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Land Suitability and Farmer Perception on Maize Cultivation in Limboto Basin Gorontalo

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ABSTRACT. Agropolitan program, leads by increasing maize production, has been promoted in Gorontalo. Such effort requires, among others, study on spatial land suitability. The objectives of this study were to determine land suitability for maize in Limboto Basin and to spatially present the quality of land units to the plant (maize) requirements. Farmer perception on maize cultivation is also generated. Standard field and laboratory procedures have been performed to characterize land suitability for maize. Besides, geographical information system has been employed to delineated the spatial availability. Among 35,594 ha evaluated area in Limboto Basin Gorontalo, 21,233 ha is categorized as fairly suitable for maize while 14,361 ha is classified as marginally suitable for maize. Majority of the observed farmers were in favor to cultivate maize on their farmland.

Keywords: farmer perception, land suitability, maize cultivation.

Introduction

Land-use suitability is the ability of a given type of land to support a defined use. It is assessed considering rational cropping system, for optimizing the use of a piece of land for a specific use (FAO 1976; Sys *et al.* 1991). The suitability is a function of crop requirements and land characteristics and it is a measure of how well the qualities of land unit match the requirements of a particular form of land use (FAO 1976). The process of land suitability analysis involved evaluation and grouping of specific areas of land in terms of their suitability for a defined use. The principles of sustainable development make land-use suitability analysis become increasingly complex due to consideration of different requirements/criteria. It includes consideration not only inherent capacity of a land unit to support a specific land use for a long period of time without deterioration, but also the socioeconomic and environmental costs.

Geographic Information System (GIS) is considered as the powerful tool for input, storage and retrieval, manipulation and analysis, and output of spatial and attribute data. Meanwhile, land-use suitability analysis is required to handle both spatial and attribute data in many data layers. Therefore, it is appropriate to use GIS to exploit its strong capability in handling spatial data.

There are several methods and approaches for land evaluation; namely simple limitation, limitation, and parametric methods. Simple limitation method compares and matches land characteristics with plant requirements. While limitation method refers to the magnitude of limiting factors belong of the evaluated land (FAO 1976). In this case, land suitability class is dictated by its availability (S) and non-availability (N). Parametric method values different land characteristics in maximum (usually 100) to the minimum scale (Sys *et al.* 1991). Each land character will be rated and calculated using mathematical formula to obtain land productivity based on climatic data. Plant production data input can predict land actual productivity (Juniarti 2003). Land evaluation is classified according to its availability level (FAO 1996) as following:

Ordo: categorizing land suitability as suitable (S) and not suitable (N).

Class: further classified the suitable land (S) as highly suitable (S_1), moderately suitable (S_2) and marginally suitable (S_3). The S_1 land has no, or insignificant limitations to the given type of use, S_2 land have minor limitations to the given type of use, and S_3 land has moderate limitations to the given type of use. The N ordo is classified as N_1 (currently not suitable) because it has severe limitations that preclude the given type of use, but can be improved by specific management, and N_2 (permanently not suitable) since it has so severe limitations that are very difficult to be overcome.

Since 1965, maize production has increased from 1 MT/ha to 1.69 MT/ha in 1986 and 6 MT/ha in 1989. Presently maize yield has reached 8 to 10 MT/ha. Low maize yield is mainly due to the soil condition that is not fully suitable for maize (Siradz 1992). Increasing maize yield in Inceptisols can be achieved by increasing soil fertility using combination of 300 kg urea/ha, 125 kg SP-36/ha, and 75 kg KCl/ha to provide N, P, and K nutrient (Botutihe 2000).

In 2011, Gorontalo Province contributes 4% of Indonesian maize product and the effort to increase maize product is being promoted by means of agropolitan program. Nevertheless, spatial data concerning land suitability for maize has not been provided. Providing spatial data on land suitability for maize is necessary as to optimize maize yield as well as soil productivity and to prevent soil quality degradation through soil erosion.

In this study, limitation method for land evaluation integrated with GIS was applied to evaluate the suitability of the agricultural land of the study area for maize using the relevant variables of soil physical and chemical parameters. Also, fertilizer recommendation as well as farmers perception on agropolitan program have been generated.

Methodology

Study Area

The study was conducted at Limboto Basin, Gorontalo, Indonesia (0.30’49"-0.47’42" N and 122.41’52"-123.53’49"E with total area of 91,199 Ha. During the last decade the study area has been suffered from flood and inundation (Figure 1). High rainfall occurs from November to March and low rainfall usually takes place from August to September (Figure 2). Mean monthly temperature usually indicated by tropical hot and humid temperature that range from 26 to 27^{O}C, while mean monthly humidity ranges from 73 to 83% (Figure 3).

