

# Study of Land Potential and Suitability for Development Estate Crops on Buru Island, Moluccas Province, Indonesia

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## Abstract

Moluccas widely recognized by the world community as a centre of high genetic diversity, including commodities producer of high economic value, such as estate crops. Although Moluccas has substantial resources, but has not been able to provide adequate welfare for society because natural resources are available not optimally managed. Therefore, it is necessary to study the potential of land for the development of the estate crops. This research aims to determine the land potential and his referrals use for the development of estate crops on Buru Island (Buru and Southern Buru Regency). The methodology used was a desk study of some libraries and field observation. Land potential of Buru Island for developing a estate crops based on data analysis and use of existing biophysical taking into account the status of

the forest is an area of 86,140 ha covering an area of moderate to high potential area of 58,650 ha, and low potential areas covering an area of 27,490 ha with limiting factor drainage, rooting conditions, nutrient retention, slope, rooting conditions, floods, water availability, and slope. Wherever according by Agro-Ecological Zone (AEZ) approach from AIAT Moluccas with using AEZ analysis data, present land use, and statistical data for 8 years (2009 – 2016) is an area of 34,923.36 ha with covering sub zone II ax 15,952.78 ha, sub zone II ax.i 8,924.26, sub zone II ay 5,887.99 ha, and sub zone II ay.i 4,158.33 ha.

**Keywords:** Land potential, suitability, estate crops, Buru Island, AEZ approach

## 1. Introduction

Agricultural development policy refers to the agricultural area layout should consider the feasibility, biophysical, economic, social and cultural, so that outcomes could improve the lives of farmers and the sustainability of agricultural systems. Therefore, the development of innovative approaches to agricultural research and agricultural development in accordance with the vision of Indonesia, which is building a farm with agro ecological zone (AEZ) approaches (Kasryno et al. 2002).

According Wiradisastra (1996), agricultural development by AEZ approach is sorting an agricultural development area into units smaller and have relatively homogeneous characteristics so that the recommendations given in accordance with the needs and potential of the region owned farms. Plantation sector has a very important role in the strategic and national development, especially in improving the prosperity and welfare of the people. The main target is the development of plantation planters improving standards of living as whole and sustainable farming systems by implementing integrated sustainable plantations.

Leading commodities development strategies should be implemented based on the principle of benefit and sustainability and integration. To achieve these objectives, the development should be based on potential plantation land, primarily directed at the land suitability class is suitable (S1) and is quite suitable (S2). To be able to utilize resources in a focused and efficient land necessary to provide comprehensive data and information on the climate, soil and other physical properties of the environment, as well as the growing requirements of the crop.

Data climate, soil, and other physical properties of the environment that influence plant growth and the management aspects need to be identified through the survey and mapping of land resources. Land resources data is required primarily for the benefit of agricultural development planning and development. The data generated from the survey and mapping of land resources is still difficult to be used by the user (users) for a plan without any interpretation for certain purposes (<http://bbsdlp.litbang.deptan.go.id/>). Land evaluation is an approach or a way to assess the potential of land resources. Land evaluation results will provide information and /or direction of land use and value of production expectations are likely to be obtained.

Dent & Young (1981) states that the land evaluation is the process of estimating the potential of land for alternative kinds of use, is one of the important components in the process of land

use planning. According to FAO (1976), suitability of land or land suitability classification is a way of a land suitability for a particular use. While the land suitability classification is the appraisal process and grouping of units of land according to its suitability for a particular use (Hakim et al. 1986). One system used in this study is a framework for land suitability evaluation of land suitability the FAO. Land suitability assessment is divided into 4 levels of detail, ie order, class, subclass, and unit (Rossiter 1994; Djaenudin et al. 1993; Ritung et al. 2011), but was commonly used only to the subclass level.

