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The community based controlling for the widely spread of dengue haemorhagic fever (DHF) in North Sumatra

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Abstract

The widely spread of the *Dengue Haemorhagic Fever* (DHF) in North Sumatra made a field work study on this topic was very important. It was reported that the *Dengue Haemorhagic Fever* (DHF) is an acute fever in 2 until 7 days with two or more manifestations such as headache, retro-orbital pain, *mialgia*, *atralgia*, skin rash, and haemorhagic manifestation. A case study of the Community Based Control was carried to know the responsible factors of the widely spread of DHF and the way of controlling its by applied Comunity Based Model. This study basically sought the influential factors of the widely spread of DHF such as rainfall, air humadity, air temperature, and wind velocity that might be possible to be anticipated by Community and government. Thus, the effectiveness of Community Based Controlling Model was also presented. The combination of recorded cases and a field observation was proceeded to the liniar regression test; so it was known that there was an association between air temperature and DHF case in Binjai Municipality 2011-2015 because the *p* value was 0,038 ($p <$ 0.05). The association between wind velocity and DHF cases showed a strongly significant association (r = 0,899) and patterned positively.it is necessary to eradicate the mosquito breeding place in a high number of DHF case.

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Introduction

Public health in many developing countries, like Indonesia, recognizes the Dengue Haemorhagic Fever (DHF) as primarily diseases of children. It is known that the children have been the largest segment of susceptible individuals within the population at risk in Indonesia. The Dengue haemorrhagic fever (DHF) is characterized by four major clinical manifestations: high fever, haemorrhagic phenomena, often with hepatomegaly and, in severe cases, signs of circulatory failure (WHO, 1997). Additionally, the Dengue Hemorrhagic is clinical variants of this disease, which have a significant morbidity and mortality (Guerdan, 2010). Typically, DHF is an acute febrile illness characterised by frontal headache, retroocular pain, muscle and joint pain, nausea, vomiting, and rash (José et al., 1998). It has been noted that the *Dengue Haemorhagic Fever* (DHF) as the most serious mosquito-borne viral disease in the world and had been significantly affected by temperature (Fan *et al.,* 2015). The temperature range for dengue fever lies between 14 °C and 18 °C at the lower end and 35 °C and 40 °C at the upper end (WHO, 2011). The impacts of temperature and rainfall on dengue transmission are partly translated through the effects of temperature and rain on the rates of biological development, feeding, reproduction, population density, and survival of Aedes mosquitoes (Hii, 2013). Aedes aegypti, domestic Aedes mosquito, has been recognized to be the main vector of DHF since 1903. Aedes albopictus, or the garden Aedes mosquito, which lives in vegetation in forested areas, may also serve as a vector (Thammapalo, 2005).

Theoretically a high number of rainfall would effect on the breeding place of *Aedes aegypti*. It allows more breeding places, but it also might be able to wipe out the those. The differences in the arrival of the rainy season, dry season and the length of its seasons is causing the effect of the mosquito bionomic changes. Thus, rainy and dry season have the influential factors on the level of ambient temperature. Refer to the Binjai Central Bureau of Statistics it was found that the total amount of rainfall in a year was 2195 mm/year. The highest average rainfall in 2014 was in South Binjai District (289,58 mm). The total average of air temperatures in a year were 23,3^{o}C until 23,4^{o}C, with humidity between 81% until 83%. The turnover from rainy season to dry season, air temperatures ranged from 23-31^{o}C, it is a maximum range for mosquito breeding (24-28^{o}C) that will stimulate mosquito to be more aggressive and increasing the frequency of mosquito bites that increases probability of contracting the disease. Additionally, wind velocity will affect the range of mosquito flying.

Due to complicated problems of the DHF in Binjai Municipal of North Sumatra Indonesia, this reserach thus sought the influential factors of the widely spread of DHF such as rainfall, air humadity, air temperature, and wind velocity that might be possible to be anticipated by Community and government. Therefore, the effectiveness of Community Based Controlling Model was also analyzed from the obtained data of fieldwork.

Materials and methods

The materials that were used in the seeking of influential factors that made the widely spread of DHF in Binjai Municipal were as follows:

1. Statistical Data from Meteorology Climatology Geophysics Agency
2. Tool for testing the air temperatres,
3. Tool for testing the rainfall,
4. Tool for testing the air humidity, and
5. Tool for testing the wind velocity

Methods

A combination of document analysis and observational fieldwork was carried out in order to gather information about widely spread of DHF in Binjai of North Sumatra. This research was carried out to trace the responsible factors made the widely spread of DHF. The rainfall, air humadity, air temperature, and wind velocity were analyzed to find their effects on the growth of DHF in Binjai of North Sumatra.

Data collection

A trace study was conducted in Binjai Municipality of North Sumatra, Indonesai. Population of this research included the DHF cases of each District in Binjai Municipality in 2011-2015 from the Health Department. Therefore, all the data of air temperatures, rainfall, air humidity, and wind velocity in 2011-2015 from Central Bureau of Statistics and Meteorology Climatology Geophysics Agency in Medan Municipality.

