

## Analysis the Effect of Landslide Hazard on Land Value Zone in Boyolali Regency

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**Abstract:** Landslides are disasters that often occur in mountainous areas. According to Regional Disaster Management Agency Boyolali Regency from 2019-2021 there were recorded 25 landslides in Selo District. As a result, it has an impact on the loss of both lives and the economy. Indirectly impact on land prices in the area. Therefore, it is necessary to analyze the land values changes in Selo District in landslide hazard areas. In this study, the land value is obtained based on a land price survey. The results are the land value of Selo District in 2022 can be divided into 113 zones with the highest price of IDR 1,150,240 in zone 1787 and the lowest price of IDR 37,013 in zone 1777. The land value at low landslide hazard has an average of IDR 709,970, the land value at medium landslide hazard has an average of IDR 317,089 and the land value at high landslide hazard has an average of IDR 111,160. By using linear regression obtained the correlation  $r=-0.880$ . Shows that if the landslide hazard increases, land prices will decrease.

**Keywords:** Land Value Zone, Landslide Hazard, Land Value changes, Linear Regression, Selo District

### INTRODUCTION

Boyolali Regency is one of 35 Regencies/Cities in Central Java Province. According to the Head of Emergency and Logistics BPBD Central Java (Kedaruratan, 2022), disaster threats in Boyolali Regency include volcanic eruption of Mount Merapi and Merbabu, landslides, drought, hurricanes, flash floods and inundation floods, land fires, and earthquakes. A number of disaster threats in the Boyolali area are divided based on their area. For example, from the threat of landslides hazard to occur in locations near cliffs during the rainy season, for example on the Solo Selo Borobudur (SSB) Cepogo - Selo route, the residential route of residents in Selo District, and others. Landslides are one of the disasters that often occur in Boyolali, especially in Selo District, which is located on the slopes of Mount Merapi and Merbabu. One of the landslides occurred in Jrasah Village, Selo District on February 15 2023, landslides buried residents' houses and closed road access between villages and resulted in losses of hundreds of millions of rupiah (Jarmaji, detikcom, 2023). Based on disaster data from the Regency BPS and BPBD Boyolali Regency in 2019 – 2021 there were 102 landslides. Landslide disasters can have devastating impacts on the

economic, social and environmental fields. Damage to infrastructure can disrupt social activities, cause loss of life, damage to ecosystems, and loss of shelter (BPBD, 2022).

This condition also has an indirect impact on land prices. The impact that arises when a landslide fills up the main road is to cut off transportation routes and cause the economy to stagnate in the area where the landslide occurred (Jarmaji, [www.detik.com](http://www.detik.com), 2023). This situation is in line with the Regulation of the Head of the National Land Agency of the Republic of Indonesia Number 3 of 2007 Article 28 Paragraph 2 (BPN, 2007) says that the things that affect land prices are the location and layout of the land, land status, land allotment, suitability of land use with regional spatial planning or regional spatial planning or existing cities, available facilities and infrastructure, and other factors that can affect land prices.

In previous research entitled "Analysis of Changes in Land Value Zones 2012-2017 Due to the Rob Flood Disaster in Sayung District, Demak Regency". This research focuses on areas affected by tidal flooding, the method used is the market price approach, and sampling uses random sample selection. From the analysis of land value changes in 2017 and 2012, the highest land value change occurred in zone 48 amounting to 2468% located in Sayung Village, Loireng Village and Tambakroto Village, the lowest land value change occurred in zone 10 amounting to 85% located in Gemulak Village. Meanwhile, changes in land value zones were related to tidal flooding, the highest land value changes were in zone 34 with a decrease of 80%, located in Sriwulan Village, Purwosari Village and Bedono Village. It can be concluded that the tidal flood disaster can affect land prices (Utomo, 2017).

This study aims to identify land value zones in landslide hazard areas in Selo Regency, based on the landslide hazard map 2021 from the Regional Disaster Management Agency Central Java or BPBD. While the land value zone is generated by surveying land prices in the field. The land value zone 2021 is used as a reference for making the initial zone. Then from the 2022 land value zone data will be analyzed and calculations will be carried out with the 2021 and 2019 land value zones to determine changes in land prices from 2019 to 2019 and changes in land prices from 2021 to 2022.

This research was conducted with the hope of realizing information related to land prices that is relevant and accurate so that it can reflect actual conditions on the ground. So that the results of the land that has been produced can be used as a reference in all matters related to land prices, both for the community and the government. With an analysis related to the influence of landslide hazard areas on land prices, it can be used as a material consideration in selecting settlement locations.

