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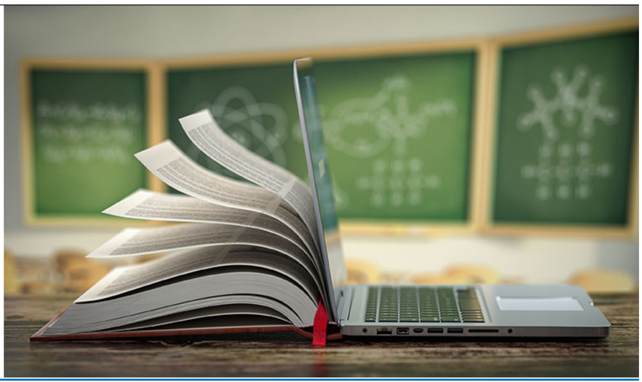

Arabica coffee land suitability with a parametric approach based on square root

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Abstract. Arabica coffee is one of the most popular drinks by people in various countries. Coffee production is able to become a source of state income, especially Arabica coffee which has good export competitiveness. Therefore, an assessment of the suitability of land, especially Arabica coffee, needs to be carried out to estimate the extent to which land in Bantaeng Regency is suitable for Arabica coffee plants. The method used in this land suitability assessment is square root. Determination of the research location point is based on land use, especially coffee plants. The results showed that the land suitability class at all profile observation points was N1 (not suitable at this time) with the factors of soil depth, soil pH, calcium carbonate and salinity. The limiting factor for soil depth is difficult to repair, while the soil pH which is so high due to the presence of calcium carbonate which is also high enough for Arabica coffee can be repaired by providing sulfur. Salinity improvement efforts can be made by reclamation.

1. Introduction

Coffee is one of the plantation products that is in great demand by the community. The existence of coffee is one of the plants with high selling value. The composition of coffee plantation business forms in Indonesia is dominated by smallholder plantations (PR) with 96% of the total area in Indonesia, and the remaining 2% are State Large Plantations (PBN), and 2% are Private Large Plantations (PBS) [1]. The types of coffee plants cultivated by Indonesian farmers are Arabica coffee and Robusta coffee. Each coffee has its advantages, Arabica coffee has a distinctive taste so that it has a special market, while Robusta coffee [2] is a commodity that has strategic value in the framework of empowering the people's economy.

Based on BPS data [3], Indonesian coffee plantation production in 2018 reached 713.921 tons with an area of 1,235,798 hectares. Most of Indonesia's coffee production is exported abroad and the rest is marketed domestically. The top five importing countries for Indonesian natural coffee are the United States (52.10 thousand tons), Malaysia (38.80 thousand tons), Japan (30.37 thousand tons), Egypt (29.31 thousand tons), and Italy (27, 93 thousand tons) Meanwhile, total coffee imports in 2018 were recorded at 78.85 thousand tons or a drastic increase of 454.48 percent from 2017.

Bantaeng Regency is one of the regency that develops coffee plants. This is based on Local Regulation No.2 of 2012 concerning the 2012-2032 of Bantaeng Regency spatial plan [4] which makes Tompobulu, Eremerasa and Uluere Districts as areas for developing plantation commodities, especially coffee. According to Sys et al. [5] optimal coffee production at the farm level ranges from 0.5-1.2 tonnes / ha. The production of coffee in Bantaeng Regency ranges from 0.22 to 1.01 thousand tons, so it can be seen that the development of coffee in Bantaeng Regency is quite potential. Therefore, evaluation of land suitability is necessary to determine the land potential of a land to be analyzed using a parametric approach.

The parametric approach in evaluating of land suitability is the assignment of values at different levels of boundary to land properties, on a normal scale given a maximum value of 100 to a minimum value of 0. A value of 100 is given if the optimal land properties for the type of land use being considered [6].

