African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

ASSESSING THE EFFECTS OF TEMPERATURE VARIATION ON QUALITY OF SIGNAL RECEPTION OF SATELLITE SYSTEM AT KU-BAND IN NORTH CENTRAL STATES, NIGERIA

Ndanusa B*, Jibrin Y. A., Oladipupo M. D. and Muhammad B. L.

Department of Physics, Ibrahim Badamasi Babangida University, Lapai.

*Contact Author: +2348036367463

ABSTRACT: *This research work examines the effects of variation in temperature on signal reception of Direct broadcasting satellite (DBS) on Ku-Band in some selected towns in North central states, Nigeria. Data used were obtained through experimental approach of recording both temperature and the quality of signal received from direct-to-home (DTH) satellite system at 12.517 GHz, for regular interval of one hour for whole year covering two climatic conditions in 2018. Daily and monthly mean values used were evaluated from the data obtained in the field. The result showed a consistence in the values of temperature across the states under study largely to the fact they lie within same coordinates. All the towns experience gradual increase in temperature value as the hours of the day progresses and declined again as night falls, due the absence of solar energy radiation at night. While this was observed, the quality of signal reception reduces from its highest value in January to its lowest value in month of August. The result showed that the states have temperature values of 38^{o}C and 18^{o}C as high and low values respectively. The averaged value for the whole states showed a weak negative correlation coefficient value of -0.298 and coefficient of determination (R^2) value of 0.077 when fitted into linear regression between temperature and the quality of signal reception within the study area, which shows that the signal quality reception is reduced by about 0.08% with 1^{o}C rise in temperature.*

KEYWORD: Temperature, Direct-to-Home Satellite, Signals Reception Quality, Nigeria

INTRODUCTION

Weather and climate affect day-to-day activities and lifestyles from the clothes we wear to the buildings we design, the food and energy we produce and consume. Climate-environment relationship and impacts on human activities are predicted to change dramatically if global warming accelerates at the rates currently proposed. One of such impact is on satellite TV signal distortions as well as video quality and clarity (Ikuomola, 2011).

Changes in the weather condition affect the quality of the satellite television signal reception though this occurs rarely, and lasts only a short period (Wole, 2015; Nweke, 2017). For the majority of users, it is heavy rains that can attenuate signal enough to result in noticeable degradation of image quality. In extreme cases, the reception can be effectively disrupted; the level of concern about the possibility of signal degradation/loss in a particular area depends on (i) regional yearly rainfall figure, (ii) location in the satellite footprint and (iii) height of the satellite above the horizon. Ezekoye (2007) noted that radio waves which are the ultimate wave used in telecommunication suffer lots of disturbances as a result of the irregular behaviour of the ionosphere which is caused by erratic solar radiation from the sun.

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

Direct-to-home satellite service refers to the satellite television (TV) systems in which the subscribers or end users receive signal directly from the geostationary satellite orbit (GEO) dedicated for such purposes. These signals are broadcast in digital format at microwave frequencies (Elbert, 2008). The service providers make use of satellite link to transmit their signal to the entire world through space known as atmosphere consists of a mixture of ideal gases with molecular nitrogen and oxygen as predominant in volume, while carbon-dioxide, water vapour and ozone as minor constituents play crucial roles, is the thin layers of gases, commonly referred to as air that surround the earth and retained by the earth's gravity; seals the planet and protects us from the vacuum and electromagnetic radiations given off by the sun (David, 2010).

Radio wave propagation is influenced by the properties of the earth and the atmosphere. The curvature of the earth and the condition of the atmosphere can refract electromagnetic waves either up, away from, or down toward the earth's surface (Adediji, 2014). Where the ionosphere reflects transmitted radio frequency waves back to Earth.

Geographical Location of Study Area

This research covers the north central states of Nigeria - viz, Niger, Kogi, Kwara, Plateau, Benue, Nasarawa and the Federal Capital Territory (FCT) Abuja. They represent one of the six geo-political zones in Nigeria. Figure 4 shows the map of Nigeria with the six geo-political zones in the country. These states are located in the tropical region marked by two distinctive seasons: viz: Dry Season spanning November – March and Rainy Season which spans April – October of each year with August as the peak month of rainy season.

