

Land Capability Evaluation for Agriculture in Krueng Sieumpo Watershed, Aceh

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ABSTRACT

Land utilization especially land in watershed should be based on land capability. Land capability should be classified based on their potential for general agricultural utilization without causing damage in the long term. Land utilization in Krueng Sieumpo watershed should be based on its land capability. This research was conducted in Krueng Sieumpo watershed Aceh Indonesia that located on 96°40'00"-96°50'10" E and 04°52'20"-05°07'40" N in June-December 2013. Land capability class in this location were grade II (3.35%), III (33.26%), IV (25.07%), VI (30.78%) and VII (7.53%), with dominant limiting factors were slope (l), erosion hazard (e), rocks (b), and permeability (p).

Keywords: Land capability, Limiting factors, Agriculture

INTRODUCTION

Soil and water are the most important resources in the watershed which is intended for human activity (Badaruddin, et.al, 2013). One form of land use by humans is in agriculture, wherein Land use for agriculture can be optimally by adjusting land use to land capability (Oluwatosin et al., 2006). Land use must be in accordance with the terms of the required, so that the soil can function properly without reducing fertility (Lin et al, 2012).

The increase in the number of people accompanied by the increase in the economic needs, especially for the benefit of agriculture, makes a pressure rate on land resources inevitable that causes an impact on the land degradation and the environmental pollution (Lu et al., 2008). To be able to utilize the land resources in a focused and efficient, are require appropriate technology to optimize land (Shekinah et al, 2004), complete information on climatic conditions, biophysical soil properties, as well as the growing requirements of the plants to be cultivated, especially the plants that have economic value (Saida et al, 2013).

Land basically has different abilities to support a spesific use. To determine the ability of an area it is necessary to conduct land capability classification. Land capability classification is land valuation with the systematic components and grouping into categories based on nature of which is the potential and constraints in its use of sustainable (Arsyad, 2010). Land classified on the basis of a physical constraints and other potential hazards that could interfere with plant growth. Thus, the results of this classification can be used to determine the general direction of land use such as for cultivation of seasonal crops, plantations, forest production, etc (Samranpong et al, 2009). On determining land capability class, the nature and the limiting factor are used that determines whether or not the soil is easily processed if the land is used as an agricultural business (Kusumaseta, 1987). Nature of the land and limiting factors that influence the ability of land in one place can be influenced by rock , climate , soil, land form, length and slope and processes at work in the land (Hardjowigeno and Widiatmaka, 2007).

Krueng Sieumpo watershed located in three districts, most of its territory located in Bireuen District has high potential of land especially for agriculture. Potential of existing land when there is no special attention will forever be a potential output, that is, not important and beneficial product. But now that potential has not been optimally arranged, therefore there is no outstanding contribution. Therefore, for the expectation to be realized, it requires an effort in order to know for certain about the potential of Krueng Sieumpo watershed by determine the ability of land as well as how land suitability can be modified so as to produce the maximum production.

Krueng Sieumpo watershed landscape largely hills and mountains shaped with slopes sufficient conditions varied. Seeing the potential of that land is good enough for a variety of pupose, e.g for settlements, agricultural, livestock, irrigation, should be based on an evaluation of land capability and land suitability. so that land use in the region can be classified according to their proper use. Therefore, evaluation of the ability in Krueng Sieumpo watershed needs to be done, so that Krueng Sieumpo watershed land use can be adapted to land capability. Thus, land degradation can be minimized and land use is sustained. This study aimed to evaluate land capability in Krueng Sieumpo watershed that use as agricultural cultivation land.

RESEARCH METHODS

Sources and Data Collection Techniques

Observations and data retrieval of soil properties for land capability evaluation performed on each of land units. Land units formed from overlay between soil type maps, slope maps and land use maps (Alesheikh et.al, 2008). Soil properties and land use in land capabilities evaluation include physical properties and morphology of the land and that can be directly observed in the field and soil analysis results in the laboratory.

Land capability classes based on its potential for general agriculture without causing any damage in the long term (Arsyad, 2010). Physical and morphological properties were observed for the grade level is slope, erosion sensitivity, soil solum, soil texture, permeability, drainage, presence of rocks on the surface, the threat of flooding and salinity or sodium content. For the division of the sub-class, it is observed: the threat of erosion (e), or excess drainage water conditions or the threat of flooding (w), root zones barriers (s), and climatic barriers (c) (Arsyad, 2010).

