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Soil Damage Potential Index Based on Weighting Scoring Analysis and Utilization of Geographical Information Systems

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ABSTRACT

Indonesia's population in 2021 will increase by 0.92% from 2020. The increasing population demands the fulfillment of food. Land changes and their consequences indicate land damage. The purpose of the study was to assess the soil damage potential index (SDPI) on the slopes of Mount Argopura through terrain analysis and the use of geographic information system technology. The research was carried out on the slopes of Mount Argopura in 2022. The tools used included a clinometer, a GPS, spectrophotometer, AAS, arc GIS 13 and minitab. The materials included administrative maps, soil maps, slope maps, RBI maps, land use maps, rainfall maps. This research is descriptive exploratory with field survey method. The activity is divided into 3 stages, namely pre-survey, field survey, and post-survey. Research parameters include texture, soil thickness, soil type, soil pH, CEC, base saturation, soil drainage, parent material, landform, relief, rainfall, and land use. Based on the results of the study, the SDPI with an area of 22,148.75 ha was in the heavy category 44.12% (9772.28 ha), the medium category was 53.11% (11762.84 ha), and the light category was 2.77% (613.63 ha).

1. INTRODUCTION

Soil is part of the land resource which plays a very important role, especially in storing water and supporting the productivity of the plant biomass above it. The role of soil which is very important in protecting the environment needs to be maintained especially for the survival of living things. Activities carried out by humans in processing both providing inputs and reducing soil material which includes the process of cultivating plant commodities will affect processes in the soil such as infiltration, eluviation, illuviation, runoff, erosion, and landslides as well as decreasing soil quality. Human activities that affect the process of changing soil conditions include fertilization, monoculture management, plowing, soil compaction, irrigation, reduction of soil depth, land clearing (Basuki *et al*., 2021; Basuki *et al*., 2022).

The total population of Indonesia in 2021 will increase by 2.53 million people (0.92%) from 2020. The increase in population has an impact on increasing demand for food, especially from agricultural commodities. In 2021 the demand for rice food will increase by 351.71 thousand tons from 2020 (31.69 million tons). The increase in population and the amount of food will have an impact on demands for increased production of agricultural products. On the other hand, agricultural land is decreasing due to the conversion of agricultural land to non-agricultural land such as settlements, industrial buildings, roads and other public facilities. Land conversion in Indonesia annually reaches 60,000-100,000 ha, which includes > 4,000 ha of paddy fields (Nurchamidah & Djauhari, 2017). The decrease in the agricultural land area due to conversion of land use, demands an increase in the productivity of cultivated plants through intensification methods. Intensification and excessive land use can damage the soil.

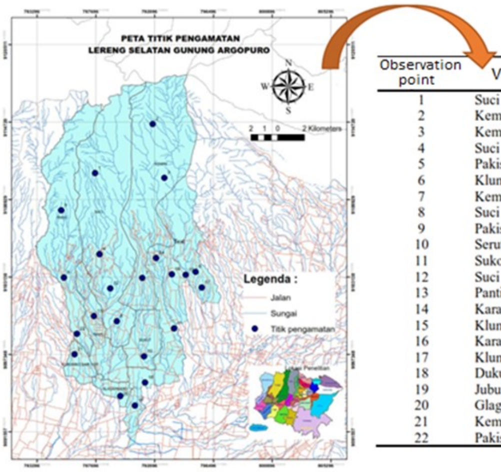
Mount Argopura is part of the Iyang mountain complex in the horseshoe area of East Java. The Iyang mountain complex stretches from Mount Raung, Mount Ijen, Mount Argopura, and Mount Lemongan. Mount Argopura has a height of 3,088 meters above sea level (masl). The area of Mount Argopura stretches and is in 5 districts namely Jember Regency, Bondowoso Regency, Situbondo Regency, Probolinggo Regency and Lumajang Regency. Amin (2011), states that Mount Argopura is an inactive mountain that has old quarter volcanic residue which has land deposits in the southern part of Mount Argopura which are getting thicker and experiencing physical changes that are getting softer. This softening causes the removal of materials, elements, and the weathering process is accelerated by the introduction of water into the cracks (Kendarto *et al*., 2021; Nugraha *et al*., 2021). This process will cause landslides due to damage to the top soil, especially in areas with an altitude of 400-800 masl. This is supported by land conversion for settlements and land use activities for economic activities.

The conversion of forests to agriculture and fields on the slopes of Mount Argopura in 1998-2000 caused significant changes, especially in 2006 there were floods and landslides caused by rain for 2 consecutive days because the soil was unable to hold and hold water in it. Floods in the area on the southern slopes of Mount Argopura occurred in Pakis Village, Panti Village, Suci Village, Kemiri Village, Glagahwero Village, and several villages on the southern slopes of Mount Argopura. The land change and its consequences indicate soil damage on the southern slopes of Mount Argopura. Remedial action through reforestation and reforestation activities is needed so information on the status of land damage is needed as a basis for policy making. The aim of the study was to assess the soil damage potential index (SDPI) on the southern slopes of Mount Argopura using the terrain method and the use of geographic information technology.

2. MATERIALS AND METHODS

The research was conducted on the southern slopes of Mount Argopura, Panti District and Sukorambi District, Jember Regency with coordinate positions 113.572-113.687 East Longitude, 7.97-8.22 South Latitude and the Laboratory of Soil Science Study Program, Faculty of Agriculture, University of Jember. The laboratories used include the Chemistry & Soil Fertility Laboratory, the Physics & Soil Conservation Laboratory, the Pedology & Land Resources Laboratory, and the Geographic Information Systems Laboratory. The time of the research was carried out in January-May 2022.

The tools used in field and laboratory research include a Global Positioning System (GPS), altimeter, abney level, compass, dagger, hoe, clay meter, soil drill, camera, spectrophotometer, AAS, and other laboratory support tools. The tools used for data analysis included computers along with arc gis 13 and minitab software. Materials used in the study included administrative maps, soil type maps, land slope maps processed from DEM data, Indonesian topographical maps, land use maps, and rainfall maps.



