Landscape characteristics of Codot Coffee in Kota Agung Utara Forest Management Unit, Lampung

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Abstract. Codot coffee is a new coffee variety produced from *codot* or fruit-eating bats activity . This coffee is produced from bats spitting activity after they eat a full ripe coffee bean. We believed that there are interactions between coffee and codot along the landscape that can be withdrawn by using Geographic Information Systems (GIS). The purpose of this study is to determine the landscape characteristics of the distribution of codot coffee over Community Forest (*Hutan Kemasyarakatan*/HKm) area in Kota Agung Utara Forest Management Unit (FMU) (*Kesatuan Pemangkuan Hutan*/KPH). The codot coffee's points were collected using direct GPS survey technique followed by spatial analysis. It was indicated that codot coffee has a tendency to exist between 0 to 300 m from the river, and more than 1,000 m from the road. The buffer analysis results of codot coffee distribution showed that codot has a tendency to require forests as a place to live and rest. Data showed that codot coffee mostly found in the slope between 15 to 30 percent and in the slope of 0 to 7 percent. The codot coffee were only found in area within 500 to 900 asl.

1. Introduction

According to [1], community forestry is a connection in efforts to reduce the poverty line, empower the community around the forest and improve the condition of the forest. There has been an important policy in Indonesia with regard to the community forestry (*Hutan Kemasyarakatan*/HKm) which is came from Ministry Regulation on Social Forestry (P83/2016). HKm is carried out in the state forests which utilized for empowering local communities. The land use of HKm in each region has differences in terms of the composition of plant species. HKm permit holders to choose the type of plant's canopy [2]. The land use system carried out by Hkm communities are combination of trees and agricultural or seasonal crops to obtain benefits that is usually called an agroforestry system [3].

The Beringin Jaya HKm, located in the Kota Agung Utara Forest Management Unit (KPH), is also conducting agroforestry system in their land. They produced new coffee variety, called codot coffee. This coffee is produced from the spitting activity of these bats after they eaten a full ripe coffee bean. The coffee was made by the community as their flagship product from the HKm. At present, the market price of codot coffee was quite expensive and can be a competitor for *luwak* coffee. In online shop, the price of codot coffee was reaching Rp. 90,000 per 100 grams. The demand of codot coffee is quite existed and somehow exponential, which possess a potential to be promoted to the global economic market.

Codot coffee shall possess a specific landscape characteristic, because the relationship between coffee and codot is an interaction within a landscape. However, this relationship was poorly studied,

because the issue of codot coffee was quite new. The interaction between codot, coffee and the landscape can be studied using geographic information system. It is necessary to know the landscape characteristics of codot coffee in the HKm community as the basic data for the development of codot coffee production.

2. Materials and Methods

The data used for this study includes the distribution coordinate of codot coffee by ground survey, national digital elevation model (DEMNAS) from Geospatial Information Agency (BIG), Sentinel 2 image data in 2018, and other ancillary spatial data (roads and rivers) from BIG.

2.1. Satellite Image Analysis

This analysis includes pre-processing of satellite image (e.g. image composite, image enhancement, and image subsection based on the study area). The Object Oriented Classification (OOC) was used to analyze the satellite image into land cover map. Composite images were then processed into objects through the segmentation process. Then the segments were classified into four land-cover classes namely forest, settlement, garden (agroforestry), and shrubs.

2.2. Distance Analysis

Near Distance is used to determine the distance of codot coffee's points from the river and road variables. The data were then classified in attribute tables with query technique.

2.3. Buffer Analysis

Buffer analysis will produce polygons as far as the distance specified around the input features, in this study the distances used are 100 m, 500 m and 1000 m from the codot coffee points. We overlay the buffer area with the land cover data to evaluate the cruising area of codot.

2.4. Extract Values to Point

This spatial analysis was used to analyze the distribution of codot coffee on the specific slope and elevation classes.

3. Result and Discussion

3.1. Codot Coffee Distribution Preferences on Distance from Roads

Based on the distance analysis (Figure 1 and Figure 2), the codot coffee points were mostly found in distance more than 800 m from the road (85 points or 65%). A significant codot coffee points were also found in less than 300 m from the road (41 points or 32%). Whereas the least are in the class range 301-400 m, 501-600 m, 601-700 and 701-800 m. According to [4], traffic volume will disrupt the movement of small mammals such as porcupines, badgers, and bat groups.

