THE MOVEMENT OF LANDSLIDE BASED ON GEOLOGY AND GEODETIC DATA IN SUWIDAK AREA, BANJARNEGARA REGENCY, CENTRAL JAVA

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ABSTRACT

Landslide disaster is one of the most occur disasters in Suwidak, Banjarnegara. Landslide is a recurring event and until now there is no suitable method to respond to the threat, so the preventive stage have not been maximized. According to the research that the movement of land in the area is very active but can not be known qualitatively or quantitatively the level of activity that can cause landslides. The long-term goal of this research is to make the landslide prone areas map.

There are two methods that used to achieve these purposes. The method that used to identificate landslide zoning in research area is geology and landscape morphology mapping. Meanwhile the second method to calculate the movement of the land using ground positioning observed over a period of time, analyzing the movement using parameter significance difference test, congruency test and point movement test.

Based on the geology and landscape morphology mapping, the slope in Suwidak are 30 - 70%, while the rock type are interbedded shale and calcareous sandstones from Rambatan Formation. Geological structure that found is right slip fault (Rickard, 1972), with strike and dip of fault is N 310°E/78°. Angle of direct shear is 10° with safety factor value is 0.868 included into the unstable class. Those factors related with the result of movement that measured with GPS geodetic. Based on the result indicate that the measurement point was move from first periode to third periode measurement.

Keywords: *landslide, geology, geodetic, suwidak, banjarnegara*

1. INTRODUCTION

From data of National Coordination Board for Disaster Management, from 1998 to mid 2003, there have been 647 incidents of disaster in Indonesia, where 85% of the disaster is flood and landslide (Marwanta 2003). From the description shows that landslide is a natural disaster that is very threatening and important to note after the flood, because the frequency of the incident and the number of casualties caused significant. Given that some places in Banjarnegara regency, Central Java is an area that has a high potential of land movement (Djadja et al, 2009), it is necessary to study a study of potential mass movement of the land. The area that will be the area of investigation can be seen in Figure 1. Based on the data of Banjarnegara regency it is known that the area is a densely populated area and residential area. *On November 6, 2016, there was a landslide disaster in Suwidak, Banjarnegara.* The direction of landslide that occurred in Suwidak is N 210°E. This landslide occured in the area of the old cracks (2008), due to high rainfall (heavy rain for approximately 5 hours) then the land move continously. The catastrophic effect caused 13 houses to be severely damaged and destroyed, 31 houses and 3 public facilities are threatened.

