Full Length Research Paper

Effects of Climate Change on Malaria Occurrence and Food Security in the Humid Tropics: An Example from Umuahia-South, Southeastern Nigeria

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Abstract

The recent climate change and its effects on malaria occurrence and by extension food security in the humid tropics have not been given their deserved attention in the region. This work investigated this process using temperature and rainfall changes as tools of climate change to assess malaria occurrence vis-à-vis food security in Umuahia-South Local Government Area, Southeastern Nigeria.

The study covered a 34-year period from 1977 to 2011 for the meteorological data (temperature and rainfall) and a 10–year period from 2002 to 2011 for the malaria occurrence data. These data were analyzed in this work. Results obtained showed gradual but steady increases in both temperature and rainfall. The results indicated that Umuahia-South is warming at an average annual rate of 0.027°C and becoming wetter at a rate of 5.253 mm per annum. Malaria occurrence was observed to have a positive trend of 232.6 (approximately 233) patients per annum. Results obtained in the work therefore suggest that following climate change, malaria occurrence was rapidly increasing thereby threatening the food security of the area.

Keywords: Climate Change, Malaria Occurrence, Food Security, Humid Tropics.

INTRODUCTION:

The initial controversies that surrounded the present climate change with regard to its reality (for example, Linacre, 1992; Barry and Chorley, 1992; Goudie, 2002), have long waned with increasing manifestations of it in the environment and in human health. The on–going change which is due to increased temperature of the globe, commonly referred to as global warming is manifesting differently in different regions of the world. For example, for some regions, the rising temperature has increased their rainfall levels while it has reduced the levels for some other regions. Though the humid tropics within which the study area, Umuahia-South is located is being the least warmed in the present warming (Meyer, 1996), any warming at all makes it a region of very high temperature which could cause an increase in rainfall levels or a reduction in them. Higher temperature in combination with favourable rainfall pattern could prolong disease transmission seasons in some locations where certain diseases already exist, while in some locations, the changing climate will decrease transmission via reduction in rainfall or temperature (WHO, 2003; WHO, 2006; UNICEF, 2006). Some pathogens and vectors are sensitive to changes in climatic factors of temperature and precipitation (rainfall, as in the tropics) patterns. Among these are the survival and reproduction rates of vector, the level of vector activity (i.e. the biting or feeding rate) and the development and reproduction rate of the pathogen within the vector or host (Patz et al., 2003). Equally, some illnesses are climate induced while several diseases that affect human health show a close correlation with climatic conditions and season in their incidence (Critchfield, 1974; Haines et al., 2006; Jacinthe, 2008).

With changing global climatic conditions, conditions for pests are also changing (Adler and Wills, 2003; Ahlenius, 2005; Balbus and Malina, 2010). This is the case with the female anopheles mosquito, the vector of
malaria disease as this disease is on the rise in some parts of the world (Anon, 2010). Malaria, which is a disease marked with fever and shaking of the body, kills millions annually (WHO, 2008) especially in the tropics where high temperatures and heavy rainfall directly and indirectly encourage the reproduction, survival and growth of mosquitoes. Warming and increased humidity have already contributed to observed increase in some health risks and these can be anticipated to continue in future. As a result, the effects of weather and climate on malaria transmission have attracted particular attention in recent years because of sensitivity to changes in climatic and environmental conditions especially as malaria contributes an estimated annual global disease burden of about 225 Million cases (accounting for about 85% of mortality world-wide became of vector borne diseases) (Partham, 2012). The increasing malaria disease burden or occurrence could mean that a more conducive environment (climate) is being created by climate change for mosquitoes, in particular the female anophelines mosquitoes (malaria vector). Being a debilitating disease, an increase in malaria disease occurrence could by extension threaten food security as agricultural food production in the humid tropics, including Umuahia-South, Southeastern Nigeria (the study area), is majorly through human labour. Based on this, this paper is aimed at examining the effects of climate change on malaria occurrence, and by extension food security in the humid tropics with example from Umuahia-South Local Government Area (simply called Umuahia–South here) of Abia State, Southeastern Nigeria.

**Area Description**

Umuahia-South is located between latitudes 5°26' and 5°34’N and longitudes 7°22' and 7°33'E (Figure 1). Umuahia–South is thus a typical humid tropical area and situated in the tropical rainforest vegetation zone. The rainfall of the study area is about 2200mm per annum while the mean annual temperature is 27°C and the average relative humidity is over 80% (Aruocha, 2012).

