DYNAMICS OF DENGUE HEMORRHAGIC FEVER INCIDENCE WITH SPATIO-TEMPORAL APPROACH IN MARITENGNGAE SUBDISTRICT, SIDENRENG RAPPANG DISTRICT, SULAWESI SELATAN PROVINCE, IN 2008-2009

I Made Swastika[1]*, Tri Baskoro Tunggul Satoto[2], Anis Fuad[3]
[1]Denpasar Class I Port Health Office, Bali. [2]Department of Parasitology, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta,[3]Department of Public Health, Faculty of Medicine, Universitas Gadjah Mada, Yogyakarta.

*Corresponding author: swtkb@yahoo.co.id

ABSTRACT
Introduction: Dengue Hemorrhagic Fever (DHF) causes 40% of world population at risk for infection, and 50 million people get infection with as many as 24,000 die every year. Incidence rate in Indonesia, particularly in Maritengngae Subdistrict, Sidenreng Rappang District, is increasing and needed to be controlled. Disease distribution has not been documented regionally. The dynamics of the incidence,that comprises the characteristics of the patient, environmental conditions, susceptibility of mosquitoes resulted from insecticide use, transovarial infectivity, and the incidence pattern were unknown.
Objectives: To identify the dynamics of DHF incidence with spatio-temporal approach, includes gender, age, the habit of cleaning the water containers, house density, the density of water containers within the radius of 100 meters from the house of the patient, resistance of the mosquito, and transovarial transmission of Dengue virus.
Methods: Subjects were DHF patients in Maritengngae Subdistrict. It was an epidemiological observational study with cross-sectional design and spatio-temporal approach to variables of the study, which included the patient characteristics (age, gender, habit of cleaning the water containers), environmental conditions (house density, water container density within 100 meter radius around the patient's house), and vector conditions (resistance status to organophosphate insecticide, and transovarial transmission of Dengue virus).
Results: Cases of DHF in Maritenggae Sub district, Sidenreng Rappang District, South Sulawesi decreased from 95 cases in 2008 to 38 cases in 2009, except in *Kelurahan* Majeling. Incidence distribution of DHF in 2008-2009 based on gender were not different (p=1.000), patients with age <15 years old were different from age ≥15 years (P=0.016 and p = 0.013), house density and density of water containers around the patient's house were not different (p=0.829 and p = 0.538). The habit of cleaning water containers at the house was 43.84%. There were 1.94% of *Aedes aegypti* samples showed medium resistance (tolerance) status against organophosphat insecticide and 33.33% of samples showed transovarial transmission of Dengue virus. The highest of transovarial transmission occured in *Kelurahan* Majeling with transovarial transmission index of 100%.
Conclusion: The transmission dynamic of DHF in Maritengngae sub district is not influenced by gender, house densities, water container densities, and the frequency of source reduction, but influenced by ages. Most of *Ae. aegypti* mosquitoes are still susceptible against organophosphate insecticides. The highest of transovarial transmission of dengue virus in *Ae. aegypti* in *Kelurahan* Majeling with Transovarial transmission index of 100% may contribute in the increasing of DHF cases in the *Kelurahan* Majeling in 2009.

Key words: dynamics, dengue, spatio-temporal, *Ae. aegypti*, Maritengngae.

INTISARI

Pendahuluan: Demam Berdarah Dengue (DBD) beresiko menyebabkan 40% dari populasi dunia terinfeksi dan dari 50 juta orang yang terinfeksi, sebanyak 24.000 meninggal setiap tahunnya. Angka kejadian DBD di Indonesia, khususnya di Maritengngae Subdistrict, Sidenreng Rappang District, bertambah dan perlu dikendalikan. Distribusi penyakit belum didokumentasikan regional. Dinamika kejadian, yang terdiri dari karakteristik pasien, kondisi lingkungan, kerentanan nyamuk dihasilkan dari penggunaan insektisida, infektivitas transovarial, dan pola kejadian tidak diketahui.

Tujuan: Untuk mengidentifikasi dinamika kejadian DBD dengan pendekatan spatio-temporal, termasuk jenis kelamin, usia, kebiasaan membersihkan wadah air, kepadatan hunian, kepadatan wadah air dalam radius 100 meter dari rumah pasien, resistensi nyamuk, dan transmisi transovarial virus Dengue.

Metode: Subyek adalah penderita DBD di Kecamatan Maritengngae. penelitian ini merupakan penelitian epidemiologi observasional dengan desain cross-sectional dan pendekatan spatio-temporal. Variabel yang diteliti mencakup karakteristik pasien (umur, jenis kelamin, kebiasaan membersihkan wadah air), kondisi lingkungan (kepadatan hunian, kepadatan wadah air dalam radius 100 meter sekitar rumah pasien), dan kondisi vektor (status resistensi terhadap insektisida organofosfat, dan transmisi transovarial virus Dengue).

Hasil: Kasus DBD di Kecamatan Maritenggae, Sidenreng Rappang Kabupaten, Sulawesi Selatan menurun dari 95 kasus di tahun 2008 menjadi 38 kasus pada tahun 2009, kecuali di Kelurahan Majelling. Distribusi kejadian DBD pada tahun 2008-2009 berdasarkan jenis kelamin tidak ada perbedaan bermakna (p = 1.000), demikian pula kepadatan hunian dan kepadatan wadah air di sekitar rumah pasien (p = 0,829 dan p = 0,538). Perbedaan distribusi bermakna pada pasien dengan usia <15 tahun yang berbeda dari usia ≥ 15 tahun (P = 0,016 dan p = 0,013). Kebiasaan membersihkan wadah air di rumah adalah 43.84%. Sebanyak 1,94% sampel *Ae. aegypti* menunjukkan status resistensi menengah (toleransi) terhadap insektisida organophosphat dan 33,33% dari sampel menunjukkan terjadinya transmisi transovarial virus Dengue. Penularan transovarial tertinggi terjadi di Kelurahan Majeling dengan indeks transmisi transovarial 100%.

Simpulan: Dinamika transmisi DBD di Kecamatan Maritengngae tidak dipengaruhi oleh jenis kelamin, kepadatan rumah, kepadatan wadah air, dan frekuensi pengurangan sumber, namun dipengaruhi oleh usia. Sebagian dari *Ae. aegypti* masih rentan terhadap insektisida organofosfat. Penularan transovarial virus dengue pada *Ae. aegypti* di Kelurahan Majelling dengan indeks transmisi transovarial 100% dapat berkontribusi dalam peningkatan kasus DBD di Kelurahan Majeling tahun 2009.

Kata kunci: dinamika, demam berdarah, spatio-temporal, *Ae. aegypti*, Maritengngae.

INTRODUCTION

Dengue hemorrhagic fever (DHF) is distributed found in 107 countries, and until year 2000 there were 40% of world populations were at risk of DHF. Each year, 50 million people is infected, and 24,000 are died. Indonesia is the second most endemic country in Southeast Asia in morbidity and mortality rate, after Thailand[2]. Incidence rate (IR, cases/10,000 populations) in 2003 was increased until 2007, with case peak in January-February[3]. Control has been conducted with success indicator of maximum IR 2/10,000, case fatality rate (CFR) <1%, and larva-free rate 95%[4,5]. However, the incidence has been expanded to the areas previously free from DHF. There were 330 cities/districts infected in 2006 and it have been increased to 355 cities/districts in 2007[3].

All cities/districts in Sulawesi Selatan Province have reported DHF in 2007[6]. Endemic districts were Sidenreng Rappang (Sidrap), which had increased patients in 2006-2007(IR from 3.6/10,000 to 5/10,000)[7]. Each year DHF cases were found in Maritengngae Subdistrict, Sidrap Distric which had the largest population (47,578) and had most density (725/km^2) compared with other subdistrict. The strategic location has facilitated the transmission. DHF patients reported in 2007 were 27 (IR 5.7/10,000), and increased in 2008 to 85 patients (IR 17.9/10,000).

