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Planning For Land Use Based on Sustainable Agriculture in the Krueng Peutoe, (Watershed) North Aceh Regency, and Aceh Province

Halim Akbar[1], Kukuh Murtilaksono[2], Iskandar[2]
[1]Program study Agroecotechnology, Faculty of Agriculture, University of Malikussaleh.
[2]Department of Soil and Land Resources, Faculty of Agriculture, Bogor Agricultural University

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ABSTRACT
The Krueng Peutoe watershed located in North Aceh district is one of the sub-watersheds of the Jambo Aye watershed. The purpose of this study is to develop a plan for sustainable agricultural land use in the Krueng Peutoe watershed. The method used consists of 1) overlay map, 2) field survey, 3) evaluation of land capability, 4) evaluation of cropping and agrotechnology patterns, 5) erosion prediction, 6) socioeconomic analysis, and 7) cropping and agrotechnology recommendation. The results showed that, evaluation of land capability classification (KKL) II with slope limiting factor be discocered inhomogeneous land units (SLH) 15 and 10, KKL III with slope limiting and erosion factors at SLH 16, slope limiting factor at SLH 1, 5, 9, and 12. KKL VI with slope limits factors in SLH 3, 4, 6, 7, 8, 14, and KKL VII with slope limiting factors in SLH 17. The results of erosion prediction in mixed gardens were 14.56 - 403.82 tons/ha/year and greater than tolerance erosion (ETol) (23.03 - 39.60 tons/ha/year), resulting in a decrease in land productivity where farmers' income ranges from 754,000 IDR - 7,434,000 IDR/KK/year. With the improvement of cropping patterns followed by agrotechnology and the addition of side businesses (the results of calculations), there was a decrease in the value of erosion to 1.09-30.28 tons/ha/year followed by an increase in farmer's income (10,267,200 IDR - 12,441,060 IDR/KK/year). The result of planting pattern recommendation as follows: KKL II and III need to be worked improvement of planting pattern and agrotechnology. KKL VI carried out the application of agrotechnology with the planting of terrace reinforcing plants and planting according to contour. The use of forest land in the same class is recommended nonetheless as a forest, while the use of land for shrubs in the same class is recommended for pasture.

Keywords: land capability, land use, sustainable, watershed, agrotechnology

Correspondance:
Halim Akbar
Program study Agroecotechnology,
Faculty of Agriculture,
University of Malikussaleh.
Email id : halim@unimal.ac.id

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INTRODUCTION

Utilization of forest, land, and water natural resources is one of the basic assets of national development that must be planned base on the principle of sustainability and national benefits. Any development related to natural resource management needs to be planned appropriately and directed in watershed units (watershed). Currently, almost all parts of the watershed in Indonesia are used for agricultural land, plantations, fisheries, settlements, irrigation and exploitation of forest products, some of these land uses do not follow. The rules of soil and water conservation, causing land damage (land degradation). In addition, if the inappropriate management not addressed, the increase in the area of critical land will continue to increase. According to Baharsja (1994) in Sinukaban (2001), currently unproductive land area is estimated to have reached 38 million hectares or 20% of the land area of Indonesia. Judging from the condition of watershed in different regions also tends to deteriorate and the order of balance from year to year is increasing concern. Sustainable farming is a farming system that is not destructive, does not alter, harmonize, align, and balance with the environment (Salikin, 2003). so that if managed properly in a watershed, the availability of water sources and river discharges will be sufficient in the dry season and not excessive river flow (flooding) during the rainy season (Hadisuparto, 1998). Watershed Krueng Peutoe with an area of 21,283 ha, land use consisting of 729 ha settlements, 11,620 ha mixed plantations, 4,294 ha plantations, 2,653 ha primary forests and 1,987 ha shrubs (watershed Krueng Aceh, 2004). The area of critical land in the Krueng Peutoe watershed is currently 2,700 ha (Distan Aceh Utara, 2005). This can be seen from the habits of local people who are still using their land, not by their abilities, namely still using land continuously (without fallow), shifting cultivation, leaving open land without vegetation or without planting any plants on it and cutting down forests in the area upstream. This is one of the causes of land degradation (formation of critical land).

