Spatial Analysis of the correlation between Topographic Wetness Index with Annual Parasites Incidence Malaria in South Central Timor District 2017 – Indonesia

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Abstract: Malaria occurs in 106 countries in the world with 97 of them are malaria endemic countries including Indonesia. East Nusa Tenggara province is one of the provinces in Indonesia with malaria incidence of 6.8 and prevalence of 23.3. South Central Timor District is one of malaria endemic districts with Annual Parasites Incidence in year 2017 equal to 2,7 per 1000 population with case number 1,301.This research aims to determine the relation of Topographic Wetness Index category (Ranged Very High => 8.8, High = 7.0 – 8.8, Medium = 6.0 – 7.0, Low = 5.2 – 6.0, Very Low = <5.2) with the category of Endemic Value Annual Parasite Incidence (Ranged High => 5, Medium = 1-5, Low = <1) in 278 villages in South Central Timor district. The method of this study employs spatial analysis with DEM 30 Meter data and analysed by SAGA GIS application and then using Kendall's Tau test statistic analysis to observe the relation between TWI category and API category. The result obtained was linkage between TWI category and API with τ = 0,122, sig = 0,034, α <0,05. Thus, further analysis of TWI data with Endemic breeding place is needed to determine Malaria endemic areas.

1 INTRODUCTION

Transmission of Malaria occurs in 106 countries in the World and 97 countries of which endemic areas of Malaria according to the World Malaria Report of 2014 (Health Ministry Republic of Indonesia, 2014) the incidence of malaria in Indonesia tends to decline from 2005-2013, in 2005, incidence of malaria is 4.10 ‰ and in 2013 is 1.38 ‰ . The number of Blood Count (SD) examinations for malaria diagnosis test increased, from 47% (982,828 Blood Disorders examinations from 2,113,265 clinical cases) in 2005, to 63% (1,164,405 Blood Disorders examinations from 1,849,062 clinical cases) in 2011, However, the success is still happen because during 2011 malaria outbreaks were still occurred of malaria in 9 districts / cities from 7 provinces with cases reached 1,139 cases with 14 cases of death or case fatality rate (CFR) reached 1.22%. The 5 provinces with the highest incidence and prevalence in Indonesia are Papua (9.8% and 28.6%), East Nusa Tenggara (6.8% and 23.3%), West Papua (6.7% and 19.4%) , Central Sulawesi (5.1% and 12.5%), and Maluku (3.8% and 10.7%) (Health Ministry Republic of Indonesia, 2013).

The aim of this study is to use an elevation data derived Topographic Wetness Index (TWI) within each village of one district in West Timor and then to find out the relationship between TWI and malaria API data. TWI data is the result of analysis from Digital Elevation Modeling (DEM) 30 Meter data to describe of malaria risk area. TWI data is used with the intention to predict the *Anopheles* mosquito breeding place of malaria disease vector. The TWI data can be used to predict the Malaria vector mosquito breeding area compared to land use or land cover data (Cohen *et al.*, 2010).

Topographic Wetness Index (TWI) is a water tendency to accumulate at one point based on the force of gravity where water always flows to a lower place (Quinn and Planchon, 1991). Thus the value of the index is much greater on a very flat slope while the index on a steep slope is smaller (Haas, 2010). If an area accumulates the flow of water then the soil will become saturated with water causing inundation. This puddle occurs due to the pores of

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the soil is no longer able to accommodate water. This puddle is the potential for *Anopheles* mosquito breeding which is a vector of Malaria disease

A study link to the Topographic Wetness Index to areas at risk for malaria was Cohen et al (2008). The topography of the Wetness Index in Kenya with a highly variable field is more accurate in predicting homes with malaria risk than considering the characteristics of land cover / land use. The results of this study are like those produced in South Central Timor District. This circumstance explaines the correlation between TWI and API.

Based on the secondary data of malaria incidence in South Central Timor District the relation between TWI and API has been analyzed to predict the malaria risk in those areas.

The results of this study can provide a quick overview to the community at large and Puskesmas staff in particular to further take steps to anticipate and manage malaria. Mapping of malaria risk areas are very helpful in the elimination of malaria, especially in the provision of medicines and the process of program intervention such as the provision of netting for the people residing in the region (Rahadjo, 2016).

The use of DEM data in predicting malaria vector is more effective. This is explained in the results of research conducted by Jephtha C Nmor, 2013 in Africa. In this study, a possible location map of where malaria vector habitat is very helpful in the integrated malaria treatment program in Africa

2 METHOD

The research was conducted in South Central Timor District, East Nusa Tenggara Province. The population of South Central Timor District based on the projection of population in 2016 is 461,881 people consisting of 227,877 males and 233,804 females. Population growth rate of South Central Timor District in 2016 is 0,56%, and population density is 117 soul / Km2. (Central Berau of Statistic TTS District, 2017)

District Health Office in 2014 showed that the number of positive malaria patients with microscopy examination is 3,654 patients with API of 8 per 1000 population, meaning that for every 1000 people there are about 8 people suffering from positive malaria. Data in the Year 2017 indicates that the number of patients as many as 1,301 positive malaria patients with API of 2.7 per 1000 population, meaning that in every 1000 people there are 3 people who suffer from positive malaria. (South Central Timor Health Office, 2014).

