Volume 9, Issue 10, October– 2024 International Journal of Innovative Science and Research Technology
ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

Impact of Climate Change on the Prevalence of Climate-Sensitive Diseases in Bolori 2 Ward of Maiduguri Metropolitan Council of Borno State, Northeast Nigeria

Abdulrahman Ahmed. RN[1], (MSc. N, MPH); Dr. Abba Jidda. RN[2], (Ph. D);
Dr. Hadiza Yahaya RN[3] (Ph. D); Dr. Umar Datti. RN[4], (Ph. D)
[1,2]Maryam Abacha American University of Niger, Maradi, Republic of Niger.
[3]College of Nursing and Midwifery Maiduguri Borno State, Northeast Nigeria.
[4]University Teaching Hospital College of Nursing Maiduguri, Borno State Nigeria.

Abstract:- If to say the importance of any element that increases disease prevalence could be measured by how it makes population vulnerable to diseases, then, climate change and its impacts must be mentioned much more than other direct or indirect causes and determinants of diseases. For more than a decade, climate change impacts have been one of the obstinate problems with greater burden on the public health sector, especially in the prevalence of climate-sensitive diseases. This study was explored to investigate the impacts of climate change on the prevalence of climate-sensitive diseases. The study was also conducted to investigate the perception and awareness of the households on climate change. To further find out and disclose the climate change prevalence of climate-sensitive diseases, and climate-health related impacts, and to explore the coping mechanisms and adaptation to the impact of climate change and climate-sensitive diseases prevalence respectively. The research was a mix-method research design. It was conducted in Bolori 2 ward of Maiduguri Metropolitan council of Borno state northeast Nigeria. The target population for study area was 138,875 according to Premier Urgence Internationale (PUI). The sample size was 383 obtained using Cochran formula. The instruments for data collection were meteorological data review for a decade interval, review of health facility records of climate-sensitive disease in the study area, and a structured questionnaire. The data were obtained, analyzed and presented using tables, frequency, percentage and charts. The result of the study revealed that there was an increase in the annual rainfall in the last decade. That's from 2014 to 2024. The amount of rainfall in 2014 was 450mm per annum. And 550mm per annum in 2024. This significant increase in the annual rainfall in Bolori 2 justified the devastating flood in September 2024 which consumed nearly 70% of the Maiduguri metropolitan council of Borno state in northeast Nigeria. Additionally, the result also shows an increase in the temperature within the last decade (2014-2024). With 2014 having 30.5 °C and 2024 having 37.1 °C. This difference in temperature of 6.6°C increases the development cycle of vector-borne disease malaria. The elevation of temperatures within the last 5 to 10 years increases the proliferation of vibro cholerae, an agent that causes cholerae. Humidity may not have direct effects on cholerae, although humid and warmer environments support bacterial growth which increases the chances of waterborne diseases outbreak. The health facility records on climate-sensitive diseases prevalence indicated that there are long term increases in Malaria from 14.45 per 1,000 in the year 2014 to an increase up to 28.00 per 1,000 in the year 2024. This implies a 100% increase in the incidence of malaria disease as the most recognized climate sensitive diseases in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria. This also suggests that there is a growing burden in health, likely induces by climatic factors such as in the increase in rainfall, temperature which increasing mosquito breeding. In the prevalence it postulated that numerous percentages of the population were affected by malaria in 2014. temperature elevation led to more incidence of heatwaves which aggravate respiratory condition such as bronchitis, asthma, and chronic obstructive pulmonary disease (COPD). Unstable temperature aid in increase respiratory infections specifically during dust storm. The increase in humidity trapped air pollutants worsening air quality and in turn increase respiratory infections, especially in vulnerable populations such as Bolori2. The prevalence of cholera began low as 0.24 per 1,000 in the year 2024. Continues change in the climate skyrocketed the incidence rate to 2.43 per 1,000 in the year 2024. This is entangled to the immense weather changing aiding in severe flooding in 2024 that contaminated various water sources from Maiduguri metropolis down to Bolori 2 instigating outbreak occurrences. Additionally, the prevalence of cholera is less in recent years, it became at a peak during flooding that affected nearly 70% of the Maiduguri city which affected about 90% of the communities in Bolori 2. The demographic data on the age of the respondents revealed that most of the respondents (33.68%) fall between the age range 36-50. Findings on the gender of the respondents shows that most of the respondents were female with 57.38% accounting for 221/383 of the respondents. On the educational level of the respondents,

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

the findings show that many of the respondents (68.82%) 264/383 possessed tertiary education in Bolori 2. On occupation of the respondents, it revealed most of the respondents 46.21% are farmers. on the perceptions of climate of the Respondents indicated that most of the respondents (80.67%) have observed changes in weather conditions within 5-1o year interval. 88.25% of respondents indicated an increase in climate-sensitive diseases in their household. 52.74% of the respondents have affirmed that someone in their household has experienced malaria disease. 46.73% of the respondents opine that someone in their household has visited the health facility several times a month for treatment related to diseases. On climate-related or climate-sensitive health impact in Bolori 2. 87.98% of the respondents implied that extreme weather events such as heatwaves and floods have contributed to an increase in diseases in the Bolir 2 community. 54.30% of the respondents indicated that there are regular water shortages in their households. This implies that most of the respondents 54.30% indicated that that the change on rainfall pattern which causes regularly cause water shortages. 54.04% of the respondents used mosquito nets as a coping mechanism and adaptation strategy for the incidence of climate-sensitive diseases. 51.43% of the respondents indicated lack of healthcare access as one of the challenges they face in managing health impacts of climate change in their household. Based on the study, it is recommended the government, non-governmental organizations, communities, women to strengthen health infrastructure, improve access to healthcare, increase healthcare personal training and capacity building, strengthen diseases surveillance system, promotion of water sanitation and hygiene programs, improve access to clean water, increase public awareness campaigns, promotion of climate-smart agricultural practices, focusing on vulnerable for internation, increase community engagement, support women's participation in health climate adaptation and monitoring and evaluation.

Keywords:- *Climate Change, Prevalence, Climate-Sensitive Diseases, Borno State, Nigeria.*

I. INTRODUCTION

Globally, climate change is considered as one of the devastating phenomena which affects almost all if not all aspects of human endeavors [1]. Climate change denotes to the changes over time in the average weather patterns that have come to describe the planet earth's local, regional and global climate in its entirety [2]. The ever-dynamic nature of change in the climate gave rise to obstructions in the environment where humans and animals live [3]. Climate change also connotes to the persistent and prolonged variation and adaptation in the degree of heat and cold, precipitation and other atmospheric conditions that happened over decades to even longer [4]. Climate change is driven by both human and natural processes [5].

In a blunter phrase, increase in global thermal level, reduction or excess rainfall per annum, and more significant and frequently the extreme weather incidences such as heatwaves, erosions, floods, and drought resulting in human health alteration is an element that can never be over emphasized as far as the impact of climate change is concerned [6].

Climate change today is widely seen as one of the obstinate problems of the 21st century, with unquantifiable and sometimes irreversible effect on human health and well-being [5]. Climate change has aggravated and escalated the frequency and imbalances in the atmospheric variables that must be experienced and kept to a narrow limit [7]. This results in an alteration in the health of individuals, families and communities [8]. The environmental impact of climate change has been well recognized globally [9]. Health related impacts and results specifically in the developing region of the globe and disaster reading region remain less documented [10]. In Nigeria, especially in the northeast, where Borno state is situated, the interconnections between variables and indicators such as climate change, poverty has given rise to uncontrollable disaster and undisputable avenue for vulnerability and fundamentally posing threats to health and livelihood of the population in the region [11].

The situation in Bolori 2 ward of Maiduguri Borno state, Northeast Nigeria has exacerbated by the ongoing Boko-Haram Insurgency with resultant huge population internal displacement [12]. Bolori 2 ward as an urban community has become more exposed to climate-sensitive diseases such as malaria, cholera and respiratory and integumentary diseases [13]. These diseases have inclination to climate as they are a result of environmental changes over time of the average weather of the region [14]. Numerous forms of these diseases are dependent on temperature, rainfall and humidity for transmission and proliferation [15]. For Bolori 2 in Maiduguri Borno state northeast Nigeria, these impacts are almost double implying a burden to the entire nation's health sector denoting a serious public health concern [16].

For more than 5 decades, the climatic condition in the northeast Nigeria has experience dramatic changes [17]. It includes the increasing temperature, irregular rainfall, and persistent dry spells which have resulted in food scarcity, food insecurity and a serious drop in the standard of living of the population [10]. The degree of heat and coldness aggravated the breeding of mosquito thereby exacerbating the prevalence of mosquito-borne diseases such as malaria and African trypanosomiasis [13]. Additionally, cholera, a significant water-borne disease, become more evident in the time flood due to water source contamination [18].