Agriculture is a popular source of livelihood of the people of Umuahia-South and contributes significantly to the food consumed in Umuahia Capital city (the capital of Abia State, Nigeria). The population of Umuahia-South which was 138,570 in 2006, is mainly indigenous with about 60% of it involved in staple food production (NPC, 2007). The area covers a landmass of 140km² (Aruocha, 2012).

**MATERIALS AND METHODS**

**Data Used**

Data on two indicators of climate change namely temperature and rainfall, and those on malaria occurrence were collected and used in this study. The climatic data covering a period of 34 years were collected from the Agro-Met Unit of the national Root Crop Research Institute, Umudike, Umuahia. Those on malaria covered a period of 10 years (2002-2011) (being period with the most reliable data on the disease) were collected from the Disease Surveillance Department of Umuahia-South Local Government Area. Daily maximum and minimum temperatures were first of all transformed to mean monthly temperatures and then mean annual temperatures. Monthly rainfall totals were summed up to give annual totals. There were no missing values.

**Data Analysis**

The linear regression, correlation coefficient and student’s ‘t’ statistics were used in analyzing the data on temperature, rainfall and malaria occurrence. Linear regression may be expressed by the equation.

\[ y = a + bx \]

Where

\[ b = \frac{n \sum xy - (\sum x)(\sum y)}{n \sum x^2 - (\sum x)^2} \]

And

\[ a = \frac{\sum y}{n} - b \frac{\sum x}{n} = \bar{y} - b \bar{x} \]

While the Pearson’s Product Moment Correlation Coefficient r is:

\[ r = \frac{n \sum xy - (\sum x)(\sum y)}{\sqrt{n \sum x^2 - (\sum x)^2} \sqrt{n \sum y^2 - (\sum y)^2}} \]

And to test the significance of the coefficient, a version of the student’s ‘t’ test is employed i.e.

\[ t = \frac{r \sqrt{n-2}}{\sqrt{1-r^2}} \]

where a is the intercept; b the regression coefficient or slope; y the temperature, rainfall or malaria occurrence values; x the time in years; \( \bar{x} \) the mean time; and \( \bar{y} \) the mean temperature, rainfall or malaria occurrence values; and n is the number of years.

**RESULTS AND DISCUSSION**

The modelling of the trend in the mean annual temperature of Umuahia-South showed that \( y = 26.37 + 0.027x \), where y is the mean annual temperature; 26.37 the intercept (a); and 0.027 the slope (b) (Table 1 and Figure 2). For rainfall \( y = 2052 + 5.253x \), where y is the annual rainfall total; 2052; the intercept (a); and 5.25, the slope (b) and x is the time in years (Table 1 and Figure 3). In the case of malaria occurrence \( y = 594.8 + 232.6x \), where y is annual malaria occurrence 594.8, the intercept (a); 232.6 the slope (b); and x, the time in years (Table 1 and Figure 4). Table 1, Figure 2, 3 and 4 show that the three parameters used in this
Figure 1. Map of Study Area (Umuahia-South)

Table 1. Prediction Models for Parameters Used

<table>
<thead>
<tr>
<th>S/N</th>
<th>Parameter</th>
<th>Station</th>
<th>a(Intercept)</th>
<th>b(Slope)</th>
<th>Regression Line Equation(Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mean Temperature</td>
<td>Umudike-Umuahia</td>
<td>26.37</td>
<td>0.027</td>
<td>$Y=26.37+0.027x$</td>
</tr>
<tr>
<td>2.</td>
<td>Annual Rainfall total</td>
<td>Umudike-Umuahia</td>
<td>2052.3</td>
<td>5.253</td>
<td>$Y=2052.3+5.253x$</td>
</tr>
<tr>
<td>3.</td>
<td>Annual Malaria Occurrence</td>
<td>Umuahia-South</td>
<td>594.8</td>
<td>232.6</td>
<td>$Y=594.8+232.6x$</td>
</tr>
</tbody>
</table>
study namely mean annual temperatures; annual rainfall totals and annual malaria occurrence possess upward trends, though their increases are not at the same rate.

