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Identification of Critical Land based on Land Damage Standard Criteria in Manten Sub Watershed, Malang City

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ABSTRACT

Land is an important part of the watershed because it is where the hydrological process occurs. There are several problems that can lead to land damage, especially in the downstream area of the watershed, precisely in the Manten Sub-watershed because it has the potential to become critical land. Therefore, this research was conducted with the aim to overcome the existing problems, it is necessary to identify the standard of land degradation in the Manten Sub-Watershed area in accordance with PP No. 150 of 2002. Manten sub-watershed covers 4 sub-districts namely Wajak, Poncokusumo, Tajinan, and Bululawang. Land use in Manten sub-watershed is divided into 3, namely rice fields, kailyards and fields. Based on the results of the analysis of all land use in Manten Sub Watershed, all parameters that have been observed do not exceed the critical threshold criteria except for the redox parameter has a very low value of <200mV. However, this condition can still be improved with proper management such as improving soil aeration using the addition of organic materials so as to increase oxygen levels in the soil and increase redox values.

1. INTRODUCTION

Land is an important part of the watershed because it is where hydrological processes such as infiltration, percolation, and surface flow occur. Land with dense vegetation cover has high surface flow which can cause flooding, especially in the downstream areas of the watershed and has the potential to be critical. The Manten Sub-watershed is part of the Upper Brantas Watershed which is used as the main source in meeting the living needs of the surrounding population, which is a source of water for irrigation and a home for various other living things. If soil function declines or is damaged, it will cause disasters such as floods and landslides (Edwin, *et. al*, 2023). Therefore, the purpose of this study was to determine the level of land damage in the Manten Sub-watershed and to analyze the factors that cause land damage in the Manten Sub-watershed.

The Brantas River Basin is one of the second largest river basins on the island of Java, based on the Regulation of the Minister of Public Works and Public Housing (Menteri PUPR, 2015), the Brantas Watershed has an area of 11,800km^2 or a quarter of the area of East Java province. However, there are several problems that arise in the Manten Sub-watershed which have an impact on land damage because changes in land use do not pay attention to the balance of nature, thus triggering an increase in the area of critical land from year to year, in addition, natural factors and inappropriate management can also make land critical. According to Kurniawati (2022), in addition to natural factors, inappropriate management can also lead to critical land. Based on the map of potential land damage in the Manten Sub-watershed, the extent of critical land is a sign of damage that occurs in the watershed so that there is a decrease in the function of the water system which results in flooding or drought (Ariyani *et al*., 2020).

Land damage if prolonged and not immediately managed properly will have an impact on the increasing area of critical land, while land is an environmental support and balances the relationship between humans and the surrounding environment. Land degradation is based on intensive land use that is not properly managed and does not comply with conservation principles, and occurs continuously (Gultom *et al.,* 2021). Based on the existing problems, a research test study was carried out on the identification of critical land based on standard damage criteria to be able to determine the level of damage to the land and to be able to provide recommendations for appropriate management solutions to restore the quality of damaged land in accordance with conservation principles.

2. MATERIALS AND METHODS

The research was conducted in February–June 2024. Based on the research conducted, it includes several activities, namely data collection, laboratory analysis, data processing and report preparation. Data collection on observations and sampling was carried out in the Manten Sub-watershed, Malang Regency–East Java. The sample results were analyzed and carried out at the SDL Laboratory, Faculty of Agriculture, UPN "Veteran" Jawa Timur. The research was an exploratory descriptive method with a field survey approach. Land use types (SPL) evaluated in the Manten Sub-watershed during this research included rice fields, kailyards, and fields.

