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Weather Implication for Dengue Fever in Jakarta, Indonesia 2008-2016

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Abstract

Dengue Fever is an endemic disease that occurs throughout the year. It is caused by the dengue virus and is transmitted by mosquitoes, especially Aedes aegypti. Weather factors such as temperature, rainfall, and humidity are the optimal conditions for mosquitoes to breed. The purpose of this research is to know the relationship of dengue fever with weathers factors (temperature, rainfall, and humidity) in *Daerah Khusus Ibukota* (DKI) Jakarta in 2008-2016. This research is descriptive with ecological study design. The data source is secondary data from DKI Jakarta Health Office for Dengue Hemorrhagic Fever case and Jakarta Central Bureau of Statistics for climate data. Correlation test is used to know the strength and direction of the relationship between independent variable and dependent variable. The results show a significant relationship between weather variables that have been studied; temperature (p-value <0.05, r = -0.264), rainfall (p-value <0.05, r = 0.210), and humidity (p-value <0.05, r = 0.504); and dengue fever cases in DKI Jakarta in 2008-2016. In conclusion, there are two weather variables that have a positive correlation to dengue fever cases; they are rainfall and humidity. While the temperature has a negative correlation. The highest correlation to dengue fever cases is humidity it is strong. While others such as temperature and rainfall are in the category of moderate and weak correlation, respectively.

Keywords: Dengue fever, temperature, rainfall, and humidity

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1. Introduction

Dengue fever is an infectious disease caused by one of four different dengue virus and transmitted by mosquitoes, especially *Aedes aegypti* and *Aedes albopictus* found in tropical and subtropical regions [1, 2]. In tropical and subtropical areas, Dengue fever is an endemic disease that occurs throughout the year, especially during the rainy season when optimal conditions for mosquitoes multiply and usually large numbers of people will be infected in a short time (epidemic) [3]. The disease is still one of the world's health problems because it is estimated to affect 200-500 million people annually and other studies suggest dengue prevalence, counting 3.9 billion people in 128 countries at risk of dengue virus infection [2].

Dengue fever is one of the most painful diseases of climate change [5]. It is estimated that this disease will explode in 2080, about 6 billion people will be at risk of contracting dengue as a consequence of climate change, compared to 3-5 billion people if the climate remains unchanged. It can be said that global warming contributes to the disease of the vector [2.6]. Climate change affects the development of mosquito vector causes of dengue through various ways such as weather elements that affect the metabolism, growth, development, and population of these mosquitoes and rainfall with relatively long irradiation affect the habitat of the mosquito breeding [7–9].

The increased of rainfall will elevate the humidity and the temperature level. This will support all mosquitos activity including prolonged life and reproduction. *Aedes aegypti* vectors will grow optimally at temperatures of 20^0-28°C. Longer mosquitoes increase the chances for dengue virus to resolve its extrinsic incubation period. If the mosquito becomes more infectious toa warmer temperature, it has a greater chance of infecting humans before they die [3].

Indonesia is one of the countries in the tropics and one of the dengue-endemic countries in Southeast Asia. Recorded in 2015, as many as 126.675 dengue fever patients in 34 provinces in Indonesia and 1.229 of them died. The number is higher than the year 2014 as many as 100.347 people with dengue fever, and 907 patients died [4]. DKI Jakarta Province is one of the provinces with a high number of dengue fever cases. DKI Jakarta Province is the third province in Java with an incidence rate of DHF of 48.67 per 100.000 population [4]. The high population and weather changes in DKI Jakarta, especially in the rainy season with high rainfall, ideal air temperature, and appropriate relative humidity, are perfect spaces to support mosquito breeding and breeding sites and the increasing population of *Aedes aegypti* mosquitoes [4]. This study uses three weather variables that become independent variables, namely temperature, humidity and rainfall that aims to determine the effect of weather factors on the occurrence of dengue cases in DKI Jakarta 2008-2016.