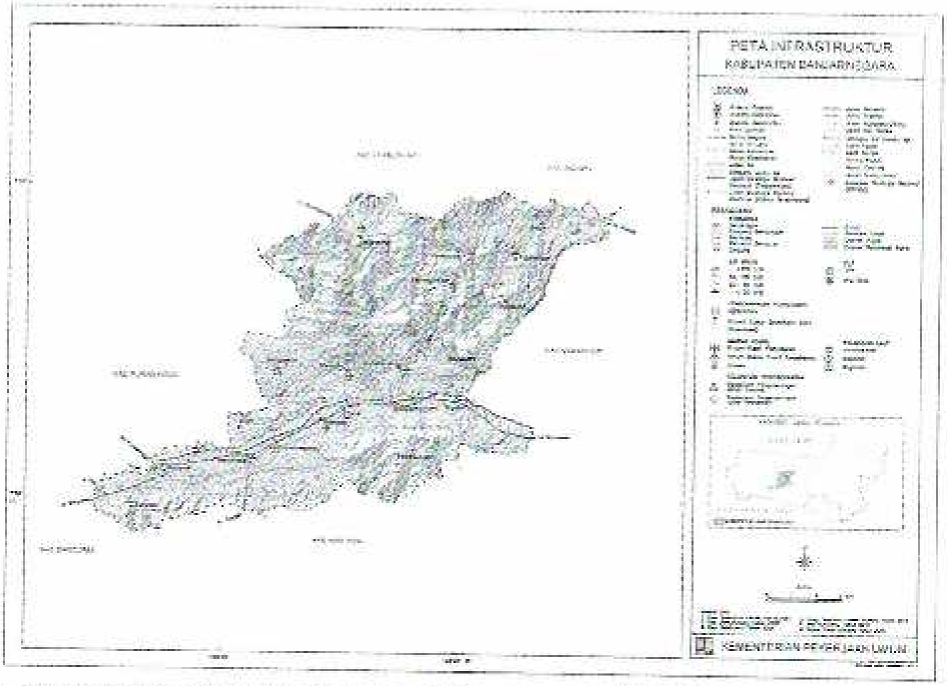

Figure 1. Map of Infrastructure District of Banjarnegara 2012 (source: Ministry of Public Works)

2. METHODOLOGY

Activities undertaken at the primary data collection stage are mapping of surface geology with a scale of 1: 20000, from April - July. Details of activities include:

1. Geomorphological observations
2. Lithology and geology structure observations.
3. Direct shear test to identificate the angle of direct shear and safety factor value.
4. Observation and geodetic measurements to determine the movement of the land.
5. Documentation, making of tracking map & location of observation.
6. Analysis of land movement with geodetic measurements.

3. RESULTS AND DISCUSSION

The river pattern in this area is rectangular pattern, it means that this area controlled by joint and fault. This research area divide into two landform, structural and volcanic landform. The angle of slope calculated with formula and then classified with Van Zuidam clasification of slope (1983). Based on clasification of slope by Van Zuidam (1983), the slope in Suwidak are 30 - 70% and can classified into steep slope (**Figure 2**).

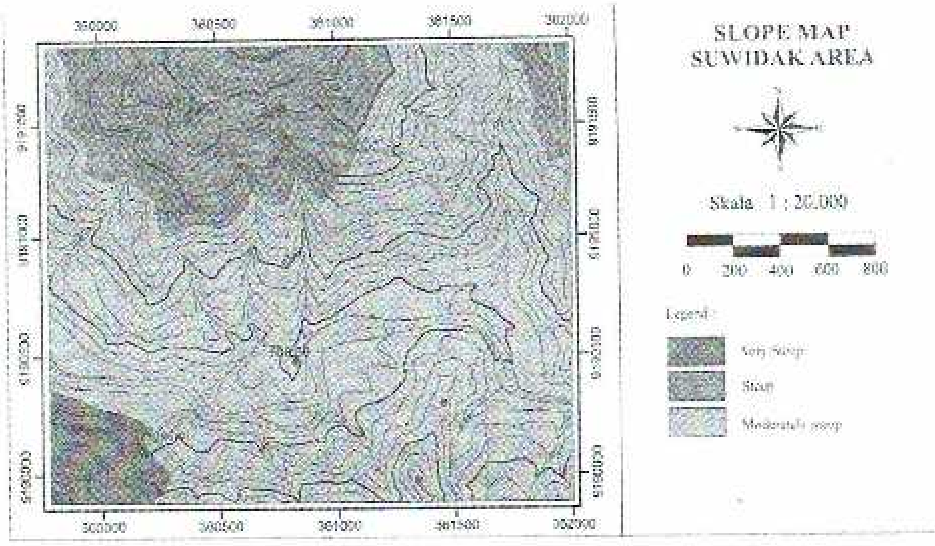

Figure 2. Slope Map Suwidak Area

Stratigraphy in research area the oldest formation is Rambatan Formation consist of interbedded calcareous sandstone and shale. Environment depositional of this formation is lower bathial, that depositioned in Early – Middle Miosen. The sedimentology structure in this rock such as convolute, wavy lamination and parallel lamination. In north west of research area, found a Miosen diorite intrusion. In south east of research area, found the youngest formation consist of volcanic breccia from Tapak Formation. Environment depositional of this formation is upper neritic that depositioned in Plistocen (**Figure 3**). The activities of geological structures observation included measurement of joint and fault. Geology structure that found in this area is right slip fault (Rickard, 1972), with strike and dip of fault is N 310°E/78°. The soil sampling in P6 point Suwidak Area use to identificate the angle of direct shear and safety factor value with direct shear test. The result from the test indicate that the sample has angle of direct shear 10° with safety factor value is 0.868 included into the unstable class (**Figure 4**).

