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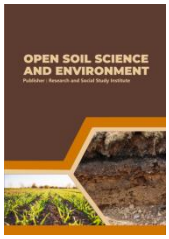

Evaluation of Land Suitability for Durian (*Durio zibethinus*), Mango (*Mangifera indica*), and Banana (*Musa* sp.) Cultivation in Banyumas Regency

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ABSTRACT

This study aimed to (1) determine the actual and potential land suitability level for durian, mango, and banana cultivation in Banyumas Regency, and (2) determine the limiting factors that affect the land suitability for durian, mango, and banana cultivation in Banyumas Regency. This study's results are expected to provide valuable information to support agricultural planning and development, especially for fruit crops in Banyumas Regency. This study was conducted from December 2019 to February 2020 through field survey method at the field level (scale 1:250,000). Land unit was analyzed using a physiographic analysis approach that categorized the survey area into a number of land units based on similarities in land surface shape, slope, soil type, and land use purposes. Delineation of land unit boundaries was conducted by overlaying the slope map, soil type map, and geological maps using GIS application. Evaluation results of actual land suitability reveal that land area of 8,557 ha is moderately suitable, 71,381 ha is marginally suitable, and 15,771 ha is unsuitable for durian cultivation; land area of 33,809 is marginally suitable, and 61,900 ha is unsuitable for mango cultivation; land area of 8,557 ha is moderately suitable, 71,381 ha is marginally suitable, and 15,771 ha is unsuitable for banana cultivation. Evaluation results of potential land suitability reveal that land area of 37,338 ha is suitable, 19,600 ha is moderately suitable, and 23,000 ha is marginally suitable for durian cultivation; land area of 39,319 ha is marginally suitable, and 56,390 ha is unsuitable for mango cultivation; land area of 30,889 ha is suitable, 21,273 ha is moderately suitable, 27,776 ha is marginally suitable, and 15,771 ha is unsuitable for banana cultivation. The main limiting factors to develop durian, mango, and banana crops are temperature, rainfall, drainage, rooting media, soil CEC, C-organic matter, nutrient availability, and erosion risk.

1. Introduction

One of the agricultural development programs in Indonesia is the development of horticultural commodity production. Horticultural crops consist of vegetables, fruits, ornamental plants, and medicinal plants. Horticultural crops are mainly cultivated as foodstuff. In addition to serving as a food provider, horticultural crops have other functions, namely economic function, health function, and socio-cultural function. One group of horticultural crops that continues to be developed today is fruits, which are expected to support the agricultural sector as an economic backbone in Indonesia.

The prospect of developing fruits in Indonesia is actually quite promising. This is indicated by the increasing amount of production and market potential, but the production is still unstable. Data from 2009 to 2014 show that fruit production in Indonesia had fluctuated. In 2009, fruit production in Indonesia reached 18,653,900 tons, but it decreased to 15,490,373 tons in 2010, while in 2011 and 2012, it increased to 18,313,507 tons and 18,916,731 tons, then it decreased to 18,288,279 tons in 2013. In 2014, fruit production in Indonesia increased and reached 19,805,977 tons (Directorate General of Horticulture, 2018).

Banyumas Regency is an area with altitudes varying from 10 m above sea level to > 2,000 m above sea level, located between 7°15'05" north latitude and 7°37'10" south latitude, and between 108°39'17" west longitude and 109°27'15" east longitude. The total area of Banyumas Regency is 132,759 ha, consisting of 27 subdistricts. As a tropical wet monsoonal climate area, Banyumas Regency experiences two seasons, namely the dry season and the rainy season with rainfall ranging from high to very high (Banyumas Regency's Central Bureau of Statistics, 2020).

Fruit crops are commodities that continue to be developed in Banyumas Regency. There are several fruit crops that are considered important commodities in this area, namely durian, mango, and banana. Banyumas Regency's Central Bureau of Statistics (2020) stated that the production level of fruit crops in Kabupaten Banyumas in 2014 was 2,318.5 tons of durian, 3,000.5 tons of mango, and 17,653.7 tons of banana.

The production of fruit commodities in Banyumas Regency has not been maximized because it has faced several obstacles. One of the constraints in developing fruit crops in Banyumas Regency is the unavailability of comprehensive information on land suitability for cultivating these crops. Information on land suitability is necessary in agricultural development planning so that land in Banyumas Regency can be utilized optimally and sustainably.

Land evaluation is one of the instruments commonly used in assessing land suitability for various agricultural commodities in an area. Land can be classified as suitable for cultivating certain commodities after it is declared suitable, both biophysically and socio-economically (Sukarman et al., 2018). In addition, Siswanto and Fikrinda (2017) stated that land evaluation is expected to improve agricultural cultivation patterns, thereby minimizing errors in its management.

Land suitability is the feasibility of land for a particular use. Land suitability can be assessed for current conditions (actual land suitability) or conditions after improvement (potential land suitability) (Ritung et al., 2007). Land suitability classification aims to evaluate and classify land units based on land specifications, the soil conditions, and their limiting factors (Khan & Khan, 2014).

Land suitability is the level of suitability of a piece of land for a particular use. Land suitability classification concerns the comparison between land quality and the requirements of the expected land use (Rayes, 2007). Therefore, this study aimed to (1) determine the level of actual land and potential land suitability for durian, mango, and banana cultivation in Banyumas Regency, and (2) determine the limiting factors that affect the land suitability for durian, mango, and banana cultivation in Banyumas Regency. The results of this study are expected to provide valuable information to support agricultural planning and development activities, especially fruit crops in Banyumas Regency.

2. Methods

2.1 Location and time

The study was conducted from December 2019 to February 2020 in the majority of Banyumas Regency areas. Soil analysis was conducted at the Soil and Land Resources Laboratory, Faculty of Agriculture, Jenderal Soedirman University.

