EFFECT OF THE VARIABILITY AND CLIMATE CHANGE TO DETECT CASE OF DENGUE FEVER IN INDONESIA

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Abstrak

Hasil dari penelitian para pakar iklim menunjukkan bahwa suhu global termasuk di Indonesia cenderung meningkat dari waktu ke waktu, serta telah terjadi pergeseran variasi curah hujan di beberapa wilayah. Terjadinya variasi dan perubahan iklim akan mempengaruhi area perkembang biakan nyamuk. Situasi ini berdampak langsung terhadap munculnya kasus demam berdarah. Pada penelitian ini dilakukan prediksi kasus demam berdarah wilayah Jakarta berdasarkan data curah hujan, hari hujan, kasus demam berdarah pada bulan sebelumnya, dan asumsi bahwa pada tahun 2010 musim kemarau basah tidak terjadi, maka kasus demam berdarah pada tahun 2010 diperkirakan menurun dibandingkan tahun 2007-2009. Hal ini karena musim hujan di tahun 2009-2010 di DKI Jakarta cenderung berkurang dibandingkan dengan tahun 2007-2008 dan 2008-2009. Dari hasil analisis menunjukkan bahwa kasus demam berdarah dapat dijadikan sebagai peringatan dini untuk dilakukan tindakan pencegahan kedepan, selain faktor alam (meteorologi) perlu juga dilakukan kajian sosial, budaya dan faktor lingkungan. Salah satu strategi untuk mengatasi kasus demam berdarah dapat dilakukan melalui koordinasi, kerjasama, dan kolaborasi antara pemerintah, peneliti dan masyarakat.

Kata kunci : demam berdarah, curah hujan, hari hujan

Abstract

Results from climate experts researches showed that global temperature including in Indonesia tends to increase from time to time, as well as a shift in rainfall variation in some regions. The occurrence of variation and climate change will affect the growth areas of mosquitoes. This situation has a direct impact on the emergence of dengue fever cases.
In this research, prediction of dengue fever cases in the Jakarta region based on rainfall data, rainy days, cases of dengue fever in the previous month, and the assumption that in the year 2010 wet - dry season condition will not occur, Then the cases of dengue fever in the year 2010 is expected to decline compared years 2007-2009. This is because the rainy season in the years 2009-2010 in Jakarta is relatively reduced compared to the years 2007-2008 and 2008-2009.
From the results of the analysis showed that cases of dengue fever can be used as an early warning for future preventive action, in addition to natural factors (meteorology) should also be examined social, cultural and environment factors. One strategy for addressing cases of dengue fever can be done through coordination, cooperation and collaboration between government, researchers and the society.

Key words *:* dengue, rainfall, rainy days

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I. INTRODUCTION

Due to the increase of public awareness on meteorological information, Indonesian Meteorological and Geophysical Agency should improve its meteorological information performance for various purposes. Public health sector also needs meteorological information which is part of Biometeorology.

The World Health Organization considers dengue to be the most important vectorborne viral disease, potentially affecting 2.5 billion people in tropical and subtropical countries throughout the world[1,2]. Current estimates suggest that 50 to 100 million dengue cases occur annually, in addition to 500,000 cases of the more serious, dengue hemorrhagic fever[3].

Classical dengue fever, also known as breakbone fever, is characterized by headaches, fevers, sore muscles and joints, with occasional nausea/vomiting and rash; these symptoms may persist for several days. Dengue hemorrhagic fever (DHF), is a much more serious illness mainly affecting children and young adults.

Symptoms include a sudden onset of fever and hemorrhagic manifestations that result in significant fluid loss and may lead to shock – dengue shock syndrome. Five percent of DHF cases are fatal[4]. A prior infection with one of the four dengue viruses results in a greater probability of contracting DHF. No vaccine currently exists for dengue.

The earliest reports of dengue fever epidemics date back to 1779–1780 in Asia, Africa and North America, indicating a widespread tropical distribution of *Ae.aegypti* during the past 200 years[4]. Since then, a global dengue pandemic, including the emergence of DHF, began in Southeast Asia after World War II. This pandemic intensified in the Americas during the 1980s with outbreaks in Caribbean and Latin American countries including Venezuela, Colombia, Brazil, French Guyana, Suriname, and Puerto Rico[4]. More recently, outbreaks of dengue have occurred in Brazil, Puerto Rico and in the western Pacific, including Vietnam, Fiji, Cambodia, Philippines, Malaysia, and Singapore [2].

Climate Factors and *Aedes Aegypti* Mosquito

Climate may affect the *Aedes aegypti* mosquito, the principal vector for yellow fever and dengue, since increasing global temperatures and other associated climate variability and changes may modify the mosquito’s geographic range.

