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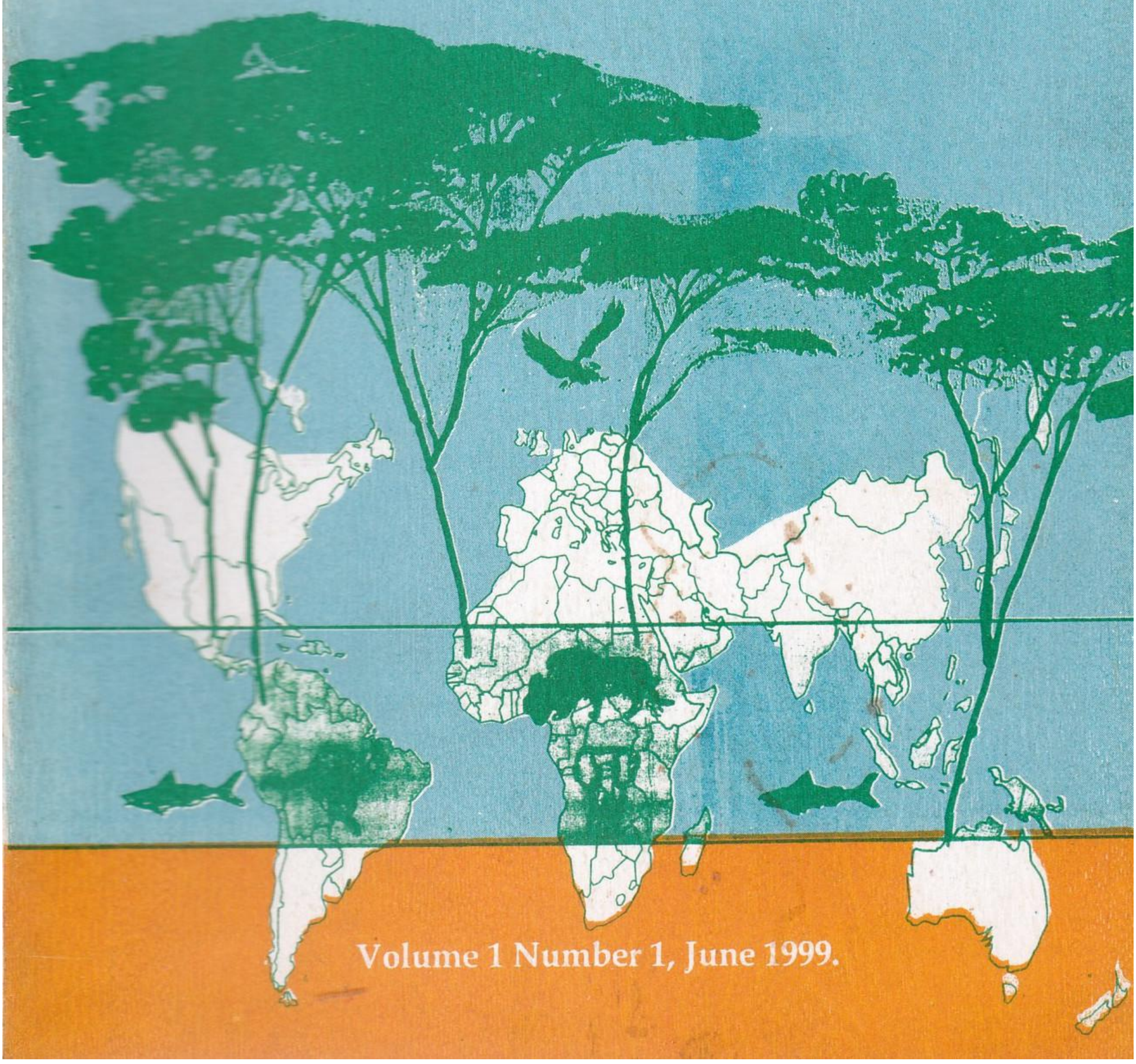

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Reflectivity coefficient over tarred road surface in a humid tropical city of Aba, Nigeria

