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Analysis of Spatial Patterns of Smallholder Cocoa Plants in the Mondoke Mountain Area in East Kolaka Regency

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Abstract

The Mondoke Mountains are a mountain morphological unit located in East Kolaka Regency and most of them are in Lambandia Subdistrict. This sub-district is a cocoa center in East Kolaka Regency in particular and generally in Southeast Sulawesi. During its development, production has decreased due to old cocoa age, attack by pests and plant diseases as well as land-use change. To restore the glory of cocoa in East Kolaka, then integrated planning is needed with accurate data and information starting from the presence of cocoa through the actual and potential spatial patterns of cocoa plants. This research was conducted for four months from July to November 2019. The research method used is a survey through analysis of high-resolution satellite imagery and direct observation in the field. The distribution pattern of plants is seen from the approach of land use of forest, settlements, mixed gardens, rice fields and moor and other infrastructure. The research results showed that the actual and potential land spatial patterns of smallholder cocoa plant were concentrated in their development locations. The area of Lambandia Subdistrict is 20.128 Ha and has actual land for smallholder cocoa plants covering an area of 12.391,35 Ha and a potential land area of 4.622,51 Ha and the remaining 3114.14 which is used for settlements, forests, rice fields and other land use activities. It is recommended that for potential lands for development, a technology review should be carried out considering the limiting factors for the growth and production of smallholder cocoa plants are quite heavy and a lot.

Keywords: Spatial Patterns and Smallholder Cocoa Plants

INTRODUCTION

The Mondoke Mountains are a mountain morphological unit located in East Kolaka Regency and spreading to the west and east. This mountainous area spreads evenly in Lambandia Subdistrict, East Kolaka Regency. East Kolaka Regency is one of the cocoa production centers in Indonesia since twenty years ago. In its development, it has experienced ups and downs with various obstacles faced, from problems with land availability, cultivation to production. Land availability is one of the obstacles currently facing due to aging cocoa over 18 years old and lower productivity. (Syaf, 2014). This is also because the planting of cocoa plants has not paid attention to the biophysical aspects or soil characteristics and the suitability of the land for cocoa plants, so that the plants cannot produce optimally (Kang ., & Akinnifesi, 2000; Woods, 2004; Yatno et al., 2015; Utom et al., 2016; Peprah, 2019).

This condition requires lands that have the potential to be developed into productive land through a land appraisal mechanism in accordance with scientific mechanisms. Considering that the development lands are heavily influenced by external and internal conditions. These conditions such as

topography, elevation, slope, drainage, water and soil characteristics (Risamasu, 2016 and Ali, 2016). In addition, it is necessary to develop cocoa land through expansion of planting land (Anglaaere et al., 2011; Jayanti et al., 2013; Asare et al., 2014; Mustaman et al., 2019; Hidayanto et al., 2020; Asaaga et al., 2020; Tenkap & Balogun, 2020). Selection of land use to achieve optimal productivity will be carried out well if it is carried out through the land evaluation stage with criteria that reflect the growing requirements for optimal production of a plant (Yatno, 2016).

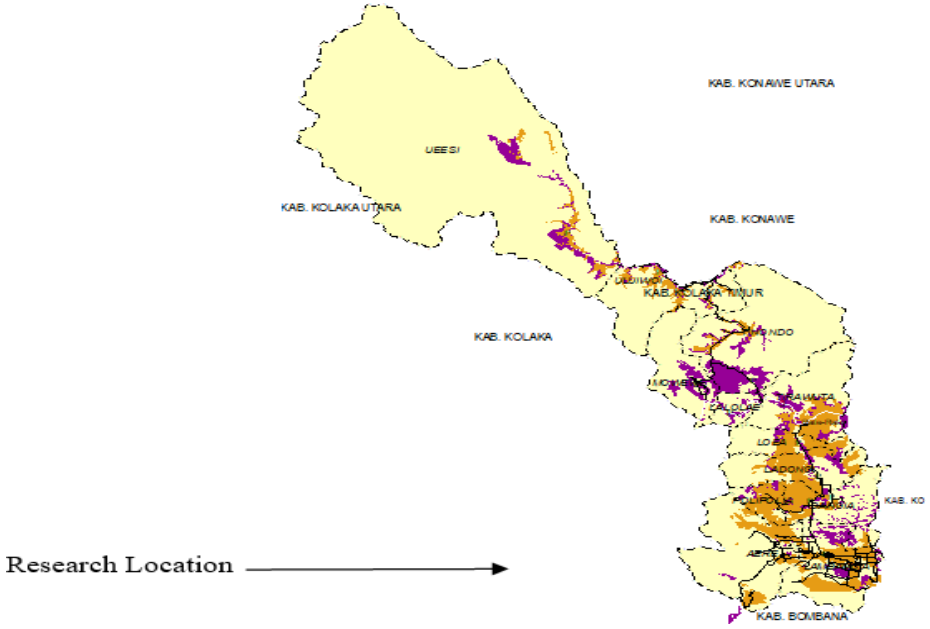
The sustainability Assessment of potential cocoa land is carried out using survey methods and evaluation of land suitability (Tufaila et al., 2014; Ayorinde et al., 2015; Hartati et al., 2018; Neswati et al., 2019; Akpoti et al., 2019; Nurqadri et al., 2020; YF Syahri et al., 2021). This method was used to obtain an overview of the actual land availability and the potential for the development of cocoa plants in Lambandia Subdistrict. This sub-district is an area of Agriculture and Animal Husbandry of East Kolaka Regency (Syaf et al., 2016) which has an area of 20128 hectares or 5,39% of the area of East Kolaka Regency. This sub-district is the largest area in utilizing the land for smallholder cocoa plant (Syaf, 2010). The condition of the smallholder cocoa plants needs to be known about the actual and potential spatial distribution patterns. Actual is the condition of the land planted with smallholder cocoa plants and the potential is the land that can still be developed by smallholder cocoa in the future.

