



# Analysis of Land Use Changes due to Landslides in Panti District Using Landsat 8 Imagery

Zubaidah<sup>1\*</sup>, Anis Watin Faizah<sup>1</sup>, Annastasya Putri<sup>1</sup>, Dianti Prakastiwi<sup>1</sup>, Era Iswara Pangastuti<sup>1</sup>, Ana Susiati<sup>1</sup>

<sup>1</sup>Department of Geography Education, Jember University, Jl. Kalimantan37 Jember, East Java, 68121, Indonesia

\*Email: [zub28702@gmail.com](mailto:zub28702@gmail.com)

**Abstract.** The Panti District area which is located in the highlands often experiences landslides, on the other hand the population growth of the Panti District has also experienced an increase in population. This of course can provide potential land damage, disruption of ecosystem balance, and loss of land cover vegetation. This study aims to determine changes in land use due to landslides in the Panti District. This study uses a quantitative descriptive research method with data collection techniques sourced from secondary data. While the analysis technique uses the supervised maximum likelihood classification method and accuracy test. This accuracy test is carried out to determine the accuracy of the classified image with data in the field. The results of the Landsat 8 imagery accuracy test in Panti District in 2018 and 2022 using Google Earth obtained the same results, namely 86.66% of the 30 sample points. Meanwhile, the classification is determined into 4 classes, namely, forest, sawan, settlements, and gardens. Where from the results of the classification and accuracy test, it was obtained data that land use in the Panti District between 2018 and 2022 there was an almost complete change in land use on all of its land with the use of paddy fields having the most changes, namely increase to 8,421 Ha in 2022 which causes degradation and deforestation of forest lands, thus triggering an increase in landslide disasters. Therefore, it is necessary to reduce development near steep slopes and minimize development near areas with less stable slopes, as well as reduce the conversion of forest land to rice fields.

**Keywords:** Land Use, Natural Disasters, Landsat Imagery 8, Remote Sensing, ENVI

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## 1. Introduction

Panti District, Jember Regency, East Java has an area of 93.96 Km<sup>2</sup> with a population of 65,084 people and a population density of 706.72 people/Km<sup>2</sup>, and the population growth rate of the Panti District from 2010-2021 is 0.92% (BPS, 2022). The consequence of the increasing population growth rate is environmental problems, because with increasing population growth and increasing population activity in an area it will affect the need for food, raw materials, and settlements as well as other basic needs, which means the need for land is also experiencing enhancement.

Land is a human resource in supporting human life activities either as a permanent residence or as a processing of natural resources (Permana et al., 2018). This land can be interpreted as a certain part of the earth's surface which includes everything that makes up the biosphere such as the atmosphere, soil and parent rock, topography, water, flora and fauna, as well as the influence of past and present human activities, which have global impacts. evident in land use both now and in the future. Basically a piece of land cannot increase, this is what makes a change in land use which tends to reduce the proportion of previous land (Kusrini et al., 2011). If this condition continues, it can reduce the quality of the environment, as well as the carrying capacity of the environment which will decrease and can cause environmental problems.

The Panti area is located on the slopes of Mount Argopuro which is part of the tropics, causing the intensity of rainfall in the area to be quite high. Panti Subdistrict, which has very high rainfall and mountainous areas with an average slope of 40%, has the potential for soil cracks and soil movement which triggers landslides (Robbi, et al., 2022). The steeper the slope or slope of a slope, the greater the potential for landslides to occur, because the stability of the slope depends on the slope of the slope. The topographical conditions of the Panti District vary from flat areas to mountainous areas which predominate so that there are many steep and steep slopes which will affect soil stability (Robbi, et al, 2022). In 2006 Panti District experienced landslides and flash floods on the slopes of Mount Argopuro (Kholida, 2018). The natural disaster that occurred in Panti Sub-District took quite a number of victims because it happened in the early hours of the morning which caused them to be unable to save themselves and the victims who

survived were traumatized. When heavy rains continued to flush Jember Regency, hundreds of residents who were victims of the 2006 flash floods were traumatized again and made them afraid because during the past week after the afternoon until evening the rain did not stop, the residents of Suci Village, Panti District, a number of villages in Panti are still prone to incidents. the disaster, even in some parts of the ground cracks have been found (Robbi, et al., 2022). The existence of these disasters does not only have a negative impact on humans, but also on nature which can experience damage to land or land that becomes critical, disruption of ecosystem balance, and loss of land cover vegetation.