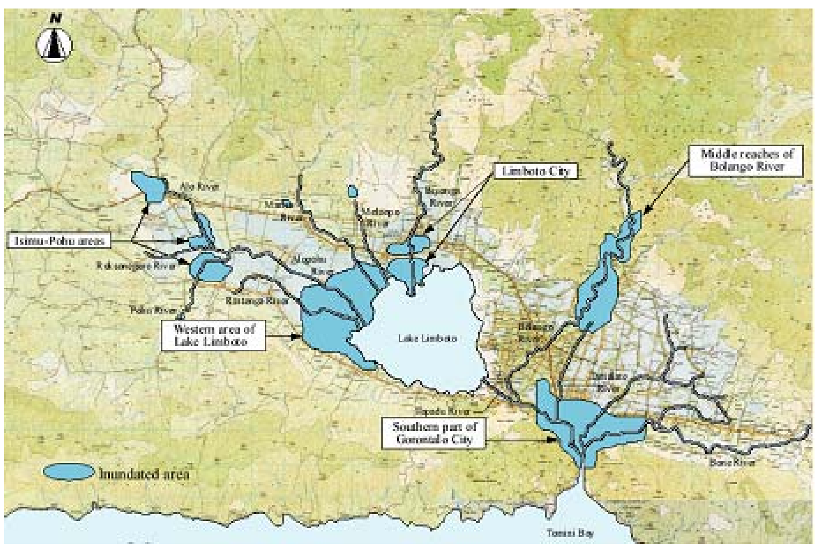

Figure 1. Study area

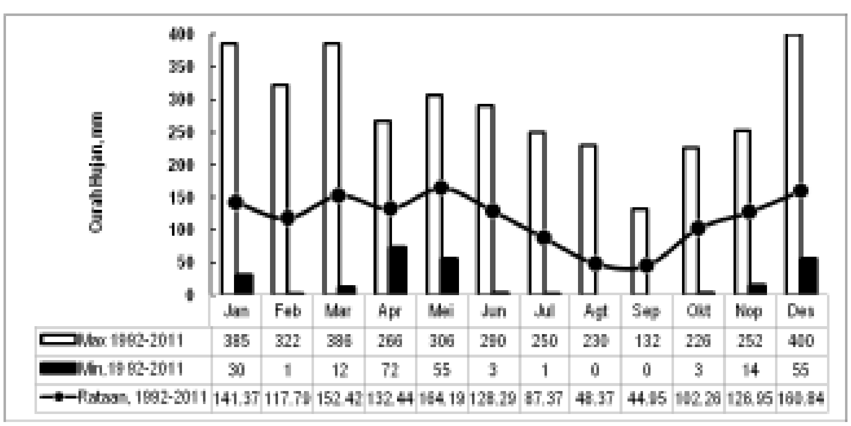

Figure 2. Mean, Maximum, and Minimum Monthly Rainfall during 1992-2011.

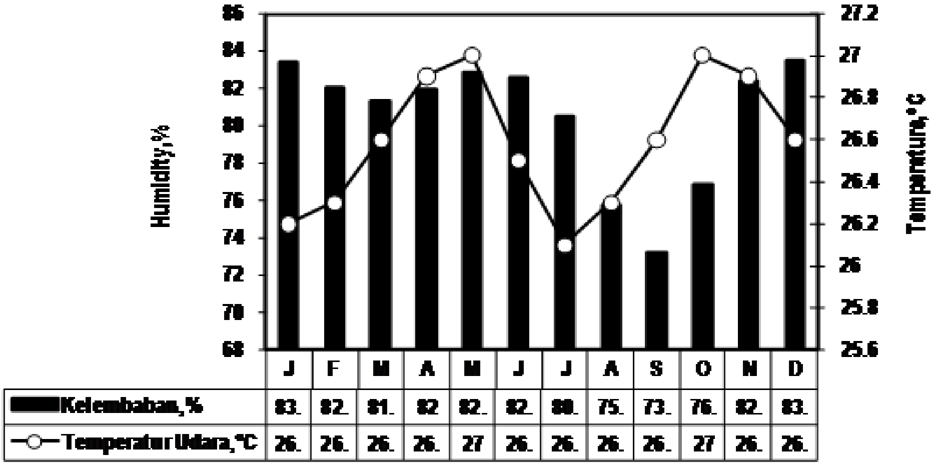

Figure 3. Mean, maximum, and minimum monthly temperature and humidity.