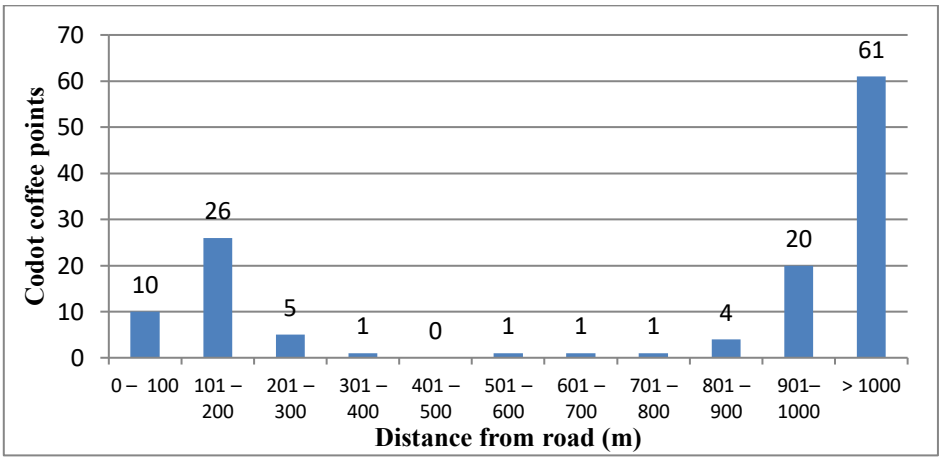

Figure 1. Codot Coffee Preference Graph of the distance to the Road

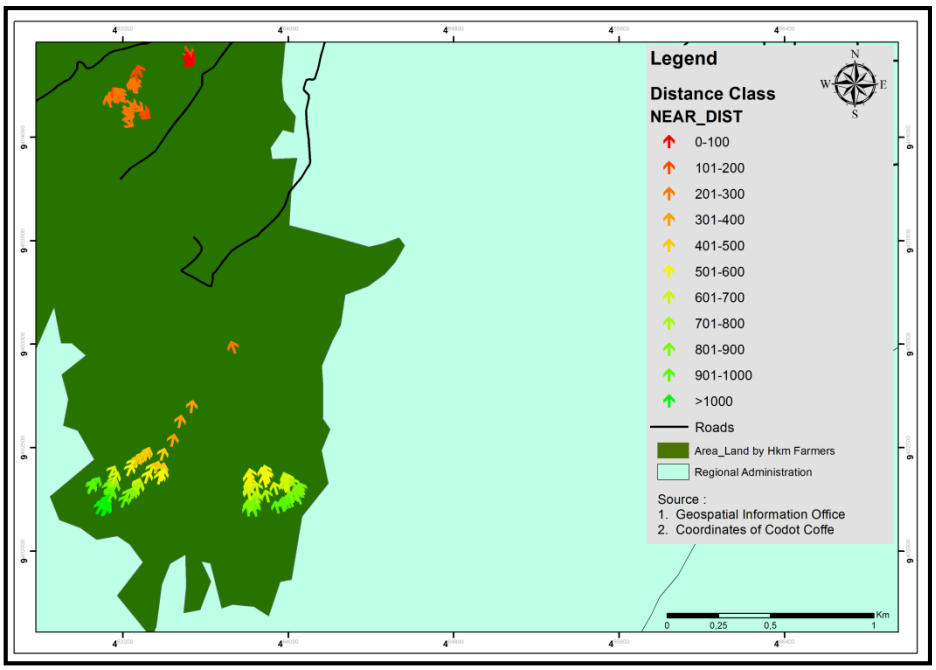

Figure 2. Codot Coffee Distribution Preference for distance to Road

Based on the results of linear regression, it showed that the distance from the road did not significantly affect the distribution of codot coffee, this can be seen from the significant value of 0.26 with the value of R^2 was 0.14 (14%). The result of the linear regression analysis contrast with the opinion of [5] that the road is an artificial landscape that can affect the existence of codot activity. This can occur because codot activity looking for food (coffee fruit) with a good level of maturity.

