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**THE RISK OF PHYSICAL, BIOLOGICAL, AND SOCIAL  
ENVIRONMENTS TOWARD MALARIA INCIDENT  
IN SENTANI LAKE**

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## ABSTRACT

**Background.** Malaria was endemic disease in Papua which it's prevalence from the past until present was still similar. Malaria disease was the number one of the death cause in Papua although the local government had strived for some restraints methods for malaria such as using mosquitoes' net, larva eradicating, and routine medical treatment for the malaria sufferers, but these efforts didn't work. This research was aimed to know and analyze the correlation between: (1) physical environment risk and malaria spreading, (2) biotical environment risk and malaria spreading, (3) social factor risk and malaria spreading, (4) condition of location of mosquitoes' and larva's propagation, and *buffer zone* (malaria potential area) as the location of mosquitoes' distribution and malaria spreading in Sentani Lake area.

**Method.** Population in this research were all population in Sentani District in the number of 47.758 persons. Sample in this research were 200 persons from 4 villages: Yoboi/Kehiran Village, Hobong Village, Ifar Besar Village, and Ifale Village, from each village it were taken 50 persons. The sampling technique was done randomly. The data collecting used questionnaire, observation, interview, and documentation. The analysis method used *bivariate* analysis, statistic test of *Chi-Square*, and logistic regression test.

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**Result.** Based on the analysis result, it could be known that physical environment had meaningful correlation with malaria incident that showed with Chi-square value of 7.531 with  $p = 0.006 < 0.05$  and logistic regression result with OR value of 4.132 with  $p = 0.009 < 0.05$ . Biological factor had meaningful correlation with malaria incident that showed with Chi-square value of 16.328 with  $p = 0.000 < 0.05$  and logistic regression result with OR value of 2.117 with  $p = 0.017 < 0.05$ . Social factor had correlation with malaria incident that showed with Chi-square value of 9.737 with  $p = 0.002 < 0.05$  and logistic regression result with OR value = 3.704 with  $p = 0.014 < 0.05$ . The using of GPS in spatial analysis had meaningful correlation toward the coordinate measurement of place of mosquitoes' and larva's propagation that could help the restraint of malaria mosquitoes in Sentani Lake area.

**Conclusion.** Result of hypothesis test showed that factors of physical, biological, and social environments were significantly influenced toward malaria incident in Sentani Lake area.

**Suggestion.** It was needed to give counseling to the societies especially in order to change their attitude and behavior in using the mosquitoes' net, closed clothes at the night, and using anti mosquitoes' lotion. Else, it was needed to reorder the settlements, and plant *zodia* in front of the house.

## INTRODUCTION

Malaria incident in Jayapura Regency were not spread evenly. From 16 clinic area, there found the most incidents in 3 clinics, they were East Sentani, Sentani, and West Sentani clinics. West Sentani stated as area of malaria endemic. Sentani Lake was included into area of Sentani Clinic with the data as follow: in 2013 the malaria cases were increasing with Annual Parasite Incidence (API) 232 per1000 inhabitants, while malaria cases was decreasing became 13,824 cases (AMI 122 per 1000 inhabitants) ( Health Department of Jayapura, 2013).

According to the reality of malaria incident in Sentani Lake area, there were some prior researches such as Ayomi et.al. 2012 about the temperature in Sentani Lake area which was stated normal as same as the temperature in other areas in Indonesia because it was temperature of tropical area that emphasized on the difference of lowest to highest temperature at the day and night that influenced the mosquitoes' propagation.

Else, the other similar research was conducted by Arsin and Karim, 2008 about the correlation of temperature with malaria incident in Central Halmahera

which measured the temperature in that area was around between 26,8 °C to 27 °C influenced the malaria incident.

Marrai (2006) did the research with the title "Factors which was related to the dynamic of malaria *falciparum* spread in Nabire City Sub District". The research used *Cross Sectional* method. Based on the research result, it could be known that there was relation between environment condition, population condition, and vector existence with malaria incident (*falciparum*) in Nabire City Sub District.

The change of weather elements was influenced to the disease's vector. The increasing of temperature, humidity, and rainfall, were proven to be followed by the increasing of malaria cases happened in Srilangka and Punjab. The difference of area characteristic was influenced to weather difference so that the vector population in certain area which has different characteristic would also have different density (Raharjo, 2003; Kumar, et.all., 2014).

In Sentani Lake area, the malaria incident was high. This research was aimed to know the influence of physical environment factor toward the malaria incident in Sentani Lake area.

Other factors that could influence malaria incident were **biological factor**. Sentani District was growth with many plants. Plants which surrounded the Sentani's flood plain was one factor that influenced malaria incident. Other biological factor which supported the growing of malaria disease were the making of pets' stable near or be one with the house and catfish's or other fish's pool were around the house.

