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CROPS AND TREES FOR FUNCTION TO THE EXISTING LAND USE OF BLONGKENG SUB WATERSHED, JAVA, INDONESIA

AMBAR KUSUMANDARI

Faculty of Forestry, Universitas Gadjah Mada, Jl. Agro No. 1. Bulaksumur, Yogyakarta 55281
**E-mail: ambar_kusumandari@ugm.ac.id*

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ABSTRACT

Although the Government of Indonesia has the rule to state the land area function, however the existing land use could be improper to its function. The objective of this research is to study the suitability of the existing land use with the land area function and to assess the land suitability of several food crops and trees. This research was carried out in Blongkeng sub watershed. Observatory research method was applied and the parameters collected include slopes, soil type, and rainfall using maps. GIS was applied and data were analyzed using quantitative descriptive. In this study, matching method was used to define the fitness of the land unit for growing of such crops or trees. To recognize the land suitability, 12 parameters were analyzed. Blongkeng sub watershed has the area of 7,498.64 ha and consists of 92 land units and 9 land use types includes: mixed cropping, National Park, dry field, water, shrubs, settlement, grass, rice field, and dry rice field. The land area function is composed: 397 ha of protected (5.29%); 1,292.56 ha of buffer (17.24%); 1,265.51 ha of annual plant silvyculture (16.88%), and 4,543.58 ha of perennial crop and settlement (60.59%). The existing land use that is improper with the land area function was found in all land areas. Most of the existing land use of Blongkeng sub watershed area is suitable to the function of the land (83.65%) and the rest of the area (16.35%) is improper. The majority of the land units have the marginally suitable (S3) for zea mays, dry paddy field, rice field and cassava with the constraints of rainfall depth, soil texture, and soil solumn. Furthermore, soy bean and sweet potato can be promoted to be planted, however peanut is not suitable (N) for the area. The suitability of trees showed that all land units in annual plant silvyculture zone are marginally suitable (S3) for *P. falcataria* (*sengon*). Some of the land units are marginally suitable (S3) for coconut, jackfruit, papaya, guava, longan, mango, avocado, and mahogany. The constraints factors mostly are soil texture, slopes, and rainfall depth. So, the government should change their policy in managing the land properly.

Keywords: Land area function, suitability, Blongkeng

INTRODUCTION

The high human dependency on land result in the more land is required to fulfill human's need, the more intensive and the more improper land use. The increase number of population will impact on the increase food, clothes, and places for human living.

Watershed is the area which has the natural border. Naturally, the watershed quality is influenced by the biophysical characteristics such as soil, relief, topography, climate, water, and vegetation (Tan, 1991). However human's activities in using the land cause the disturbance of watershed equilibrium. Land exploitation creates problems such as floods in the rainy season and drought in the dry season because of the decrease of discharge, erosion, sedimentation and landslides. As a consequences of these issues leads to the reducing of land productivity and the lack of water along the year (Komaruddin, 2008).

Generally, the utilization of the land will result in the land use change, which usually does not followed by the techniques to combat land degradation. According to Bailey *et al*. (2016), globally, there has been a decline in biodiversity over the last four decades, which could be attributed due to habitat fragmentation and land conversion. Based on the above explanation, it is very important to study about how the existing land use is improper to its function.

The Government of Indonesia has the rule (Ministry of Agriculture Decree number 837 Kpts/

* To whom correspondence should be addressed.

Unit/11/1980) to state the area of the watershed, composed 4 types, these are: protected zone, buffer zone, annual plant silviculture, perennial crops and settlement. Although there is a strict rule stated, but not all of the existing land use fits or suitable to the function of the land (zone), so it triggered the erosion process that further leads to the degradation of the land.