## **METHODS**

The research method used to obtain land value zones is to conduct a direct survey of land prices in the field. The data needed for this research includes transaction data on land prices in Selo District obtained from direct surveys in the field for a period of 2 years, Offer

Prices from interviews with landowners and land brokers, Administrative Map of Selo District for 2021 with scale 1:25.000 obtained from BAPPEDA Boyolali Regency, Map Selo District Land Use with scale 1:25.000 was obtained from BP3D Boyolali Regency, SPOT-6 Imagery for 2021 obtained from BRIN, Land Value Zone Map for Boyolali Regency for 2019 and 2021 with scale 1:25.000 obtained from BPN Boyolali Regency, Landslide Hazard Map for Boyolali Regency for 2021 with scale 1:50.000 obtained from the Mitigation Agency Central Java Regional Disaster Management Agency (BPBD), Data on the occurrence of landslides for the range 2019 to 2021 were obtained from the Boyolali Regency Central Statistics Agency (BPS) and the Boyolali Regency Regional Disaster Management Agency (BPBD). The stages of implementing the research are as follows:

1. Initial Zone Creation and Sample Determination

The initial zone determination uses data from the 2021 Land Value Zone Map from BPN Boyolali Regency and the 2021 Selo District Land Use Map with scale 1:5.000 from BP3D Boyolali Regency. This initial zone determination stage aims to facilitate the collection of sample points in conducting field surveys. Taking the number of sample points in a zone depends on the area of the zone. A minimum of 3 samples taken in a zone with a size of 10 cm x 10 cm on a map with a scale of 1: 5000 and a minimum of sample points taken in zones with a size of more than 10 cm x 10 cm at least 5 sample points and multiples so on based on the provisions of the ATR /BPN ([atrbpn.go.id](http://atrbpn.go.id), 2021).

2. Sampling Data Collection

This stage is the collection of information on market prices and other data related to land being traded in Selo District, Boyolali Regency. The prices surveyed are in the form of transaction prices and bid prices.

3. Calculation of Land Value Zones

Furthermore, calculations are carried out to obtain the actual value of the land. The actual land value data will later be used as land prices in the land value zone. The following are the stages and calculations, including: Calculation of data type correction; Calculation of time correction; Calculation of rights status correction; Corrected land value calculation; Calculation of RCN (Replacement Cost New); Calculation of land per square meter; NIR calculation (average indicated value); Standard deviation calculation.

4. Making Land Value Zone (*Zona Nilai Tanah/ZNT*) Map

After obtaining the NIR (average index value) that meets the standard deviation of <30% for each zone, fill in the attribute table in ArcGIS so that land value zones can be formed. Then the ZNT (land value zone) classification is carried out into 8 intervals (Subiyanto, 2021).

5. Changes in Land Value in 2019, 2021 and 2022

To find out changes in land values, it is done by comparing land values between 2019, 2021 and 2022. Then a calculation of the difference in the Average Indicated Value is carried out to find out the changes.

6. Determination of Landslide Affected Zone Samples

Sampling to determine the landslide hazard points was carried out using a randomized purposive method.

7. Simple Linear Regression on the Effect of Landslide Hazard on Land Prices

Simple linear regression is an analysis that aims to measure the value of the influence of one independent variable on the dependent variable.

**RESULTS AND DISCUSSION**

**Zone Analysis of Land Values in Selo District**

Zone Analysis of Land Values in Selo District in 2022 was formed from 113 zones with a total of 575 samples scattered in each zone. Based on the processing and calculation results, a ZNT map in Selo District in 2022 is produced in Figure 1.

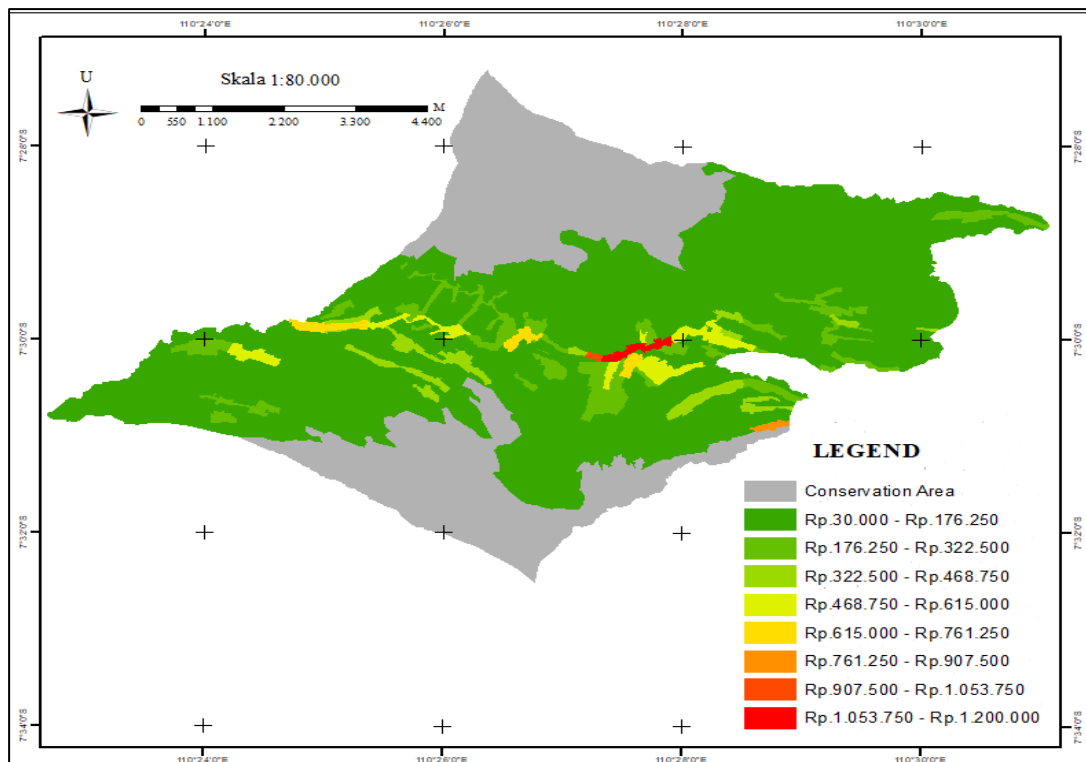


Figure 1. Land Value Zone Map for 2022

From the results of this study it can be seen that the zone that has the highest land price is the red zone 1787 with a land price of IDR 1,150,241 per m<sup>2</sup> and an area of 14.95 Ha. As for