2. Methods

This study was conducted in DKI Jakarta due to the number of dengue fever cases and the availability of dengue fever case data throughout nine years (2008-2016) (table 1), plus the total area of DKI Jakarta covering 662.33 km^2 with the entire population of DKI Jakarta 10.187. 595 people [10] with a population density of 1 km2 on average there were 15.105 inhabitants. Population density factors may affect the incidence of dengue fever. This research is quantitative with descriptive analysis using ecological design study. Knowing the effects of weather factors affecting Dengue fever cases in Jakarta 2008-2016.

The data used in this study is secondary data from 2008 to 2016 on a monthly basis. Data on Dengue fever incidence were from DKI Jakarta Health Office and climate data, mean temperature, mean rainfall, and cumulative humidity came from Jakarta Central Bureau of Statistics taken from data of Meteorology Climatology and Geophysics Agency. Data on rainfall and dengue incidence are presented in table form described as monthly change for nine years (2008-2016). Statistical analysis used is correlation analysis to answer the correlation between weather factor with dengue fever case, where the relationship direction, and how significant the correlation and reason of DKI Jakarta many incidents and its cause factor. In this study used the Pearson test with numerical measurement scale as well as normally distributed data and the alternative test is the Spearman test if the data is not normal [11].

Table 1: The incidence of Dengue fever in DKI Jakarta 2008-2016.

Nama Wilayah	Tahun									Total
	2008	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	
Jakarta Pusat	3.458	3.180	3.596	1.264	1.294	1.783	1.760	1.002	3.463	20.800
Jakarta Utara	4.052	5.572	4.784	2.545	2.185	3.721	3.628	3.307	6.555	36.349
Jakarta Barat	4.524	3.513	4.860	1.781	2.269	3.101	3.544	2.089	8.485	34.166
Jakarta Selatan	7.063	7.187	6.850	2.045	2.704	4.396	4.572	2.370	8.864	46.051
Jakarta Timur	9.010	8.777	8.609	3.156	3.802	6.291	4.916	3.178	12.271	60.010
Kep. Seribu	1	7	3	12	12	7	18	19	20	99
Jumlah	28.108	28.236	28.702	10.803	12.266	19.299	18.438	11.965	39.658	197.475

3. Results

The number of Dengue fever cases in Jakarta during the period of 2008-2016 shows an increase in incidence every year [12]. Recorded cases of Dengue fever in Jakarta for nine years as many as 197.475 people who suffer (table 1). The highest number of cases was 39.658 cases, occurred in 2016 and the most areas with dengue fever cases were East Jakarta. Description of the incidence of dengue fever cases is in table 1.

Table 1 present of Dengue fever cases in Jakarta every month during the period of 2008-2016 fluctuated. A high case occurred between February and April. Cases have decreased from July to October and again rose in November to January. The average claim in the month is between 3500 to 7000. The highest case occurred in April 2016 of 7.273 cases and the lowest 320 cases in October 2012.

The result of the correlation between temperature, rainfall, and humidity shows that they have a significant relationship to Dengue fever during 2008-2016 in DKI Jakarta. Weather and climate affect the pathogenesis of different diseases and in different ways. One of the effects of climate change is on the potential increase in the incidence of mosquito-borne diseases such as malaria, filariasis, Japanese encephalitis, and dengue fever. Changes in temperature, humidity and wind speed can increase populations, prolong life and expand the spread of vector, increasing in cases of infectious diseases such as malaria, dengue fever, schistosomiasis, filariasis and pes [13].

From correlation analysis, it shows that rainfall and humidity has a positive correlation to dengue fever cases. While temperature has a negative relationship. The highest correlation value is humidity with a strong category. While the other is the temperature and rainfall is in the category of moderate and weak correlation (table 2).

Temperature and incidence of Dengue fever for 9 years (2008-2016) in Jakarta varied every month between from 26.3˚C to 30.2˚C. The average temperature in January to March is in the range of 26.3˚C-27.4˚C followed by an increase in dengue cases. After that,t the temperature rose in October between 29˚C-30.2˚C where the number of Dengue fever incidence decreased during this period. The temperature dropped again in November-January between 26˚C-28˚C and the number of dengue cases increased. Temperature picture affects the occurrence of dengue fever described in Figure 2.

