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Climatological Effects of Total Solar Radiation in Awka, Nigeria

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Abstract: *Harmattan, humidity and temperature are amongst some climatological variables that affect solar radiations. In this paper we evaluated the effects of these climatological variables on solar radiation in Awka, Anambra State, Nigeria. The city Awka has the latitude of 6.06^{o}N and longitude of 7.0^{o}E. We took various readings of temperature and humidity from December, 2012 to July 2013 and we observed as expected that solar radiation increased with increase in temperature, while increase in humidity greatly reduces solar energy. The harmattan effect on solar radiation showed less fluctuations in the value of solar radiation during any particular day. The basic problem during this period is dust, which uniformly reduces the solar radiation during any particular day. Observations during the period of measurement showed that the fluctuations during harmattan and high temperature were essentially due to dust which was responsible for the high diffuse nature and attenuation on the solar radiation. The regression co-efficient for the periods under study in the city were determined for use in predicting solar radiation.*
Keywords: *Harmattan, Humidity, Temperature, Solar Radiation and Attenuation*

I. Introduction

It is generally believed that the solar energy in a place depends to a large extent on the latitude of the place, height above sea level, time of the year, etc. Theoretically the influences of these factors are not very significant when compared to the influence of harmattan, humidity and temperature on solar radiation. In this work we tried to compare the values of these climatological factors which influence solar radiation. Some of the influence are known since many researchers like Angstron, (1956) and Sabbagh, (1971) have used them in predicting solar radiation values in places with no measured solar values. The city of Awka, Anambra State located at latitude 6.24^{o}N and longitude 7.31^{o}E was used as case study with a Davis Weather Station 1 mounted at the Physics Department of Nnamdi Azikiwe University, Awka.

II. Measurement

The humidity, insolation and temperature for the city Awka were measured dialy for a period of seven months. The data for the period were obtained at our Weather Station 1 with the aid of Davis Pro 2 Vantage Data Logger. The data collected were transferred to our personal computer from where we were able to take the graphical variations of humidity, insolation and temperature for the stipulated months of the year. The values obtained using the instrument were standardized with similar data values obtained using Eppley pyranometer. From this we got a correction factor of 1.20.

III. Analysis And Result

The insolation for Awka was compared in fig. 1, where a plot of average daily insolation and month of the year were made. The comparison revealed that between the months of January and April the variation in their values were reasonable. However, during the dry season a period where the effect of harmattan is felt, this variation is significant. For instance, in the month of February, a variation of up to 800W/m^2 existed in the insolation level for the Awka. The fig. 2 showed a consistent variation in temperature for Awka with January to April having the difference of 2.1^{o}C. We also noticed the same variational pattern existing in fig. 3, where a plot is made for the humidity values obtained for Awka during the same period. Although, the period of this study is quite short compared to the expected eleven year period that would be adequate for such a study, the result got will serve as a useful guide for design work when the measured data are absent. Nevertheless, work is still in progress and this has been extended to other locations in the Eastern part of Nigeria. It is hoped that collaborative effort with researchers in other towns will improve the result of this study.

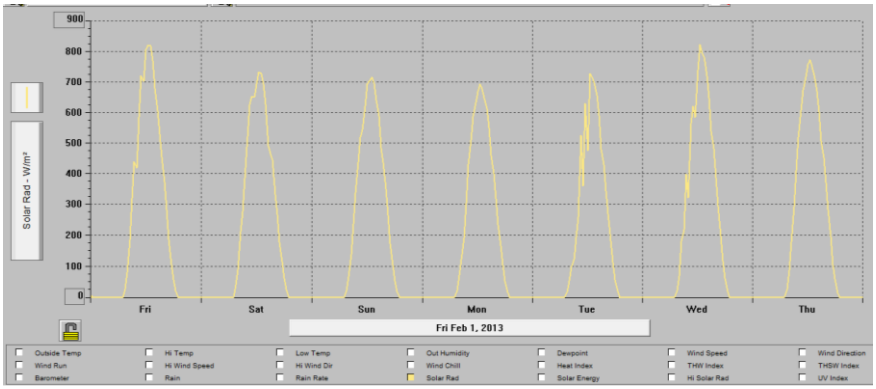

Fig. 1a: Insolation for first week of the month of February 2013, for Awka, Nigeria