the zone that has the lowest land price is the green zone 1777, which is priced at Rp. 37,014 per m<sup>2</sup> and a zone area of 29.95 Ha. And there are zones that do not have NIR values, namely zone 1781 and zone 1841 because these zones are the Forest Conservation Areas of Mount Merapi and Mount Merbabu.

This change analysis uses ZNT data for 2019 and 2021 obtained from BPN Boyolali Regency. According to (Naufalita, 2018) the classification of changes in value is divided into 4 namely low, medium, high and very high. The low classification has a value range of IDR 0 – IDR 70,000. Medium classification is worth IDR 70,000 – IDR 140,000. High classification is worth IDR 140,000 – IDR 210,000. Very high classification worth IDR 210,000 – IDR 280,000. The ZNT change map for 2019 and 2021 can be seen in Figure 2.

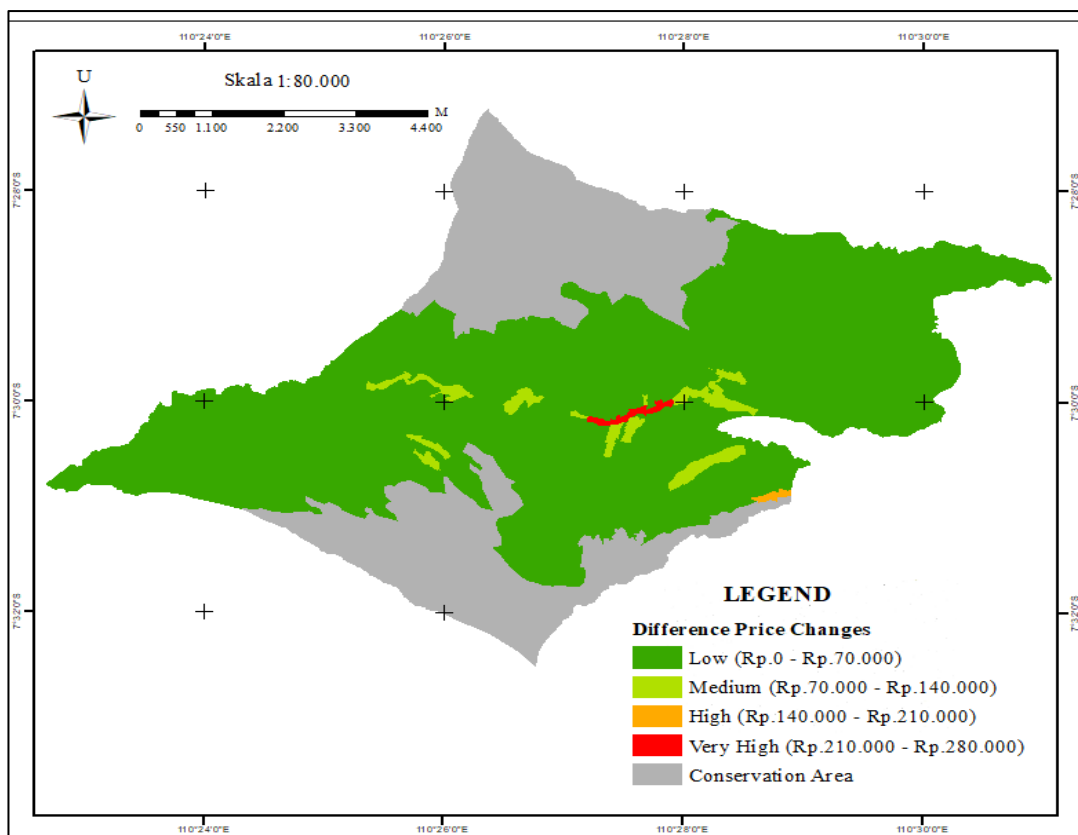


Figure 2. ZNT Change Map in 2019 – 2021

Changes in NIR with the highest increase in the rupiah figure were in the 1787 zone located in Samiran Village. A map of land zone changes with the highest increase in rupiah figures can be seen in the map image in Figure 3.

