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Climate Conditions, Larvae Free Number, DHF Incidence in Surabaya Indonesia*

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Dengue is a serious public health problem in Indonesia, including the city of Surabaya. Dengue is endemic Surabaya city in Indonesia. Dengue incidence has been attributed to climatic conditions, this study aimed to determine the relationship of climate conditions (air temperature, relative humidity, rainfall, number of days rain, and duration of solar radiation), the condition of dengue vectors (larvae-free number), the incidence of DHF (Dengue Hemorrhagic Fever) in Surabaya in 2010-2012. The results of this study indicate that there is a significant correlation among air humidity, rainfall, number of rainy days, and duration of solar radiation with the incidence of DHF. Other climatic conditions such as temperature have no relationship with the incidence of DHF.

Keywords : climate conditions, larvae-free number, Dengue Hemorrhagic Fever (DHF), Surabaya Indonesia

Vector borne diseases such as malaria and Dengue Hemorrhagic Fever (DHF) is necessary because the transmission of diseases such as these will increase with climate change (Glen & Sia, 2008; World Health Organization [WHO], 2013). In many tropical countries the disease is a cause of death (WHO, 2013; Amah, Rina, & Ririn, 2010; Chakravarti & Kumaria, 2005). Dengue continues to spread widely in tropical and subtropical countries, about 2.5 billion people (two fifths of the world population) are at risk for dengue virus infection (WHO, 2013). More than 100 tropical and subtropical countries have experienced outbreaks of dengue, approximately 500,000 cases each year are hospitalized with thousands of fatalities (WHO, 2013; Chakravarti & Kumaria, 2005). Dengue has become endemic in large cities in tropical countries, including Indonesia (Surabaya City Health Department, 2012). Since it was first discovered in 1968 in the city of Surabaya number of dengue incidence continues to rise and spread to all areas of the city (Surabaya City Health Department, 2012; Brisbois & Ali, 2010).

Some studies show the spread of the disease from a large urban area that acts as a reservoir of virus spread to many residential areas smaller communities (Chakravarti & Kumaria, 2005). Climatic conditions that affect the incidence of dengue such as rainfall, temperature, and humidity can influence the condition of dry *Aedes* eggs to develop into larvae when exposed to water, the larva to pupa and finally to adult mosquitoes

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(Wongkoon, M. Jaroensutasinee, K. Jaroensutasinee, Preechapon, & Chumkiew, 2006; Halide & Ridd, 2008; Satoto, Umniyati, Suardipa, & Sintorini, 2013). Rainy days and rainfall caused much so that the chance of breeding place of mosquitoes breeding will increase, causing the mosquito population increases so will the risk of dengue transmission (Chakravarti & Kumaria, 2005). The disease is transmitted by Aedes spp mosquitoes that carry the dengue virus, of the family flaviviridae from. There are four types of dengue viruses that can cause dengue disease that DEN-1, DEN-2, DEN-3 and DEN-4 (Surabaya City Health Department, 2012; Chakravarti & Kumaria, 2005). Dengue virus enters the body through the bite of the mosquito vector *Aedes aegypti* and *Aedes albopictus* females.

Surabaya city is a dengue endemic areas in East Java Province, Indonesia has a climate factors mean air temperature 27.85°C with a mean of 75.75% air humidity (The Meteorology, Climatology, and Geophysics Agency [BMKG], 2012). Thus, climatic conditions (temperature and humidity) will support the increased density of the mosquito population and the subsequent impact on the transmission and spread of dengue fever, changes in ecological and socio-demographic factors play an important role in the improvement and expansion of endemic dengue disease (WHO, 2013; Chakravarti & Kumaria, 2005; Brisbois & Ali, 2010). The high status of entomological (vector) DHF as House Index (HI), Container Index (CI), Breteau Index (BI), and Resting Index (RI), supported by heavy rainfall also can lead to outbreaks (Chakravarti & Kumaria, 2005; Wongkoon et al., 2006). Status of the other vectors, can be seen through Ovitrap Index (OI) and Pupa Index (PI), also plays a role in the evaluation of post-dengue vector control (Chakravarti & Kumaria, 2005; Wongkoon et al., 2006; Satoto et al., 2013). This study was conducted to determine the relationship between the picture and climatic conditions (air temperature, relative humidity, rainfall, number of days rain, and duration of solar radiation) with the incidence rate of dengue fever in the city of Surabaya in 2010-2012.