2.2 Materials and tools

The materials used in this study were administrative map of Banyumas Regency (scale 1:250,000), geological map (scale 1:250,000), soil type map (scale 1:250,000), contour map (scale 1:250,000), land use map (scale 1:250,000), soil samples from land with a depth of 0–50 cm at each observation point, and chemical reagents for soil chemical analysis in the laboratory. The tools used in this study included field equipment and laboratory equipment. Field equipment included a set of computer, ArcGIS (Geographic Information System) 10.6 mapping software, Google Earth Pro mapping software, color printer, GPS (Global Positioning System), field knife, soil drill, plastic bags for storing samples, stationery, and labels. Equipment for laboratory analysis included pH meter, EC meter, analytical scales, film bottle, shaker, spectrophotometer, flamefotometer, weighing bottle, oven, waterbath, measuring flask, measuring pipette, kjeldahl flask, erlenmeyer flask, burette, test tube, test tube rack, and distillation device.

2.3 Sampling design

This study applied the field survey method. Land unit analysis was conducted using a physiographic analysis approach that categorizes the survey area into a number of land units based on similarities in land surface shape, slope, soil type, and land use purposes. Delineation of land unit boundaries was conducted by overlaying the slope map, soil type map, and geological map. The slope map was obtained through the DEM (Digital Elevation Model) method using the ArcGIS 10.6 application.

The transect approach was used to determine the observation points for each land unit. These points represent land units, which were taken at various slope positions. At each observation point, disturbed soil samples were taken at a depth of 0–50 cm. The disturbed soil samples were then mixed to obtain composite soil samples representing a particular land unit. The composite samples were then used in laboratory analysis to examine various required soil properties. At each observation point, the land surface and several soil properties that can be observed directly in the field were observed, such as vegetation, slope condition, erosion danger, soil solum depth, soil texture, soil structure, and soil drainage.

2.4 Variables

The following are several measured variables and soil properties in this study:

a. Temperature
b. Rainfall
c. Air humidity
d. Drainage
e. Texture
f. Coarse materials
g. Soil depth
h. Soil CEC (Cation Exchange Capacity)
i. Base saturation (BS)
j. pH H_2O
k. Organic C

l. Total N
m. Total P
n. Total K
o. Salinity
p. Slope
q. Erosion danger
r. Flood danger
s. Land preparation

2.5 Land suitability analysis

Data and information obtained from field surveys and laboratory analysis were used as attributes for each land unit. Evaluation of land suitability was conducted by referring to the maximum limitation method established by FAO, namely matching the land characteristics with the land use requirements for durian, mango, and banana cultivation. This process has resulted in the level of land suitability of each land unit and its limiting factors. The analysis of potential land suitability using assumptions has also included improvements concerning the limiting factors. Suggested improvements regarding the land and its limiting factors were used to determine the land potential. The results of this land evaluation were then visualized in the form of maps of actual and potential land suitability.

3. Results and discussion

The data on each land unit in the study area was obtained through the delineation of land unit boundaries by overlaying the slope map, soil type map, and geological map. The slope map was obtained through DEM (Digital Elevation Model) method using ArcGIS 10.6 GIS application. The results of the overlay produced of 18 land units are presented in Table 1.

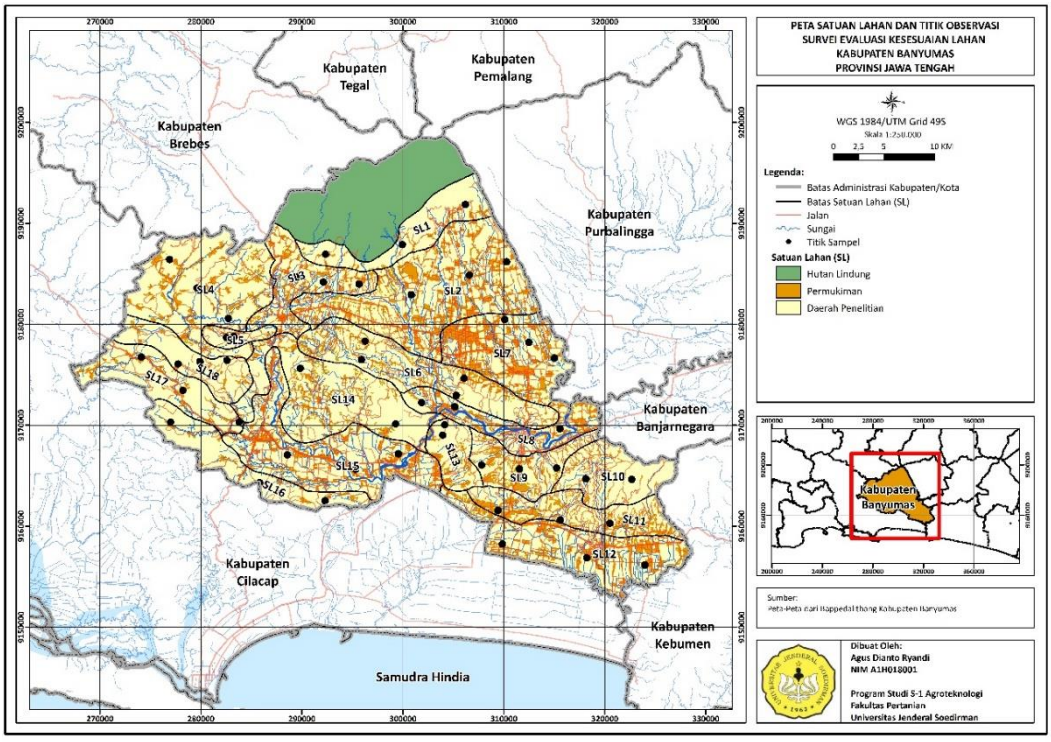

Figure 1. Map of land units and observation points of land suitability evaluation survey in Banyumas Regency