Moreover, health impacts of climate-sensitive diseases are even more critical induce by the socio-economic context of Bolori 2 in Maiduguri Borno state northeast Nigeria [1]. The Bolir 2 ward, like many others in the region, faces challenges such as poverty, poor access to clean water, inadequate sanitation, and a fragile healthcare system [19]. Climate change acts as a "threat multiplier" and "Risk Escalator" in this context, exacerbating pre-existing

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

vulnerabilities and creating new challenges for health and nutrition especially climate-sensitive diseases. Furthermore, the ongoing conflict in the region has weakened governance structures, reduced access to healthcare, and limited the ability of local authorities to effectively respond to the growing public health issues [20].

This study aims to investigate the impact of climate change on the prevalence of climate-sensitive diseases in Bolori 2 Ward, focusing on three major diseases: malaria, cholera, and respiratory infections. By understanding the relationship between climate variables and disease prevalence, the study seeks to provide insights into how climate change is affecting public health in the region and to propose strategies for mitigating these effects. The findings from this study will be crucial for policymakers, healthcare providers, and humanitarian agencies working in Borno State, as they will highlight the need for targeted interventions to reduce the health impacts of climate change.

This article aims to amplify the significant public health problems posed by climate change such as climate-sensitive diseases for public health intervention and effective planning and implementation within the health sector and with the aim of raising awareness to the public to take ownership of their health.

II. RESEARCH METHODS

➢ *Research Design.*

The research design adopted for this study is a mix-method design. This method deals with combination of quantitative and qualitative data. Quantitative data such as climate records and disease prevalence statistics while the qualitative data will focus on interviews, questionnaires, and focus group discussions with residents of Bolori 2 ward and health workers. This method will give a full light detail of records of disease and communities experiences and perceptions of climate change. It allows for an in-dept analysis, correlating climate variability with health outcomes, while ensuring local context and lived experiences are considered.

➢ *Study Setting.*

Bolori 2 Maiduguri Metropolitan Council of Borno State, Nigeria (11°51'29"N 13°07'54"E).

The study setting is Bolori 2 ward of Maiduguri Borno State Northeast Nigeria. It is situated in the heart of the Maiduguri Metropolitan council of Borno State. It is more to the north to the metropolis. Bolori 2 ward has several communities as units within it. These area units are Gonidamgari, Ummarari, Bulabulin Alajeri, Zajeri, and Ngarnam respectively. These 6 communities made up the Bolori 2 ward.

According to premier Urgence International PUI Nigeria country program 2019, Bolori 2 has about a total of 138,875 population. Bolori 2 is the largest ward among the other Bolori wards of Maiduguri of Borno state in northeast Nigeria. There are also other Bolori wards, Bolori 3, 5,6,7,8,9, 10 and 10 and Bolori 11 respectively. Bolori 2 is neighbored by Ajari ward in Jere Local Government area of Borno state from the east, Shehuri at the south, Bolori 3, and 8 at the west.

Bolori 2 is multi-dimensional in relation to ethnic composition. Most of the people who reside in the Bolori 2 are Kanuri ethnic group, other ethnic groups are, Babur Bura, Marghi, Fulani, Shuwa, and Hausa Fulani. Each area unit in Bolori 2 has numerous community leaders called “Bulama” and combination of numerous unit’s areas are headed by amore higher leaders called “Lawan”. Most of the people in Bolori are Muslims. They practice Islam as religion. Other populations practice Christianity as religion. Majority of the people are Traders while some significant numbers of the population are farmers and others are civil servants.

Bolori 2 has a single rainy season per annum. It is sandy-Loamy soil in nature based on topography. The area has an average atmospheric temperature of 38 to 40 degrees Celsius. The area has 4 health facilities situated in Gonidamgari, Zajeri, Bulabulin and Ngarnam. Some of the health challenges within the area are malaria, cholera, acute watery diarrhea and respiratory infections.

➢ *Target Population*

According to Premier Urgence International (PUI) 2019, the target population of Bolori 2 is 138, 875.

➢ *Sample and Sampling Technique*

The methods Adopted are stratified Random Sampling and Purposive Sampling. In stratified random sampling, the population were divided into different strata such as age group, socio-economic status, level of education to have diverse representation then randomly select from each stratum. For purposive sampling, it will be used to obtain key and in-depth knowledge of health issues. These include the healthcare workers, and community leaders for the purpose of those who have knowledge of health issues and impact. Cochran formula was used to determine the sample size. For a population of 138,875 with a 95% confidence level and 5% margin of error, you would need a sample size of around 383. The sample size 383 was used to provide statistical reliable results for the study.

➢ *Instruments for Data Collection*

To collect both quantitative and qualitative data, the instruments used for data collections were structured questionnaires, health Facility records, in-depth interviews, and meteorological data review respectively.

➢ *Meteorological Records (MR)*

Data obtained are from the Nigerian Meteorological agency (NiMet). A tailored data of Maiduguri and Bolori 2 for the period of 5 to 10 years.

➢ *Health Facility Records.*

Review of quantitative data on reported cases of climate-sensitive diseases from local health clinics and hospitals. Review Medical records to track trends in disease

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

incidence (e.g., malaria, cholera) over time in relation to climate patterns.

➢ *Structured Questionnaire.*

The structured questionnaire was used for household surveys to collect quantitative data on disease prevalence, health status, and access to healthcare. questions on perceived changes in climate, health outcomes (e.g., malaria, cholera, respiratory infections), and socio-demographic information were also included to have a whole sum of the findings and knowledge in that regard. The questionnaire was designed to capture demographic information, perception of climate change, prevalence of diseases, and adaptation strategies used by the population.

➢ *Data Analysis and Procedure.*

For clarification of data analysis and procedure, meteorological data were presented and analyzed that will first be served as the basis for understanding the environmental conditions affecting health. The health facility record will provide quantitative data on disease prevalence. Health records come after the meteorological findings to correlate spikes in disease outbreak with climate conditions. The use of the questionnaire will provide community level data into perceptions of climate change and its effects on health. It will further explain lucidly the human experience behind the statistical findings from health records and meteorological data respectively.

➢ *Ethical Consideration.*

Upon the commencement of this study, an informed consent was obtained and issued at the request of the participants involvement in the study. The reason for the study and the participants' right to withdraw at any point in the study is guaranteed without equanimity. Confidentiality and information protections of the respondents were assured, and it was stressed that information received from questionnaires, and health records will be safeguarded with utmost confidentiality and professionalism. Data security was assured to the participants of the study including health facility administrators of the health records of climate-sensitive diseases data. Information will be shared with respective governments entities, NGOs, CBOs when there is plan intervention that will positively impact Bolori 2 communities. Additionally, the participants of this study were informed that there will be no harm intended before, during and or after the study either physically or mentally. The importance of the study was clearly stated to the participants that include improving lives and livelihoods of the members of the Bolori 2 while fostering initiatives and development of climate friendly practices. The findings of the study will inform areas that need to be addressed for the health and wellbeing of the people in Bolori 2. It will also provide justification to the government of Borno state and Nigeria on the need for involving climate change initiatives and conjoin the impact of climate change as a pillar in health national budget and planning. It will further add to the existing knowledge and serve as a source of literature for future studies. It will amplify the existing echo procreated by the roars of vulnerabilities and the ever-increasing humanitarian needs because of Boko-Haram insurgency that holds Bolori 2 ransom for almost two decades.

