FUDMA Journal of Sciences (FJS)
ISSN online: 2616-1370
ISSN print: 2645 - 2944
Vol. 4 No. 1, March, 2020, pp 647 –654

INFLUENCE OF RAINFALL AND TEMPERATURE VARIATION AMONGST MALARIA DIAGNOSED ENROLLEES OF NATIONAL HEALTH INSURANCE SCHEME, AHMADU BELLO UNIVERSITY, ZARIA, NIGERIA

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ABSTRACT

The occurrence and frequency of malaria in humans has been attributed to climate change due to change in human activities over the years. The paper assessed the influence of temperature and rainfall variation on malaria diagnosed enrollees of NHIS in Ahmadu Bello University, Zaria. Temperature and rainfall data and malaria prevalence for the period of 2008-2017 were analyzed. Second order polynomial curve fitting was used to determine the non-linear trends of temperature, rainfall and malaria cases. Its relationship was tested using Pearson's product moment correlation coefficient. The result revealed that an upward trend in temperature and rainfall is capable of increasing the occurrence of malaria in the study area. There is a strong relationship between the number of malaria diagnosed enrollees of NHIS and the change in temperature and rainfall. It is recommended that there is need for proper environmental sanitation and more awareness on the need to use insecticide treated nets (ITN) to prevent mosquito bites. Also, proper budget on malaria for both enrollees should be made increased during the rainy season than the dry season in order to checkmate the challenges derived from variation in temperature and rainfall on individual's health.

Keywords: Rainfall, Temperature, Trend, Malaria, and Enrollees

INTRODUCTION

Health is wealth and as a result of that National Health Insurance Scheme (NHIS) was implemented on 16th June, 2006 by the Federal Government of Nigeria under the act 35 of 1999 constitution, in order to achieve Universal Health Coverage (UHC) of the populace (Etobe and Etobe, 2014). NHIS principle implies mobilising resources for health, pool risk and provides quality healthcare system to all Nigerians. It covers only routine illness and excludes epidemic outbreaks, cancer, hepatitis, injuries from extreme sports and terrorist attack (Ayanleye, 2013; Etobe and Etobe, 2013).

Malaria disease is among routine illnesses covered by NHIS. Its reproductive, survival, production, transmission and habitation stages depend on suitable temperature and rainfall amount of an area for its pathogens and vectors to affect its hosts. The spread of malaria diseases cut across highlands and lowlands provided its prevailing climatic condition is conducive for the vectors. According to Caminade *et al* (2014), changes in climatic condition over the years in some regions have favoured the prevalence of malaria presently and in the future. For instance, central Kenya highland had no record of malaria cases before 1990 but in the year 2005 malaria cases were found in the highland due to change in temperature which fluctuated between 17.4 ^{o}C to 18.2^{o}C. In addition, it was observed that the anomalous warm and wet event of El Nino of the year 2003 contributed to the establishment of malaria vectors and there cases in Central Kenya highland while predicted areas for future occurrence of malaria cases are Central Europe and North America (Caminade *et al,* 2014). Watson *et al* (1997), Chretien *et al* (2014) and Tain *et al* (2015) attributed the occurrence of malaria in areas which had no incidence of malaria before to the effect of present-day human actives (anthropogenic).

According to IPCC (2001) there has been a global rise in average temperature of 1.5 - 5.8 ^{o}C in the twenty-first century. This global increase in temperatures is as a result of increase in greenhouse gases (GHGs) due to human activities such as industrial pollution, destruction of nature (e.g. deforestation and bush burning), combustion of fossil fuel, gas flaring, used of chemicals among others (Abaje and Oladipo, 2019). Malaria which is basically transmitted by insects is presume to strive well in this change in climatic condition. Thus, change in climatic condition would affect the prevalence of malaria in an area (Wilson, 2001). Malaria cases are sensitive to climatic condition of a place; rainfall facilitates breeding ground of mosquitoes while temperature at a threshold of 18ºC facilitates its reproductive stage (Andrew, 2009). The above malaria cases are suitable for developed countries while that of under developed or developing countries is a synergy of factors for the prevalence malaria in a place. Such factors include sleeping without mosquito nets, poor sanitation, poverty, flooding and poor drainage system (Andrew, 2009).