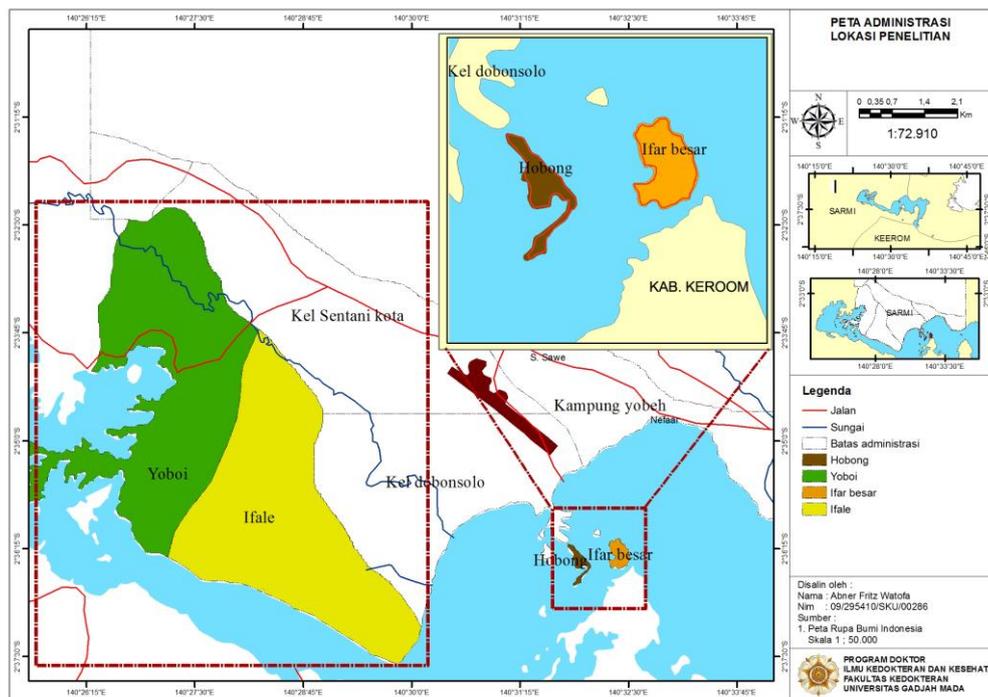
Social factor included the population density in Sentani Lake area was rated overcrowding so that it made the malaria mosquitoes were easy to reach it's bite targets. The societies' knowledge about malaria in the research area was limited, for example the societies had not known that malaria was dangerous and it's treatments was done traditionally. Other variable was societies' attitude in facing of malaria disease, some of them assumed that malaria disease was disease in common. Societies' behavior in Sentani Lake area toward malaria disease could become the cause of malaria incident in this area, such as: some of te societies didn't use mosquitoes' net at the night when they were sleeping.

This research was aimed to know and analyze the correlation between: (1) physical environment risk and malaria spreading, (2) biotic environment risk with malaria spreading, (3) social environment risk with malaria spreading, (4) condition of location of

mosquitoes' and larva's propagation and *buffer zone* (malaria potential area) as location of mosquitoes' distribution and malaria spreading in Sentani Lake area.

## METHODS

This research was done during 6 months (April-November 2013). The locations were four villages in Sentani District of Jayapura Regency, they were Yoboi/Kehiran, Hobong, Ifar Besar, and Ifale villages with cross sectional approach with analytical observation research where the samples were 200 persons. Sampling was done randomly.



**Figure 1.** Administration Map of Research Location in Sentani lake Area

## Procedure

The data collecting method of physical, biotical, and social environments were done by doing observation, documentation, questionnaire, and interview. Those data then were analyzed spatially in the form of maps in order to know the physical variable by using *bivariate* analysis, statistic test of *Chi-Square*, and logistic regression test in order to know the frequency distribution of each independent variable toward the malaria spreading of the respondents' answer at each questionnaire.

Statistic test used to analyze the data was *Chi Square* test with cross tabulation  $2 \times 2$  to find *odds ratio* (OR) (Thompson, 1994). This statistic test was used in order to get p value with meaningful level  $p < 0,05$  to see how far the correlation between explanation (*exposure*) with malaria incidents (*outcome*) was used value of prevalence ratio (RP) with 95% *confidence interval* (Ci).

Sometimes, logistic regression was called as logistic model or logit model, in statistic it was used

to predict the probability of an incident by crosschecking the data at logit function of logistic curve (Ghozali, 2012). This method was kind of general linear model that used for binomial regression. Similar with common regression analysis, this method used some predictor variables, both numeric and categories. Logistic regression test was one of mathematic regression that was used to analyze correlation of one or some independent variables and a dependent variable with categories, such as healthy and sick.

