ISSN No:-2456-2165

# Spatio-Climatic Influence on Malaria Vector Distribution

Tosin Samuel Afeniforo, Centre for Sustainable Development, University of Ibadan.
Prof. Godson R. E. E. Ana, Environmental Health Science, University of Ibadan.

**Abstract:- Malaria is a major public health disease in Nigeria and the risk exists throughout all the country. However, it is a widely accepted view that climate change may affect the distribution of vector species. To better understand the epidemiology of the disease, it is important to study the climatic parameter such as temperature, relative humidity, and rainfall because these parameters influence the life cycles and development of both the malaria parasite and mosquito vector. Climate change can increase the areas at risk of malaria incidence and thereby enabling malaria transmission. The study focuses on the spatio-climatic influence on malaria vector distribution in the University of Ibadan and Awe town in Oyo state between March and May 2017. Anopheles mosquitoes were sampled using Pyrethroid spray collection and reported cases of malaria infection were obtained from the clinic. Environmental practices prevalent in the study area were also obtained through an observation checklist. The following meteorological parameters (temperature, relative humidity, and rainfall) were obtained to assess the relationship between climate and malaria incidence. The total number of mosquitoes caught in the University of Ibadan during the three months was 97 while the total number of mosquitoes caught in Awe was 43. A non-significant difference P (0.07) exists between the malaria vector burden in University of Ibadan and Awe while a non-significant difference P (0.131) exists between the malaria prevalence reported cases in the University of Ibadan and Awe. Environmental practices prevalent in Awe town include roadside ditches that do not drain properly, storm drains/catch basins that hold water, detention/retention ponds, low-lying areas with standing water, used tires, containers: buckets, litter, etc. pet/livestock waters that are not rinsed and mud-house. While those prevalent in the University of Ibadan include roadside ditches that do not drain properly, Storm drains/catch basins that hold water, low-lying areas with standing water, containers: buckets, litter, etc. House plants with watering saucers and grown bushes/grasses. The correlation analysis shows that a positive correlation (r = 0.995), (r = 0.980) exists between the temperature of the study areas and incidence of malaria vector in the study areas. Also, correlation analysis shows that a negative correlation (r = -0.937), (r = -0.894) exists between the relative humidity of the study areas and the incidence of malaria vector in the study. A negative correlation (r = -0.343), (r = -0.240) also exists between the rainfall of the study areas and the incidence of malaria vectors in the study areas. This study has provided essential baseline data for the climate-malaria vector incidence relationship.**

***Keywords*:-** *Climate Change, Malaria, Vector, Temperature, Rainfall.*

## I. INTRODUCTION

Changes in climate may alter the distribution of important vector species and may increase the spread of disease to new areas and populations that fall outside areas of stable endemic malaria transmission may be vulnerable to increases in malaria due to climate changes. Many of the diseases that currently occur in the tropics are mosquito-borne (Cook, 1996). It is a generally accepted view that global warming and climate change affect infectious diseases such as malaria. It is commonly assumed that malaria distribution is determined by climate and that warmer global temperatures will increase their incidence and geographic range (McMichael, Haines, Slooff, Kovats, 1996) and (Watson, Zinyowera, Moss, 1998).

The response of many Nigerians to the effects of climate change appears to regard it as superstitious. The living style within the country such as dumping of refuse in canals, deforestation and bush burning, use of wood as fuel, presence of junks and waste motor tires, blocking of drainages, waste disposal, and use of electric generators indicate a low understanding of the effects of some of their activities on climatic changes that require more elucidation. As it were, global warming could lead to intense earthquakes, storms, and flooding with consequential disastrous risks such as witnessed in Haiti and Japan (Eke Patrick Omoruyi and Onafalujo Akinwumi Kunle, 2011).

IPCC (2007) Fourth Assessment Report defined climate change as a change in the state of the climate that can be identified using statistical tests by changes in mean and/or in the variability of its properties that can persist for an extended period usually decades or longer. BNRCC, 2008 synonymously termed climate change as global warming. IPCC (2007) links it to the changes in global average temperature between (0.74 ± 0.18). The results are fiercer weather lasting for longer cycles; extreme scorching heat, precipitation of rainfall, increased intensity of storms, hurricanes, floods, droughts, an outbreak of fire, induces earthquake, acid rain, and indirectly connected to malnutrition and poverty.

