

Land Capability and Suitability Assessment for Sweet Potato (*ipomoea batatas* L.) in Cimanggung Sub District, Citarik Sub watershed, West Java

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ABSTRACT

Cimanggung Sub District, located in the area of Citarik Sub Watershed, West Java, Indonesia, is one of important watershed that support life and water need. However, the pollution in this sub watershed is high, degraded the environment. Therefore, the agricultural management must be suitable with land capability and land suitability. The objective of this research was to evaluate the land capability and suitability for sweet potato (*Ipomoea batatas*, L). The assessment used the limiting factor for land capability and matching table for land suitability. The results showed that the Cimanggung Sub District consisted of 13 land mapping unit (LMU) with land capability classes: II- L₂,E₁,R₁, LMU 8; III-P₄, LMU 10; IV- L₃, KE₆, LMU 1, 2, 4, 6, 9, 12 and 13; VI-L₄, LMU 5 and 7; VII- 15, LMU 3 and 11. Areas suitable for agriculture were classes II, III, and IV (LMU 8, 10, 1, 2, 4, 6, 9, 12 and 13) and the areas non suitable for agriculture were classes VI and VII (LMU 5, 7 and 3). The actual land suitability for Cilembu sweet potato was S₃ at LMU 8 and 10 and N₁ at LMU 1, 2, 4, 6, 9, 12, and 13 with the main limiting factors were nutrient retention and rooting zone. Liming is the management that can be used to improve potential land suitability to LMU 1, 2, 4, 6, 12 and 13, which improve N_{nr} to S_{3nr}, and to LMU 8 and 10, improve S_{3nr} to S_{2nr}. Clay fraction limiting factor in LMU 9 was irreparable.

Keywords: agricultural management, land assesment, sweet potato, limiting factors.

1. INTRODUCTION

Citarik Sub Watershed is part of Upper Citarum Watershed, one of the longest (297 km) and largest (11,324 km²) watershed in Java (Sahu et. al., 2011). It is administratively located in Sumedang Regency, West Java Province, Indonesia. It has important function as water source, and therefore supporting the water need in this area. However, the waste pollution in the surrounding is also high, degraded the resources of ecosystem (Sholeh et al., 2018). This sub watershed area must be managed properly to keep it environment ecofriendly.

Cimanggung is one of the Sub District located in the Citarik Sub Watershed. Agricultural management is one thing that must be considered in Cimanggung Sub District, cover the area with appropriate plants, prevent bare land that cause erosion. The decision of suitable crop must consider the land capability and land

suitability. Look to the adjacent area, the neighbourhood Sub District is used to grow Cilembu sweet potato (*Ipomoea batatas* L). This favour and qualified sweet potato has not been grown in Cimanggung Sub District. The farmers in this area have no effort yet to cultivate their farm with this high economically crop. Land evaluation therefore is important and needed to know the potentiality of this area and to manage land productivity optimizely (Mehrijardi et al, 2020). This is one approach to assess land potentiality as a sustainability using.

Cilembu sweet potato is a sweet potato that specific in Cilembu village, the adjacent area to Cimanggung Sub District. It has a special sweet honey taste (Anda et al, 2018), and the sweetness quality fulfill the requirements of export standard (Agustina and Erwina, 2016). This sweet potato supplies market in several countries like Japan, Singapore, South Korea

(Hoeridah and Sarianti, 2011). It actually growth exclusively in the Cilembu Village, but the hybrid of Cilembu sweet potato has almost same quality with a wider adaptability if cultivated in the area around Cilembu (Solihin et. al., 2018).

2. METHODH

The summarize of the methodology in this research and the sources of data and processing

is presented in Figure 1. This research used several materials like maps, field equipments and laboratory instruments. Maps used were administrative map of Cimanggung Sub District, rainfall map, land used map, topographical map and soil map. Some field equipments used were GPS (global postioning system), clinometer, auger, ring sampler, Munsell Soil Color Chart Book, and other common field things.