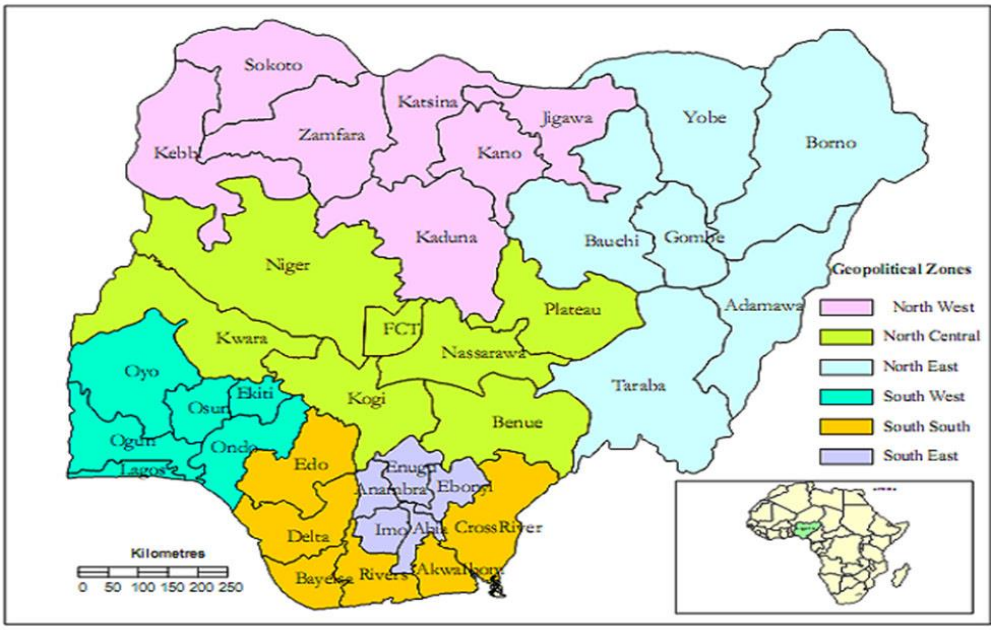

Figure 4: Map of Nigeria showing the six geo-political zones (NASDRA, 2013)

Figure 5 shows the study area of the research, the north central states showing the state capitals, some major towns and cities and particular towns covered in the research. Three towns from each state were mapped out as the study area with at least one from each

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

senatorial district of the state as represented in Table 1 with their respective coordinates and altitudes.

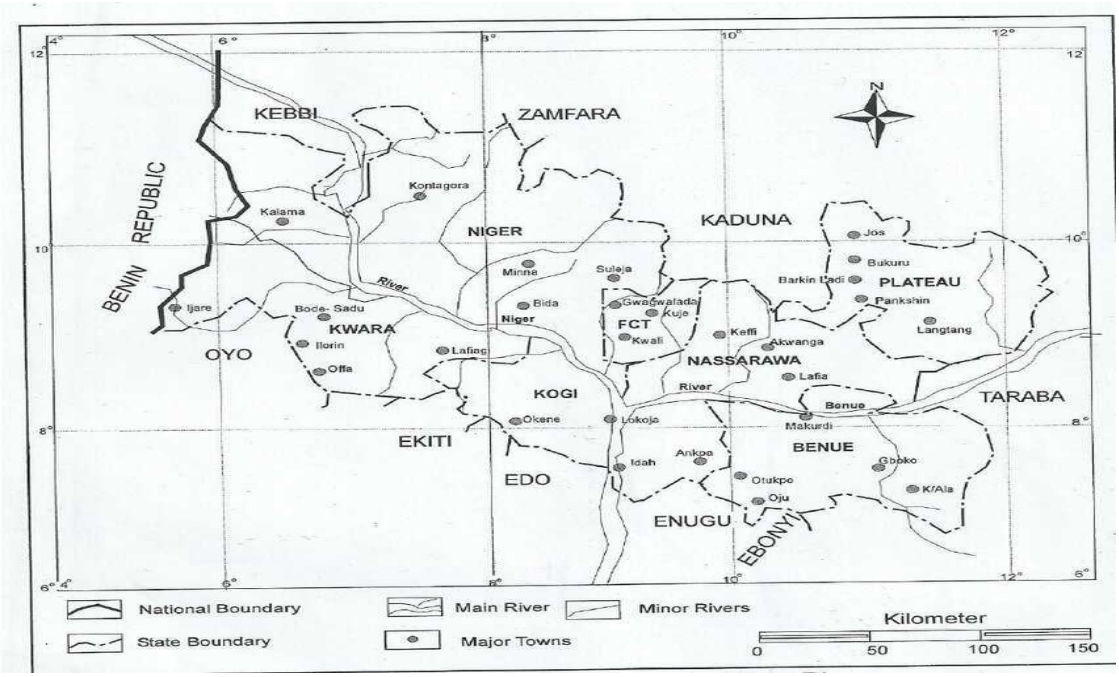

Figure 5: Map of North central states showing the study area (NASDRA, 2013)

