GUIDELINES

LAND SUITABILITY EVALUATION

with a Case Map of Aceh Barat District

Sofyan Ritung, Wahyunto, Fahmuddin Agus dan Hapid Hidayat

INDONESIAN SOIL RESEARCH INSTITUTE and WORLD AGROFORESTRY CENTRE

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PREFACE

The Tsunami of 26th December 2004 caused serious damage to agricultural land, soils and vegetation along the coastal areas of Aceh. Reconstruction of damaged land and soils will require careful planning based on damage intensity, nature and suitability of land for different crops. This booklet has been prepared as a guideline for the district government of Aceh Barat for spatial lay-outing of tree crops suitable for its coastal areas. The principles and method of developing land suitability maps can serve as an input in land use planning. The principles explained in this booklet are not site specific and thus can be applied to other districts. Tree crop options considered in this booklet are based mainly on biophysical characteristics of land. However, it is also important to consider site specific socio-economic conditions, local context and farmers' preferences in land use planning process. We believe this booklet will contribute to spatial land use planning in the districts.

This booklet has been prepared as an output of the project "Trees, Resilience and Livelihood Recovery in the Tsunami-affected Coastal Zone of Aceh and North Sumatra (Indonesia): Rebuilding Green Infrastructure with Trees People Want" or ReGrIn project, funded mainly by the European Union through its Asia Pro-Eco IIB Program. We also appreciate the scientific interaction between partners of the project - Indonesian Soil Research Institute (ISRI), World Agroforestry Centre (ICRAF), Indonesian Research Institute for Estate Crops (Lembaga Riset Perkebunan Indonesia or LRPI) and University of Hohenheim (Germany).

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Content

1. INTRODUCTION

1.1. The concept of land evaluation and suitability

Land evaluation is a process for matching the characteristics of land resources for certain uses using a scietifically standardized technique. The results can be used as a guide by land users and planners to identify alternative land uses.

Land Suitability is the degree of appropriateness of land for a certain use. Land suitability could be assessed for present condition (Actual Land Suitability) or after improvement (Potential Land Suitability).

Actual Land suitability is a land suitability that is based on current soil and land conditions, i.e. without applying any input. The information is based on physical environment data generated from soil or land resources surveys. The information is based on soil characteristics and climate data related to growth requirements of crops being evaluated. Potential Land Suitability is the suitability that could be reached after the land is improved. The land to be evaluated can be natural (conversion) forest, abandoned or unproductive lands, or land currently used for agriculture, at a sub-optimal level of management in such a way that the productivity can be improved by changing to more suitable crops.

1.2. Land suitability classification

The land suitability classification, using the guidelines of FAO (1976) is divided into Order, Class, Sub Class, and Unit. Order is the global land suitability group. Land suitability Order is divided into S (Suitable) and N (Not Suitable).

Class is the land suitability group within the Order level. Based on the level of detail of the data available, land suitability classification is divided into: (1) For the semi detailed maps (scale 1:25.000-1:50.000) the S order is divided into Highly Suitable (S1), Moderately Suitable (S2), and Marginally Suitable (S3). The "Not Suitable" order does not have further divisions. (2) For reconnaisance level map (scale 1:100.000-1:250.000), the classes are Suitable (S), Conditionally Suitable (CS) and Unsuitable (N). The difference in the number of classes is based on the level of details of the database in each scale.

Class S1	Highly Suitable: Land having no significant limitation or only have minor limitations to sustain a given land utilization type without significant reduction in productivity or benefits and will not require major inputs above acceptable level.
Class S2	Moderately Suitable: Land having limitations which in aggregate are moderately severe for sustained application of the given land utilization type; the limitations will reduce productivity or benefits and increase required inputs to the extent that the overall advantage to be gained from the use, although still attractive, will be appreciable compared to that expected from Class S1 land.
Class S3	Marginally Suitable: Land having limitations which in aggregate are severe for sustained application of the given land utilization type and will so reduce productivity or benefits, or increase required inputs, that any expenditure will only be marginally justified.
Class N	Not Suitable as the range of inputs required is unjustifiable.

The Subclasses are a more detailed division of classes based on land quality and charactersitics (soil properties and other natural conditions). For example, Subclass S3rc is land that is marginally suitable due to rooting condition (rc) as the limiting factor. Furthermore, the Units S3rc1 and S3rc2, are differentiated by the soil effective depths of 50 -70 cm and <50 cm, respectively. This land unit, however is rarely used in land suitability evaluations.

1.3. Land evaluation methods

Some Land Evaluation Systems use several approaches such as parameters multiplying system, parameters totaling system, and matching system between land quality and land characteristics with crop requirements.

The land evaluation system used at the Centre for Agricultural Land Resources Research and Development (formerly known as The Centre for Soil and Agroclimate Research and Development) is the Automated Land Evaluation System (ALES) (Rossiter and Van Wambeke, 1997). ALES is a software that uses land characteristics required for plant growth. ALES matches between Land Qualities and Land Characteristics with the criteria of land evaluation. For semi-detailed map (1:50,000), the main criteria used are based on the Guidelines for Land Evaluation for agricultural commodities (Djaenudin et al., 2003) with few modifications in response to the local land condition and additional references. For the 1:100.000-1:250.000 scale the criteria are referred to that of Petunjuk Teknis Evaluasi Lahan Tingkat Tinjau (Puslittanak, 1997).

2. LAND QUALITIES AND CHARACTERISTICS

Land quality is the complex attributes of lands and contains one or more land characteristics. The land quality could either be directly observed in the field or estimated based on land characteristics according to the guidelines by FAO (1976). The relationship of land quality and land characteristics is described in Table 1.

Table 1. The relationship between land quality and land characteristics used in land evaluation according to Djaenudin *et al*. (2003)

Land Qualities	Land Characteristics
Temperature (tc)	Average temperature (°C)
Water availability (wa)	Rainfall (mm), moisture (%), Number of dry months
Oxygen availability (oa)	Drainage
Rooting condition (rc)	Texture, Coarse material (%), Soil depth (cm)
Peat	Depth (cm), Depth (cm) of mineral interlayer or enrichment (if any), Maturity/ripeness
Nutrient retention (nr)	Clay CEC (cmol/kg), Base saturation (%), pH_{H2O}, Organic C (%)
Toxicity (xc)	Salinity (dS/m)
Sodicity (xn)	Alkalinity/ESP (%)
Sulfidic material (xs)	Depth of sulfidic materials (cm)
Erosion hazard (eh)	Slope (%), erosion
Flood hazard (fh)	Inundation
Land preparation (lp)	Surface stoniness (%), Surface outcrops (%)

Important land characteristics in any land evaluation include topography, soil, and climate. These, especially topography and soil, are important components in determining land units.