III. RESULTS

A. Presentation of Meteorological Data and Findings.

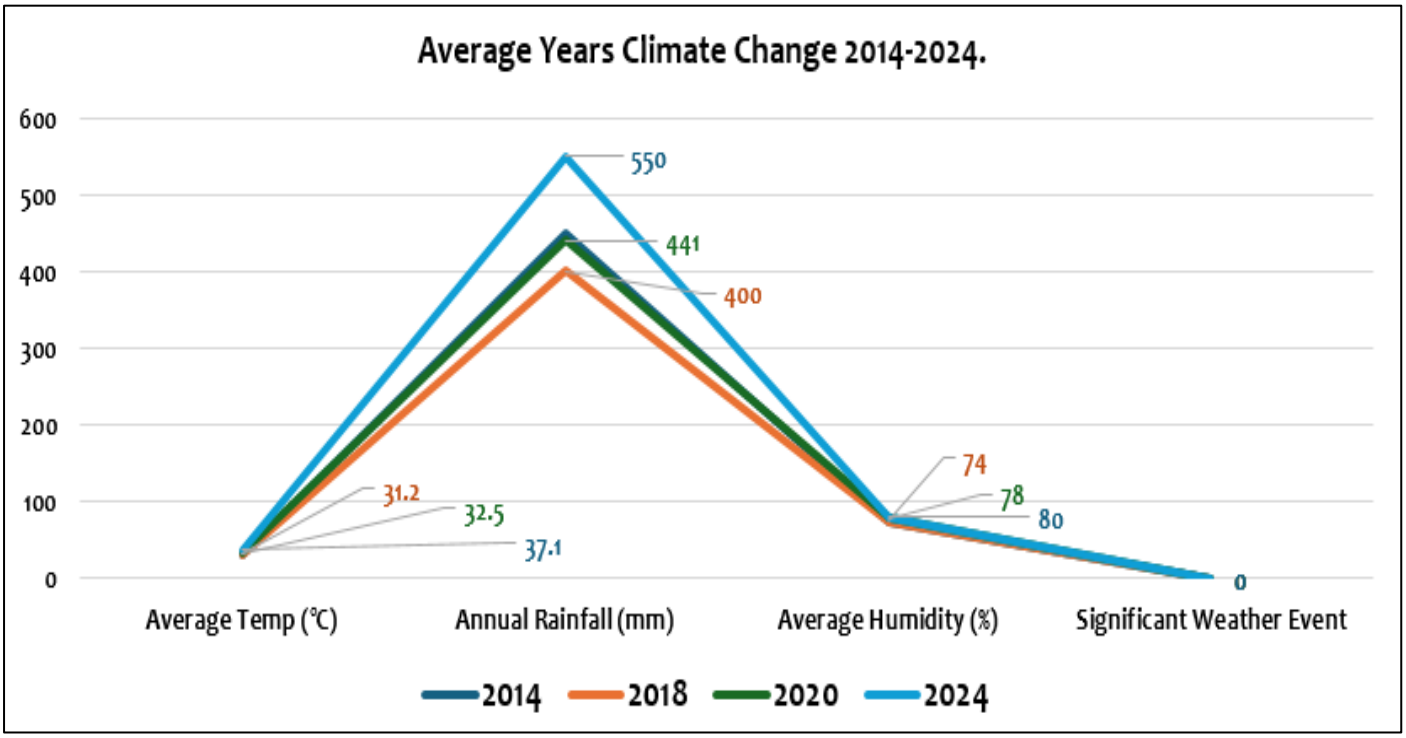
Table 1 Present average Monthly and annual Temperature, Rainfall and Humidity for the Period of a Decade.

Year	Average Temp (°C)	Annual Rainfall (mm)	Average Humidity (%)	Significant weather event
2014	30.5	450	72	Drought
2018	31.2	400	74	Drought
2020	32.5	441	78	Drought
2024	37.1	550	80	Flood

Sources: Nigerian Meteorological Agency (NiMET)October 2024.

Line Graph 1.0 The graphical representation of average monthly and annual temperature, rainfall and humidity for the period of a decade.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376



Graph 1 The line graph shows Graphical Representation, October 2024.
Source: Study findings of NiMET 2024

➢ *Interpretation:*

From the above findings in table 1 and the graphical representation it can be deduce that temperature trends, with respect to Annual average temperature in from 2014 to 2024 that's over a decade in Bolori 2 indicated an increase with 2014 having 30.5 °C and 2024 having 37.1 °C. for monthly temperature, the hottest month is the period between the month of April to June. With April 2014 having 38 °C and April 2024 temperatures was 42.0 °C. Additionally the cooler months falls between the month of December to February with temperature range of 28 °C to 30 °C. this implies that the increase in temperatures during the rainy season in Bolori 2 from the month of July to September will give rise to the suitable and conducive atmosphere for mosquito vector breeding which in turn elevate malaria transmission. The flood experienced in the month of September couple with an accompanied heatwaves also aggravated respiratory conditions in vulnerable populations like Bolori 2 of Maiduguri Metropolitan Council of Borno State northeast Nigeria.

Table 1 also highlighted the annual rainfall in Bolori 2 have emanated being erratic with some years having low rainfall per annum leading to drought and others have shown increase rainfall. In 2014, the 450mm per annum rainfall was recorded in Bolori region 2, and 550mm per annum was recorded in 2024 according to the devastating flood experience submerging nearly 70% of the Borno State cities with Bolori 2 inclusive. There were differences of 100 mm per annum between 2014 to 2024 justifying the devastating flood in September 2024. The based rain distribution, 2014 to 2016 were marked as period of persistent dry spells in rainy season which subject the population into water scarcity. Based on the account of the seasonal changes, the rainy season in Bolori 2 shifts from early June in a year to later in the beginning of July and runs all through October. By implication these changes have affected the timing for diseases outbreak in Bolori 2.

The table 1 shows that average humidity in Bolori 2 has remain above 70% for more than a decade. It can increase significantly up to 85% at the time of the rainy season that is places around July to September. This signifies that high humidity at the time of the rainy days coupled with elevation in temperatures have the likelihood of vector-borne diseases such as Malaria and an increase in respiratory infections as humid setting contribute the growth of pathogens such as bacteria and viruses.

Furthermore, extreme weather incidences such as heat waves and floods occurred. Heatwaves increase with elevation of temperature of 40 °C for some days during the hottest months, that's April to June. This gives rise to an increase in heat related illnesses such as dehydration and complicating respiratory ailments. Floods on the other hand particularly in the month of September 2024 resulting from heavy rain have contaminated water sources given rise to water-borne diseases such as cholera outbreak. This implies that floods lead to water-borne diseases thought water sources contamination.

B. Health Facility Data on Climate-sensitive Disease.

Tables 1 to 1 Presents data of cases, incidence and prevalence of key climate-sensitive diseases such as Malaria, Cholera and Respiratory infections.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

Table 2 Present Cases Climate-sensitive diseases such as Malaria, Cholera and Respiratory infections in Bolori 2 from 2014 to 2024.

Year	Malaria Cases	Cholera	Respiratory Infections	Total Cases
2014	2,007	34	1,345	3,386
2016	2,174	88	1, 444	2,406
2018	2,401	101	2,000	4,502
2020	3,564	123	2,047	5,734
2024	3,889	337	2,779	7,005

Sources: Cases From 4 Health Facilities in Bolori 2 including 7 Outreach Clinics operated by NGO and UN. 2014 to 2024.

