

Comparison of Land Suitability Classes Under Smallholder Cocoa Plantations in Inland and Offland Region of Southeast Sulawesi

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ABSTRACT

The Province of Southeast Sulawesi covers the southeast region of Sulawesi Island (afterwards referred as inland) plus several smaller islands and many isles (afterwards referred as offland) adjacent to the region. The land in this province is dominated by mineral soils, but through different soil formations. This causes different physical and chemical soil properties under cocoa plantations in inland and offland regions. The study was conducted to compare soil suitability classes under cocoa plantations in inland and offland region of the province. The inland region was represented by the Regency of Kolaka Timur, while the offland region was represented by the Regency of Buton Utara. The soil survey was conducted using land unit analytical approach. A hundred land units were used per each region. The soil data was obtained from soil observations and laboratory analysis. The soil suitability evaluation was conducted using the limiting factor lowest values by matching the actual soil characteristics to cocoa growth requirements. The resulting soil suitability classes in inland and offland region were then compared. The results showed that lands in offland region of Southeast Sulawesi Province were relatively more potential as compared to those in inland region even though the chemical properties in inland soils were relatively better. It is suggested that cultivation of cocoa crops should be done in moderately and marginally suitable land units only, while those under not suitable class should be kept alone in order for the forest covers to keep intact.

Keywords: *cocoa, soil suitability class, inland, offland*

I. INTRODUCTION

Indonesia is the third-largest cocoa producer worldwide, after Ivory Coast and Ghana [1] and the Province of Southeast Sulawesi is the second largest cocoa producer, after Central Sulawesi, in Indonesia [2]. All of the cocoa plantations in this province are smallholder cocoa plantations which spread throughout the region, either in the southeast part of the Sulawesi Island (inland) or in the smaller islands and isles (offland) adjacent to the region and contributes 15-16% to the national cocoa production [2].

The land in the province is dominated by mineral soil, but through different soil formations [3, 4, 5, 6, 7], resulting in inland and offland having different physical and chemical soil properties. How different they are could be assessed via land evaluation, and how suitable they are for cocoa cultivation could be assessed via land suitability evaluation [8].

Land evaluation is defined as 'the assessment of land performance when used for a specified purpose, involving

the execution and interpretation of surveys and studies of land forms, soils, vegetation, climate and other aspects of land in order to identify and make a comparison of promising kinds of land use in terms applicable to the objectives of the evaluation' [9], while land suitability evaluation is the description of a land for a particular user [10], and land suitability evaluation for cocoa cultivation is a process of matching land characteristics against cocoa growth requirements [5] resulting in land suitability classes based on which cocoa plantation expansion and management of the soil can be done more accurately and effectively. This is because different land suitability classes will affect cocoa growth and yield differently. This study was conducted to compare land suitability under smallholder cocoa plantations in inland and offland region of Southeast Sulawesi Province.

II. METHODS

The study was conducted in the Regency of Kolaka Timur (inland) and Buton Utara (offland) in 2010 and 2014-2019.

The method used was land unit-based survey using analytical approach. The number of land units evaluated in inland and offland region was 320 and 140, respectively. Data of variables for land suitability were obtained from field observations and laboratory analysis, and secondary data. Data of climate were rainfall and temperature; Soil physics were drainage, texture, coarse materials, effective soil depth, erosion hazard, dan surface rocks. Soil chemistry were clay CEC, base saturation, pH and organic-C. The evaluation of land suitability for cocoa cultivation was based on the limiting factor lowest values by matching the actual and potential soil values against cocoa growth requirements [8]. A simple comparison between the inland and outland land suitability classes was then conducted. Materials used during the study were lands under smallholder cocoa plantations which were recorded on the Landsat TM7 images covered from April 1997 to 2017 and censor ASTER_30m of the Terra Satellite, and thematical maps. Other materials included chemical substances used for field observations and laboratory analysis. Tools and equipment used could be grouped into 3, i.e. image analysis software (desktop PC-AT Pentium 4, printer dan application ER-MAPPER 6.4, ArcView 3.3., ArcGIS 9.2., Minitab Vers. 11, SPSS Vers.16, Lisrell version. 8.72 and MS Excel 2003/2007), field observations (soil auger Belgia, Munsell Soil Color Chart, pH Trough, compass, Abney level, soil thermometer, altimeter, Global Positioning System (GPS), digital anemometer, thermometer (dry and wet), flux meter, air speed and direction, measuring tape, raffia, soil knife, plastic bags for soil samples, and stationery) and laboratory analysis (AAS, Spectrophotometer, pH meter, sieves, sample shaker, and others).

