Spatial Analysis on Vulnerability to Dengue Hemorrhagic Fever in Kotabaru Subdistrict, Jambi Municipality, Jambi Province

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ABSTRACT

Introduction: High incidence of DHF in Kotabaru Subdistrict was high even endemic in all villages. Utilization of Geographical Information System technology integrated with the wide of settlement land, the density of Aedes sp, maya index, resistance and transovarial of virDen, got a picture or map vulnerable areas prone event of DHF in Kotabaru Subdistrict.
Objectives: This study to map areas vulnerable to dengue hemorrhagic fever is based on the highest incidence of DHF in Kotabaru Subdistrict, Jambi Municipality.
Methods: This study is an observational survey with cross sectional design. The variable of the study was population density, the wide of settlement land, the density of Aedes sp. population, rainfall, vector vulnerability, and transovarial of virDen.
Results: The result showed population density had no correlation to Dengue Hemorrhagic Fever (DHF) incidence, whereas the wide of settlement land (p=0.004) and population density of Aedes sp. (p=0.001) influenced DHF incidence. The number water containers controllable sites (89%) and percentage of Maya Index (p=<0.001) was high influenced DHF incidence. Rainfall not influenced DHF incidence. The vector resistance not influenced the high of DHF incidence and the high of DHF incidence was not influenced by transovarial of virDen. The high vulnerability to DHF in Kotabaru Subdistrict occurred in 2 villages and the intermediate vulnerability happens in 4 villages. The area with intermediate vulnerability generally have direct border to the village with high vulnerability category.

Keywords: Spatial, Maya Index, Resistance, DHF

INTISARI

Pendahuluan: Kejadian Demam Berdarah Dengue (DBD) tinggi di Kecamatan Kotabaru Kota Jambi bahkan endemis di seluruh kelurahan. Pemanfaatan teknologi Sistem Informasi Geografis (SIG) yang dipadu dengan luas lahan pemukiman, kepadatan Aedes sp, maya index, resistensi dan transovarial virDen dapat menunjukan daerah rentan atau peta rawan kejadian DBD di Kecamatan Kotabaru.
Tujuan: Penelitian ini untuk memetakan wilayah rentan Demam Berdarah Dengue berdasarkan kejadian DBD tertinggi di Kecamatan Kotabaru Kota Jambi.
Metode: Penelitian ini menggunakan survei observasional dengan rancangan cross sectional. Variabel penelitian meliputi kepadatan penduduk, luas lahan pemukiman, kepadatan populasi Aedes sp, maya index, curah hujan, kerentanan vektor dan transovarial virDen.

Hasil: Hasil penelitian menunjukkan bahwa kepadatan penduduk tidak berhubungan dengan kejadian DBD, sedangkan luas lahan pemukiman (p=0,004) dan kepadatan populasi Aedes sp (p=0,001) mempengaruhi kejadian DBD. Jumlah Tempat Penampungan Air (TPA) (89%) dan persentase Maya Index (pd"0,001) mempengaruhi tingginya kejadian DBD. Curah hujan tidak mempengaruhi kejadian DBD. Resistensi vektor tidak mempengaruhi tingginya kejadian DBD dan tingginya kejadian DBD tidak dipengaruhi transovarial virDen. Kerentanan tinggi kejadian DBD terjadi di 2 kelurahan dan kerentanan sedang terjadi di 4 kelurahan. Wilayah dengan kerentanan sedang pada umumnya berbatasan langsung dengan kelurahan dengan kategori kerentanan tinggi.

Kata kunci : Spasial, Maya Index, Resistensi, DBD.

INTRODUCTION

Period of 5 years the incidence of Dengue Hemorrhagic Fever (DHF) was high, the average rate of 60 cases per year, even entire villages in Kotabaru Subdistrict are dengue endemic areas.

