ECO-EPIDEMIOLOGY Analysis of Dengue Hemorrhagic Fever ENDEMICITY Status in Sulawesi Selatan Province, Indonesia

Arsunan, A.A [1], Ade Devriany [2], Anwar Mallongi [3], Arifin Seweng [4], Aisyah [5]

[1]*Epidemiology Department, Faculty of Public Health, Hasanuddin University, Makassar Indonesia.*
[2] *Polytechnic of Health, Pangkal Pinang, Bangka Belitung Province, Indonesia*
[3] *Environmental Health Department, Faculty of Public Health, Hasanuddin University, Makassar Indonesia.*
[4] *Biostatistics Department, Faculty of Public Health, Hasanuddin University, Makassar Indonesia.*
[5]*Polytechnic of Agriculture, Pangkajene Kepulauan District, South Sulawesi Province, Indonesia*

ABSTRACT

Dengue Hemorrhagic Fever (DHF) is a major health problem in many countries, particularly in tropical regions. Dengue is found in almost all provinces of Indonesia, including the province of South Sulawesi. Ecological approach to the dengue epidemiology in different areas needs to be done. Eco-epidemiology is the study of ecological effects on human health. This study aims to determine the relationship of ecological factors in the epidemiology of status of endemicity of dengue in South Sulawesi province in 2011. This observational study commenced with cross sectional design and use of Geographic Information Systems in visualizing and exploring data spasial. Sampel as many as 24 districts / cities in South Sulawesi province are categorized based on the endemicity status against dengue. Analysis of the data that used was theMann-Whitney test, Chi-square and logistic regression.The results shows that ecological factors that affect the status of dengue endemicity of an area is rainfall (p=0.030), population density (p=0.044) and the larva-free rate (LFR) (p=0.011). altitude of region was ecological factor that are not associated with DHF endemicity status (p=0.272). The most dominant ecological factors determining the status of dengue endemicity of an area is a larvae free-rate (LFR) (B=5.273). This study suggested that the monitoring, prevention, and control of dengue disease can be more quickly and efficiently with the determination of status based on the endemicity and spread of dengue mosquito breeding.

Keywords: Dengue hemorrhagic fever, ecology, spatial and endemicity

1. INTRODUCTION

Dengue hemorrhagic fever is a major health problem in the world because it can affect all age groups and causes of death. About 2.5 billion people live in dengue endemic countries and by 70% of the population at risk of dengue live in the countries of Southeast Asia and the Western Pacific (WHO, 2009). Studies have shown that dengue has been found in all provinces in Indonesia. In South Sulawesi, according to a report from Subdin P2 & PL, although the number of patients showing a decline, almost all regencies / municipalities in the province of South Sulawesi classified dengue endemic areas. There are 20 districts / cities in 2011 were classified as endemic, which means dengue cases occur each year for three years (South Sulawesi Provincial Health Office, 2011).

Ecological approach to the epidemiology of dengue in different circumstances needs to be done. Various studies have demonstrated the ecological factors closely related to the epidemiology of dengue. Ecological factors include the factors biotic and abiotic ecosystem, including vector, climate or season, including topography and ecology of human behavior related to the development of the vector. Research conducted Chakravarti and Kumaria in India (2005) showed that precipitation, temperature, and relative humidity is the main climate factors and important both individually and collectively affecting dengue fever outbreak. Previous research shows that the temperature variations that affect the efficiency variation of Ae. aegypti is one important factor variation of incidence of dengue (Sukri et al., 2003). Ecological survey in Lao PDR, June 2000, showed that environmental differences, which include differences in vegetation and the presence of predators difference vectors, entomology parameters also influence the differences associated with the incidence of dengue (Tsuda et al,2002)

2. MATERIALS AND METHODS

2.1 Study area and research design

The research was conducted in Sulawesi Selatan. This observational study is using a cross sectional study design using the available secondary data.

2.2 Population and sample

Target population is the data eco-epidemiology of dengue in each regency / city in the province of South Sulawesi. The sample was 24 regencies / cities in South Sulawesi that are categorized by the status of endemic and non-endemic to dengue within 2009-2011.