Table 1: Towns and Coordinates of the Study Area

S/NO	STATE	TOWN	LOCATION	ALTITUDE(m)
1	BENUE	Gboko	7.325°N / 9.005°E	335
		Makurdi	7.741°N / 8.512°E	104
		Otukpo	7.333°N / 8.750°E	127
2	KOGI	Ankpa	7.300°N / 7.633°E	70
		Lokoja	7.800°N / 6.740°E	55
		Okene	7.550°N / 6.233°E	270
3	KWARA	Bode-Sadu	8.933°N / 4.783°E	152
		Ilorin	8.500°N / 4.540°E	290
		Lafiagi	8.867°N / 5.418°E	74
4	NASARAWA	Akwanga	8.917°N / 8.367°E	359
		Keffi	8.843°N / 7.871°E	338
		Lafia	8.492°N / 8.517°E	290
5	NIGER	Bida	9.083°N / 6.017°E	152
		Kontagora	10.400°N / 5.467°E	335
		Minna	9.614°N / 6.557°E	299
		Lapai	9.625°N / 6.570°E	162
6	PLATEAU	Jos	9.933°N / 8.883°E	1,208
		Langtang	9.133°N / 9.783°E	430
		Pankshin	9.333°N / 9.450°E	1371
7	FCT	Abuja	9.058°N / 7.489°E	840

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

MATERIALS AND METHODS

The equipment used in this research work includes: HTC RH data logger for recording the values of temperature as shown in Figure 1 and a complete set of direct-to home satellite kit (Antenna, signal Decoder and Scopes) shown in Figure 2 and 3 for the observation of the signal responses as a result of variation in temperature.

Figure 1: Temperature and Relative Humidity Data Logger

Figure 2: Parabolic Antenna

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

Figure 3 TV Setup for Observation

The experimental approach was adopted in which both temperature and signal reception pattern were recorded at regular interval of one hour for the whole year. While the data obtained from field and Nigeria Meteorology Agency (NiMet) was used as of secondary data source.

RESULTS

The results obtained were as depicted in the Figures listed. The average monthly values of temperature and signal quality over the study area are as shown in Figure 6 and 7 respectively, while, Figure 8 shows the hourly daily record of the variations recorded for five (5) days in the month of June, 2018, Figure 9-15 shows the correlation between the average values of the temperature and the signal quality per state under study and figure 16 shows the mean correlation for the entire study area.