It is one of the causes of land degradation (formation of critical land). Based on the results of the recapitulation of the poor family in North Aceh Regency, the percentage of poor families 44.75%, while in the location of a poor KK Krueng Peutoe at the amount of 1,815 KK (27.9%) (BPS Aceh Utara, 2005). Several actors because poverty is caused by low land productivity, narrow agricultural land, low prices of agricultural products and employment opportunities outside of farming or income outside of farming is very limited (Sinukaban, 2001). Based on these conditions, it is necessary to set up land use planning based on the ability of environmentally sound land and revenue equality, so that the natural resources at watershed Krueng Peutoe can be maintained sustainably. The research aims to develop a sustainable land-use plan for the field at WATERSHED Krueng Peutoe.

MATERIALS AND METHODS

Place of Research

This research iss conducted in the Krueng Peutoe watershed, which is one of the Jambo Aye sub-watersheds located in North Aceh Regency, Aceh Province. The research location is 38 km from the district capital of North Aceh. The material used in this study is primary data and secondary data. Primary data used are physical data from measurements in the field and socioeconomic data. The secondary data used is the 10 annual rainfall data from the

station BMKG Malikussaleh 2005, North Aceh district data in figures, earth scale map of scale 1 50,000 (Bakosurtanal, 1978), map of soil types and land use (Distan Aceh Utara, 2005). The equipment used in this study is a working map (overlay map), ground drill, Abney level, compass, sample ring, knife, hoe, meter, plastic bag, writing stationery, label paper, documentation tools, and GPS.

RESEARCH METHODS

The research method used in this study is a survey method, while the stages of analysis in preparing land use planning consist of (1) evaluation of land capability, (2) erosion prediction, and determination of ETol, (3) analysis of farming and (4) planning alternative land uses.

Land Ability Evaluation.

Evaluation of land capability is carried out based on the land capability classification criteria proposed by Klingebiel and Montgomery (1973) modified by Arsyad (2000) Erosion

Prediction and ETol

Determination. Erosion prediction is calculated by the USLE equation (Wischmeier and Smith, 1978) as follows

$$A = R \times K \times L \times S \times C \times P$$

Where A magnitude of erosion (ton\/ha\/year), R rainfall erosivity index, K soil erosiveness factors, L factor long Slope (m), S slope inclination factor (%), C crop management factor, P conservation action factor

$$A < ETol \rightarrow RKLSCP < Etol$$

$$CP \leq \frac{ETol}{RKL} \rightarrow CP_{rek} < CP_{max}$$

Untolerated erosion (ETol) erosion that can be tolerated based on Hammer approach (1981).

$$ETol = \frac{DE - Dmin}{UGT} + LPT$$

where erosion tolerable ETol (mm/yr), DE equivalent depth De x fd, De effective soil depth (mm), fd soil depth factor according to sub-order soil, minimum minimum soil depth suitable for plants (mm), age UGT land use (years), LPT soil formation rate (mm / yr).

Farming analysis.

Farming analysis uses three variables, namely the acceptance of farming, farming costs and income ventures. The minimum standard of physical needs and decent living is determined based on the need for rice per head of household (KK) and the price of rice that prevails in an area. The threshold value of food sufficiency (rice) for the level of household expenditure in rural areas ranges from 240 - 320 kg/person/year, while in urban areas it ranges from 360 - 480 kg/person/year (Sajogyo, 1990)

Alternative Land Use Planning

Land use planning is determined using CP values (plant and soil management factors) where the criteria for setting the maximum CP to be recommended are carried out using the following approach

RESULTS AND DISCUSSION

Homogeneous Land Unit Overlay results of overlapping land use maps, topographic maps and maps of soil types obtained 17 homogeneous land units (Table 1).

Tabel 1. Luas Satuan Lahan Homogen pada Masing-masing Penggunaan Lahan Di WATERSHED Krueng Peutoe

No.	Land Unit Use	Homogeneous (SLH)	Luas Ha	Luas %
1.	Mixed Gardens	14, 15, 16, 17	11.620	56,5
2.	Plantation	08, 09, 10, 12	4.294	20,9
3.	Shrubs	06, 07	1.987	9,7
4.	Forest	01, 03, 04, 05	2.653	12,9
	Total		20.554	100,

Resource: Result overlay Peta, 2015.