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ABSTRACT - The reflectivity coefficient of the tarred road surface in an urban center was measured using solari-albedometer. Measurement were taken over the tarred road surface at 7.00am (0700hr), 10,00am (1000hr), 1.00pm (1300hr) 4.00pm (1600hr) and 6.00pm (1800hr). These measurements were taken once a week for the twelve calendar months of the year. Results showed that the reflectivity co-efficient of the tarred road was rather low, decreasing from morning to late afternoon and increasing from wet season to dry season. The early mornings had a minimum value of 9% and a maximum value of 13%; the afternoon had 6.20% minimum and 12.80% maximum with an overall average of 9.63%. In the evenings the minimum was 9.20% while the maximum was 12.6%. This low reflectivity was attributed to the hard dark surface which is the characteristic of tarred road, making the surface nearer a black body than a grey body. This has serious implication for the energy balance of the urban environment. It will result in the alteration of the micro-climatic characteristic of the environment. An increase in the surface area of tarred road as may be desired by urban inhabitants will duly increase the energy balance over the urban centre with consequent serious climatic effects on the physiological comfort of the area.

KEY WORDS: Reflectivity, Coefficient, Environment, Energy Balance, Humid, Temperatures.

INTRODUCTION

All aspects of the climate system of the earth – the winds, rains, clouds and temperature - a re the results of energy transfer and transformation within the earth atmosphere system. These energy exchanges create and drive the climate. The radiation from the sun penetrates to the surface and a part is reflected back and the other part is absorbed. Variations in the amount of radiant energy received at the surface creates the temporal and spatial variation of energy exchanges which lead to our climate. Seller and Robinson (1986) had stressed that at the surface, albedo should be calculated from direct measurements for a single type of surface because the value of this component is highly dependent on the nature of the surface. Therefore variation between surface type has significant consequences for the energy balance of the environment and subsequently the micro climate.

This emphasizes the need to measure and note the magnitude of the albedo on individual surface which was the focus of this work. This becomes more important within the urban environment where heat transfer processes are altered and temperatures are generally higher in the urban centres than outside. In our urban centres, the roads are continuously being changed from bare ground to the hard concrete or bitumen tarred surfaces. This is a sign of development as evident from the efforts and development policies of the State and the Federal Government authorities to increase the number of road paved or tarred.

AIMS AND OBJECTIVES

This work aimed at studying the character of the reflectivity coefficient of the tarred road surface within an urban environment. The approach was by:

(a) determining the magnitude of the reflectivity coefficient over the tarred road surface;

(b) determining the seasonal and diurnal variations of the reflectivity coefficient;

(c) examining the effect of this on the thermal character of the immediate urban environment, and

(d) examining the implication of the results in (a-c) for urban planning.

STUDY AREA

Earlier studies in urban climate had been mostly in the temperate environment and those in the tropical environment concentrated on large towns (Ojo, 1988; Adebayo, 1990). Aba, a medium size town, was therefore chosen in contrast to the large towns for this study. It is continental, which eliminates influences of large bodies of water. It can be regarded as a tropical hot humid climate. It is an important commercial centre east of the Niger, and is located about 5.06°N and 7.21°E (Fig.1). Aba is generally below 100 meters above sea level (Ofometa, 1975). The ambient temperatures are constantly high and only change slightly within the year. The daily and seasonal march of temperatures seem to be more significant than the annual temperature march. The relative humidity fluctuates through a wide daily range, and the diurnal variation is generally a reversal of the temperature regime, since hourly relative humidity is largely a function of temperature. The seasonal relative humidity reflects the characters of the major airmass affecting the areas at different times. Generally, the relative humidity is high, especially during the rainy season and in the mornings. Rainfall distribution in the study area shows a longer wet season from March to October, followed by a dry season from November to March. The total annual rainfall of the area ranges between 2250 and 2500 mm (Monaun, 1975).

As result of intense convection activity, cloudiness is an outstanding phenomenon which has serious influence on the solar radiation received in this area especially during the rainy season when the skies are most of the time experiencing intense cloud activities (Ekanem, 1997).

