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Determination and mapping land sustainable agriculture to prevent exchangeable land functions in Bangli Regency, Bali

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Abstract. The research was done in the area of paddy soil in Tembuku and Susut District, Bangli Regency, Bali, to the identification, evaluation, and mapping the paddy soil area that has to maintain as sustainable agriculture. To achieve these objectives, the research conducted through several activities, namely: soil survey and environment, physical and chemistry of soil analysis, and mapping the model of the prevented exchangeable paddy soil functions. Most of the paddy (54.55%) soil in Tembuku district, Bangli regency was a moderately suitable (S2) for rice plant, and 45.45% was marginally suitable (S3). In Susut district, Bangli regency, most of the paddy (55.55%) soil was a moderately suitable (S2) for rice plant, and 54.55% was marginally suitable (S3). The generally limiting factors were the low content of nitrogen, phosphorous, potassium, and organic matter. Depend on plan layout space (called RTRW) of Bangli regency, the paddy soil in Tembuku district could be changing function was agriculture land conversion, as 15.06 ha (2011 – 2021) and 37.36 ha (2021 – 2031) respectively; while in the Susut district, was 94.66 ha (2011-2031) could be changing function

1. Introduction

The Government of the Republic of Indonesia has produced regulation on the Protection of Sustainable Agriculture Land. The scope of protection of agricultural land includes planning and establishing, developing, researching, utilizing, coaching, controlling, monitoring, information systems, farmer empowerment, financing, and community participation. One point of the Law mandates the planning of sustainable agricultural lands arranged at the national, provincial, and district/city levels; with the aim of preventing the exchangeable functions of agricultural land. The minimum factor of sustainable development is the maintenance of all things given by nature (total natural capital stock) at the same level or if it is higher than the present situation [1, 2]. Bangli Regency with an area of 520.81 km2 or 9.25% of the total area of Bali Province owns 36,327 ha of agricultural land, consisting of 2,886 ha of paddy fields and non-rice field 33,441 ha [3]. The rice fields of Bangli Regency are not only important for rice production and food security, but also their agrarian cultural values and lands with exquisite and exotic landscapes are a very important factor for the development of tourism and other sectors. Efforts to maintain cultural integrity and physical landscape are certainly not an easy task as development will always bring changes to the ecosystem [4-8]. Tourism development should pay attention to environmental sustainability because the development of tourism causes the spatial need for physical infrastructure and socio-cultural activities. The overly favored tendency of the favorite sector of tourism has been proven in

many other places as the base cause of unbalance environments, aesthetics, and environmental aesthetics are threatened, and unsustainable development. Therefore, it is necessary to study the determination and mapping of sustainable agricultural land for environmental sustainability of Bangli Regency. This activity is very important, because based on the results of the assessment to be conducted will be identified and can be mapped agricultural lands that must be maintained as sustainable agricultural land, should not be converted with comprehensive consideration from the geographical aspect and strategic location, socio-economic-culture, potential and natural suitability, environmental aesthetics, nice view, and others.

2. Methodology

2.1 Survey on soil and environment conditions.

The research was conducted on paddy soil spread in Tembuku and Susut district, Bangli Regency, through survey method that was done at the Department of Agriculture, Plantation and Forestry, Bappeda of Bangli Regency, and also to headmasters of Subak. In each subak, information is collected as follows: (1) the suitability of the location of the rice field with RTRW, (2) land use, (3) the subak position in the watershed and its administrative unit, (4) irrigation water, (5) rainfall, (6) (9) land productivity, (10) subak distance from downtown, (11) land area, (11) view, and (12) existence of holy place. All information is given the weight, score, and value according to the method of control strategy of land use change by Subadiyasa *et al.* (2013) [8], which has been modified by the author.

2.2 Analysis of Soil Characteristic.

Soil sampling was done in all Subak spread in Tembuku and Susut district, Bangli Regency. The soil was taken on a soil layer of 30 cm deep so that 46 samples were collected. The soil samples were dried, pounded and sieved with 2 mm sieve, then analyzed the soil characteristics as table 1. Also, the supporting data such as slope, effective depth, rock outcrop, rainfall, flood condition, and cultivation techniques were carried out farmers. Furthermore, based on the data, the land suitability evaluation.