Data analysis

Data analyzed were through a correlational test, simple linear regression, and multiple linear regression ways. The *Kolmogorov smirnov* with the *Pearson Correlation* and Linear Regression applications in computer was done. The analysis was aimed at relating the DHF data from Health Department of Binjai Municipality to air temperatres, rainfall, air humidity, and wind velocity data from Meteorology Climatology Geophysics Agency. The results were used as basic material to formulate a model to control DHF.

Results and discussion

The obtained data were the combination of the spread record of the DHF in the Binjai Municipal of North Sumatra and the observation datum of fieldwork in the community. The data were presented in the following tables:

Table 1. The Average DHF data per months in Binjai Municipality 2011-2015.

No.	Year	The highest cases	Percentage
1.	2012	46 Cases in Sept-Oct	26,20%
2.	2013	43 Cases in Oct	26,71%
3.	2014	30 Cases in August	19,74%
4.	2015	7 Cases in May	0,67%
		The average	13,42

Table 2. Result of normality tests for each variables per Year in 2010-2014.

Variable	P value	Result
DHF Cases	0,429	Normal
Rainfall	0,278	Normal
Air Humidity	0,727	Normal
Air Temperature	0,484	Normal
Wind Velocity	0,444	Normal

The table above showed that the average number of DHF each years in 2011-2015 were 13,42. The highest average of DHF per months were in September and October, 26.2. the highest amount of DHF case in 2013 which occurred on October were 43 cases (26,71%), in 2014 decreased to 30 cases (19,74%), and decreased in following year, 2015. Meanwhile, the lowest average amount of DHF occurred on May 2011-2015. The lowest amount of DHF in May 2015 were 0,67% with average number 6,4%.Therefore, the average DHF data in Binjai Municipality on 2011-2015 can be seen in fig. 1.

Table 3. Correlation test result of variables per month 2011-2015.

Independent Varibles	Dependent Variables	R	p value	Information
Rainfall	DHF case	-0,897	0,039	Strongly correlated significantly
Air Humidity		-0,297	0,627	Uncorrelated significantly
Air Temperature		0,950	0,013	Strongly correlated significantly
Wind Velocity		0,899	0,038	Strongly correlated significantly

From Fig. 1 it showed that DHF cases decreased every year. 2011 to 2012, DHF cases decreased into 11,36 cases. In 2013 significantly increased and it was the highest amount of DHF case, 13,42 and in 2013 until 2015 decreased from 13,42 until 12,43 cases.

Table 4. Correlation test result of each research variables per month in 2011-2015.

Variables	R	R2	Equation	p value
Rainfall	-0,897	0,804	Y = 19,758-0,045* rainfall	0,039
Air Humidity	-0,297	0,088	Y = 15,216-0,033* air humidity	0,627
Air Temperature	0,950	0,902	Y = -34,798+1,711* air temperature	0,013
Wind Velocity	0,899	0,809	Y = 4,150+3,086* wind velocity	0,038

Fig. 2 showed that the highest average DHF occurred in North Binjai Sub District in 5 years, 87,8 cases, followed by East Binjai Sub District with 79,8 cases, then west Binjai got 50 cases, and the lowest average of DHF cases occurred in South Binjai with 28 cases. Figure 3 above showed that rainfall in January until March was relatively constant, but it increased significantly in April and August, 147 mm and 195 mm. The highest amount of rainfall occurred in October, 279,2 mm and the lowest amount occurred in June 72,8 mm.

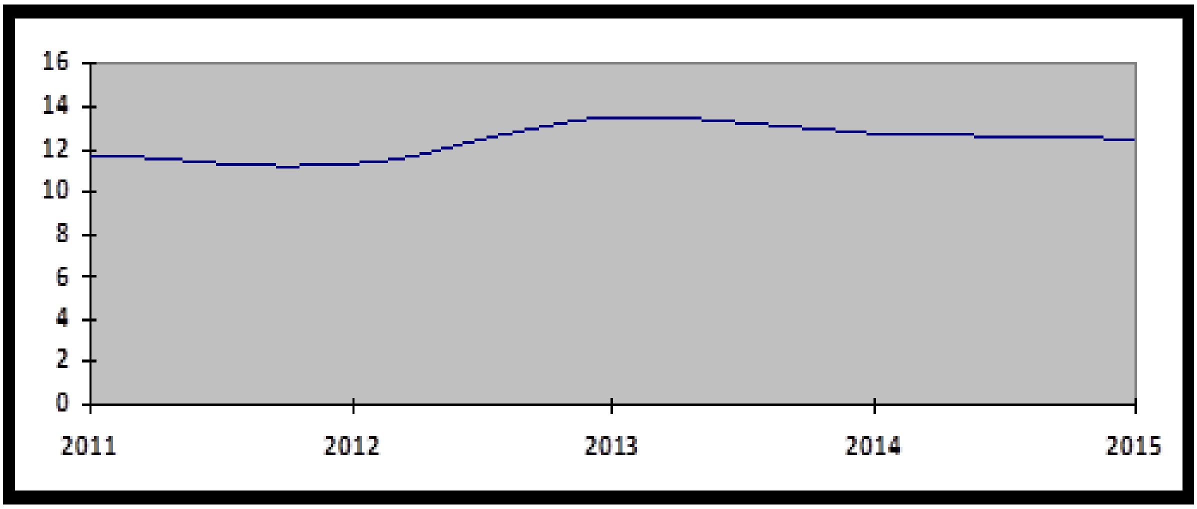

Fig. 1. The Average DHF Data per year in Binjai Municipality 2011-2015.

