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Original Research

THE EFFECT OF CLIMATE FACTORS FOR DENGUE HEMORRHAGIC FEVER IN BANJARMASIN CITY, SOUTH KALIMANTAN PROVINCE, INDONESIA, 2012-2016

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ABSTRACT
Background: One of the factors that lead to high incidence of DHF is climate change.
Objective: To analyze the effect of climate factors (temperature, humidity, wind speed, and rainfall) associated with DHF incidence in Banjarmasin City, 2012-2016.
Methods: We used the national data on annual reported incidence from Health Office of Banjarmasin City and climate variations from Meteorology Climatology and Geophysics Agency 2nd Class Climatology Station Syamsudin Noor Banjarmasin, January 2012-December 2016. The analysis techniques using path analysis to explained the mechanism of causal relationships between variables.
Results: The result showed the overall incidence of DHF in Banjarmasin City during 2012- 2016 was 243 cases, of DHF cases were fluctuates by the monthly trend, where the highest number of DHF cases in January to March, climate variation which occurred in Banjarmasin City period 2012-2016 included temperatures ranged from 25.8-28.7°C, humidity ranged from 65-88%, wind speed ranged from 4-6 knots and rainfall ranged from 0.0-546.7 mm, and the path analysis showed that rainfall variable (X_4) was the only variable which positively effected to DHF incidence variable (Y) equal to 0.613 unit ($Y = 0.613\ X_4$) (p value = 0.002).
Conclusion: Climate information can used as a precautionary signal through early warming of the readiness in facing the outbreaks of vector borne diseases so that further efforts in environmental management by manipulation method and environmental modification.

Keywords: dengue hemorrhagic fever, climate factors, aedes aegypti

INTRODUCTION

Dengue Hemorrhagic Fever (DHF) is a public health problem of the world, especially in developing countries (Perwitasari & Ariati, 2015; Setiawan, Supardi, & Bani, 2017) and the one of the infectious diseases on deathly effect (Mangguang & Sari, 2017; Sihombing, Nugraheni, & Sudarsono, 2018). DHF is an infectious disease caused by four serotypes of Dengue virus (DEN 1, 2, 3, 4) transmitted through the bite of Aedes aegypti mosquitoes (Sihombing et al., 2018; Tosepu, 2017), an endemic in tropics and subtropics in various parts of the world especially in the rainy season (Handoyo, Hestinigsih, & Martini, 2017; Johansson, Dominici, & Glass, 2009; Sumi et al., 2017). Recently, WHO estimates that there were 50 to 100 million people dengue infection with an average 2.5% number of deaths each year and estimated more than 70% of The Southeast Asian and Western Pacific regions were the most seriously area affected by DHF (WHO, 2011).

Indonesia, one of the countries in Southeast Asia, has a large burden of dengue fever infections. One of the provinces in Indonesia including in a DHF endemic region is South Kalimantan. Spreading of Dengue fever in this region occurs in 13 (thirteen) cities/districts. In 2016, total population was 4.055.479 people, dengue cases of Incidence Rate (IR), Case Fatality Rate (CFR), and number of deaths were 101.5/100.000 population, 0.68%, and 28 people, respectively (Riskesdas, 2016). The highest case occurred in Banjarmasin City (Marlinae, 2016). Reported data from the Health Office of Banjarmasin City showed that the incidence of DHF last four years was increase. In 2013, there were 33 cases and 1 death, in 2014 than decreased to 11 cases, and contrarily in 2015-2016 were increase more than six times to 75 cases (5 deaths) and 57 cases and (a death) (DinKes, 2016).

One of the factors that lead to high incidence of DHF is climate change (Baylis, 2017; Butterworth, Morin, & Comrie, 2016; Lasut, Kaunang, & Kalesaran, 2017; Yushananta & Ahyanti, 2016). Transmission of some infectious diseases is strongly influenced by climate especially temperature, humidity, and wind speed (Brisbois & Ali, 2010). Dengue fever transmission very sensitive to climate, causing bionomic changes such as environments being warm and suitable temperatures enhance the biting behavior of adult mosquitoes, gonotrophic cycles, larval development rates, viral replication speeds, and rainwater induced by rainfall are indispensable by DHF vectors to proliferate (Cheong, Burkart, Leitão, & Lakes, 2013; Mangguang & Sari, 2017). Rainfall affects density of adult female mosquitoes. High rainfall lead to establishment of a breeding ground for mosquitoes that can increase the mosquitoes population (Promprou, Jaroensutasinee, & Jaroensutasinee, 2005).