MATERIAL AND METHODS

Measurements were taken over the tarred road surface using a portable solari-albedometer. This instrument is designed to be compact. It is a hybrid containing two thermopile and sensor plates. The instrument has the advantage of very accurately locating the reflective coefficient with respect to the incoming solar radiation. Each measurement was taken at about 0.3 meters (one foot) above the tarred road surface. This was deliberate, to eliminate the shadow effect of the instrument and any motion effect at the surface. This was also to allow maximum reception of the reflectivity of the radiation at any point in time.

Five consecutive readings were taken, on the average, within a chosen day of measurement, at 7.00am (0700hr); 10.00am (10.00hr) 1.00pm(1300hr); 4.00pm (1600hr); and 6.00pm (1800hr). These observations were done once a week. Every month therefore had at least four series of readings. This was done for twelve (12) calendar months so that the seasonal variations could be noted. The choice of the site of measurement was done in such a way as to reduce to the barest minimum, the effect of advected energy. In this case the site chosen for measurement was an section of the road that was about 3 meters by 4 meters.

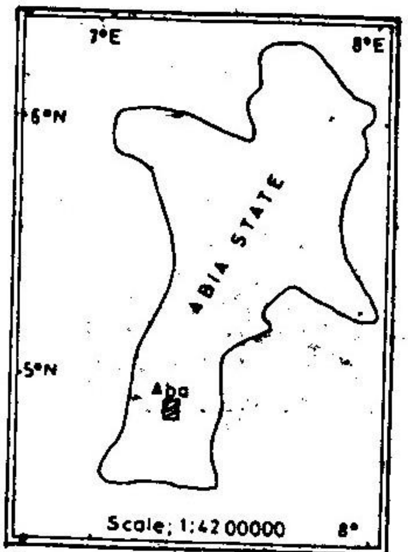

Fig 1a: Abia state showing the location of Aba(study area)

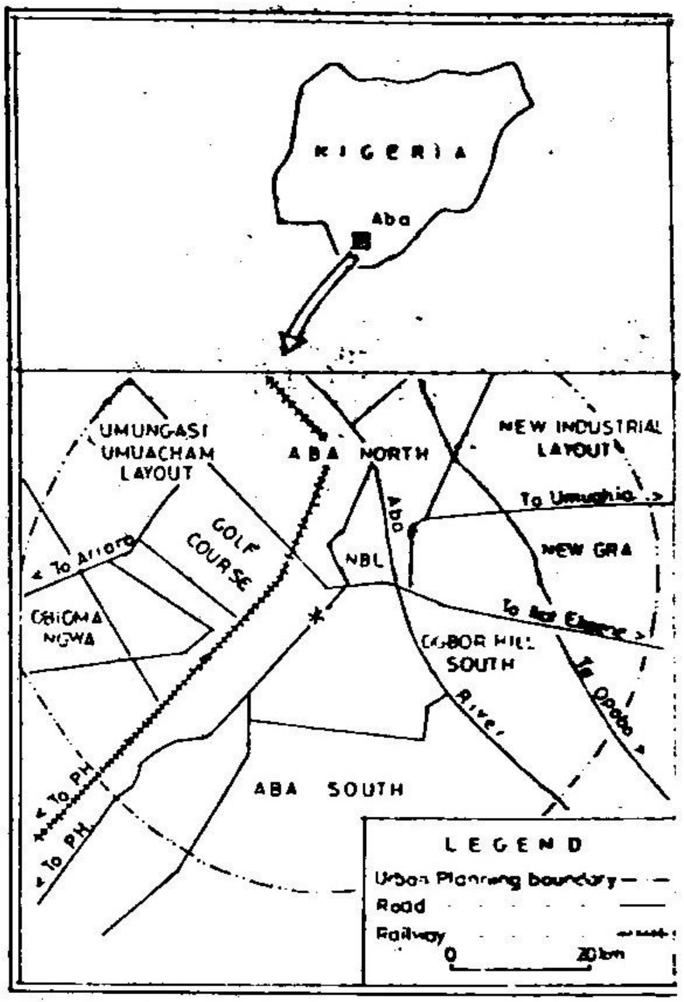

Fig 1b Point of measurement ; *

RESULTS AND DISCUSSION

Generally the reflectivity coefficient for the tarred road surface seem to be low compared to other surfaces (Ekanem,1997). In, the early morning the least value was observed in September, about 9%, while the maximum value was recorded in February, about 13% . The pattern is that of lower values of the reflectivity in the rainy season and higher value during the dry season. This is because during the dry season there are higher insulation and longer hours of sunshine. The overall average value for this early morning period was about 11.08%