Data Analysis

Land capability classification used is the system of the United States Department of Agriculture (USDA), which is expressed in Agricultural Handbook No. 210 (Klingebiel and Montgomery, 1961 in Arsyad, 2010). The classification of land capability made up to subclass category. Grouping in to class based on the intensity of the inhibiting factors. Land grouped in eight classes, namely class I to VIII. The threat of damage or resistance increased successively from class I to VIII. Land on class I to IV with good management and is able to generate suitable for a variety of uses. Land on the class V, VI, and VII according to pasture, plant trees or natural vegetation. Class of VIII land should be left in its natural state (Hardjowigeno and Widiatmaka, 2007).

Limiting or threat caused by erosion, excess water, limiting root development (depth of soil, rocks on the surface, low water holding capacity, salinity, or salt content), which can be changed or partially mitigated and are limitations on the precedence of the climate in determining the subclass, and subclass marks given e, w or s. Lands with no limiting except

climate characterized by subclass c. Land capability classification matrix criteria presented in Table 1.

Table 1. Matrix Criteria of land capability class

No	Limiting Factors	Land Capability Class							
		I	II	III	IV	V	VI	VII	VIII
1	Surface slopes (l)	0	1	2	3	0	4	5	6
2	Erosion level (e)	0	1	2	3	(**)	4	5	(*)
3	Soil solum (k)	0	0	1	2	(*)	3	(*)	(*)
4	Texture of the top layer (t)	1-3	1-3	1-4	1-4	(*)	1-4	1-4	5
5	Texture of the bottom layer (t)	1-3	1-3	1-4	1-4	(*)	1-4	1-4	5
6	Permeability (p)	2-3	2-3	2-3	2-3	1	(*)	(*)	5
7	Drainage (d)	1	2	3	4	5	(**)	(**)	0
8	Rocks (b)	0	0	1	2	3	(*)	(*)	4
9	Flooding hazards (o)	0	1	2	3	4	(**)	(**)	(*)
10	Salinity (***)	0	1	2	3	(**)	4	(*)	(*)

Source: Arsyad (2010); Description: (*): Can have any properties; (**): Not applicable; (***): Commonly found in dry climates

RESULTS AND DISCUSSION

Land Units In Krueng Sieumpo Watershed

Land unit is a unit of lands that has similar characteristics. In this study, land unit was formed based on common land slope, soil type, and land use. Results overlay map soil type, slope maps and map use in Krueng Sieumpo watershed acquired 24 land units. There are 11 units of land in Krueng Sieumpo watershed used for agricultural cultivation, which consists of: the moor (4 land units), non irrigated rice (1 land unit) and mixed farms (12 land units). Whereas two other land units used in non-agricultural land use such as forests and grasslands. Soil types in Krueng Sieumpo watershed consists of Alfisol, Entisol, Inceptisol and Ultisol. Slope is declivous to steep.

Physical Characteristics of Land in Krueng Sieumpo Watershed

The physical characteristics of the land in Krueng Sieumpo Watershed include slope, erosion sensitivity, soil solum, soil texture, permeability, drainage, presence of rocks on the surface, and exposed rocks. The results of the field observations and laboratory analysis are presented in Table 2.

Table 2. Physical and morphological land characteristics of Krueng Sieumpo watershed

