THE VULNERABILITY TO A DENGUE OUTBREAK IN MALAYSIA, 2003-2017: A DESCRIPTIVE ANALYSIS OF 15 YEARS DATA

Zuliana Azwa Zulkifli
zulianazulkifli@student.usm.my
Universiti Utara Malaysia

Azeem Fazwan Ahmad Farouk
azeemf@usm.my
Universiti Sains Malaysia

Dayang Haszelinna Abang Ali
dyghaszelinna@usm.my
Universiti Sains Malaysia

Norhayati Binti Mokhtar
drnorhayati_m@moh.gov.my
Ministry of Health Malaysia (MOH)

ABSTRACT

Dengue had first been reported in Malaysia in 1902 and since then, Dengue had been spread throughout Malaysia and caused a significant health burden to Malaysian. This study describe the vulnerability of dengue in Malaysia during the period of 15 years, to identify high-low risk areas among sample of studies (except Wilayah Persekutuan Putrajaya).We describe the dengue reported cases in Malaysia using data provided by the Disease Control Division Vector, Ministry of Health Malaysia (MOH) from 2003-2017. As per literature, we identify factors influencing vulnerability to infectious disease outbreak as population density, urbanization, medical care workforce, medical care infrastructure, public health delivery, safe water and sanitation, and economic strength. We test this framework to empirical cases of Dengue outbreak in Malaysia. The dataset is using widely available data (e.g. from the Department of Statistics Malaysia (DOSM) and Health Indicator Report by MOH). From 2003-2017, 829,299 cases were reported in Malaysia. The highest number was recorded in 2015 (63198, Selangor). The key findings from our assessment include a color shading table reflecting the normed scores for all the states about their vulnerability and the actual dengue reported cases. The result also conclude that the framework prediction did not match the actual outbreak reported. Recently in Malaysia, the reported cases have increased steadily in most areas. The surveillance and control strategies should be strengthened especially for the area with the most vulnerable to dengue outbreak without deprioritize least vulnerable state. Further research should be conducted to explore other drivers that may reflect the vulnerability.

Keywords: *Dengue, Vulnerability, Malaysia, State-Rank*

Introduction

This study regards vulnerability assessment as the way to conceptualize the interactions between the chosen vulnerability variables (population density, urbanization, medical care workforce, medical care infrastructure, public health delivery, safe water and sanitation and economic strength) to the empirical cases of dengue in Malaysia. Dengue is part of infectious disease and since the first case reported in 1902, Dengue and become long way become no.1 top killing infectious disease in Malaysia. (Fong and Ahmad, 2019).

The Crisis Preparedness and Response Centre (CPRC), Ministry of Health Malaysia reported that only within the year 2020 (January to May), accumulative total reported dengue cases in Malaysia were 41,234 cases (CPRC, 2020). Only by the period of January to March 2018 until January to March 2017, the increment of Dengue death is 90% as per reported by Ministry of Health Malaysia in their official Facebook account. The Ministry urges the public to take serious action against Dengue as this disease killed up to 59 persons during the first 3 month of the year 2017. Ironically, Dengue has no specific treatment and vaccine to prevent it and it was hard to predict dengue pattern of outbreak.

Highlighting the case, there are various conditions that may contribute to the worsening burden of dengue such as the growing population densities, unplanned urban development, poor water storage and unsatisfactory sanitary conditions. Some research also associated the increase dengue cases during rainy seasons but also admitted that nowadays dengue cases is recorded throughout the year (ASEAN e-Health Bulletin, 2017). Recently, the effort to eradicate dengue had been done globally and regionally. The WHO had come out with global strategy for dengue prevention and control 2012-2020; targeting the leaders in national control program, research and funding organizations and other stakeholders involved in dengue prevention and control (e.g. urban planners, water resources managers): with the main goal to reduce the burden of dengue. Various action and strategies had been listing out including: - the integrated surveillance, outbreak preparedness, sustainable vector control, future vaccine implementation and basic, operation and implementation research (WHO, 2012).

In some way, Dupas (2011) state that in comparison to developed countries, developing countries face a different range and burden of health problems due to their geographical, cultural, socio-economic and political situations. Developing countries face an additional disease burden related to geography and poverty, including tropical diseases (such as malaria, Dengue fever), food and waterborne diseases, and infectious diseases (such as HIV/AIDS). Additionally, they are more vulnerable to these diseases because they have fewer resources to adapt socially, technologically and financially. A study shows that countries that are more vulnerable to infectious disease outbreaks might be higher priorities for technical and funding support (Moore et al, 2016).