DHF in Maritengngae Subdistrict has been the priority health problem which needs more intensive control. The obstacles in disease control are the susceptibility of population at risk, density and mobility, good transportation, seasonal change influenced by world climate, environmental conditions, viral virulence, health behavior[8,9], the unavailability of antiviral agent and vaccine to prevent the disease[10], and unintegrated mosquito eradication of mosquito nest. Chemical eradication with insecticide has been conducted, but the result has not been documented and mosquito resistance was unknown. Development and dissemination of the disease has not been documented by regional analysis.

Pattern of DHF incidence in 2008 was unknown, and the comparison with that in 2009 was also unknown. The research problems were: what are the dynamics of DHF incidence, which consist of the patient characteristics (gender, age, and habit of cleaning the water containers), specific environmental conditions (house density, density of water containers around the patient's house), mosquito resistance to insecticide, and transovarial mosquito infectivity. Epidemiological analysis with spatial and temporal approach is needed to be conducted to understand the factors which had role in the transmission of DHF in Maritengngae Subdistrict, and to identify the dynamics of DHF incidence with spatio-temporal approach, includes gender, age, the habit of cleaning the water containers, house density, the density of water containers within the radius of 100 meters from the house of the patient, resistance of the mosquito, and transovarial transmission of Dengue virus.

MATERIALS AND METHODS

Subjects were DHF patients in Maritengngae subdistrict, Sidenreng Rappang District, South Sulawesi Province. It was an epidemiological observational study with cross-sectional design and spatio-temporal approach to variables of the study, which included the patient characteristics (age, gender, habit of cleaning the water containers), environmental conditions (house density, water container density within 100 meter radius around the patient's house), and vector conditions (resistance to organophosphate insecticide, and transovarial transmission of Dengue virus).

Mean and deviation standard of absorbance value (AV) was measured at 450 nm to figure out susceptibility status of *Ae. aegypti* mosquitoes against organophosphate insecticide based on the determination of non-specific esterase activities toward α-naphtyl acetate. The presence of dengue antigen on head squashes of unbloodfed *Ae. aegypti* mosquitoes from ovitrap placed in Maritengae subdistrict were detected using monoclonal antibody against dengue (DSSC7) based on immunohistochemical assays to measure the transovarial trasmission Index (TTI) on the F1 generation of *Ae. aegypti* mosquitoes.

RESULTS AND DISCUSSIONS

1. Location of the study

Maritengngae Subdistrictis located at 3º56,357'-3º57,899'SL and 119º47,971'-119º49,927'EL, in the 50° zone at the South of Equator[11], and consists of 7 *Kelurahan* and 5 Village. Total area is 6,590 hectare[12] with population of 40,945, and ratio of male and female is 1.05:113. The age compositions are mostly in 15-44 years old (28.81%) and 45-64 years old age group (25.9%).

2. DHF incidence in 2008-2009

Confirmed DHF patients were 127, consisted of 89 patients in 2008 and 38 patients in 2009, scattered in 11 Village/Kelurahan. Most patients in 2008 were found in Kelurahan Pangkajene, Rijang Pittu, and Lautang Benteng, while in 2009 they were found in Kelurahan Majjeliing and Pangkajene.

DHF incidence in 2009 was mostly decreased in each Village/Kelurahan, compared with that in 2008. However, it was increased in Kelurahan Majjelling, Takkalasi Village, and Sereang Village, where there were no previous infections. Thematic visualization of DHF incidence based on Village/Kelurahan in 2008 and 2009 is shown in Figure 2.

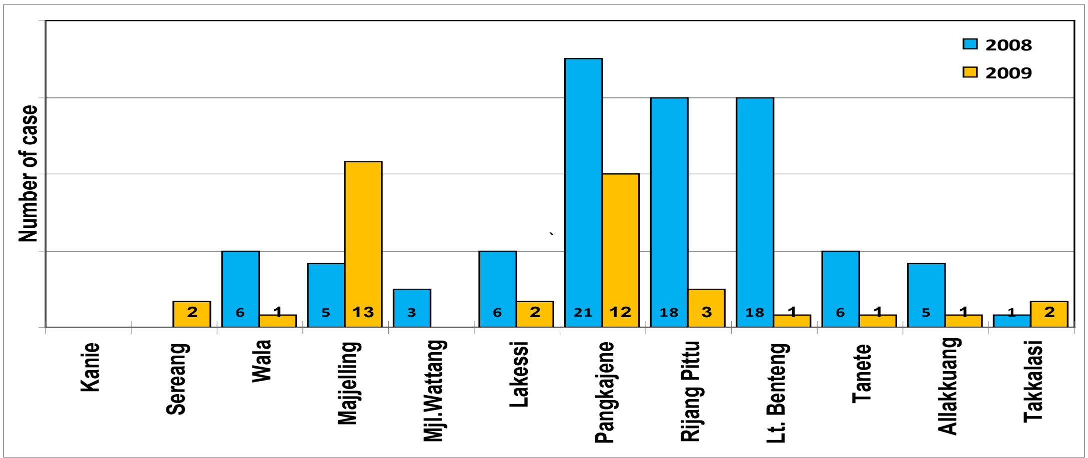


Figure 1. Distribution of DHF patients based on Village/Kelurahan in Maritengngae Subdistrict in 2008 and 2009

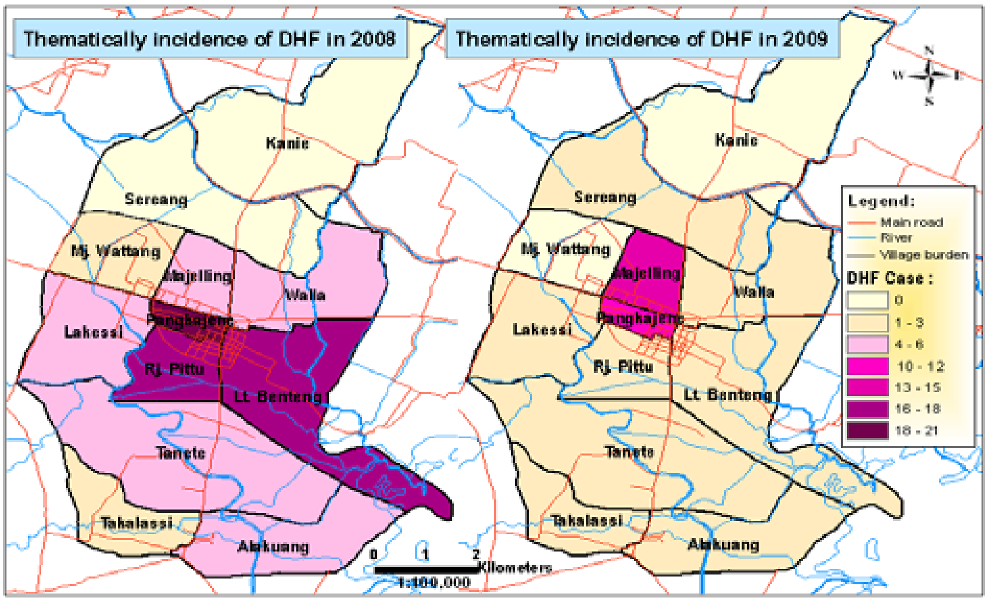


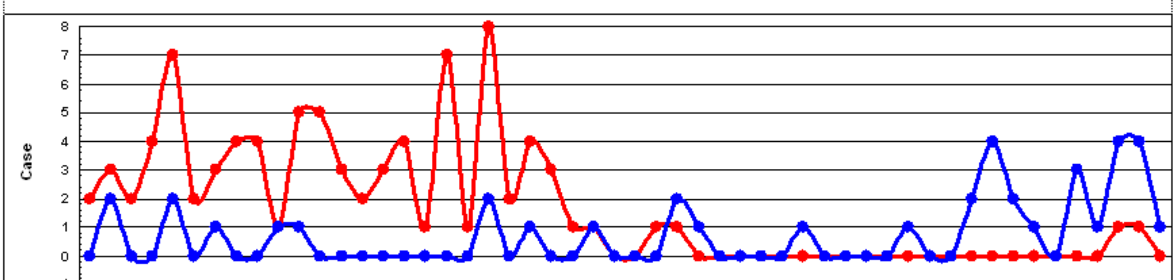
Figure 2. Thematic DHF incidence based on Village/Kelurahan in Maritengngae Subdistrict in 2008 and 2009

The cause of the decrease in 2009 was unknown, either accidental or resulted from intervention and prevention efforts. In the field study, there were no reports on the control and prevention of DHF in 2008-2009. Reports on focus management activity, fogging focus, and insecticide use in that period could not be obtained. Surveillance staff in local healthoffice informed that insecticide used in that period was organophosphate.