Observation point	Village	UTM Zona 49 S BT	UTM Zona 49 S LS
1	Suci	113,609	8,035
2	Kemiri	113,648	8,002
3	Kemiri	113,657	8,038
4	Suci	113,613	8,089
5	Pakis	113,587	8,061
6	Klungkung	113,678	8,102
7	Kemiri	113,642	8,106
8	Suci	113,625	8,136
9	Pakis	113,589	8,106
10	Serut	113,644	8,158
11	Sukorambi	113,664	8,140
12	Suci	113,621	8,113
13	Panti	113,610	8,132
14	Karangpring	113,651	8,093
15	Klungkung	113,671	8,104
16	Karangpring	113,662	8,103
17	Klungkung	113,683	8,113
18	Dukuhmencek	113,645	8,176
19	Jubung	113,637	8,192
20	Glagahwero	113,628	8,186
21	KemuningLor	113,597	8,157
22	Pakis	113,598	8,145

Figure 1. Observation points

This research is a descriptive explorative research using field survey method. Research activities are divided into 3 stages, namely pre-survey, field survey, and post-survey. Pre-survey activities include preparing tools and materials for survey activities, determining correspondence to facilitate field surveys, determining the location of soil observation points to be taken (Figure 1). The working map is obtained from the overlay process of soil type maps, slope maps, land use maps, rainfall maps. The result of the overlay map is a working map or land unit map. Determination of observation points resulting from work maps. Field surveys were carried out by observing soil and environmental characteristics. Soil characteristics observed in the field included texture, soil thickness, soil type, soil pH, cation exchange capacity (CEC), base saturation (KB), soil drainage. The observed biophysical characteristics include parent material, landform, relief, rainfall, and land use. The criteria for each soil parameter and land biophysics as a basis for determining soil damage are shown in Table 1 and Table 2.

Table 1. Soil parameter score criteria

No.	Soil Texture	Score	Soil Depth	Score	Soil Drainage	Score	Soil Type	Score
1.	Fine	1	Very deep, >150 cm	1	Very slow	1	Vertisol	1
2.	Slightly fine	2	Deep (100-150 cm)	2	Slow	2	Oxixol	2
3.	Medium	3	Medium (50-99cm)	3	Slightly slow, good, medium	3	Alfisol, Molisol, Ultisol	3
4.	Slightly coarse	4	Shallow (25-49 cm)	4	Slightly fast	4	Inceptisol, Entisol, Histosol	4
5.	Coarse	5	Very shallow (<25 cm)	5	Fast	5	Spodosol, Andisol	5

Source: (Hikmat *et al*., 2009; Syamsul & Syahrul, 2021)

Table 2. Score criteria for land biofisical parameters

No.	Relief	Score	Rainfall	Score	Land use	Score
1.	Fat (0-3%)	1	<1500 mm/y	1	Forest, ricefields	1
2.	Rather flat (3-8%)	2	1500-2000 mm/y	2	Shrubs, mead-ows, mixed gardens	2
3.	Sloping (8-15%)	3	2000-2500 mm/y	3	Production for-est, plantation, dry farming	3
4.	Little hilly (15-25%)	4	2500-3000 mm/y	4	Moor (annual crops)	4
5.	Hilly (25-40%), Very steep (40-60%), Very very steep (>60%)	5	>3000 mm/y	5	Open fields	5

Source: (Hikmat *et al*., 2009; Syamsul & Syahrul, 2021)

The weight of the soil damage potential index (*SDPI*) was assessed based on the total weighted scores of soil characteristic parameters and biophysical parameters. The weight value of each parameter was 10. The results of calculating the weight of the soil damage assessment were classified as in Table 3. The formula for determining the *SDPI* was as follows:

$$SDPI = \frac{1}{35}\,(TS + DR + JT + RE + CH + PL + KT)\ \times 100\% \qquad (1)$$

where *TS* is score of soil texsture, *DR* is soil drainage score, *JT* is score for soil type, *RE* is score for land relief, *CH* is rainfall score, *PL* is land use score, and *KT* is score for soil depth. If all parameters have score of 5, then the *SDPI* will be 100%.

Table 3. Classification of the weight of potential land damage assessment

No.	SDPI (%)	Appreciate the potential for land damage
1.	0-20	Not damage
2.	21-40	Lightly damage
3.	41-60	Moderate damage
4.	61-80	Heavily damage
5.	81-100	Very heavily damage

Sumber: (Hikmat *et al*., 2009; Syamsul & Syahrul, 2021)

Table 4. Interval of correlation value and its interpretation

No	Correlation coeffisient	Interprestation of correlation
1.	0,80-1,00	Very strong
2.	0,60-0,79	Strong
3.	0,40-0,59	Strong enough
4.	0,20-0,39	Low
5.	0,00-0,19	Very low

Data analysis used a correlation test using the minitab program. The correlation test intervals are shown in Table 4. The results of the data analysis were continued by making spatial images using interpolation analysis so that the map distribution and potential area of soil damage were obtained using the arc gis 13 program.

3. RESULTS AND DISCUSSION

3.1. Biophysical Characteristics

Mount Argopura is a mountain that is currently inactive and volcanic activity has affected the biophysical characteristics of the land on the southern slopes. The geology that composes the southern slope of Mount Argopura is the Argopura Breccia Formation (Qvab) and the Argopura Fan Sediment Formation (Qaf). The Argopura breccia formation that composes the southern slope is andesite rock interspersed with lava, while the Argopura fan deposit formation is composed of fragments of Argopura mountain rock. Table 5 shows that the parent material composing the south slope of Argopura is composed of andesite and basaltic andesite. Andesite has a glass afiric to porphyric-aphanitic collocrystalline texture with a composition of pyroxene (10-15%), againoclast (50-80%), amphibole (5-10%) (Sophian *et al.*, 2011). Basaltic andesite is a rock composed of the minerals plagioclase (75%), hornblend (3%), pieoxene (5%), biotite (2%), glass (20%), and quartz (5%) (Kristanto & Sugarbo, 2020).

Table 5. Biophysical characteristics (parent material, landform, relief)