The goal of this study is to create a vulnerability framework that can use the available secondary sources about the chosen vulnerability variables, use it to match and rank the state vulnerability to dengue outbreak.

Dengue Trend in Malaysia

A report from Asean conference in 2017 reported that Malaysia is lack in capacity to analyses data to predict dengue outbreak (Asean e-Health Bulletin, 2017). The problem persists to date, Malaysia still facing the same issue with the increasing trend of dengue case reported. The number of dengue reported cases remain unpredictable and not decreasing. Looking at the trend from 2015 to 2019, the case recorded as 120836 then continues to decrease to 101357,83849,80615 but unfortunately increase tremendously in 2019 by 130101.

The Crisis Preparedness and Respond Centre (CPRC) Malaysia list 8 state with the most dengue reported cases in Malaysia were: Selangor, WP Kuala Lumpur, Johor, Sabah, Perak, Kelantan, Negeri Sembilan and Pahang (as at December 2019- June 2020). Total of reported case is had reach 50511 within that stipulated period (Kementerian Kesihatan Malaysia, 2020) .This figure requires further explanation as the COMBI had been implemented since 2001 with increasing number of volunteers, dengue issue had been within the common discussion among policymakers since 2006 lead to budget allocation provided adequately. More importantly, in 2013, Dengue Task Force Committee had been set up. But why the case number do not continue to be decreasing?

The researcher estimates worsening trend for dengue reported cases recently due to the outbreak of Covid-19. Due to the pandemic, Malaysia implementing Movement Control Order (MCO) since 18th March 2020 (continues until today with less stricter movement order), lead to abandon construction site and many cleaning services which previously may help to demolish the dengue breeding site. The CPRC Malaysia on 9th August 2020, urge the public to raise their attention not only in fighting Covid-19 but also the dengue as per the high number of dengue reported death starting since 2020. 106 death had been recorded and the highest reported cases are in Selangor, Johor and Sabah (CPRC Malaysia, 2020).

Dengue Vulnerability Assessment

The topic of dengue vulnerability assessment is proven an idealistic topic to be researched. In the past ten years, the "dengue vulnerability assessment" has become predominantly important in order to assess the country's ability to prevent or contain a dengue outbreak in conjunction with increasing number of dengue reported cases worldwide. There is a need to define target areas for control measures when the transmission of dengue outbreak is most serious. However, this is a challenge in areas without adequate data and technical resources to develop predictive models and early warning systems, including low-income regions and newly endemic areas that have not been identified (Eisen and Eisen, 2011). Additionally, vulnerabilities level should be clear on *where* the most vulnerable and *what* contributes to their vulnerabilities. Hence, recent studies are

welcoming the development of the rigorous and quantitatively based tool to assess the vulnerability and resilience of countries to infectious disease (Moore et.al (2016).

The issue lead to problems that require the urgency to get the more robust, practical and feasible vulnerability assessment. Traditionally, vulnerability factors listed are relationship between human and environment, but more recent studies listed more factors such as demographic, health care, public health, disease dynamics, economic, political-domestic and political- international. However, there has been little work exploring to what extend these factors is applicable and able to be replicated in the regional level perspective, such as Malaysia. Hence, this study highlighted the level of replication of the dengue vulnerability assessment framework.

There is a substantial body of research concerning vulnerability frameworks in dengue that can guide the instructional design, such as the Water-Associated Disease Index (WADI) and the Infectious Disease Vulnerability Index (IDVI). The WADI provide best framework to illustrate dengue vulnerability assessment, meanwhile the IDVI provide the recent infectious disease vulnerability assessment. However, the result from this vulnerability assessment may sometimes associated negatively with number of dengue reported cases, more empirical research is needed. Hence, this study intends to fulfil the gaps of knowledge for methodological.