2.1. Topography

The most important elements in topography are relief/slope and elevation. The relief is related to land management and erosion hazard and elevation is related to temperature and solar radiation and thus closely linked to plant requirements. The relief and slope classes are listed in Table 2.

Table 2. Relief and slope classes

No.	Relief	Slope (%)
1.	Flat	< 3
2.	Undulating/gently sloping	3-8
3.	Rolling/sloping	8-15
4.	Hilly	15-30
5.	Mountainous	30-40
6.	Steep mountainous	40-60
7.	Very steep mountainous	> 60

2.2. Climate

2.2.1. Air temperature

Quinine and coffee, for example, prefer high altitude or low temperature, while rubber, oil palm, and coconut are suitable for the low elevation. In areas where data of air temperature is unavailable, it is estimated by elevation (above sea level). The higher the elevation, the lower is the air temperature, and can be estimated using Braak (1928) formula:

$$T = 26{,}3^{o}C \ (0{,}01 \times \text{elevation in meter asl} \times 0{,}6^{o}C) \qquad [1]$$

The average air temperature at zero elevation (coast) ranges from 25 to 27°C.

2.2.2. Rainfall

Rainfall data should be obtained from weather stations located at representative sites. The measurement can either be conducted manually (usually daily rainfall that may be summed up to monthly and annual rainfall) or automatically that could be set to minutely, five minutely, etc. records, according to need.

For land evaluation, the required data are annual rainfall and the number of dry and wet months. Oldeman (1975) climatic classes are based on the number of consecutive wet months and dry months. The wet months are the months with >200 mm rainfall and the dry months are the months with <100 mm rainfall. This criterion is more applicable for annual crops, especially rainfed rice. Based on these criteria, Oldeman (1975) divided the climatic zones into five major classes (A, B, C, D and E). Schmidt and Ferguson (1951) used a different criteria, in which the wet months are those with >100 mm rainfall and the dry months are those with <60 mm rainfall. This latter criterion is usually used for, but not limited to, perennial crops.

2.3. Soil

The most important soil characteristics in land evaluation include drainage, texture, soil depth, nutrient retention, (pH, cation exchange capacity; CEC), alkalinity, erosion hazard, and flood/inundation.

2.3.1. Soil drainage

Soil drainage indicates the speed of water infiltration or the soil condition describing the duration and level of water saturation and inundation. In general, plants require good drainage soils to facilitate oxygen availability.

The drainage classes are given in Table 3. The most preferred classes by most plants are classes 3 and 4. Classes 1 and 2 have a very low water holding capacity, while classes 5, 6, and 7 are often saturated and oxygen deficient and thus are unsuitable for most plants, but lowland rice is suitable in this kind of soil.

Table 3. Soil drainage characteristics for land suitability evaluation

No	Drainage class	Characteristics
1	Excessively drained	The soil has a very high hydraulic conductivity and low water holding capacity, and thus requires irrigation for annual crops. The soil color is homogenous without mottles or gley (reducted) layer.
2	Somewhat excessively drained	The soil has a high hydraulic conductivity and low water holding capacity.
3	Well drained	The soil has a moderate hydraulic conductivity and moderate water holding capacity; moist, but not wet near the surface. The soil color is homogenous without iron and manganese concretion and no gley (reduced) layer at up to 100 cm soil depth.
4	Moderately well drained	The hydraulic conductivity is moderate to somewhat low, low water holding capacity (available water pores), and the soil may sometimes be wet near the surface. The soil color is homogenous without iron and manganese concretion and no gley (reduced) layer at up to 50 cm soil depth.
5	Somewhat poorly drained	The hydraulic conductivity is somewhat low and the water holding capacity (available water pores) is low to very low, the soil sometimes flooded. This soil is suitable for lowland rice and selected other crops. The soil color is homogenous without iron and manganese concretion and no gley (reduced) layer at up to 25 cm soil depth.
6	Poorly drained	The soil hydraulic conductivity is low and the water holding capacity (available water pores) is low, the surface is flooded for extended length of time to the surface. This soil is suitable for lowland rice and selected other crops. The soil has some iron and Manganese concretion up to the surface layer.
7	Very poorly drained	The soil hydraulic conductivity is very low, and the water available pores are very low. The soil is permanently wet and inundated for extended length of time. This soil is suitable for lowland rice and selected other crops. The soil has some iron and manganese concretion up to the surface layer.

The profile of soil based on the drainage classes is schematically represented in Figure 1.

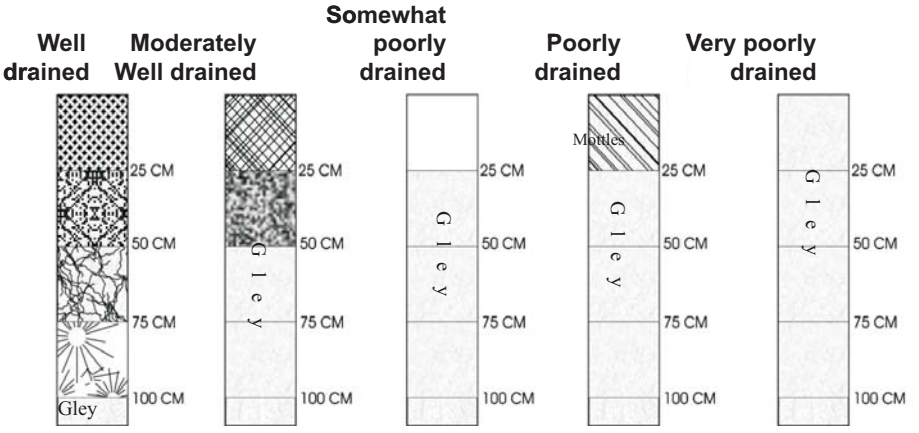


Figure 1. Schematic representation of soil profiles based on drainage classes

2.3.2. Texture

Texture is the composition of fine soil particles (≤ 2 mm diameter) consisting of sand, silt and clay. Soil texture could be assessed manually in the field (Table 4), but preferably determined quantitatively based on texture laboratory analysis and classified according to Figure 2.