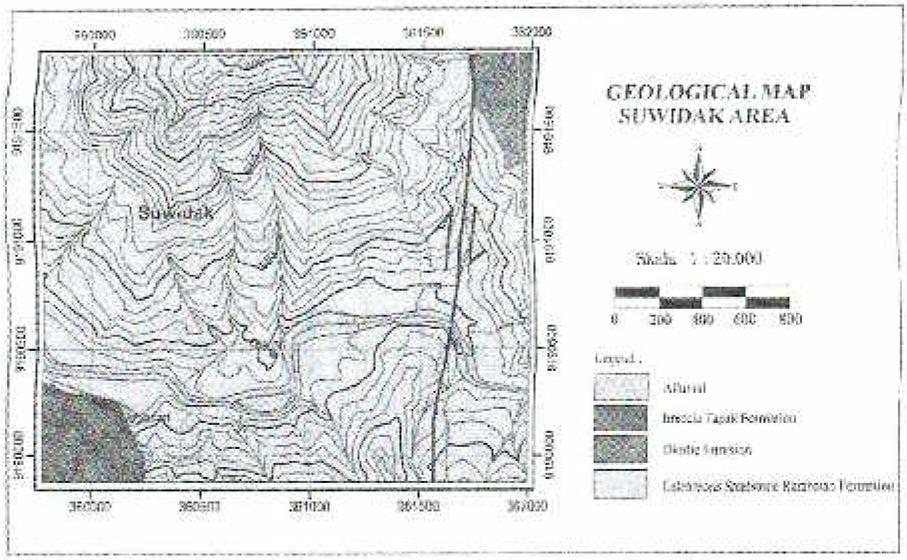

Figure 3. Geological Map

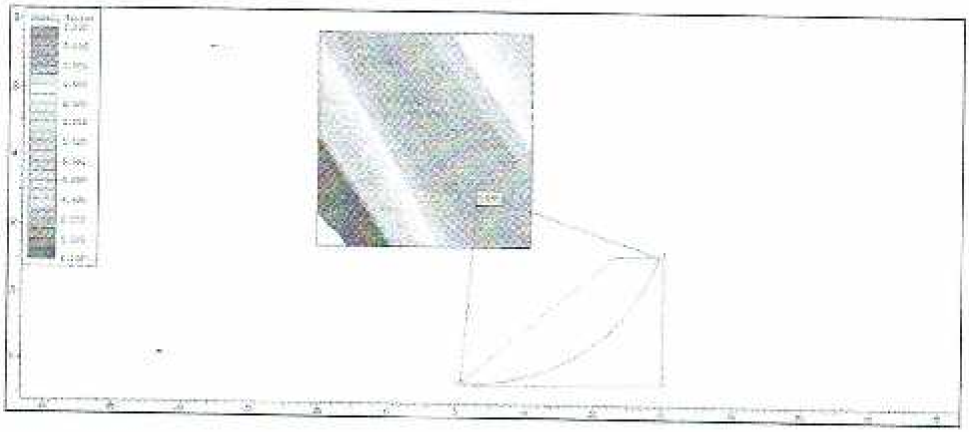

Figure 4. Safety factor value analysis

The results of the first X and Y estimates of the coordinates of X, Y and Z are shown in Table 1. In Table 2 the results of the second component estimate of X, Y, and Z and accuracy of second stage. In Table 3 shows the estimation results of X, Y, and Z components and accuracy of third stage. The first, second, and third stage coordinate estimation results were obtained from GPS Geodetic data processing using Geogenius software.