According to Asri (2010) in Pratama (2018), the flash floods and landslides that occurred at the beginning of the turn of 2006 were the biggest floods in recent years and brought enormous damage. With various factors causing this disaster, both natural factors, such as high rainfall, presence of faults, high slope and regolith depth, the potential for landslides will also increase with the presence of infrastructure or settlements due to population density in areas prone to landslides (Susanti , 2017). The condition of the Panti area which is prone to landslides makes it necessary to study the background of this research, related to how land use changes in Panti District, Jember Regency due to the landslide natural disaster.

## 2. Methods

The type of research used in this study is a quantitative descriptive data analysis. Quantitative research is an approach to test objective theory by examining the relationship between variables (Creswell, 2014). In collecting data using non-participant observation techniques and literature studies, where researchers are not directly involved with the object being studied by researchers and observation activities are carried out through secondary data in the form of Landsat 8 imagery obtained from remote sensing technology to analyze changes in land use is done by processing the images of the Panti sub-district in 2018 and 2022 using ENVI 4.5 and ArcGis 10.4.1 software.

This research was conducted in the Panti sub-district, Jember district with the data collection techniques used in this study, namely the preparation stage, the image classification stage, and the accuracy test stage. The data processing technique uses image classification techniques in the form of supervised classification and accuracy testing. The following is a diagram of the stages of the research carried out.

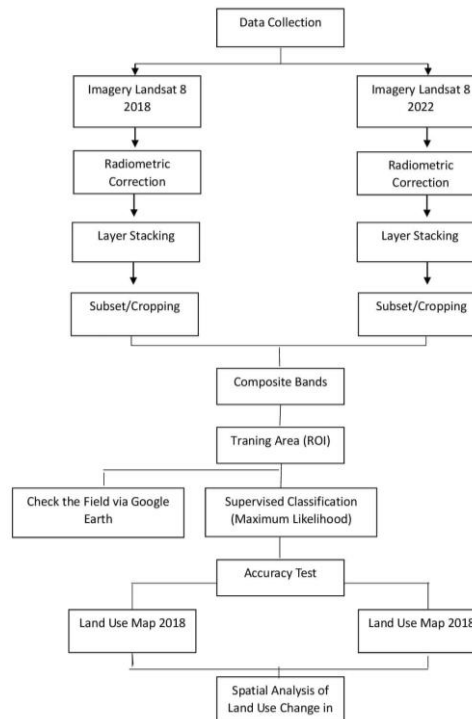


Fig. 1 Research Flowchart

Data analysis in this study will be presented in the form of land use change maps for 2018 and 2022 which will show the results of land use changes from images that have been processed in the Envi 4.5 software using the supervised maximum likelihood and ArcMap 10.4.1 methods. As for knowing the level of accuracy, that is by using a suitability table or confusion matrix. Through the suitability table, the results of each of the appropriate land use image interpretations are then divided by the number of samples and multiplied by 100%, in order to obtain accuracy for each land use in the study area. From the suitability table to ensure the accuracy of the interpretation, the following equation can be used:

$$\text{Interpretation Correctness Level} = \frac{\text{number of correct points}}{\text{number of surveyed points}} \times 100\% \dots (1)$$

Susanti, et al (2020) stated that an accuracy value in land use mapping with an accuracy value of more than 85% can be categorized as good, while an accuracy value of less than 50% is categorized as sufficient or bad.