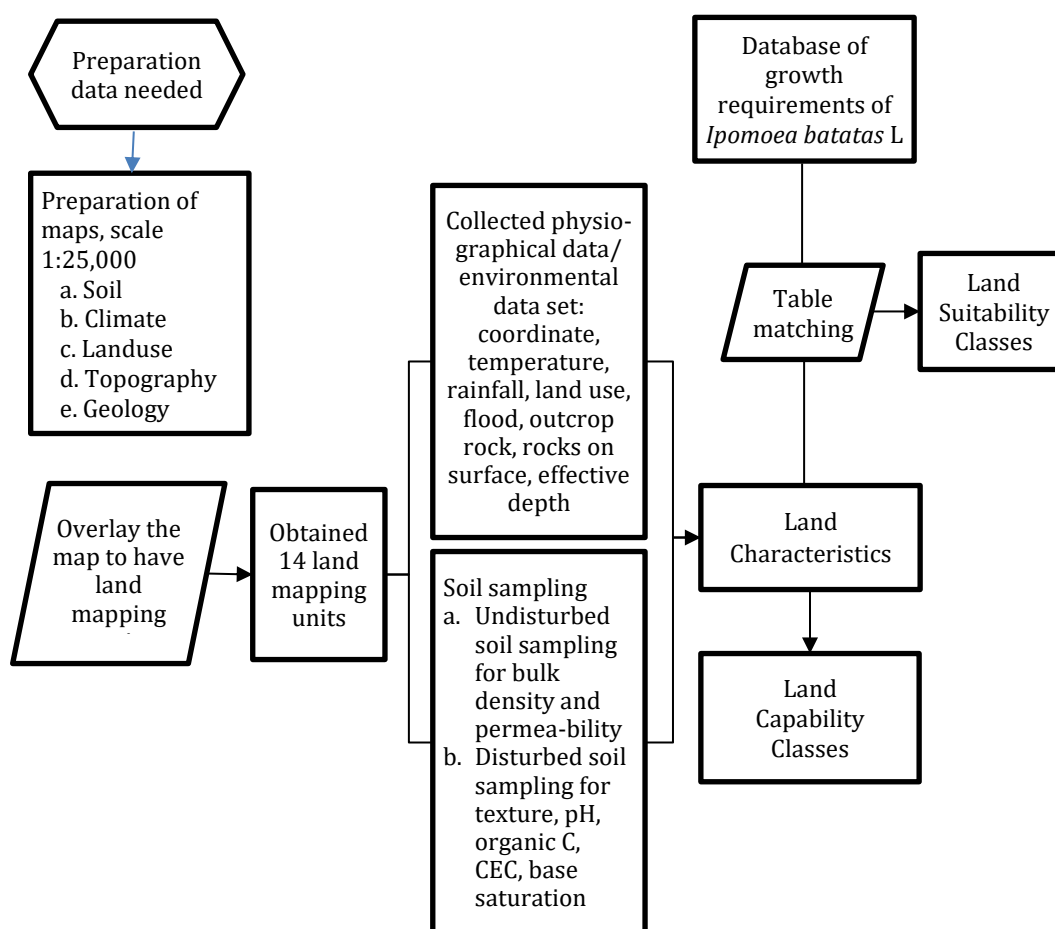


Figure 1. The scheme of data source and step of processing

Instruments used in laboratory and workshop were pH meter (measuring pH), AAS (measuring CEC and base saturation), combustions (measuring organic C), oven (measuring bulk density), circulating water-supply system (measuring permeability), analytic scale, sieving (measuring texture), EC

meter (measuring salinity) and and Arc Gis 10.6.1 (processing maps).

The method used was a descriptive and explorative, approaching to land mapping units obtained from overlaying maps to have appropriate landmapping units with the similarity of several characteristics. Soil

sampling were done to representative land mapping unit.

Soil samples were taken in every land mapping unit in several spots and be mixed compositely to homogenise further to be analysed chemical and physical characteristics. Soil samples were taken disturbed to the depth of 30 cm for analysing pH, organic C, CEC, base saturation, salinity, and texture by referred to Van Reeuwijk (1982). Soil samples were taken undisturbed with ring samplers for analysing bulk density and permeability by referred to Klute and Dirksen (1986).