Table 1. 3D component values (X, Y, and Z) in the first stage and their standard deviations

POINTS	Xi (m)	Yi (m)	Zi (m)	σXi (mm)	σYi (mm)	σZi (mm)
P6	360974.9045	9191641.34	762.541	5.9	5.7	17.4
P7	361008.3442	9191664.067	767.066	5.8	5.4	14.7
P8	361056.4148	9191609.4	748.554	7.1	5.7	18.1

Table 2. 3D component values (X, Y, and Z) in the first stage and their standard deviations

POINTS	Xi (m)	Yi (m)	Zi (m)	σXi (mm)	σYi (mm)	σZi (mm)
P6	360974.922	9191641.334	762.581	4.8	4.3	13.9
P7	361008.338	9191664.076	767.104	7.8	8.5	16.4
P8	361056.413	9191609.474	748.494	6.2	4.1	12.7

Table 3. 3D component values (X, Y, and Z) in the first stage and their standard deviations

POINTS	Xi (m)	Yi (m)	Zi (m)	σXi (mm)	σYi (mm)	σZi (mm)
P6	360974.9361	9191641.341	762.563	2.7	3.3	6.4
P7	361008.3395	9191664.105	767.026	2.6	2.2	7.8
P8	361056.4809	9191609.453	748.583	4.9	3.7	10.9

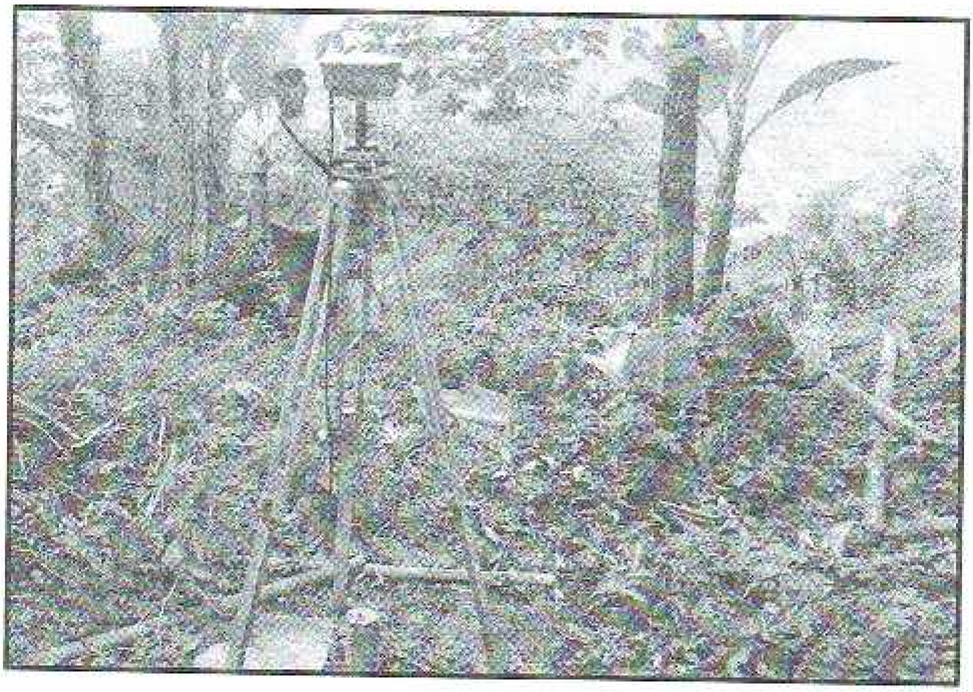

Figure 3. Geodetic measurement in P6

In Table 4 show the value of horizontal and vertical movement and the direction of horizontal movement in the first stage to second stage. Table 5 shows the horizontal and vertical movement as well as the direction of horizontal movement in the second stage of the third stage. Table 6 shows the horizontal and vertical movement values as well as the direction of the horizontal movement in the first stage of the third stage. Further, in Fig. 3 to 5, we illustrate the magnitude and direction of the ground movement in Suwidak from the first stage of the second stage, second to the third stage, and the third in the third stage respectively. On the vertical value there is a negative value, it indicates that there has been a decrease in land, if a positive value means indicating an increase in land.