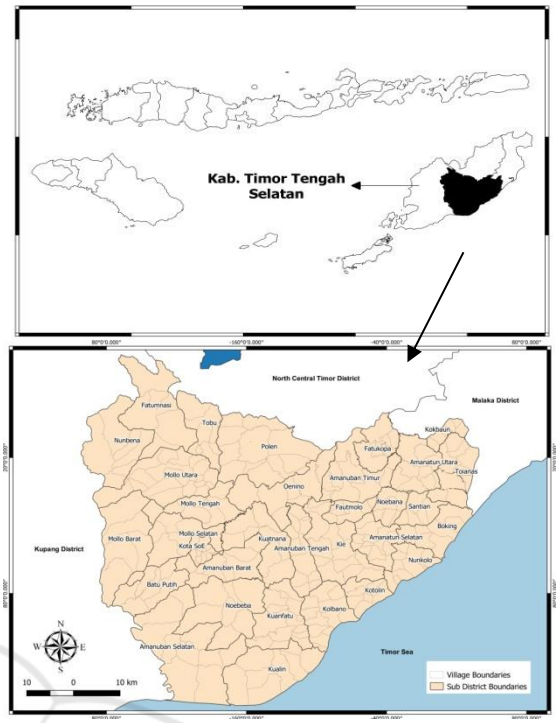

Figure 1: Study South Central Timor (TTS) district in East Nusa Tenggara Province.

This research uses spatial analysis method to get the result of the average value of TWI in 278 villages and then use statistical analysis to see the correlation between TWI category with malaria API in each village. Spatial analysis uses SAGA GIS (Rohan Fisher, 2012) and Layout uses QGIS.

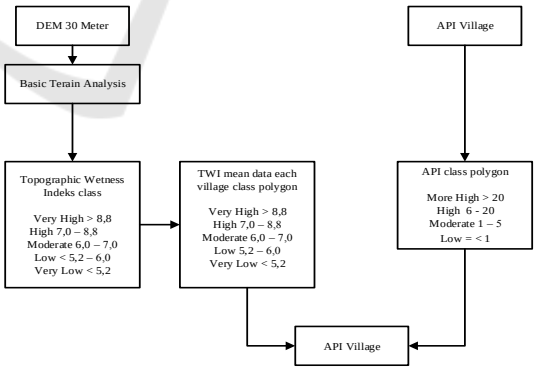

Figure 2: Flow Chart Processing TWI data and API

2.1 TWI Pre-processing

The TWI formula used is as follows:

$$W = \text{Ln}\ \frac{\propto}{tan\beta} \qquad (1)$$

W **:** wetness index

A :Accumulation of the upper slopes that drain water at a point in each contour unit
ß **:** The angle of the slope at that point

The steps taken to obtain TWI value for each village is to download DEM data from USSG with 30 Meter resolution. Furthermore, spatial analysis was done with SAGA GIS software (Rohan Fisher, 2012), then classified into 5 classes. Very High > 8.8, High 7,0 – 8,8, Medium 6,0 – 7,0, Low 6,0 – 7,0 and Very Low < 5,2. The results of this classification are incorporated into the village area shape file with the mean TWI data per village. All this process is done with SAGA GIS software. The use of TWI data is to find out the malaria risk areas.

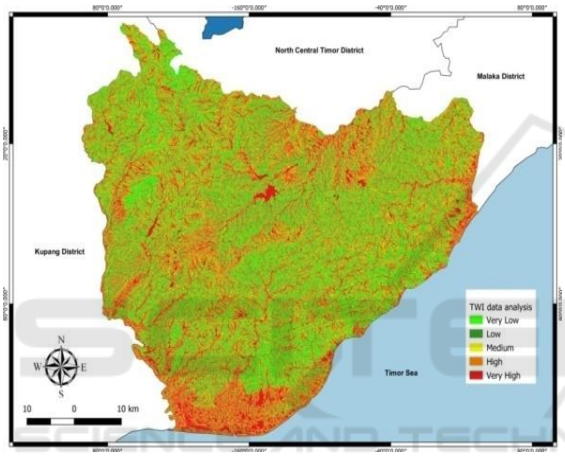

Figure 3: TWI data Analysis

3 RESULT

The map above shows the result of analysis Mean TWI data for each village in the district of South Central Timor. From 278 villages, the result is 11 villages with high TWI category (orange color), TWI with medium category as many as 246 villages with yellow color and TWI with low category of 21 villages with green color on the map above.

