ANALYSIS OF LAND CAPABILITY IN ALLUVIAL PLAIN AND VOLCANIC SLOPE OF REMBANG DISTRICT USING LANDFORMS APPROACH

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Abstract. Landform is typical morphological appearance of the earth who reflect the morphology and material of the land (soil type) that is approximately the same. This study aimed to assess the land characteristics and land capability of the landforms unit in the study area. The research method prepared using geomorphology-ground approach. Landforms unit used as the unit of analysis in assessing the land capability. The data collection was held by field observations, analysis of remote sensing data, taking aerial photo using UAV (Unmanned Aerial Vehicle), and laboratory analysis. Remote sensing techniques and Geographical Information Systems (GIS) is used to analysis the morphogenesa, morphology, morphoaranggement, and morphocronology unit in alluvial plains, karst hills and volcanoes slopes landforms. Land capability classification is analized using landform approach. The results showed that parts of Rembang District has four land capability classes (II, III, IV, and V) and eight land capabilty subclasses. Forms of land use in the study site must conform with existing land capability in order to achieve sustainable land use.

Keywords: Land Capability, Land Forms, Rembang

1. Intoduction

The agricultural sector was a focus on the food provision for 245 million people in Indonesia today (Murtilaksono and Anwar 2013). Food needs to be one of the challenges that need to be completed to create the conditions of food security and sovereignty in Indonesia. Agricultural land is important to support food sovereignty in Indonesia (Wuryanta and Susanti 2013). Rembang has the potential of agricultural land in all districts, including in the Capital District of Rembang. When compared with other districts, Rembang District ranks second to the region with the largest rice area (Table 1). This is the potential and the challenges that need to be taken precisely because environmental conditions vary Rembang District cause of current land use need to be adjusted and not only the pursuit of economic interests alone.

Requirements to achieve food sovereignty in Rembang is the mapping capabilities of existing fields that are used as the prioritization of agricultural land use directives (Figure 1 and Figure 2). Another benefit of the land capability mapping is an approximate calculation of the intake of food crop production needs such as seed, fertilizer, pesticides, and others (Murtilaksono and Anwar 2013).

Table 1. Total Land Uses According Rembang District in 2014

Sub-Districts	Agricultural Land (Ha)		Non-Agricultural Land (Ha)
	Paddy Field	Non-Paddy Field	
Sumber	2.950	4.004	719
Bulu	1.835	7.833	572
Gunem	1.269	3.966	2.785
Sale	1.789	8.782	143
Sarang	2.413	3.903	2.817
Sedan	2.101	3.237	2.626
Pamotan	2.244	4.232	1.680
Sulang	2.036	4.051	2.367
Kaliori	3.638	1.569	948
Rembang	3.103	1.696	1.082
Pancur	1.167	2.734	693
Kragan	2.296	2.717	1.153
Sluke	1.023	1.949	787
Lasem	1.161	2.489	860

Source: Central Bureau of Statistics, 2015

Figure 1. Aerial Photo of Agricultural Land in Rembang (Source: Maulana 2016)

Figure 2. Paddy Field in Rembang (Source: Maulana 2016)

Utilization of agricultural land in Rembang (and elsewhere) should be arranged so that their physical functions and provide sustainable results. To maintain the natural order to avoid environmental degradation required an effort to map the land capability classification so that it can also which are suitable to be developed for the agricultural aspect. One assessment used to determine the land cability is used the land cability analysis, developed by the USDA first time in 1958 (Montgomery and Dragisevic 2016; Rosca et al. 2015).

The land cability is defined as land that assessed the quality of the physical aspects of Geographical for a variety of uses agricultural activities (Rosca et al. 2015; Wirosoedarmo et al. 2014). Another approach that can be used to analyze the land cability is through the landscape analysis. Landscape analysis consider morphology, morphogenesa, morpho-aranggement, and morphocronology aspect. Landscape approaches can be used to analyze the land cability for landscape analysis can describe in detail the land characteristics in an area.Rembang have varying land characteristics and of course this will affect the agricultural activities are undertaken. Therefore, the objectives of this research is to assess the land characteristics and land capability with base/unit landforms in the Rembang District.