Table 4. Values and direction in first and second period of horizontal and vertical movement

POINTS	HORIZONTAL MOVEMENT (cm)	VERTICAL MOVEMENT (cm)	DIRECTION (...°)
P6	1.813891361	4	108.6147
P7	1.090240896	3.8	327.549
P8	7.52575182	-6	12.5478

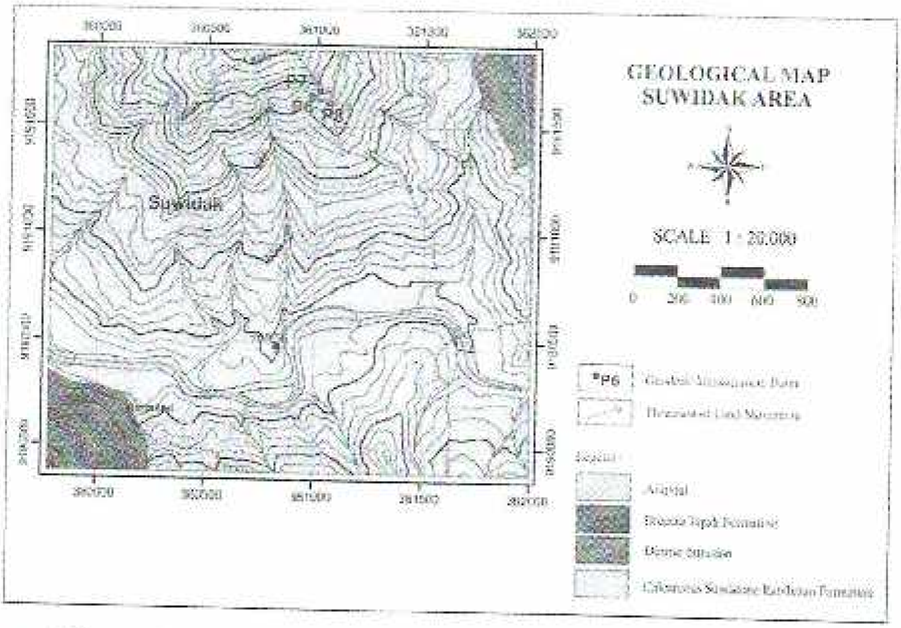

Figure 4. The value and direction of land movement in first and second period

Table 5. Values and direction in second and third period of horizontal and vertical movement

POINTS	HORIZONTAL MOVEMENT (cm)	VERTICAL MOVEMENT (cm)	DIRECTION (...°)
P6	1.591578129	-1.8	64.706907
P7	2.828338917	-7.8	2.33028356
P8	5.37760285	8.9	112.339569