Information about vectors, neighborhoods, virtual index, transovarial and resistance *Aedes* sp mosquito in Jambi City to insecticides is needed for vector controlling programs. The success of DHF eradication was influenced by factors of mosquito resistance to insecticides[1]. Environmental factors, the more dense the population the easier transmission of the virus occurs[2]. The factors of mosquito population density, the more dense populations of Aedes mosquitoes, the higher the risk of infection with DHF virus[2]. Environmental conditions have a risk of becoming a breeding ground for mosquitoes can be measured by the Maya Index parameter. There is a significant correlation between the Maya Index (an indicator of environmental hygiene/ hygiene risk indicator) with the incidence of DHF because there are objects that are a breeding ground for mosquitoes that are not controlled will result in increasing the number of mosquitoes[3]. High rainfall creates a breeding ground for mosquitoes, lots of used goods such as cans, plastic cups, plastic wrap, scrap tires and the like were disposed of or placed irregularly in any place, allowing the number of cases of DHF will increase[4].

The absence of information about the relationship of population density, settlement area, Maya Index, density of Aedes sp, precipitation, resistance and transovarial virDen on the incidence of DHF as well as how the grouping of cases and areas that are susceptible to dengue incidence will affect the control of dengue in the Kotabaru Subdistrict.

Geographic Information System (GIS) can be utilized in observing vector and the factors that influence the incidence of DHF, expected to give a picture of areas that are prone to the incidence of DHF in Kotabaru Subdistrict, so it can determine the operational steps in the prevention and eradication of dengue.

MATERIALS AND METHODS

Research sites is the entire village in the Kotabaru Subdistrict which experienced the highest cases of DHF. The method used was an observational survey with cross sectional design and use of Geographic Information Systems (GIS) in order to obtain a visual interpretation about the vulnerable area to DHF incidence. The number of samples for the density of *Aedes* and the Maya Index was 100 houses in each villages using Depkes method[5], resistance test and transovarial virDen mosquito samples were taken from three different locations (home patients, primary schools, garden/grave) using 11 ovitrap at each villages.

The data collection was done in several stages of activities, namely Phase field by taking the point coordinates using GPS Oregon 550 in all DHF patients location and mapping of regional administrative boundaries ranging from RT up to a village. Incidence of DHF based on the

RT region was classified in the low category (for 1 case of DHF/RT), medium (2-3 cases of DHF/RT) and high (> 3 cases of DHF/RT)[6], for the village category of incidence DHF was classified according to the Health Departement which modified[7]. Population density based on the range calculation, obtained from the difference the highest and lowest density divided by the number of categories. The collection of eggs of Aedes sp used ovitrap. Each patient's house was placed ovitrap as many as 2 pieces (1 ovitrap inside and 1 ovitrap outside of house). Every school placed ovitrap as much as 2 pieces (1 ovitrap in and 1 ovitrap outside the school building). Ovitrap on open land was placed at place that was not exposed to direct sunlight and rain. Filter paper on the ovitrap and water in the ovitrap replaced every 3 days to 3 repetitions. Water container which became breeding sites mosquito Aedes sp grouped in the category of controllable site and disposable site and Maya Index was determined from the value indicator of HRI and BRI[8]. The selection of samples for the density of larvae with the indicator HI, CI and BI, were done based on procedures for conducting surveys (larvae/larvae)[5]. Density of larvae classified into categories of low, medium and high[9]. Colonization of mosquito eggs obtained from ovitrap performed in parasitology laboratory of Faculty of Medicine, Universitas Gadjah Mada. Larvae mosquitoes fourth instar in each village were taken as much as 23 tails were then tested resistance and analyzed by reading absorbance value (AV) using the ELISA reader at ë = 450[10]. The transovarial test using Immunohistochemistry SBPC method. Preparat head squash or squeeze the head of the mosquito Aedes sp. ± 7 days old who have been turned off and separated from his body on top of a specially prepared glass objects corresponding standard SOPs[11].

