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The Relation between Rainfall and Larval Density of Dengue Hemorrhagic Fever with Spatial Modeling

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ABSTRACT

Dengue Hemorrhagic Fever (DHF) is a disease transmitted by the aedes aegypti mosquito. This study aims to determine the relationship between rainfall and larval density which consist of House Index (HI), Container Index (CI), Breteau Index (BI), and Larval Free Rate (LFR) on the incidence of dengue hemorrhagic fever using GIS modeling. The research method is quantitative with a spatial approach and Univariate and Bivariate analysis. The study population was all cases of DHF in all working areas of Lahat District Health Center, Lahat Regency in 2016-2019. The results of the statistical correlation test showed that there was a correlation between rainfall and the incidence of DHF with a value (p=0.003), while larval density showed a correlation between HI and the DHF incidence (p-*value*=0.007), CI (p-*value*=0.007), BI (p-*value*=0.007). ABJ (p-*value*=0.012). Spatially, it was found that the incidence of dengue fever was high in the working regions of Public Health Center with high HI (≥5%), low CI (<10%), low BI (<50%), and low larvae-free rate (<95%). It can be concluded that there is a relation among rainfall, HI, CI, and BI on the incidence of DHF in Lahat Regency in 2016-2019 and spatially shows the high incidence of DHF in high HI (≥5%) and low LFR (<95%). It is recommended that the Lahat Regency Office used climate information from the BMKG in planning a program to eradicate DHF and eradicate mosquito nests during the rainy season in Lahat District.

INTRODUCTION

Diseases that transmitted through various media are called infectious diseases. One of the infectious diseases that still become global health problem in the world is Dengue Hemorrhagic Fever (DHF). The spread of this disease is caused by a virus, namely the Flaviviradae family transmitted by the bite of Aedes mosquitoes, namely *Aedes aegypti* and *Aedes albopictus* infected with dengue virus which transmitted to humans.[1]

DHF cases that occurred in Indonesia in 2017 with a total of 68,047 cases (IR 26.12/100,000 population and CFR 0.72%) experienced a significant decrease compared to 2016 about 204,171 cases (IR 78.85/100,000 population and CFR 0.78%). In 2018 there were 53,975 cases (IR 20.01/100,000 population and CFR 0.65%) and in 2019 there were 13,683 cases (IR 5.08/100,000 population and CFR 0.94%). In 2016 the highest dengue cases were in three provinces, namely West Java, East Java and Central Java. Meanwhile, the lowest number of cases was North Maluku Province.[2]

Dengue fever is still a problem for people in several regencies in South Sumatra, including in Lahat regency. Lahat Regency consists of 24 subdistricts covering 360 villages, 17 sub-districts and has 33 health centers located in the region of Lahat Regency Health Office.[3] One of the subdistricts that has the highest number of dengue cases in the last four years is Lahat District.

DHF cases in Lahat District showed a fairl fluctuating morbidity rate (IR) from the last four years which is in 2016, there are about 109 cases of DHF with an IR of 103.03 per 100,000 population, it decreased to 62 cases of DHF with an IR of 57.90 per 100,000 population in 2017, it decreased again to 31 cases of DHF with an IR of 28.95 per 100,000 population in 2018 and it increased again to 41 cases of DHF with an IR of 42.40 per 100,000 population in 2019. The DHF mortality rate (CFR) in 2016 was 4 cases of death, there were 2 cases of death in 2017 and there were no deaths in 2018 and 2019.[3]

Several factors that influence the spread of dengue cases are the host, agent and environment consisting of geographical conditions (weather and climate), one of which is rainfall, because high rainfall can also affect the population density of adult female mosquitoes to breed.[4] Besides that, other causes that can affect the spread of DHF are the larval density, this is because the higher the density of larvae in an area, the risk of transmission of dengue disease also increases.[5] To determine the density of larvae, several indexes are used, including the House Index (HI), Container Index (CI), Breteau Index (BI) and Larva Free Rate (LFR).

The existence of spatial analysis can help to analyze the dissemination of risk factors transmitted by Mosquitoes which carry disease or vectors and can control the development of dengue disease that requires special and quick handling. The specific source of information regarding an event that occurs in a certain area with a period is by using the spatial analysis function.[5]

The spatial analysis of the incidence of DHF in Lahat District is unknown, so that with this research it is possible to know the spatial analysis of the incidence of DHF to be seen from the larval density. Therefore, this research was carried out to find out whether there is a relation between rainfall and larval density in terms of the House Index (HI), Container Index (CI), Breteau Index (BI) and Larva-Free Rate (LFR) (Flat Free Rate) on the incidence of disease. DHF with geographic information system modeling in Lahat District, Lahat Regency in 2016-2019.