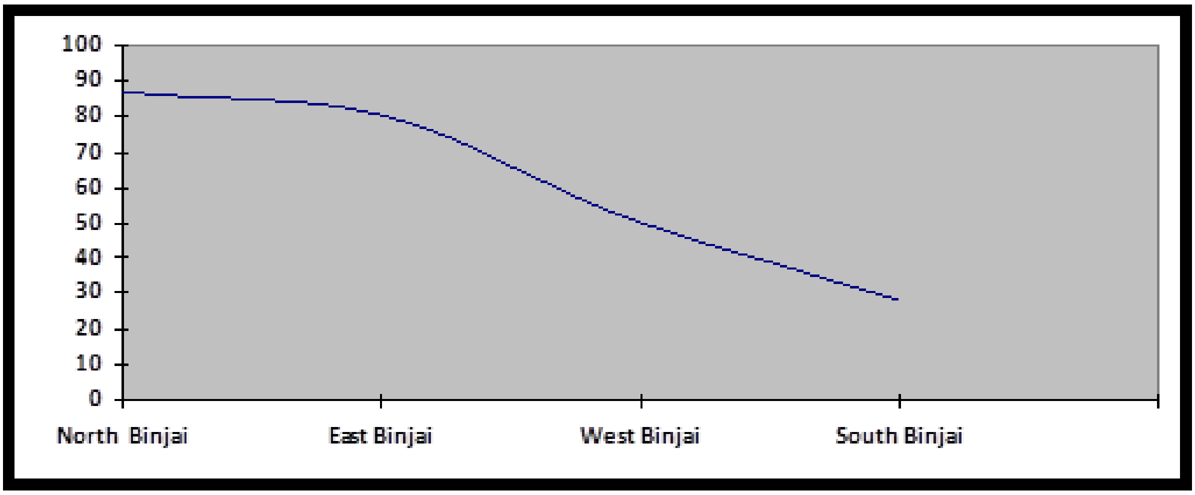

Fig. 2. The Average DHF case for each Sub District in Binjai Municipality 2011-2015.

Fig. 4 shows that the average rainfall in Binjai Municipality was relatively constant. The average of rainfall decreased in 2011-2013, but it increased in 2014-2015. The highest average amount of rainfall occurred in 2011, 188,7 mm and the lowest occurred in 2013, it was 145,2 mm.

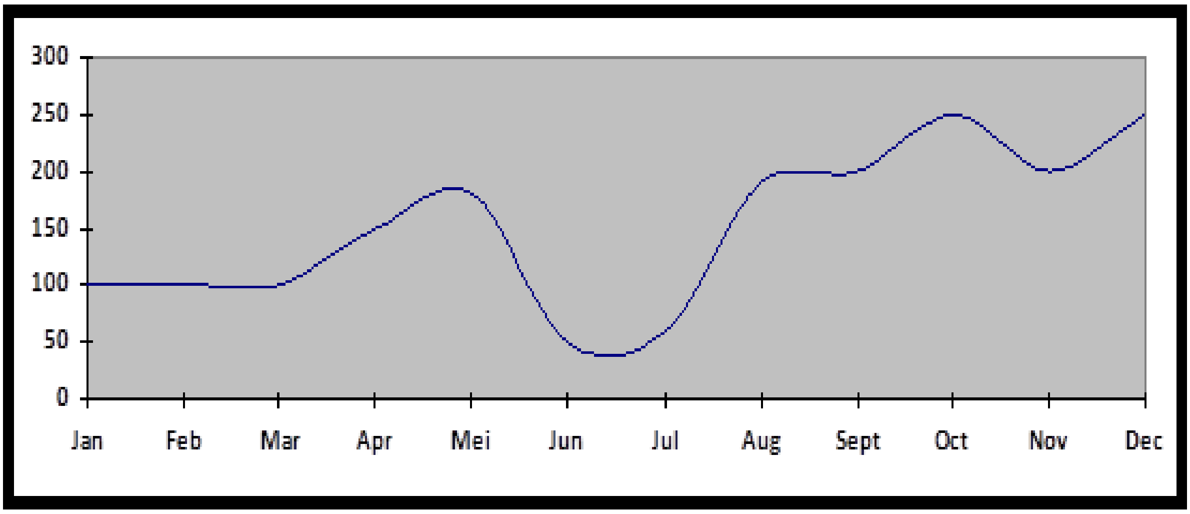

Fig. 3. The Average of Rainfall per month in Binjai Municipality 2011-2015.

Wind Velocity Representation in Binjai Municipality 2011-2015

Fig. 5 showed that wind velocity in Binjai Municipality 2011-2015 were relatively constant, but it increased significantly in August to September, it was 2,54 knot until 2,74 knot.

The highest average amount of wind velocity occurred in September, 2,74 know, while the lowest average amount occurred in May, 2,5 knot.