METHODS

This research was conducted in Lambandia Subdistrict, East Kolaka Regency from July to November 2019 and the research locations are presented in Figure 1. The research method used is a survey through analysis of high-resolution satellite imagery and direct observation in the field. The distribution pattern of plants is seen from the approach of the land use of forest, settlements, mixed gardens, rice fields and moor and other infrastructure.

The materials used namely fieldwork maps, plastic bags, label paper, rainfall and temperature data for the East Kolaka Regency and its surroundings and chemicals for laboratory analysis. The tools used in this study namely GPS (Global Positioning System), compass, clinometer, roll meter, hoe, shovel, field knife, machete, soil drill, sample ring, pin, raffia rope, stationery and equipment for laboratory analysis.

The survey was carried out through the preparation stage, the implementation stage and the laboratory analysis stage. The preparatory stage conducted through collecting various literature that supports research problems, collecting information on the conditions of the research location, making a 1: 50000 scale fieldwork map which carried out in the field. The arrangement of research permits, preparing tools and materials. Making work maps that based on overlay thematic maps including maps of soil, slopes, land use and location of cocoa plants. Furthermore, combined with the climatic conditions in the Lambandia subdistrict based on climate data from four rainfall stations, namely the Motaha, Atari Jaya, Taubonto rainfall station and the Andowengga climate station for the last 10 years. The area coverage of each of these stations is determined by the Thiessen method (Polygon Thiessen).



The implementation stage was carried out by field surveys with plant and soil sampling at predetermined UL and there is a cocoa plant cultivation business carried out by farmers. Samples of smallholder cocoa plants were taken based on direct observations in the field. Soil sampling was carried out in a composite manner for land evaluation assessments. Soil samples were taken for each UL for soil analysis needs in the laboratory. The laboratory analysis stage is carried out through field observations and laboratory analysis. Observation variables of physical properties and soil morphology namely soil color, BV, soil chemical properties, soil texture, soil structure, soil permeability and porosity, soil depth, slope, surface rock conditions and soil drainage conditions.

Data analysis carried out in this study includes analysis and tabulation of data from field observations as well as interpretation of data from analysis of soil samples in the laboratory, then conducted an evaluation of land suitability using matching methods between physical characteristics and production of cocoa plants using climate suitability criteria and physical land to be cultivated (Syaf et al., 2010) for smallholder cocoa plants. Furthermore, conducted the percentage of land suitability with the observed variables. Then conducted mapping the actual and potential of the smallholder cocoa plants in Lambandia Subdistrict.

RESULT AND DISCUSSION

The research location is in Lambandia Subdistrict, East Kolaka Regency with an area of 20.128 ha, located in the peninsula of Southeast Sulawesi. Lambandia sub-district is located at the east direction of the capital of East Kolaka Regency, with a distance of ± 40 km from the center of the capital city of East Kolaka. In general, the people in the sub-district work as farmers. The boundaries of the area of Lambandia Subdistrict, namely in the north bordered with Poli-Polia and Dangia. Subdistricts, in the east bordered with Basala Subdistrict (South Konawe Regency), in the south bordered with Bombana Regency, and in the west bordered with Aere Subdistrict. Seeing from the topography, all villages/urban villages in Lambandia have a topography in the form of plains, not a single village/urban village is in the form of slopes or valleys. The land area according to each village can be seen in Table 1.