III. RESULTS AND DISCUSSION

A. Actual Land Suitability Evaluation

Actual land suitability is suitability of a land under natural conditions, without efforts of improvement. The actual land suitability for smallholder cocoa plantations in inland and offland region are presented in Table 1 and Table 2, respectively, while their distribution is presented in Figure 1.

Table 1. The actual land suitability of smallholder cocoa plantations in inland region of Southeast Sulawesi Province

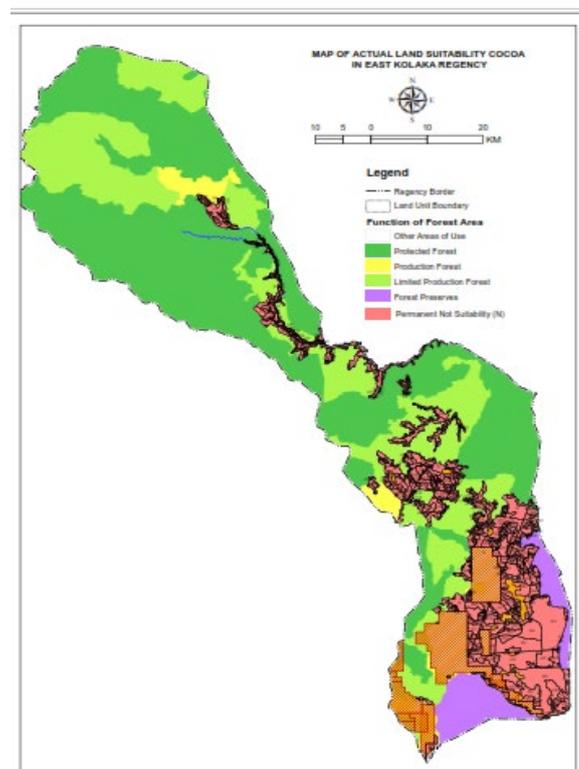
Actual Land Suitability Class	Land Unit	Area covered (ha)	%
Not suitable (N)	1-320	69,934.56	100
Total		69,934.56	100

Table 1 shows that all land units (69,934.56 ha) in inland region of the province are under actual suitability class not suitable (N). Some land units were with limiting factors of limited water availability (wa) because of the <1,000 mm of annual rainfall, some with high erosion hazard (eh) due to high slope gradients (>40%), some with flood hazard (fh), and the rest with poor root conditions (rc) due to shallow effective soil depth.

Table 2 shows that the actual land suitability of smallholder cocoa plantations in offland region was under class not suitable (N) (27,245.44 ha), with limiting factors of water availability, root condition, and land preparation. 15,262.60 ha was under class marginally suitable, with limiting factors of water and soil nutrient availability.

Table 2. The actual land suitability of smallholder cocoa plantations in offland region of Southeast Sulawesi Province

Actual Land Suitability Class	Land Unit	Area covered (ha)	%
Not suitable (N)	1-28, 31, 33-35, 38-53, 55-58, 60, 61, 66, 67, 70, 73-76, 80, 86-88, 98, 111-114, 117-123, 125, 126, 129-137, 139, 140	27,245.44	64.10
Marginally suitable (S3)	29, 32, 36, 37, 54, 59, 62-65, 68, 69,71, 72, 77-79, 81-85, 89-97, 99-110, 115, 116, 124, 127, 128, 138, 141	15,262.16	35.90
Total		42,507.60	100.00