Table 4. Field determination method of soil texture

No.	Texture class	Description
1	Sand (S)	Very coarse, can not form clods or balls, and no stickiness.
2	Loamy sand (LS)	Very coarse, can form balls/clods but easily collapse.
3	Sandy loam (SL)	Somewhat coarse, can form balls that can easily collapse, have some stickiness.
4	Loam (L)	Not coarse and not slippery, can form balls; can be rolled with shiny surface and somewhat sticky.
5	Silt loam (SiL)	Slippery, can form strong clods/balls, can be rolled with shiny surface, and rather sticky
6	Silt (Si)	Very slippery, can be rolled with shiny surface, and rather sticky.
7	Clay loam (CL)	Some rough/coarse materials; can form rather firm balls when moist, can be rolled but easily broken, somewhat sticky.
8	Sandy clay loam (SCL)	The coarse materials can be easily recognized, can form a rather firm balls, can be rolled but easily broken, sticky.
9	Silty clay loam (SiCL)	Slippery, can form firm balls, can easily form shiny rolls, and sticky
10	Sandy clay (SC)	Slippery but rather coarse, can easily form shiny rolls but can not easily bent, and sticky.
11	Silty clay (SiC)	Slippery, can form balls, can easily be rolled, and sticky.
12	Clay (C)	Heavily sticky, can form very rounded and good balls, hard when dry, sticky when wet.

The grouping of textural classes:

Fine (f)	: Sandy clay, clay, silty clay
Moderately fine (mf)	: Clay loam, sandy clay loam, silty clay loam
Moderate (m)	: Fine sandy loam, loam, silt loam, silt
Somewhat coarse (sc)	: Sandy loam
Coarse (c)	: Sandy, loamy sand
Very fine (vf)	: Clay (2:1 type)

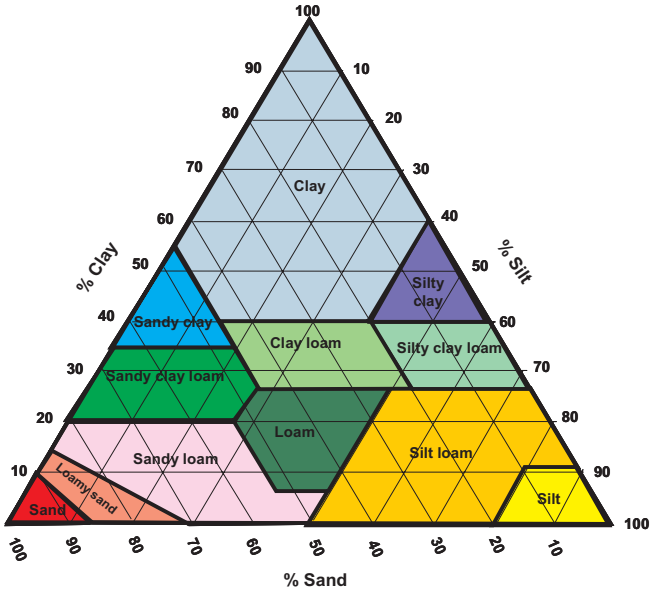


Figure 2. The soil texture triangle.

2.3.3. Coarse materials

Coarse materials are texture modifier that is determined by the percentage of pebbles, gravels or stones in every soil layer. The classes are:

Few	: < 15 %
Plenty	: 15 - 35 %
Abundant	: 35 - 60 %
Dominant	: > 60 %

2.3.4. Soil depth

Soil depth is divided into:

Very shallow	: < 20 cm
Shallow	: 20 - 50 cm
Moderately deep	: 50 - 75 cm
Deep	: > 75 cm

2.3.5. Thickness of peat

Thin	: < 60 cm
Moderate	: 60 - 100 cm
Somewhat thick	: 100 - 200 cm
Thick	: 200 - 400 cm
Very thick	: > 400 cm

2.3.6. Alkalinity

Alkalinity is usually indicated by the exchangeable sodium percentage, ESP:

$$ESP = \frac{\text{Exchangeable Na x 100}}{\text{Soil CEC}} \qquad [2]$$

$$SAR = \frac{Na^{+}}{\sqrt{\frac{Ca^{++} + Mg^{++}}{2}}} \qquad [3]$$

2.3.7. Erosion hazard

The erosion hazard is based on the signs of sheet, rill, and gully erosion. Another approach is by estimating the average annual eroded surface layer, relative to the uneroded soils as shown by the thickness of the A horizon. The A horizon is characterized by dark color because of high organic matter content. The level of erosion hazard is presented in Table 5.

Table 5. Erosion hazard

Class	Surface soil loss cm/yr
Very low (sr)	< 0.15
Low (r)	0.15 - 0.9
Moderate (s)	0.9 - 1.8
High (b)	1.8 - 4.8
Very high (sb)	> 4.8

2.3.8. Flood/ inundation hazard

Flood is characterized by the combination of flood depth (X) and duration (Y). This information can be obtained by interviewing local people. Flood hazard, Fx,y, is presented in Table 6.

Table 6. Flood hazard classes.

Symbol	Flood hazard classes	Flood depth (x) (cm)	Flood duration (y) (month/year)
F0	No hazard	Nil	Nil
F1	Slight	<25	<1
		25-50	<1
		50-150	<1
F2	Medium	<25	1-3
		25-50	1-3
		50-150	1-3
		>150	<1
F3	Somewhat	<25	3-6
	severe	25-50	3-6
		50-150	3-6
F4	Severe	<25	>6
		25-50	>6
		50-150	>6
		>150	1-3
		>150	3-6
		>150	>6

2.3.9. Soil acidity

Soil reaction is based on pH in 0-20 cm and 20-50 cm soil depths (Table 7):

Table 7. Soil acidity classes (pH)

Class	Soil pH
Very acid	< 4.5
Acid	4.5 - 5.5
Slightly acid	5.6 - 6.5
Neutral	6.6 - 7.5
Slightly alkaline	7.6 - 8.5
Alkaline	> 8.5

3. LAND EVALUATION PROCEDURE FOR ACEH BARAT DISTRICT

The process of land evaluation includes the following steps (schematically presented in Figure 3):

1. Identification of land characteristics
2. Data compilation of land use/crop requirements (LURs)
3. Matching process of the above two
4. Screening of land suitability options into land use recommendation (in this case for perennial tree crops).

3.1. Identification of land characteristics

Land characteristics are developed based on climatic, soil, and topographic data/maps. Soil data considered in the land characteristics include slope, soil drainage, soil depth, soil texture (0 - 30 cm and 30 - 50 cm soil depths), soil acidity (pH), CEC of clay, salinity, sulfidic contents, flood/ inundation, and surface out-crops (stoniness and rock out-crops). Climate data consist of annual rainfall, number of dry months, and air temperature which are generated either from weather stations or from climatic maps. Those climatic maps, however, usually have small scales and thus should be used very carefully, because the land suitability evaluation is usually carried out at 1:25,000 or 1:50,000 scale. If the temperature data over the study areas are not available from weather stations, it could be estimated from Equation [1].