Thus, vector borne disease such as Dengue Hemorrhagic Fever (DHF) needs to be watched as transmission of this disease will increase with climate change and it can be said that global warming is predicted by 2100, with a temperature rise of 2.0°C-4.5°C will have a major impact on the disease caused by vector (WHO, 2011).

Banjarmasin City condition which is always increasing the number of cases of dengue fever every year and less of study on climate effect (temperature, humidity, wind speed, and rainfall) in Banjarmasin urban area encourage more specific research related to climate effect to DHF incidence. So the results of this study can be used as a reference of important information as an effort to prevent the case of DHF through early warming.

METHODS

Study design

The type of this research was a quantitative descriptive with ecological time trend as a study research design to analyzed the magnitude of climate effect on the incidence of dengue disease in time period of 2012-2016 in Banjarmasin City.

Location and time research

This research was conducted in Banjarmasin City, which started in September until December 2017.

Research subject

In this research used population where the data used was aggregate data of DHF incidence in Banjarmasin City, period 2012-2016.

Instrument

The cases of DHF was a patient who exposed to Dengue Hemorrhagic Fever with Incidence Rate per 100.000 inhabitants (Dinas Kesehatan Kota Banjarmasin, 2016) and climate factors include temperature, average per month in ºC optimum 25ºC-27ºC, humidity, average per month in % steam, optimum < 60%, wind speed, average per month in knots and rainfall, average per month in mm (Badan Meteorologi

Klimatologi dan Geofisika (BMKG) Klas II Stasiun Klimatologi Bandara Syamsudin Noor Banjarmasin., 2016).

Data collection
This research was document observation used secondary data obtained from the Health Office of Banjarmasin City and Meteorology Climatology and Geophysics Agency 2nd Class Climatology Station Syamsudin Noor Banjarmasin.

Ethical considerations
The ethical approval was obtained from the Health Office of Banjarmasin City and Meteorology Climatology and Geophysics Agency 2nd Class Climatology Station Syamsudin Noor Banjarmasin.

Data analysis
Mechanism of causal relation between temperature, humidity, wind speed, and rainfall on the incidence of DHF disease were analyzed using path analysis. Correlations between variables were associated with model parameters expressed by path diagrams.

RESULTS

Figure 1 shows that data of DHF incidence in Banjarmasin City during the period of 2012-2016 was 243 cases. The lowest cases found in 2014 while the highest found in 2015 by 11 cases and 75 cases (5 deaths) respectively.

