

JOES

JOURNAL OF ENVIRONMENTAL SCIENCES

Vol. 5, No. 1 June 2001

ISSN 1118-8936



Published by the Faculty of Environmental Sciences, University of Jos, Nigeria.

THE REFLECTIVITY COEFFICIENT OF CONCRETE SURFACE WITHIN THE URBAN ENVIRONMENT

E. M. EKANEM
Department of Geography
University of Uyo
Uyo, Akwa Ibom State

Abstract *The natural surfaces in the urban areas around homes, are being changed to concrete hard surfaces for two main reasons: to check erosion and water logging and to beautify the areas. These changes especially along court yard and frontage of buildings have effects on the micro climate regimes of the environment. This study is aimed at studying the reflectivity of concrete surfaces within the urban environment. The albedo was measured using the Solari-albedometer for twelve calendar months and the results show marked diurnal and seasonal variation in the magnitude of albedo over the concrete surface. The results show a decrease in albedo with time from morning till late afternoon. Thereafter it begins to increase. This pattern was observed for all the seasons. The study concluded that the low reflectivity of the concrete surface contributes immensely to the thermal character of the urban environment. Appropriate recommendations with regard to the above were made.*

INTRODUCTION

In humid tropical environment, surfaces are gradually being changed from the natural grass and bare ground to hard concrete, especially in the urban environment. This is in an attempt to avoid the muddy surface experienced in these areas as a result of intense and long rainfalls and to check erosion within these areas. The growth of urban centres increases the area being covered by the hard concrete. —

Courtyards and frontages of buildings within the urban centers are covered

with concrete for the two main reasons: checking erosion and water logging on one hand and beauty on the other. This has effects on the micro-climatic characteristics of the area which is affected by radiation fluxes of the surfaces.

This study aims at studying the reflectivity coefficient of concrete surfaces around homes within the urban environment. This was achieved by examining the albedo magnitude over the concrete surfaces and relating it to

energy regime and the micro-climatic characteristics of the environment.

STUDY AREA

Aba was selected as the study area. It is an important commercial center in the east of the Niger. This humid tropical city is located at 50.06'N and 7.21'E. Other studies have been on large urban centres like Lagos and Ibadan (Ojo, 1988; Adebayo, 1985) whereas this is a medium size city that is growing (Fig:1). Aba is 90 meters above sea level (Ofomata, 1975) and has a diameter of about 12 kilometers. It has-tropical rain hot climate with high temperatures of about 300C; high rainfall of about 200mm per annum, high relative humidities of over 80% and thick vegetation cover.

MATERIALS AND METHODS

The reflectivity coefficient was measured over the concrete surface for twelve calendar months within the urban center. These measurements were taken weekly within a specified day of the week and five consecutive readings were made at 700hr, 1000hr, 1300hr, 1600hr and 1800hr using Solari-albedometer. The reflectivity coefficient of any surface depends on the solar insolation, the colour of the surface, the natural texture. The degree of the reflectivity of the surface determines the heat retention capacity of the surface or material.

RESULTS AND DISCUSSION

The summary of the data collected is presented in Table 1. The analysis of results shows that the average albedo for this concrete surface is low. This low value of albedo is attributed to the rough nature, and the dry dark colour of concrete surface.

The early morning (0700 hr) value of the coefficients of reflectivity was the highest with a monthly average of about 11.58%. The next highest value was about 11.18%, the average for albedo at 1800 hrs. This could be attributed to the angle of the incident radiation upon the surface at these times and the fact that in the morning most of the surfaces are wet as a result of early morning dew. The angle of incidence on the wet morning surface is directly proportional to the reflectivity of the radiation and it increases as the angle of incidence increases. The late morning (1000 hr) monthly average value was about 10.86% while that of the afternoon monthly average was about 9.20%. The diurnal pattern of the reflectivity coefficient suggests that the zenith angle of the sun is an important factor in the magnitude of the reflectivity. The monthly trend shows, that for the early morning period (0700 hr), the albedo exhibits higher values in the rainy and dry seasons with lower values in the transition months. June

