



ORIGINAL RESEARCH ARTICLE

Assessing the Influence of Climate Variability on Malaria and Typhoid Fevers Cases in Guyuk Local Government of Adamawa state of Nigeria

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ABSTRACT

The study focuses on the impact of climate variability on Malaria and Typhoid Fevers cases in Guyuk Local Government of Adamawa State. The objective of the study is to look at how variations in patterns of climatic elements influence the incidence of malaria and typhoid fevers cases in Guyuk Local Government Area. The method of data collection is fieldwork where the researcher visited the hospitals in the study area in order to collect data. The research used both primary and secondary data sources. The data of monthly record of temperature (minimum and maximum); rainfall and relative humidity from 2014 to 2023 for Guyuk, were collected from Nigerian Meteorological Agency (NIMET) Adamawa. Descriptive and inferential statistics such as such as correlation was used to analyze the data where results were presented in percentages and bar charts. The research reveals that malaria and typhoid fevers were the two most common climate variability related diseases that occur in the study area. The relationship between malaria and typhoid fevers and the climatic elements such as temperature and relative humidity were high meanwhile relative humidity have the most significant effect on the two diseases. On the seasonal basis, all the three climatic elements were found to influence the occurrence of these diseases based on prevailing season, but the influence varied from one disease to another. It was observed that malaria and typhoid had the highest number of mean of occurrence in all the months. The frequency of typhoid was low when compared to malaria. The study showed that relative humidity and rainfall have a greater influence on the occurrence of malaria and typhoid when compared to the effect of temperature, hence malaria and typhoid showed a more significant relationship with the weather elements. The study recommends that Because of the prevalence of malaria in the study area, it is recommended that free mosquito nets should be provided regularly to the people.

Introduction

Human health is profoundly impacted by natural environmental factors such as temperature, rainfall, relative humidity, wind direction, and others. Climate influences health in various ways, as evidenced by recent research. For instance, Chirebvu, Chimbari and Gwenya (2010) conducted an ecological time series analysis examining the association between climate variability and the transmission of Ross River Virus (RRV) diseases. Their findings revealed the sensitivity of RRV transmission cycles to climate variability, with rainfall, temperature, and tidal level emerging as important meteorological determinants. Numerous studies, including those by Sawa and Bukhari (2021), Brunkard, Cifuentes, and Rothenberg (2022), and Ayoade (2020), have established a close link between local climate and the occurrence or severity of certain diseases. Ayoade (2020) highlighted weather's potential to alter the average exposure conditions suitable for disease vectors and pathogens. Weather and climate can influence host defenses, vectors, pathogens, and habitat, as noted by Epstein (2023). The temporal and spatial changes in temperature, precipitation, and humidity expected to occur under different climatic scenarios could significantly affect the biology and ecology of vectors and intermediate hosts, consequently altering the risk of disease transmission (WHO, 2022). Furthermore, recent studies underscore the various direct and indirect ways climate affects health. Temperature and rainfall are identified as significant causal factors of diseases, with even minor changes in these parameters potentially leading to significant impacts on disease spread (Epstein *et al.*, 2020; Alpha 2014). Changes in weather patterns, such as those associated with the passage of weather fronts, have been implicated in various health outcomes, from discomfort to changes in birth rates and

outbreaks of respiratory diseases (Kalkstein & Valimont, 2023).

Humidity levels influence the survival and reproduction of pathogens and their vectors, while precipitation can increase humidity, affecting humans directly (Greenwood, L.M. 2022). Cold weather exacerbates chronic diseases, while low humidity during winter increases the risk of microbial and viral infections (Kalkstein & Valimont, 2023). Recent research also emphasizes the profound impacts of climatic variations and extreme weather events on infectious diseases.

This study is to investigate the influence of rainfall, temperature, and relative humidity on the prevalence of malaria and typhoid in Guyuk Local Government Area (LGA) of Adamawa State from 2014 to 2023.

Research Hypotheses

- I. There's no significant relationship between weather elements (rainfall, temperature, and relative humidity) and the occurrence of malaria and typhoid in the study area.
- II. There's a significant relationship between weather elements (rainfall, temperature, and relative humidity) and the occurrence of malaria and typhoid in the study area.

Materials and Methods

The Study Area

The study area is located between longitudes 11° 45' and 12° 02' E, and latitudes 10° 05' and 9° 35' N in north-eastern Nigeria. It is bounded in the west by Gombe State, in the east by Shelleng Local Government Area, (Figure 1) in the north by Borno State and in the south by Lamurde and Numan Local Government Areas. It has a land mass of 757 sq . km (Adebayo and Tuku , 1999).

Guyuk LGA, generally has high temperatures, with little variation between seasons. Daytime temperatures often exceed 30°C (86°F) throughout the year, with occasional peaks reaching higher temperatures, particularly during the dry season (Adebayo, 1999). Night-time temperatures are usually cooler but still relatively warm, rarely dropping below 20°C (68°F). The highest temperatures are typically experienced during the dry season, while the wet season tends to bring some relief with slightly cooler temperatures due to increased cloud cover and precipitation. (Adebayo 1999). The wet season typically spans from around May to October, characterized by heavy rainfall,

thunderstorms, and occasional flooding. Rainfall during this period is usually abundant, contributing to the replenishment of rivers, streams, and groundwater reservoirs. Conversely, the dry season, which lasts from around November to April, is marked by reduced rainfall and lower humidity levels. This season often experiences hot and dusty conditions, with occasional harmattan winds blowing in from the Sahara Desert. Guyuk LGA experiences relatively high humidity levels, especially during the wet season when moisture levels are elevated due to increased rainfall and evaporation. (Adebayo and Tukur , 1990).

