Conference Paper

Climate Factors and Dengue Fever in Jakarta 2011–2015

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Abstract

Dengue fever is a public concern because of its outbreak with a high mortality rate. Aedes aegypti as a vector of dengue fever is very sensitive to its environment, especially to climate variability. The aim of the study was to examine the correlation between climate factors (temperature, rainfall, humidity, and solar radiation) and dengue fever cases in Jakarta 2011-2015, since Jakarta is the capital city of Indonesia. It was a quantitative study with an ecological study design. A correlation test was used to determine the correlation between the independent and dependent variables. The study was carried out in Jakarta using secondary data from the Health District Office of Jakarta for monthly data on dengue fever cases and the Soekarno-Hatta Meteorological Station for daily converted to monthly climate data from January 2011 to December 2015. The instruments used to measure independent variables were a thermometer for temperature, tipping for rainfall index, hygrometer for humidity, and Campbell-stokes for solar radiation. The results showed a significant correlation between the climate variables studied – these were temperature (p-value<0.05, r=-0,293), rainfall (p-value<0.05, r=0,327), humidity (p-value<0.05, r=0,586), and solar radiation (p-value<0.05, r=-0,408) – and dengue fever cases in Jakarta 2011-2015. It was concluded that four independent variables had an influence of the increase in the number of cases. There were two climate variables that had a positive correlation with dengue fever cases, namely humidity and rainfall, while temperature and solar radiation had negative correlations. The highest correlation value was that of humidity with a strong correlation category. The remaining factors, namely temperature, rainfall, and solar radiation, were in the medium correlation category.

Keywords: Dengue, temperature, rainfall, humidity, solar radiation

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1. INTRODUCTION

Dengue fever and severe dengue are mosquito-borne viral diseases especially common in tropical and subtropical regions [23]. The disease became a public concern

because of its outbreak cases with a high mortality [6]. Every year, around 22,000 people die due to dengue fever [22]. Indonesia is in a tropical area; thus dengue fever spreads. It is also an endemic area, causing the high-level of morbidity due to dengue infection [5]. Indonesia had the third highest number of dengue fever cases of any country in the Southeast Asia region with 101,218 cases [15]. Jakarta became the sixth province in Indonesia and the third province in Java island in terms of number of dengue fever cases in 2015 [10].

Dengue fever is caused by the dengue virus that is transmitted by the Aedes mosquito with the main vector Aedes aegypti [20]. In this era, the role of the climate in the spreading of the disease cannot be ignored. Mosquitos as a vector of dengue fever disease are very sensitive to their environment, especially to climate conditions, namely temperature, rainfall, humidity, and solar radiation [12]. In a certain area, an epidemic of dengue occurs during the warm, humid, rainy seasons, which supports mosquitos' growth and shortens the extrinsic incubation period [8]. Therefore, the study about the climate factors related to dengue fever cases was conducted to examine the correlation between climate variables and dengue fever cases in Jakarta 2011-2015.

2. METHODS

Jakarta was chosen as the location for this study because it is the capital of Indonesia and has the fifth highest total population in Indonesia with 10,177,924 residents. This ecological study utilized five years of data ranging from January 2011 to December 2015.

The variables included in this study were dengue fever cases as the dependent variable, and climate factors, which were temperature, rainfall, humidity, and solar radiation, as independent variables. The total population of this study was every dengue fever case reported in Jakarta between 2011 and 2015. Data were collected through secondary data. Monthly dengue fever data was collected from the Health District Office of Jakarta. Daily temperature, rainfall, humidity, and solar radiation data that was converted into average monthly data was collected from the Soekarno-Hatta Meteorological Station. The instruments used to measure the independent variables were a thermometer for temperature, tipping for rainfall index, hygrometer for humidity, and Campbell-stokes for solar radiation.

Data were analyzed using univariate and bivariate analysis by statistical data application. Univariate analysis was useful to determine the nature of a number of dengue

fever cases and also the fluctuation of climate factors, namely temperature, rainfall, humidity, solar radiation. Bivariate analysis helped to assess the correlation between the independent variables, which were climate factors, and the dependent variable, which was dengue fever cases in Jakarta 2011-2015.