Observation point	Village	UTM Zona 49 S		Main Rock	Landform	Relief (%)
		E Long	S Lat			
1	Suci	113.609	8.035	Andesite	Upper volcanic slope	Very very steep (>60)
2	Kemiri	113.648	8.002	Andesite	Upper volcanic slope	Very very steep (>60)
3	Kemiri	113.657	8.038	Andesite	Upper volcanic slope	Very steep (40-60)
4	Suci	113.613	8.089	Andesite	Middle volcanic slope	Hilly (25-40)
5	Pakis	113.587	8.061	Andesite	Upper volcanic slope	Very steep (40-60)
6	Klungkung	113.678	8.102	Andesite	Middle volcanic slope	Hilly, small (15-25)
7	Kemiri	113.642	8.106	Andesite	Vulcan ridges	Hilly, small (15-25)
8	Suci	113.625	8.136	Basaltic Andesite	Lava flow	Sloping (8-15)
9	Pakis	113.589	8.106	Andesite	Middle volcanic slope	Hilly (25-40)
10	Serut	113.644	8.158	Andesite	Lava flow	Sloping (8-15)
11	Sukorambi	113.664	8.140	Andesite	Vulcan ridges	Sloping (8-15)
12	Suci	113.621	8.113	Andesite	Middle volcanic slope	Hilly (25-40)
13	Panti	113.610	8.132	Andesite	Middle volcanic slope	Hilly, small (15-25)
14	Karang pring	113.651	8.093	Basaltic Andesite	Vulcan ridges	Hilly, small (15-25)
15	Klungkung	113.671	8.104	Basaltic Andesite	Lava flow	Sloping (8-15)
16	Karang pring	113.662	8.103	Andesite	Lava flow	Sloping (8-15)
17	Klungkung	113.683	8.113	Basaltic Andesite	Middle volcanic slope	Hilly, small (15-25)
18	Dukuh Mencek	113.645	8.176	Basaltic Andesite	Vulcan plains	Flat (0-3)
19	Jubung	113.637	8.192	Basaltic Andesite	Vulcan plains	Flat (0-3)
20	Glagah wero	113.628	8.186	Basaltic Andesite	Vulcan plains	Flat (0-3)
21	Kemuning Lor	113.597	8.157	Basaltic Andesite	Lava flow	Sloping (8-15)
22	Pakis	113.598	8.145	Basaltic Andesite	Lava flow	Sloping (8-15)

The geomorphology of the landform on the slopes of Mount Argopura from 22 observation points has varied lanforms which are divided into 5 landforms, namely upper volcanic slopes, middle volcanic slopes, volcanic ridges, lava flows, and volcanic plains. Landforms have an important meaning in land identification both past, present and future. Landforms can provide an overview of the location regarding the potential for erosion, landslides, or other activities that occur at the research location (Ikqra, 2013). Landform has a positive correlation with relief with a correlation value of 0.8 (strong). The southern slope of Argopura has a relief of mostly steep, small hills. Observation points 1 and 2 have steep relief with a slope percentage of > 60%, observation points 3 and 5 have very steep relief (40-60%), observation points 4, 9 and 12 have hilly relief (25-40%), observation points 6, 7, 13, 14, and 17 have hilly, small relief (15-25%), observation points 8, 10, 11, 15, 16, 21, 22 have sloping relief (8-15%), and observation points 18, 19, 20 have flat relief (0-3%). The distribution of lanforms and relief of the south slope of Mount Argopura is shown in Figure 2. The parent material is a natural foundation that has an influence on the deformation of the landform because each parent material has different characteristics (Suratman *et al*., 2018; Ferdeanty *et al*., 2020).

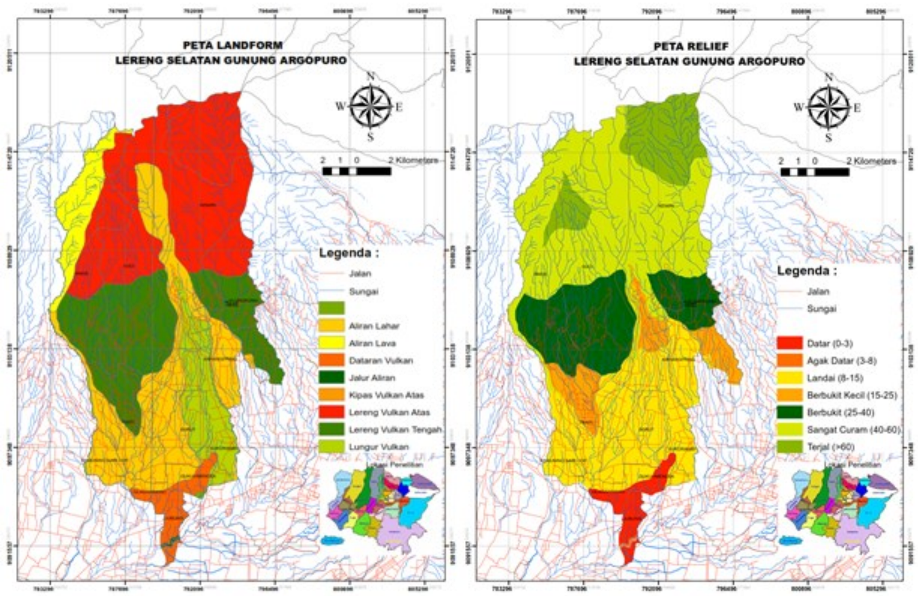


Figure 2. Map of the landform and relief map of the southern slope of Mount Raung

The parent material has a different lithology which is the building block of the soil (Ridwan *et al*., 2018). The lithology of each region is different so that it influences the shape of the land that is formed (Ferdeanty *et al*., 2020). Samples of sedimentary rock will form relatively sloping to flat land found on the banks of river plains. The slope of the slope results from deformation effects related to gravitational forces so that steep slopes will trigger soil movements and rock fall will move down the slope rapidly (Zaennudin *et al*., 2012). Ground movement on steep land will accelerate land formation quickly because rock fall is always associated with steep slopes and rock outcrops. Outcrop rocks move downward if these rocks are in soil with shallow depths that are easily shaken due to external factors (Mulyani *et al*., 2020).

The correlation test shows that the relief has a fairly strong correlation with soil depth with a correlation value of 0.589. Soil depth of the southern slopes of Mount

Argopura 9.09% of the number of observation points has a shallow soil depth (25 – 49 cm) at observation points 1 and 2; 40.90% of the total points have moderate soil depth (50 – 99 cm); 9.09% of the total points have deep soil depth (100-150 cm); 40.90% of the total points have very deep soil depth (>150 cm) (Table 6). Soil depth is one of the determining factors for soil erodibility. Erodibility is the amount of soil that is eroded and lost due to erosion or carried by runoff.