Data analyses were done for detemining land capabilitiy classes by determined the inhibiting factors and be sequentially from small and few inhibiting factors (Class I) to large and many inhibiting factors (Class VIII) referered to Verheye (2009). Environment and soil data resulted in land characteristics. These characteristics will then be matched with plant growth requirements of sweet potato mentioned by Solihin (2018) for determining actual land suitability classes. The actual land suitability will then can be improve to potential land suitability if the inhibiting factors can be overcomes.

3. RESULT AND DISCUSSION

Cimanggung district in Citarik sub watershed located at the elevation of 683 to 1,110 m above sea level (asl) covers the area of 4,265 ha. The location of Cimanggung Sub Distric, Citarik Sub Waterhed in West Java Province, Indonesia is presented in Fig 2. Only a very few parts of this area can be used for agriculture, due to most of them are very steep as an arable land. Among the flat or rather flat area, that can be used as agriculture area devided into wet land farming for paddy field (9.21 ha) and dry land farming for horticulture (23.9 ha) as informed by Statistic Indonesia (2018).

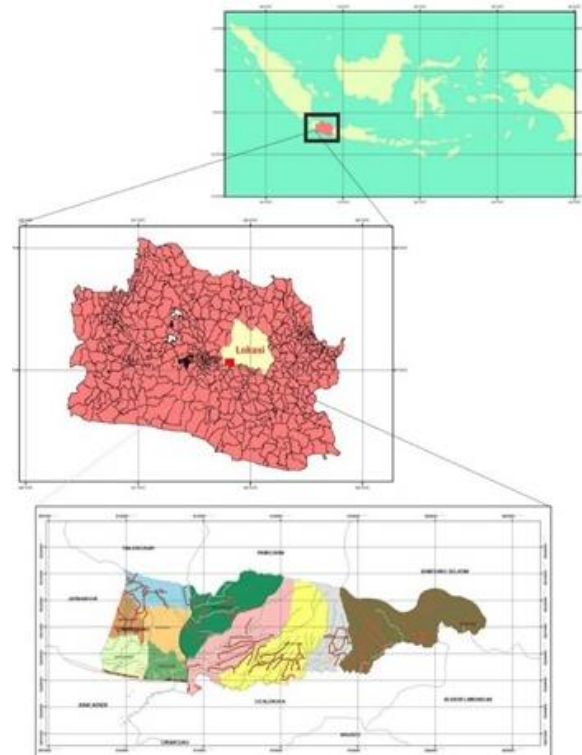


Figure 2. Map of Cimanggung Sub District, West Java Province, Indonesia

3.1 Land Capability Analyses

Land capability analyses were done based on the field and laboratory data. Field data covered climate, slope, potential and factual erosion, effective soil depth, drainage, permeability, outcrop rock, rock on surface, flooding and salinity (Verheye, 2009; Constantini, 2017). Monthly annual rainfall average is presented in Figure 3. Average rainfall map is presented in Figure 4.

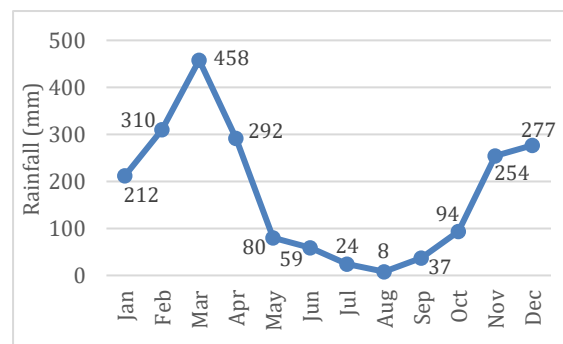


Figure 3 Monthly annual rainfall average in Cimanggung Subdistrict (2014 - 2019)