Table1. The Area of Lambandia Subdistrict, East Kolaka Regency

No	Village/Urban village	Area	
		Ha	%
1	Penanggosi	1585	7.87
2	Mokupa	2207	10.96
3	Lowa	1050	5.22
4	Atolanu	1970	9.79
5	Penanggo Jaya	1311	6.51
6	Wonuambuteo	2215	11.00
7	Bou	2300	11.43
8	Lere Jaya	1020	5.07
9	Lambandia	1062	5.28
10	Inotu	700	3.48
11	Lalolera	1285	6.38
12	Pomburea	785	3.90
13	Penanggootu	1515	7.53
14	Mondoke	464	2.31
15	Onemanu	659	3.27
Total		**20128**	**100,00**

Source : BPS, Lambandia Subdistrict in Figures, 2015

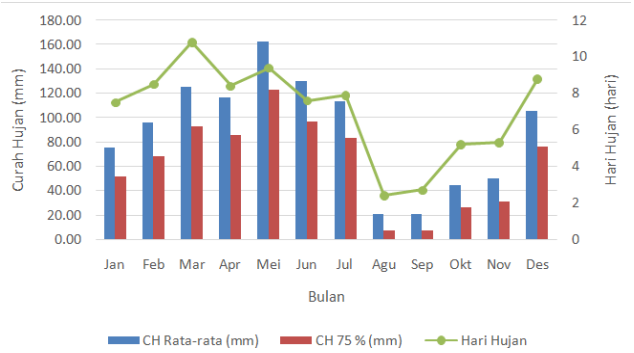
Table 1 shows that Mokupa Village and Bou Village have the largest area compared to other villages, namely 2.207 Ha and 2.300 Ha, respectively. Meanwhile, Mondoke Village has the smallest area of 464 hectares compared to other villages/urban villages in Lambandia Subdistrict based on BPS data in 2015.

The geological conditions in Lambandia Subdistrict have rock types composed of complex rocks ranging from the very old (Jurassic) to the youngest (Holocene). These rock units are still broken down into more specific rock units, detailed with the symbol and color of each unit. Based on the geological map of Lasusua - East Kolaka Sheet, Sulawesi and the geological map sheet of East Kolaka Sheet, Sulawesi with a scale of 1: 250.000 issued by the Center for Geological Research and Development(P3G), Directorate General of Geology and Mineral Resources, Bandung 1993, as well as map compilation by the Mining and Energy Agency of Southeast Sulawesi Province (2005), East Kolaka Regency, is composed of several types of skiss and mafic rocks and has medium age.

Based on the results of the Spatial Analysis of the 90-meter SRTM Image Slope (2018) the topographical conditions of the Lambandia Subdistrict, East Kolaka Regency based on its landscape shape (morphology) are generally flat to sloping (0-25). Soil types found in Lambandia Subdistrict are three, namely Entisol, Inceptisol and Ultisol, but predominantly Inceptisol and Ultisol. The climatic conditions at the research location were obtained from climate data covering the Lambandia Subdistrict area which was obtained from three rainfall stations and one climate station.

The area coverage of each of these stations is determined by the Thiessen method (Polygon Thiessen). Diagrams of average rainfall, 75% rainfall, and rainy days at each rainfall station in the Lambandia Subdistrict is presented in Figure 2.

Figure 2. Diagrams of average rainfall, 75% rainfall, and rainy days at each rainfall station in the Lambandia



Subdistrict (2008 – 2017)

Based on Figure 1, referring to the climate classification for food crops, then based on the Oldeman Classification system (Wet Month = Average Rainfall > 200 mm month $^{-1}$; Dry Month = average rainfall <100 mm month $^{-1}$), the climate in The area of East Kolaka Regency is generally classified as the type of agro-climate E. Generally the research locations had consecutive wet months of less than three months. *Smallholder Cocoa Actual Land:* Generally, the cocoa plant conditions in Lambandia Subdistrict are 15 to 21 years old using local varieties. This condition explains that some of the cocoa plants are still productive and have an advanced age and it is confirmed that the production has decreased. The average farmer's land ownership is 1-3 ha.