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

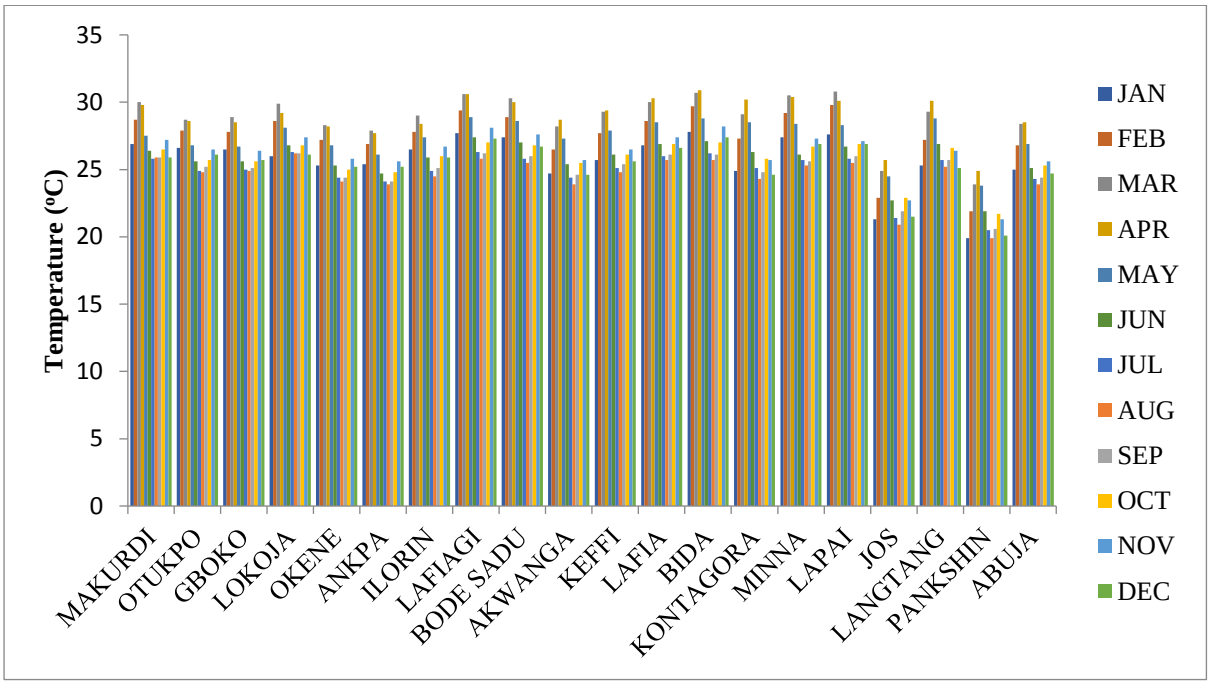

Figure 6: Average Monthly Variation in the Temperature of the Study Area

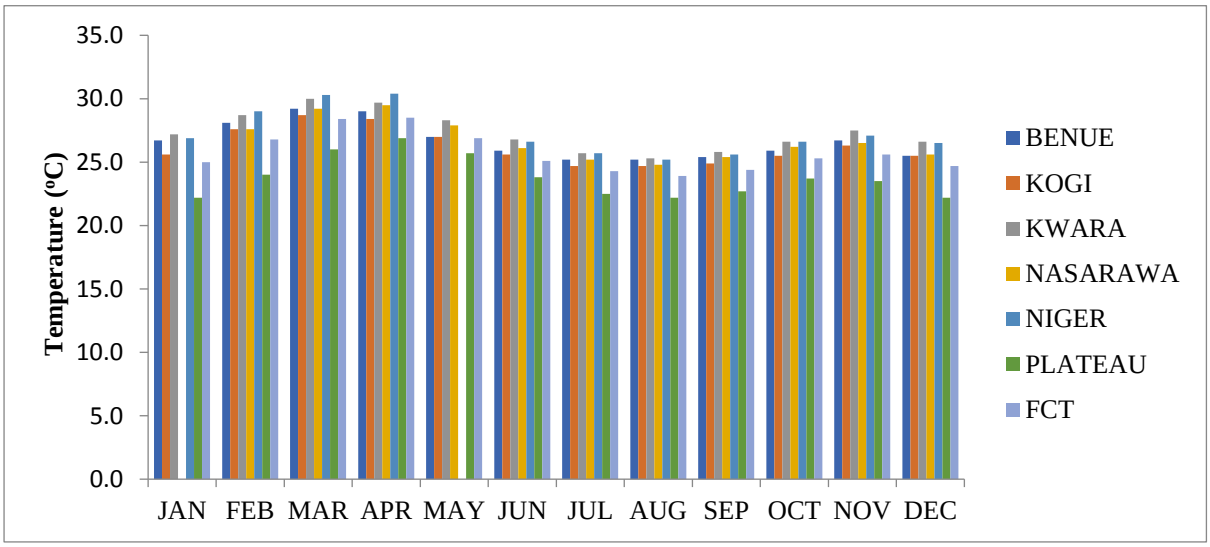

Figure 7: Average Monthly Variation in the Signal Quality of the Study Area

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

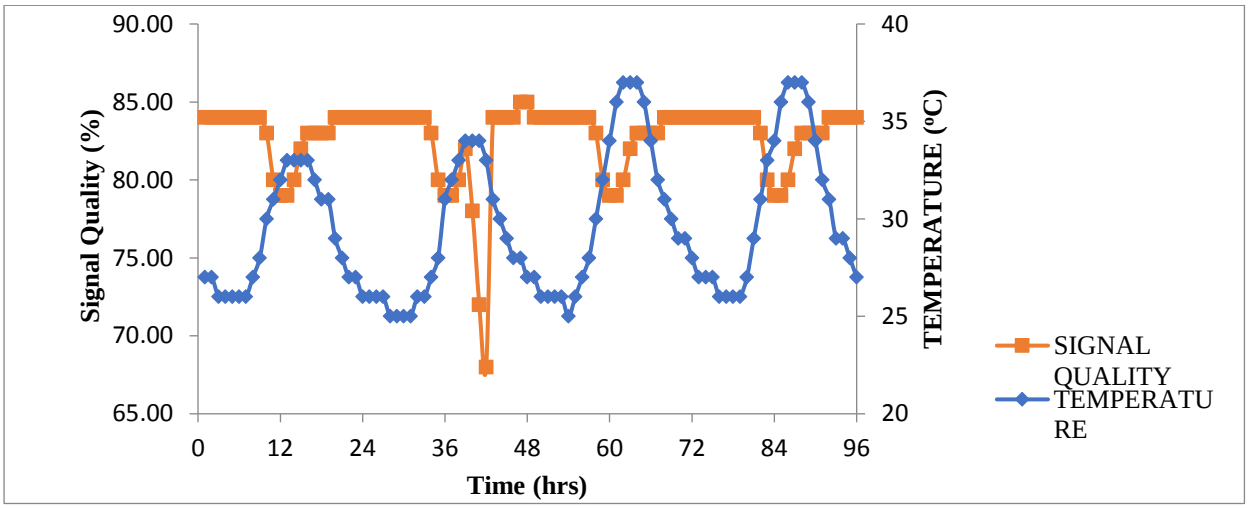

Figure 8: Hourly Daily Record of the Temperature Variations Recorded 5th to 9th June, 2018