Table 6. Biophysical characteristics (soil depth, soil drainage)

Observation point	Village	UTM Zona 49 S		Soil depth	Soil drainage
		E Long	S Lat		
1	Suci	113.609	8.035	Shallow	Good
2	Kemiri	113.648	8.002	Shallow	Good
3	Kemiri	113.657	8.038	Deep	Good
4	Suci	113.613	8.089	Very deep	Good
5	Pakis	113.587	8.061	Deep	Good
6	Klungkung	113.678	8.102	Very deep	Good
7	Kemiri	113.642	8.106	Very deep	Good
8	Suci	113.625	8.136	Medium	Good
9	Pakis	113.589	8.106	Very deep	Good
10	Serut	113.644	8.158	Medium	Good
11	Sukorambi	113.664	8.140	Very deep	Good
12	Suci	113.621	8.113	Very deep	Good
13	Panti	113.610	8.132	Very deep	Good
14	Karangpring	113.651	8.093	Very deep	Good
15	Klungkung	113.671	8.104	Medium	Good
16	Karangpring	113.662	8.103	Medium	Good
17	Klungkung	113.683	8.113	Very deep	Good
18	Dukuh Mencek	113.645	8.176	Medium	Slow
19	Jubung	113.637	8.192	Medium	Slow
20	Glagah Wero	113.628	8.186	Medium	Slow
21	Kemuning Lor	113.597	8.157	Medium	Good
22	Pakis	113.598	8.145	Medium	Good

Soil depth is closely related to the storage capacity of groundwater, the deeper the soil the more it stores groundwater and vice versa. Water that enters the soil will be distributed into the soil pores through the infiltration process and the rest will be removed through the percolation process (Haridjaja *et al*., 2013). As much 90.47% of the observation sites were dominated by good drainage class, and the rest had obstructed drainage. Obstructed drainage classes are in valleys with flat topography and are in areas traversed by rivers. Drainage is hampered apart from being in a stretch of river because it has a fine soil texture (Kartika *et al*., 2016).

Rainfall in the Districts of Panti and Sukorambi is divided into 4 rainfall classes, namely 2000-2500 mm/y, 2500-3000 mm/y, 3000-3500 mm/y, 3500-4000 mm/y (Table 7). The distribution of rainfall is dominated by an intensity of 3000-3500 mm/y. Based on these data, rainfall in the Districts of Panti and Sukorambi is in the high category. Indonesia is located in a tropical climate region that has a wide variety of rainfall intensity (Rahayu *et al*., 2018). The intensity of rainfall will affect the stability of the soil. A rainfall intensity of 51 mm/hour can remove up to 40% of topsoil and when supported by a slope of 20o can increase the erosion rate by 3% (Sitepu *et al*., 2017). Topography and landform affect rainfall intensity, coastal areas and lowlands have high rainfall intensity due to higher temperatures than mountain peaks (Fadilla *et al*., 2017; Prasetyo *et al*., 2018).

Observation point	Village	UTM Zona 49 S		Rainfall (mm)	Soil type	Land use
		E Long	S Lat			
1	Suci	113.609	8.035	3000-3500	Lithic Hapludands	Forest
2	Kemiri	113.648	8.002	2000-2500	Lithic Hapludands	Forest
3	Kemiri	113.657	8.038	3000-3500	Typic Hapludands	Shrubs
4	Suci	113.613	8.089	3000-3500	Andic Dystrudepts	Shrubs
5	Pakis	113.587	8.061	3500-4000	Typic Hapludands	Forest
6	Klungkung	113.678	8.102	3000-3500	Typic Dystrudepts	Moor
7	Kemiri	113.642	8.106	3000-3500	Typic Dystrudepts	Moor
8	Suci	113.625	8.136	3000-3500	Typic Eutrudepts	Moor
9	Pakis	113.589	8.106	3500-4000	Andic Dystrudepts	Moor
10	Serut	113.644	8.158	3000-3500	Typic Eutrudepts	Moor
11	Sukorambi	113.664	8.140	3000-3500	Typic Dystrudepts	Moor
12	Suci	113.621	8.113	3000-3500	Andic Dystrudepts	Plantation
13	Panti	113.610	8.132	3000-3500	Typic Dystrudepts	Plantation
14	Karangpring	113.651	8.093	3000-3500	Typic Dystrudepts	Plantation
15	Klungkung	113.671	8.104	3000-3500	Typic Eutrudepts	Upland rice
16	Karangpring	113.662	8.103	3000-3500	Typic Eutrudepts	Upland rice
17	Klungkung	113.683	8.113	3000-3500	Typic Dystrudepts	Plantation
18	Dukuh Mencek	113.645	8.176	2500-3000	Typic Epiaquepts	Ricefields
19	Jubung	113.637	8.192	2500-3000	Typic Epiaquepts	Ricefields
20	Glagah Wero	113.628	8.186	2500-3000	Typic Epiaquepts	Ricefields
21	Kemuning Lor	113.597	8.157	3000-3500	Typic Eutrudepts	Upland rice
22	Pakis	113.598	8.145	3000-3500	Typic Eutrudepts	Upland rice

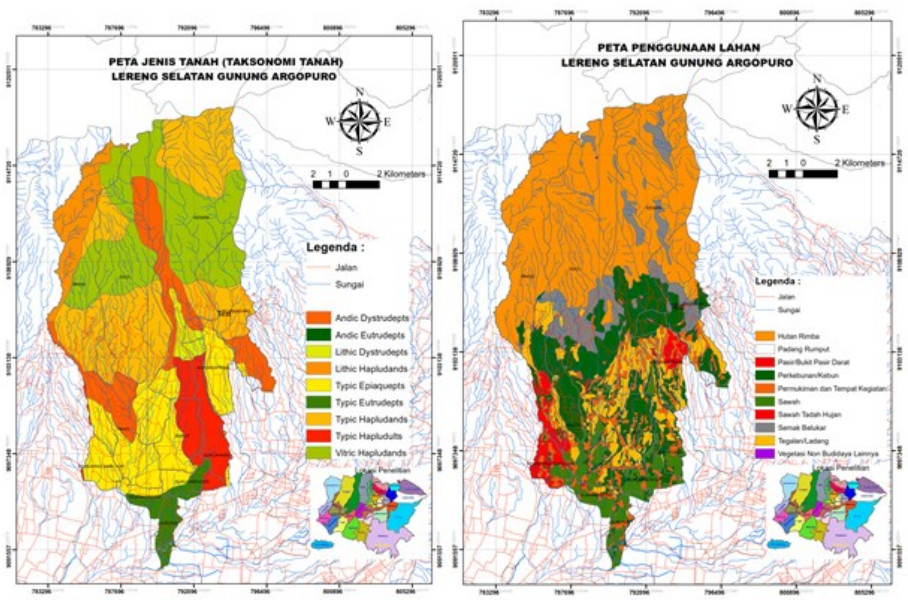


Table 7. Rainfall, soil type, and land use type

Figure 3. Map of soil types and land use on the southern slopes of Mount Argopura

The five soil-forming factors that most actively influence the process of soil development in the tropics, namely climate factors (Sabila & Abdurrachman, 2020). The dominant climatic factors in soil formation are temperature and rainfall (Basuki *et al*., 2021). Soil formed south of Mount Argopura based on USDA classification in the andisol and inceptisol orders. Andisol soils are scattered at several observation points including observation points 1, 2, and 3. Observation points 1 and 2 are included in the lithic hapludands subgroup. Lithik hapludands are soils that are formed to a moderate depth and there is lithic contact at a depth of 50 cm from the soil surface (Basuki *et al*., 2022; Sukri *et al*., 2020). The use of soil with a shallow-medium solum having a fine soil texture with steep slope conditions is used for conservation land and forests (Harijanto *et al*., 2016; Mulyani *et al*., 2020; Zaennudin *et al*., 2012). Nineteen observation points with a percentage of 86.36% soil type in the Inceptisol order with land use as dry fields, forests, plantations, rice fields, shrubs. Inceptisol soil is soil that is starting to develop with marked formation of a soil horizon on the cambic endopedon (Azuka *et al*., 2015; Basuki & Sari, 2020).