2.3 Data collection and analysis

The data used in this study is a secondary data obtained from the relevant agencies such as from Public Health Service, Agency for Meteorology and Geophysics Agency, the Central Bureau of Statistics and the National Land Agency Sulawesi Selatan. Data were then processed using SPSS for Windows. To assess the correlation between the ecological status of dengue endemicity, we used bivariate tests. Furthermore, through a spatial approach with Geographic Information System analysis determined the status of dengue endemicity associated with the location, topography, land use and the ecological factors.

3. RESULTS

South Sulawesi province is one of the provinces on the island of Sulawesi and is located in the central part of Indonesia. South Sulawesi Province is is still classified as dengue endemic provinces. From 24 districts / cities in South Sulawesi province, there are 20 districts / municipalities are classified as dengue endemic areas. From the results of research based on secondary data obtained that the morphology of South Sulawesi province is at altitudes ranging from 0-3478 m dpl. Endemic dengue region spread in various heights visible parts of the district / city. There are 92.9% of the area with a relatively low elevation of the status of endemic dengue and 30% area with a relatively high altitude status of non-endemic to dengue.

Table 1, we found an increase in population density in the entire county / city. In the year 2009 amount of people reach to 557.05 person/km^2, in 2010 amounted to 579.92 person /km^2 and in 2011 amounted to 579.92 person /km^2. As a whole from 2009 to 2011, the population density of 572.30 person /km^2 South Sulawesi, with the lowest population density of 34.18 and the highest population density person /km^2 was 7616.

Clearly the results of the univariate analysis of this study are presented in Table 1. On variable larva-free rate (LFR), it can be seen that the average percentage of Figures LFR in the county / city has increased significantly, in 2009 amounted to 65.79%, in 2010 was 75.99% and in 2010 amounted to 81.07%. Overall average value of LFR in South Sulawesi from years 2009 - 2011 amounted to 74.72%, with the lowest value of 27.87% and a figure-LFR, the highest 95.90%. Clearly the results of the univariate analysis of this study are presented in Table 1.

Table 1. Univariate analysis results of ecological factors that may effect

Variable	n	Minimum value (mm)	Maximum value (mm)	Mean (mm)	Deviation standard
Rainfall					
2009	24	71,25	286,08	157,66	63,18
2010	24	79,75	455,5	231,95	110,59
2011	24	62,83	403,75	265,68	86,82
2009-2011	72	62,83	455,5	218,43	98,8
Population density					
2009	24	34,18	7235,99	557,05	1442,89
2010	24	35	7615,99	579,92	1521,18
2011	24	35	7616	579,92	1521,17
2009-2011	72	34,18	7616	572,30	1474,3
Larva free rate					
2009	20	27,87	92,50	65,79	20,07
2010	21	30,11	95,30	75,99	14,45
2011	24	45,63	95,90	81,07	10,58
2009-2011	65	27,87	95,90	74,72	16,3

The results showed that the average annual rainfall in South Sulawesi Province has increased over the three years. For more details, the results of the univariate analysis of the average annual rainfall in this study can be seen in Table 1. Furthermore in Figure 1, 2 and 3 shows the highest rainfall occurred at the beginning and at the end of the year and patterns of DHF clumped distribution in the total amount of high rainfall.