The results in the table and figures indicate gradual but steady increases in mean annual temperatures and annual rainfall totals while annual malaria occurrence is
increasing rapidly and steadily too. Whereas the study area is warming at an average annual rate of 0.027°C, and wetter by 5.253mm per annum, malaria occurrence is increasing at an annual rate of 232.6 (approximately 233) persons.

Subjecting the resulting correlation coefficients (and hence the trends in the parameters examined) to statistical significance, mean annual temperatures and annual malaria occurrence are significant at 95% level of confidence (See Table 2); only that of annual rainfall totals that is not significant. Thus, there is no randomness in the trends of those that are significant but random in the trend of that which is not significant, though this does not in any way mean that the positive trend of annual rainfall totals cannot affect malaria occurrence. High temperatures in combination with favourable rainfall have been found to cause an increase in the number of persons affected by diseases (IPCC, 2007). It could therefore imply that the combination of increasing annual mean temperatures and annual rainfall totals in Umuahia–South is responsible for the upward trend in malaria occurrence in Umuahia–South or is greatly contributing to it. That is, the positive trends in the climatic parameters are exacerbating the infection rate of malaria on humans.

This being the case, further increases in the upward trends of these climatic parameters would correspondingly drive the occurrence of malaria upward in the study area. This situation implies much for agriculture as malaria is not only a debilitating disease but also a killer one especially in the humid tropics of Nigeria where agriculture is still very manual making the demand on human labour very much. This is compounded by poor medical facility. As people go down with malaria or die of it, the production of food and/or fibre will be threatened. Therefore, as more people are affected by this disease in an area, nation, country or region, the more such a location would suffer from food insecurity. Little wonder therefore that Umuahia-South, an area with a combination of good soil and climate for agriculture and about 60 percent of the population involved in agriculture (Aruocha, 2012), cannot feed itself talk less of feeding the growing population of the capital city of Abia State, South Eastern Nigeria.

The effects of climate change are never the same globally (Nwagbara, 2008). Different regions are differently affected. Climate change by way of upward trends in annual mean temperatures and annual rainfall totals glaringly means a threat to agricultural production in Umuahia-South as such trends are bringing about an increase in the population of mosquitoes, and by extension an upward trend in malaria occurrence. Though such trends in some other regions could mean increase in agricultural production as ice covered surfaces are melted and more land made available for agriculture. And in some regions with such trends their agriculture may be less or more affected depending on other factors such as the presence of malaria vector (female anopheles mosquitoes), topography, forest and stagnant water.

Since the food security of Umuahia-South and environs is being negatively affected by the prevailing climatic trend as a result of increased occurrence of malaria disease, as is common in the sub-urban and rural areas of the tropics (the food producing areas), the need for well equipped health centres that are close to the people becomes expedient. Fake and expired malaria drugs and fake and /or sub standard malaria testing kits and chemicals are not helping matters. Therefore, concerted efforts by governments and people of areas/regions so affected are required for food security to be guaranteed. And regions not presently affected may need to watch out as climate change can aid the spread of malaria by making such regions favorable for the vectors (Alyshah, 2011).

### REFERENCES


Anon (2010), “Climate change one factor in malaria spread”. Science News, March 4


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**Table 2.** correction coefficient, coefficients of Determination and significance at 95% confidence level for parameters used

<table>
<thead>
<tr>
<th>S/N</th>
<th>Parameter</th>
<th>Station</th>
<th>a(Intercept)</th>
<th>$r^2$ (coefficient of Determination)</th>
<th>Calculated value</th>
<th>Table value</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Mean Annual Temperature</td>
<td>Umudike-</td>
<td>0.69</td>
<td>0.484</td>
<td>5.42</td>
<td>1.70</td>
<td>Significant</td>
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<td></td>
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<td>Umuahia</td>
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<td></td>
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</tr>
<tr>
<td>2.</td>
<td>Annual Rainfall total</td>
<td>Umudike-</td>
<td>0.20</td>
<td>0.035</td>
<td>1.15</td>
<td>1.70</td>
<td>Not significant</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Umuahia</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.</td>
<td>Annual Malaria Occurrence</td>
<td>Umuahia-South</td>
<td>0.95</td>
<td>0.907</td>
<td>8.97</td>
<td>1.86</td>
<td>Significant</td>
</tr>
</tbody>
</table>