3.2. Codot Coffee Distribution Preference to distance from the River

Water is a natural element that are needed in the survival [6]. The river becomes a gathering place for water which is then used by animals to fulfill their water need, including codot. The preference or tendency of the distribution of codot coffee to the distance from the river is depicted in Figure 3.

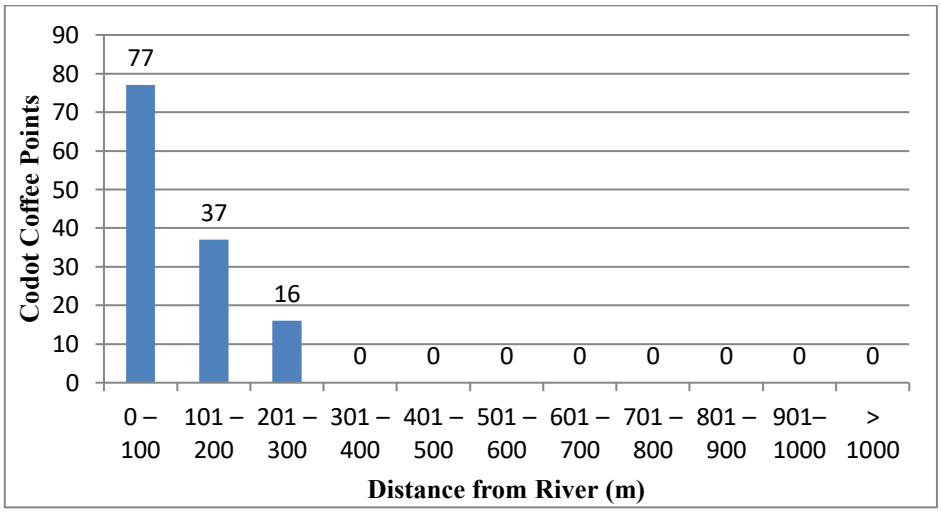

Figure 3. Codot Coffee Points and Distance from River

Figure 3 showed that the highest distribution of codot coffee was found in the distance class of 0-100 m (i.e. 77 points or 59%). In the distance class of 101-200 m, it was found 37 points of codot coffee and the least found in the 201-300 m distance class which was 16 points. The codot coffee point was not found in the distance class of more than 300 m. Based on research by [7], codot was quite common in places near rivers. Linear regression analysis showed that the distance from river has a significant effect on the distribution of codot coffee with a significant value of 0.01 with an R-square value of 0.96 (96%). This is in line with [6] that water is one of the natural elements that is needed in the survival of living things. Codot will choose a cruising area for food on land close to a water source (river) to meet their needs. Map of the trend of distribution of codot coffee to rivers can be seen in Figure 4.