Potential of an area for the development of agriculture is essentially determined by the match between the physical nature of the environment and land use requirements or the requirements of growing plants (Department of Agriculture 1997). Each agricultural commodity production to be able to grow and require specific growing conditions. According Djaenudin et al. (2003), commodities are cultivated on the land in accordance with the requirements of the growth will be able to produce optimally with high quality and requires relatively low inputs. Therefore, the potential and suitability of land as well as inhibiting factors for the development of a commodity to know in order to set the most appropriate commodity (Rossiter & van Wambeke 1997).

Buru Island is one of a relatively large island in the Moluccas region with an area of approximately 860.787 ha (Moluccas Provincial Agriculture Office 2008). Potential land resource area is quite diverse because of differences in climate, parent material, soil, and topography/relief. The diversity of the land resource potential indicates the need for a proper land use planning, optimal and sustainable. Data and information of land resources is necessary to support agricultural development planning. This paper aims to provide information on the potential use of land and direction for the development of the estate crops on the Buru Island.

## **2. Materials and Methods**

### **Reshaping Analysis Map of Agro-Ecology Zone (AEZ)**

AEZ realignment map aims to validate the map of AEZ long Buru, which includes the districts of South Buru. AEZ map is a map spatial agricultural development for macro planning, including estate planning. In this mapping factor slope, soil, climate, and land use now (present land use) serve as the basis for zoning. Stages of the preparation of the map AEZ described below.

*Preparation of maps/data.* Land resource data, includes map RePPProT 1:250,000 scale soil map 1:100,000 or 1:250,000 scale, temperature and rainfall data from multiple weather stations and climate graduated there in the area over the last 10 years, the data/information relating the socioeconomic situation, maps Joint Operational Geographic (JOG) and administrative maps prepared.

*Interpretation of the data.* To specify an alternative commodity to be commercialized performed using Expert System software. Climate data and other resources that have been collected are prepared in accordance with the predetermined format to get agroecological zoning alternatives with commodities that have the potential to be developed in the zone.

*Proper overlap (overlay).* Overlap exactly done to map AEZ with forest status maps and present land use. It aims to determine whether the region has seen in the manner intended, not suitable for use is lower than its capacity or is not appropriate because it is used beyond its capacity. At this stage also determined whether an area is needed intensification, extension or rehabilitation or conservation in the form of reforestation.

*Completion map.* Completion of the map is intended to explain the symbols in the map unit AEZ by making the legend map. The map legend provides the information contained in each set of maps covering AEZ: symbol zones, temperature regime (elevation), moisture regime, physiography, slope, soil group (Soil Survey Staff 1998), drainage and agricultural development zoning/forestry consisting of alternative production systems and commodities.

### **Criteria Used as Basis of AEZ Map**

The criteria used in the preparation of AEZ map is:

1. Moisture regime, distinguished by 'humid (x)' if the dry months is equal to or less than 3 months, 'a little dry (y)' if the dry months between 4 to 7 months. If the state of the land is always inundated either permanently or periodically then given the symbol 'z'.
2. Temperature regime, divided into 3 groups: hot temperature regime/ isohipertermik (a) if the difference in average air temperature of the warmest and coldest daily greater than 5 °C (the area with an altitude of <750 m above sea level/asl), the temperature cool/isothermic (b) if the difference average air temperature of the warmest and coldest day of less than 5 °C (altitude >750 to 2,000 m asl.), and cold temperatures (c) at altitude > 2,000 m asl.
3. Relief, there are eight (8) groups based on the state of the ground zone, topography and land use types, namely:
  - a. Zone I is the area with slope > 40%, the type of land use for forestry;
  - b. Zone II is the area with slopes 15 - 40%, the type of land use for plantation (annual crops);
  - c. Zone III is the area with slopes between 8 - < 15% with the type of land for agro-forestry agro- forestry);
  - d. Zone IV is the area with slopes between 0 - < 8% with the type of land use for food crops;
  - e. Zone V is the region with the slope < 3%, peat soil type to the type of land use for horticulture (shallow peat with thickness <150 cm) or forestry (deep peat with thickness > 150 cm);
  - f. Zone VI is the region with the slope < 3% in the acid sulfate soil or saline soil by land use type for fisheries (aquaculture) or to forest (mangrove);
  - g. Zone VII is a region with a slope < 3% with a growing set of soil from quartz with the type of land use for forestry beach/marsh (pandanus);
  - h. Zone VIII is the area with slopes < 8% in shallow or rocky soil with the type of land use for livestock (pasture).

