

The relationship between rainfall and dengue hemorrhagic fever incidence during 2009-2013 (Case study at Grati and Tuter Sub-district, Pasuruan, Indonesia)

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Abstract. Dengue Hemorrhagic Fever (DHF) is one of a health problem worldwide, which 3.9 billion people, in 128 countries, are at risk of infection of dengue viruses. There are several factors associated with DHF, such as climate change, rainfall, etc. The aim of the study is to describe the relationship of rainfall with the incidence of DHF from 2009-2013 at Pasuruan, Indonesia. The study was analytic study, which secondary data were used from Health and Statistics office of Pasuruan. The data was analyzed univariate and bivariate by Spearman test with SPSS. The results informed there were total of 1,453 cases of DHF incidence during 2009-2013 in Pasuruan, where Grati and Tuter Sub-district has 182 cases and 1 case, respectively. According to statistical test, the p value of rainy days period and rainfall with DHF incidence is 0.000 and 0.000 ($\alpha=0,05$) in Grati, respectively. Therefore, there were relation between rainy days period and rainfall with DHF incidence, which the rainy days period and rainfall have strong association.

1. Introduction

Dengue Hemorrhagic Fever (DHF) is one of a health problem worldwide, which severe dengue is a leading cause of serious illness and death among children in some Asian and Latin American Countries [1]. Dengue Hemorrhagic Fever is communicable disease caused by dengue virus that is transmitted by *Aedes aegypti* [2]. Before 1970, only 9 countries had experience severe dengue epidemic. However, the disease is now endemic in more than 100 countries in Africa, the Americas, the Eastern Mediterranean, South-east Asia and the Western Pacific [1]. Gubler (1992) describes hundreds of thousands of DHF cases are reported each year in tropical region of the Americas, Africa, Asia and Oceania [3]. WHO noted about 50-100 million DHF cases occur annually in over 100 endemic countries [4]. CDC noted more than one-third of the world's population living in areas at risk of dengue infection, which about 400 million people are infected yearly [5]. Furthermore, WHO estimated 3.9 billion people, in 128 countries, are at risk of infection with dengue viruses, which the number of cases reported increased from 2.2 million in 2010 to 3.2 million in 2015 [1]. Therefore, DHF is needed to pay attention of the community to reduce the impact of DHF.

Severe dengue (also known as Dengue Hemorrhagic Fever) is commonly found in tropical and subtropical countries, especially South-east Asia, Central America, and Caribbean that firstly occurred in Philippines [1], and then spread to other South-east Asia countries such as Thailand (1960), Vietnam



(1960), Singapore (1962), Srilanka (1965), and Myanmar (1968) [6]. In Indonesia, the first case of DHF is reported both in Surabaya and Jakarta on 1968 [7], and DHF case is also found in 30 provinces of Indonesia with 58,301 on February through April 2004 [8]. Indonesian Health Ministry noted that the number of DHF case in 2012 is 90,245 cases, which the number of death caused by DHF is 816 people (Incidence Rate (IR) = 37.27 per 100,000 people and Case Fatality Rate (CFR) = 0.9%) [9]. In 2012, East Java, one of the provinces in Indonesia, has the highest level of DHF case after West Java with 8,177 cases, which the number of death caused by DHF is 116 cases [9]. In 2016, the incidence rate of DHF cases in East Java is 64.8 per 100,000 people, which is increase than 2015 (IR = 54.18 per 100,000) [10]. Based on data from Pasuruan Health Office describes the total of DHF cases during 2009-2013 in Pasuruan is 1,453 cases, which Grati Sub-district has high level of DHF case in Pasuruan.

Grati and Tutar Sub-district is in Pasuruan Regency. The range area of Grati is 57.7 km² [11], which the number of population in 2013 is 75,494 [12]. According to population density, Sumber Agung village has the highest level with 2,704.77 people per square kilometer in 2013 [12]. Based on statistics office of Pasuruan, the range area of Tutar is 86.315 km² [13]. In 2013, the total population in Tutar is 53,709, which the highest and lowest population density level occurs in Wonosari (1,920.50 people per square kilometer) and Ngadirejo (235.05 people per square kilometer) village, respectively [13]. In 2013, The DHF case in Pasuruan Regency is 440 cases, which Grati and Tutar Sub-district are 42 cases and 0 cases, respectively. The DHF case in Pasuruan is elevated on 2016 with 764 cases [10].

