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To cite this article: A Apriani *et al* 2021 *IOP Conf. Ser.: Earth Environ. Sci.* **672** 012010

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The effect of land use conversion on landslides risk in protected function areas: case study in Samigaluh district, Kulon progo reGENCY, Yogyakarta, Indonesia

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Abstract. Protected areas whose function have been converted became problems in many regions. The cause of landslides is still being studied whether it is natural conditions or human contributions, namely land use changes. Investigation of land use change events play an important role in environmental sustainability. The purpose of this study was to determine the effect of land use change in protected areas against landslides. The method used is a surveillance method. The data is processed using non-parametric statistical tests by comparing the level of landslide hazards in areas where there is no land function conversion with those that have land function conversion. The data description shown that 58% of the protected function area in Samigaluh District had the potential for high landslides. The results obtained shown that there was a significant difference in the level of landslide hazard between areas with and without land function conversion. So that the land conversion that occurred in the protected forest in Samigaluh District had a significant effect on landslides as evidenced by the asymp sig (0.031) <p-value (0.05). This result becomes consideration for the local government in monitoring protected forests for environmental sustainability.

1. Introduction

The conversion of land functions is an activity resulting from changes in the economic structure of the community and from increase in population [1]. The conversion of land functions will affect environmental conditions[2]. In addition, it will be detrimental to the ecological function of the existing protected area[3]. Land conversion events occur in large cities including the Special Region of Yogyakarta (DIY) [4].

The DIY landscape is a combination of coastal areas, plains and hills / mountains which are grouped into four physiographic units. First, the physiographic unit of Mount Merapi with an altitude of 80-2,911 m in Sleman Regency, Yogyakarta City and parts of Bantul Regency. Second, the physiographic unit of the Southern Mountains (height 150-700 m) is located in the Gunungkidul Regency area. Third, the Kulonprogo Mountains physiographic unit, which is located in the northern part of Kulonprogo and is a hilly topographic landscape. Fourth, the lowland physiographic unit (altitude 0-80m) stretches in the southern part of the DIY region from Kulonprogo to the Bantul region bordering the Seribu Mountains [6].

The varied natural conditions of Yogyakarta have resulted in this region having varying potential for potential disasters [7]. Natural resource development must pay attention to the sustainable use and environmental preservation [2]. Mistakes in utilizing natural resources will actually result in disasters,



although disasters can also arise due to natural factors themselves. Disasters that occur can threaten and disrupt the lives and livelihoods of the community causing human casualties, environmental damage, material loss, and psychological impacts [8]. Natural disasters that often occur in DIY include floods, landslides, drought, fires, earthquakes and hurricanes [9].

The sub-districts where landslides often occur are Samigaluh and Kalibawang sub-districts. Meanwhile, according to BPS data, Kulon Progo Regency is the area with the second highest number of landslides after Bantul, namely 25 landslides with 2 people dying [11]. Many landslides in Kulon Progo occurred in Samigaluh District with 6 landslides [12]. Apart from being influenced by high rainfall and due to mining, land conversion is also a form of human intervention in nature that also triggers geomorphological processes that lead to disasters [13]. Based on the results of previous research that there were 47% land conversion in the Samigaluh District [14].

The purpose of this study was to determine the effect of land use change in protected areas against landslides. This study focuses on the quantitative analysis of the effect of land use change on landslides that occur in the protected area function of Samigaluh District, Kulon Progo Regency. The data scale in this study were ordinal and nominal scales, so the analysis used non-parametric statistical analysis, namely the Mann-Whitney test.

2. Method

The method used is a quantitative method by analyzing the effect of land use change on the level of landslide hazard in the protected area function in Samigaluh Subdistrict, Kulon Progo Regency using a non-parametric statistical mann witney test.

2.1. Protected Area Function

The determination of the function of the area in the research area is based on the Decree of the Minister of Agriculture No.837/Kpts/Um/11/1980 and No. 683/Kpts/Um/8/1981 regarding criteria and procedures for determining protection forest and production forest[14]. The criteria for determining the function of an area are evaluated according to three variables of land characteristics, namely: field slope, soil type, sensitivity to erosion, and average daily rainfall intensity. This information is obtained from the processing of topographic maps, soil maps, and rain data.

