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LEVEL OF LANDSLIDE SUSCEPTIBILITY IN CIBAL DISTRICT OF MANGGARAI EAST NUSA TENGGARA

Dominikus Victorius Bate[1], Puguh Karyanto[2], Moh.Gamal Rindarjono[3]
[1,2,3] Sebelas Maret University, Indonesia
Email : dominikusbate04@gmail.com

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Abstract

This research aims to determine the degree of susceptibility of landslides in Cibal Districts. The method used in this research is descriptive survey method. The population in this research is all of the land in Cibal Districts. data collection technique is done by using observation technique and documentation study. Data analysis technique in this research uses crosstab technique. The results of this study can be seen that the level of susceptibility of landslides in Cibal based on crosstab results, there are three categories of vulnerability of landslide , they are low, medium and high. Low landslide susceptibility rate of 6.979,65 hectares or 64,09% is found in Nine sub-districts / village. The moderate landslide susceptibility rate has an area of 3.634,67 hectares or 33,38%, in seven villages. While the high landslide susceptibility rate is found only in one village with an area of 275,65 hectares or 2,35% of the total area of Cibal districts.

Keywords : Susceptibility, Landslide, Cibal District

1. Introduction

Natural disasters are disasters that caused by events or events that is caused by nature such as earthquakes, tsu-nami, eruption volcanoes, floods, dry, hurricanes, and landslides. Natural disasters can give effects on the economic, social and environmental sectors.

Suripin (2002) defines landslides as a form of erosion where the transport or movement of the soil mass occurs at some point in a relatively big volume. In terms of movement, there are some erosion caused by the movement of the soil mass, creep, rock fall and mud flow. The mass that moves in the landslide is a big mass. Therefore, the occurrance of landslide will bring victims, such as environmental damage, agricultural land, settlement and infrastructure and property and even loss of human life.

According to Minister of Public Works Regulation No. 22 of 2007, the process of landslide that starts from the absorption of rain water into the soil that will increase the weight of soil. If the water penetrates to the impermeable soil that acts as a slip plane, the soil

becomes slippery and the weathering soil above. It will move along the slope and out the slope. Landslide can occur if the intensity of rainfall is high, slope to steep slopes, thick weathering, rocks and geologic structure varies. Land use is less suitable with the characteristics of the land (Sutikno, 1994 in Permata, 2016).

Susceptibility is a condition caused by human activities (the result of physical, social, and environmental processes) that causes the increasing Susceptibility of society to harm. The degree of vulnerability can be assessed from physical (infrastructure), social, demographic and economic susceptibility (Muta'ali, 2012). Susceptibility is the degree which society, structure, service or geographic area potentially or may be damaged or disturbed by a certain dangerous impact due to its nature, its construction, and its proximity to dangerous or vulnerable areas (Djaelani, 2008).

Susceptibility is a condition of a community group that leads or causes inability to face the threat of danger (Nurjanah, 2011: 16). According to the Regulation of the Head of National Disaster Management Agency (BNPB) No. 04 of 2008 Susceptibility is a state or behavior of people or society that causes inability to face threats or danger.

Cibal is one of the areas that often occur landslide . Recorded on March 3, 2007 occured a great landslide that cause 44 people died, 21 people were injured, 6 houses severely damaged, 500 people evacuated, along the road. There are 5 major landslide point, 14 medium landslide and 12 small landslide and total broke road. In 2016, there were 13 landslide occur in Cibal sub-district which resulted in 14 damaged houses and also many people who suffered injuries . Then, there were 11 major landslides and 4 moderate landslides (BPBD Manggarai Regency, 2007, 2016)

2. The Methods

The location of this research is in Cibal District of Manggarai Regency East Nusa Tenggara which is astronomically located between 8^0 22 '52' '- 8^0 32' 50 " LS and 120^0 29 '13' '- 120^0 30' 48"BT and based on coordinates *Universal Transfer Mercator* (UTM) is located between 13396556 mT - 13400525 mT and 932037 mU - 950452 mU. The research was conducted from June to August 2017. The area has 17 villages , an area of 10.889,97 hectares and the population is 27.482 soul.