Table 1. Description of each land unit

Land Unit	Relief	Slope (%)	Lithology	Soil Type	Land Use	Land Area	
						Hectare	%
1	Wavy	8–15	Halang Formation, Rambatan Formation, non-differentiated rocks of Mt. Slamet	Association of brown mediterran and yellowish brown andosol	Garden, rain-fed rice field, moorland, scrub/bush	4,563	4.8
2	Undulate	3–8	Non-differentiated rocks of Mt. Slamet, old eruption rock products of Mt. Slamet, lava of Mt. Slamet	Association of brown Mediterranean and reddish brown latosol	Rain-fed rice field, irrigated rice field, garden, moorland	11,208	11.7
3	Undulate	5–8	Volcanic mudflow sediment of Mt. Slamet, non-differentiated rocks of Mt. Slamet	Complex of red mediterran and lithosol, reddish brown latosol	Rain-fed rice field, irrigated rice field, garden	3,597	3.8
4	Hilly	15–30	Non-differentiated rocks of Mt.Slamet	Complex of red mediterran and lithosol, reddish brown latosol	Moorland, shrub/bush, irrigated rice field, rain-fed rice field, garden	10,031	10.5
5	Wavy	8-15	Member of limestones	Complex of red mediterran and lithosol, reddish brown latosol	Shrub/bush, rain-fed rice field, irrigated rice field, moorland, garden	638	0.7
6	Wavy	8-15	Old eruption rock products of Mt. Slamet, alluvial	Association of gray alluvial, fawn alluvial, reddish brown latosol, and reddish brown mediterran	Moorland, irrigated rice field, garden, rain-fed rice field	6,813	7.1
7	Flat	1–3	Old eruption rock products of Mt. Slamet, alluvial	Association of reddish brown latosol, grayish brown alluvial, and reddish brown mediterran	Irrigated rice field, rain-fed rice field, garden	4,776	5.0
8	Flat	1–2	Alluvial, Undak sediment	Association of gray alluvial, grayish brown alluvial, yellowish gray alluvial, and reddish brown latosol	Moorland, garden, rain-fed rice field, irrigated rice field	3,643	3.8
9	Hilly	15–20	Halang Formation, Undak sediment, member of breccia	Complex of red mediterran and reddish brown latosol	Garden, moorland, irrigated rice field	2,920	3.0
10	Mountainous	30–40	Member of breccia, Halang Formation, Penosogan Formation	Complex of red mediterran and reddish brown latosol	Garden, moorland, shrub/bush	4,470	4.7
11	Hilly	15–25	Halang Formation, member of breccia	Complex of red mediterran and reddish brown latosol	Irrigated rice field, moorland, garden	3,845	4.0
12	Flat	0–1	Alluvial, member of breccia, Halang Formation	Complex of red mediterran and lithosol, low gley humus and gray alluvial, gray alluvial and fawn alluvial	Garden, irrigated rice field	6,449	6.7
13	Hilly	20–30	Basalt, member of breccia, Halang Formation	Complex of red mediterran and reddish brown latosol	Garden, moorland, shrub/bush	1,921	2.0
14	Wavy	10–15	Tapak Formation, non-differentiated rocks of Mt. Slamet, breakthrough rocks, Halang Formation	Association of reddish brown latosol and red mediterran	Garden, irrigated rice field, rain-fed rice field, moorland, shrub/bush	9,078	9.5
15	Flat	1–3	Alluvial, Halang Formation, member of breccia	Association of brown latosol, yellowish gray alluvial, gray alluvial, and grayish brown alluvial	Irrigated rice field, moorland, garden	8,557	8.9
16	Wavy	12–15	Basalt, Halang Formation, alluvial, member of sandstones	Association of reddish brown latosol	Garden, rain-fed rice field, moorland, shrub/bush	4,824	5.0
17	Wavy	8–15	Member of sandstones, alluvial, basalt	Complex of brown latosol, reddish brown latosol, and black grumusol	Garden, rain-fed rice field, moorland, shrub/bush	4,787	5.0
18	Mountainous	30–40	Halang Formation, Tapak Formation, Kumbang Formation	Complex of brown latosol, reddish brown latosol, and black grumusol	Garden, rain-fed rice field, moorland, shrub/bush	3,589	3.8
Total						95,709	100

Table 2. Quality and characteristics of each land unit

Criteria	Land Unit																	
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Temperature (t)																		
Average temperature (°C)	22	25	24	25	25	25.5	26	26	25	23	26	26	26	26.5	26	25	25.5	25
Water availability (w)																		
Rainfall (mm)	5,000	4,250	3,750	3,750	3,250	3,250	3,250	2,500	2,500	2,750	2,750	2,750	250	2,500	2,50	2,50	2,500	2,500
Humidity (%)	66	70	75	84	93	86	90	87	70	78	65	70	61	87	69	75	76	84
Oxygen availability (o)																		
Drainage	moderate	moderate	moderate	rather hampered	rather fast	moderate	moderate	rather fast	moderate	rather hampered	rather hampered	rather hampered	moderate	moderate	moderate	moderate	rather fast	moderate
Rooting media (r)																		
Texture	moderate	moderate	rather fine	rather fine	rather coarse	fine	moderate	fine	fine	moderate	fine	rather fine	rather coarse	fine	fine	fine	fine	fine
Coarse materials (%)	<15	<15	20	20	30	<15	20	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
Soil depth (cm)	>100	80	>100	85	60	80	70	85	85	>100	90	80	85	>100	80	90	>100	>100
Nutrient retention (f)																		
Soil CEC (cmol)	15.20	12.60	15.10	8.40	28.50	19.50	15.10	15.50	18.90	20.40	15.10	14.80	16.60	37.70	29.80	16.10	12.10	15.50
Base saturation (%)	87.10	88.10	94.00	95.00	95.60	82.00	91.10	87.00	62.70	51.20	89.00	72.70	82.00	67.30	54.00	94.90	89.50	81.50
pH H_2O	5.70	6.60	6.80	6.00	7.30	6.20	6.40	6.00	5.90	5.00	5.30	5.50	6.30	5.60	6.10	6.80	6.60	5.60
Organic C (%)	4.46	4.34	3.19	1.32	2.79	1.01	1.55	1.71	1.39	1.88	1.09	2.23	0.94	1.24	1.09	1.88	1.09	0.94
Nutrient availability (n)																		
total N (%)	0.59	0.52	0.53	0.20	0.29	0.27	0.14	0.19	0.19	0.19	0.28	0.32	0.14	0.25	0.13	0.22	0.18	0.15
total P (mg/100g)	14.07	16.50	16.74	5.8	26.22	14.07	21.36	13.08	7.89	8.36	10.03	20.31	6.81	10.26	23.10	11.64	9.59	9.81
total K (mg/100g)	10.81	10.58	8.96	13.65	6.67	11.94	10.11	8.38	5.19	4.72	5.75	8.98	7.56	5.36	11.68	15.47	13.43	13.90
Toxicity (x)																		
Salinity (d.S/m)	0.13	0.10	0.23	0.23	0.18	0.10	0.29	0.23	0.11	0.11	0.13	0.13	0.25	0.12	0.13	0.27	0.15	0.16
Erosion danger (e)																		
Slope (%)	8–15	3–8	5–8	15–30	8–15	8–15	1–3	1–2	15–20	30–40	15–25	0–1	20–30	10–15	1–3	12–15	8–15	30–40
Erosion danger	moderate	very minor	very minor	high	moderate	moderate	very minor	very minor	high	high–very high	high	very minor	high	moderate	very minor	moderate	moderate	high–very high
Flood danger (b)																		
High (cm)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Duration (days)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Land preparation (p)																		
Rocks on surface (%)	<5	7	<5	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
Rocks exposure (%)	<5	7	<5	<5	7	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5