Vincent and Sunday (2015) used climatic data of temperature and rainfall for a period of 65 years on malaria cases in Port Harcourt and employed multiple regression as the statistical tool. The result revealed that the region had an increase in temperature of 3ºC from 1950 to 2014; poor drainage system, improper sanitation and flooding constituted towards the breeding of mosquitoes in the area. There were double maxima in the prevalence of malaria cases, 1006 cases in July and 1540 cases in September. Malaria cases have become a global health burden due to its dimension of socio- economic impact on human. For instance, 655,000 deaths have been reported to have occurred due to malaria cases and a greater percentage (86%) of it is among children who are under five years of age. One would wonder if the set goals by NHIS exclude the achievement of UHC for under five years' age group with the above high mortality rate. In considering enrollees coverage, it is observed that only 4% of Nigerians are enrolled into the scheme and are mainly formal sector participants (Ayanleye, 2013).

Studies have observed that the level of NHIS awareness and utilization are based on individual's profession and level of educational attainment, this perhaps might be correct or not. For examples, Chibueze (2013) studied the level of awareness on NHIS among civil servants in Enugu and Abakaliki, South Eastern Nigerian. Inegbedion (2015) investigated the awareness and utilization of NHIS in Edo State. So far there has not been any research carried out on the diagnosed enrollees of NHIS with malaria cases that is related to variation in temperature and rainfall. As a result of this gap, this paper seeks to investigate the influence of climate change on NHIS enrollees diagnosed with malaria in Ahmadu Bello University (ABU), Zaria.

MATERIALS AND METHODS

Study Area

The study area is Ahmadu Bello University, main campus, Samaru (Figure 1). It is located along Zaria-Sokoto express road of Samaru. Samaru is a settlement under Basawa ward which is in Sabon Gari Local Government Area of Kaduna State. It's within latitude 11º03′N and longitude 7º42′ East (Mortimore, 1970; Bako, 2011). The climatic condition is of tropical continental climate with distinct seasonal regimes of tropical wet and dry season (Aw Climate of Koppen's classification). It entails six (6) months of wet season and 6 months of dry seasons. Its rainy season commence in May and ends in October with a single peak in August, while its dry season starts from November and ends in April of the following year. Daily maximum temperature rises gradually from 33 ºC to 40 ºC and it reaches it peak in April. The influence of two air masses which are tropical continental air mass (cT) and tropical maritime air mass (mT) constitute to the prevailing weather condition in the study area.

The geology of the area is underlain by crystalline metamorphic and igneous rocks of Precambrian to lower Paleozoic age such include quartz, schists, laterites and aluminum which are formed due to depth of weathering activities (Spencer, 2003; Bako, 2011). Thus leads to leached ferruginous soils that are rich in iron oxide, mica and feldspar. These soils have marked clear horizon differentiation, and with the aid of its climatic condition, the soil has high clay content with an overlain drift and shallow surface capping due to high rainfall intensity which infiltrate and favours an overland flow (Jaiyeoba, 1986). The area is drained by the tributaries of Kubanni River and it is dammed for water supply. The vegetation cover of the study area is the northern guinea savanna which consists of shrubs which are intersperse with grasses and economic tress such as Mangifera indica, and Parkia clappertoniana (Bako, 2011).