Climatic variables such as temperature and precipitation significantly influence the mosquito’s development and survive[5]. In Colombia, for example, changes in the elevational distribution of *Ae. aegypti* have already been observed; previously limited altitude below 1500 m, the mosquito has recently been found above 2200 m, presumably due to temperature increases[6]. In Mexico, dengue cases have also been reported at previously unaffected higher altitudes[7].

According to WHO (2001)[8] Indonesia is one of hyper-endemic region of Dengue Hemorrhagic Fever (DHF). It is possibly due to warm climate which is favorable for mosquito development. In addition bad-managed environment with high density of population especially in urban areas provide a ideal place for mosquito to complete its life-cycle. High intensity rainfall will also make the condition worse during rainy season. Middle to lower level of city-residents still relatively has minimum awareness of public health. These conditions enabled mosquito as vector of DHF to develop and spread rapidly.

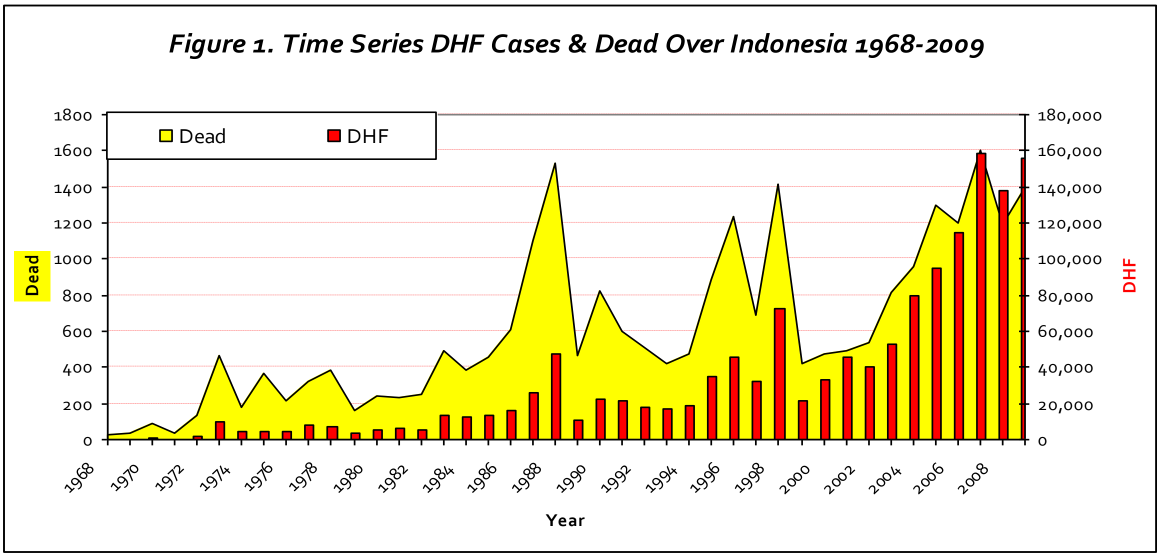

Figure 1. *Time Series DHF Cases & Death in Indonesia 1968-2009*
(source : Indonesian Ministry of Health, 2010)

To contribute in the field of biometeorology as preliminary research Indonesian Meteorological Climatological and Geophysical Agency conducted assessment on meteorological parameters which are suggested as precursor of DHF occurrences. With assumptions that mosquito life-cycle begins in the water, in this research we use rainfall and rain days data to predict DHF cases/occurrences in Jakarta areas.

DHF cases data from year 1968-2007 over Indonesia shows that DHF cases are increased from year by year. Especially for El~Nino year, DHF cases are usually decreased while before and after El~Nino year it is quite increased (see **figure 1**) *(source : Indonesian Ministry of Health, 2010).*

II. METHODOLOGY

This study aims to determine the impact of climate change on mosquito growth data represented by cases of dengue fever. The first phase of data analysis is the temperature of the air temperature in several cities in Indonesia and using the reference results of research conducted by other researchers. If the region is increasingly the result of heat (+), believed to be the development of mosquitoes in many and at the same time provide information dengue fever cases is projected to increase. Conversely if the price obtained negative (-) in the case of dengue fever is assumed to be reduced. The second stage comes to sea level rise scenarios, if the area is projected to increase sea level, is assumed to be a lot of inundation areas as breeding places of mosquitoes.

Another way to find out the scenario of dengue fever cases in Indonesia in 50 -100 years to come perform data analysis of dengue fever cases using the trend line model. This model is used with the assumption that in resolving cases of dengue fever during the period be like today.