3.1 Land quality and characteristics of the study area

Land quality is the complex identifying properties or attributes of each piece of land. Each land quality exhibits a performance that affects its suitability for certain uses, and usually consists of one or more land characteristics. Several land qualities can be estimated or measured directly in the field, but they are generally determined based on the established definition of land characteristics (FAO, 1976). The resulted data on the quality and characteristics of each land unit are presented in Table 2.

3.2 Actual land suitability for durian, mango, and banana crops

Land suitability classes for durian, mango, and banana crops were obtained through matching the quality and characteristics of the study area with land suitability criteria using the maximum limitation approach method according to Ritung et al. (2011). Actual land suitability is the suitability assessed for current conditions before land improvement efforts are performed. The matching method has generated the data on suitability level of actual land, as presented in Table 3, 4, and 5.

Table 3. Suitability level of actual land for durian crops

Land Unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	S3	S3wn	3,597	3.8
4	S3	S3wne	10,031	10.5
5	S3	S3worne	638	0.7
6	S3	S3wn	6,813	7.1
7	S3	S3r	4,776	5.0
8	S3	S3on	3,643	3.8
9	S3	S3ne	2,920	3.0
10	S3	S3ne	4,470	4.7
11	S3	S3ne	3,845	4.0
12	S3	S3n	6,449	6.7
13	S3	S3rne	1,921	2.0
14	S3	S3n	9,078	9.5
15	S2	S2rfn	8,557	8.9
16	S3	S3n	4,824	5.0
17	S3	S3on	4,787	5.0
18	S3	S3ne	3,589	3.8

**) Description: S2 (moderately suitable), S3 (marginally suitable), N (unsuitable), w (water availability), o (oxygen availability), r (rooting media), f (nutrient resistance), n (nutrient availability), e (erosion danger)*

Land area of 8,557 ha (8.9%) has a land suitability classified as moderately suitable (S2) with limiting factors in the form of rooting media, nutrient resistance, and nutrient availability. Land area of 71,381 ha (74.6%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability, oxygen availability, rooting media, nutrient availability, and erosion danger. This land is located in land units (SL) 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, and 18. Land area of 15,771 ha (16.5%) has a land suitability classified as unsuitable (N) with limiting factor in the form of water availability. This land is located in land units (SL) 1 and 2. The distribution of actual land suitability for durian crops is presented in Figure 2.