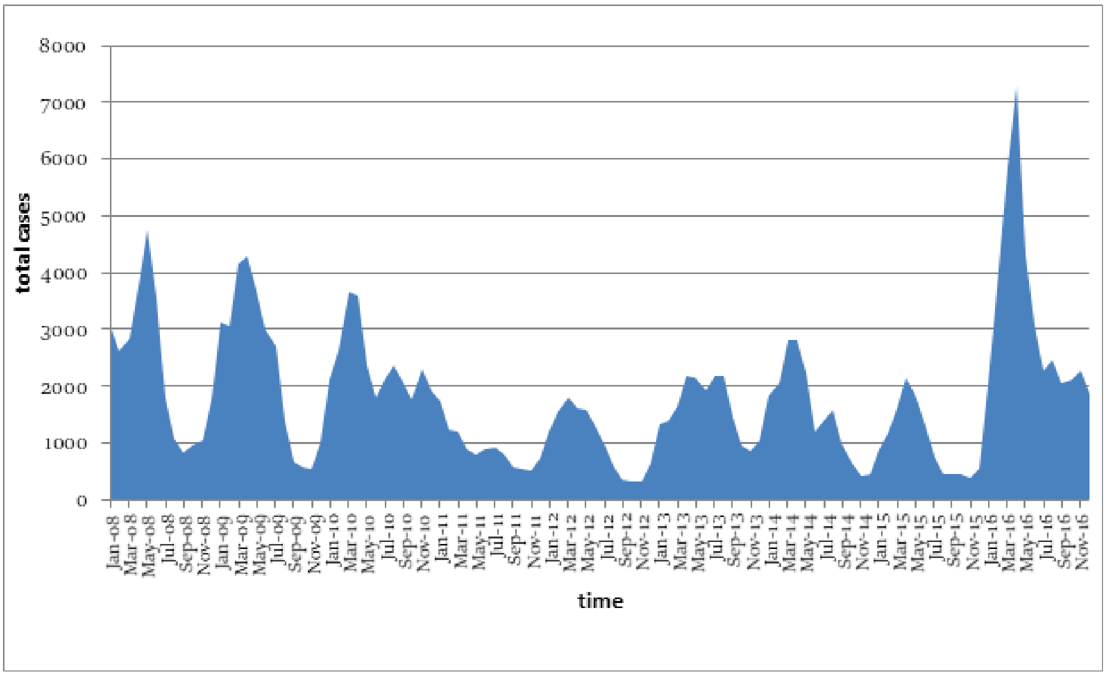

Figure 1: Cases of dengue fever per month/year in DKI Jakarta 2008-2016 .

Table 2: Correlation between weather factors (temperature, rainfall, and humidity) and Dengue fever in DKI Jakarta 2008-2016.

Variabel	Dengue Fever		
	p value	r	Information
Temperature	0.005	-0.264	Negative correlation, meaningful relationship
Rainfall	0.001	0.210	Positive correlation, meaningful relationship
Humadity	0.005	0.504	Positive correlation, meaningful relationship

There is a significant correlation between temperature and incidence of dengue fever in DKI Jakarta 2008-2016 (p = 0.005; r = -0,264), and lower temperature has a negative association with dengue fever occurrence, a higher case occurs. Temperature variations have an impact on reproduction and survival of mosquitoes.

Rainfall that declined in Jakarta during 2008-2016 tends to show the same pattern, which increases at the beginning of the year (January-April), then down in mid-year (May-September) and back up at the end of the year (starting October - December). Rainfall> 200mm occurred at the beginning of the year followed by an increase in dengue cases