Symbol 'i' on agroecological subzona means the use of land in accordance with its designation now means the area should diintensifikasi.

### Field Verification

Verification is done to get a general overview of efforts by farmers and plantation as well as match results, with the actual conditions in the field.

### Data Collection

Data collected included primary and secondary data. Collection of secondary data obtained from the CBS, districts, and related agencies, including acreage, harvested area, production and productivity of plantation crops. Primary data were collected with participatory rural approach

## 3. Result And Discussion

### Climate of Buru Island

Climate of northern regions of Buru Island (Namlea) including Awa categorized according to Koppen classification and category class D according to Schmidt and Ferguson with an average of 6.1 months and 4.2 months of dry wet, while areas of Buru Island and southern central part, including Afa according to the Koppen classification and class B category according to Schmidt and Ferguson with an average of 8.4 months and 2.6 months wet dry (Table 1). Oldeman based classification, regional climate Namlea included in class E, which is an area with a wet month less than 3 months in a row and the long dry months, while the area Leksula including climate type C1, ie wet month over 5 months and in a small area of adjacent to the mountains to have a different climate class.

Table 1. Rainfall Average Monthly of Buru Island

Station	In Observation	Number of DM < 60			Number of WM >			Q	Schmidt & Fergusonn	Kopper	Oldeman	Annual Rainfall (mm)
		mm			100 mm							
		Mean	Max	Freq	Mean	Max	Freq					
Namlea	20	4.2	7	1	6.1	10	1	68.8	D	Awa	E	1,388
Leksula	20	2.6	8	2	8.4	11	3	30.9	B	Afa	C1	2,919

Sources: Moluccas Provincial Agriculture Office (2008)

Water and climate is one factor limiting plant growth. Water management and climate plays a very important and is one key to the success of the increased production of crops on dry land. Water management technology depends on the climatic conditions of a region. Climate technologies and water management is important in dryland include rain harvesting technologies (water harvesting), climate prediction technology, as well as the determination of planting and cropping patterns.

### Soil Type of Buru Island

Soil types found at Buru Island include Histosols (Terric Sulfisaprists and Typic Sulfihemits), Entisols (Sulfic Fluvaquents, Typic Fluvaquents, Aquic Udifluvents, Lithic Udorthents, Typic Udorthents, Lithic Ustorthents, Typic Ustorthents, Typic Udipsamments, Typic Ustipsamments), Mollisols (Typic Hapludolls and Typic Haplustolls), Inceptisols (Fluvaquentic Endoaquepts, Sulfic Endoaquepts Aeric Endoaquepts, Typic Endoaquepts, Typic Epyaquepts, Aquic Eutrodepts, Fluvaquentic Eutrodepts, Lithic Eutrodepts, Typic Eutrodepts, Aquic Haplustepts, Fluventic Haplustepts, Lithic Haplustepts, and Typic Haplustepts), and Alfisols (Typic Hapludalfs and Typic Haplustalfs). Completely of soil types at Buru Island are showing in Table 2.

### Land Use of Buru Island

Landsat image analysis results were equipped with field observational data indicate that the use of land on the island of Buru divided into fields, grass and bushes, shrubs, moor and village, eucalyptus and shrubs, coconut and mixed farms, primary forest, secondary forest, mangrove, sago forest, and open land, such as in Table 3.