2. Methods

The research was conducted in Uluere and Eremerasa Districts, Bantaeng Regency. The research method used is a mixture of qualitative and quantitative methods. Soil sampling was conducted by purposive sampling. The approach method of this research was the parametric approach. The stages in this study were: 1) secondary data collection such as climate data and basic maps (administration, soil type, land use, geology, and slopes), 2) work maps development by overlaying the base maps, 3) preliminary surveys, 4) description of observation profile and soil sampling, 5) analysis of soil samples in the laboratory, 6) climate and land suitability analysis [7]. Calculation of the climate index based on square root method by Khiddir [7] equation:

$$\text{Ic}=Rmin\sqrt{\frac{\text{A}}{100}\ \text{x}\ \frac{\text{B}}{100}\ \text{x} \dots\dots\dots} \tag{1}$$

Rc = (0,9 x Ic) + 16,67 (Jika, 25 < Ic < 92,5)
Rc = (1,6 x Ic) (Jika, Ic < 25)

notes:
Ic = Climate index
Rc = Climate rating
Rmin = Minimum rating
A, B …… = Other ratings besides the minimum rating

Calculation of the land index based on square root method by Khiddir [7] equation

$$\text{I}=Rmin\sqrt{\frac{A}{100}\ \text{x}\ \frac{\text{B}}{100}\ \text{x}\frac{\text{C}}{100}\ \text{x}\dots\dots\dots} \tag{2}$$

notes:
I = Land index
Rmin = Minimum rating
A, B…. = Other ratings besides the minimum rating

3. Results and discussion

3.1. External characteristichs of soil morphology

Soil morphology was observed based on the predetermined soil profile. Soil profiles in this study are located in Eremerasa and Uluere Districts with varying slopes (figures 1). Soil morphology is the description of a soil regarding the appearance, characteristics and properties of a soil that can be observed in the field (table 1).

Table 1. External characteristichs of soil morphology.

Characteristics	Land units					
	1	2	3	4	5	6
Location	Pa'Bumbungang village, Eremerasa district	Pa'Bumbungang village, Eremerasa district	Kampala village, Eremerasa district	Bontomaranu village, Uluere district	Bontomaranu village, Uluere district	Bontolojong village, Uluere district
Geographic coordinates	Latitude $05^0$27'30.4" S Longitude $119^0$59'08.1"E	Latitude $05^0$27'29.1" S : Longitude $119^0$59'13.9"E	Latitude $05^0$26'48.3" S Longitude $119^0$54'51.4"E	Latitude $05^0$26'36.1" S Longitude $119^0$54'49.1"E	Latitude $05^0$26'48.3" S Longitude $119^0$54'51.4"E	Latitude $05^0$25'33" S Longitude $119^0$55'33"E
Altitude	754 masl	742 masl	500 masl	1,147 masl	1,152 masl	1,353 masl
Profile slopes	flat	flat	slightly sloping	flat	flat	slightly sloping
Land use	mix	mix	mix	mix	mix	mix
Main crop	coffee	coffee	coffee	coffee	coffee	coffee
Other plants	cloves	corn	cloves	corn	Banana, cocoa	Potatoes, carrots
Planting system	polyculture	monoculture	polyculture	monoculture	polyculture	polyculture