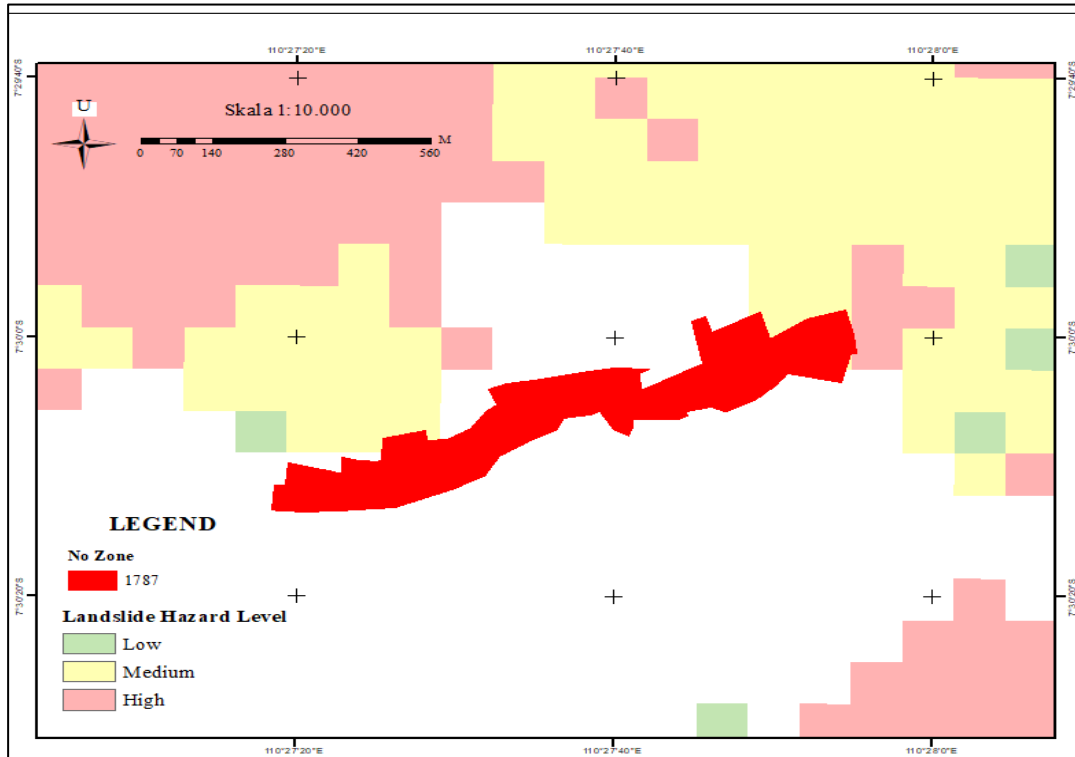


Figure 3. ZNT Change Map in 2019–2021 Highest

Zone 1787 experienced the highest increase in land value, amounting to IDR 271,989, in 2019 from IDR 735,502 to IDR 1,007,491 in 2021. This happened because the location of zone 1787 is a very strategic place that is crossed by collector roads, close to Alun -Alun Selo, close to Selo Market, is not affected by the landslide hazard and prices are already high from the start, so the value of land in that zone has a very high change.

The change in NIR with the lowest increase in the rupiah figure is atzone 1938which is locatedin Tarubatang Village. Land zone change map withThe lowest increase in rupiah figures can be seen in the map image in Figure 4.