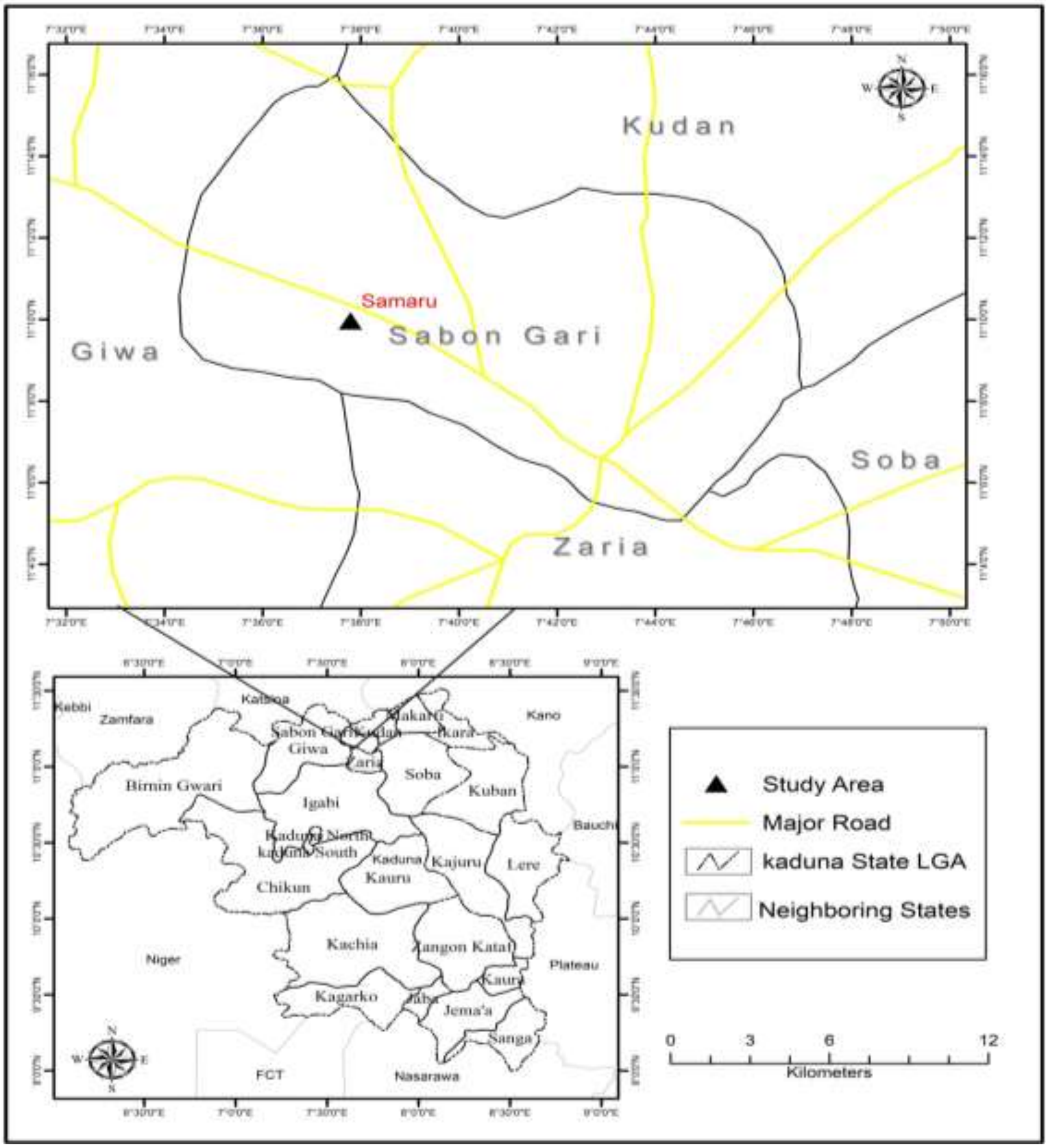

Fig. 1: Map of Kaduna State showing the Study Area

Agricultural activities such as fishery, poultry and vegetable gardens made at a small scale are common within the campus but extensive agricultural activities are carried out kilometers away from the campus. The school environment comprises of administrative area, public space, residential area, trade and commercial areas such as markets, kiosk, shops, bank and restaurants/food vendors (Researcher observation).

