International Journal of Geography and Regional Planning Research
Vol.6, No.2, pp.1-12, 2021
Print ISSN: 2059-2418 (Print),
Online ISSN: 2059-2426 (Online

THE EFFECT OF CLIMATE CHANGE ON HUMAN HEALTH IN DAMATURU

Abdullahi Mustapha[1]
Nigerian Meteorological Agency (NiMet),
Bill Clinton drive, Nnamdi Azikwe International Airport, Abuja, FCT, Nigeria

Yusuf Maina-Bukar[2]
Desert Research, Monitoring and Control Centre (DRMCC),
Yobe State University, Damaturu, Nigeria

Kamoli Makanjuola Kazeem[3]
Department of Geography,
Yobe State University, Damaturu, Nigeria

ABSTRACT: *The frequency and intensity of rainfall and temperature health related incidences are expanding from micro-scale to global scale with intensive direct and indirect impacts. This study assessed the effect of temperature and rainfall variability on human health in Damaturu, Yobe State from 2009 to 2018, which was achieved by determining the annual trends of temperature and rainfall occurrence in relation to diseases incidence in the study area. Multi-stage stratified systematic random sampling technique was adopted. Based on the National water rehabilitation house numbering in Damaturu, the study area was stratified into three strata where two communities from each of strata were selected using systematic random sampling. Data was collected using questionnaire, meteorological records of temperature and rainfall occurrences and hospital records of diseases incidences. The findings of the research established that rainfall and temperature variability are significantly associated with the prevalence of seasonal diseases incidences in Damaturu. Malaria incidences have high correlation with rainfall and temperature variability at significant level of 0.033 whereas measles and diarrhoea indicate a positive correlation. These indicated that about 38%, 14% and 8% of variances in malaria, diarrhoea and measles incidences respectively are associated with temperature and rainfall fluctuation in Damaturu. The combination of higher temperatures, prolonged dry season and floods coupled with scarce water resources and poor sanitation made traditional and newly established settlements more vulnerable to outbreaks of diarrhoeal and malaria incidences in Damaturu town. The study recommended that meteorological agencies in collaboration with health agencies should develop a proactive solution that will provide a timely and accurate forecasting and projection of vulnerability of the population in Damaturu to climate sensitive diseases and infection.*
KEYWORDS: disease incidence, rainfall, temperature, variability

INTRODUCTION

The magnitude and frequency of rainfall and temperature health related cases in Nigeria were expanding from micro scale to global scale with intensive direct and indirect

impacts (Ekpoh and Bassey, 2016). The increase in global temperature and rainfall variability has been projected to cause changes in the global climate systems which are reflected in variability of the frequency and duration of extreme weather occurrence including heat wave, flooding and rise in global sea level (Pachauri et al., 2014). Svalastog et al., (2017) noted that one of the primary goals of sustainable development is human health which has been threatened for long due to frequent and continues variability in temperature and rainfall and they are also the primary causes of significant increases of mortality, morbidity and poverty at global scale.

Rainfall and temperature variability are considered as any form of alteration in temperature and rainfall amount over time whether due to natural change or as a result of human activity (Popoola, 2014). The variability in temperature and rainfall affect human wellbeing from a variety of direct and indirect variable mechanism. They are factors that increase the frequency and severity of health illness which accentuate health risks and morbidity rate among population. Omoruyi and Kunle (2010) described variability in temperature and rainfall as a pincer threat based on advancing Sahara and flood prone coastal region that is below or close to sea level.

In Nigeria, variability in rainfall and temperature have resulted to an increase in the geographical ranges of diseases occurrences especially in the Northeast (Eludoyin and Adelekan, 2013). Ahsan, (1999) stated that warmer temperatures significantly increase the risk of vector-borne diseases outbreaks as it enhances the replication of the vector and reduces maturation period. Thus, Malaria is claiming one to two million lives annually and recent modelling exercised have predicted that malaria will increase by 5% to 7% by 2100 (Tanser et al., 2003).