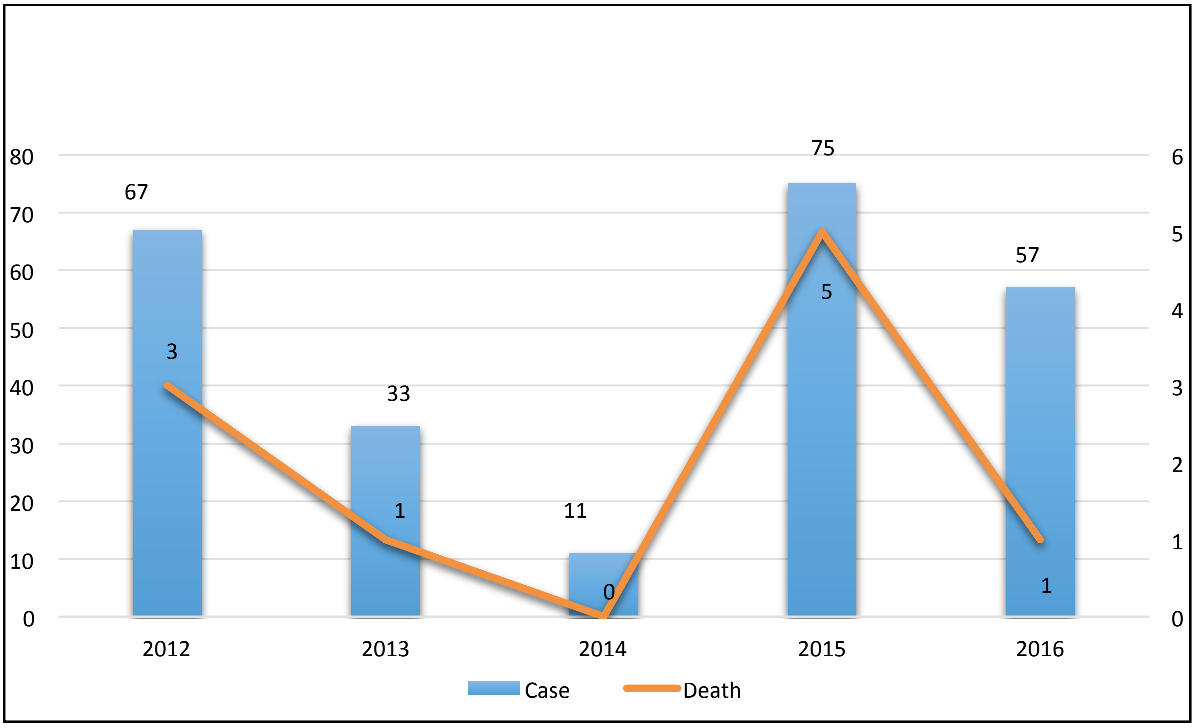


Figure 1 Cases of Dengue Hemorrhagic Fever in Banjarmasin City, 2012-2016

Figure 2 shows that monthly trend over a five years (2012-2016), the number of dengue fever cases began to increase in January, February and March, than decreased in April. The lowest cases occurred in September, and cases of DHF incidence began to increase again from October to December.

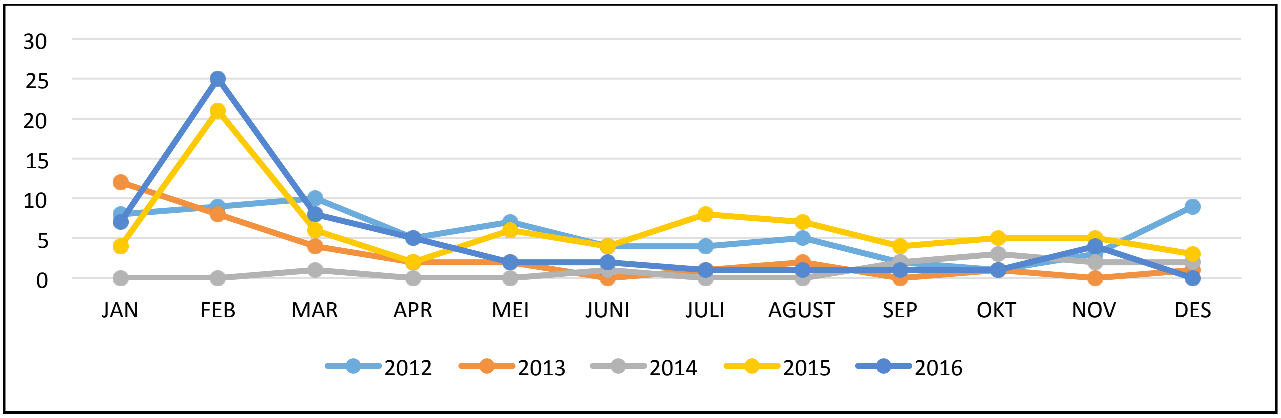
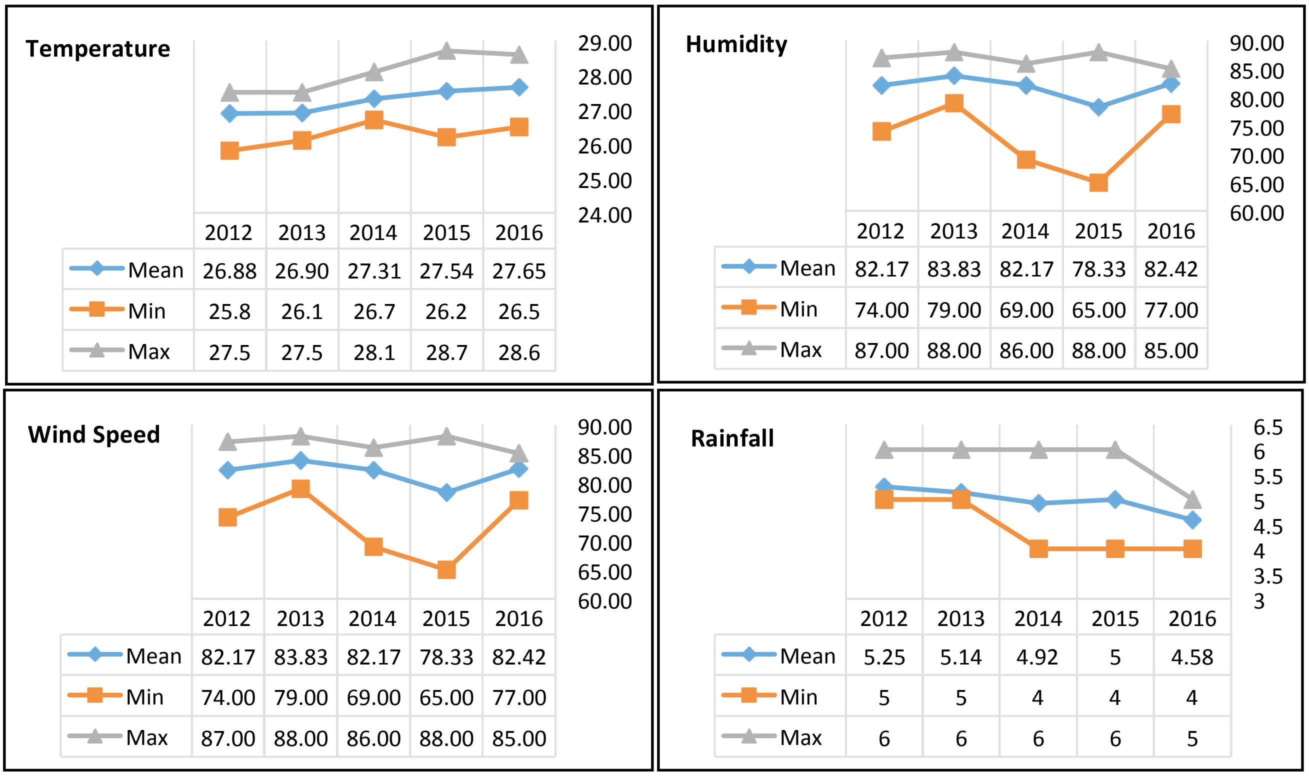