In Fig. 6, the average amount of wind velocity in Binjai Municipality was relatively constant. The highest amount was in 2013, 2,9 knot, while the lowest amount was in 2011, 2,3 knot.

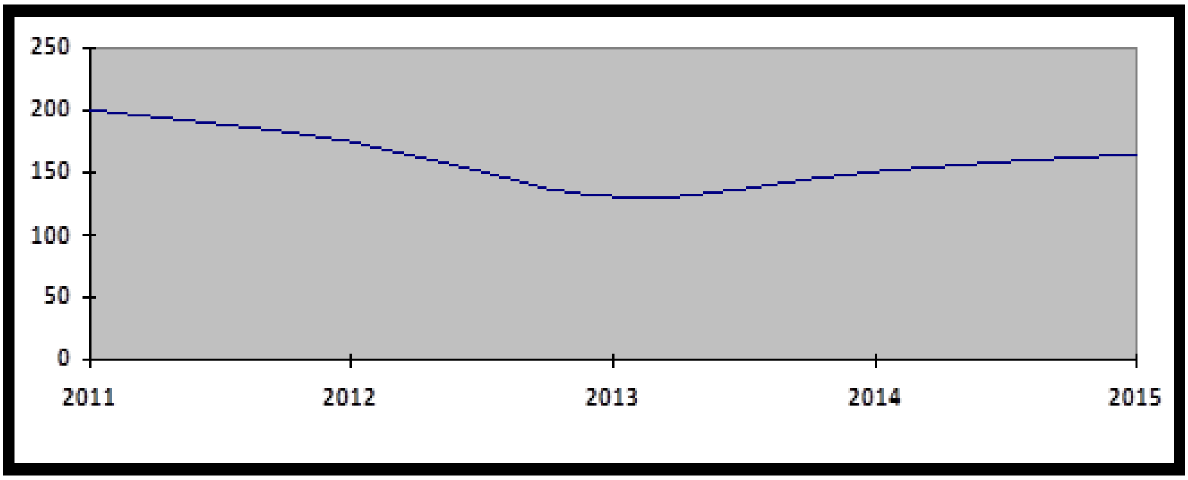

Fig. 4. The average of rainfall per year in Binjai Municipality 2011-2015.

Air temperature representation in Binjai Municipality 2011-2015

Fig. 7 shows that the average of air temperature was not constant. The average of air temperature increased from January until June, it was 27,039°C to 28,097°C, meanwhile in August and December decreased to 27,608°C and 26,917°C. The highest average amount of air temperature was in June, 28,097°C and the lowest was in December, 26,917°C.

Based on Fig. 8, the air temperature in Binjai Municipality in 2011-2012 were relatively constant and in 2013 the average of air temperature increased significantly, it was 28,1°C. However, the average of air temperature in 2014 and 2015 decreased into 27,9°C – 27,4°C. The highest average amount of air temperature was in 2011 and 2012, 27,1°C.

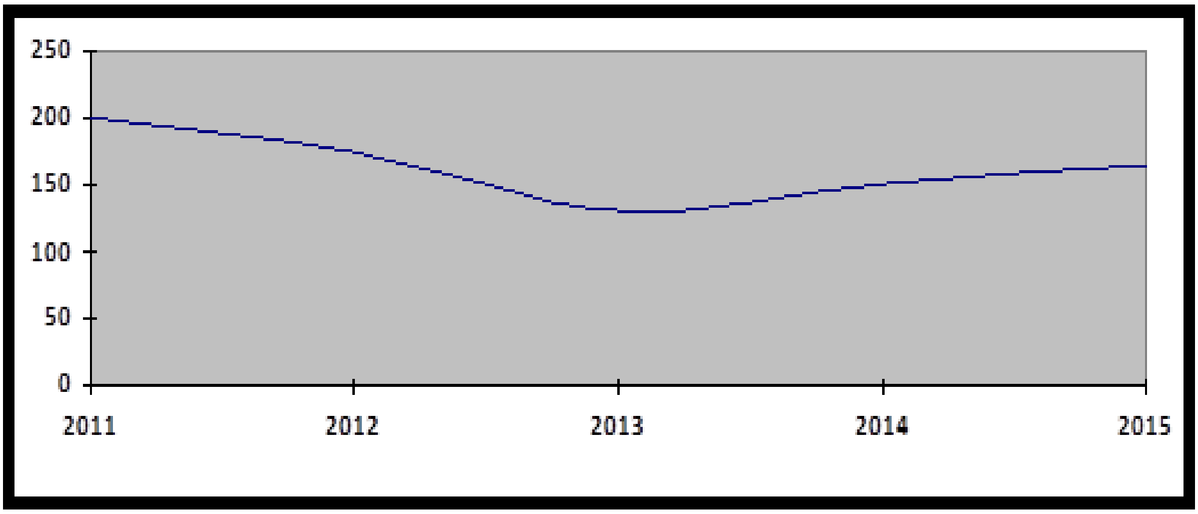

Fig. 5. The average of wind velocity per month in Binjai Municipality 20100-2015.