To this period, not much studies had been done by matching the framework. The present study adds to the limited based on integrating WADI and IDVI elements to vulnerability assessment involving the dengue outbreak. Besides that, the "vulnerability assessment variables" such as demographics, healthcare, public health and economics had widely been discussed by previous studies but rarely focus on regional scope creating the new methodological gap. Most studies rather highlighting international cases (Moore et.al, 2016; Z Gelfeld, 2015, Fullerton et.al, 2014) and countries cases (Dickin et.al, 2013); (Dickin & Schuster-Wallace, 2014). More importantly, there are limited number of studies have using time series or panel data in doing vulnerability assessment compared to 15 years of duration as per this study. In other perspective, it is impossible to summarize simply the discussion on dengue vulnerability assessment without doing the ranking analysis. Hence, the aim of the present studies is to indicate the level of the state vulnerability to dengue outbreak based on the case of dengue in Malaysia from the year 2003 to 2017.

Methodology

The research objective is to indicate the level of vulnerability among the states in Malaysia and use dengue reported case (as the empirical examples) for the year 2003 to 2017 or in exact to identify the ranking of the state vulnerability to dengue outbreak by using descriptive statistics analysis. First, general overview on the number of dengue reported cases is being analyses and rank as per percentage. Then, the dataset is being transform into range to create data standardization. The range normalization/scaling the data chosen based on the range of 0 to 1. The numerical score is created whereby between 0 (worse) to 1 (best), (except for population density

and urbanization, vice versa). Missing value is being compensate through interpolation method. Lastly, this study matching the data with the dengue reported case (as the empirical examples).

This study locates the sources of secondary data firstly based on the report and publication by the government for example, the DOSM website and MOH website. Most of the information listed from this website are readily access to the public without restriction. The data collection is based on their variables.

Table 1 Data Measure and Sources

Variables	Measure	Sources
Population Density	Persons per square km (High=bad)	DOSM
Urbanization	Percentage of persons living in urban areas (High=bad)	Health Indicators (MOH)
Medical Care Workforce	Numbers of doctors under MOH (High=good)	Health Indicators (MOH)
Medical Care Infrastructure	Numbers of hospital bed under MOH (High=good)	Health Indicators (MOH)
Public Health Delivery	Percentage coverage with third dose of Diphtheria, Tetanus and Pertussis (DTP) vaccine (High=good)	Health Indicators (MOH)
Safe Water and Sanitation	Houses Covered with Safe Water Supply in Rural Area (High=good)	Health Indicators (MOH)
Economic Strength	GDP per capita (High=good)	DOSM
Dengue Reported Cases	Numbers of dengue reported cases (High=bad)	Dengue Control Division, MOH

Range Normalization

The chosen range is 0 to1. In order to scaling the number from 0 to 1 range, the formula below is being used: -

$$y = \frac{(x - \min(d) * (\max(n) - (\min(n))}{\max(d) - \min(d)} + \min(n)$$

Notice the following values need to be known:
The maximum/highest value in the data: max(d)
The minimum/lowest value in the data =min(d)

The maximum/highest value in the new range = max(*n*)
The minimum/lowest value in the range = min (*n*)
Input value=*x*
Based on the formula, the dataset is being transformed – for all the states are presented as normed values between 0 (worse) to 1 (best), (except for population density, urbanization and number of dengue reported cases, vice versa).