## RESULTS

### 1. Description of Research Data

#### a. Respondents' Characteristics

**Table 1.** Respondent Distribution based on Gender

Gender	Quantity (person)	Percentage (%)
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Man	116	58
Woman	84	42
Total	200	100

Most of the respondents in this research were men (116 persons) because there were many of them who worked in the field as farmers, or fishers. While the other 84 women were house wives.

**Table 2.** Respondents Distribution based on Ages

Group of Age (year)	Quantity (person)	Percentage (%)
≤ 20	14	7
21 – 30	91	45.5
31 – 40	70	35
41 – 50	21	10.5
> 50 years old	4	2
Total	200	100

The dominant ages was productive ages between 21 – 40 years old, which was categorized as work ages. While the rest was > 50 years old of 2% .

**Table 3.** Respondents Distribution based on Education Level

Education Level	Quantity (person)	Percentage (%)
SD	17	8.5
SMP	53	26.5
SMA	117	58.5
D-3	3	1.5
S-1	10	5
Total	200	100

Respondents who had SMA education background were 117 person or (58.5%), most of them

worked as farmers and fishers. While the rest of S1 of 10 person (5%) worked in the office.

Thereby, number of respondents with low education background started from SD to SMP were 70 persons (35%) would be influenced to their knowledge, attitude, and behavior toward malaria incident became low.

**Table 4.** Respondents Distribution based on Professions

Profession	Quantity (person)	Percentage (%)
Farmer	127	63.5
PNS	11	5.5
Labor	57	28.8
Entrepreneurship	5	0.5
Total	200	100

There were 127 persons (63.5%) had professions as farmers and PNS, of 11 persons (5.5%) while the rests of 57 persons (28.8%) had profession as labors. This stated that they who had profession as farmer often went to the field so that they got more chances to get mosquitoes' bites.

#### b. Description of Research Variable

Variable of this research included: physical, biological, and social factors. Physical environment factors included: temperature, humidity, rainfall, water condition of pH, height, the using of land, and societies' house condition. The average of temperature in the research location was 27.3<sup>0</sup>C. while the lowest temperature was 23<sup>0</sup>C and the highest was 32<sup>0</sup>C. this air temperature was supported by the report about temperature issued by BMG Papua.

**Table 5.** Water Temperature When It's Rain, Not Rain, at the Day, and at the Night

No	Name of the Village	House	Time			
			Day		Night	
			Rain	Not rain	Rain	Not rain
1	Yoboi/Kehiran	1	25 <sup>0</sup> C	28 <sup>0</sup> C	28 <sup>0</sup> C	27 <sup>0</sup> C
		2	26 <sup>0</sup> C	28 <sup>0</sup> C	28 <sup>0</sup> C	27 <sup>0</sup> C
2	Hobong	1	26 <sup>0</sup> C	32.80 <sup>0</sup> C	24 <sup>0</sup> C	26 <sup>0</sup> C
		2	25 <sup>0</sup> C	30 <sup>0</sup> C	25 <sup>0</sup> C	26 <sup>0</sup> C
3	Ifar Besar	1	25 <sup>0</sup> C	28 <sup>0</sup> C	25 <sup>0</sup> C	27 <sup>0</sup> C
		2	25 <sup>0</sup> C	27 <sup>0</sup> C	25 <sup>0</sup> C	27 <sup>0</sup> C
4	Ifale	1	25 <sup>0</sup> C	27 <sup>0</sup> C	25 <sup>0</sup> C	27 <sup>0</sup> C
		2	26 <sup>0</sup> C	26 <sup>0</sup> C	26 <sup>0</sup> C	28 <sup>0</sup> C

**Water Temperature** at the day and night when it was raining or not raining was around 25°C – 32°C. The data that was got by direct measurement or from BMG showed the same temperature in the research location at around 27°C. The mosquitoes' growth could be extinct if the temperature was less than 10°C or more than 40°C. The species of Anopheles was able to adapt from temperature 23°C - 32°C that similar with air temperature in the research's location.

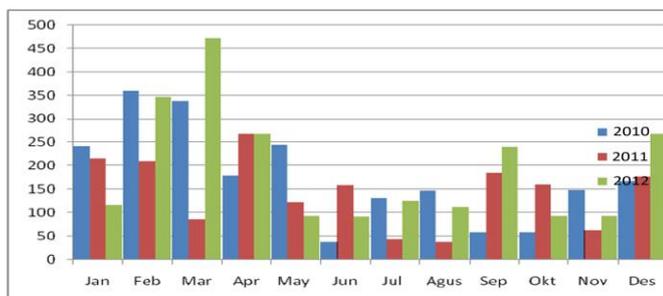
Based on the report from BMG Papua, maximum temperature in research location at the day was 32.2°C, temperature at the night was 23.6°C, while the average temperature at the day was around 27.6°C commonly occurred in November and December. If the temperature in the location was compared with category of temperature issued by Sutikno (1998; Githeko, 2000; Hariyanto, 2000) as quoted by Raharjo (2003), so it was included appropriate with the malarias' propagation.