Air humidity representation in Binjai Municipality 2011-2015

Fig. 9 shows that the average of air humidity per month in Binjai Municipality were relatively constant. It decreased in March and June, but increased in Jully until December. The highest number of air humidity was in December, 90,0% meanwhile the lowest number was in June, 84,5%.

Figure 10 shows that the average of air humidity each years were relatively constant. The air humidity decreased in 2012 and 2015, 82,4% and 81,8%. Then it increased in 2013 and 2014.

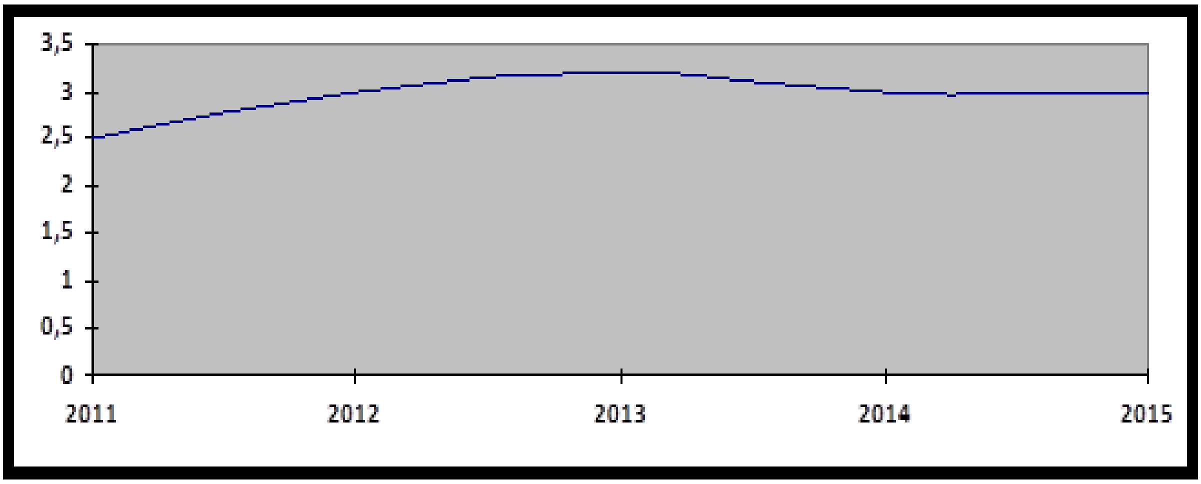

Fig. 6. The average of wind velocity per year in Binjai Municipality 2011-2015.

The highest average amount of air humidity occurred in 2011 (98,6%) and the lowest occurred in 2015 (81,8%). All the data has tested with Shapiro-Wilk normality test. Normality test intended to test data distribution. Table 1 shows that variables per year in 2011-2015 have normally distributed such as DHF cases, rainfall, air humidity, air temperature, and wind velocity.

Based on *p* value classification, it can be concluded that rainfall, air temperature, and wind velocity were strongly correlated significantly toward DHF cases in Binjai Municipality, $p < 0{,}05$. Air temperature had the highest correlation number, r = 0,950 while air humidity was not correlate significantly and had a weak correlation with DHF with $p > 0{,}05$.

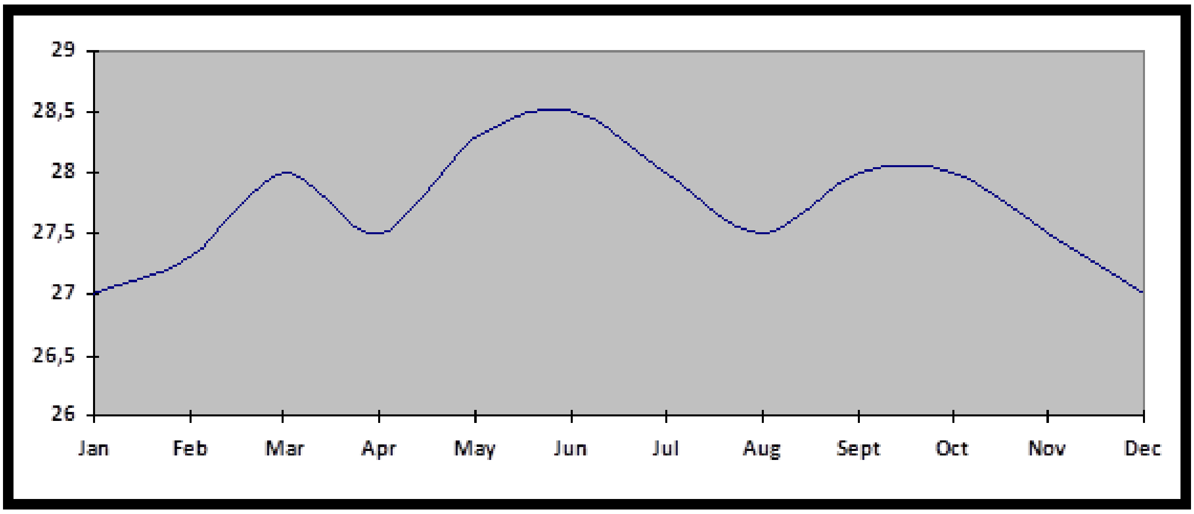

Fig. 7. The Average of Air Temprature per month in Binjai Municipality 2011-201.

