The Movement of Landslide Based on Geodetic Data in Clapar Area, Banjarnegara Regency, Central Java

by Sugeng Rahardjo

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The Movement of Landslide Based on Geodetic Data in Clapar Area, Banjarnegara Regency, Central Java

Sugeng Rahardjo[a*], Eko Teguh Paripurno[b], Joko Hartadi[b], Dewi Oktavia Alfiani[b]

[a*b] Lecturer in Geological Engineering Department, University of Pembangunan Nasional "Veteran", Yogyakarta

[*]sugengrhj58@yahoo.co.id

ABSTRACT

Landslide disaster is one of the most occur disasters in Clapar, 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. This research is expected to help related parties to design landslide mitigation in Clapar Banjarnegara district so as to reduce the loss of both infrastructure or soul in the future. While the long-term goal of this research is to make map clearly the landslide prone areas so that it can facilitate in modeling to design of disaster mitigation.

The method used in the achievement of the objective is calculating 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, compile the method as the basis of mitigation design of landslide disaster in the research area. In addition to published in scientific meetings and journals, research results will also be informed to relevant parties and the public through the medium of information with simple language so that more easily digested by the public and can be applied directly.

Based on the statistical test of land movement indicates that the test results are accepted, then congruency test and point movement test to better ensure results that have been obtained from parameters significance difference test. Based on the results of the congruency test and point movement test obtained the same results with parameters significance difference test, the test results are accepted. It shows that the horizontal and vertical movement values occurring at the period of I up to III, II up to III and the I up to III are not caused by the movement of the land, but due to random errors in the measurements in the first, second, and third period. The results of statistical tests show that which appropriate with the condition when the measurement was in conditions before the rain, while the landslide occurs in after rain.

Keywords : *landslide, lithologi, hazard, clapar, 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 March 28, 2016, there was a landslide disaster in Clapar, Banjarnegara. The bridge stretched suddenly. The highway was swept away by the mass flow in the land.

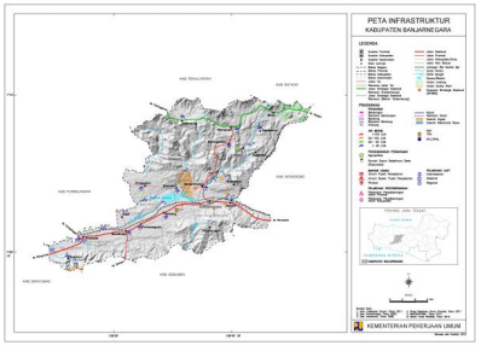

Figure 1. Map of Infrastructure District of Banjarnegara 2012 (source: Ministry of Public Works)

When the land movement started on March 24, 2016 at 19:00 pm, which was followed on March 25, 2016 at 01:30 pm and at 06:00 pm, the area of the landslide is still limited to 5 hectares with a circumference of 1.2 kilometers. The impacts included 9 heavily damaged houses, 3 moderately damaged houses and 2 minor damages with 29 other houses in threatened condition. The number of refugees reached 158 people. One form of mitigation in the face of the occurrence of natural disasters and simultaneously to reduce the impact it generates is the availability of early warning system including the availability of data and information on areas prone to landslide hazards. Knowing the movement of the land based on geodetic GPS observation and also based on the morphology and land surface land authors, is expected to be a good compiler to develop the appropriate method so that it can be used for landslide mitigation in the telitian area.

2. RESEARCH METHODOLOGY

Activities undertaken at the primary data collection stage are

Mapping of surface geology with a scale of 1: 20,000. Details of activities at this stage include:

1. Geomorphological observations, consisting of morphological observations and landscapes, observation of river flow patterns including genetic type and river erosion level and geomorphological unit determination.
2. Observation of geological potential in the form of potentially positive and negative impacts.
3. Observation and geodetic measurements to determine the movement of the land.
4. Documentation, making of tracking map & location of observation.

2.1. Stage of Data Analysis and Processing

Analysis of land movement

Based on the history of landslide events occurring in the investigation area become the basic indication of land movement. With observations and geodetic measurements can know the amount of movement of the soil every period of time to be used as a reference estimation of landslide event design in the future.