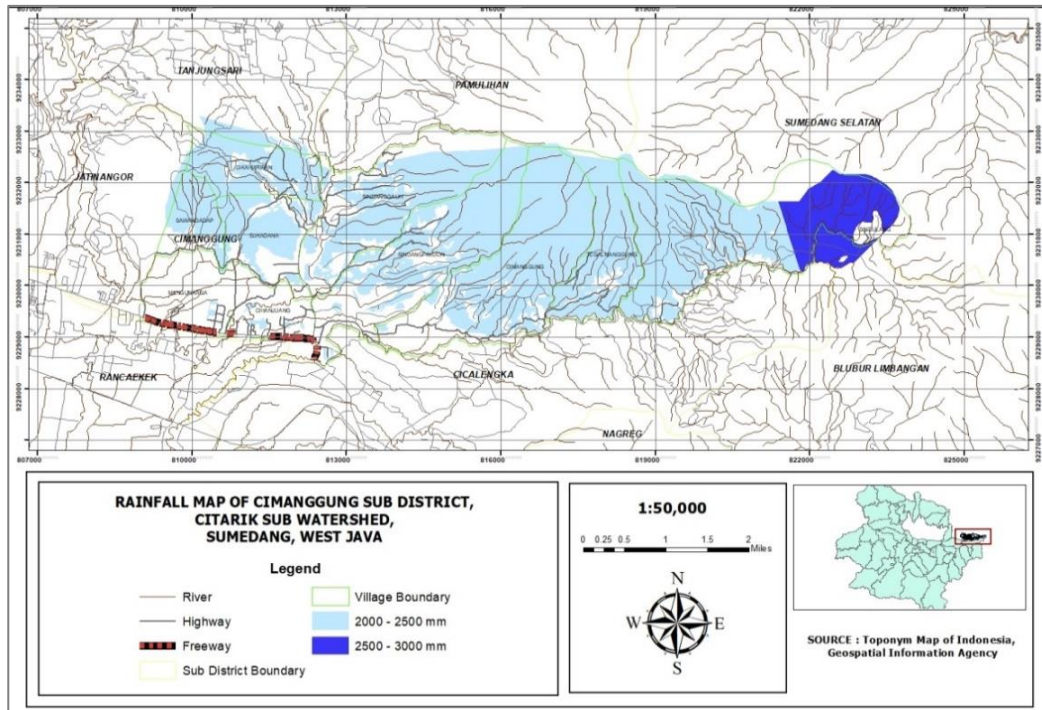


Figure 4 Average annual rainfall map

The temperature in this area range from 19.5 to 22.1 °C with the annual average of 20.8 °C. The annual rainfall is 2105 mm year⁻¹ with maximum (458 mm) fall in March and minimum (8mm) fall in August. There are six months successively from November to April where the rainfall are more than 200 mm month⁻¹ and another six months from April to October the monthly rainfall is lower than 100 mm month⁻¹. Referred to Oldeman (1982) this

area is C3 type, and crop rotation of rice and horticulture periodically once a year.

Some field and laboratory data of land characteristic presented in Table 1. Land characteristics informed that the slope of Cimanggung District was range from flat (1%, land mapping unit 10) to steep (55%, land mapping unit 3). Others land mapping unit had wavy and hilly slope.

Table 1. Land characteristic of Cimanggung District

Land Mapping Unit	Land Use	Slope %	Texture	Permeability cm hour ⁻¹	Erodibility (K)	Salinity mmhos
1	Moor	17	Silty loam	8,94	0,59	0,014
2	Moor	16	Clay	6,08	0,04	0,017
3	Moor	55	Silty clay	8,29	0,15	0,012
4	Moor	30	Silty loam	7,32	0,45	0,020
5	Shrubs	35	Silty clay	4,58	0,13	0,023
6	Moor	25	Clay	3,8	0,04	0,016
7	Moor	35	Silty clay	5,74	0,19	0,035
8	Moor	6	Silty clay	4,34	0,14	0,028
9	Moor	6	Silty loam	5,77	0,58	0,018
10	Shrub	1	Silty clay loam	7,31	0,24	0,038
11	Moor	49	Loam	3,37	0,37	0,018
12	Moor	25	Clay	5,64	0,04	0,019
13	Garden	23	Clay	8,5	0,02	0,015

The erosion rate was slight (less than 25% of top soil loss). Regarding to soil erodibility (K), the calculation had been done using the formulation by Wischmeier and Smith (1978) resulted in highest K value (0.59, land mapping unit 1) to the lowest (0.02, land mapping unit 13). Effective soil depth was 60 cm or more. No mottling found from the top soil to the 60 cm depth, informed that the drainage was good, and permeability was quick (3.58-8.94 cm hour⁻¹). Quick permeability impacted to flooding, where there was no flood that more than 24 hours in this area (threat of flooding was zero). There was no outcrop rock and very few gravels in certain area (less than 15%). The whole area was free from salinity (less than 4).