2. Study Area

This research was conducted in Rembang, Central Java. Rembang Regency is one of regencies in Central Java which has coastal and marine areas are quite spacious, with long sandy beaches ± 65 Km^2 (Kismartini and Joseph 2015). More specifically, this study was limited in the alluvial plains, karst hills, and volcano slopes. Three landforms are located on the north coast of Rembang. Some great river headwaters in the north coast of Rembang. Usually during the rainy season some rivers like Kaliori and Lasem flooded (Darmawan et al. 2003).

The coastal area of Rembang is dominated by forested, agriculture, salt ponds and settlements. The main livelihood of coastal communities of Rembang Regency are fishermen, farmers, ranchers, and salt farmers. Fisheries productivity in Rembang is high (Prihatmaji and Rustiani 2007), therefore a lot of people who work as fishermen. The forest area in karst hills and volcanic slopes, commonly for sale by the community. In recent years, the Government developed the Mangrove for anchoring abrasion. Results of research conducted by Hendrarto and Nitisuparjo (2010)showed that the rehabilitation of mangroves in Rembang in the last decade, a significant result. Agricultural activities in the coastal Rembang is not good enough because in the rainy season, some rivers overflowed and during the dry season some farms affected by drought. Farming activities carried Rembang coastal communities are still in the scale of household commodities such as cattle, goats and poultry. In the dry season when the river affected by drought, farmers took the initiative to drain the salt sea water into a muddy plain to embank salt. The agricultural production of salt in Rembang, especially in Sub Kaliori not too maximal because they need an additional input (Berutu 2014). General overview of the location of the research can be seen in Figure 3.

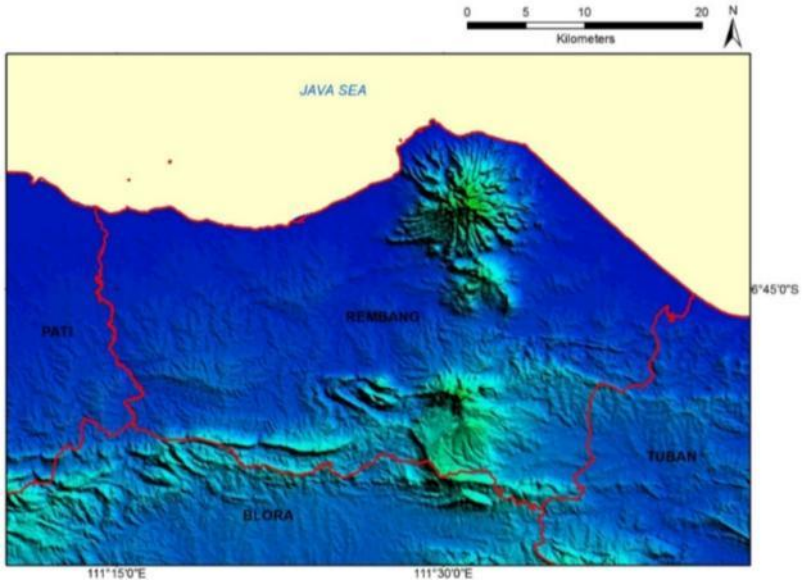

Figure 3. Study Area (Source: SRTM 30m)

3. Data and Methods

Land capabilities research of coastal Rembang using the landscape approach. Landscape approach used to identify landforms to be a mapping unit (Sartohadi et al. 2014). The materials used for the interpretation of Rembang coastal landforms is SRTM 30m, Topography Map of Indonesia Map Scale 1: 25,000 and BingMaps image resolution of one meter. Java Landsystem map scale of 1:250,000 is used for the validation study variations in the geological conditions of the area.