The cocoa production currently quite varies, namely 200 kg to 700 kg per ha per year. Farmers use chemical fertilizers in the form of Urea, TSP, ZA and Phonska depending on the farmers' available funding needs. Maintenance is carried out according to farmers' habits through spraying cocoa pests and diseases and pruning. this is also done by cacao farmers in PNG, where in the research of Daniel et al. (2011), that Despite the availability of better management technology, transfer and absorption of this technology among small-scale cocoa farmers still occurs, and the potential for high bean yields and farmers' incomes has not been realized (Opara, 2010; Ajani, 2012; Deininger, K., & Byerlee, 2012; Ejembi et al., 2015; Andrzejczak, 2017).

A series of IPDM options demonstrated to improve crop management and cocoa bean yield in a research trial demonstrated to farmers using a participatory approach in the field through pruning, sanitation, weed management and regular harvesting of full pods, regular harvesting of full pods, and application of fertilizers, fungicides and pesticides. Currently, side-cleft grafting has been carried out in almost all existing villages. Harvesting is done manually and sales are generally carried out through collectors and brokers. The actual land area data for cocoa in Lambandia Subdistrict is presented in Table 2. The actual and potential cocoa spatial patterns in Lambandia Subdistrict are presented in Figure 3.

Table 2. The area of existing Cocoa land in Lambandia Subdistrict

No	Village	Area	
		(Ha)	%
1	Atolanu	2174.23	17.55
2	Bou	746.13	6.02
3	Inotu	397.99	3.21
4	Lalolera	574.06	4.63
5	Lambandia	1057.52	8.53
6	Lere Jaya	175.3	1.41
7	Lowa	585.35	4.72
8	Mokupa	2169.39	17.51
9	Penanggo Jaya	1030.72	8.32

10	Penanggoosi	2019.39	16.3
11	Pomburea	533,09	4.30
12	Wonuambuteo	928.18	7.49
Total		**12391.35**	**100**

Based on Table 1, shows that in Lambandia Subdistrict there is around 12391.35 Ha of actual cocoa plantation area which until now is managed by the community and spread over twelve villages in Lambandia Subdistrict with each land area per village/urban village, namely Atolanu Village there is an existing cocoa land area of 2174.23 hectares; Bou Village with an existing cocoa land area of 746.13 Ha; Inotu Village with a cocoa land area of 397.99 Ha; Lalolere Village with an existing cocoa land area of 574.06 Ha; Lambandia village has an existing cocoa land area of 1057.52 hectares; Lere Jaya Village has cocoa land with a land area namely 175.3 Ha, Lowa Village with an existing cocoa land area of 585.35 Ha, Mokupa Village with an existing cocoa land area of 2169.39 Ha, Penanggo Jaya Village with an existing land area of 1030.72 Ha, Penanggosi Village with an existing cocoa land area with an area of 2019.39 Ha, Pomburea Village with a land area namely 175,3 Ha, Lowa Village with an existing cocoa land area namely 533.09 Ha, Monuambuteo Village with an existing cocoa land area of 928,18 Ha. The largest percentage of land is in Atolanu Village and the narrowest land is in Lere Jaya Village.