Table 1. Methods analysis of soil characteristic

No	Soil characteristics	Method of analysis
1	Soil texture	Pipet
2	Cation Exchange Capacity (CEC)	Ekstrak NH_4Oac. pH 7
3	Base naturation	Ekstrak NH_4Oac. pH 7
4	Soil pH	pH matter
5	Soil salinities	Conductometer
6	Total-N	Kjeldhal
7	Available-P	Bray 1
8	Available-K	Bray 1
9	C organic	Black and Walkley

2.3 Mapping the model of agricultural land conversion.

Modeling steps:
- Software Preparation QGIS 2.10.01 and ArcGIS 10.3, Quickbird Image Data of 2013 Bangli Regency Liputan 2012 which has been in Orthoretrifikasi
- Preparation of Spatial Data per parameter with format ship, then in registration and equated system projection coordinates become UTM WGS 50 s.
- After that, each data digitals parameters added column description, score, and value, then filled by the data scoring parameters.
- Perform the process of Geoprocessing (overlay) with Intersect type of all spatial parameter data
- Then the overlay results in add the total scores column and the total count is Dalin overall parameter values

- Database overlay results moved into excel, then conducted a search Ring Population to know the distribution of data group overlay digital results
- Then from the total score is done the process of classification (modeling) by searching the average data, the amount of data overlay digital, standard deviation. Classification is done with some modeling of the average data and standard deviation.
- Then the data -data classification in the input into the digital database to do spatial classification in Qgis. And the Subak Zoning Limits were obtained in several models.
- After that, a broad measurement was taken to obtain the area of sustainable subak, buffer, and converted from each model of wetland zoning
- The process of cartography (layout) maps (11 Map Parameters + 4 Modeling Map).

3. Result and discussion

3.1 The model of determination sustainable land agriculture.

Bangli Regency has been planned spatial areal, call *RTRW* that is valid from 2011 and ends in 2031. The model of sustainable agricultural land-use is prepared during the period of the *RTRW*. Until the year 2021, determination of sustainable agricultural land of Tembuku district, Bangli regency using model 3 because (wide sustainable + buffer = 553,31 ha) approaching paddy soil area, now is 568,116 and still bigger than the farming area of food crops (RTRW) that is 517 ha is 137, 99 ha. Instead, the land conversion should be done on rice fields outside the agricultural zone or non-paddy soil areas, according to the prevailing laws and regulations, and the extent and extent of each village varies (table 2).

Table 2. Distribution and extent of converted rice field (transfer function) in Kecamatan Tembuku, Kabupaten Bangli.

Villages	Model I (ha)			Model II (ha)			Model III (ha)		
	sustainable	buffer	convertion	sustainable	buffer	convertion	sustainable	buffer	conversion
Bangbang	28.16	62.6	0	68.34	7.4	14.92	75.35	15.31	0
Jehem	0	113.84	37.36	67.2	33.09	50.91	78.07	58.07	15.06
Peninjauan	107.91	15.82	0	116	7.73	0	121.01	2.72	0
Tembuku	11.24	86.86	0	80.66	17.44	0	82.35	15.75	0
Undisan	7.64	54.23	0	53.02	8.85	0	53.19	8.68	0

Area of calculated land of Quickbird Satellite Year 2013 in Sub-district shrinkage amounted to 896.86 ha, while the area of allotment / agricultural area of food crops in RT RW Kab. Bangli Year 2011-2031 is covering 1000.68 ha. This indicates that the area of the existing rice field is smaller than the area specified for the land use. This means that the existing paddy fields in Susut Subdistrict must be preserved at this time, and also need to be carried out agricultural extensification as well as agricultural intensification affecting the regional food balance. The model used in Kecamatan Susut is Model 3 where buffer zone and converted are also included into sustainable zone due to wetland area which is smaller than crop agriculture area. Then in the year 2017, 2020, 2030 and after the Year 2030 use Model 3 because of wide of rice field (896.86 ha) which is smaller than its designation (1000.68) ha (table 3, figure 1 and 2).