### 3. Results and Discussion

#### A. General description

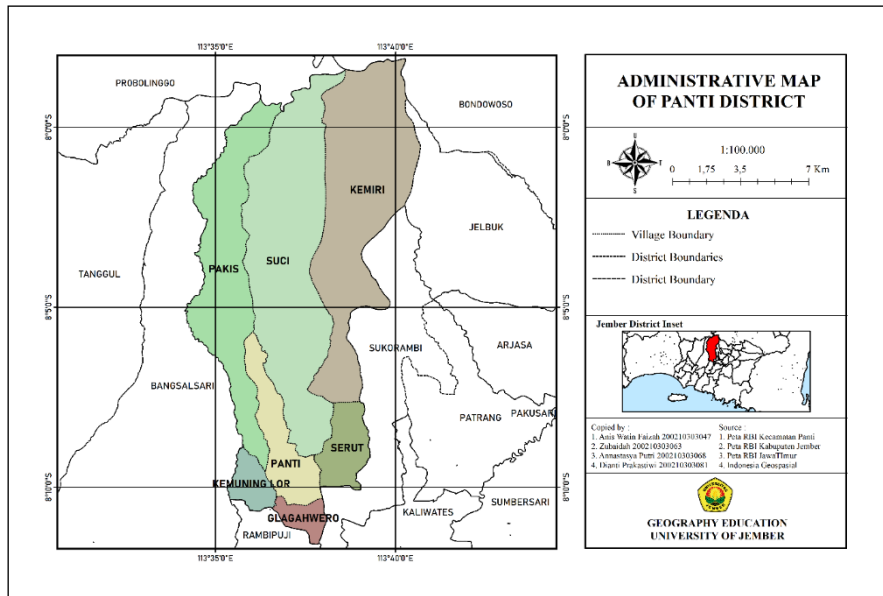


Fig. 2 Administrative Map Of Panti District

Panti sub-district is one of the sub-districts in Jember district. This sub-district is located approximately 12 km to the northwest of the capital city of Jember Regency. The area of Panti District is 160.71 km<sup>2</sup> with an average height of 71 m above sea level. Based on Figure 1. it can be seen that the Panti District consists of 7 Villages which include Panti Village, Glagahwero Village, Kemuning Sarilor Village, Pakis Village, Serut Village, and Kemiri Village. Administrative boundaries of Panti District are to the north by Argopuro Mountains, to the west by Bangsalsari District, to the south by Rambipuji District, and to the east by Sukorambi District.

Geographically, Panti District is located in a highland area located under Mount Algotpuro (Sulistiyo, 2020). The morphology of the Panti Subdistrict area is dominated by hilly areas, with varying slopes. However, more than 30% of the Panti Subdistrict area is on a slope of >40. With these geographical conditions, this region has a fairly high average intensity of rainfall. Because the higher the place, the higher the rainfall intensity will also be (Nurnasari & Djumali, 2010 in Rizki, et al., 2020). The type of soil in Panti District is a type of andosol soil formed from the weathering of volcanic rocks.

#### B. Image Classification Accuracy Test 2018

Based on the 2018 accuracy test on the results of image classification which was carried out using data from a comparison of sample points according to the number of sample points. The following is a calculation of the accuracy of the classification of changes in land use in the Panti sub-district which is presented in Table 1.

**Table 1**  
2018 Accuracy Test Error Matrix

Field Category	Interpretation Category				Line Totals
	Jungle	Ricefield	Settlement	Plantations	
Jungle	8				8
Ricefield		6	2		8
Settlement		1	6	1	8
Plantation				6	6
<b>Column Totals</b>	<b>8</b>	<b>7</b>	<b>8</b>	<b>7</b>	<b>30</b>

Mapping Accuracy				Accuracy of Interpretation Results
Producer's Accuracy	Error Omission	User Accuracy	Error Omission	
8/8 = 100%	0%	8/8 = 100%	0%	(8+6+6+6)/30 = 86.66%
6/7 = 85.71%	14.29%	6/8 = 75%	25%	
6/8 = 75%	25%	6/8 = 75%	25%	
6/7 = 85.71%	14.29%	6/6 = 100%	0%	

