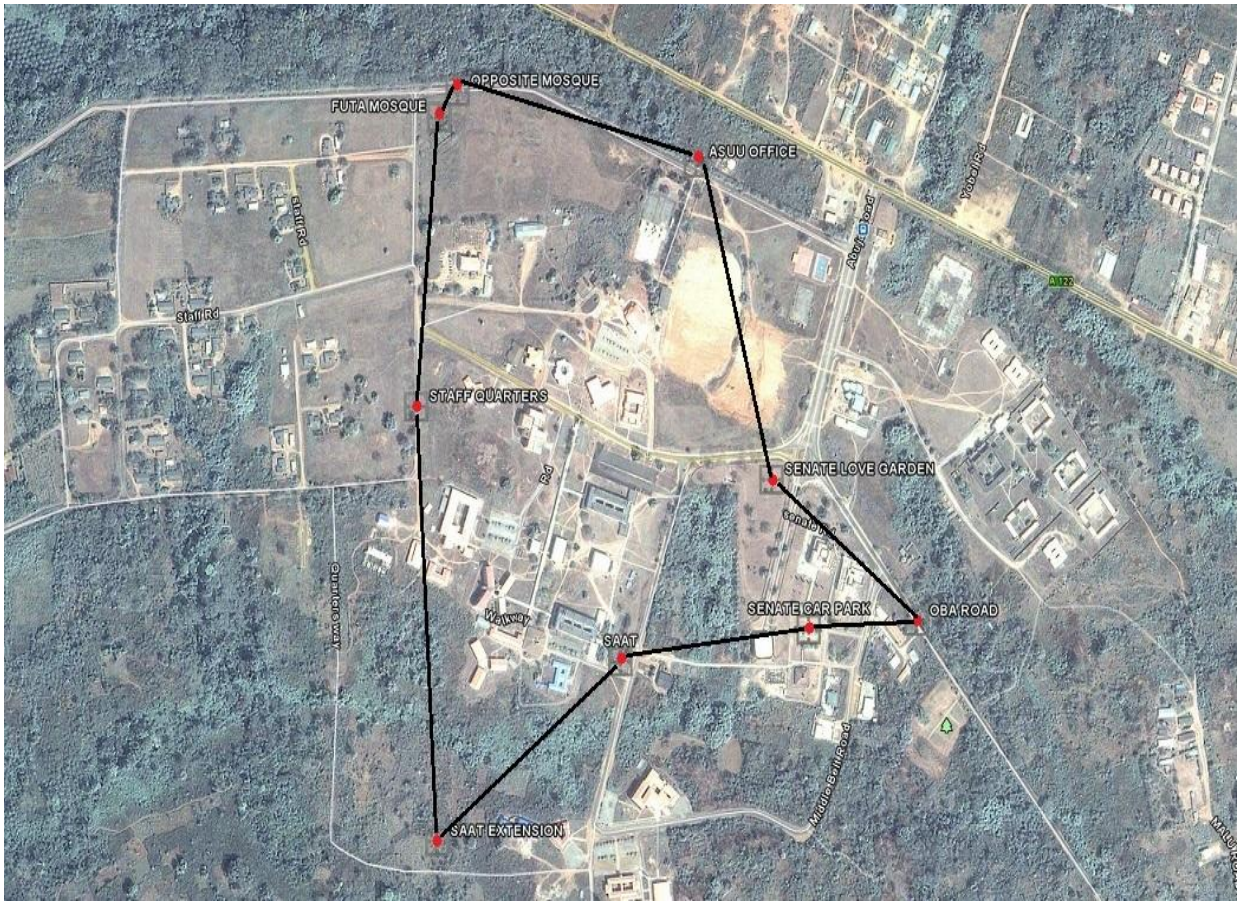


Fig.1 Aerial view of the study area with the 'red dots' connected with black lines.

3. Results and Discussion

Figure 2 represent the variation of the measured climate parameter from the three categories (trees with greens, open lawn space and open space tarred) that are prominent in the selected site.

