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RESEARCH ARTICLE

# Spatio-temporal Patterns of Dengue in Maran District from 2014-2018

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**Abstract**

Dengue fever is a systemic viral infection transmitted by the *Aedes aegypti* and *Aedes albopictus* mosquitoes to human and become endemic in more than 100 countries of Southeast Asia, America, Western Pacific, Africa and Mediterranean regions. Many studies are discussing on how to control public health issues including Dengue using temporal and spatial analysis. This study was conducted to assess the distribution of dengue cases in Maran District, Pahang from 2014 to 2018. A retrospective study was carried out in Maran by using data from e-notification system from the year 2014 until 2018 in which 634 cases of Dengue in the analysis to see patterns of Dengue in Maran. All the data regarding the cases of longitude and latitude were based on "mukim" and locality by using ArcGIS. Female and aged group (15-29 years old) were more likely to be infected by Dengue (51% and 32.2%%, respectively). Descriptive spatial analysis indicated the DF infection was normally distributed in all zones. Descriptive analyzes show a spatial Dengue infection has spread sporadically in all "mukim" with mukim Chenor was the most affected. All the pattern analysis showed clustered pattern. The factors that cause the occurrence of Dengue identified should be considered to ensure that control measures can approach to be more drastic and carried out to prevent the spread of Dengue in the Maran District.

***Keywords*:** Dengue, temporal index, socio-demographic, epidemiological, ArcGIS



## INTRODUCTION

Dengue fever is a systemic viral infection transmitted by the Aedes aegypti and Aedes albopictus mosquitoes to human (Simmons et al., 2012) and becomes endemic in more than 100 countries of Southeast Asia, America, Western Pacific, Africa and Mediterranean regions (Guzman and Harris, 2015). The weather condition in the Asian countries such as Malaysia, Thailand, Indonesia and Singapore consider as a suitable country for the dengue outbreaks. Dengue has been spreading from a sporadic disease to a major public problem due to the increase in geographical extension, the number of cases and disease severity with substantial social and economic impacts.
Malaysia has record dramatically risen annual cases of dengue infection since 1980 (Azami et al, 2011). According to the 2019 Health Facts by the Malaysian Ministry of Health, the incidence rate of dengue is 61.4 per 100,000 population with a mortality rate of 23.8. Selangor reported the largest number of cases of dengue fever among other states in Malaysia with 72,543 cases while in Pahang, the number of cases of dengue fever is 2873 (MOH, 2019).

The study of temporal and spatial analysis is the best method to create a model or picture on how to manage the disease. The Geographic Information System (GIS) is also known as another methodology in mapping cases thus helping the information of the cases to read easily. GIS is information bases that can catch, store, analyse and show information that is connected by a typical spatial organize framework and can incorporate different spatial and non-spatial information to analyse the risk of dengue cases. Dengue fever is randomly spread or will, in general, happen as a bunch over the long haul or space and thus it is very important to assess the trend of the cases. Vector-borne disease incidences and geographical are the factors influencing the disease that may include meteorological, land use, demographic and socio-economic factor (Mala et al, 2019).

## METHODOLOGY

### Study Design

The study is a retrospective study. The collection of data included demographic data and analysis on the number of dengue cases started from January 2014 until December 2018. In this study, secondary data related to dengue cases between year 2014 to

2018 was collected from Maran Health District Office. All the data regarding the cases of longitude and latitude data based on 'mukim' and locality has been filled into the *e-notifikasi* and *eDengue* system.

### Study Location

The declaration of Maran District was made through a credential that was published in number 14 of Warta Government Pahang Darul Makmur, volume 34, on 13th May 1981. Before the declaration, Maran is a part of Temerloh District and Pekan District. Maran is the tenth district out of eleven in Pahang State with its geographical coordinates at 3° 35' North 102° 46' East. It is a small town which is surrounded by isolated forest and oil palm plantations. Figure 1 shows the map of Pahang which indicates where Maran is located.


Figure 1 Map of Pahang

The Maran district which is the tenth district in the state of Pahang comprised of four areas ("Mukim") namely "Mukim" Luit (587.93 km$^2$), "Mukim" Chenor (1,169.38 km$^2$), "Mukim" Kertau (147.63 km$^2$) and "Mukim" Bukit Segumpal (90.65 km$^2$) which covers 1,995.59 km2 of land area. The total population of the Maran district is 180,000 people.