Land suitability is the fitness of a given type of land for a defined use. The land may be considered in its present condition or after improvements. The process of land suitability classification is the appraisal and grouping of specific areas of land in terms of their suitability for defined uses (FAO Framework, 1976). A prerequisite of land use planning is land suitability assessment (Akinci *et al*., 2013). It was concluded by Ahmadi *et al*. (2017) that the finding of the research clearly show the land suitability to develop industrial, agriculture, tourism land uses and can be the basis for planning the future development of the island based on the ecological sustainability. Globally, there has been an increasing amount of food over the last five decades. In Indonesia, it is attributed by the increasing area was converted to agricultural land.

Blongkeng sub watershed has the area of 7,498.64 ha and consists of 92 land units and 9 land use types includes: mixed cropping, National Park, dry field, water, shrubs, settlement, grass, rice field, and dry rice field. Based on the formula stated in the Ministry of Agricultural Decree number 837/ Kpts/Unit/11/1980 and 683/Kpts/Um/8/1981, the calculation resulted the land area function is composed by: 397 ha of protected (5.29%); 1,292.56 ha of buffer (17.24%); 1,265.51 ha of annual plant silvyculture (16.88%), and 4,543.58 ha of perennial crop and settlement (60.59%) (Kusumandari, 2016). This study was carried out at the two function areas that are annual plant silvyculture zone and perennial crops and settlement zone.

The goals of this research was to quantify the existing land use of Blongkeng sub watershed, to study the distribution of the function of the land (zone) and to evaluate the land use which is improper to the function of the land (zone). Moreover this research also examine the land evaluation of the existing food crops includes maize, dry paddy field, rice field and cassava; and to promote soy bean, sweet potato, and peanut.

MATERIALS AND METHODS

This research was carried out in Blongkeng sub watershed and focuses on the 2 functions area: annual plant silvyculture zone (16.88%), and perennial food crops and settlement zone (60.59%). The sub watershed is located in Magelang Regency, Central Java, Indonesia. The average temperature of the study area is about 22-26°C, the average humidity around 70–92% and the annual rainfall depth of 2,186 mm/year. The soil type varies of Regosol, Latosol, and Lithosol. Where majority have the soil texture of sandy loam, so the soil drainage is classified as good. The soil solumn also varies from more than 30 cm until more than 100 cm. As a consequence of the flat slopes, the erosion rates are mostly very low to moderate. The C organic content is ranging between 1.96 to 3.93%.

Land suitability was discussed in a significant amount of literature. Mendoza (2015) explained different methods of land capability and suitability analysis were surveyed by Anderson (1978) by using ranging in degrees of computational and analytical sophistication. Moreover, Hopkins (1977) wrote a report about a comparative evaluation of alternative methods of assessing land use suitability. Then, Steiner (1984) reviewed land evaluation and site assessment (LESA) using USDA-recommended standard. More recently, Mendoza (2015) used the GIS-based multi criteria approaches to land use suitability assessment and allocation.

This research was carried out in Blongkeng sub watershed. Data collected includes primary and secondary data. To collect the primary data, observatory or field research method was applied and the parameters assessed include slopes, soil type, and rainfall using maps. GIS was applied and data were analyzed quantitatively.

The site assessment was started by making the land unit, three maps (soil type, slopes, and land use maps) were overlapped. At every land units then was evaluated by using the Government of Indonesia's rule: Ministry of Agricultural Decree number 837/ Kpts/Unit/11/1980 and 683/Kpts/Um/8/1981. There are three parameters considered in this method includes: slopes, soil type, and rainfall. These three parameters were classified and scored as seen in Table 1.

After scoring of the 3 parameters, then the sum of those parameters was calculated and indicated the zone type by using Table 2.

To analyze the land use which is improper to the function of the land, the map of the zone was overlapped with the existing land use. Then, to evaluate the resulted map, matching analysis was applied.

