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LAND EVALUATION FOR PADDY CULTIVATION IN THE RECLAIMED TIDAL LOWLAND IN DELTA SALEH, SOUTH SUMATRA, INDONESIA

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Abstract: The research objective of this study is to carry out land evaluation for paddy cultivation in reclaimed tidal lowland area in Delta Saleh, South Sumatra, Indonesia. Research sampling was conducted based on the land typology of the area, i.e. typology of A, B, C and D. The works were divided into two steps, field survey activities and laboratory work. The results showed that i.e, the land has the potency and suitability for paddy cultivation which can be divided into four main groups, i.e. high potency (classes of S1 and S2), middle potency (classes of S2 and S3), low potency (class of S3) and less potency (class of N). The high potency classes S1 and S2 was a land suitability for paddy cultivation with, suitability > 75% and limited suitable < 25%. An acreage of this high potency land is around 17,982.3 ha (67.4% of the total research area) with its land productivity of more than > 6.0 tons dried paddy per ha per year. The middle potency classes of S2 and S3 were a land with suitability between 25-50% and limited suitable 50-75%. An acreage of this middle potency land is around 5,389.4 ha (20.2% of the total research area) with its land productivity of around 2-5 tons dried paddy per ha per year. The low potency classes S3 was land suitability for paddy cultivation with limited suitable 50-75% and not suitable 25-50%. An acreage of this low potency land is around 3,308.3 ha (12.4% of the total research area) with its land productivity of around 1-2 tons dried paddy per ha per year. The less potency classes of N were land suitability for paddy cultivation with limited suitable < 15% and not suitable > 75%. An acreage of this low potency land is not found in the field (0% of the total research area) with its land productivity of around < 1 ton dried paddy per ha per year. The needed efforts to improve land capability from original suitability to potential land suitability for rice cultivation are i.e. (1) to develop drainage systems, (2) to develop water barriers to retain the water in the cultivated land, (3) to apply agricultural lime in the land, (4) to apply some organic matters in the land without removal in organic matters, (5) to remove cations of Na and H, and (6) to apply the fertilizer of N, P and K

KEYWORDS: Land evaluation, paddy, reclaimed tidal land, Delta Saleh

Introduction

Land evaluation is used to assess the suitability of land for specified land uses. The increasing population pressure often causes over-exploitation of high potential land and/or misuse of marginal land. The rate of change of pressure on land in the critical regions will increasingly violate the limits of the land's carrying capacity, even if available technological package for managing the land resources is better (Armanto *et al.*, 2008). Land evaluation is purposely created for land use planning. Most land evaluation is qualitative and based on an expert judgment. The experts interpreted their data to make understandable by the planners, engineers, extension officers and farmers. More recently, the in-depth studies of specific soil-related constraints, in particular soil fertility, water availability, soil workability and degradation hazards such as soil erosion and soil salinization have all facilitated the quantitative simulation of specific land use processes and opened the way for yield prediction. The development of information technology during the last twenty years has enabled researchers to make rapid progress in the analysis of interactions between land resources and land use and in quantitative land evaluation based on quantitative modeling of land use systems (Beek *et al.*, 1996, Armanto, 2003).

Land use planning is expected to make a major contribution to the realization of sustainable development. It can facilitate the allocation of land to the use(s) that provide the greatest sustainable benefits. This demands that development remains within the carrying capacity of supporting ecosystems. The continuing worldwide mismanagement of soils, inadequate land use policies and ineffective implementation of soil management and conservation programs, raises questions about how the communication of natural resources information to land use planners and decision makers can be improved and how this knowledge can be placed for good use (Lagacherie *et al.*, 2006, Mcbratney *et al.*, 2003).

The main problems that developed in the Delta Saleh since reclaimation process for transmigration program till today are said that the land suitability is not really known, the changing of the landuse patterns are difficult to estimate and the detail distribution of traditional uses from year to year was not known. Thus, we do not know which area is suitable for any particular crop until presently, these questions are still unanswerable, and thus the land remains with low production (Armanto, 2002, Armanto *et al.*, 2010). This study aims to carry out land evaluation for paddy cultivation in the reclaimed tidal lowland of Delta Saleh, South Sumatra.