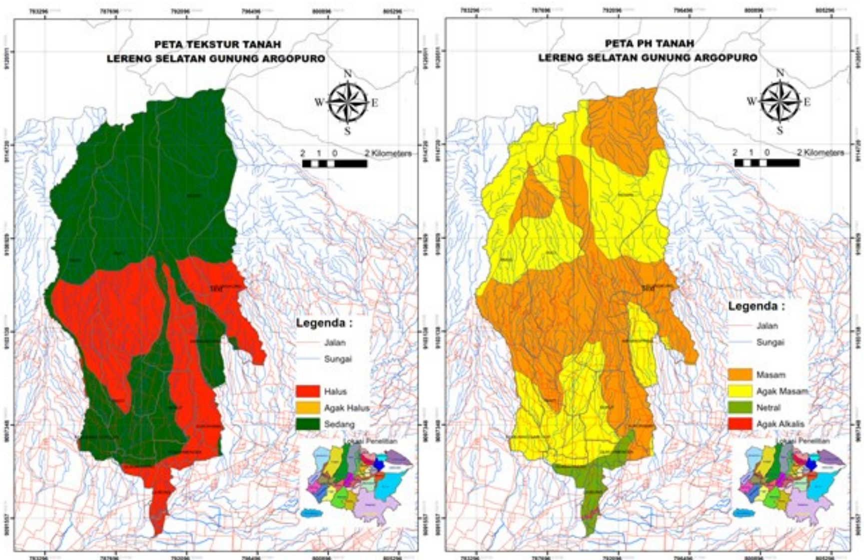
3.2. Soil Physical and Chemical Characteristics

Andisol and inceptisol soil types are young soil types that are affected by volcanic activity (Savitri & Supriatna, 2021). Young soil types have a medium-fine soil texture (Ferdeanty *et al*., 2020). As much 48% of the number of observation points with medium textures are scattered with observation points 1, 2, 3, 5, 8, 10, 15, 16, 21, and 22. Soils with medium texture in the soil texture class are divided into loam, sandy loam, loam, dusty loam, and dust. The percentage of loamy textured soils is around 12.5-27.5%; dust 30-80%; and sand 20-80%. Fine soil texture occupies 52% of the number of observation points and is spread over observation locations 4, 6, 7, 9, 11, 12, 13, 14, 17, 18, 19, 20. Soil texture has a positive correlation to permeability values, soil drainage conditions and soil porosity (Surya & Nuraini, 2015; Nita *et al*., 2015). The correlation between soil texture and soil drainage is very close with a probability value of 0.89.

Soil characteristics that are influenced by parent material and the environment

Observation point	Village	UTM Zona 49 S		Texture	pH	CEC	KB
		E Long	S Lat				
1	Suci	113.609	8.035	Medium	Acid	Medium	Medium
2	Kemiri	113.648	8.002	Medium	Acid	Medium	Medium
3	Kemiri	113.657	8.038	Medium	Slightly acid	Low	Medium
4	Suci	113.613	8.089	Fine	Acid	Medium	Medium
5	Pakis	113.587	8.061	Medium	Slightly acid	Low	Medium
6	Klungkung	113.678	8.102	Fine	Acid	Medium	Medium
7	Kemiri	113.642	8.106	Fine	Acid	Medium	Medium
8	Suci	113.625	8.136	Medium	Slightly acid	Low	Medium
9	Pakis	113.589	8.106	Fine	Acid	Medium	Medium
10	Serut	113.644	8.158	Medium	Slightly acid	Low	Medium
11	Sukorambi	113.664	8.140	Fine	Acid	Medium	Medium
12	Suci	113.621	8.113	Fine	Acid	Medium	Medium
13	Panti	113.610	8.132	Fine	Acid	Medium	Medium
14	Karangpring	113.651	8.093	Fine	Acid	Medium	Medium
15	Klungkung	113.671	8.104	Medium	Slightly acid	Low	Medium
16	Karangpring	113.662	8.103	Medium	Slightly acid	Low	Medium
17	Klungkung	113.683	8.113	Fine	Acid	Medium	Medium
18	Dukuh Mencek	113.645	8.176	Fine	Neutral	High	Very high
19	Jubung	113.637	8.192	Fine	Neutral	High	Very high
20	Glagah Wero	113.628	8.186	Fine	Neutral	High	Very high
21	Kemuning Lor	113.597	8.157	Medium	Slightly acid	Low	Medium
22	Pakis	113.598	8.145	Medium	Slightly acid	Low	Medium

include soil pH, cation exchange capacity (CEC), and base saturation (KB) (Table 8). Most of the soils with forming materials from volcanic activity have a slightly acidic soil pH (Basuki *et al*., 2015; Basuki *et al*., 2022; Basuki & Winarso, 2021; Pertami *et al*., 2022). The slopes of Mount Argopura are areas formed from volcanic landform with andesite as the main material. Andesite rock is an external igneous rock that has acidic properties with a pH value of 5.28-5.48 (Ferdeanty *et al*., 2020; Haumahu, 2009; Kristanto & Sugarbo, 2020; Ridwan *et al*., 2018; Setiawati *et al*., 2019; Sophian *et al*., 2011; Stepanus *et al*., 2014). The main parent material and rainfall affect the soil characteristics that are formed (Ayyu *et al*., 2014). Observation points 18, 19, and 20 have a



neutral pH because they are in the plains area and are used for technical irrigated rice fields (Figure 4). The flooding process causes cations such as Fe, Mn, and Al to dissolve and infiltrate into the bottom layer which will leave alkaline cations, so that the soil pH rises. Acid cations will precipitate according to the redox potential (Eh) (Susanto, 2013). The redox potential value of ferric Fe becoming ferrous in paddy soil is Eh +300 mV at pH 6, Eh +100 mV at pH 7, Eh - 100 mV at pH 8 (Cyio, 2008).