### Data Analysis

The secondary data of dengue cases was collected through e-notifikasi and eDengue to get the number of population and data about dengue cases. This study has been using GIS spatial analysis and modelling functions to achieve the objective which is to come out with a model of GIS to map the risk of dengue cases. The plotting of cases was a need to deal with the pattern of the dengue cases. The transmission of dengue cases by month is investigated and the findings were analysed into maps and charts.

The temporal analysis was used to assess the management and prevention of dengue cases. The temporal analysis was used to analyse the pattern and gap of the disease. ArcGIS 10.2 software was used to determine the analysis of Kernel Density Estimation (KDE) and the Average Nearest Neighbour (ANN). ANN analysis measures the distance between each feature and its nearest neighbour's centroid location for every year of the cases. It then averages all these nearest neighbours' distances. The average nearest neighbour ratio was calculated as the observed dengue cases in Maran District. KDE has calculated the density of Dengue infection in this study area and determined the hotspots area.

## RESULTS AND DISCUSSION

### Distribution of Dengue Cases in Maran, Pahang from 2014 to 2018

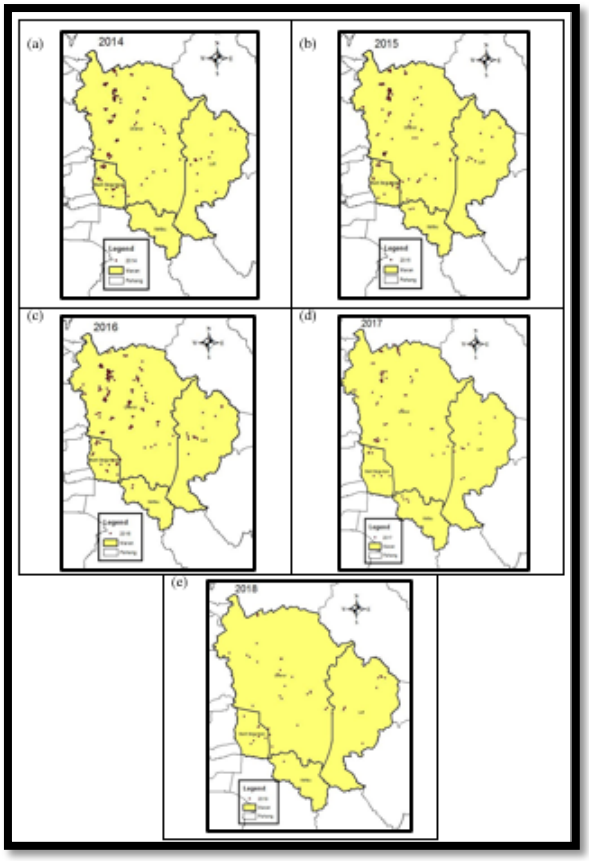



Figure 2 Distribution of Dengue Cases in Maran, Pahang between 2014 to 2018 by year (a) 2014, (b) 2015, (c) 2016, (d) 2017 and (e) 2018

Generally, a sum of 635 dengue cases were recorded between the years 2014 to 2018 in Maran District, Pahang where Chenor recorded the highest number of cases every year compared with the Bukit Segumpal, Luit and Kertau. Kertau has the least number of dengue cases every year. Figure 2 shows the distribution of dengue cases in Maran, Pahang between 2014 to 2018 by year.

Dengue cases in Maran District demonstrated a rising pattern from 2014 to 2016, however, from 2017 to 2018, the data shows a declining number of 100 cases. The reported cases of Dengue in 2016 were higher throughout the four years which are 197 cases. The increasing cases from 2016 are because of the socioeconomic factors and weather conditions. But from 2017 to 2018, it shows a decreasing pattern of Dengue cases. This map would provide the useful information to health authorities that in focusing the implementation of the control measures and prevention activities of Dengue cases from spread to the community and need to control the incidence of dengue effectively, especially when no cases are reported in any locality (Aziz et al, 2011).

**Temporal Analysis of Dengue Distribution in Maran, Pahang between 2014 to 2018**

Figure 3 shows that Chenor has higher dengue cases every year compared to the other "mukim" in Maran District while Kertau has the least number of dengue cases.

