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Evaluation of Land Suitability for Sugar Cane Cultivation

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ABSTRACT

Land suitability is an important aspect in land planning and management, especially to determine the potential of land to support various agricultural and forestry activities. This study aims to evaluate the land suitability in the UPN Veteran East Java State Defense Garden located in Wonosalam District, Jombang Regency. The methodology used in this study involves the analysis of various factors such as soil texture, slope, soil type, rainfall, and water availability. Data were collected through field observations, soil sampling, and literature reviews related to soil physical and chemical characteristics. The evaluation results showed that most of the garden area has good suitability for certain agricultural activities, with some areas requiring special handling to optimize land use. The main factors affecting land suitability in this area include varying slope gradients and organic matter content in the soil. Recommendations from the results of this evaluation include better soil management, including the application of soil conservation techniques, and the selection of plant types that are appropriate to the characteristics of the land. This study is expected to provide useful information for garden planning and management to achieve optimal and sustainable productivity.

1. INTRODUCTION

Sugarcane (*Saccharum officinarum* L.) is one of the commodities used as the main raw material for sugar (Isnaini *et al*., 2015). Sugarcane can grow in tropical and subtropical areas (Hidayat, 2018). The land in a suitable area has the potential for its use in the present and the future. The potential of land resources in an area can be optimized to meet market needs for food, especially for agriculture itself. Land resources can be optimized by determining the suitability value of the existing land with a reference. According to Sitorus (1985), land suitability refers to the extent to which a land is suitable for use in certain activities. Land suitability varies depending on the subject and object being analyzed.

Land suitability is influenced by various structural aspects of nature or physical nature such as rainfall, soil type, slope, and rock type. In addition to these aspects, land suitability is also influenced by the use of the land. Improper land use can also affect its ability to support the activities carried out on it. Land suitability can be evaluated based on the function of the area, which is determined through an assessment or scoring process for an area. Concerning spatial planning, the function of an area can be categorized into three types: cultivation areas, buffer zones, and protected areas (Presiden R.I., 2007). Therefore, an assessment of the land use function is needed so that it is used according to its designation, especially for agriculture.

Improper land use can result in land degradation, especially if the use exceeds the land's carrying capacity and ignores the principles of soil and water conservation. To plan land use effectively, the land capability or suitability analysis approach can be applied. Land suitability analysis for agriculture and plantations is important for mapping land resources and evaluating areas suitable for certain uses. In accordance with Government Regulation No. 16-2004 (Presiden R.I, 2004) concerning Land Use, Article 3(b) states that the main objective is to create order in the control, use, utilization, as well as maintenance and control of land. Therefore, proper planning and identification of actual and potential land are needed for future agricultural development.

The purpose of this study is to analyze land use in Wonosalam District, Jombang Regency by considering the value of land suitability classification requirements and growing requirements for the use of sugarcane. The benefits of this study are expected to be used to determine the potential land authority of UPN "Veteran" East Java in Wonosalam District, Jombang Regency based on the land suitability approach.

2. MATERIALS AND METHODS

This research was conducted for 4 months on land owned by UPN "Veteran" East Java, located in Wonosalam District, Jombang Regency, and in the Land Resources Laboratory of the Faculty of Agriculture, UPN "Veteran" East Java. The method was descriptive qualitative with a spatial analysis approach, utilizing GIS (Geographic Information System) software and scoring analysis. The spatial analysis process was carried out through overlay or overlapping of land suitability parameters that have been scored, to produce spatial data on agricultural land suitability. Sampling points (Figure 1) were determined by purposive sampling, namely random and deliberate location selection. After the soil samples were taken, analysis was carried out in the laboratory.

The equipment used in this study included GPS (Global Positioning System), sample point maps, trowels, hoes, crowbars, plastic bags, rubber, camera, oven, hotplate, Elenmeyer, measuring cup, sieve, funnel, texture brush, gloves, cups, pipettes, trays, scales, and spectrophotometers. For data processing, a computer with Microsoft Excel and ArcGIS software was used. The materials used in this study include topographic maps, land use unit maps, slope maps, and statistical data such as rainfall, climate, and humidity.