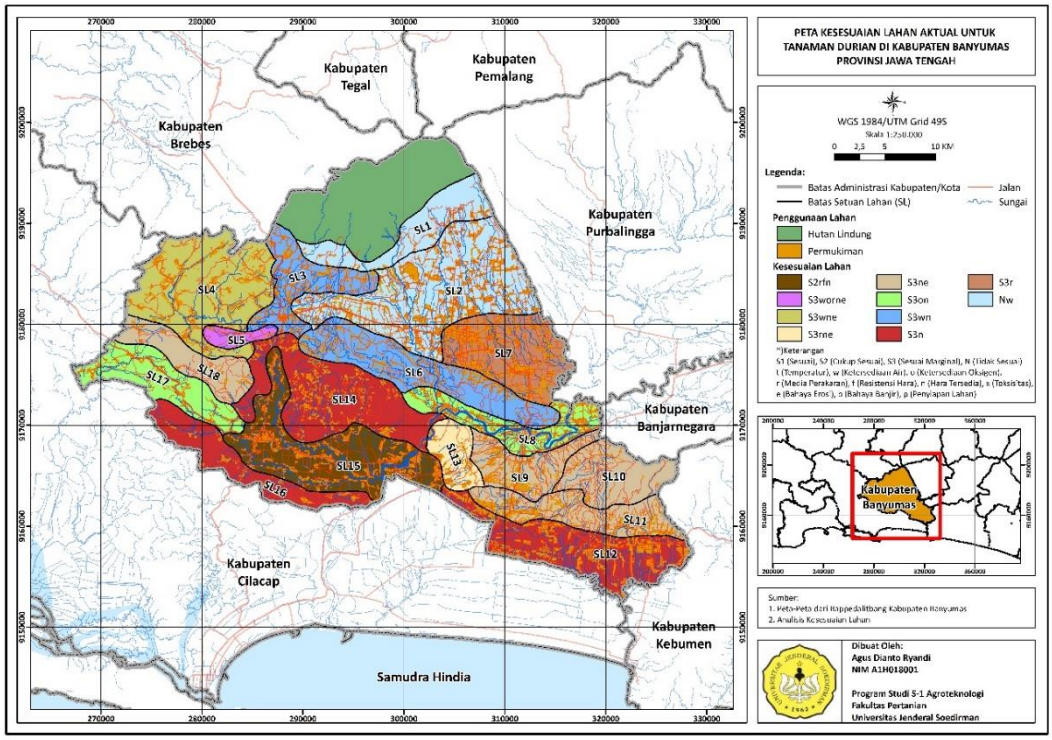

Figure 2. Map of actual land suitability for durian crops

Table 4. Suitability level of actual land for mango crops

Land unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	N	Nw	3,597	3.8
4	N	Nw	10,031	10.5
5	N	Nw	638	0.7
6	N	Nw	6,813	7.1
7	N	Nw	4,776	5.0
8	S3	S3wn	3,643	3.8
9	S3	S3wn	2,920	3.0
10	N	Nw	4,470	4.7
11	N	Nw	3,845	4.0
12	N	Nw	6,449	6.7
13	N	Ne	1,921	2.0
14	S3	S3wn	9,078	9.5
15	S3	S3w	8,557	8.9
16	S3	S3wn	4,824	5.0
17	S3	S3wn	4,787	5.0
18	N	Ne	3,589	3.8

**) Description: S3 (marginally suitable), N (unsuitable), w (water availability), n (nutrient availability), e (erosion danger)*

Land area of 33,809 ha (35.2%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability and nutrient availability. This land is located in land units (SL) 8, 9, 14, 15, 16, and 17. Land area of 61,900 ha (64.8%) has a land suitability classified as unsuitable (N) with limiting factors in the form of water availability and erosion danger. This land is located in land units (SL) 1, 2, 3, 4, 5, 6, 7, 10, 11, 12, 13, and 18. The distribution of actual land suitability for mango crops is presented in Figure 3.

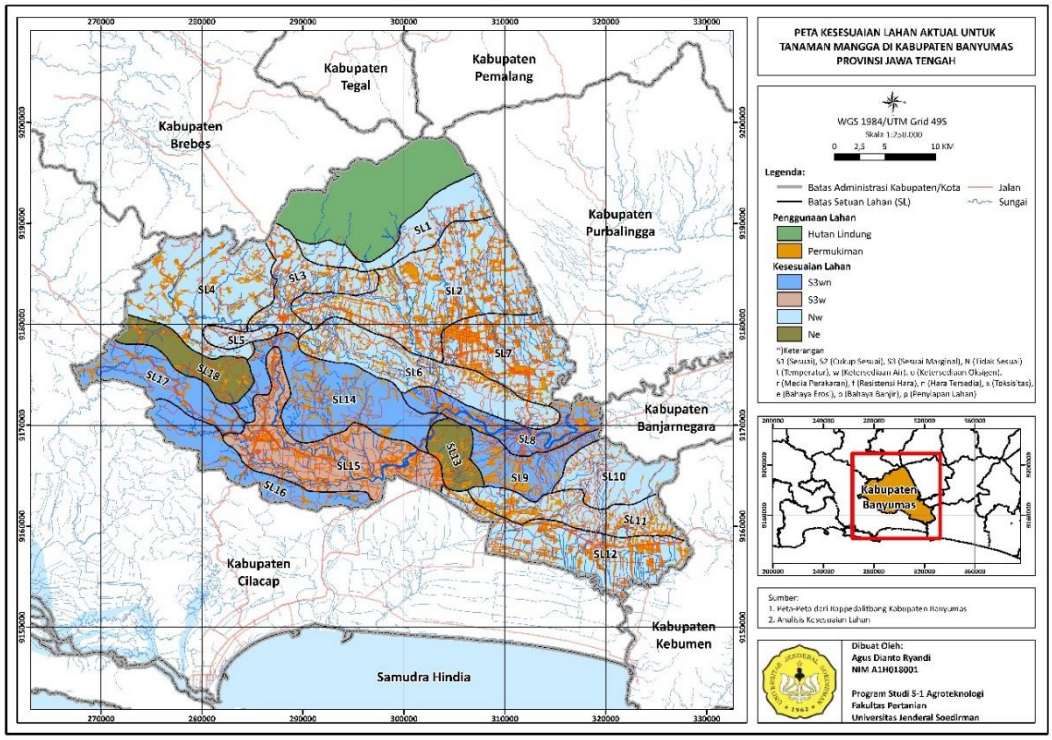

Figure 3. Map of actual land suitability for mango crops

Table 5. Suitability level of actual land for banana crops

Land unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	S3	S3wn	3,597	3.8
4	S3	S3wne	10,031	10.5
5	S3	S3wrn	638	0.7
6	S3	S3wn	6,813	7.1
7	S3	S3w	4,776	5.0
8	S3	S3n	3,643	3.8
9	S3	S3ne	2,920	3.0
10	S3	S3fne	4,470	4.7
11	S3	S3ne	3,845	4.0
12	S3	S3n	6,449	6.7
13	S3	S3rne	1,921	2.0
14	S3	S3n	9,078	9.5

15	S2	S2ofn	8,557	8.9
16	S3	S3n	4,824	5.0
17	S3	S3n	4,787	5.0
18	S3	S3n	3,589	3.8

**) Description: S2 (moderately suitable), S3 (marginally suitable), N (unsuitable), w (water availability), o (oxygen availability), r (rooting media), f (nutrient resistance), n (nutrient availability), e (erosion danger)*

Land area of 8,557 ha (8.9%) has a land suitability classified as moderately suitable (S2) with limiting factors in the form of oxygen availability, nutrient resistance, and nutrient availability. Land area of 71,381 ha (74.6%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability, rooting media, nutrient resistance, nutrient availability, and erosion danger. This land is located in land units (SL) 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 16, 17, and 18. Land area of 15,771 ha (16.5%) has a land suitability classified as unsuitable (N) with limiting factor in the form of water availability. This land is located in land units (SL) 1 and 2. The distribution of actual land suitability for banana crops is presented in Figure 4.