There are factors related with DHF incidence, such as population density, mobility, urbanization, economic growth, community's behavior, climate change, environmental sanitation and clean water availability [10][14]. Githeko (2000) describe by 2100 it is estimated that average global temperatures will have risen by 1.0-3.5°C, where it is increasing the likelihood of many vector-borne disease in new area [15]. Based on Colón-González (2013), weather significantly influences dengue incidence, which climate change contribute to an increase in dengue incidence [16]. Pereda (2014) noted the increase in temperature and humidity in temperate regions (South of the country) will increase the incidence of dengue in the region [17]. Rahman (2012) describe there are many factors that could explain the growth in the number of cases of dengue, but surely increases in temperature and precipitation because of climate change is the most important factor contributing to DHF cases [18]. Climate factors (e.g. temperature, precipitation, humidity, wind velocity, and air pressure) may affect dengue fever through impacting its three essential bioecological aspects: dengue fever virus, mosquitoes and transmission environment [19]. Furthermore, Liu-Helmersson (2016) note beside vector control, mitigating greenhouse gas emission crucially reduces the future epidemic potential of dengue in Europe [20]. Therefore, climate change has correlation with DHF incidence.

The aim of study is to analyze the relation between climatic aspect and DHF incidence in Pasuruan during 2009-2013. The researchers wish that the research result is considered as reference of government to create policy to control the DHF case, where the study is newly conducted in Pasuruan, East Java-Indonesia.

2. Material and Method

The study used analytic method, where secondary data were used and collected from Health Office and Statistics Office of Pasuruan. The data of DHF case during 2009-2013 in Pasuruan was collected on August-October 2014, which the data of Health Office contain list of DHF patients and the diagnosis date of patients getting DHF from doctor. Furthermore, the climatic data were collected from Statistics Office, where the data contain the number of rainy days period (days) and rainfall (mm) monthly. However, the climatic data were collected on July 2018.

The study was conducted in Pasuruan Regency, where the range area of Pasuruan Regency is about 1,474.02 km² [21]. Tutar and Grati Sub-district were selected as study area caused by DHF incidence. Grati has 15 village, 77 hamlets, 118 citizen pillars, and 383 neighbor pillars, which most of population livelihood is farmer [11]. Furthermore, Tutar has 12 village, 70 hamlets, 88 citizen pillars, and 304 neighbor pillars [22]. Spearman test were used to analyze the relationship between rainy days period and rainfall with DHF incidence, where SPSS version 22 were also employed. Therefore, the climatic

data were assayed to find the correlation between climatic aspects with DHF incidence in Pasuruan Regency