Land use

Land use at watersheld Krueng Peutoe is generally almst uniform, which is an annual plant that is overgrown with food crops and horticultural crops, except the use of land for plantations (oil palm) that Monoultures (table 2).

The results of the assessment of the conformity of land use at watershed Krueng Peutoe for a variety of
land use by guiding the land capacity class according to Klingebiel and Montgomery (1973 in Arsyad 2000), at research site acquired land capacity class II, III, VI and VII with the main barrier factor in the form of slopes (l), and erosion (e). The land-ability class for mixed-land use is found in class II, III, VI and VII, for plantation uses found in class II, III and VI, for the use of bushland found in class VI and for forest land use Found in class III and VI.

Planting Pattern Evaluation

The results of observations in the field, the planting pattern applied by farmers is as seen in table 3.

Table 2. Actual planting pattern in mixed garden and plantation in an intensive observation site at watershed Krueng Peutoe.

No.	SLH	cropping pattern	KPT
		Mixed garden	
1.	14, 15 and 17	Anual Plants and Panga Pangan	A
2.	16	Rice and Food Plants	B
3.	8, 9, 10, 12	Annual plant	C
		Shrub	
4.	6, 7	Taller and erect trees	D
		Forest	
5.	1, 3, 4, 5	Natural forest	E

Description : KPT = code Type of Plant ; SLH = Land unit Homogen

Erosion Prediction

Results of erosion and erosion prediction that can be tolerated in each homogeneous unit of landcan be seen in table 3.

Table 3. Erosion and ETol predictions on actual land use and planting patterns at WATERSHED Krueng Peutoe

No.	SLH	Pola Tanam	KPT	A (Ton/ha/year)	ETol (Ton/ha/year)	
		Mixed garden	1. 14, 15 dan 17	Annual plants and Food crops	A	14,56-403,82 23,03-39,60
2.	16 99	Rice and food crops,	B	88	36,31	
		Plantation				
3.	8, 9, 10, 12	Annual plants Shrubs	C	2,91-315,37	26,26-38,15	
4.	6, 7	Saplings and tree stands	D	137,63-180,76	29,38-43,63	
		forest				
5.	1, 3, 4, 5	natural forest	E	0,54-1,47	13,87-32,00	

Table 4 shows that the result of erosion prediction (A) on the pitch is greater than the value of the erosion that can be tolerated (ETol). The erosion prediction value is greater than the value of ETol due to land use not accompanied by

soil conservation techniques such as crop rotation, the use of land cover crops or green manure, minimum soil treatment, use of Mulch or a combination of these conservation techniques. It is necessary to change the planting pattern and
application of alternative agrotechnology to minimize the value of the erosion prediction that will occur

Cost and revenue analysis of Farmer's business
The cost and income analysis were done on this research is specialized in the mixed garden planting patterns. As for the calculation of farming, income is assumed for each family that, the consists of 5 people (father, mothers and 3 children) can be fulfilled, if having net income equal to 9.6 million IDR/kk/year (320 kg/person/year x 2.5 (the value of multiplier Factor index) x 5 persons X 2,400 IDR (rice prices at present at the research site) = 9.600.000 IDR/kk/year). The result of the analysis of the cost and income of farmers for the actual cropping pattern in mixed gardens is to see in table 5.

Table 4. Analysis result on cost and income of farming for actual planting pattern of mixed garden at WATERSHED Krueng Peutoe

SLH	KKL	KPT	Gross income (IDR/KK/year)			Total	Net
			lives stock	Other business	ventures Animal check	(IDR/KK/ha/thn)	(IDR/KK/ha/tyear)
14	VI	A_1	5.775.000	2.962.000	1.350.000	4.949.000	5.138.000
15	II	A_2	7.925.000	3.137.000	1.650.000	5.073.000	7.639.000
17	VII	A_3	5.450.000	-	-	3.349.000	2.101.000
16	III	B_1	3.150.000	-	1.450.000	3.846.000	754.000