Data Collection

The study employed archival data of temperature, rainfall and National Health Insurance (NHIS) enrollees from Medical Centre of A.B.U., Zaria. The rainfall and temperature data were collected from the Nigerian Meteorological Management Agency (NiMet) and it was for a period of ten years (2008–2017). Records on enrollees diagnosed with malaria were also obtained from Medical Centre of A.B.U (an accredited NHIS HCF) for a period of ten years (2008-2017).

Data Analysis

Climatic data and number of enrollees diagnosed with malaria were correlated by employing descriptive and inferential statistics. Second order polynomial curve fitting was used to determine the non-linear trends of both the annual and average monthly data temperature, rainfall and malaria cases. The equation is of the form:

$$y = a + b_1 x + b_2 x^2 \quad \text{------------------------------- (1)}$$

To evaluate the three unknowns (*a*, b_1, b_2), the normal equations become a set of 3 simultaneous equations:

$$\sum y = na + b_1\left(\sum x\right) + b_2\left(\sum x^2\right) \quad \text{-------------------------------- (2)}$$

$$\sum xy = a\left(\sum x\right) + b_1\left(\sum x^2\right) + b_2\left(\sum x^3\right) \quad \text{----------------------------- (3)}$$

$$\sum x^2 y = a\left(\sum x^2\right) + b_1\left(\sum x^3\right) + b_2\left(\sum x^4\right) \quad \text{------------------------------- (4)}$$

Here $\sum xy$ is the sum of the products obtained by multiplying each value of *x* by the corresponding value of *y*, $\sum x^2 y$ is the sum of the products obtained by multiplying the square of each value of *x* by the corresponding value of *y*, and $\sum x^2$, $\sum x^3$, and $\sum x^4$ are the sums of the second, third, and fourth powers of the *x'*s respectively.

Similarly, the relationship between temperature /rainfall and malaria cases was tested using Pearson's product moment correlation coefficient. This is computed as:

$$r = \frac{\sum (x - \bar{x})(y - \bar{y})}{\sqrt{\sum (x - \bar{x})^2}\sqrt{\sum (y - \bar{y})^2}} \quad \text{------------------------ (5)}$$

Where: r = correlation coefficient

x and *y* = individual observations of dependent and independent variables respectively

$\bar{x}$ and $\bar{y}$ = mean of dependent *(x)* and independent *(y)* variables respectively.

RESULTS AND DISCUSSION

Climatic Elements and Malaria Cases

The average annual temperature, annual rainfall, and annual malaria cases for the ten years (2008-2017) are presented in Table 1. The Table shows that there have been changes in climatic parameters and number of NHIS enrollees diagnosed of malaria. In terms of average annual temperature, the highest value of 26.1°C was recorded in 2013 while the lowest value of 24.6°C was recorded in 2008.

Table 1: Annual Temperature (Average), Rainfall, and Malaria Cases

Year	Average Annual Temp. (°C)	Annual Rainfall (mm)	Annual Malaria Cases
2008	24.6	993.6	2252
2009	24.7	896.2	2199
2010	25.0	1018.4	2253
2011	25.9	1112.5	2237
2012	25.4	1406.3	2960
2013	26.1	1165.5	2697
2014	26.0	1237.3	3074
2015	26.0	1158.6	3826
2016	25.9	1124.9	4458
2017	25.8	1216.7	3353

Source: Fieldwork, 2018

The annual rainfall within the study period also showed an increasing trend, its minimum amount of rainfall is 993.6 mm and was recorded in 2008 while its maximum rainfall (1406.3 mm) was recorded in 2012. This means that the heavy rainstorm for that year was responsible for 2012 flood that ravaged the northern States. This unusual and frequent torrential rain in the area is as a result of variation in rainfall amount. This is in agreement with the observations made by Trenberth *et al* (2007) that climate change occurs when there is change in the type of precipitation, its amount, frequency and intensity. This change in climatic condition indicates the influence of human activities such activities include burning of bushes, burning of fossil fuels, and combustion from automobile exhaust pipe. The result from the study seems to affirm the conclusion made by IPCC (2001) regarding climate change and its influence on human health. From the result, it could be seen that the number of enrollees with malaria increased from 2199 in the year 2009 to 4458 in the year 2016 (Table 1).