Stage Application of Geographic Information System (GIS) was done to obtain a map of the incidence of DHF and maps of variables that affect DHF incidence by overlaying. Map areas vulnerable to DHF incidence obtained from dignity variable value according to the assessment criteria that have been classified, multiplied by the weight or weighing factor based on whether or not the dominant groups of variables[12]. Class areas vulnerable DHF were divided into areas with low vulnerability category (score < 28), medium (score 28 – 39) and high (score > 39).

Analysis of data using ArcGIS version 9.3 performed in the laboratory of the Faculty of Geography, Universitas Gadjah Mada.

RESULTS AND DISCUSSIONS

Incidence of DHF only occurs in 9 villages with incidence rate varying as shown in Table 1.

Table 1. DHF incidence by Region Village in Kotabaru Subdistrict

No	Village	Population	Cases	IR/10000 population	Percentage	DHF IR
1.	Mayang Mengurai	15715	11	7.00	22.10	Very high
2.	Simpang III Sipin	22731	14	6.16	19.45	High
3.	Kenali Bawah	16204	6	3.70	11.68	High
4.	Beliung	7205	3	4.16	13.14	Medium
5.	Kenali Besar	27779	9	3.23	10.22	Low
6.	Paal V	13278	4	3.01	9.50	Low
7.	Bagan Pete	7645	2	2.62	8.27	Low
8.	Suka Karya	8925	1	1.12	3.54	Very low
9.	Rawasari	15223	1	0.65	2.10	Very low
10.	Kenali Atas	6969	0	0	0	Very low
	Sum	141684	51	31.7	100	

Table 1 shows that the high incidence of DHF occurred in the Mayang Mengurai Village with IR per ten thousand population was 7.00 (22.10%) and Simpang III Sipin Village Sub-District with IR per ten thousand population was 6.16 (19.5%) and Kenali Bawah Village with IR per ten thousand population was 3.7 (11.68%).

The risk of DHF in each RT low-medium, was not found any occurrence of more than 3 cases of DHF.

1. Population density

Population density data based on administrative area in each village are shown in Table 2.

Table 2. Population density and DHF cases according to village in Kotabaru Subdistrict in 2011

Village	Cases	Population density/Ha	Density category
1. Simpang III Sipin	14	80.89	Veri high
2. Rawasari	1	59	High
3. Suka Karya	1	55.09	High
4. Beliung	3	47.72	High
5. Paal V	4	36.08	Medium
6. Kenali Atas	0	28.92	Medium
7. Kenali Besar	9	27.92	Medium
8. Mayang Mengurai	11	24.71	Medium
9. Kenali Bawah	6	10.27	Low
10. Bagan Pete	2	4.01	Low
Sum	51	374.61	

Table 2 shows that the Simpang III Sipin Village have larger population densities than any other village, followed by Rawasari Village, Sukakarya and Beliung. At the densely populated village, found cases of DHF were high. Unlike the Rawasari Village, Beliung and Sukakarya although the high population density, DHF incidence was not high in the region (p=0,551), it can only happen when seen from the number of DHF incidence in each RT less than three cases and not found transovarial transmission allows the spread of DHF Virden low because virDen transovarial transmission in mosquitoes *Aedes aegypti* plays a role in improving and maintaining epidemics Dengue[13]. Transovarial virDen rates higher in endemic areas than in sporadic[14].

Factors that play a role in transmission of dengue virus are human, intermediaries and virus. Human who have a good immune status was one factor protected from dengue fever. The theory of secondary infections showed if someone get a primary infection with one type of virus, there will be immunity to the type of the virus for long periods of time[15]. It was confirmed that a dengue fever found in a native, 50% of them did not show any clinical manifestations (asymptomatic) that are often not reported[16].

Densely populated (soul/ha) allows transmission of DHF increased, given the mosquito flight range of ± 100 meters[17]. But the population density (people/ha) to be biased because the calculation is based on administrative boundaries where there lands are open/vacant land and a land area built is not used as a settlement area so that things are included in the calculation of the area as the denominator[18]. Proven significant (p = 0.009), high incidence DHF in villages with a high population (soul). At the large population of virus

transmission easier[2] but a research in Banjarmasin City found that dengue transmission was not related to population density[19].