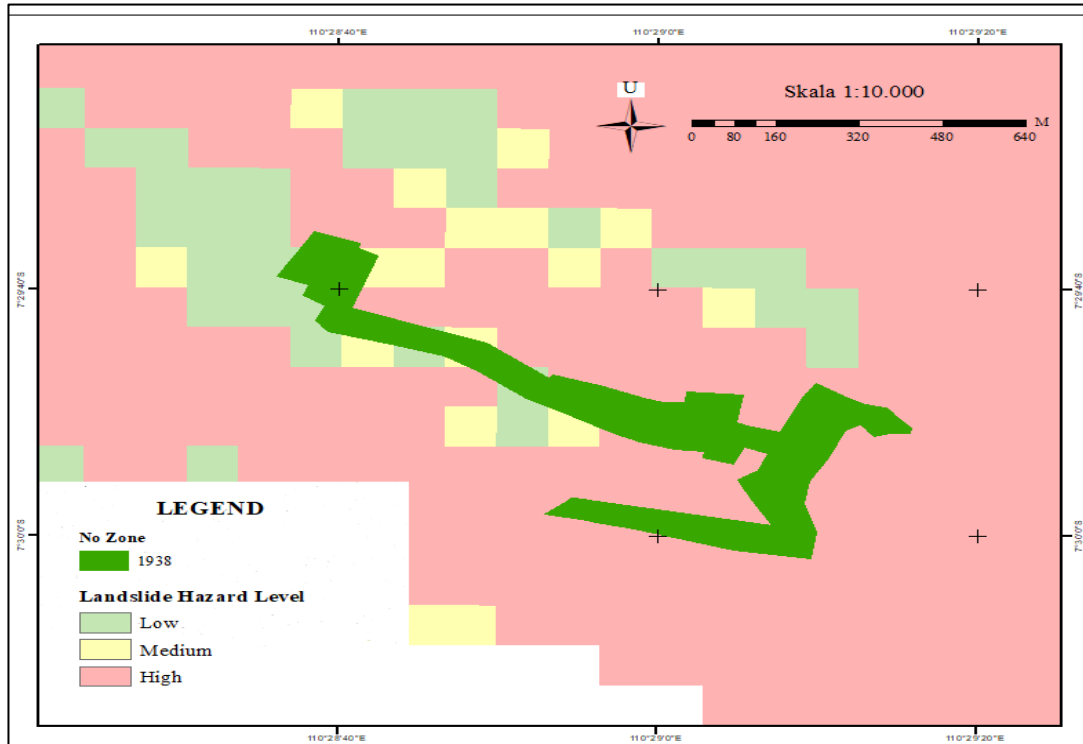


Figure 4. ZNT Change Map in 2019–2021 Lowest

Zone 1938 experienced the lowest increase in land value, namely IDR 1,716, in 2019 from IDR 98,059 to IDR 99,775 in 2021. This happens because the average 1938 zone is the Moor area. This zone is also not crossed by collector roads. In this zone it is also very far from the center of Selo District, namely Alun-Alun Selo, the Pasar Selo shopping center, was hit by the danger of landslides and prices were already low from the start, so that the value of land in that zone has not changed much, or you could say it's low.

This change analysis uses ZNT data for 2021 obtained from the BPN of Boyolali Regency and ZNT data for 2022. According to (Naufalita, 2018) the classification of changes in value is divided into 4 namely low, medium, high and very high. The low classification has a value range of IDR 0 – IDR 37,500. Medium classification is worth IDR 37,500 – IDR 75,000. High classification is worth IDR 75,000 – IDR 112,500. Very high classification worth IDR 112,500 – IDR 150,000. The ZNT change map for 2019 and 2021 can be seen in Figure 5.

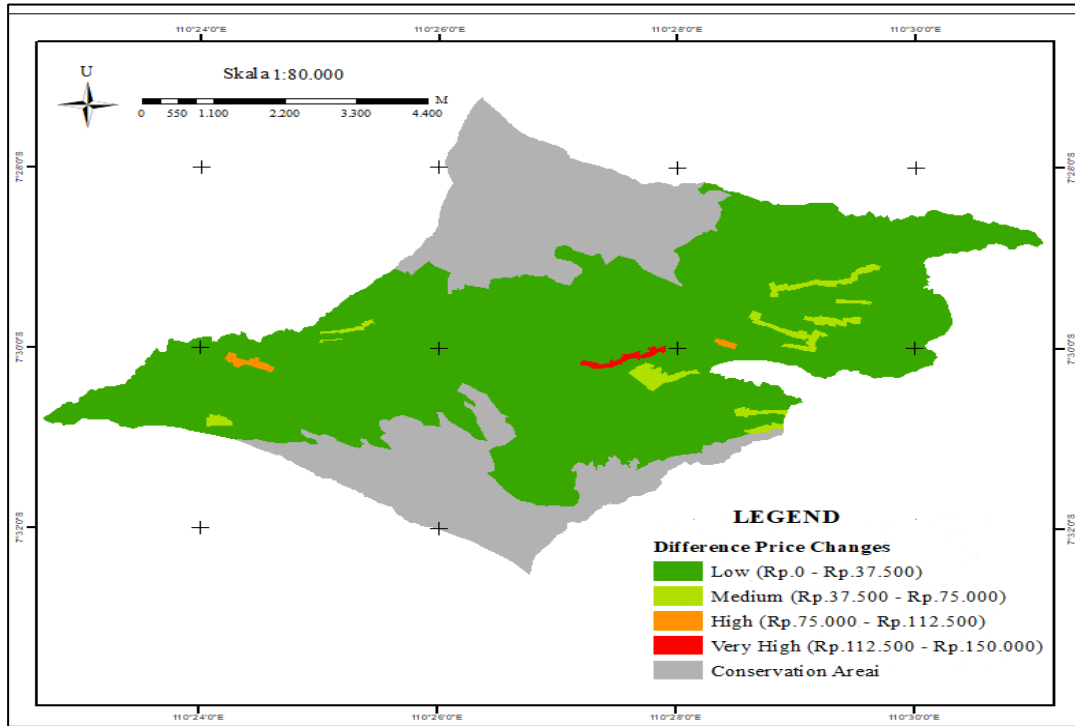


Figure 5. ZNT Change Map in 2021–2022

Changes in NIR with the highest increase in the rupiah figure were in the 1787 zone located in Samiran Village. A map of land zone changes with the highest increase in rupiah figures can be seen in Figure 6.