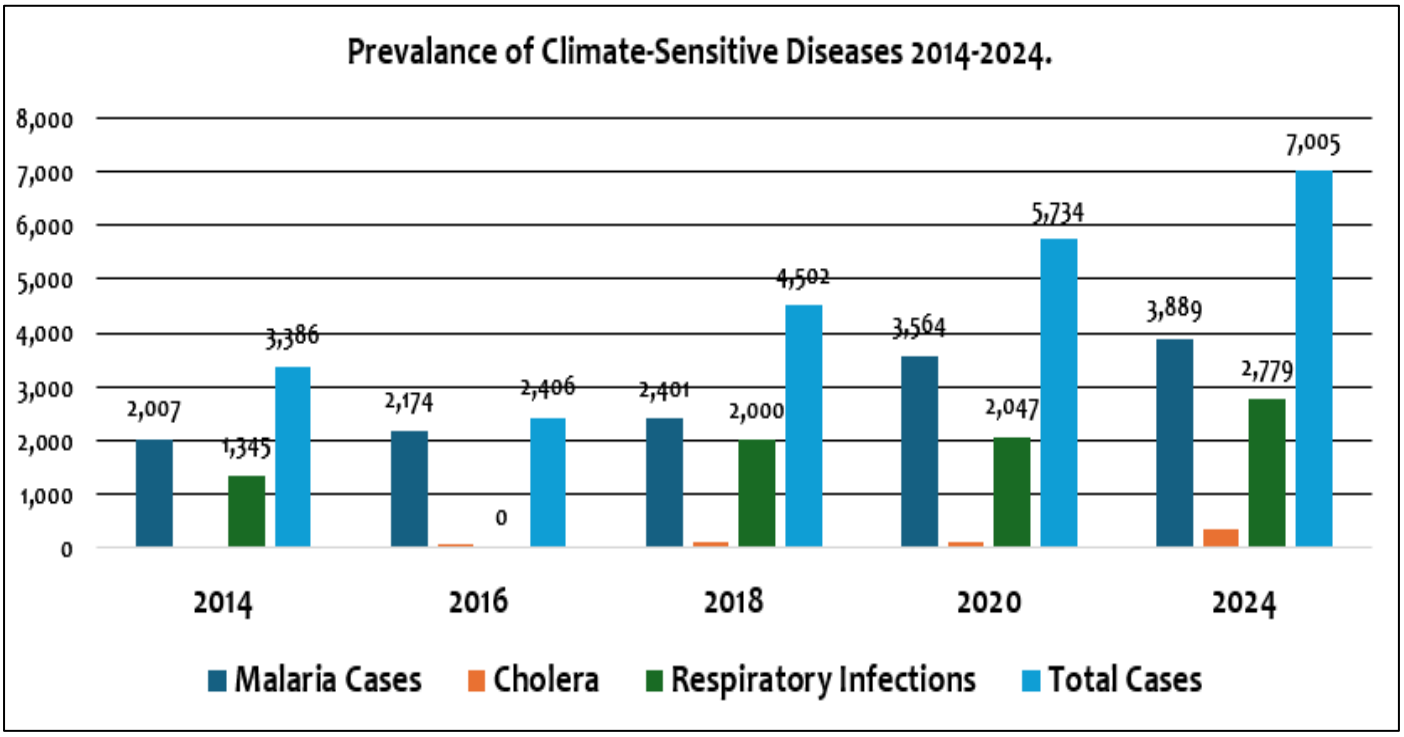


Chart 1 The Bar Chart representation of health facility records of Prevalence of Climate-sensitive diseases in 4 government health facilities in Bolori 2 and 7 health outreach facilities operated by NGOs and UN from 2014 to 2014.
Source: Obtained from the Date above Table 1 in this study 2024.

Table 3 shows the Prevalence of Climate-Sensitive Diseases in Bolori 2 from the Period of 2014 to 2024.

Year	Malaria (per 1,000)	Cholera (per 1,000)	Respiratory infections (Per 1,000)	Total Incidence (Per 1,000).
2014	14.45	0.24	9.69	24.39
2016	15.65	0.63	10.40	17.33
2018	17.65	0.73	14.40	32.41
2020	25.67	0.89	14.74	41.30
2024	28.00	2.43	20.01	50.44

Sources: Finding from the study October 2024.

Chart 2 The Bar Chart representation of health facility records of prevalence of Climate-sensitive diseases in 4 government health facilities in Bolori 2 and 7 health outreach facilities operated by NGOs and UN from 2014 to 2014.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

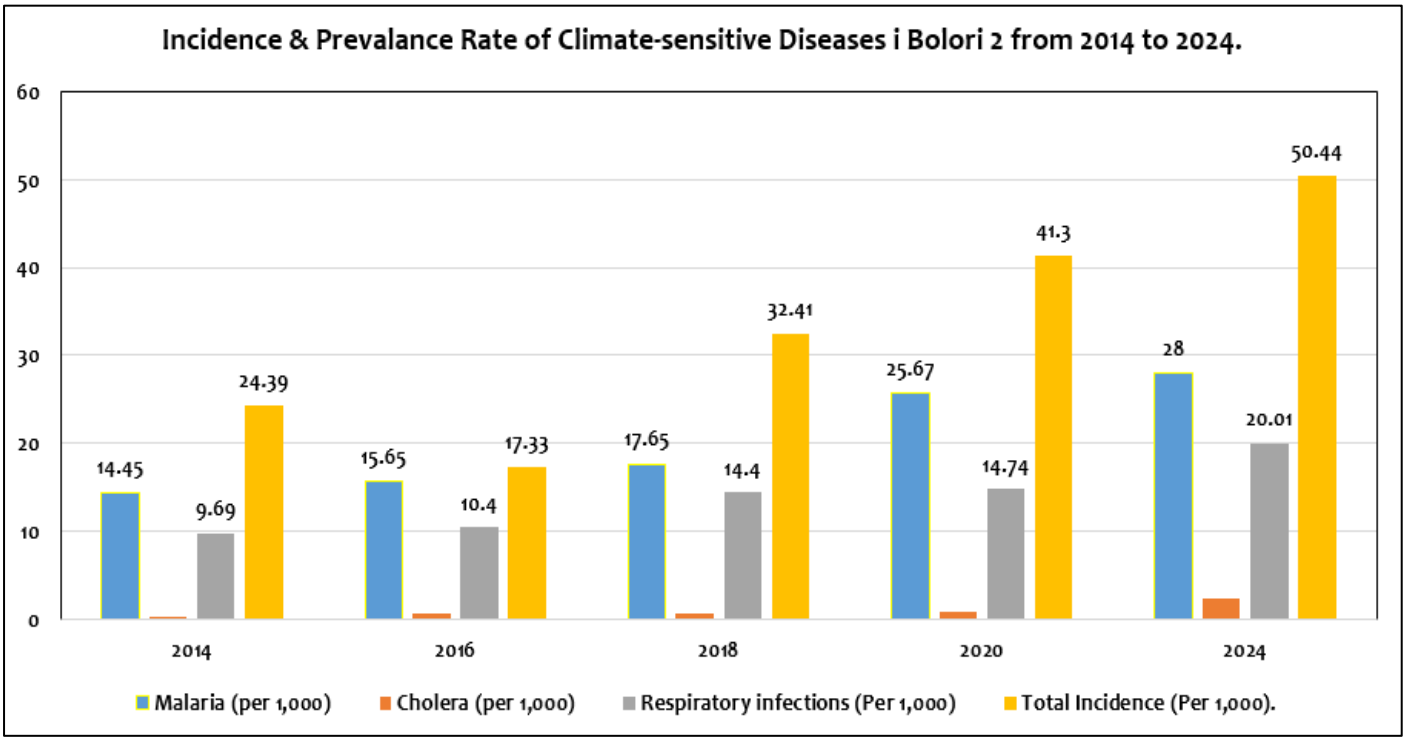


Chart 2 Incidence & Prevalance Rate of Climate-Sensitive Diseases i Bolori 2 from 2014 to 2024.
Source: Obtained from the Date above Table 3 in this study 2024.

➢ *Interpretation:*

Tables 2 to 3 and charts Presents data of cases, incidence and prevalence of key climate-sensitive diseases such as Malaria, Cholera and Respiratory infections. Analytically, the incident and prevalence rate show there are long term increases in Malaria from 14.45 per 1,000 in the year 2014 to an increase up to 28.00 per 1,000 in the year 2024. This implies that that are is 100% increase in the incidence of malaria disease as the most recognized climate sensitive diseases in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria. This also suggests that there is a growing burden in health, likely induces by climatic factors such as in the increase in rainfall, temperature which increasing mosquito breeding. In the prevalence it postulated that numerous percentages of the population were affected by malaria in 2014.

Based on the findings, the incidence cholera began low as 0.24 per 1,000 in the year 2024. Continues change in the climate skyrocketed the incidence rate to 2.43 per 1,000 in the year 2024. This is entangled to the immense weather changing aiding in severe flooding in 2024 that contaminated various water sources from Maiduguri metropolis down to Bolori 2 instigating outbreak occurrences. Additionally, the prevalence of cholera is less in recent years, it became at a peak during flooding that affected nearly 70% of the Maiduguri city which affected about 90% of the communities in Bolori 2.

Furthermore, respiratory infections incidence and prevalence rate has a stable increase from 9.69 per 1,000 in the last decade (2014) to higher rate of 20.01 per 1,000 in 2024. This means that certain environmental situations and conditions vis a vis air quality alteration are due to long-term change in average weather conditions in Bolori 2. The rise in rate of respiratory infections was also inclined to increased duct and sandstorms during the dry season and time just before the rain starts annually in Bolori 2.

In general, the total prevalence rate of climate-sensitive diseases increased from 24.39 per 1,000 in 2014 to a dramatic increase of 50.44 per 1,000 in 2024 is denoted to double of diseases burden. In a more lucid terms, the increase in climate-sensitive diseases over the decade correlates strongly with worsening climate conditions, such as increase in rainfall, humidity and heatwaves. This drastic increase emanated strongly both the direct and indirect impacts of climate change on the health of the communities in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria.

Questionnaire Findings on the impact of climate change on Climate-sensitive diseases in Bolir 2 ward of Maiduguri Metropolitan Council of Borno State.

The questionnaire composed of 4 sections, section A requests demographic data from the respondents. Section B deals with the finding on Perception of the respondents on climate change. Section C deals with disease prevalence, and section D asked the response of the participants on climate-related health impacts. Section E deals with the coping mechanisms and adaptation of the respondents on the climate change prevalence of climate-sensitive diseases.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

Table 4 Demographic Data of the Respondents.