Discussion

Figure 1 Total Dengue Reported Cases in Malaysia, 1999 to 2019

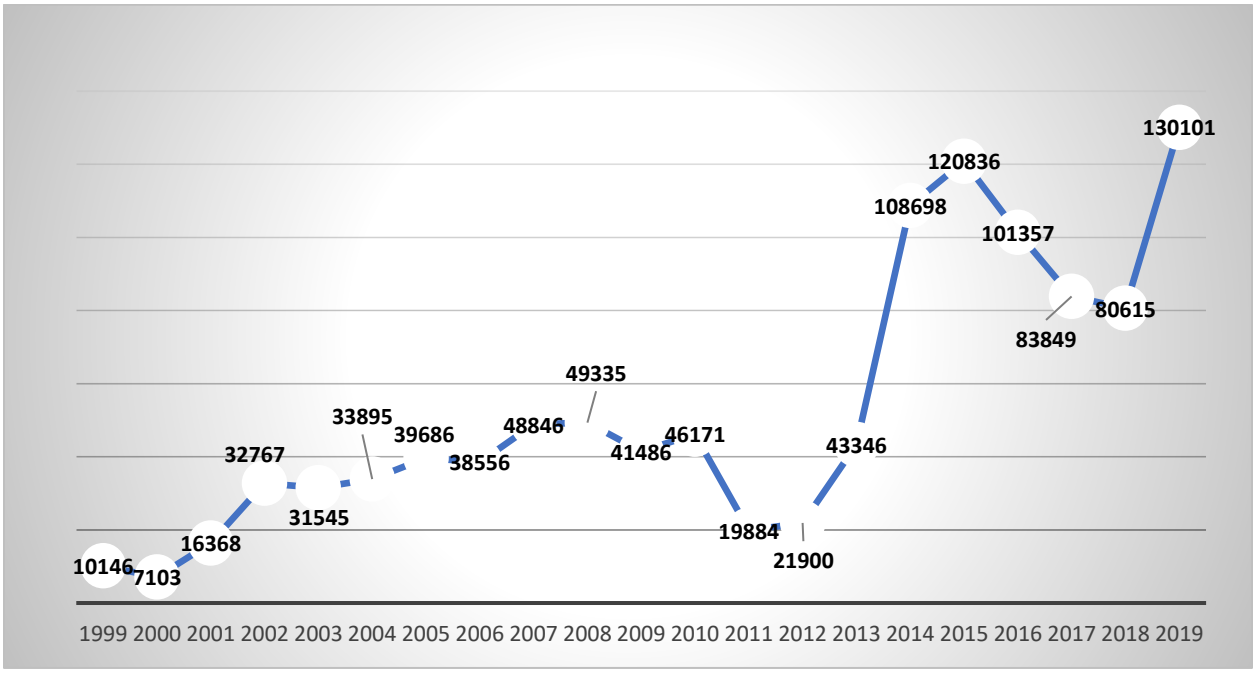

Figure 1 shows the dengue reported cases in Malaysia from the year 1999 to 2019. It was 2 decade of dengue trend recorded. From figure, the trend is fluctuated but obviously the trend is increasing with only 31545 cases in 2003 but 83849 in 2017. The reported cases are also dramatically high in those recent years of 2014 to 2019, with peak indication in year 2015 by 120836 cases. From the analysis, research found that there the pattern of reducing trend unable to sustain for period more than one year regardless various dengue preventive programmed, and strategies had been set up by the government.

Table 2 Ranking for Dengue Reported Cases Based on State in Malaysia, 2003-2017

State	Ranking for Dengue Reported Cases	Total Number of Cases	Percentage
Johor	3	74910	9%
Kedah	11	19165	2%
Kelantan	5	47625	6%
Melaka	12	18497	2%
Negeri Sembilan	8	26090	3%
Pahang	9	25015	3%
Perak	4	56570	7%
Perlis	14	3405	1%
Pulau Pinang	6	36052	4%
Sabah	10	23179	3%
Sarawak	7	28752	4%
Selangor	1	368276	44%
Terengganu	13	16297	2%
WP Kuala Lumpur	2	85189	10%
WP Labuan	15	368	0%
Total		829390	100%

In order to further indicate the level of vulnerability among the states in Malaysia, Table 2 illustrate the total number of dengue outbreak from the year 2003-2017, indicating the areas of concern. Each of the time series contains 225 observations, which are collected in yearly frequency from 2003 to 2017. Total number of dengue reported cases was 829390, with average of 55292 cases per year. By far the highest count are in Selangor with by 368276 cases that approximately 44% out of total percentage of dengue outbreak. The dengue outbreak in WP Kuala Lumpur (10%) and Johor (9%) have also had some of the largest outbreaks but still the number is for times higher in Selangor. In contrast, state with lowest reported cases are Perlis (1%) and WP Labuan (0%).