3. Results and Discussion

3.1 Rainy Days and Rainfall in Grati and Tuttur Sub-district

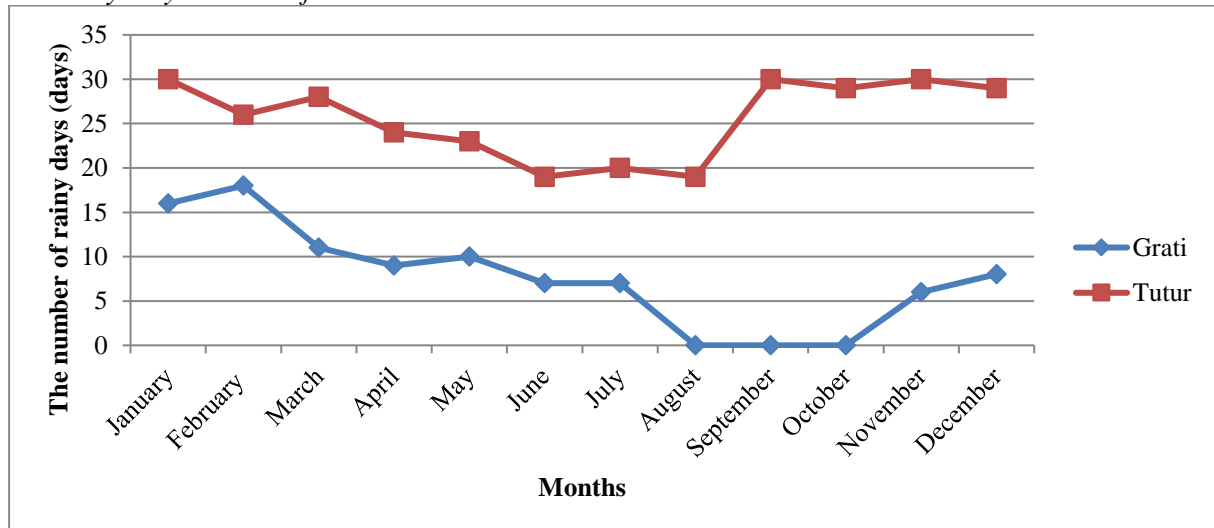


Figure 1. The Number of Rainy Days Period (days) in Grati and Tuttur 2013

The number of rainy days in Grati and Tuttur Sub-district is showed by Figure 1. Figure 1 presents the number of rainy days in Tuttur is higher than Grati, which the average of rainy day in Tuttur and Grati is 26 days and 8 days, respectively. In Grati, the high number of rainy days occurs in February. On the other hand, the number of rainy days in Tuttur occurs in January, September and November.

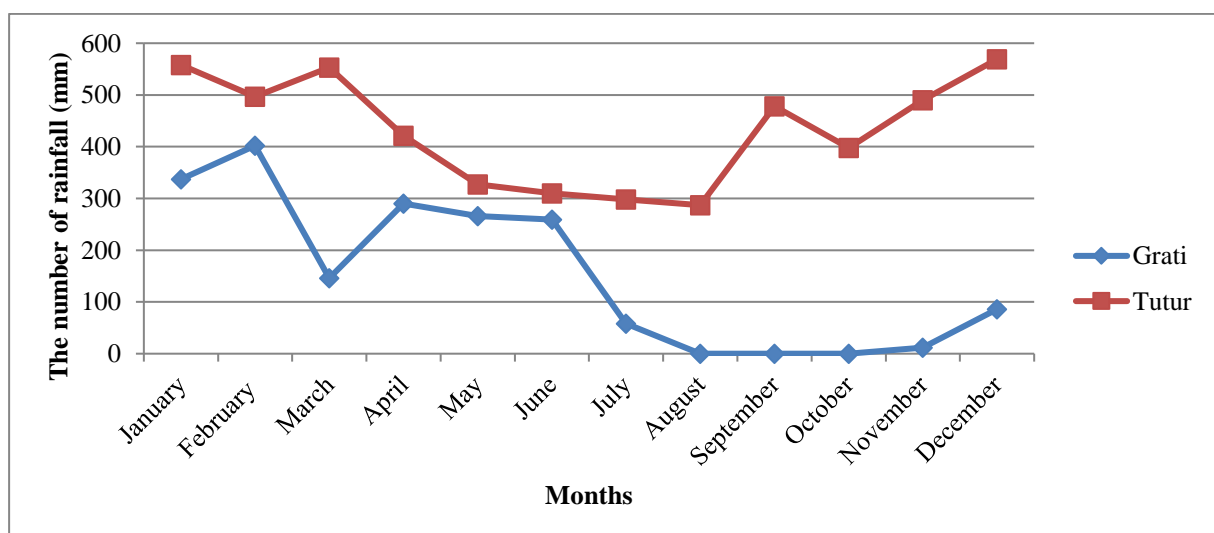


Figure 2. The Rainfall (mm) in Grati and Tuttur 2013

The number of rainfall is showed by figure 2. Figure 2 presents the number of rainfall in Tuttur is higher than Grati Sub-district, which the average of rainfall in Tuttur and Grati is 432.17 mm and 154.57 mm, respectively. The high number of rainfall in Grati and Tuttur is occurs in February (402 mm) and December (569 mm), respectively.