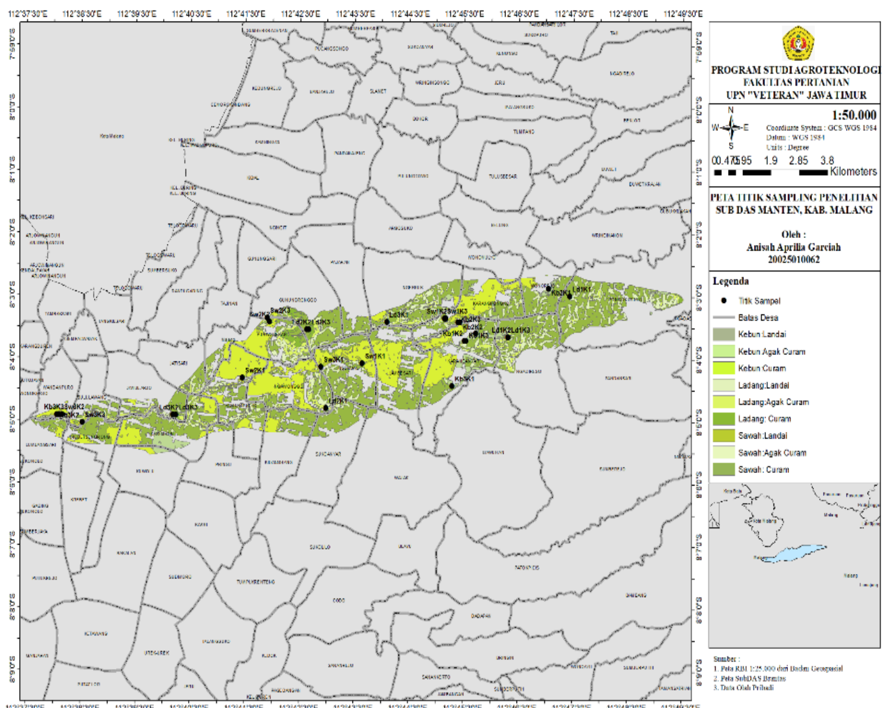

Figure 1. Map of sampling location points

Soil samples were taken at 18 points (Figure 1), with each land use repeated three times. Samples were taken based on two depths, namely (0–30) and (30–60), and three slopes, namely (8–15%), (15–25%), and (25–45%) so that the total is 54 soil samples. The soil samples taken are intact soil samples, disturbed soil samples. Each soil sample is used according to the needs of the parameter test to be analyzed in the laboratory. The materials used for analysis in the laboratory are in accordance with each method used.

Based on the Regulation of the Ministry of the Environment (Menteri Negara Lingkungan Hidup, 2006), physical parameter tests using intact soil samples are bulk density tests using the gravimetric method, water permeability degrees using the permeability method, fraction composition tests using the pipette method, and porosity methods using the calculation method of the value of bulk density and specific gravity. In the chemical parameter test, pH test was carried out using the potentiometric method, electrical conductivity using the electrical resistance method and redox using the electrical voltage method. In the biological parameter test using the soil plating technique method, in addition, a field parameter test was carried out which was observed directly in the field, namely measuring the thickness of the solum, measuring the drainage and measuring the slope.

2.1. Method for Determining Land Damage Status

The results of the laboratory analysis obtained were then processed. Furthermore, the matching and scoring methods were carried out in accordance with the standard provisions for land damage based on government regulation (Presiden RI, 2002). After the matching and scoring methods were carried out on the data, the determination of the status of land damage was found in the Manten Sub-watershed, Malang Regency.

2.1.1. Matching Method

The matching method is used to compare the standard threshold parameter data for land damage and land damage assessment with the results of data collection from field research and laboratory analysis results in accordance with Government Regulation Number 150 of 2002 (Table 1) as a comparison of the determination parameters.

Table 1. Critical threshold criteria for soil degradation in dryland areas

No.	Parameter	Critical Threshold
1	Solum Thickness	< 20 cm
2	Surface Rock Coverage	> 40%
3	Fraction Composition	< 18% colloids > 80% quartz sand
4	Bulk Density	> 1.4 g/cm³
5	Soil Porosity	< 30%, > 70%
6	Water Infiltration Rate	< 0.7 cm/hour
7	pH (H_2O) 1:2.5	< 4.5 : > 8.5
8	Electrical Conductivity (EC)	> 4.0 mS/cm
9	Redox Potential	< 200 mV
10	Microbial Count	< 10^2 cfu/g

Source: Government Regulation No. 150 of 2002 (Presiden RI, 2002)

2.1.2. Scoring Method

The scoring method is based on several physical, chemical and biological parameters obtained from soil samples, both field observations and laboratory analysis on each land use by matching the analysis data with the determination indicators, then giving a score to each parameter and then the score is totaled to determine the potential damage status of the land. The score and soil degradation status were based on the relative frequency of degraded soil as detailed in Table 1.

