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LAND SUITABILITY FOR FOOD CROPS AND PLANTATIONS IN BANGLI REGENCY PROVINCE BALI-INDONESIA

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Abstract

Research was conducted, the aim of: evaluating the suitability of land for food crops and plantations, and the factors that led to improper plant growth. Soil samples were taken based on a land unit map, one land unit represented by one sample so that there were 49 samples. Field surveys were to determine the characteristics of the sample soil. The results of laboratory analysis and field observations were then used to match the growing requirements of food crops and plantations. Based on the evaluation of land suitability for food crops and plantations, it is known that the land suitability class is very suitable (S1= units 1, 2, 3, 4, 5, 6,7, 11, 22, 23, 36, and 37), quite suitable (S2= units 8, 12,13, 24, 25, 26, 38, 39, and 40), suitable marginal (S3= units 9,10,14,15, 27, 28, 29, 41, 42 and 43) and not suitable (N units 16,17,18,19, 20, 21, 30, 31, 32, 33, 34, 35, 44, 45, 46, 47, 48, and 49), with limitations: slope factors and very high rainfall. Land management that needs to be done is with soil and water conservation technologies: namely increasing plant density, improving terraces, and adding organic matter or providing mulch for crop residues.

Key words : Land suitability, food crop, plantations crop.

Introduction

In Bali Province the rate of land conversion for non-agricultural purposes (tourism, settlements, small industries, businesses, infra structure) is now at a very alarming point. The transfer of land has implications for food production, but it also influences the physical, social, cultural and economic environment of the community, so that the existence of agriculture must be maintained to be sustainable and use wise and planned land. Land suitability evaluation requires the characteristics of an area and each land quality usually consists of one or more soil properties (Djaenudin *et al.*, 2011). According Bandyopadhyay *et al.*, (2009), land suitability potential evaluation is an important step to detect the environmental limit in sustainable land use planning. Land use that is not consistent with conservation rules will cause erosion, so evaluation of land suitability for several types of plants needs to be done (Takuya Marumoto, 2017).

Land suitability analysis is a method of land evaluation, which measures the degree of appropriateness of land for a certain use. Land suitability classification can be divided into 4 levels, namely: ordo, classes, sub-classes, and units. Ordo is a condition of land suitability, which consists of an ordo of conformity (S) and unsuitability ordo (N). Class is land suitability that is distinguished by the level of conformity being a very suitable class (S1), less suitable (S2) and suitable of marginal (S3), and unsuitable (N). Subclass is the class condition in the land suitability class which is distinguished by the quality and characteristics of the land being the limiting factor, while the unit is the level of state in the subclass of land suitability, based on additional influence. Evaluation of land suitability is done so that land use plans can be well regulated, to support sustainable agriculture and food security at regional and national levels. If land suitability is not appropriate, then limiting factors are sought which are constraints and must be considered in land management, so that recommendations in land use are based on regional potential (FAO, 1976 and Arsyad, 2010)

Bangli Regency is one of 8 districts in Bali Province,

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has a climate that is suitable for some agricultural crops, but has obstacles, namely: high rainfall and has a flat topography, bumpy, up to very steep, especially in Kintamani Regency. If this situation does not get serious attention from the local community and the local government in particular, then the potential of the area will be lost. Based on field observations, some land uses in Bangli District are not in accordance with the rules of soil conservation, resulting in landslides and erosion also seen in several locations, such as in Kintamani sub-district (Sumarniasih *et al.,* 2016 and Sumarniasih, 2017). Therefore it is necessary to conduct research, to determine the evaluation of land suitability, for food crops and plantations, as well as constraints that occur in the field so that land use planning can be done. Based on the above, the research was conducted with the aim of (1) evaluating the suitability of land for food crops and plantations, (2) to find out the factors that become obstacles, for management planning.

Materials and Methods

Research Location

Research carried out in Bangli Regancy included four (4) sub-districts namely: Kintamani, Susut, Bangli and Tembuku. Geographically the study location is located at 115°13'43 'BT to 115° 27'24'BT and 08°08'30'LS to 08°31'07'LS. Land use is plantation = 13.860.48 ha, moor/ dry land = 10.858.46 ha, bush = 3.862.99 ha and forest = 2.884.36 ha(Central Bureau of Statistics, 2016).

