Rainfall, Temperature and the Incidence of Dengue in Central Visayas, Philippines Are not Correlated

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ABSTRACT

Climatic factors have been considered as agents of the transmission and spread of the dengue virus in the Philippines. This present paper investigated the correlation of two climatic factors; rainfall and temperature, to the cases of dengue fever observed in Region 7, Philippines from 2006-2010. Multiple regression analysis was utilized to determine the extent of correlation between incidence of dengue and climatic factors. Results showed no significant correlation ($r^2 = 0.2$, $p = 0.964$) between either rainfall or temperature and the prevalence of dengue cases.

Keywords: dengue fever, region 7, rainfall, temperature, climatic factors, Philippines

INTRODUCTION

The emergence and reemergence of dengue can be traced to a number of factors such as population growth and unplanned urbanization which may result in large, crowded human populations with substandard housing, poor sewage systems, inadequate water and improper disposal of garbage (Gubler 2002; Guzman and Kouri 2003). These factors, along with the deterioration of effective mosquito control services and increased human migration and travels (Ashley 2010) made major tourist destinations like the Philippines a dengue-endemic region in Southeast Asia and the Pacific region. In recent years, studies have also focused on the role of climate in human health issues, particularly vector-borne diseases.

In like manner, several studies have pointed out that factors (temperature and rainfall) concerning changes in climate considerably increase the toll from dengue infections so that the risk of a dengue epidemic becomes alarming. These factors are believed to enhance the vector–virus relationship (Shope, 1992) and thereby affect the abundance and distribution of the disease (Lindsay and Birley, 1996). However, the relationship of the climatic factors to dengue incidence remains inconclusive as provided in the contradicting evidence of Kanchanapairoj, McNeil, and Thammapalo (2000). This is also true because of the limited researches vis a vis the ill health effects of climate factors, particularly on dengue infections in the Philippines. Hence, this study aims to correlate dengue cases (DC) to temperature and rainfall for the five (5) year period from 2006 to 2010.
investigates the influence of temperature and rainfall on dengue cases in Central Visayas and thereby provides information to have a better understanding of the complex relationship between climate and health. Moreover, this will provide valuable information to medical practitioners and health officers in generating effective measures in controlling the spread of dengue infections.

METHODS

Five years’ (2006-2010) data on temperature (°C) and rainfall (mm) were collected from Philippine Atmospheric, Geophysical and Astronomical Services (PAGASA), Central Visayas Office, while dengue cases were accessed online from the Regional Epidemiology and Research Unit of the Department of Health Regional Office 7- Central Visayas. Temperature and rainfall were linked with dengue cases through multiple regression analysis and scatter plot diagrams. MINITAB software version 13 was used to perform the data analysis.

RESULTS

Monthly mean rainfall measurements and dengue cases in Central Visayas are presented in Figures 1 and 2, respectively. For the five-year period (2006-2010), the dengue cases in Central Visayas ranged from 24 to 4,228, where the highest occurred in October 2010. The monthly mean rainfall measurements varied from 0.08 mm to 360.25 mm. The highest recorded rainfall was in February 2007.

Figure 1. Mean monthly rainfall
Figure 2. Incidence of Dengue in Central Visayas

The monthly mean temperature (Fig. 3) readings varied from 26.05°C to 30.54°C, the latter being recorded in the month of May, 2010.

Figure 3. Mean monthly temperature
The scatter plot diagram (Fig. 4) shows that all dengue cases are observed to be concentrated in the category of between 0 – 10 mm rainfall, while dengue cases occurred at a temperature range of 27.5 to 28.5°C, as shown in Fig. 5. The relationship between rainfall and temperature (Fig. 6) indicates that, except for one observation, no observable changes in the climate were noted during the period 2006 – 2010.

**Figure 4.** Scatter plot of dengue cases vs rainfall

**Figure 5.** Scatter plot of dengue cases vs temperature
The corresponding regression analysis between incidence of dengue and climatic factors (rainfall and temperature) is presented in Table 1.0 below. The coefficient of determination ($r^2 = 0.2$) and $p$ – values ($p > 0.05$) are provided.

**Table 1.** Multiple regression analysis results

<table>
<thead>
<tr>
<th>Predictor</th>
<th>Coef</th>
<th>SE Coef</th>
<th>T</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1869</td>
<td>4386</td>
<td>0.43</td>
<td>0.672</td>
</tr>
<tr>
<td>Temp</td>
<td>-42.1</td>
<td>156.4</td>
<td>-0.27</td>
<td>0.789</td>
</tr>
<tr>
<td>Rainfall</td>
<td>-0.216</td>
<td>2.714</td>
<td>-0.08</td>
<td>0.937</td>
</tr>
</tbody>
</table>