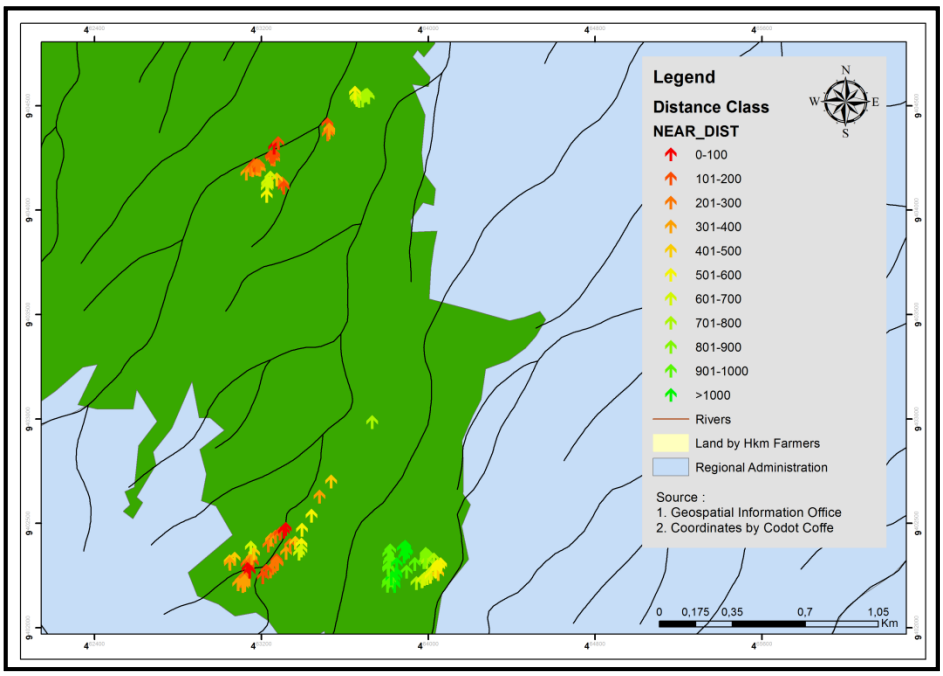

Figure 4. Codot Coffee Distribution Preferences on the River.

3.3. Codot Coffee Distribution Preference on Land Cover Types

The spatial variation of habitat based on habitat type and altitude also influences the presence of codot species related to the availability of feed sources [8]. According to [9] some types of bats have a distance between perch during the day (day roost) and a foraging area (foraging area) ranging between 363 and 725 m. Whereas according to [10] some bat species such as *D. minor*, the distance between daytime perches and foraging areas are 150 - 1150 m. The buffer analysis can be seen in Figure 5.

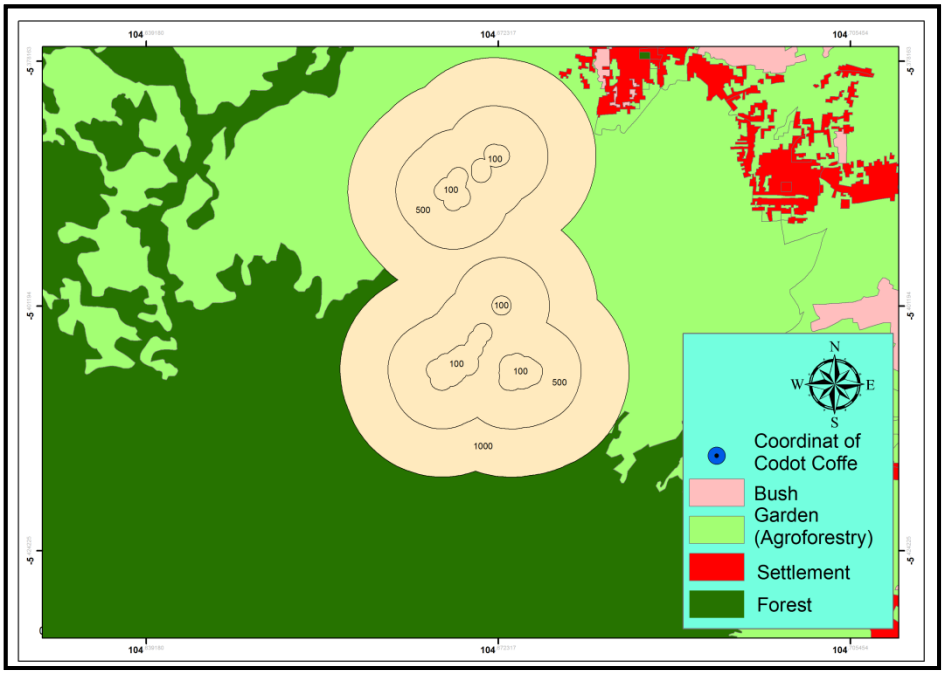

Figure 5. Codot Coffee Distribution Preferences on land cover

Figure 5 showed that the distribution of codot coffee only covers forests and gardens, not including residential areas and shrubs. This proves that codot need forests as a place to live and rest. [11] stated that the codot will be more abundant when the ecological conditions of a landscape match the criterion of codot habitat from the nest, resting place to foraging. Good environmental conditions will maintain the codot habitat as a codot coffee producing agent.

The results of codot coffee distribution preferences on land cover types can be seen in Table 1. The tendency of the codot coffee distribution buffer area is only in the forests and gardens.