Figure 2 Cases of Dengue Hemorrhagic Fever by months in Banjarmasin City, 2012-2016



Temperature

	2012	2013	2014	2015	2016
Mean	26.88	26.90	27.31	27.54	27.65
Min	25.8	26.1	26.7	26.2	26.5
Max	27.5	27.5	28.1	28.7	28.6

Humidity

	2012	2013	2014	2015	2016
Mean	82.17	83.83	82.17	78.33	82.42
Min	74.00	79.00	69.00	65.00	77.00
Max	87.00	88.00	86.00	88.00	85.00

Wind Speed

	2012	2013	2014	2015	2016
Mean	82.17	83.83	82.17	78.33	82.42
Min	74.00	79.00	69.00	65.00	77.00
Max	87.00	88.00	86.00	88.00	85.00

Rainfall

	2012	2013	2014	2015	2016
Mean	5.25	5.14	4.92	5	4.58
Min	5	5	4	4	4
Max	6	6	6	6	5

Figure 3 Climate Variations (Temperature, Humidity, Wind Speed, and Rainfall) in Banjarmasin City, 2012-2016

Figure 3 shows that climate variations of Banjarmasin City during the period of 2012-2016 such as the temperature ranged from 25.8-28.7°C with the lowest and highest temperatures being is in 2012 and 2015 respectively. The humidity ranged from 65-88% with the lowest and highest humidity is in 2015 and 2013, 2015 respectively. The wind speed ranged from 4-6 knots. This condition tends stable over a 5-year period. And, the rainfall ranged from 0,0-546.7 mm with the lowest and the highest rainfall occurs in 2015. Effects of climate factors (temperature, humidity, wind speed, and rainfall) variables on the incidence of DHF can be illustrated in the following path analysis diagram.