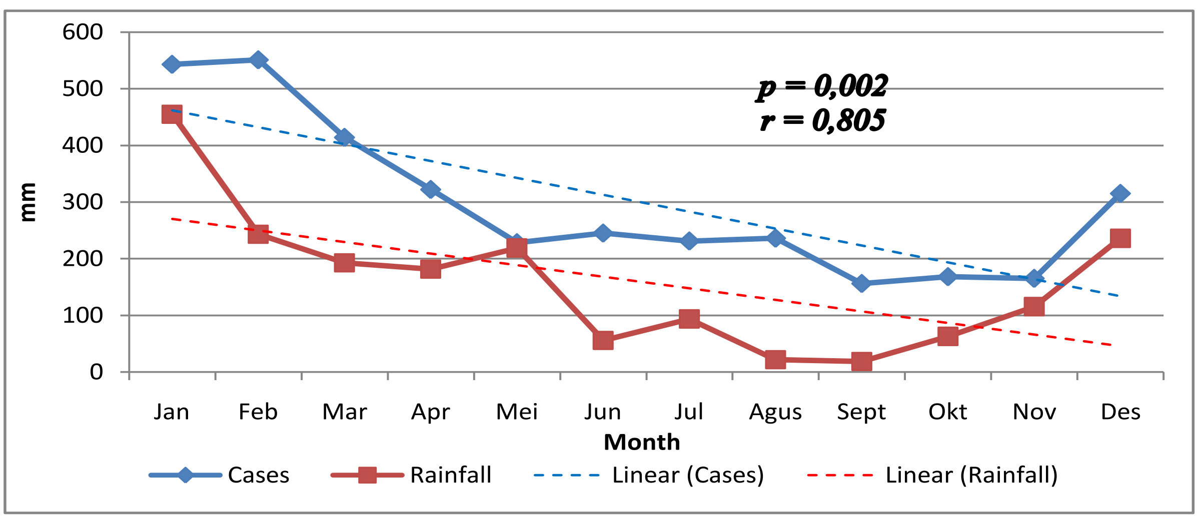

Figure 1. DHF incidence distribution and rainfall based on time in South Sulawesi in 2009

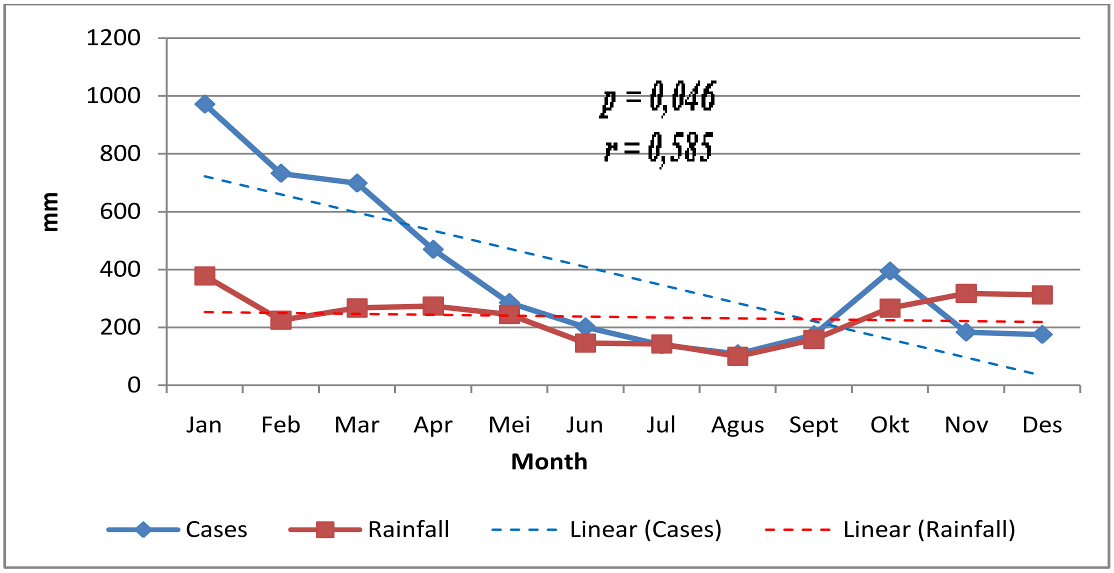

Figure 2. DHF incidence distribution and rainfall based on time in South Sulawesi in 2010