Research Procedure

1. Land unit map obtain by overlay of land use map, slope map and soil map.
2. One soil sample is taken based on the land unit map to represent the land characteristics, so that there are 49 soil sample
3. Soil physical and chemical properties analysis do at Soil and Environmental Laboratory, Faculty of Agriculture-Udayana University-Bali
4. Soil properties analyzed in the laboratory are: soil texture, soil permeability, weight of soil volume, total N, available P, K-available, Cation Exchange Capacity (CEC), Base Saturation (BS), soil pH, and C-organic, while rock outcrops, soil depth effective, drainage, conducted direct observation in the field

Data Analysis

Analysis of land suitability evaluation based on data from field observations and soil analysis in the laboratory, compared to the growing requirements of plants for food crops and plantations (according to the characteristics made by Djaenudin *et al.,* 2011). The methodology used for land suitability evaluation was matching diagnostic land qualities against crop requirements and assigning suitability rates for each land qualities.

Results and Discussion

The administratively of Bangli district has the following limits: North: Buleleng District, East: Karangasem Regency, South: Klungkung Regency, West: Gianyar and Badung Regencies (Central Bureau of Statistics, 2016). The area of Bangli Regency is 520.81 ha or 9.24% of the total area of Bali Province (563.666 ha). The topography of the region lies at an altitude between 100 – 2.152 meters above sea level, with the highest peak being Puncak Penulisan. In general, the altitude range of the Sub-district Susut (100-920 m), Bangli Sub-district (100-1200 m), Tembuku Sub-district (320 - 920 m) and Kintamani Sub-district (920 – 2.152 m). The slopes of the area from vary sub-districts are generally in flat (0-2%), ramps (2-15%), wavy (15-30%), steep (30-40%) and very steep (> 40%). Flat condition is relatively only found in the area at the foot of Mount Batur, ramps and bumpy on the Sub-district Susut, Bangli and Tembuku while wavy and steep to very steep in the Sub-district Kintamani.

Bangli regency has relatively low air temperatures ranging from 15^0–30^0 C, increasingly to northern of temperatures getting cooler. The distribution of relatively high rainfall (2.500 – 3.500 mm) includes the northern part (the slopes of Mount Batur) and getting the of the less rainfall southerly. The highest rainfall occurred in December- March and the lowest in August. Based on the calculation results using rainfall data from several stations in Bangli Regency (Bangli, Sidembunut, Kintamani, and Lumbuan) on the last five years (2012-2016). The average annual rainfall is 1799.16 mm (Central Bureau of Statistics, 2016). Has a type of soil Regosol (Regosol of brown, Regosol humus, Regosol of gray) (Bakosurtanal, 2000). Regosol is a very young soil, almost without any development of the soil, the soil are mostly easy loose soil materials, without or with very weak soil developments, retained little water, have loose structure and single grains.

The results of field observations and laboratory analysis are compared with the growing requirements for food crops and plantations. The criteria for land suitability classification used is the land suitability classification system according to Hardjowigeno and Widiatmika (2011); Djaenudin (2011). Food crops evaluated were: paddy rice, maize, and tubers, while for plantation commodities: coconut, chocolate, cloves, oranges, and coffee. The results of field observations

and analysis of soil properties in the laboratory can be seen in table 1.

Land suitability analysis for agriculture is important information for agricultural development and future planning. Land suitability is the ability of some land to obtain sustainable crop production. This analysis enables the identification of the main limiting factors of certain crop production and enables decision makers to develop crop management systems to increase land productivity. Conformity is a function of plant requirements and land characteristics and is a measure of how the quality of land units will match the requirements of certain types of land use. Crop land suitability analysis is a prerequisite for achieving optimal utilization of available land resources for sustainable agricultural production (FAO, 1976; Halder, 2013)

Based on the results of the laboratory analysis and field observation, the quality of the land in terms of root media: (soil drainage, texture and effective depth). Has drainage from slow until moderate. Texture of the clay loam, and sandyclay. Has an average effective depth above 50 cm. Nutrient content such as: CEC medium-very high, and SB high-very high, pH average rather acid - neutral, C-organic from low - medium. This means that the quality of land is suitable for the development of food crops and plantations, but the constraints due to high rainfall causing the nutrients are washing. Soil quality from nutrient availability (N-total, available P_2O_5, and K_2O available), had a low-medium average N-total, P_2O_5 high-very high, P elements in the soil come from chemical fertilizers (TSP) and the results of measurements of soil potassium levels (K_2O) available in each land use are medium-high. Greater cation exchange capacity increases the ability of the soil to hold K. Potassium is available accumulate in the soil if there is no washing. Low total N content characterizes the lack of vegetation cover, intensive land use without any returns in the form of organic or mulching with plant residues. While to salinity is not an obstacle for the development of food crops and plantations, because it is far from the coast. In terms of terrain: surface rock and low percentage outcrops average below 5%, but the problem is the slope of the slope, because the slope above > 30% is used for seasonal crops without the treatment of soil conservation. This is actually a constraint in the research area, so that need repair existing terraces, to prevent top soil loss due to erosion because the research area has high rainfall.