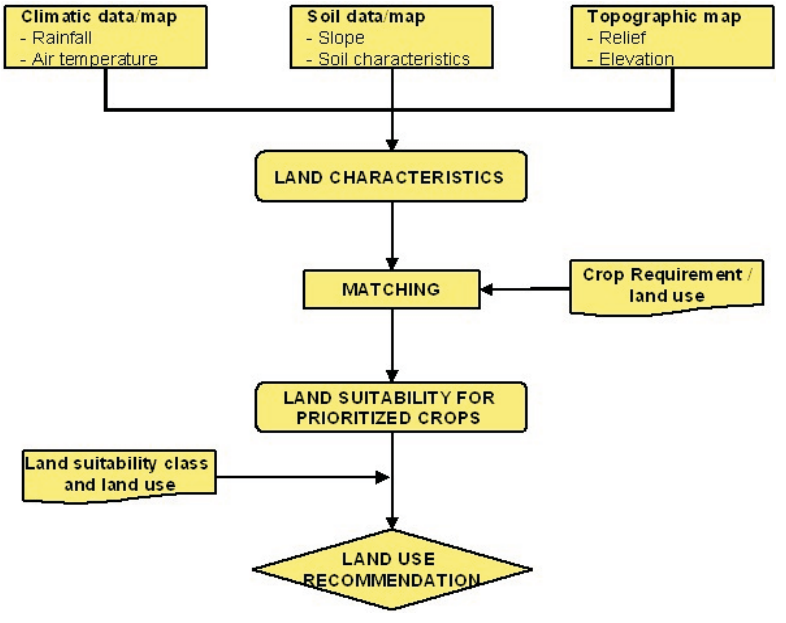


Figure 3. Flowchart for land evaluation.

Land characteristics of selected soil mapping units (SMU) of Aceh Barat are shown in Table 8.

Table 8. Land characteristics of selected Soil Mapping Units in Aceh Barat District

No. SMU	Soils		Physiography	Parent			Climate*)		Water Availability		Soil	Rooting Zone Condition			
	Soil Classification	Proportion	(Marsoedi et. al., 1997)	Material	Relief	Slope	Avarage temp	Humidity	Rain fall	Number of dry	Drainage	Soil tecture		Coarse Mat	Soil depth
	(USDA, 2003)					(%)	(°C)	(%)	(mm)	Month		Top Soil	Sub-soil	(%)	(cm)
3	Association: Typic Psammaquents	P	Sand beach recent (Mq.1.2)	Marine sediment	Flat	0-1	**28.78**	**83.9**	**3109**	0	5	SL	LS	-	100 - 150
	Typic Udipsamments	M									2	SL	S	-	100 - 150
4	Typic Udipsamments	P	Beach ridges recent (Mq.1.1.1)	Marine sedimen	Nearly flat	1-3	**28.78**	**83.9**	**3109**	0	2	SL	LS	-	100 - 150
16	Typic Haplohemists	D	Peat (1,0 - 2,0 m)	Organic material	Flat	0-1	**28.78**	**83.9**	**3109**	0	6	Hemik	Hemik	-	
	Typic Haplosaprists	F	(G.2.1.1.2)									Saprik	Hemik	-	
27	Typic Hapludults	P	Undulating tectonic plain	Clay (sand) stone	Undulating	3-8	**28.78**	**83.9**	**3109**	0	3	SiC	C	-	100 - 150
	Typic Endoaquepts	M	Moderately dissected (Tfq.4.u2)	Mudstone							6	CL	C	-	100 - 150

Table 8. (continued)

No. SMU	Soil		Organic material (Peat)		Nutrient Retention						Toxicity	Sodisity/	Depth of	Erosion	Flood /	Land Managemen	
	Soil Classification	Proportion	Thickness	Ripeness	CEC-clay	BS	pH H_2O	pH	C-Organic		Salinity	Alkalinity	Sulfidic Ma-	Hazard	Inundation	Stoniness	Rock Outcrops
	(USDA, 2003)		(cm)		(cmol)	(%)	(Field)	Lab	Top soil	Sub-soil	(dS/m)	ESP (%)	terial (cm)		hazard		
3	Asociation: Typic Psammaquents	P		-	> 16	> 50	5.5	A	0.76-2.38	0.34-1.23	< 1	-	-	-	slight	-	-
	Typic Udipsamments	M			> 16	< 50	5.0	A			< 1	-	-	-		-	-
4	Typic Udipsamments	P		-	> 16	< 50	5.0	A	1.71-2.16	0.23-0.64	< 1	-	-	-	-	-	-
16	Typic Haplohemists	D	100-200	Hemic	> 16	< 50	4.5	Sa	31.54-45.26	31.97-56.80	< 1	-	-	-	Slight to mod	-	-
	Typic Haplosaprists	F	100-200	Hemic	> 16	< 50	4.5	Sa			< 1	-	-	-		-	-
27	Typic Hapludults	P		-	> 16	< 50	5.0	A	1.06-2.98	0.44-0.73	< 1	-	-	Slight	-	-	-
	Typic Endoaquepts	M		-	> 16	> 50	5.5	A	3.9-6.84	1.27-1.63	< 1	-	-	Slight		-	-

Note: P= Predominant (> 75%), D= Dominant (50-75%), F= Fair (25-49%), M=Minor (10-24%), T=Trace (<10%), a =acid, sa = strongly acid, CEC= Cation Exhangeable Capacity, BS= Base Saturation.

3.2. Crop requirements

The requirements for growth of various crops can be obtained from available literature such as Djaenudin et al. (2003). For the evaluation of land suitability in Aceh Barat District, modifications were made to the original criteria provided by Djaenudin et al (2003). These modifications include the grouping of peat soils and poor drainage soils as unsuitable for clove and cacao. Also for tree crops, the texture classes is based on top soil and subsoil, rather than just the top soil texture. Requirements for tree crops evaluated in this report are provided in Annex 1.

3.3. Matching process

After land characteristics data are available the next process is evaluating the land by matching (comparing) between land characteristics in every mapping unit with its crop requirements. The process can be carried out by computerized system using ALES software or manually if only a few points or mapping units are to be evaluated. By computerized system the process can be executed very quickly for several crops simultaneously. Manual evaluation can only be done for one crop at a time and thus can be very time consuming.

The land suitability classifications are defined based on their most serious limiting factors. The limiting factors may consist of one or more factors depending on land characteristics. Examples of land suitability classification for coconut in mapping unit 4 and for banana in mapping unit 27 based on actual and potential suitabilities are provided in Table 9 and 10.

Table 9. Land Suitability Evaluation for Coconut for Soil Mapping Unit 4.