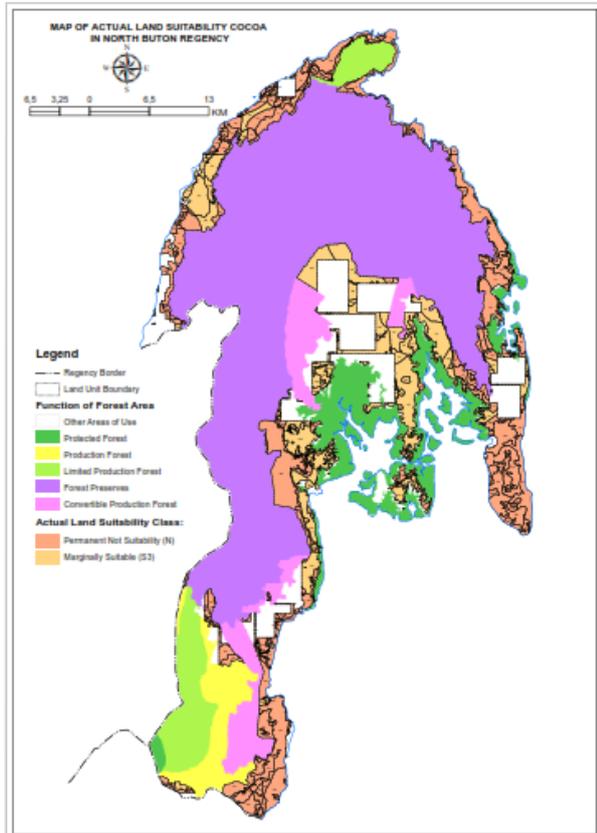


Figure 1. Distribution of actual land suitability under smallholder cocoa plantations in inland (top) and offland region (bottom) of the province

B. Potential land suitability evaluation

The evaluation of potential land suitability for smallholder cocoa plantations is to assess the potential of a land for the cultivation of cocoa crops after the existing limiting factors have been ameliorated. The results of the evaluation in inland and offland are presented in Table 3 and Table 4, respectively.

Table 3 indicates that the land suitability for cocoa cultivations increased after the land had been improved. The not-suitable land decreased 0.77% to 539.55 ha, while the marginally suitable land increased 99.23% to 69.395,01 ha.

Table 3. The potential land suitability of smallholder cocoa plantations in inland region of the province

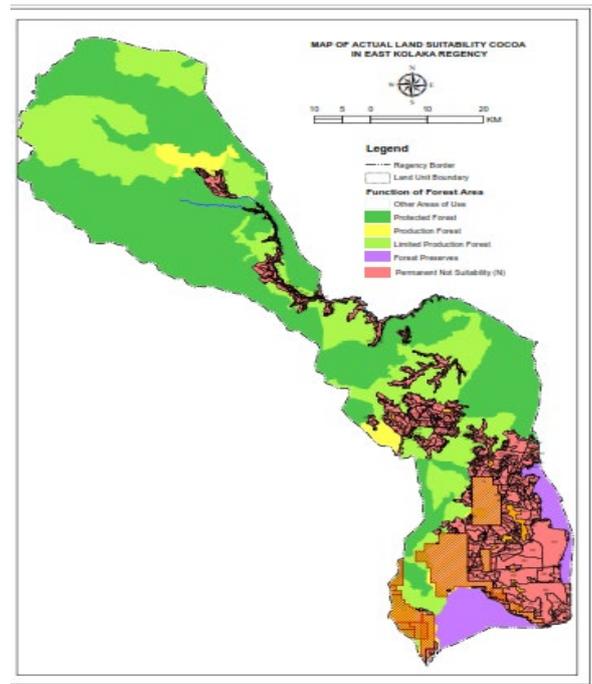
Actual Land Suitability Class	Land Unit	Area covered (ha)	%
Not suitable (N)	66--69, 72	539,55	0,77
Marginally suitable (S3)	1-65, 70, 71, 73-320	69.395,01	99,23
Total		69.934,56	100,00

Table 4 indicates that the improvement approach resulted in a 23.77% reduction in not-suitable land, a 23,40% increase in moderately suitable land and a 52.83% increase in marginally suitable land.