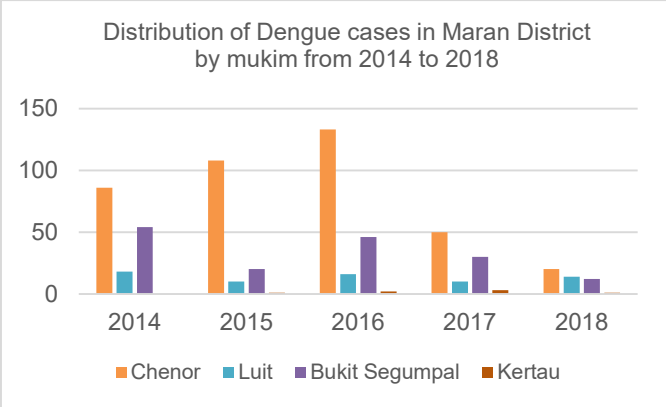
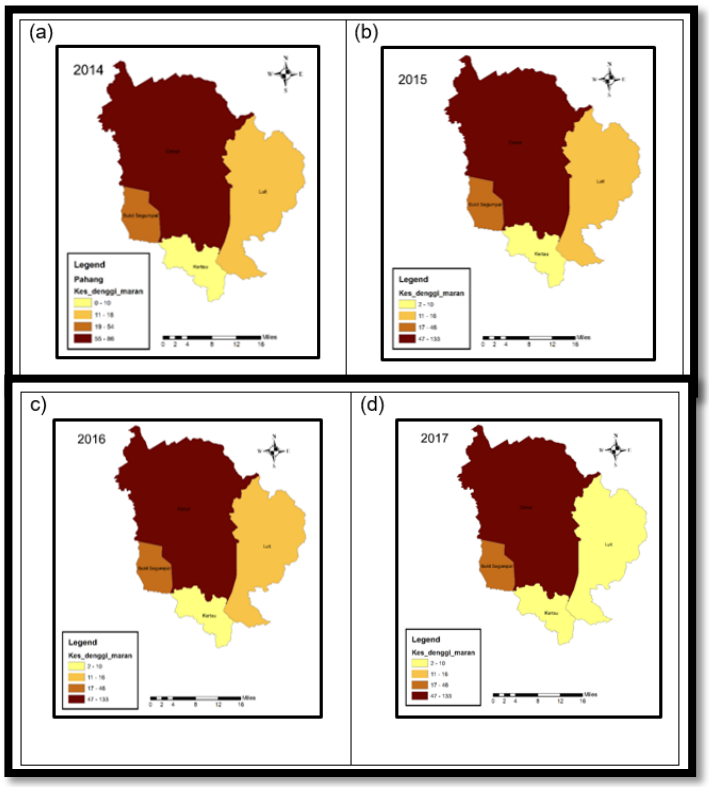



Figure 3 Distribution of Dengue cases for Maran District from 2014 to 2018 by "mukim"

The most noticeable warning of Dengue cases between 2014 to 2018 was accounted in September 2014. 32 cases of Dengue were reported to Maran Health Office during September 2014. The trend of Dengue cases shows an increasing number from June until September every year. In 2018, the Dengue cases show the lowest cases with an average number of two to four cases in each month. Figure 4 shows the distribution of Dengue cases in Maran District by month from 2014 to 2018.



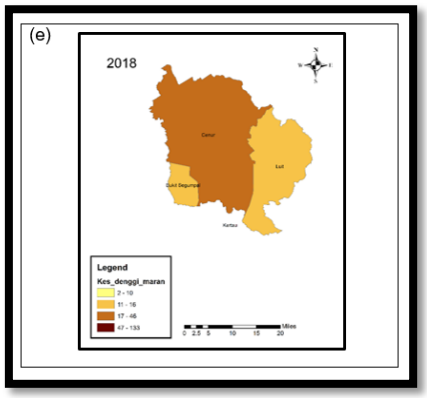




Figure 4 Distribution of Dengue Cases in Maran District by month from 2014 to 2018

**Spatial Analysis of Dengue Cases in Maran, Pahang from 2014 to 2018**

Based on the Dengue cases, the "mukims" of Maran are categorized into four classes as shown in Figure 1.4. For class 1, the indicator number of cases start from two cases until ten cases. Meanwhile, for class 2, data includes 11 cases to 16 cases. Class 3 includes 17 cases to 46 cases and Class 4 is where more than 47 cases are reported in that area. Chenor showed as Class 4 locality as they recorded the highest cases every year. Figure 5 shows the spatial distribution of Dengue cases in Maran District, Pahang by year.