2. Settlement area wide

High incidence DHF in village that have wide settlement area, as shown in Table 3 below.

Table 3. DHF incidence and Settlement Area in the Kotabaru Subdistrict Jambi in 2011.

No	Village	Case	Area (Ha)	Settlement Area Wide (Ha)	Non Settlement Area Wide & Open Space (Ha)
1	Kenali Besar	9	995	238	757
2	Simpang III Sipin	14	281	196	85
3	Mayang mengurai	11	636	156	480
4	Kenali Bawah	6	1578	152	1426
5	Paal V	4	368	125	243
6	Rawasari	1	258	114	144
7	Bagan Pete	2	1908	86	1822
8	Beliung	3	151	74	77
9	Kenali Atas	0	241	49	192
10	Sukaka rya	1	162	14	148
	Sum	51	6578	1204	5374

Table 3 shows the villages which have a settlement wide area, experienced a high incidence DHF in Simpang III Sipin Village, Mayang Mengurai, Kenali Besar and Kenali Bawah. They have strong and significant relationship (p=0.004).

DHF continues to rise due to a shift in land use to be more toward the man-made structure (settlements) which tends to make a lot of water reservoirs as a breeding ground for *Aedes* sp[20]. Table 3 shows the largest area in the Bagan Pete Village has a lot of non-settlement than settlement land, the occurrence of dengue cases in the region was very low. Unlike the Simpang Village III Sipin, many settlement areas compared to non-settlement so that the high incidence DHF in the region. These results confirm that the land area used as settlement risk will be higher incidence of DHF. The research results were consistent with research in Johar Bahru Malaysia which provide information that 76% of DHF cases in Johor Bahru area found in settlement areas[21].

3. Maya Index

Water container as containers larvae positive as much as 500. Controllable category water container as much 89%, the highest in the bath (43.2%), then in the drum (31%) and in tires (6.8%). The high status of Maya Index (MI) at Simpang III Sipin Village with 10% houses high-risk as a breeding ground for *Aedes* sp, Mayang Mengurai with 4.8% houses, Kenali Besar and Kenali Bawah of each 3% of homes are at high risk. The results of analysis between the percentage incidences of DHF that has a high MI status highly significant (pd"0.001).

The number of homes with high MI status 11,46 times greater risk of endemicity DBD[22], thus the village which has a (CS) or Breeding Rist Indicator value (BRI) and the high percentage of homes with high MI indicates the status of the village as a potential breeding ground for *Aedes* sp, because of high BRI values indicate high value of Controllable and risk becoming breeding places for mosquito vectors of dengue[8].

4. Population density of Aedes sp.

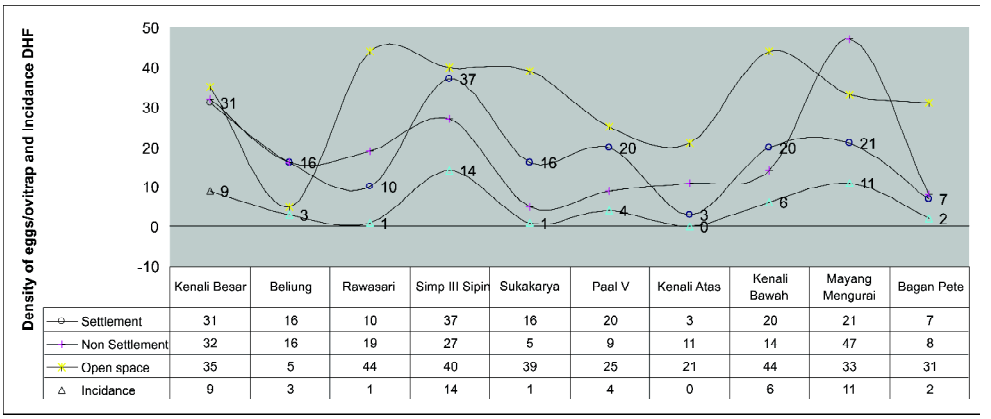
Mosquito population density (Density Figure) was obtained from the combined value of HI, CI and BI. Data from all three indicators were shown in Table 4.