Land use suitability analysis is the process of determining the suitability of a given land area for a certain type of use and the level of suitability. Moreover, in evaluating the suitability, the matching method was applied to assess the fitness of the land characteristics with the habitat requirement of the crops. The preliminary study was carried out prior to the land suitability analysis. At this step, both biophysical and social data of the

Table 1. Parameters and scores of the function of the land

1 Slope	Slope of (%)	Class	Score
	0-8	Flat	20
	8-15	Flat to moderate	40
	15-25	Moderate steep	60
	25-45	Steep	80
	>45	Very steep	100
2 Soil	Soil type	Class of sensitivity to erode	Score
	Alluvial, Gley, Planosol, Grey Hydromorph, Lateritic, Ground water	Not sensitive	15
	Latosol	Less sensitive	30
	Brown Forest Soil, Non Calcic	Moderate Sensitive	45
	Andosol. Lateritic Grumosol, Podsolic	Sensitive	60
	Regosol, Lithosol, Organosol, Rendzina	Very sensitive	75
3 Rainfall	Rainfall (mm/yr)	Class	Score
	1,500-2,000	Very low	10
	2,000-2,500	Low	20
	2,500-3,000	Moderate	30
	3,000-3,500	High	40
	3,500-4,000	Very high	50

Table 2. Criteria of the function of the land

Number	Function of the land (zone)	Total score
1	Protected	>175
2	Buffer	125–175
3	Annual plant Silviculture	<125
4	Perennial Crop and settlement	<125, slopes: ≤ 8%

study area were gathered. The biophysical parameters include: land use, slope, soil type, temperature, rainfall depth, humidity, soil drainage, soil texture, solumn, soil organic matter content, erosion hazard, and surface roughness. Whereas the social study was done to determine the trees and food crops which needed to be evaluated, based on those which can be found in the field and also trees and crops species that supposed to be fit or suitable to the land characteristics of Blongkeng sub watershed.

The land suitability for several kind of trees was analyzed at the annual plant silvyculture zone includes 16.88% of the watershed area. However, for crops suitability analysis was carried out at the perennial food crops and settlement zone that is 60.59% of the sub watershed area.

RESULTS AND DISCUSSION

Blongkeng sub watershed has the area of 7,498.64 ha and consists of 92 land units and 9 land use types includes: mixed cropping, National Park, dry field, water, shrubs, settlement, grass, rice field, and dry rice field.

The Blongkeng sub watershed consists of 397 ha of protected zone (5.29%), 1,292.56 ha of buffer zone (17.24%), 1,265.51 ha of annual plant silviculture zone (16.88%) and 4,543.58 ha of perennial crop and settlement zone (60.59%). The protected zone is the smallest, by contrary, this area has the most important function for controlling the other zone. The buffer zone and the annual plant silviculture zone each has an area of around 17% of the watershed area, although both the buffer zone and annual plant zone also have a significant role in protecting the land from erosion, sedimentation and water conservation. The largest area is perennial crops and settlement zone, it means that the human dependency on the land is very high, where they use most of the land for fulfilling their food and settlement. To evaluate the existing land use, this map was overlapped with the function of the land and the result is below (Table 3).

The above table shows that most of the existing land use of Blongkeng sub watershed area is suitable to the function of the land (83.65%) and the rest of the area (16.35%) is improper. The evaluation also shows that the improper land use happens at all of the function of the land (zone). Furthermore, it can be noticed that the people has