Generally in wet tropical regions such as Indonesia, in addition to the parent material factor, climate and topography affect the characteristics and properties of the soil formed and its potential for agriculture. Wet climatic conditions with rainfall and high temperatures cause weathering of parent materials to run very intensively to form high-impact soil, and tend to reduce land quality and level of agricultural productivity (Kartasapoetra, 2004). Temperature greatly influences the development of soil profiles, these factors determine the chemical properties and physical properties of the soil. High average temperatures tend to increase the speed of weathering and clay formation. Based on the temperature, in Bangli temperatures average 26°C are included in the class “very suitable” because it is the optimal temperature for plant growth. Rainfall greatly affects the development of soil profiles through chemical properties and physical properties of the soil. High rainfall tends to increase the rate of weathering and clay formation and indirectly affects the soil reaction. In addition, it can also result in washing of base cations from the soil surface layer to deeper soil layers so that the soil pH will become rather acidic. Good soil aeration causes oxygen to be available in the soil, thus plant roots can absorb nutrients and can develop well. Soil texture is closely related to soil type. According to Sudjana *et al.,* (1991) the texture of the soil that is most suitable for plants is a smooth texture or clay as dusty clay or sandy clay. The effective depth of rooting affects root growth and development, drainage and physical properties of the soil. Land with effective depth of deep roots (e” 60 cm for secondary crops) is able to support the growth and development of plant roots so that they can grow well. Cation Exchange Capacity (CEC) indicates the ability of the soil to hold the cation. CEC as a guide in the availability of nutrients. Land with moderate to very high CEC will have the highest land suitability class for annual crops. The amount of CEC value is influenced by the level and type of clay. Clay texture has a high CEC value. The value of soil acidity (pH) is important to determine whether or not the nutrients are absorbed by plants. Soil reactions greatly affect the availability of nutrients for plants. In a neutral soil reaction, which is pH 6.5 - 7.5, nutrients are available in sufficient quantities (optimal). The organic C content in the research areas has a low until medium category in almost all regions. Plants can grow optimally if the C-organic content in the soil is more than 0.4. These slope characteristics are related to the morphological nature of the land. The sloping topography has more stable soil aggregate than steep slopes, because erosion often occurs on topography high so that the organic material which is the aggregate adhesives is lost so that the aggregate stability of the soil becomes weak. If the slope is large so the surface flow rate and the eroding strength of the soil will increase.

Table 1*:* Result of Characteristic Analysis of Land in Bangli Regency.