The potential damage value was taken based on the assessment and weighting values for each type of data on each parameter. Table 2 detailed the weighting score and the related soil degradation potential. The highest value occurs if all attribute values from each type of data used have the potential for soil damage.

Table 2. Soil degradation scores based on relative frequency (Menteri Negara Lingkungan Hidup, 2009)

Relative Frequency of Degraded Soil (%)	Score	Soil Degradation Status
0-10	0	Not degraded
11-25	1	Lightly degraded
26-50	2	Moderately degraded
51-75	3	Heavily degraded
76-100	4	Severely degraded

Table 3. Classification of soil degradation potential based on score values

Symbol	Soil Degradation Potential	Weighting Score
PR. I	Very light	< 15
PR. II	Light	15 – 24
PR. III	Moderate	25 – 34
PR. IV	High	35 – 44
PR. V	Very high	45 – 50

Note: PR = Degradation Potential. (Source: Menteri Negara Lingkungan Hidup, 2009).

3. RESULTS AND DISCUSSION

3.1. Land Characteristics

Land identification was carried out in the Manten Sub-watershed, Malang Regency, which includes 4 sub-districts, namely Poncokusumo, Tajinan, Wajak and Bululawang sub-districts. The Manten Malang Sub-watershed (Figure 2) has an area of approximately 287.02 km^2 and borders Sumbermanjing Wetan Sub-District to the north, Kepanjen Sub-District to the east, Gondanglegi Sub-District to the south, and Ngantang Sub-District to the west. Land use in the Manten Sub-watershed area is SPL paddy fields, SPL kailyards and SPL fields with various slopes. The economic conditions in the Manten Sub-watershed area are mostly farmers because of the existing land use units. Based on data from the SHP map overlay, land use in the 4 sub-districts in the Manten Sub-watershed is 1,121 ha of rice fields, 160 ha of kailyards, and 2,799 ha of dryfields. The Manten Malang Sub-watershed has a tropical climate and quite high rainfall with an average of 1,500 mm per year.

The Manten Sub-watershed area is located in a volcanic mountain area so that some of its areas have Inceptisol soil types with 3 sub-groups including Andic Dystrudepts, Typic Dystrudepts, and Typic Epiaquepts. The Inceptisol soil type can be called young soil or initial soil. The characteristics of the Inceptisol type of soil are that it has a grayish black to dark black color, is classified as acidic mineral soil, the texture of the inceptisol soil is quite diverse from coarse to fine, this is because the inceptisol type of soil is newly developed soil. Based on the results of the analysis of the texture of the inceptisol soil, it has a low clay content and has a high dust content. According to Husein *et al*. (2023), soil with low clay content has a high bulk density.