Based on table 1, the results of the calculation of the accuracy of the land use classification above are 86.66%. This accuracy value indicates that the results of the image classification accuracy test that has been carried out can be categorized as accurate. This is supported by research conducted by Susanti, et al (2020) which states that an accuracy value in land use mapping with an accuracy value of more than 85% can be categorized as good, while an accuracy value of less than 50% is categorized as sufficient or bad. In the accuracy test in this study the number of sample points used was 30 samples. The appropriate samples were 24 samples and 4 samples that were not suitable.

**C. Image Classification Accuracy Test 2022**

**Table 2**  
2022 Accuracy Test Error Matrix

Field Category	Interpretation Category				Line Totals
	Jungle	Ricefield	Settlement	Plantations	
Jungle	7	1			8
Ricefield		6	1	1	8
Settlement			8		8
Garden		1		5	6
<b>Column Totals</b>	<b>7</b>	<b>8</b>	<b>9</b>	<b>6</b>	<b>30</b>

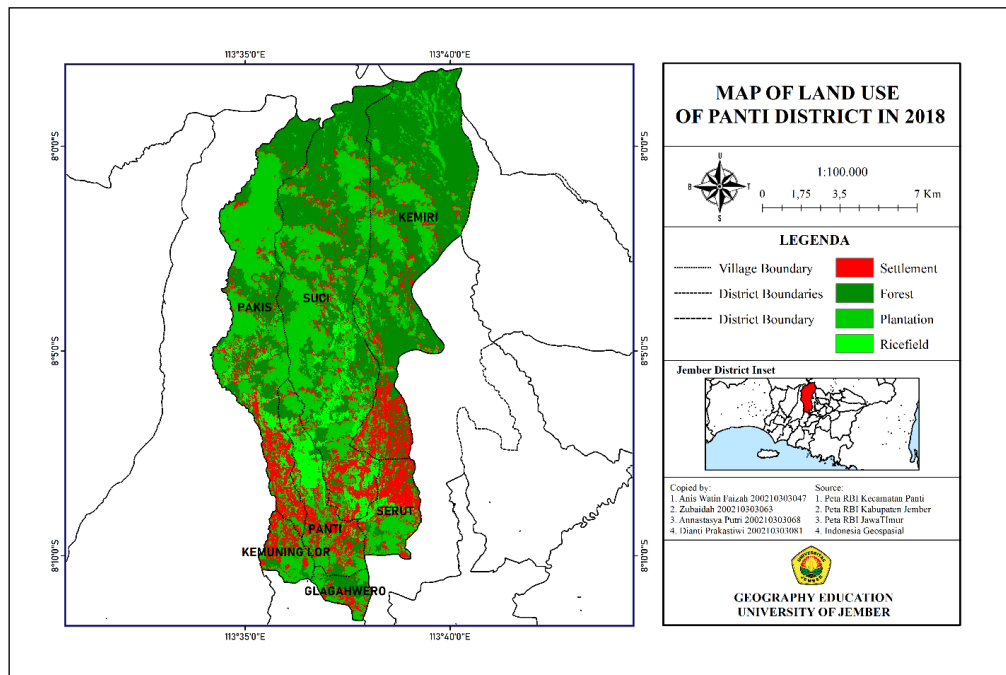
Mapping Accuracy				Accuracy of Interpretation Results
Producer's Accuracy	Error Omission	User Accuracy	Error Omission	
7/7 = 100%	0%	7/8 = 87.5%	12.5%	(7+6+8+5)/30 = 86.66%
6/8 = 75%	25%	6/8 = 75%	25%	
8/9 = 88.88%	11.11%	8/8 = 100%	0%	
5/6 = 83.33%	16.67%	5/6 = 83.33%	16.67%	