Land characteristics	**Land suitability class**				
	Value	**Actual suit-ability class**	**Manage ment**	**Potential suitability**	
Temperature (tc)		**S2**			**S2**
Mean temperature (°C)	28.8	S2		S2	
Water availability (wa)		**S2**			**S2**
Annual Rainfall (mm)	3109	S2		S2	
Number of dry months (month)	0	S1		S1	
Oxygen availability (oa)		**S3**			**S3**
Drainage	Some-what high	S3		S3	
Rooting condition (rc)		**S3**			**S3**
Texture	SL/LS	S3		S3	
Rough materials (%)	0	S1		S1	
Soil depth (cm)	> 100	S1		S1	
Peat:		**S1**			**S1**
Depth (cm)	0	S1		S1	
Thickness (cm) of inter mineral layer (if any)					
Maturity/ripeness					
Nutrient retention (nr)		**S2**			**S1**
Clay CEC (cmol/kg)	>16	S1		S1	
Base saturation (%)	< 50	S2	*	S1	
pH H_2O	5	S2	*	S1	
Organic C (%)	1.7-2.1	S1		S1	
Toxicity (xc)		**S1**			**S1**
Salinity (dS/m)	< 0.5	S1		S1	
Sodicity (xn)					
Alkalinity/ESP (%)	-				
Sulfidic material (xs)					
Sulphidic depth (cm)					
Erosion hazard (eh)		**S1**			**S1**
Slope (%)	1-3	S1		S1	
Erosion hazard					
Flood hazard (fh)		**S1**			**S1**
Inundation	F0	S1		S1	
Land preparation (lp)		**S1**			**S1**
Surface stoniness (%)	0	S1		S1	
Rock outcrops (%)	0	S1		S1	
Suitability class	**Actual (A)**	**S3**	**Potential (P)**		**S3**

Remark: * With management input, suitability class does not change.

Table 10. Land Suitability Evaluation for Banana in Soil Mapping Unit 27.

Land characteristics	**Land suitability class**			
	Value	**Actual suitability class**	**Management**	**Potential suitability**
Temperature (tc)		**S2**		**S2**
Mean temperature (^{o}C)	28.8	S2		S2
Water availability (wa)		**S2**		**S2**
Rainfall (mm)	3109	S2		S2
Number of dry months (month)	0	S1		S1
Oxygen availability (oa)		**S1**		**S1**
Drainage	Good	S1		S1
Rooting condition (rc)		**S1**		**S1**
Texture	SiC/C	S1		S1
Rough materials (%)	0	S1		S1
Soil depth (cm)	> 100	S1		S1
Peat:		**S1**		**S1**
Depth (cm)	0	S1		S1
Thickness (cm) of inter mineral layer (if any)				
Maturity/ripeness				
Nutrient retention (nr)		**S3**		**S2**
Clay CEC (cmol/kg)	>16	S1		S1
Base saturation (%)	< 50	S2	*	S1
pH H_2O	4.5	S3	*	S2
Organic C (%)	1.1	S1		S1
Toxicity (xc)		**S1**		**S1**
Salinity (dS/m)	< 0.5	S1		S1
Sodicity (xn)				
Alkalinity/ESP (%)	-			
Sulfidic material (xs)				
Sulphidic depth (cm)				
Erosion hazard (eh)		**S1**		**S1**
Slope (%)	3-8	S1		S1
Erosion hazard				
Flood hazard (fh)		**S1**		**S1**
Inundation	F0	S1		S1
Land preparation (lp)		**S1**		**S1**
Surface stoniness (%)	0	S1		S1
Rock outcrops (%)	0	S1		S1
Suitability class	**Actual (A)**	**S3**	**Potential (P)**	**S2**

Remark: * With management input, suitability class can be improved from S3 to S2.

From Table 9, as the most limiting factor is soil texture, it is unlikely that any management can upgrade the suitability class. On the other hand, for Table 10, since the most limiting factor is nutrient retention, the suitability class can be raised.

3.4. Screening of land suitability for developing land use recommendation

To interpret the combination of land suitability class, screening is necessary based on the priority of regional/district development and existing land use. In the screening for annual food crops and vegetable crops, only S1 and S2 classes were considered, but for the perennial tree crops, S3 or marginally suitable class was also included because of the higher priority of the current project on perennial tree crops suitability evaluation.

The appoach in screening of land suitability is given in Table 11. The land that is currently being utilized, especially for perennial tree crops and paddy fields were left as such as long as they fall into suitable class. Those lands may be recommended for intensification for increasing their productivity. Lands that currently are not optimally used or not being used such as shrub, conversion forest, or absentee agricultural lands were recommended for extensification for other suitable commodities (Ritung and Hidayat, 2003).

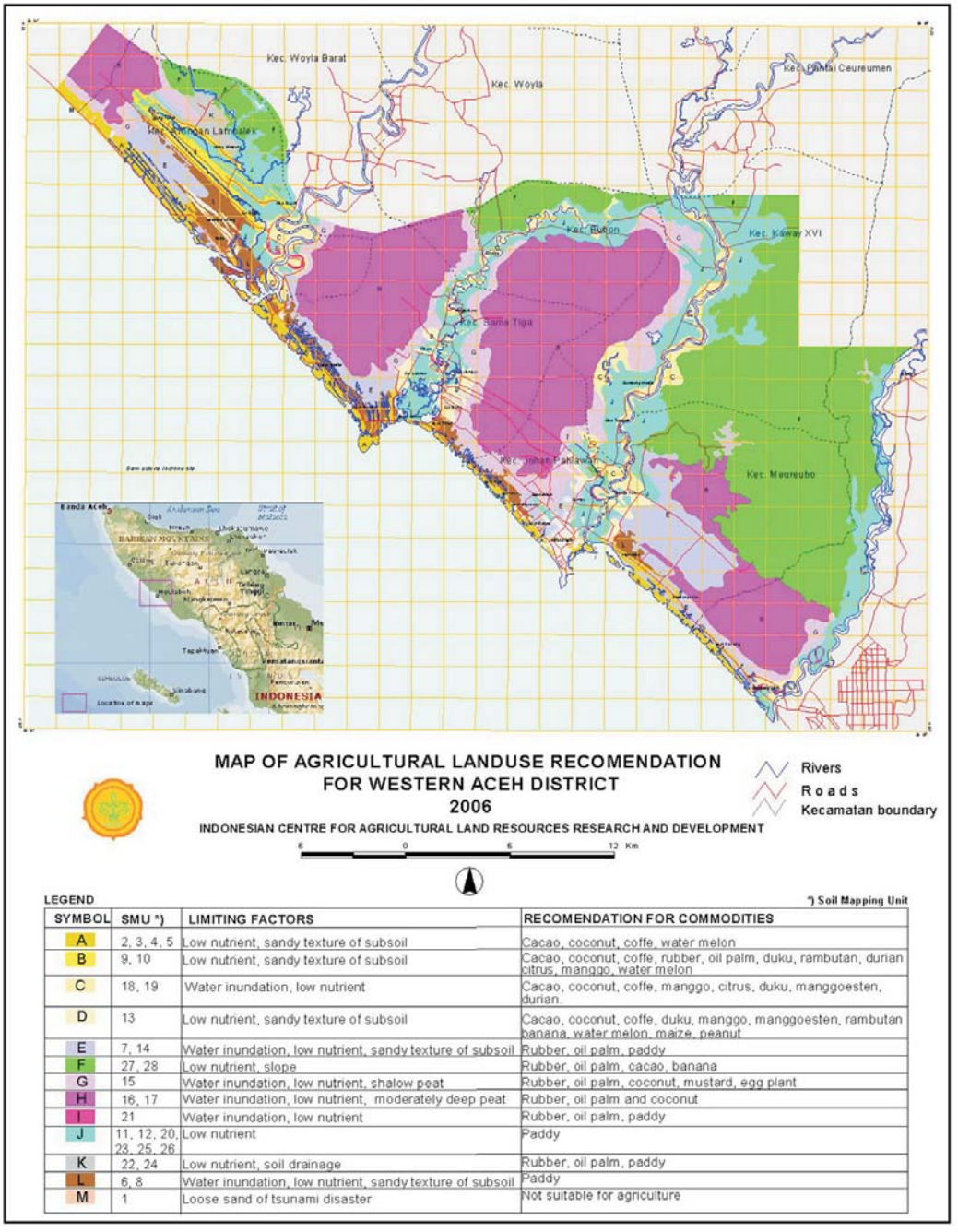
Table 11. Approach in developing land use recommendation.