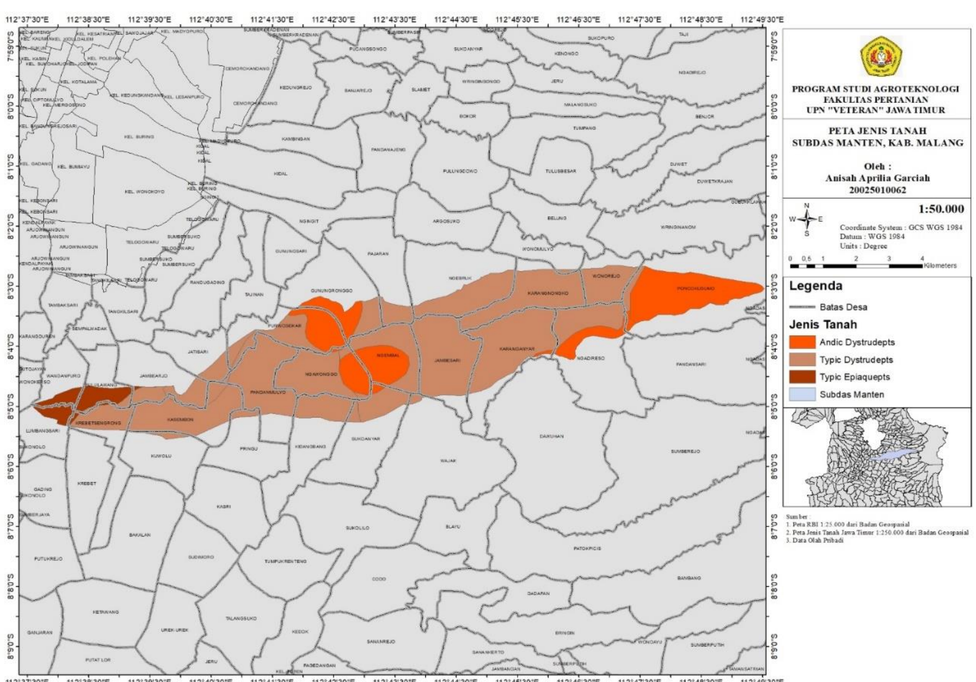

Figure 2. Map of soil type in the Manten Sub-watershed

Land is an important part of the watershed because it is where hydrological processes such as infiltration, percolation, and surface flow occur. Land with dense vegetation cover has high surface flow so that it can cause flooding, especially in the downstream areas of the watershed, making it critical land. Critical land in the Manten Sub-watershed is caused by inappropriate land management. In considering conservation policies at the sub-watershed scale, spatial data on erosion rates and soil solum are needed to indicate the level of erosion hazard (Pambudi *et al.,* 2023). With the existence of the Critical Threshold Determination Parameters for the Standard Criteria for Land Damage on Dry Land using Government Regulation of the Republic of Indonesia Number 150 of 2002 which was updated in Government Regulation of the Republic of Indonesia Number 22 of 2021 (Presiden RI, 2021), the level of criticality of the land can be determined so that the right management solution can be found using the Matching method which then uses the scoring method based on the regulation of the Ministry of Environment (Menteri Negara Lingkungan Hidup, 2009). The criteria parameters used are solum thickness, surface rock, fraction composition, bulk density, total porosity, permeability, pH, electrical conductivity, redox, and number of microbes. Table 3 summarizes results of analysis on land degradation in the Manten Sub-Watershed, Malang Regency.

3.1.1. Solum Thickness

Solum thickness is the vertical distance from the soil surface to the layer that limits the flexibility of root system development. Solum thickness affects the availability of nutrients and minerals needed by plants for optimal growth, thus affecting biomass production. Based on physiographic data obtained in the field, it shows that slope affects solum thickness. The steeper the slope, the shallower the solum thickness. Land cover can also affect the thickness of the soil solum, the shallower the solum thickness, the less land cover, this can trigger land damage or critical land.

The solum of the Manten Sub-watershed soil in the use of rice fields has a shallow solum depth compared to the use of kailyard and field land. In the field area, there is quite a lot of vegetation in the land area and several annual plants, so this affects the thickness of the solum. The vegetation of annual plants in the field area is mostly sengon plants, so that plant roots can grow optimally downwards, therefore requiring a fairly thick solum. The thickness of the solum in the Manten Sub-watershed area is not classified as damaged or does not exceed the critical threshold criteria because it has a thickness of 71–120 cm, it can be said to be included in the critical threshold criteria if the solum thickness is <20 cm. According to Alfiyah *et al*. (2020), the effective solum thickness will affect the effectiveness of the depth of root growth. The thicker the solum, the more space is available for the roots so that plants can grow and find nutrients from the soil.

3.1.2. Surface Rocks

Surface rocks are rock conditions that cover the surface conditions of the soil. The large percentage of rocks on the surface and the slope of the land will affect the acceleration of landslides (Saputra *et al*., 2022). Based on the results of field observations, the physiographic conditions in the Manten Sub-watershed area in the surface rock parameters for each land use and its slope have different surface rock percentages from the slightly rocky class, namely 2–9% to quite rocky, namely 10–25%. The highest surface rocks are found in the use of 8–15% slope fields with the LDK1 code reaching 20%. In the use of rice fields, surface rocks are low compared to the use of kailyards and fields, which is only 7%. The higher the slope, the less surface rocks there are.

The Manten Sub-watershed area has relatively low surface rocks because the texture is more dominant in the dust fraction compared to the sand fraction. This condition shows that surface rocks do not exceed the critical threshold in the standard criteria for land damage. Surface rocks can be said to exceed the critical threshold if they reach >40%. However, in this area, there is quite high rainfall so that it can trigger cracks in the rocks and movement towards the lower slope due to rainwater infiltration, especially in areas with quite high slopes. This can trigger an increase in the rate of erosion and landslides. Surface rockiness is used to assess the potential for landslides in the area because it affects drainage (Girsang *et. al.,* 2024).