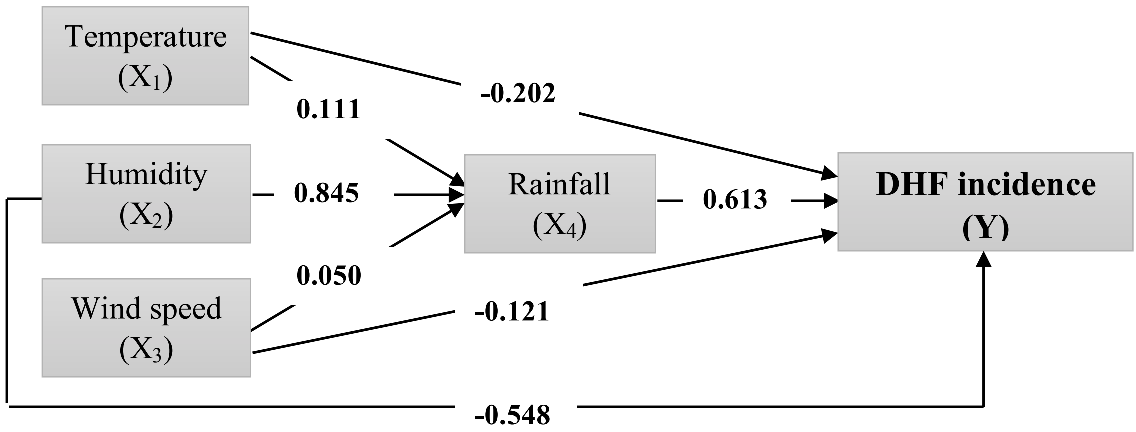


Figure 4 Diagram of relationship path between X_1, X_2, X_3, X_4 to Y

Figure 4 shows that relationship path between variables through direct and indirect effects. Direct rainfall positively affects the incidence of DHF. The direct quantity of rainfall on the occurrence of DHF is 0.613 (61.3%) (p value = 0.002) means that the high incidence of DHF is influenced by rainfall of 61.3% while the remaining 38.7% is influenced by other factors outside the model.

The indirect effect of X_1 to Y through X_4 = 0.111 x 0.613 = 0.068, with total effect = -0.202 + 0.068 = -0.134. The indirect effect of X_2 to Y through X_4 = 0.845 x 0.613 = 0.517, with a total effect = -0.548 + 0.517 = -0.031. And, the indirect effect of X_3 to Y through X_4 = 0.050 x 0.613 = 0.030 with the total effect = -0.121 + 0.030 = -0.091.

DISCUSSION

DHF incidence in a region is influenced by many factors, whether it comes from demographic aspects (population density, mobility, behavior, social economy), vectors (type and density), host (vulnerability and immunity), as well as environmental aspects including weather or climate (Ariati & Anwar, 2014). In this study the incidence of DHF is only seen from one of the factors, namely climate factors include temperature, humidity, wind speed, and rainfall. The results show that monthly trend analyze over the five-year period (2012-2016), the incidence of DHF in Banjarmasin City is fluctuates, where the number of dengue cases began to increase in January, February and March, than decreased in April. The lowest number of cases occurred in September, and cases of DHF began to increase again from October to December. These results are in line with the rainy season that occurred in the Banjarmasin City, which began in early October to March. Study states that the season of transmission of dengue fever generally occur at the beginning of the rainy season, at the beginning of the year and the end of the year (Lasut et al., 2017).

Dengue epidemics in most countries reported occur during the wet, humid and warm seasons that support mosquito growth and shorten the extrinsic incubation period (Iriani, 2016). Temperature has a direct relationship with vector metabolism. The optimum average temperature for development of mosquitoes is 25°C-27°C (Wulandari, Fitriany, & Dini, 2010). The temperature level in Banjarmasin City 2012-2016 ranges from 25.8-28.7°C, an optimum temperature for mosquitoes development. The speed of a mosquitoes development depends on the speed of its metabolism which is partially regulated by the temperature so that certain biological events such as the length of pre-adulthood, the digestive velocity of the sucked blood and maturation of the ovaries and the frequency of taking food or biting differ by temperature, as well as duration of viral travel in the body mosquito. Mosquitoes can survive at low temperatures, but their metabolism decreases or even stops when the temperature falls below the critical temperature. The growth of the mosquito will stop completely if the temperature is less than 10°C or more than 40°C (Ariati & Anwar, 2014).