Based on table 2, the results of the calculation of the accuracy of the land use classification above are 86.66%. This accuracy value indicates that the results of the image classification accuracy test that has been carried out can be categorized as accurate with the results of the accuracy of the image with the results in the field. This is because the results of the accuracy is more than 85% so it is categorized as good. In the accuracy test in this study the number of sample points used was 30 samples. The appropriate samples were 24 samples and 4 samples that were not suitable

**D. Land Use in 2018**

Classification of landsat 8-OLI imagery for land use in Panti District in 2018 was studied using the supervised maximum likelihood analysis method. Based on the results of the analysis, it showed that there were four classes of

land use that were distributed quite dominantly in Panti District in that year, including settlements, forests, plantations and rice fields. Settlements are symbolized in red, forests are symbolized in dark green, plantations are light green and rice fields are symbolized in bright green. This is stated in the results of the 2018 Panti sub-district land use map in Figure 1 which has been processed using supervised maximum likelihood.



**Fig. 3** Map of Land Use of Panti District in 2018

Land use in 2018 in Panti District in 2018 on the map shows that forest land and plantation land have the largest distribution area. Forest land and plantations are mostly spread over the three Administrative Villages of Panti District, namely Kemiri Village, Suci Village and Pakis Village. In terms of regional topography, the results of the image extraction data are accurate because the three villages above are highland areas that are close to Mount Pasang with fertile land areas that are still beautiful. The distribution of land use for settlements in the Panti District in 2018 is spread across Serut Village, Panti Village, Glagahwero Village and Kemuning Lor Village. Residential land is also scattered at several points in Suci Village, Kemiri Village and Pakis Village with an elongated pattern of settlement distribution. Distribution of settlement land in Serut Village, Panti Village.

#### E. Land Use in 2022

Landsat 8-OLI image classification for land use in Panti District in 2022 was studied using the supervised maximum likelihood analysis method. Based on the results of the analysis, it showed that there were four classes of land use spread across the Panti District in that year, including settlements, forests, plantations and rice fields. Settlements are symbolized in red, forests are symbolized in dark green, plantations are light green and rice fields are symbolized in bright green. This is stated in the results of the 2022 Panti sub-district land use map in Figure 2. which has been processed using supervised maximum likelihood.