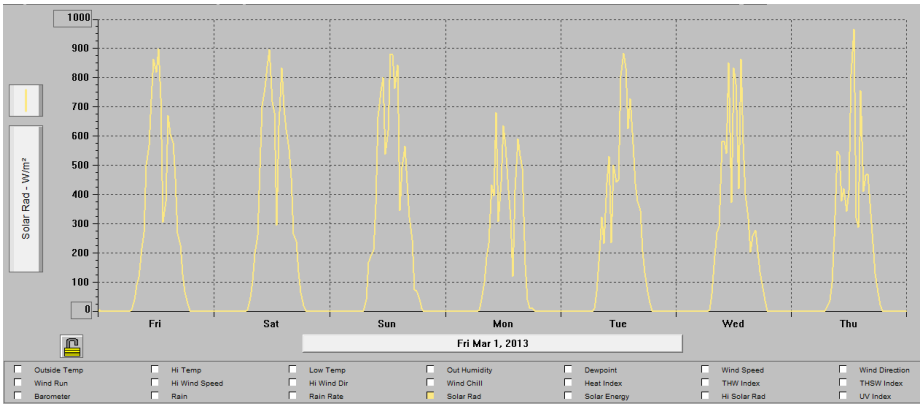

Fig. 1b: Insolation for first week of the month of March 2013, for Awka, Nigeria

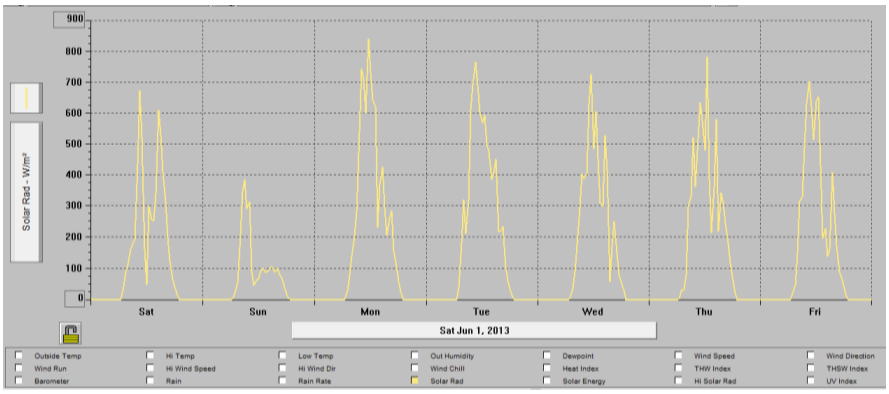

Fig. 1c: Insolation for first week of the month of June 2013, for Awka, Nigeria

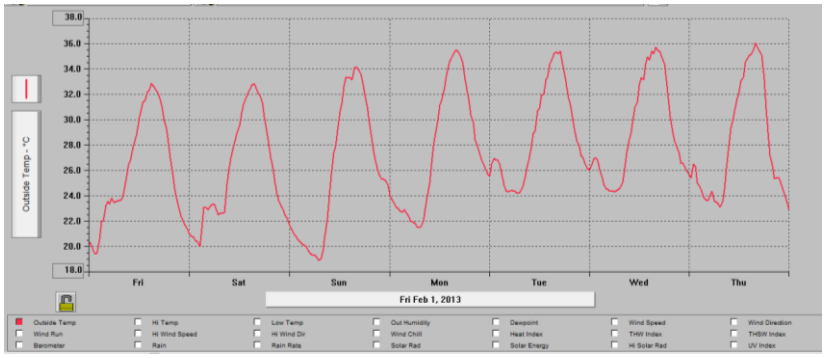

Fig. 2a: Temperature for first week of the month of February 2013, for Awka

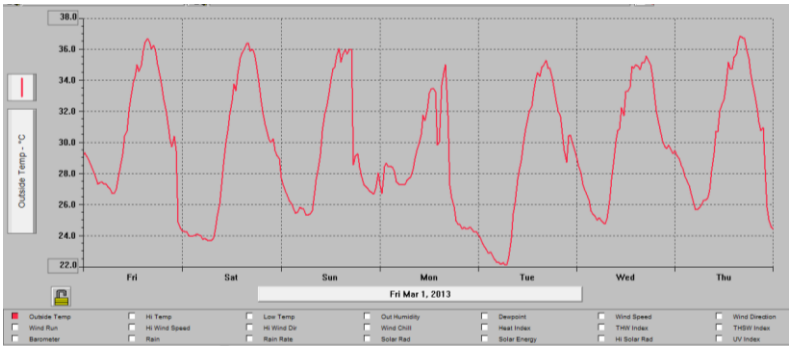

Fig. 2b: Temperature for first week of the month of March 2013, for Awka

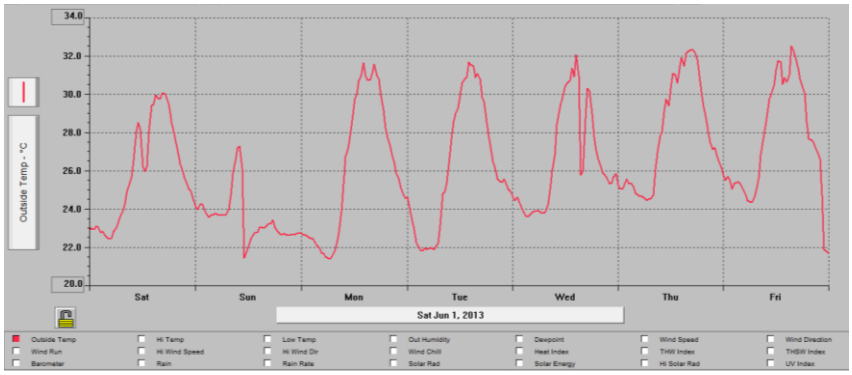

Fig. 2c: Temperature for first week of the month of June 2013, for Awka

The relation that has emerged for the prediction of insolation in Awka is

$$H = 2.15S + 6.24$$

Where H is the total global radiation in MJm^2 per day and S is the bright sunshine hour.