Data were collected by field surveys. The data collected consist of land characteristic data and aerial photographs to strengthen the research findings. Soil samples were collected at points of doubtful interpretation of landforms unit sites. Soil samples were analyzed in the laboratory to obtain the value of texture, structure, and soil pH. Interpretation of visual and manual detection is used to

determine the boundaries of land mapping units (Maulana and Wulan 2015). Each unit is filled with the attributes of land consisting of morphogenesa, morphology, morphoaranggement, and morphocronology unit in alluvial plains and volcanoes slopes landforms. Land capability is analyzed using a four parameter was linked with data on land characteristics and the results of laboratory analysis.

4. Results and Discussion

4.1. Landform of Rembang

Rembang's landforms in general consists of four original formation process, namely volcanic landforms, solutional landforms, fluvial landforms and marine landforms. Volcanic landform origin affected by volcanic processes of Lasem located in the north of Rembang. Composing materials on landforms origin volcanic processes in the form of andesite and basalt. Composing materials on volcanic landforms may influence the constituent material found along the coast of Rembang. Structural landforms are building blocks making up Rembang on the south side. Material constituent structural landforms in the form of conglomerate, sandstone, shale, and mudstone. Structural landforms are influenced by their constituent material which is unaffected by the presence of tectonic processes in the form of removal, folding and faulting. Landforms structural contained in Rembang form of hills folds, hills remainder, the valley between the hills folds, complex hills fold, the lower slopes of the hills anticlinal, the slopes of the hills above the crease, plains foothills anticlinal, hills anticlinal, the slopes are steep hills folds, hillsides folds, the slopes of the foothills of the crease, and the slopes of the foothills anticlinal. Composing materials contained in Rembang influence the configuration of landforms occur. Landform folds dominate most of the territory of Rembang.

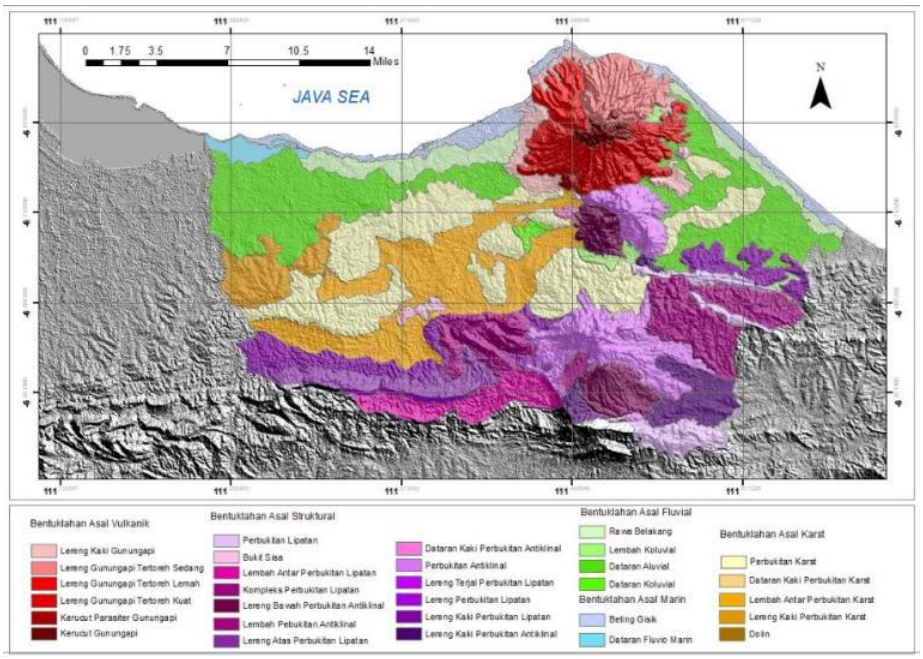

Figure 4. Landforms of Rembang

In addition to structural landforms, contained in Rembang is the origin of solutional landforms. Material constituent solutional landform form of marl, limestone and mudstone. Solutional landform is in the Central part of Rembang. Landforms contained in Rembang form karst hills, the foothills of the karst plateau, karst valleys between the hills, and doline. One of karst landforms such as doline formed at the basin in the karst region. Notching the form of the basin was gradually filled by rainwater.