Methods

This study is a quantitative and descriptive study using ecological study design. This study can determine the relationship between climatic conditions (air temperature, relative humidity, rainfall, number of days rain and duration of solar radiation), and the incidence (rate of occurrence) of dengue in the city of Surabaya 2010-2012. Research location is in the city of Surabaya, East Java, with 31 sub-districts. The location of the study site made with due consideration to all districts in the region are endemic. The timing of the data collection was done during the months of May to October 2013. The population in this study was all recorded incidence of dengue in Surabaya City Health Department in 2010-2012. Observations were made on the total population in endemic areas of the city of Surabaya. Secondary data collection form and the incidence of dengue larvae-free rate are taken from Surabaya city health office in 2010-2012. Data climatic conditions (air temperature, relative humidity, rainfall number of days rain, and duration of solar radiation) were obtained from the Center for Meteorology, Climatology and Geophysics (BMKG) Surabaya *Perak* Station last three years. The data were analyzed to provide information free larvae number and incidence rate of dengue and climatic conditions in the city of Surabaya in 2010-2012 collected. Stages of analysis conducted univariate and bivariate analysis. Univariate analysis is useful to illustrate the distribution of dengue incidence rate fluctuations as well as an overview of climatic factors (air temperature, relative humidity, rainfall number of days rain, and duration of solar radiation) in 2010-2012. Bivariate analysis using regression-correlation test, conducted to see the relationship between the independent variable is the dependent variable climatic conditions, namely free numbers larvae and incidence of dengue in the city of Surabaya in 2010-2012. To determine the

degree/closeness of the relationship and the direction of the relationship between two numerical variables used correlation analysis. The numerical relationship between two variables can be patterned positive or negative. Positive relationship occurs when the increase of the variable followed by an increase of other variables. While the negative relationship occurs when one variable increment followed by a decrease in another variable.

Results

Distribution of Dengue

In 2010, the distribution of the incidence of dengue in the city of Surabaya showed that 50% more sub-districts have dengue incidence or Incidence Rate (IR) ≥ 100 per 100,000. In 2010, 50% of districts have IR ≥ 100 per 100,000, while in 2011 and 2012, 50% of districts in Surabaya have IR < 50 per 100,000. The mortality rate or Case Fatality Rate (CFR) due to dengue in Surabaya in 2010 was 0.38%, whereas in 2011 and 2012 respectively 0.69% and 0.64%. Based on national targets CFR Ministry of Health of the Republic of Indonesia DHF is 1%. Similarly, the larvae-free number in Surabaya in general still does not meet expectations or target of the Ministry of Health of the Republic of Indonesia, which is 95%. Larvae-Free Number (LFN) mean for the city of Surabaya for three years ranging from 80.24%-85.76%.

DHF data that are in the city of Surabaya in the period 2010-2012 are available in Table 1.

Table 1

Recapitulation Data Dengue Patients in the City of Surabaya Region

Month	Year 2010		Year 2011		Year 2012	
	Patients deaths	Deaths	Patients deaths	Deaths	Patients deaths	Deaths
January	128	0	138	0	90	0
February	242	2	132	0	105	2
March	477	4	133	0	173	0
April	490	3	110	4	131	2
May	475	4	126	2	196	2
June	515	0	146	1	118	1
July	360	0	76	0	70	0
August	209	0	46	0	48	0
September	94	0	28	0	45	0
October	119	0	28	0	46	0
November	131	0	22	0	36	0
December	139	0	21	0	33	0
Total	3,379	13	1,008	7	1,091	7

Note. Sources : City Health Office Surabaya (2013).

Climate Conditions

Climate change can affect the macro and micro spreader an infectious diseases, including the mosquito vector borne diseases. Increased humidity and rainfall is directly proportional to the increase in mosquito density, while the temperature has the optimum limit for mosquito breeding between 25-27°C. Climatic conditions have a significant effect on the risk of transmission of vector-borne diseases such as malaria and DHF (WHO, 2013; Brisbois & Ali, 2010).