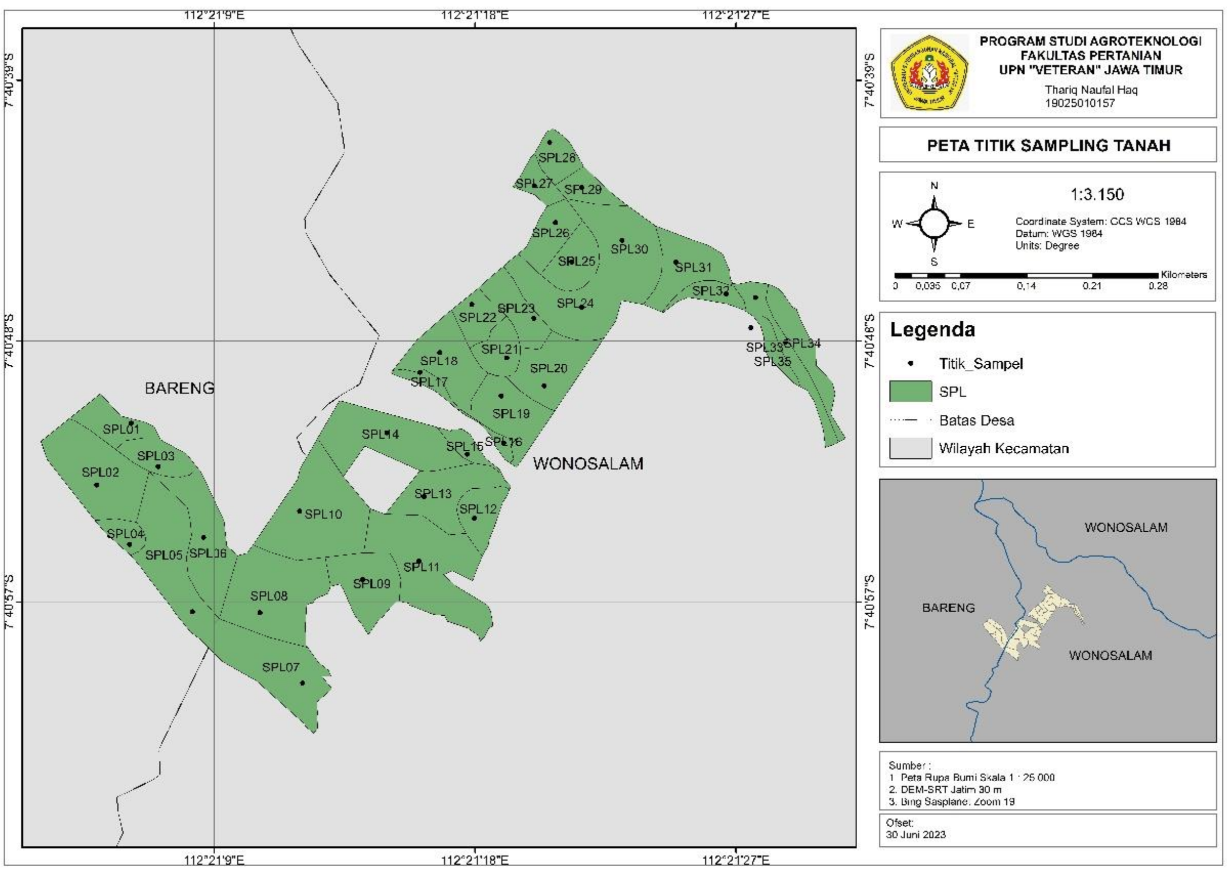

Figure 1. Map of research location in Wonosalam along with sampling points

Table 1. Analysis of soil physical and chemical properties

No.	Parameter	Unit	Analysis Method
1.	Texture	%	Pipette
2.	C-organic	%	Walkley and Black
3.	Clay CEC (Cation Exchange Capacity)	cmol/kg	NH_4OAc 1 N pH 7
4.	Base Saturation	%	NH_4OAc 1 N pH 7
5.	pH H_2O	--	Potentiometric

2.1. Data Collection and Soil Sampling

The data used in this study consisted of primary data and secondary data. Primary data were obtained through field observations and laboratory analysis covering physical and chemical properties of soil and land use (Table 1). Meanwhile, secondary data included information on rainfall, land use, administrative data, and land slope, which were obtained and processed from the official Sasplanet website, Geospatial Information Agency, and NASA. Soil sampling was carried out using disturbed soil samples, as much as 1 kg, which were used for texture analysis, organic carbon, pH, cation exchange capacity (CEC), and base saturation.

2.1.1. Determining Sampling Points

Determination of sampling points was obtained from geological maps obtained from the Geospatial Information Agency, topographic/relief maps were obtained by overlapping structures, slope maps were obtained by downloading topographic maps from the official Sasplanet website, rainfall data, temperature data, and humidity data were obtained from the official NASA website. Determination of sample points was based on the division of areas, which is divided into 35 land use units (SPL). The existing SPLs were mixed plantations consisting of banana, sapodilla, teak, cassava, durian, clove, longan, teak, bamboo, and cogongrass vegetation.

2.1.2. Physical Properties Analysis

Analysis of physical and chemical properties of the soil was taken from soil samples taken at the research sample point as much as ±1 kg, which then checked in the laboratory to determine the physical and chemical properties of the soil used for land suitability research, physical properties of the soil including texture. The chemical properties included C-organic, pH, CEC (cation exchange capacity), and base saturation.