Doline formations that looked at the ground in the form of the lake which is located between karst hills. Limestone material is a material that is susceptible to dilution so as to form a basin-shaped natural configuration.

Fluvial landforms origin affected by the presence of the river that flows in Rembang. Stream-flow patterns can reflect the constituent material of an area. Dendritic stream pattern is controlled by a homogeneous rock lithology. Composing materials on fluvial landforms in the form of material colluvium and alluvium. Colluvium material derived from the results of sedimentation by rivers flowing in hilly areas. Alluvium material is a material derived from a sedimentary deposit of material that flows in the lowlands. Trellis-shaped flow pattern is controlled by the geological structure in the form of synclinal and anticlinal folding.

4.2. Land Capability of Rembang

The Land capability classification is process to evaluate arable and non arable lands for limitations or hazards for sustain usage using soil characteristics (AbdelRahman et al. 2015). Land capability analysis allows identifying the main limiting factors are erosion (e), wetness (w), soil rooting inhibitors (s), and climate (c) (Sartohadi 2012). Objectives of land capability study enables decision makers to develop crop managements able to increase the land productivity (AbdelRahman et al. 2015). Production could be met through formulating land use plans which were economically viable, socially acceptable, and environmentally sound (Satish and Niranjana, 2010). Land capability has eight classes. Land capability class I, II, and III are considered suitable for croplands, class IV for haylands, and class V, VI, VII, and VIII for limited use (AbdelRahman et al. 2015).

The moderately dissected of volcano slope (IV-b) occupy more than 20% of the area in this study (Table 2). The major limiting factor was gravel/rock. These area not suitable for agriculture due to moderately steep slope, 10-50% outcrops, and slighty soil depth (Figure 5). Agricultural land just being in the mountains valley with gently sloping.

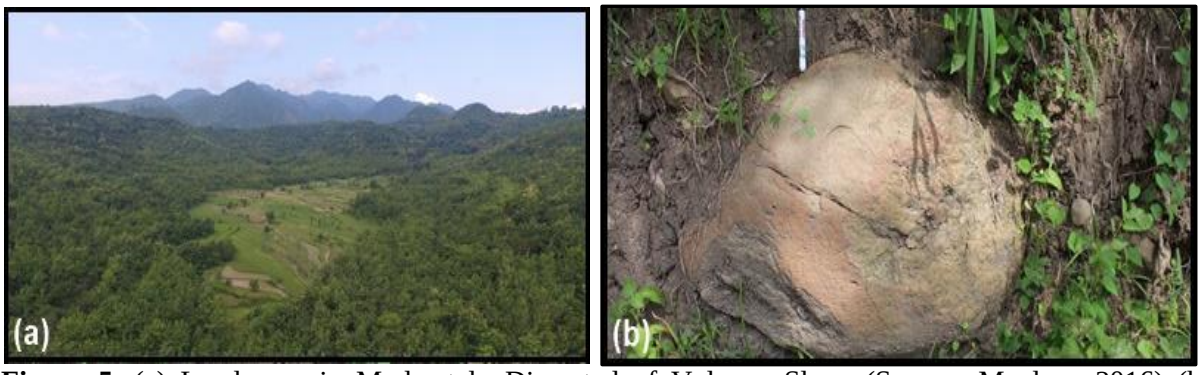

Figure 5. (a) Landscape in Moderately Dissected of Volcano Slope (Source: Maulana 2016) (b) Andesite Outcrops in Land (Source: Maulana 2016)

The slightly dissected of volcano slope has land capability class III-L. It's directed as cultivation area. The main limiting factor was landslides. Landslides can be managed with appropiate conservation in slightly dissected of volcano slope. Land use in this area directed for secondary crops, agriculture, protected forest or nature reserves, production forests, and pastures.The most narrow land capability class was beach ridges in Sluke District (II-Olkd). The area occupy 2,19%. The limiting factors were flood, slope, soil depth, and drainage. The area has sandy loam texture so that infiltration capability is being and able for croplands.