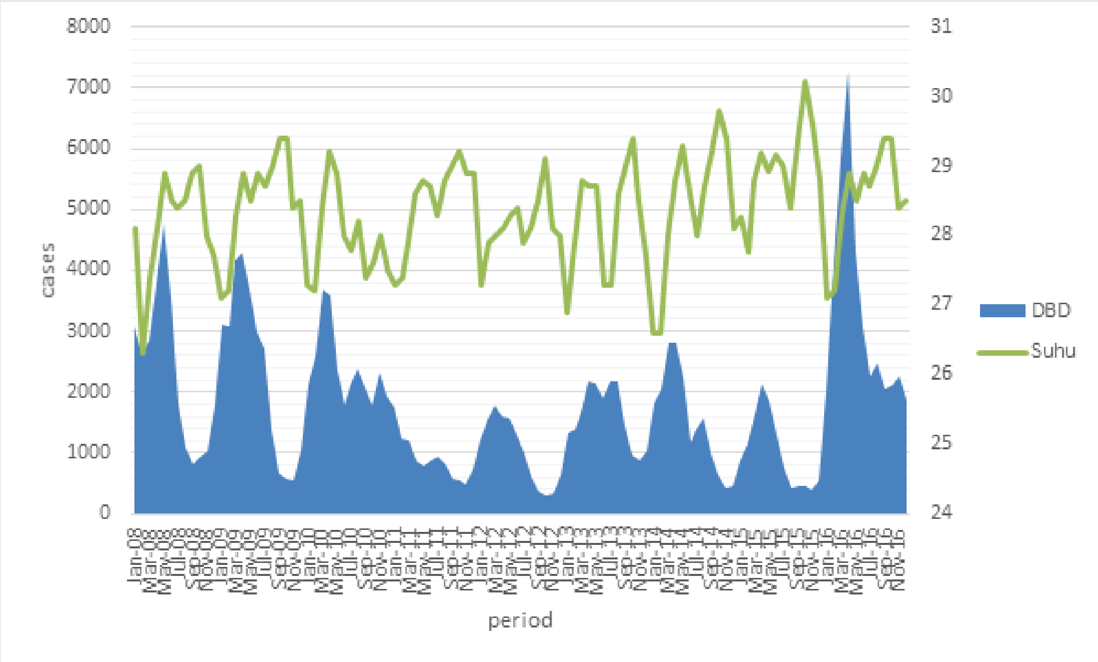

Figure 2: Distribution of Dengue fever with temperature per month/year in DKI Jakarta 2008-2016.

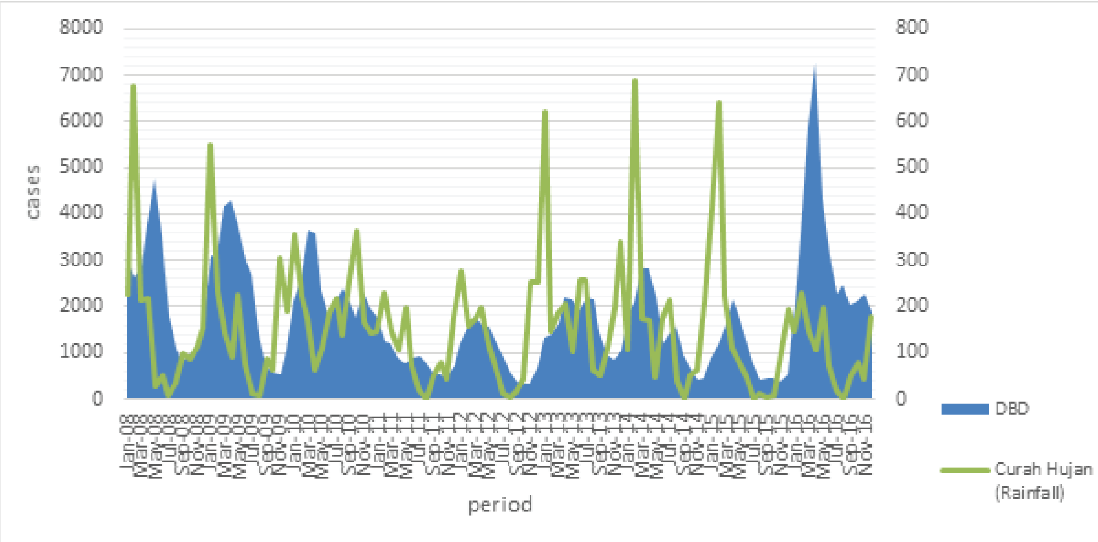

Figure 3: Distribution of Dengue fever incidence with rainfall per month/year in DKI Jakarta 2008-2016.

in those months and decreased after rainfall decreased in mid-year then increased again at the end of the year. The potential impact of rain can lead to the occurrence of water puddles that become a place of mosquito breeding. The rainfall picture affecting the incidence of dengue fever is illustrated in Figure 3.