Table 2. Soil Types which Found at Buru Island

Ordo	Sub Ordo	Group	Subgroup
Histosols	Saprists	Sulfisaprists	Terric Sulfisaprists
	Hemists	Sulfihemists	Typic Sulfihemists
Entisols	Aquents	Fluvaquents	Sulfic Fluvaquents
			Typic Fluvaquents
		Fluvents	Udifluvents
	Orthens	Udorthents	Lithic Udorthents
			Typic Udorthents
		Ustorthents	Lithic Ustorthents
			Typic Ustorthents
Psamments	Udipsamments	Typic Udipsamments	
	Ustipsamments	Typic Ustipsamments	
Mollisols	Udolls	Hapludolls	Typic Hapludolls
	Ustolls	Haplustolls	Typic Haplustolls
Inceptisols	Aquepts	Endoaquepts	Fluventic Endoaquepts
			Sulfic Endoaquepts
			Aeric Endoaquepts
	Udepts	Eutrodepts	Typic Endoaquepts
			Typic Epiaquepts
			Aquic Eutrodepts
		Fluventic Eutrodepts	
		Lithic Eutrodepts	
		Typic Eutrodepts	

	Ustepts	Haplustepts	Aquic Haplustepts Fluventic Haplustepts Lithic Haplustepts Typic Haplustepts
Alfisols	Udalfs Ustalfs	Hapludalfs Haplustsifs	Typic Hapludalfs Typic Haplustalfs

Table 3. Buru Land Use Analysis Based on Landsat Imagery

Land Use	Area (Ha)	Percentage (%)
1. Wetland	8,900	1.03
2. Grass and Shrubs	2,685	0.31
3. Shurblands	4,014	0.47
4. Moor and Kampong	21,667	2.52
5. White Wood and Shrubs	159,772	18.56
6. Coconut and Mixed Garden	2,212	0.26
7. Primary Forest	422,341	49.06
8. Secondary Forest	193,043	22.43
9. Mangrove	4,554	0.53
10. Sago Swamp Forest	19,785	2.30
11. Open Land	21,814	2.53
<b>Total</b>	<b>860,787</b>	<b>100.00</b>

Sources: Moluccas Provincial Agriculture Office (2008)

### Agro-Ecology Zone for Estate Crops

Buru Island consists of two regency, namely Buru and Southern Buru. Buru regency is administratively divided into 5 districts, namely District Namlea, Air Buaya, Waeapo, Waplau, and Batabual. Similarly, South Buru district consists of 5 districts namely Waisama, Leksula, Kapala Madan, Namrole and Ambalau (In the development of the region, Buru Regency has become 10 districts and Southern Buru Regency to 6 districts). Agro-Ecological Zones of Buru is very diverse. There are five (5) zones are then lowered 15 subzona, that I ax, I bx, I cx, II ax, II ax.i, II ay, II ay.i, IV ax, IV ax.i, IV ay, IV ay.i, IV az, IV az.i, IV bz.i, and VI az (Susanto & Bustaman 2006). Figures of AEZ map for estate crops in each districts of Buru and Southern Buru Regency shown in Appendix 1 and 2.

In this study, the zoning we boundary only for estate crops including zone II. Zone II having an area of about 34,923.36 ha, which is divided into 4 (four) subzona, namely II ax, II ax.i, II ay, and II ay.i, while other zones covering an area of 821,134.59 ha, as in Table 4.