No.	Location (village)	Temp. average (oC)	availability of water(w)		rooting media (r)			hara retension (f)			
			Dry Dry	rain fall/ year(mm)	Drainage	Soil Texture	effective depth of soil(cm)	CEC (me/100g)	SB(%)	pHH_2O	C-org (%)
1	Bunutin	26	3-4	1799.16	rather slowly	CL	55	35.30 H	95.61 VH	6.2	1.62
2	Sulahan	26	3-4	1799.16	rather slowly	CL	60	36.30 H	96.21 VH	6.2	1.73
3	Bunutin	26	3-4	1799.16	rather slowly	CL	50	25.72 H	85.21 VH	6.2	1.35
4	Tamanbali	26	3-4	1799.16	rather slowly	CL	52	26.72 H	99.41 VH	6.1	1.25
5	Bangbang	26	3-4	1799.16	rather slowly	CL	50	26.72 H	89.85 VH	6.1	1.20
6	Sulahan	26	3-4	1799.16	rather slowly	CL	51	26.20 H	72.73 VH	6.2	1.28
7	Bebalang	26	3-4	1799.16	medium	SL	130	25.93 H	92.89 VH	6.3	1.86
8	Undisan	26	3-4	1799.16	medium	SL	120	25.50 H	79.89 VH	6.3	1.82
9	Cempaga	26	3-4	1799.16	medium	SL	150	26.50 H	81.76 VH	6.2	1.83
10	Bangbang	26	3-4	1799.16	medium	SL	130	25.90 H	89.98 VH	6.3	1.80
11	B. Selatan	26	3-4	1799.16	medium	SL	130	40.26 VH	88.65 VH	6.4	2.31
12	Buahan	26	3-4	1799.16	medium	SL	145	45.20 VH	78.63 VH	6.2	2.54
13	Kintamani	26	3-4	1799.16	medium	SL	130	56.74 VH	76.22 VH	6.3	2.45
14	Pengotan	26	3-4	1799.16	medium	SL	145	55.50 VH	89.31 VH	6.3	2.23
15	Sukawana	26	3-4	1799.16	medium	SL	155	56.68 VH	77.76 VH	6.3	2.32
16	Pinggan	26	3-4	1799.16	medium	SL	150	45.57 VH	89.00 VH	6.4	2.83
17	Sukawana	26	3-4	1799.16	medium	SL	145	50.31 VH	88.79 VH	6.2	2.45
18	Sukawana	26	3-4	1799.16	medium	SL	137	50.21 VH	79.88 VH	6.2	2.72
19	Pinggan	26	3-4	1799.16	medium	SL	145	55.27 VH	75.17 VH	6.3	2.62
20	Sukawana	26	3-4	1799.16	medium	SL	140	49.20 VH	95.61 VH	6.4	2.18
21	AB.Dinding	26	3-4	1799.16	medium	SL	150	49.28 VH	96.01 VH	6.2	2.67
22	Yangapi	26	3-4	1799.16	medium	SL	140	25.27 H	85.21 VH	6.3	1.18
23	B. Utara	26	3-4	1799.16	medium	SL	140	25.74 H	99.41 VH	6.2	1.69
24	Satra	26	3-4	1799.16	medium	SL	120	25.20 H	89.85 VH	6.4	1.49
25	Penglumbaran	26	3-4	1799.16	medium	SL	130	29.70 H	72.73 VH	6.3	1.25
26	Sukawana	26	3-4	1799.16	medium	SL	140	27.70 H	92.89 VH	6.3	1.23
27	Songan A	26	3-4	1799.16	medium	SL	140	33.98 H	88.89 VH	6.3	1.22
28	Sulahan	26	3-4	1799.16	medium	SL	130	25.22 H	77.76 VH	6.4	1.30
29	Bantang	26	3-4	1799.16	medium	SL	130	26.22 H	89.98 VH	6.4	1.32
30	Songan A	26	3-4	1799.16	medium	SL	130	25,72 H	78.65 VH	6.4	1.20
31	Mengani	26	3-4	1799.16	medium	SL	115	36.74 H	78.63 VH	6.3	1.15
32	B. Selatan	26	3-4	1799.16	medium	SL	120	25.50 H	78.22 VH	6.3	1.45
33	Subaya	26	3-4	1799.16	medium	SL	125	32.68 H	89.31 VH	6.1	1.23
34	Sukawana	26	3-4	1799.16	medium	SL	130	26.57 H	67.76 VH	6.2	1.22
35	Kintamani	26	3-4	1799.16	medium	SL	130	30.31 H	89.00 VH	6.2	1.23
36	Yangapi	26	3-4	1799.16	medium	SL	65	24.21 M	88.79 VH	6.3	1.33
37	B. Selatan	26	3-4	1799.16	medium	SL	55	24.27 M	69.88 H	6.4	1,25
38	Songan A	26	3-4	1799.16	medium	SL	75	24.20 M	65.17 H	6.4	1,76
39	Tiga	26	3-4	1799.16	medium	SL	55	29.28 H	65.61 H	6.5	1.41
40	Sukawana	26	3-4	1799.16	medium	SL	60	25.27 H	66.21 H	6.2	1.30
41	Songan B	26	3-4	1799.16	medium	SL	70	24.74 M	70.21 H	6.3	1.49
42	Pengotan	26	3-4	1799.16	medium	SL	60	25.20 H	69.41 H	6.3	1.35
43	B. Tengah	26	3-4	1799.16	medium	SL	60	24.70 M	69.85 H	6.4	1.40

Table 1 contd....

Table 1 contd....

No.	Location (village)	Temp. average (oC)	availability of water(w)		rooting media (r)			hara retension (f)			C-org (%)
			Dry Dry	rain fall/ year(mm)	Drainage	Soil Texture	effective depth of soil(cm)	CEC (me/100g)	SB(%)	pHH_2O	
44	Songan B	26	3-4	1799.16	medium	SL	70	27.70 H	62.73 H	6.5	1.57
45	Bangli	26	3-4	1799.16	medium	SL	70	23.98 M	62.89 H	6.3	1,41
46	Blandingan	26	3-4	1799.16	medium	SL	60	20,22 M	68.89 H	6.4	1.21
47	Trunyan	26	3-4	1799.16	medium	SL	60	21,12 M	61.76 H	6.4	1.39
48	Pinggan	26	3-4	1799.16	medium	SL	60	24.42 M	69.98 H	6.3	1.31
49	Pinggan	26	3-4	1799.16	medium	SL	60	21.55 M	68.65 H	6.3	1.29