MATERIAL AND METHOD

The type of research used is quantitative research with a spatial approach. This study took secondary data from the Lahat Regency Health Office, each working region of the Public Health Center in Lahat Regency and Sultan Mahmud Badaruddin II Climatology Station Class II Palembang. The tools used in data collection in this study are monthly and annual reports that have been collected from several related agencies and using a checklist table to review secondary data documents. Several methods were carried out by surveying people's home to find out the presence of mosquito larvae assisted by using additional lighting devices, namely flashlights. The population in this study were all cases of DHF in all working areas of the Public Health Center in Lahat District.

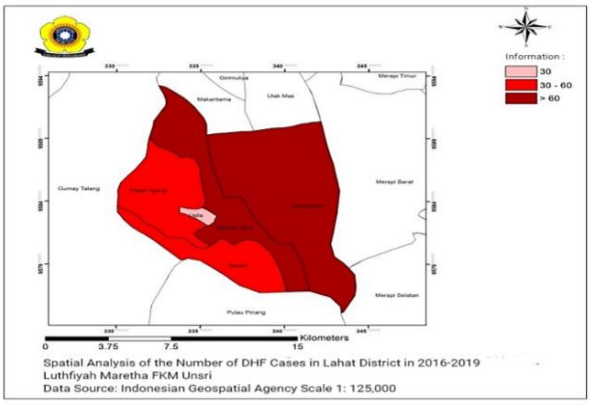
The sample of this research is the sum of

all population in Lahat District which consists of five working areas of Public Health Center namely Bandar Jaya, Pagar Agung, Perumnas, Selawi and Usila from 2016 to 2019. The data analysis technique in this study is univariate and bivariate analysis using SPSS software and spatial analysis using GIS software support. This study meets the requirements of the applicable code of ethics with the number 344/UN9.1.10/ KKE/220 Faculty of Public Health Sriwijaya University.

RESULTS

The DHF morbidity rate in Lahat District decreased from 2016 to 2018, namely in 2016 from 103.03 per 100,000 population to 28.95 per 100,000 population in 2018. Then it increased 68.3% from the previous year of 42, 4 per 100,000 population in 2019. The following is a map of the distribution of dengue cases from 2016 to 2019 in Lahat District (Figure 1).

Based on the figure 1 below, it shows that there are two public health center working areas that have the highest number of DHF cases from 2016 to 2019 namely Bandar Jaya Health Center and Perumnas work areas with 75 cases and 68 cases. While the highest case values after Bandar Jaya Health Center and Perumnas work areas were Pagar Agung Health Center Work area with 49 cases and Selawi with 30 cases. The lowest distributioUsila Health Center with 21 cases.

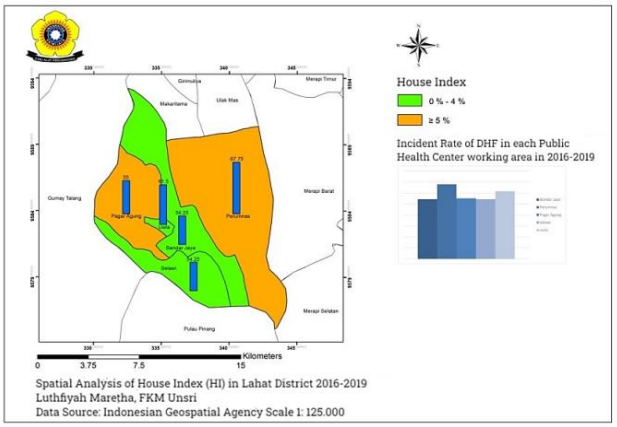


Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

Figure 1. Distribution of DHF Cases in Lahat District in 2016-2019

Spatially (Figure 2), it can be seen that the distribution of HI with the category of high risk of transmission in the period 2016 to 2019 is more commonly found in the work areas of the Perumnas and Pagar Agung Health Centers with an IR of DHF > 49 per 100,000 population. The following is a map of the distribution of HI to the incidence of DHF from 2016 to 2019 in Lahat District. The results of statistical analysis (Table 1) it is known that there is a relationship between HI and the incidence of dengue hemorrhagic fever with a *p-value* = 0.007<0.05 and an *p-value* 0.007 of 0.583 which means the strength of the correlation is moderate, a positive value means that the higher HI value, the higher incidence of cases. DHF in Lahat Regency from 2016 to 2019.