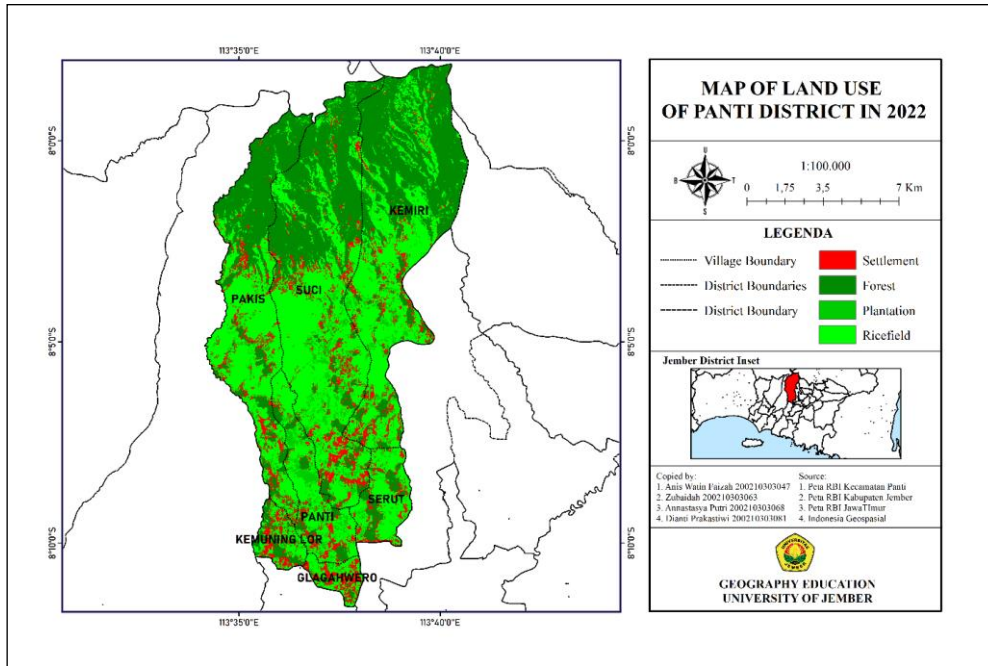


Fig. 4 Map of Land Use of Panti District in 2022

The results of Panti District land use based on 2022 data show that green area land still dominates according to the distribution of colors shown on the map. The majority of forest land is scattered in Kemiri Village, Suci Village and Pakis Village. The use of paddy fields almost dominates the entire area of the Panti District. On average, plantations are located in areas adjacent to forests which are areas with a highland topography at the foot of Mount Pasang. Settlement Land which is symbolized in red shows a distribution that is not too dense. The settlement pattern in Panti District extends following the road and in Glagahwero Village, because the area is not too wide, the settlement pattern is grouped

**F. Land Use Area**

**Table. 3**  
Land Use Area

No	Land Use	Area Ha	
		2018	2022
1	Ricefield	1411	8421
2	Settlement	2967	1680
3	Plantations	6221	1038
4	Forest	7497	6959
<b>Amount</b>		<b>18086</b>	<b>18098</b>

Based on Table 3. the distribution area of the Panti District land use in 2018-2022 which is most dominated by land use in 2018, namely forest with an area of around 7497 ha. Meanwhile, the highest land use in 2022 will be the use of paddy fields with an area of around 8421 ha. In addition, there has been a decrease in land use in settlements and plantations from 2018 to 2022.

**Discussion**

Based on the results of OLI landsat 8 image extraction regarding land use in Panti District in 2018 and 2022 through mapping data it shows that land classification is divided into four classes, including settlements, forests, plantations and rice fields. The results of the 2018 and 2022 land use maps show that in the Panti District forest lands show quite a stark difference. The distribution of forest land is very dominant in Kemiri Village but in 2022 it shows that the appearance of the forest has diminished enough and has been replaced by land use conversion for

the rice fields sector. This is in accordance with image data that the area of forest land in 2018 is around 7,497 Ha, while in 2022 the area of forest has decreased to a total area of 6,959 Ha. Areas of forest land change that are quite significant in 2022 are very visible in Kemiri Village. The condition of the extensive forest indicates that the area is in a highland area, this is in accordance with the topographical conditions of the area in Serut Village, Suci Village and Kemiri Village which have altitudes above 200 meters above sea level, for the height of the Suci Village and Kemiri Village reaching 700 and 600 above sea level because the area is in a highland area at the foot of Mount Pasang.

Changes in land use in Panti District, which was originally a forest land area, became paddy fields. The conversion of land use change is indicated by a decrease in the area of forest land which can be seen on the map. this change is shown by data in 2018 paddy fields had an area of 1,141 Ha, while in 2018 it had increased to 8,421 Ha. Wider paddy fields in 2022, this is in accordance with the conditions of agricultural yields in the Panti District which continue to increase. Activities Changes in land use from forest land to paddy fields are changes caused by humans with the aim of long-term regional planning in accordance with the required needs. Devi & Triyatno, (2020) conveyed that a human activity that can change land cover is called agroforestry which means a technological practice carried out after appropriate diagnosis, design, participatory research or characterization studies depending on social, economic and environmental problems in an area, the consequences of Such actions result in deforestation and degradation of land, for example forest areas, especially protected forests. This requires monitoring in the right way and at the right time because forest resources are very important. As a result of these actions, there is deforestation and degradation of land, for example forest areas, especially protected forests. This requires monitoring in the right way and at the right time because forest resources are very important. As a result of these actions, there is deforestation and degradation of land, for example forest areas, especially protected forests. This requires monitoring in the right way and at the right time because forest resources are very important.