The average of **humidity** in the research location was 81.2%. The air humidity in the research location was also supported by the measurement result reported by BMG Papua as described in Table 6.

**Table 6.** Air Humidity in the Research Location Reported by BMG Papua 2012

No	Village	Average Level of Humidity	The Highest Humidity
1	Yoboi/Kehiran	82%	84%
2	Hobong	81%	82%
3	Ifar Besar	80%	81%
4	Ifale	80%	81%
<b>Average</b>		<b>325/4 = 80.7%</b>	

Those data showed that the average of humidity in Yoboi/Kehiran village was 82%, in Hobong was 81%, while in each Ifar Besar and Ifale villages were 80%.



**Figure 2.** Daily Rainfall

The highest humidity was in Kampung Yoboi/Kehiran village of 84%. While the humidity average in four research locations was 80.7% almost similar with temperature humidity that got by direct measurement of 81.2%.

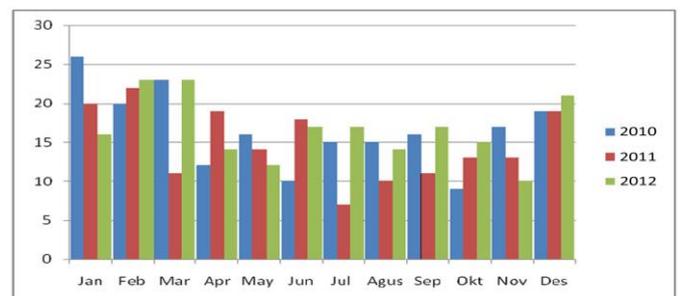
Based on the data reported by BMG Papua, the highest air humidity in the research location started from January until December 2012 at around 81 – 84 %. The highest air humidity was in January until June 2012. The lowest humidity was occurred in Ifar Besar and Ifale villages because both of them were in island.

The highest **Rainfall** could be one thing that supported the mosquitoes' propagation. This rainfall caused many slicks, the place of mosquitoes tarried. The data about rainfall in the research location taken from BMG of Sentani District in the year of 2013 as described in Table 7.

**Table 7.** Rainfall in the Research Location in 2012

No	Description	Rainfall
1	Rainfall	135mm/month
2	Rain day	13 day/month
3	Wet month	Mey – February
4	Dry month	March - April

Those data showed that rainfall in the research location was 135mm/month, the rain days were 13 days/month or almost half of each month were rain day. While, the wet days occurred in Mei-February, and dry days were March-April. Based on the data from BMG Papua, the rain fall per month started from 2010-2012, the highest was in March of 471,7 mm, while the least was in June of 92.4 mm. Those facts was showed in Figure 2 and figure 3.



**Figure 3.** Monthly Rainfall

The high rainfall in the research location caused water in the river and lake were overloaded, because it was permanent river that was full of rainwater. During the time, the lake had not experienced with the reduction of water because water sources from these rivers were mouthed to the Sentani Lake as the inlet, while the outlet was only one river which was mouthed to the Pacific Ocean. The rainfall also added the slicks that caused the lands became wet around the villages such as marsh of sago and nipa palm that supported the live cycle of mosquitoes in doing propagation in this area. There were many water slicks in settlement area in the slope of lake and was functioned as permanent place of mosquitoes' propagation (*breeding place*) and supported the live cycle of mosquitoes in it's propagation.

Water condition or **water pH** was one of indicators that could supported the mosquitoes' propagation. Water pH of this research was gor from Health Department of Jayapura Regency in 2012. Based on the report from Helath Department, the water pH was as described in Table 8.

**Table 8.** Water pH in Research Location in 2012 Based on the Report of Health Department of Jayapura Regency

No	Description	Water pH
1	Yoboi/Kehiran	7.70
2	Hobong	6.9
3	Ifar Besar	7.1
4	Ifale	6.8

Data showed that water pH in the research location was around 6.8 – 7.70. The highest water pH was in Yoboi/Kehiran village of 7.70, while the lowest water pH was in Ifale of 6.8. The result of water pH measurement that was done in the research location showed similar result around 6,68-7,68. Those measurement result was as stated in Table 9.

**Table 9.** Result of Water pH Measurement inthe Research Location in 2013

No	Description	Water pH
1	Yoboi/Kehiran	7.68
2	Hobong	6.6
3	Ifar Besar	7.2
4	Ifale	6.68

Those data showed that the highest water pH was in Yoboi/Kehiran village of 7.68, while the lowest water pH was in Kampung Ifale village of 6.68. Based

on both data result from Health Department of Jayapura Regency and self measurement, it could be explained that water pH in the research location run around 6.68 – 7.70. Lake's water pH was around 6,68 - 7,70, supported the malaria mosquitoes' propagation. That was stated by Effendi (2008) with referring to water pH of 6,68-7,68 could be categorized into normal which supported the propagation of larva's live. It meant, water pH in Sentani lake area did not disturb the breathing of larva organism. In the contrary, if the water pH was sour of high wet, it would disturb the larva's breathing (Effendi, 2008). The measurement result of water pH in Ifar Besar, Ifale and Hobong vilages, around 6,68-7,68, showed that those condition was very appropriate for the living of *anopheles* and *culex* mosquitoes.