Table 3. The evaluation of the function of the land and land use

No.	Function of the land (Zone)	Land use	Area (Ha)	Suitable (S)	Not Suitable (TS)
1	Perennial crop and settlement	Dry rice field	594.48	S	
2	Perennial crop and settlement	Water	103.13	S	
3	Perennial crop and settlement	Mixed cropping	228.79		TS
4	Perennial crop and settlement	Settlement	1141.07	S	
5	Perennial crop and settlement	Dry field	25.07	S	
6	Perennial crop and settlement	Building	0.49	S	
7	Perennial crop and settlement	Rice field	2450.56	S	
8	Annual plant silviculture	Water	14.61		TS
9	Annual plant silviculture	Shrubs	12.37		TS
10	Annual plant silviculture	Mixed cropping	217.41	S	
11	Annual plant silviculture	Settlement	85.65		TS
12	Annual plant silviculture	Grass	42.74		TS
13	Annual plant silviculture	Rice field	604.25		TS
14	Annual plant silviculture	National park	196.54	S	
15	Annual plant silviculture	Dry field	91.95	S	
16	Protected	Shrubs	0.04		TS
17	Protected	Grass	0.40		TS
18	Protected	National park	392.85	S	
19	Protected	Dry field	3.71		TS
20	Buffer	Dry rice field	4.34		TS
21	Buffer	Water	0.51	S	
22	Buffer	Shrubs	24.02		TS
23	Buffer	Mixed cropping	268.90	S	
24	Buffer	Settlement	24.23		TS
25	Buffer	Grass	15.20		TS
26	Buffer	Rice field	25.37		TS
27	Buffer	National Park	789.54	S	
28	Buffer	Dry field	140.45		TS
	Total (Ha)		**7,498.64**	**6,272.47**	**1,226.17**
	(%)		**100**	**83.65**	**16.35**

converted the protected, buffer and annual plant silviculture zones to the land use that its yields potential for covering their foods and for their settlements. It can be seen that they use those three zones for rice field, settlements, and dry field. According to Nugraha (2009), the improper land use can cause the land degradation and environmental disturbance. So, although only around 17% of the watershed area is classified as improper land use, efforts in reducing the ecological hazard should be implemented in Blongkeng sub watershed.

The matching analysis for trees was focused at the function area of annual plant silvyculture that can be divided into 12 land units and the result can be seen in Table 4.

It can be seen that in Table 4 all land units in annual plant silvyculture zone are marginally suitable (S3) for *P. falcataria* (*sengon*). Some of the land units are marginally suitable (S3) for coconut, jackfruit, papaya, guava, longan, mango, avocado, and mahogany. The constraints factors mostly are soil texture, slopes, and rainfall depth. On the other hand, some land units are considered as not suitable (N) for those kind of trees. Banana is not suitable (N) at all land units.

In more detail, it can be explained that the suitability for sengon is classified as marginally suitable (S3) with the constraint factors of soil texture and erosion (moderate to high rates) as a result of the slopes. For coconut, the land suitability consists of S3 and N with the constraints factor are soil texture and erosion. This result is almost the same as for growing other fruit trees such as jackfruit, papaya, guava, longan, and mango. But, for papaya, mango and avocado, the constraint factors are not only soil texture and erosion, but also water availability. All areas were not suitable (N) for growing banana with constraints factor of water availability and soil texture. For mahogany, the result showed that almost all areas are marginally suitable (S3) with the constraints factor of soil solumn, soil texture and erosion.

At the function area of perennial crops and settlement that consists of eight land units, the land suitability analysis results is as follows (Table 5).

The above table shows that the majority of the area have the marginally suitable (S3) level for zeamays, dry rice field, rice field, and cassava. For sweet potato and soybean can be promoted to be planted because the land evaluation analysis results