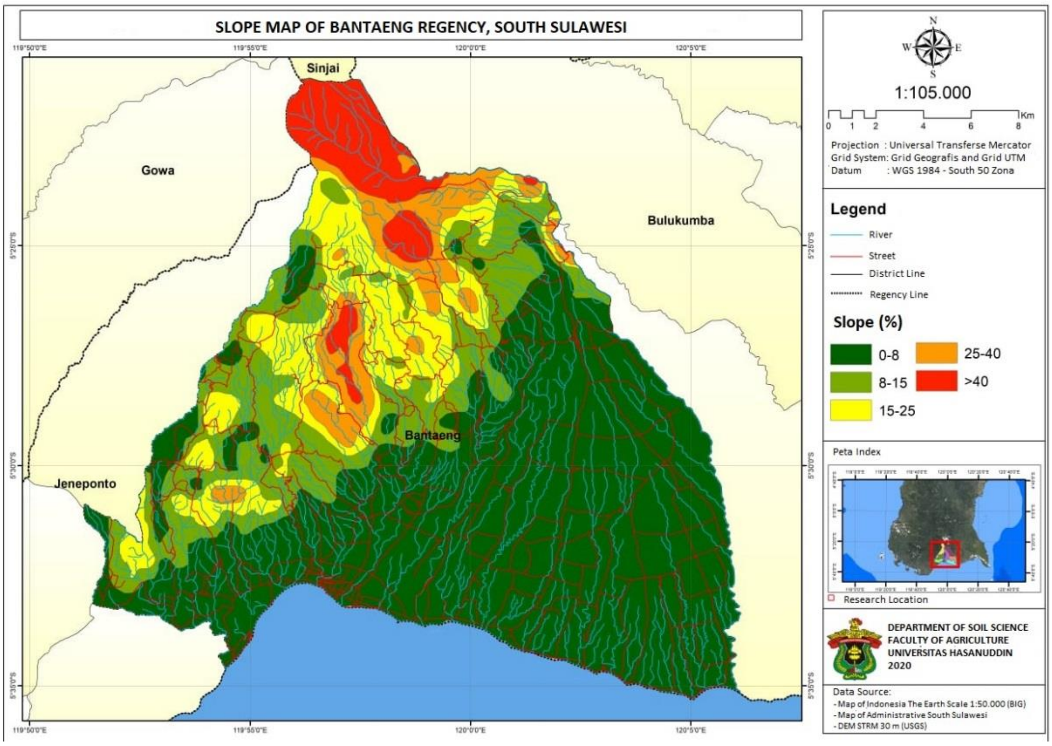

Figure 1. Slope map of Bantaeng regency, South Sulawesi.

3.2. Climate suitability analysis

The climate suitability analysis was carried out based on the square root method which was based on the climate requirements of Arabica coffee [5]. Based on the results of the climate suitability analysis, Arabica coffee is classified as S1 (very suitable) with a climate rating of 83.01. The limiting factor in the climate suitability analysis is the average minimum daily temperature for the month with the highest rainfall (ºC). The average temperature is difficult to improve [8]. The results of climate suitability analysis for Arabica coffee can be seen in table 2.

Table 2. Analysis of climate suitability for Arabica coffee.

Climate characteristics	Arabika coffee
Annual Rainfall (mm)	83.21
Long dry season	100.00
Average maximum annual temperature (ºC)	97.93
The average minimum daily temperature for the month with the highest rainfall (ºC)	94.4
Average annual temperature (ºC)	97.9
Average humidity of the driest month (%)	90
The driest 5 months of exposure time	96.35
Ic	73.71
Rc	83.01
Climate suitability class	S1

3.3. Land suitability analysis

Land suitability analysis was carried out based on the square root method which was based on the land requirements for Arabica coffee [5]. Based on the results of land suitability analysis at all profile observation points, Arabica coffee is classified into N1 (not suitable at this time) with limiting factors for soil depth, $CaCO_3$, Salinity (profiles 1, 2, 3, 4, 5 and 6) and pH of H_2O (profiles 2 and 3). The results of land suitability analysis for Arabica coffee can be seen in table 3 and figure 2.

Table 3. Land suitability analysis of arabica coffee.

Land characteristics	Land units					
	1	2	3	4	5	6
Climate	83.01	83.01	83.01	83.01	83.01	83.01
Topography (t)						
Slope (%)	100	100	95.00	100	100.00	95.00
Wetness (w)						
Flood	100	100	100	100	100	100
Drainage	85	85	85	85	85	85
Soil physical characteristics (s)						
Texture	100.00	60.00	100.00	85.00	100.00	100.00
Coarse fragment (vol%)	85.00	100.00	100.00	100.00	85.00	85.00
Soil depth (cm)	40.00	40.00	48.00	40.00	40.00	40.00
$CaCO_3$ (%)	46.27	54.23	52.93	51.53	44.91	49.38
Characteristics of soil fertility (f)						
CEC (cmol(+)/kg clay)	100	100	100	100	100	100
Base saturation (%)	96.01	97.08	83.93	96.73	83.63	95.55
Sum of base cations (cmol(+)/kg soil)	100.00	100.00	100.00	100.00	100.00	100.00

pH H_2O	98.75	63.13	63.13	95.00	95.00	97.50
Organic carbon (%)	94.87	94.56	100.00	94.45	100.00	96.21
Salinity & alkalinity (n)						
Ece (dS/m)	48.50	49.47	53.90	41.76	43.97	43.90
Land index	13.92	10.26	15.28	13.39	12.27	13.31
Land suitability class	N1	N1	N1	N1	N1	N1