Figure 2 shows the annual rainfall and average annual temperature while Figure 3 shows the annual malaria cases. The second order polynomial curve fitting for the annual rainfall in Figure 2 showed an increasing rainfall trend from 2008 to 2017. This result is in conformity with other studies (Odekunle *et al*, 2008; Abaje *et al*, 2018) in Northern Nigeria in which rainfall was found to be increasing in recent years.

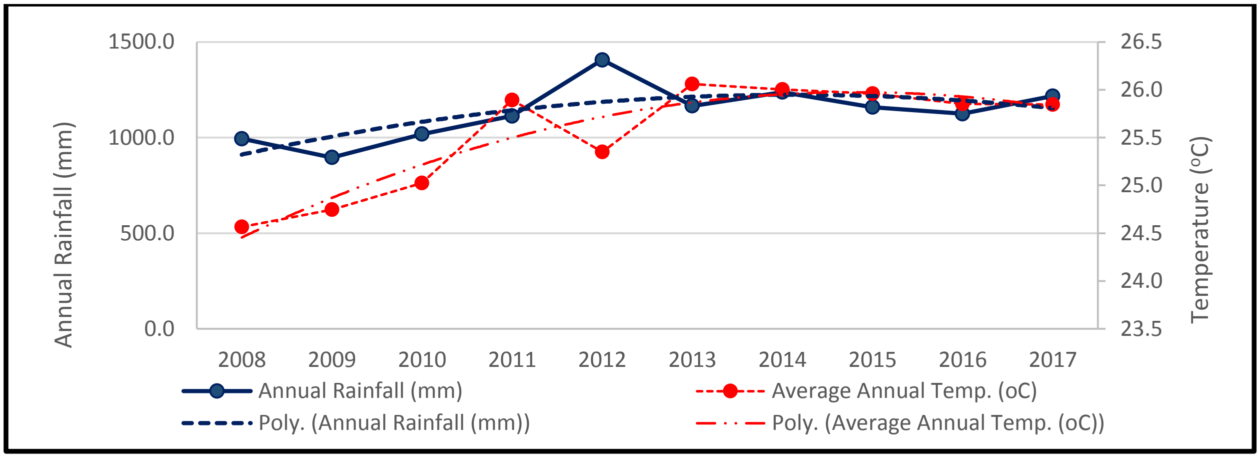

Figure 2: Annual rainfall and average annual temperature (2008 to 2017)
Source: Fieldwork, 2018

The second order polynomial curve fitting for the average annual temperature also showed an increasing trend from 2008 to 2017. This result is in agreement with the report of NiMet (2015) and Abaje (2016) in which the trend analyses revealed a higher rate of temperature increase in the Northern States.