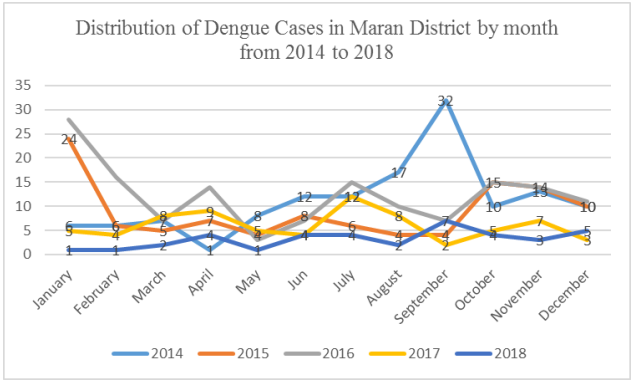



Figure 5 Spatial distribution of Dengue cases in Maran District, Pahang by year (a) 2014, (b) 2015, (c) 2016, (d) 2017 and (e) 2018

Kertau "mukim" was categorized as Class 1 locality because it recorded the least number of Dengue Cases every year which is less than ten cases. In 2018, Kertau "mukim" recorded zero cases. Bukit Segumpal "mukim" was put as Class locality as it recorded 17 cases until 46 cases every year. In 2014 and 2015, Luit "mukim" recorded 18 cases and 11 cases respectively and it was classified as Class 2 locality. In 2018, there was a sudden decrease of Dengue cases involving all the "mukims". Chenor "mukim" was the most affected locality with 20 cases recorded in 2018.

**Distance Analysis of Dengue Distribution in Maran, Pahang from 2014 to 2018**

**Average Nearest Neighbour (ANN)**

The ANN analysis was used to measure the distance between each feature and its nearest neighbour's centroid location for every year of the cases. It then averaged all these nearest neighbours' distances. The average nearest neighbour ratio was calculated as the observed dengue cases in Maran District and the target area of Dengue case is then determined as clustered, random or dispersed. Nearest Neighbour Ratio (R), z-scores and p-value are the three values that were determined for this study as shown in Table 1.

Table 1 Average Nearest Neighbour of Dengue Cases in Maran District from 2014 to 2018

| ANN Value | Year Observation (2014-2018) | | | | |
|---|---|---|---|---|---|
| | 2014 | 2015 | 2016 | 2017 | 2018 |
| Nearest Neighbour Ratio | 0.395436 | 0.395436 | 0.359202 | 0.435398 | 0.512201 |
| z-score | -14.5379 | -14.5379 | -17.2062 | -10.2469 | -6.39765 |
| p-value | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |

From the outcome of ANN analysis, it can be said that the average ratio was less than one. All the z-score and p-value were statistically significant in every one of five years where the ANN outline shows p-value less than 0.05. The pattern of Dengue cases from 2014 to 2018 could be determined as clustered. Dengue incidence from 2014 to 2018 was within the z-score of -11.33 ($p<0.001$) and spatial of Dengue incidence occurred at an average distance of 522.77 meters. Figure 6 shows the average nearest neighbour summary of dengue distribution at Maran, Pahang.