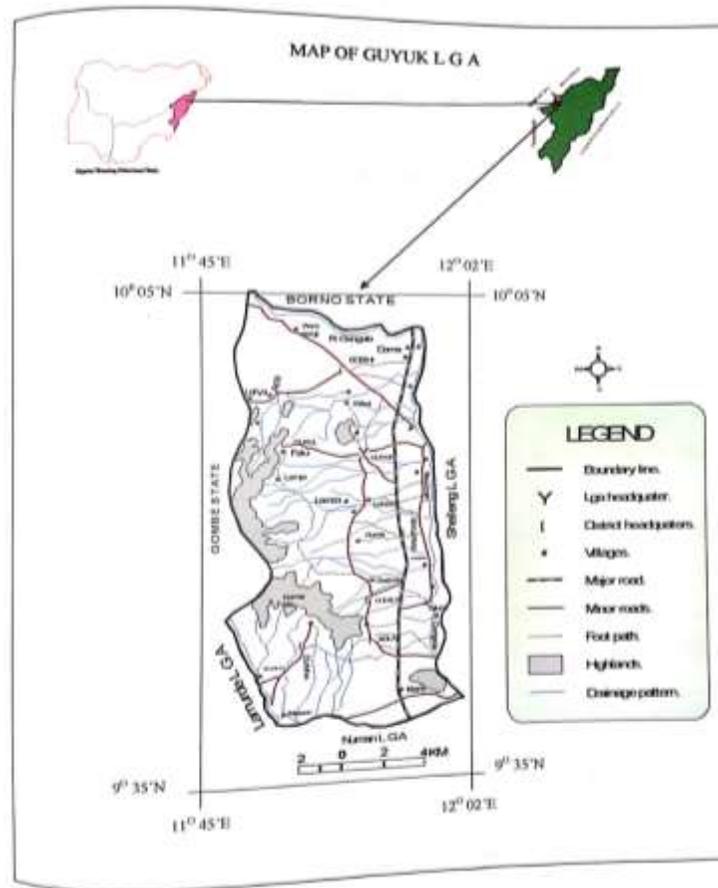


Figure 1: Study Area
Source: Ministry of land and Survey, Yola.

Methodology

The method of data collection was a field work where hospitals were visited for collection of data. The research used both primary and secondary data sources. Primary data source involves oral interview with the relevant Personnel of the Health Centers and collection of medical records of cases of malaria and typhoid for the corresponding years were obtained. While secondary data sources included journals, published materials and data. (Hospital records, Climatic data). The data of monthly record of temperature (minimum and maximum); rainfall and relative humidity from 2014 to 2023 for Guyuk, were collected from Nigerian Meteorological Agency (NIMET) Adamawa State office located in Yola. Both Descriptive and inferential methods of data analysis such as correlation were used to analyze the data and results were presented in percentages and bar charts.

Results and Discussion

Trend of Rainfall in Guyuk Local Government Area (2014-2023)

The trend in Figure 2 shows that rainfall in the study area has been fluctuating and there is a significant decrease in the trend (Figure 2). The linear trend line equation $y = -5.7539x + 185.53$ indicates that the mean annual rainfall has been decreasing over the time frame of study. The peak of the rainfall was in 2015 while the lowest rainfall was observed in 2023. The decreasing trend in rainfall due to climate change, which is a phenomenon that has been described as a statistical variation in weather elements that persist for an extended period, typically for decades or longer. Climate change leads to a distortion of seasonal patterns and consequently, changes in rainfall patterns (IPCC, 2023).

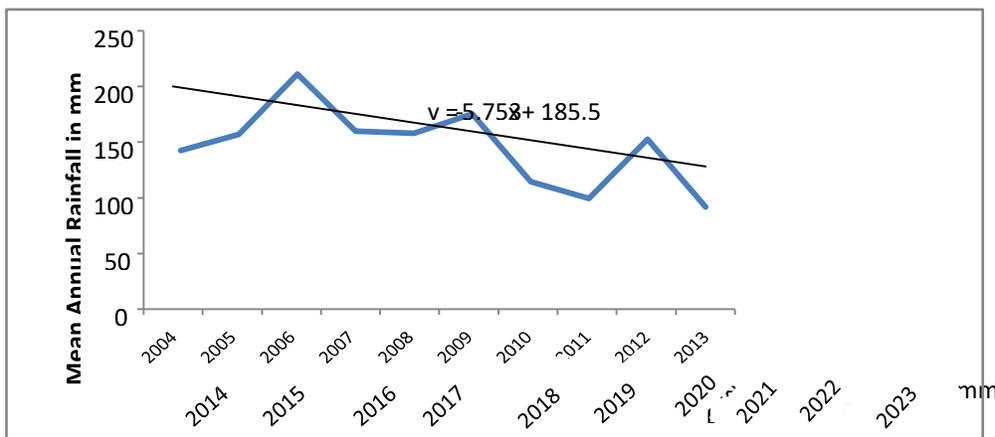


Figure 2: The trend of rainfall in the study area for the period of ten years (2014-2023).

Trend in Temperature Distribution (2014-2023)

From Figure 3 below, it can be observed that temperature has been fluctuating but not as much as when compared to rainfall within the time of the study period. The linear trend line equation $y = 0.3368x + 24.381$ indicates that

mean annual temperature has been on the increase, this is also supported by the trend line as seen in Figure 2. Increasing trend in temperature has been associated with global warming.