The independent and dependent variables had to be tested by using normality test distribution following Kolmogorov-Smirnov in order to observe data normality and to decide the best correlation analysis for the next step. There were four normal variables, which were dengue fever, temperature, humidity, and solar radiation, while rainfall data was not normal. Variables with normal distribution would be tested by Pearson correlation, while rainfall distribution would be tested by Spearman correlation.

3. RESULTS

The number of dengue fever cases in Jakarta in 2011-2015 followed a similar pattern each year. For instance, the highest number of cases in 2013-2015 were in April, while in 2011-2012, January and March saw the highest number of cases. The description of cases is depicted in Figure 1. Meanwhile, the lowest number of cases was in November in 2011, 2013, 2014, 2015, while in 2012 October saw the fewest cases.

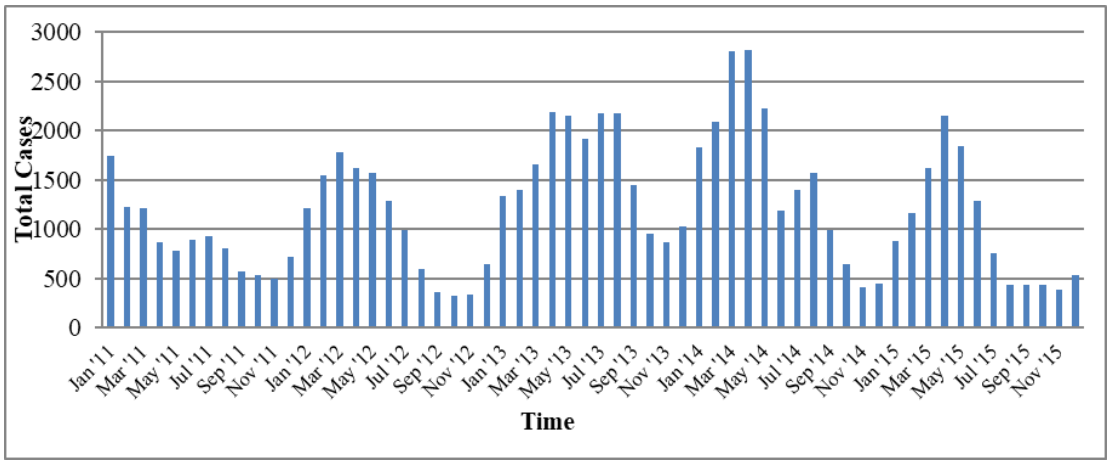

Figure 1: Dengue Fever Cases in Jakarta 2011-2015.

The results showed that there was a significant correlation between temperature, rainfall, humidity, and solar radiation and dengue fever disease (p-value < 0.05) in the years 2011-2015 in Jakarta. The correlation analysis demonstrated that the highest correlation value was humidity with a strong correlation category. Meanwhile, the others factors, which were temperature, rainfall, and solar radiation, were in the medium correlation category. There were two climate variables with positive correlation with cases of dengue fever, which were humidity (r=0,586) and rainfall (r=327). On the other

hand, temperature (r=-0,293) and solar radiation (r=-0,408) had negative correlations with cases of dengue fever.

This study showed that temperature had negative correlation with dengue fever disease. Therefore, the lower the temperature, the more cases were reported. The trend of temperature in Jakarta 2011-2015 fluctuated every month in a year from about 26.1°C to 29.2°C. The highest case was in 27.8°C and the lowest case was in 28.5°C. Figure 2 depicts how temperature influenced dengue fever cases.

Rainfall was also a variable in this study. Rainfall in Jakarta fluctuated from about 0 mm to 719.7 mm in a month. The highest case occurred when there was 213.4 mm of rain in April 2014 and the lowest case was in 67.2 mm in October 2012. Rainfall had a positive correlation with cases of dengue fever, meaning that the greater the rainfall was, the more cases occurred. Figure 3 depicts the influence of rainfall on dengue fever cases.