Weekly pattern of DHF incidence was fluctuated, with difference in incidence time. In 2008, incidence was started from week 1-29 with case peak in week 5, 18, and 20. There were no cases in the subsequent weeks. In 2009, there were 3 periods, in week 1-11, 20-30, and 40-52. Each period was interspersed with case-free weeks, and the highest cases were occurred in week 44, 50, and 51.

The dwellings of patients in January-March 2008 were partly grouped to form cluster (p=0.035) based on retrospective space-time analysis with weekly aggregate (α=0.05). Epicentrum cluster was in Pangkajene (radius 330 meter). The presence of cluster showed that the DHF transmission in area it covered was faster, based on weekly duration. Patients in the cluster area were generally ill at the relatively adjacent time and location.

However, the dwellings of patients in April-June 2008 and October-December 2009 were adjacent, but did not form significant cluster. Most patients in 2008 lived in groups to form cluster in 2 areas (p=0.01 and p=0.017), which different from the incidence in 2009. Epicentrum cluster was in Pangkajene, consistent with epicentrum cluster of patients in January-March 2008 (coordinate 3,92688° SL and 119,79292°EL). Pangkajene is a city area, and the capital of subdistrict and distric. There are many housings and gathering places[14] in the urban area, therefore, more people will have contact with mosquitoes, along with the fast development of mosquito population[1]. Cluster in Kelurahan Wala (radius 10 meter) was formed by case of housemates and neighbors. DHF incidence in 2009 did not form any clusters (p=0.085), although the houses were adjacent.



Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
2008	2	3	2	4	7	2	3	4	4	1	5	5	3	2	3	4	1	7	1	8	2	4	3	1	1	0
2009	0	2	0	0	2	0	1	0	0	1	1	0	0	0	0	0	0	0	0	2	0	1	0	0	1	0

Week	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52
2008	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0
2009	0	0	2	1	0	0	0	0	1	0	0	0	0	1	0	0	2	4	2	1	0	3	1	4	4	1

2008	Jan	Peb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nop	Des
2009	Jan	Peb	Mar	Apr	Mei	Jun	Jul	Ags	Sep	Okt	Nop	Des

Explanation: - week 1 in 2008 start at 6 January
- Week 1 in 2009 start at 4 January

Figure 3. Weekly trend of DHF incidence in Maritengngae Subdistrict in 2008 and 2009

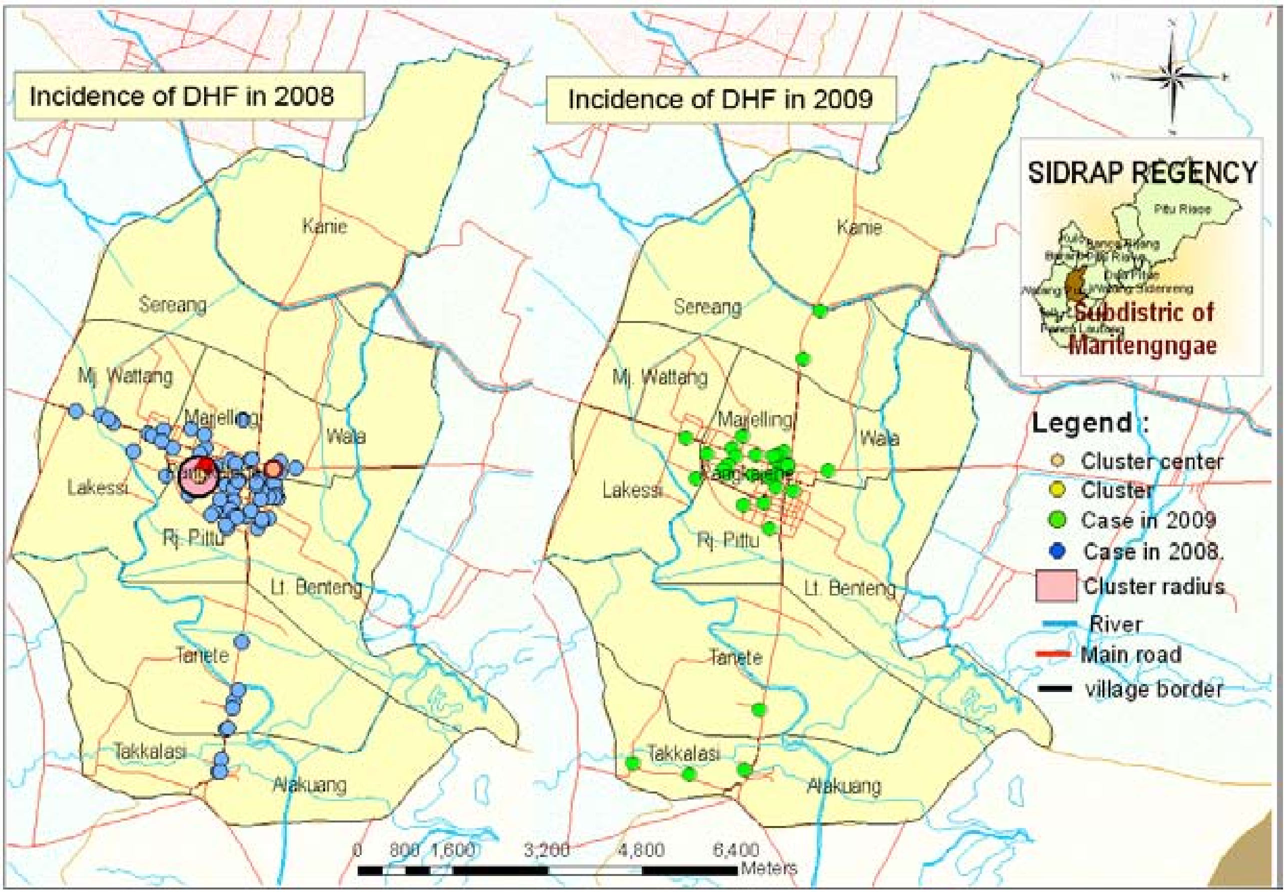


Figure 4. DHF incidence and clusters formed in Maritengngae Subdistrict in 2008 and 2009