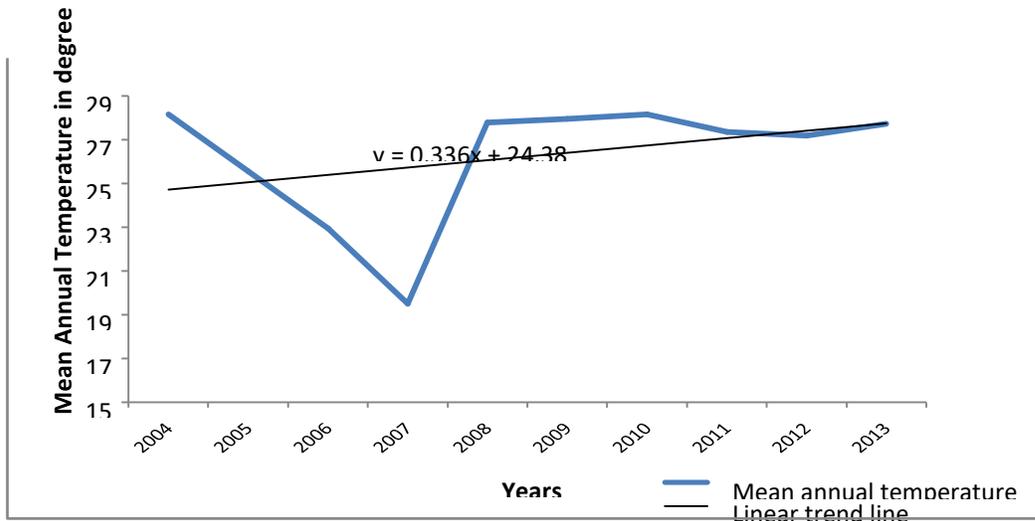


Figure 3: Trend of Temperature in Guyuk Local Government Area (2014- 2023)

Trend in the Distribution of Relative Humidity (2014-2023)

From figure 4 below, the highest percentage of relative humidity was observed in 2014, while the lowest percentage in 2022. The trend shows that relative humidity in the study area has been fluctuating. The linear

trend line equation is $y = -0.9373x + 69.469$, this indicates that relative humidity has been decreasing time within the study period which might be affiliated with climate change which includes shift in the frequency and magnitude of sporadic weather events.

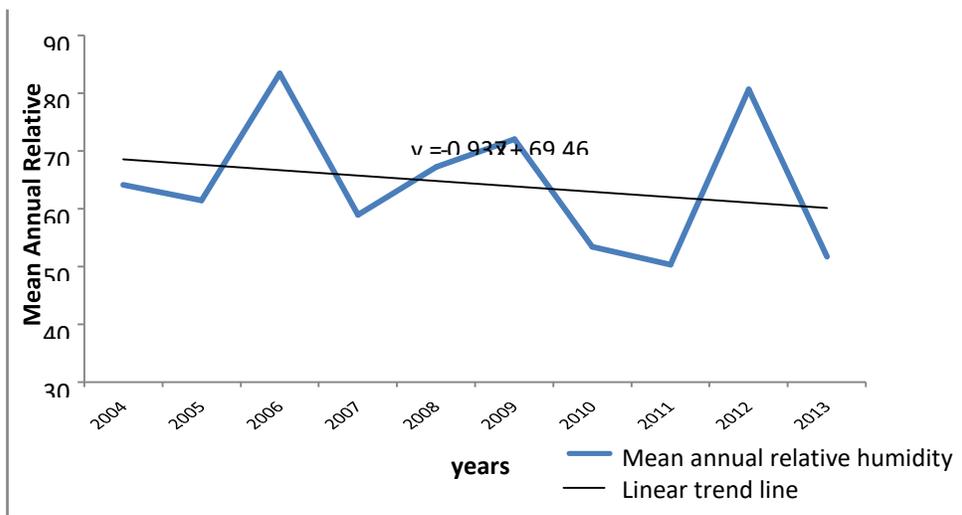


Figure 4: Trend of Relative Humidity in Guyuk Local Government Area (2014- 2023)

Trend in the Occurrence of Malaria Fever (2014-2023)

Figure 5 below shows that the trend of malaria fever cases has been fluctuating with higher cases recorded in 2022. This can be related to the flood disaster that took place in the area in 2022. The occurrence of Malaria is generally high in the study area because of the high amount of rainfall received since Malaria is associated with stagnant water which usually occurs when there

is high rainfall and poor drainage systems. The trend as indicated by the linear trend line shows a slight insignificant pattern of occurrence. The linear trend line equation is $y = -0.3619x + 84.883$, indicating that the rate of occurrence of malaria has been on the decrease to a small extent which may be due to an increase in the National awareness of the use of mosquito nets over the time frame of study.