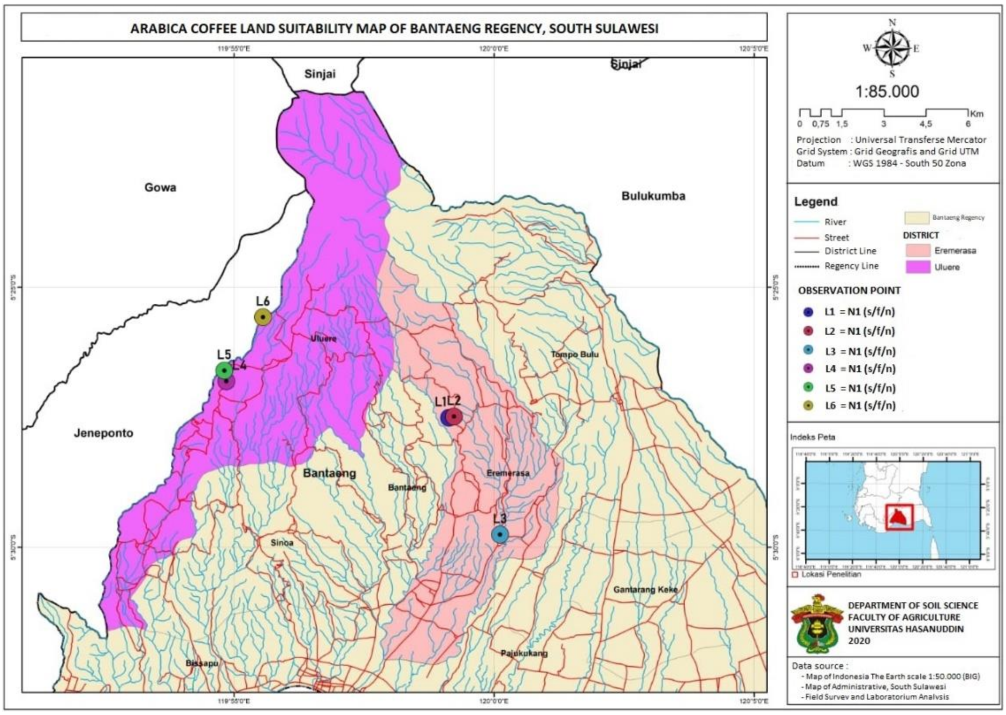

Figure 2. Arabica coffee land suitatability map of Bantaeng Regency.

Limiting factors such as $CaCO_3$, pH H_2O, and Salinity can still be improved by giving sulfur to reduce pH and $CaCO_3$. The oxidation of sulfur will produce H+. the higher the H+ content in the soil will make the soil pH acidic [10]. Salinity can be reduced by adjusting the water system such as increasing drainage, so that water will flow and wash the salts contained in the soil [9]. Limiting factors such as soil depth are difficult to repair. The constraints that can still be overcome make it possible for the land suitability class to change from the previous land suitability class. The results of potential land suitability classes can be seen in table 4.

Table 4. Potential land suitability analysis.

Type of coffee	Actual land suitability class	Improvement	Potential land suitability class	Limiting factors	Information
Arabica	N1 (soil depth, $CaCO_3$, pH H_2O, salinity)	• $CaCO_3$ and pH with the use of sulfur (sulfur) • Salinity by regulating the water system in the form of increased drainage	S3	Soil depth	Difficult to repair in soil depth

4. Conclusions
The conclusion in this study is that the land suitability class with the parametric method (square root) is N1 (not suitable at this time) at all points of observation of profiles with limiting factors for soil depth, $CaCO_3$, Salinity (profiles 1, 2, 3, 4, 5 and 6) as well as pH H_2O (profiles 2 and 3).vLimiting factors such as soil depth are limiting factors that are difficult to repair. The high of pH H_2O and $CaCO_3$ can be lowered by giving sulfur / sulfur. Salinity can be overcome by regulating the water system such as increased drainage. The constraints that can still be overcome allow for the land suitability class to change from the previous land suitability class.

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