Besides temperature and rainfall, humidity was also a factor affecting the rising number of cases of dengue fever. Humidity in Jakarta in 2011-2015 ranged from about 70.1% to 86.8%. The highest case was in 81.4% humidity and the lowest case was in 75.8%. There was a significant correlation between humidity and the occurrence of dengue fever cases in Jakarta 2011-2015. Humidity had positive correlation with cases, as the greater humidity, the higher the number of cases occurring. Figure 4 depicts the correlation between humidity and dengue fever cases.

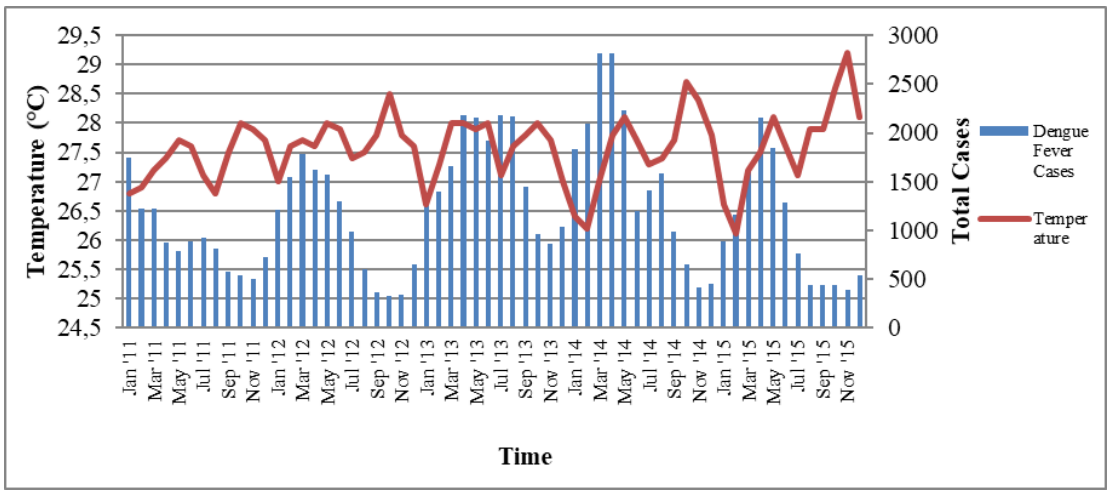

Figure 2: Correlation Between Temperature and Dengue Fever Cases in Jakarta 2011-2015.

Solar radiation was also a factor influencing the rising number of cases of dengue fever. In Jakarta 2011-2015 the average solar radiation ranged from about 0 hour to 8.4 hours. The highest case occurred when there was 7 hours of solar radiation in April 2014 and the lowest case was in 67,2 mm in October 2012. Solar radiation had a

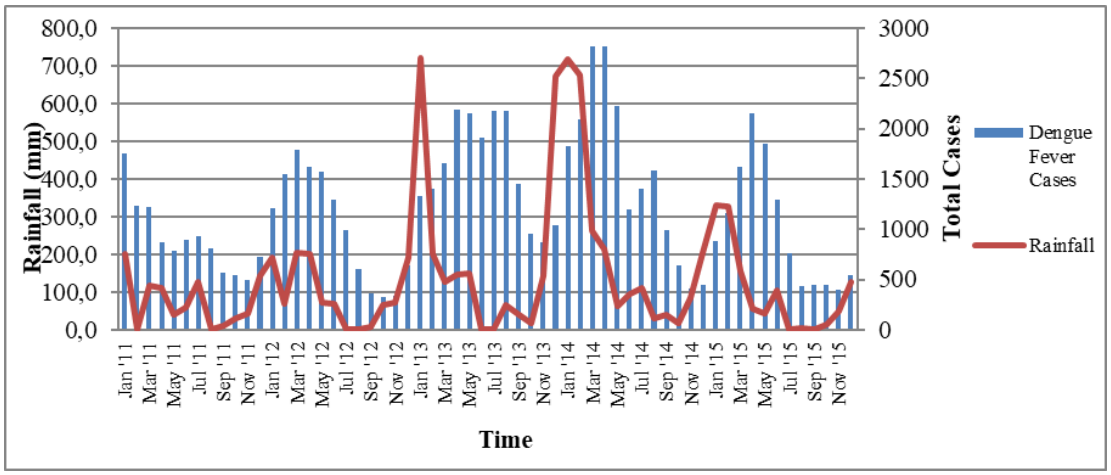

Figure 3: Correlation Between Rainfall and Dengue Fever Cases in Jakarta 2011-2015.