Generally, the research locations were in the low plateau. The height of dry land area was only 60<sup>0</sup>, while for the marsh was only 10<sup>0</sup>. From the north side, the slope of Sentani Lake had declivity of 0 – 10<sup>0</sup>, while from the south side was only 0 – 4<sup>0</sup>. By using GPS, it could be measured the flying length of *anopheles mosquitoes*. The mosquitoes mostly did activity or flied at the low land with the distance of 2 km. The height of the research location was 300 m above the ocean surface. This helped greatly the investigation of mosquitoes' flying ability to sip human's blood. If the bite and sip target of human's blood was at the plateau between 1000 m-2000 m, so that became an obstacle for the continuity of mosquitoes' live and finally the mosquitoes density was decreased and moreover none.

In the research location, especially in the societies' settlements, there was wide enough thicket. Else, the marsh forest, both primary and secondary, was also wide. Around the settlements, there was dry land of field and mixed dry land. There were 200 persons was farmers, 127 persons (63.5%) of them breaking the lands around the research location as plantation or un-irrigated agricultural field which planted with many horticulture plants such as cassava, caladium, corn, and vegetables, chili, and other long term plants such as mango, rambutan, etc..

Some houses in the research location were built above the river or lake. The observation result showed that the inhabitants' houses in Sentani Lake consisted of two types: stage houses type above the water and semi-permanent houses on the land. In Ifale, Ifar Besar and Hobong villages, commonly, the societies used stage houses type because they domiciled in island around the Sentani Lake. Sample of stage houses built above the water was in the Figure 4.



**Figure 4.** Inhabitants' Houses Built above Water

Those picture showed that houses were built from very simple materials and it's size very small and it's placed above the water. There were no sanitation (WC) inside those houses. Most of the societies defecated directly into the river.

Biological factor was one of the factors related with malaria incident in Sentani Lake area. This biological factors included: plants and animals. Based on the observation result, it could be known that component

of land flora in Sentani Lake area included tress which had dense crown/canopy such as sago palm, matoa, trembesi, and soan trees which included into tropical forest around the Sentani Lake area. This biological environment components of plants gave chance to the malaria mosquitoes so the number was excessively and difficult to be solve maximally.

The existence of animals around the societies' settlements could be one of supporting factors of mosquitoes' propagation. Based on the data about animals taken from direct observation in the research location, the most kinds of animals in this area was pig of 65% of all livestock. The correlation between this pet and malaria disease was about it's stable which commonly was very near with the people's houses. Some respondents, moreover, made the stables became one with their houses. The risk of the livestock's stable that was very near with house could be the breeding place of malaria mosquitoes.

Some respondents kept mujaer and mas (*Cuprinus carpio*). While tawes (*Puntius gonionotus*) was kept in kangkung's pool and in the waters of Sentani Lake. Those fish often got difficulties in catching the larve which hided in the roots of eceng gondok (*Eichornia crassipis*) that had fiber roots.

Sentani Lake area was one of malaria endemic areas. The data about this mosquitoes taken with observation or direct monitoring in the research location. Based on the observation result, it could be known that kinds of mosquitoes in the research location were female *Anopheles* as the spreader of transmitter of malaria disease at the human being.

**Table 10.** Variable of Biological Environment about Number of Mosquitoes in Sentani Lake

Location	GPS Data	Plants Around The Data Colleting	Data of Larva Taken
Location 1. Ifar Besar Village	+/- 9 ft S 02°35.223 E 140°34.745	Grasses and eceng gondong plants	Colleting was done 5 times Cidukan 1 = 3 larva 2 = 2 larva 3 = 1 larva 4 = 2 larva 5 = 2 larva
Location 2. Ifale Village	+/- 11 ft S 02°35.240 E 140°34.828	Grasses and eceng gondok plants	Colleting was done 5 times Cidukan 1 = 4 larva 2 = 2 larva 3 = 1 larva 4 = 2 larva 5 = 2 larva

Location	GPS Data	Plants Around The Data Colleting	Data of Larva Taken
Location 3. Hobong Village	+/- 9 ft S 02°34.432 E 140°30.076	Sago forest and eceng gondok plants	Collection was done 5 times Cidukan 1 = 1 larva 2 = 2 larva 3 = 1 larva 4 = 1 larva 5 = 2 larva
Location 4. Yoboi/kehiran Village	+/- 9 ft S 02°34.465 E 140°29.737	Kangkung, genjer and grasses	Collection was done 5 times Cidukan 1 = 5 larva 2 = 3 larva 3 = 5 larva 4 = 4 larva 5 = 4 larva