2.2. Data Processing

2.2.1. Calculation of Positioning Using GPS

Positioning with GPS is basically done with the principle of backward binding that is by measuring the distance from several satellites known position so that the position of the observer can be calculated. Observations with GPS technology result in coordinates in geodetic coordinate system (φ, λ, h), three-dimensional coordinate coordinates (X, Y, Z) and time parameters. The counting process is done by subtracting the carrier signal phase from the satellite with the signal generated in the receiver.

2.2.2. Calculation of Horizontal and Vertical Movements

The value of the horizontal and vertical movement occurring is obtained from the different values of the components X, Y, and h each time. In this subchapter process the input data are X, Y, and Z components. How to calculate the horizontal and vertical movement according to the equation 1 up to 3 as follows:

$$d_X = X_{period}^{2} - X_{period}^{1} \quad (1)$$

4

$$d_Y = Y_{period}^{2} - Y_{period}^{1} \quad (2)$$

5

$$d_Z = Z_{period}^{2} - Z_{period}^{1} \quad (3)$$

6

To determine the value of horizontal and vertical movement from period I to III, done with three stages. The first stage by calculating the horizontal and vertical movement values between period I and II, the second calculates the horizontal and vertical movement values between period II and III and the third calculates the horizontal and vertical movement values between period I and III.

2.2.3. Movements Analysis

Analysis of deformation conducted to evaluate horizontal and vertical movement that is the parameters significance difference test, congruency test and points movement test. The parameters significance difference test was performed to see the significance of the coordinate differences of the two parameters statistically. Another analysis to more convincing the results of horizontal and vertical movement caused by the deformation or movement. Furthermore after the congruency test was done, the next stage is calculate the point movement test.

2.2.4. Calculate of 3D Coordinate Movements (X, Y, and Z)

Calculate of 3D movement is done by using 3D coordinate input data that is UTM coordinate component X, Y, and Z. UTM coordinate value (X, Y, Z) is obtained from separate processing each period using GPS processing software, that is Geogenius.

2.2.5. Determine of 3D Coordinate Direction

Movement values in 3D coordinate systems (X, Y and Z) are used as input data in plotting geometric 3D movement. The input data includes values of dX, dY and dZ. Plotting is done to see the pattern of movement in 3D space. Therefore, it can be made a large global conclusion and direction of 3D movement at three period interval.

3. RESULTS AND DISCUSSION

3.1.Result of processing using Geogenius Software

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	X_i (m)	Y_i (m)	Z_i (m)	σ_{Xi} (mm)	σ_{Yi} (mm)	σ_{Zi} (mm)
P1	363637,0058	9187100,36	769,05	5,3	5	12,9
P2	363629,6242	9186980,6	758,246	6,4	6,1	19,3
P3	363856,6577	9187119,05	762,256	7,6	6,2	18,6
P4	364465,6844	9189351,469	865,782	10,7	7,9	23,8
P5	364309,6167	9189622,287	837,657	9,2	6,4	22,5
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

3.2. Accuracy of X, Y, and Z component

Based on the results of GPS data processing using Geogenius Software, obtained standard deviation value XYZ each period. The standard deviation value is used to see the accuracy of XYZ coordinates in each of the respective periods. In Figure 2 shows the accuracy ratio of XYZ coordinates every period.