No.	Location	Hara available (n)			Salinitas	Terrain (s)			Flood(b)
		N-Total(%)	P_2O_5(ppm)	K_2O (ppm)	(mmhos/cm)	Slope(%)	Surface rock(%)	Rock outcrop (%)	
1	Bunutin	0.41	113.66	352.30 H	0.14	0-8	<2	<5	0
2	Sulahan	0.50	166.56	269.87 H	0.17	0-8	<2	<5	0
3	Bunutin	0.39	110.75	323.75 H	0.17	8-15	<2	<5	0
4	Tamanbali	0.42	168.17	354.98 H	0.20	8-15	<2	<5	0
5	Bangbang	0.45	143.66	321.18 H	0.15	30-45	<2	<5	0
6	Sulahan	0.44	132.04	323.15 H	0.13	45-65	<2	<5	0
7	Bebalang	0.42	57.85	275.12 H	0.19	0-8	<2	<5	0
8	Undisan	0.43	58.72	312.18 H	0.19	0-8	<2	<5	0
9	Cempaga	0.32	74.30	298.23 H	0.20	8-15	<2	<5	0
10	Bangbang	0.33	56.56	243.11 H	0.20	8-15	<2	<5	0
11	B. Selatan	0.50	113.66	397.12 H	0.10	30-45	<2	<5	0
12	Buahan	0.50	166.56	244.45 H	0.07	45-65	<2	<5	0
13	Kintamani	0.48	410.75	261.29 H	0.07	0-8	<2	<5	0
14	Pengotan	0.43	168.17	312.01 H	0.09	0-8	<2	<5	0
15	Sukawana	0.41	143.66	265.71 H	0.05	8-15	<2	<5	0
16	Pinggan	0.40	132.04	271.12 H	0.07	8-15	<2	<5	0
17	Sukawana	0.41	157.85	289.13 H	0.12	30-45	<2	<5	0
18	Sukawana	0.46	181.72	233.14 H	0.10	45-65	<2	<5	0
19	Pinggan	0.41	174.30	321.15 H	0.13	0-8	<2	<5	0
20	Sukawana	0.50	236.56	252.30 H	0.13	0-8	<2	<5	0
21	AB.Dinding	0.42	113.66	269.87 H	0.14	8-15	<2	<5	0
22	Yangapi	0.29	56.56	223.75 M	0.17	8-15	<2	<5	0
23	B. Utara	0.21	46.75	234.98 M	0.17	30-45	<2	<5	0
24	Satra	0.23	68.17	221.18 M	0.12	45-65	<2	<5	0
25	Penglumburan	0.22	143.66	223.15 M	0.15	0-8	<2	<5	0
26	Sukawana	0.26	132.04	235.12 M	0.17	0-8	<2	<5	0
27	Songan A	0.27	57.85	212.18 M	0.19	8-15	<2	<5	0
28	Sulahan	0.29	181.72	218.23 M	0.19	8-15	<2	<5	0
29	Bantang	0.19	74.30	211.11 M	0.13	30-45	<2	<5	0
30	Songan A	0.29	236.56	187.12 M	0.13	45-65	<2	<5	0
31	Mengani	0.21	113.66	144.45 M	0.14	0-8	<2	<5	0
32	B. Selatan	0.30	166.56	161.29 M	0.17	0-8	<2	<5	0
33	Subaya	0.29	210.75	162.01 M	0.17	8-15	<2	<5	0
34	Sukawana	0.22	68.17	165.71 M	0.12	8-15	<2	<5	0

Table 1 contd....

Table 1 contd....

No.	Location	Hara available (n)			Salinitas	Terrain (s)			Flood(b)
		N-Total(%)	P_2O_5(ppm)	K_2O (ppm)	(mmhos/cm)	Slope(%)	Surface rock(%)	Rock outcrop (%)	
35	Kintamani	0.15	143.66	161.12 M	0.15	30-45	<2	<5	0
36	Yangapi	0.14	132.04	179.13 M	0.17	45-65	<2	<5	0
37	B. Selatan	0.12	57.85	156.14 M	0.19	0-8	<2	<5	0
38	Songan A	0.13	181.72	157.15 M	0.19	0-8	<2	<5	0
39	Tiga	0.12	74.30	159.30 M	0.13	8-15	<2	<5	0
40	Sukawana	0.13	236.56	169.87 M	0.13	8-15	<2	<5	0
41	Songan B	0.21	113.66	156.75 M	0.14	30-45	<2	<5	0
42	Pengotan	0.30	166.56	158.98 M	0.17	45-65	<2	<5	0
43	B. Tengah	0.19	110.75	156.18 M	0.17	0-8	<2	<5	0
44	Songan B	0.12	68.17	156.15 M	0.12	0-8	<2	<5	0
45	Bangli	0.15	143.66	175.12 M	0.15	8-15	<2	<5	0
46	Blandingan	0.14	132.04	158.18 M	0.12	8-15	<2	<5	0
47	Trunyan	0.12	57.85	158.23 M	0.15	30-45	<2	<5	0
48	Pinggan	0.13	181.72	158.11 M	0.11	45-65	<2	<5	0
49	Pinggan	0.12	74.30	157.18 M	0.13	30-45	<2	<5	0

Source : Results of soil analysis in the laboratory, and field observationsCriteriaa: Soil Research Center (1995). Note : M= medium, H= high, VH= very high. SB= base saturation, CEC= (cation exchange capacity).