2.2. Observation Parameters

The parameters used in this study included temperature, water availability, rooting media, nutrient retention, flood hazard, and land preparation. Rooting media parameters consisted of soil drainage class, coarse material, and soil depth (Ritung *et al*., 2011). For nutrient retention parameters included CEC value, base saturation, soil pH, and soil organic carbon content were taken into account (Ritung *et al*., 2011). For land preparation, the parameters included relief on the soil surface and the presence of rocks on the surface.

2.3. Data Analysis

Data analysis was carried out using the matching method, namely by comparing the land characteristics of each area with the criteria for land suitability classes for plantation crops set by Ritung *et al.* (2007). All observation parameters were interpolated and classified according to the standard from the Center for Agricultural Land Resources Research and Development (BBSDLP), then scored based on the Decree of the Agriculture Minister No. 79/2013 (Menteri Pertanian, 2013). The interpolation results were processed using the overlay technique to determine the land suitability class according to the established criteria. Determination of land suitability was carried out by weighing or scoring to each land parameter as summarized in Table 2 (Adininggar *et al.*, 2016). Table 3 detailed parameters along with their scores and criteria used for this study. Class determination from total score for suitability class was obtained using the Equation (1). The land suitability was classified according to total score listed in Table 4.

$$\text{Interval Width (I)} = \frac{Interval\ Distance\ (R)}{Number\ of\ Intervals\ (N)} \tag{1}$$

Table 2. Land suitability class and assigned scores

Land Suitability Class	Symbol	Score
Highly Suitable	S1	3
Moderately Suitable	S2	2
Marginally Suitable	S3	1
Not Suitable	N	0

Source: (FAO, 1976; Ritung *et al*., 2011)

Table 3. Soil characteristic scores for specific uses

Parameter	Class	Score
Temperature (°C)	18 – < 25	3
	> 15 – < 18 / > 25 – < 30	2
	> 10 – < 15 / > 30 – < 35	1
	< 10 / > 35	0
Rainfall (mm)	>1000–<2000	3
	>500–<1000 / >2000–<3000	2
	>250–<500 / >3000–<4000	1
	<250 / >4000	0
Drainage	Good	1
	Somewhat Good	2
	Moderate	3
	Somewhat Impeded	2
	Impeded	1
	Severely Impeded	0
Permeability (Arsyad. 1989)	Very Fast/Fast	1
	Somewhat Fast	2
	Moderate	3
	Somewhat Slow	2
	Slow/Very Slow	1
Texture	Somewhat Fine. Medium	3
	Fine	2
	Somewhat Coarse	1
	Coarse	0
Soil Depth (cm)	Deep > 90	3
	Moderate (50–90)	2
	Shallow (25–50)	1
	Very Shallow < 25	0
pH KCl	>5.5–<7.8	3
	>5.0–<5.5 / >7.8–<8.0	2
	<5.0–>8.0	1
	td	0
Organic C (%)	Very Low	0
	Low	1
	Moderate	2
	High	3
	Very High	1

Parameter	Class	Score
K (Potassium)	Very High. High. Moderate	3
	Low	2
	Very Low	1
	No Data	0
Salinity	> 0 – 4	3
	> 4 – < 6	2
	≥ 6 – 8	1
	> 8	0
Total N (%)	Very Low	1
	Low	2
	Moderate	3
	High	0
	Very High	0
Available P (ppm)	Very Low	0
	Low	3
	Moderate	2
	High	1
	Very High	0
Slope Gradient (%)	<8	3
	> 8 – < 16	2
	> 16 – < 30	1
	> 30	0
Base Saturation (%)	Very Low	0
	Low	1
	Moderate	2
	High	3
	Very High	3
CEC (Cation Exchange Capacity, cmol)	Very Low	0
	Low	1
	Moderate	2
	High	3
	Very High	3

Table 4. Total soil parameter scores

No	Suitability Class	Total Score Range
1	Highly Suitable (S1)	≤ 33 – 24
2	Moderately Suitable (S2)	≤ 24 – 16
3	Marginally Suitable (S3)	≤ 16 – 8
4	Not Suitable (N)	≤ 8 – 0

3. RESULTS AND DISCUSSION

The characteristics found at the research location are various land uses such as plantations, forests and dry fields on land owned by UPN "Veteran" East Java. The characteristics of the research location include several SPLs in the form of mixed gardens with various vegetation listed in Table 5 such as bananas, sapodilla, teak, cloves, durian, cogon grass, and bamboo. Based on climate data obtained from the power data access viewer in the last five years (2018 – 2022), it states that rainfall is 2,385 mm/year with an average monthly rainfall of 199 mm and an average temperature of 26°C. According to Rochimah *et al.* (2015), the research location has very good potential for the development of sugarcane plants based on the suitability value of the land with the growing requirements of sugarcane plants. Sugarcane plants have optimal humidity requirements ranging from 25 – 75% (Djaenudin *et al*., 2011).