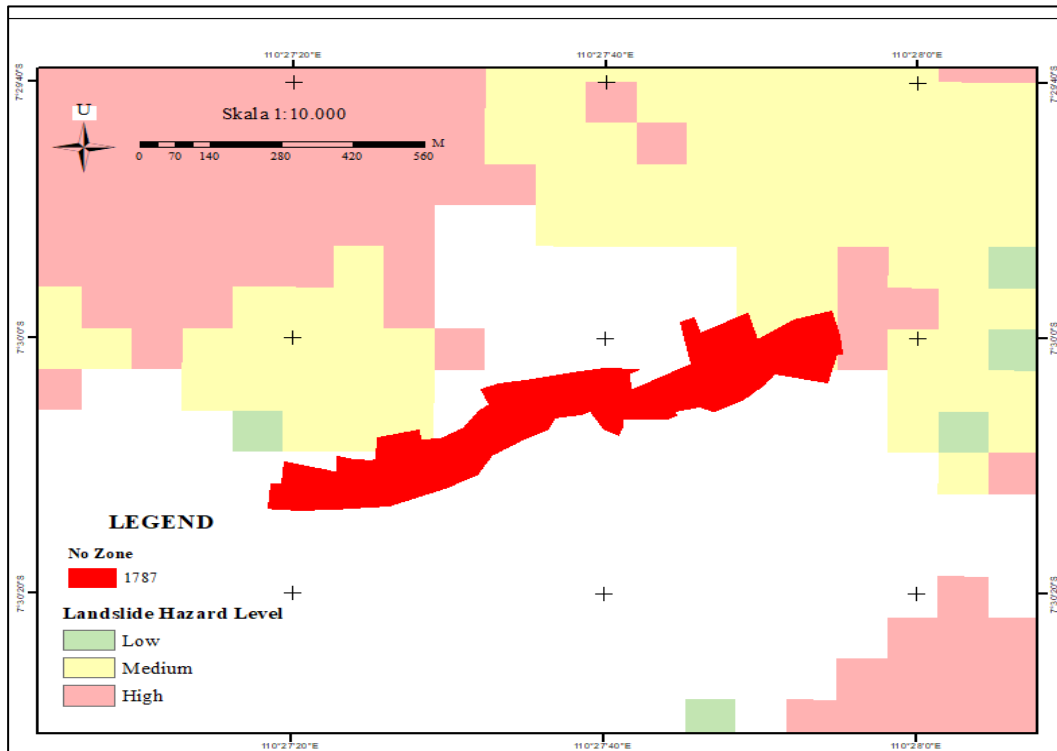


Figure 6. ZNT Change Map in 2021 – 2022 Highest



Zone 1787 experienced the highest increase in land value, amounting to IDR 142,749, in 2021 from IDR 1,007,491 to IDR 1,150,240 in 2022. This happened because the location of zone 1787 is a very strategic place that is crossed by collector roads, close to Alun -Alun Selo, close to Pasar Selo, is not affected by the landslide hazard and prices have been high from the beginning, so the value of land in that zone has a very high change.

The change in NIR with the lowest increase in the rupiah figure is at zone 1795 located in Tarubatang Village. Land zone change map with the lowest increase in rupiah figures can be seen in Figure 7.

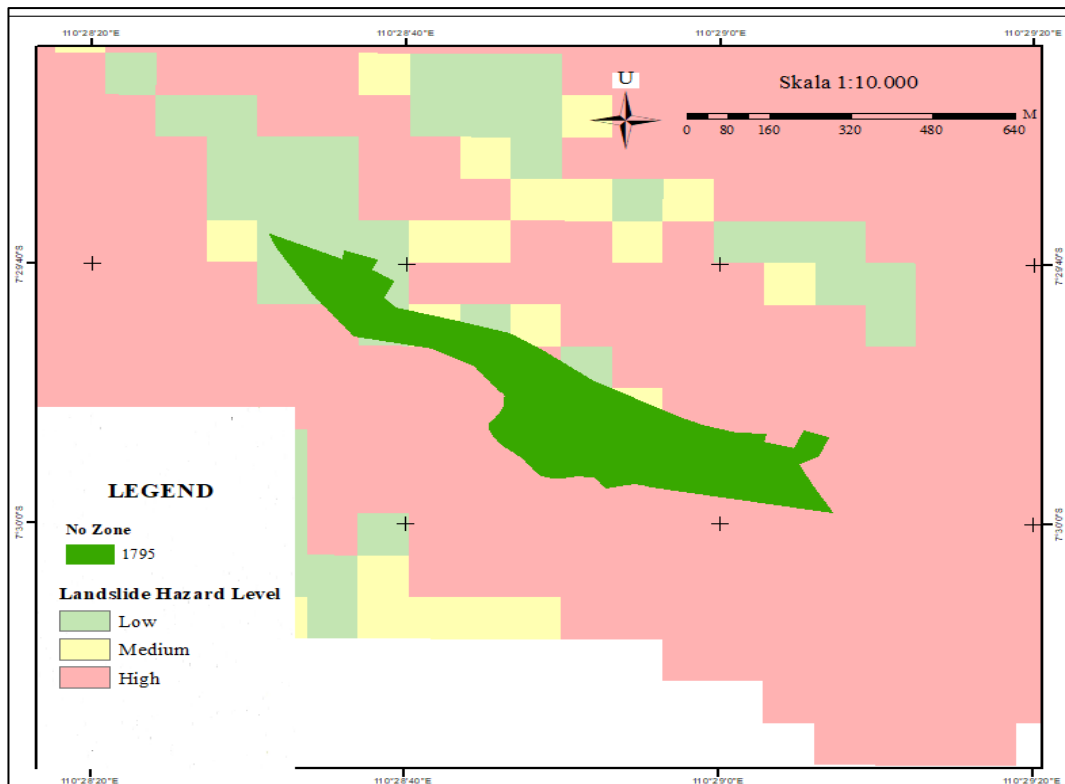


Figure 7. ZNT Change Map in 2021–2022 Lowest

Zone 1795 experienced the lowest increase in land value, namely Rp. 684, in 2021, which was originally Rp. 64,467 to Rp. 65,151 in 2022. This occurs because zone 1795 is on average the Tegalan area. This zone is also not crossed by collector roads. This zone is also very far from the center of Selo District, namely Selo Alun-Alun, Selo Market shopping center, affected by the landslide hazard and prices which were already low from the start, so that the land value in the zone has changes that are not high or can be said to be low.