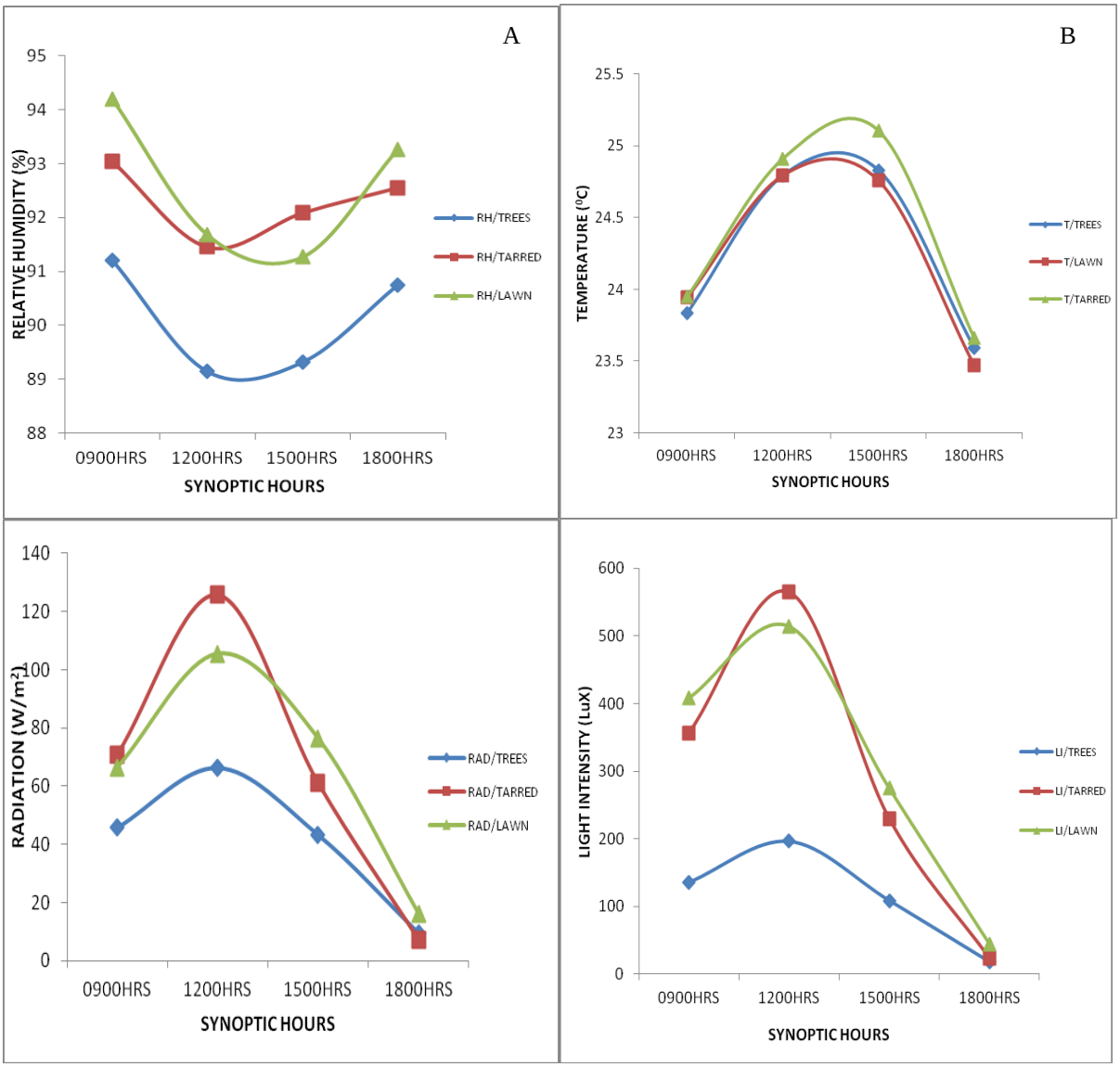
RELATIVE HUMIDITY; Figure 2a, areas with trees showed that the amount of moisture in the atmosphere is high compared to that of the open spaces (both lawn and tarred) which are directly exposed to solar heating and reduces the moisture content of the atmosphere. This agrees with Labadz et al.,(2008) stated that evaporative effect may be small during a rainfall event, but over time, a reduction in soil moisture content will occur as trees and plant use water for nutrient production and consequentially return moisture to the air.

