Climate variability (temperature, humidity, rain intensity and wind speed) and dengue hemorrhagic fever case correlations in Depok City in 2009-2018

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Abstract. Climate issues caused by industrial pollutant has affected the spread of vector-borne diseases such as Dengue Hemorrhagic Fever (DHF). DHF cases are suspected to have links with the everchanging environmental climate conditions. Using an ecological design-based study, this research aims to determine the correlations between climate variability and the DHF cases at Depok City in a time period from 2009 to 2018. This study utilizes secondary data in which DHF cases were collected through the records of Department of Health of Depok City, and temperature, humidity, rain intensity, and wind speed from Depok City Meteorological, Climatological, and Geophysical Agency. Analytical method consists of univariate analysis and bivariate analysis which is shown by a correlation value and linear regression between the variables. Results revealed that there was a significant relationship between temperature and the number of DHF cases (p-value = 0.023, r = -0.645) and also between humidity and the number of DHF cases (p-value = 0.016, r = 0.673). No significant correlations were found within rain intensity and wind speed variables. In conclusion, this study showed that the effects of climate temperature and humidity changes also affect the rise and declining number of DHF cases in this study location.

1. Introduction
Dengue Hemorrhagic Fever (DHF) is a mosquito-borne viral disease that has one of the world’s fastest growing burden [1]. In the last 50 years, incidence has increased 30-fold with increasing geographic expansion to new countries and, in the present decade, from urban to rural settings. An estimated 50 million dengue infections occur annually and approximately 2.5 billion people live in dengue endemic countries [2]. Some 1.8 billion (more than 70%) of the population at risk for dengue worldwide live in member states of the World Health Organization South-East Asia Region and Western Pacific Region, which bear nearly 75% of the current global disease burden due to dengue [3]. New studies that is held over the 50-year period, there was a sharp increase in the annual IR of DHF in Indonesia, from just 0.05 cases per 100,000 person-years in 1968 to 77.96 cases per 100,000 person-years in 2016 [4]. In Indonesia, where more than 35% of the country’s population lives in urban areas, 150,000 cases were reported in 2007 (the highest on record) with over 25,000 cases reported from both Jakarta and West Java [4]. The Ministry of Health of Indonesia recorded 204,171 DHF cases occurred in 2016, then 68,407 cases in 2017, 53,075 cases in 2018.
The purpose of this research was to identify the spread and the rising case of the DHF in Depok City, Indonesia within ten years span (2009-2018). Next was to identify the climate change and progress (temperature, humidity, rain intensity, and wind speed) that occurs in Depok City also within ten years of span (2009-2018). When all of the data required was met, then the next step of this research was to correlate the relations between each climate factors and the number of DHF cases in Depok City within ten years of span (2009-2018).

The scope of this research is determined by knowing the correlations between climate factor variables with the number of DHF cases, where the existence of DHF is always consistent and ever fluctuating in Depok City as year continues. This research utilized secondary data that was routinely recorded, and utilizes an ecological based study. It is expected that this research will produce a known correlation either strong or weak.

2. Methodology
The design of this research utilizes an ecological approach characterized by a stretch of timeline and the observation of trend in a certain data group within a certain time. It is then expected that this method can identify and clarify the correlations between climate factors (temperature, humidity, rain intensity, and wind speed) and the amount of DHF cases in Depok City in the span of ten years (2009-2018).

Data collection and analysis in this study utilizes a computerized method. The data management procedures consist of check and editing, Verifying and formatting, and lastly sorting and arrangement. The data analysis in this research consists of a univariate analysis and a bivariate analysis. The statistical analysis performed in this research are correlation and regression which is meant to discover the degree of correlation value and the numerical direction of the two variables. The direction of the correlation value, or as we can call “r”, can either be positive or negative. Positive number shows a direction where each time a variable value increases, the other variable value will also increase. Where when a negative number shows the direction whenever each time a variable value increases, the other variable value will decrease.

Data analysis step of this research were firstly performed by doing a normality test. Normality test was done with the purpose to test weather a data is normally distributed or abnormally distributed. So, when the time comes for the data to be analyzed using bivariate method, the method of statistic testing can be determined. After the process of normality test, the data will then be selected to seek the correlation value of “r”. If the data is normally distributed, a method called Pearson’s is performed. If the data is abnormally distributed, a method called Spearman’s parametric test is performed.