In recent years, the prevalence of disease incidences including malaria, cholera, diarrhoea and measles have been proliferating with a significant threat to public health and socioeconomic development of the community in the northern regions (NiMet, 2019). The pattern and trend of rainfall variability across the country has significantly affected the environment and indirectly human health.

Despite the number of documented literatures on climate change related issues. Climate change studies in Damaturu were mostly limited to climate awareness, impact and adaptation strategies on socioeconomic activities and livelihood. These are reflected in the studies of Galadima and Nandi (2015); Musa (2012); Orounye (2011); and Maina-Bukar et al. (2017) based on the knowledge gap identified on climate related studies in Damaturu, the study focus on the examining the trend of temperature and rainfall occurrence in relation to disease incidences. It further assesses the effect of the prevalence of diseases associated with the pattern of temperature and rainfall occurrence in the study area from the period of ten years (2009-2018) in Damaturu local government area.

MATERIALS AND METHODS

This Damaturu town located between latitude $11^0 39'3^0''$-$11^0 47'0^0''$N and longitude $11^0 54'0^0''$-$12^0 02'0^0''$E is the administrative town of Yobe state which serve as a nodal town connecting different regions of the state and Maiduguri. Based on the 2006 National Population Census, the town has a population of 88,014 with a density of 38 persons' per km2 and a total land area of 2366 km2 with an average elevation 456m above mean sea level (Isma'il et al., 2014). The climate pattern of Damaturu is generally determined by the warm moist south-west maritime trade winds during the rainy season (June–October) and the north-east continental trade winds during the dry and dusty Harmattan season (November–April) period (Uko and Tamunobereton-Ari., 2013). This has led to the different seasonal pattern experienced which have an influence on the rate at which different diseases spread. Temperatures are generally high, ranging between 320C to 400C. Minimum temperature are mostly experienced between August and December and maximum temperatures between January to July. Annual rainfall averages about 700 millimetres per annum (NiMet 2016). Rainfall season starts from June and ceased in October. Relative humidity is generally high during the rainy season and low during the dry hot season of April, between 70 to 80 percent. The highest figures are experienced during the wet season and the lowest during the dry season (NiMet, 2019).

Type and Source of Data

The study utilised two sources of data that includes direct source and indirect source. The direct data source collected for the study includes the primary data obtained from the household through questionnaires administration. The indirect data source include data collected from secondary source that comprises clinical records of diseases occurrences (Malaria, Diarrhoea/cholera and measles) at the primary health care centres within the vicinity of Damaturu town from 2008 to 2018. Also, monthly record of temperature and rainfall from 2008 to 2018 was collected from Desert Research, Monitoring and Control Centre (DRMCC) in Yobe State University and Global Weather Data for SWAT were obtained for Damaturu town.

However, Krejcie and Morgan sample size determining method was used to determine the sample size of the population for the study. Using the Krejcie and Morgan (1970) formula to determine sample size:

$$n = \frac{x^2 \times N \times P(1-P)}{\left(ME^2 \times (N-1)\right) + (x^2 \times P \times (1-P)}$$

Where:
n = Sample size
x^2=Chi-square value for specified confidence level at 1 degree of freedom
N= Population size
P= Population proportion at 0.5
ME=Desired margin error (degree of accuracy express as proportion (0.5))

Considering Damaturu with a population of 124,500 (2010 projection) and a density of about 51.62/Km^2. At confidence level of 95% and margin error of 0.5, the sample size of the study is determined to be 384 which were distributed in the selected wards.

Sampling techniques

Multi-stage stratified-systematic random sampling technique was adopted in the research. In selection of the residential sample unit, the study area was divided into three strata based on the new water rehabilitation scheme which includes (traditional settlements, newly established settlements and housing estate settlements). Using systematic random sampling, two communities /district where selected from each of the strata. Thus, due to the absence housing population data at ward level, the house numbering of the National Water Rehabilitation Project adopted by Ismail et al. (2014). Three hundred and eighty-four (384) questionnaires were disseminated to the respondents in the study area proportionally based on the population distribution of each district**.** The trend of weather variability and diseases incidence in Damaturu was determined using time-series analysis. Also, Pearson's Mann correlation analysis and regression analysis was further used to examined the association between the weather variables