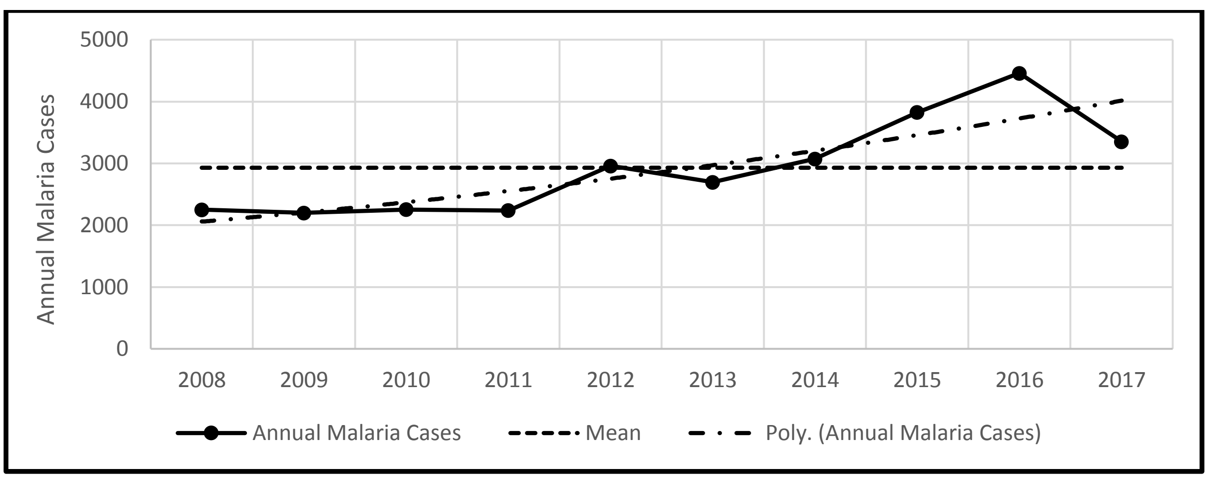

Figure 3: Annual Malaria Cases (2008 to 2017)
Source: Fieldwork, 2018

The second order polynomial trend line for annual malaria cases (Figure 3) showed a gradual increase from 2008 to 2017. A closer examination of both Figure 2 and 3 shows that increase in temperature constitute increase in number of enrollees with malaria disease from year 2012-2017 while the low temperature experienced from 2008-2011 resulted to a stable number of enrollees with malaria disease. A drop in temperature coupled with increase in rainfall amount from 1000 mm (2011) to above 1400 mm (2012) might have contributed to the gradual increase in the number of NHIS enrollees with malaria from 2000 to above 3000. This aids to explain why malaria is sensitive to changes in climatic condition in tropical regions (Caminde *et al*., 2014).

From Table 2, it shows that the study area has high rainfall amount in July, August, and September, thus implies a single rainfall regime compared to that observed by Vincent and Sunday (2015) on climate and epidemiology of malaria in River State. This high rainfall facilitates the breeding sites of mosquitoes which increases its larval and embryonic stage. The minimum value of the average monthly temperature is 21.6 ^{o}C (December) while the maximum value is 29.4 ^{o}C (April). This range of temperature tends to fall within the range at which the vector spreads its life cycle and commence the act of transmission of the malaria disease.

Table 2: Average Monthly Temperature, Rainfall, and Malaria Cases

Months	Average Monthly Temp. (^{o}C)	Average Monthly Rainfall (mm)	Average Monthly Malaria
January	22.0	0.9	81
February	25.6	0.0	79
March	28.4	5.5	67
April	29.4	36.1	54
May	28.0	115.4	64
June	26.0	149.7	90
July	25.0	237.7	65
August	24.6	327.1	65
September	25.1	209.7	72
October	26.1	50.8	128
November	24.6	0.0	92
December	21.6	0.0	61

Source: Fieldwork, 2018

During this period the number of NHIS enrollees diagnosed with malaria increase from 92 to 128 numbers of enrollees per month in September to October. This indicates single maxima of malaria cases in the study area. Table 2 also shows that the decrease in temperature (21.6 ^{0}C) in December decreases with low number of NHIS enrollees (61) diagnosed with malaria.

Table 3 shows the p-value derived from the correlation analysis between climatic parameter and number of NHIS enrollees' diagnoses with malaria. The average change in rainfall had more influence on the number of NHIS enrollees due to its P-value of 0.8 at 5% confidence level than the average change in temperature with a P-value of 0.1. This is expected since rainfall aids in facilitating the survival, reproduction, distribution and transmission stages of anopheles mosquitoes in the tropical region. The influence of rainfall and temperature on enrollees is also reflected at the monthly level on Table 3. The P-values of annual and monthly average temperature and rainfall shows that rainfall and temperature have a strong influence on the occurrence of malaria among NHIS enrollees. The findings illustrate the explanation of Oladipo (1993), Federal Republic of Nigeria (FRN) (2000) and Okorie (2003) on the dry spells that occur in the tropical continental climate and its adverse effect on the health of its residents.