Table 4. Agro-Ecology Zone Extents for Estate Crops at Buru Island (Buru and Southern Buru Regency)

Agroecology		Development of Agriculture and Forestry			Total Area	
Sub Zone	Physiographic	Slope (%)	System	Commodities	Ha	%
I ax	Mountains, hills, karst, force, volcanic, plains	> 40	Mixed forest	Natural vegetation, coconut, cloves, cocoa, nutmeg.	429,794.24	50.21
I bx	Mountains, hills forces, volcanic and karst	> 40	Forestry	Natural vegetation	310,878.50	36.32
I cx	Mountains, hills forces, volcanic and karst	> 40	Forestry	Natural vegetation	8,532.81	1.00
II ax	Terrace, wavy, hilly, mountains, hills, plains, force, vulkan, karst	16 - 40	Agroforestry	Coconut, oil palm, cocoa, cloves, nutmeg, walnuts, durian, banana, duku, mangostan, jackfruit, salak, rambutan.	15,952.78	1.86
II ax.i	Terrace, wavy, hilly, mountains, hills, plains, force, vulkan, karst	16 - 40	Agroforestry	Coconut, nutmeg, cocoa, cloves, banana, duku	8,924.26	1.04
II ay	Terrace	16 - 40	Agroforestry	Coconut, coffee, cloves, cashew, mango, pineapple, watermelon, bark, banana, eucalyptus, citrus, cotton	5,887.99	0.69
II ay.i	Terrace	16 - 40	Agroforestry	Coconut, coffee, cloves, cashew, mango, pineapple, banana, eucalyptus, citrus	4,158.33	0.53
IV ax	karst plains, terraces, fans and lava, meanders, alluvial	3 - 8	Dryland agricultural	Upland rice, corn, beans, tubers	4,514.57	0.53
IV ax.i	Alluvial, fans and lava, karst terrain, terraces, meander	3 - 8	Dryland agricultural	Corn, beans, tubers	7,573.51	0.88
IV ay	Plain, fan and lava, karst and terraces	3 - 8	Dryland agricultural	Upland rice, corn, beans, tubers	4,070.32	0.48



IV ay.i	Plain, fan and lava, karst and terraces	3 - 8	Dryland agricultural	Corn, beans, tubers	3,300.58	0.39
IV az	Alluvial plains, alluvial valleys and alluvial river	< 3	Wetland agricultural	Rice, horticultura	27,828.57	3.25
IV az.i	Alluvial plains, alluvial valleys and alluvial river	< 3	Wetland agricultural	Rice, horticultura	9,685.28	1.13
IV bz.i	Alluvial plains, alluvial valleys and alluvial river	< 3	Wetland agricultural	Rice, horticultura	2,546.26	0.30
VI az	Tidal swamp	< 2	Shrimp Fishery	coast, crabs, milkfish	11,385.05	1.33
Lake			Freshwater carp	carp, tilapia, cork, etc	1,064.80	0.12
<b>TOTAL</b>					<b>856,057.95</b>	<b>100.00</b>

Sources : Susanto & Bustaman (2006) (data reprocessed 2013)

### ***Subzona II ax***

Subzona II ax broad is 15,952.78 ha, located in the physiographic porch, wavy, hilly, mountains and hills, plains, force, volcanic, and karst with slopes between 16% to 40%. This area of the biophysical potential to be developed for the plantation business with yard pattern, monoculture, polyculture and alley cropping. Alternative commodities that can be cultivated are coconut, oil palm, cocoa, clove, nutmeg, walnuts, durian, banana, duku, mangostan, jackfruit, salak and rambutan.

### ***Subzona II ax.i***

This is a broad subzona 8,924.26 ha, located in the same physiographic subzona II ax. Subzona has cultivated plantation society with primary commodities coconut, nutmeg, cocoa, clove, banana and duku. Intensification of plantation needs to be done here to improve farming techniques and increase productivity.

### ***Subzona II ay***

Broad subzona II ay is 5,887.99 ha, located on the terrace physiographic slope between 16% to 40%. This Subzona for the development of agricultural commodities such as coconut, coffee, cloves, cashew, mango, pineapple, watermelon, bark, banana, eucalyptus, citrus, and cotton.

### ***Subzona II ay.i***

Broad subzona II ay.i is 4,158.33 ha, located on the terrace physiographic slope between 16% to 40%. This Subzona for the development of agricultural commodities such as coconut, coffee, cloves, cashew, mango, pineapple, banana, eucalyptus, and citrus.