Considering all data needed for classifying land capability in Cimanggung Sub District of Citarik Sub Watershed by taking into account the limiting/inhibiting factors found in the area

like slope, erosivity, outcrop rock, rock in the surface, erodibility, and permeability, the area can be divided into five classes as described in Table 2 and Figure 5. Slope (L) is one of limiting factor that found in all land mapping unit (except land mapping unit 10) and in all class of Land Capability Classes (except III P4).

Table 2 Land Capability Classes at Cimanggung District

No	Land Capability Classes	Land mapping unit	Area	
			Hectar	%
1	II- L ₂ ,E ₁ ,R ₁	8	2.57	0.11
2	III-P ₄	10	8.34	0.36
3	IV- L ₃ , KE ₆	1,2,4,6,9,12,13	1462.87	63.57
4	VI- L ₄	5,7	383.53	16.66
5	VII- L ₅	3,11	444.18	19.30
Total area			2301.49	100

Notes: Roman number indicated land capability classes, latin letters indicated inhibiting factors and latin numbers indicate the level of inhibiting factors. L Slope, KE: Erodibility, R: rock on surface, E: degree of erosion, P: Permeability.

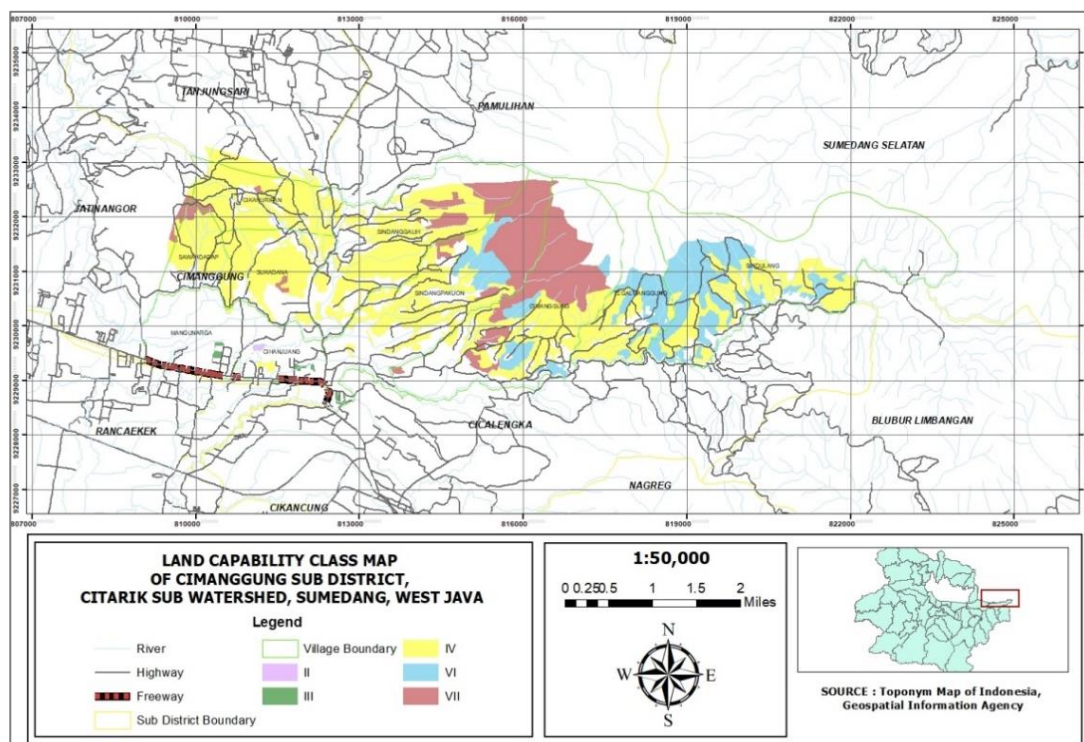


Figure 5 Land Capability Classes Map

3.2 Land Suitability Analyses

Land suitability analyses were done by matching the land characteristics with criteria

of growth requirements of sweet potato. The assesment of land suitability was taking into account the limiting factor in every land

mapping unit. Parameter with lowest suitability will be taken as the class of land suitability at representative area. Parameter with higher or highest suitability in the other hand are not the consideration in determining land suitability.