According to Achmadi (2012), wind velocity, rainfall, and air temperature should be monitored because they can play a role in mosquito breeding particularly *Aedes aegypti* in urban areas.

Based on table above, known that there is association between rainfall per year with DHF cases in Binjai Municipality 2011-2015, because p < 0,05 (p = 0,039). The association between rainfall and DHF cases showed a strongly correlated significantly (r = -0,897) and patterned negatively.

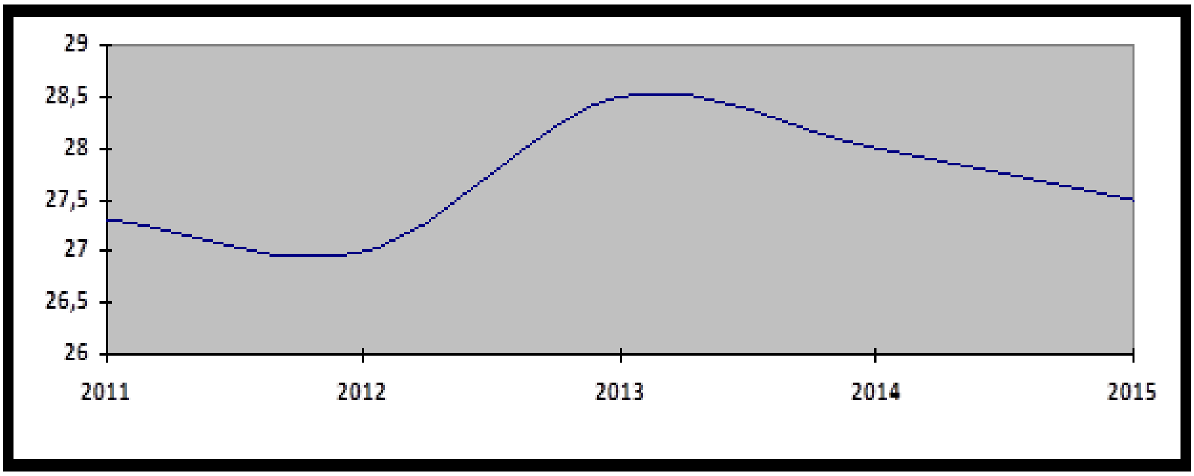

Fig. 8. The Average of Air Temperature per year in Binjai Municipality 2011-2015.

Association between Rainfall and DHF Cases in Binjai 2011-2015

Based on the results of this research, it is known that there was an association between rainfall in each year with DHF cases in Binjai Municipality 2011-2015 with *p* value < 0,05 (*p* = 0.039). The rainfall has a direct impact on the presence of vectors, *Ae.aegpyti*. A high rainfall in a long time can cause flooding so it eliminate the *Ae.aegypti* breeding place that normally living in clean water. But if the rainfall low and last longer, it would increase mosquito density.

This research is in line with Iriani's research which stated that there is a correlation between rainfall and DHF cases, where the correlation started from 1 month before the rainfall increased and decreased in the next month. The rainfall enhancement can increase vector borne disease presence by expanding the size of habitat and make new breeding place. A high rainfall index will provide much place or container occupied by the rain and it will be the breeding place for *Ae.aegypti*. The rainfall is influential toward relative air humidity and breeding place will multiply.

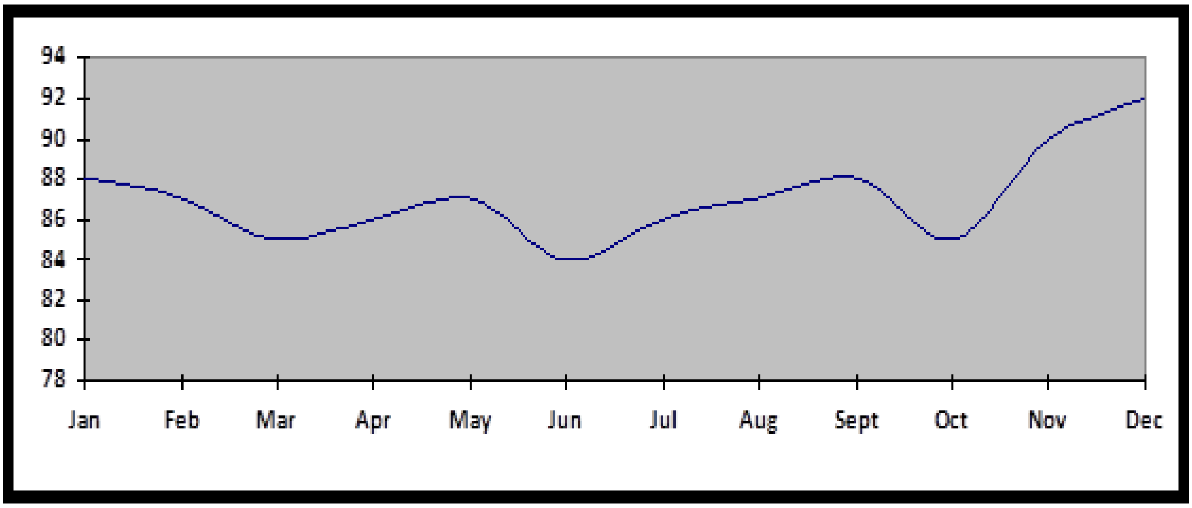

Fig. 9. The average of air humidity per month in Binjai Municipality 2011-2015.