The area of malaria potential (*buffer zone*) divided into 3 (three) zones, they were red potential zone (*red buffer zone*) between 0 – 100 m that was water slick in the houses' yard such as : kangkung pool, fish pool, and trace of animal nails; yellow potential zone (*yellow buffer zone*) with 100 – 200 m place of mosquitoes larva's breeding place that was near with inhabitants' settlements; while the green potential zone (*green buffer zone*) 200 – 300 m included sago marsh, primary and secondary forest which became the mosquitoes' (*resting place*) and (*breeding place*). Primary forest had high vegetation density, example: sago forest that caused high air humidity of around 68,8%-76,8%, this humidity condition supported the mosquitoes ages.

Social factor of this research included: population density, societies' knowledge about malaria disease, and societies behavior toward malaria disease. These social factors became one of causes of malaria incidents that occurred in Sentani Lake area.

Number of population in the research location, the most was in Kampung Ifale Village of 1.135 persons, while the least was in Ifar Besar Village, as stated in Table 11.

**Table 11.** The Population Density in Sentani lake Area in 2012

Village	Wide of Area	Number of Population	Density Average
Hobong	4.40 km <sup>2</sup>	846 soul	0,05 soul/km <sup>2</sup>
Ifale Besar	8.52 km <sup>2</sup>	812 soul	0,67 soul /km <sup>2</sup>
Ifale	4.45 km <sup>2</sup>	1.135 soul	0,39 soul /km <sup>2</sup>
Yoboi/kehiran	3.84 km <sup>2</sup>	966 soul	0,39 soul /km <sup>2</sup>
<b>Total</b>	<b>21.21 km<sup>2</sup></b>	<b>37.59 persons/km<sup>2</sup></b>	<b>17.71 persons /km<sup>2</sup></b>

The population density in the research location could be classified into 5 classes, that are: population density <1.000 persons/km<sup>2</sup> included into score 1 was not appropriate for mosquitoes' propagation, while > 4.000 persons/km<sup>2</sup> was very appropriate for mosquitoes' propagation.

Societies' knowledge about malaria disease was still limited. That showed with some respondents' answer at the questionnaire's items that showed their limited knowledge. Thereby, it could be stated that societies' limited knowledge about malaria disease was one of causes malaria incident in Sentani Lake area.

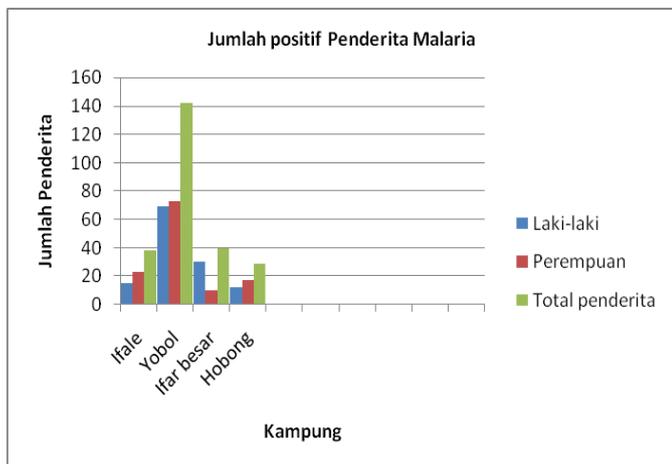
Societies' behavior toward malaria disease was tended to be incurious, for example when they got malaria's bite, got high fever, they didn't immediately examined themselves to the hospital or clinic. This incurious behavior could become one of the causes of malaria incident in Sentani Lake area.

Societies' negative behavior about malaria disease in Sentani Lake area was high, for example when they went home out didn't wear closed clothes, had habit of talking all night out of home, didn't clean the bathing tub, unwilling to use mosquitoes' net when sleeping at the night.

Based on the report from health department, it could be known the malaria incident in four villages, Hobong, Ifar Besar, Ifale and Yoboi/Kehiran Villages in Sentani District of Jayapura Regency, there were 132 persons (66%) got malaria, while 68 persons (34%) didn't got malaria. Number of positive malaria for respondents in the productive ages (19-54 years old) were high, that were 38 person (66%) while 68persons were healthy. If it was done the further investigation, the number of malaria parasite was tended to be high because some cause factors, for example mostly the

societies did their work out of home at the day such as took or fell the sago trees down, gather the sago, hunt, fishing, found the firewood, worked at the field, harvested the plantation, didn't wear appropriate clothes to cover their body from mosquitoes' bites.

Based on the report of Health Department of Jayapura Regency in 2012, it could be known the comparison of malaria sufferers in 4 research locations as stated in Figure 5.