Table 1. Preference for Land Cover Types

Buffer Class	***Buffer Area* (Ha)**	**Land Cover**	**Area (Ha)**	**%**
100 m	60,125	Garden	60,125	100
		Forest	0	0
500 m	357,326	Garden	90,400	25.29
		Forest	266,926	74.70
1000 m	601,280	Garden	200,501	33.34
		Forest	400,779	66.66

3.4. Codot Coffee Distribution Preference on Land Slope

The results indicated that the distribution of codot coffee is found in the slope class of 15-30% (68 points), and at least in the slope class 0-2% and 2-7% (6 points). Based on the results of a field survey of coffee plants that have dense fruit, the grade of the slope is approaching steep to near steep. According to the community, the grade of the approaching steep slopes of the ground floor is not cleaned from dry leaves because if it is cleaned it can potentially erode. The results of the analysis can be seen in Figure 6.

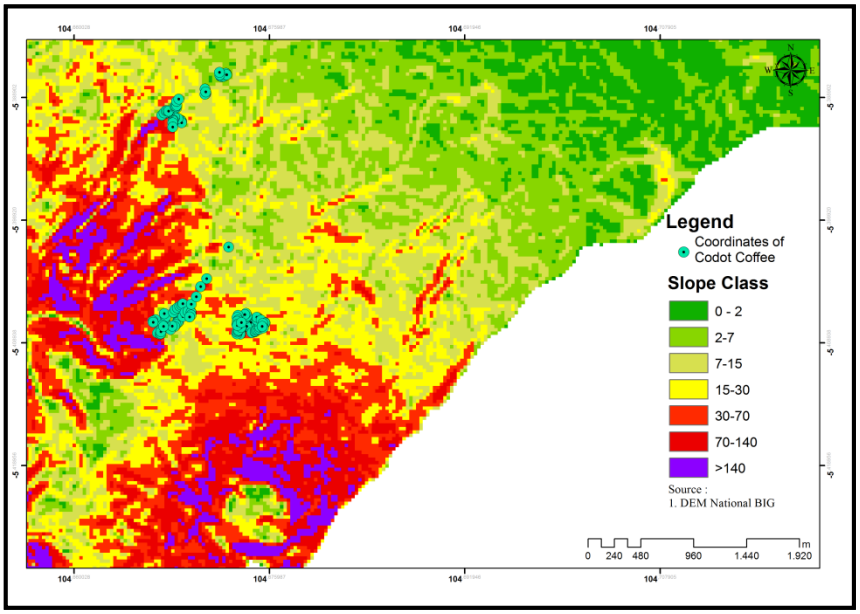

Figure 6. Codot Coffee Distribution Preference on Land Slope

Other results indicate that codot coffee is not found in the slope class 70-140% and > 140% or in steep slope classes. Factors that cause not to find codot coffee in the slope class were the composition of fewer coffee plants, so that the diet source is fewer. Table 2 below showed the percentage distribution of codot coffee in the slope classes.

Table 2. Codot Coffee Distribution Preferences on Land Slope.

Slope Class	Process, Characteristics and Conditions of the land	Color symbol	Points	Persentage (%)
0^0 - 2^0 (0 - 2%)	Flat or almost flat.	Dark green	6	4.16
2^0 - 4^0 (2 - 7%)	The land has a sloping slope.	Light green	6	4.16
4^0 - 8^0 (7 - 15%)	The land has a slope to steep slope	Light yellow	23	17.69
8^0 - 16^0 (15 - 30%)	The land has a steep slope.	Dark yellow	68	52.31
16^0 - 35^0 (30 - 70%)	The land has a steep to steep slope	Pink	27	20.77
35^0 - 55^0 (70 - 140%)	Land has a steep slope.	Dark red	0	0
> 55^0 (> 140%)	Land has a steep slope.	Dark Purple	0	0

3.5. Codot Coffee Distribution Preference to Elevation

The results indicated that codot coffee was most commonly found in areas with an altitude of 500-700 m asl with a total point of 84 points (Figure 7 and Table 3). In the height class of 700-900 m asl found 46 points of codot coffee. The distribution of codot coffee is not found in areas below 500 m asl and

above 900 m asl, this is because robusta coffee have good fruit quality at an altitude of more than 500 masl.