WHO (1990) considers the consequences of global warming as the most pressing problem of the 21st century. However, the world's climate system is very fundamental to supporting continuity of life. According to BNRCC the direct consequences of climate change in Nigeria include cerebral-spinal meningitis, a cardiovascular respiratory disorder of the elderly, skin cancer, high blood pressure, malaria, and cholera. Temperature rises (associated with current rates of carbon emission) of just 2–3 degrees Celsius could increase the number of people who are vulnerable to malaria by up to 5%, representing several hundred million people (WMO and WHO, 2009). According to the IPCC, without additional measures to reduce greenhouse gas emissions (mitigation) the Earth is on the way to a temperature increase of 3.7–4.8 degrees Celsius (IPCC, 2014). A World Bank report indicates that by 2050, climate change may threaten some previously unexposed regions of South America, sub-Saharan Africa, and China causing a 50% higher probability of malaria transmission (The Potsdam Institute for Climate Impact Research and Climate Analytics, 2012).

## II. STUDY AREA/METHODOLOGY

**University of Ibadan:** The University of Ibadan is the oldest and one of the most prestigious Nigerian universities, and is located 8 kilometers from the center of the major city of Ibadan in Western Nigeria (Figure 1). It is located between latitude ($7^0$25'50" N) and longitude ($3^0$51'18" E) with an altitude of 195.55 meters.

**Awe town**: Awe is one of the towns in
Afijio Local Government Area in Oyo State, Nigeria with a population of 152,193 (Figure 1). It is located between latitude ($7^0$49'58'' N) and longitude ($3^0$54'21'' N) with an altitude of 303 meters above sea level.

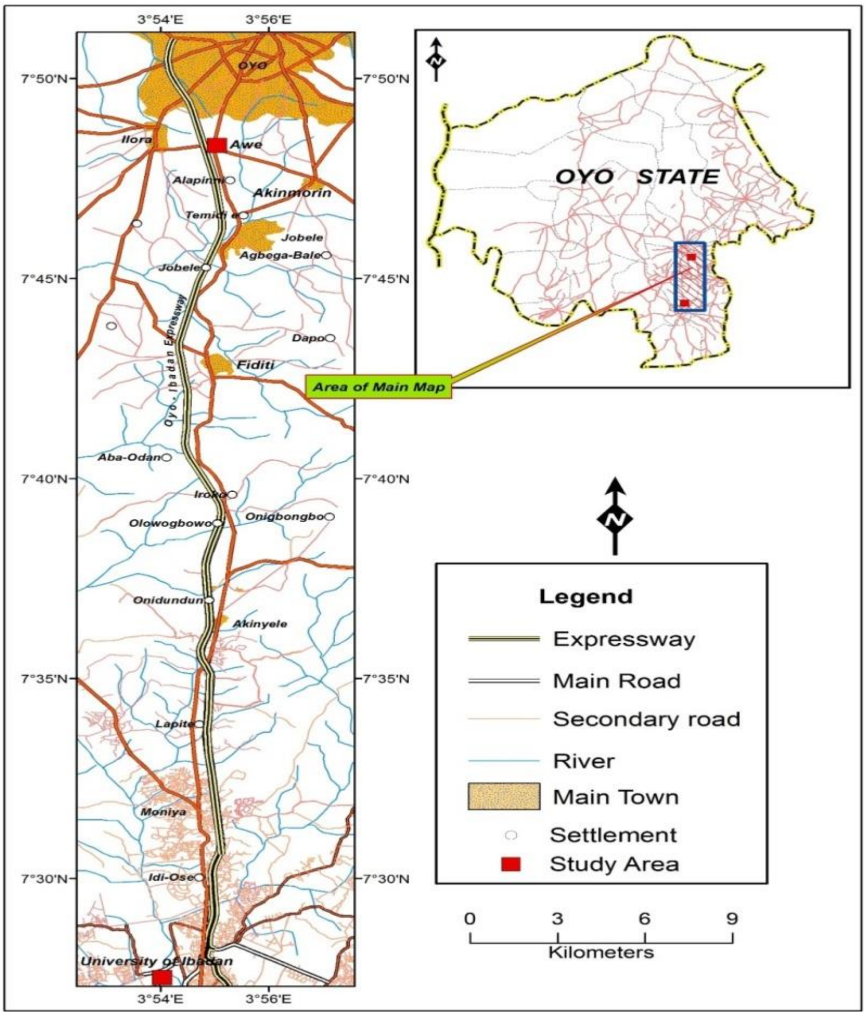


**Figure 1: A map showing the University of Ibadan community and Awe town in Oyo State**
**Source: Tosin Samuel Afeniforo (c) 2017**

The study employed a descriptive design involving surveys, fieldwork (primary data), and secondary data. Climate parameters: temperature, relative humidity and rainfall were collected from the Geography Department University of Ibadan and Nigeria Meteorological Agency from March to May 2017. On-site observations on environmental practices in the study communities that contribute to malaria vector abundance were gathered through an observation checklist.