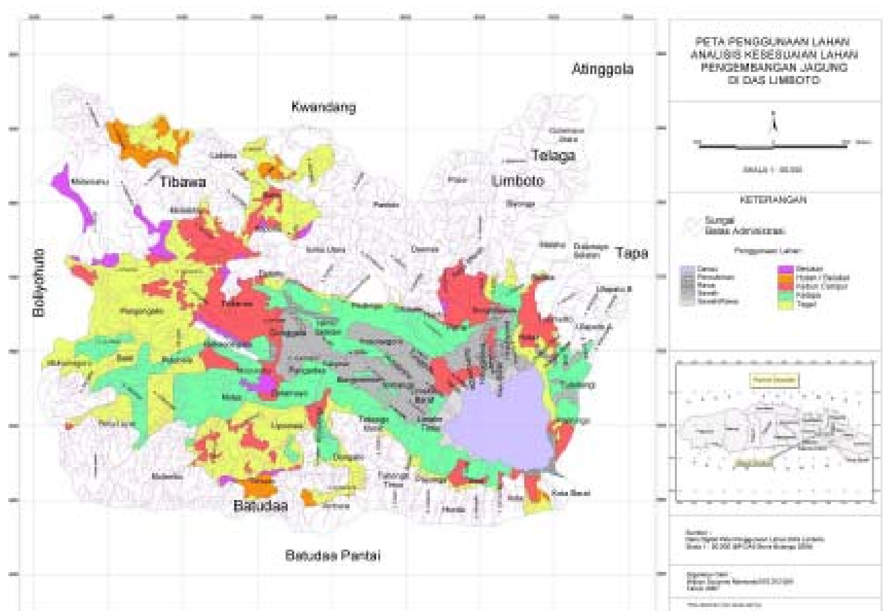

Figure 4. Landuse of the study area excluding forest, rice field, public facilities.

Procedure

Land evaluation was conducted employing the Agro Ecological Zone (FAO 1976) and Soil and Agro climate Research Center (1980) procedures. The study area was deliniated as preserved, buffer, and cultivated zones based on the elevation, slope, erosion hazard, and forest status. Preserved forest, rice field, residential, and other publc facilities were excluded and eliminated (Figure 4).

The remaining land was then evaluated based on slopes and landuse to classify land unit (Figure 5).

Soil samples were collected from each land unit for chemical and physical laboratory analyses. Meanwhile, farmer perception regarding maize cultivation on their farmland were observed by means of questionnaire. Spatial analysis was carried out employing Arc View version 3.2 computer software. The observed biophysics and chemical as well as socio economic data is presented in Table 1.

Results And Discussions

Table 2 shows that only about 36,000 ha of total 78,000 ha was studied. Landuse type of the study area (Figure 6), excluding forest, rice field, and public facilities, consisted of annual and mixed crops, bushes, coconut, and secondary forest.

Table 2 also pinpoints that about 70% of the study area was situated on slightly steep land. In addition, about 14,000 ha of 36,000 ha study area has been planted with annual crop while 11,000 ha planted with coconut.

Table1. Observed biophysics and chemical as well as socio economic data.

Variables	
Biophysics and chemical	Socio economic
Temperature(^{0}C)	Population
Rainfall (mm)	- Density
Soil effective depth (cm)	- Age
Soil texture	- Occupation
Soil fertility	- Education
Soil pH	Perception
Soil salinity	Farming system
Drainage	