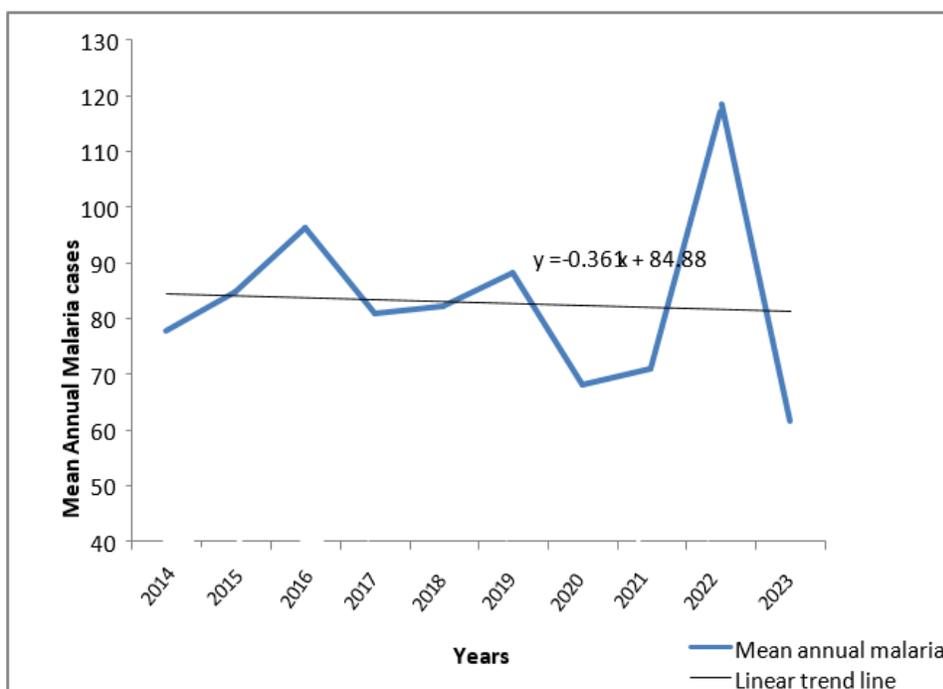


Figure 5: Trends in the Occurrence of Malaria in Guyuk Local Government Area (2014-2023)

Trends in the Occurrence of Typhoid (2014-2023)

Trend in the occurrence of typhoid for Guyuk Local Government Area is presented in Figure 6. The linear trend line equation is $y = 0.0351x + 1.9991$, indicating that the occurrence of typhoid has been increasing over the time frame of study. The trend shows that there has been a significant fluctuation in the pattern of

occurrence of typhoid with its highest value in 2016 and its lowest value in 2015. This can be attributed to the uncertainty of weather changes caused by climate change in most areas. The poor quality of drinking water in connection with the polluted ground water increases the chance of epidemics of water-borne diseases such as cholera and typhoid fever, and other diseases.

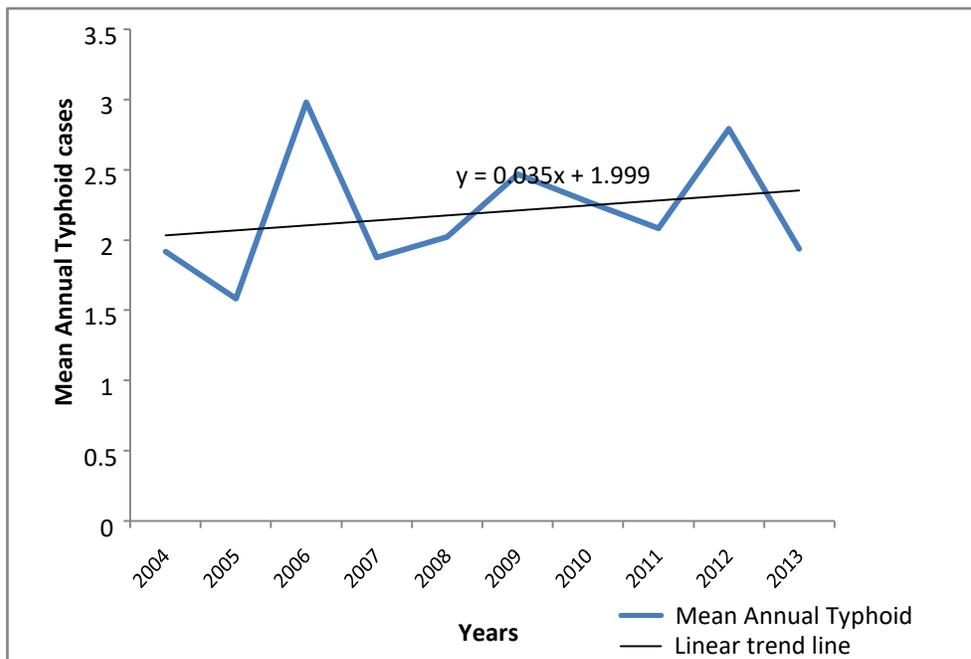


Figure 6: Trend in the occurrence of Typhoid fever in Guyuk Local Government Area (2014-2023)

Relationship between the various weather elements and the selected diseases

Table 1 shows the relationship between the

weather elements and the occurrence of Malaria and Typhoid Between 2014-2023 in the study area.

Table 1: Correlation between the Weather Elements, Malaria and Typhoid Fever cases

| Weather Elements | Selected Diseases | |
|-------------------|-------------------|---------|
| | Malaria | Typhoid |
| Rainfall | 0.646* | 0.519 |
| Temperature | -0.194 | -0.253 |
| Relative Humidity | 0.852** | 0.807** |

KEY : *0.05 level of significance; ** 0.01 level of significance

Relationship between Rainfall and the Occurrence of Malaria

From Table 1 the correlation between rainfall and malaria was 0.646 which was significant at 0.05 level of significance. This means that there is a strong relationship between rainfall and the occurrence of malaria in the study area. Changes in rainfall are strongly and positively correlated with changes in the occurrence of malaria, i.e. an

increase in rainfall would lead to an increase in the occurrence of malaria, and hence the occurrence of malaria is highly dependent on the amount of rainfall.