RESULTS

Trend of weather variables and incidence of disease occurrence in Damaturu

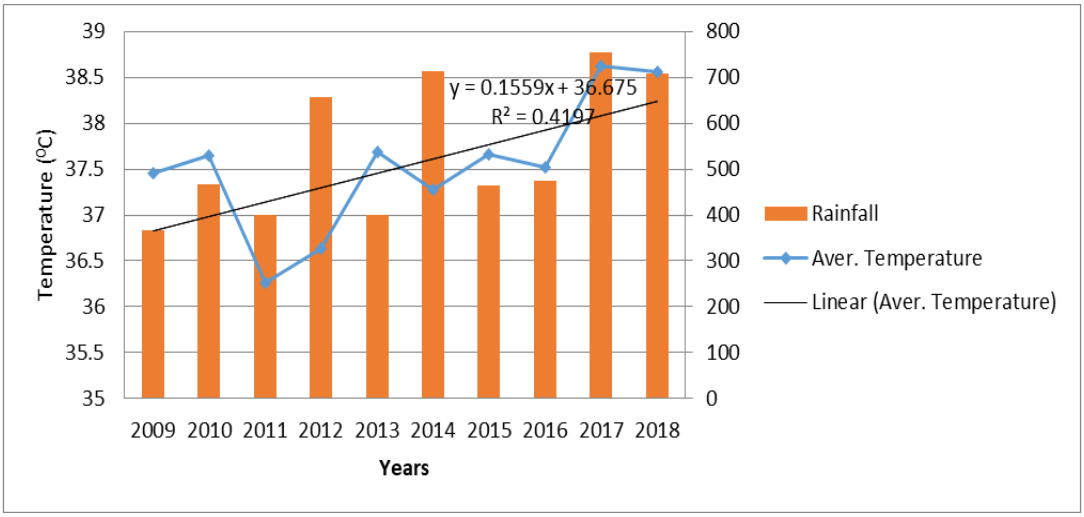

Figure 1: Time series analysis of rainfall and temperature occurrence in Damaturu

Considering Damaturu town, a transitional zone of Sudano-Sahelian vegetation characterized with distinct dry climate pattern. Time series analysis was use to examined the trend of rainfall and temperature as well as incidence of diseases recorded from 2009 to 2018. The time series analysis of temperature and rainfall in fig. 2 have indicated a significant fluctuation with a linear increasing trend. The ten years' variability in average temperature ranges from 36^{0}C observed in 2011 as the lowest average annual temperature and 39^{0}C as the maximum observed average annual temperature from since 2009. Furthermore, the pattern of rainfall in Damaturu also indicated a linear increasing trend. High amount of rainfall was recorded in 2012, 2014,

2017 and 2018 with the highest mean annual of 755mm experienced in 2017. Moderate amount of rainfall was observed through the year 2010, 2013, 2015 and 2016 with mean rainfall ranging from 400mm to 500mm. Thus, low amount of annual rainfall was experienced in 2008 with about 355mm of rainfall record in the year. The trend of temperature and rainfall occurrence have decreased between the year 2011 and 2012 as well as in 2016. Linear trend significant increase has been noticed in the temperature of Damaturu which is associated with the increase in global atmospheric temperature. the Nigerian Meteorological Agency, Seasonal Rainfall Prediction (SRP) report of 2016 and 2019 explained that the diurnal maximum temperature experienced in the country are mostly recorded in the north-eastern meteorological station of Nguru, Potiskum and Maiduguri during the period of March to April (NiMet, 2016 and 2019).