S/n	Age Group	Frequency	Percentage
1	Under 18	17	4.43%
2	18-35	116	30.28%
3	36-50	129	33.68%
4	51 & above	121	31.59%
6	Total	383	100%

Source: Findings from the questionnaire issued October 2024.

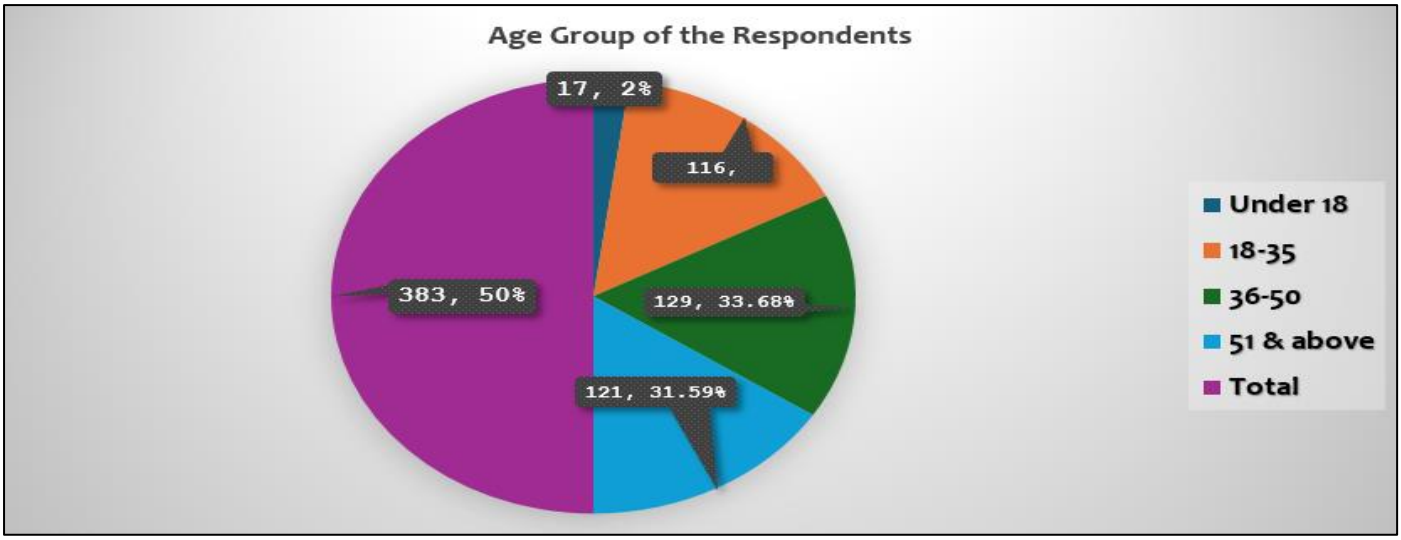


Chart 3 Age Group of the Respondents

Sources: Age group Demographic Data obtained from the findings October 2024. (Chart 3)

Table 5 Gender of the Respondents.

S/n	Gender	Frequency	Percentage
1	Female	221	57.38%
2	Male	162	42.38%
3	Total	383	100%

Source: Findings from the questionnaire issued October 2024.

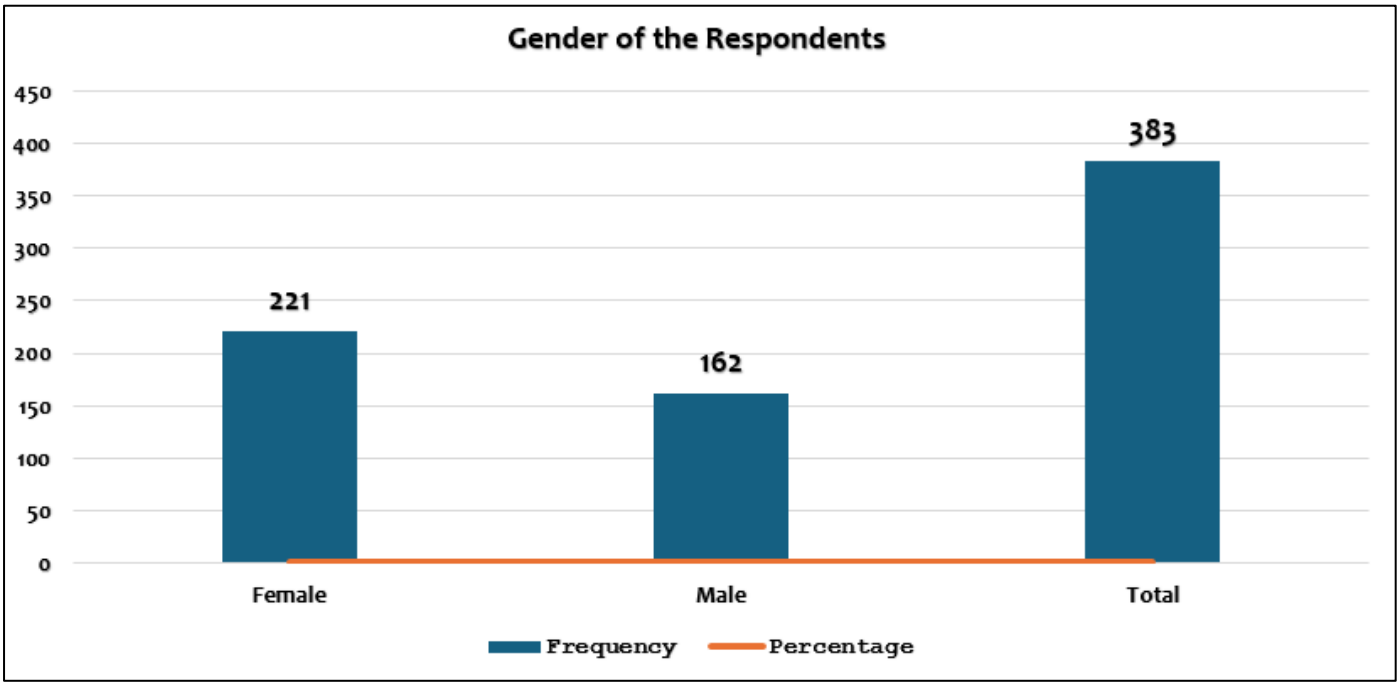


Chart 4 Gender of the Respondents

Sources: Gender of the Respondents, Demographic Data obtained from the findings October 2024. (Chart 4)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

Table 6 Level of Education of the Respondents.

S/n	Level of Education	Frequency	Percentage
1	Primary Level	23	6.00%
2	Secondary Level	96	25.38%
3	Tertiary Level	264	68.92%
4	Total	383	100%

Source: Findings from the questionnaire issued October 2024.

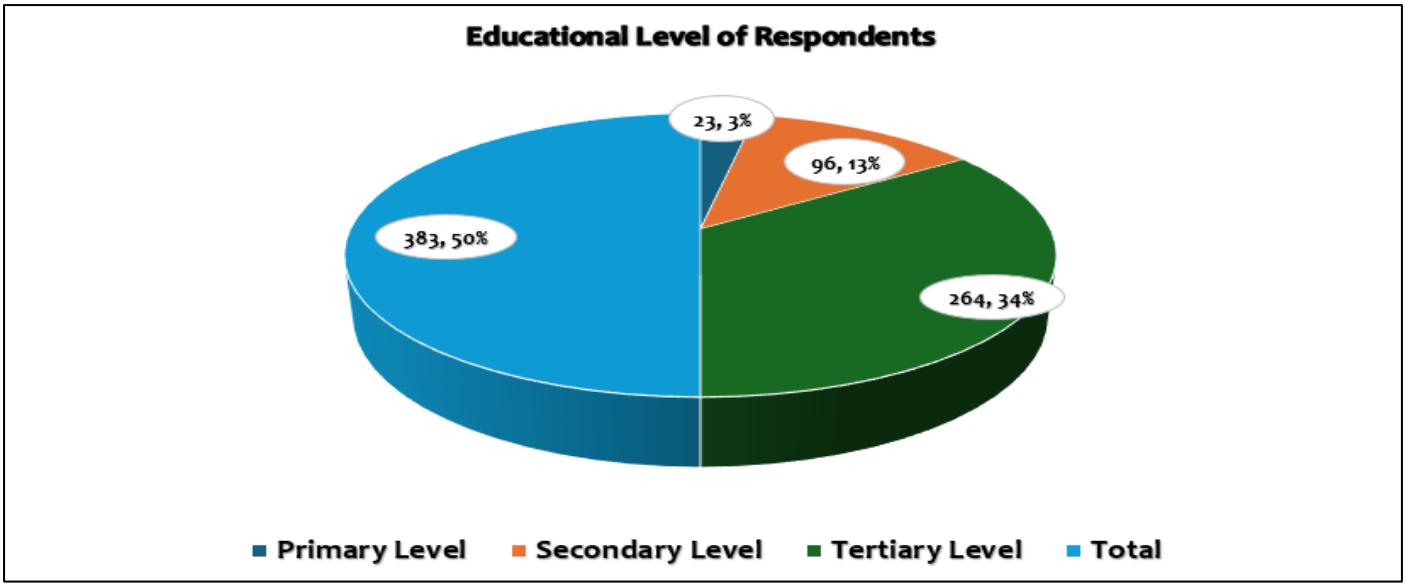


Chart 5 Educational Level of Respondents

Sources: Educational Level of the Respondent, Demographic Data obtained from the findings October 2024. (Chart 5)

Table 7 Occupation of the Respondents.