The mathematical model was used in this study is two tiers approaches are used for this study. First approach uses time series model that can be applied to predict DHF cases to correlated with climate change scenario. The second uses meteorological data, such as: rainfall, rain days, temperature, or relative humidity whenever available. Then linear regression model is applied to predict DHF cases to be correlated with climate variability scenario. Time series trend describes historical development of a variable and one can use to predict future values of the variable.

DHF Prediction Model Theory.

Other than Time series model for DHF prediction, one can estimate DHF cases by using linear regression model with meteorological data as predictors. Key assumption considered in this study is that life-cycle of *Aedes aegypti* as DHF cases is resultant of meteorological factors (rainfall and rain days), human factors (culture and life-style), environment, and dengue viruses itself, which can be formulated as follows:

- *For Jakarta area:*

y(t,i) = a(i)+b(i)*RR(t-1)+c(i)*RD(t-2) + d(i)*DHF(t-1)+e(i)*DHF(t-2) ……(1)

Where:

Y = prediction of DHF cases & a, b, c, d, e = coefficient

RR = rainfall, where i = n = 1, 2, 3,..,12 (Month)

RD = rain days where t = time lag

DHF = DHF cases/observation

To calculate the rainfall estimates (RR) and rainy days (RD) monthly data is used as a predictor in the equation (1) above using an empirical linear regression model. Mathematically written as follows:

RR = a + b * RD ………………(2)

Where:

Rd = rain days

a = 0

b = coefficient

III. RESULT AND DISCUSSION

3.1. Results

Indonesia as a maritime continent, that has many volcanoes, lies in the tropical region between two continents, Asia and Australia. Besides Indonesia lies between two oceans, pacific and Indian oceans. More over, all years weather and climate in Indonesia are dominated by monsoon activity October~Maret are usually dominated by the Asian wet monsoon, while on April~September are dominated by the Australian dry monsoon. Besides according to solar inclination, weather and climate over Indonesia are disturbed by tropical cyclone in the north and South Hemisphere. Local circulation of Indonesia is dominated by sea/land breeze and orographic processes. Based on physical and dynamical process Indonesia there are three general rainfall types, those are: Equatorial, Monsoon, and Local type.

Based on rainfall data sample year 1961-2006 on the island of Java, the analysis shows that the development of annual rainfall generally varies in Java, which tends to increase in some areas in Banten, West Java, southern, and eastern parts of East Java.

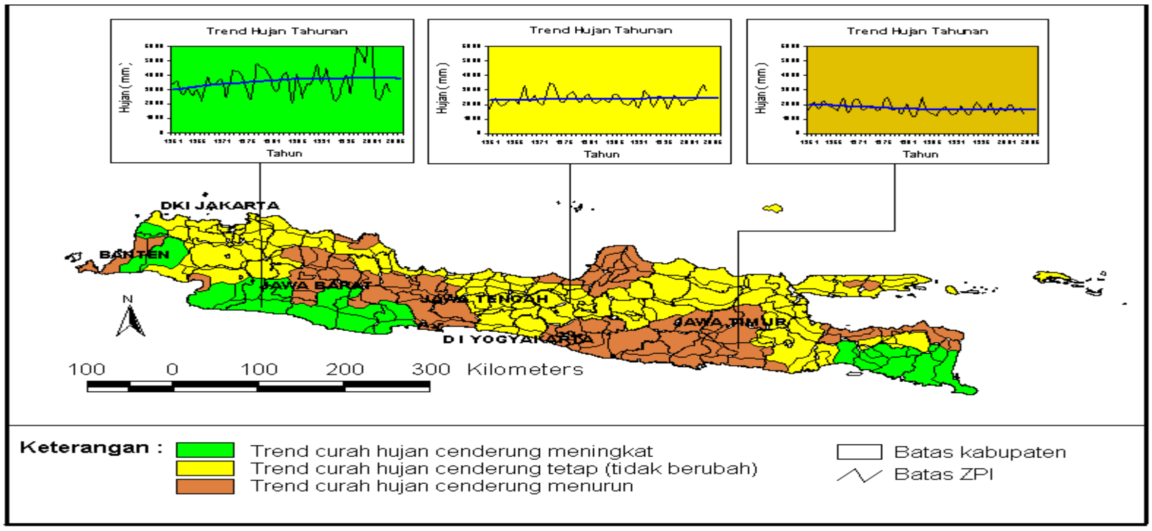

Figure 2. *Trend Rainfall Data 1961-2006 Over Java Island*

Meanwhile, a declining trend occurred in the area of Pandeglang, West Java, the central, western part of Central Java, Semarang, Kudus, Pati, Wonogiri, Yogyakarta, East Java, some parts of western, Pasuruan, Bondowoso, and Situbondo. Other areas in Java, the annual rainfall trend are unchange or steady.