Table 3 Total Summary (2003-2017) State Vulnerability Level

State	PD	UR	MCW	MCI	PHD	SWS	ES	DEN
Johor	0.31942	8.35008	4.26583	10.5593	11.3976	13.7511	2.42873	1.18532
Kedah	0.38336	4.68111	3.00374	5.599	10.5981	12.2853	1.21214	0.30325
Kelantan	0.18252	2.16222	2.25062	4.01039	9.37685	4.48106	0.54699	0.75358
Melaka	0.92839	10.4198	1.70568	2.36248	11.1702	13.8888	3.43308	0.29268
Negeri Sembilan	0.27723	6.76012	2.37408	3.68995	11.2052	13.726	3.29316	0.41283
Pahang	0.0492	3.74048	2.4165	4.67219	11.007	12.909	2.54796	0.39582
Perak	0.19385	7.32444	4.16034	12.006	10.7807	12.8834	1.89509	0.89512
Perlis	0.54969	3.11035	0.60299	0.78325	10.3232	13.275	1.61492	0.05388
Pulau Pinang	3.03097	11.7285	3.03411	4.69464	11.5453	13.4038	4.16239	0.57046
Sabah	0.05495	4.79745	3.40473	9.31273	11.7758	10.4102	1.56277	0.36677
Sarawak	0.00478	4.609	3.40586	8.64372	10.9392	11.6458	4.17584	0.45495
Selangor	1.37436	12.5457	7.53216	10.6854	11.1133	13.8544	3.81894	5.82734
Terengganu	0.13054	5.19531	1.91767	3.29112	10.8938	12.2386	2.38759	0.25787
WP Kuala Lumpur	13.9003	15	4.63913	5.50972	8.57812	14.2917	8.72386	1.34797
WP Labuan	1.8999	10.7442	0.03778	0.02982	12.7397	14.3655	5.1835	0.00582

*The color shading is arranging from red (most vulnerable) to green (least vulnerable), however for the value of population density, urbanization and number of dengue reported cases is different from other variables. These variables indicate that high number is bad whereas others shows that high number is good (for variable such as medical care workforce, medical care infrastructure, public health delivery, safe water and sanitation and economic strength).

Table 3 shows the result for overall state vulnerability level. From the table, if the vulnerability score is being sum up, all the state is vulnerable considering their population density, urbanization and dengue reported cases. This due to these variables are experiencing increasing in number every year despite the increment is not a good sign for the case of dengue outbreak. For the variables such as medical care workforce, only Terengganu, WP Kuala Lumpur, Perak and Johor have a bit least vulnerable compared to others (turning slightly to green) to indicate that this 4 states have better in term of medical care workforce compared to the rest of the state. Same goes to medical care infrastructure. Only 5 state indicate least vulnerable (Johor, Perak, Sabah, Sarawak and Selangor) due to the number of medical infrastructures is higher compared to others. Same goes to economic strength. All the state (except Wilayah Persekutuan Kuala Lumpur) indicate red color showing that this area needs to be improved in term of their vulnerability.

Differently, the color shading result shows that in the aspect of public health service delivery and safe, water and sanitation, all the state are considered as least vulnerable. Only Kelantan have the issue in safe, water and sanitation. This indicate that both two elements should be maintaining as Malaysia had reach good indicator. Overall, the color shading help to indicate state vulnerability based on their strength and weaknesses. The continuing effort being done by this study to provide the state-rank based on these results to ensure that the prediction is helpful and rigorous. Further information is reflected in Table 4.

Table 4 State Vulnerability Ranking from Most Vulnerable to Least Vulnerable

State	Population Density	Urbanization	Medical Care Workforce	Medical Care Infrastructure	Public Health Delivery	Safe Water and Sanitation	Economic Strength	Ranking Vulnerability Score	Ranking for Dengue Reported Cases
Johor	8	6	13	13	12	11	7	14	3
Kedah	7	11	8	10	4	5	2	4	11
Kelantan	11	15	5	6	2	1	1	2	5
Melaka	5	5	3	3	10	13	10	5	12
Negeri Sembilan	9	8	6	5	11	10	9	9	8
Pahang	14	13	7	7	8	7	8	11	9
Perak	10	7	12	15	5	6	5	10	4
Perlis	6	14	2	2	3	8	4	1	14
Pulau Pinang	2	3	9	8	13	9	12	8	6
Sabah	13	10	10	12	14	2	3	12	10
Sarawak	15	12	11	11	7	3	13	15	7
Selangor	4	2	15	14	9	12	11	13	1
Terengganu	12	9	4	4	6	4	6	3	13
WP Kuala Lumpur	1	1	14	9	1	14	15	7	2
WP Labuan	3	4	1	1	15	15	14	6	15

To what extent this vulnerability assessment able to predict and rank the state vulnerability to the dengue outbreak correctly? In order to interpret this result, Table 4 concludes by ranking of 1-15, 1-5 (most vulnerable), 6-10 (medium vulnerable) and 11-15 (least vulnerable).