Bivariate analysis is done through certain steps. After a result is obtained, the first step is to translate the meaning of the value from observing a standard r parameter [5]:
\[ r = 0.00 – 0.25 \text{ (no correlation at all/weak correlation)} \]
\[ r = 0.26 – 0.50 \text{ (moderate correlation)} \]
\[ r = 0.51 – 0.75 \text{ (strong correlation)} \]
\[ r = 0.76 – 1.00 \text{ (very strong correlation/perfect correlation)} \]

When the “r” correlation value had been obtained and translation process has been completed, the second step was to perform a significance test with a result of p-value to further understand if the correlation between the two variables were significant or not. If the probability number shows a value >0.05 then there is no meaningful correlation between the variables. If the probability number shows a value <0.05, then it is known that there is a meaningful correlation between the variables [5].

To further discover the direction of the correlations of the variables, a regression analysis is performed. In this research, the regression analysis is performed to create a prediction value of DHF case (dependent variable) through the existing climate factors (independent variables). To achieve the prediction, a method called least square is performed. This method is a way of creating a regression line by minimalizing the value of square distance and the distance of Y value that is being observed. Mathematically, the equation line can be described in below [5]:
\[ Y = a + bx \]  
(1)
Where $Y$ is the dependent variable or DHF Cases, $x$ is independent variable or climate variables, $a$ is intercept value or the average difference of $Y$ variable when variable $x = 0$, and $b$ equals Slope, the predicted value difference of $Y$ variable if variable $x$ changes one unit of measurement.

The most important and most performed measurement in regression analysis is the determination coefficient which is symbolized by $R^2$ (R Square). Determination coefficient is very useful to discover how big the dependent variable variation can be explained by the independent variable. The higher the $R^2$ value, the better or the more accurate that variable can predict the dependent variable. The value of $R^2$ value is ranged between 0-1 or between 0%-100%.

3. Results and discussion

3.1. Correlation between temperature and DHF cases in Depok City, 2009-2018

A compelling evidence shows that climate affects many diseases including DHF in humans [6]. Temperature is regarded as one of the most important climatic factors for dengue transmission. It affects almost every aspect of the dengue epidemiologic triad directly and indirectly (dengue viruses, Aedes mosquitoes, and humans) and their interactions [7]. Based on the research performed between temperature and DHF cases in Depok City in 10 years study span (2009-2018). It is found that a meaningful correlation between the two variables were found. The meaningful correlation within the 10 years study can be observed only in 2011, 2014, and 2015 (Table 1). In 2011, the average temperature increases constantly until 2015 which within that year, the ENSO phenomenon occurred [8]. This event is the main cause of the declining case of DHF whilst temperature rises. This result indicates a similarity to the research performed by Hii, explains that whenever ENSO phenomenon occurred, the rise and fall of DHF cases follows [9]. This result is also supported by the study performed by Morin et al. [7] that resulted a meaningful correlation between ENSO and DHF endemic in the islands of Indonesia and North of Southern American [10]. If observed, all of study years that resulted a meaningful correlation between temperature variables and DHF cases (2011, 2014, 2015) shows a negative r value. This explains that every time temperature rises, the DHF case will fall.

| Year | $R$  | P-Value |
|------|------|---------|
| 2011 | -0.697 | 0.012  |
| 2014 | -0.839 | 0.001  |
| 2015 | -0.732 | 0.007  |

3.2. Correlation between humidity and DHF Cases in Depok City, 2009-2018

The correlation between humidity and DHF cases in Depok City, 2009-2018 shows a meaningful and strong correlation with a positive direction. Meaning whenever humidity rises, the number of DHF case will also rise. It can be observed in (Table 2) that the meaningful correlation can be found in 2009, 2014, 2015, and 2016.