S/n	Primary Occupation	Frequency	Percentage
1	Farming	177	46.21%
2	Trading	85	22.19%
3	Government Worker	90	23.49%
4	Student	10	2.61%
5	Unemployed	10	2.61%
6	Other	11	2.87%
7	Total	383	100%

Source: Findings from the questionnaire issued October 2024.

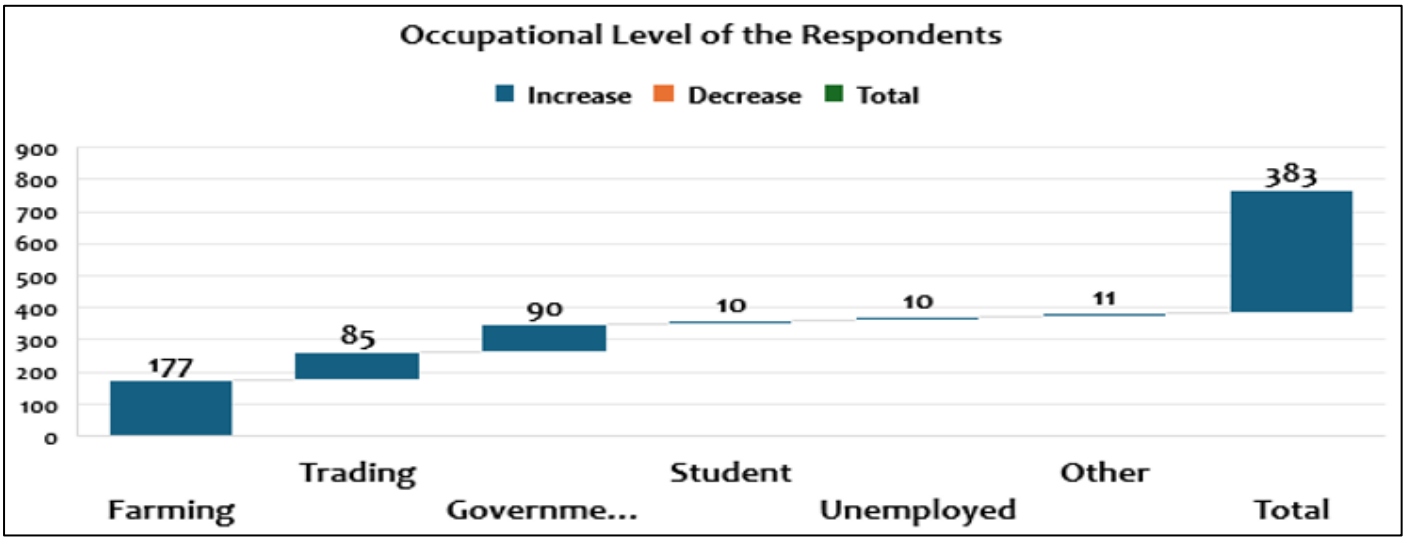


Chart 6 Occupational Level of the Respondent

Sources: Occupational Level of the Respondent, Demographic Data obtained from the findings October 2024. (Chart 6)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

➢ *Interpretation:*

Table 4. shows the age group of the respondents. Based on the findings, 4.43% of respondents fall within the age category of under 18. This accounts for 17/383 of the respondents. 30.28% of the respondents were within the age category range of 18-35 years of age. That means that 116/383 of the respondents were within the age category of 18-35 years of age. 33.28% percent of respondents fall between the age range 36-50 years of age. By implication 129/383 of the respondents were within the age range 36-50 years of age. 31.59% of respondents fall between the age range 51 and above. By demographic data on the age of the respondents, most of the respondents fall between the age range 36-50. The pie chart 3 illustrates the findings on demographic findings on age.

Table 7 and chart 4 presents the demographic findings on the gender of the respondents. 57.38% of the respondents were female and 42.38% of the respondents were male. This means that most of the respondents were female with 57.38% accounting for 221/383 of the respondents.

Table 8 and chart 5 shows the demographic findings on the level of Education of the respondents. Respondents who hold Primary level of education have 6.00%. those with secondary school account for 25.38%. and respondents with tertiary education hold 68.92%. This implies that many of the respondents (68.82%) 264/383 possessed tertiary education in Bolori 2.

Findings on occupation of the respondents as shown in table 9 and chart 6 revealed that 46.21% of the respondents are farmers. 22.19% are Traders, 23.49% are government workers, 2.61% are students, 2.61& are unemployed and respondents with specified occupations as other with 2.87%. This means that many of the respondents are farmers in Bolori 2.

Table 8 and 7 shows findings on the perceptions of climate of the Respondents.

S/n	Options	Variables	Frequency	Percentage
1	Have you noticed any changes in the weather patterns (Temperature, Rainfall) in the past 5-10 years?	Yes No Not sure.	309 50 24	80.67% 13.05% 6.26%
2	How do you think these weather changes affected your health or the health of the people in your household?	No effect. Increase Diseases. Reduced Health issues. Not sure of changes.	45 338 0 7	11.74% 88.25% 0 1.82%
3	**Total**		**383**	**100%**
Sources: Findings from this study obtain through Questionnaire October 2024				

➢ *Interpretation:*

Based on the above table, it can be deduced that 80.67% of the respondents have noticed changes in the weather patterns such as temperature and rainfall in the past 5-10 years. 13.05% of respondents opine that there are no changes in weather patterns noticed. 6.26% of the respondents were not sure if there are changes or not. This indicates that most of the respondents (80.67%) have observed changes. 11.74% of the respondents opine that there is no effect of weather changes which affect their health or people within their household. 88.25% of respondents indicated an increase in diseases in their household. 1.82% of respondents said they are not sure if an increase or reduced in diseases due to weather changes in Bolori 2. This implies that most of the respondents indicated that there is an increase in diseases due to weather changes.

Table 9 Shows the Findings on Climate Change Disease Prevalence in Bolori 2.

S/n	Options	Variables	Frequency	Percentage
1	In the last 12 months, has anyone in your household experienced one of the following diseases?	Malaria. Cholera. Respiratory Infection (Bronchitis, Rhinitis, Asthma). Diarrhea None.	202 17 100 64 0	52.74% 4.43% 26.10% 16.71% 0
2	How often do you or someone in your household visit the health facility for treatment related to these diseases?	Once a month. Several times a month. Every few months.	84 179 164	21.93% 46.73% 42.81%
3	**Total**		**383**	**100%**
Sources: Findings from this study obtain through Questionnaire October 2024				

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

➢ *Interpretation:*

Based on the above findings, we can submit to say that 52.74% of the respondents have affirmed that someone in their household has experienced malaria disease. 4.43% of the respondents indicated a household member had experienced cholera within the last 12 months. 26th.10% of the respondents indicated someone has had experienced respiratory diseases such as Bronchitis, Rhinitis, and asthma and their likes. 16.71% of respondents indicated diarrhea experiences within the last 12 months respectively. 21.93% of respondents said that someone in their household visits the health facility once a month for treatment related to this disease. 46.73% of the respondents opine that someone in their household visits the health facility several times a month for treatment related to diseases. 42.81% of respondents indicated that someone in their household visited the health facility every few months for the treatment of malaria and other climate-related diseases.

Table 10 Shows the Findings on Climate-Related or Climate-Sensitive Health Impacts in Bolori 2.