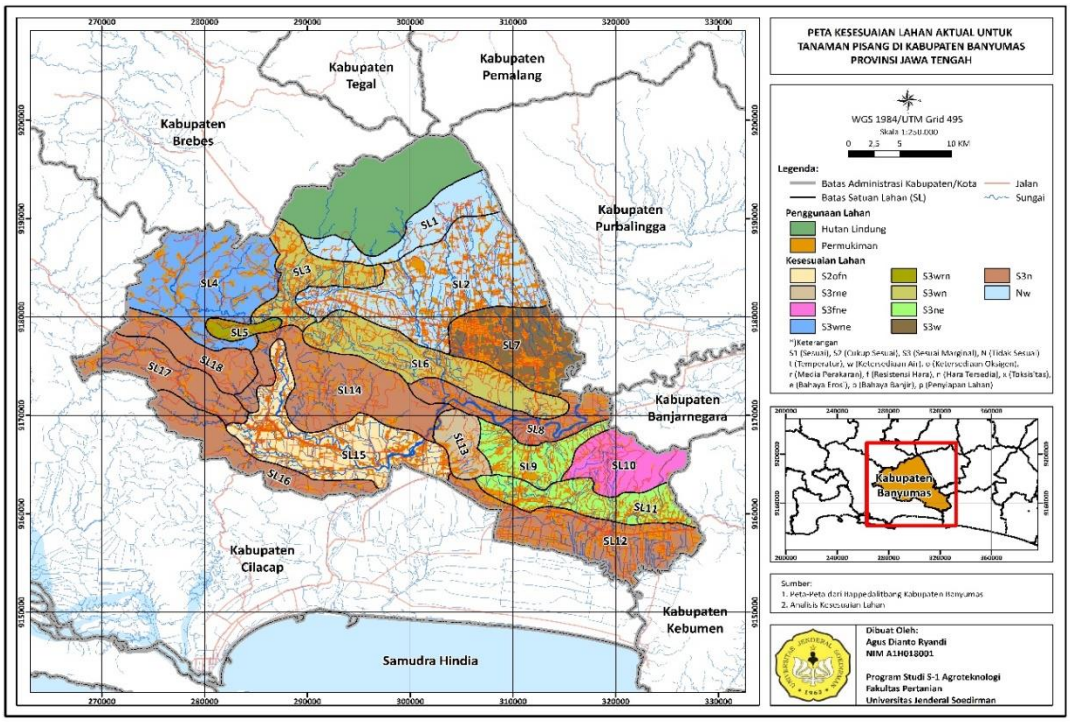

Figure 4. Map of actual land suitability for banana crops

3.3 Potential land suitability for durian, mango, and banana crops

Potential land suitability is the land suitability that will be achieved after land improvement efforts are performed. Potential land suitability is a land condition that is expected to be achieved after inputs and suggestions are given according to the level of management to be applied, so that the level of productivity of a land along with the production yield per unit area can be estimated. The resulted data on suitability level of potential land for durian, mango, and banana crops are presented in Table 6, 7, and 8.

Table 6. Suitability level of potential land for durian crops

Land unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	S3	S3w	3,597	3.8
4	S3	S3w	10,031	10.5
5	S3	S3wr	638	0.7
6	S3	S3w	6,813	7.1
7	S2	S2wr	4,776	5.0
8	S1	S1	3,643	3.8
9	S2	S2e	2,920	3.0
10	S2	S2tre	4,470	4.7
11	S2	S2e	3,845	4.0
12	S1	S1	6,449	6.7
13	S3	S3r	1,921	2.0
14	S1	S1	9,078	9.5
15	S1	S1	8,557	8.9
16	S1	S1	4,824	5.0
17	S1	S1	4,787	5.0
18	S2	S2e	3,589	3.8

**) Description: S1 (suitable), S2 (moderately suitable), S3 (marginally suitable), N (unsuitable), t (temperature), w (water availability), r (rooting media), e (erosion danger)*

Land area of 37,338 ha (38.9%) has a land suitability classified as suitable (S1). This land is located in land units (SL) 8, 12, 14, 15, 16, and 17. Land area of 19,600 ha (20.5%) has a land suitability classified as moderately suitable (S2) with limiting factors in the form of temperature, water availability, rooting media, and erosion danger. This land is located in land units (SL) 7, 9, 10, 11, and 18. Land area of 23,000 ha (24.1%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability and rooting media. This land is located in land units (SL) 3, 4, 5, 6, and 13. Land area of 15.771 ha (16.5%) has a land suitability classified as unsuitable (N) with limiting factor in the form of water availability. This land is located in land units (SL) 1 and 2. The distribution of potential land suitability for durian crops is presented in Figure 5.