Tabel 2. Land Capability in parts of Rembang District

Landform	Land capability	Limiting Factor	Land capability subclass	Area (m^2)	Percentage (%)
Fluvio marine plain	V	Permeability	V-P	8914416,11	6,95
Moderately dissected of volcano slope	IV	Gravel/rock	IV-b	28530476,58	22,25
Slightly dissected of volcano slope	IIII	Landslide	III-L	15731655,37	12,27
Backswamp	III	Top soil texture; Bottom soil texture	III-tbta	40107631,95	31,27
Volcano foot slope	II	Slope; Drainage	II-Id	3981530,46	3,10
Beach ridges	II	Flood; Slope; Drainage	II-Old	16644517,09	12,98
Beach ridges	II	Flood; Slope; Soil depth; Drainage	II-Olkd	2810821,12	2,19
Beach ridges	III	Top soil texture; Bottom soil texture	III-tbta	11528019,23	8,99

Source: Analysis (2016)

The study area has four land capabilty classes and eight land capability subclasses. Up to now the criteria that are taken into consideration in the land capability classification are topography especially inclination of slope and soil properties, in general. But, in a mountainous country or regions topographic-geomorphic units, climate and parent material are factors that must be taken into consideration in order to establish land capability classification (Atalay 2016), included in Rembang. Landforms in Rembang District affected by North Java Sea and Lasem Volcano. Tropical climate in Rembang forms a suitable environment for the growth of miscellaneous vegetation, especially for croplands.

Land capability class II-Old located in beach ridges specifically inactive ridges. There are general relationships among the geomorphic units and land class in plains (Atalay 2016), included in beach ridges landform. Characteristics of beach ridges were gently sloping, silty clay texture in up and bottom soil layers, platy soil structure, and soil depth more than 90 cm. These characteristics enable moderate drainage and permeability so suitable for croplands or fishponds but still has moderate limitations that restrict the choice of plants. Land use existing in beach ridges is settlements, fishponds, and croplands (Figure 6). These was according to a statemant from Verstappen (2013)that beach ridges generally used for settlements and yards. Based on land characteristic and land capability, beach ridges (II-Old) directed as cultivation area. However, land utilization should be able to overcome the limiting factors, such as flood, slope, and drainage. It's asses to sustainable usage.

Figure 6. Land use existing in beach ridges (II-Old) (Source: Maulana 2016)

Backswamp class III-tbta located in west and east of Rembang plain. Sandy loam texture with moderate drainage in these area due to paddy crops. Conservation land in irrigation management also should be done to overcome soil limitations and against land degradation in future.Land capability class V-P located in fluvio-marine plain which combination of marine an fluvial origin. Sediment materials comes from sea and rivers so it has clay texture. Class V are subject to little erosion but has pemeability limitation. It generally unsuitable for cultivation so land use existing is fishponds and salt ponds (Figure 7).

Figure 7. Salt Ponds in Fluvio Marine Plain(Source: Maulana 2016)

Beach ridges and backswap in east of Rembang District include land capability class III. It's directed as cultivation area. The main limiting factor was soil texture and soil depth. Types of vegetation should be selected appropriately considering the area is quite close with North Java Sea. Land use in this area directed for secondary crops, agriculture, protected forest or nature reserves, production forests, and pastures.

5. Conclusions and Recommendations

Information of landforms have a very close relationship with the land characteristics.Landform analysis was used to analyze the land capability in Rembang. Based on the interpretation of visual and manual detection is known that Rembang dominated by alluvial plain and volcanic slopelandforms. The analysis showed that the majority of Rembang coastal area have land capability class II till V. The limitation factor consists of permeability, gravel / rock, landslide, top soil texture, bottom soil texture, slope; drainage, flood and soil depth. The most dominant area is backswamp with the land capability class III-tbta. The area is 40,107,631.95 m^2, or equivalent to 31.27% of the total area of the study. Land capability in Rembang can be maximized by well spatial planning and land conservation. It is the best solution for reducing land degradation in Rembang.

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