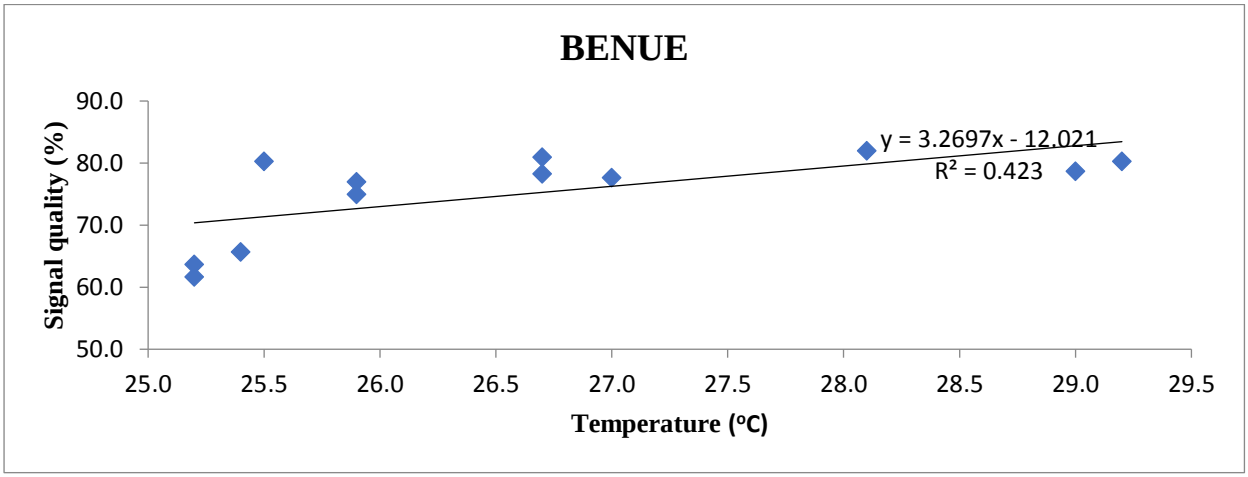

Figure 9: Correlation between the Mean Values of Temperature and the Signal Quality for Benue State

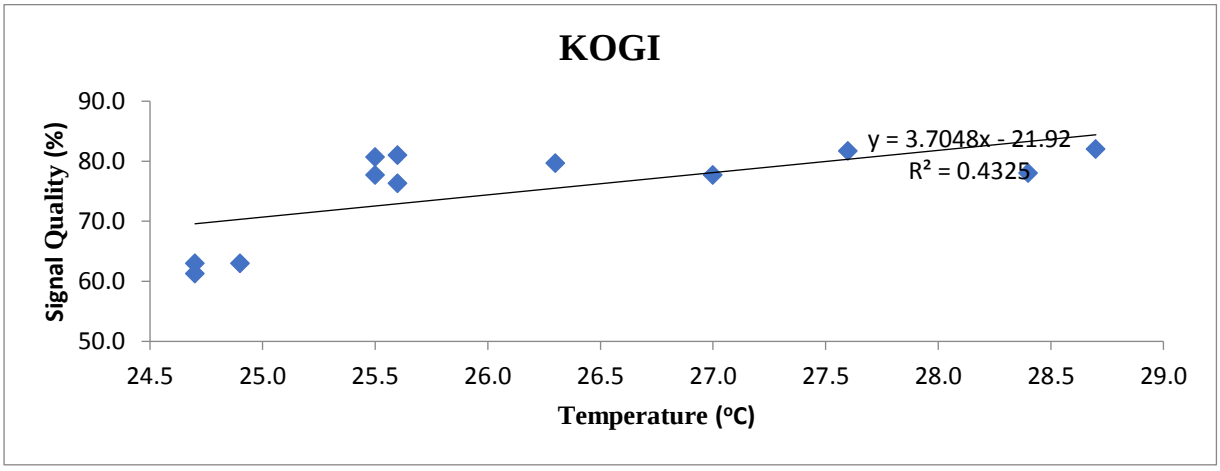

Figure 10: Correlation between the Mean Values of Temperature and the Signal Quality for Kogi state