Materials and Methods

This study was conducted in the Delta Saleh, Banyuasin District, South Sumatra, Indonesia. The study was carried out from April to December 2010. Materials used in this study were, 1) Maps of reclamation sites network and hydrotopography, 2) Landsat TM image Path/Row 124/62 in June 1992, June 2001 and August 2009 that were packaged in a CD-media ROM, and 3) Questioner for reclamation network conditions, cropping patterns, and tracking network data. The tools used were Global Position System (GPS), ground driller, Peroxide (H_2O_2), label, elastic band, plastic sample, program of image interpretation tool of Arc View GIS (Geographical Information System) and its stationery.

The data processing and analyses were carried out in stages. The stages of the analyses are explained in the flow diagram chart of Figure 1. The data analyses (FAO, 1976, FAO, 1981) include:

1) ***Pre processing:*** Activities included image rectification process on a scale of 1: 50,000 which are doing the rotation, translation and geometric correction of remote sensing imagery to obtain the position and location in accordance with the position and location on the earth's surface in a Universal Transverse Mercator System *(UTM).* It was followed by atmospheric correction to minimize variations in the value of an object under the influence of the spectral atmospheric particles and radiation of the sun.

2) ***Processing:*** This includes: 1) Sharpening the image contrast stretching and balancing. Special sharpening is also performed on the territory where there are shadows or cirrus clouds using contrast stretching the original data format 11, 2) Vectorisation including the process objects digitize landuse, roads, irrigation, rivers, settlements, fields, bushes, grass, etc. Delineation of each object was stored in the coverage area of different layers, so it is possible for the object of analysis in accordance with the objectives and specific needs, 3) Interpretation of land coverage of Landsat data based on the key remote sensing data interpretation, and 4) data format conversion of GIS of thematic maps include administrative, soil, slope, elevation, geology, climate, etc. into a digital map 05).

3) ***Field Survey:*** The field survey aims to conduct field checking or verification of land coverage information and check the

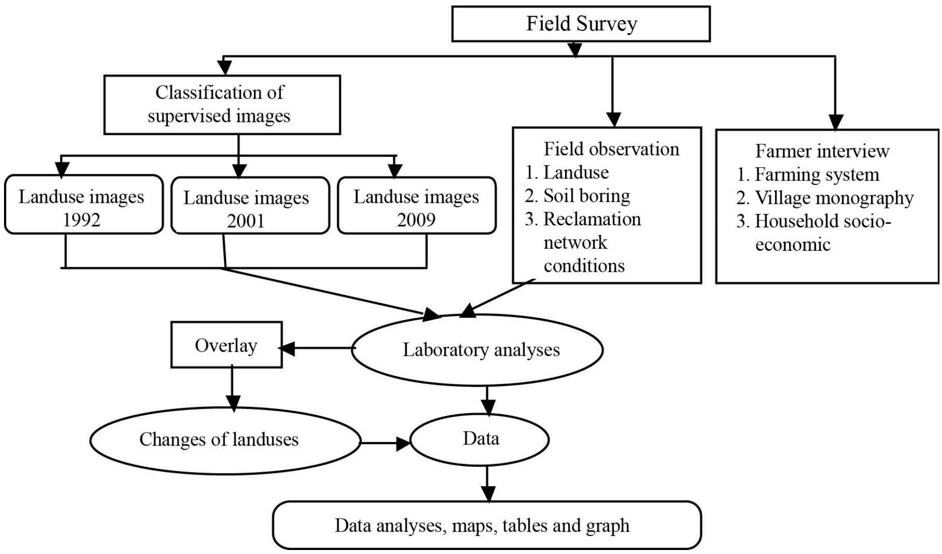

Figure 1: Flowchart of field activities and data analysis.