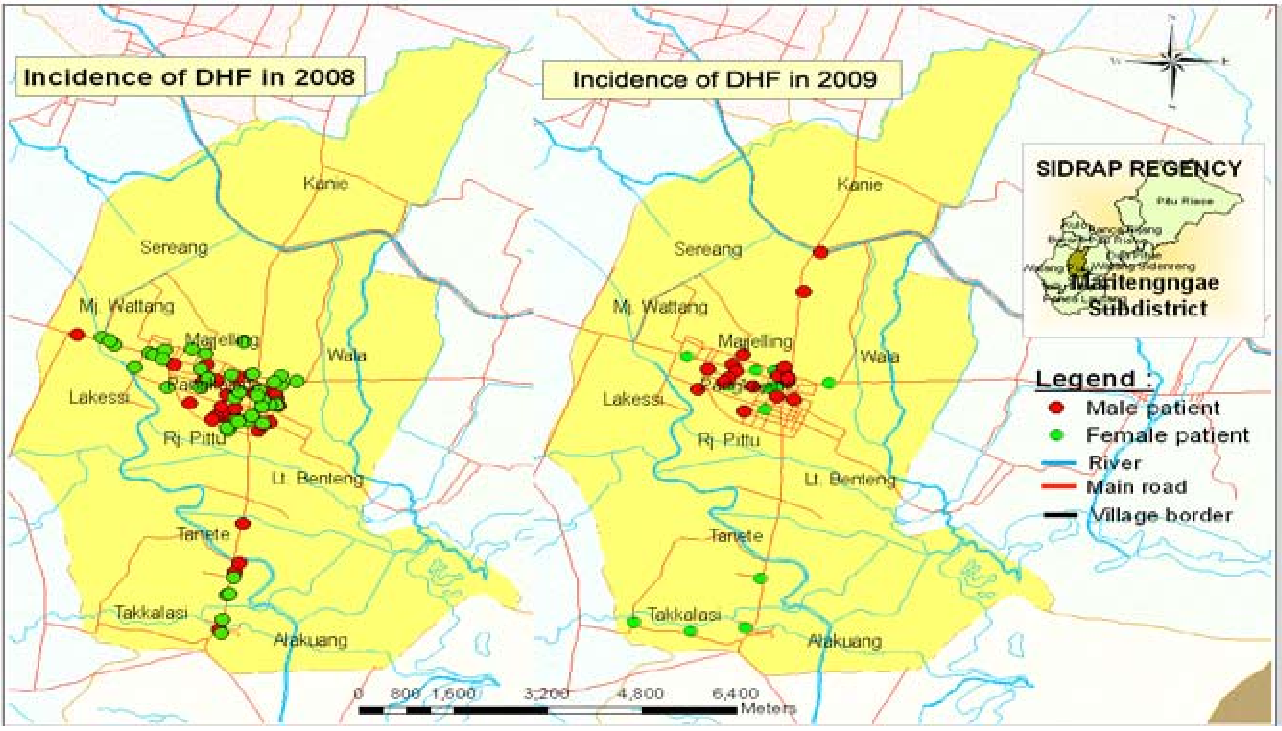


Figure 5. Distribution of DHF patients based on gender in Maritengngae Subdistrict in 2008 and 2009

Table 1. Distribution of DHF patients based on gender and incidence year in Maritengngae Subdistrict in 2008 and 2009

Gender	Year incidence				Total		*p*-value
	2008		2009				
	n	%	N	%	Total	%	
Male	41	32.29	18	14.17	59	46.46	1.000
Female	48	37.79	20	15.75	68	53.54	
Total	89	70.08	38	29.92	127	100	

Table 2. Distribution of DHF patients based on age group in Maritengngae Subdistrict in 2008 and 2009

Age group	Year incidence				Total		*p*-value
	2008		2009				
	n	%	N	%	Total	%	
<15 years old	83	65.35	29	22.83	112	88.19	0.016
≥15 years old	6	4.72	9	7.09	15	11.81	
Total	89	70.08	38	29.92	127	100	

3. **DHF incidence based on characteristics of the subjects**

a. DHF incidence based on gender

DHF patients consisted of female (53.54%) and males (46.46%). Analysis with chi-square showed no significant difference in patient distribution in 2008 and 2009 based on gender (p=1.000). Retrospective space-time analysis on patient dwellings in 2008 based on gender gave p-value of 0.058 (males) and 0.362 (females). Similar analysis for incidence in 2009 gave p value of 0.720 (males) and 0.121 (females). Analysis showed no significant cluster based on gender, thus, the difference in distribution was not significant.

Proportion of female patients was higher than male patients, but the difference was not significant[15]. However, the total number of male cases was higher than female cases in Singapore, with the ratio of 1.9:116. Particular disease are found more in one gender, but it does not mean that the particular gender has higher risk[17]. Gender was part of epidemiologic triad of disease need to be calculated[18] and DHF endemicityis affected by its epidemiological component, such as gender[19]. Females mostly stay at home, giving them more exposure and more infection while stay inside the house[20], parallel with behavior of *Ae. Aegypti* who has activities inside the house. On the other hand, immune responses of females increased faster compared with males[20], so that they develop immunity faster, but this is needed to be studied further.

b. DHF incidence based on age

Most patients were distributed in <15 years old age group (88.19%) compared with ≥15 years old age group (11.81%). Analysis with chi-square showed a significant difference in distribution between patients in 2008 and 2009 based on age group (p=0.016).

Most patients <15 years old in 2008 lived closely, gave a cluster (p=0.013) with 10 meter radius in Wala and 530 meter in Pangkajene, but there were no clusters for patients ≥15 years old (p=0.85). Dwellings of patients in 2009 did not form any significant clusters for <15 years old (p=0.184) and ≥15 years old (p=0.722). Cluster in Wala was formed by patient group with adjacent houses, with patients in the age between 3-8 years old, and mostly ill in February.

Age affects susceptibility. Children are commonly susceptible to DHF[1]. Under-five-years-olds mostly stay at home, sleep in the morning and afternoon, which is the optimum activity time of Aedes[10,21]. Mosquito activity is increased around two hours after the sun rises and several hours before the sun sets[22]. School children (5-14 years old) are commonly susceptible to DHF[23,13]. However, the proportion of patient ≥15 years old in 2009 was higher than in 2008, which showed a shift of proportion to adults. The highest proportion of patients in 1994-1995 was in school children, but in 1996-1998 it was shifted to ≥15 years old[24], which may be associated with the interaction of various serotypes of Dengue virus, particularly in the endemic area.