Relationship between Temperature and the Occurrence of Malaria

The relationship between temperature and the occurrence of malaria is presented in Table 1.

The Pearson Product Moment Correlation Co-efficient (r) between temperature and the occurrence of malaria was -0.194, hence indicating a weak negative insignificant relationship. This implies that change in temperature weekly and negatively influences changes in the occurrence of malaria.

Relationship between Relative Humidity and the Occurrence of Malaria

Table 1 also presents the relationship between relative humidity and the occurrence of malaria in the area. The Correlation Co-efficient (r) between relative humidity and the occurrence of malaria was 0.852 which is significant at 0.01, level of significance. This implies that there is a very strong positive relationship between relative humidity and the occurrence of malaria in the study area for the study period. The relationship indicates that a significant increase in relative humidity would likewise lead to a very significant increase in the occurrence of malaria; hence the occurrence of malaria is highly dependent on the amount of relative humidity received in the study area.

Relationship between Rainfall and the Occurrence of Typhoid

From Table 1, the r value of the correlation between rainfall and typhoid was 0.519 which was not significant at 0.05 level of significance. This means that there is a moderate positive insignificant relationship between rainfall and the occurrence of typhoid in Guyuk Local Government Area. An increase in rainfall would

lead to a moderately insignificant increase in the cases of typhoid.

Relationship between Temperature and the Occurrence of Typhoid

From Table 1 since the r value between temperature and typhoid was -0.253, it means that there is a weak insignificant negative relationship between temperature and the occurrence of typhoid in the area. This means that a significant increase in temperature would lead to an insignificant decrease in the cases of typhoid; hence the occurrence of typhoid is not significantly dependent on temperature.

Relationship between Relative Humidity and the Occurrence of Typhoid

The correlation between relative humidity and the occurrence of typhoid in the area is shown in Table 1. The Correlation Co-efficient was 0.807 which was significant at 0.01, level of significance; indicating that there is a very strong relationship between relative humidity and the occurrence of typhoid in the area. A significant increase in relative humidity would lead to a significant increase in the occurrence of typhoid and likewise a significant decrease in the amount of relative humidity received would lead to significant decrease in the occurrence of typhoid, hence the occurrence of typhoid is highly dependent on the amount of relative humidity received in the area.

Seasonality of the Two Diseases in 2014

The seasonality of the occurrence of malaria and typhoid in 2014 is shown in Figure 7.

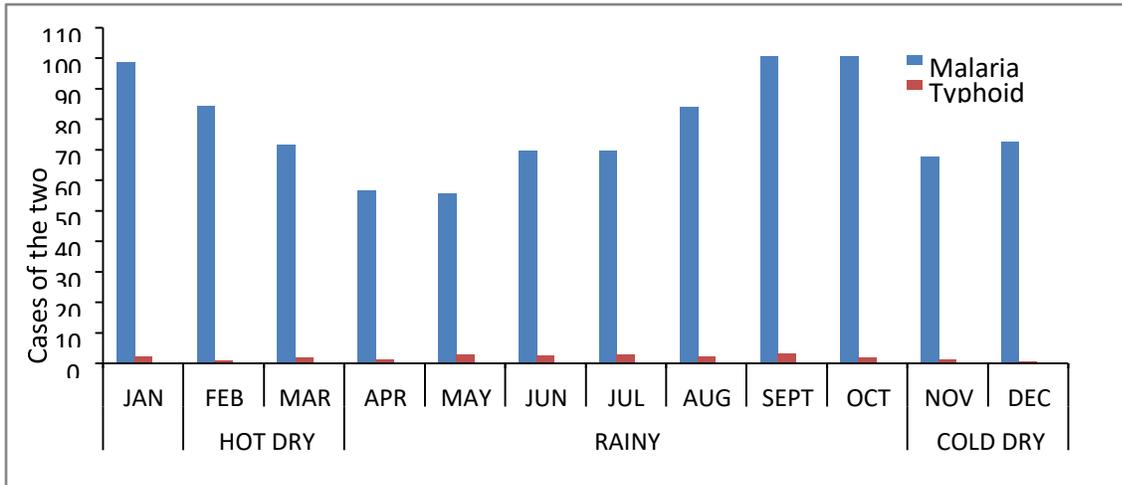


Figure 7: Seasonality of Malaria and Typhoid (2014)

From Figure 7 .it can be seen that the frequency of occurrence of malaria in the study area is very high with the highest peak occurring during the rainy season peak (August to October) and its lowest incidence occurred during the early part

of the rainy season (April to May). The occurrence of typhoid was relatively evenly distributed throughout the year with its peak during the mid to peak of the rainy season (June to September).