Table 3. Distribution and extent of converted rice field (transfer function) in Kecamatan Susut, Bangli District

Villages	Model I (ha)			Model II (ha)			Model III (ha)		
	sustainable	buffer	convertion	sustainable	buffer	convertion	sustainable	buffer	Conversion
Abuan	15.57	119.75	32.03	17.12	112.36	37.87	51.13	96.70	19.52
Apuan	0	129.62	38.99	6.50	119.78	42.33	41.31	88.32	38.98
Demulih	24.36	81.71	31.52	24.36	73.44	39.79	51.02	56.64	30.03
Tembuku	40.35	37.73	1.27	55.57	16.03	7.75	56.13	21.95	1.27
Selat	92.35	72.21	0.10	98.16	62.94	3.56	120.96	43.60	0.1
Sulahan	29.71	128.38	4.76	98.45	22	42.40	101.04	57.05	4.76
Susut	11.73	4.72	0	11.73	4.72	0	13.34	3.11	0
Tiga	15.57	119.75	32.03	17.12	112.36	37.87	51.13	96.70	19.52
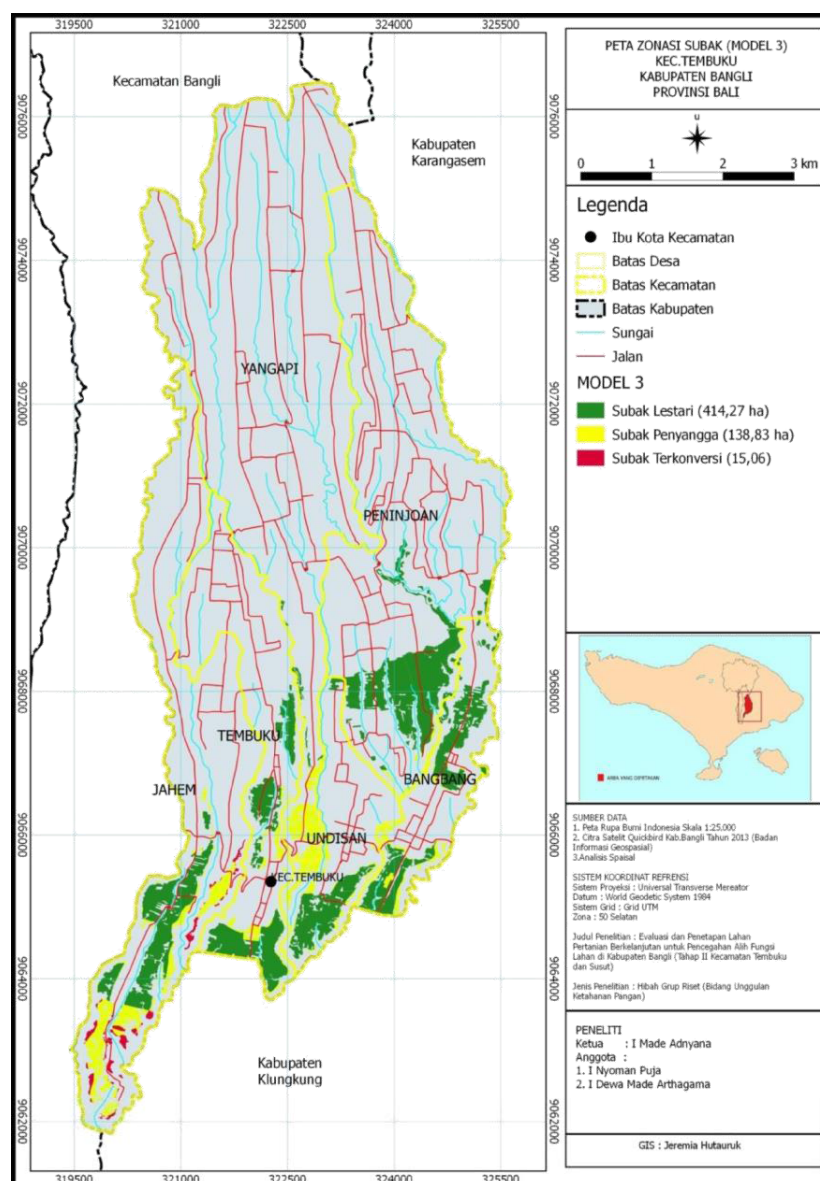
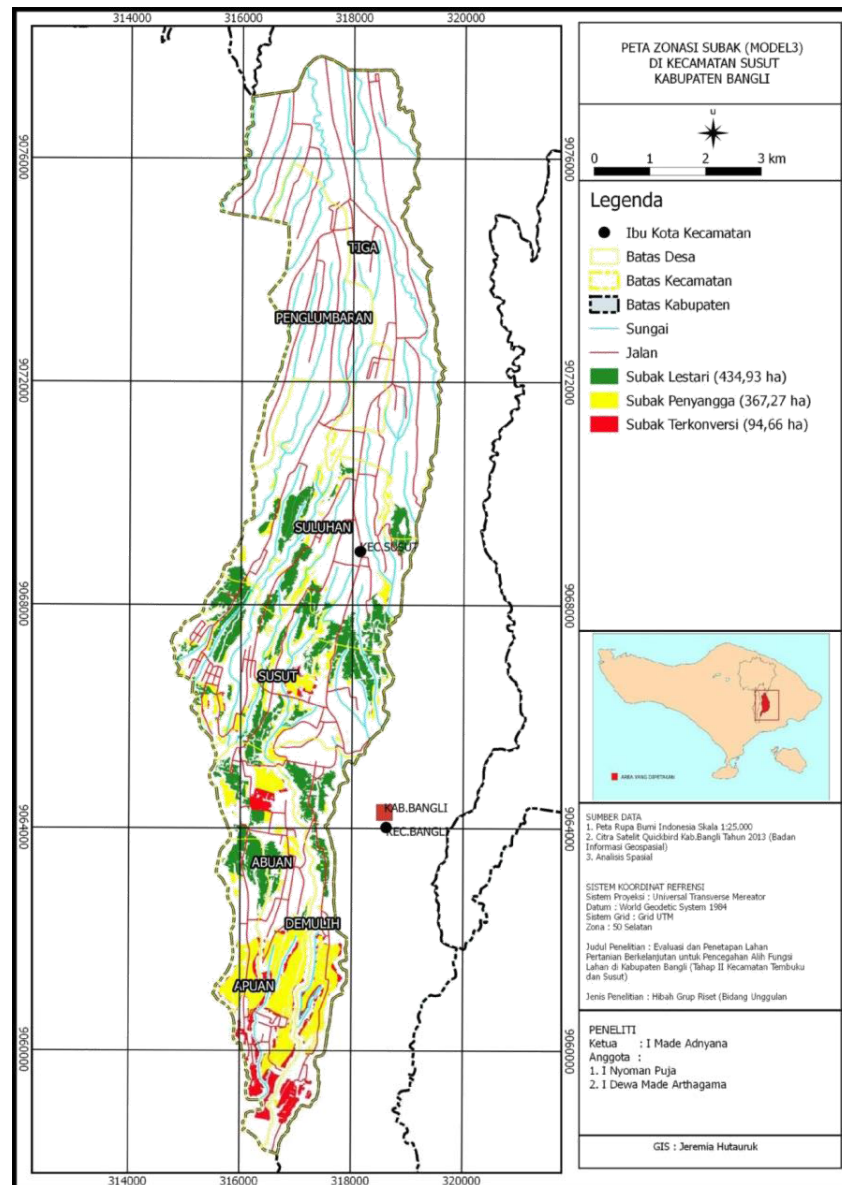**Figure 1**. Subak Zonation Map (Model 3) Tembuku District, Bangli Regency, Bali Province

Figure 2. Subak Zonation Map (Model 3) Susut District, Bangli Regency, Bali Province.

4. Conclusions and suggestions

4.1 Conclusion.

- In Tembuku sub-district, Bangli regency during the first decade (2011-2021), the validity of Bangli Regency RTRW determination of sustainable agricultural land can be done through a model approach that is 414.27 ha of sustainable farmland, 138.83 ha of buffer farmland and 15, 06 ha converted farmland; while in Kecamatan Susut, Bangli regency, there are 434.93 ha of sustainable agriculture, 367.27 ha of buffer farms, and 94.66 ha of converted agricultural land

- Converted farmland has the opportunity to be converted to function, and the extent varies in each village. Differences in the size of agricultural land converted to the model are due to changes in

land function. Buffer farming land may be transformed into sustainable agricultural land or converted farmland

4.2 Suggestion.
Determination of sustainable agricultural land should be done on sustainable agricultural land, while the conversion of agricultural land to non-agricultural land should be prioritized on converted agricultural land

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