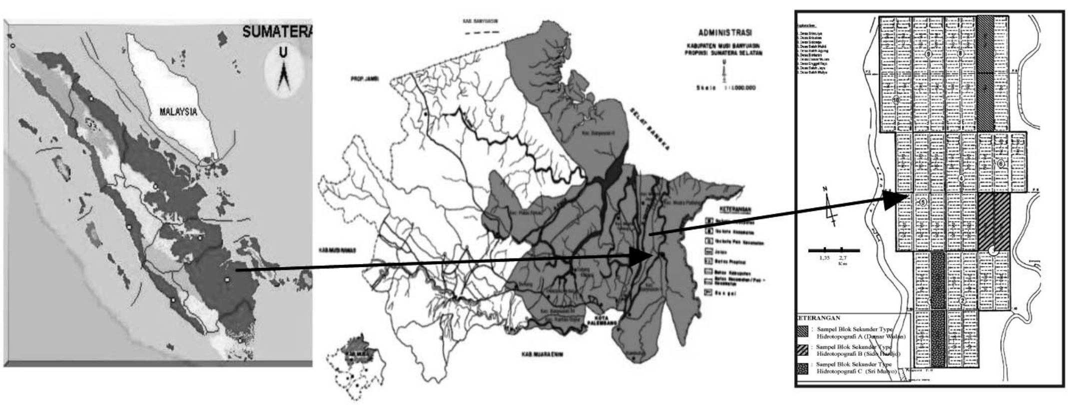

Figure 2: Research site of Delta Saleh in Eastern Parts of Sumatra.

class boundaries, especially boundaries plantations.

4) ***Analysis:*** This activity involves the analysis of availability and landuse pattern. Landuse pattern analysis was done by combining spatial information with land coverage of spatial information of land characteristics, analysis of changes carried out only in 1992; 2001 and 2009. This was done according to the availability of satellite images.

Results and Discussion

Overview of Delta Saleh

The Delta Saleh is located geographically at 105^{o} 02'31" to 105^{o} 33'66" longitude and 2^{o} 20'10" up to 3^{o} 07'43" latitude. The Delta Saleh in the northern part is bordered with Bangka Strait, in the southern with the river Musi and Cinta Manis Transmigration area, in the eastern with the River Saleh, while in the western part with the Upang River (Figure 2).

Delta Saleh is a tidal land that was reclaimed and occupied by migration since 1981. Based on the type of land reclamation in the Delta Saleh hydrotophography, the flood type B was 1,856 ha area, type C 5,630 ha and type D 2,944 ha (Figure 2). The dominant land is a potential land area with about 9,438 ha, and acid sulphate soil with around 992 ha.

Descriptions of Soil Profiles

The descriptions of the soil profiles were obtained through the field observations and analysis of the soil and water samples in the laboratory.

The soil pedons in the study site consists of several horizons based on the soil depth. The horizon of Apg (0-20 cm) is upper soil horizon which are strongly cultivated. The horizons also showed strong process of gleization as indicated by the low chroma (2) and a rusty that almost spread to the entire horizons. Bg horizon (20-41 cm) is a horizon that has undergone further development as indicated by changes in color with a lower value. This horizon showed gleization process with a low chroma (1). Cg1 horizon (41-63 cm) and Cg2 horizon (63-100 cm) are the parent material horizon which is slightly influenced by the process of pedogenesis. The process of pedogenesis which can be observed in the field is the result gleization process as indicated by the low chroma (0) and rusty spread on the entire horizon.

The soil texture is dominated by sand (25.10-50.61%), followed by silt (32.13-40.90%), and clay fractions (17.26-35.84%). Therefore, the soil has a large pore spaces, so that the soil is very porous and less able to hold water. As a result, it is relatively higher in water loss. While the texture analysis method in pedons showed an increase in clay fractions from the horizon above it, except in the Cg1 horizon (depth of 41-63 cm) to the Cg2 horizon (63-100 cm). This is caused by different sediments, but it has not been able to form under argillic horizon. This is because the total clay content of more than 40%, so as to meet the requirements of argillic horizon, it must have a clay increase of more than 8% over the horizon clay content on it. It turned out that these requirements are not met.