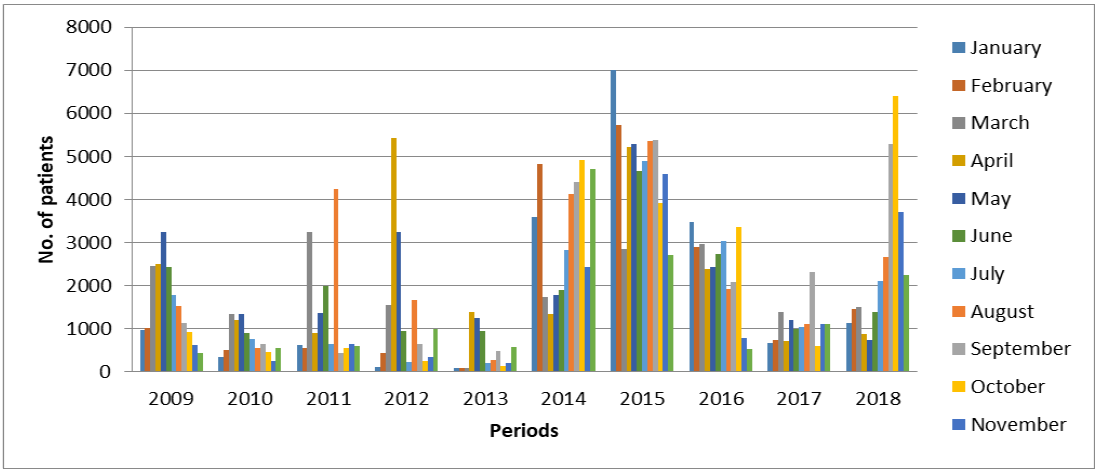

Figure 2: Trend of Diseases Incidence in Damaturu from 2008 to 2018

High incidence of diseases occurrence in Damaturu was recorded by the Primary Health Care Centres in 2015 and 2018 with more than 7000 patients recorded in January, whereas low incident of disease occurrence was recorded in 2013 and 2010 with least number of diseases recorded in January. Furthermore, the chart indicates that most of disease incidence are recorded in the month of August and April which might be due to variability of temperature in the two month (increase in April and decrease in August) as well as intensive amount of rainfall experienced during the period of August. Thus, the chart vividly indicates gradual increases in the number of diseases recorded by primary health care centres in Damaturu.

The increase in the incidence of diseases recorded in 2015 and 2018 is associated with the sudden increase in the average temperature and rainfall amount of the years. Whereas the decrease in the incidence of diseases record in 2010 and 2011 is associated with the fluctuations of the temperature and rainfall of the years as well as the impact of insurgency in the region which made some health care centres not functioning for that periods. Such changes in rainfall and temperature where mostly noticed in traditional and new layout. fig.4. indicated that majority of the people has experienced the most significant disease outbreak in 2015 and 2018 that are associated with diarrhoea and malaria incidence. Considering the significant variability of rainfall and temperature in 2015 and 2018. The prevalence of the disease outbreaks in Damaturu

are associated with fluctuation of rainfall and temperature observe. According to Obi and Eboreime, (2017), about 788 health care facilities have been lost to insurgent activities in northeast. In a related report of World Bank, 2016, about 201 health centres were damaged in Borno state due to insurgency (Bakare, 2016). The high percentage of damages on health care centres coupled with anxiety and psychological trauma due to frequent insurgency attack was a factor that causes a decrease in number of recorded diseases incidence in the early decadal years.