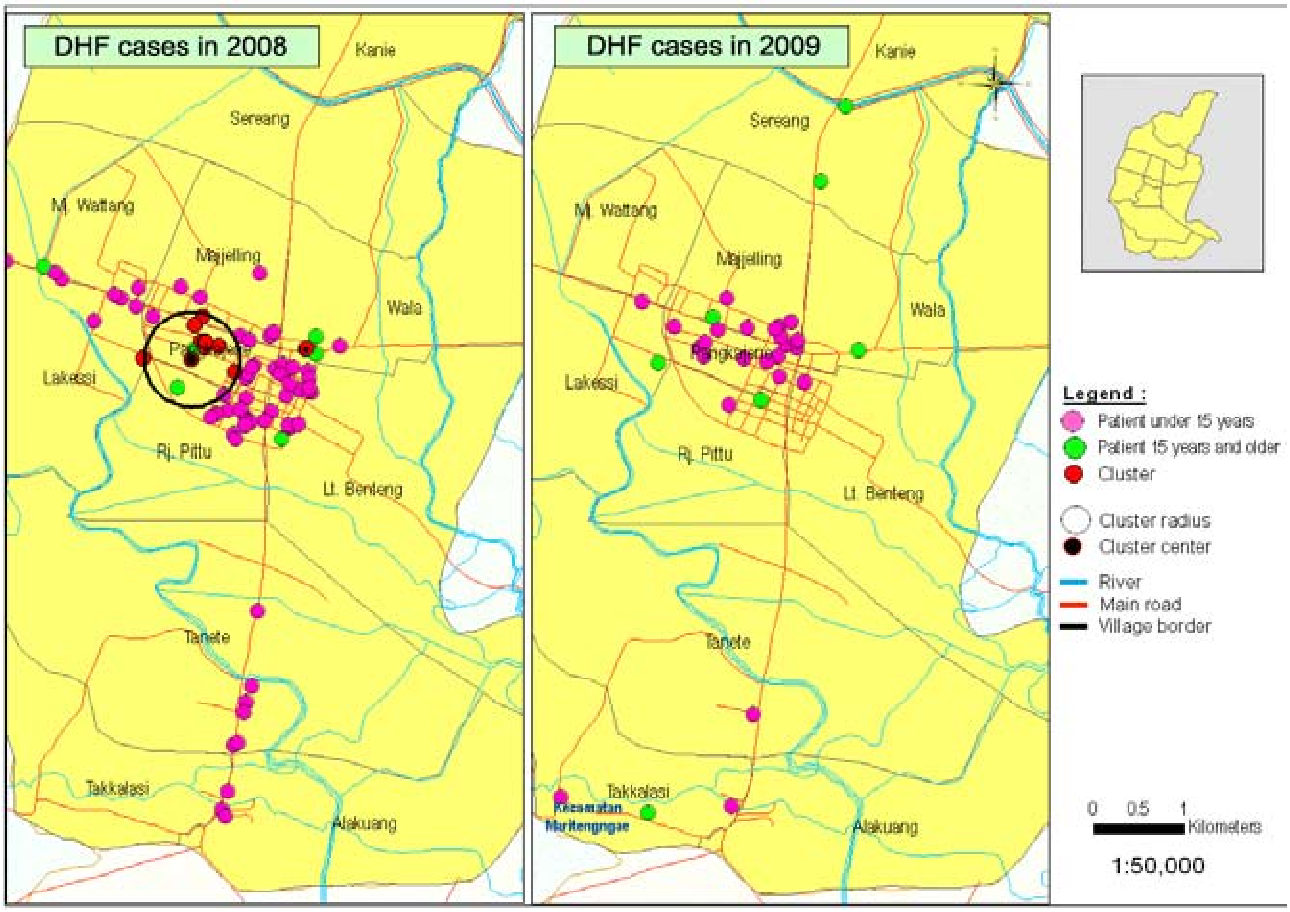


Figure 6. DHF patients based on age group and clusters formed in Maritengngae Subdistrict in 2008 and 2009

c. Habit of cleaning the water containers

Water containers in 127 patient's houses consisted of closed water tanks in 10 houses, water buckets in 114 houses, and *bak mandi* (cuboid/rectangular water container in the bath room) water tubs in 73 houses. The habit of cleaning the water buckets was found in almost all houses (110 houses, 96.49%). Most people even clean them every day (87.77%), therefore, possibility of *Ae. Aegypti* hatching eggs in the water containers were decreased. However, the habit of cleaning the *bak mandi* for a minimum of once a week was only occurred in 32 houses (43.84%).

The availability of water containers in the patient's house showed the habit to save the water. This is similar with the result of the study in Sangata Utara (Kutai Timur) which indicated that the people had habit of saving water for household[25]. The more the water containers represent the more available locations for the breeding of mosquitoes[23]. There was a significant association between the activity of draining the water containers and population of Aedes mosquitoes. Risk of DHF transmission will still exist when the transmission vector is still breeding[25]. Irregular cleaning of the bak mandi provides a place for *Ae. Aegypti* to breed. Cleaning the water container in household for a minimum of once a week may break the mosquito life cycle, which corresponds with the duration of egg, larva, and pupa growth[27]. Generally, the growth from *Ae. Aegypti* egg to adult mosquito needs 9-10 days[28,29,30].

Most houses with frequency of cleaning the *bak mandi* minimum once a week formed cluster with radius of 540 meter (p = 0.026). The breeding of mosquitoes in that cluster area was supposed to be low.

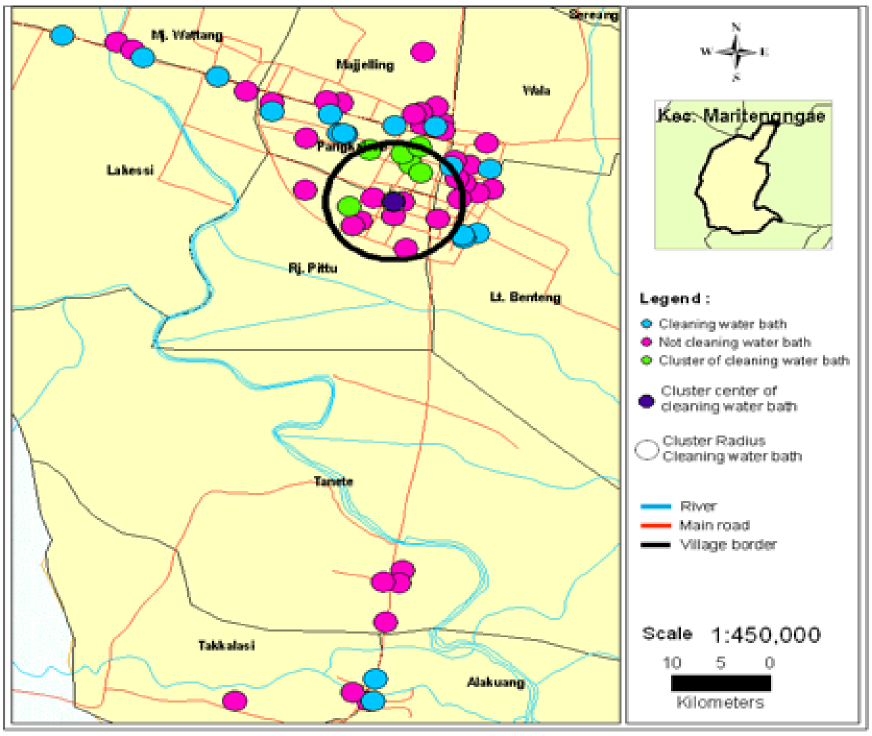


Figure 7. Cluster of DHF patients' houses with the habit of cleaning the *bak mandi*

4. DHF incidence based on environmental conditions

Environmental conditions around the DHF patient's houses consist of house density, and the density of water containers within the radius of 100 meter, which is the flying distance of Aedes mosquito[27,36], as the buffer area of Dengue virus transmission. Buffer area is also determined internationally to prevent the transmission of Yellow Fever (radius 400 meter) from airports and harbors[31].

Epidemiological investigation, focus management, and focus fogging use 200 meter radius from patient's house[32]. House density and density of water containers around the patient's house is part of potential environmental conditions in DHF transmission. Each house forms buffer area which coincident and intersects with each other, so that the flying distance and transmission area of the mosquito are wider. Most houses of patients in 2009 were in the same location with those in 2008, so that the transmission buffer area formed was overlapped. It showed the similarity of pattern of DHF incidence which concentrated in similar places, although the total number of patients in 2009 was smaller. Based on the pattern, DHF incidence in previous and subsequent years would probably concentrated in the similar locations.

a. DHF incidence based on house density

Each transmission buffer area was situated between 5-93 houses. The similarity of house density around the houses of DHF patients in 2008 and 2009 was that the distribution was bigger in the interval of 30-39 houses than in the other intervals, although the proportion in 2008 was bigger (23.6%) than in 2009 (18.42%). Total number of houses in each