3.1. Biophysical Character

Observations of biophysical and environmental characteristics in the research area include the condition of coarse materials, soil depth, surface rocks, rock outcrops, erosion hazards, flood inundation, and slope gradients. Observations were carried out directly in the field using description sheets. The results of coarse material data on 35 SPL (Land Use Units) had coarse materials <15% which were classified as small and were classified as very suitable (S1). The results of the percentage of surface rocks and rock outcrops had the highest value of 7% and the lowest of 1% with 10 SPLs classified as very suitable (S1) and 25 other SPLs included as suitable (S2). Based on research by Alfiyah *et al*. (2020), it shows that the proportion between rocks and root density in the soil influence each other.

Table 5. Vegetation in various land use units (SPL)

No.	SPL	Coordinate	Vegetation
1.	SPL 1	7° 40' 50.808" S 112° 21' 5.443" E	Bananas, Sapodilla, and Teak
2.	SPL 2	7° 40' 52.504" S 112° 21' 4.917" E	Cassava and Bananas
3.	SPL 3	7° 40' 51.909" S 112° 21' 7.040" E	Bananas, durian, and Sapodilla
4.	SPL 4	7° 40' 54.709" S 112° 21' 5.839" E	Clove and Bananas
5.	SPL 5	7° 40' 55.392" S 112° 21' 7.578" E	Clove and Bananas
6.	SPL 6	7° 40' 54.913" S 112° 21' 8.480" E	Durian
7.	SPL 7	7° 40' 59.408" S 112° 21' 10.905" E	Bananas and durian
8.	SPL 8	7° 40' 56.765" S 112° 21' 11.089" E	Durian and Longan
9.	SPL 9	7° 40' 56.553" S 112° 21' 14.202" E	Bananas
10.	SPL 10	7° 40' 53.723" S 112° 21' 12.468" E	Bananas
11.	SPL 11	7° 40' 55.937" S 112° 21' 16.402" E	Bananas and durian
12.	SPL 12	7° 40' 54.078" S 112° 21' 18.242" E	Clove and Bananas
13.	SPL 13	7° 40' 53.354" S 112° 21' 17.010" E	Teak
14.	SPL 14	7° 40' 51.377" S 112° 21' 15.089" E	Bananas and Teak
15.	SPL 15	7° 40' 51.694" S 112° 21' 17.728" E	Bananas
16.	SPL 16	7° 40' 51.370" S 112° 21' 18.608" E	Cogon grass
17.	SPL 17	7° 40' 49.562" S 112° 21' 16.289" E	Clove and Bananas
18.	SPL 18	7° 40' 48.731" S 112° 21' 16.911" E	Teak
19.	SPL 19	7° 40' 50.620" S 112° 21' 19.245" E	Clove
20.	SPL 20	7° 40' 48.989" S 112° 21' 20.716" E	Clove
21.	SPL 21	7° 40' 48.254" S 112° 21' 18.766" E	Clove
22.	SPL 22	7° 40' 47.194" S 112° 21' 18.106" E	Clove
23.	SPL 23	7° 40' 46.886" S 112° 21' 19.408" E	Clove
24.	SPL 24	7° 40' 46.590" S 112° 21' 21.101" E	Clove
25.	SPL 25	7° 40' 45.158" S 112° 21' 21.353" E	Cogon grass
26.	SPL 26	7° 40' 44.365" S 112° 21' 20.592" E	Teak
27.	SPL 27	7° 40' 42.509" S 112° 21' 20.193" E	Teak
28.	SPL 28	7° 40' 41.670" S 112° 21' 20.824" E	Clove
29.	SPL 29	7° 40' 42.740" S 112° 21' 21.918" E	Clove
30.	SPL 30	7° 40' 44.886" S 112° 21' 22.966" E	Clove
31.	SPL 31	7° 40' 45.533" S 112° 21' 25.302" E	Clove and Teak
32.	SPL 32	7° 40' 46.423" S 112° 21' 26.028" E	Bamboo and Clove
33.	SPL 33	7° 40' 48.591" S 112° 21' 28.703" E	Bananas and durian
34.	SPL 34	7° 40' 48.495" S 112° 21' 29.325" E	Bananas and durian
35.	SPL 35	7° 40' 48.327" S 112° 21' 28.377" E	Bananas and weeds

The optimum soil depth for sugarcane plants is >75 cm (Djaenudin *et al*., 2011), and 23 SPLs are included in the very suitable class (S1), 8 SPLs are quite suitable (S2), and 4 SPLs are marginally suitable (S3). Soil depth affects the types of plants that can grow and the productivity of the land. Soil depth affects the space for roots to grow and absorb water and nutrients in it, if the soil depth is adequate it will support optimal plant growth.