Seasonality of Malaria and Typhoid (2014)

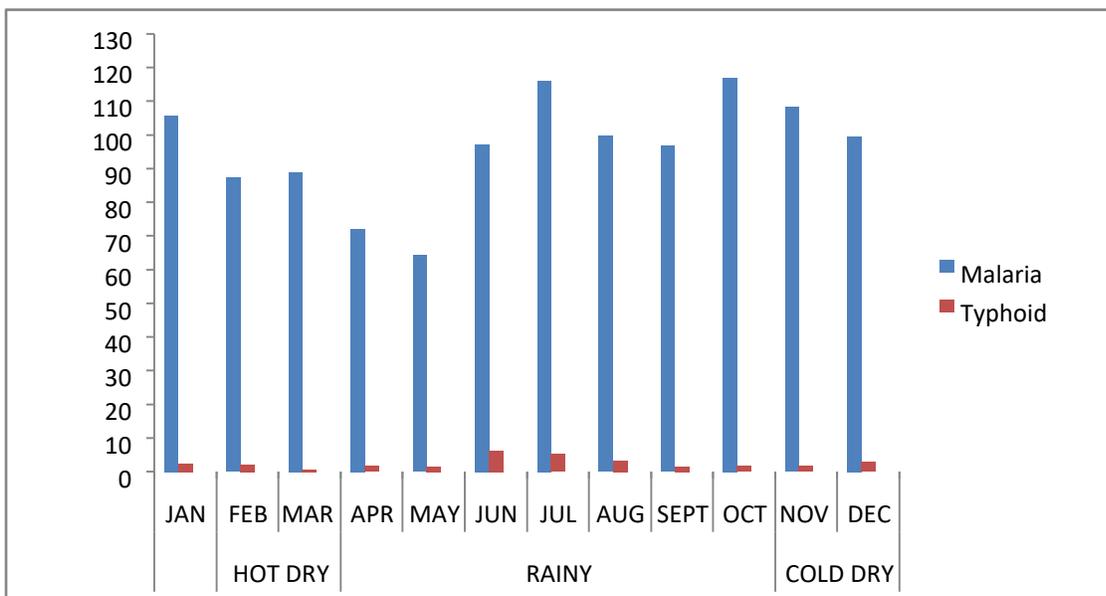


Figure 8: Seasonality of Malaria and Typhoid (2014).

The highest cases of malaria were recorded in the peak of the rainy season (July to October) and its lowest recorded case in the early rainy season (April to May). Typhoid also had its highest cases recorded in the rainy season (July to August) and its lowest cases recorded in the hot dry to early rainy season (March to May).

malaria had its highest occurrence in the cold dry season (January to February) and its lowest occurrence in the rainy season (April to September). This is contrary to the previous years which had their peak occurring in the rainy season. The distribution of typhoid was relatively constant throughout the year, peaking in the rainy season (May to August) and having its lowest in the cold dry season.

Figure 8 presents the distribution of the cases of malaria and typhoid 2015. From this figure

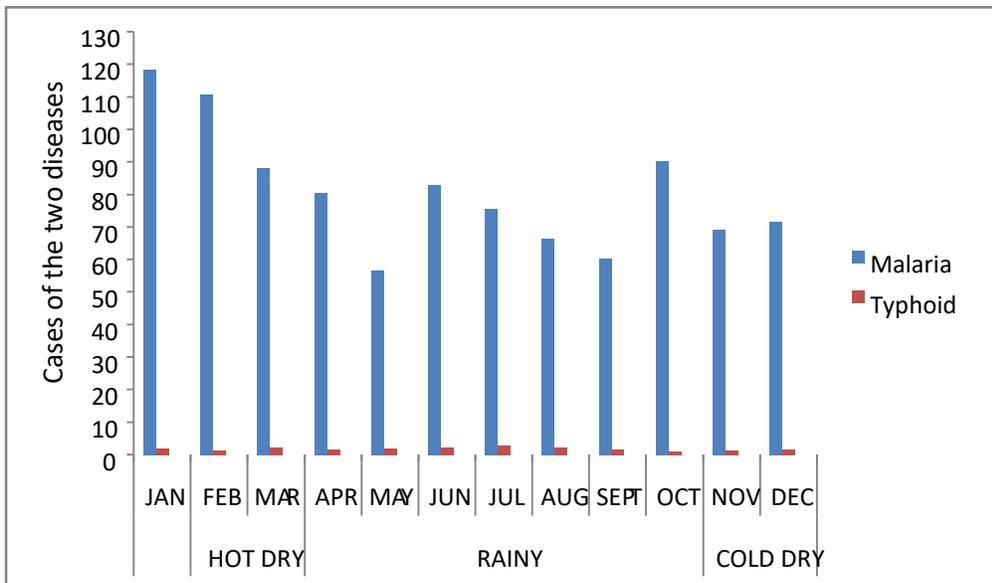


Figure 9: Seasonality of the Two Diseases (2015)

Seasonality of the Two Diseases (2016)

Figure 9 showed like in 2016 malaria also had its highest number of reported cases in the cold dry season with an average of 58.5 cases. The

occurrence of typhoid was highest in cold dry season and lowest reported case also in the cold dry season.