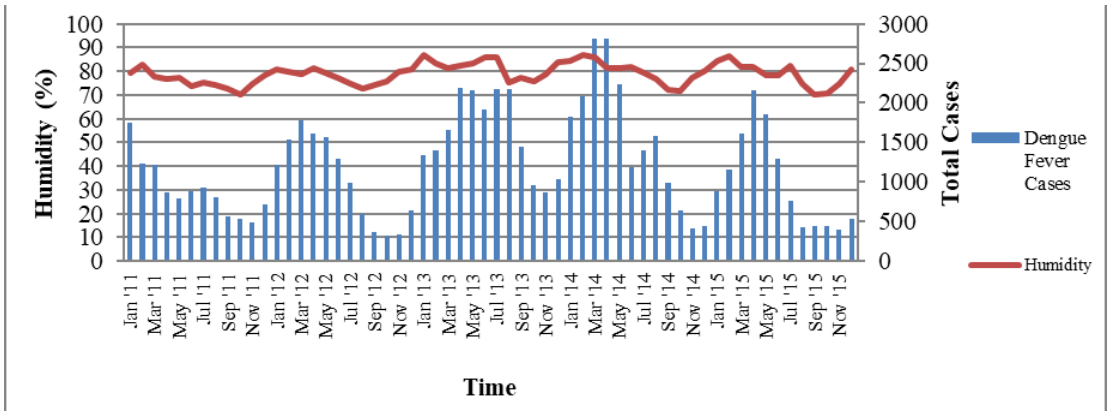

Figure 4: Correlation Between Humidity and Dengue Fever Cases in Jakarta 2011-2015.

negative correlation with cases of dengue fever, meaning that the greater the amount of solar radiation there was, the fewer number of cases happened. Figure 5 depicts the correlation between solar radiation and dengue fever cases.

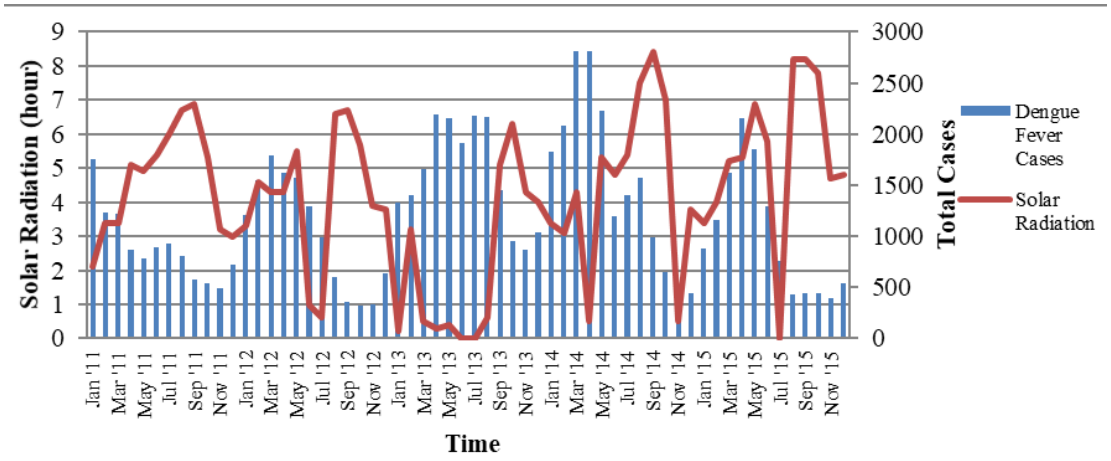

Figure 5: Correlation Between Solar Radiation and Dengue Fever Cases in Jakarta 2011-2015.