Field observation results regarding drainage classes showed varying results. A total of 31 SPLs showed a very suitable drainage class (S1). There were two SPLs with a fairly suitable drainage class (S2), namely SPL 6, SPL 23. The SPL 24 showed the results of a marginal drainage class (S3), while SPL 32 showed the results of a drainage class that was not suitable (N). According to Djaenudin *et al.* (2003), soil drainage is divided into 7 drainage classes for land evaluation, namely fast, slightly fast, good, slightly good, slightly inhibited, inhibited, and very inhibited. The quality of soil drainage is said good if the soil color is uniform and there is no iron or aluminum spots on each layer of soil (Djaenuddin *et al*., 2003).

Based on the results of slope measurements at the research location, it was between 3%–38%, and 16 SPLs were categorized as very suitable (S1), 18 SPLs were categorized as fairly suitable (S2), 6 SPLs are categorized as marginally suitable, and one SPL is categorized as unsuitable (N). The level of erosion hazard found at the research location shows that the very suitable category (S1) is 19 SPLs, the fairly suitable category (S2) is 9 SPLs, the marginally suitable category (S3) is 6 SPLs, and the unsuitable category (N) is 1 SPL. The potential for erosion hazards can be predicted through field observations of erosion symptoms such as sheet erosion, groove erosion, and gully erosion (Djaenuddin *et al*., 2011). The inundation/flood class found at the research location is included in F0 or is categorized as a very suitable land suitability class (S1) according to the evaluation requirements for sugarcane land.

3.2. Soil Texture

The results of laboratory analysis of the soil texture of the research location showed that the texture was rather fine, fine, and medium. The texture class of land suitability for sugarcane plants showed results that the category was very suitable (S1). This is in line with research by Djaenudin *et al.* (2011), that land with high suitability category (S1) for sugarcane is characterized by soil having textures class of fine, slightly fine, moderate, and slightly coarse. The movement of water and disolved substances, soil aeration, heat movement, volume weight, specific surface area, and ease of soil compaction are greatly influenced by soil texture (Hardjowigeno & Widiatmaka, 2018).

3.3. pH H_2O

Land quality requirements for sugarcane plants are between 5.5–6.2 for optimum growth (Djaenudin *et al*., 2011). The results of the study showed that 19 SPLs showed a very suitable class (S1) because they were within the limits of 5.5 – 6.2, while the other 16 SPLs were less than the optimum value for sugarcane growth. The ideal soil acidity level creates conditions where nutrients in the soil are more easily dissolved in water. This allows plant roots to absorb nutrients more efficiently, so that plant growth is optimal. Neutral pH in the soil will be able to absorb nutrients well (Maroeto *et al*., 2022). Very low soil acidity levels cause aluminum and iron to become more soluble, so that the toxicity of both elements increases. This condition can inhibit plant growth, reduce nutrient availability, and have a negative impact on soil fertility.

3.4. C-Organic

Based on the data in Figure 3, the C-Organic value of 35 SPLs found that the lowest C-Organic content was at 1.83%, while the highest content was at 3.8%. The total SPL is high because it is more than 1.2, which means it is very suitable (S1). According to the opinion of Djaenudin *et al*. (2011), the C-Organic value in the soil for the suitability of sugarcane land is > 1.2, categorized as very suitable. According to Sipahutar *et al*. (2014), the higher the height of microorganism activity, the faster the decomposition process of organic matter and the more C-Organic is formed in the soil. This is because microorganisms act as the main decomposers of organic matter. The decomposition process by microorganisms will integrate the carbon into the organic matter of the soil (Ruddiman, 2007).

3.5. Cation Exchange Capacity (CEC)

The results of laboratory analysis showed that 35 SPLs had cation exchange capacities (CEC) varying between 15.00

and 32.97. SPLs with high CEC content included SPL 1, SPL 4, SPL 31, SPL 33, and SPL 34, while the other 30 SPLs showed moderate CEC levels. Sugarcane plants can grow optimally if the CEC content exceeds 16. Based on the suitability of land for sugarcane plants, SPL 14, SPL 15, SPL 16, SPL 25, and SPL 35 are included in the fairly suitable category (S2) because their CEC is less than 16. The other 30 SPLs are included in the very suitable category (S1). Cation exchange capacity provides nutrients for plants and is an important indicator of soil fertility (Suryani, 2014). Soil with high CEC is generally more fertile and productive than soil with low CEC.

3.6. Base Saturation

Based on the table, it shows that the results of base saturation vary by 8.81%–20.14%. SPL 14 and SPL 15 have low base saturation values of 20.14%. A total of 32 SPLs have very low base saturation values. Base saturation to optimize sugarcane growth is when the base saturation value is more than 35%. The land suitability class for base saturation in sugarcane in SPL 14 and SPL 15 is included in the fairly suitable category (S2), with a value of 20.14%. Meanwhile, the other 32 SPLs are included in the marginally suitable category (S3) because they are less than 20%. According to Sembiring *et al*. (2015), base saturation describes the extent to which the soil is able to absorb and retain base ions such as calcium, magnesium, sodium, and potassium.