3.2.1 Actual Land Suitability

The criteria of very suitable (S1) cover the average temperature (21,7-24,6 °C), rainfall at third and fourth month after planting (152,5-423 mm and 133,2-443,7 mm), percentage of clay fraction (44-56%) and sand fraction (6,29%), effective soil depth (> 91,4 cm), cation exchange capacity (>21.9 cmol kg⁻¹), base saturation (44,7-83,7%), pH_{water} (6,30-7,40), organic C (0,9-1,9%), rock on the surface (< 3.4%), and outcrop rock (< 1.1%) as mentioned by Solihin (2018). Other value higher or lower than these values will be classed as S2 (suitable), S3 (marginal suitable), N1 (non suitable for this moment) or N2 (non suitable forever), depend on how much or how far the difference with the criteria to S1 (Verheye, 2009; Constantini, 2017).

The temperature in this area ranged from 19.5 to 22.1 °C with the annual average of 20.8 °C. The annual rainfall was 2105 mm year⁻¹ with maximum (458 mm) fall in March and

minumum (8mm) fall in August. There were six months succesively from November to April where the rainfalls were more than 200 mm month⁻¹ and another six months from April to October where the monthly rainfall were lower than 100 mm month⁻¹. The rainfall requirements for the third and fourth months in the criteria of land characteristics aimed to to determine the beginning of the best planting period, to have enough water content in that month. It should not too high, causing decreasing the sugar content in sweet potato or too low, causing lacking water. Average temperature in the area were same (20.8 °C) and were classified as S2. The rainfall of the third and fourth month can be managed by adjusted the proper month to start planting.

The comprehensive analyses result of land characteristics is presented in Table 3. Effective soil depth (60 cm), rock on surface (< 5%) and outcrop rock (<5%) found in whole land mapping units and were classified as S1, therefore will not be limiting factors in this district refered to Solihin (2018). Actual land suitability based on the actual land condition therefore can be seen in Table 3 and the map is presented in Figure 6.

Table 3 Land Suitability (LS) in every Land Mapping Unit (LMU)

LMU	Root Zone (rc)					Nutrient Retention (nr)					Land Suitability			
	Clay %	LS	Sand %	LS	CEC	LS	BS %	LS	pH _w	LS	Org.C %	LS	Actual	Potential
1	60,47	S2	26,03	S1	25,39	S3	26,06	S3	4,4	N	0,83	S1	Nnr	S3nr
2	37,2	S2	16,8	S1	34,23	S3	27,60	S3	4,2	N	1,84	S1	Nnr	S3nr
4	62,41	S2	22,59	S1	33,42	S3	14,96	S3	4,4	N	2,17	S2	Nnr	S3nr
6	26,2	S2	2,3	S3	25,71	S1	20,92	S1	3,8	N	1,30	S1	Nnr	S3nr
8	49,62	S1	3,38	S2	39,54	S1	63,17	S1	5,2	S3	2,04	S2	S3nr	S2nr
9	76,39	N	10,11	S1	25,38	S1	51,29	S1	5,0	S3	1,11	S1	Nrc	Nrc
10	54,71	S1	9,79	S1	36,92	S1	46,60	S1	5,0	S3	2,03	S2	S3nr	S2nr
12	34,58	S2	8,92	S1	28,40	S2	30,37	S2	4,3	N	1,09	S1	Nnr	S3nr
13	26,26	S2	13,24	S1	43,14	S2	40,24	S2	4,3	N	1,44	S1	Nnr	S3nr

Note: nr: nutrient retention (pH); rc: root zone (clay percentage)