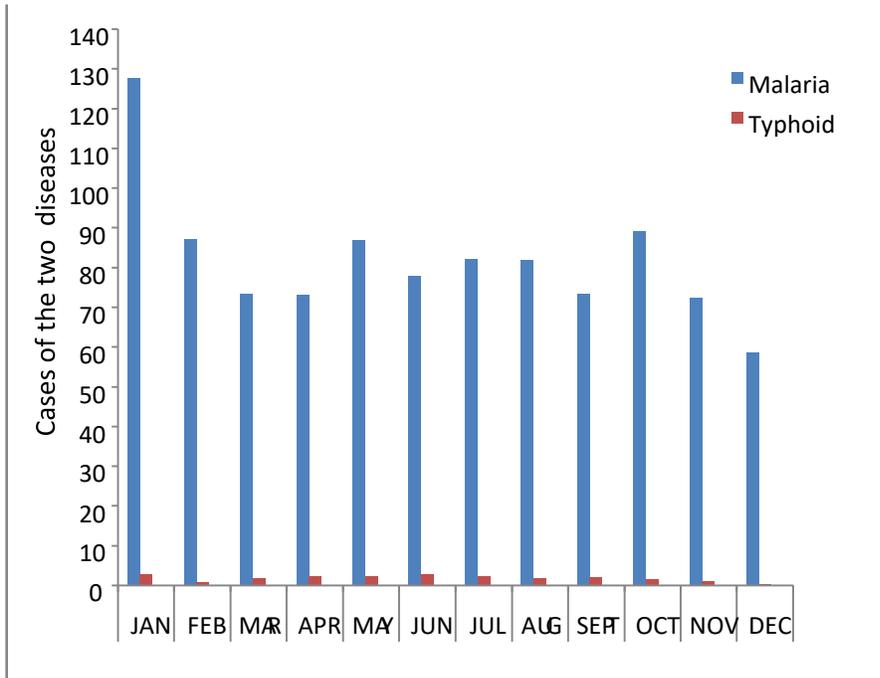


Figure 10: Seasonality of the Two Diseases (2016)

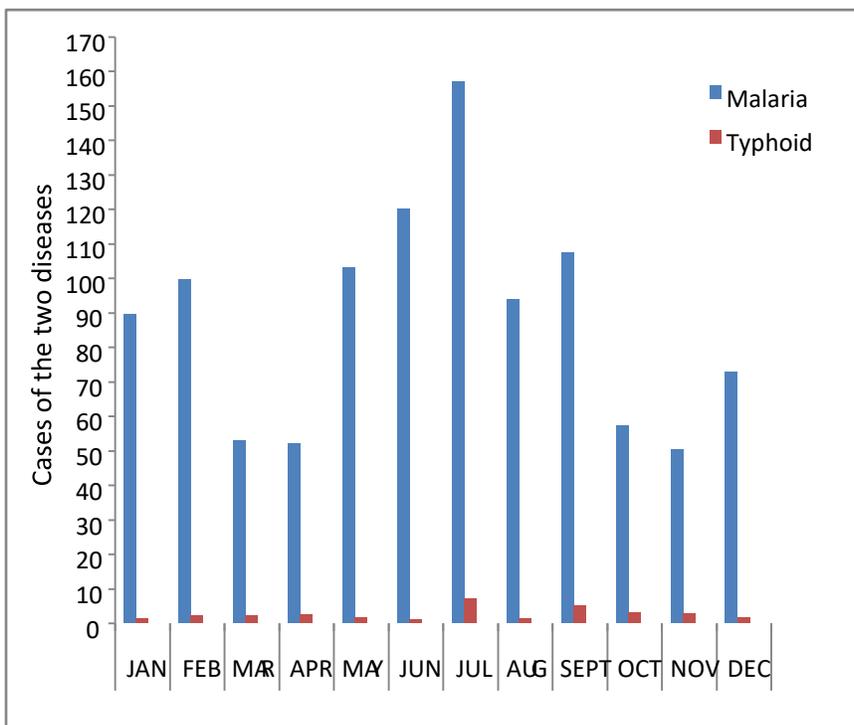


Figure 11: Seasonality of Malaria and Typhoid 2017

Figure 10 shows that in 2017 malaria had its reported cases of highest occurrences in the rainy season when compared with the other two seasons (cold dry and hot dry) having its peak in the middle of the rainy season (May to Sept) and

its lowest occurrences in the cold dry season (November). Typhoid on the other hand also had its highest occurrences in the peak of the rainy season (July) and its lowest occurring in the cold dry season (December, January, June).