Description
SLH: homogeneous land unit; KKL: Land capacity class; KPT: Planting pattern Code; A1: Pinang + chili-soy beans + chicken cattle business + other ventures; A2: Cocoa + soy beans-chilli + chicken cattle business + other ventures; A3: Pinang + cocoa + peanut; B1: Rice + corn-soy beans/long beans + other ventures; (+) Intercropping, (/) overlapping, (-) overlap The average net income of farmers for the management of mixed plantation with a one-hectare area is 754,000 IDR to 7,639,000 IDR/kk/ha/year. While the average cost of farmers incurred annually is 3,349,000 IDR to 5,073,000 IDR/kk/ha/year. The highest net income gained by farmers is on SLH 15 with the planting pattern A2 (cocoa + soy beans-chilli) amounting to 7,639,000 IDR with other side business is the business of chicken cattle coupled with efforts Other results. While the lowest farmer's income is obtained on SLH 16 with planting pattern B1 (rice + corn-soybeans/long beans) amounting to 754,000 IDR, plus the input from another business of 1,450,000 IDR.
Results of financial analysis for alternative planting and agrotechnological patterns that should be applied to the mixed garden so that farmers ' income at the research site increases can be seen in table 6.

Table 5. Result analysis of cost and income for various alternative planting patterns on mixed garden at WATERSHED Krueng Peutoe

SLH	KKL	KPT	Gross income (IDR/KK/Tahun)			Total cost incured	net income
			Planting pattern	livesstock stock	ect	(IDR/KK/ha/thn)	(IDR/KK/ha/thn)
14	VI	A_1	13.100.000	3.137.000	1.350.000	5.145.940	12.441.060
15	II	A_2	9.730.000	8.112.000	3.954.000	8.735.800	13.060.200
17	VII	A_3	9.480.000	5.749.000	4.104.000	7.068.280	12.264.720
16	III	B_1	6.125.000	8.412.000	4.054.000	8.323.800	10.267.200

Description:
A1: Pinang + soy – Kc. Ground + corn/chilli + chicken cattle business + other businesses; A2: Cocoa + Kc. Green – Soy + chilli + business chicken cattle + goats + other ventures; A3: Pinang + cocoa + soy-Kc. Green + Chicken Cattle + other ventures; B1: Gogo rice + corn – corn + eggplant + soy/chilli + chicken cattle + goat + other ventures; (+) Intercropping, (/) overlapping, (-) overlap
Based on the results of the cost and income analysis for various alternative planting patterns in mixed garden is seen that farmers ' income increases when done with the application of several planting patterns such as an intercropping, intercropping or a insert attached to the application of agrotechnology that is by the creation of the porch of *gulud*, the contours according to contour and giving mulch. While the additional efforts that need to be done for the increase of income is with the effort of livestock (chicken and goat) and processing agricultural products such as the manufacture of banana chips, fried beans, fried banana in hopes can support the success of its efforts.

Planting pattern and agrotechnology recommendations
Agrotechnological alternatives are determined by comparing the magnitude of erosion with the value of ETol. The results of erosion prediction are smaller than ETol by simulating the value of C, P or CP so that the best agrotechnological alternatives or land and plant management are obtained. The type and pattern of planting recommended is adjusted to the condition of biophysical (aspect of land conformity), market demand and acceptable to farmers. For that type of plant recommended is the type of plant that has been commonly cultivated in the location (table 6).

Table 6. Recommendations for planting patterns and agrotechnology on the use of mixed plantation in WATERSHED Krueng Peutoe