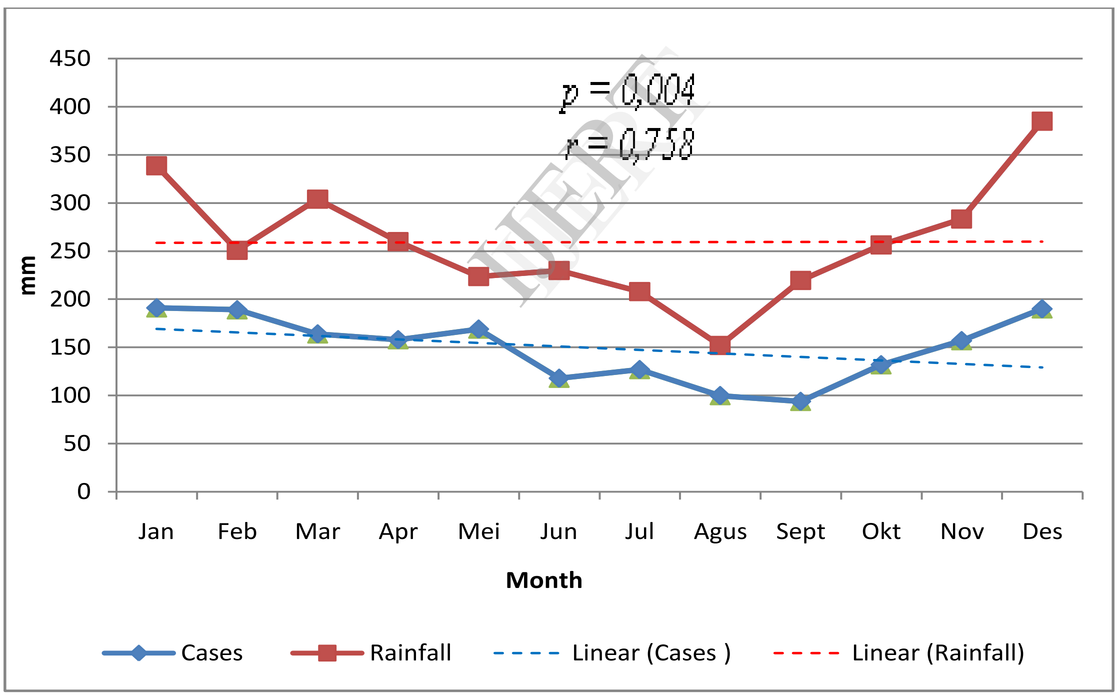

Figure 3. DHF incidence distribution and rainfall based on time in South Sulawesi in 2011

This study used Bivariate analyzes (Mann Whitney and Chi-Square test), to determine whether independent variables and dependent variable has relationships. Calculations obtained bivariate analysis results in Tables 2 and 3.

Table 2. Results of the bivariate analysis at the heights region of dengue endemicity status, 2011

Height	Endemicity				Total		P
	Endemic		Non-Endemic				
	n	%	n	%	n	%	
Low	13	92,9	1	7,1	14	100,0	0,272
High	7	70	3	30	10	100,0	
Number	20	83,3	4	16,7	24	100,0	

Table 3. Results of the bivariate analysis of ecological factors that influence the status of dengue endemicity

Variable	Endemicity status		P
	Endemic	Non-endemic	
Rain fall			
Mean	347,87	249,24	0,030
Deviation Standard	43,99	84,33	
Population Density			
Mean	672,6	116,5	0,044
Deviation Standard	165,71	63,69	
Larva free rate			
Mean	78,9	91,88	0,011
Deviation Standard	10,17	4,04	

Table 2 shows that there are 92.9% of the area with a relatively low elevation of the status of endemic dengue and 30% area with a relatively high altitude status of non-endemic to dengue in the province of South Sulawesi. Based on the results of statistical tests using Fisher's test Exact obtained p value = 0.59 ($p > 0.05$), thus Ho is accepted and Ha is rejected. Means that there is no relationship with the heights of dengue endemicity status in the province of South Sulawesi in 2011.

Table 3 imply that the value of average rainfall in endemic areas (347.87 mm) higher than the non-endemic area (249.24 mm). The average value of rainfall endemic region ranged from 303.85 mm to 391.86 mm. The average value of rainfall in the region of non-endemic ranged from 164.91 mm to 333.57 mm. Then, in population density imply that the average density of the population in endemic areas (672.6 person/km^2) higher compared to non-endemic areas (116,50 person/km^2). The average value of the population density of the endemic region ranged from 838.31 to 506.89 person/km^2. The average value of the population density of the non-endemic region ranged between 52.81 person/km^2 to 180.19 person/km^2.

Likewise, larva free rate (LFR) describes that the average density of larvae that expressed by the LFR in endemic areas (78.9%) was lower than the non-endemic region (91.88%). The average value LFR endemic region ranged from 68.2% to 89.07%. The average value of the non-endemic region LFR ranged from 87.84% to 95.92%.