3.7. Actual Land Suitability

The actual land suitability class provides an overview of how suitable something on the land is for a particular use based on the current land conditions, without considering the potential for improving land quality through improvement efforts. Several limiting factors in land evaluation assessments are divided into two, namely non–permanent and permanent. Permanent factors are generally difficult or impossible to improve, while non–permanent factors can be attempted with improvement efforts using appropriate technology (Ritung *et al*., 2007).

The results of matching various land use units (SPL) in the land suitability criteria for sugarcane plants produce marginal land suitability classes (S3) and unsuitable (N) as in Figure 2 and Table 6. The land suitability class is supported by several limiting factors in each land use unit (SPL). The limiting factors found include base saturation, slope, erosion hazard, soil C-organic content, drainage and soil depth. These limiting factors inhibit plant growth on land that will be planted with sugarcane.

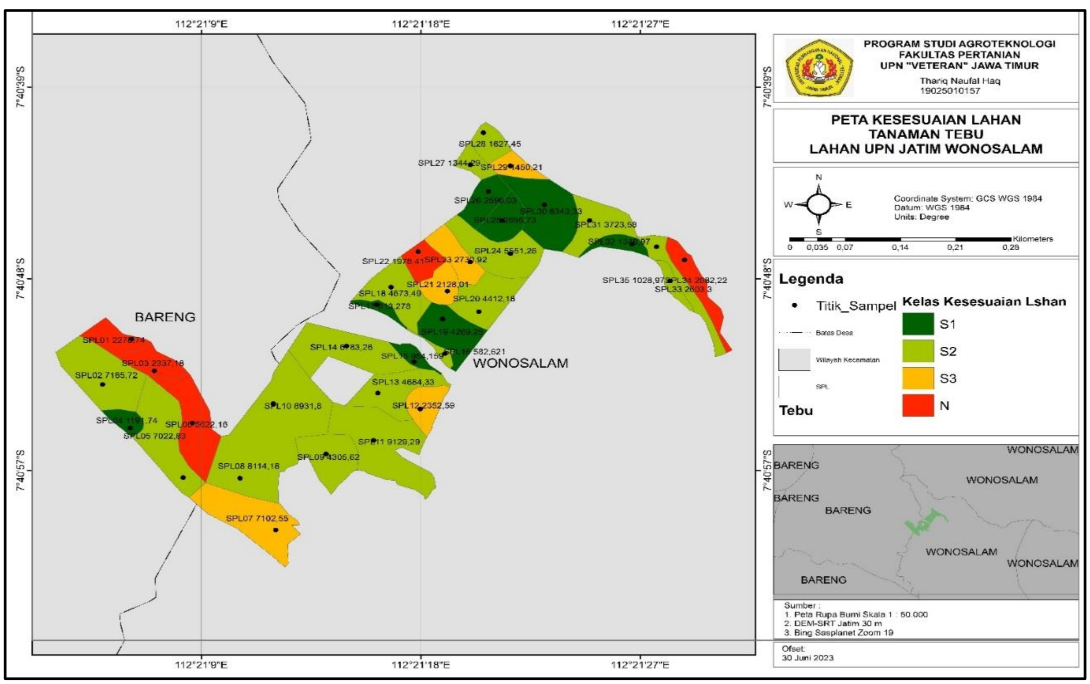

Figure 2. Actual land suitability map

Table 6. Actual land suitability class based on score of parameters

SPL	Rock	pH	BS	CEC	SD	Texture	Temp.	Drainage	Rainfall	Erosion	Slope	C-organic	Total Score	Land Suitability Class	Limiting Factors*
SPL01	2	3	1	3	1	3	3	3	1	1	1	3	25	N	N wa1 rc3 nr2 eh12
SPL02	3	1	1	3	2	3	3	3	1	3	2	3	28	S2	S2 wa1 nr2
SPL03	2	3	1	3	1	3	3	3	1	1	1	3	25	N	N wa1 rc3 nr2 eh12
SPL04	3	2	1	3	2	3	3	3	1	3	3	3	30	S1	S1 wa1 nr2
SPL05	3	3	1	3	1	3	3	3	1	1	3	3	28	S2	S2 wa1 nr2 eh1
SPL06	3	2	1	3	0	3	3	2	1	2	2	3	25	N	N wa3
SPL08	3	2	1	3	2	3	3	3	1	1	2	3	27	S3	S3 wa1 nr2 eh1
SPL09	3	3	1	3	2	3	3	3	1	2	2	3	29	S2	S2 wa1 nr2
SPL10	3	2	1	3	2	3	3	3	1	3	2	3	29	S2	S2 wa1 nr2
SPL11	3	2	1	3	2	3	3	3	1	3	2	3	29	S2	S2 wa1 nr2
SPL12	3	3	1	3	1	3	3	3	1	1	1	3	26	S3	S3 wa1 nr2 eh12
SPL13	3	2	1	3	2	3	3	3	1	3	2	3	29	S2	S2 wa1 nr2
SPL14	3	2	2	3	1	3	3	3	1	2	2	3	28	S2	S2 wa1 nr2
SPL15	3	2	2	3	2	3	3	3	1	3	3	3	31	S1	S1 wa1 nr2
SPL16	3	3	1	3	0	3	3	3	1	3	3	3	29	S2	S2 wa1 nr2
SPL17	3	2	1	3	2	3	3	3	1	3	3	3	30	S1	S1 wa1 nr2
SPL18	3	2	1	3	2	3	3	3	1	3	2	3	29	S2	S2 wa1 nr2
SPL19	3	3	1	3	2	3	3	3	1	3	2	3	30	S1	S1 wa1 nr2
SPL20	3	3	1	3	2	3	3	3	1	2	2	3	29	S2	S2 wa1 nr2
SPL21	3	2	1	3	2	3	3	3	1	1	1	3	26	S3	S3 wa1 nr2 eh12
SPL22	3	2	1	3	1	3	3	3	1	1	1	3	25	N	N wa1 rc3 nr2 eh12
SPL23	3	3	1	3	1	3	3	2	1	2	2	3	27	S3	S3 wa1 rc3 nr2
SPL24	3	3	1	3	2	3	3	1	1	3	2	3	28	S2	S2 wa1 nr2 oa
SPL25	3	3	1	3	2	3	3	3	1	3	3	3	31	S1	S1 wa1 nr2
SPL26	3	3	1	3	1	3	3	3	1	3	3	3	30	S1	S1 wa1 rc3 nr2
SPL27	3	2	1	3	1	3	3	3	1	3	3	3	29	S2	S2 wa1 rc3 nr2
SPL28	3	3	1	3	2	3	3	3	1	2	2	3	29	S2	S2 wa1 nr2
SPL29	2	3	1	3	2	3	3	3	1	1	1	3	26	S3	S3 wa1 nr2 eh12
SPL30	3	3	1	3	2	3	3	3	1	3	2	3	30	S1	S1 wa1 nr2
SPL31	3	3	1	3	2	3	3	3	1	2	2	3	29	S2	S2 wa1 nr2
SPL32	3	3	1	3	1	3	3	3	1	3	3	3	30	S1	S1 wa1 rc3 nr2
SPL33	3	3	1	3	2	3	3	3	1	2	2	3	29	S2	S2 wa1 nr2
SPL34	2	2	1	3	2	3	3	3	1	1	0	3	24	N	N eh1