The soil color from top to bottom on each horizon indicates a color change that leads to more black color. The top layer of soil is brown-grey (10YR5/2 - 10YR4/1), while the horizon beneath is blackish grey to dark grey (2.5 Y4/0 to 2.5 Y3/0). This happens due to the reduction process permanently inundated (water logged), so that the color of grey (gley), grew stronger. Even though the color of the topsoil has a value lower than 3.5 (moist), but it cannot enter into the other epipedons, thus it is included in the category ochric epipedon. Rusty soil was found almost spreading in all horizons except the Bg horizon (20-41 cm depth). Rusty reddish brown (7.5 YR5/8) was found in the Apg and deeper horizons, leading to a rusty color of dark grey (10YR4/1) in Cg2 horizon. Rusty like this is often found in the soil containing with the moisture regime as a result of groundwater fluctuations.

Evaluation of Soil Fertility Status

Fertile soil exists when the soil is able to provide the sufficient and balanced nutrients for the plant, free of Al toxicity or excess salts and should be sufficient to provide water and air. Plants will grow well when soil fertility and other environmental factors can support its growth. The level of soil fertility is determined by several factors, including contents of primary mineral and organic matter, the level of climate destruction, sorption complex, the intensity of leaching and soil reaction. In general, soil fertility status at the study site is low, it is characterized by the low levels of Nitrogen (N), potassium (K) and organic C and soil acidity is high (very acid). The results of soil analyses from composite samples are presented in Table 1. The composite samples were taken from each Soil Mapping Unit (SPT).

The soil reaction is closely related to some soil chemical properties, such as solubility H, organic matter content, the content of the bases, saturation-Al and so others. Soils with

Table 1: Results of laboratory analyses and soil texture.

Laboratory analyses and units		Results of laboratory analyses			
		SPT*/ 1	SPT 2	SPT 3	SPT 4
pH H_2O (1:1)	-	4.26-4.71	3.90-4.16	3.82-4.44	4.14-4.18
pH KCl (1: 1)	-	3.52-3.78	3.42-3.52	3.39-3.77	3.39-3.45
C-organic	%	5.51-6.41	3.98-5.12	4.51-5.28	2.45-4.44
N-Total	%	0.22-0.48	0.35-0.40	0.37-0.43	0.19-0.34
P-Bray I	ppm	25.95-38.70	9.75-19.50	13.80-18.00	5.10-7.65
K-exch **/	me/100g	0.26-0.32	0.32-0.38	0.32-0.64	0.19-0.32
Na	me/100g	0.55-0.65	0.55-0.65	0.55-1.09	0.33-0.66
Ca	me/100g	1.21-1.65	0.63-1.45	0.83-1.30	0.63-0.78
Mg	me/100g	0.65-1.00	0.27-0.80	0.27-0.55	0.15-0.22
CEC	me/100g	14.23-18.05	16.40-17.23	15.58-16.05	16.88-19.05
Al-exch	me/100g	2.32-2.80	4.52-5.88	3.96-6.52	5.82-6.60
H-exch	me/100g	0.16-0.56	0.32-1.32	0.40-0.88	0.16-0.26
Texture					
1) Sand	%	25.10-50.61	36.83-31.63	38.83-42.32	25.69-37.79
2) Silt	%	32.13-39.06	35.44-39.04	34.80-38.61	32.72-40.90
3) Clay	%	17.26-35.84	27.73-29.33	22.56-22.88	29.49-33.41

Explanation: */ SPT: Soil Mapping Unit, **/ exch: exchangeable
Source: Results of laboratory analyses (2010).

high hydrogen ion solubility and high organic acids, low bases content and high Al saturation generally reacted as an acidic to a very acidic soil. Instead, the soils have properties opposite to those above generally reacted neutral. The average value of pH H_2O and pH KCl are 3.82-4.71 and 3.39-3.78 respectively which indicated that the soil is generally classified as acid. The value of pH and CEC data was connected each other. This is also an indication that the oxidation of Fe and Al-free on these lands is rather high. This condition is possible because of the circulation of water in this area is poor.