Table 4. Levels of *Aedes* density in the Subdistrict Kotabaru Based on Indicators House Index, Container Index and Breteau Index

Village	Cases	Densitiy Indicators			Density of Aedes sp
		House Index	Countainer Index	Breteau Index	
1. Simpang III Sipin	14	55	40	86	High
2. Mayang Mengurai	11	49.35	34.09	91.35	High
3. Kenali Besar	9	46	28.04	53	High
4. Kenali Bawah	6	51	32.77	77	High
5. Paal V	4	28.56	15.57	38.76	Medium
6. Beliung	3	35	20	39	Medium
7. Bagan Pete	2	30	24.83	37	Medium
8. Rawasari	1	21	1.54	23	Medium
9. Suka Karya	1	16	11.68	23	Medium
10. Kenali Atas	0	24	13.36	37	Medium

Table 4 shows the Simpang III Sipin Village, Mayang Mengurai, Kenali Besar and Kenali Bawah had a high incidence DHF with a high population density of *Aedes* sp (p=0.001).

The results of 90 ovitrap layed in open fields showed an egg density of 31,3 eggs/ovitrap, from 120 ovitrap in elementary school showed an egg density of 18,7 eggs/ovitrap and the laying of 120 ovitrap at home DHF patients showed the density of eggs by 18.1 eggs/ovitrap. Urban village with the highest density of eggs found in Simpang III Sipin and Mayang Mengurai Village, the urban villages are also experiencing a high incidence of DHF. The relationship egg density with the incidence of DHF in Kotabaru Subdistrict shown in Figure 1.



	Kenali Besar	Beliung	Rawasari	Simp III Sipin	Sukakarya	Paal V	Kenali Atas	Kenali Bawah	Mayang Mengurai	Bagan Pete
Settlement	31	16	10	37	16	20	3	20	21	7
Non Settlement	32	16	19	27	5	9	11	14	47	8
Open space	35	5	44	40	39	25	21	44	33	31
Incidance	9	3	1	14	1	4	0	6	11	2

Figure 1. Association DHF incidence wih the density of eggs in settlement, non-settlement and open space

Figure 1 shows an association the density of eggs with the incidence of DHF in the settlements (patients house) and non-settlement (Primary School), test results of egg density with DHF incidence was meaningful (each p=0.001 and p=0.009), in contrast with open land (garden/grave) egg density did not affect the incidence of DHF with the results of test p = 0.433.

The high population of *Aedes* sp can be used to view the threat of dengue fever in an area[5]. This was confirmed there was research 100 houses that was examined the status of high vector density followed by a high incidence of DHF in Wonokusumo Village, Surabaya[23]. The high population density of larvae in areas with high DHF incidence rates demonstrates that the implementation of mosquito eradication nest (PSN) in the region has not been effective and public participation is still low. Although methods of dengue control programs effective and sustainable long term requires the community participation[7]. Seeing the largest percentage of larvae in the bath (43.2%) and in drums (31%) showed that community participation is still low.

5. Virus Dengue Transovarial

Transovarial virDen DHF test did not found any virDen transovarial DHF in the mosquito *Aedes* sp in Kotabaru Subdistrict. The first possibility because the egg samples were hatched dominated from the site of open space (garden/grave) with a density of eggs 31.3 eggs/ovitrap. Statistical tests proved the density of eggs in open fields do not affect the incidence of DHF (p=0.433), so likely not infected female mosquitoes human blood viremia, consequently there was no infectious larvae[24]. Other researchers said that not all mosquitoes can transmit the transovarial Virden depends on the virus strain and geographic strains of mosquitoes[25]. The second possibility could be caused by differences in temperature and humidity at the time of field conditions with current conditions in colonization, so that at the time of colonization of adult mosquitoes were found dead. Death was possible due to different laboratory conditions or field conditions can also be a dead mosquito was a mosquito that is infected by Virden. Other studies have claimed that the death rate in immature stages and adult mosquitoes infected Virden-3 or Virden-2 was higher than that of control mosquitoes not infected Virden-3 or Virden-2[26, 27]. Research in Thailand on the mosquito Ae.aegypti and Ae.albopictus in urban and rural areas not found transovarial transmission[28], not finding suggests that transovarial transmission virDen in Kotabaru Subdistrict possible horizontally, from patients with dengue fever, is transmitted to other humans via the mosquito vector *Aedes* sp.