Table 8. Soil physical and chemical characteristics

Cation exchange capacity (CEC) is the ability of the soil to bind and exchange cations. The south slope of Mount Argopura from 22 observation points has mostly low -medium CEC, and a few have high CEC. High CEC was found at observation points 18, 19 and 20. CEC correlated quite closely with texture, landform, relief, drainage, land use, soil pH and base saturation. Fine textures dominated by clay fractions have greater ability to exchange cations because clay is negatively charged (Intara *et al*., 2011). The

Observation point	Village	UTM Zona 49 S		Weighting score (%)	Soil damage potential
		E Long	S Lat		
1	Suci	113.609	8.035	74.29	Heavy
2	Kemiri	113.648	8.002	68.57	Heavy
3	Kemiri	113.657	8.038	71.43	Heavy
4	Suci	113.613	8.089	60.00	Medium
5	Pakis	113.587	8.061	65.71	Heavy
6	Klungkung	113.678	8.102	57.14	Medium
7	Kemiri	113.642	8.106	57.14	Medium
8	Suci	113.625	8.136	65.71	Heavy
9	Pakis	113.589	8.106	60.00	Medium
10	Serut	113.644	8.158	65.71	Heavy
11	Sukorambi	113.664	8.140	54.29	Medium
12	Suci	113.621	8.113	62.86	Medium
13	Panti	113.610	8.132	60.00	Medium
14	Karangpring	113.651	8.093	60.00	Medium
15	Klungkung	113.671	8.104	62.86	Medium
16	Karangpring	113.662	8.103	62.86	Medium
17	Klungkung	113.683	8.113	60.00	Medium
18	Dukuh Mencek	113.645	8.176	45.71	Light
19	Jubung	113.637	8.192	45.71	Light
20	Glagah Wero	113.628	8.186	45.71	Light
21	Kemuning Lor	113.597	8.157	62.86	Medium
22	Pakis	113.598	8.145	62.86	Medium

clay mineralogy that dominates the Inceptisol soil is kaolinite. Kaolinite has the ability to bind and exchange high cations. Most of the base saturation values are moderate and only three observation points have very high values.

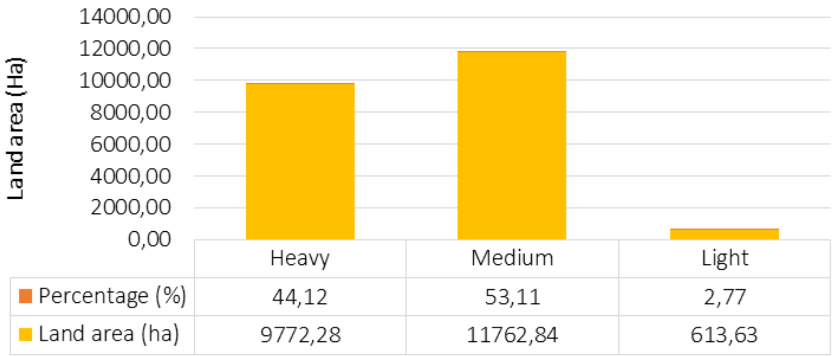


Figure 4. Map of the soil texture and soil pH distribution of the southern slopes of Mount Argopura

3.3. Soil Damage Potential Index

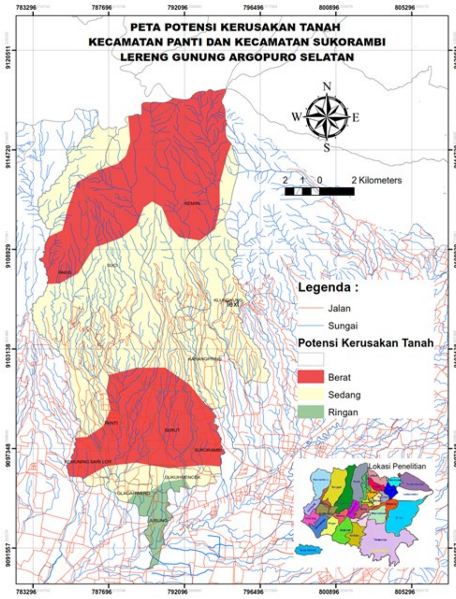
Land is the environment in which it consists of vegetation, soil, relief, climate, and other factors utilized for human welfare. Soil management needs to pay attention to the science of soil and environmental conservation. Land with poor management will be damaged. Soil damage without knowing the cause and happening continuously will cause disaster. The results of the analysis of potential soil damage at the study site show that there are three categories of potential soil damage including severe, moderate and light. Table 9 shows that 27.27% of the observation points have the potential for severe soil damage, 59.09% of the observation points have the potential for moderate soil damage, 13.64% of the observation points have the potential for light soil damage. Soil damage for potential weight with a weight classification value above 66% is spread over the observation points of the villages of Suci, Kemiri, Pakis, Serut with weight classification percentage values respectively 74.27%, 68.57%, 71.43% , 65.71%, and 65.71%.

Table 9. Potential for soil damage

Sub district	Village	Land damage potential index (ha)			
		Heavy	Medium	Light	Total
Sukorambi	Dukuh Mencek	119.45	346.91	98.02	564,38
Sukorambi	Jubung	0.00	0.00	381.89	381,89
Sukorambi	Karangpring	0.14	885.36	0.00	885,49
Sukorambi	Klungkung	4.23	1852.95	0.00	1857,18
Sukorambi	Sukorambi	530.71	326.24	0.00	856,95
Panti	Pakis	938.96	2729.62	0.00	3668,58
Panti	Panti	641.05	692.41	0.00	1333,46
Panti	Serut	953.50	3.43	0.00	956,93
Panti	Suci	2912.76	3023.52	0.00	5936,28
Panti	Glagahwero	0.00	213.56	133.71	347,28
Panti	Kemiri	3310.55	1559.70	0.00	4870,25
Panti	Kemuning Sari Lor	360.93	129.14	0.00	490,07
Total		**9772,28**	**11762.84**	**613.63**	

The potential for soil damage with a weight classification percentage value of 51-65% in the medium category is spread over the observation points of the locations of

Suci Village, Pakis, Sukorambi, Suci, Kemuning lor with a percentage of sequentially, among 57.14-62.86%, 57.14%, 62.86%, 62.86%. The damage in the light classification of 31-observation points of Dukuh Mencek Village, with a percentage of



Klungkung, Kemiri, Panti, Karangpring, weight classification potential soil damage others 60-65.71%, 60-62.86%, 60%, 60-potential for soil category with a weight 50% is spread over the the study locations in Glagah Wero, Jubung 45.71% each.