This result is similar to the research performed by Prompou et al. [11], whom discovered that there is a meaningful correlation between humidity and DHF cases in Thailand. High humidity in the meaningful correlated years of 2009, 2014, 2015, and 2016 can be caused by the high rain intensity in the end of each year. The condition can be categorized as the most optimal conditions for the breeding and growth of DHF vectors and can increase the replication rate of the virus [12].
Table 2. Humidity and DHF case correlation analysis in Depok City, 2009-2018.

| Year | R    | P-Value |
|------|------|---------|
| 2009 | 0.594| 0.042   |
| 2014 | 0.665| 0.018   |
| 2015 | 0.673| 0.016   |
| 2016 | 0.608| 0.036   |

3.3. Correlations between rain intensity and DHF cases in Depok City, 2009-2018

Results of correlation study shows no meaning and weak correlation between the analysis of rain intensity and DHF cases in Depok City, 2009-2018. The number can be observed in (Table 3). In 10 years of study span, only 2009 shows a strong and meaningful correlation, the other years showed otherwise. The rain intensity in 2009 can be predicted to have increased the water puddles that can be utilized as a breeding habitat of mosquitos. With the increase of mosquito habitats, the number of infecting mosquitos will follow, thus it enhances the chance of DHF infections. This notion is supported by the research performed by Prompou et al. [11] whom stated that there is a correlation between rain intensity and DHF cases in Thailand. In the study year of the non-existing correlation of 2010-2018, it can be observed that the cause of this result is due to the yearly average rain intensity becomes exceedingly high, higher than the all 10 years rain intensity average. An exceedingly high rain intensity can cause the elimination of the mosquito breeding site caused by flooding. This assumption is in accordance with the study performed by Thammapalo et al. [13], which stated that there are no correlations between rain intensity and Aedes aegypti overflow in Thailand. Based on the study outcome performed by Thammapalo et al. [13], in Kaohsiung City, rain intensity may not have a positive correlation with the DHF cases due to the main reservoir of Aedes aegypti which is usually contained inside empty bottles, spare tires, and other places and items that lies around has been minimized. This causes the probability of why the rain intensity in this study does not provide a water puddle that usually resides within the mentioned containers [14].

Table 3. Rain intensity and DHF case correlation analysis in Depok City, 2009-2018.

| Year  | R   | P-Value |
|-------|-----|---------|
| 2009  | 0.643| 0.024   |

3.4. Correlations between wind speed and DHF cases in Depok City, 2009-2018

In the study of wind speed correlations and number of DHF cases, it is found that that there is no correlation between the two variables in all 10 years study span (2008-2018) which can be seen in (Table 4) Besides this study, a research performed [15] mentions that the correlation between wind speed towards the DHF cases are not clear since the direct effects of wind only applies when the mosquito flies, and the criteria of speed that can interrupt the mosquito’s flight is 22-28 knots. Determined by the domestic characteristics of Aedes aegypti mosquito that prefers to fly and rest within confined spaces, this has no correlation towards the rise and fall of DHF cases [15].

Table 4. Wind speed and DHF case correlation analysis in Depok City, 2009-2018.

| Year   | R     | P-Value |
|--------|-------|---------|
| 2009-2018 | -0.251| 0.432   |
4. Conclusion

Correlation analysis results obtained between temperature and DHF case variables in Depok city in 2009 until 2018 shows a p-value of 0.023, indicating a meaningful correlation between temperature and the number of DHF cases. The r correlation value is -0.645 indicating that there is a strong relationship. Negative r value explains that every time temperature rises, the number of DHF cases will fall. Correlation analysis results obtained between humidity and DHF case variables in Depok City in 2009-2018 shows a p-value of 0.016, indicating a meaningful correlation between humidity and the number of DHF cases. The r correlation value is 0.673 indicating a strong relationship between the two variables. Positive r value explains that every time humidity rises, the number of DHF cases will also rise. Correlation analysis results obtained between rain intensity and DHF case variables in Depok city in 2009 until 2018 shows a p-value of 0.190, indicating no meaningful correlation between rain intensity and the number of DHF cases. The r correlation value is 0.407 indicating that there is a moderate relationship. Positive r value explains that every time rain intensity rises, the number of DHF cases will also rise.

Correlation analysis results obtained between wind speed and DHF case variables in Depok City in 2009-2018 shows a p-value of 0.432, indicating no meaningful correlation between wind speed and the number of DHF cases. The r correlation value is -0.251 indicating a weak relationship between the two variables. Negative r value explains that every time wind speed rises, the number of DHF cases will fall.

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