6. Resistance

Test of resistance to the larvae of *Aedes* sp obtained that all villages have been resistant to organophosphate insecticides in Kotabaru Subdistrict. More is presented in Table 5.

Table 5. Picture of the vulnerability status of Aedes sp mosquito larvae in the Kotabaru Subdistrict with biochemical tests (non-specific esterase activity of the enzyme to the substrate α - netil acetate) quantitative methods.

Larvae Origin Population Village	Susceptibility status of mosquito larvae (%)		
	Susceptible (SS) AV < 0.700	Tolerant (RS) AV 0.700-0.900	Resistant (RR) AV > 0.900
1. Mayang Mengurai	0	0	100
2. Bagan Pete	0	0	100
3. Beliung	0	4.3	95.7
4. Kenali Asam Bawah	0	0	100
5. Rawasari	0	34.8	65.2
6. Simpang III Sipin	0	8.7	91.3
7. Paal V	0	0	100
8. Sukakarya	0	0	100
9. Kenali Asam Atas	0	21.7	78.3
10. Kenali Besar	0	0	100

Table 5 shows the entire village has a percentage of absorbance value (AV) over 65% means that all the villages in Kotabaru Subdistrict into the resistant category. Even the five villages namely Mayang Mengurai Village, Bagan Pete, Kenali Asam Bawah, Paal V and Sukakarya the percentage absorbance value (AV) reached 100%. There are not significant correlation test with p value 0.823.

Larva of *Aedes aegypti* was resistant to temefos in Brazil[29], but still tolerant in Surabaya City[30]. According to some entomologists, insecticide when used in large scale continuously in the time period long enough and high frequencies can lead to a decrease in susceptibility in mosquitoes exposed[31]. This indicates that the use abatisasi and influence the use of malathion from 2000 until now by the City Health Department as an insecticide contribute major for mosquitoes resistance.

7. Rainfall

The incidence of DHF and rainfall in Kotabaru Subdistrict as shown in Figure 2.

