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Data Article

# Exploration of solar radiation data from three geo-political zones in Nigeria

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ABSTRACT

In this paper, readings of solar radiation received at three meteorological sites in Nigeria were analysed. Analysis of Variance (ANOVA) statistical test was carried out on the data set to observe the significant differences on radiations for each quarter of the specified years. The data were obtained in raw form from Nigerian Meteorological Agency (NIMET), Oshodi, Lagos. In order to get a clear description and visualization of the fluctuations of the radiation data, each year were considered independently, where it was discovered that for the 3rd quarter of each year, there is a great fall in the intensity of the solar radiation to as low as 73.27 ($W/m^2$), 101.66 ($W/m^2$), 158.51 ($W/m^2$) for Ibadan, Port-Harcourt and Sokoto respectively. A detailed data description is available for the averages across months for each quarter. The data can provide insights on the health implications of exposure to solar radiation and the effect of solar radiation on climate change, food production, rainfall and flood patterns.



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**Specification Table**

| | |
|---|---|
| **Subject area** | Environmental Science |
| **More specific subject area** | Solar Radiation |
| **Type of data** | Table and figure |
| **How data was acquired** | Unprocessed secondary data |
| **Data format** | Processed as Monthly Averages Across Quarters from 2011 to 2015 for Three Meteorological Sites |
| **Experimental factors** | Data obtained from Nigerian Meteorological Agency (NIMET) |
| **Experimental features** | Computational Analysis: Analysis of Variance (ANOVA) with Post Hoc Test and Correlation Analysis. |
| **Data source location** | Ibadan, Port-Harcourt and Sokoto Meteorological Stations. |
| **Data accessibility** | All the data are in this data article. |
| **Software** | Microsoft Excel and Minitab 17 Statistical Software |

**Value of the data**

- The energy sector of the economy can incorporate the data set and findings for the utilization of solar radiation received from the sites.
- The vitality of these data set is widely recognised in the energy research community for forecasting minutely, hourly, daily and monthly solar radiations using time series tools which could also cater for volatility that exist in the data.
- For educational purposes and environmental studies. See similar works [1–33].
- Findings from the data bring the awareness of the Nigerian government to the most suitable location for the establishment of both solar plants and research institutes to generate electricity.
- The data can provide insights on the health implications of exposure to solar radiation.

## 1. Data

The raw data for this work were obtained from Nigerian Meteorological Agency (NIMET) Oshodi Lagos, as daily averages on solar radiation for three weather stations namely; Ibadan, Sokoto and Port-Harcourt. The readings were taken using the Gunn-Bellani Radiation Integrator measuring the radiations in millilitres (ml). However, for the sake of this research, the readings were converted to Watts per Sq. meters (1 ml to 13.153 W/m$^2$) covering from 1st of January, 2011 to 31st of December, 2015 and further transformed into monthly-quarterly averages (Table 7) for the specified years using Microsoft Excel software.

**Table 1a**
Summary for the quarterly average for the sites.

| Variable | N | Mean | S.E Mean | Std. Dev. | Minimum | Q1 | Median | Q3 | Maximum |
|---|---|---|---|---|---|---|---|---|---|
| **Ibadan** | 60 | 142.24 | 3.84 | 29.76 | 73.27 | 115.07 | 151.91 | 166.75 | 186.77 |
| **Sokoto** | 60 | 235.01 | 4.40 | 34.08 | 158.51 | 217.05 | 237.96 | 258.57 | 308.72 |
| **Port H** | 60 | 153.29 | 3.85 | 29.85 | 101.66 | 129.08 | 156.36 | 179.17 | 231.96 |

**Table 1b**
Summary for the quarterly average for the sites.

| Variable | Kurtosis | Skewness |
|---|---|---|
| **Ibadan** | −0.77 | −0.60 |
| **Sokoto** | −0.02 | −0.45 |
| **Port H** | −0.57 | −0.05 |