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

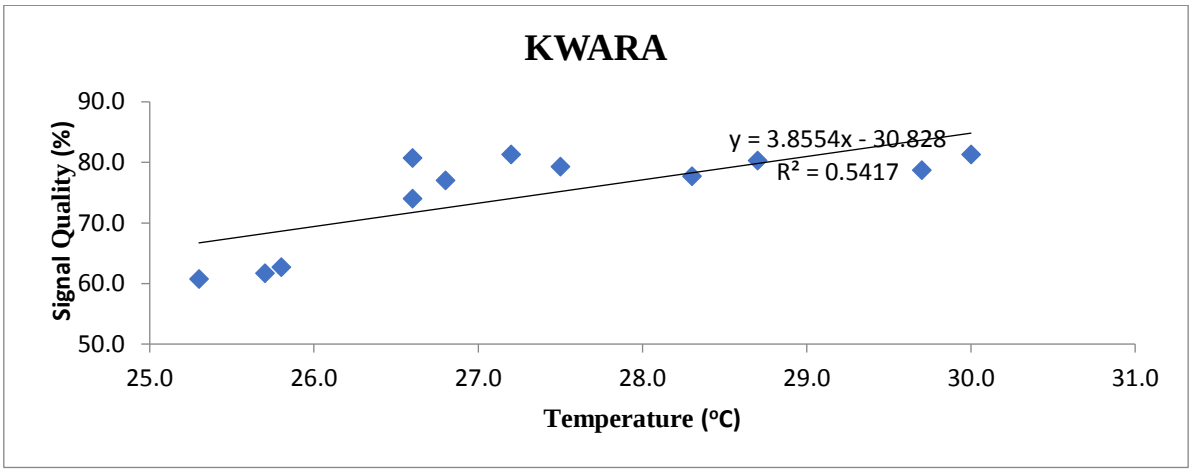

Figure 11: Correlation between the Mean Values of Temperature and the Signal Quality for Kwara State

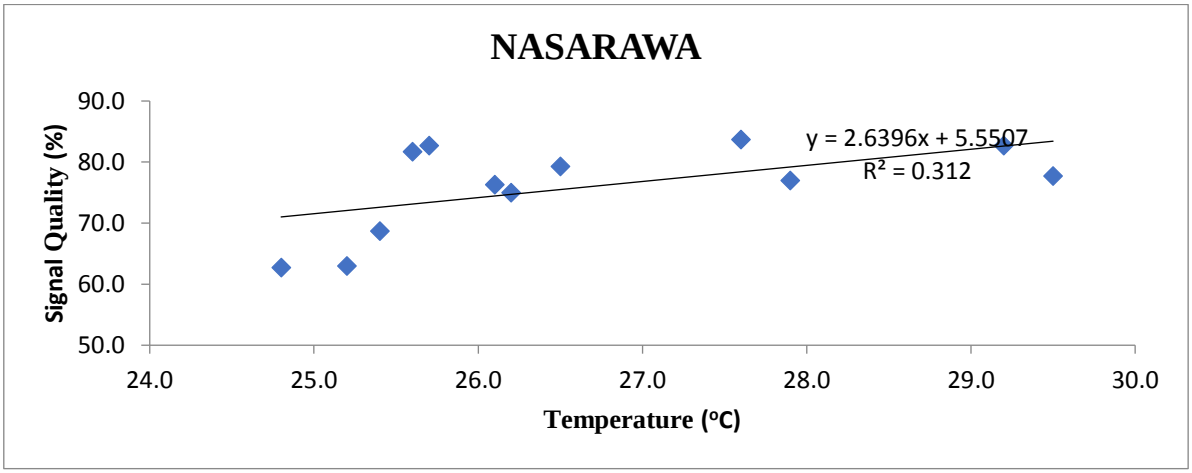

Figure 12: Correlation between the Mean Values of Temperature and the Signal Quality for Nasarawa State

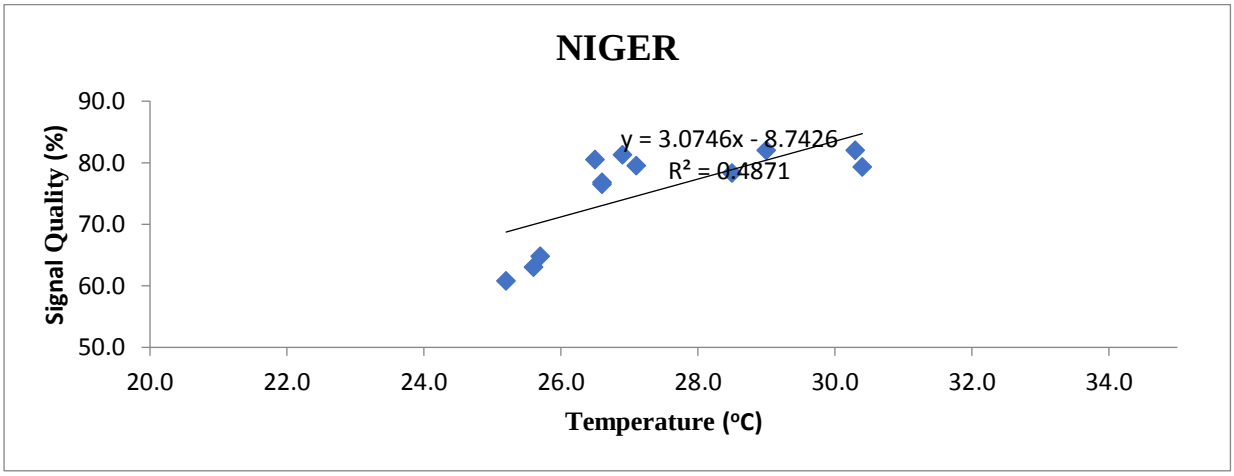

Figure 13: Correlation between the Mean Values of Temperature and the Signal Quality for Niger State