3.2 Dengue Hemorrhagic Fever in Grati and Tuttur Sub-district

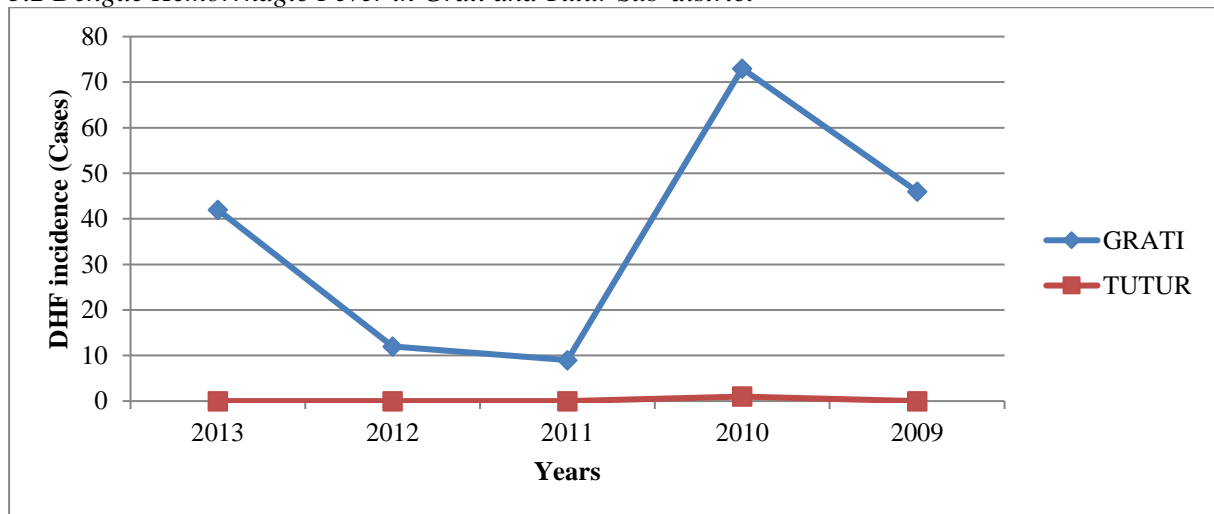


Figure 3. The number of DHF cases in Grati and Tuttur during 2009-2013

The number of DHF cases is showed by figure 3. Based on Figure 3, the number of DHF cases in Grati is higher than Tuttur Sub-district, which the total DHF incidence in Grati during 2009-2013 is 182 cases. The high number of DHF cases in Grati occurs in 2010.

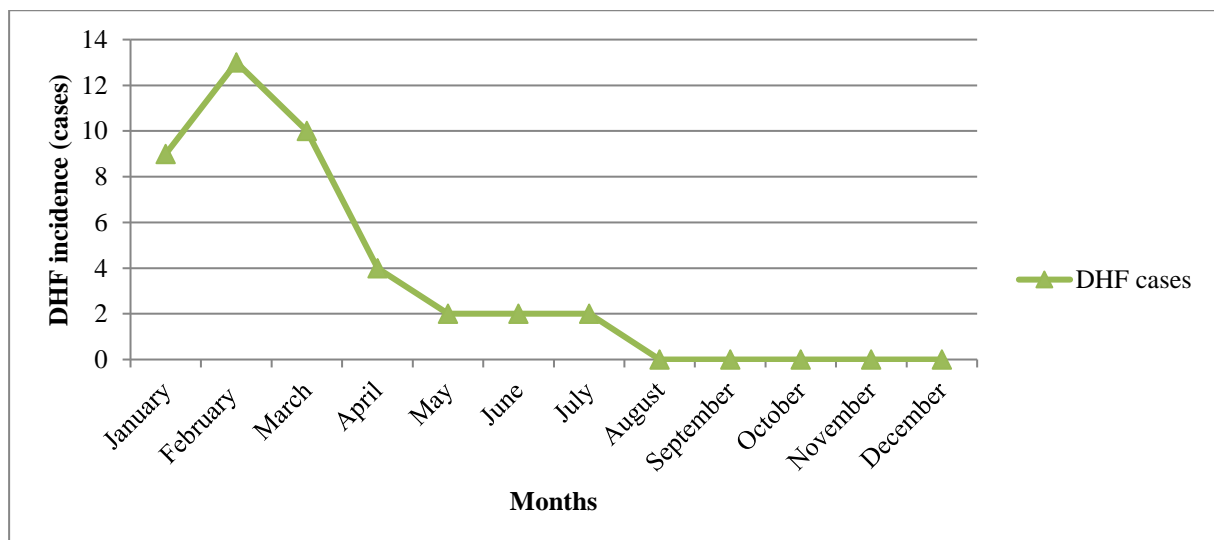


Figure 4. The number of DHF cases in Grati on 2013

Figure 4 presents the number of DHF cases in Grati, which the highest DHF cases occur in February (13 cases). The lowest numbers of DHF cases occur in August, September, October, November, and December with 0 cases.