The actual land suitability class is land suitability based on data from land survey results or current conditions, not yet considering the input needed to overcome constraints or limiting factors. Based on the analysis of evaluated plant commodities, land suitability for food crops and plantations in Susut, Tembuku, Bangli and Kintamani Subdistricts: very suitable (S1), quite suitable (S2), suitable of marginal (S3) insuitable (N). The characteristics of the soil which are the inhibiting factors are: the danger of erosion due to high rainfall and slope. Potential land suitability is the condition of the land that must be achieved if improvement efforts are made and must pay attention to economic aspects. This means that if the land can be overcome obstacles, will be able to provide benefits. Meaning between capital or investment and technology provided compared to the value of production to be generated is still able to provide benefits. The results of land evaluation can be used as a basis for selecting alternative agricultural commodities to be developed. Keep in mind in choosing agricultural commodities certainly not only based on land suitability class, but must pay attention to aspects of market opportunities (economy). Erosion in less steep terrain can be overcome by conservation measures by vegetative or mechanical means. Vegetative management for food crops with increasing plant density or intercropping cropping patterns of seasonal plants. Mechanical management for food crops by repairing existing terraces or terraces by planting terrace reinforcement plants. While to manage plantation crops by planting erosion resistant crops such as elephant grass plants or terrace plants that can be used for animal feed. On steep slopes to very steep with very severe erosion hazards, it is very difficult to repair, and has the potential to limit the development of the land in question, but gradually can be minimized by management in accordance with the principles of soil and water conservation.

In addition to the slope which is a limiting factor, the availability of water (rainfall) that is too high in the upper region, (North) is still a limiting factor in the development of several food crops and plantation crops. This can be prevented by vegetative and mechanical methods, while for very steep slopes it must be reforested (reforestation) (Sudaryono, 2003). The results of the analysis of actual land suitability, potential and land management can be seen in table 2. The map of the actual suitability for food and plantation crops presented in Fig. 1 and Fig. 2. Map Potential suitability for food and plantation crops

The land suitability analysis for agriculture is an important piece of information for agricultural development and future planning. Land use planning in each unit of land is prepared based on the evaluation of land suitability. The basic principle of the land use plan used is the increase of agricultural production both physically and economically, sustainably, without damaging the environment. Land use in accordance with the suitability of land, then first selected the type of plant

Table 2: Actual Suitability, Limiting Factor and Soil Management.