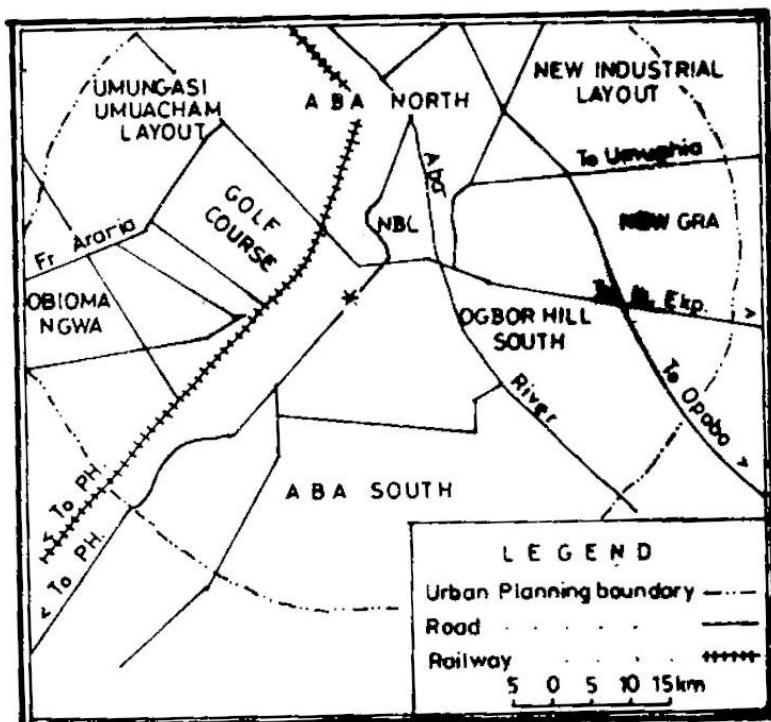


Fig.1a: Point of Measurement ; *

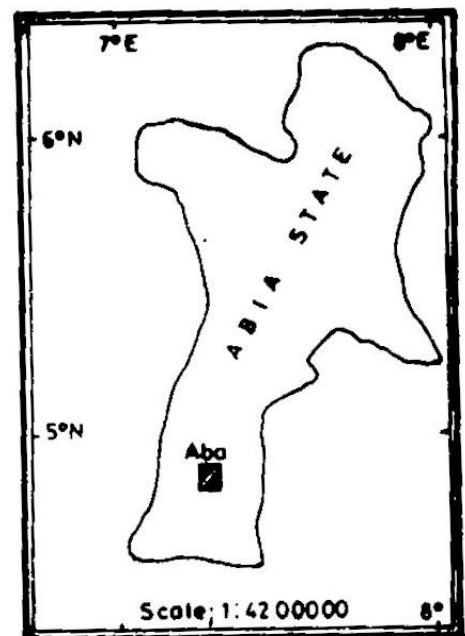


Fig. 1b. Abia State showing the location of Aba (study area)

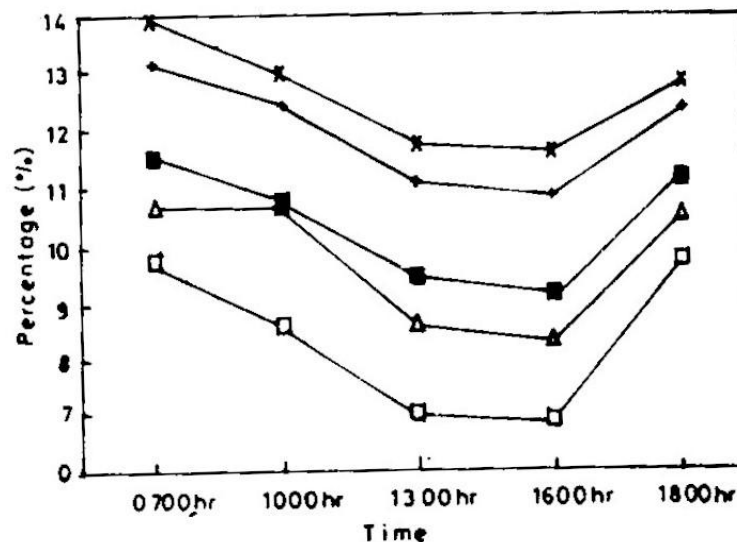


Fig. 2a: Average Albedo Over Concrete Surface ; —■— Monthly Average ; —+— Dry season average ; —△— Wet season average ; —□— Minimum ; —×— Maximum

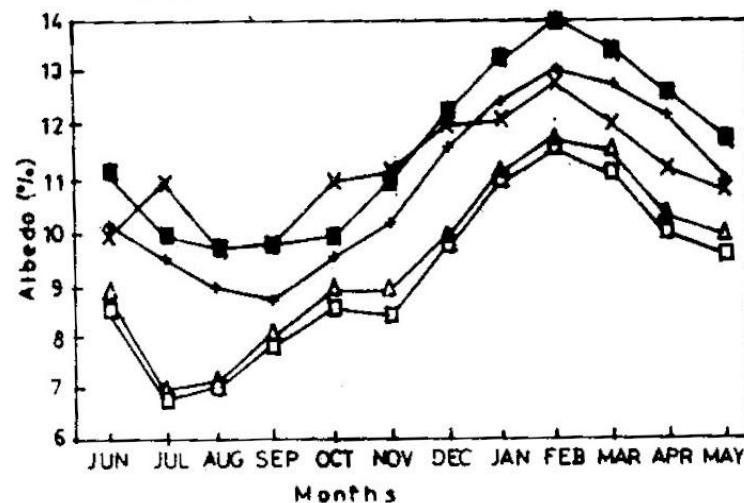


Fig. 2b: Monthly Average Albedo over Concrete surface : —■— 7.00 am ; —+— 10.00 am ; —△— 1.00 pm ; —□— 4.00 pm ; —×— 6.00 pm .

and July had higher albedo than October and November. The highest values for this morning period were recorded in the dry season months of February and March. This is as a result of increased insolation due to reduced cloudiness during the dry season. The highest value for the late morning was also recorded in February and March with 13.00% and 12.8% respectively; while the lowest was recorded in September with about 8.7% (Fig. 2).