African Journal of Environment and Natural Science Research
ISSN: 2689-9434
Volume 3, Issue 1, 2020 (pp. 13-23)
www.abjournals.org

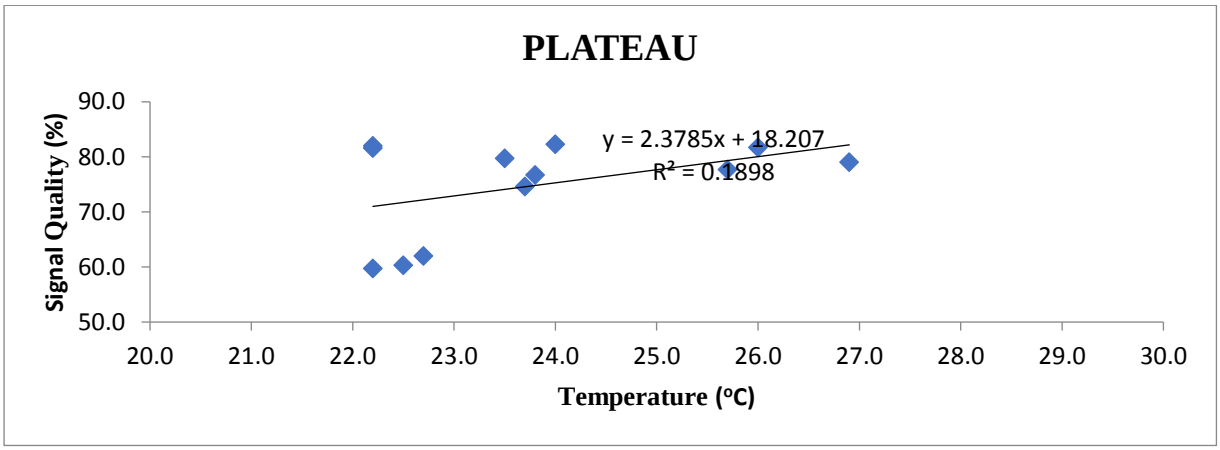

Figure 14: Correlation between the Mean Values of Temperature and the Signal Quality for Plateau State

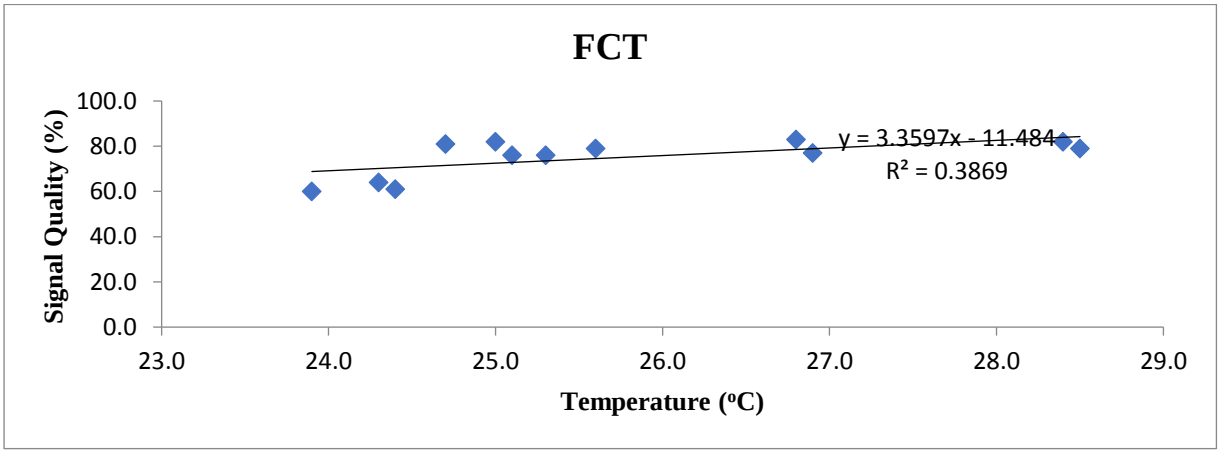

Figure 15: Correlation between the Mean Values of Temperature and the Signal Quality for Federal Capital Territory (FCT)