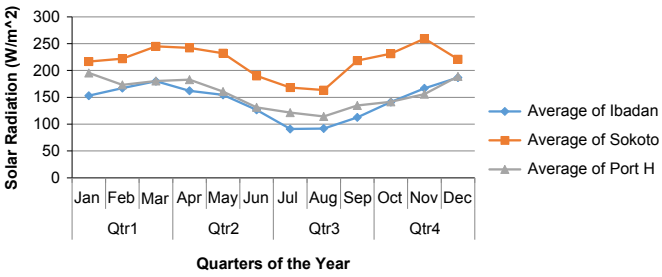


**Fig. 1.** Quarterly averages of solar radiation for the three sites in the year 2011.

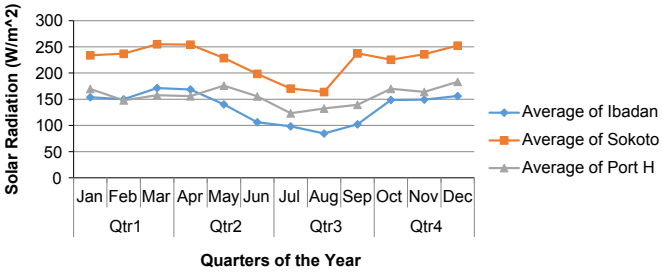


**Fig. 2.** Quarterly averages of solar radiation for the three sites in the year 2012.

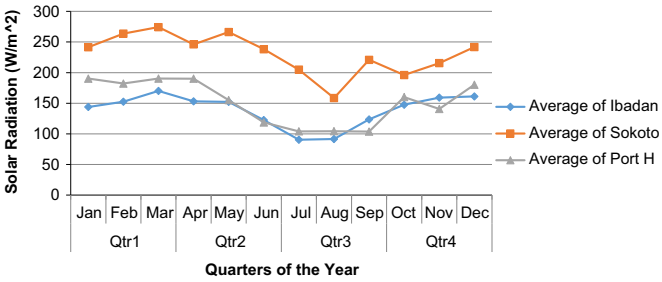


**Fig. 3.** Quarterly averages of solar radiation for the three sites in the year 2013.

Table 1a is the statistical summary of the quarterly averages for solar radiation from the 1st of January 2011 to 31st of December 2015. Meanwhile, it was observed that on an average, Sokoto receives the highest intensity of solar radiation followed by Port Harcourt and Ibadan.

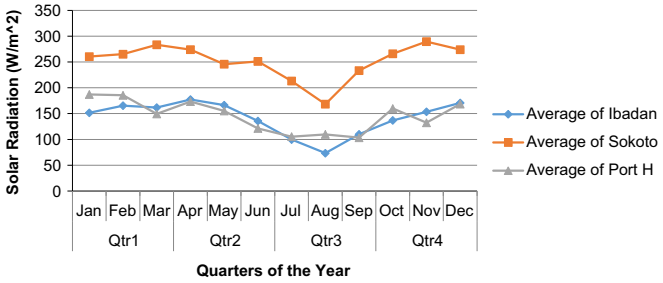


**Fig. 4.** Quarterly averages of solar radiation for the three sites in the year 2014.

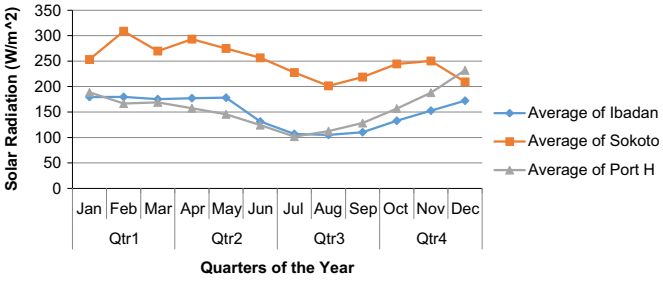


**Fig. 5.** Quarterly averages of solar radiation for the three sites in the year 2015.

Furthermore, Table 1b shows that the data set from all sites exhibit negative kurtosis and skew, implying that the distributions are light-tailed and skewed to the left respectively.