The rainfall index does not directly affect mosquito breeding, but the ideal rainfall will affect the rainfall index. Ideal rainfall means the rain does not cause flooding and stagnant water in a container which can be a safe and clean breeding place for mosquito (e.g basin on bamboo fence, trees, cans, gutters home).
Mosquito eradication program needs to be done to anticipate DHF cases in Binjai Municipality before the rainy season come. Beside the rainfall, there are so many factors affect DHF cases in Binjai Municipality, such as environment, community behavior, knowledge, host, and *dengue* virus in Binjai.

Association between Air Humidity and DHF cases in Binjai Municipality 2011-2015
Based on the result of this research, known that there was no association between air humidity per year toward the DHF cases because *p* value was 0,627 (*p* < 0,05). It showed a low relationship, r = -0,297 and patterned negatively. Theorically, air humidity affect mosquito age, mating period, deployment, eating habit, and the rate of virus replicates. In the high air humidity, the mosquito live longer and spread quickly. Therefore, the mosquito have bigger chance to eat in people that infected and transmit the virus to others. Commonly, the mosquito can survive in 60-80% of air humidity.

The air humidity in Binjai Municipality was founf in the stable degree; so it did not affect to DHF case and it proved by the humidity in Binjai Municipality. The air humidity in November until December was high because it was rainy season. In November until December is an optimum rate of air humidity for mosquito breeding, 60%-80%. Air humidity affected by the temperature (Harel et al, 2014; Yousif and Tahir, 2013)), when humidity and temperature are high, they can facilitate the hatching of mosquito eggs and the number of DHF case will increase in Binjai Municipality. The secondary data obtained from climate data such as rainfall, air temperature, air humidity, and wind velocity from Central Bureau of Statistics and Meteorology Climatology Geophysics

Agency, and DHF case data from Binjai Municipality Health Department for each sub district started from January 2011 until December 2015. Normality test used The *Kolmogorov smirnov* with the *Pearson Correlation* and Linear Regression applications to see correlation between climate and DHF cases. The result of this research showed that there was a relation between rainfall, wind velocity and air temperature with DHF cases, and there was no relation between air humidity with DHF cases in Binjai 2011-2015. Next, the Focus Group Discussion has conducted jointly with Health Department officer and community of health center that aimed to determine the model and the right time for DHF control in Binjai based on climate.

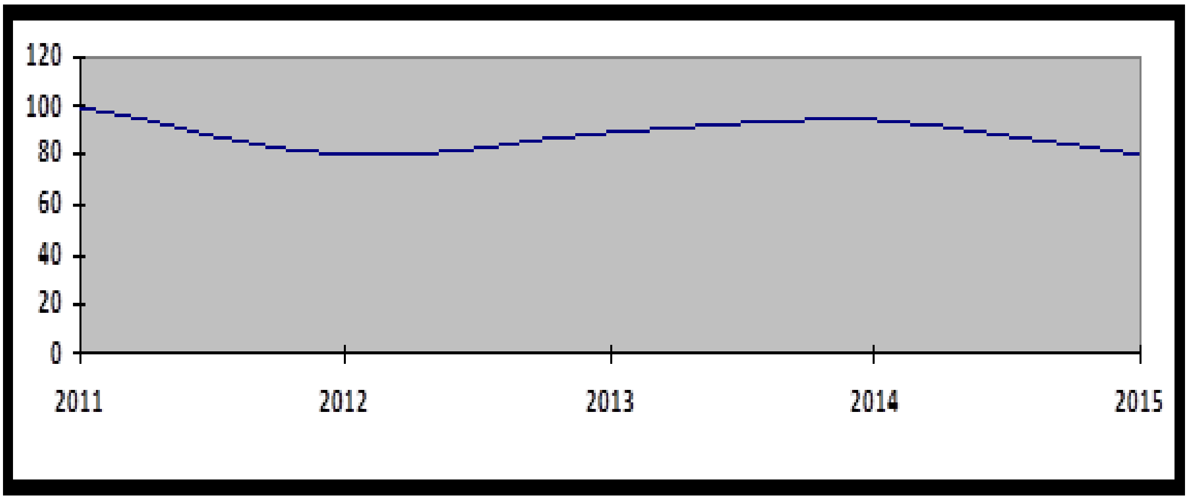

Fig. 10. The average of air humidity per year in Binjai Municipality 2011-2015.

Association between Air Temperature and DHF cases in Binjai Municipality 2011-2015

Based on the liniar regression test result, known that there was an association between air temperature in each year with DHF cases in Binjai Municipality 2011-2015 because the *p* value was 0,013 ($p < 0{,}05$).

The association between air temperature and DHF cases showed a strong association (r = 0,950) and patterned positively.