S/n	Options	Variables	Frequency	Percentage
1	Do you believe that extreme weather events such as floods and heatwaves have contributed to an increase in disease in your community?	Yes No	337 46	87.98% 12.01%
2	How have changes in rainfall patterns affected the availability of clean water in your household?	No effect. Sometimes water shortages cause. Regularly causes water shortages.	74 101 208	19.32% 26.37 54.30%
3	**Total**		**383**	**100%**
Sources: Findings from this study obtain through Questionnaire October 2024				

➢ *Interpretation:*

On climate-related or climate-sensitive health impact in Bolori 2. 87.98% of the respondents implied that extreme weather events such as heatwaves and floods have contributed to an increase in diseases in the Bolir 2 community. 12.01% of the respondents indicated that they don't believe extreme weather events increase diseases in the Bolori2 community. This means that many of the respondents believed that extreme weather conditions contributed to increase in diseases occurrences in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria. 19.32% of the respondents said that there was no effect on the rainfall pattern affecting the availability of clean water in their household. 26.37% of respondents said that there is sometimes water shortages caused by change in rainfall pattern in their respective households. 54.30% of the respondents indicated that there are regular water shortages in their households. This implies that most of the respondents 54.30% indicated that that the change on rainfall pattern which causes regularly cause water shortages.

Table 11 Shows Findings on the Coping Mechanism and Adaptation to the Impacts of the Prevalence of Climate-Sensitive Diseases in Bolori 2.

S/n	Options	Variables	Frequency	Percentage
1	What measures have you or your household taken to protect yourselves from climate-sensitive diseases?	Use mosquito nets. Boil drinking water. Avoid outdoor activities during extreme heat. No specific measures.	207 33 97 46	54.04% 8.61% 25.32% 12.01%
2	What is the biggest challenge you face in managing the health impacts of climate change in your household?	Lack of healthcare access Lack of clean water Poor sanitation Insufficient information on prevention	197 26 60 100	51.43% 6.78% 15.66% 26.10%
3	**Total**		**383**	**100%**
Sources: Findings from this study obtain through Questionnaire October 2024				

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

➢ *Interpretation:*

Findings on the coping mechanism and adaptation to the impacts of the prevalence and incidence of climate-sensitive diseases in Bolori 2 identified that 54.04% of the respondents used mosquito nets as a coping mechanism and adaptation strategy for the incidence of climate-sensitive diseases. 8.61% indicated boiling water as household coping mechanisms and adaptation strategies to climate-sensitive diseases. 25.32% of the respondents avoid outdoor activities during extreme heat. While 12.01% of respondents indicated no measures were employed for coping mechanisms and adaptation strategies in their household. This implies that 54.04% of respondents responded they used mosquito nets as coping mechanisms and adaptation. 51.43% of the respondents indicated lack of healthcare access as one of the challenges they face in managing health impacts of climate change in their household. 6.78% of respondents said that lack of clean water is a challenge. 15.66% of the respondents identified poor sanitation and 26.10% of the respondents opine that insufficient information on prevention of climate-sensitive disease is the challenges they encountered in managing climate change impacts. This means that majority of the respondents, 51.43%, indicated lack of healthcare access as the challenges they face in managing climate change in the household.

IV. DISCUSSION OF FINDINGS

From the meteorological data reviews and data in this study. The findings revealed that there was an increase in the annual rainfall in the last decade. That's from 2014 to 2024. The amount of rainfall in 2014 was 450mm per annum. And 550mm per annum in 2024. This significant increase in the annual rainfall in Bolori 2 justified the devastating flood in September 2024 which consumed nearly 70% of the Maiduguri metropolitan council of Borno state in northeast Nigeria. Bolori 2 was also inclusive in the flood experienced. Rainfall increases per annum (-100mm per annum) which gave rise to stagnant water which provide breeding sites for mosquitoes specifically anopheles mosquitoes that transmit malaria. Additionally, the result also shows an increase in the temperature within the last decade (2014-2024). With 2014 having 30.5 °C and 2024 having 37.1 °C. This difference in temperature of 6.6°C increases the development cycle of vector-borne disease malaria. This will aid in making the mosquitoes more infectious and increase and increase the rate of transmission. Increase in humidity from 2014 to 2024 from 72% in 2014 to 80% in 2024 contributed to the increase in mosquito survival.

Based on the findings, excess rainfall can overwhelm the dams and drainage systems in Bolori 2. This will contaminate water sources with sewage and bacteria, giving rise to disease outbreak such as cholera. The increase in the annual rainfall per annum in 2024 (100mm/annum) signifies the flood with resultant cholera that occurred in the Maiduguri metropolis including Bolori 2. The elevation of temperatures within the last 5 to 10 years increases the proliferation of vibro cholerae, an agent that causes cholerae. Humidity may not have direct effects on cholerae, although humid and warmer environments support bacterial growth which increases the chances of waterborne diseases outbreak.

Moreover, temperature elevation led to more incidence of heatwaves which aggravate respiratory condition such as bronchitis, asthma, and chronic obstructive pulmonary disease (COPD). Unstable temperature aid in increase respiratory infections specifically during dust storm. The increase in humidity trapped air pollutants worsening air quality and in turn increase respiratory infections, especially in vulnerable populations such as Bolori2.

Findings on the health facility record on climate-sensitive diseases prevalence indicated that there are long term increases in Malaria from 14.45 per 1,000 in the year 2014 to an increase up to 28.00 per 1,000 in the year 2024. This implies a 100% increase in the incidence of malaria disease as the most recognized climate sensitive diseases in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria. This also suggests that there is a growing burden in health, likely induces by climatic factors such as in the increase in rainfall, temperature which increasing mosquito breeding. In the prevalence it postulated that numerous percentages of the population were affected by malaria in 2014.

On the other hand, the prevalence of cholera began low as 0.24 per 1,000 in the year 2024. Continues change in the climate skyrocketed the incidence rate to 2.43 per 1,000 in the year 2024. This is entangled to the immense weather changing aiding in severe flooding in 2024 that contaminated various water sources from Maiduguri metropolis down to Bolori 2 instigating outbreak occurrences. Additionally, the prevalence of cholera is less in recent years, it became at a peak during flooding that affected nearly 70% of the Maiduguri city which affected about 90% of the communities in Bolori 2.

Respiratory infections incidence and prevalence rate has a stable increase from 9.69 per 1,000 in the last decade (2014) to higher rate of 20.01 per 1,000 in 2024. This means that certain environmental situations and conditions vis a vis air quality alteration are due to long-term change in average weather conditions in Bolori 2. The rise in rate of respiratory infections was also inclined to increased duct and sandstorms during the dry season and time just before the rain starts annually in Bolori 2.

Based on the review of the health facility records it can be deduced that the total incident rate of climate-sensitive diseases increased from 24.39 per 1,000 in 2014 to a dramatic increase of 50.44 per 1,000 in 2024 is denoting to double of diseases burden. In a more lucid terms, the increase in climate-sensitive diseases over the decade correlates strongly with worsening climate conditions, such as increase in rainfall, humidity and heatwaves. This drastic increase emanated strongly both the direct and indirect impacts of climate change on the health of the communities in Bolori 2 of Maiduguri Metropolitan council of Borno state northeast Nigeria.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

Findings about the impact of climate change prevalence of climate-sensitive diseases among the households for in-depth knowledge of the community. The demographic data on the age of the respondents revealed that most of the respondents (33.68%) fall between the age range 36-50. Findings on the gender of the respondents shows that most of the respondents were female with 57.38% accounting for 221/383 of the respondents. On the educational level of the respondents, the findings show that many of the respondents (68.82%) 264/383 possessed tertiary education in Bolori 2. On occupation of the respondents, it revealed most of the respondents 46.21% are farmers.

Findings on the perceptions of climate of the Respondents indicated that most of the respondents (80.67%) have observed changes in weather conditions within 5-1o year interval. 88.25% of respondents indicated an increase in climate-sensitive diseases in their household. 52.74% of the respondents have affirmed that someone in their household has experienced malaria disease. 46.73% of the respondents opine that someone in their household has visited the health facility several times a month for treatment related to diseases. 21.93% of respondents said that someone in their household visits the health facility once a month for treatment related to this disease. And 42.81% of respondents indicated that someone in their household visited the health facility every few months for the treatment of malaria and other climate-related diseases.

On climate-related or climate-sensitive health impact in Bolori 2. 87.98% of the respondents implied that extreme weather events such as heatwaves and floods have contributed to an increase in diseases in the Bolir 2 community. 54.30% of the respondents indicated that there are regular water shortages in their households. This implies that most of the respondents 54.30% indicated that that the change on rainfall pattern which causes regularly cause water shortages.