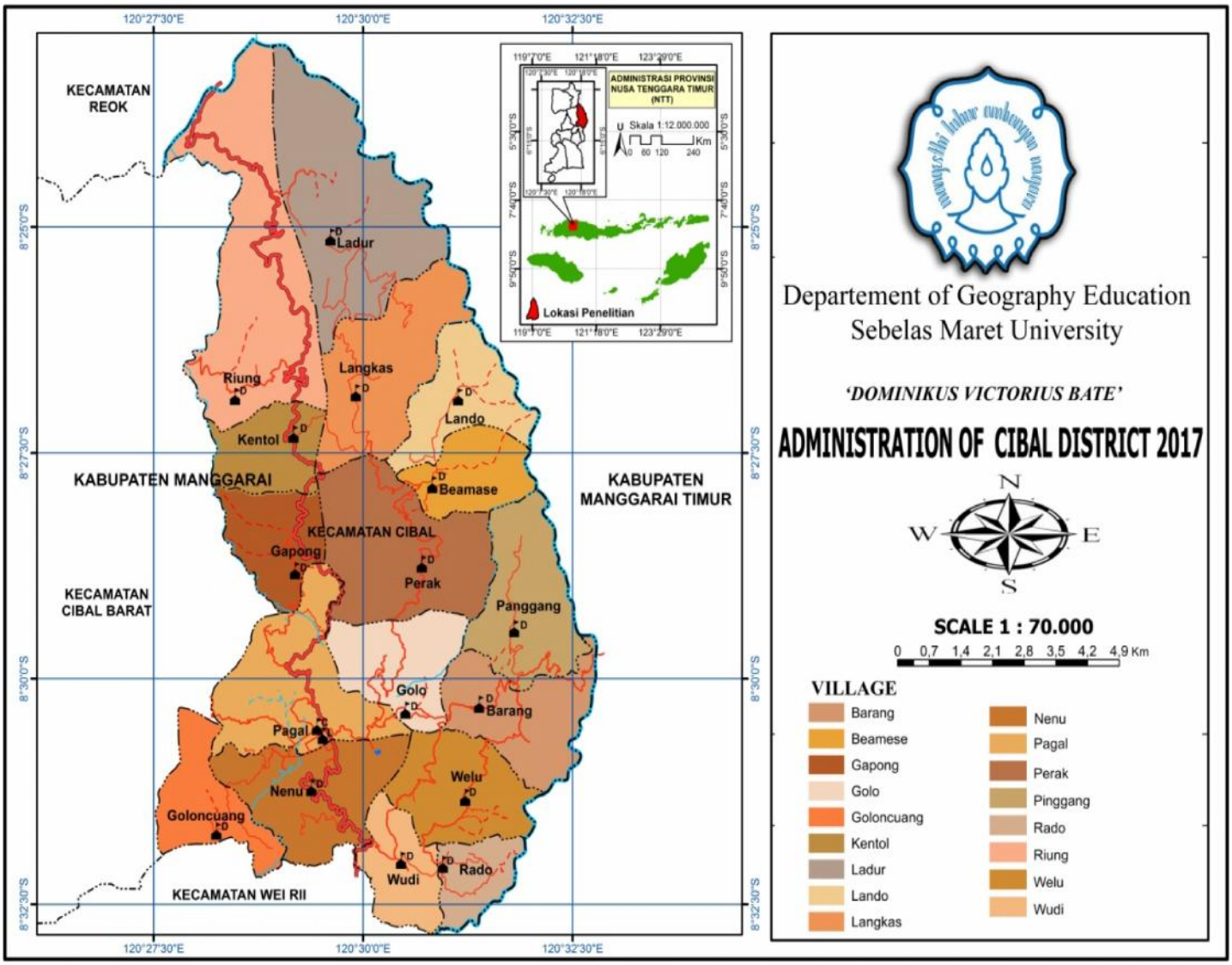

Figure 1: Administration Map of Cibal Districts 2017

The type of this research is qualitative descriptive research. The data used are the primary data in the form of measurement and observation results in the research sites includes population data and settlements (units). While the secondary data in this research is administrative map of Cibal districts, Manggarai Regency.

The sampling technique is saturated side where the member of population as a sample (Sugiyono, 2016). The sample in this research is all sub-districts / village in Cibal Districts of Manggarai Regency.

The landslide Susceptibility analysis only uses population and settlements. Settlement is the density of settlements in areas that occur landslide. The population is obtained from Cibal District data in 2016 figures.