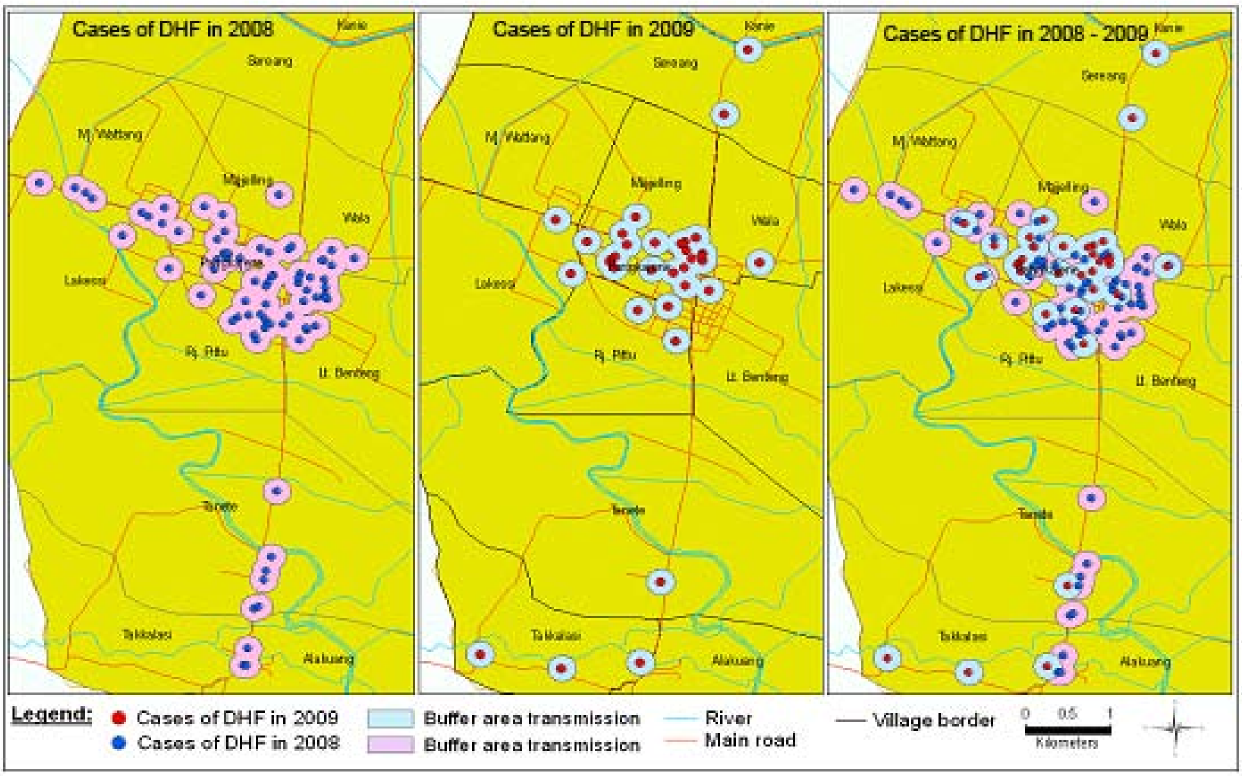


Figure 8. DHF patients and transmission buffer area formed in MaritengngaeSubdistrictin 2008 and 2009

transmission buffer area gave different risk in DHF transmission by Aedes aegypti. Analysis with independent t-test showed no difference in average houses in transmission buffer area in 2008 and 2009 (p = 0.829), therefore, the house density 100 meter from patient's house was not significantly different. The recurrent DHF incidence in the same area caused no significant difference in house density in transmission buffer area in 2008 and 2009.

Houses around the patient's house were mostly grouped in Kelurahan Pangkajene, Majjelling, Lautang Benteng, and Rijjang Pittu. The area was the center of the city and the center of government in Sidrap District. Therefore, the population was heavier and become the gathering place for people from other Village and Subdistrict. The growth of *Ae. aegypti* population is faster in the urban area, results in more contact with human, particularly in areas close to household water containers[1]. One of the causes of the increased DHF cases are the population density, house density, and other complex causes[9].

b. DHF incidence based on the density of water containers

Total number of water containers in each transmission buffer area was 12-267, with the highest distribution in the interval of 90-199 (28.35%). The more the water containers, the faster the mosquito population increased[27]. The similarity of distribution of water containers in each transmission buffer area for DHF incidence in 2008 and 2009 was that the highest number was found in the interval of 90-119, although each proportion was different (28.09% and 28.95%). Analysis with independent t-test showed insignificant difference (p=0.538) in the average of total number of water containers in transmission buffer area in 2008 (125.79) and 2009 (118.39). It meant that the density of water containers in the radius of 100 meter from patient's house in 2008 and 2009 was not different.

Table 3. House distribution in each transmission buffer area in DHF incidence in Maritengngae Subdistrict in 2008 and 2009

Year incidence	Min	Max	Average	SD	SE	p-value	N
2008	8	93	43.99	18.873	2.001	0.829	89
2009	5	91	44.82	21.747	3.528		38

Note: Min=minimum; Max=maximum; SD=standard deviation; SE=standard error; N= total subject

Table 4. Distribution of water containers in each transmission buffer area in DHF incidence in Subdistrict Maritengngae in 2008 and 2009

Incidence year	Min	Max	Average	SD	SE	p-value	N
2008	19	267	125.79	59.357	6.292	0.538	89
2009	2	255	118.39	66.984	10.866		38

Note: Min=minimum; Max=maximum; SD=standard deviation; SE=standard error; N= total subject

Aedes mosquito hatches eggs in clean water containers, such as (bak mandi), buckets, and others[26]. They only put their eggs in clean water[29]. Eggs are hatched in the house and around it, or in public places and particular locations which drowned by water, until radius of 500 meter from surrounding buildings[27].

5. Resistance to insecticide and transovarial transmission

Ae. Aegypti mosquitoes for dengue virus examination were obtained from 6 Villages/*Kelurahan*, and those for resistance examination were obtained from 4 Villages/*Kelurahan*.

a. Resistance to insecticide

Resistance to organophosphate insecticide examination with non-specific esterase[33] technique showed absorbance value (AV) of 0.342-0.857. Average AV of mosquitoes from 4 Villages/*Kelurahan* was higher than the average AV of negative control mosquitoes, which meant that there was esterase enzyme activity in the body of mosquito to metabolize insecticide. Resistance status using average AV limit of control mosquito+2SD showed that there were mosquitoes with moderate resistance in Majeling (4.44%), and in Lautang Benteng, Rijang Pittu, and Takalasi (1.11%).

Table 5. Distribution of susceptibility status of *Ae. aegypti* based on Village/*Kelurahan* in 2010

Kelurahan	Susceptibility status Total				Total	
	Sensitive (AV<0.753)		Moderately resistant (0.753 ≤AV<1.236)			
	N	%	N	%	N	%
Majjelling	86	95.56	4	4.44	90	100
L. Benteng	89	98.89	1	1.11	90	100
RijangPittu	89	98.89	1	1.11	90	100
Takkalasi	89	98.89	1	1.11	90	100
Total	353	98.06	7	1.94	360	100

Table 6. Distribution of result examination of transovarial transmission in *Aedes aegypti* based on the origin of mosquito in 2010

No	Origin of mosquito	Result			TTI (%)
		Negative	Positive	Total	
1	Majjeling	0	8	8	100.00
2	Lautang Benteng	7	1	8	12.50
3	Rijang Pittu	7	1	8	12.50
4	Lakessi	7	1	8	12.50
5	Tanete	4	4	8	50.00
6	Takkalasi	7	1	8	12.50
	Total	32	16	48	33.33

Most *A. aegypti* mosquitoes examined were sensitive to organophosphate insecticide. The presence of moderately resistant mosquitoes prompts a consideration of changing the type of insecticide used. *Ae. Aegypti* studied in Cimahi District also showed a decrease in susceptibility to organophosphate insecticide[34], while in Yogyakarta they tended to be resistant to similar insecticide[35]. Active substance of insecticide is related to resistance of mosquitoes, which effect still present in the environment after being used for more than 6 years, and the resistance process may occurred between one to several decades[36]. Each year, DHF incidence is followed by continued insecticide use. Mosquito coil (*obat nyamuk bakar*) has been used daily in more than 85% of patient's houses. Mosquito repellent used continuously in the household may affect the susceptibility of the mosquitoes. The susceptibility of Aedes mosquito to organophosphate and pyrethroid insecticides in Cimahi city was decrease[34]. In Takalasi, Majjelling, and Lautang Benteng Village, most area is used for agriculture and cattle centre. Continuous pesticide use for agriculture and livestock may affect susceptibility status of Aedes mosquito in the area. However, various types of insecticides used is not documented, so that it is difficult to predict the exposure to *A. aegypti* based on area and time.