Statistically, there was a significant correlation between the incidence of dengue fever and rainfall in DKI Jakarta during 2008-2016 ($p = 0.001$; $r = 0.210$) with positive correlation. The results of this study are in line with studies in Cambodia and Thailand [14, 15]. Rainfall that occurred in Jakarta for nine years significantly affects the incidence of dengue fever in 0-3 months beginning of the year. The requires intensive mosquito control and supervision during periods with high rainfall. However, it should be noted other supporting factors such as temperature, humidity and environment also determine the case of dengue fever that occurs. Air humidity in DKI Jakarta during the period 2008-2016 ranged from 62% -86.8%. The highest humidity occurred in February 2016, and the lowest occurred in September 2012. Description of the incidence of dengue fever with humidity shown in Figure 4.

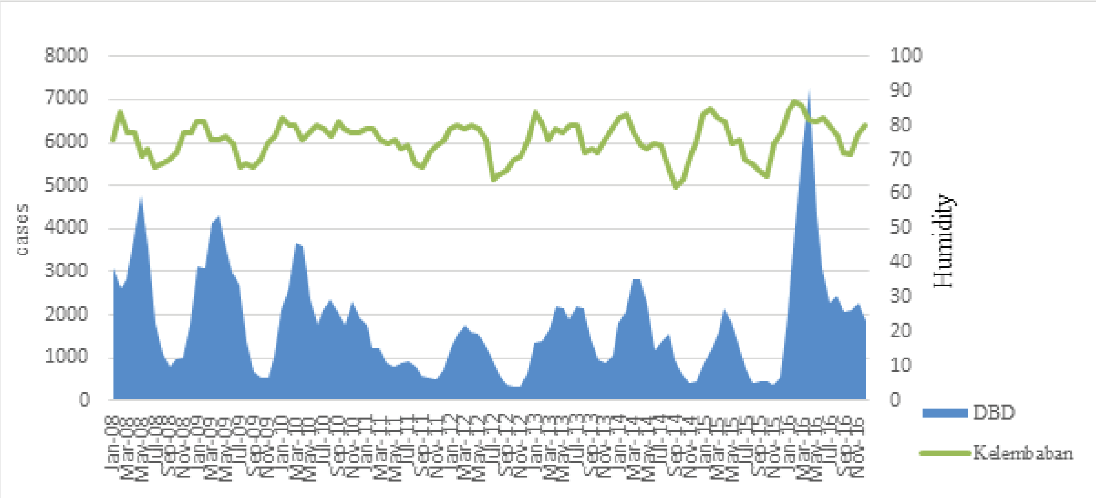

Figure 4: Distribution of Dengue fever incidence with humidity per month/year in DKI Jakarta 2008-2016.

Statistically shows the relationship between dengue fever case and humidity (p = 0.005; r = 0,504) with positive correlation. Humidity does not directly affect the incidence rate Dengue fever but affects the age of mosquitoes because humidity less than 60% will cause the evaporation of water from the mosquito body that shorten the life of the mosquito [7, 16].

4. Discussion

Dengue fever occurs in many cities such as Jakarta. The rainy season in DKI Jakarta cases of dengue fever increases, this is because DKI Jakarta area is densely populated. The spread of *Aedes aegypti* mosquitoes is influenced by population density because the closer the distance between homes the more easily the mosquito spreading mosquitoes is estimated to be 50-100 meters.

DKI Jakarta area that many cases of dengue fever in East Jakarta (table 1) this is because East Jakarta is a densely populated area among other areas of DKI Jakarta, other than that East Jakarta area is a lowland area that is located not far from the beach and has more vegetation many of which allow the life of mosquitoes to breed more quickly. The East Jakarta area also has the largest and most extensive cemetery, where the tomb area is one of the places with high dengue fever spreading. In the area of the tomb found flower pots from soil or ceramics that contain water that is rarely cleaned or drained. In addition to the area of the grave found plastic waste bottles and trees with leaves/stem that allows a water reservoir in the rain and a breeding place *Aedes aegypti* mosquitoes.