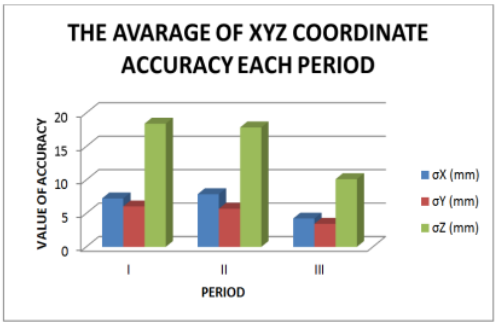

Figure 2. Graph of accuracy of coordinates X, Y and Z each period

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

POINTS	X_i (m)	Y_i (m)	Z_i (m)	σ_{Xi} (mm)	σ_{Yi} (mm)	σ_{Zi} (mm)
P1	363637,016	9187100,370	769,020	5,5	4,7	15
P2	363629,635	9186980,596	758,270	15,7	7,6	37,5
P3	363856,662	9187119,054	762,199	5,2	5,3	12,8
P4	364465,700	9189351,501	865,740	9,6	5,5	16,3
P5	364309,587	9189622,331	837,678	8,2	5,6	18,2
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	361056,431	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	X_i (m)	Y_i (m)	Z_i (m)	σ_{Xi} (mm)	σ_{Yi} (mm)	σ_{Zi} (mm)
P1	363637,02320	9187100,36952	769,086	2,7	2,1	8,4
P2	363629,63833	9186980,59800	758,226	4,8	4,4	10,1
P3	363856,65889	9187119,05406	762,241	3	2,8	7,6
P4	364465,68749	9189351,46746	865,705	7,2	5	16
P5	364309,61253	9189622,33847	837,659	6	4,1	13,8
P6	360974,93606	9191641,34124	762,563	2,7	3,3	6,4
P7	361008,33954	9191664,10469	767,026	2,6	2,2	7,8
P8	361056,48089	9191609,45347	748,583	4,9	3,7	10,9

Based on Figure 4.4 show that the results of measurements in the third stage have the most accurate XYZ coordinate threshold accuracy compared with the measurement results in the first and second stage. XYZ coordinate accuracy of first and second stage has the same relative accuracy.

3.3. Horizontal and Vertical Movement Value

In Table 4 show the value of horizontal and vertical movement and the direction of horizontal movement in the first stage s.d 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 s.d 5, we illustrate the magnitude and direction of the ground movement in clapar 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 (DEGREES)
P1	1,433404975	-3,000	43,07767
P2	1,167578707	2,400	113,0955
P3	0,564278254	-5,700	44,71281
P4	3,598374	-4,200	26,15204
P5	5,338993577	2,100	326,3814
P6	1,813891361	4,000	108,6147
P7	1,090240896	3,800	327,549
P8	7,52575182	-6,000	12,5478

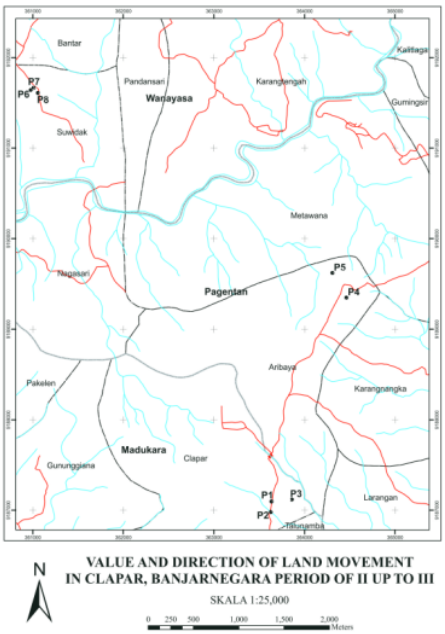

Figure 3. The value and direction of land movement

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

POINTS	HORIZONTAL MOVEMENT (CM)	VERTICAL MOVEMENT (CM)	DIRECTION (DEGREES)
P1	0,768346283	6,60000	94,4787815
P2	0,417825305	-4,40000	53,7609095
P3	0,277625662	4,20000	276,203476
P4	3,61670137	-3,50000	20,7099422
P5	2,641063819	-1,90000	74,3376969
P6	1,591578129	-1,80000	64,706907
P7	2,828338917	-7,80000	2,33028356
P8	5,37760285	8,90000	112,339569

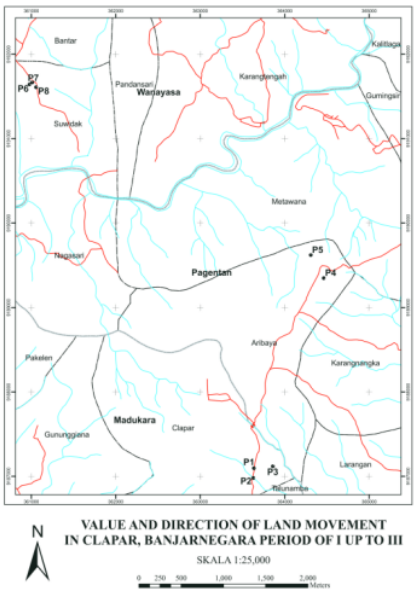

Figure 4. The value and direction of land movement

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

POINTS	HORIZONTAL MOVEMENT (CM)	VERTICAL MOVEMENT (CM)	DIRECTION (DEGREES)
P1	2,004792673	3,60000	60,50681
P2	1,426689184	-2,00000	98,50495
P3	0,447662886	-1,50000	15,68168
P4	0,343013076	-7,70000	116,4903
P5	5,175504927	0,20000	355,423
P6	3,159614689	2,20000	88,16817
P7	3,775369768	-4,00000	352,8486
P8	8,472902896	2,90000	51,26204