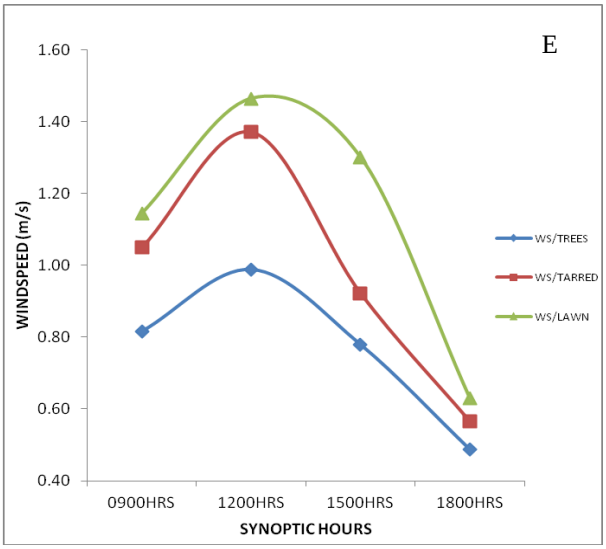
TEMPERATURE: Figure 2b showed a progressive increase in temperature measured in all the locations from 0900hrs till 1500hrs and a drastic fall at 1800hrs. However, the open space (tarred) made a constant lead as it had the highest temperature in all the synoptic hours considered. Shading from trees can act to cool the atmosphere below by simply intercepting solar radiation. Water in the leaf is vaporized and released through the stomata. This release of vapour is known as evapotranspiration and this not only uses the received energy, but also the water vapour released "warms the air less" resulting in cooler air temperatures around the area of vegetation (Dimoudi and Nikolopoulou, 2003).

SOLAR RADIATION AND LIGHT INTENSITY: Light intensity and solar radiation varies synoptically in a similar characteristics manner as shown in figure 2c and d. The open space (tarred) is observed to be highest during the mid-day when the sun is directly overhead. Although the variable dropped below the values recorded at the open space (lawn) from the late afternoon by 1500hrs to 1800hrs. But the tree canopies locations recorded the lowest of both variables throughout the day. At 1800hrs, the sun sets, the amount of illumination reduced and hence resulting to all the locations recording almost same low value. The amount of light intensity or illumination depends on the amount of solar radiation that has reached the surface. The extent to which solar energy heats the urban environment is linked to surface albedo, or rate of reflectance. Less reflectance means that more energy is absorbed and stored to warm the environment as recorded during the 1800hrs. Solar energy is the sole

source of light intensity, therefore, it is expected that as the rate of radiation increases, so also does light intensity as well as temperature increases and vice versa as shown in figure 2d and 2b respectively.

WIND SPEED: The characteristic behaviour of wind speed under the different locations as presented in figure 2e showed that the wind speed is highest at the open spaces (lawn) and least in areas with tree. This can be attributed to the fact that open spaces (tarred and lawn) are not been obstructed. Therefore, there is an increased wind speed compared to tree canopies due to the free flow of air. This agrees with earlier studies by Yu and Hien, (2006) that the ambient temperature is strongly correlated to the density of plants. Therefore, vegetation and the presence of open lawn spaces change the surface roughness of the landscape which may affect air movement and in turn change the surrounding temperature of the environment.





A- Relative Humidity
B- Temperature
C- Radiation
D- Light Intensity
E- Wind Speed

Figure 2: Line graphs of different meteorological variables at all synoptic hours.

Figure 3 shows the graphs of temprature values for all locations during the wet season. Observations were taken at 0900hrs, 1200hrs, 1500hrs and 1800hrs. Figures 3a (morning readings) and 3b (noon readings) showed that on the 8th of August, hightest temperature values for all locations were recorded at 0900hrs and 1200hrs. This was because it was a sunny morning (0900hrs) and also sunny at noon (1200hrs), but preceeded with rain in figure 3c (1500hrs) which recorded least temperature value of about 23^0C for location with open spaces (lawn) and while open space (tarred) recorded a temperature of above 25^0C as represented with location H. This implies that the ambient temperature is strongly correlated to the density of plants. Therefore, vegetation and the presence of open spaces (lawn) change the surface roughness of the landscape which may affect air movement and in turn change the surrounding temperature of the environment. Other days which were raining showed that the 0900hrs of the day were cooled and high at noon (1200hrs) time due to the sun overhead when there was no precipitation.