SLH	Planting pattern	CP	RKLS	A (ton/ha/year)	ETol (ton/ha/year)	A vs ETol	and Agroteknologi
			Mixed Plant				
14	PN+Kedelai - KT+JG/Cabe+M+TG	0,012	310,79	3,73	28,28	<	
15	KK+KH - Kedelai+Cabe+JG+M+TG	0,015	72,78	1,09	39,60	<	
16	PG+JG - JG+TR+Kedelai/Cabe+M+TG	0,021	499,41	10,48	36,31	<	
17	PN+KK+Kedelai-KH+M+TG+PMK	0,015	2.019,11	30,28	23,03	>	
			forest				
8	PN+KK+NG+KLP+M+TG	0,015	630,74	9,46	26,26	<	
9	KK+KP+NG+KLP+M+TG	0,015	346,88	5,20	26,40	<	
10	KS+M+TB	0, 13	29, 05	3, 78	38, 15	<	
12	KK+M+TB	0, 08	265, 55	21, 24	29, 60	<	
			hrub				
6	Pasture	0, 0025	602, 52	1, 51	43, 63	<	
7	Pasture	0, 0025	458, 78	1, 15	29, 38	<	
			forest				
1	Agroforestry+TG	0,0021	171,59	0,36	13,87	<	
3	High density forest	0,0012	1466,89	1,76	22,64	<	
4	Forest or pasture	0,0023	537,46	1,24	32,00	<	
5	Agroforestry+TG	0,0021	138,45	0,29	17,14	<	

Description of PN Pinang, Cocoa, NG jackfruit, coconut KLP, KP coffee, JG corn, KT Kc. Soil, KH Kc. Green, TR eggplant, PG Padi Gogo, KS palm oil, M mulch, TG Teras *Gulud,* TB Terrace bench, PMK planting according to Contour, () intercropping, (-) overlap, (\/) overlapping, SLH homogeneous land unit.
The level of erosion that occurred in actual cropping patterns (Table 7) for mixed garden land use (SLH 15), plantations (SLH 10 and 12) and forests (SLH 1, 3, 4 and 5) is still at a mild level. The erosion value obtained (A) is smaller than ETol, for that the recommended conservation technique is by making the *gulud* terrace followed by the planting of the reinforcement terrace, planting according to the contour, and agroforestry (agroforestry).
The aim to reduce the slope length, retain water to reduce the speed and amount of surface flow are strengthened with terrace reinforcement plants. Furthermore, on the use of mixed plantation land (SLH 14, 16), and land use for plantations (SLH 8 and 9) due to the level of erosion that occurs greater than the erosion that can still be tolerated

(ETol), it is recommended in addition to the manufacture of Porch *Gulud,* planting according to Contour, agroforestry (Wanatani) also included with the administration of mulch, so that the erosion value is smaller than Etol. The use of shrubland (SLH 6 and 7) with hilly topography (25 - 45%), recommended for grazing so that erosion values are smaller than ETol (1.15 - 1.51 tons/ha/year) Mixed garden land use (SLH 17) with steep topography (\u003e 45%) has an erosion value of 403.82 tons/ha/year. recommended for agroforestry use. Forestland Use (SLH 1 and 5) with corrugated topography (9 – 11%) Recommended for the forest or agroforestry that is accompanied by the creation of a *gulut* terrace. Further forest land use (SLH 3 and 4) with steep topography (27 -43%) Recommended remains for forest use.

CONCLUSION

Based on the results of research conducted in WATERSHED Krueng Peutoe, it can be concluded as follows:

1. Land use for mixed garden and plantation in class II land (5,660 ha) with erosion value (1.09-3.78 ton/ha/thn) and Class III (6,871 ha) with erosion value (0.29-21,24 ton/ha/thn) retained the use of the soil which is covered by improvement of planting pattern and agrotechnology such as plant type selection, intercropping, intercropping, overlapping, giving mulch cover of the ground and the porch of the.
2. Land use for mixed garden and plantation in class VI land (2,698 ha) with erosion value (3.73-9,46 ton/ha/yr) need to be done making *gulut* terrace with planted with terrace reinforcement plant, and planting according to contour.
3. Land use for forest in the same class of 2,239 ha with erosion value (1.24-1.76 ton/ha/yr) is recommended remains for the forest, while the use of land for bushland also in the same class with an area of 1,987 ha and erosion value (1.15-1.51 ton/ha/yr) is recommended for grazing.
4. Land use for mixed plantation on class VII land with an area of 685 ha has a erosion value of 403, 82 tons/ha/year recommended use of the land for agroforestry.
5. In order to increase the income of farmers need the addition of livestock (poultry and goat) and other side businesses of processing agricultural products so that the net income obtained by farmers can fulfill the standard of living decent (above Rp 9.6 million/kk/year).

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