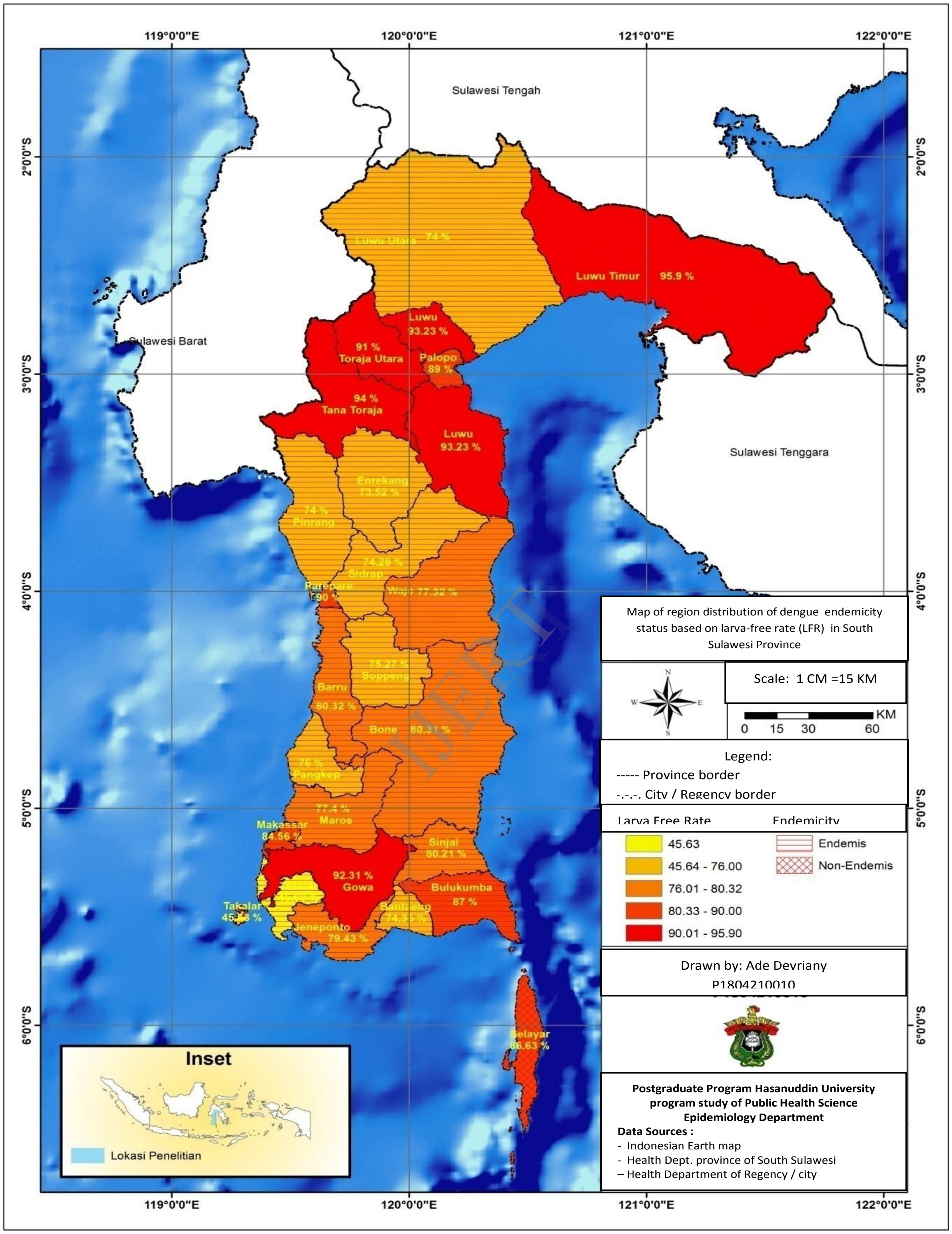

Figure 1. Map of relationships between larva density and endemicity status in study area in South Sulawesi Province, Indonesia

Table 4. The results of multiple logistic regression analysis of the ecological factors that affect the status of dengue endemicity.

	B	Wald	P	Exp (B)	OR (95% CI)	
					Lower	Upper
Larva free rate	5,273	0,000	0,997	195,035	0,000	-
Population density	-0,101	0,000	0,997	0,904	0,000	1,615E20
Rain fall	0,952	0,000	0,992	2,591	0,000	6,644E81

Table 4 revealed that the exponent of the equation of the regression equation coefficients are formed freely larvae, it showed that a low number in a region can lead the region to be endemic of 195 times greater than the larvae-free rate area when population density and rain was controlled.