Based on the analysis of rainfall data using conducted by researchers BMKG "Aldrian et.al, 2009"[11)] showing different parts of the climate change rainfall decreases (-10%), especially in Java, while others will place increasing rainfall up to 20%.

Based DHF cases data in Indonesia for 1985 – 1998 or Jakarta data for 1995 – 2009, when El Nino event occurred (e.g. year 1987, 1991, 1994 and 1997) number of DHF cases relatively low, whereas one or two years after or when

La Nina event occurs, there is dramatic increase of DHF cases (e.g. year 1998, 1996 and 1998). In 1992 and 1993, although El Nino just passed through no significant increase of DHF cases. We suggest in Indonesia during rainy season 1992 – 1993 rainfall amounts below or up to its normal.

perceived differences and variations in temperature between the places with each other. On the basis of surface temperature observations in several cities in Indonesia during the last 30 years when the projected temperature 50 -100 years has increased significantly in some cities reached a maximum 0.4 ^{o}C/100 years.

In addition, the results of research conducted by Aldrian (2009) in Indonesia is projected to increase in temperature of about 2-3 ^{o}C, and the results of studies conducted by Anthony J. McMichael et.al 2008[12)], global temperatures in the year 2100 is projected to increase 2.5 ^{o}C. Based on the results of surface temperature data analysis in several cities in Indonesia shows a trend that tends to go up or getting hot, and rainfall generally increased, although some areas have reduced, then the above scenario is based on cases of dengue fever in the coming period 50-100 projected increases of as much as 150,000 - 275,000 cases (see **figure 3**).

Especially for areas Jawa trend of dengue fever cases have the same pattern with the territory of Indonesia. Year 2100 projects will be occur 14,000 cases of

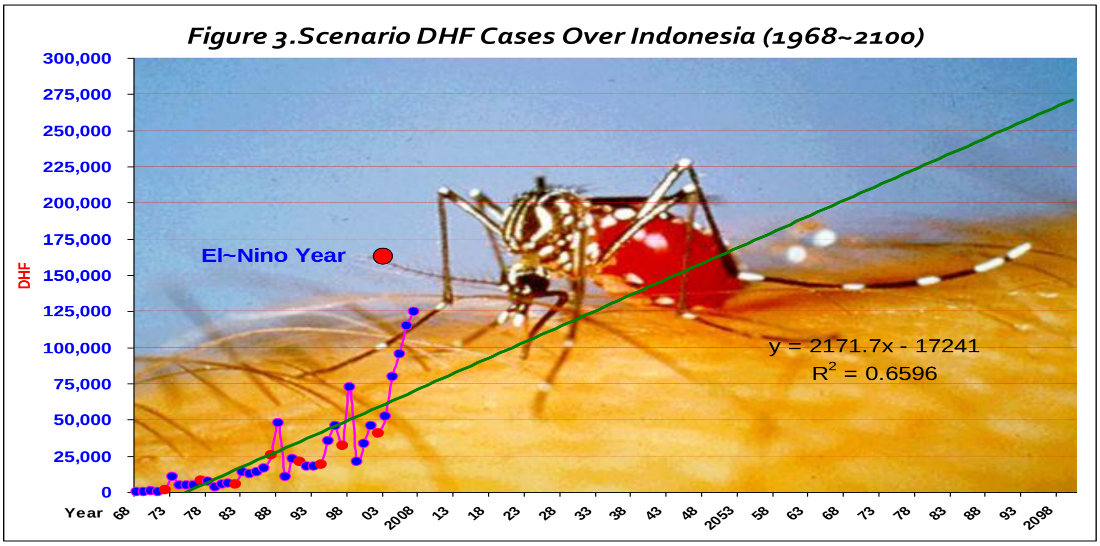

Figure 3. *Scenario DHF Cases Over Indonesia (1986-2100)*

Because of the nature and influence of non-uniform distribution of gases in the atmosphere, solar radiation reaching the earth's surface is not equal between the regions to each other. A direct result of the

dengue fever cases.

The results of data analysis dengue DKI Jakarta area from 1968 shows a tendency to increase from time to time. Since the year 2006-2009 an increase in dengue fever cases very sharp when compared with the previous year. Forecast of dengue cases in 2010 with a rainfall predictor, days of rain, and the data of dengue cases in 2009, with the assumption that in 2010 the wet dry season did not happen, then the estimated cases of dengue fever will be lower when compared to year 2006 -2009 (see **Figure 4)**.