**Figure 5.** The Comparison of Malaria Sufferers in Each Village

Figure 4 showed positive number of malaria sufferers in four villages: in Ifale Village were 38 persons consisted of 15 men and 23 women. In Yoboi/Kehiran Village there were 142 malaria sufferers consisted of 69 men and 73 women. Malaria sufferers in Ifar Besar Village were 40 persons consisted of 30 men and 10 women. While in Hobong Village there were 29 persons consisted of 12 men and 17 women. This data showed that generally the most malaria sufferers were women because there did many activities out of home.

### 1. Statistical Analysis

Chi-Square test was done to know whether it was meaningful or not the factors of physical, biological, and social environment toward the malaria incident in Sentani Lake area. In order to know it, the physical environment factors (temperature, humidity, rainfall,

water pH, height, the using of land, and physical condition of house) toward malaria incident were examined by using crosstab test. The analysis result showed Chi-Square value of 7.531 with  $p = 0.006 < 0.05$ . From  $RO = 4.93$ , so it could be known that the correlation strength between physical environment factors and malaria incident was 83%. Thereby, it could be explained that physical environment factor were very meaningful toward malaria incident in Sentani Lake area (was 83%). It meant that physical environments (temperature, humidity, rainfall, water pH, height, the using of land, and physical condition of house) gave big influence toward malaria incident in Sentani Lake area.

Result of crosstab test, in order to know whether it was meaningful or not the biological factor toward malaria incident, showed Chi-Square value of 16.328 with  $p = 0.000 < 0.001$ . From  $RO = 8.04$ , it could be known that the strength between biological factors and malaria incident was 89%. Thereby, it could be explained that biological factor were very meaningful toward malaria incident in Sentani Lake area (was 89%). It meant that biological factors (plants, animals, fish, and mosquitoes) gave big influence toward malaria incident in Sentani Lake area.

Result of crosstab test, in order to know whether it was meaningful or not the social factors (population density, knowledge about malaria, attitude toward malaria) toward malaria incident, showed Chi-Square value of 9.737 with  $p = 0.002 < 0.05$ . Based on  $RO = 3.20$ , it could be known that the strength between social factors (population density, knowledge about malaria, attitude toward malaria) toward malaria incident was 76%. It meant that social factors (population density, knowledge about malaria, attitude toward malaria) gave big influence toward malaria incident in Sentani Lake area.

Logistic regression test was done in order to know how independent variables, that are factors of physical, biological, and social environments could predict dependent variable, that is malaria incident. Based on the result of logistic regression test, the result showed in Table 12.

**Table 12.** Result of Logistic Regression Test of Independent Variables toward Dependent Variable in Equation

	B	S.E	Wald	df	Sig.	Exp (B)	95.0% C.1 for EXP (B)	
							Lower	Upper
Step1 <sup>a</sup> Physical (1)	2.569	.423	4.560	1	.009	4.132	1.211	8.397
Biologi (2)	1.099	.354	2.658	1	.017	2.117	1.280	9.324

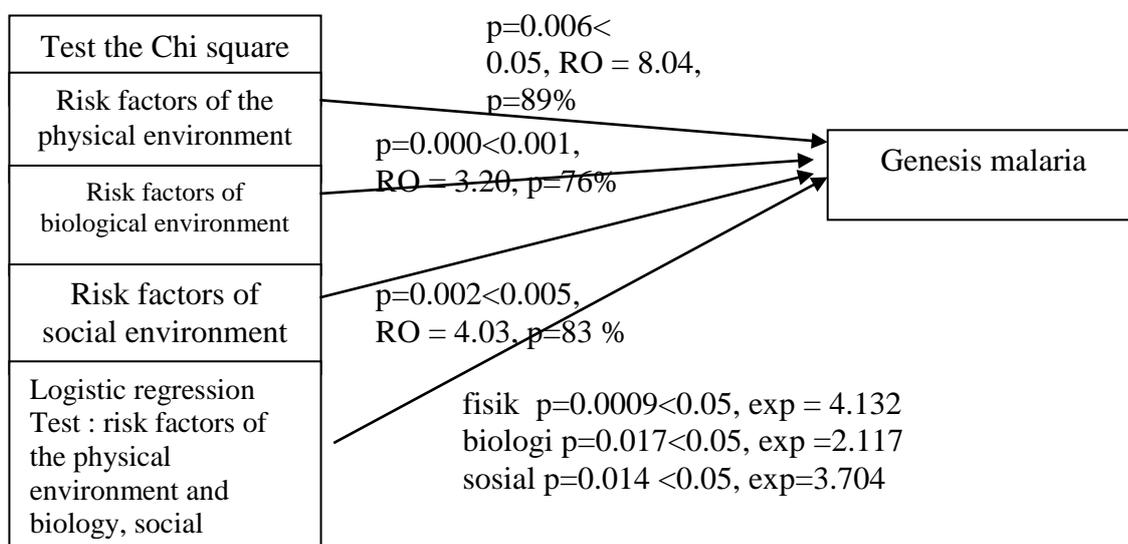
Sosial (1)	1.748	.327	3.019	1	.014	3.704	1.480	7.067
Constant	2.203	.320	34.602	1	.000	1.615		