From the graphs (Figs. 1–5), it was observed that Sokoto was top on the presented charts with an exception on December 2015. This validates that the closer the earth's surface is to the sun, the greater the radiations it receives, which is well applicable to the case of Sokoto ranking top among the other stations with a height of 309 m above sea level. Furthermore, the solar radiation received at Sokoto increases yearly within the 1st quarter. It has to be noted that the *y*-axis of the figures is the solar radiation reading for the zones measured in Watt per square meter.

## 2. Methods and materials

The summary of the location sites of the raw data are displayed in Table 2.

Linear correlation is traditionally used to roughly determine the relationship between two variables. Table 3 shows the correlation matrix between the three meteorological stations. Though independent, the correlations among each station are positive and that of Sokoto–Ibadan and Ibadan–Port Harcourt are highly positively correlated. It is either the solar radiation levels are increasing or decreasing at the three sites simultaneously.

The ANOVA test carried out on the data set for all sites and the result was displayed in Tables 4–6. The results showed significant differences in the means for solar radiation received quarterly at the stations independently.

The significant differences in the means as revealed from the ANOVA results led to further analysis using the Tukey's Simultaneous 95% Confidence Interval Post Hoc test. The aim is to detect the specific quarters where differences lie across the specified years.

The results revealed that for Port Harcourt, significant differences lie within all other quarters except for the 1st and 4th quarters and for the 2nd and 4th quarters yearly as seen in Fig. 6. Similarly,

**Table 2**
Location of the sites.

| Sites | Latitude | Longitude | Height (m) |
|---|---|---|---|
| **Ibadan** | 07.22′ | 03.59′ | 224.01 |
| **Sokoto** | 12.55′ | 05.12′ | 309.0 |
| **Port Harcourt** | 05.01′ | 06.57′ | 247.0 |

**Table 3**
$3 \times 3$ Correlation matrix for the sites.

| *Sites* | *Ibadan* | *Sokoto* | *Port Harcourt* |
|---|---|---|---|
| **Ibadan** | 1 | | |
| **Sokoto** | 0.741099 | 1 | |
| **Port H** | 0.755118 | 0.426821562 | 1 |

**Table 4**
Analysis of Variance (ANOVA) for Port Harcourt.

| Source of variation | D.F | S.S | M.S | *F*-value | *P*-value |
|---|---|---|---|---|---|
| **Quarters** | 3 | 31672 | 10557.3 | 28.29 | 0.000 |
| **Error** | 56 | 20898 | 373.2 | | |
| **Total** | 59 | 52570 | | | |

**Table 5**
Analysis of Variance (ANOVA) for Sokoto.

| Source of variation | D.F | S.S | M.S | *F*-value | *P*-value |
|---|---|---|---|---|---|
| **Quarters** | 3 | 29161 | 9720.4 | 13.83 | 0.000 |
| **Error** | 56 | 39364 | 702.9 | | |
| **Total** | 59 | 68526 | | | |

**Table 6**
Analysis of Variance (ANOVA) for Ibadan.

| Source of variation | D.F | S.S | M.S | *F*-value | *P*-value |
|---|---|---|---|---|---|
| **Quarters** | 3 | 38059 | 12686.3 | 50.04 | 0.000 |
| **Error** | 56 | 14197 | 253.5 | | |
| **Total** | 59 | 52256 | | | |