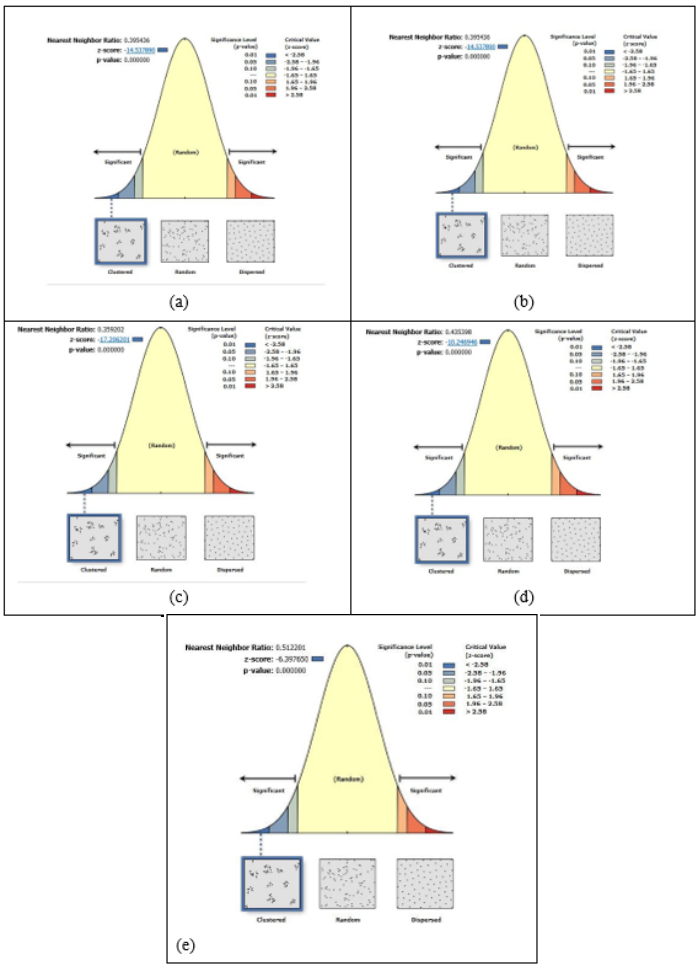



Figure 6 Dengue Distribution at Maran District, Pahang by year (a) 2014, (b) 2015, (c) 2016, (d) 2017 and (e) 2018

**Dengue Distribution Hotspot Analysis in Maran District from 2014 to 2018**

The distribution of Dengue cases recorded from 2014 to 2018 was evaluated further by analysing the Kernel Density as shown in Figure 7.

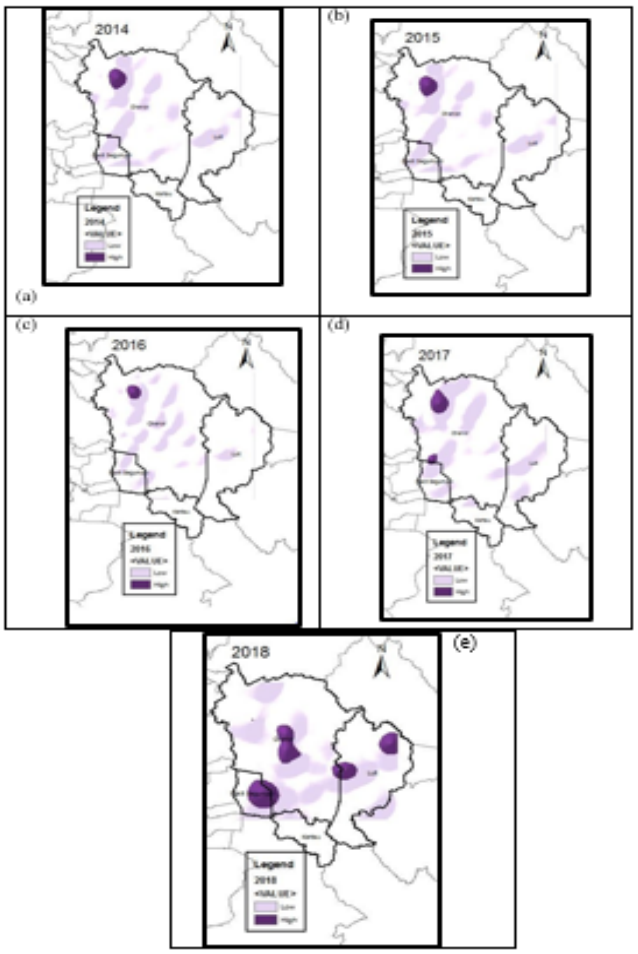



Figure 7 Kernell Density Estimation at Maran District, Pahang by year (a) 2014, (b) 2015, (c) 2016, (d) 2017 and (e) 2018

With this analysis, the location in Maran district with the highest risk of Dengue cases was identified. This analysis provided the location of the most affected area with Dengue cases. The hotspot area with a higher case of Dengue were spreading in all township especially in Chenor. It indicated the high risk of Dengue cases every year. This analysis outcome is demonstrated by using purple colour as the hotspot with a high number of Dengue cases while light purple as the hotspot area but with a low density of population and low infection of Dengue virus. In this analysis, the most density of Dengue cases was situated at Taman Desa Jaya and Taman Rantau Perintis for each year. It was the main hotspot area for every year in Maran District and therefore more effort need to be put in order to effectively control the cases from continuing to rise. From the result, the area most affected by dengue infection will identify and able to target specific area which highest incidence of dengue cases (Hazrin et al, 2016).

**Descriptive Analysis on Factors Associated With HFMD Infection Based On Socio-Demographic**

Socio-demographic characteristics of dengue cases from 2014 to 2018 divided into five categories: age, gender, race,

occupation and “mukim” are shown on Table 1.2. The age group from 15-29 years old are the most highly infected with dengue, namely with 32.2%.