A protected function area is an area in which the condition of natural water resources, flora and fauna such as protected forests, forest reserves, tourism forests, areas around springs, river channels, and other protected areas as regulated in Presidential Decree 32 of 1990. A land is designated as protected function area, if the land score is ≥ 175 , or it meets one / more of the following conditions:

- a) Has a land slope of more than 40%
- b) Soil types are very sensitive to erosion (regosol, lithosol, organosol, and renzina) with a field slope of more than 15%,
- c) It is a water flow / river safety line, which is at least 100 meters on either side of a large river and 50 meters either side of a creek
- d) Is a spring protection, which is at least a radius of 200 meters around the spring,
- e) Is a lake / reservoir protection, which is 50-100 meters around the lake / reservoir,
- f) Has a height of 2,000 meters or more above sea level,
- g) Is a National Park area whose location has been determined by the government,
- h) For special purposes / interests and designated as a protected area.

2.2. Change of land function

The conversion of land functions in Samigaluh District, Kulon Progo District is determined based on field observations. The results of the observations found that 61 out of 128 observations (47%) occurred land use change which is described in the following table[14]:

Table 1. Determination of Area Function Types

Regional function	No Function Change Occurred	There was a change of function	Total
Protect	43	29	72
Buffer	17	29	46
One season	7	3	10
Amount	67	61	128

2.3. Landslide incident

Landslides are categorized as high landslides, moderate landslides and low landslides. The data is taken from BPBD Kulon Progo Regency. Meanwhile, to prove the incident, all observation points that have changed land functions or where land functions do not change are seen whether high, medium or low landslides have occurred through field observations. Landslide hazard map in Samigaluh district can be seen in Figure 1 [15].

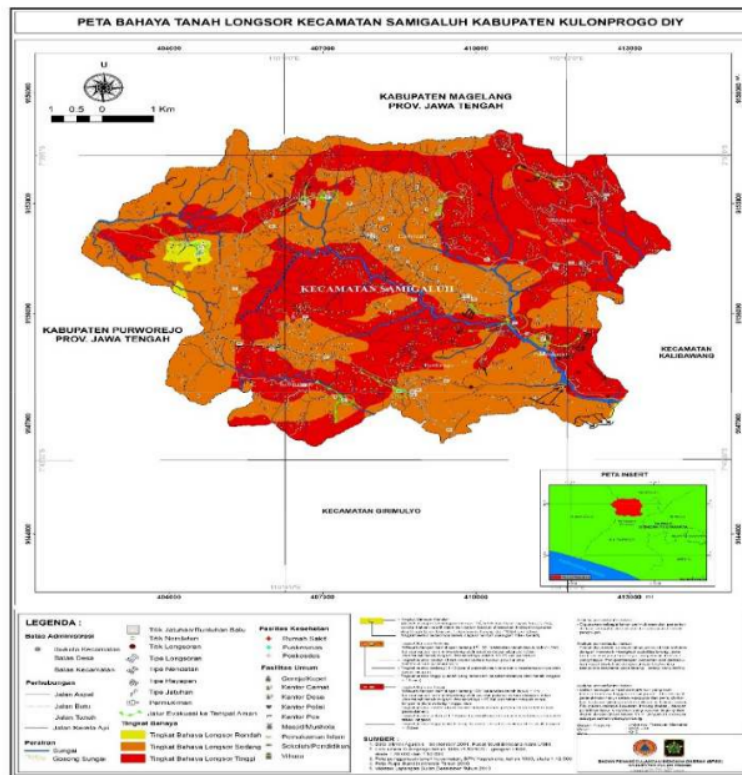


Figure 1. Landslide Hazard Map in Samigaluh District, Kulon Progo Regency

The image is then analyzed using ArcGIS software to determine the extent of each landslide hazard level category.

2.4. Data Analysis Process Using the Man Witney Test

The next process in this research is to analyze the data using no parametric analysis, namely the Man-Wilney test [16]. The Mann Wilney test is part of non-parametric statistics that aims to assist researchers in differentiating the performance results of the groups contained in the sample into two groups with two different criteria.[17].

If the sample is large (more than 20), the z formula is used, namely:

$$\text{Average} = \mu_u = \frac{n_1 n_2}{2} \text{ and standard deviation } \sigma_u = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}} \quad (1)$$

So that the standard normal variable is formulated

$$Z = \frac{U - \frac{n_1 n_2}{2}}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}} \quad (2)$$

Decision making was carried out with a significance level of 0.05 (5%) with the criteria H_0 rejected if p value <0.05.

3. Results and discussion

The purpose of this research is to find out influence land use change to landslides in a protected function area in Samigaluh District, Kulon Progo Regency, Yogyakarta. The sample used as a representation of this research is 72 observation points consisting of 43 data where there is no land use change and 29 data that occur land function change.