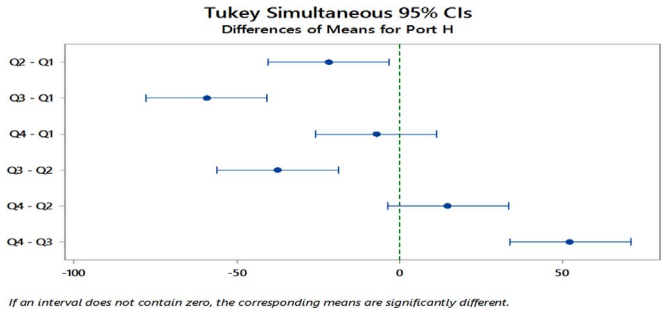


**Fig. 6.** Tukey's Post Hoc test for mean-quarterly differences in Port Harcourt site from 2011 to 2015.

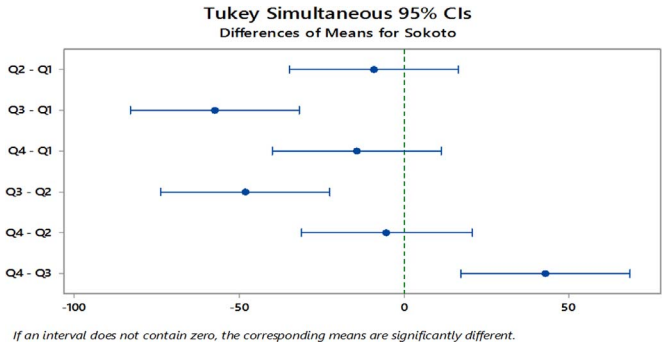


**Fig. 7.** Tukey's Post Hoc test for mean-quarterly differences in Sokoto site from 2011 to 2015.

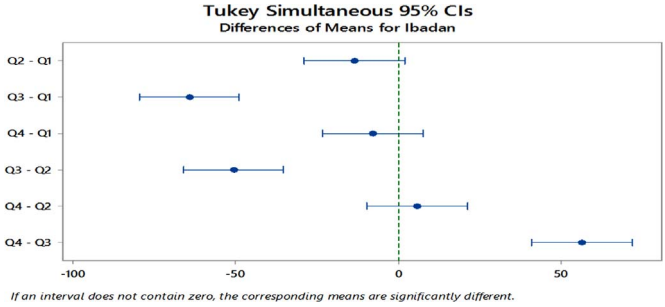


**Fig. 8.** Tukey's Post Hoc test for mean-quarterly differences in Ibadan site from 2011 to 2015.

**Table 7**
Monthly-quarterly solar radiation for three sites from 2011 to 2015.

| Year | Month | Quarter | Ibadan | Sokoto | Port Harcourt |
|---|---|---|---|---|---|
| **2011** | Jan | Q1 | 152.9544 | 216.6395 | 195.3404 |
| **2011** | Feb | Q1 | 167.1816 | 221.9066 | 173.1943 |
| **2011** | Mar | Q1 | 179.9389 | 244.9392 | 180.448 |
| **2011** | Apr | Q2 | 162.218 | 242.0993 | 182.9117 |
| **2011** | May | Q2 | 154.397 | 232.1683 | 160.7612 |
| **2011** | Jun | Q2 | 126.53 | 189.8827 | 131.3527 |
| **2011** | Jul | Q3 | 90.88166 | 168.1862 | 121.4725 |
| **2011** | Aug | Q3 | 91.89994 | 163.3494 | 114.3021 |
| **2011** | Sep | Q3 | 112.588 | 218.2928 | 134.7724 |
| **2011** | Oct | Q4 | 141.0745 | 231.2348 | 141.5836 |
| **2011** | Nov | Q4 | 166.8653 | 259.2857 | 155.8608 |
| **2011** | Dec | Q4 | 186.7699 | 220.9247 | 188.9337 |
| **2012** | Jan | Q1 | 153.8454 | 233.9503 | 169.7561 |
| **2012** | Feb | Q1 | 149.9874 | 236.8866 | 148.0371 |
| **2012** | Mar | Q1 | 171.4956 | 255.0796 | 157.5473 |
| **2012** | Apr | Q2 | 168.6628 | 254.1561 | 155.8032 |
| **2012** | May | Q2 | 140.2683 | 228.6467 | 175.9798 |
| **2012** | Jun | Q2 | 106.2308 | 198.5635 | 155.5539 |
| **2012** | Jul | Q3 | 98.30663 | 170.3925 | 123.297 |
| **2012** | Aug | Q3 | 84.72954 | 163.9434 | 132.4191 |
| **2012** | Sep | Q3 | 102.2412 | 237.7151 | 139.4198 |
| **2012** | Oct | Q4 | 148.6692 | 225.507 | 169.9258 |
| **2012** | Nov | Q4 | 149.4159 | 235.8298 | 164.1032 |
| **2012** | Dec | Q4 | 156.1366 | 252.3218 | 183.3756 |
| **2013** | Jan | Q1 | 143.9172 | 241.5025 | 190.2066 |
| **2013** | Feb | Q1 | 152.4786 | 263.7138 | 182.1664 |
| **2013** | Mar | Q1 | 170.1379 | 274.2572 | 190.2914 |
| **2013** | Apr | Q2 | 153.0987 | 246.2206 | 190.1896 |
| **2013** | May | Q2 | 152.318 | 266.2807 | 155.0758 |