Table 2 Socio-demographic of dengue cases in Maran District from 2014 to 2018

| Socio-demographic | Variables | Frequency (n) | Prevalence% |
|---|---|---|---|
| Age Groups | 1-14 | 109 | 17.2 |
| | 15-29 | 204 | 32.2 |
| | 30-44 | 173 | 27.3 |
| | 45-59 | 63 | 10 |
| | 60-74 | 76 | 12 |
| | 75-89 | 9 | 1.4 |
| Gender | Male | 309 | 49 |
| | Female | 325 | 51 |
| Race | Malay | 601 | 95 |
| | Chinese | 16 | 2.5 |
| | India | 6 | 0.9 |
| | Orang Asal | 1 | 0.2 |
| | Indonesia | 9 | 1.4 |
| | Thailand | 1 | 0.2 |
| Occupation | Government | 74 | 11.7 |
| | Farm Labour | 241 | 38 |
| | Own Work | 112 | 17.7 |
| | Student | 24 | 3.8 |
| | Unemployed | 102 | 16 |
| | House wife | 72 | 11.4 |
| | Infant | 9 | 1.4 |
| Mukim | Luit | 68 | 10.7 |
| | Chenor | 397 | 62.6 |
| | Bukit Segumpal | 162 | 25.6 |
| | Kertau | 7 | 1.1 |

## CONCLUSION

From this study, the finding on the execution of GIS for Dengue was proven effective. It was confirmed that by using GIS and spatial statistic mechanism, the spatial-temporal density of Dengue infection can be determined. Spatial mapping of Dengue cases distribution likewise may assist health agencies, epidemiologist, public health officer and authorities to encounter the dengue fever. It provides a more effective way to help the health authorities to monitor the next potential Dengue clusters systematically and through with good management without any mistake.

Although GIS cannot fix the disease from spreading to the community, it provided useful information as well as the skill to determine spatial relationship among Dengue cases location through spatial analysis. Vector control with source reduction as the main environmental control measure can suppress vector populations to very low levels, and if maintained, can prevent Dengue outbreaks every year. Other than that, the role of the community in the prevention of dengue fever is very important to ensure Aedes breeding places destroyed. Apart from that, residents can take just 10 minutes a week to find and destroy the breeding places outside the home. They can educate their children how to prevent this disease start from childhood. Health education via social media such as television, newspapers, internet, radio and through distribution flyer, banner and constructed to be intensified to tell people how dangerous this disease and the importance of dengue control and elimination in dengue disease.

## REFERENCES

Azami, N. A. M., Salleh, S. A., Neoh, H. M., Zakaria, S. Z. S., & Jamal, R. (2011). Dengue epidemic in Malaysia: Not a predominantly urban disease anymore. *BMC research notes*, *4*(1), 216-218.

Dom, N. C., Ahmad, A. H., Ishak, A. R., & Ismail, R. (2013). Assessing the risk of dengue fever based on the epidemiological, environmental and entomological variables. *Procedia-Social and Behavioral Sciences*, *105*, 183-194.

Dom, N. C., Ahmad, A. H., Latif, Z. A., Ismail, R., & Pradhan, B. (2013). Coupling of remote sensing data and environmental related parameters for dengue transmission risk assessment in Subang Jaya, Malaysia. *Geocarto International*, 28(3), 258-272.

Guzman, M. G., & Harris, E. (2005). Dengue. *The Lancet*, *385*(9966), 453-465.

Hazrin, M., Hiong, H. G., Jai, N., Yeop, N., Hatta, M., Paiwai, F & Othman, W. (2016). Spatial distribution of dengue incidence: A case study in Putrajaya. *Journal of Geographic Information System*, *8*(1), 89-97.

Mala, Suchi., & Jat, M. K. (2019). Geographic information system based spatio-temporal dengue fever cluster analysis and mapping. *The Egyptian Journal of Remote Sensing and Space Science*, 22(3), 297-304.

Mia, M. S., Begum, R. A., Er, A. C., Abidin, R. D. Z. R. Z., & Pereira, J. J. (2013). Trends of dengue infections in Malaysia, 2000-2010. *Asian Pacific journal of tropical medicine*, *6*(6), 462-466.

Simmons, C. P., Farrar, J. J., van Vinh Chau, N., & Wills, B. (2012). Dengue. *New England Journal of Medicine*, *366*(15), 1423-1432.