Organic matter and N-total content clearly showed the influence of organic matter for the plant growth both in terms of physical, physical-chemical and biological. Mineralization of organic matter is important to produce plant nutrients. Organic matter is the main source of N elements. Therefore the total-N content is correlated with soil organic matter. In addition to the adding a number of nutrients in a pool, organic matter plays a role in oxidation-reduction process that helps the nutrient concentrations retain in soil solution. In general, organic content and N-total in the study plot area is relatively moderate.

The levels of organic C ranged from 2.45% (low) to 6.41% (medium). The organic material on the top layer is still relatively moderate; the decomposition process is not perfect because the land is often flooded. The condition of land has not been clearly opened, dominated by Gelam forest and tidal swamp grass. This condition reflects that the soil organic matter is influenced by vegetation. It is possible because at certain location that has vegetation growing shrubs and grasses, are not good because it often flooded. The soil organic matter content is derived from vegetation growing on it, the more and varied vegetation that will grow, the more the soil organic matter content (Table 2). The organic materials have a significant role both in chemistry, namely as a provider of nutrients and soil nutrient buffer as well as physically, that is capable of improving the condition of soil structure and water absorption.

N content can be predicted from the levels of C-organic. The high value of C-organic N was also followed by the value of the total. Soils with shrubs and tidal swamp grass proved to have a value of N-high total in the upper layer compared with the bottom layer, N-total analysis shows the range of 0.3% seen in both the upper layer and only 0.1% at the bottom. This suggests that the availability of nutrient nitrogen in tidal wetlands is influenced by the presence of organic material because the main source of soil N was organic material. The soils that have high organic matter content will be followed by a high total N concentration as well. With the parameter value of N is clearly shown that the quality of land has no signs of environmental damage.

Cation exchange capacity (CEC) reflects the amount of surface charge. This value is strongly influenced by the clay content, clay mineralogy, and organic matter content as well as alkali-action exchanged. The finer the soil texture is and the higher organic matter will be and both components generally increase the value of CEC. In addition, the CEC is closely related to soil pH value. In soils with high pH, sorption complex of silicate clay minerals are generally dominated by 2:1 or 2:2 types with permanent charge. In acid/very acid soils, their charge is generally dominated by variable charge of the oxidation or Fe hydroxide, and Al, silicate clay mineral type of 1:1 silicate clay or a mixture with oxidation/iron hydroxide Al. The CEC values of soils at the study sites are in ranges (14.23-18.05 me/100 g). This condition occurs because the levels of base cations (like Ca, Na, K, and Mg) are low. Thus the sorption complex soils are believed to be dominated by 1:1 clay minerals or mixed oxidation/hydroxide of Fe and Al.

The phosphorus (P) in the soil is generally found in the forms of organic and inorganic fraction, depending on the levels of organic material. Organic P was found in the form of "surface-P" which is relatively more available than "sub-surface". The forms of inorganic P are composed of Al-P, Fe-P and Ca-P. The availability of P for plant is influenced by several factors, namely soil pH, content of Fe, Al and Mn in solution, the amount and rate of decomposition of organic matter, Ca availablity and the activity of soil organisms. The P-Bray I analyses have an average rating of low to moderate (5.10-38.70 ppm P_2O_5). This condition is probably due to the influence of tidal flood water. This is consistent with low soil pH, which is usually followed by very low Ca content and an acidic parent material determines the availability of the P element. Bray I method usually extracts forms of Ca-P soluble and the new Al-P formed. Extraction is difficult to extract Ca-P forms which are alkaline and Fe-P.

The potassium (K) of soils is connected to sediment types and vegetation types that will influence nutrient availability, including nutrients K. Potassium content is around 0.19-0.64 me/100g (classified as low).

Aluminum (Al-dd) belongs to micro nutrients which is needed by plant in very little amount, and if the presence of Al in the soil is much, it will be toxic and inhibiting factors for plant growth. The Al content is fluctuated depending on the process of soil development process. The Al content is increasing if drainage is in bad condition (land is often flooded). Therefore, it can be concluded that the soils should be in good drainage system.