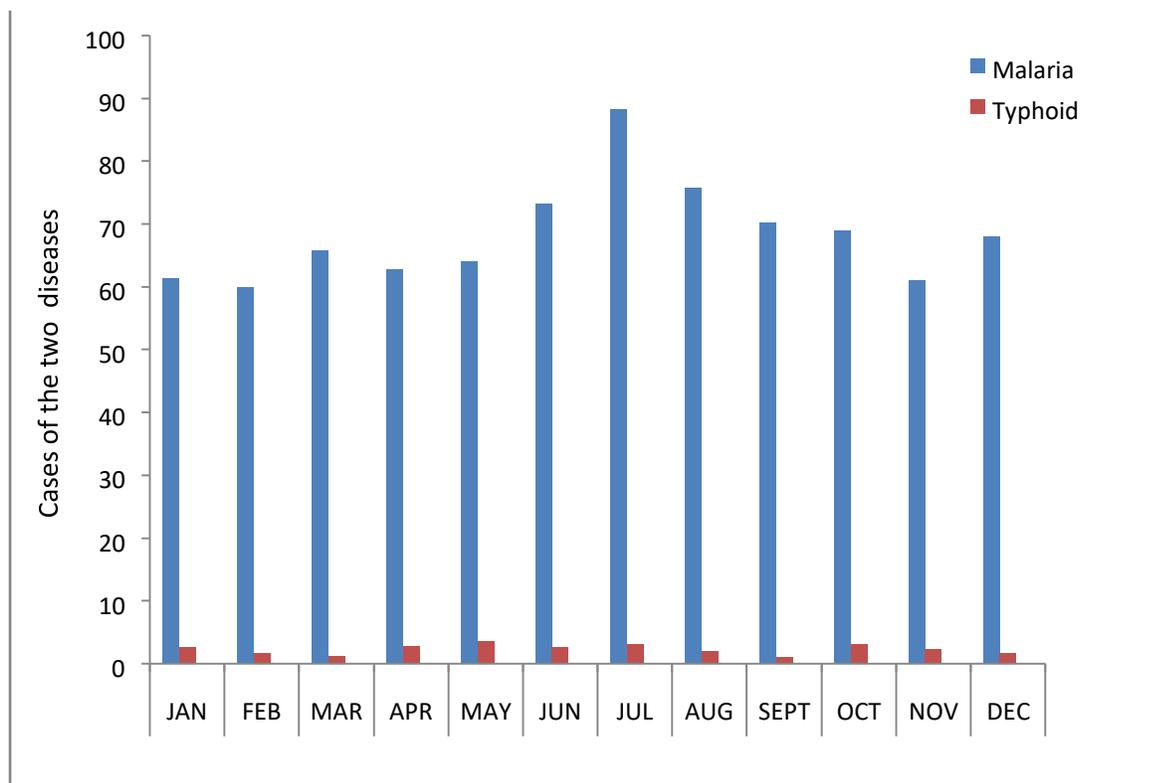
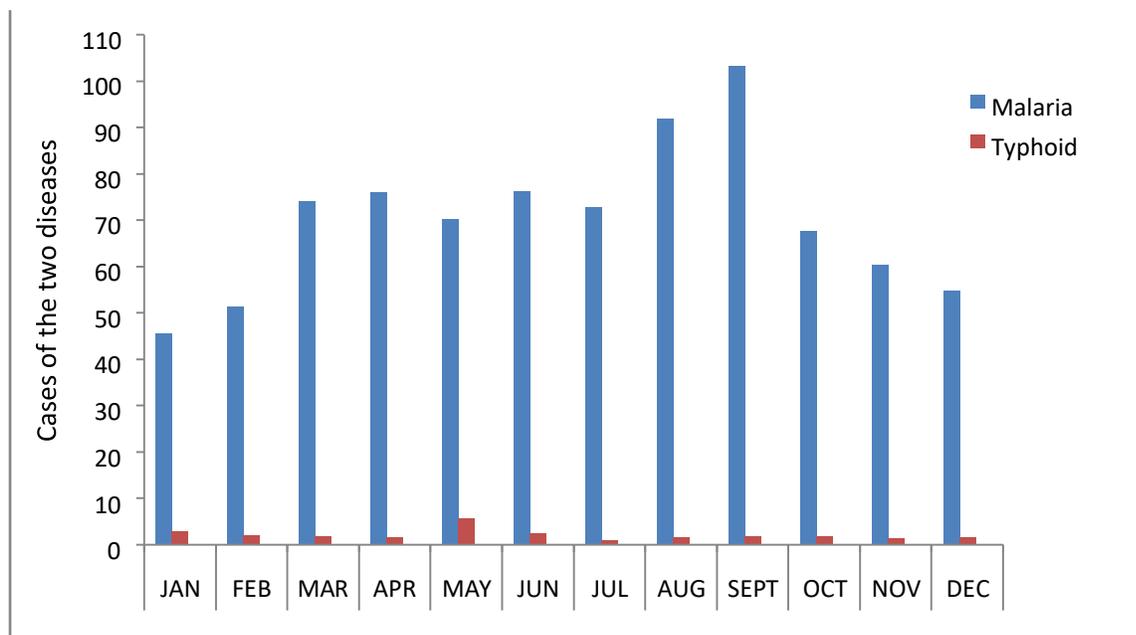


Figure 12: Seasonality of Malaria and Typhoid (2018)

From Figure 12, just like the previous year (2017), the highest reported cases of malaria were recorded in the peak of the rainy season (June -September) and the lowest reported cases was recorded at the end of the cold dry season to early hot dry season (January-February). The

spread of typhoid across the months was relatively uniform having its highest number of occurrences recorded in the early to middle stage of the rainy season and its lowest occurrences were also recorded in the latter part of the rainy season (September).



Figure

13: Seasonality of Malaria and Typhoid (2019).

From Figure 13, it is seen that the distribution of malaria is highly uneven with the highest incidence of occurrences towards the ending of the rainy season (August-September) and its lowest incidences occurring in the cold dry to early hot season (November-February). Typhoid had its highest recorded cases at the beginning of the rainy season (May-June) and its lowest occurring at the peak of the rainy season to the cold dry season (July-December).

Conclusion

The research investigated the effect of temperature, rainfall and relative humidity on the occurrence of malaria and typhoid in Guyuk LGA. This research shows that malaria and typhoid were the two most common diseases that occur in the study area. The relationship between malaria and typhoid and the weather elements were high while relatively moderate with relative humidity having the most significant effect on the diseases. On the seasonal

basis, all the three climatic elements were found to influence the occurrence of these diseases based on prevailing season, but the influence varied from one disease to another. It was observed that malaria and typhoid had the highest number of mean of occurrence in all the months. The frequency of typhoid was low when compared to malaria. The study showed that relative humidity and rainfall have a greater influence on the occurrence of malaria and typhoid when compared to the effect of temperature, hence malaria and typhoid showed a more significant relationship with the weather elements. Because of the prevalence of malaria in the study area, it is recommended that free mosquito nets should be provided regularly to the people.

Recommendation

Enlightenment programs should be conducted to educate the people on the effect of climate change on the occurrence of diseases. Proper

town planning should be carried out by the State government in order to reduce the rate of indiscriminate building of houses so as to prevent the congestion of buildings. The State government should provide safe and adequate drinking water for the masses to reduce the incidences of waterborne diseases. Adamawa State government should encourage proper environmental sanitation so as to clean the environment and reduce stagnant water which promotes the breeding of mosquitoes.

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