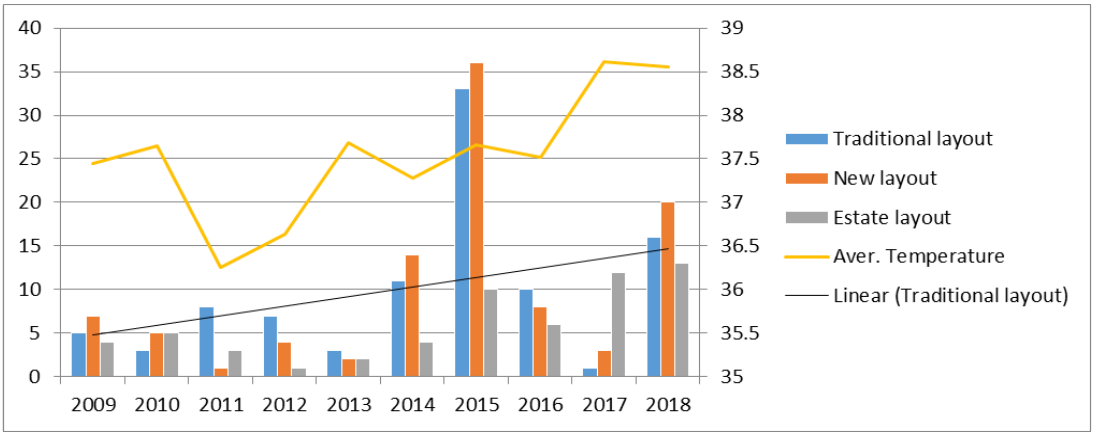

Figure 3: Years in which disease outbreak was experienced in Damaturu

Effect of temperature and rainfall variability on human health in Damaturu

A number of statistical techniques were employed to test the severity and relationship of weather variables on human health in Damaturu. These include descriptive statistics, ʒ-score and regression analysis.

Table 1: Responses to severity of diseases with respect to changes in temperature and rainfall pattern

Descriptive Statistics							
	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Malaria	10	50355.00	1823.00	52178.00	16130.8	15765.2	248540952.8
Diarrhoea	10	6624.00	782.00	7406.00	3732.0	2357.6	5558404.0
Measles	10	566.00	87.00	653.00	368.10	147.3	21710.3

Table 1 shows the descriptive statistics of (i.e. mean and standard deviation) of Malaria, Diarrhoea and Measles incidence occurrence from 2009 to 2018 in Damaturu. The table indicates that the most frequent disease incidence over the decade is Malaria with highest mean point of 16130.8. This shows that Malaria is one of the major health problems in Damaturu that is influenced by the variability of weather variables. The least frequent observed diseases incidence in Damaturu is Measles with lowest mean point of 368.10.

Table 2: Severity test of the selected disease incidence in response to temperature and rainfall variability from 2009-2018 using z-score

Variables	ZMalaria	ZDiarrhoea	ZMeasles
S.D Years	15765.2	2357.6	147.3
2009	-0.233	0.565	1.933
2010	-0.267	-0.430	0.209
2011	-0.295	0.011	0.108
2012	-0.663	-1.251	-0.143
2013	-0.730	-1.226	-0.856
2014	1.134	0.187	0.495
2015	2.286	0.519	0.501
2016	0.299	1.558	-0.530
2017	-0.623	1.194	-1.908
2018	-0.907	-1.125	0.189

Table 2. the ʒ-score to describe the position of the raw score in term of its distance from the mean measured in standard deviation units, the severity of the three diseases observed over a decade in Damaturu were determined. Hence a positive z-score value indicates the raw score is higher than the mean average whereas a negative z-score value indicates that the raw score is below the mean average. Table 4 indicates that a significant number of strong severities were experienced in Malaria where the extreme z-score was obtained in 2015 as 2.286. This shows that malaria has extreme strong severity than diarrhoea and measles occurrence in the year. However, severity decadal trend depicts that all the three diseases incidence has weak negative severity in the early decade period. An increase in number of positive severity was noticed from 2012 to 2018 with the exception of malaria occurrence where a negative weak severity was experienced in 2017 and 2018.

The correlation between variability of temperature and rainfall in relation to diseases prevalence in Damaturu from 2009 to 2018 was determined using the meteorological record of temperature and rainfall as well the records of diseases incidence obtained from primary health care centre in Damaturu.

Table 3: Correlation Analysis of Temperature, Rainfall and Incidence of disease occurrence in Damaturu

Correlations		
Variables	**Mean Annual rainfall**	**Average temperature**
Malaria incidence	0.033	0.427
Diarrhoea	0.198	0.272
Measles	0.261	0.343

Significant at 0.05 (2-tailed)