Land use transitions that are quite visible in the Panti District in the next 2018 and 2022 are residential land. Based on BPS data for Jember Regency, Panti District has an area of around 93.96 km<sup>2</sup>. The results of the two maps show that residential land in 2018 looks denser compared to residential land use in 2022. Residential land in Panti District in 2018 was 2,967 Ha, then in 2022 the area was around 1,038. The most visible decrease in changes in settlement areas was found in Serut Village and Suci Village. Then data on the population density of the Panti District in 2020 reached 65,084 people while in 2018 the population was around 62,148 people. Through these data, it certainly shows that there has been an increase rather than a decrease so that there is a possibility of expanding the area for settlements in the Panti District in 2022 which will cause the residential area to decrease slightly. The decrease in the number of residential land areas in the Panti District was probably caused by the relocation of residential areas from the highlands to the lowlands with a non-clustered residential development pattern. Suci Village is a highland area with an altitude above 400 meters above sea level, so it is necessary to relocate residential land to avoid potential landslides which are identical to occur in areas with highland topography with steep hills. The third difference is that plantation land in the Panti District between 2018 and 2022 has not experienced significant changes. Empowerment of plantation land in Panti District is widely spread in Kemiri Village and Suci Village with scattered plantation products including coffee, cocoa and rubber.

Land use change activities in the Panti District between 2018 and 2022 were caused by the regional development pattern in the Panti District in the form of land transfer and reconstruction. The most visible land change in Panti District is the conversion of forest land to paddy fields. These changes are enough to cause defortation and land degradation on forest land to become paddy fields. The decline in water catchment areas and vegetation in the form of large trees in forest areas has triggered an increase in landslides in Panti District, which topographically the area is classified as a hilly plain located at the foot of Mount Pasang. The landslide natural



disaster which is quite common in Panti District is vulnerable in 2018 and 2022, especially at points with steep slopes. Most of the landslides in Panti District occurred in Kemiri Village, which is adjacent to the plantation area. Landslides occur due to scouring on the cliffs of Mount Pasang because the area is a highland area so it is quite frequent during the rainy season. In accordance with the results of Nurcahyo's research (2011), which predicts that Panti District has a Stable condition with an area of 36.2 km<sup>2</sup> (20.85%), a Marginal condition of 4 km<sup>2</sup> (2.30%), and an Unstable condition of 133.4 km<sup>2</sup> (76.84%). Meanwhile, from the area and percentage of Stability index classes in Panti District, it can be predicted that the villages are the most stable and the villages most prone to landslides. The village with the most stable condition is Glagahwero village with a stable total area of 2.2 km<sup>2</sup> (98% of the total area of Glagahwero Village) and the village with the most unstable conditions (Unstable) is Kemiri Village with an unstable total area of 48.2 km<sup>2</sup> (91.5% of the total area of Kemiri Village). This condition shows that the importance of vegetation for rainwater infiltration and reducing development near steep slopes and minimizing development near areas with less stable slopes.

#### 4. Conclusion

The results of landsat 8-OLI image extraction, Panti District, Jember Regency in 2018 and 2022 are categorized into 4 land use classes, including forests, rice fields, plantations, and settlements. Land use in the Panti District in 2018 and 2022 has experienced quite striking changes in some of its land, where in this paddy field land use class there has been the largest change in area among the others. In 2018, paddy fields had a land use area of 1,141 Ha, while in 2022 it increased to 8,421 Ha, which means that there has been a change in the use of forest land into paddy fields, because forest land has decreased in area. This decrease in land area can cause deforestation and degradation of forest land. This of course can trigger landslides due to lack of catchment areas and vegetation due to forest degradation and deforestation. In addition, the increase in population did not significantly affect changes in land use, which actually experienced a decrease in land use from 2018 - 2022. This was due to the expansion of the area which resulted in the distribution of settlements not being clustered and the possibility of land reconstruction. In an effort to prevent landslides, several efforts can be made, namely by reducing development near steep slopes and minimizing development near areas with less stable slopes, as well as carrying out reforestation.

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