No.	Location(land use)	Actual suitability	Limiting factor	Soil management
1	Bunutin /rice field	S1	-	rice field maintained
2	Sulahan//rice field	S1	-	rice field maintained
3	Bunutin /rice field	S1	-	rice field maintained
4	Tamanbali/rice field	S1	-	rice field maintained
5	Bangbang /rice field	S1	-	rice field maintained
6	Sulahan /rice field	S1	-	rice field maintained
7	Bebalang/ mixed cropping	S1	-	mulch, repairing terrace
8	Undisan / mixed cropping	S2	slopes, rainfall	mulch, repairing terrace
9	Cempaga / mixed cropping	S3	slopes, rainfall	mulch, repairing terrace
10	Bangbang/ mixed cropping	S3	slopes, rainfall	mulch, repairing terrace
11	B. Selatan/forest	S1	-	retained as a forest
12	Buahan /forest	S2	slopes, rainfall	retained as a forest
13	Kintamani/forest	S2	slopes, rainfall	retained as a forest
14	Pengotan /forest	S3	slopes, rainfall	retained as a forest
15	Sukawana/ forest	S3	slopes, rainfall	retained as a forest
16	Pinggan/forest	N	slopes, rainfall	retained as a forest
17	Sukawana /forest	N	slopes, rainfall	retained as a forest
18	Sukawana/forest	N	slopes, rainfall	retained as a forest
19	Pinggan/ forest	N	slopes, rainfall	retained as a forest
20	Sukawana/ forest	N	slopes, rainfall	retained as a forest
21	AB.Dinding/ forest	N	slopes, rainfall	retained as a forest
22	Yangapi/mixed cropping	S1	-	mulch, repairing terrace
23	B. Utara/mixed cropping	S1	-	mulch, repairing terrace
24	Satra /mixed cropping	S2	slopes, rainfall	mulch, repairing terrace
25	Penglumburan/ mixed cropping	S2	slopes, rainfall	mulch, repairing terrace
26	Sukawana/ mixed cropping	S2	slopes, rainfall	mulch, repairing terrace
27	Songan A/mixed cropping	S3	slopes, rainfall	mulch, repairing terrace
28	Sulahan /mixed cropping	S3	slopes, rainfall	mulch, repairing terrace
29	Bantang /mixed cropping	S3	slopes, rainfall	mulch, repairing terrace
30	Songan A / mixed cropping	N	slopes, rainfall	mulch, repairing terrace
31	Mengani/ mixed cropping	N	slopes, rainfall	mulch, repairing terrace
32	B. Selatan/ mixed cropping	N	slopes, rainfall	mulch, repairing terrace
33	Subaya / mixed cropping	N	slopes, rainfall	mulch, repairing terrace
34	Sukawana / mixed cropping	N	slopes, rainfall	mulch, repairing terrace
35	Kintamani/dry land	N	slopes, rainfall	mulch, repairing terrace
36	Yang api /dry land	S1	-	mulch, repairing terrace
37	B. Selatan/dry land	S1	-	mulch, repairing terrace
38	Songan A/ dry land	S2	slopes, rainfall	mulch, repairing terrace
39	Tiga /dry land	S2	slopes, rainfall	mulch, repairing terrace
40	Sukawana/dry land	S2	slopes, rainfall	mulch, repairing terrace
41	Songan B/dry land	S3	slopes, rainfall	mulch, repairing terrace
42	Pengotan/ dry land	S3	slopes, rainfall	mulch, repairing terrace
43	B. Tengah dry land	S3	slopes, rainfall	mulch, repairing terrace
44	Songan B/dry land	N	slopes, rainfall	mulch, repairing terrace
45	Bangli /dry land	N	slopes, rainfall	mulch, repairing terrace
46	Blandingan/dry land	N	slopes, rainfall	mulch, repairing terrace
47	Trunyan/dry land	N	slopes, rainfall	mulch, repairing terrace
48	Pinggan/ dry land	N	slopes, rainfall	mulch, repairing terrace
49	Pinggan /dry land	N	slopes, rainfall	mulch, repairing terrace

Source: Results of analysis.

with the highest agro-ecological land suitability with the lightest limiting factor. Another factor to consider in selecting the type of plants to be planned in addition to land suitability is the type of plant has a high economic value, is needed by the community, support the interests of tourism and socio-cultural acceptable by the local community. So to prevent erosion and environmental conservation it is necessary to formulate a land management scheme is right. According to Masganti *et al.*, (2013) to keep the land from degradation then one of the strategies to be doneis to use the land according to their ability and suitability.

Based on observations in the field, the use of rice fields is dominant in Susut Subdistrict, while in Tembuku and Bangli Subdistricts, land use for paddy fields is less, whereas in Kintamani land use is dominated by mixed gardens, dry fields, forests and shrubs. Management of land recommended for slopes > 15% is by intercropping with high density seasonal crops such as corn or beans (food crops), adding organic matter or mulch using plant residues, to increase the capacity to hold water, improve the ridge to prevent or reduce length and slope, so that the danger of erosion can be minimized (Arsyad, 2010). While in land use planning, slopes > 30% are not suitable for agriculture and must be left for forests (Hardjowigeno and Widiatmaka, 2001).

The use of forest land must be maintained as forest,

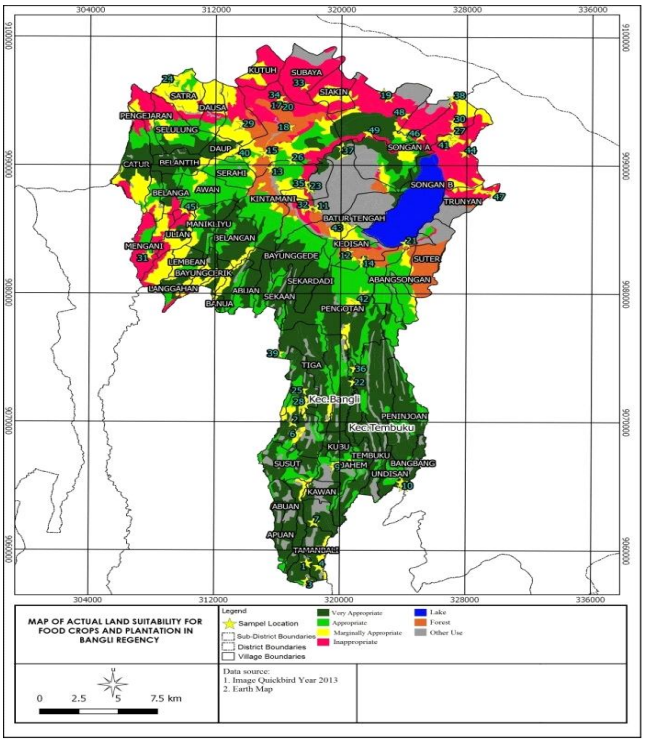

Fig. 1: Map of Actual Land Suitability for Food Crops and Plantation in Bangli Regency.