Variable (s) entered on step 1 : Physical, Biological, Social

Those data showed that at the test of stage or model 1, all variables had  $p < 0,05$  so that model 1 could be used. Based on data in table 8, it could be explained that factors of physical, biological, and social environments influenced to malaria incident in Sentani Lake area. The correlation strength could be seen from value of OR (EXP (B)). The biggest correlation to the smallest correlation were factors of physical environments included temperature, humidity, rainfall, water pH, height, the using of land, and houses'

physical condition (OR = 4.132); social factors that included density, knowledge about malaria disease, and behavior toward malaria disease (OR = 3.704); and biological factors that included plants, animals, fish, and mosquitoes (OR = 2.117).

Based on that description, it could be explained about the correlation between factors of physical, biological, and social environments with the malaria incidents in Sentani Lake area statistically as follow.



**Figure 6.** Schema of Correlation between Factors of physical, biological, and social environment risks with the malaria incidents in Sentani Lake area.

## DISCUSSION

**Finding of this research** showed that rainfall was the most influenced factor of physical environment toward malaria incident in Sentani Lake area. This showed that high rainfall in the research location, in fact, was the most related factor toward malaria incident in Sentani Lake area. This research finding was supported by the research conducted by Subbarao (1998) about the malaria incident in India. His research showed that physical environment from time to time was spread evenly supported mosquitoes' propagation so that it was difficult to fight the mosquitoes totally, because environment risk factors in each area enable the run of malaria transmission. Finding in his research showed that rain was one of factor that influenced the high of humidity in the research location because the air

temperature became low. Low air temperature added the rest time of mosquitoes in the (*resting place*) and did not do an effort to bite and sip human's blood but on the contrary, to mature the eggs inside the mosquitoes' stomach in order to produce the spreading of malaria.

**Other finding of this research** was that the existence of mosquitoes around the Sentani Lake area such as in fish pools which growth with eceng gondok was the most influenced of biological factor toward malaria incident. This result strengthened the research even done (Gandahusada, dkk., 1998), White (1989), and Kartono (2003). *Anopheles* mosquitoes as vector which spread parasite of malaria and *Culex* as vector which spread filarial disease at human being (Gandahusada, dkk., 1998). White (1989) stated that female *anopheles* mosquitoes spread malaria disease.

Number of mosquitoes in the world was found not less than 3.500 *species*. *Anopheles* has been found 400 *species*, 67 *species* of them (16,75 percent) proved as malaria vector, 22 *species* (32,84 percent) of them were found in Indonesia (Kartono, 2003). In Papua, there were two species of anopheles, they are *farauti*, *koliencis* and *punctulatus* species (Karyana, 2008).

**Other finding of this research** that density in the research area was one of the main causes of malaria incident in Sentani Lake area. Else, the societies' knowledge about malaria disease which was still less, was one of the factors that caused malaria incident in the research location. The societies hadn't made the using of mosquitoes' net as one of ways to solve malaria incident. The societies also had habit to chat out of house until the late night without using any protection. If the societies got high fever, they commonly allowed it until getting well itself or used traditional medicines.

Based on the result of spatial, descriptive, and statistic test of Chi Square analysis, the physical, biological, and social environment risks was significantly contributed toward the malaria incident in Sentani Lake area.

## CONCLUSION

The research result showed that factors of physical, biotic, and social environment had meaningful correlation with malaria incident. That fact was showed with Chi-Square value gotten at each variable, that were physical environment of 7.531 with  $p = 0.006 < 0.05$  and logistic regression ratio with OR value of 4.132 with  $p = 0.009 < 0.05$ , biotic environment factor of  $p = 0.00 < 0.01$  with RO = 3.20 with  $p = 76 \%$ , while social environment factor of  $p = 0.002 < 0.05$ , RO=4.93 with  $p = 83\%$ . This showed that physical environment factor was influenced to malaria incident in Sentani Lake area.

## Suggestion

The government and societies needed to compromise in order to swallow the mosquitoes' propagation place with the soil at the rain season. Water plant such as *eceng gondok* needed to be removed it's growth so that it reduced the mosquitoes' propagation.

In the other side, the personnel of health information needed to give comprehension to the societies about the danger of keeping pets near or moreover became one with the house. Pets such as cow, goat, and pig needed to be stabled.

The local government needed to relocate the societies' settlement that categorized into healthy houses based on health standard.

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