Findings on the coping mechanism and adaptation to the impacts of the prevalence of climate-sensitive diseases in Bolori 2 emanated that 54.04% of the respondents used mosquito nets as a coping mechanism and adaptation strategy for the incidence of climate-sensitive diseases. 8.61% indicated boiling water as household coping mechanisms and adaptation strategies to climate-sensitive diseases. 25.32% of the respondents avoid outdoor activities during extreme heat. While 12.01% of respondents indicated no measures were employed for coping mechanisms and adaptation strategies in their household. This implies that 54.04% of respondents responded they used mosquito nets as coping mechanisms and adaptation.51.43% of the respondents indicated lack of healthcare access as one of the challenges they face in managing health impacts of climate change in their household. 6.78% of respondents said that lack of clean water is a challenge. 15.66% of the respondents identified poor sanitation and 26.10% of the respondents opine that insufficient information on prevention of climate-sensitive disease is the challenges they encountered in managing climate change impacts. This means that majority of the respondents, 51.43%, indicated lack of healthcare access as the challenges they face in managing climate change in the household.

V. CONCLUSIONS AND RECOMMENDATIONS

Based on the findings of the study conducted on the impacts of climate change on the prevalence of climate-sensitive diseases in Bolori 2 ward of Maiduguri Metropolitan council of Borno state northeast Nigeria. The study clearly shows the irrefutably non-controvertible impact of climate change on public health with fundamental effects on the prevalence of climate-sensitive diseases. most of the community has recognized changes in the average weather pattern within the interval of 5-10 year, more especially in forms in terms of increase average weather condition such as temperature, and rainfall. These have direct relationships to increase in diseases such as malaria, cholera, respiratory infections and diarrhea.

According to this study, the health burden in Bolori 2 of Maiduguri Metropolitan council is beyond contradictions. The study emanated that half of the population in Bolori 2 have experienced malaria in recent years. Many households have visited health facilities for treatment. Respiratory infections and waterborne diseases also present significant challenges, driven by environmental factors such as heatwaves, floods, and irregular rainfall patterns, which contribute to water contamination and mosquito breeding.

Despite community awareness, coping mechanisms remain insufficient. While most households use **mosquito nets**, many do not take other preventive measures such as boiling drinking water or avoiding outdoor activities during extreme heat. Additionally, structural challenges such as lack of healthcare access, poor sanitation, and limited information on disease prevention exacerbate the situation, leaving many vulnerable to climate-sensitive diseases.

The study underscores the critical need for urgent interventions to address the health impacts of climate change in Bolori 2. While some progress has been made in adopting basic prevention measures, systemic gaps in healthcare infrastructure, sanitation, and public awareness persist. Addressing these issues will require a multifaceted approach involving the community, local government, and international humanitarian organizations.

Based on the findings in the study, it is highly recommended to strengthen health infrastructure through investing in standardization of local health facilities to manage the increased demand for services more especially management of climate-sensitive diseases such as malaria, cholera and respiratory infection. It is also recommended that government and humanitarian agencies aid in improving access to healthcare to all the households through establishing more health facilities including mobile outreach clinics. Government to Increase the healthcare workforce and provide training to aid the healthcare personnel have the required skills for managing the emerging climate-sensitive diseases in Bolori2. It is also very imperative and highly recommended to increase the public health expert to increase

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

the surveillance and emergency response. This expert will aid in establishing and expanding the disease surveillance system to monitor trends in climate-sensitive diseases and respond accordingly. As part of outbreak prevention and response, it's important to scale up water sanitation and hygiene interventions. This is also integral as it will address issues of poor sanitation and water contamination in Bolori 2.

Government and non-governmental organizations drill boreholes to address water shortages and improve access to clean water, contructs and maintain timely dams and drainage systems to counteract the effect flood in Bolori 2. Increase public awareness sensitization and campaigns about climate change and climate-sensitive diseases and the importance of preventive measures such as boiling water, use of insecticide treated nets and avoidance of outdoor activities. Promotion of climate-smart agricultural practice to reduce the impact of climate variability on food security which can aid in causing malnutrition. Implementation of vector control programs such as insecticides and pesticides spraying and avoidance of stagnant water within Bolori 2 communities. Intervention to reduced climate change impacts on climate sensitive disease should focus on the vulnerable population or group such as under 5 children, the elderly, pregnant and lactating women respectively. This group is at risk of climate sensitive diseases. Community involvement and collaboration in health initiatives to foster change and reduce the impacts of climate change.

Encourage, support and advocate for women's involvement in the health and climate change adaptation program to ensure gender-sensitive solutions leveraging on women's role in household health management. Improve data collection on climate-sensitive diseases to better understand the patterns of disease outbreaks and inform targeted interventions. Create emergency funds that can be quickly mobilized during disease outbreaks or extreme weather events to support rapid response efforts and prevent the situation from worsening. Introduce climate and health education in schools to raise awareness among children and teachers about the links between climate change and disease and promote good hygiene and prevention practices. Collaborate with government agencies and NGOs to develop comprehensive climate change adaptation plans that address the health impacts of climate change at the community level. Ensure that households have access to water purification technologies (e.g., chlorine tablets, water filters) to reduce the risk of cholera and other waterborne diseases. Recognize the psychological stress caused by climate-related events such as floods and heatwaves and provide mental health services to support individuals and families affected by such events. And finally, establish a robust system for monitoring the implementation of these recommendations, with regular reports to ensure accountability and to adjust strategies as needed based on new findings and evolving climate conditions.

The effective implementation of the above recommendations in Bolori 2 of Maiduguri Metropolitan council of Borno State northeast Nigeria. There will be a significant reduction in the impact of climate-sensitive diseases, improve health outcomes and build resilience to the ever-changing adverse effects of climate change. The recommendations will not only be intentional on improving the current health conditions in Bolori 2 population but also provide a base for more prosperous and sustainable healthier communities on the side of the ever-increasing climate change challenges.

REFERENCES

[1]. United Nations Framework Convention on climate change; framework for international cooperation to combat climate change by limiting average global temperature increases and addressing its impacts (UNFCCC); 2020.
[2]. United Nations office of Disaster Risk Reduction; works to reduce disaster risks related to climate change (UNDRR); 2021.
[3]. United Nations Environnent Programme, central role in promoting global environmental sustainability, (UNEP) ; 2020.
[4]. United Nations Development Programme (UNDP); Building resilience and reducing emissions while promoting sustainable development. 2023.
[5]. World Meteorological Organization (WMO); scientific expertise related to climate, weather, and atmospheric conditions, and contributes to global climate change monitoring and assessments 2019.
[6]. Food and Agriculture Organization (FAO): Climate impacts in disaster affected areas regions; 2021.
[7]. World Health Organization (WHO): Addressing the health impacts of climate change, including the spread of climate-sensitive diseases and health systems; 2022.
[8]. African Climate Policy Centre (ACPC); United Nations Economic Commission for Africa (UNECA); research Approach to help African countries address climate challenges 2022.
[9]. Intergovernmental Authority on Development (IGAD); Climate Prediction and Application Centre (ICPAC);' 2023
[10]. African Ministerial Conference on the Environment (AMCEN); Resource on facilitates cooperation among African governments on climate change and environmental issues.2016.
[11]. African Development Bank (AfDB); &; Africa Climate Change Fund (ACCF), climate change adaptation and mitigation projects in Africa charter. 2018.
[12]. Southern African Development Community (SADC); addressing climate change through regional cooperation in areas such as agriculture, water resource management, and disaster risk reduction 2017.
[13]. Climate for Development in Africa (ClimDev-Africa); Conference on limited information and strengthen Africa's capacity to manage climate risks and opportunities. 2019.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/IJISRT24OCT1376

[14]. Pan-African Climate Justice Alliance (PACJA); Overview on AFRI- Climate change; raising awareness and mobilizing communities to tackle climate change 2020.
[15]. Nigerian Federal Ministry of Environment, Department of Climate Change; (FMEDCC); addressing environmental issues in Nigerian region. 2017.
[16]. Nigerian Meteorological Agency; (NiMET); forecasts, climate data, and meteorological services; 2024.
[17]. National Environmental Standards and Regulations Enforcement Agency (NESREA); Handbook of environmental laws and regulations to control activities that contribute to climate change; 2019.
[18]. Nigerian Conservation Foundation (NCF); Pamphlets overview of non-governmental approach to environmental conservation and climate change adaptation; .2015.
[19]. National Agency for the Great Green Wall (NAGGW); Great Green Wall Initiative Nigerian charter handbook; 2023
[20]. Energy Commission of Nigeria (ECN); Overview for energy planning and policy and power resources; 2018.