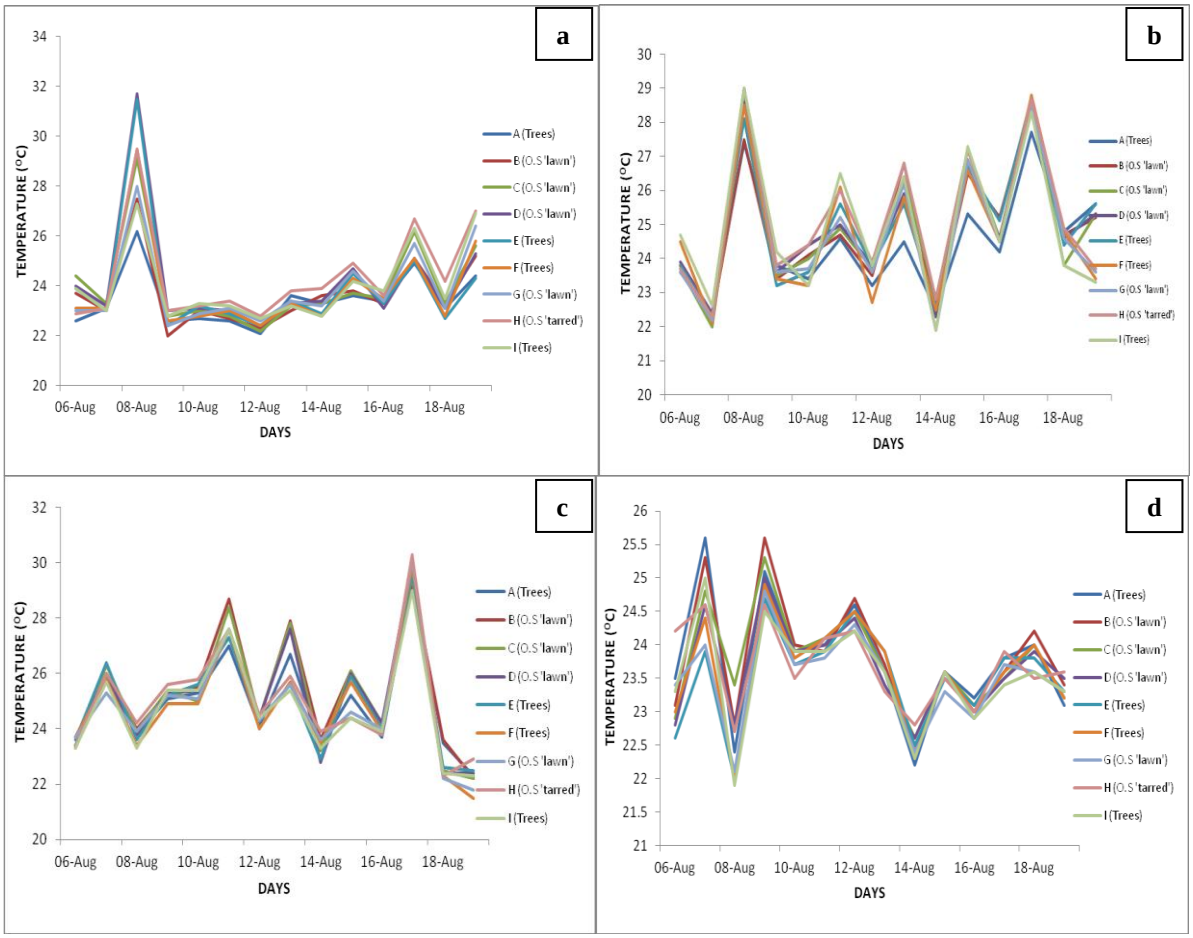


Fig. 3 Temperature graphs of all locations at: (a) 0900hrs; (b)1200hrs; (c) 1500hrs; and (d) 1800hrs.

4. Conclusion

In conclusion, results shows that trees and open spaces (lawns) can help reduce urban heat island when compared to results from open spaces (tarred) through shading and cooling effect within the environment. Trees can reduce air temperature and can help improve human comfort by creating cool environment in which people can shade from the sun. It is certain that trees provide a greater cooling benefit due to their canopy size and shape. This has a great impact in the interception of radiation above the tree thereby reducing the amount of solar radiation that is reaching the surface under the canopy.

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References

Akbari H, Taha H (1992) The impact of trees and white surfaces on residential heating and cooling energy use four Canadian cities. *Energy* **17(2**):141–149.

Akbari H, Pomerantz M, Taha H (2001) Cool surface and shade trees to reduce energy use and improve air quality in urban areas. *Solar Energy* **70(3**):259–310

Dimoudi A, Nikolopoulou M (2003) Vegetation in urban environment: microclimatic analysis and benefits. *Energy and Buildings* **35**:69–76

Ferrante A, Mihalakakou G (2001) The influence of water, green and selected passive techniques on the rehabilitation of historical industrial buildings in urban areas. *Solar Energy* **70(3)**:245–253

EmmanueL, M.R. (2005). An urban approach to climate-sensitive design: Strategies for the tropics. Spon Press, Oxfordshire.

Labadz, J. C., Butcher, D. P. and Sinnott, D., 2008. Wetlands And Still Waters. In:M. R. Perrow and A. J. Davy eds Handbook Of Ecological Restoration - **Volume 1** Principles Of Restoration. New York: Cambridge University Press, Ch.7. pp 106-132.

Shashua-Bar L, Hoffman ME (2003) Geometry and orientation aspects in passive cooling of canyon streetswith trees. *Energy and Buildings* **35**:61–68