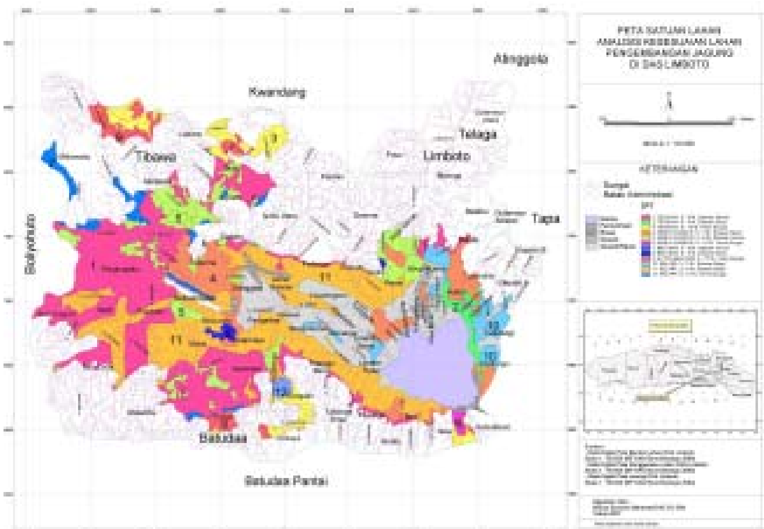

Figure 5. Land unit

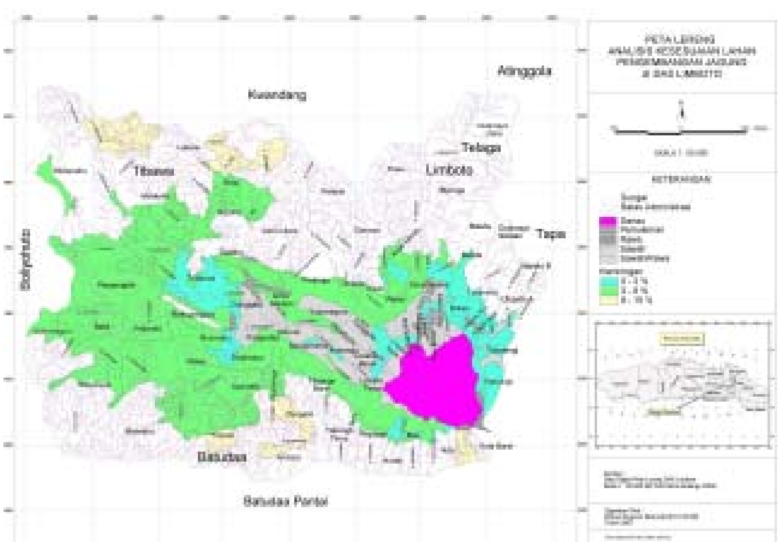

Figure 6. Slope of the study area.

Table 2. Landuse and slope of the study area.

Slope,%	Category	Landuse	Limboto basin		Study area (< 15 % slope)	
			ha	%	ha	%
0 - 3	Flat	Annual crop	559	0.7	559	1.6
		Mixed crop	3,564.96	4.5	3,564.96	10
		Bush	20859	0.3	208.59	0.6
		Coconut	1,376.22	1.7	1,376.22	3.9
3 - 8	Slightly steep	Annual crop	11,300.07	14.5	11,300.07	31.7
		Mixed crop	3,858.78	4.9	3,858.78	10.8
		Bush	1,071.68	1.3	1,071.68	3
		Coconut	9,932.80	12.7	9,932.80	28
8 - 15	Gently steep	Annual crop	2,121.26	2.7	2,121.26	5.9
		Mixed crop	147,08	0.1	147.08	0.4
		Bush	198,99	0.2	198.99	0.6
		Secondary forest	1,254.56	1.6	1,254.56	3.5
15 - 25	Steep	Annual crop	694.93	0.8	-	-
		Mixed crop	1208.65	1.5	-	-
		Coconut	169.07	0.2	-	-
		Bush	713.44	0.9	-	-
		Secondary forest	61.27	0.07	-	-
25 - 40	Moderately steep	Annual crop	16016.4	19.6	-	-
		Mixed crop	3452.79	4.4	-	-
		Coconut	549.34	0.6	-	-
		Bush	4997.26	6.4	-	-
		Secondary forest	11394	14.6	-	-
> 40	Very steep	Annual crop	788.71	1	-	-
		Mixed crop	1020.4	1.3	-	-
		Coconut	435.41	0.5	-	-
		Bush	827.52	1	-	-
		Secondary forest	1883.59	2.4	-	-

Table 3. Land suitability for maize.

Land suitability		Limiting factor	Area	
Class	Sub class		Ha	%
S_2 (moderately suitable)	S_2twrs	Mean annual temperature 26.9^{o}c, mean annual rainfall 1107.9 mm/y, slightly poor drainage	11,300.07	31.7
	S_2twrfs	Mean annual temperature 26.9^{o}c, mean annual rainfall 1107.9 mm/y, slightly poor drainage, low CEC	9,932.80	28
S_3 (marginally suitable)	S_3nf	Low P_2O_5 and CEC	6,002.59	16.9
	S_3ns	Low P_2O_5, require mechanization	1,401.64	3.9
	S_3n	Low P_2O_5	4,636.64	13
	S_3nfs	Low P_2O_5 K_2O, and CEC, require mechanization	198.99	0,6
	S_3s	require mechanization	2,121.26	5.9

Remarks: t = temperature, r = drainage, s = slope, f = nutrient retention, n = nutrient availability, w = rainfall

Land suitability for maize is presented in Table 3. It was found that about 21,000 ha of the study area categorized as moderately suitable for maize while about 13,000 ha classified as marginally suitable. Among those suitable area, the limiting factors were temperature, rainfall, drainage, and nutrient availability.

Findings on farmer perception regarding maize cultivation on their farmland revealed that 69% farmers in favor of maize cultivation, 26% were not sure and only 6% did not want to cultivate maize on their farmland.

Conclusion

1. Among 35,593.99 ha study area, about 21,232.87 ha was classified as S_2 and 14,361.12 ha as S_3. The limiting factors for land suitability for maize were temperature, rainfall, drainage, and nutrient availability.
2. Present land uses of the maize suitable land were annual crops and coconut.
3. Majority of farmers were in favor to cultivate maize on their farmland.

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