## Land Potential and Suitability for Development of Estate Crops

Development of estate crops in Moluccas Province, including on the Buru Island (Buru and Southern Buru Regency) is very fast compared to the potential land available. Based on data AEZ, potential land for estate crops on the Buru Island area of 34,923.36 ha, excluding other uses (forestry, agro-forestry, dry land for food crops, and others) which covers an area of 821,134.59 ha (Susanto 2013, rationalization of data) (Table 5).

Table 5. Land Potential of Buru Island for Estate Crops Development by AEZ in Zona II

Code AEZ	Physiographic	Slope (%)	Agriculture System	Alternative Commodities	Land Potential Ha	%
II ax	Terrace, wavy, hilly	16 – 40	Agro-forestry	Coconut, palm oil, nutmeg, cocoa, clove, rambutan, durian, banana, duku, mangostan, salak	15,952.78	1.86
II ax.i	Terrace, wavy, hilly	16 – 40	Intensification of agro-forestry	Coconut, nutmeg, cocoa, clove, durian	8,924.26	1.04
II ay	Terrace, wavy, hilly	16 – 40	Agro-forestry	Coconut, coffee, clove, mango, cashew, nanas, watermelon, salak, banana	5,887.99	0.69
II ay.i	Terrace, wavy, hilly	16 – 40	Intensification of agro-forestry	Coconut, coffee, clove, cashew banana.	4,158.33	0.49
Total II (ax, ax.i, ay, ay.i)					34,923.36	4.08
Other uses (forestry, agroforestry, drylands, wetlands, ponds, coastal forests, and lakes)					821,134.59	95.92
<b>Total</b>					<b>856,057.95</b>	<b>100.00</b>

Existing plantation area in Buru Island (Buru and Southern Buru Regency) in 2016 of 40,734 ha, far in excess of the total potential of the land based on the data AEZ, consists of 15,686 ha of coconut, 10,897 ha of cocoa, clove 8,740 ha, 252 ha of coffee, nutmeg 3,985 ha, and 1,174 ha of cashew (CBS of Buru Regency 2017; CBS of Southern Buru Regency 2017).

This is presumably because some things, namely (1) the data of land use for agricultural commodities overlap because each commodity is calculated based on the plantation, the thing on the ground is mixed farms, and (2) the use of land for plantations have exceeded their addresses which may have been using the agricultural zone dry land (zone IV), agro-forestry zone (III) or forest zone (zone I).

Based on data from Institution of Agriculture Moluccas Province in 2008, the potential of land for plantation crops in Buru area of 169,979 ha, consisting of suitable class (S1) covering an area of 51,597 ha, is enough suitable class (S2) covering an area of 54,235 ha,

and the marginally suitable (S3) covering an area of 64,147 ha, while the class is not in accordance measuring 690,809 ha (Moluccas Provincial Agriculture Office 2008), as shown in Table 6.

Table 6. Land Suitability for Development of Estate Crops on Buru Island (Buru and Southern Buru Regency)

Land Suitability	Limiting Factor	Area (Ha)		Total Area Potential	
		Buru	Southern Buru	Ha	%
Suitable (S1)	Drainage, rooting conditions	33,260	18,337	51,597	6.00
Enough Suitable (S2)	Nutrient retention, slope, rooting conditions, flood hazards, water supply	28,629	25,606	54,235	6.30
Marginally Suitable (S3)	Rather steep slope, rooting conditions, the availability of water	35,843	28,304	64,147	7.45
Not Suitable (N)	A steep slope, rooting conditions, floods, temperature, nutrient retention, water supply, drainage, sulfidic danger.	362,877	327,932	690,809	80.25
<b>TOTAL</b>		<b>460,609</b>	<b>400,179</b>	<b>860,788</b>	<b>100.00</b>

### Condition of Estate Crops at Buru Island

Estate crops that occupy the largest planting area on Buru Island is coconut. Area of coconut cultivation on Buru Island in year 2016 amounted to 15,684 ha, much higher compared to other commodities (Table 7). The second and third largest planting area is cacao and cloves, each 10,897 and 8,740 ha, respectively.