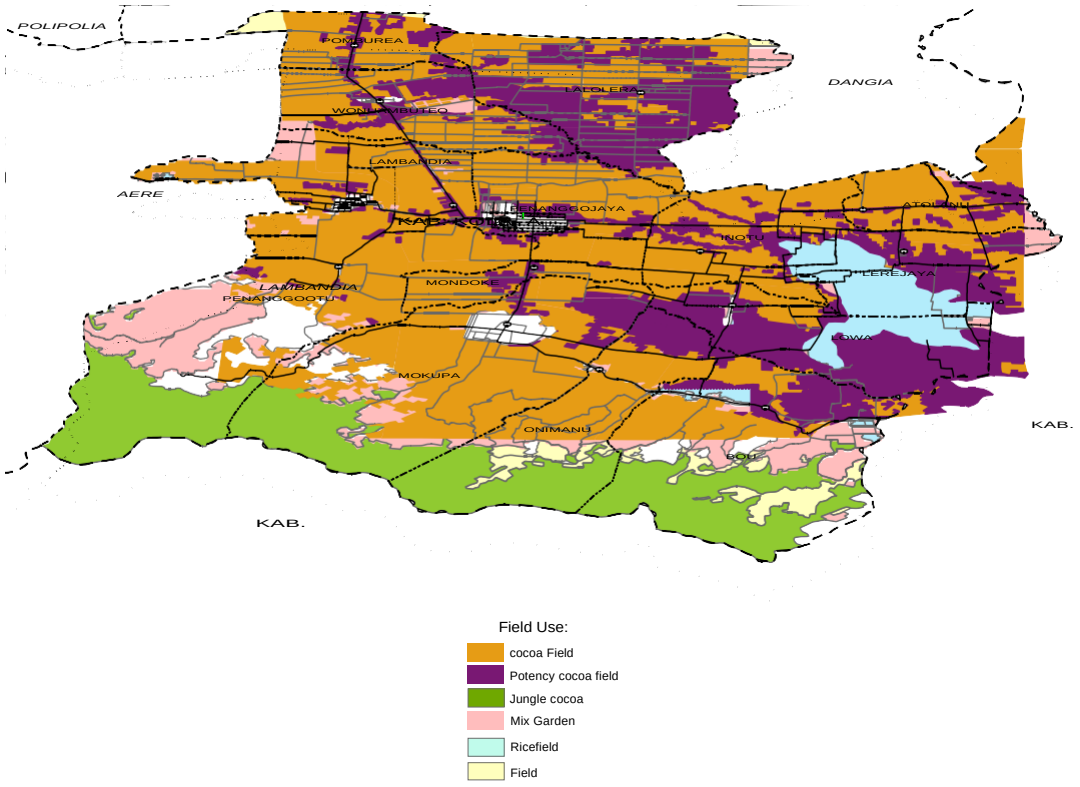


Figure 3. Actual and Potential Cocoa Spatial Patterns in Lambandia Subdistrict

Potential Land for Smallholder Cocoa: This potential land is obtained through a series of research implementation stages to ensure that these lands are available and can be developed as an extensification of cocoa land in Lambandia Subdistrict. The Potential of Cocoa Land Area in Lambandia Subdistrict Based on the Results of the Analysis of Actual and Potential Land Suitability is presented in Table 3.

Table 3. Potential of Cocoa Land Area in Lambandia Subdistrict Based on the Results of Analysis of Actual and Potential Land Suitability

No	Village/Urban village	Land Suitability		Area	
		Actual	Potential	(Ha)	%
1	Atolanu	Nwa	S3wa	556.64	12.04
2	Bou	Nwa.fh	S3wa.fh	835.96	18.08
3	Inotu	Nwa	S3wa	64.13	1.39
4	Lalolera	Nwa	S3wa	434.08	9.39
5	Lambandia	Nwa	S3wa	286.2	6.19
6	Lere Jaya	Nwa	S3wa	655.92	14.19
7	Lowa	Nwa	S3wa	448.25	9.70
8	Mokupa	Nwa	S3wa	215.31	4.66
9	Penanggo Jaya	Nwa	S3wa	237.85	5.15
10	Penanggoosi	Nwa.fh.rc	S3wa.fh.rc	66.84	1.45
11	Pomburea	Nwa	S3wa	114.36	2.47
12	Wonuambuteo	Nwa.eh	S3wa.eh	706.97	15.29
Total				**4622.51**	**100.00**

Based on Table 3, it shows that the area of land potential for planting cocoa plants in Lambandia Subdistrict is around 4.622,51 Ha which is currently not being managed productively by the community in the Subdistrict. The potential of this cocoa land is widespread in twelve villages in Lambandia Subdistrict. The largest potential land area for planting and cultivating cocoa plant is in Bou village with an area of 835,96 Ha (18,08%) and a potential land area with a small land area, namely Inotu Village based on data from the current potential land survey namely 64, 13 Ha (1,39%). Based on the actual land suitability class in the twelve villages in the Lambandia subdistrict, it is not suitable (N) due to several inhibiting factors for plant growth and productivity among others water availability, root media in the form of coarse soil texture, flood hazards and erosion hazards. If improvements are made, potentially some limiting factors such as water availability by making embankments or trenches and erosion hazard factors by making terraces, then inhibitor class will decrease to a marginal value (S3) so that cocoa plantations can be carried out, but there are inhibiting factors that cannot be repaired due to their permanent nature, namely the root media in Penanggosi Village so that the suitability class was still not suitable (N).

CONCLUSIONS AND RECOMMENDATIONS

The conclusion of this research is that the actual and potential land spatial patterns of smallholder cocoa are concentrated in the locations of their development. The area of Lambandia Subdistrict is 20.128 Ha and has actual land for smallholder cocoa plants covering an area of 12.391,35 Ha and a potential area of 4.622,51 Ha and the remaining 3.114,14 which is used for settlements, forests, rice fields and other land use activities.

It is recommended that for potential lands for development, a technology review should be carried out considering the limiting factors for the growth and production of smallholder cocoa plants are quite heavy and a lot.

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