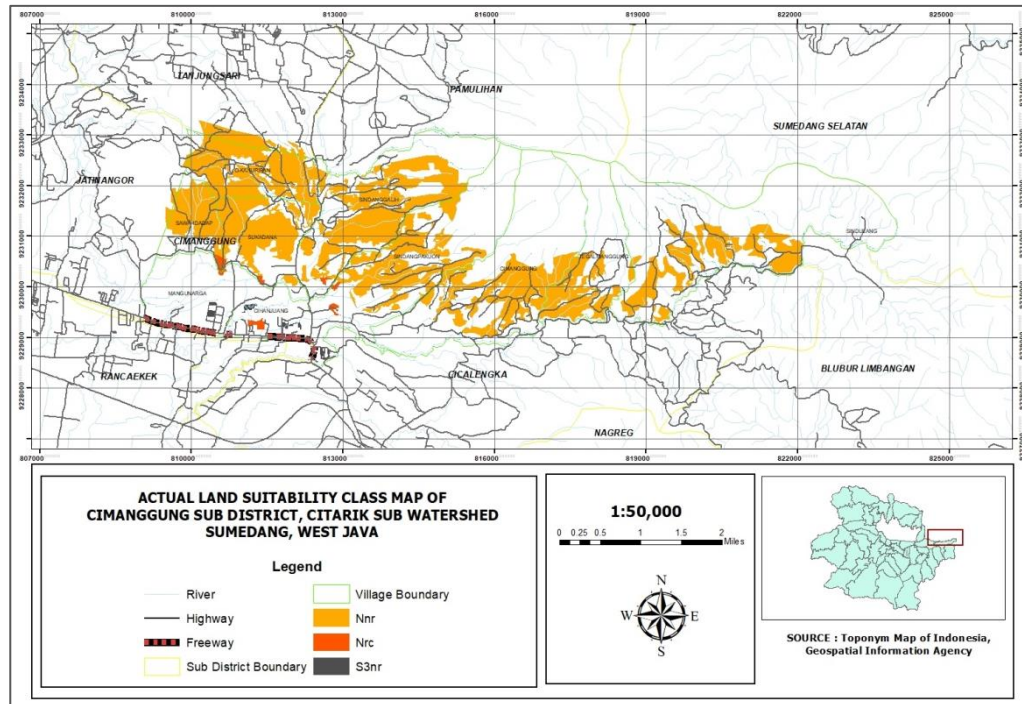


Figure 6 Actual land suitability map

3.2.2 Potential Land Suitability

Potential land suitability is obtained by corrected some possible improving from actual land suitability (Costantini, 2017). Low soil pH can be corrected by increasing it with lime (Jaskulska, et al, 2014). Low CEC can be improved by adding organic matter (Liang et al, 2006). However, several limiting factors are difficult to be fixed. Rainfall, temperature, humidity, texture, steep slope are some limiting factor that difficult to be improved or customized (Sys et al, 1991; Girmay et al, 2018; Kurniawan and Pamungkas, 2020). The complete potential land suitability and the improving is presented in Table 4.

The limiting factors found in this sub watershed as can be seen in Table 3 were low soil pH (4.4 or lower in land mapping unit 1, 2, 4, 6, 12, 13), much lower than that can be allowed (6.3-7.40). These land mapping unit were classified as S3nr. Meanwhile land mapping unit 8 and 10 had the same similar pH limiting factor, but the value a little bit higher (5.2 and 5.0) that only 1.3 unit lower than

allowed value, and therefore were classified as S2nr.

Table 4 Actual Land Suitability, Improving effort and Potential Land Suitability

LMU	Actual Land Suitability	Improving Effort	Rate of Improving	Potential Land Suitability
1	Nnr	Liming	Moderate	S3nr
2	Nnr	Liming	Moderate	S3nr
4	Nnr	Liming	Moderate	S3nr
6	Nnr	Liming	Moderate	S3nr
8	S3nr	Liming	Light	S2nr
9	Nrc	Irreparable	N/A	Nrc
10	S3nr	Liming	Light	S2nr
12	Nnr	Liming	Moderate	S3nr
13	Nnr	Liming	Moderate	S3nr

Another limiting in this area factor was the high clay content (76.3%; land mapping unit 9), much higher than appropriate one (44-56%). High dosage of liming can improve land suitability in land mapping unit, 2, 4, 6, 12, 13. Therefore, the land suitability classes increased from Nnr (actual land suitability) to S3nr (potential land suitability). Lower dosage of liming should be corrected the actual land

suitability classes (S3nr) to S2nr. However, high clay content in land mapping unit 9 can not be fixed and potential land suitability will be same

with actual land suitability. The map of potential land suitability is presented in Figure 7.