4. DISCUSSION

Dengue transmission occurs predominantly during the wet season between May and October [3]. This is in contract to the findings of this study, which showed that the highest number of dengue fever cases in 2011-2015 occurred in April 2014 and the fewest were reported in October 2012. April is a transition from the rainy to dry season and October is a transition from the dry to the rainy season. Climate could influence the infection disease model because agents such as viruses, bacteria, and parasites have become sensitive to temperature, humidity and other environmental factors [19].

Additionally, several studies have not found a significant corrrelation between climate variables and dengue fever. This happened because several previous studies lacked sufficient data. In contrast, this study found that four variables were significant. This study analyzed sixty data for each variable starting from 2011 until 2015. Climate variables had significant correlation with cases of dengue fever but were in different categories of correlation.

Humidity had a strong correlation while the other factors exhibited moderate correlation. Cases of dengue fever increasing due to humidity was significant because of the increase in mosquito density [1]. According to Hidayanti (2008), the highest cases in Indonesia occurred when there was 82% humidity. The optimum humidity that supports the growth of Aedes aegypti is 70-80% [13]. Humidity can influence a number of vector transmissions. The survival level of mosquitos decreases in dry conditions; therefore humidity is a critical factor causing the increase of cases of dengue fever [21].

Another variable which became a determining factor of dengue fever cases was temperature. A temperature ranging from 20°C to 30°C makes Aedes aegypti competent to transmit cases [2]. This means that the temperature in Jakarta 2011-2015 was optimum to increase the number of Aedes aegypti as a vector of dengue fever. A study conducted by Alshehri (2013) also showed a strong (negative) correlation between mosquito density and temperature. Temperature influences the rising number of dengue fever cases as, when the average surface temperature dropped, the number of reported cases increased, and vice versa [16].

Another variable affecting the number of dengue fever cases was rainfall. Rainfall and cases of the disease in Jakarta 2011-2015 ($p < 0.05$) had a positive correlation. Previous studies also showed the same result ($p < 0.05$), that when the amount of rainfall increases, then the number of Aedes aegypti that attack humans also increases [18]. The rainy season occurs from December to February, as proven by the finding that

highest amount of rainfall in Jakarta occurred in January 2013. However, it was also found that the highest number of dengue fever cases were reported in April, while April is the transition from the rainy season to the dry season [14].

The potential impact of rainfall could be to increase the transmission of Aedes aegypti by promoting the breeding site, or to eliminate it by flooding the vector [7]. Another study also showed that every 1 mm of rainfall will increase the average mortality rate due to dengue fever disease in the next month. Sufficient intensities of rainfall will cause puddles, which are the breeding sites of Aedes aegypti [4].

Solar radiation had a negative correlation with the occurrence of dengue fever cases. Silaban (2005) concluded that there was a significant correlation between solar radiation and the incidence of dengue fever in Bogor 2004-2005. Solar radiation can influence the habit of mosquitos with regards to finding places for eating and resting. This is because some species of mosquito will leave the resting place 20 to 30 minutes after sunset [13].

The limitation of this study included the lack of cases and climate data. On the other hand, several sets of daily climate data that are provided by the Soekarno-Hatta Meteorological Station are not available which may be expected have a strong correlation with the dependent variable. Statistically, there was one variable that did not have normal distribution data. This meant that the Pearson correlation analysis to find the correlation value could not be applied to rainfall.

5. CONCLUSION

As mentioned, climate factors such as temperature, rainfall, humidity, and solar radiation had a significant correlation with the incidence of dengue fever cases. The highest correlation value was that of humidity with a strong correlation category. Meanwhile temperature, rainfall, and solar radiation were in the medium correlation category. This means that climate factors have an influence on the increase in the number of cases reported. Further study is required because, in this study, there were others variables of climate that could be measured, namely wind velocity. The time range also should be extended to obtain more accurate results.

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