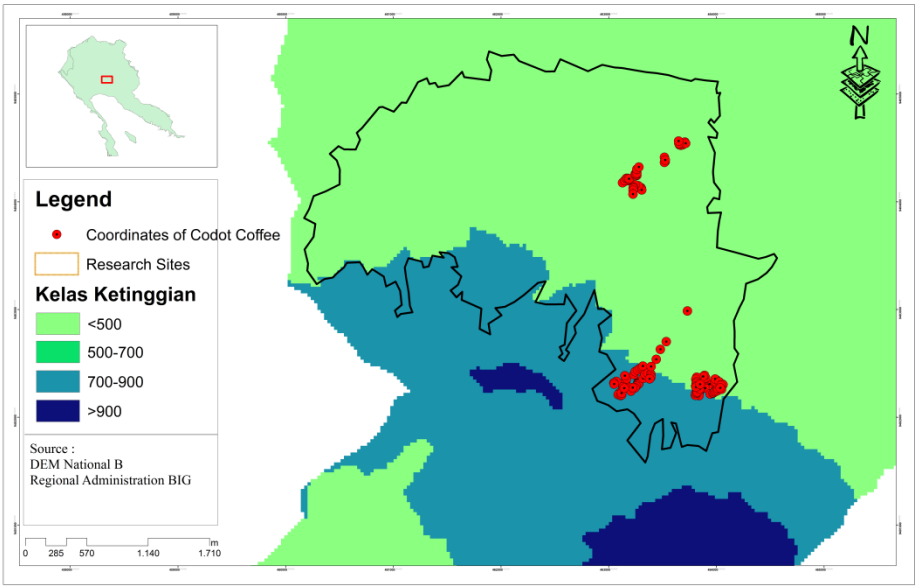

Figure 7. Codot Coffee Distribution Preference to Elevation

Table 3. Codot Coffee Distribution Preference to Altitude

No	Altitude Class (masl)	Number of Points	Presentage (%)
1	0-500	0	0
2	500-700	84	64.62
3	700-900	46	35.38
4	>900	0	0

The largest codot coffee points was found in the altitude class of 500-700 masl. This is in accordance with the study of [12] which states that many fruit-eating bats are found at an altitude of 500-600 masl. The height of an area can affect the conditions of air humidity, temperature and wind speed, so the codot tends to be at a certain height in foraging activities.

3.6. Implications for the management of Codot Coffee Cultivation

This study explained the relationship between coffee, codot and the landscape. The results of this study can be used as the basis for increasing the production codot coffee. The development of codot coffee cultivation can be done by giving special treatment to codot habitat and increase the quality of coffee. Treatment of codot habitat is carried out by maintaining ecological conditions such as maintaining river availability and forests and mixed gardens as stated by [13] that codot likes areas with dense vegetation or good ecological conditions such as water availability and stable temperatures. Adjusting the ecological conditions favored by codot provides an opportunity for the development of codot coffee cultivation.

According to [14] the cropping system of coffee in Lampung has the opportunity to apply mixed garden planting practices to produce various types of products. In addition, mixed garden systems will improve the quality of coffee and maintain the temperature. It also can protect them against watersheds. [15]reveals that the sustainability of agroforestry will be achieved if it is done technically right in accordance with local conditions as well as having to consider the socio-cultural and economic aspects of the local community. Adjust the ecological conditions of the codot and preserving the practice of

agroforestry can maintain the sustainability of codot coffee. The higher the activity in ecological-based management and social capital of the community will preserve the sustainability of forest ecosystems.

4. Conclusion

The trend of the distribution of codot coffee to the road was mostly found at a distance of more than 1000 m from the road. The distance of coffee codot to the river was found most at a distance of 0-100 m. This proves that the codot likes areas that are close to water sources. The land cover class in the form of forest in the garden becomes the land where the distribution of codot coffee were mostly found. Codot coffee was not found in the class of settlements, and shrubs. The codot coffee was found dominantly in the 15-30% of slopes or on the land that has a steep slope. The tendency of the distribution of codot coffee to height was only found in the class 500-700 and 700-900 asl.

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