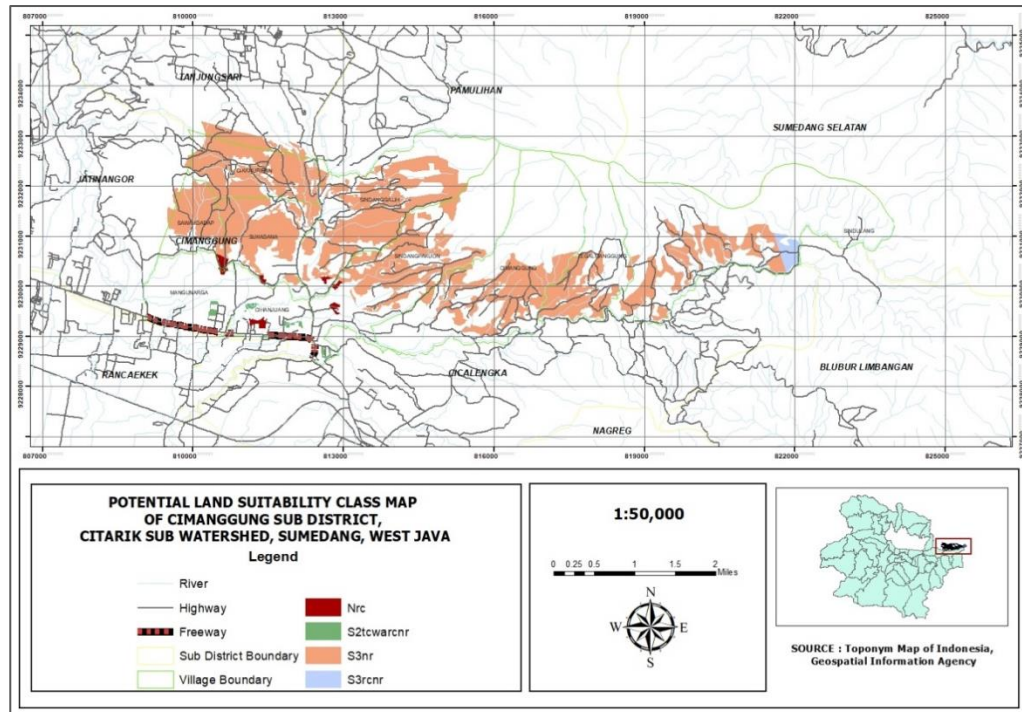


Figure 7 Potential land suitability map

4. CONCLUSIONS

Cimanggung Sub District consisted of 14 land mapping unit with land capability classes: II- L₂,E₁,R₁, land mapping unit (LMU) 8; III-P₄, LMU 10; IV- L₃, KE₆, LMU 1, 2, 4, 6, 9, 12 and 13; VI-L₄, LMU 5 and 7; VII-15, LMU 3 and 11. Areas suitable for agriculture were the classes of II, III, and IV (LMU 8, 10, 1, 2, 4, 6, 9, 12 and 13) and the areas non suitable for agriculture were the the classes of VI and VII (LMU 5, 7 and 3). The actual land suitability for Cilembu sweet potato was S3 at LMU 8 and 10 and N1 at LMU 1, 2, 4, 6, 9, 12, and 13 with the main limiting factors were nutrient retention and rooting zone. Liming is the management that can be used to improve potential land suitability that can be done to LMU 1, 2, 4, 6, 12 and 13, improve Nnr to S3nr, and to LMU 8 and 10, improve S3nr to S2nr. Clay fraction limiting factor in LMU 9 was irreparable.

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