Spatially (Figure 3) the distribution of CI in the period 2016 to 2019 only found 2 working areas of the public health center with a high transmission category in Lahat District, namely Pagar Agung Health Center working area in 2017 and Perumnas Health Center working area in 2016 and 2019 with IR DHF > 49 per year. 100,000 inhabitants.



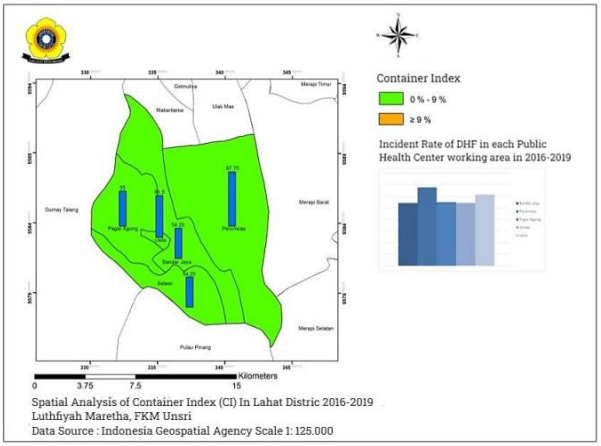
Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

Figure 2. House Index (HI) Spatial Map of DHF Incidence 2016-2019 in Lahat District

The following is a map of the distribution of CI in the incidence of DHF from 2016 to 2019 in Lahat District. Statistical results (Table 1) it is known that there is a CI relationship (*p-value* = 0.007<0.05; r = 0.583) to the incidence of dengue hemorrhagic fever with moderate correlation strength, a positive value means that the higher CI value, the higher incidence of dengue cases in Lahat District 2016 to 2019.

Spatially (Figure 4) the distribution of BI in the period 2016 to 2019 did not find any Work areas in public health center with a high transmission category in Lahat District with an IR of DHF > 49 per 100,000 population. The following is a map of BI's distribution of DHF incidence from 2016 to 2019 in Lahat District. Statistical results (table 1) it is known that there is a relation between BI (*p-value* = 0.012<0.05; r = 0.548) to the incidence of dengue hemorrhagic fever with a moderate correlation of strength value, a positive value means the higher BI value, the higher incidence of dengue cases in the district. Look at the years 2016 to 2019.

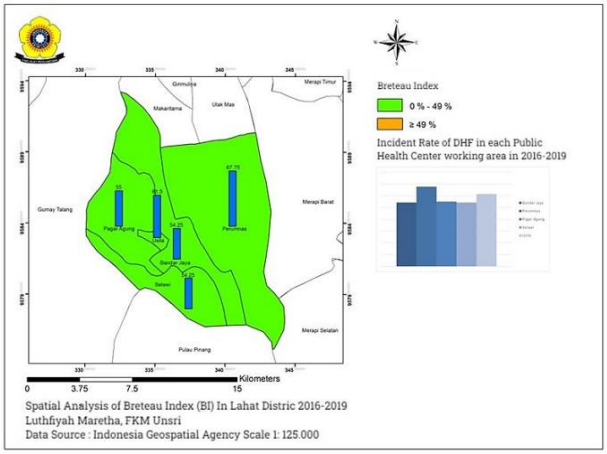
Spatially (Figure 5), the low distribution of LFR in the period 2016 to 2019 was mostly found in the work areas of the Pagar Agung, Selawi and Perumnas Health Centers. Figure 5 shows that IR > 49 per 100,000 population. The following is a map of the distribution of LFR for the incidence of DHF from 2016 to 2019 in Lahat District. Statistical results (Table 1) shows that there is no relation between LFR (p-value = 0.218 > 0.05) and the incidence of dengue hemorrhagic fever in Lahat District in 2016-2019.



Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

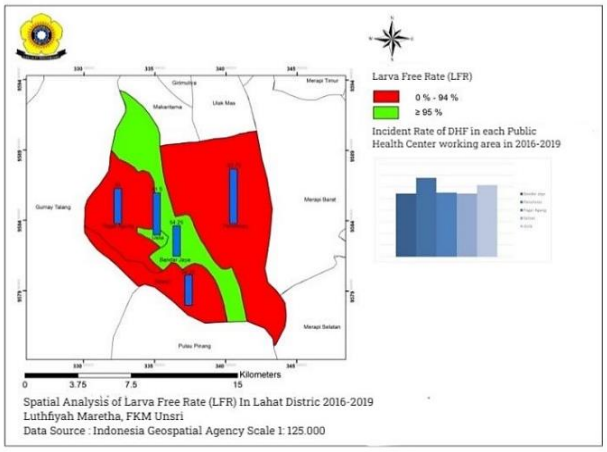
Figure 3. Container Index (CI) Spatial Map of DHF Incidence 2016-2019 in Lahat District

Table 1. above shows the result of the bivariate analysis in the rainfall, HI, CI, LFR variabel with the Dengue Hemorrhagic Fever.



Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

Figure 4. Breteau Index (BI) Spatial Map of DHF Incidence 2016-2019 in Lahat District



Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

Figure 5. Larva Free Rate (LFR) Spatial Map of DHF Incidence 2016-2019 in Lahat District

Table 1. Results of Analysis of the Relation among Rainfall, HI, CI, BI and LFR on the Incidence of Dengue Hemorrhagic Fever in Lahat District 2016-2019

Variable	Dengue Hemorrhagic Fever		
	n	*p-value*	r
Rainfall Years 2016-2019	48	0,003	0,417
HI Years 2016-2019	20	0,007	0,583
CI Years 2016-2019	20	0,007	0,583
BI Years 2016-2019	20	0,012	0,548
LFR Years 2016-2019	20	0,218	-0,288

Source: Secondary Data of the Lahat Regency Health Office, 2016-2019

DISCUSSION

An increase or decrease in the number of dengue fever from year to year has something to do with rapid urban population growth, population mobility followed by improved transportation facilities and infrastructure but not paying attention to strong vector population control.[8]

The high or low number of dengue cases is supported by several factors, including densely populated urban areas while Lahat District is an urban center area in Lahat Regency. The peak of dengue cases in Lahat District from January to December 2016-2019 shows that there were 38 cases in February 2016, there were 18 cases in 2017, there were 6 cases in 2018 there were 6 cases in 2018. there were about 14 cases in December 2019.

The heavy rainfall in Lahat District from 2016 to 2019 fluctuated for a month so that this supported the increase in the number of vectors of the Aedes aegypti mosquito and the potential for the transmission of dengue fever in the rainy season was also high. Besides that, it can also be affected by small rainfall and for a long time so that it can add mosquito breeding places and increase their population. Babita's study in India area shows that larvae are more often found in breeding places inside the house in the rainy season, larvae are found often in breeding places outside the house and natural breeding places.[9]

Rainfall can affect the increase in dengue cases, which is followed by an increase in air temperature and humidity, thereby increasing the breeding ground for the *Aedes aegypti* mosquito. This happens because the more breeding places the *Aedes aegypti* mosquito will also lay its eggs. The ideal temperature for transmission of dengue disease is 21.6°C – 32.9°C with humidity ranging from 79%.

High rainfall will increase the number of natural mosquito breeding places outside such as cans, used bottles, leaves that can accommodate rainwater.[10] The same thing was obtained from Lahdji's study which showed that there was a relationship between rainfall and the number of dengue cases in Semarang City for the 2006-2015 period.[11]

The House Index (HI) is the number of houses that are positive for larvae in the water reservoir from all the houses examined. According to WHO, high-risk area if an area has HI value 5%, while at low-risk if the HI value is < 5%.[1]

The relation between HI and the incidence of DHF is caused by the behavior of people who rarely drain the bath tub, do not cover the water reservoir, pay less attention to the clean environment around the house so that there is still garbage such as used bottles and cans, broken glass and pieces of bamboo so that it can trigger transmission. and the breeding of eggs into adult mosquitoes and eventually mosquitoes become vectors of dengue. This research is in line with Indriyani's research which states that there is a significant relation between HI and the incidence of DHF in Jepara District, Jepara Regency.[12]

Spatially, the distribution of CI was found in the working regions of public health center with CI in the category of low-risk of transmission. Meanwhile, the distribution of CI with the category of high transmission was only found in 2 work areas of public health center, namely the work regions of Pagar Agung Health Center in 2017 and the work area of Perumnas Health Center in 2016 and 2019. One of the causes of the high CI value in the work area of Perumnas Health Center and Pagar agung Health Center work regions where the community has an open container condition, so that it is easier for mosquitoes to enter and breed in water reservoirs. This situation is the same as water reservoirs that are not closed properly or not tightly. In such circumstances, mosquitoes prefer water reservoirs that are not closed properly because it makes the water reservoir darker and moister, so that mosquitoes will grow better.