3.1.3. Sand Fraction Composition

The composition of the sand fraction is part of the primary minerals in the soil that comes from the physical weathering process of rocks. The condition of the surface rocks in the Manten Sub-watershed in the use of rice fields,

Table 4. Analysis results of land degradation in the Manten Sub-Watershed, Malang Regency

No	Parameter	Critical Threshold	SPL Paddy Field			SPL Kailyard			SPL Dry Field			B	R	SFR
			Swk1	Swk2	Swk3	Kbk1	Kbk2	Kbk3	Ldk1	Ldk2	Ldk3			
1.	Solum Thickness (cm)	< 20 cm	78	76	71	110	113	101	120	116	108	9	-	0
2.	Surface Rock (%)	> 40%	10	7	8	13	15	11	20	16	13	9	-	0
3.	Sand Fraction Composition (%)	< 18% colloids > 80% quartz sand	20.0	19.8	23.2	38.4	30.5	27.4	41.7	21.0	19.4	9	-	0
4.	Bulk Density (g/cm^3)	> 1.4 g/cm^3	1.38	1.18	1.21	1.20	1.15	1.13	1.27	1.19	1.23	9	-	0
5.	Total Porosity (%)	<30%. >70%	46	53	53	53	55	54	52	53	52	9	-	0
6.	Water Infiltration Rate (cm/hour)	<0.7 cm/hour	1.3	4.4	5.2	5.0	4.9	7.7	2.9	3.6	2.7	9	-	0
7.	pH (H_2O)	< 4.5 : > 8.5	6.2	6.2	6.2	5.8	5.8	5.8	5.4	5.1	5.7	9	-	0
8.	Electrical Conductivity (mS/cm)	> 4.0 ms/cm	0.16	0.13	0.14	0.13	0.08	0.11	0.18	0.39	0.17	9	-	0
9.	Redox Potential (mV)	< 200 mV	60.5	48.6	53.3	73.6	85.0	72.0	97.3	105.8	81.1	-	9	2
10.	Microbial Count (cfu/g soil)	< 10^2 cfu/g												
	(Fungi)		12	36	25	13	11	59	36	47	65	9	-	0
	(Bacteria)		157	119	189	225	189	131	93	369	463			
	Status		TR	TR	TR	TR	TR	TR	TR	TR	TR			

Notes:
TR = Not Degraded
B = Good, R = Degraded, SFR = Degradation Frequency Score
Code: Sw (Paddy Field), Kb (Kailyard), Ld (Dry Field)
K1: (Slope 8-15%), K2: (Slope 15-25%), K3: (Slope 25-45%)

all of its land on various slopes has the same texture, namely dusty clay texture with a very diverse composition of sand fractions, namely from 19–23%. In the use of kailyard land with the KBK1 code, it has a clay texture while the KBK2 and KBK3 codes have a dusty clay texture with a fraction composition of 27–38%. In the use of field land with the LDK1 code, it has a clay texture while the LDK2 and LDK3 codes have a dusty clay texture with a fairly high field fraction composition compared to the composition of rice fields and kailyards, the sand fraction composition is 19–41%. A factor that can trigger land damage is the percentage of soil fraction. Sand-based soil is more prone to damage than clay-based soil (Edwin *et al.,* 2023).

Erosion can occur based on the slope and the type of fraction that is more dominant, in the Manten Sub-watershed area the soil texture is clay and dusty clay where both are dominated by dust fractions. The fine dust and clay fractions are transported first compared to the sand fraction so that on the lower slopes the dust and clay fractions tend to be higher, while on the upper slopes the sand fraction tends to be higher (Henny *et al*., 2023). The types of clay and dusty clay textures are not classified as damaged or do not exceed the critical threshold criteria, it can be said to be included in the critical threshold criteria if the sand fraction reaches > 80%. Dusty clay has a fairly good water retention capacity, has high nutrients and can store nutrients quite well, these conditions make the land very suitable for agricultural land (Rizal *et al*., 2022).

3.1.4. Bulk Weight

Soil bulk weight is used to determine the density of a soil in making it easier for roots to penetrate the soil. Based on soil samples taken in the Manten Sub-watershed area, a bulk density test was carried out in the laboratory with different results for each land use and was classified as non-critical, but there was a point approaching the critical threshold, namely in the use of rice fields with a bulk density reaching up to 1.38 $g.cm^{-3}$ while the critical threshold criteria were >1.4 $g.cm^{-3}$. So that in the use of rice fields, proper management is needed so that later it does not exceed the critical threshold criteria so that erosion occurs.