Table 7. Average Acreage and Production of Estate Crops in Buru and Southern Buru Regency (Buru Island) in 2016

Commodities	Buru Regency		Southern Buru Regency		Total (Buru Island)	
	Area planted (Ha)	Production (Ton)	Area planted (Ha)	Production (Ton)	Area planted (Ha)	Production (Ton)
Clove	1,252	448	7,488	2,197	8,740	2,645
Nutmeg	1,242	29	2,743	4,625	3,985	4,654
Coconut	4,996	3,091	10,690	9,496	15,686	12,587
Cocoa	4,687	4,050	6,210	4,098	10,897	8,148
Coffee	130	62	122	40	252	102
Cashew	1,174	625	-	-	1,174	625

Sources : CBS of Buru and Southern Buru Regency (2017) (data reprocessed)

#### 4. Conclusions

Based on the analysis of Agro-Ecology Zone map, land potential of Buru Island for development of estate crops was area of 34,923.36 ha (4.08%) of the total area of Buru Island, spread on subzona IIax, IIax.i, IIay and IIay.i. The area does not include dryland for food and agroforestry.

Based on data from Institute of Agriculture Moluccas Province, land suitability for estate crops of Buru Island area of 169,979 ha, consisting of suitable class (S1) covering an area of 51,597 ha, is enough suitable class (S2) covering an area of 54,235 ha, and the marginally suitable (S3) covering an area of 64,147 ha.

Coconut, cocoa and cloves are the three estate crops that occupy the widest area on Buru Island, but nutmeg plant is one of the potential estate crops to be developed.