In the afternoon the highest value of 11.08% was recorded in February followed by 11.06% in March. The lowest was observed in July with a value of 7.0%. From July, the albedo increased steadily till February. Thereafter, it also began to decrease

steadily. The lowest value was recorded in August in the late afternoon. Thereafter, the values began to increase steadily reaching the peak in February with albedo of 11.60%.

In the evening, the lowest value was 9.8% obtained in August and September. The following months had higher albedo values and steadily the peak was reached in February. The albedo values obtained are on the low side, which is an indication of the high retentive capacity of the concrete surface.

The low albedo coupled with other factors of the urban environment results in a high energy balance situation over concrete surfaces resulting in increased ambient air temperature of the environment.

TABLE 1 AVERAGE ALBEDO OVER CONCRETE SURFACE (%)

TIME/HOUR	MONTHLY AVERAGE	DRY SEASON AVERAGE	WET SEASON AVERAGE
0700 hr	11.58	13.20	10.78
1000 hr	10.86	12.45	10.78
1300 hr	9.53	11.15	8.71
1600 hr	9.20	10.90	8.35
1800 hr	11.18	12.35	10.60
MEAN	10.47	12.01	9.84

This surplus energy resulting from low reflectivity is therefore converted into sensible heat to increase the ambient temperature as there is hardly any other source of dissipation within the urban

environment. This will result in raised air temperature within the urban environment. The consequences of this to human physiological comfort is best

imagined, as the air temperatures will be high.

RECOMMENDATIONS AND CONCLUSION

The concrete cement surfaces, contribute immensely to the alteration of the environment. Excess energy and heat are stored up in the day and released in the night making the ambient air temperature higher than what is required for human comfort. The use of concrete surfaces over large areas should be discouraged in urban centers. Instead grass should be used in such areas. This will increase the rate of infiltration and also check erosion.

REFERENCES

- Adebayo, Y. R. (1985)** "The Micro-Climatic Characteristics within the Urban Canopy of Ibadan"
Unpublished Ph.D. Thesis,
Department of Geography
University of Ibadan.
- Adebayo, Y. R. (1990)** "Aspects of the Variation in some Characteristics of Radiation Budgets within the Urban Canopy of Ibadan"
Atmospheric Environments Part B 24 B (1) 9-17.
- Ekanem, E. M. (1997)** The Surface Energy Balance in a Humid Tropical City of Aba Unpublished Ph. D. Thesis, Dept. of Geography, University of Ibadan.
- Ekanem, E. M. (1999a)** "Reflectivity Coefficient over the tarred Road Surface in a Humid Tropical City of Aba" International Journal of Tropical Environment, Vol.2 No.1 129 - 132.
- Ekanem, E. M. (1999b)**
Environmental Implication of Radiation Balance over Concrete Surface in Nigeria's Urban Center. An Example of Aba in Abia State, Nigeria, Environmental Analar No.3 174 - 181.
- Ekanem, E. M. (2000a)** "Reflectivity Coefficient of the Aba River"
Journal of Applied Sciences Vol.3 No.4 1430 - 1436.
- Ekanem, E. M. (2000b)** Radiation Balance Over the Concrete Surface in an Urban Environment Journal of Applied Science Vol3 No.1 797 - 804.
- Ofomata, G. E. K. (1975)** "Relief" in Ofomata G. E. K. (ed) Nigeria in maps: Eastern States Ethiope Publishing House Benin City 8 - 9.
- Ojo, O. (1988)** "Urbanization and Thermal Problem in Tropical Cities: The Lagos Experience" In Sada P. O. and Odemerho F. O. (eds) Environmental Issues and Management in Nigerian Development Evans Brothers, Ibadan 291 - 308.
- Sellers, A. H. and Robinson, P. J. (1989)** Contemporary Climatology Longman & John Wiley N. Y. 439PP.

Alternatively green belt should be created near areas with concrete surfaces in the form of grass cover. This will enhance an effective energy advection system where surplus energy will be transferred out to be used for evapo-transpiration in the adjacent areas. The atmospheric temperatures are expected to be lower than they were over concrete surfaces. In addition, the concrete surface should be covered with shed leaves to reduce the rate of absorption of the direct insolation.