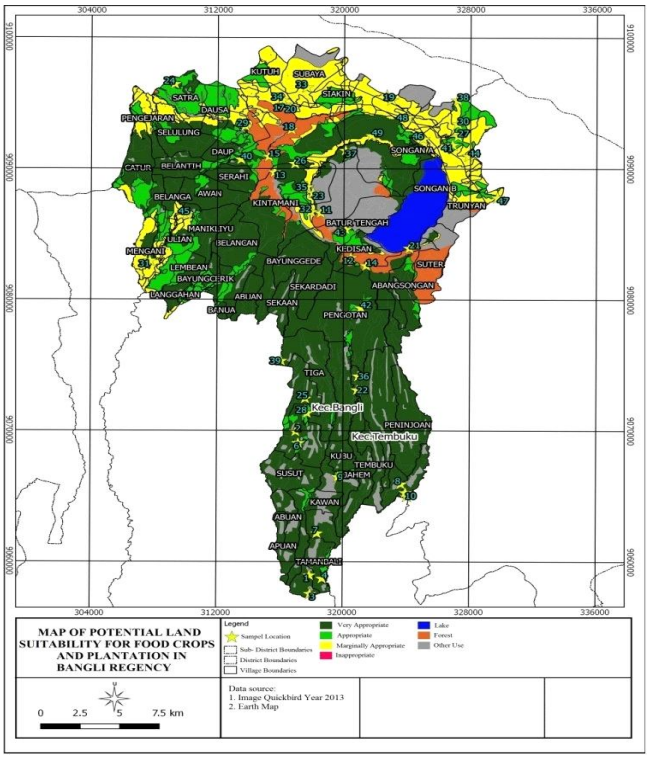

Fig. 2: Map of Potential Land Suitability for Food Crops and Plantation in Bangli District.

land units: 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, and 21. Use of paddy fields on land units: 1, 2, 3, 4, 5 and 6 is maintained as paddy fields, although suitable for food crops or other plantations. Land use that needs to be considered is land use on steep slopes that are used as mixed gardens or dry land. For this land it is necessary to increase plant density and plant residues used as mulch, so that high rainfall and steep slopes do not cause erosion. In general, land use in the research location, according to the evaluation of land suitability from very suitable until unsuitable. The obstacle is high rainfall and steep slopes without conservation action. So the objectives to be achieved in land use planning must meet the requirements of sustainability, efficiency, equality and acceptance. Especially in land with steep slopes (25 - 40%) to very steep (> 40%) and vulnerable to landslides, an increase in plant density must be distinguished between the middle slope and the upper slope. The plantation subsector has a strategic position in the economic development of Bangli Regency. Potential plantation commodities that are developed and have regional export opportunities for Bangli Regency are Arabica Coffe, Cocoa, and Citrus. The leading sector with good prospects is the famous orange which is often called Kintamani orange, with planted area is 5.020 ha. The types include Siem Kintamani, Selayar and Other Oranges. “The main centers of oranges are spread in Kintamani, Bangli and Tembuku and Susut sub-districts. Now there are 15 agro wisata citrus tourism locations

From several types of erosion prevention and landslides, the plants used must have deep roots and many roots, according to biophysical conditions. Recommended plants are: Aleurites moluccana (Kemiri), Vitek pubescens (Laban), Lagerstroemia speciosa (Bungur), Melia azedarach (Mindi), Cassia siamea (Johar), Acacia villosa, Eucalyptus alba, Leucaena glauca. Land suitability in Bangli Regency for food crops and plantations ranging from very suitable (S1) to incompatible (N), the problem is the high rainfall and slope, therefore it is recommended to improve the terrace and add organic matter or mulch using plant residues, so incompatibility due to slope and rainfall can be overcome. Alternative land management must be based on land suitability evaluation, namely a description of soil quality, soil type and inhibiting factors.

Conclusion

Results of evaluation of land suitability for food crops and plantations in Subdistricts of Susut, Bangli, Tembuku, and Kintamani: from very suitable (S1), quite suitable (S2), suitable marginal (S3) and unsuitable (N). The inhibiting factors are high slope and rainfall, so that planned land use planning is to add organic matter or mulch residue, make or repairing the *gulud* terrace as prevention of erosion and plant crops to strengthen the

terrace, for bush land use it should be forested.

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