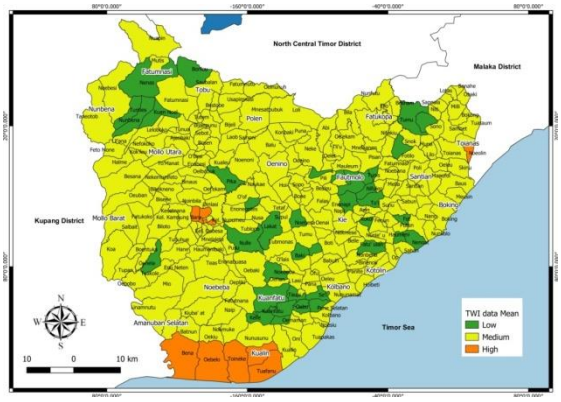

Figure 4: TWI data mean each Villages

The Malaria API data was obtained from the health office of the district of Central South Timor in the field of health problem control. This API data is the number of malaria morbidity based on laboratory results per 1000 population within 1 year stated in the permil. The data are categorized into: High> 5, Medium 1-5 and low = <1 (MOH, 1999). The malaria district of South Central Timor district in 2017, obtained by 2.7 per 1000 population with the number of cases of 1,301. This API data is inputted into village area shape file and created into several category

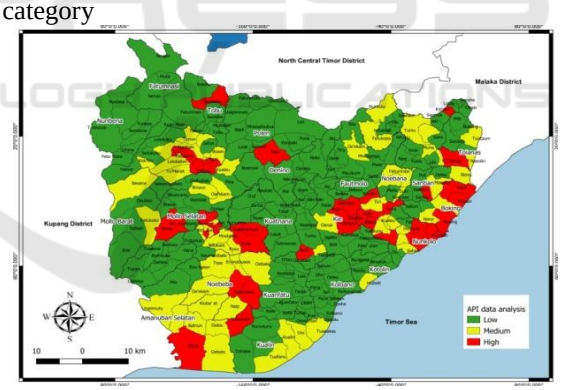

Figure 5: API data Analysis

Analysis of API data in 149 villages are categorized as low and marked with yellow color, the medium category occurs at 92 villages and marked with green color, and high level occurs at 92 villages and marked with red color (figure 5). Villages with high category spread in 16 sub-districts, those are South Amanatun, West Amanuban, South Amanuban, Amanuban Center, Boking, KiE, Kokbaun, SoE City, South Mollo, North Mollo, Noebeba, Nunkolo, Polen, Santian, Tobu and Toianas.

Statistical test aims to see whether there is a link between the data TWI and API. The result of this research is Kendall's Tau statistic test where the researcher compares the category or class of Malaria risk based on Topographic Wetness Index with category or class of Annual Parasites Incidence and the result is N = 278, τ = 0,146, sig = 0,010, α <0,05. This result shows that there is correlation between TWI and API.

4 DISCUSSION

The use of TWI data in predicting the risk of malaria should be considered as an additional tool in the program of malaria elimination in South Central Timor District. This is in line to research conducted by Cohen et al (2010) in which TWI data is better at predicting malaria risk than land cover data and land use data. The use of TWI data is also supported by the technological development and the increasing availability of free satellite imagery data by providers. The availability of a free version of software and application, has beneficial for researchers to obtain spatial data (Fisher *et al.*, 2018).

Topography is a major factor in which moist or wet areas are identified to have high vector densities. Wet areas in the area is inundated inviting vector *Anopheles* mosquito to breed. It will be even worse if the area is a malaria endemic (Mwakalinga *et al.*, 2018). Malaria is strongly influenced by environmental ecology. Furthermore, rapid people movement increase the transmission of malaria.

The use of the TWI to predict malaria risk areas is motivated by a shift in malaria cases that previously occurred in many coastal areas, but now the annual data of Parasites Incidence are also high in mountainous areas. The large number of malaria cases in mountainous areas, has challenged the prediction of malaria risk areas that uses elevation data of a region.

Mapping the malaria risk areas is very important in the process of eliminating malaria. This mapping is a basis for elimination activities in order to be right on determining target. If we do not know about malaria risk areas it will be difficult to carry out the elimination activities, with this analysis, malaria program managers in the district or provincial level will be able to predict malaria risk areas and conduct the activities in order to eliminate malaria appropriately.

5 CONCLUSION

The result of this study shows that there are correlation between TWI and API. The use of TWI analysis results is very good for predicting areas at risk of malaria. This is in line with the results of the analysis that the TWI category is linked to the 2017 data API in 278 villages / sub-districts in South Central Timor District. It needs to be done in-depth analysis to see more other variables especially location of malaria patient on risky area. The result of this analysis can be a guide for Puskesmas and Health Department to conduct a program of elimination of malaria disease in South Central Timor District.

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