| **2013** | Jun | Q2 | 122.4965 | 238.1973 | 118.5945 |
| **2013** | Jul | Q3 | 90.37251 | 204.8868 | 104.1193 |
| **2013** | Aug | Q3 | 91.51808 | 158.5125 | 104.4163 |
| **2013** | Sep | Q3 | 123.5487 | 220.8356 | 103.7318 |
| **2013** | Oct | Q4 | 147.5236 | 196.0405 | 160.1248 |
| **2013** | Nov | Q4 | 159.2367 | 215.5635 | 140.6912 |
| **2013** | Dec | Q4 | 161.1007 | 241.7571 | 180.2359 |
| **2014** | Jan | Q1 | 151.5119 | 260.3407 | 187.0669 |
| **2014** | Feb | Q1 | 165.4435 | 265.0291 | 185.4546 |
| **2014** | Mar | Q1 | 161.6947 | 283.3369 | 149.3904 |
| **2014** | Apr | Q2 | 177.256 | 273.8853 | 173.354 |
| **2014** | May | Q2 | 166.4042 | 245.7454 | 155.1183 |
| **2014** | Jun | Q2 | 135.6931 | 251.1309 | 121.3127 |
| **2014** | Jul | Q3 | 99.66434 | 213.1179 | 105.4346 |
| **2014** | Aug | Q3 | 73.27386 | 168.3135 | 109.7623 |
| **2014** | Sep | Q3 | 109.8259 | 233.287 | 103.2934 |
| **2014** | Oct | Q4 | 136.8316 | 265.9048 | 159.7854 |
| **2014** | Nov | Q4 | 153.5371 | 289.4494 | 132.2734 |
| **2014** | Dec | Q4 | 170.6895 | 273.8075 | 168.4408 |
| **2015** | Jan | Q1 | 179.5146 | 253.1279 | 188.5943 |
| **2015** | Feb | Q1 | 179.7237 | 308.7152 | 166.6179 |
| **2015** | Mar | Q1 | 175.399 | 269.7174 | 169.0348 |
| **2015** | Apr | Q2 | 177.2122 | 293.1761 | 157.4829 |
| **2015** | May | Q2 | 178.2418 | 274.8512 | 145.487 |
| **2015** | Jun | Q2 | 131.3527 | 256.4359 | 124.2063 |
| **2015** | Jul | Q3 | 106.962 | 227.5436 | 101.6585 |
| **2015** | Aug | Q3 | 105.1376 | 201.4077 | 112.5626 |
| **2015** | Sep | Q3 | 110.3959 | 218.6873 | 128.3276 |
| **2015** | Oct | Q4 | 132.8434 | 244.4301 | 156.8578 |
| **2015** | Nov | Q4 | 152.7041 | 250.2541 | 187.9975 |
| **2015** | Dec | Q4 | 172.3018 | 209.2145 | 231.9561 |

Fig. 7 shows that for Sokoto, the 1st and 3rd quarters, 3rd and 4th quarters and the 2nd and 3rd quarters as having significant differences. Lastly, Fig. 8 shows that for Ibadan, significance differences exists between the 1st and 3rd Quarters, 2nd and 3rd Quarters and the 3rd and 4th Quarters for these years. Minitab17 software was implemented for analysis on the solar radiation data, which produced the ANOVA results and the Post Hoc test for the stations (Table 7).