Figure 5. Area of soil damage potential index on the southern slope of Mount Argopura

Figure 5 shows the potential index area for soil damage to the southern slope of Mount Argopura divided into three levels of potential soil damage, namely heavy, medium and light categories. Soil damage potential index (SDPI) on the southern slopes of Mount Argopura, precisely in Panti and Sukorambi Districts for the heavy category with an area of 9772.28 hectares (44.12%), the medium area area of 11762.84 hectares (53.11%), and the light category is 613.63 hectares (2.77%). The SDPI area distribution for each village is presented in Table. Villages that have an index of potential for heavy soil damage are Kemiri Village with an SDPI area of 3,310.55 ha, followed by Suci Village with an area of 2,912.76 ha, Serut Village with an area of 953.50 ha, Pakis Village with an area of 938.96 ha, Panti Village with an area of 641, 05 hectares, Sukorambi Village with an area of 530.71 ha, Kemuning Sari Lor Village with an area of 360.93 ha, Dukuh Mencek Village with an area of 119.45 ha, Klungkung Village with an area of 4.23 ha, and Karangpring Village with an area of 0.14 ha (Table 10 and Figure 6).

Table 10. Soil damage potential index (SDPI) on the southern slope of Mount Argopura

Figure 6. Soil damage potential index (SDPI) map of the southern slope of Mount Argopura

Medium category SDPI on the southern slope of Mount Argopura with the highest area being in Suci Village with an area of 3,023.52 hectares, followed by Pakis Village with an area of 2,729.62 hectares, Klungkung Village with 1,852.95 hectares, Kemiri Village with an area of 1,559.70 hectares, Karangpring Village with an area 885.36 hectares, Panti Village 692.41 hectares, Dukuh Mencek Village with an area of 346.91 hectares, Sukorambi Village with an area of 326.24 hectares, Glagahwero Village with an area of 213.56 hectares, Kemuning Lor Village with an area of 129.14 hectares, and Serut Village with an area of 3 .43 hectares. The low SDPI area with a total area of 613.36 hectares is spread over Jubung Village with an area of 381.89 hectares, Glagahwero Village with an area of 133.71 hectares, and Dukuh Mencek Village with an area of 98.02 hectares.

4. CONCLUSIONS

Based on the results of the study it can be concluded that the soil damage potential index (SDPI) of the southern slopes of Mount Argopura in Panti District and Sukorambi District with an area of 22,148.75 hectares consists of the heavy category 44.12% (9772.28 hectares), the medium category 53.11% (11762.84 hectares), and 2.77% light category (613.63 hectares). Villages with heavy SDPI were dominant in Kemiri Village with an area of 3,310.55 hectares, moderate SDPI was dominant in Suci Village with an area of 3,023.52 hectares and low SDPI was dominant in Jubung Village with an area of 381.89 hectares.

REFERENCES

Surya, J.A., Nuraini, Y., & Widianto, W. (2015). Kajian porositas tanah pada pemberian beberapa jenis bahan organik di perkebunan kopi robusta. *Jurnal Tanah dan Sumberdaya Lahan*, ***4***(1), 463–471.

Rahayu, A., Utami, S.R., & Rayes, M.L. (2014). Karakteristik klasifikasi tanah Jombang, *Jurnal Tanah dan Sumberdaya Lahan*, ***1***(2), 79–87.

Azuka, C.V, Igué, A.M., Diekkrüger, B., & Igwe, C.A. (2015). Soil survey and soil classification of the Koupendri catchment in Benin, West Africa. *African Journal of Agricultural Research*, ***10***(42), 3938–3951. https://doi.org/10.5897/ajar2015.9904

Basuki, B., Mandala, M., Bowo, C., & Fitriani, V. (2022). Evaluation of the suitability of a sugarcane plant in mount argopura's volcanic land using a geographic information system. *Jurnal Ilmiah Rekayasa Pertanian dan Biosistem*, ***10***(1), 145–160. https://doi.org/10.29303/jrpb.v10i1.315

Basuki, B., & Sari, V.K. (2020). Efektifitas dolomit dalam mempertahankan pH tanah inceptisol perkebunan tebu Blimbing Djatiroto. *Buletin Tanaman Tembakau, Serat & Minyak Industri*, ***11***(2), 58-64. https://doi.org/10.21082/btsm.v11n2.2019.58-64

Basuki, B., Sari, V.K., & Mandala, M. (2022). Pemanfaatan bahan organik sebagai solusi solum tanah dangkal di Desa Slateng Kecamatan Ledokombo Kaki Gunung Raung. *Jurnal Pengabdian Magister Pendidikan IPA*, ***5***(1), 208–213. https://doi.org/10.29303/jpmpi.v5i1.1407

Basuki, B., Purwanto, B.H., Sunarminto, B.H., Nuryani, S., & Utami, H. (2015). Analisis cluster sebaran hara makro dan rekomendasi pemupukan untuk tanaman tebu (*Saccharum officinarum* Linn.). *Ilmu Pertanian*, ***18***(3), 118–126. https://doi.org/10.22146/ipas.10614

Basuki, B., Romadhona, S., Sari, V.K., & Erdiansyah, I. (2021). Karakteristik iklim dan tanah vulkanis di sisi barat Gunung Api Ijen Jawa Timur sebagai dasar penentu pengelolaan varietas tanaman padi (*Oriza sativa* L.). *Jurnal Penelitian Pertanian Terapan*, ***21***(2), 108–117.

Basuki, B., & Winarso, S. (2021). Peta sebaran pH tanah, bahan organik tanah, dan kapasitas pertukaran kation sebagai dasar rekomendasi aplikasi bahan organik dan dolomit pada lahan tebu. *Buletin Tanaman Tembakau, Serat & Minyak Industri*, ***13***(2), 78–93. https://doi.org/10.21082/btsm.v13n2.2021.78-93

Cyio, M.B. (2008). Efektivitas bahan organik dan tinggi genangan terhadap perubahan Eh, pH, dan status Fe, P, Al terlarut pada tanah ultisol. *J. Agroland*, ***15***(4), 257–263.

Fadilla, L., Subiyanto, S., & Suprayogi, A. (2017). Analisis arah dan prediksi persebaran fisik wilayah kota Semarang tahun 2029 menggunakan sistem informasi geografis dan CA Markov model. *Jurnal Geodesi Undip*, ***6***(4), 517–525.