The correlation between rainfall variable and the incidence of diseases in table 3 indicate that malaria incidence has a significant strong correlation of 0.033 which is below the significance level of 0.05, whereas diarrhoea and measles incidence in Damaturu indicate a perfect positive correlation of 0.198 and 0.261, this indicate that as rainfall amount increase, the incidence of diseases occurrence proliferates in Damaturu. However, the significant relationship of the diseases and rainfall incidence

is associated with the increase in vulnerability and spread of water borne and water contact diseases during the rainfall season. Furthermore, the correlation analysis between temperature variability and incidence of disease indicated that all the diseases incidence measured have perfect positive correlation with temperature but statistically an insignificant relationship was proofed as their correlation coefficient is > 0.05(significance level). This shows that as temperature increases, the incidence Malaria, measles and diarrhoea also increases. However, the insignificant relationship of diseases incidence and temperature variability is associated with other non-climatic factors that harbours the growth of vector and microorganism in the community.

Table 4: Coefficient of r' in regression analysis

Diseases	R	R^2	Adjusted R^2	Std. Error of the Estimate	Change Statistics		
					R^2 Change	F Change	Sig. F Change
Malaria	0.610	0.378	0.192	11597.17763	0.372	2.070	0.197
Diarrhoea	0.364	0.133	-0.155	2489.85362	0.133	.535	0.608
Measles	0.279	0.078	-0.186	196.657377	0.078	.295	0.753

$R^{2=}$>0.133

Table 4. Shows that 38%, 13% and 8% of variances in Malaria, diarrhoea and measles occurrence are attributed to the variability of temperature and rainfall occurrence in the Damaturu Temperature and rainfall fluctuation have a significant influence on the prevalence of malaria, diarrhoea and measles over a decade in Damaturu. This is because temperature and rainfall variability have significant profound influence on people livelihood and environment. This explained that the remaining 62%, 86 and 92% of the variance in malaria, diarrhoea and measles are explained by other factors not included in the study. Such factors include biological (microorganisms), environmental and socioeconomic such as standard of living, environmental hygiene, water source and contamination might be responsible for the incidence of diseases occurrence in Damaturu.

DISCUSSION

Temperature and rainfall variability plays a pivotal role in prevalence of diseases occurrence in Damaturu. The decadal trend of temperature and rainfall variability in relation to diseases prevalence explained that a significant fluctuation in weather variables was experienced and has determined the incidence of diseases prevalence through all the year. Thus, seasonal prevalence of diseases incidence in Damaturu has depicted a linear increased as compared to trend of weather variability. High number of diseases incidence were observed in years that were related with high temperature and rainfall variability. For instance, high incidence of disease cases where recorded from 2014 to 2018 which correspond to the significant fluctuation experienced in rainfall and temperature of the year. According to Campbell-Lendrum and Wheeler

(2018), the year 2014, 2015, 2016, 2017 and 2018 were the sequential years in which significant increase in weather variable was noticed since 1851.

Based on the established data, the significant changes in weather variable are related with the changes in seasonal pattern of diseases incidence observed. Most of the disease incidences especially malaria and diarrhoea are related to changes in weather pattern. For instance, high prevalence of Malaria occurrence where observed in Damaturu mostly during the rainy season and dry (hot) season than during the cold season in Damaturu. This is in relation to studies of Oluleye and Akinbobola (2010) which explained that there is significant correlation between Malaria and pneumonia occurrence and weather variables is high during the month of March, April and August. Change in climatic parameters especially temperature and rainfall is anticipated to causes change in the outbreak of certain common diseases such as Malaria and Diarrhoea (Aina and Adewoyin, 2017).

Changes in duration of rainfall, late onset and early cessation of rainfall were among the major observed changes in rainfall pattern experience by majority of the people dwelling in all the settlement communities. The change in rainfall pattern have indirect effect to the communities as extreme weather occurrence such as flooding led to destruction of building, latrine and properties which inadvertently diffused contaminant into the food and water source of the communities. Such incidence has frequently notice in the traditional settlements (Pompamari, Nayinawa and Pawari) where annual flash-flooding led to high incidence and spread of cholera and diarrhoea in the communities especially during the rainfall season. Changes in pattern of temperature is link with the national change in observed changes in temperature (NiMet., 2019).