No	Land Unit	Slope (%)	Permeability	Soil Solum (cm)	Soil Texture	Flooding	Rocks	Erosion Level	Exposed Rocks	Drainage
1	24	Strongly Steep	Few fast	Depth	Medium	None	None	None	None	Good
2	1	Strongly sloping	Medium	Depth	Few fine	None	None	None	None	Good
3	17	Strongly sloping	Medium	Depth	Few fine	None	None	Slight	None	Good
4	20	Steep	Few slow	Depth	Fine	None	None	Medium	None	Good
5	23	Strongly Steep	Medium	Depth	Fine	None	None	Medium	None	Good
6	18	Strongly sloping	Medium	Depth	Fine	None	None	Medium	None	Good
7	3	Gentle/declivous	Medium	Medium	Fine	None	None	Medium	None	Good
8	2	Strongly sloping	Few fast	Medium	Fine	None	None	Slight	None	Good
9	4	Gentle/declivous	Medium	Depth	Fine	None	None	None	None	Good
10	9	Strongly sloping	Medium	Depth	Fine	None	None	Slight	None	Good
11	15	Sloping	Medium	Medium	Medium	None	None	Medium	None	Good
12	21	Sloping	Few slow	Depth	Fine	None	None	Medium	None	Good
13	7	Sloping	Few slow	Depth	Fine	None	None	Slight	None	Good
14	5	Moderately sloping	Medium	Depth	Few fine	None	Slightly	Medium	None	Good
15	16	Sloping	Fast	Depth	Fine	None	tidak ada	Slight	None	Good
16	22	Steep	Few fast	Depth	Few fine	None	tidak ada	Medium	None	Good
17	19	Moderately sloping	Medium	Depth	Fine	None	tidak ada	Medium	None	Good
18	14	Moderately sloping	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good
19	8	Moderately sloping	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good
20	11	Gentle/declivous	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good
21	10	Moderately sloping	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good
22	12	Moderately sloping	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good
23	13	Sloping	Medium	Depth	Fine	None	tidak ada	Medium	None	Good
24	6	Sloping	Medium	Depth	Few fine	None	tidak ada	Medium	None	Good

Source: field survey data

Slope on Krueng Sieumpo watershed are between gentle, sloping, moderately sloping, hilly, Strongly sloping, and steep. The slope of the land affects the erosion that occurs. The more

oblique the slope, the greater erosion is (Satriawan and Harahap , 2013) . This can be seen in the parameters of erosion rate. Erosion in Krueng Sieumpo watershed range from none, slight dan medium.

Effective soil depth is the depth of good soil for the growth of plant roots, that is until the layers cannot be penetrated by plant roots. Effective soil depth found in Krueng Sieumpo watershed is from medium (80-90 cm) to depth (> 90-175 cm). Soil depth greatly affects the development of plant roots . The development of plant roots determine the productivity of crops.

Soil texture is the relative comparison between the fraction of sand, silt and clay. Soil texture in Krueng Sieumpo watershed quite varied; medium, few fine and fine. Medium -textured soils include clay. Rather fine texture soils are clay loam, and fine texture is sandy clay.

The permeability of the soil in Krueng Sieumpo watershed includes the range from medium, few slow, few fast and fast. The rates are: few slow category, the permeability is 0.5 to 2.0 cm/hr, medium category is 2.0 to 6.25 cm /hr, few fast category is 6.25 to 12.5 cm/hr, and fast categories with > 12.5 cm /hr. Soil drainage of land in Krueng Sieumpo watershed classified as good. Good drainage means that the soil has good air circulation. The whole land from top to bottom brightly colored uniform and there are no patches of yellow, brown or gray.

The rock on the surface is rough or small rock materials diameter 7.5 cm to 25 cm if a round, or long axis measuring 15 cm to 40 cm if shaped depressed (Wright et al, 2006). The abundance of small rocks on the surface of the soil in the study area is none to slightly, and has no effect on the treatment of soil and crop growth. The rocks outcrop is a small portion of the rock that appears on the surface and most are found in the soil (Bibby et al, 1991). There is no outcrop in Krueng Sieumpo watershed, meaning that less than 2% of the land surface covered by rocks that appear on the surface of the ground.

Land Capability Classification in Krueng Sieumpo Watershed

Based on the physical and morphology characteristics of the land presented in Table 2, and the matrix of the criteria from the USDA land capability classification modified (Arsyad, 2010) in table 1, the land in Krueng Sieumpo watershed are included in the category of classes II, III, IV, VI, and VII, with the limiting factor permeability (p), the slope (l), the threat of the occurrence of erosion (e) and the rock surface (b). Land capability classification for each land unit are presented in Table 3 and Figure 1.

Land capability class II in Krueng Sieumpo watershed is a gently slope (3-8 %), permeability is (2.0 to 6.25 cm /hr) , and the depth is - in (80-115 cm). Land capability class II suitable for a wide range of uses, including use for seasonal crops, annual crops, pasture, forest production, etc. Therefore, when applied to agricultural crops each season, in order the land is not damage, it requires a light soil conservation actions such as the addition of organic matter to improve water binding capacity , mulch and mound ducts. Land area for class II in Krueng Sieumpo watershed is 1048.9 ha (3.35 %).