Kailyard land has a fairly good bulk density where the highest bulk density only reaches 1.2 $g.cm^{-3}$, so that the use of kailyard land is classified as non-critical. The existence of non-excessive land management obtained from organic fertilizers makes the land looser so that its bulk density does not exceed the critical threshold criteria. The use of field land has a fairly good bulk density the same as the use of kailyard land where the highest bulk density only reaches 1.2 $g.cm^{-3}$. Land management obtained from litter that is used as fertilizer makes the land condition good for agriculture, where this condition can increase the organic content in the soil so that the soil is fertile. In addition, litter is also used to cover the surface of the soil to prevent erosion. Land processing can affect the density of the soil, the higher the processing, the lower the density of the soil. Intensive land management will compact the lower layers of the soil, while the upper layers of the soil tend to have a lower density than the inner layers of the soil. This is because the weight of heavy equipment can compact the soil layer beneath it more intensively (Foldal, 2021).

3.1.5. Porosity

Porosity is the volume or collection of soil pores in the form of a percentage. The results of the porosity analysis are obtained from the results of the unit weight and specific gravity. Soil porosity as a place to store water and air stored in the soil that can be used for root respiration. The permeability rate determines the size of the porosity, the greater the permeability rate, the greater the porosity, and vice versa, the smaller the permeability rate, the smaller the porosity. The porosity in the Manten Sub-watershed area has a percentage value of 46–55%. The highest percentage value is found in the use of kailyard land in the KBK2 code with a percentage value of 55% and the lowest percentage value is found in the use of rice fields in the SWK1 code with a percentage value of 46%. Soil density can occur due to lack of management in the use of rice fields so that the porosity is low, apart from the management of the use of rice fields, it has a fairly thick clay texture so that it can also affect its porosity due to soil density. Based on the porosity analysis of various land uses in the Manten Sub-watershed, there was no damage because none of them were less than or exceeded the critical threshold criteria, it can be said to be critical if <30% to> 70% so that the area is classified as non-critical when viewed from the percentage value of its porosity. Organic fertilization is considered to have a fairly high function in improving management for soil porosity. With the addition of organic material for management, it will help the soil granulation process, thereby reducing soil compaction.

3.1.6. Degree of Water Permeability

Water permeability is another name for soil permeability where the process of water velocity or infiltration rate occurs in the soil perpendicularly downward with the units owned, namely centimeters per hour. Infiltration rates are influenced by various factors, including soil texture and structure, soil slope, and the level of suspended matter in the water, as well as time (Khoiroh *et al.,* 2020). The type of soil affects the permeability value and is directly proportional to the porosity value, but inversely proportional to the bulk density value. Permeability can also determine the amount of rainwater that can seep into the soil and become surface runoff (Alista *et al.,* 2021). Based on the permeability test in the Manten Sub-watershed area, it is classified as a slow, slow to moderate and moderate permeability class. The highest class of permeability is found in the use of kailyard land which is classified as medium, but there are also points of kailyard land use which are classified as slow medium but the condition is still relatively high compared to the slow medium class owned by the fields. This happens because of the management of land in the use of kailyard land which is quite intensive with the use of organic fertilizers so that the permeability class owned is quite good.

All field land slopes are classified as slow medium, but the speed still tends to be lower compared to the slow medium class owned by kailyards and rice fields, this is because the use of field land uses management with leaf litter. The thickness of the litter can affect permeability, the thicker the litter, the lower the permeability. While in the use of rice fields with the code SWK1 where the point is classified as slow with a speed of 1.3 cm/hour, while the critical threshold criteria are <0.7 cm/hour so that the use of rice fields in the SWK1 code is almost approaching the critical threshold criteria, if left unchecked it will cause the land to become prone to landslides, then proper management is needed.