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## Transparency document. Supplementary material

Transparency data associated with this article can be found in the online version at http://dx.doi.org/10.1016/j.dib.2017.05.017.

## References

[1] M. Muluget, D. Tolossa, G. Abebe, Description of long-term climate data in Eastern and Southeastern Ethiopia, Data Brief 12 (2017) 26–36.
[2] S. Mwalusepo, E. Muli, A. Faki, S. Raina, Land use and land cover data changes in Indian Ocean Islands: case study of Unguja in Zanzibar Island, Data Brief 11 (2017) 117–121.
[3] K.G. Pantavou, C.P. Jacovides, G.K. Nikolopoulos, Data on solar sunburning ultraviolet (UVB) radiation at an urban Mediterranean climate, Data Brief 11 (2017) 597–600.
[4] M.J. Mohammadi, A. Takdastan, S. Jorfi, A. Neisi, M. Farhadi, M. Yari, et al., Electrocoagulation process to chemical and biological oxygen demand treatment from carwash grey water in Ahvaz megacity, Iran, Data Brief 11 (2017) 634–639.
[5] F. Babaahmadi, S. Dobaradaran, A. Pazira, S.S. Eghbali, M. Khorsand, M. Keshtkar, Data on metal levels in the inlet and outlet wastewater treatment plant of hospitals in Bushehr province, Iran, Data Brief 10 (2017) 1–5.
[6] I. Estrada-Contreras, C.A. Sandoval-Ruiz, F.S. Mendoza-Palmero, S. Ibáñez-Bernal, M. Equihua, G. Benítez, Data documenting the potential distribution of *Aedes aegypti* in the center of Veracruz, Mexico, Data Brief 10 (2017) 432–437.
[7] B.N. Rekadwad, C.N. Khobragade, Is the increase in oil pollution a possibility of the presence of diverse microorganisms? An experimental dataset on oil prevalent areas of Goa, India, Data Brief 9 (2016) 8–12.
[8] C.O. Okoye, O. Taylan, Performance analysis of a solar chimney power plant for rural areas in Nigeria, Renew. Energy 104 (2017) 96–108.
[9] S.T. Ogunjo, A.T. Adediji, J.B. Dada, Investigating chaotic features in solar radiation over a tropical station using recurrence quantification analysis, Theor. Appl. Clim. 127 (1–2) (2017) 421–427.
[10] T.R. Ayodele, A.S.O. Ogunjuyigbe, Performance assessment of empirical models for prediction of daily and monthly average global solar radiation: the case study of Ibadan, Nigeria, Int. J. Ambient Energy (2017), in press.
[11] O.D. Ohijeagbon, O.O. Ajayi, Solar regime and LVOE of PV embedded generation systems in Nigeria, Renew. Energy 78 (2015) 226–235.
[12] O.S. Ohunakin, M.S. Adaramola, O.M. Oyewola, O.J. Matthew, R.O. Fagbenle, The effect of climate change on solar radiation in Nigeria, Sol. Energy 116 (2015) 272–286.
[13] T.R. Ayodele, A.S.O. Ogunjuyigbe, Prediction of monthly average global solar radiation based on statistical distribution of clearness index, Energy 90 (2015) 1733–1742.
[14] H.O. Njoku, Solar photovoltaic potential in Nigeria, J. Energy Engine 140 (2) (2014) (Article number 04013020).
[15] O.O. Ajayi, O.D. Ohijeagbon, C.E. Nwadialo, O. Olasope, New model to estimate daily global solar radiation over Nigeria, Sust. Energy Technol. Assess. 5 (2014) 28–36.
[16] E.O. Ogolo, Estimation of global solar radiation in Nigeria using a modified Angstrom model and the trend analysis of the allied meteorological components, Indian J. Radio Sp. Phys. 43 (3) (2014) 213–224.
[17] A. Giwa, A. Alabi, A. Yusuf, T. Olukan, A comprehensive review on biomass and solar energy for sustainable energy generation in Nigeria, Renew. Sustain. Energy Rev. 69 (2017) 620–641.
[18] G.N. Okonkwo, A.O.C. Nwokoye, Solar radiation analysis and temperature profiles of thermosyphon solar water heater at Awka, Nigeria, Adv. Nat. Appl. Sci. 6 (2) (2012) 189–194.
[19] L.S. Taura, A.O. Musa, S. Saleh, Estimation of the global solar radiation and its derivatives over the two (2) vegetation zones of Jigawa state, Eur. J. Sci. Res. 79 (1) (2012) 99–109.
[20] A.O. Boyo, K.A. Adeyemi, Analysis of solar radiation data from satellite and Nigeria meteorological station, Int. J. Renew. Energy Res. 1 (4) (2011) 314–322.
[21] S. Olayinka, Estimation of global and diffuse solar radiations for selected cities in Nigeria, Int. J. Energy Environ. Engine 2 (3) (2011) 13–33.