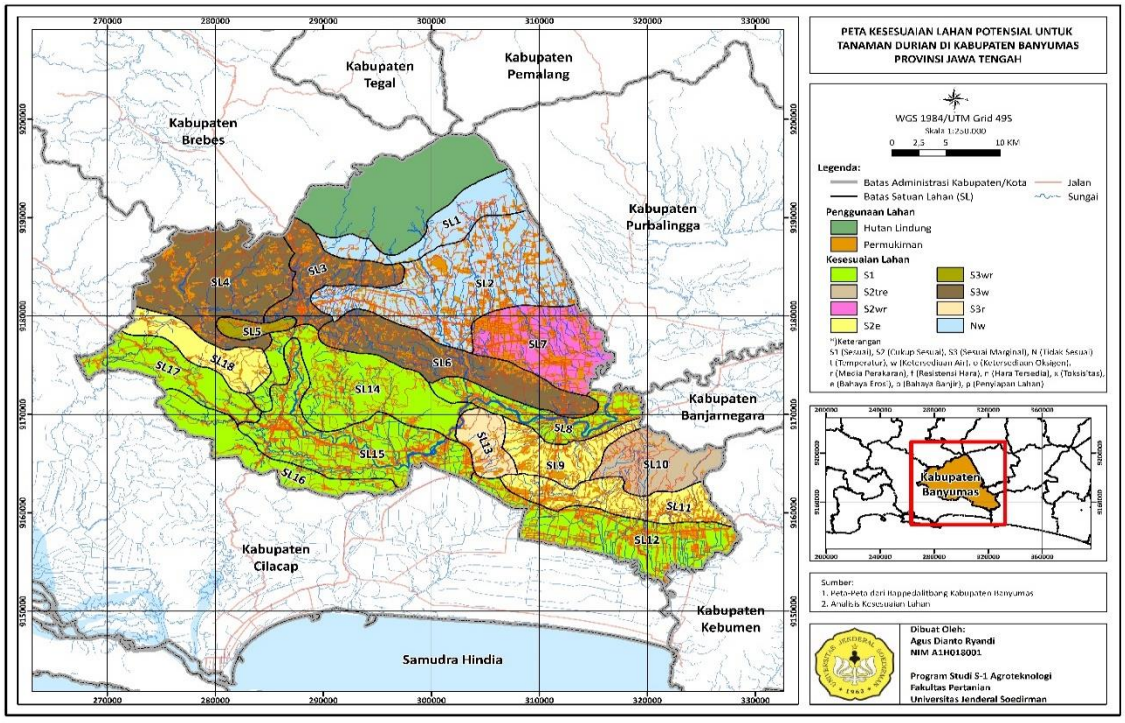

Figure 5. Map of potential land suitability for durian crops

Table 7. Suitability level of potential land for mango crops

Land unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	N	Nw	3,597	3.8
4	N	Nw	10,031	10.5
5	N	Nw	638	0.7
6	N	Nw	6,813	7.1
7	N	Nw	4,776	5.0
8	S3	S3w	3,643	3.8
9	S3	S3w	2,920	3.0
10	N	Nw	4,470	4.7
11	N	Nw	3,845	4.0
12	N	Nw	6,449	6.7
13	S3	S3wre	1,921	2.0
14	S3	S3w	9,078	9.5
15	S3	S3w	8,557	8.9
16	S3	S3w	4,824	5.0
17	S3	S3w	4,787	5.0
18	S3	S3we	3,589	3.8

**) Description: S3 (marginally suitable), N (unsuitable), w (water availability), r (rooting media), e (erosion danger)*

Land area of 39,319 ha (41.0%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability, rooting media, and erosion danger. This land is located in land units (SL) 8, 9, 13, 14, 15, 16, 17, and 18. Land area of 56,390 ha (59.0%) has land suitability classified as unsuitable (N) with limiting factor in the form of water availability. This land is located in land units (SL) 1, 2, 3, 4, 5, 6, 7, 10, 11, and 12. The distribution of potential land suitability for mango crops is presented in Figure 6.

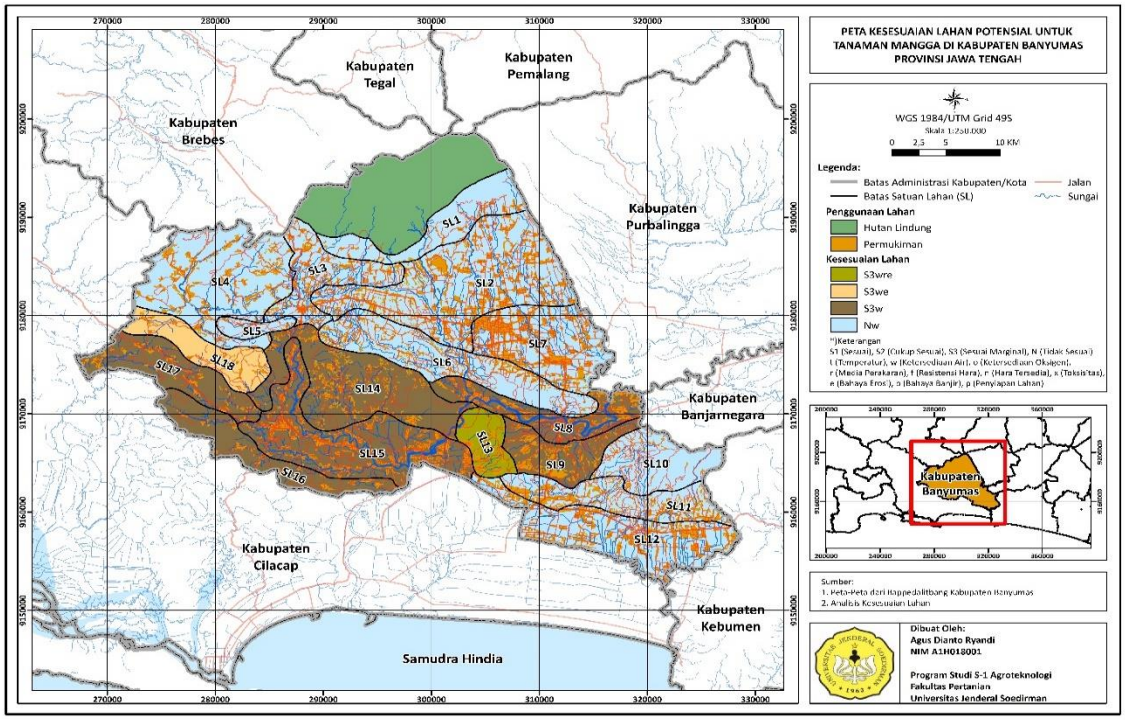

Figure 6. Map of potential land suitability for mango crops

Table 8. Suitability level of potential land for banana crops

Land Unit	Class	Subclass	Area	
			Hectare	%
1	N	Nw	4,563	4.8
2	N	Nw	11,208	11.7
3	S3	S3w	3,597	3.8
4	S3	S3w	10,031	10.5
5	S3	S3wr	638	0.7
6	S3	S3w	6,813	7.1
7	S3	S3w	4,776	5.0
8	S1	S1	3,643	3.8
9	S2	S2e	2,920	3.0
10	S2	S2tw	4,470	4.7
11	S2	S2we	3,845	4.0
12	S2	S2w	6,449	6.7
13	S3	S3r	1,921	2.0