Pyrite will explain levels of soil development and its levels increased with soil depth. At a depth of < 41 cm, its levels ranged from 0.05-0.08% pyrite, while starting 41 cm depth levels it ranged from 2.72-5.02% pyrite. Based on the criteria above sulfidic material limitation, the soil contains pyrite (sulfidic material) was found in the soil depth of 50-70 cm.

Land Suitability for Paddy Cultivation

The most important paddy growing environment is the climate, physical conditions and soil fertility. Based on these factors it is classified into 4 (four) classes of land capability, i.e. Class of S1 (highly suitable), S2 (suitable),

Table 2: Potency and land suitability for paddy.

No.	Potency and land suitability	Class of land suitability */	Acreages (ha)	Percentage (%)	Productivity (ton paddy / ha/year)
1.	High potency (S1, S2)	Highly suitable (S1)	13,900.3	52.1	> 10
		Suitable (S2)	4,082.0	15.3	6-9
2.	Middle potency (S2, S3)	Suitable (S2)	3,415.1	12.8	4-5
		Marginally suitable (S3)	1,974.3	7.4	2-3
3	Low potency (S3)	Marginally suitable (S3)	9.75-19.50	13.80-18.00	5.10-7.65
4	Less potency (N)	Temporary not suitable (N1)	0.0	0.0	< 1
		Permanently not suitable (N2)	0.0	0.00	Very low
	Total		26,680	100.0	

Source: */Land suitability is based on topographic maps of Indonesia scale 1:50.000, landsat imaginary analyses (2010), soil maps, geology maps, field observations and laboratory analyses (2010).

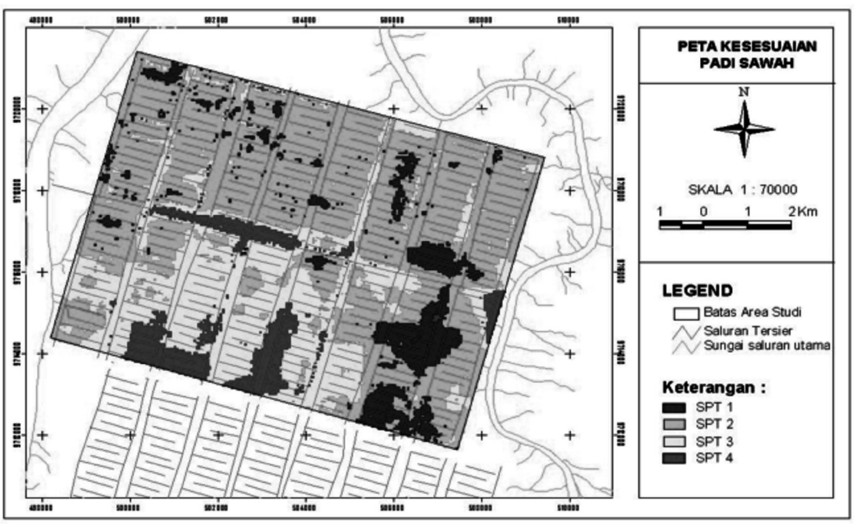

Figure 3: Land suitability map for paddy in Delta Saleh.

S3 (marginally suitable), and N (not suitable). Based on the comparison criteria of land quality and land use requirements (PPT, 1983) and Land Mapping Unit (SPT) according to paddy, land suitability for paddy in Delta Saleh is classified as highly suitable classification (S1). Soil class at the suitable (S2) is found in almost the entire Delta Saleh and the marginally suitable (S3) area is located along the borders of the River Saleh. Land suitability classes are completely presented in Table 2 and described spatially as maps in Figure 3.

Based on Table 2, the potential land for development of the paddy can be further elaborated in the form of high-potential, medium potential and low potential, which is explained as the following:

Table 3: Limitation factors of land suitability classes for paddy in the research site.