Table 4. The potential land suitability of smallholder cocoa plantations in offland region of the province

Actual Land Suitability Class	Land Unit	Area covered (ha)	%
Not suitable (N)	2-5, 7-9, 14-16, 26, 31, 44, 46, 61, 66, 67, 70, 73-76, 80, 86-88, 98, 133	10.103,67	23,77
Marginally suitable (S3)	1, 6, 10-13, 17-25, 26, 27, 28, 30, 32-35, 38-43, 45, 47-53, 55-60, 62, 64, 65, 69, 72, 78, 79, 81, 84, 85, 89, 91, 95, 102, 111-123, 125, 126, 129-132, 134-141	9.946,30	23,40
Moderately suitable (S2)	29, 36, 37, 54, 63, 68, 71, 77, 82, 83, 90, 92-94, 96, 97, 99-101, 103-110, 124, 127, 128	22.457,63	52,83
Total		42,507.60	100.00

As depicted in Figure 2, most potential land suitability classes in inland region were found in areas for other purposes and some were found adjacent to forest covers. In offland region, on the other hand, the potential land suitability classes spread along the coastal line.



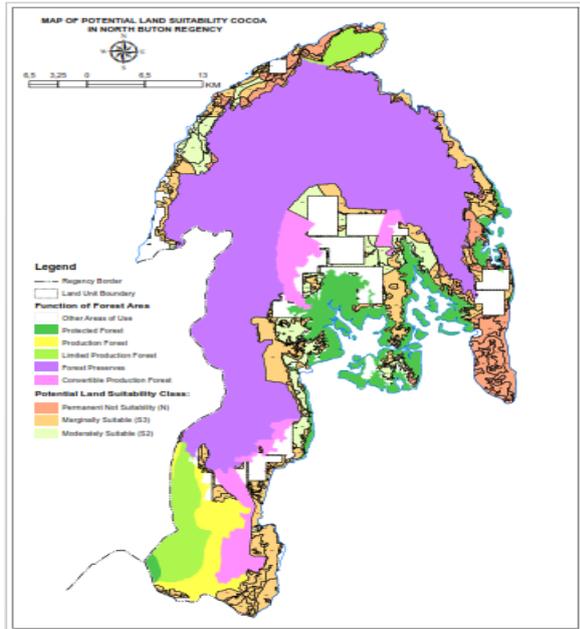


Figure 2. Distribution of potential land suitability under smallholder cocoa plantations in inland (top) and offland region (bottom) of the province

C. Comparison of land suitability classes in inland and offland region

A simple comparison of land suitability classes in inland and offland region was done using 100 land units per each region. Each class was then rated to see whether any land suitability class has a tendency to change. The number of land suitability classes in both regions are presented in Figure 3.

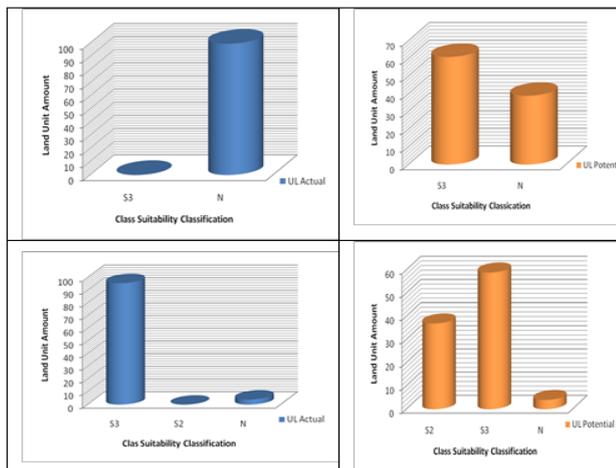


Figure 3. Changes from actual to potential land suitability classes under smallholder cocoa plantations in inland region (top) and offland region (bottom)

Figure 3 shows that there were one actual land suitability class in inland region and two classes in offland region. Of 100 land units in inland region, all were under not-suitable

class. After improvement, 61 land units became marginally suitable, while the other 39 land units remained under not suitable class. Of 100 land units in offland region, on the other hand, 96 and 4 land units were under marginally suitable and not suitable actual land suitability class, respectively. And after improvement, 37 land units became moderately suitable class, 59 land units became marginally suitable, and the other 4 land units remained under not suitable class. This figure indicates that land suitability for cocoa plantations in offland region is more promising than that in inland region. In other words, the lands in offland region have more potential than those in inland region.

IV. CONCLUSION

The study shows that lands in offland region of Southeast Sulawesi Province are relatively more potential as compared to those in inland region even though the chemical properties in inland soils were relatively better. Therefore, cultivation of cocoa crops should be done in moderately and marginally suitable land units only, while those under not suitable class should be kept alone in order for the forest to keep intact.

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