3.1.7. Soil pH

Soil pH is a tool to measure the degree of soil wet acidity to adjust plant needs according to the type of plant. Acidic pH is found at a value of 0–6, neutral pH is found at a value of 7 and wet pH is found at a value of 8–14. While the ideal pH for plants is around 5.5–6.5. Based on soil samples that have been taken in the Manten Sub-watershed area, a pH analysis test was carried out in the laboratory including having an acidic pH and a slightly acidic pH with a value of 5.1–6.2. In the use of rice fields and kailyards, the pH is slightly acidic, namely with a value of 5.5–6.5, so the soil conditions are quite ideal for agriculture, where the pH has good macro micro nutrients for plants so that they can be absorbed by plant roots. The lowest pH is found in the use of field land where all slopes have an acidic pH condition with a value of 5.1–5.4.

According to Mufida *et al*. (2020), plants require a pH ranging from 5.5 to 6.5. Acidic soil pH conditions will affect the condition of plant growth, the availability of nutrients and a decrease in the activity of inhibited microorganisms. In the use of field land, the pH is lower than the use of kailyard and rice field land, this can occur because the management is carried out using litter, where there are several types of litter that have nutrients such as nitrogen or sulfur, causing the pH to decrease and become acidic. Based on the analysis of the chemical properties of the pH in the Manten Sub-watershed area, there was no damage because none exceeded the critical threshold criteria, it can be said to be critical if the pH is <4.5 : >8.5. In the Manten Sub-watershed area, there is quite high rainfall which affects soil acidity, this can occur due to leaching of ions that have wet properties. If the soil pH is acidic, micronutrients such as Fe, Mn, Cu, and Zn increase (Basuki *et al*., 2022).

3.1.8. Electrical Conductivity (EC)

Electrical conductivity (EC) is the ability of ions in the soil to conduct electricity in the form of numerical values. EC values increase or decrease in line with the conductivity of materials mixed with water. EC values or conductivity levels are scattered across small areas that are separated from one another, and often without any discernible pattern (Nikita *et al.,* 2021). In the use of field land, all points have high EC compared to the use of rice fields and kailyards, reaching 0.39 ms/cm. Land management in the use of field land with leaf litter has ions which can increase EC.

Kailyard land with the KBK2 code has a relatively low EC which only reaches 0.08ms/cm. The low EC condition is caused because the Manten Sub-watershed area has quite high rainfall and is caused by inappropriate management such as excessive use of fertilizers and inappropriate irrigation in the use of rice fields. Based on the EC analysis of various land uses in the Manten Sub-watershed, there was no damage because none exceeded the critical threshold criteria, it can be said to be critical if> 4.0 ms/cm so that the area is classified as non-critical when viewed from its EC value. Soil that has high ions also has high electrical conductivity conditions, in addition, the high EC is also caused because the NaCl salt content is more dominant as a salinity former.

3.1.9. Redox

Redox is a tool used to determine the degree of anaerobicity and to determine the level of oxidation and reduction in the soil. Based on soil samples that have been taken in the Manten Sub-watershed area, a redox analysis test was carried out in the laboratory, including exceeding the critical threshold criteria where all points have low redox, namely <200 mV in all land uses so that all points are classified as lightly damaged, this is because the Manten Sub-watershed area has quite high rainfall so that flooding occurs. In addition, increased flooding can also be caused by an increase in pH. Flooding conditions indicate that the redox status is classified as moderately reduced, where this condition experiences a reduction in the rate of oxygen diffusion 10,000 times slower (Darmanto & Setiawan, 2021).

Management also affects the results of high redox. In the use of field land, it has a fairly high redox compared to the use of rice fields and kailyards. This is because in the use of field land, management is carried out using leaf litter, some types of leaf litter have compounds that can increase redox. In addition, environmental conditions such as temperature, humidity and soil pH can also affect the high level of redox. The Manten Sub-watershed has quite high rainfall so that flooding occurs. In addition, increased flooding can also be caused by an increase in pH. Flooding conditions indicate a moderately reduced redox status condition where this condition experiences a reduction in the rate of oxygen diffusion 10,000 times slower (Darmanto & Setiawan, 2021).

3.1.10. Number of Microbes

The number of soil microbes is the total population of microbes from the soil in an environment which is calculated using colony calculations. The presence of a high population of soil microbes is an indicator of soil fertility and has a good effect on the physical and chemical properties of the soil. To maintain the balance of microorganisms in the soil, proper management and good environmental conditions are needed, so that the soil has a quality of fertility that can be used in agriculture. Good microorganisms can be seen from soil conditions that have the appropriate pH and fairly high organic matter. Low pH and organic matter have a small number of microbes, while improper or excessive management also has an impact on the large number of microbes.