In addition, the container with larvae shows the existence of larvae that have the potential to transmit dengue. The larvae found in the container indicated that the gravid female mosquito laid eggs in the container. Pregnant female signifies success in mating with male mosquito. Ae. aegypti at a time, capable of laying about 100-400 eggs and placed in the water container wall.[13] This is because the use of containers such as buckets as water reservoirs can be a protective factor against the presence of

mosquito larvae.[14]

Breteau Index (BI) is a calculation to find out the water storage containers inside and outside the house that were found to be positive for *Aedes aegypti* mosquito larvae from the house got inspected. According to WHO, the standard value for BI is 50%.[1]

Based on the results of the survey conducted by jumantik officers, it was found that the BI value in the working regions of the Lahat District Health Center had more than 1 larvae positive container in 1 house that was inspected. This means that the number of containers that have larvae is classified as varied, such as bathtubs, flower vases, used cans, barrels and so on. The results of this study are in line with Riandi's research which shows that there is a relationship between BI and the incidence of dengue hemorrhagic fever cases in Tawang District, Tasikmalaya City.[13]

Spatially the distribution of BI in 2016-2019 in Lahat District shows a high morbidity rate of dengue cases (> 49 per 100,000 population) mostly found in public health center working areas with BI with a low-risk category of transmission and no BI value with a high-risk of transmission in the area. Public health center work in Lahat District in 2016-2019. The low value of BI in all public health center working areas, is due to water storage/containers such as inside and outside houses found in people's home that have a low BI category. The Larva Free Rate (LFR) is an illustration of the density of the *Aedes aegypti* mosquito vector in an area. The parameter or indicator of the success of PSN DHF is if the LFR is 95% so it is hoped that the transmission of DHF can be prevented or controlled.

Several factors that influence the high value of LFR are to get a larva-free number, researchers use secondary data obtained from the public health center, so the need for validity of LFR data regarding larvae examinations has been carried out in accordance with the procedure. The research is in line with Yuliawati's research which shows that there is no correlation between the LFR and the incidence of dengue hemorrhagic fever in 2018 in Rowosari Health Center working area.[15]

Spatially, the distribution of larva-free numbers (LFR) in Lahat District in 2016-2019 shows that high DHF case morbidity rates (> 49 per 100,000 population) are mostly found in public health center working areas with low LFR (many larvae are found). Meanwhile, the low distribution of LFR in 2016-2019 was found in the work areas of Pagar Agung, Perumnas and Selawi Health Centers. The average LFR value for 2016-2019 is 89.3% below the national indicator of 95%.

The low value of LFR in the working area of Pagar Agung, Perumnas and Selawi Public Health Centers is due to the lack of community participation in eradicating mosquito nests (EMN) which is caused because people think that PSN is only carried out by larvae monitors from the public health center only. In addition, many people have asked for suggestions for fogging to anticipate dengue transmission, even though fogging is only able to kill adult mosquitoes, while larvae that breed in puddles can still grow into adult mosquitoes.

Until now vaccines and drugs for the DHF virus have not been found, so one of the main and most effective strategies to control DHF is to take preventive parameters by breaking the chain of transmission through the PSN-DHF movement. According to the Technical Instructions from the Ministry of Health, LFRs are obtained during Periodic Lartic Checks (PLC) which are carried out periodically at least once every 3 months by each public health center, especially in endemic villages/ward in breeding places for *Aedes aegypti* mosquitoes in 100 samples of houses/buildings randomly selected and repeated for each inspection cycle.[16]

CONCLUSION AND RECOMMENDATION

The conclusion in this research is there is a relation between rainfall, House Index (HI), Container Index (CI) and Breteau Index (BI) and there is no relation between LFR and DHF incidence in Lahat District in 2016-2019. While spatially, it was found that the high incidence of DHF was found in the working regions of the public health center with high HI (≥ 5%), low CI (< 10%), low BI (< 50%) and low larva free rate (< 95%). Suggestions for the Lahat District Health Office require that every public health center area in Lahat Regency, not only Lahat District, is to have a spatial picture of the distribution of DHF in their respective regions and it is hoped that the community, especially in

the work area of Pagar Agung, Perumnas and Selawi Health Centers, should be able carry out independently and routinely in mosquito nest eradication activities (PSN) which are by doing 3M Plus and paying more attention to containers or puddles around the house.

AUTHOR CONTRIBUTIONS

Rahmatillah Razak and Achmad Fickry compiled and designed experiments, Luthfiyah Maretha collected data, Luthfiyah Maretha and Rahmatillah Razak analyzed data and compiled manuscripts.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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