4. DISCUSSIONS

Ecological factors were significantly associated with the status of dengue endemicity based on existing analisis bivariat analisis with the three variables: rainfall, population density and larva-free rate (LFR). Results of the analysis showed that the height of the region is not associated with dengue endemicity status (p = 0.272). No significant relationship between altitude regions with endemic status, due to dengue cases that have been found in the region with an altitude of more than 1000 m above sea level. Ecosystem shifts as one of the effects of global warming causing cold mountainous environment initially transformed into heat so that the state of the tap open for breeding mosquitoes to transmit dengue fever Ae.aegypti (Fitriyani. 2007; Marianne, J. 2001.) The results are consistent with the Chowell study (2008) which indicates that there is no difference of dengue cases in the coastal areas and highlands region in Peru.

Results of bivariate analysis showed that rainfall associated with dengue endemicity status ($p < 0.05$), analysis results found that the average rainfall in endemic areas (347.87 mm) higher than the non-endemic area (249.24 mm). In Malaysia, an increase of 120% of dengue cases occur when rainfall > 300 mm (Lim, et al 2005). According to Souza et al (2010) Dengue vector habitat affected by the rainy season and the availability of surface water. Dengue cases tend to increase during the rainy season. Water is the habitat of the mosquito vector of dengue at pra-mature stage. Rainfall can create a pool of water where mosquito eggs Ae.aegypti stored, and where the development of mosquito larvae into adults (Chakravarti, A and Kumaria, R. 2005; Promprou, S. 2005; Wiwanitkit, V. 2006).

Aqsa (2010) stated that the effects of forests on rainfall is very large. In the island states, the influence of rainfall reached 60% and 40% in the ocean. According to Souza et al (2010) Dengue vector habitat affected by the rainy season and the availability of surface water. Water is the habitat of the mosquito vector of dengue pra-mature stage. Changes in precipitation affect the number of vector breeding habitats.

One of the studies that support the relationship between rainfall and dengue cases was Wiwanitkit study (2006) revealed that the prevalence of dengue infection in Thailand rely on rainfall. But not in line with the research conducted by Nalole (2010) in Gorontalo city that does not show a correlation for the two study periods.

Study at City Maracy, Venezuela by Barrera (2002) showed that population density was positively correlated with the level of endemicity of an area ($r = 0.40$, $p < 0,05$). This is consistent with the results of this study that there is a relationship between population density with dengue endemicity status in the province of South Sulawesi ($p = 0.044$). The average value of the density of population in endemic areas (672.6 person/km^2) higher compared to non-endemic areas (116,50 person/km^2). The spread of dengue in urban areas with dense population characteristics have more intensive than in rural areas. The distance between the house with other houses very close together that potentially easier for dengue vector (mosquito Ae.aegypti) to spread the dengue virus from one person to another. This spread is influenced by the mosquito flight range which is estimated only between 50 to 100 meters (Ali, M., et al., 2003).

Likewise, results of the analysis also showed that the density of larvae is expressed as a percentage figure larva free rate associated with dengue endemicity status ($p = 0.011$). average number larva free rate in endemic areas (78.9%) was lower than the non-endemic region (91.88%). The existence figures show a significant relationship between larva free rate with endemicity status, due to the high level density of of larvae which had a risk of dengue, in principle, the higher the mosquito population in a region, the greater likelihood of contact with humans, so that the transmission of dengue disease is increasing (Ministry of Health, 2005).

In term of spatial and dengue incidence analysis, the study performances are consistent with the results of the study by Nalole (2010) in Gorontalo city that spatially and statistically larva free rate have meaningful relationships with the incidence of dengue. Furthermore it is also supported by research in Mataram by Fathi (2004) have proved that there is a significant correlation between the presence of the container with an outbreak of dengue fever. Vector density can be affected by the presence of the container as more containers available, the more mosquito breeding places. Besides the mosquito population will increase and the risk of dengue infection has increased with a faster deployment time, the number of cases will rapidly increase, which in turn lead to outbreaks.

Spatial maps of dengue endemicity status is the result of the processing and analysis of spatial data with geographical information system (GIS). It provides an overview tendency that deployment region based on the status of dengue endemicity in 24 districts / cities in South Sulawesi. The spatial pattern of the spread of dengue fever that is the area which supports the specificity pattern Ae.aegypty and mosquitoes spread dengue fever endemic areas for the establishment in the province. Based mapping commencement, there has been spreading mosquitoes Ae.aegypty in lowland areas with high population density and low larva free rate. Coping strategies based on geographic characteristics such as handling should be pursued based on the geographical characteristics can be more focused with a mix of handling by administrative area.