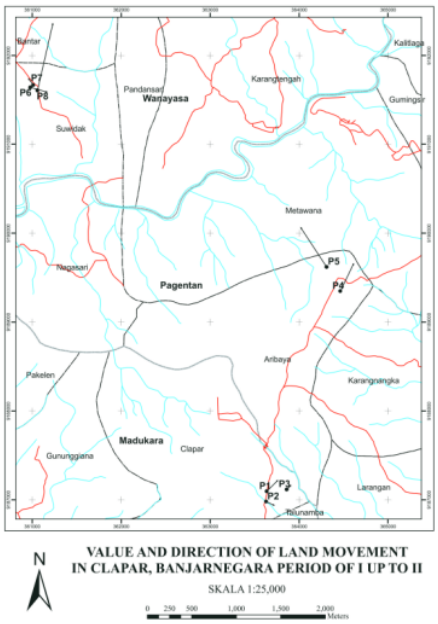

Figure 5. The value and direction of land movement

3.4. The Results of Horizontal and Vertical Movement Analysis

The horizontal and vertical movement values that have been obtained at each interval of period, then analyzed horizontal and vertical movement using statistical test, that is the parameter significance difference test, the congruency test, and the point movement test. The statistical test is performed to find out the horizontal and vertical movement values, caused by the movement or because a random error in the measurement of the monitor point. In Table 7 shows the results of parameters significance differences test in the period I up to II.

Table 7. The results of parameters significance differences test in the period I up to II

Points	Coordinate (i)	$T = \frac{X_i - X_{ii}}{\sqrt{\sigma_{xi}^2 + \sigma_{xii}^2}}$	(T table = 2, 228)	Results of test
P1	X	1,28E-06	2, 228	accepted
	Y	1,526E-06	2, 228	accepted
	Z	-1,52E-06	2, 228	accepted
P2	X	6,335E-07	2, 228	accepted
	Y	-4,7E-07	2, 228	accepted
	Z	5,691E-07	2, 228	accepted
P3	X	4,311E-07	2, 228	accepted
	Y	4,916E-07	2, 228	accepted
	Z	-2,52E-06	2, 228	accepted
P4	X	1,103E-06	2, 228	accepted
	Y	3,355E-06	2, 228	accepted
	Z	-1,46E-06	2, 228	accepted
P5	X	-2,4E-06	2, 228	accepted
	Y	5,228E-06	2, 228	accepted
	Z	7,257E-07	2, 228	accepted
P6	X	2,26E-06	2, 228	accepted
	Y	-8,11E-07	2, 228	accepted
	Z	1,796E-06	2, 228	accepted
P7	X	22,023851	2, 228	accepted
	Y	-6,02E-07	2, 228	accepted
	Z	9,136E-07	2, 228	accepted
P8	X	1,735E-06	2, 228	accepted
	Y	1,046E-05	2, 228	accepted
	Z	-2,71E-06	2, 228	accepted

Based on Table 7 indicates that the test results are accepted, furthermore calculate the congruency test and the point movement test to ensure the results of obtained from the parameters significance differences test. Based on the results of the congruency test and point movement test obtained the same results (accepted) with the parameters significance differences test, the test results are accepted. In Table 8 shows the results of parameters significance differences test in the period II up to III. In Table 9 shows the results of parameters significance differences test in the period I up to III.