Land capability Class III is located on land that slopes with a slope slightly sloping or undulating (8-15 %), soil depth is (85-125 cm). These are sensitive to erosion or erosion experienced mild-moderate, and surface rocks lightly. Land capability class III is suitable for crop farming season, annual crops, pasture, forest production, or protected forests. If used for agriculture, so as not damage and loss of hydrological function, then require pretty heavy conservation action by manufacturing mound ducts, addition of organic matter, no tillage, minimum tillage or a combination of vegetative method.

Table 3. Land capability class, subclass and area of land in Krueng Sieumpo watershed

Class	Subclass	Area (ha)	Percentage (%)
II	IIp	1048.9	3.35
	III 1	6597	21.08
III	III 1,e	3758.2	12.01
	III 1,e,b	53.9	0.17
	IV 1	1928.2	6.16
IV	IV 1,e	5915.9	18.91
VI	VI 1,e	9631.7	30.78
VII	VII 1	2356.5	7.53
	Total	31.290,3	100

The data in Table 3 shows the total area of land class III in Krueng Sieumpo watershed is 10.409,1 ha (33.27 %). Class III with slopes limiting factor (1) (subclass III 1) is 6597 ha, land with slopes and erosion limiting factors (subclass III 1 , e) are 3758.2 ha, and land with a limiting factor slopes, erosion and rock (subclass III 1 , e , b) measured as 53.9 ha.

Land capability class IV is located on the slopes gently sloping or hilly (15-30 %), and medium depth soil (80-90 cm), has experienced erosion are (50% of the top layer has been lost). Land capability class IV can used for seasonal crops, annual crops with good ground cover, pasture, forest production, or protected forests. If applied to the crop season, to avoid damage and loss of soil function, so that conservation action is required as heavy as the core manufacturing benches, individuals benches, rorak, and a combination of several methods such as vegetative ground for cover crop. Land area for class IV in Krueng Sieumpo watershed is 7844.1 ha (25.07 %), the limiting factor is the slope and erosion (subclass IV 1, e).

Class VI is located on the land which has steep slopes (35-45 %), and has experienced erosion are (50% of the top layer). Land capability classes VI unsuitable for seasonal crops, but according to an annual crop with good ground cover plants, intensive grasslands, forest production, or protected forests. When solum in soil can be used for production of seasonal and annual crop plants, with heavy erosion prevention methods such as core manufacturing bench and a combination of vegetative methods such as mixed cropping/agroforestry. Land area for class VI in Krueng Sieumpo watershed is 9631.7 ha (30.78 %), the limiting factor is the slope and erosion (subclass VI 1, e). Land with capability class VII is located on strongly steep slopes (50-60 %), and soil depth are (90-175 cm). Land capability class VII unsuitable for agricultural crops, but can be used for pasture, limited production forest in the prevention of erosion, and the best allocation is protected forest or nature reserve. Land area for class VII in Krueng Sieumpo watershed is 2356.5 (7.53%) ha, the limiting factor is the slope (subclass VII 1) .