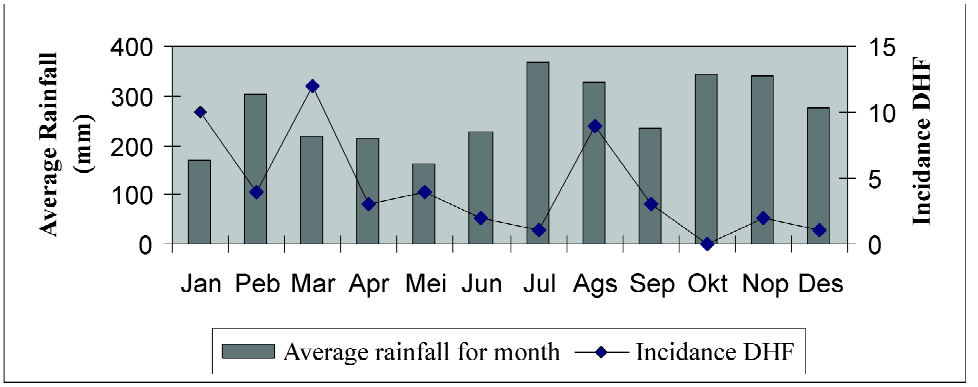


Figure 2. Rainfall and the number of cases per month in Kotabaru Subdistrict

Figure 2 shows the high rainfall did not affect the incidence of DHF. Though rainfall has a close relationship with the rate of increase the mosquito breeding places by category disposible site (DS) such as cans, plastic cups, plastic wrap, scrap tires and the like possible high number of mosquito population will increase DHF incidence. Water container at Category of disposable site in Kotabaru Subdistrict only 11%. At least disposible site (DS) as a breeding place for Aedes sp is not a threat to the onset of standing water during heavy rainfall, allowing rainfall does not affect the incidence of DHF. Another possibility, with high rainfall may flush mosquito eggs in the water reservoir so that the mosquito population was reduced[32]. Similar incident occurred in Puerto Rico, and Sri Lanka where DHF epidemics emerge not during high rainfall[33,34].

8. Cluster of DHF

Clusters of dengue cases SatScan results using the Space-Time Poisson Model got Most Likely centered at coordinates (342691, 9818080 UTM) value p-value 0,002 so that the significant occurrence of clusters as shown in Figure 3.

Figure 3 shows clustering got the Most Likely cluster that included four villages of Simpang III Sipin, Mayang Mengurai, Kenali Bawah and Beliung. Areas that were included in clustering were an area with a high incidence rate. Addition to the high incidence rate, Simpang III Sipin and Mayang Mengurai Village has the potential formation of clusters of DHF caused as a settlement wide area, high vector density and high percentage of house Maya Index. Clusters weare formed at risk of the spread of dengue to 61855 souls. But people outside the cluster need to be vigilant, although there has been no

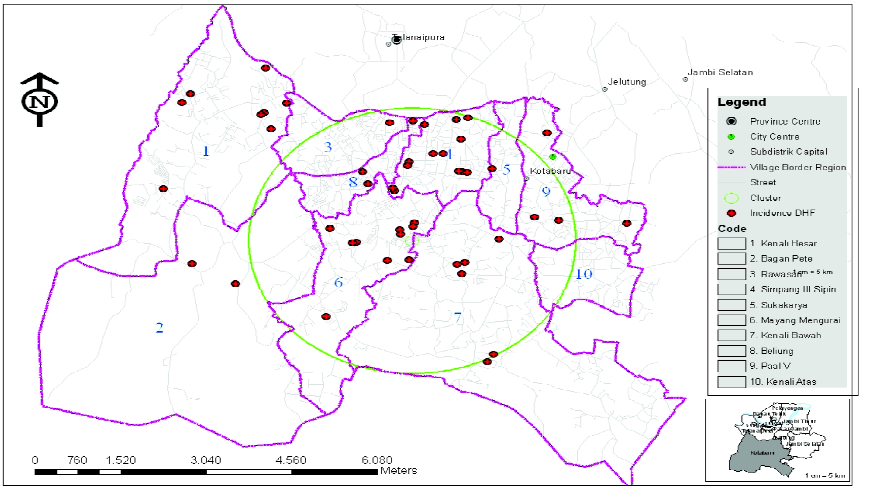


Figure 3. DHF clusters in Kotabaru Subdistrict Jambi in 2011

evidence of transovarial transmission. Dengue virus transmission occurs horizontally through the infective human showed no symptoms or only show mild symptoms of fever, more dangerous because they are free to go everywhere with a high mobility, people with this virus plays a more important role in the virDen transmission, of the mobility of the mosquito *Aedes* sp itself[35].

9. The Area Vulnerability to DHF incidence

Villages with a high vulnerability are Simpang III Sipin Village (score=44) and Mayang Mengurai (score=43), villages being the medium vulnerability are Kenali Besar, Beliung, Paal V, Kenali Bawah dan Sukakarya, while the villages with low vulnerability are Bagan Pete, Rawasari and Kenali Atas (Figure 4).