Population and settlement density data were obtained from the Statistic Central Bureau of Manggarai Regency. Population density and settlements were classified into three classes. They were low, medium, and high class. To know the class interval of population density and settlement, it is used formula:

$$c = \frac{X \quad - X1}{\mathrm{k}}$$

Exp :

C = Estimation of Class Amount (Low, Medium, high)
K = Class Amount
Xn = Highest Value
X1 = Smallest Value

Source : (Supranto, J, 1996)

After population density and settlement, the two parameters are classified again into three classes . the classes are low, medium, and high class. To know the class is used calculation in crosstab, as follows :

Table 1. Matrix between Population and settlement Density

Population Density		Low	Medium	High
Settlement Density	Low	Low	Low	Medium
	Medium	Low	Medium	Medium
	High	Medium	Medium	High

Source : *Aditya, Triyas,(2009)*

3. Results and Discussion

3.1 Population Density

The existence of the population is one of the parameters. It is very important in setting the level of susceptibility of landslides because community is a distinguishing factor determining whether the disaster landslide can be categorized as a disaster or just as a natural phenomenon.

Administratively, Cibal districts area is one of area in Manggarai Regency which has a large number of residents. The population in Cibal Districts is 27.482 soul that consist of 13.588 male and 13.894 female population.

Classification of population density is divided into three categorie. The categories are low, medium and high population density. The calculation is obtained by using the formula:

$$C = \frac{X \quad - X1}{\mathbf{k}}$$

Exp : C= Approximation of Class Amount
k= Class Amount
Xn= Highest Value
X1= Smallest Value
Source : Supranto :1996

From the formula above, it can be obtained the amount of classes are 155 . Therefore , it can be known the clasification category as follows :

Table 2. Clasification of Population Density Class

No		Class of Population Density
1.	150 – 305 soul/km^2	Low
2.	305 – 461 soul/km^2	Medium
3.	461 – 615 soul/km^2	High

For further related of Population Density can be seen on table 4 below :
Table 3. Population Density of Cibal 2017

No	Sub-Districts/Village	Population Amount	Large (km^2)	Population Density (soul/Km^2)	Category
1	Nenu	2.452	6,95	353	Medium
2	Wudi	1.477	3,55	416	Medium
3	Rado	1.694	2,76	615	High
4	Welu	2.152	5,60	384	Medium
5	Barang	1.310	5,83	225	Low
6	Pinggang	1.452	6,58	221	Low
7	Golo	1.312	5,01	262	Low
8	Pagal	2.703	8,27	327	Medium
9	Gapong	1.095	3,97	276	Low
10	Perak	1.432	9,54	150	Low
11	Beamese	1.250	3,78	331	Medium
12	Lando	990	4,85	204	Low
13	Langkas	1.416	7,90	179	Low
14	Kentol	1.081	3,90	277	Low
15	Riung	2.109	13,87	152	Low
16	Ladur	1.965	12,32	160	Low
17	Goloncuang	1.592	4,22	377	Medium
	Total	27.482	108,90	4.908	

Source : Research Data Analysis 2017

Based on table 3 above, it can be seen that Cibal has three classes of population density . They are low, medium, and high. There are ten villages that have low population density. The villages in Barang, Pinggang, Golo, Gapong, Perak, Lando, Langkas, Kentol, Riung, and Ladur Village. Six sub-distric/ Villages in Medium category are Nenu Village, Wudi, Welu, Pagal, Beamese, and Goloncuang Village. One Village with high category is Rado Village. Perak Village is the village with the lowest population density of 150 soul/km^2 while Rado village is the highest population density of 615 soul/km^2. Population density can be seen in the below map:

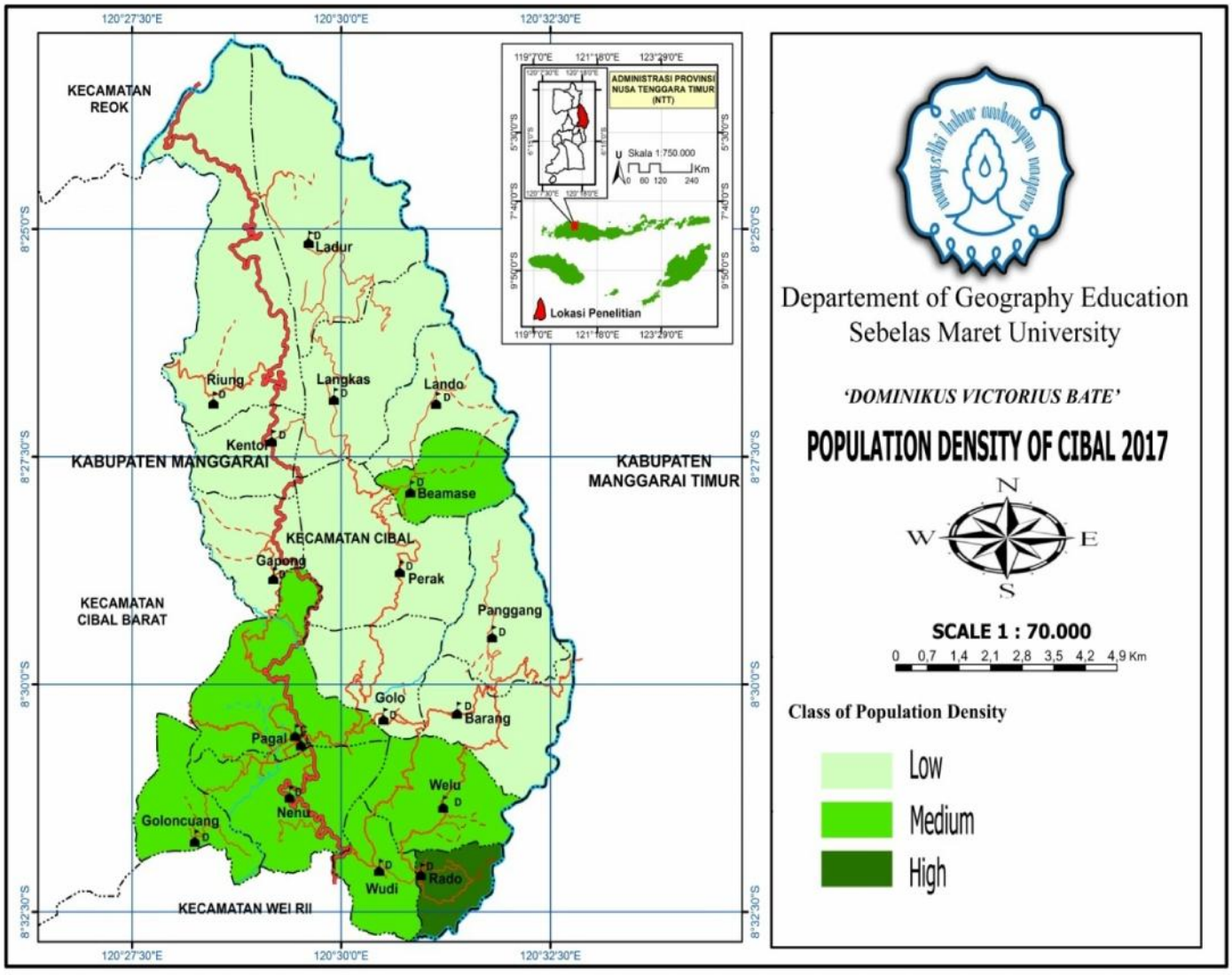

Figure 2 : Population Density Map of Cibal 2017

3.2 Settlement Density

The density of settlements has an effect on the susceptibility of landslide is the addition of load on the land which is in high danger zone so with the addition of this load can potentially the occurrence of landslide. The density of the settlement is the number of houses, schools, and other buildings on a certain land area expressed in units/km^2. Classification of settlement density equal to population density is divided into three categories; low, medium, and high. The calculation of settlement density classification also uses the same formula as population density. From the formula , it can be obtained the number of classes is 19 so it can be known classification category, as follows:

Table 4. Clasification of Settlement Density

No	Settlement Density	Class of Settlement Density
1.	20 – 39 Units/km^2	Low
2.	39 – 58 Units/km^2	Medium
3.	58 – 76 Units/km^2	High

For further related to the density of settlements can be seen in table 6 below:

Table 5. Settlement Density of Cibal 2017

No	Sub-districts/Village	Settlement Amount(Unit)	Large (km^2)	Settlement Density (Unit /Km^2)	Category
1	Nenu	430	6,95	62	High
2	Wudi	268	3,55	76	High
3	Rado	184	2,76	67	High
4	Welu	322	5,60	57	High
5	Barang	199	5,83	34	Low
6	Pinggang	265	6,58	40	Medium
7	Golo	225	5,01	45	Medium
8	Pagal	458	8,27	55	Medium
9	Gapong	236	3,97	59	High
10	Perak	222	9,54	23	Low
11	Beamese	208	3,78	55	Medium
12	Lando	95	4,85	20	Low
13	Langkas	255	7,90	32	Low
14	Kentol	192	3,90	49	Medium
15	Riung	296	13,87	21	Low
16	Ladur	310	12,32	25	Low
17	Goloncuang	318	4.22	75	High
	Total	4.483	108,90	797	

Source : Research Data Analysis 2017

Based on table 5, the density of the settlements is classified into three classes. The classesare low, medium, and high. There are six sub-districts / villages with low

density categories .They are Barang Village, Perak, Lando, Langkas , Riung , and Ladur Village . Five sub-districts / village with medium category that is Pinggang Village, Golo , Pagal , Beamese , and Kentol Village. Six other villages with high category are Nenu Village, Wudi, Rado, Welu, Gapong, and Goloncuang Village. Lando village is the village with the lowest density of settlements .There are 20 units/km^2 while Wudi Village is the village with the highest density of settlements of 76 units/km^2. For more details can be seen on the following map:

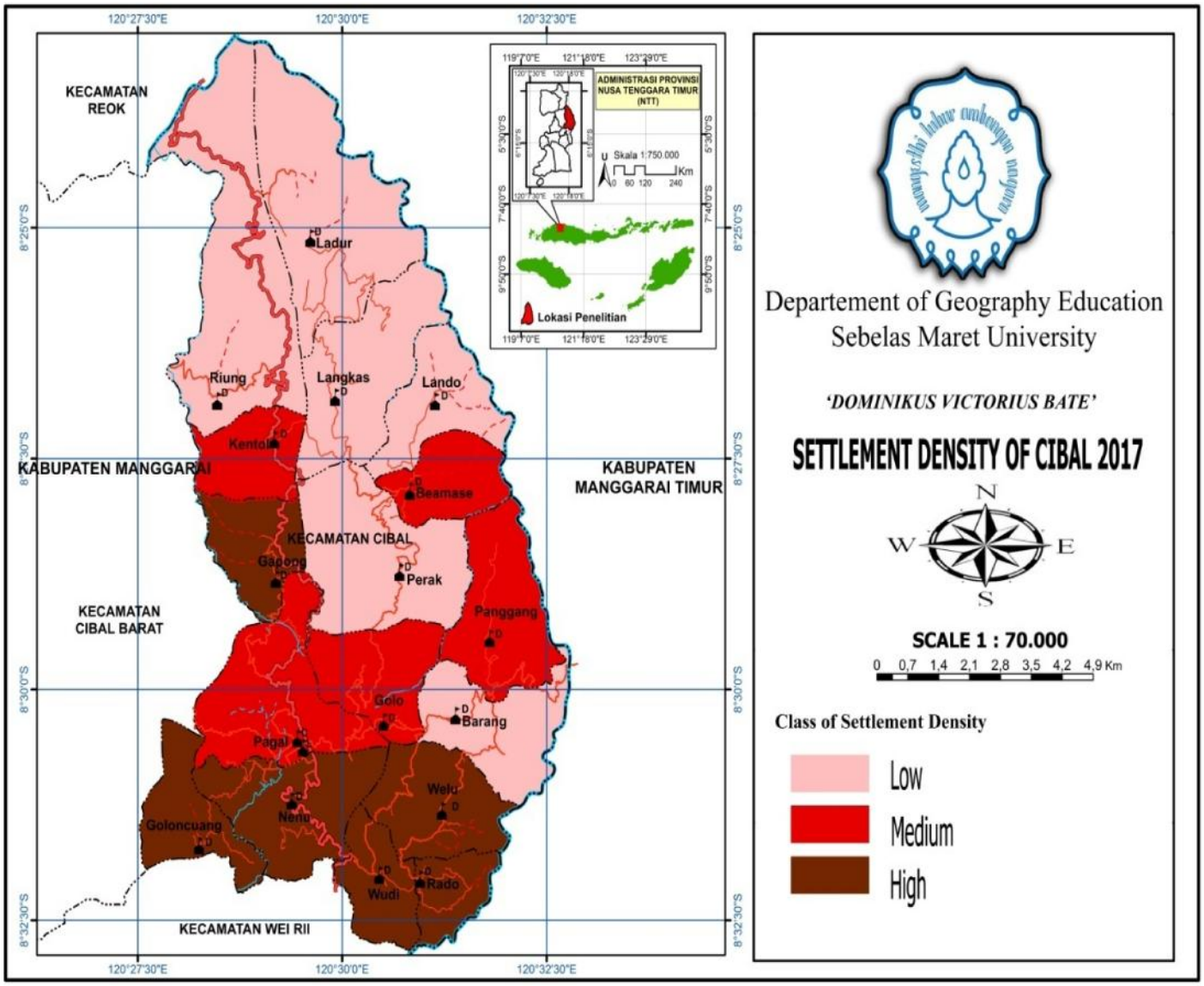

Figure 3 : Settlement Density Map of Cibal 2017

3.4 Landslide Susceptibility

After knowing the condition of population and settlement, so it can be counted density of population and settlement in every Village. The calculation is divided into three classes. The classes Low, Medium, and High class. To search the landslide susceptibility class using Crosstab, it can be seen in table 7 below:

Table 6. Class Count of Landslide Susceptibility Cibal Districts 2017

No	Sub-districts/Village	Population Density	Setlement Density	susceptibility of landslides
1	Nenu	Medium	High	Medium
2	Wudi	Medium	High	Medium
3	Rado	High	High	High
4	Welu	Medium	High	Medium
5	Barang	Low	Low	Low
6	Pinggang	Low	Medium	Low
7	Golo	Low	Medium	Low
8	Pagal	Medium	Medium	Medium
9	Gapong	Low	High	Medium
10	Perak	Low	Low	Low
11	Beamese	Medium	Medium	Medium
12	Lando	Low	Low	Low
13	Langkas	Low	Low	Low
14	Kentol	Low	Medium	Low
15	Riung	Low	Low	Low
16	Ladur	Low	Low	Low
17	Goloncuang	Medium	High	Medium

Source : Data Analysis 2017

Based on the calculation of the class of population density and the density of settlements, it can be obtained level of susceptibility landslide in each Sub-districts or village in Districts Cibal Manggarai Regency. For the class of susceptibility is divided into three classes namely low, medium, and high landslide susceptibility classes. As for explanation of each class of landslide susceptibility, as follows:

a. Low Landslide susceptibility level (L)

Areas with low landslide susceptibility have little or no impact on landslides. The relatively small population and settlement density makes the area relatively vulnerable. Population density in this area ranges from 150 - 305 soul/km^2 while the density of settlements ranges from 20 to 39 units/km^2. Low landslide susceptibility rates are found in village Barang, Pinggang, Golo, Perak, Lando, Langkas, Kentol, Riung, and Ladur.

Low landslide susceptibility can occur due to low population densities and clasified settlements. The area of low landslide susceptibility is 6.979,65 hectares or 64,09% of the total area.

b. Medium Landslide susceptibility level (M)

Areas that has medium susceptibility landslides are having moderate effects on landslides. The medium of Population density and settlements that are making the area relatively has medium susceptibility. Population density in this area ranges from 305 - 461 soul/km^2 while the density of settlements ranges from 39 to 58 units/km^2. The level of landslide susceptibility in Pagal, Nenu, Wudi, Welu, Gapong, Beamese and Goloncuang villages. The area of moderate avalanche susceptibility is 3.634,67 hectares or 33,38% of the total area.

c. High landslide susceptibility level (H)

Areas with high landslide susceptibility have a high or large influence on landslides. Population density and high settlement make the area classified as having high susceptibility. Population density in this area ranges from 461 - 615 soul/km^2 while the density of settlements ranges from 58 to 76 units/km^2. The high landslide susceptibility rate is found only in Rado Village. The high landslide susceptibility area is 275,65 hectares or 2,35% of the total area of Cibal Districts.