Commodity	Suitability	Existing land use	Land use recommendation	Availability for coconut
Coconut	Suitable	Sawah	Sawah	Unavailable
		Upland annual crops	Upland annual crops	Unavailable
		Oil palm	Oil palm	Unavailable
		Rubber	Rubber	Unavailable
		Coconut	Coconut	Unavailable
		Shrub	Coconut	Available
		Conversion forest	Coconut	Available
		Settlement	Settlement	Unavailable

The overall land use recommendation for Aceh Barat District is presented in Table 12, and the spatial distribution is given in Figure 4.

Table 12. Land use recommendation for agricultural commodity for the wet coast of Aceh Barat District.

Symbol	Soil Mapping Unit	Limiting Factor	Recommendation For Commodities	Input recommendation
A	2, 3, 4, 5	Low nutrient, sandy texture of subsoil (brackish water)	Cacao, coconut, coffee, water melon	Fertilizer, soil structure management
B	9, 10	Low nutrient, sandy texture of subsoil, fresh water	Cacao, coconut, coffee, rubber, oil palm, duku (lanseum), rambutan, durian, citrus, mango, water melon	Fertilizer, soil structure management
C	18, 19	Water inundation, low nutrient, moderately well drained	Cacao, coconut, coffee, rambutan, manggo, citrus, duku, manggosten, durian	Fertilizer, drainage
D	13	Low nutrient, sandy texture of subsoil	Cacao, coconut, coffee, duku, mango, manggosten, rambutan, banana, water melon, maize, peanut	Fertilizer, soil structure management
E	7,14	Water inundation, low nutrient, sandy texture of subsoil	Rubber , oil palm, paddy	Fertilizer, drainage
F	27, 28	Low nutrient, slope	Rubber, oil palm, cacao, banana	Fertilizer, conservation practices
G	15	Water inundation, low nutrient, shallow peat	Rubber, oil palm, coconut, mustard, eggplant	Drainage, fertilizer
H	16, 17	Water inundation, low nutrient, moderate to deep peat soil	Rubber, oil palm, coconut	Drainage and fertilizer
I	21	Water inundation, low nutrient, somewhat poorly drained	Rubber and oil palm, paddy	Drainage and fertilizer
J	11,12, 20, 23, 25, 26	Low nutrient	Paddy	Fertilizer
K	22, 24	Low nutrient, poor soil drainage	Rubber, oil palm, paddy	Fertilizer, drainage
L	6, 8	Water inundation, low nutrient, sandy texture of sub-soil	Paddy	Fertilizer
M	1	Loose tsunami sand	Not suitable for agriculture	-



SYMBOL	SMU *)	LIMITING FACTORS	RECOMENDATION FOR COMMODITIES
A	2, 3, 4, 5	Low nutrient, sandy texture of subsoil	Cacao, coconut, coffe, water melon
B	9, 10	Low nutrient, sandy texture of subsoil	Cacao, coconut, coffe, rubber, oil palm, duku, rambutan, durian citrus, manggo, water melon
C	18, 19	Water inundation, low nutrient	Cacao, coconut, coffe, manggo, citrus, duku, manggoesten, durian
D	13	Low nutrient, sandy texture of subsoil	Cacao, coconut, coffe, duku, manggo, manggoesten, rambutan banana, water melon, maize, peanut
E	7, 14	Water inundation, low nutrient, sandy texture of subsoil	Rubber, oil palm, paddy
F	27, 28	Low nutrient, slope	Rubber, oil palm, cacao, banana
G	15	Water inundation, low nutrient, shalow peat	Rubber, oil palm, coconut, mustard, egg plant
H	16, 17	Water inundation, low nutrient, moderately deep peat	Rubber, oil palm and coconut
I	21	Water inundation, low nutrient	Rubber, oil palm, paddy
J	11, 12, 20, 23, 25, 26	Low nutrient	Paddy
K	22, 24	Low nutrient, soil drainage	Rubber, oil palm, paddy
L	6, 8	Water inundation, low nutrient, sandy texture of subsoil	Paddy
M	1	Loose sand of tsunami disaster	Not suitable for agriculture

Figure 4. Land use recommendation map of the coastal area of Aceh Barat District (based on 1:25,000 scale map). See the accompanying CD in the pocket of this booklet.

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Annexes

Annex 1. Requirements for growth of Rubber (*Hevea brasiliensis* M.A.)