### Areas Affected by Landslide Hazard

Selo District has many areas affected by landslide hazard which are spread out of a total of 113 land value zones, there are 107 zones affected by landslide hazard and there are only 6 land value zones that are not affected by landslide hazard, namely zones 319, 63, 66, 71, 80, and 85 in Figure 8.

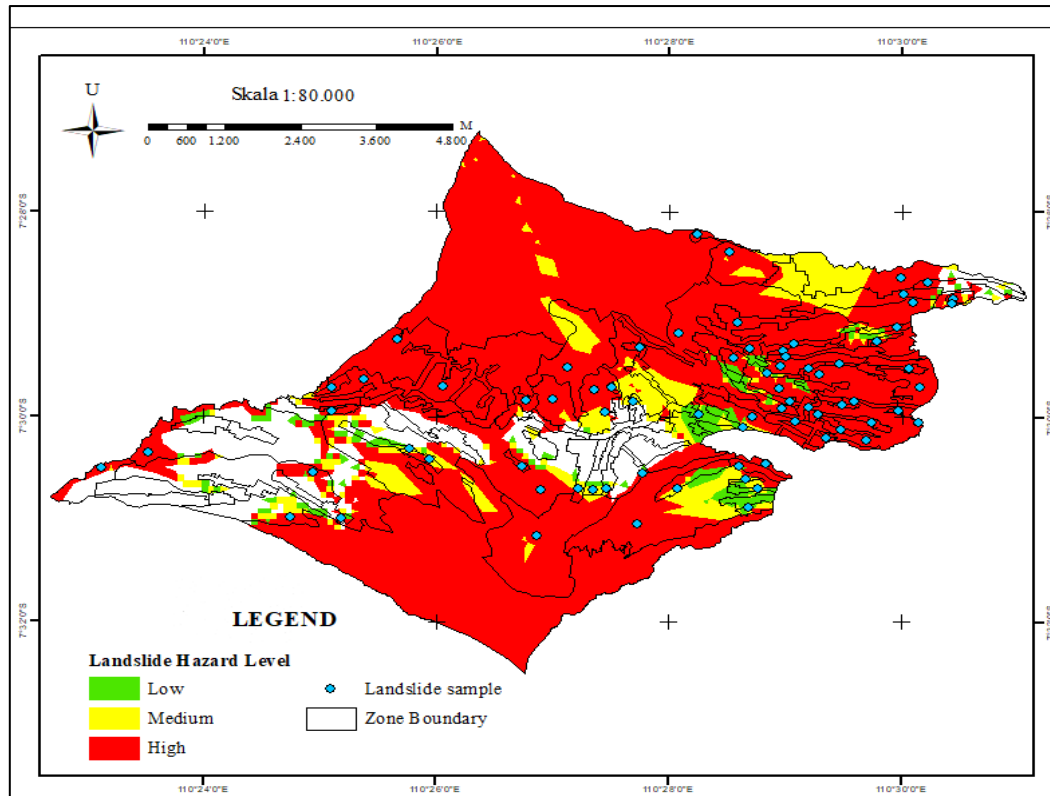


Figure 8. Affected Zone and Distribution of Landslide Hazard Samples

The figure shows that the distribution of samples affected by the landslide hazard is spread over several land value zones with the majority of the hazard level being classified as high and only a few hazard levels being classified as medium and low. From a total of 75 samples, a low landslide hazard level has a high NIR, a medium landslide hazard level has a medium NIR, and a high landslide hazard level has a low NIR. The average NIR for each classification of landslide hazard level can be seen in Table 1.

Table 1. Average NIR in Landslide Affected Zones

Danger Level	NIR Average
Low	IDR 709.970
Medium	IDR 317.089
high	IDR 111.160

Based on the Table 1 it can be seen that at a low landslide hazard level it has an average NIR of IDR 709.970 medium landslide hazard level has an average NIR of IDR 317.089, and high landslide hazard level has an average NIR of IDR 111.160. So it can be concluded that the existence of landslide hazard can affect the value of land in Selo District.

From the landslide hazard sample data and the land price value of each sample that has been obtained, a simple linear regression calculation is then performed to calculate the effect of the landslide hazard level on land prices. Linear regression is an analysis that aims to measure the value of the influence of one independent variable on the dependent variable. The result of the calculation can be seen in Table 2.

Table 2. Correlation Results Between Variables

correlations		Land Price	Landslide Hazard
Pearson Correlations	Land Price	1.000	-0.880
	Landslide Hazard	-0.880	1.000
Sig. (1-tailed)	Land Price	-	0.000
	Landslide Hazard	0.000	-
N	Land Price	75	75
	Landslide Hazard	75	75

The correlation between the level of landslide hazard and land prices obtained a value of  $r = -0.880$ . This value indicates a strong negative relationship between X1 and Y. The meaning of a strong negative is that there is an opposite relationship between X1 and Y. That is, if the value of the landslide hazard level goes up, the price of the land drops significantly and if the value of the landslide hazard level goes down, the price of the land goes up significantly.