Class	Sub class */	Limitation factors	SPT	Acreages	
				ha	%
S3	S3-anxf	Soil acidity, soil fertility, flood (water stagnant) and Al, Fe toxicity	1	3,308.3	12.4
S2	S2-anxf	Soil acidity, soil fertility, flood (water stagnant) and Al, Fe toxicity	2	13,900.3	52.1
S2	S2-nfx	Soil fertility, flood (water stagnant) and Al, Fe toxicity	3	1,974.3	7.4
S1	S1-nx	Soil fertility and Al, Fe toxicity	4	7,497.1	28.1
Amount				26,680	100.00

Explanation: */ a: Very acid soil acidity and difficult to be managed.
n: Very low to low soil fertility
f: Flood (frequency and duration), flood air depth and water flow should be considered in order to determine this limitation.
x: Salinity, high salt content which limits crop growth.
Source: Results of field observation, laboratory and image analyses (2010).

1) Highly potential land has land suitability classes (LSC) for paddy, 75% is classified suitable and < 25% belongs to marginally suitable.
2) Moderately potential land has land suitability classes (LSC) for paddy, 25-50% is classified suitable and 50-75% belongs to marginally suitable.
3) Lowly potential land has land suitability classes (LSC) for paddy, 50-75% belongs to marginally suitable and 25-50% is classified as not suitable.

According to Figure 3, more than 52.1% of the research area belongs to highly suitable (S1), that means it is very likely to be developed for paddy. By considering the factors of land suitability, we can obtain maximum yields of paddy. Theoretically predicted with high-potential land suitability it can produce > 10 tons per ha per year. For some areas with suitable class (S2), which is about 15.3%, and is large enough also to be developed and it is considered theoretically to produce 6-9 tons paddy per ha per year.

As for areas of moderate to low potential which have some limiting factors for the development of paddy, namely: 1) the roots condition (r) that includes inhibiting factors, namely soil drainage class, soil texture and rooting depth. Rooting depth is an indicator for effectively shallow depth of soils, especially in areas with high pyrite content and poor drainage, 2) Holding capacity of soil nutrients (f), which include inhibiting factor is the CEC and soil pH, 3) Poisoning (x), which include inhibiting factor is the salinity, 4) Existence of potential acidic sulfate soil. The lower potential suitability means it needs more input to make the land becomes suitable for the growth and development of paddy. To soil class of N (not suitable), then the constraints are permanent and very difficult to be reclaimed or require a very high cost. Based on the character of both physical and chemical properties, the research location does not have soils that belong to not suitable N (Table 3).

Almost all the areas are suitable for paddy, some biophysical soil and climate constraints to determine the level of suitability. From the facts on the ground and development and regional development issues that crop is likely to be developed. Efforts to improve the ability of land for food crops are presented in full in Table 4. Table 4 states clearly that paddy is highly suitable (S1) for the soils if organic material, lime and fertilizer P are given. Land suitability

Table 4: Efforts to increase land capability for paddy.

SPT	Land suitability		Efforts to increase land capability for paddy from actual suitability to potential land suitability
	Potential	Actual*/	
1	S2	S3-anfx	1) Make drainage channels 2) Make barriers for holding of water going to the land 3) Give agriculture lime 4) Give and maintain organic matters in the soils 5) Do not burn biomass 6) Do not wash elements of Na and H 7) Fertilize soils with N, P and K fertilizers
2	S1	S2-anfx	1) Make drainage channels 2) Make barriers for holding of water which going to the land 3) Give agriculture lime 4) Give and maintain organic matters in the soils 5) Do not burn biomass 6) Fertilize soils with N, P and K fertilizers
3	S1	S2-anfx	1) Make drainage channels 2) Give agriculture lime 3) Give and maintain organic matters in the soils 4) Do wash elements of Na and H 5) Fertilize soils with N, P and K fertilizers
4	S2	S1nx	1) Make drainage channels 2) Give agriculture lime 3) Give and maintain organic matters in the soils 4) Fertilize soils with N, P and K fertilizers

Explanation: */ a: Very acid soil acidity and difficult to be managed
n: Very low to low soil fertility
f: Flood (frequency, duration, water velocity and salt intrusion), flood air depth and water flow should be considered in order to determine this limitation.
x: Salinity, high salt content which limits crop growth.