Three locations were randomly selected from each study area. Adult mosquitoes that bite and rest indoors were sampled using the spray sheet collection method with pyrethrum spray catches between the hours of 6:00 am and 10:00 am. Large white sheets were spread across the room with all doors and windows closed. Then the room was sprayed and after 10 - 15 minutes, the spreadsheets were checked for knocked down mosquitoes which were collected into a Petri dish. The collected samples were taken to the Zoology Department for proper identification of female anopheles' mosquitoes. The mosquitoes were identified using the gross morphology of the species, mouthparts, antennae, proboscis, patches of pale and black scales on the wings and legs, and the terminal abdominal segments (Gillet, 1972).

Malaria infection reported cases in the study areas were collected from the University of Ibadan clinic and Awe town clinic from March to May 2017. SPSS version 20 was used for statistical analysis. Paired Sample T-test was used for descriptive analysis and to test for differences in malaria vector/infection between the two study locations. Data were analysed for the significant difference at P<0.05 Correlation analysis was used to test for the extent of the relationship between meteorological data and malaria vector incidence.

## III. RESULTS AND DISCUSSION

**Meteorological readings:** It was observed that there were slight fluctuations in the mean monthly climate parameters of the study locations: temperature, relative humidity, and rainfall. Temperature decreased from March to May (Figure 2). Relative humidity increased from March to May (Figure 3). The month with the highest recorded rainfall was May and April has the lowest recorded rainfall (Figure 4).

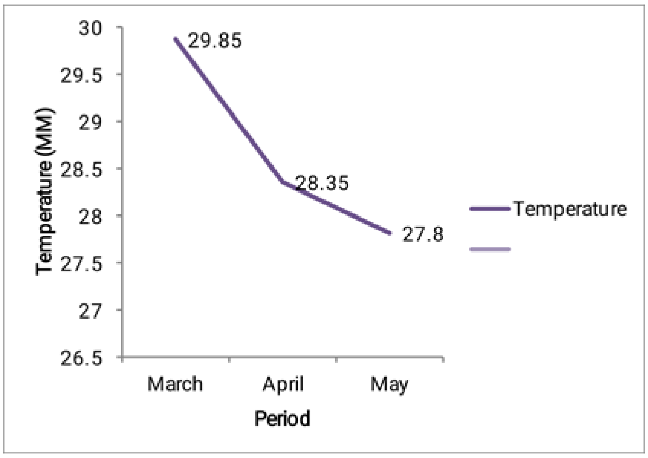


**Figure 2: Temperature changes across three months in both Awe and UI (similar readings were obtained)**

**Environmental practices in Awe town:** The practices predominant include storm drains/catch basins that hold water, detention/retention ponds, low-lying areas with standing water, used tires, containers, Pet/livestock waters that are not rinsed, and mud-house.

**Environmental practices in the University of Ibadan:** The practices predominant include roadside ditches that do not drain properly, Storm drains/catch basins that hold water, low-lying areas with standing water, containers, House plants with watering saucers, and grown bushes/grasses.

**Malaria vector burden**: The result shows that a non-significant difference P (0.07) exists between the malaria vector burden in the University of Ibadan and Awe. A total number of 97 mosquitoes were caught indoors at the University of Ibadan (Table 1). A total number of 43 mosquitoes were caught indoors at Awe (Table 2). This was in agreement with Onyido et al, 2009a who reported that the prevalence, intensity, and regularity of malaria differs from location to location depending on factors such as rainfall patterns, the proximity of human dwelling places to vector breeding sites, and environmental practices among others.

**Malaria prevalence:** The total number of reported cases was 830 in the University of Ibadan community (Table 3). The total number of reported cases was 256 in Awe town (Table 4).