The link between the weather and dengue fever case in DKI Jakarta during the period 2008-2016 is very close. Environment and weather and humidity factors due to the monsoon can extend the life of the Aedes aegypti mosquito [2]. Rain affects the increase of air relative humidity and the increasing number of mosquito breeding places.

Temperature affects the incidence of dengue large enough in the population dynamics of mosquitoes. Temperatures can have a good impact on the condition of mosquito eggs to hatch [17]. This ecological process resulted in larger populations of *Aedes* mosquitoes, faster-replicating viruses, greater transmission risk, and led to an increase in dengue incidence [17]. *Aedes aegypti* mosquitoes potentially spread the infection at a temperature of 20°C and did not affect the average high temperature of 30°C [18]. Figure 2 describes the temperature in Jakarta is highly optimized for mosquitoes breeding temperatures above 300C, and relative humidity less than 60% decreases the mosquito oviposition level [16]

The impact of monthly rainfall on Dengue in DKI Jakarta for nine years (2008-2016) positively influences this because long periods of moderate rain will add breeding places and thus increase the risk of the mosquito population. Rainfall can generally make the habitat of mosquitoes grow a lot. Otherwise,e the decrease of rain can drive larva and pupa to breed [19, 20]. Rainfall in DKI Jakarta during the period 2008-2016 has fluctuated (Figure 3). This is because moisture in the Jakarta area has a monsoon type, which is a type of rain that is marked by a concave graph and has two rain peaks between November-December and January-March [21]. Average rainfall that occurred at the beginning of the year ranged from 254 mm - 667 mm and followed by a high incidence of dengue fever cases.

High humidity along with optimum temperature can increase vector breeding while low humidity decreases the effectiveness of mosquitoes for survival [17]. DKI Jakarta area has good moisture for mosquito breeding. The average thickness in Jakarta ranges from 70% -80% (Figure 4). Research on this is also done in several locations, the incidence of dengue is associated with moisture and pressure vapor [22, 23]. Variations in moisture and precipitation, as well as temperature, also play an essential role in terms of their effect on mosquito populations (17). The influence of humidity and rain also affects the age of mosquitoes. Humidity < 60% of short mosquito life (potency as vector decreasing). At 85% humidity,y female mosquitoes will reach 104 days, while the age of male mosquitoes 68 days and at humidity 60% age of mosquitoes will be short and not become vector because not enough time to transfer the virus from the stomach to its salivary glands [24].

5. Conclusions

Dengue fever cases that occurred during the period of 9 years (2008-2016) in DKI Jakarta most in the months at the beginning of the year (January - April) is supported by weather factors (temperature, rainfall, and humidity) that affect the acceleration of mosquitoes as a vector for the breed. Weather factor in this research which has strong category is humidity and supported by optimum temperature factor and relatively high rainfall causing DKI Jakarta area prone to dengue disease.

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References

[1] Louis Lambrechts, Thomas W. Scott, Duane J. Gubler. Consequences of the expanding global distribution of *Aedes albopictus* for dengue virus transmission. https://doi.org/10.1371/journal.pntd.0000646

[2] World Health Organization. Dengue and dengue hemorrhagic fever fact sheet. WHO; 2013 Available at http://who.int/mediacentre/factsheets/fs117/en/index.html# (accessed Juli 05, 2017).

[3] Center for Disease Control and Prevention (CDC). Dengue Available at: https://www.cdc.gov/dengue/ Accessed 10 Juli 2017)

[4] Kementerian Kesehatan RI, 2016. Situasi DBD di Indonesia. Pusat Data dan Informasi Kementerian Kesehatan RI.

[5] Murray, N.E.A., Quam, M.B., Wilder-Smith, A., 2013. Epidemiology of dengue: past, present and prospects. Clin. Epidemiology. 5, 299–309.