Land use requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	26 - 30	30 - 34	-	> 34
		24 - 36	22 - 24	< 22
Water availability (wa)				
Average annual rainfall (mm)	2500 - 3000	2000 - 2500	1500 - 2000	< 1500
		3000 - 3500	3500 - 4000	> 4000
Dry months (month)	1 - 2	2 -.3	3 - 4	> 4
Oxygen availability (oa)				
Soil drainage class	Good	Moderate	Mod. poor, poor	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 60	> 60
Soil depth (cm)	< 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	-	-	-	-
Base saturation (%)	< 35	35 - 50	> 50	
pH H2O	5.0 - 6.0	6.0 - 6.5	> 6.5	
		4.5 - 5.0	< 4.5	
C-organic (%)	> 0.8	≤ 0.8		
Toxicity (xc)				
Salinity (ds/m)	< 0.5	0.5 - 1	1 - 2	> 2
Sodicity (xn)				
Alkalinity/ESP (%)	-	-	-	-
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 175	125 - 175	75 - 125	< 75
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
			16 - 45	> 45
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock outcrops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified mineral material/enrichment.

Annex 2. Requirements for growth of Oil palm (*Elaeis guinensis* JACK.)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	22 - 25	20 - 22	< 20
		28 - 32	32 - 35	> 35
Water availability (wa)				
Average annual rainfall (mm)	1700 - 2500	1450 - 1700	1250 - 1450	< 1250
		2500 - 3500	3500 - 4000	> 4000
Dry months (month)	< 2	2 - 3	3 - 4	> 4
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, Mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽16	-	-
Base saturation (%)	> 20	⩽20		
pH H2O	5.0 - 6.5	4.2 - 5.0	< 4.2	
		6.5 - 7.0	> 7.0	
C-organic (%)	> 0.8	⩽0.8		
Toxicity (xc)				
Salinity(ds/m)	< 2	2 - 3	3 - 4	> 4
Sodicity (xn)				
Alkalinity/ESP (%)	-	-	-	-
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flood hazard (fh)				
Flooding	F0	F1	F2	> F2
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 3. Requirements for growth of Coconut (*Cocos nicifera* L.)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	28 - 32	32 - 35	> 35
		23 - 25	20 - 23	< 20
Water availability (wa)				
Average annual rainfall (mm)	2000 - 3000	1300 - 2000	1000 - 1300	< 1000
		3000 - 4000	4000 - 5000	> 5000
Dry months (month)	0 - 2	2 - 4	4 - 6	> 6
Humidity (%)	> 60	50 - 60	< 50	
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, Mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	Slighlty fine	Very fine	Coarse
Coarse material (%)	< 60	15 - 35	35 - 55	> 55
Soil depth (cm)	< 140	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	Fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	-	-	-	-
Base saturation (%)	> 20	⩽ 20		
pH H2O	5.2 - 7.5	4.8 - 5.2	< 4.8	
		7.5 - 8.0	> 8.0	
C-organic (%)	> 0.8	⩽ 0.8		
Toxicity (xc)				
Salinity(ds/m)	< 12	12 - 16	16 - 20	> 20
Sodicity (xn)				
Alkalinity/ESP (%)	-	-	-	-
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 4. Requirements for growth of Cocoa (*Theobroma cacao* L.)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	20 - 25	-	< 20
		28 - 32	32 - 35	> 35
Water availability (wa)				
Average annual rainfall (mm)	1500 - 2500	-	1250 - 1500	< 1250
		2500 - 3000	3000 - 4000	> 4000
Dry months (month)	1 - 2	2 - 3	3 - 4	> 4
Humidity (%)	40 - 65	65 - 75	75 - 85	> 85
		35 - 40	30 - 35	< 30
Oxygen availability (oa)				
Drainage	Good, moderate	Good, moderate	Mod. poor, poor, Mod. rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse, very fine	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	-	-	-	-
Thickness (cm), if stratified with mineral material/ enrichment	-	-	-	-
Ripening	-	-	-	-
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽ 16	-	-
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	6.0 - 7.0	5.5 - 6.0	< 5.5	
		7.0 - 7.6	> 7.6	
C-organic (%)	> 1.5	0.8 - 1.5	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 1.1	1.1 - 1.8	1.8 - 2.2	> 2.2
Sodicity (xn)				
Alkalinity/ESP (%)	-	-	-	-
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003), with modification for peat material and drainage.

Annex 5. Requirements for growth of Robusta Coffee (*Coffea caephora*).

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	22 - 25	-	19 - 22	< 19
		25 - 28	28 - 32	> 32
Water availability (wa)				
Average annual rainfall (mm)	2000 - 3000	1750 - 2000	1500 - 1750	< 1500
		3000 - 3500	3500 - 4000	> 4000
Dry months (month)	2 - 3	3 - 5	5 - 6	> 6
Humidity (%)	45 - 80	80 - 90; 35 - 45	> 90; 30 - 35	< 30
Oxygen availability (oa)				
Drainage	Good	Moderate	Mod. Poor, mod. Rapid	Poor, very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	slightly coarse, very fine	Coarse, very fine
Coarse material (%)	< 15	15 - 35	35 - 60	> 60
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	≤16		
Base saturation (%)	> 20	≤20		
pH H2O	5.3 - 6.0	6.0 - 6.5	> 6.5	
		5.0 - 5.3	< 5.3	
C-organic (%)	> 0.8	≤0.8		
Toxicity (xc)				
Salinity(ds/m)	< 1	-	1 - 2	> 2
Sodicity (xn)				
Alkalinity/ESP (%)	-	-	-	-
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 175	125 - 175	75 - 125	< 75
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30; 16 - 50	> 30; > 50
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	F0	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 6. Requirements for growth of Clove (*Eugenia aromatica* L.)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	28 - 32	32 - 35	> 35
		20 - 25		< 20
Water availability (wa)				
Average annual rainfall (mm)	1500 - 2500	-	1250 - 1500	< 1250
		2500 - 3000	3000 - 4000	> 4000
Dry months (month)	1 - 2	2 - 3	3 - 4	> 4
Humidity (%)	⩽70	> 70		
Oxygen availability (oa) Drainage	Good, Moderate	Good, Moderate	Mod. Poor, moderate rapid	Very poor, poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	-	-	-	-
Thickness (cm), if stratified with mineral material/ enrichment	-	-	-	-
Ripening	-	-	-	-
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽16		
Base saturation (%)	> 50	35 - 50	< 35	
pH H2O	5.0 - 7.0	4.0 - 5.0	< 4.0	
		7.0 - 8.0	> 8.0	
C-organic (%)	> 0.8	⩽0.8		
Toxicity (xc)				
Salinity(ds/m)	< 5	5 - 8	8 - 10	> 10
Sodicity (xn)				
Alkalinity/ESP (%)	< 10	10 - 15	15 - 20	> 20
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	F1	> F1
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003), with modification for peat material and drainage.