In the late morning, due to the ability of the surface to absorb insulation, there are lower reflectivity values than those of the early morning. Also, by this time, the surface is dried up from the dew that normally falls on it in the night. The least value recorded during this time was about 8,2% which was observed in September and the highest value was 13.00%. There was a general steady increase in the reflectivity from September till February, the peak. Thereafter, it began to decrease steadily first and then more rapidly at the peak of the rains. The overall average of this late morning was about 10.66%.

During the early afternoon, there was a drop in the value of reflectivity over the tarred road surface. The minimum value came in August which was about 6.20%, while the maximum came in February with a value of about 12.80%. The overall average for this early afternoon period was about 9.63% , By late afternoon, the minimum reflectivity value dropped to 6.00% in August and the maximum decreased to 12.50% in February. There was a steady increase of the reflectivity from August till the peak, which was recorded in February. However, there was also a slight increase in the reflectivity by the evening over the tarred road surface. This was exemplified by the minimum of 9.20% recorded in the early rainy period of May. Thereafter, there was a steady, though small, increase to 9.4% in June, July and August. However, by November, there was a rapid increase to 11.00%. By February, the maximum was reached, which was 12.60%. The monthly average for this late afternoon was about 10.38%.

The all time, overall average reflectivity for the tarred road surface was about 10.12%. The all time overall average values also exhibited the same pattern as that of all other periods. The minimum was 7.98% recorded in August while there was a steady increase from the rainy to the dry season. The peak was recorded in February with a value of about 12.82%. Figs 2 and 3 depict the pattern of both the