Table 4. Land evaluation for trees

No.	Land unit	Area (ha)	Sengon	Coconut	Jackfruit	Papaya	Guava	Longan	Mango	Banana	Avocado	Mahagony
1	KC_GBregosol_II	55.45	S3(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N (rc)	N(wa,rc)	N(rc)	S3(cm,rc,eh)
2	KC_GBregosol_III	11.77	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa,eh)	S3(rc,eh)	S3(cm,rc,eh)
3	KC_andosol_latosol_III	0.26	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa,eh)	S3(rc,eh)	S3(cm,rc,eh)
4	KC_regosol_lithosol_II	149.93	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa)	S3(rc,eh)	S3(cm,rc,eh)
8	Tegalan_regosol_lithosol_III	89.82	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa,eh)	S3(rc,eh)	S3(cm,rc,eh)
12	belukar_regosol_lithosol_II	3.26	S3(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	S3(cm,rc,eh)
13	belukar_regosol_lithosol_III	9.11	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa,eh)	S3(rc,eh)	S3(cm,rc,eh)
16	rumput_regosol_lithosol_II	42.74	S3(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	S3(cm,rc,eh)
17	sawah_GBregosol_II	312.83	S3(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N2(rc)
18	sawah_regosol_lithosol_II	195.34	S3(rc,eh)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(wa,rc,eh)	N(rc)	S3(rc)
19	sawah_regosol_lithosol_III	96.07	S3(eh)	S3(eh)	S3(rc,eh)	S3(wa,eh)	S3(rc,eh)	S3(rc,eh)	S3(wa,rc,eh)	N(wa,eh)	S3(rc,eh)	S3(eh)
20	tegalan_GBregosol_II	2.12	S3(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(wa,rc)	N(rc)	S3(eh)
	Total	1265.51										

Table 5. Land Evaluation for Crops

No.	Land unit	Area (ha)	Zeamaize	Dry rice field	Rice field	Cassava	Sweet potato	Soybean	Peanut
1	STH GB Regosol	318.97	S3(wa,rc)	S3(rc)	S3(rc)	S3(rc)	S2(rc)	S3(wa,rc)	N(wa,rc)
2	STH Latosol 1	5.72	S3(wa,rc)	S3(rc)	S3(rc)	N(rc)	S3(rc)	S3(wa,rc)	N(wa,rc)
3	STH Rego-Litho 1	269.79	S3(wa,rc)	S3(rc)	S3(rc)	S3(rc)	S2(rc)	S3(wa,rc)	N(wa,rc)
4	Sawah GB Rego 1	2440.98	S3(wa,rc)	S3(rc)	S3(rc)	S2(rc)	S2(rc)	S3(wa,rc)	N(wa,rc)
5	Sawah Rego-Litho 1	9.58	S3(wa,rc)	S3(rc)	S3(rc)	S3(rc)	S2(rc)	S3(wa,rc)	N(wa,rc)
6	Teg GB Rego 1	21.74	N(wa,rc)	N(rc)	N(rc)	N(rc)	N(rc)	N(wa,rc)	N(wa,rc)
7	Teg Litho 1	1.38	S3(wa,rc)	S3(rc)	S3(rc)	N(rc)	S3(rc)	S3(wa,rc)	N(wa,rc)
8	Teg Rego-Litho 1	1.95	S3(wa,rc)	S3(rc)	S3(rc)	S3(rc)	S2(rc)	S3(wa,rc)	N(wa,rc)