SPL35	2	2	1	3	2	3	3	3	1	3	3	3	29	S2	S2 wa1 nr2

Note: BS: Base saturation, SD: Soil depth, S1: Highly Suitable, S2: Moderately Suitable, S3: Marginally Suitable, N: Not Suitable.
wa1: Rainfall, oa: Drainage, rc2: Coarse Material, rc3: Soil Depth, nr2: Base Saturation, nr3: pH, eh1: Slope, eh2: Erosion Hazard.

The suitability of sugarcane land produces class S2 with limiting factors of rainfall, coarse material, soil depth, base saturation, pH value, slope, and erosion hazard. The optimal rainfall required by sugarcane plants ranges from 600–1,200 mm, while the rainfall in the field is 2385 mm. The optimum soil depth required by sugarcane plants is more than 100 cm, but SPL 6 and 16 are zero because the soil depth is less than 50 cm. The optimal base saturation value for sugarcane plants is >35%, the results of soil analysis produce a value of <20%. The optimum level of erosion hazard that can be accepted by sugarcane plants is very light, in field conditions a very severe level of erosion hazard is found. The limiting factor of erosion hazard is influenced by rainfall, wind, slope and human factors. Impact High slope gradient affects the level of erosion hazard. The longer the slope, the steeper the slope so that the impact of rainwater falling on the ground will be greater and accelerate the occurrence of surface flow or run off (Sinaga, 2014). The limiting factor of low base saturation often causes the soil to be acidic. High acid cation content, especially Al_3^+, can be toxic to plants (Hardjowigeno, 2015). The level of CEC in the soil also affects base saturation. One way to improve this condition is by liming. Lestari *et al*. (2018) explained that liming can increase soil pH and the content of base cations such as Ca and Mg, using dolomite lime as an example.

Low organic carbon content can have a negative impact on plant growth. To increase soil organic carbon levels, compost or urea fertilizer can be added according to standards. Increasing soil organic carbon contributes to sustainable soil fertility. Soil drainage conditions also affect plant growth. Improving the soil drainage system affects aeration, humidity, nutrient and pesticide transport, soil temperature, and reduces toxic materials, pests and diseases, soil erosion, and flooding, which have an impact on plant fertility and yields. Sugarcane, for example, requires good drainage for optimal growth. Limited soil depth can affect plant root media. Improving soil structure in hard layers is usually difficult, except for soft and thin hard layers that can be destroyed or dismantled through mechanical soil processing. Hardjowigeno & Widiatmaka, (2018) stated that the ability of plant roots to penetrate the soil and absorb water and nutrients is limited. Soil depths of less than 50 cm can limit the growth of plants that require deep root space, so that only annual plants or shallow-rooted plants can grow well (Djaenudin *et al*., 2000).