In theory, the air temperature affect the hatch and age of mosquito (Makara et al, 2015;Dickerson, 2007). Finding showed that the air temperature in May until July in Binjai Municipal were in a dry season.

At those months, air temperature increased and it facilitated the eggs to hatch. Eventhough hatching time of mosquito was at low temperature, mosquito also able to hatch their eggs in increasing temperature. It supported by 60%-80% air humidity temperature as an optimum humidity to hatch the eggs.

Association between Wind Velocity and DHF Cases in Binjai Municipality 2011-2015

Based on the liniar regression test result, known that there was an association between air temperature and DHF case in Binjai Municipality 2011-2015 because the *p* value was 0,038 ($p < 0.05$). The association between wind velocity and DHF cases showed a strongly significant association (r = 0,899) and patterned positively.

Based on this result, known that wind velocity in 5 years affected the DHF cases in Binjai Municipality. Because the wind velocity can affect the mosquito flying distance to bite host.

In assumption, the wind velocity in Binjai Municipality 2011-2015 is still far from wind velocity limit which obstruct mosquito flying activity, 22-28 knot. Based on Dini's research, the fluctuation of wind velocity in Serang 2007-2008 was only 2,5 knot, it means, it was far from wind velocity limit which obstruct mosquito flying.

Parajuli (2016) stated that wind will not directly affect the air evaporation and air temperature. Wind is influential toward the mosquito flying distance. The wind velocity which less than 8,05 km/hour will not affect mosquito actitivity. It will affected by the wind velocity which higher than 8,05 km/hour (2,2 meter/second). If the wind velocity is 22-28 knot per hour or 11-14 meter/second, it will obstruct the mosquito activities (Rasham, 2016).

The Focus Group Discussion (FGD) result of DHF Controlling Model in Community Based on Climate in Binjai Municipality

DHF control which done by Binjai Health Department consist of health promotion by doing drain, close, and pile up, carrying out of fogging and using abate. The result of this research used as material of Focus Group Discussion (FGD) to Health Department and community health center to formulate appropriate methods and time of controllong DHF cases in Binjai Municipality.

Based on FGD results, the appropriate model and time of DHF control is health officer anticipate the DHF case in Binjai Municipality before December, it is September until November. Anticipation is done by doing mosquito breeding place eradication which done before the rainy season in October until the end of January. In addition, Mosquito breeding place eradication program needs to be done in an area which have high number of DHF cases.

Various efforts have been done by the local Government to decrease the DHF cases, however it increased in each year in North Sumatra of Indonesia. It was found that the ineffectiveness controlling program was mosquito eradication one that principally was unsuitable with mosquito time breeding or mosquito density. It was strongly influenced by the climate. The *Dengue Haemorhagic Fever* (DHF) is an acute fever in 2 until 7 days with two or more manifestations such as headache, retro-orbital pain, *mialgia*, *atralgia*, skin rash, haemorhagic manifestation, *leukopenia*, *thrombocytopenia* (100.000 cells per mm^3 or less). The Binjai Municipality Health Department to anticipate the DHF cases in Binjai before December, those are September until November which have high number of DHF case. The anticipation was done with counseling of mosquito eradication and it carried out before the rainy season, October until the end of January Tropical countries are most afflicted by the transmission of this virus which threatens over 2.5 billion people who live in the tropics (Sitepu, 2013). Most of the regions in Indonesia have tropical climate and sub-tropics. These circumstances make Indonesia as one of the Dengue Haemorrhagic Fever endemic countries in South East Asia (Ali, 2016). The endemic places for DHF in North Sumatera Province such as Medan City, Deli Serdang, Binjai, Langkat, Asahan Tebing Tinggi, Pematang Siantar, and Karo Regencies. The sporadic places for DHF are Sibolga Municapality , Tanjung Balai, Simalungun, South Tapanuli, Labuhan Batu, Humbang Hasundutan, Serdang Bedagai, and Samosir Regencies. In North Sumatra Indonesia, based on data from Binjai Municipal Health Department, in 2009 the morbidity of DHF were 61,4 per 100.000 population, decreased from the previous year. The highest records of DHF cases in Binjai occurred in Binjai Timur, with the average number of Incidence Rate (IR) in the last five years were exceeding IR national target, ≤ 55/100.000 population. Total amount f DHF cases in Binjai Timur in 2007 were 198,4 per 100.000 population, in 2008 were 163,1 per 100.000 population, in 2009 were 50,1 per 100.000 population, in 2010 increased significantly until 400,5 per 100.000 population, and in 2011 were 100,1 per 100.000 population.

Conclusion

The findings and analysis gave the conclusions as following.

It was found that here was no significant association and patterned positively between air humidity and DHF cases per year. Additionally, there was a significant association which patterned positively between wind velocity and DHF cases per year. Also it found a significant association which patterned positively between air temperature and DHF cases per year in Binjai Municipality 2011-2015.

Based on FGD results, the appropriate model and time of DHF control had been in the anticipation of the health officers, so the DHF case in Binjai Municipality before December, it is September until November. Anticipation is done by doing mosquito breeding place eradication which done before the rainy season in October until the end of January. In addition, Mosquito breeding place eradication program needs to be done in an area which have high number of DHF cases.

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