14	S1	S1	9,078	9.5
15	S1	S1	8,557	8.9
16	S1	S1	4,824	5.0
17	S1	S1	4,787	5.0
18	S2	S2e	3,589	3.8

**) Description: S1 (suitable), S2 (moderately suitable), S3 (marginally suitable), N (unsuitable), t (temperature), w (water availability), e (erosion danger)*

Land area of 30,889 ha (32.2%) has a land suitability classified as suitable (S1). This land is located in land units (SL) 8, 14, 15, 16, and 17. Land area of 21,273 ha (22.2%) has a land suitability classified as moderately suitable (S2) with limiting factors in the form of temperature, water availability, and erosion danger. This land is located in land units (SL) 9, 10, 11, 12, and 18. Land area of 27,776 ha (29.1%) has a land suitability classified as marginally suitable (S3) with limiting factors in the form of water availability, rooting media, and erosion danger. This land is located in land units (SL) 3, 4, 5, 6, 7, and 13. Land area of 15,771 ha (16.5%) has a land suitability classified as unsuitable (N) with limiting factor in the form of water availability. This land is located in land units (SL) 1 and 2. The distribution of potential land suitability for banana crops is presented in Figure 7.

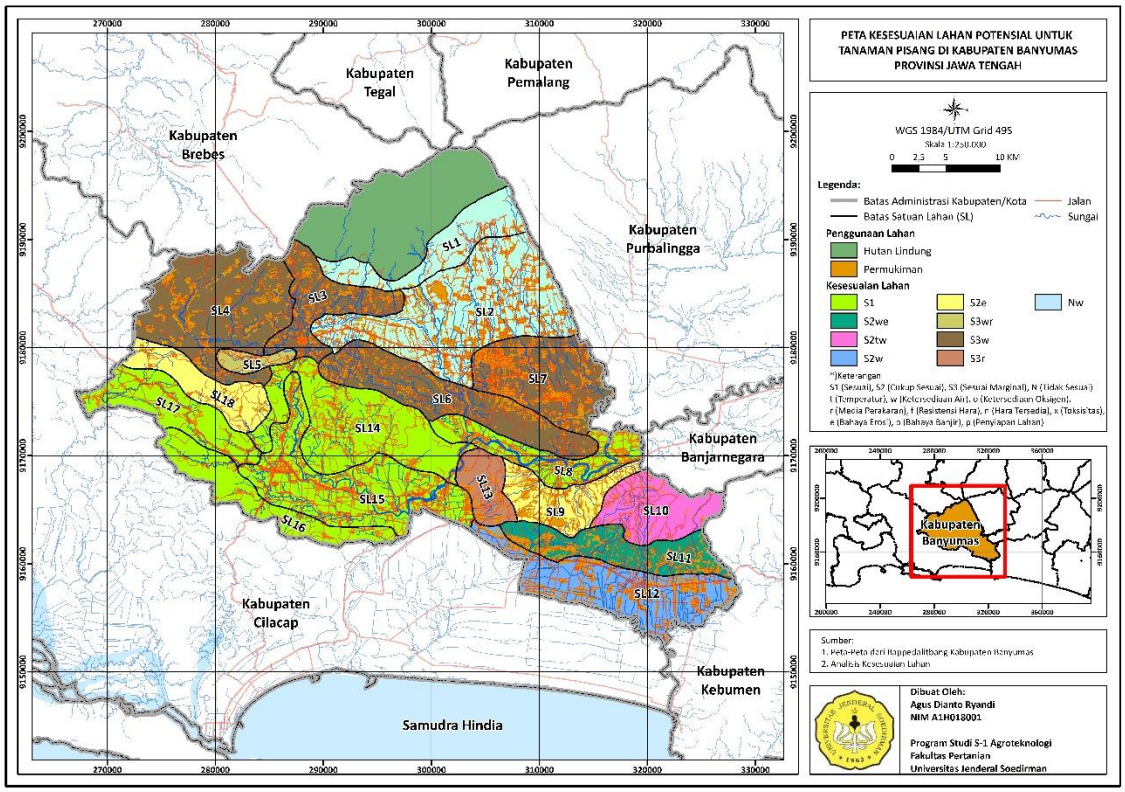

Figure 7. Map of potential land suitability for banana crops

4. Conclusions

The conclusions in this study can be drawed as follows:

1. Evaluation results of actual land suitability in several areas in Banyumas Regency reveal that land area of 8,557 ha (8.9%) is classified as moderately suitable (S2), 71,381 ha (74.6%) is marginally suitable (S3), and 15,771 ha (16.5%) is unsuitable (N) for durian cultivation. Land area of 33,809

(35.2%) is classified as marginally suitable (S3) and 61,900 ha (64.8%) is unsuitable (N) for mango cultivation. Land area of 8,557 ha (8.9%) is classified as moderately suitable (S2), 71,381 ha (74.6%) is marginally suitable (S3), and 15,771 ha (16.5%) is unsuitable (N) for banana cultivation.

2. Evaluation results of potential land suitability in several areas in Banyumas Regency reveal that land area of 37,338 ha (38.9%) is classified as suitable (S1), 19,600 ha (20.5%) is moderately suitable (S2), 23,000 ha (24.1%) is marginally suitable (S3), and 15.771 ha (16.5%) is unsuitable (N) for durian cultivation. Land area of 39,319 ha (41.0%) is classified as marginally suitable (S3) and 56,390 ha (59.0%) is unsuitable (N) for mango cultivation. Land area of 30,889 ha (32.2%) is classified as suitable (S1), 21,273 ha (22.2%) is moderately suitable (S2), 27,776 ha (29.1%) is marginally suitable (S3), and 15,771 ha (16.5%) is unsuitable (N) for banana cultivation.
3. The main limiting factors for the development of durian, mango, and banana crops are temperature, rainfall, drainage, rooting media, soil CEC, C-organic matter, nutrient availability, and erosion danger.

As a suggestion, further studies can investigate more deeply regarding the efforts to manage low and medium level limiting factors in order to increase crops productivity.

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