Table 3. Results Summary models

Summary models						Changed Statistics				
Model	R	R Square	Adjusted R Square	std. Error of the Estimate	R Square Changed	F Square	df 1	df2	Sig. Changed	F
1	0.880	0.775	0.772	63217.167	0.775	251.584	1.000	73.000	0.000	

The table shows that the R square value is 0.775 or the coefficient of determination is 77.5%. R square is in the range of values from 0 to 1 which indicates that the smaller the value of R, the weaker the relationship between these variables.

Table 4 Coefficient Result

Coefficients <sup>a</sup>								
Model		Unstandardized		Standardized		95.0% Confidence Interval		
		B	std. Error	Betas	t	Sig.	LowerBound	Upperbound
1	(Constant)	846168.192	43867.032		19.289	0.000	758741.324	933595.060
	Score	-246205.145	15522.278	-0.880	-15.861	0.000	-277141.002	-215269.289

Table of coefficients (a) shows that the simple regression equation model used to estimate land prices that are affected by the level of landslide hazard is  $Y = 846168.192 - 246205.145 X$ .

From the equation above, several things can be analyzed, including:

- If the land price is without the landslide hazard level ( $X=0$ ), then it is estimated that the land price has a value of IDR 846,168.192. But if the level of landslide hazard has a value of 2 ( $X=2$ ), then it is estimated that the value of the land price is  $846168.192 - 246205.145 (2) = \text{IDR } 353,757.902$ .
- The regression coefficient  $b = -246205.145$  identifies the amount of reduction in land prices for each increase in the level of landslide hazard

Table 5. F test results

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	MeanSquare	F	Sig.
1	Regression	1.005E+12	1	1.005E+12	251,584	0.000 <sup>b</sup>
	residual	2.917E+11	73	3996410187		
	Total	1.297E+12	74			

The calculated F value can be seen in the table. Based on the table shows that the calculated F value is 251.584. Whereas for F table =  $(k; nk) = (1; 75-1) = (1; 74) = 3.970$ . This shows that  $F \text{ count} > F \text{ table}$ , so it can be concluded that landslide hazard (X) affects land prices (Y).

## CONCLUSION

Based on the results of land value zone calculations based on market prices in Selo District, Boyolali Regency, 113 zones with 575 samples obtained the zone with the highest

land price, namely zone 1787 which has a land price of IDR 1,150,240 per m<sup>2</sup>. Meanwhile, the zone that has the lowest land price is zone 1777, which is priced at IDR 37,013 per m<sup>2</sup>.

Analysis of changes in land values in 2019, 2021 and 2022 can be concluded that:

- a. Changes in the value of land in Selo District from 2019 to 2021 concluded that zone 1787 experienced the highest increase in land value, amounting to Rp. 271,989, in 2019 which was originally Rp. 735,502 to Rp. 1,007,491 in 2021. This is due to the location of the zone 1787 was not affected by the landslide hazard and prices were indeed high from the start, so that the value of land in the zone has a very high change. And the zone that experienced the lowest increase in land value was zone 1938, which amounted to IDR 1,716, in 2019 which was originally IDR 98,059 to IDR 99,775 in 2021. This happened because zone 1938 was affected by landslides and prices were already low from the start, so the value the soil in the zone has changes that are not high or can be said to be low.
- b. Changes in the value of land in Selo District in 2021 - 2022 concluded that zone 1787 experienced the highest increase in land value, namely Rp. 142,749, in 2021 which was originally Rp. 1,007,491 to Rp. 1,150,240 in 2022. This occurs because of the location Zone 1787 is not affected by the landslide hazard and prices are already high from the beginning, so the value of land in that zone has a very high change. And the zone that has experienced the lowest increase in land value is zone 1795, which is IDR 684, in 2021 from IDR 64,467 to IDR 65,151 in 2022. This occurs because of zone 1795 affected by the landslide hazard and prices which were already low from the beginning, so that the value of land in the zone has changes that are not high or can be said to be low.

Analysis of the effect of landslide hazard on land prices is as follows:

- a. It is known that zones affected by low level landslide hazard are zones that have dry land use, settlements/built-up land, and a few plantations that have an average NIR of IDR 709,970 zones affected by moderate landslide hazard, namely zones that have use of dry land, gardens, and a few settlements/built-up land which have an average NIR of IDR 317,089, and zones that are affected by a high level of landslide hazard, which is dominated by zones that have garden and moor land use which have an average NIR of IDR 111,160. So it can be concluded that the existence of landslide hazard can affect the value of land in Selo District.
- b. Based on the statistical tests that have been carried out, it is found that the correlation between landslide hazard and land prices is  $r = -0.880$ . This shows that if the value of the landslide hazard level increases, land prices will decrease significantly. The simple regression equation model used to estimate land prices that are affected by landslide hazard is  $Y = 846168.192 - 246205.145 X$ .

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