Realtionship Between Temperatures and the Incidence of DHF

Climate can influence the pattern of infections caused by either viral disease agents, bacteria or parasites,

and vector is sensitive to temperature, humidity, and other ambient environmental conditions. In addition, the WHO also stated that mosquito-borne diseases such as dengue fever associated with warm weather conditions (WHO, 2013). The mean temperature in Surabaya city from 2010 to 2012: 30.2°C (in October 2011) and 30.2°C -30.4°C (October to November 2012), while the lowest in July 2012 (Surabaya City Health Department, 2012). Research carried down the Glenn and Sia (2008), Metro Manila Philippines period 1996-2005 concluded that there was no significant correlation between the incidence of dengue temperature, as well as the results of the study Amah et al. (2010) in Serang district, Banten, West Java Indonesia. There is no significant relationship between the temperature in the incidence of dengue fever. Although the average monthly temperatures range between 30.2°C, an optimal temperature for breeding Aedes aegypti (21°C-31°C), but although the temperature in the city of Surabaya is the optimal temperature to increase mosquito populations, but not enough to infect DHF (WHO, 2013; Surabaya City Health Department, 2012; Halide & Ridd, 2008; Foley, Klein, Kim, Wilkerson, & Rueda, 2008) .

Relationship Between Humidity and the Incidence of DHF

From the secondary data obtained from BMKG, looks humidity in October 2011 (63.2%) is the lowest humidity, while the highest humidity in April 2010 (80%) (BMKG Surabaya, 2012). Such moisture conditions make the ongoing proliferation of mosquitoes. Increased humidity and rainfall is directly proportional to the increase in the density of mosquitoes. Humidity conditions in Surabaya have averaged above 60%, which are optimal for breeding mosquitoes, primarily *Aedes aegypti*. In addition to the effect on the flies fly mosquito, higher humidity makes the mosquitoes become more active and frequent blood sucking. Often *Aedes* mosquito, *Aedes aegypti* and *Aedes albopictus* females looking for food by sucking the blood of humans, is used to continue the process of reproduction. This condition increases the transmission and spread of dengue in the region (Chakravarti & Kumaria, 2005).

Rainfall and the Incidence of DHF

Rainy days and high rainfall in Surabaya, the number of rainy days at 28 days a month. Events differ in the dry season, where low rainfall and number of rainy days can reach zero (Surabaya City Health Department, 2012). Rainfall has a direct influence on the presence of the *Aedes aegypti* mosquito breeding places. The population of *Aedes aegypti* mosquito breeding depends on the place. High rainfall and lasts for a long time can lead to flooding so as to eliminate the breeding places of *Aedes aegypti* mosquito that usually live in fresh water. As a result the number of mosquito breeding will be reduced so that the mosquito population will be reduced (Surabaya City Health Department, 2012; Wongkoon et al., 2006; Halide & Ridd, 2008). However, if the rainfall is small and for a long time will increase the breeding places of mosquitoes and mosquito populations increase (Halide & Ridd, 2008). As with other vector based diseases, dengue fever showed a pattern related to rainfall due to climate mainly affect the spread of vector mosquitoes and the possibility of transmitting the virus from one human to another human (Halide & Ridd, 2008; Foley et al., 2008). Rainfall is dependent on the number of days of rain, the highest rainfalls are on December 20 and January 10, 2012 (28 days), while the lowest in August to September 2011 and July to September 2012, which does not occur during the rainy months.

Duration of Solar Radiation With DHF Incidence

The intensity or duration of solar radiation is very influential with the temperature and humidity around it. Long exposures of the sun, is also associated with season and sunlight affect the growth of mosquito larvae (Wongkoon et al., 2006). Therefore, the mosquito *Aedes aegypti* is generally liked the shade, in the city of

Surabaya, the old high solar irradiation in September and October, this condition causes rainfall and rainy days decreased (Halide & Ridd, 2008; Satoto et al., 2013). At the same time an increase in temperature and decrease in relative humidity (Wongkoon et al., 2006; Halide & Ridd, 2008). Even though the air temperature is high in Surabaya, but the humidity is not much change. This is indicated by the condition of 60% humidity in Surabaya, allowing *Aedes aegypti* and *Aedes albopictus* is able to reproduce well (Satoto et al., 2013). Mosquitoes *Aedes aegypti* have a habit of resting in a dark place and protected from the sun, so are in the habit of laying eggs (WHO, 2013; Wongkoon et al., 2006). There is a relationship between the seasons and the sun shines longer, the long dry season the sun shines longer than during the rainy season. The duration of sunshine makes more rapid growth of mosquito larvae and the activity of female mosquitoes seek blood for humans (anthropophilic) will increase. Activities of female mosquitoes in search of food related to sustain reproduction (Wongkoon et al., 2006; Foley et al., 2008).