3.3 The Rainy Days, Rainfall and Dengue Hemorrhagic Fever

Based on Figure 4, the high number of DHF incidence occurs on February with 13 cases, which the number of rainy days and rainfall is also high with 18 days and 402 mm, respectively. The number of rainy days in August, September, and October is 0, where the DHF cases is also 0. Furthermore, the number of rainfall and DHF incidence is 0 in august, September, October, and November. Based on statistical test, the p value of rainy days period and rainfall with DHF incidence is 0.000 and 0.000

($\alpha=0.05$; $p<\alpha$), respectively. Therefore, there are relationship between rainy days period and rainfall with DHF incidence. Furthermore, the r value of rainy days period and rainfall with DHF incidence is 0.885 and 0.854, respectively. It showed rainy days period and rainfalls have strong relationship through DHF incidence in Grati on 2013.

Dengue Hemorrhagic Fever is one of neglected tropical disease (NTDs) worldwide that in recent decades has emerged as a major international public health concern [23]. Mitra (2017) describe more than a billion people are infected with one or more of neglected tropical disease, which 250 million people are at risk of DHF and 50 million cases per year in over 100 countries [24][25]. DHF is communicable disease that is caused by a virus belonging to family *Flaviviridae* that is spread by *Aedes* mosquitoes, and commonly found in tropical and subtropical regions around the world [26]. Furthermore, dengue is transmitted to human by female *Aedes aegypti* mosquitos, with high transmission rates throughout the day and night in urban area [17]

Based on Figure 1 and 2, both rainy days and rainfall level in Grati is lower than Tukur Sub-district, which the average of rainy days and rainfall in Grati is 7,6 days and 154,67 mm, monthly, respectively. The DHF case during 2009-2013 is showed by Figure 3. The DHF case in Grati is higher than Tukur with 182 cases, which the DHF case in Tukur during 2009-2013 is 1 case. The distribution of monthly cases of DHF incidence in Grati is showed by Figure 4. Most of DHF cases occur in February, which the level of rainy days and rainfall in Grati is high with 18 days and 402 mm, respectively. The result is relevant with Iriani (2012), which the strong correlation of rainfall and DHF incidence occurs on the peak of rainfall in Palembang [27]. The association of rainfall and DHF incidence is well-documented, which most of article mention there are correlation between rainfall and DHF incident among society [28][29][30][31][32]. Although Tukur has higher level of rainy days and rainfall than Grati, the DHF incidence in Tukur is the lowest. It is caused by the geographical condition, which Tukur located in high area (600>1600 masl) [22].

WHO describes dengue is widespread throughout the tropics, with local spatial variations in risk influenced strongly by rainfall, temperature and the degree of urbanization [33]. Global climate change refers to large-scale changes in climate pattern over the years, including fluctuations in both rainfall- and temperature-related greenhouse effects [26], which if climate change occurs, this will increase the epidemic potential of dengue-carrying mosquitos, given viral introduction and susceptible human populations [34]. McMichael (2006) describe climate change will affect the potential incidence, seasonal transmission, and geographic range of various vector-borne diseases [35]. Furthermore, Abraham (2017) describes global warming caused warmer air holds more water vapor, where the amount of moisture that can be held in air grows rapidly as temperatures increase [36]. Therefore, global warming is increasing rainfall rates, where weather condition affects the DHF incidence.

4. Conclusion

The DHF incidence in Grati during 2009-2013 is higher than Tukur Sub-district with 182 cases. The mean rainy days period in Grati and Tukur is 7.6 days and 25.6 days, respectively. Furthermore, the mean rainfall in Grati and Tukur is 154.6 mm and 432.2 mm, respectively. The high DHF incidence in Grati occurs on high level of rainy days and rainfall in 2013. Based on Spearman test, the p value of rainy days period and rainfall with DHF incidence is 0.000 and 0.000 ($\alpha=0.05$; $p<\alpha$), respectively. Therefore, there are correlations between rainy days period and rainfall with DHF incidence in Grati on 2013, where rainy days period ($r=0.885$) and rainfall ($r=0.854$) have strong correlation with DHF incidence. Based on the result, it can be conclude rainy days period and rainfall related with DHF incidence, where the number of rainy days period and rainfall is one of climate change indicators that contribute to an increase in dengue incidence.

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