[22] A.F. Alonge, O.D. Iroemeha, Estimation of solar radiation for crop drying in Uyo, Nigeria using a mathematical model, Adv. Mater. Res. 824 (2013) 420–428.
[23] O.S. Ohunakin, M.S. Adaramola, O.M. Oyewola, R.O. Fagbenle, Correlations for estimating solar radiation using sunshine hours and temperature measurement in Osogbo, Osun State, Nigeria, Front. Energy 7 (2) (2013) 214–222.
[24] M.S. Adaramola, Estimating global solar radiation using common meteorological data in Akure, Nigeria, Renew. Energy 47 (2012) 38–44.
[25] O.R. Oladosu, L.A. Sunmonu, Investigation of surface energy budget over a humid tropical site at Ile-ife, Nigeria: a comparison of eddy covariance and bowen ratio methods, Indian J. Radio Sp. Phys. 40 (1) (2011) 37–44.
[26] M.S. Okundamiya, A.N. Nzeako, Empirical model for estimating global solar radiation on horizontal surfaces for selected cities in the six geopolitical zones in Nigeria, J. Control Sci. Engine (2011) (Article number 356405).
[27] T.C. Chineke, U.K. Okoro, Application of Sayigh "Universal Formula" for global solar radiation estimation in the Niger Delta region of Nigeria, Renew. Energy 35 (3) (2010) 734–739.
[28] D.A. Fadare, Modelling of solar energy potential in Nigeria using an artificial neural network model, Appl. Energy 86 (9) (2009) 1410–1422.
[29] C. Augustine, M.N. Nnabuchi, Relationship between global solar radiation and sunshine hours for Calabar, Port Harcourt and Enugu, Nigeria, Int. J. Phys. Sci. 4 (4) (2009) 182–188.
[30] I.U. Chiemeka, Estimation of solar radiation at Uturu, Nigeria, Int. J. Phys. Sci. 3 (5) (2008) 126–130.
[31] T.C. Chineke, Equations for estimating global solar radiation in data sparse regions, Renew. Energy 33 (4) (2008) 827–831.
[32] O.O. Jegede, E.O. Ogolo, T.O. Aregbesola, Estimating net radiation using routine meteorological data at a tropical location in Nigeria, Int. J. Sustain. Energy. 25 (2) (2006) 107–115.
[33] O.O. Jegede, A note on net radiation at Osu, Nigeria, Meteorol. Z. 12 (5) (2003) 269–271.