Annex 7. Requirements for growth of Mango (*Mangifera indica* L.)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	22 - 28	28 - 34	34 - 40	> 40
		18 - 22	15 - 18	< 15
Water availability (wa)				
Average annual rainfall (mm)	1250 - 1750	1750 - 2000	2000 - 2500	> 2500
		1000 - 1250	750 - 1000	< 750
Humidity (%)	> 42	36 - 42	30 - 36	< 30
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽ 16		
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	5.5 - 7.8	5.0 - 5.5	< 5.0	
		7.8 - 8.0	> 8.0	
C-organic (%)	> 1.2	0.8 - 1.2	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 4	4 - 6	6 - 8	> 8
Sodicity (xn)				
Alkalinity/ESP (%)	< 15	15 - 20	20 - 25	> 25
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	-	> F0
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 8. Requirements for growth of Rambutan (*Nephelium lappaceum* LINN).

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	28 - 32	32 - 35	> 35
		22 - 25	20 - 22	< 20
Water availability (wa)				
Average annual rainfall (mm)	2000 - 3000	1750 - 2000	1250 - 1750	< 1250
		3000 - 3500	3500 - 4000	> 4000
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse, very fine	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽16		
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	5.0 - 6.0	4.5 - 5.0	< 4.5	
		6.0 - 7.5	> 7.5	
C-organic (%)	> 1.2	0.8 - 1.2	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 4	4 - 6	6 - 8	> 8
Sodicity (xn)				
Alkalinity/ESP (%)	< 15	15 - 20	20 - 25	> 25
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	F1	F2	> F2
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 9. Requirements for growth of Durian (*Durio zibethinus* MURR)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	25 - 28	28 - 32	32 - 35	> 35
		22 - 25	20 - 22	< 20
Water availability (wa)				
Average annual rainfall (mm)	2000 - 3000	1750 - 2000	1250 - 1750	< 1250
		3000 - 3500	3500 - 4000	> 4000
Humidity (%)	> 42	36 - 42	30 - 36	< 30
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽16		
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	5.5 - 7.8	5.0 - 5.5	< 5.0	
		7.8 - 8.0	> 8.0	
C-organic (%)	> 1.2	0.8 - 1.2	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 4	4 - 6	6 - 8	> 8
Sodicity (xn)				
Alkalinity/ESP (%)	< 15	15 - 20	20 - 25	> 25
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	-	-	> F0
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 10. Requirements for growth of Manggis (*Garcinia mangostana* LINN).

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	20 - 23	23 - 30	30 - 40	> 40
		18 - 20	15 - 18	< 15
Water availability (wa)				
Average annual rainfall (mm)	1250 - 1750	1750 - 2000	2000 - 2500	> 2500
		1000 - 1250	750 - 1000	< 750
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	⩽ 16		
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	5.0 - 6.0	4.5 - 5.0	< 4.5	
		6.0 - 7.5	> 7.5	
C-organic (%)	> 1.2	0.8 - 1.2	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 4	4 - 6	6 - 8	> 8
Sodicity (xn)				
Alkalinity/ESP (%)	< 15	15 - 20	20 - 25	> 25
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	F1	F2	> F2
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

Annex 11. Requirements for growth of Banana (*Musa acuminata* COLLA)

Landuse requirements/Land characteristics	Land suitability class			
	S1	S2	S3	N
Temperature regime(tc)				
Annual average temperature	20 - 23	23 - 30	30 - 40	> 40
		18 - 20	15 - 18	< 15
Water availability (wa)				
Average annual rainfall (mm)	1250 - 1750	1750 - 2000	2000 - 2500	> 2500
		1000 - 1250	750 - 1000	< 750
Oxygen availability (oa)				
Drainage	Good, Moderate	Mod. Poor	Poor, mod. Rapid	Very poor, rapid
Rooting conditions (rc)				
Soil texture (surface)	Fine, slightly fine, medium	-	Slightly coarse	Coarse
Coarse material (%)	< 15	15 - 35	35 - 55	> 55
Soil depth (cm)	> 100	75 - 100	50 - 75	< 50
Peat:				
Thickness (cm)	< 60	60 - 140	140 - 200	> 200
Thickness (cm), if stratified with mineral material/ enrichment	< 140	140 - 200	200 - 400	> 400
Ripening	sapric*	sapric, hemic*	hemic, fibric*	fibric
Nutrient retention (nr)				
CEC-clay (cmol/kg)	> 16	≤ 16		
Base saturation (%)	> 35	20 - 35	< 20	
pH H2O	5.0 - 6.0	4.5 - 5.0	< 4.5	
		6.0 - 7.5	> 7.5	
C-organic (%)	> 1.2	0.8 - 1.2	< 0.8	
Toxicity (xc)				
Salinity(ds/m)	< 4	4 - 6	6 - 8	> 8
Sodicity (xn)				
Alkalinity/ESP (%)	< 15	15 - 20	20 - 25	> 25
Toxicity of sulfidic (xs)				
Depth of sulfidic (cm)	> 125	100 - 125	60 - 100	< 60
Erosion hazard (eh)				
Slope (%)	< 8	8 - 16	16 - 30	> 30
Erosion hazard (eh)	Very low	Low-moderate	Severe	Very severe
Flooding hazard (fh)				
Flooding	F0	F1	F2	> F2
Land preparation (lp)				
Surface stoniness (%)	< 5	5 - 15	15 - 40	> 40
Rock out crops (%)	< 5	5 - 15	15 - 25	> 25

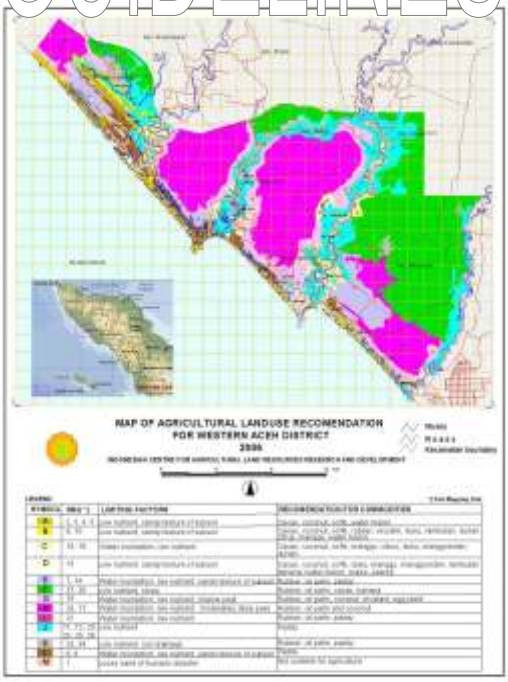
Source: Djaenudin et al. (2003).

Note: sapric*, hemic*, fibric* =sapric, hemic, fibric with stratified of mineral material/enrichment

GUIDELINES

LAND SUITABILITY EVALUATION

with a Case Map of Aceh Barat District



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