[6] Felipe J. Colón-González, Carlo Fezzi, Iain R. Lake, Paul R. Hunter. The Effects of Weather and Climate Change on Dengue. https://doi.org/10.1371/journal.pntd.0002503

[7] Alshehri, M.S.A. 2013. Dengue Fever Outburst and its Relationship with Climatic Factors. *World Applied Sciences Journal* 22, number 4: 506-515. http://idosi.org/wasj/wasj22%284%2913/9.pdf

[8] Misslin R, Telle O, Maude E, Vaguet A, Paul RE. Urban climate versus global climate change-what makes the difference for dengue? Ann N Y Acad Sci 2016; http://dx.doi.org/10.1111/nyas.13084.

[9] L'Azou M, Taurel AF, Flamand C, Quenel P. Recent epidemiological trends of dengue in the French territories of the Americas (2000-2012): a systematic literature review. PLoS Negl Trop Dis 2014;8:e3235. https://doi.org/10.1371/journal.pntd.0003235

[10] Badan Pusat Statistik Provinsi DKI Jakarta. https://jakarta.bps.go.id/

[11] Hastono, S.P. 2016. *Analisis Data pada Bidang Kesehatan*. Jakarta: PT. Raja Grafindo Persada.

[12] Dinas Kesehatan Provinsi DKI Jakarta. 2017. Surveillance online Dinas Kesehatan DKI Jakarta

[13] Paul R. Epstein and Evan Mills, Climate Change Futures. Health, Ecological and Economic Dimensions. The Center for Health and the Global Environment Harvard Medical School. 2006.

[14] Choi Y, Tang CS, Mciver L, Hashizume M, Chan V, Abeyasinghe RR, et al. Effects of weather factors on dengue fever incidence and implications for interventions in Cambodia. BMC Public Health [Internet]. 2016;1–7. Available from: http://dx.doi.org/10.1186/s12889-016-2923-2

[15] V Wiwanitkit - Journal of vector-borne diseases, 2006. An observation of the correlation between rainfall and the prevalence of clinical cases of dengue in Thailand. http://www.mrcindia.org/journal/issues/432073.PDF

[16] De Almeida Costa EAP, et al. Impact of Small Variations in Temperature and Humidity on the Reproductive Activity and Survival of Aedes aegypti (Diptera, Culicidae). Revista Brasileira de Entomologia. 2010; 4(3):488-493

[17] Xu L, Stage LC, Chan K, Zhou J, Yang J, Sang S, et al. Climate variation drives dengue dynamics. 2017;114(1):113–8

[18] Carrington, L.B, *et al*. 2013. Effects of Fluctuating Daily Temperatures at critical Thermal Extremes on *Aedes aegypti* Life History Traits. *Plus* 8 (March) : 1-9. http://journals.plos.org/plosone/article/asset?id=10.1371/journal.pone.0058824.PDF

[19] Pontes RJ, Freeman J, Oliveira-Lima JW, Hodgson JC, Spielman A. Vector densities that potentiate dengue outbreaks in a Brazilian city. Am J Trop Med Hyg. 2000;62:378–83

[20] Thu HM, Aye KM, Thein S, 1998. The effect of temperature and humidity on dengue virus propagation in Aedes aegypti mosquitoes. Southeast Asian J Trop Med Public Health 29: 280–284.

[21] BMKG Reports. 2010. Seasonal Prediction: Wet and Dry Season Prediction. Jakarta: Pusat Iklim Agriklimat dan Iklim Maritim B

[22] Bhatt S, Gething PW, Brady OJ, Messina JP, Farlow AW, Moyes CL, et al. The global distribution and burden of dengue. Nature [Internet]. 2013;496(7446):504–7. Available from: http://dx.doi.org/10.1038/nature12060

[23] Estallo, E.L., Luduena-Almeida, F.F., Introini, M.V., Zaidenberg, M., Almiron, W.R., 2015. Weather variability associated with Aedes (stegomyia) aegypti (dengue vector) oviposition dynamics in northwestern Argentina. PLoS One 10 (5), e0127820

[24] Williams CR, Mincham G, Ritchie SA, Viennet E, Harley D. Bionomic response of Aedes aegypti to two future climate change scenarios in far north Queensland, Australia?: implications for dengue outbreaks. 2014;1–7.