The prediction constants a and b are 6.4 and 2.15 for Awka. These constants reveal some information on the nature of the solar radiation at the town. From the daily values of the measured insolation it was found that the values were low during the period of harmattan and that these values fluctuated rapidly. However after the month of March the values rose steeply until June when it fell.

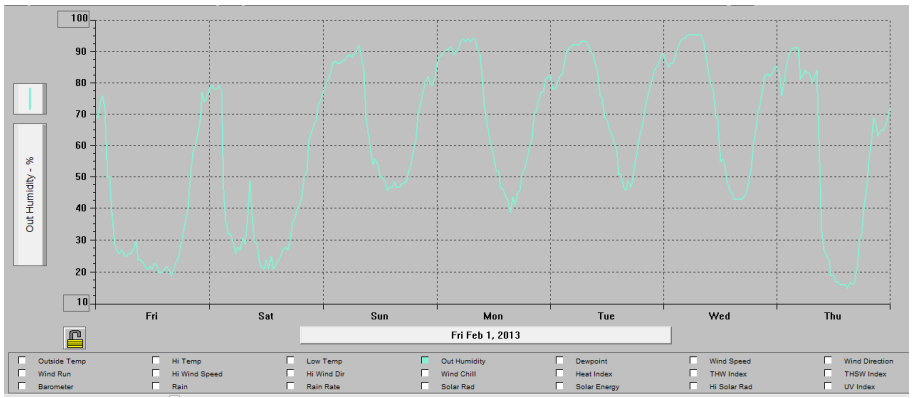

Fig. 3a: Humidity for the first week of the month of February, 2013 for Awka

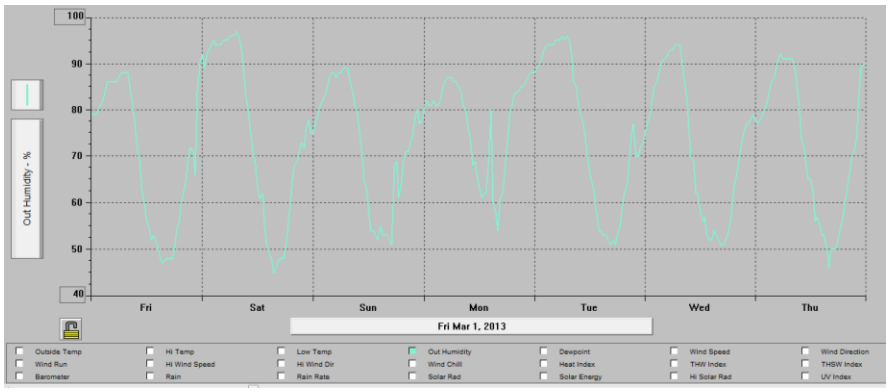

Fig. 3b: Humidity for the first week of the month of March, 2013 for Awka

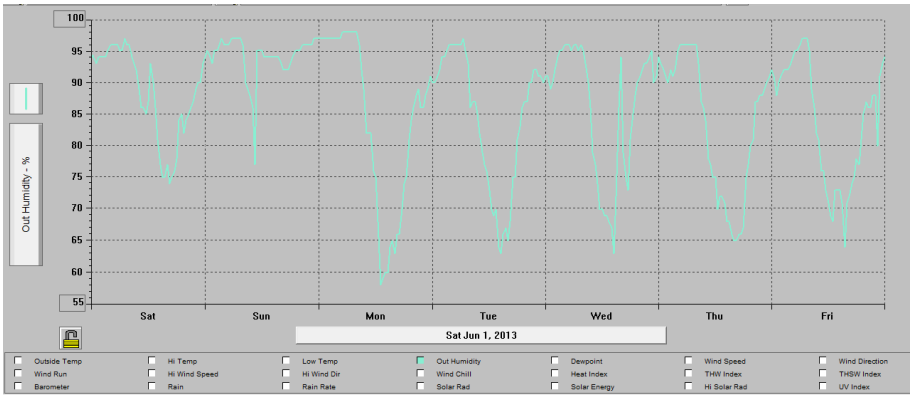

Fig. 3c: Humidity for the first week of the month of June, 2013 for Awka

A study, once more, of figures 1 and 2 reveal that as temperature increases, insolation increases. The exact relationship will be obtained as soon as enough data are assembled.

IV. Conclusion

It is shown clearly that the total solar radiation in a place is greatly affected by the climatological variable such as harmattan, humidity and temperature. A measure of the sunshine in a place when the prediction constants are known, could give the value of insolation there. The prediction constants vary significantly, especially during harmattan (dry) season. The values obtained for Awka are: a = 6.4 and b = 2.15. We observed that the effects of harmattan and even very high temperature have a higher reduction factor in Awka.

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