The District of Health Office have to conduct diversification of insecticides in managing DHF focus to decrease the resistance of the mosquitoes. Observation and prevention is needed to be increased, particularly more accurate patient recording, counselling on mosquito repellant use to school children, and controlling the habit of population in cleaning their water containers by periodic larva survey.Local government (District, Subdistrict, Village/ *Kelurahan*), The District of Health Office, and Public Healt Center (Puskesmas)have to cooperate in increasing the community participation to be more active in source reduction by conducting 3M+ (*menguras*/ draining, *menutup*/covering, *mengubur*/ burying, and *memberi*/applying larvicide). Enhanching role of cadres in each Village/ *Kelurahan* to monitor the area to prevent the transmission of DHF.

b. Transovarial transmission of Dengue virus

Dengue virus was examined with immunohistochemistry-immuperoxidase streptavidin biotin complex (IISBC)[37], which showed the transovarial Dengue virus transmission, which proportion is determined by transovarial transmission index (TTI).

Dengue virus-positive mosquitoes were obtained from *Kelurahan* Majeling (TTI=100%) and Tanete Village (TTI=50%), while the others (TTI=12.5%) came from Lautang Benteng, Takkalasi, Lakesssi, and Rijang Pittu. A study in Pontianak also found transovarial viral transmission in *A. aegypti*[38]. The viral transmission is probably occurred through DHF transmission process every year. The decrease in Dengue virus in *A. aegypti* in Selangor (Malaysia) was occurred for the subsequent five generations[39]. It was suggested that there was a double shift of virus from mosquitoes who were anthropophilic and multiple biters[16], that is, firstly, from mosquito to its offspring, and secondly, new mosquito

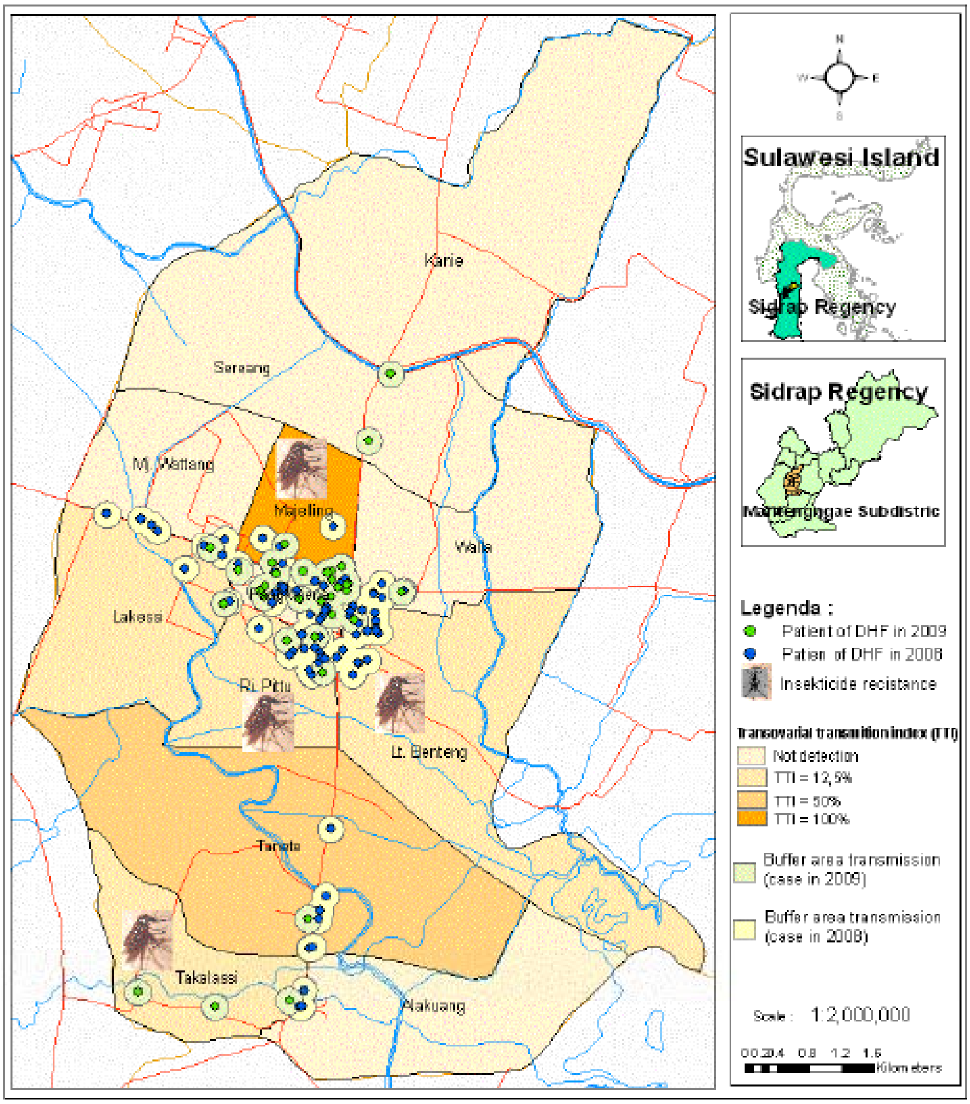


Figure 9. Transovarial transmission, resistance to insecticide, and transmission buffer area in Maritengngae Subdistrict in 2010

obtain Dengue virus from patients with viremia. However, transovarial Dengue virus transmission in Maritengngae Subdistrict is still needed to be studied further. Visualization of resistance and transovarial transmission of Dengue virus in *A. aegypti* is shown in Figure 9.

Other researchers is suggested to study further about spatio-temporal approach on the resistance of *A. aegypti* to insecticide and transovarial viral transmission in endemic and sporadic areas of DHF.

CONCLUSION

Cases of DHF in Maritengngae Sub district, Sidenreng Rappang District, South Sulawesi decreased from 95 cases in 2008 to 38 cases in 2009, except in *Kelurahan* Majelling increased from 5cases in 2008 to 13 cases in 2009. Most patients in 2008 lived in groups to form cluster with epicentrum cluster of patients on January-March at coordinate of 3.92688° SL (P=0.01), and epicentrum cluster on April-June at coordinate of 119.79292°EL (P=0.017). The epicentrum is in *Kelurahan* Pangkajene, a city area, and the capital of sub district and district. However, the dwellings of patients in April-June 2008 and October-December 2009 were adjacent, but did not form significant cluster. DHF incidence in 2009 did not form any clusters (p=0.085), although the houses were adjacent. This transmission dynamic is not influenced by gender, house densities, water container densities, and the frequency of source reduction, but influenced by ages. Most of *Ae. aegypti* mosquitoes are still susceptible against organophosphate insecticide. The highest of transovarial transmission of dengue virus in *Ae.aegypti* in Kelurahan Majelling with TII of 100% may contribute in the increasing of DHF cases in the *Kelurahan* Majeling in 2009.