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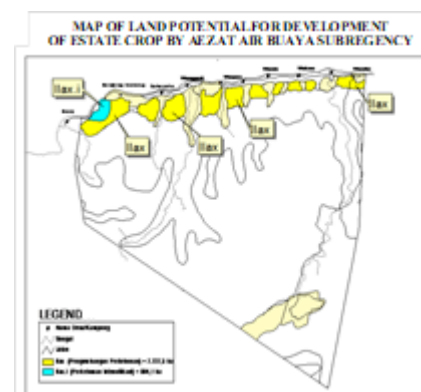
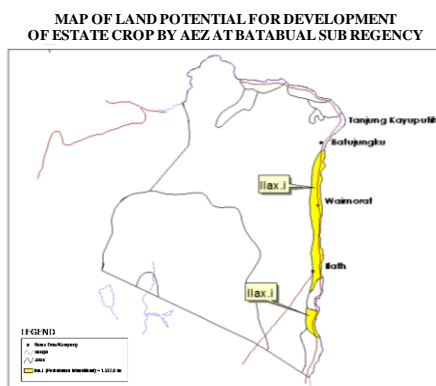
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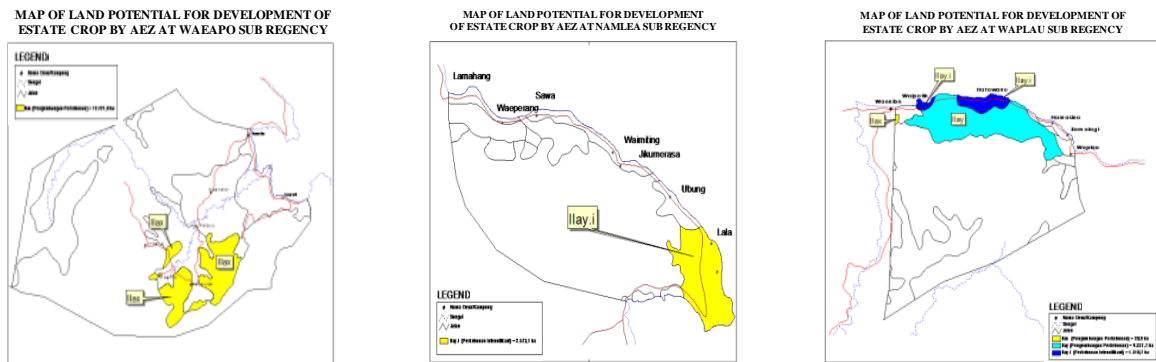
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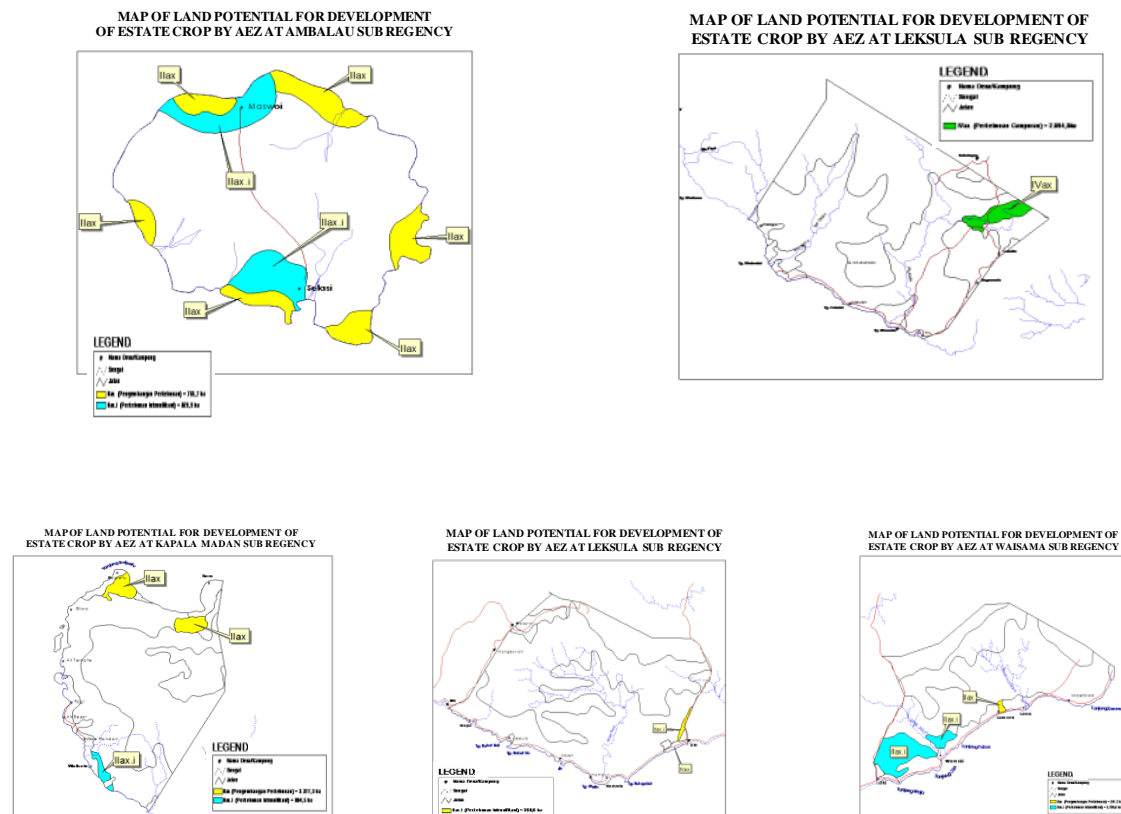
## Appendix

Appendix 1. Figures of AEZ Map for Development of Estate Crops in Each District of Buru Regency





Appendix 2. Figures of AEZ Map for Development of Estate Crops in Each District of Southern Buru Regency



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