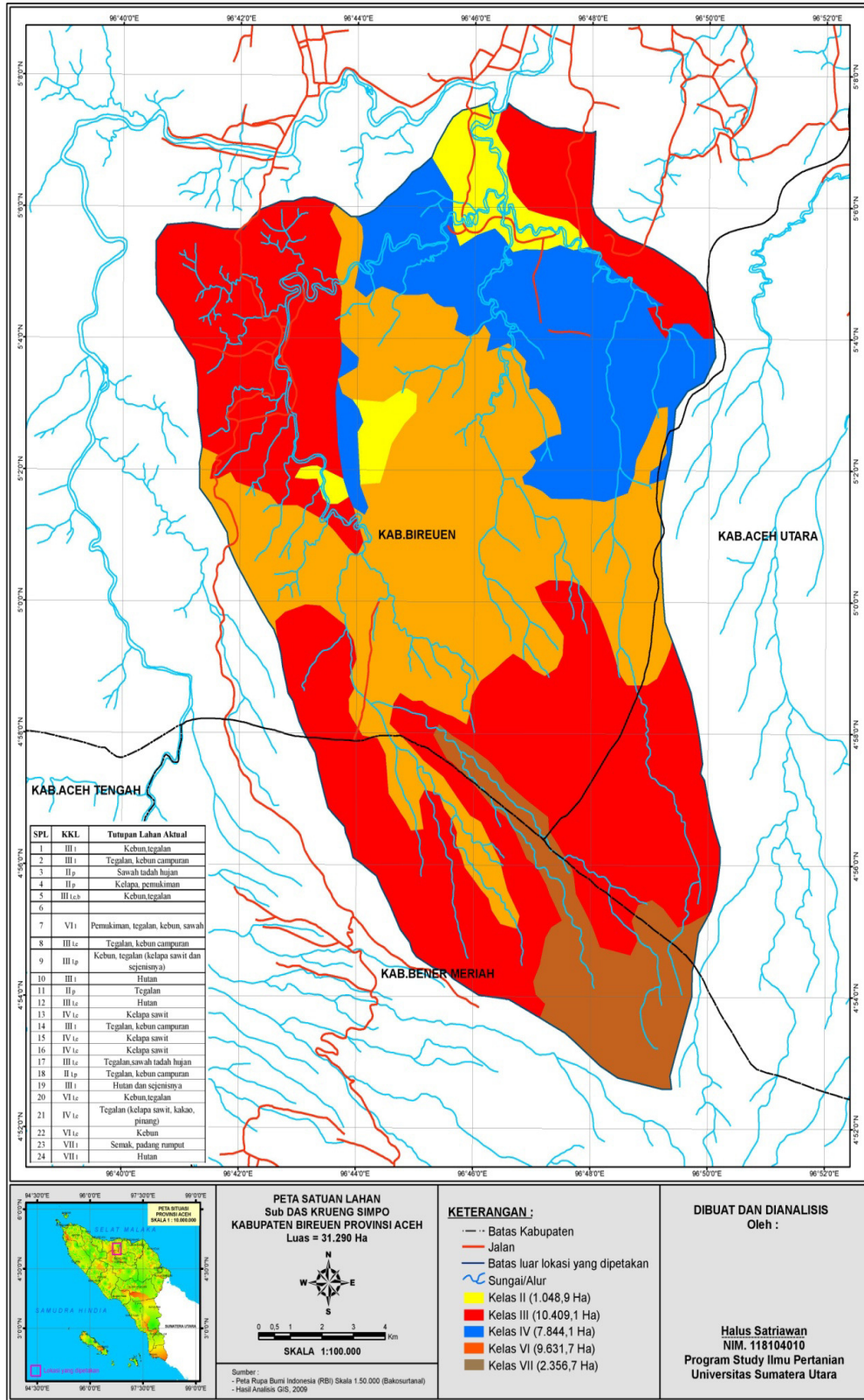


Figure 1. Land capability class and area of land in Krueng Sieumpo watershed

Table 4. Suitability classification of land use in each land capability class and land use direction in each land unit

Land Unit	Class	Limiting Factor	Area (ha)	Actual land use	Suitable/Not	Direction of land use/management
3, 4, 11	II	p	1005	rainfed rice fields, coconut gardens, moor, forest	Suitable	Addition of organic matter to improve water binding capacity, mound ducts
1, 2, 5, 8, 9, 10, 12, 14, 17, 18	III	l, e, b	10409.1	moor, mixed farms, forests	Suitable	Mound ducts, addition of organic materials, no-tillage or a combination of the methods of vegetative
6, 13, 15, 16, 21	IV	l, e	7844.1	garden, moor, rainfed	Suitable	terracing/mound/lorak, cover crops
20, 22	VI	l, e	9631.7	Garden, moor	Not Suitable	Agro forestry
23, 24	VI	l	2356.5	forest, shrub	Suitable	Maintaining the current land use

CONCLUSION

Land capability classes in Krueng Sieumpo watershed consists of five classes . Land capability class II has a permeability limiting factor (subclass PII). Land capability class III has a slope limiting factor (subclass III 1), slope and erosion limiting factor (subclass III 1 , e), and slopes, erosion hazard and rocks limiting factors (subclass III 1 , e , b). Land capability class IV has a slope limiting factor (subclass IV 1), slope and erosion hazard (subclass IV 1 , e). Land capability class VI has a limiting factor slope and erosion hazard (subclass VI l,e). Land capability class VII has a slope limiting factor (subclass VII 1) .

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