Based on the analysis of landslide susceptibility level, the distribution can be seen on the map below:

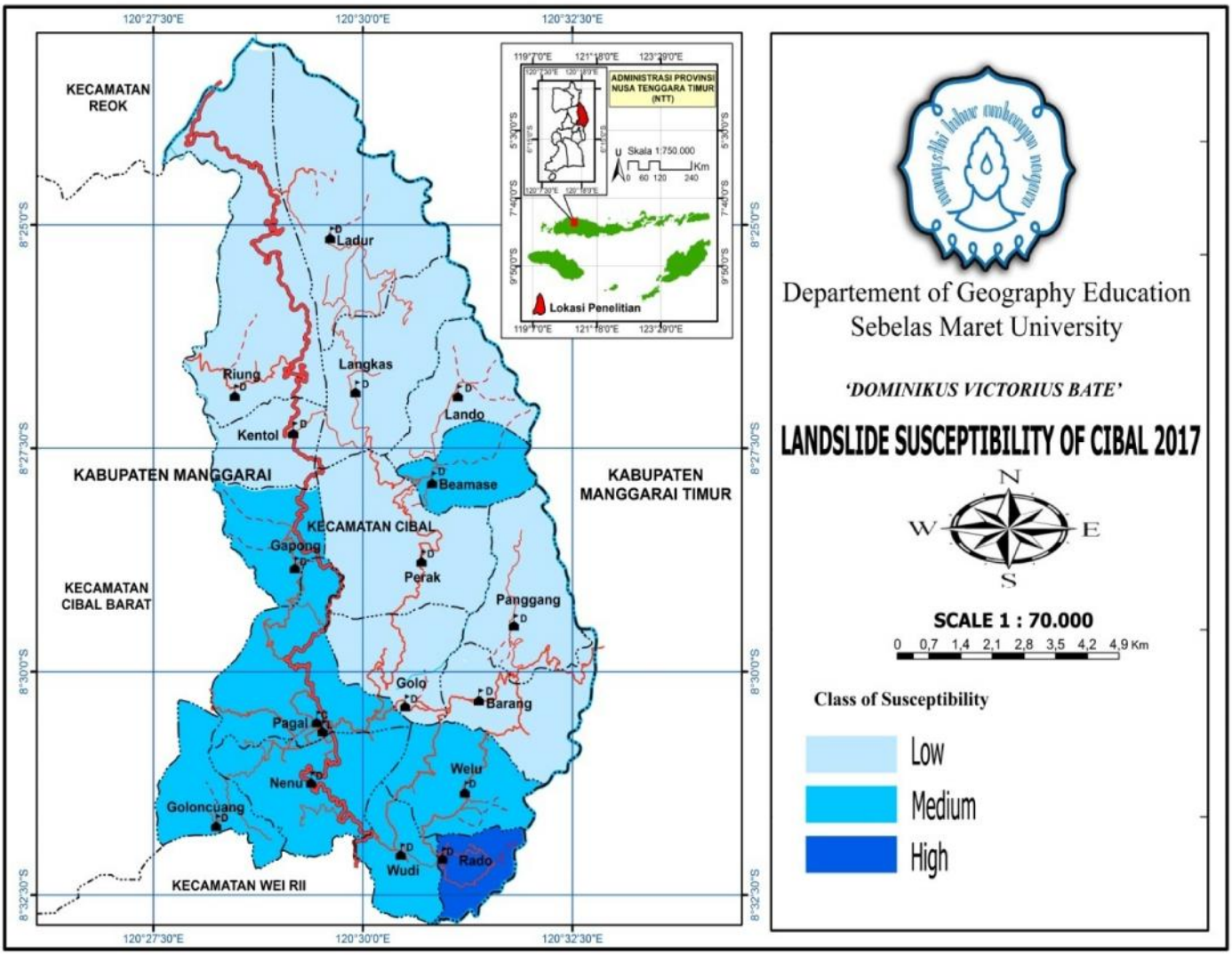

Figure 4 : Landslide Susceptibility Map of Cibal 2017

4. Conclusion

Based on the results of this research, it can be concluded that the susceptibility of landslide in Cibal Districts , Manggarai Regency of 2017. There are three classes of susceptibility, low, medium, and high. The low landslide susceptibility was found in Barang Village, Golo Village, Pinggang Village, Perak Village, Lando Village, Langkas Village, Kentol Village, Riung Village, and Ladur Village with 6.979,65 hectares or 64,09%, the susceptibility level of landslide is located in Nenu Village, Wudi Village, Welu Village, Pagal Village, Gapong Village, Beamese Village, and Golo Ncuang Village with an area of

3.634,67 hectares or 33,38%. While the high landslide susceptibility rate only found in Rado Village with an area of 275,65 hectares or 2,35% of the total area of Cibal Districts.

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