Most Vulnerable State in Malaysia

Examining the 3 most vulnerable state (Table 4) reveals few surprises as the ranking is Perlis (1), Kelantan (2) and Terengganu (3). Several notable trends emerge from this result, these three state, Terengganu and Kelantan (except Perlis) both considered under least vulnerable based on population density and Kelantan and Perlis (except Terengganu) both considered as least vulnerable. By considering these two variables (population density and urbanization), these three states should not be rank as the most vulnerable state.

However, despite good indicator for previous variables, these three-state having the most vulnerable aspect in other variables such as medical care workforce, medical care infrastructure, public health delivery, water and sanitation and even economic strength. Overall, based on those mentioned variables, the state rank most vulnerable except for Kelantan in medical care infrastructure (rank medium vulnerable), Terengganu in public health delivery and economic strength (rank medium vulnerable) and Perlis in safe water and sanitation (rank medium vulnerable).

This finding shows that the rank is contradicting the real scenario of dengue reported case. The ranking for dengue reported case is Selangor (1), Wilayah Persekutuan Kuala Lumpur (2) and Johor (3).

Least Vulnerable State in Malaysia

The three least vulnerable state are Sarawak (15), Johor (14) and Selangor (13). The justification is due to the score in most variable assesses (especially medical care workforce and medical care infrastructure) indicate that these states is among least vulnerable with rank range of 11-15. Likewise, in the aspect of safe water and sanitation and economic strength. For safer water and sanitation, both Johor and Selangor (except Sarawak) considered under least vulnerable. For economic strength Sarawak and Selangor (except Johor) considered under least vulnerable. The trend analysis indicates that for population density and urbanization, only Sarawak considered as least vulnerable.

Again, this result contradicting the actual dengue reported cases as for least vulnerable state, the ranking should be Wilayah Persekutuan Labuan (15), Perlis (14) and Terengganu (13). The state as per prediction, especially Selangor is the most vulnerable state as per actual incidence.

Dengue Outbreak as Empirical Examples

From the table 4, analysis shows that every state has their own strength and weaknesses as per estimated variables. This result also summarizes that the prediction (ranking vulnerability score) is not accurately occur as per real case (number of dengue reported cases) if the count combining vulnerabilities component. A case to point is Selangor. Selangor is the state that recorded the highest number of dengue reported cases as supposedly, it should be listed as the most vulnerable state for dengue outbreak. However, in our prediction (ranking vulnerability score), the result is also contradicting as Selangor rank number 13 (implies as among the most least vulnerable state after Johor and Sarawak).

The result indicates that in most cases, the range gap is 26.6% (weak), 40% (medium) and 33.33% (strong). Overall, it is concluded that the framework is almost devastating to predict dengue outbreak.

Conclusion

In conjunction with increasing risk to Malaysia posed by Dengue outbreak, it is essential to have clear understanding of current vulnerabilities across the state-*where* the most vulnerable state is and *what* contributes most to their vulnerabilities. This study develop dengue vulnerability assessment tool as per Malaysia landscape as a tool to help identify states that are potentially most vulnerable to dengue outbreak due to a confluence factors such as, population density, urbanization, medical care workforce, medical care infrastructure, public health delivery, safe water and sanitation and the economic strength.

However, this insignificant result does not mean this study should be eliminating. In every research, no social sciences theories and researchers able to guarantee 100% of their result will follow their hypothesis and prediction. Moreover, this study is experimental. Experimental study has lots of hypothesis need to be tested and if the result is not significant, it requires justification and maybe able to shows that there are possibilities to further discover in other aspect in the future studies.

This information can help the government and the relevant state actors to allocate and prioritize their program as per their area of weaknesses proactively in order to decrease the number of dengue outbreak. Despite this tool is almost reliable indicate the dengue outbreak scenario in Malaysia, it is undeniable that it is an interactive tool. The end users may change the variables or the measure to reflect their beliefs or changing realities on the ground. This tool is intended to identify high-low risk areas among sample of studies, and we had witnesses that result is almost devastating to reflect dengue outbreak. Others would do better to take-more extensive measure to address the vulnerability to dengue outbreak at state level in Malaysia in advance of future case. This approach seeks to visualize a good concept or method that has the potential to measure dengue susceptibility but does not yet mean it is effective.