5. CONCLUSION

This research concluded that rainfall, population density and larva-free rate (LFR) associated with dengue endemicity status in the province of South Sulawesi. However, results also showed no relationship between the height of dengue endemicity and the region status. Based on the conclusions from the results of this study, some suggestions can be submitted to the relevant agencies in order to give more attention to the aspect of prevention of dengue in areas with high rainfall, high population density along with the low percentage of larva-free rate (LFR). Then, it is suggested for the community to raise awareness on dengue prevention efforts with respect to the pattern of disease incidence which is closely related to season.

ACKNOWLEDGEMENT

Authors would like to appreciate and thanks to Public Health Service, Agency for Meteorology and Geophysics, the Central Bureau of Statistics and the National Land Agency province of Sulawesi Selatan who have assisted researchers in supplying the required data and their positive response to this research commencement.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

REFERENCES

Aqsa, Mohammad. 2010. Impact of deforestation against the Environmental sustainability (Online),(http:/mimpi22.wordpress.com/2010, accessed 19 April 2012)

Ali, M., *et al*. 2003. Use of a Geographic Information System for Defining Spatial Risk for Dengue Transmission in Bangladesh: Role for Aedes Albopictus in an Urban Outbreak. *American Journal Trop Med Hyg*, 69(6):634-40.

Barrera, R. et al. 2002. Eco-epidemiological Factors Associated with Hyper Endemic Dengue Hemorrhagic Fever in Maraca City, Venezuela. *Dengue Bulletin*. Vol.26. 2002: 109-118.

CDC. 2010. *Entomology and Ecology*. (Online), (http://cdc.gov/dengue/entomologyEcology/index.html, accessed on 24th of December 2012).

Chang, A.Y., et al. 2009. Combining Google Earth and GIS Mapping Technologies in A Dengue Surveillance System for Developing Countries. *International Journal of Health Geographics.* Vol.8 No.49 Juli 2009: 8

Chakravarti, A dan Kumaria, R. 2005. Eco-Epidemiological Analysis of Dengue Infection During an Outbreak of Dengue Fever, India.*Virology Journal*, 2(32):2-4.

Chowell, G. 2008. Spatial and Temporal Dynamics of Dengue Fever in Peru 1994-2006. *Epidemiology Infection*, 136(12):1667 – 1677.

Ministry of Health. Republic of Indonesia, 2005. Entomological Survey Guidelines Dengue Hemorrhagic Fever. Second printing. London: Department of Health.

Fitriyani, 2007. Determination of Dengue Prone Areas In Indonesia and Effect Analysis Patterns Rain on attack rate (Case Study: Indramayu District). (Online). http://iirc.ipb.ac.id, accessed on October 8, 2011.

Isaacs, N. 2006. Measuring Inter Epidemic Risk in Dengue Endemic Rural Area Using Aedes aegypti Larval Indices Indian. *Journal of Community Medicine*. Vol. 31 No.3 Juli – September 2006: 91-100.

Lim, T.W., et al. 2005. Rainfall, abudance of Aedes aegypti and Dengue

Infection in Selangor, Malaysia. Southeast Asian Journal Trop. Medical Public Health, 16(4):560-568.

Nalole, Rahmawati. 2010. Dengue incidence analysis by Using Geographic Information Systems in Gorontalo city in 2008-2009. Thesis. Makassar: Hasanuddin University.

Promprou, S. (2005). Climatic Factors Affecting Dengue Haemorrhagic Fever Incidence in Southern Thailand. Dengue Buletin, 29(5):3-7.

Sukri, N. C., et al. 2003. Transmisson of Epidemic Dengue Hemmorhagic Fever in Easternmost Indonesia. The American Journal of Tropical Medicine and Hygiene, 68(5):63-67.

Souza,et al. (2010). Association betweem Dengue Incidence, Rainfall and Larval Density of Aedes aegypti in Portugis. Medical Trop Journal,43(2):152.

Tsuda, Y.,et al. 2002. An Ecological Survey of Dengue Vector Mosquitos in Central Lao PDR. Southeast Asian J Trop Med Public Health,33(1):63-67.

Wiwanitkit, V. 2006. An Observation on Correlation between Rainfall and The Prevalence of Clinical Cases of Dengue in Thailand. Journal Vector Borne Disease, 43(6):73-76.

World Health Organization (WHO). 2009. Guidelines for Diagnosis, treatment, Prevention and Control. Geneva: World Health Organization.