Table 8. The results of parameters significance differences test in the period II up to III

Points	Coordinate (i)	$T = \frac{X_i - X_{ii}}{\sqrt{\sigma_{xi}^2 + \sigma_{xii}^2}}$	(T table = 2, 228)	Results of test
P1	X	1,2502E-06	2, 228	accepted
	Y	-1,16554E-07	2, 228	accepted
	Z	3,83903E-06	2, 228	accepted
P2	X	2,0527E-07	2, 228	accepted
	Y	2,81264E-07	2, 228	accepted
	Z	-1,13296E-06	2, 228	accepted
P3	X	-4,59745E-07	2, 228	accepted
	Y	5,00489E-08	2, 228	accepted
	Z	2,8214E-06	2, 228	accepted
P4	X	-1,06583E-06	2, 228	accepted
	Y	-4,5513E-06	2, 228	accepted
	Z	-1,53236E-06	2, 228	accepted
P5	X	2,50278E-06	2, 228	accepted
	Y	1,02731E-06	2, 228	accepted
	Z	-8,31862E-07	2, 228	accepted
P6	X	2,61291E-06	2, 228	accepted
	Y	1,25454E-06	2, 228	accepted
	Z	-1,17627E-06	2, 228	accepted
P7	X	1,3987E-07	2, 228	accepted
	Y	3,21865E-06	2, 228	accepted
	Z	-4,29506E-06	2, 228	accepted
P8	X	6,29419E-06	2, 228	accepted
	Y	-3,7011E-06	2, 228	accepted
	Z	5,31782E-06	2, 228	accepted

Table 9. The results of parameters significance differences test in the period I up to III

Points	Coordinate (i)	$T = \frac{X_i - X_{ii}}{\sqrt{\sigma_{xi}^2 + \sigma_{xii}^2}}$	(T table = 2, 228)	Results of test
P1	X	2,93371E-06	2, 228	accepted
	Y	1,81999E-06	2, 228	accepted
	Z	2,3386E-06	2, 228	accepted
P2	X	1,76375E-06	2, 228	accepted
	Y	-2,80537E-07	2, 228	accepted
	Z	-9,18146E-07	2, 228	accepted
P3	X	1,48091E-07	2, 228	accepted
	Y	6,3355E-07	2, 228	accepted
	Z	-7,46537E-07	2, 228	accepted
P4	X	2,38042E-07	2, 228	accepted
	Y	-1,63648E-07	2, 228	accepted
	Z	-2,68496E-06	2, 228	accepted
P5	X	-3,76014E-07	2, 228	accepted
	Y	6,78757E-06	2, 228	accepted
	Z	7,57723E-08	2, 228	accepted
P6	X	4,86711E-06	2, 228	accepted
	Y	1,53348E-07	2, 228	accepted
	Z	1,18664E-06	2, 228	accepted
P7	X	-7,39447E-07	2, 228	accepted
	Y	6,42434E-06	2, 228	accepted
	Z	-2,40367E-06	2, 228	accepted
P8	X	7,6611E-06	2, 228	accepted
	Y	7,80212E-06	2, 228	accepted
	Z	1,37254E-06	2, 228	accepted

Based on Table 8 and Table 9 indicates that the test results are accepted, furthermore calculate the congruency test and the point movement test to ensure the results obtained from parameters significance differences test. Based on the results of the congruency test and point movement test obtained the same results (accepted) with parameters significance differences test, the test results are accepted.

4. CONCLUSION AND RECOMMENDATION

4.1. CONCLUSION

Some conclusions that can be taken based on the results of research is the results obtained from statistical tests that have been done, shows that the value of horizontal and vertical movements that occur in the period I to III, was not occure the land movement, because a random error in the measurements at the period of I, II, and III.

The results of statistical tests that are not moving

in accordance with the conditions during the measurement, was in no rain conditions, while the movement of the land generally occurs (according to information population) during the rainy season.

4.2. RECOMMENDATION

There are some things that can be used as a recommendations was, measurements are done in every year to better know the value of movement that occurs significantly.

It is necessary to measure the coordinates of monitoring points every period periodically.

Measurements were made on relatively similar meteorological conditions between the first, second, and third stage because the observations were strongly influenced by meteorological conditions at the period of measurement.

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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Attachment

The results of congruency test

Kala	Varian aposteori $(\widehat{\sigma_o^2})$ (m^2)	Varian apriori (σ^2) (m^2)	*F* hitung = $((\widehat{\sigma_o^2})/(\sigma^2))$	Nilai tabel *Fisher* (α=0,05)	Hasil
I s.d II	4,083 x $^{10-6}$	0,5112	7,988 x $^{10-6}$	1,738770	Diterima
II s.d III	2.451 x $^{10-6}$	0.5112	4.796 x $^{10-6}$	1,738770	Diterima
I s.d III	4.176 x $^{10-6}$	0.5112	8.170 x $^{10-6}$	1,738770	Diterima

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