Table 3: Climatic Parameters and Number of NHIS Enrollees

Climatic parameters	P-value	Duration	Confidence level	Average No of NHIS enrollees
Average temperature (^{0}C)	0.1	Annual	5%	2442
Average rainfall (mm)	0.8	Annual	5%	
Average temperature (^{0}C)	0.2	Monthly	5%	862
Average rainfall (mm)	1.3	Monthly	5%	

Source: Field Survey, 2018

Observation from Vincent and Sunday (2015), Caminde *et al* (2014) and Wilson (2001) had also shown the incidence of malaria has been on the increase with time series in the tropical regions. The findings in this study are not different from the above observation. Findings from the study shows that annual malaria cases diagnosed among NHIS enrollees had a mean value of 2930 and a standard deviation of 769 with a skewness of 0.9. Its skewness value indicates an increase in the cases of malaria among NHIS enrollees annually. The mean average annual temperature was 25.53 ^{o}C and the mean average annual rainfall was 1133.0 mm, and their skweness values were -0.8 and 0.2 respectively. This implies that rainfall amount had less effect on malaria cases than temperature.

The increase in rainfall increases breeding sites for the vectors; such breeding sites include the collection of rain water in discarded tires, containers, leaf axils, drainage system and stagnant ponds/rivers (Wilson, 2001). Thus, rainfall promotes its survival, reproduction; distribution and transmission of the vector (female anopheles' mosquitoes) while temperature aid in the hatching stages i.e. the embryonic, larval and pupa development in the study area (Wilson, 2001; Andrew, 2009). The monthly changes in the number of enrollees of NHIS diagnoses with malaria in the study area influence by climate change pose a challenge on budget and planning of health care facilities for but enrollees and potential enrollees in the study area.

The incidence of malaria amongst NHIS enrollees may not depend solely on climatic parameters but the influence of other factors as acknowledge by Andrew (2009). Factors such as sanitation and hygiene, and migration of students or staffs or the populace may come to play. Being an academic environment, movement is inevitable, people can move in or out on monthly or daily or on yearly bases thereby increasing the incidence of malaria; the lifestyle of its enrollees can also expose them to the vectors. Other factors include socio-economic status of enrollees, failure to use mosquito nets or insecticides, and improper disposal of refuse all constitute to the prevailing condition of malaria in the study area.

CONCLUSION

The study revealed the existence of change in climatic parameters of rainfall and temperature in the study area. This change in climatic condition led to adverse ill health of NHIS enrollees particularly malaria diseases which is a vector borne disease. With the aid of NHIS the adverse effect of climate change is reduced because it reduces the cost effect on the frequency occurrence of malaria disease and its treatment. Most NHIS enrollees are more diagnosed with malaria in the month of October than any other month of the year. This period occurs after the biting and transmitting stage of malaria in its host.

Rainfall promotes breeding sites of mosquito production, while temperature facilitates reproductive stage and transmission stage of the mosquitoes. Hence, it is recommended that more budgets on malaria should be made during the rainy seasons than the dry season. This budget for both potential enrollees and enrollees of NHIS should cover availability of diagnostic test tools for malaria and malaria drugs. Besides, more awareness among staff and students on the use of mosquito nets and insecticides during the rainy seasons should be made in order to minimize the occurrence of malaria.

REFERENCES

Abaje, I.B. and Oladipo, E.O. (2019). Recent Changes in the Temperature and Rainfall Conditions Over Kaduna State, Nigeria. *Ghana Journal of Geography,* 11 (2), 127-157.

Abaje, I.B., Achiebo, P.J. and Matazu, M.B. (2018). Spatio-Temporal Analysis of Rainfall Distribution in Kaduna State, Nigeria. *Ghana Journal of Geography,* 10 (1), 1-21.

Abaje, I.B., Ishaya, S. and Abashiya, M. (2016). Evidence of Global Warming from Statistical Analysis of Temperature Data of Kaduna State, Nigeria. *Nigerian Geographical Journal, New Series,* 11 (1), 125-140.