As pointed out above that the growth of mosquitoes not only influenced by meteorological factors such as rainfall, temperature, and RH, but is also strongly influenced by social factors, cultural, environmental and especially for the middle-lower income, in addition to increased migration from one place to another or moving between countries.

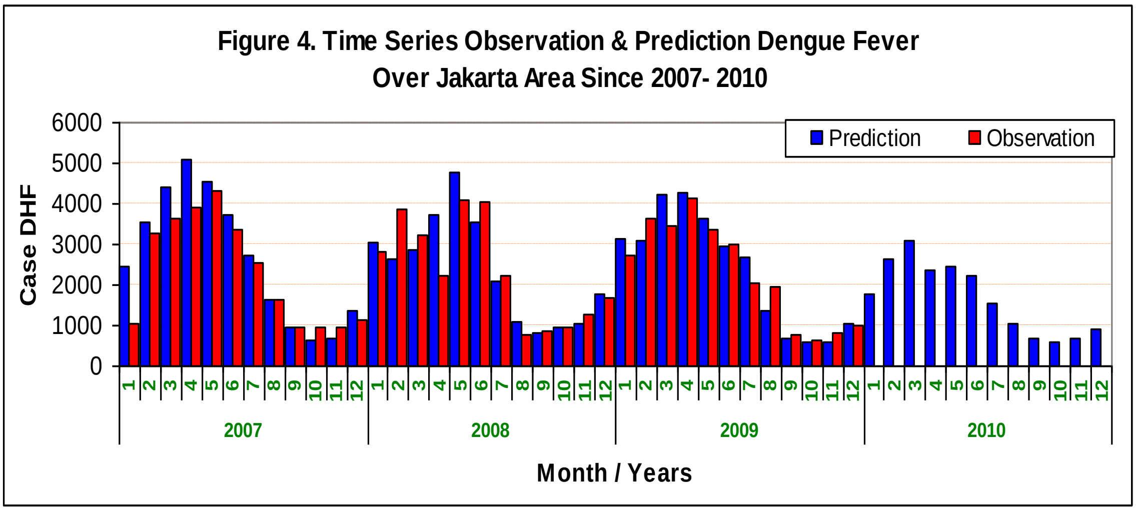

Figure 4*. Time Series Observation & Prediction Dengue Fever Over Jakarta Area Since 2007-2010*

3.2 Discussion

WHO (2003) stated that outbreak of DHF will return after 3 to 5 years, whereas El Nino phenomenon is 3 to 7 years cycle. Prediction of El Nino onset becomes important in this point, especially in predicting DHF outbreaks, because it is most likely this phenomenon closely related to ENSO as well.

As previously mentioned in hypothesis, life-cycle of *Aedes aegypti* is influenced by characteristics of local rainfall and rain days distribution. In this study similar result is also found, where the more intense rain days with normal intensity of rainfall mosquitoes tend to grow rapidly, whereas normal intensity of rainfall with less rain days resulting relatively less growth of mosquitoes. One should also notice when wet dry-season occurs, usually mosquitoes population showed rapid development as well.

The patient is very concerned about the last 5 years, from 2006-2009 cases of dengue fever in Indonesia has been a very dramatic increase in comparison with the previous year. Therefore, the Government must be more serious for the determination of the dengue fever on all aspects of coordination, cooperation and collaboration between the Government and society.

IV. CONCLUSIONS

On the basis of the results of the analysis and the previous discussion, several conclusions can be taken as follows:

1. The results of the analysis of surface air temperature data in several provincial cities show an increasing trend. This situation is expected to increase the population of various diseases, such as DHF cases, and other diseases.

2. Using data cases of dengue fever since 1968-2007, predicted that cases of dengue fever in years 2050 and 2100 in Indonesia, up to 150,000 and 275,000 cases.
3. Especially for the Jakarta area by using a predictor of rainfall, rainy days, cases of dengue fever last month, and in 2010 assumed that there is not occur wet dry season, dengue cases in 2010 expected to decline compared to year 2007-2009. This is because the rainy season in the indeed year 2009-2010 DKI Jakarta relatively reduced when compared with the year 2007-2008 and 2008-2009.
4. Based on the analysis results showed that cases of dengue fever would be expected to increase in the future, because in addition to natural factors (meteorology) there is also the problem of social, culture and environmental factors. One strategy for addressing cases of dengue fever can be done through coordination, cooperation, and collaboration between government, researcher and society

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