References

Asean e-Health Bulletin. (2017). The Asean Dengue Day: Sustaining the United Against Dengue. In ASEAN (pp. 1–16). ASEAN eHealth Bulletin. https://asean.org/storage/2017/02/19-e-Health-Bulletin-11th-Issue_Final-printing.pdf

Department of Statistics Malaysia, (n.d.), Malaysia @ a Glance. In the Source of Malaysia's Official Statistics. [Online]: https://www.dosm.gov.my/v1/index.php?r=column/cone&menu_id=ZmVrN2FoYnBvZE05T1AzK0RLcEtiZz09 (Retrieved June 15, 2020)

Dickin, S. K., & Schuster-Wallace, C. J. (2014). Assessing changing vulnerability to dengue in northeastern Brazil using a water-associated disease index approach. Global Environmental Change, 29(2014), 155–164.

Dickin, S. K., Schuster-Wallace, C. J., & Elliott, S. J. (2013). Developing a Vulnerability Mapping Methodology: Applying the Water-Associated Disease Index to Dengue in Malaysia. PLoS ONE, 8(5), e63584.

Disease Control Division Vector (2020). Kes Demam Denggi Malaysia Tahun 1999-2019.- Dr Norhayati, M, Infectious Disease Control Sector – Dengue Control Unit. Ministry of Health Malaysia (MOH).

Dupas, P. (2011). Health Behavior in Developing Countries. Annual Review of Economics, 3(1), 425–449. https://doi.org/10.1146/annurev-economics-111809-125029

Eisen, L., & Eisen, R. J. (2011). Using Geographic Information Systems and Decision Support Systems for the Prediction, Prevention, and Control of Vector-Borne Diseases. Annual Review of Entomology, 56(1), 41–61.

Fong, L. F., & Ahmad, R. (2019, December 1). Number of dengue cases set to hit all-time high | The Star. Www.Thestar.Com.My. [Online]: https://www.thestar.com.my/news/nation/2019/12/01/number-of-dengue-cases-set-to-hit-all-time-high (Retrieved June 15, 2020)

Fullerton, L., Dickin, S., & Schuster-Wallace, J. (2014). Mapping Global Vulnerability to Dengue using the Water Associated Disease Index. [Online]: https://reliefweb.int/sites/reliefweb.int/files/resources/Mapping%20Global%20Vulnerability%20to%20Dengue%20using%20WADI%20-%20full%20paper.pdf (Retrieved June 15, 2020)

Gelfeld, B., Efron, S., Moore, M., & Blank, J. (2015). Mitigating the Impact of Ebola in Potential Hot Zones: A Proof-of-Concept Approach to Help Decisionmakers Prepare for High-Risk Scenarios Outside Guinea, Liberia, and Sierra Leone. Www.Rand.Org.[Online]: https://www.rand.org/pubs/perspectives/PE146.html (Retrieved June 15, 2020)

Health Indicators 2003. (2003). In Ministry of Health Virtual Library (p. 153). Information and Documentation System Unit, Planning and Development Division, Ministry of Health Malaysia. [Online]: http://vlib.moh.gov.my/cms/content.jsp?id=com.tms.cms.document.Document_32ccdee2-a0188549-72493700-1f678010

Kementerian Kesihatan Malaysia. (2020, June 16). KEMENTERIAN KESIHATAN MALAYSIA. Www.Facebook.Com.[Online]: https://www.facebook.com/kementeriankesihatanmalaysia/photos/a.390879946236/10157140902906237/(Retrieved June 15, 2020)

Moore, M., Gelfeld, B., Okunogbe, A. T., & Paul, C. (2016). Identifying Future Disease Hot Spots: Infectious Disease Vulnerability Index. Www.Rand.Org. [Online]: https://www.rand.org/pubs/research_reports/RR1605.html(Retrieved June 15, 2020)

National Crisis Preparedness & Response Centre (CPRC), K. K. M. (2020, April 28). Current Situation of Dengue, Chikungunya and Zika in Malaysia for the Year 2019 and 2020 (19th April until 25th April 2020). Www.Facebook.Com. [Online]: https://www.facebook.com/CPRCKebangsaanKKM/posts/1335661206626560 (Retrieved June 15, 2020)

WHO (2012). Global Strategy for dengue prevention and control, 2012–2020. In WHO Report (p. 43). WHO. [Online]: https://apps.who.int/iris/bitstream/handle/10665/75303/9789241504034_eng.pdf;jsessionid=3F7406689C3C3EC7842A68D3D83CCE55?sequence=1 (Retrieved June 15, 2020)