Bako, E.J. (2011). Estimating the total daily traffic in-flow into Ahmadu Bello University Main Campus, Zaria. Unpublished undergraduate project. Department of Geography, AhmaduBelloUniversity, Zaria. Pg 19-27.

Caminade, C., Sari, K., Joacim, R., Adrian, M.T., Andrew, P.M., Felipe, J.C., Hans, S., Pim, M., and Simon, J.L. (2014). Impact of Climate change on global malaria distribution Cross Mark *Journal of PNAS III:* 3286-3191.

Chretien, J.P., Anyamba, A., Small, J., Britch, S., Sanchez, J.L., Halbach, A.C. Tucker, C., Linthieum, K.J. (2014). Global Climate anomalies and potential infectious disease risks. PLOS Curr. 7.

Federal Republic of Nigeria (FRN) (2000). National Action Programme to Combat Desertification and Mitigate the effect of drought. Towards the implementation of the United Nations Convention to combat desertification and mitigate the effect of drought in the country.

Hore, P.N. (1970). Weather and Climate in Zaria and it region (ed). In Mortimore, M.J. Occasional Paper for the Department of Geography, A.BU., Zaria.

Intergovernmental Panel on Climate Change (IPCC) (2001). Synthesis Report. Watson, R.T., Team C.W. (Eds) A Contribution of Working groups I, II and III to the third assessment report of the IPCC, Cambridge University Press, Cambridge, United Kingdom and New York.

Jaiyeoba, I.A. (1986). Analysis of the Relationship between soil properties and soil forming factors in Nigerian Savanna. Unpublished Ph.D Thesis, Department of Geography, AhmaduBelloUniversity, Zaria.

National Health Insurance Scheme (NHIS) (2012). NHIS Operational guidelines. Revised 2012 Retrieved from https://www.nhis.gov/nig/file/respository/NHIS on the 16/10/2017.

Nigerian Meteorological Agency (NiMet). (2015). *2015 Nigeria Climate Review Bulletin* (63 pp). Nigerian Meteorological Agency (NIMET), Abuja.

Odekunle, T.O., Andrew, O. and Aremu, S.O. (2008). Towards a wetter Sudano-Sahelian Ecological Zone in twenty first century Nigeria. *Weather,* 63(3), 66-70.

Okorie, F.C. (2003). Studies on drought in the sub-saharan region of Nigeria using Satellite remote sensing and precipitation data. Retrieved from http://www.mathaba.net/gci/docs/research/nigeria-drought.html.

Oladipo, E.O. (1993). Some aspects of the spatial characteristics of drought and desertification in northern Nigeria. *Natural Hazards.* 8:171-188.

Spencer, W.E. (2003). Earth Science: Understanding Environmental Systems. McGraw-Hill Higher Education. 1221 Avenue of the Americas, New York, NY, 10020. Pg 279-303.

Trenberth, K.E., Jones, P.D., Ambenje, P., Bojariu, R., Easterling, D., Klein Tank, A.,… Zhai, P. (2007). Observations: Surface and Atmospheric Climate Change. In: Solomon, S., Qin, D., Manning, M., Chen, Z., Marquis, M., Averyt, K.B.,…Miller, H.L. (Eds.). *Climate Change 2007: The Physical Science Basis,* (pp: 235-336). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). United Kingdom and New York, NY: Cambridge University Press.

Vincent, E.W. and Sunday, I.E. (2015). Climate and epidemiology of malaria in Port Harcourt Region, Nigeria. *American Journal of Climate Change* 4:40-47 Retrieved from http:dx.doi.org/10.4236/aicc.2015.41004 on July 17, 2017.

Wilson, M.L. (2001). Ecology and Infectious diseases in ecosystem change and public health: A global perspective Aron, J.L. and Patz, J.A. Johns Hopkins University Press, Baltimore. Pg 283-324.

Wright, T.R. and McCurry (1970). Geology of Zaria. In Mortimore, J. (Ed). Zaria and its regions. Occasional Paper for Development of Geography, Ahmadu Bello University, (ABU) Zaria.