3.1. Transfer of Land Functions to Protected Area Functions

The analysis to determine the occurrence of landslide hazards in the protected area function is divided into two maps, namely data on the function of protected areas with land use changes and data on protected area functions where there is no land use change as depicted in Figures 2 and 3.

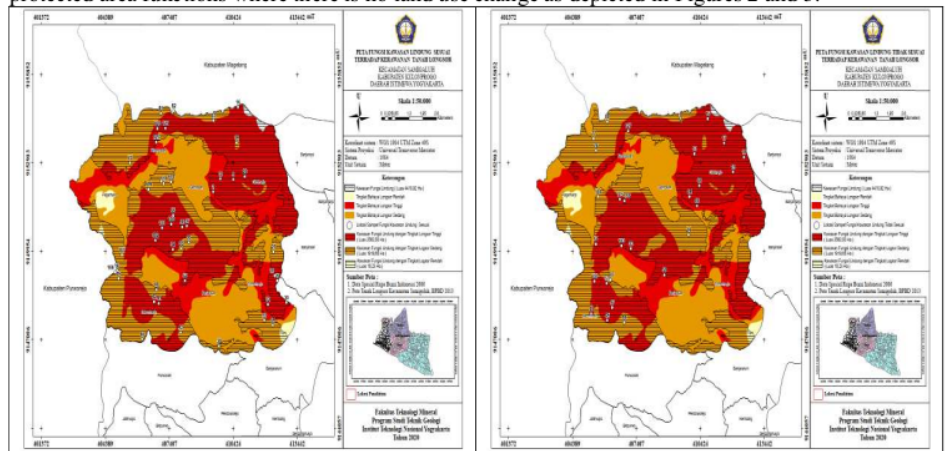


Figure 2. Map of protected areas where there is no land conversion

Figure 3. Map of Protected Areas with Change of Land Functions

Figure 2 data on the function of a protected area with no land use change. The data in the area is dominated by a moderate landslide hazard level, namely 23 places (53.5%), while high landslides are 20 places (46.5%). Figure 3, namely areas with land use change dominated by high landslide hazard levels (72.4%) while medium landslides in 8 places (27.6%).

3.2. Effect of Land Function Change on Landslide Hazard Level in Samigaluh District, Kulon Progo Regency

The relationship between Land Function Change and the level of landslide hazard in Samigaluh sub-district, Kulon Progo Regency can be seen in the Table 2.

Table 2. Cross table of land function change with landslide incidence in Samigaluh District, Kulon Progo Regency

Change of Land Function Event	Landslide Danger Level				Total	
	Moderate		High		N	%
	N	%	N	%		
There is no change of land function	23	31.9%	20	27.8%	43	59.7%
There is a change of land function	8	11.1%	21	29.2%	29	40.3%
Total	31	43.1%	41	56.9%	72	100.0%

From the data above, it can be seen that for data where land conversion does not occur, most of the landslide hazard levels are moderate, namely 23 (31.9%), for high landslide incidents of 20 places (27.8%). Meanwhile, the data that contained land use change were mostly in high landslides, namely 21 places (29.2%) and moderate landslides in 8 places (11.1%).

To determine the significance of the effect of land conversion on the level of landslide hazard in the protected area, an analysis was carried out using non parametric test, i.e., Man Witney test. The test results are shown in the Table 3.

Table 3. Mann Witney Test Results

Variables	Mean Rank	Z calculation	Significancy	Conclusion
Landslide in no change of land function	32.74	-2.162	0.031	H0 is false
Landslide in a change of land function	42.07			

Based on the output results, it shows that the p value is 0.031 <0.05 in other words H₀ is rejected. Thus, at the 95% confidence level, it can be said that the variable of land use change affects the level of landslide hazard in the protected area function in Samigaluh District, Kulon Progo Regency.

4. Conclusion

Land conversion can increase the level of landslide hazard apart from natural conditions. This is indicated by the percentage of landslide hazard levels in areas where landslide changes are higher than those without land function conversion. This study shows a significant effect of land conversion on landslides in the protected area function as indicated by the statistical test value of p value 0.031 <0.05 at the 95% confidence level.

Acknowledgments

This research is supported by the research costs of the Ministry of Research and Technology/National Agency for Research and Innovation with grant number is 04/ITNY/LPPMI/Pen.DRPM/PDP/VI/2020.

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