Ferdeanty, F., Sufardi, S., & Arabia, T. (2020). Karakteristik morfologi dan klasifikasi tanah andisol di lahan kering Kabupaten Aceh Besar. *Jurnal Ilmiah Mahasiswa Pertanian*, ***4***(4), 666–676. https://doi.org/10.17969/jimfp.v4i4.12694

Haridjaja, O., Baskoro, D.P.T., & Setianingsih, M. (2013). Perbedaan nilai kadar air kapasitas lapang berdasarkan metode alhricks, drainase bebas, dan *pressure plate* pada berbagai tekstur tanah dan hubungannya dengan pertumbuhan bunga matahari (*Helianthus annuus* L.). *Jurnal Ilmu Tanah dan Lingkungan*, ***15***(2), 52–59. https://doi.org/10.29244/jitl.15.2.52-59

Harijanto, M., Sinukaban, N., Tarigan, S.D., & Haridjaja, O. (2016). Evaluasi kemampuan lahan untuk arahan penggunaan lahan di DAS Lawo, Sulawesi Selatan. *Jurnal Penelitian Kehutanan Wallacea*, ***5***(11), 1–11.

Haumahu, J.P. (2009). Mineral pada tanah yang terbentuk dari batuan andesit dan bahan lepas di Desa Hative Besar. *Jurnal Budidaya Pertanian*, ***5***(2), 74–80.

Hikmat, M., Bariot, Hari, W., & Eka, S.N. (2009). *Pedoman Teknis Penyusunan Peta Status Kerusakan Tanah untuk Produksi Biomasa*. Kementerian Negara Linngkungan Hidup, Jakarta. (38 pp).

Ikqra. (2013). Analisis bentuk lahan (landform) untuk penilaian bahaya dan risiko longsor di Pulau Ternate Provinsi Maluku Utara. *Jurnal Dialog Penanggulangan Bencana*, ***4***(2), 99-110.

Intara, Y.I., Sapei, A., Erizal, Sembiring, N., & Djoefrie, M.H.B. (2011). Pengaruh pemberian bahan organik pada tanah liat dan lempung berliat terhadap kemampuan mengikat air. *Jurnal Ilmu Pertanian Indonesia*, ***16***(2), 130–135.

Kartika, I., Indarto, I., Pudjojono, M., & Ahmad, H. (2016). Pemetaan tingkat bahaya erosi pada level sub-DAS: studi pada dua DAS identik. *Jurnal Agroteknologi*, ***10*** (01), 117–128.

Kendarto, D.R., Suryadi, E., Sampurno, R.M., & Cahyabhuana, A.P. (2021). Daya dukung sumberdaya air dan indeks kekritisan air Sub DAS Cisokan Hulu. *Jurnal Teknik Pertanian Lampung*, ***10***(3), 402. https://doi.org/10.23960/jtep-l.v10i3.402-412

Kristanto, A.T., & Sugarbo, O. (2020). Analisis petrogenesa batuan beku sebagai tinjauan keterdapatan mineral ekonomis di daerah Wukirharjo. *Geoda*, ***01***(01), 95 –104. https://journal.itny.ac.id/index.php/geoda/article/view/1820

Mulyani, A., Nursyamsi, D., & Syakir, M. (2020). Strategi pemanfaatan sumberdaya lahan untuk pencapaian swasembada beras berkelanjutan. *Jurnal Sumberdaya Lahan*, ***11***(1), 11. https://doi.org/10.21082/jsdl.v11n1.2017.11-22

Nita, C.E., Siswanto, B., & Utomo, W.H. (2015). Pengaruh pengolahan tanah dan pemberian bahan organik (blotong dan abu ketel) terhadap porositas tanah dan pertumbuhan tanaman tebu pada ultisol. *Jurnal Tanah dan Sumberdaya Lahan*, ***2*** (1), 119–127.

Nugraha, D.K., Dwi, B., Nugroho, A., Pertanian, T., Pertanian, F.T., & Mada, U.G. (2021). Dampak perubahan curah hujan terhadap tingkat kerentanan erosi tanah di Sub DAS Merawu, Jawa Tengah. *Jurnal Teknik Pertanian Lampung*, ***10***(3), 356–366.

Nurchamidah, L., & Djauhari. (2017). Pengalih fungsian lahan pertanian ke non pertanian di Kabupaten Tegal. *Jurnal Akta*, ***4***(4), 699–706.

Prasetyo, B., Irwandi, H., & Pusparini, N. (2018). Karakteristik curah hujan berdasarkan ragam topografi di Sumatera Utara. *Jurnal Sains & Teknologi Modifikasi Cuaca*, ***19*** (1), 11. https://doi.org/10.29122/jstmc.v19i1.2787

Rahayu, N.D., Sasmito, B., & Bashit, N. (2018). Analisis pengaruh fenomena Indian Ocean Dipole (IOD) terhadap curah hujan di Pulau Jawa. *Jurnal Geodesi Undip*, ***7*** (1), 57–67.

Ridwan, P., Arfiansyah, K., Kusumah, P.A., Amrullah, F., & Gani, R.M.G. (2018). Identifikasi karakteristik dan kualitas andesit sebagai bahan bangunan daerah Batujajar, Kecamatan Batujajar Timur, Kabupaten Bandung Barat. *Padjajaran Geoscience Journal*, ***2***(3), 193–200. http://jurnal.unpad.ac.id/geoscience/article/view/17262

Pertami, R.R.D., Eliyatiningsih, E., Salim, A., & Basuki, B. (2022). Optimasi penggunaan lahan berdasarkan kelas kesesuaian lahan untuk pengembangan tanaman cabai merah di Kabupaten Jember. *Jurnal Tanah dan Sumberdaya Lahan*, ***9***(1), 163–170. https://doi.org/10.21776/ub.jtsl.2022.009.1.18

Sabila, F.S.N., & Abdurrachman, M. (2020). Mekanisme pembentukan struktur geologi di Gunung Raung. *Jurnal Teknologi Sumberdaya Mineral*, ***1***(1), 1–10.

Savitri, D., & Supriatna, A. (2021). Analisis perubahan penggunaan tanah di Indonesia: 2009-2019. *Jurnal Pertanahan*, ***11***(1), 63–75. https://doi.org/10.53686/jp.v11i1.49

Setiawati, T.C., Basuki, & Sulistyawati, N. (2019). Pengamatan kesuburan tanah, pemanfaatan organisme tanah untuk pengendali hama uret serta perbaikan manajemen laboratorium berbasis ISO 17025. *Jurnal Pengabdian Masyarakat IPTEKS*, ***5***(2), 176–181.

Sitepu, F., Selintung, M., & Harianto, T. (2017). Pengaruh intensitas curah hujan dan kemiringan lereng terhadap erosi yang berpotensi longsor. *Jurnal Penelitian Enjiniring*, ***21***(1), 23–27. https://doi.org/10.25042/jpe.052017.03

Sophian, R.I., Patonah, A., & Mohamad, F. (2011). Kualitas batuan beku andesitis