Humidity conditions in Banjarmasin City 2012-2016 ranged between 65-88%. This condition is the comfort zone for mosquitoes to breed and humid conditions can also affect the mosquitoes age flying distance, and biting habits (Paramita & Mukono, 2018). At relatively high humidity will cause mosquitoes to being endophilic and have more resting properties in the home or settlements that have the appropriate humidity (Arsin, 2013). At less than 60% humidity, the mosquito's life becomes short, so it is insufficient for the virDen breeding cycle in the mosquito body.

Wind speed at sunrise and sunset where mosquitoes fly in or out of the house determines of human contact with mosquitoes. Wind speeds ranging from 11-14 m/sec influence or inhibit mosquito flight. Wind speed will affect the flight distance of mosquitoes (Lasut et al., 2017). Wind speed conditions in Banjarmasin City 2012-2016 ranged between 4-6 knots. This speed is a velocity that will not inhibit mosquito vectors to fly, so it can be said ideal for mosquito vectors.

Rainfall contributes to availability of Aedes aegypti vector habitat. Rainfall will increase the puddle of water as a breeding ground for mosquitoes. Rainfall conditions in Banjarmasin City 2012-2016 ranged from 0.0-546.7 mm. High rainfall can cause puddles in water reservoirs around the house or other areas where larval breeding becomes mosquitoes. The effects of rainfall on vectors vary, depending on the amount of rainfall, the frequency of rainy days, the geography and the physical nature of the land or habitat type as the reservoir of water that is the mosquito breeding place (Arsin, 2013). Rainfall is one of the meteorological variables that can be used as early warming control mosquito.

Path analysis in this study was conducted to explain the mechanism of causal relationship between temperature (X_1), humidity (X_2), wind speed (X_3), and rainfall (X_4) on DHF incidence (Y). Figure 4 shows the path coefficient of temperature, humidity, wind speed, and rainfall on the DHF incidence in Banjarmasin City. The result of path analysis shows that rainfall variable is the only positively effect on the DHF incidence (Y). Where it can be interpreted that any increase of 1 unit of rainfall variables will increase incidence of dengue disease by 0.613 units ($Y = 0.613 X_4$) (p value = 0.002). This result is in line with the research conducted in Pringsewu, Lampung (Yushananta & Ahyanti, 2016), Palembang (Iriani, 2016), and Malaysia (Cheong et al., 2013) which states that rainfall directly affects the DHF incidence and there is a correlation between rainfall and the increase of dengue fever treated in the hospital. However, the results of this study are not in line with the research conducted in Serang, Banten (Wulandari et al., 2010) that there is no significant relationship between climate temperature factor, rainfall, rainy day, solar irradiance, humidity and wind speed with the DHF incidence due to lack of duration of data taken, incomplete climatic data obtained, and lack of frequency of dengue incident data taken.

Entomological status of high dengue vectors such as larvae free (ABJ) is supported by high rainfall and may encourage an occurrence of DHF and rain variability have direct consequences on outbreaks of infectious diseases (Widiarti, 2013). The Aedes mosquito itself requires an average rainfall of about 350 mm to over 500 mm per year for successful breeding (Chen et al., 2012; Jacob, Pijoh, & Wahongan, 2014).

The efforts to reduce incidence of dengue disease are by controlling the number of density of Aedes aegypti larvae with Free Rate Indicator of larvae (ABJ). While rainfall and other climatic factors are variables that can not be controlled. Climate information can be used as a precautionary signal through early vigilance related to the readiness to face outbreaks of vector-borne diseases and rainy season associated with increasing cases of DHF events, so that the efforts can be made environmental management by the manipulation method and environmental modification.To the necessary participation of all communities, in this case focuses on the role of households to be able to manage their environment by always maintaining the cleanliness of the surrounding environment.

CONCLUSION

Distribution of DHF incidence in Banjarmasin City in term of fluctuating monthly trend, where the highest number of dengue cases in January to March, climate variations that occurred in Banjarmasin City was an ideal condition for DHF vectors proliferation that potentially increase the spread of DHF incidence. The result of path analysis shows that rainfall variable is the only variable that has positive effect on the variable of DHF incidence. Early vigilance activities that can be done is cooperation among relevant agencies include proactive coordination in tackling DHF cases so that the spread of DHF is not widespread and does not occur DHF outbreaks, dissemination of measurement results based on the month of each year related to climate variations that occur, so to make efforts to prevent such as field surveys, abatesasi, fogging and regular larva monitoring (PJB) and Mosquito Nest Eradication (PSN) 3M Plus in the community.

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