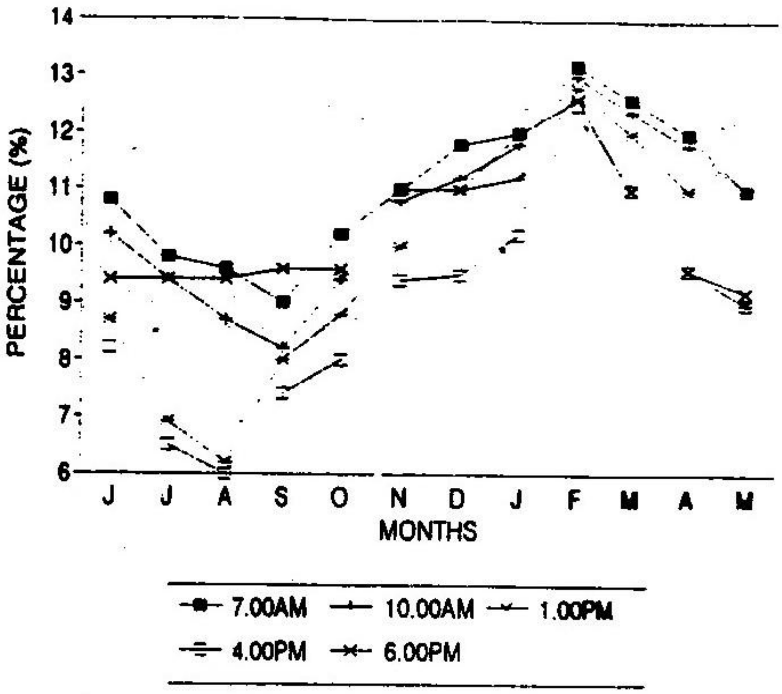

FIG 2 MONTHLY AVERAGE ALBEDO OVER TARRED ROAD SURFACE

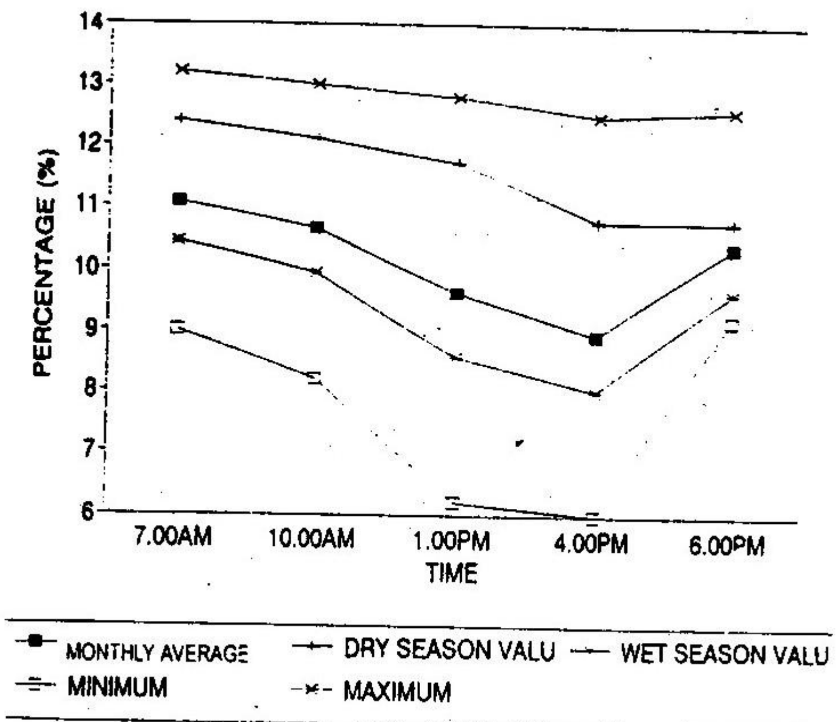

FIG 3 AVERAGE ALBEDO OVER TARRED ROAD SURFACE

seasonal average value and the monthly average values of reflectivity over the tarred road surface.

The general trend of reflectivity coefficient was exhibited as higher values during the dry season and lower value during the wet season. The high reflectivity could be attributed to the high insulation received during this period and the low coefficient during the rains could be as a result of the low insulation received during this period of heavy cloudiness. The diurnal pattern was that of higher values in the morning and evening and lower values in the afternoon.

Generally therefore from the measurements, the reflectivity coefficient of the tarred road surface was low compared to that of water, grass and bare ground (Ekanem, 1997). This could be attributed to the fact that the tarred road surface is hard and dark in colour. The dark colour of the surface is nearer that of a "black body" which absorbs all the incident radiation.

IMPLICATIONS

It is the atmosphere that provides the condition of temperature, rainfall and relative humility which makes the existence of all forms of life possible. The atmosphere keeps changing and these changes are very crucial to man and his activities on the earth. Tarred road surface because it is dark reflects minimal energy. Also because it is hard it retains the energy absorbed for quite some time, giving it out only slowly. These results in the alteration of the microclimate environment of the area. An increase in the area coverage of tarred road as desired has a profound influence on the micro climate of the surrounding environment. This situation will result in increased ambient air temperature and reduced albedo. The consequence of this is increased air temperature and increased storage of the excess heat in every available structure to be released steadily especially in the night. The thermal discomfort index becomes high.

RECOMMENDATION

In planning the urban environment, there is a need to consider that some areas should be allowed as "green areas." Not all the roads should be tarred. In every urban centre there are areas that do not receive heavy traffic; such areas should be allowed to remain unpaved as the reflectivity of such areas are likely to be higher than the dark, hard surface of the tarred road. This is because those areas contain water and reflect more incident energy.

Where there are increased area of tarred road surface there should be efforts to provide "green areas" and shed trees to reduce the direct impact of the solar radiation received in this area. The "green areas" will cause part of the excess heat generated to be spent on evapo-transpiration rather than just conversion to sensible heat which warm the ambient air of the environment.

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