REFERENCES

1. World Health Organization. Dengue and Dengue Haemorrhagic fever, Fact sheet, Period March 2009. Available from: URL:http://www.who.int/dengue/and dengue/hemorrhagic/fever.htm.
2. World Health Organization. Situation of Dengue/Dengue Haemorrhagic Fever in The South-East Asia Region, Prevention and Control Status in SEA Countries. Available from: URL: http://www.whosea.org/en/ Section10/Section332.htm.
3. Departemen Kesehatan Republik Indonesia. Profil Kesehatan Indonesia 2008. Pusat Data dan Informasi Kesehatan. Jakarta, 2009.
4. Departemen Kesehatan Republik Indonesia. Indikator Indonesia Sehat 2010 dan Pedoman Penetapan Indikator Provinsi Sehat dan Kabupaten/Kota Sehat. Peraturan Menteri Kesehatan Nomor: 1202/Menkes/ SK/VII/2003. Jakarta, 2003.
5. Departemen Kesehatan Republik Indonesia. Profil Kesehatan Indonesia 2007. Pusat Data dan Informasi Kesehatan. Jakarta, 2008.
6. Dinas Kesehatan Propinsi Sulawesi Selatan. Profil Kesehatan Provinsi Sulawesi Selatan tahun 2007. Makassar, 2008.
7. Dinas Kesehatan Kabupaten Sidenreng Rappang. Profil Dinas Kesehatan Kabupaten Sidenreng Rappang Tahun 2008. Pangkajene-Sidrap, 2009.
8. Departemen Kesehatan Republik Indonesia. Panduan Program Peningkatan Peran Serta Masyarakat dalam Pemberantasan Sarang Nyamuk Demam Berdarah Dengue di Kabupaten/Kota. Direktur Jenderal Pengendalian Penyakit dan Kesehatan Lingkungan. Jakarta, 2004.
9. Kusriastuti R. Epidemiologi penyakit demam berdarah dengue dan kebijaksanaan penanggulangannya di Indonesia. Simposium Dengue Control Update, Tropical Medicine Center of UGM. Yogyakarta, 2005.
10. Departemen Kesehatan Republik Indonesia. Pencegahan dan pemberantasan demam berdarah dengue di Indonesia. Buku 1: Penemuan dan Tatalaksana Penderita Demam Berdarah Dengue, Direktur Jenderal Pengendalian Penyakit dan Kesehatan Lingkungan. Jakarta, 2005.
11. Bakorsutanal. Panduan praktis membaca dan menggunakan peta rupa bumi Indonesia. Badan Koordinasi Pemetaan Nasional, Jakarta. 2005.
12. Bappeda Kabupaten Sidrap. Updating peta penutup lahan untuk mendukung basis data spasial menggunakan data satelit pengideraan jarak jauh resolusi menengah di Kabupaten Sidenreng Rappang-Sulsel Tahun Anggaran 2008. Pangkajene-Sidrap, 2008.
13. Puskesmas Pangkajene. Profil Puskesmas Pangkajene Kabupaten Sidenreng Rappang Tahun 2008. Pangkajene-Sidrap, 2009.
14. Siregar FA. Epidemiologi dan pemberantasan demam berdarah dengue (DBD). Faculty of Public Health, USU, Medan, 2004.

15. Sutaryo. Dengue. Medika, Faculty of Medicine, UGM. Yogyakarta, 2004.
16. Goh KT, Chan YC, Lim SJ, Chua EC. Epidemiological aspects of an outbreak of dengue fever/dengue haemorrhagic fever in Singapore. South-East Asian J Trop Med Pub Health, 1987;18:295-301.
17. Notoatmodjo S. Ilmu Kesehatan Masyarakat, Prinsip-Prinsip Dasar. Jakarta: Rineka Cipta, 2003.
18. Gordis L. Epidemiology, Second Edition. Pennsylvania. Johns Hopkins University, School of Medicine, W.B. Saunders Company Baltimore-Maryland, 2008.
19. Mardihusodo SJ, Satoto TBT, Mulyaningsih B, Umiyati SR & Ernaningsih. Bukti adanya penularan virus dengue secara tansovarial pada nyamuk Aedes aegypti di Kota Yogyakarta. *Simposium Nasional Aspek Biologi Molekuler, Patogenesis, Manajemen dan Pencegahan* KLB. 16 Mei di Pusat Studi Bioteknologi UGM. Yogyakarta, 2007.
20. Charvalos E. Sex and gender in epidemic-prone infectious disease (EPID). The view of WHO, the case of dengue fever.Paper Presented from The WHO Department of Gender, Women and Health, 2008.
21. Kristina, Isminah, Wulandari L. Kajian Masalah Kesehatan, Demam Berdarah Dengue. Departemen of Health of Indonesian Republicand Balitbangkes. Jakarta, 2004.
22. Heymann DL, Editor. Control of Communicable Diseases Manual, 19th Edition. American Public Health Association. Washington, 2008.
23. Hamzah M. Bionomik *Ae. Aegypti*. Jurnal Kedokteran Kesehatan, 2004;36(4):90-6.
24. Departemen Kesehatan Republik Indonesia. Kebijaksanaan Program Penanggulangan DBD di Indonesia. Direktur Jenderal Pengendalian Penyakit dan Kesehatan Lingkungan. Jakarta, 2008.
25. Purba M. Analisis hubungan antara kondisi sanitasi lingkungan dan perilaku penduduk dengan kepadatan vektor Demam Berdarah Dengue (DBD) di Subdistrict Sangatta Utara Kabupaten Kutai Timur Provinsi Kalimantan Timur[tesis]. Yogyakarta, Faculty of Medicine UGM, 2008.
26. Supartha IW. Pengendalian terpadu vektor virus demam berdarah dengue, *Ae. Aegypti* dan *Aedes albopictus*. Pertemuan Ilmiah (Symposium). Universitas Udayana Denpasar, 2008 Sept 3-6.
27. Departemen Kesehatan Republik Indonesia. Pencegahan dan pemberantasan demam berdarah dengue di Indonesia, Buku 3: Pemberantasan Nyamuk Penular Demam Berdarah Dengue. Direktur Jenderal Pengendalian Penyakit dan Kesehatan Lingkungan. Jakarta, 2005.
28. Mardihusodo SJ. Application of non-specific esterase anzymemicroassays to detect potential insecticide resistance of Aedes aegypti adults in Yogyakarta, Indonesia. Berkala I Ked, 1996; Vol.28. No.4:167-71.
29. Mortimer R. *Aedes aegypti* and dengue fever. Microscopy UK, 1998. Available from: URL: http://www.microscopy-uk.org.uk/mag/art98/aedrol.html.
30. World Health Organization. Prevention control for degue and dengue hemorrhagic fever. WHO regional publification SEARO, 2000; 29: pp. 3, 61-2.
31. World Health Organization. International Health Regulation 1969. Third Annotated Edition. Jeneva, 1983.
32. Departemen Kesehatan Republik Indonesia. Pencegahan dan pemberantasan demam berdarah dengue di Indonesia. Buku 4. Penyelidikan Epidemiologis penanggulangan Fokus dan Penanggulangan Vektor pada Kejadian Luar Biasa Demam Berdarah Dengue. Direktur Jenderal Pengendalian

Penyakit dan Kesehatan Lingkungan. Jakarta, 2005.

33. Lee HL, Ambibola O, Singh KI. Determination of insecticide susceptibility in Culex quinquenfasciatus say adult by rapid enzyme microassays. SEA Journal Trop Med of PH, 1992; 23(3):458-63.
34. Wahyudin D. Uji status kerentanan nyamuk vektor *Ae. Aegypti* terhadap insektisida yang digunakan dalam program pengendalian demam berdarah dengue (DBD) di Kota Cimahi Provinsi Jawa Barat [tesis]. Yogyakarta, Faculty of Medicine UGM, 2009.
35. Mardihusodo SJ. Microplate assay analysis of potential for organophosphate insecticide resistance in *Ae. Aegypti* in Yogyakarta Municipality Indonesia. B I Ked, 1995;27:71-79.
36. Georghiou GP. The magnitude of resistance problem. Pesticide Resistance. Washington: National Academy Press, 1986.
37. Umniyati SR. Prelimenary investigation on the transovarial transmission of dengue virus in the popuation of *Ae. Aegypti* in the well. Moquito Day Seminar IV. Surabaya, 21 Agustus 2004.
38. Sucipto CD. Deteksi transmisi transovarial virus dengue pada nyamuk *Ae. Aegypti* (Diptera: Culicidae) jantan dan betina serta hubungannya dengan kejadian demam berdarah dengue di Kota Pontianak. [Tesis]. Yogyakarta, Faculty of Medicine UGM, 2009.
39. Rohani A, Zamree I, Joseph RT, Lee HL. Persistency of transovarial dengue virus in *Ae. Aegypti*. Southeast Asian J Trop Med Public Health, 2008; Vol.35.5:813-16.