The prevalence of disease and incidence in Damaturu is high during the rainy season and dry (hot) season than during the dry cold season of the year. This is due to the reason that during the rainfall season, presence of stagnant water and increase in flooding proliferate the vulnerability of the population to poor uncongenial surrounding that harbour the growth of plasmodium parasite and cholera bacteria. Skin allergies and reactions are mostly associated with midst environment and poor environmental condition which are mostly attributed during the rainfall season. Also, extreme temperature occurrence during the dry hot season proliferate the spread and growth of vector based diseases and microorganism as they required an optimum temperature (NiMet, 2019). The report also reveals that; rainfall and temperature are factors that drive the abundance and feeding cycle rate of Anopheles mosquito which transmit Malaria (IRI). Thus the incidence of Malaria and other incidence are high in area with high temperature especially in the range of 18^0C to 32^0C associated with high relative humidity (above 60%). Also, precipitation and vegetation cover provides a conducive environmental for the survival and development of parasites. Despite respiratory diseases such as bronchitis and asthma are more frequent during the dry cold season. Low prevalence of diseases was experienced during the dry cold season as temperature decrease in hazy weather (NiMet, 2019).

The variability in temperature and rainfall have significant effect on human health in Damaturu. The z-score analysis further established the significant effect of weather

variables where noticed on diseases incidence through the decade. A severe effect of weather variable on human health was noticed from 2015 to 2018 which clearly depict the effect of temperature and rainfall variables on human health.

The regression coefficient r^2 indicate that about 38%, 14% and 08% of variances in malaria, diarrhoea and measles incidence are resulted from the influence of temperature and rainfall in Damaturu. This clearly depict that temperature and rainfall have profound significant effect on malaria prevalence in Damaturu than diarrhoea and measles incidence. Similar studies of Aina and Adewoyin (2017) indicate that incidence of diarrhoea and fever where much more less than prevalence of blood pressure among aged people in Lagos state. Result of his regression indicates that 11.5% of variations in climate related diseases are caused by the variability of temperature and rainfall (Aina and Adewoyin, 2017).

Damaturu town like many other communities of the Sudano-Sahelian region is vulnerable to the adverse effects of temperature and rainfall variability. Climate change has number of immediate and long term effect on the fundamental determinant of human health. The changes in temperature and rainfall result to changes in pattern of disease incidence and prevalence. Variability in temperature and rainfall in Damaturu determine the prevalence of Malaria and diarrhoea in most part of the study areas as the regression coefficient indicate that 38% and 14% of variance in Malaria and diarrhoea are resulted from variability in temperature and rainfall. This explained that weather variables have profound effect on the rate of occurrence for malaria, diarrhoea and measles. The level of effect varies with changes in seasonal pattern of weather occurrences. Incidence of malaria occurrence is high during the period of dry (hot) season and rainy season of the year whereas measles and diarrhoea incidence are often more frequent during the rainy season. Due to decrease in temperature and wet condition, diseases incidence tends to be less prevalence during the dry (cold) season in Damaturu as most of the disease causing bacteria and virus are not resistance to optimum temperature and condition of the season. Despite the influence of temperature and rainfall on disease occurrence in, the studies recommended that Meteorological agencies in collaboration with health organization, shall developed a program that involved an innovative approach to analyse weather and climate in the context of human health in order to design pro-active mitigations. This will enable reliable forecasting and projection of vulnerability of the population to climate sensitive diseases and infection. Also, an upgrade system in housing planning and development especially in the traditional settlement should be made in accompanied with well drainage system, ventilated housing system, heat resistant and well insulated building will reduce the problem of population congestion as the prevalence of airborne and water borne diseases increases in the communities. Proper and adequate environmental sanitation and hygiene will help in reducing the accumulated dump of refused and stagnant water bodies in most of the traditional settlement. This prevent plasmodium parasite and other diseases causing bacteria especially water borne from breeding and affecting the health condition of the communities.

REFERENCES

Ekpoh, I. J., & Bassey, B. J. (2016). Implications of Climate Change for Human Health in Nigeria. *Geosciences Research*, *1*(1), 39-46.