Relationship Between Climate and Vector Conditions

In the period 2010-2012, the overall larvae free number in the city of Surabaya is still below the expected target of 95%. When viewed by region districts only one sub-district in 2011 and two districts in 2012 which have a Free Flick rate > 95%. The low larvae free number indicates that many mosquito breeding places in the community (Satoto et al., 2013; Somsak, Yanyong, & Ritting, 2010; Foley et al., 2008). The analysis showed a significant association with several components larvae free number, climate among air humidity, rainfall, number of rainy days, and duration of solar radiation, unless the air temperature throughout the year showed that the optimum value for mosquito breeding. Analysis to determine the relationship of climate larvae free number with results obtained following analysis (see Table 2).

Table 2
Results of Analysis Larvae Free Number Relationship With Climate Conditions in the City of Surabaya in 2010-2012

Climate	Corellation of larvae free number-climate
Air temperature	$r = 0.370$ $p = 0.082$
Humidity	$r = -0.687$ $p = 0.000^{*}$
Rainfall	$r = -0.521$ $p = 0.011^{*}$
Number of days rain	$r = -0.665$ $p = 0.001^{*}$
Duration of solar radiation	$r = 0.649$ $p = 0.001^{*}$

Note. * Significant at 0.05.

The results of the above analysis show four variables associated with larvae free number, i.e., humidity, rainfall, number of rainy days, and duration of radiation. Three variables showed a negative correlation (relative humidity, rainfall, and number of rainy days) which means that the higher the value of these three variables, the lower the value of larvae free number. Duration of solar radiation has a positive correlation with the larvae free number (Somsak et al., 2010; Foley et al., 2008), which means the longer the daily solar radiation, the higher the value larvae free number.

Analysis of Incidence Rate by the relationship larvae free number district area showed the value of r = -0.268 and p = 0.010 ($p < 0.05$). Which mean that there is a negative relationship between Incidence Rate DHF with the mean larvae free number.

The results of this analysis, showed a lower value larvae free number than Incidence DHF. According to the

facts (WHO, 2013), to prevent the transmission of dengue depends on measures of mosquito vector control, one effective way is to eliminate or prevent the breeding places of *Aedes aegypti* and *Aedes albopictus* in order to break the life cycle of the mosquito as a vector. When you should use a water reservoir (container), the container could be pursued by the unwelcome larvae or mosquito *larvae Aedes aegypti* and *Aedes albopictus* as the use of landfill smooth-walled does not absorb water and light for example ceramics (Chakravarti & Kumaria, 2005). Measures *3 M* (Drain, Close, and Bury): landfill drain action at least once a week to abolish the mosquito population, closing the landfill to prevent mosquito infestation and used as mosquito breeding and hoarding landfill that does not want to eliminate mosquito breeding places (Brisbois & Ali, 2010; Foley et al., 2008).

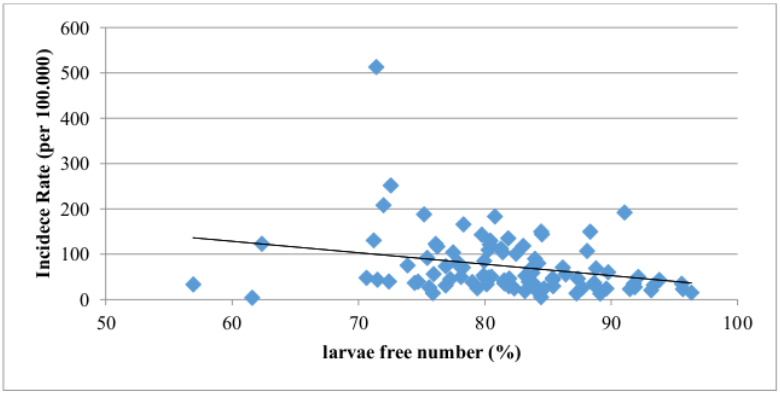

Figure 1. Relationship larvae free number value incidence rate district area with dengue in the city of Surabaya in 2010-2012. Source: City Health Office of Surabaya (the data is processed).

Conclusions

Based on the results and pembahsan research, it can be concluded that climatic factors, such as humidity than temperature, rainfall, solar radiation and the old city of Surabaya in support of dengue vector mosquito breeding. Total incidence of DHF showed a declining trend over the last three years. DHF incidence rate associated with air humidity, rainfall, and number of rainy days. Index larvae (Larvae Free Number, HI, CI, BI, and OI) indicates that the presence of dengue vectors quite high in the city of Surabaya is recommended for the Department of Public Health and the City of Surabaya to improve the prevention and eradication of mosquito breeding places, in order to decide DHF vector mosquito life cycle.

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