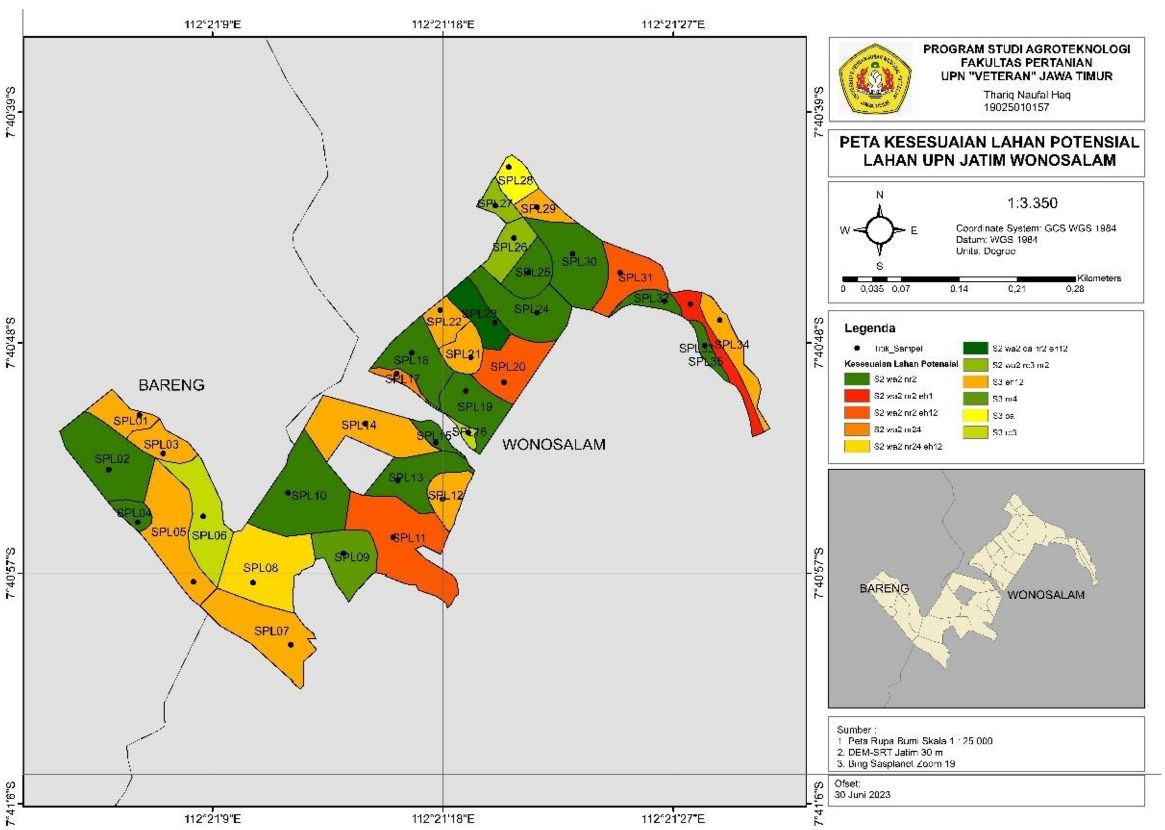

Figure 3. Potential land suitability

3.8. Potential Land Suitability Class

Suitability in potential land is an assessment of the ability of a land to achieve optimal productivity after the necessary improvement efforts are made to overcome existing constraints. Land improvement efforts in potential land suitability are divided into two, namely those that can be changed (non-permanent) and those that cannot be changed (permanent). Technological improvements developed based on the results of the analysis of actual land suitability can help overcome various factors inhibiting plant growth that occur naturally. However, it should be understood that not all types of land improvements can be applied effectively to improve soil quality, especially on land that is severely damaged or has limited resources. Efforts to improve land quality characteristics are carried out by means of appropriate management (Ritung *et al*., 2007). The assessment results show that the land suitability class has certain potential. presented in Figure 3.

4. CONCLUSION

Land suitability classes for sugarcane plants in Wonosalam District vary from very suitable (S1) to unsuitable (N). Almost all SPLs have similar limiting factors, namely slope gradient and erosion hazard level, base saturation, C-organic content, soil drainage, and soil depth. It is necessary to carry out improvement facilities for drainage limiting factors by leveling the land surface to reduce waterlogging, creating open channels to drain surface water, or creating ridges to slow down water flow and increase water infiltration into the soil. The limiting factor of base saturation can be improved by providing dolomite.

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