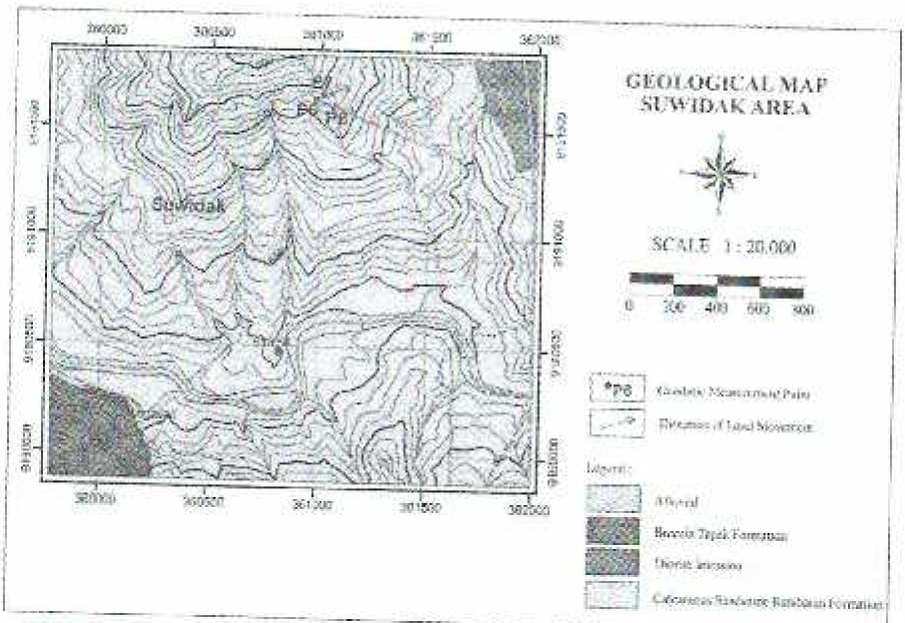

Figure 5. The value and direction of land movement in second to third period

Table 6. Values and direction in first and third period of horizontal and vertical movement

POINTS	HORIZONTAL MOVEMENT (cm)	VERTICAL MOVEMENT (cm)	DIRECTION (...°)
P6	3.159614689	2.2	88.16817
P7	3.775369768	-4	352.8486
P8	8.472902896	2.9	51.26204

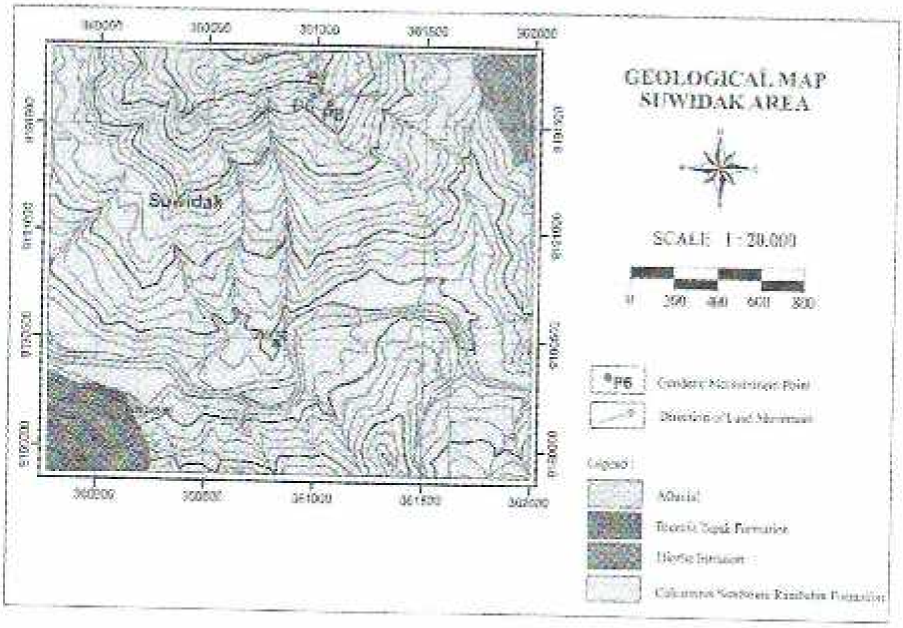

Figure 6. The value and direction of land movement in first and third period

Based on analysis, the slope in Suwidak classified as steep slope (Van Zuidam, 1983) and from direct shear test has safety factor value is 0.868 included into the unstable class (Bowles, 1991). Also litology and geological structure is an important factor that affect slope stability in research area. Mass movement in research area happened in fine grain lithology (interbedded calcareous sandstone and shale) and affected by strike slip fault. Those factors related with the result of movement that measured with gps geodetic. Based on the result indicate that the measurement point was move from first periode to third periode. The farthest movement is last period with distance P6 3.2 cm, P7 3.7 cm, and P8 8.5 cm.

4. CONCLUSION AND RECOMMENDATION

4.1. CONCLUSION

Every period of measurement has different distance and direction of land movement. The farthest movement is the last period of measurement, because the measurement did after rainy season. Beside of rain and lithology, the other factor is vegetation. This area is dominated with salak farm and moor that have fibrous root.

4.2. RECOMMENDATION

- Geodetic measurements are required when the land conditions after rain.
- It needs information from other fields such as, physical status, material properties, stress, and load relationships so that the results obtained are accurate.

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