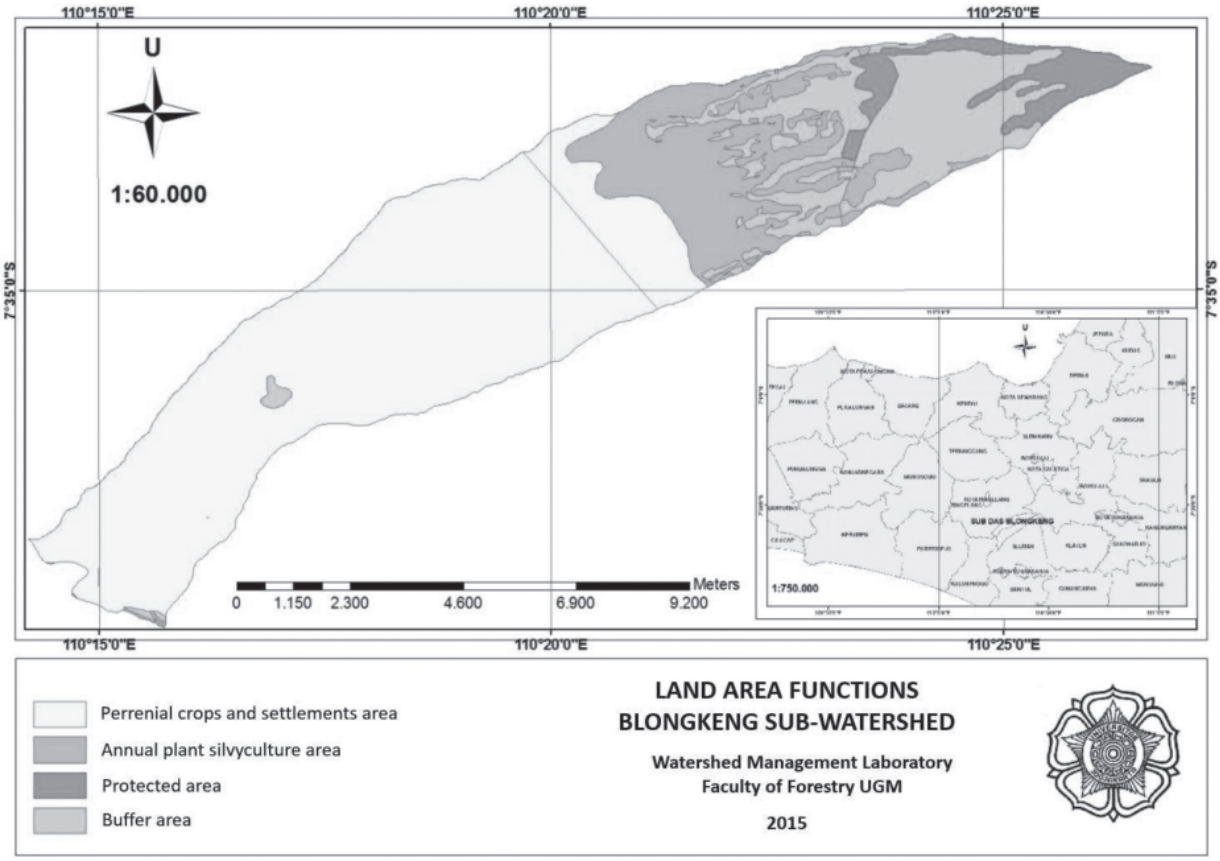

Fig. 1.

that these two crops marginally suitable. Finally, peanut is not suitable to plant at this area. The table also shows that land unit number 6 is not suitable (N) for all crops.

In more detail, soil texture is the most constraint factor for all crops growing at all areas in the watershed. Zeamays suitability is S3 (marginally suitable) at all areas, except land unit 6. Water availability and soil texture are the constraint parameters. The rainfall depth is too high for growing the zea mays. Whereas the soil texture is mostly sandy loam which is considered as marginally suitable (S3).

The land suitability analysis for dry rice field and rice field are the same as that of zea mays that are S3 for all areas except land unit 6. However, the constraint factor is different, which is only soil texture. Sandy loam is classified as marginally suitable for rice growing. By contrary, the water availability is not considered as a constraint factor. The rainfall depth of 2,186 mm/year is highly suitable for rice planting.

CONCLUSION

The area of Blongkeng sub watershed is 7,498.64 ha and consists of 92 land units and 9 land use types includes: mixed cropping, National Park, dry field, water, shrubs, settlement, grass, rice field, and dry rice field. The land area function is composed: 397 ha of protected (5.29%); 1,292.56 ha of buffer (17.24%); 1,265.51 ha of annual plant silvyculture (16.88%), and 4,543.58 ha of perennial crop and settlement (60.59%). The existing land use which is improper with the land area function was found in all land area function. Most of the existing land use of Blongkeng sub watershed area is suitable to the function of the land (83.65%) and the rest of the area (16.35%) is improper.

The results of land suitability analysis for cassava showed that land unit 4 with an area of 2,440.97 ha is suitable for cassava to grow there (S2) with the soil solumn as the constraint factor because cassava grows well at the soil with the soil solumn of more than 100 cm.

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