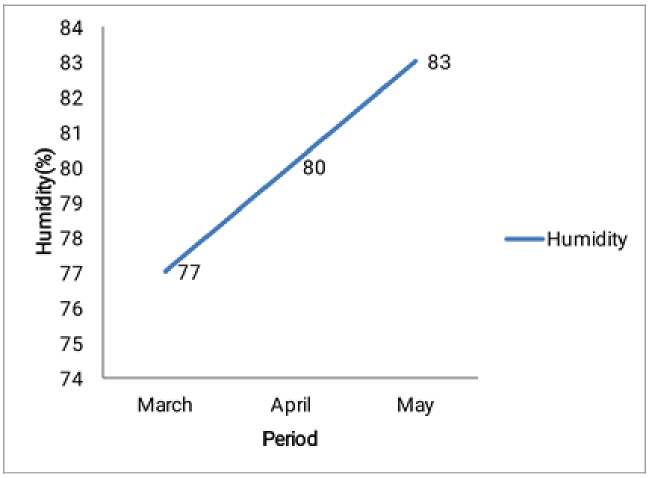


**Figure 3: Relative humidity across three months in both Awe and UI (similar readings were obtained)**

ISSN No:-2456-2165

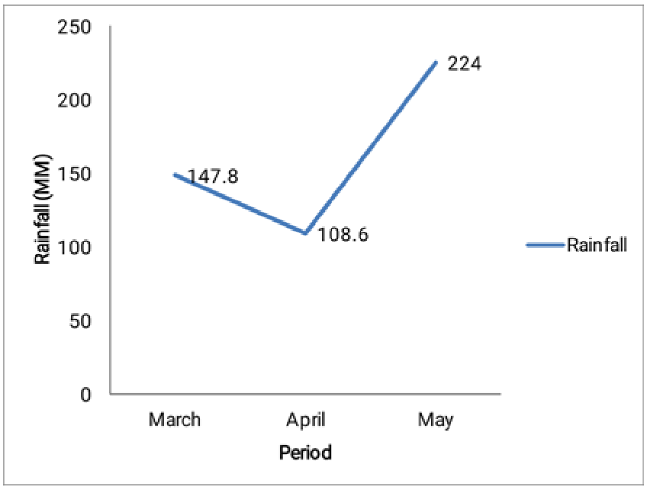


**Figure 4: Rainfall distribution across three months in both Awe and UI (similar readings were obtained)**

**Table 1: Malaria vector burden in the University of Ibadan over a period of three months**

| Months | Number of mosquitoes caught |
|---|---|
| March | 70 |
| April | **19** |
| April | **8** |
| **Total** | **97** |
| **Mean ±SD** | **32.3±33.1** |

**Table 2: Malaria vector burden in Awe town over a period of three months**

| Months | Number of mosquitoes caught |
|---|---|
| March | 24 |
| April | **10** |
| April | **9** |
| **Total** | **43** |
| **Mean ±SD** | **14.33±8.39** |

**Table 3: Malaria reported cases in The University of Ibadan**

| Months | Number of reported cases |
|---|---|
| March | 169 |
| April | **316** |
| April | **345** |
| **Total** | **830** |
| **Mean ±SD** | **276.7±94.4** |

**Table 4: Malaria reported cases in Awe town**

| Months | Number of reported cases |
|---|---|
| March | 86 |
| April | 60 |
| April | 110 |
| **Total** | **256** |
| **Mean ±SD** | **85.33±25.01** |

**Relationship between meteorological data and malaria vector distribution:** Correlation analysis shows that a positive correlation (r = 0.995), (r = 0.980) exists between the temperature of the study areas (University of Ibadan and Awe) and incidence of malaria vector in the study areas. According to Bi et al. (2003), the monthly mean temperature is positively correlated with the monthly incidence of *P. vivax malaria* in Shuchen County China. This implies that the increase in the temperature of the study areas was followed by the increase in the incidence of malaria vectors within the months. This result corroborates with the work of MacDonald, 1957 who reported that vector-borne disease transmission is sensitive to temperature fluctuations and temperature increases reduce the time taken for vector populations to breed. Increases in temperature also decrease the incubation period of the pathogen (e.g. malaria parasite, dengue, or yellow fever virus) meaning that vectors become infectious more quickly. Hence, there is a high tendency for the warmer temperature to increase the biting behavior of the vector and produce smaller adults which may require several blood meals for reproduction.

The correlation analysis shows that a negative correlation (r = -0.937), (r = -0.894) exists between the relative humidity of the study areas and the incidence of malaria vectors in the study areas. This implies that increases in humidity at moderately high temperatures led to a decrease in malaria incidence. This result shows a slight variation from the work of Sara (1990) who reported that a constant high temperature and low relative humidity led to a decline in the mosquitoes' populations between March and May. Mosquitoes, like all insects, have a limited range of tolerable humidity (Wigglesworth, 1939). The correlation analysis shows that a negative correlation (r = -0.343), (r = -0.240) exists between the rainfall of the study areas and incidence of malaria vector in the study areas. However, Bi et al. (2003) and Clements et al. (2009) demonstrate that precipitation is positively correlated with relative malaria risk. The result of this study implies that the excess rainfall of the study areas was followed by the decrease in the incidence of malaria vector of the study areas across the months. This result agreed with (Reeves, et al., 1994) who reported that increased rainfall can provide more breeding sites, but excess rain can also destroy breeding sites. Hence, too much rainfall can decrease the abundance of breeding habitats by washing away portholes and other mosquito breeding sites.