$S = 946.1 \quad R$-Sq = 0.2 \quad R$-Sq(adj) = 0.0

$R$-Sq (Temp) = $R$-Sq

$R$-Sq (Rainfall) = 0.0

Analysis of Variance

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>2</td>
<td>66440</td>
<td>33220</td>
<td>0.04</td>
<td>0.964</td>
</tr>
<tr>
<td>Residual Error</td>
<td>45</td>
<td>40278792</td>
<td>895084</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>47</td>
<td>40345232</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**DISCUSSION**

The present study found out that there was no significant correlation between dengue cases and the climatic factors - temperature and rainfall - investigated within the period 2006 – 2010. Similar results on dengue cases –
rainfall relationship were also reported in Thailand (Gould et al, 1970), and Singapore (Goh et al, 1987). On the contrary, many studies confirmed the effect of rainfall on the prevalence of dengue as reported in Brazil (Goncalves Neto and Rebelo, 2004), in the Americas (Guzman and Kouri, 2003), in India (Chakravarti and Kumaria, 2005), in Thailand (Gratz, 1993; Indarathna et al, 1998; Wiwanitkit, 2005), and most recently in the Philippines (Sia Su, 2008). The differences in the reported results might be attributed to variations in the amount of monthly precipitation relative to their geographical locations.

The relationship between temperature and the prevalence of dengue cases is reported to be uncorrelated in the present study. However, this is contrary to many studies reported previously that temperature is a major factor that influences normal metamorphosis of the dengue carrying mosquitoes particularly at the larval stage (Focks et al, 1993; Hlaing et al, 1998; Tun Lin et al, 2001; Dellate et al, 2009). Although the reported temperature of the present study is within the optimum range (20 - 30°C) for survival and larval development, it is not positively correlated ($r^2 = 0.0, p = 0.789$) with the incidence of dengue. This could possibly be attributed to near constant fluctuations of temperature, considering that extreme temperature dictates survivorship (Hliang et al, 1998; Tun Lin et al, 2001; Hopp and Foley, 2001). At very high temperature, desiccation and dehydration likely occur. These conditions decrease the possibility of egg hatching as well as larval survival (Focks et al, 1993; Hlaing et al, 1998; Tun Lin et al, 2001; Dellate et al, 2009). The risk of acclimatization of the mosquito vectors, however, may also lead otherwise and promote the amplification of the incidence of dengue (Merill et al, 2005; Lounibos, 2007).

Aside from temperature and rainfall, it is believed that other confounding factors may have an influence on the transmission of the dengue virus, such as ambient temperature and humidity (Thu et al, 1998; Goncalves Neto and Rebelo, 2004), and solar radiation (Hopp ad Foley, 2001). Therefore, there is a need to include these confounding factors before concluding that the increase or decrease of dengue cases is a result of rainfall and temperature alone.

On the contrary, epidemics of dengue underrated the effects of climate factors and favors *population dynamics* and *viral evolution* (Hay et al, 2000; Gubler et al, 2001; Nitapattana et al, 2007). While these factors were prevalent in underdeveloped countries, the high incidence of dengue may have resulted from increased population and uncontrolled urbanization (Gubler, 2002; Uddin et al, 2005; Kyle and Harris, 2008; Gubler, 2011), globalization (Khan et al, 2011; Gubler, 2011), and the lack of effective vector control mechanisms (Gubler, 2011). Consequently, these dynamics were translated into inadequate supply of water (), poor sanitation (), and susceptibility to dengue infections (). If these factors continue to be eminent, increased breeding sites are anticipated and vector control will definitely become a problem (Kyle and Harris, 2008).
The prevalence of incidence of dengue is not only accounted for by climate factors or population dynamics and viral evolution; rather it requires an integrated approach – the *ecosystem approach* – such as those employed in Havana City (Diaz, 2012).

CONCLUSION

A temperature range between 27.5 to 28.5 °C and amounts of rainfall between 0 to 10mm are ideal conditions for dengue virus prevalence. At these ranges of climatic conditions, dengue cases are observable in Central Visayas. However, the non-correlation of the climatic factors, rainfall ($r^2 = 0.2$, $p = 0.937$) and temperature ($r^2 = 0.0$, $p = 0.789$), to the incidence of dengue indicates that there are other confounding climatic factors that may influence the dynamics of dengue transmission.

RECOMMENDATION

Based on the conclusion of the study, it is imperative that similar studies including other confounding factors, such as ambient temperature, humidity, pressure, wind movement, and solar radiation, must be conducted to evaluate the collective effect of dengue fever occurrence in Central Visayas. A longitudinal study that would examine all these factors collectively is also recommended.

Moreover, to fully understand the prevalence of dengue in Central Visayas, studies on *population dynamics* and *viral evolution* (i.e. population growth, urbanization, source reduction and efficacy of vector control mechanisms) are also recommended to compensate for the gap between incidence of dengue, climate factors, and spread of transmission.

LITERATURE CITED


