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REFLECTIVITY COEFFICIENT OF THE ABA RIVER

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ABSTRACT

The reflectivity coefficient of any surface is an important factor in the determination of the energy balance of that surface and the immediate environment. In Aba there is only one small river running the length of the whole town. A solari-albedometer was used to measure the albedo of water surface for twelve calendar months. Measurements were taken once a week at 0700hr; 1000hr; 1300hr; 1600hr and 1800hr. However, average monthly values were used in the analysis. The result shows that there are seasonal/diurnal variations in the value of the reflectivity coefficient and these values were higher than what is reported in the literature for water. This was attributed to the highly polluted nature of the water of Aba river. The degree of evaporation occurring over the water surface of Aba may not be high as a result of high reflectivity coefficient.

INTRODUCTION

When radiation impinges on a much larger body such as the Earth's surface, there is a complete change on direction for the radiation, which is not absorbed, and it is conventional to regard this special case of scattering as reflection. Reflection and scattering, whether single or multiple, lead to both upward and downward radiation streams. The ratio of the two radiation streams, is the albedo.

At the top of the atmosphere, satellite measurement enables the determination of the planetary albedo, which is vital for the understanding of the large-scale climatic process of large regions.

At the surface of the earth, the surface albedo is normally calculated from direct measurement for a single type of surface, since the value is highly dependent on the nature of the surface. This stresses the need to measure the magnitude of the reflectivity coefficient of the various surfaces, especially within the urban environment where there are known energy and heat transfer processes which alter the temperature regimes in the area.

Variations between surface types have significant consequences for local climates. Albedo is very important not only in the radiation transfer but also for its influence on the local micro climatic regimes of any region.

A higher surface albedo is an indication that much of the incident radiant energy is not absorbed. Reflective coefficient has a most important single influence on the absorption of radiation (1). It is therefore not an understatement to say that reflective coefficient of the surface is of fundamental importance in determining the radiation balance and temperature of any environment. It is on this basis that the reflectivity of the Aba river is studied to know the albedo and its effect on the environment

STUDY AREA

Most studies in the urban energy radiation have been done for a vast number of temperate cities (2 and 3). Unlike other studies done in the tropical environment of Lagos and Ibadan, Aba is a medium size city. It is continental and has a tropical humid climate (4 and 5). It is located at about 5.06°N and 7.21°E, and below 100 meters above sea level with a diameter of about 12 kilometers (6). It experiences high temperatures, high rainfall output and high relative humidity.

MATERIALS AND METHODS

Measurements were taken over the water surface of Aba using a portable salari – albedometer connected to a millivoltmeter. This instrument is designed to be compact. It is a hybrid containing two thermopiles and sensor plates and 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 metres (one foot) above the water surface. This was deliberate to eliminate the shadow effects of the instrument and eddy motion effects at the water 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 7.00a.m. (0700hr); 10. 00a.m. (1000hr); 1.00 p.m. (1300hr); 4.00p.m. (1600hr) and 6.00p.m (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 sites of measurements was done in such a way as to reduce to the barest minimum the effect of the advected energy. In this case, the measurements were taken in the middle of the river where weeds and sediments were minimum.

RESULTS AND DISCUSSION

The reflection coefficient of a plain clean water surface of Aba river is given as between 2 - 4% (7). In the morning (0700hr) the values of the reflective coefficient ranged from 20.55% in the dry season to 15.8% in the wet season with a monthly average of about 17.4%. However, the least value recorded during this period was about 12.6% recorded in September. This is the peak of the rainy season in this area. The highest value for this time was recorded in the month of February with a value of about 25.00%. This again indicates the peak of the dry season in this area. The pattern here was that of decrease towards the rains and an increase towards the dry months.

By late morning (1000hr), the overall monthly average albedo was 14.46%. The least value was also recorded in September being about 11.3% while the highest value was also observed in February being about 18.6%. There was a general drop in the value of the reflectivity in the late morning. This could be attributed to the angle of incidence of the direct components of the radiation. This is because in the mornings and in the evenings, the sun comes at an oblique angle whereas in the afternoon the sun is heating the water at an angle that is almost equal to 90° .

It is also very obvious that the dry season has a higher albedo values than the wet season. During the dry season, the river is more polluted than at other periods because there is a reduction in the volume of the river and increase activities in and around the river during the period.

By early afternoon (1300hr) the observed pattern of increase towards the dry season and reduction towards the rains was also observed. The highest value was observed in January with 15.6% while the least value was observed in July with 10.0%. The monthly average value was about 11.89% while the dry and wet season values were 13.58% and 11.05% respectively. However, the dry season diurnal pattern shows less variation than the monthly end wet season, patterns.

In the late afternoon (1600hr) the least value of 10.0% was observed in July and October while the highest value was observed in January with a value of about 14.6%. However, the average monthly value for this period was 10.85% with the dry and wet season having 11.48% and 10.54% respectively.

The general pattern of the albedo was reversed in the evening (1800hr) as the rainy season values of albedo are higher than those of the dry season. This must be as a result of the angle of the sun and the clear clean nature of the water. The value of the reflectivity recorded over this particular water surface is high – almost twice to four times the average reflectivity of clear water. This is because of the high level of pollution of the water. Clean water exhibits less albedo than dirty and polluted water (7).

Earlier, Oguntoyinbo (8) had noted that there is no marked pattern of albedo for water as it is difficult to obtain a single, stable and steady pattern for water albedo.

Table 1 depicts the average reflectivity coefficient for water of Aba River.

Table 1: Reflectivity coefficient of polluted water surface of Aba River (Percentage)

| Time | Monthly Average | Dry season Average | Wet season Average |
|--------|-----------------|--------------------|--------------------|
| 0700hr | 17.4 | 20.55 | 15.80 |
| 1000hr | 14.48 | 17.13 | 13.13 |
| 1300hr | 11.89 | 13.58 | 11.05 |
| 1600hr | 10.85 | 11.48 | 10.54 |
| 1800hr | 18.22 | 14.33 | 20.16 |
| Mean | 14.56 | 15.41 | 14.14 |

Source: Derived from field data.

However, it is interesting to note that for the water surface of Aba, it is not easy to depict a consistent pattern of decrease in the surface reflectivity with increase in the intensity of insulation. This is because of the cloud effects. In the dry season when there is less clouds, a more regular pattern emerged with a higher morning value probably because of the increased insulation. Comparatively low values during this observation in the mornings were as a result of an intense harmattan haze. The January pattern decreased consistently with increase in the insulation.

The results observed above have some implications. First the higher value of the albedo shows that a higher percentage of the energy incident on this water surface is returned to space unlike most other surfaces where a substantial part of it is absorbed. This means that there is increased energy in the atmosphere. Most water surfaces will absorb a good percentage of the incident energy and this will be used in evaporating the water, and also raising the temperature of the water.

The implication of the increase reflectivity for the urban environment is that there is increased energy in the urban atmosphere to be dispensed. In most cases they are turned to sensible heat to warm the air. This will raise sensible temperature and the humidity values.

CONCLUSION

The reflectivity coefficient of the water surface of Aba river is higher than those of clear clean water surface. The general pattern of the reflectivity coefficient was that of increase towards the dry season and decrease towards the rainy season. The morning and the evening exhibited higher values than the afternoon. This was mainly attributed to the nature of water and the angle of incidence of the radiation. Generally, the high pollution and dirty character of Aba river seem to account for the higher values of albedo.

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