Source: Results of field observation, laboratory and image analyses (2010).

Table 5: Regionalization of soil orders and land suitability for paddy.

No.	Order	Sub-order	Great Groups	Land suitability level*/
1.	Histosols	Hemists Saprists Folist	Haplohemists & Sulfihemists Haplosaprists & Sulfisaprist Haplofolist	S2 and S3 S2 S2
2.	Entisols	Aquents Fluvent	Hydraquents Fluvaquents, Endoaquents & Sulfaquents	S1 and S2 S1 and S2 S1 and S2
3.	Gelisols	Histels	Soil fertility, flood (water stagnant) and Al, Fe toxicity	S2 and S3 S2 and S3
		Orthels	Historthels, Aquorthels & Haplorthels	S2 and S3 S2 and S3
4.	Inceptisols	Aquepts	Epiaquepts, Endoaquepts & Sulfaquepts	S1 and S2 S1 and S2

Explanation: */ S1 (Highly suitable), S2 (Suitable) and S3 (Marginally suitable).

for paddy is found on flat land until the slope (0-10%). For a more sloping land (> 10%) it is needed a simple conservation efforts, such as individual terrace to anticipate soil erosion.

Relationships between Suitability Class with Soil Classification

The relationships between suitability classes with soil classification are trying to find out the linkages of regionalization patterns for predicting land suitability. This relationship is agreed as vital instrument for research linkages with other research, specifically in terms of land suitability with soil classification (Table 5). Generally these relationships are divided into 4 (four) orders. For Entisols, it is identified 2 (two) sub-groups, namely Sulfic Tropaquens and Typic Tropaquents. For Inceptisols, there are also 2 (two) sub-groups, namely Sulfic Tropaquepts and Typic Tropaquepts. Apparently orders Entisols and Inceptisols can include land suitability S1 to S2 (Table 5). This can be explained that the Entisols is a newly formed land and contains a lot of soil nutrient (weathered yet advanced), so that could be incorporated into land suitability S1, but this relationship only applies specifically to this study area. For other areas, it still needs to be further reviewed.

Conclusion

In the conclusion, the result of this study revealed that:

1) The land has the potency and suitability for paddy cultivation which can be divided into four main groups, i.e, high potency (classes of S1 and S2), middle potency (classes of S2 and S3), low potency (class of S3) and less potency (class of N).
2) The high potency classes S1 and S2 was a land suitability for paddy cultivation with, suitability > 75% and limited suitable < 25%. An acreage of this high potency land is around 17,982.3 ha (67.4% of the total research area) with its land productivity of more than > 6.0 tons dried paddy per ha per year.
3) The middle potency classes of S2 and S3 was a land with suitability between 25-50% and limited suitable 50-75%. An acreage of this middle potency land is around 5,389.4 ha (20.2% of the total research area) with its land productivity of around 2-5 tons dried paddy per ha per year.
4) The low potency classes S3 was a land with suitability for paddy cultivation with limited suitable 50-75% and not suitable 25-50%. An acreage of this low potency land is around 3,308.3 ha (12.4% of the total research area) with its land productivity of around 1-2 tons dried paddy per ha per year.
5) The less potency classes of N was a land suitability for paddy cultivation with limited suitable < 15% and not suitable > 75%. An acreage of this low potency land is not found in the field (0% of the total research area) with its land productivity of around < 1 ton dried paddy per ha per year.
6) The needed efforts to improve land capability from original suitability to potential land suitability for rice cultivation are i.e. (1) to develop drainage systems, (2) to develop water barriers to retain the water in the to cultivated land, (3) to apply agricultural lime in the land, (4) to apply some organic matters in the land without removel in organic matters, (5) to remove cations of Na and H, and (6) to applye the fertilizer of N, P and K.

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