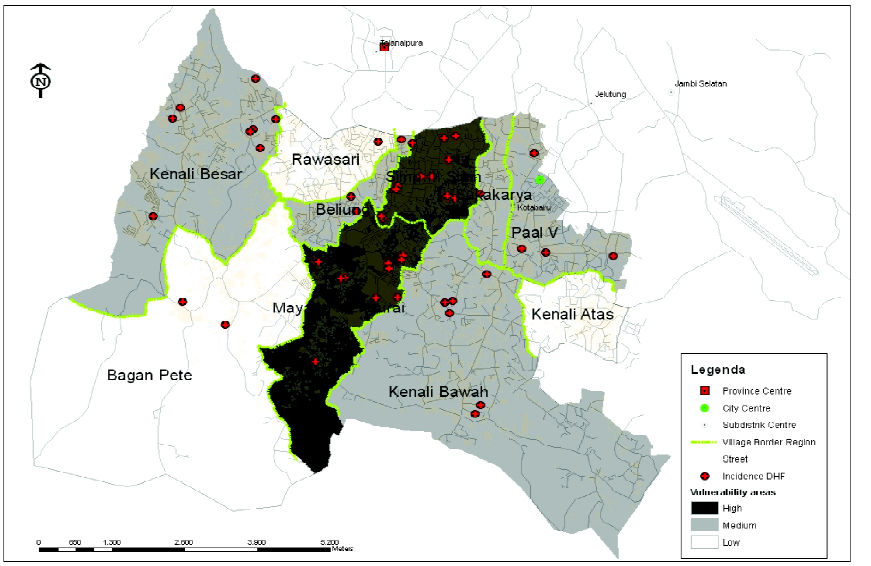


Figure 4. Map susceptibility regions on the incidence of DHF in Kotabaru Subdistrict in 2011

Simpang III Sipin and Mayang Mengurai Village vulnerable and potentially high to incidence of DHF. Two regions have an area of 680 ha, mean 8.74% of area Kotabaru District has high potential on the incidence of DHF, of which there are 38446 residents who will be affected high risk of DHF. Population at risk of DHF in the Mayang Mengurai Village spread over 8 RT with a total area of 1.68 km^2, to Simpang III Sipin Village residents who are at risk of DHF in 9 RT with a total area of 0.62 km^2. Villages vulnerable high-potential occurrence of DHF have a high mosquito population density, land use for settlement area and the percentage of homes with high-status Maya Index. Beliung Village and Kenali Bawah directly adjacent to vulnerable areas and potentially of high DHF occurs. Necessary precautions, especially Kenali Bawah Village that has a population mosquito density of *Aedes* sp high, administration area is wide and settlement landuse just ± 10%, it allows the landuse for new settlement area that could result in increased incidence of DHF in the region in the future.

When the manuscript was compiled in December 2011, Jambi City experienced an outbreak of DHF with dengue incidence highest in the Mayang Mengurai Village.

CONCLUSION

The incidence of DHF was influenced the high population density of *Aedes* sp, extent of land used as settlement, as well as the percentage of houses with status of Maya Index high. Incidence of DHF in the Kotabaru Subdistrict influenced by a high population of *Aedes* sp, settlement land area, as well as the percentage of homes with high status of the virtual index, so as to suppress the occurrence of DHF need community participation to the levels of administrative institutions in order to PSN and monitoring of the mosquito *Aedes* sp particular brood controllable sites.

In this study, population density, rainfall is high, resistance vector and transovarial infection rate did not affect the high incidence of DHF, so the need for further research especially for resistance and transovarial in patients settlement with DHF and the settlement within 100 meters around it so it can be obtained more samples and information accurately both in textual, spatial and combinations thereof.

Vulnerabe villages and high-potential occurrence of DHF are Simpang Sipin Village and Mayang Mengurai. Areas with a high susceptibility of DHF have a high mosquito population density, land use for settlement area and the percentage of homes with high-status Maya Index. Need intensive monitoring and prevention at Simpang III Sipin Village and Mayang Mengurai to prevent outbreaks, as well as the development of GIS-based data management DHF (bergeoreferensi) as well as human resource development to support the operation of GIS and is able to transform input data into useful information.

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