Based on soil samples that have been taken in the Manten Sub-watershed area, a microbe analysis test was carried out in the laboratory with types of bacterial and fungal microbes and had varying results in the number of microbes in each land use and its slope. This is because the number of microbes is classified as a type of living thing, so that each land has a different population. In the use of kailyard land, the number of microbes is almost close to the critical threshold criteria, namely in the KBK2 code with a spore count of 11 cfu/g, it can be said to be critical if the number of microbes is <102 cfu/g. So that in the use of rice fields, handling needs to be carried out to improve the number of microbes in the soil so that the soil remains fertile.

3.2. Soil Fertility Potential Map

Based on the results collected during this study, soil fertility status can be summarized as can be presented as a map as in Figure 4. The land damage potential map is the output of the results of field analysis and laboratory analysis in the Manten Sub-watershed which shows areas according to the level of damage. Based on the damage, the Manten Sub-watershed areas area in the undamaged and lightly damaged class. However, this condition can still be improved by carrying out proper management.

4. CONCLUSION

The Manten Sub-watershed area has a fairly high potential for agricultural productivity. However, several problems have arisen due to the increasing population in the Manten Sub-watershed. Based on land identification using critical threshold criteria parameters in the Manten Sub-watershed, Malang Regency, the level of damage to the land was found to be in the lightly damaged category. Light damage is caused by low redox factors that exceed the critical threshold criteria, namely with a value of <200 mV in various land uses. This occurs due to high rainfall, inappropriate management and inappropriate land use. Appropriate management to increase the redox value in overcoming the lightly damaged category in various land uses in the Manten Sub-watershed is improving soil aeration by adding organic materials so that it can increase oxygen levels in the soil.

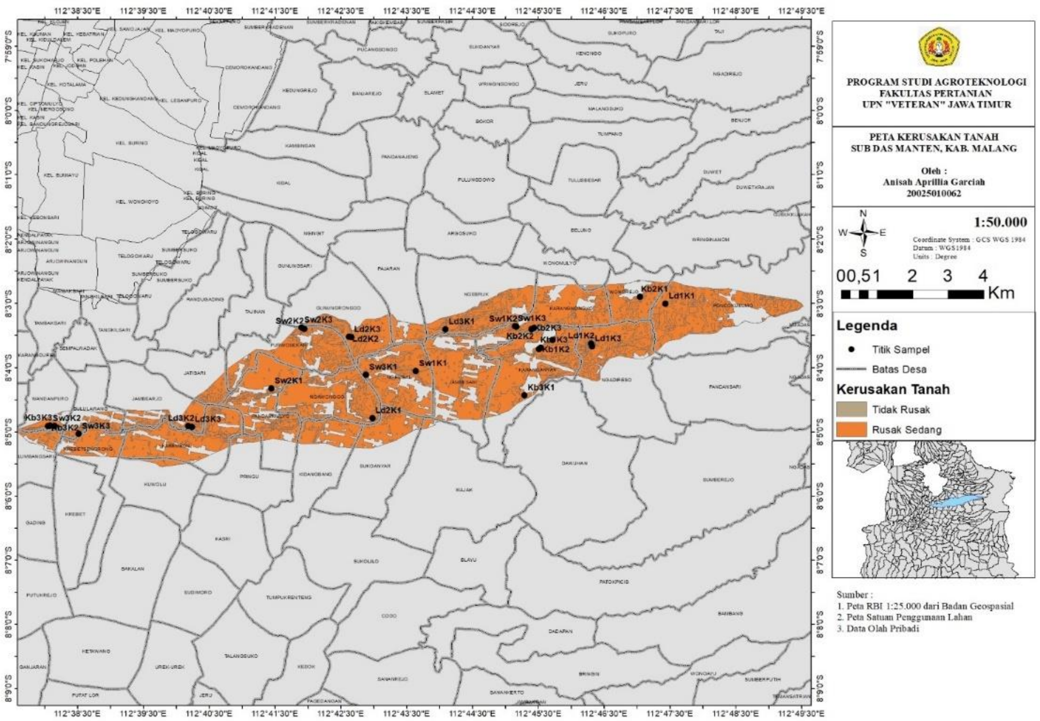

Figure 4. Map of land damage potential

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