Pachauri, R. K., Allen, M. R., Barros, V. R., Broome, J., Cramer, W., Christ, R., ... & van Ypserle, J. P. (2014). *Climate change 2014: synthesis report. Contribution of Working Groups I, II and III to the fifth assessment report of the Intergovernmental Panel on Climate Change* (p. 151). Ipcc.

Svalastog, A. L., Donev, D., Kristoffersen, N. J., & Gajović, S. (2017). Concepts and definitions of health and health-related values in the knowledge landscapes of the digital society. *Croatian medical journal*, *58*(6), 431.

Popoola, R. O. (2014). Climate Change, Health and Gender: An Overview of Implications on Women. *International Journal of Health Sciences*, *2*(1), 29-36.

Omoruyi, E. P., & Kunle, O. A. (2012). Effects of climate change on health risks in Nigeria. *Asian Journal of Business and Management Sciences*, *1*(1), 204-215.

Eludoyin, O. M., Adelekan, I. O., Webster, R., & Eludoyin, A. O. (2014). Air temperature, relative humidity, climate regionalization and thermal comfort of Nigeria. *International Journal of Climatology*, *34*(6), 2000-2018.

Ahasan, M. R. (1999). Work-related problems in metal handling tasks in Bangladesh: obstacles to the development of safety and health measures. *Ergonomics*, *42*(2), 385-396.

Tanser, F. C., Sharp, B., & Le Sueur, D. (2003). Potential effect of climate change on malaria transmission in Africa. *The Lancet*, *362*(9398), 1792-1798.

NiMET (2019). A report on Anuall Seasonal Rainfall Prediction (SRP) published by Nigerian Meteorological Agency (NiMet) ISBN:2346-7150

Galadima, M., & Nandi, J. A. (2015). Community awareness and adaptation strategy to the effect of climate change in Yobe state, Nigeria. In *2nd ICSAE 2015, International Conference on Sustainable Agriculture and Environment, September 30-October 03, 2015, Konya, Turkey. Proceedings book, volume I & II* (pp. 213-220). Selcuk University.

Musa, J. (2012). An Assessment of the Effects of Desertification in Yobe State, Nigeria. *Confluence Journal of Environmental Studies*, 7(4), 234-341.

Oruonye, E. D. (2011). An assessment of the level of awareness of the effects of climate change among students of tertiary institutions in Jalingo Metropolis, Taraba State Nigeria. *Journal of Geography and Regional Planning*, *4*(9), 513-517.

Maina-Bukar, Y., Husain, M. A., Ahmed, A. (2017). Strategies for Adapting to the Impact of the Emerging Climate Change Risks (AIECCR) in Damaturu. *International Journal of Advance Research, IJOAR .org* Volume 5, Issue 3, March 2017, pp. 1-9 Online ISSN: 2320-9186

Uko, E. D., & Tamunobereton-Ari, I. (2013). Variability of climatic parameters in Port Harcourt, Nigeria. Journal of Emerging Trends in Engineering and Applied Sciences, 4(5), 727-730.

Krejcie, R. V., & Morgan, D. W. (1970). Determining sample size for research activities. *Educational and psychological measurement*, *30*(3), 607-610.

Obi, F. A., & Eboreime, E. (2017). How boko haram is devastating health services in North-East Nigeria. *The Conversation*.

Tonye Bakare (2016). Boko Haram caused $5.9b destruction in Borno, says World Bank (Online). Available: https://guardian.ng/news/boko-haram-caused-5-9b-destruction-in-borno-says-world-bank/ [Accessed on: 16th August, 2021]

Diarmid Campbell-Lendrum and Nicola Wheeler (2018). COP24 Special Report/Health and Climate Change. *World Health Organisation* (WHO)

Oluleye, A., & Akinbobola, A. (2010). Malaria and pneumonia occurrence in Lagos, Nigeria: Role of temperature and rainfall. *African Journal of Environmental Science and Technology*, *4*(8), 506-516.

Aina, T. A., & Adewoyin, Y. (2017). Climate change and health of the aged in Lagos, Nigeria. *Australian Journal of Basic and Applied Sciences,* 11(13), 8-16.