## IV. CONCLUSION

As shown in this research, climate influences malaria transmission and incidence. Even though thresholds may vary slightly from one location to another, malaria vectors' responses to climate remain parallel. This study in agreement with others has shown that temperature has a strong positive correlation with malaria incidence because it influences mosquito and parasite development.

There are set temperature thresholds for mosquito survival. The optimal temperature range for the survival of Anopheles mosquitoes is between 20ºC and 27ºC. While this study has also shown that rainfall equally has a relationship with malaria incidence, relative humidity also proves to have a relationship but this study does not address the complex relationship between relative humidity and malaria vector incidence.

Hence, climate change and environmental practices can increase vector proliferation and can in turn increase the malaria epidemic.

## REFERENCES

[1]. Bi, P., Tong, S., Donald, K., Parton K.A., Ni J. 2003. Climatic variables and transmission of malaria: A 12-year data analysis in Shuchen County, China. Public Health Reports 118.1: 65 71.

[2]. Building National Response to Climate Change BNRCC. 2008. www.nigeriaclimatechange.org. Accessed 21st March 2011.

[3]. Clements, A.C.A., Barnett, A.G., Cheng, Z.W., Snow, R.W., Zhou H.N. 2009. Space-time variation of malaria incidence in Yunnan Province, *China. Malaria Journal*. **8**.180.

[4]. Cook, G. 1996. Manson's Tropical Diseases. London ed. W.B. Saunders Co.

[5]. Eke P. O. and Onafalujo, A. K. 2011. *Asian Journal of Business and Management Sciences* Vol. 1 No. 1 204-215.

[6]. IPCC. 2007. Climate change Impacts, Adaptations, and Vulnerability. Contribution of Working Group 2 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK, and New York, NY, USA, 2007; pp. 1-976.

[7]. IPCC. 2007. The Physical Science Basis. Contribution of Working Group 1 to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change; Cambridge University Press: Cambridge, UK, and New York, NY, USA. pp. 1-996.

[8]. IPCC. 2014. Summary for Policy Makers. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the IPCC.

[9]. MacDonald, G. 1957. The epidemiology and control of malaria. Oxford, UK, Oxford University Press.

[10]. McMichael, A.J., Haines, A., Slooff, R., Kovats, S. 1996. Climate Change and Human Health. Geneva: World Health Organization (WHO)

[11]. Onyido, A.E., Ezike, V.I., Nwosu, E.O., Ozumba, N.A., Ikpeze, O.O., Obiukwu, M.O., Amadi, E.S. 2009a: Crepuscular man-biting mosquitoes of a tropical zoological garden in Enugu South-Eastern Nigeria. *Internet Journal of Parasitic Diseases* 4.1:1-9.

[12]. Reeves W.C., Hardy J.L., Reisen W.K., Milby, M.M., 1994. The potential effect of global warming on mosquito-borne arboviruses, *Journal of Medical Entomology* 31.323-332.

[13]. Sara, E.J. 1990. The bionomic of mosquitoes in selected sites in Maiduguri unpublished M.Sc. Dissertation University of Maiduguri, Nigeria.118pp.

[14]. The Potsdam Institute for Climate Impact Research and Climate Analytics. 2012. 'Turn-down the Heat – Why a 4-degree Warmer World Must be Avoided,' International Bank for Reconstruction and Development and World Bank, Washington, DC.

[15]. Watson, R.T., Zinyowera, M.C., Moss, R.H., 1998. The Regional Impacts of Climate Change: An Assessment of Vulnerability. Special Report of the Intergovernmental Panel on Climate Change (IPCC) Working Group II. Cambridge: Cambridge University Press.

[16]. Wigglesworth, V. 1939. The Principles of Insect Physiology. London: Methuen & Co. Ltd.

[17]. World Health Organization. 1990. Tropical Diseases. TDR-CTD/HH90.1 World Health Organization.

[18]. World Meteorological Organization and World Health Organization. 2009. Factsheet #2: Climate information for protecting human health. http://www.who.int/globalchange/mediacentre/events/2011/wcc3_factsheet2_health_en.pdf