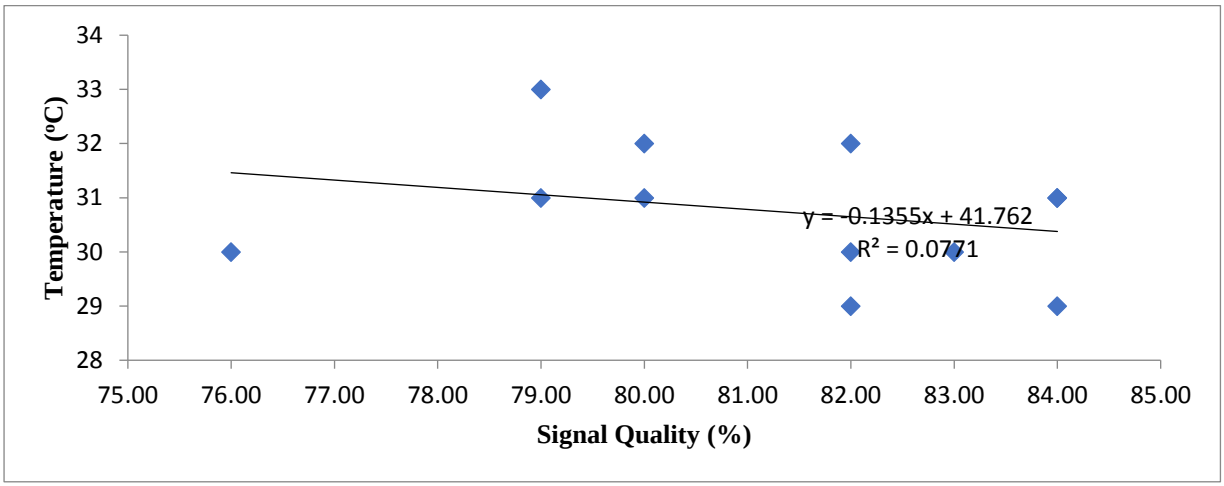

Figure 16: Correlation between the Mean values of Temperature and the Signal Quality for North central, Nigeria

DISCUSSION

The result obtained from the field shows that all areas under study have temperature variation that ranged between 17^{o}C and 39^{o}C spread over the whole year as minimum and maximum values respectively.

Figure 8 shows that an increase in temperature in daytime between 12 noon and 4pm daily depicts a slight fall in the quality of signal received and as the temperature value decreases either in early hours of day or in night, the quality of signal received increases. The trend observed shows that temperature variation results into a variation in quality of signal received though there exist some abnormalities seen intermittently, this is not as a result of variation in temperature that resulted into such sharp drop in the quality of signal received, but could be attributed to other factor(s) not under consideration as a variable e.g. relative humidity, atmospheric pressure which are both dependant on the temperature.

Figure 9-15 shows that there exists a linear regression with R^2 values when fitted into a linear line of best of fit of relation with temperature and signal quality as dependant and independent variables respectively. Figure 16 shows an average correlation between temperature and signal quality reception The best fit relation shows a negative slope trend implying that the relationship between the two parameters under observation shows an inverse correlation between them (i.e. the higher the temperature, the lower the percentage of the signal quality received, within the limit of temperature variation). The overall average correlation between the two parameters as shown in figure 16 has a negative correlation coefficient of -0.289 and by implication a weak correlation was observed.

CONCLUSION

The trend of results obtained depicts that there exists a negative correlation between these parameters (i.e. temperature and signal quality). As the temperature increases, the quality of signal received decreases. This feature was observed in all the locations of the study area. The correlation coefficient (r) and coefficient of determination (R^2) were -0.289 and 0.077 respectively, the result obtained and analyzed shows that variation in temperature has 7.7% effect on the signal reception, the value obtained shows a very weak correlation between the two parameters. Conclusively variation in temperature has little or no significant effect on the quality of satellite signal reception but rather increases the thermal noise at the antenna terminal thereby introducing additional noise and hence alters K-value for free space loss in the design stage of signal transmission and reception.

REFERENCES

Adediji, A. T., Mandeep, J. S. and Ismail, M. (2014). Meteorological Characterization of Effective Earth Radius Factor (*k*-Factor) Wireless Radio Link Over Akure, Nigeria. *Metrology Society of India* 29 (2): 131-141

David, G. A. (2010). An Introduction to Atmospheric Physics, 2nd edition, Cambridge University Press, Edinburgh, UK, Pp 1- 2.

Elbert, B. R. (2008). Introduction to Satellite Communication, 3rd Edition, Artech House, Boston London.

Ezekoye, B. A. & Obodo R. M. (2007). The effects of solar radiations on Telecommunications, *the Pacific Journal of Science and Technology (PJST), 8(1): 109 – 117.*

Ikuomola AJ (2011). Wireless communication II; Course work developed for the National Open University of Nigeria, Lagos 6-140.

Nweke FU (2017). The effect of weather and fading rate in television transmission and reception. *Middle-East Journal of Scientific Research*. 25(10):1872-1875.

Wole O (2015). Digital TV talk: Why your TV signals are affected by rain. Eagle Online Newspaper, accessed 17th April 2018 @ The Eagle Online; 2015.