Land characteristics and land evaluation for development of the area of other uses (APL) in Siempat Rube Sub District Pakpak Bharat District

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Abstract. The opening of a new area needs to be investigated so that its land resources can be used to determine land suitability for certain uses so that the area of other uses (APL) in Siempat Rube Sub-district needs to be supported with information on land suitability. The purpose of this study was to evaluate the characteristics of APL land suitability level and analyse improvement efforts to increase productivity on APL in Siempat Rube District. The research was used the survey method. Units of land were based on land maps. The research data were analysed using the matching method. Soil characteristics in Siempat Rube Sub district, both physical and chemical, have very diverse characteristics which can be a limiting or supporting factor in the development of agricultural crops, especially the development of irrigated rice fields. The actual land suitability for paddy fields were not suitable (N) (2629.44 ha) and marginally suitable (S3) (638.26 ha). After efforts to improve the level of potential land suitability for paddy to become not suitable (N) covering an area of 29.31 ha and marginally suitable (S3) covering an area of 3238.39 ha.

1. Introduction
Soil has characteristics that affect plant growth that will be cultivated. Soil classification and land evaluation is one way to find out the suitability of a land to develop agricultural crops [1,2]. Soil has various properties, which consist of physical, chemical and biological properties. With the variation of these properties, the fertility rate in various types of soil varies too, because the fertility of soil depends on these traits. Therefore, an understanding of soil characteristics is needed so that utilized according to its potential [3,4].

Minister of Forestry Decree 44 of (2005) about forest areas in North Sumatra Province with the forest area in Pakpak Bharat Regency based on the decree is 120,711 ha (88.60% of the total area of Pakpak Bharat Regency), (4.36% Nature Reserve Forest, 41.95% Limited Production Forest, 34.61%, Protection Forest, and 7.68% Production Forest). Furthermore, the Decree was issued by the Ministry of Forestry, 2005 but the Decree Letter was revised with the Minister of Forestry Decree No. 579/
Menhut-II / 2014 in accordance with the request for a proposed revision of forest area by the Pakpak Bharat Regency government. With the decree, the forest area released into another use area (APL) is only a small part of the proposed area. The conversion of productive agricultural land into non-agricultural land has been ongoing and is difficult to avoid as a result of the rapid rate of development accompanied by climate change [5]. To support rice self-sufficiency, it is necessary to expand the area of wetland rice in areas that have the potential for the development of irrigated rice fields, but are generally constrained by low land quality [6] and inadequate infrastructure [7].

Siempat Rube Sub district covering an area of 3,267.70 Ha of the total area of other uses (APL) in Pakpak Bharat Regency [8] With the vast area of APL that is quite extensive in the sub-district, of course, the potential of the land is very large to be utilized in agricultural cultivation activities, with the hope that this productivity can improve the welfare of the local community, most of whom work as farmers. The opening of a new area needs to be examined for its land resources to determine the suitability of land for certain uses, so that the land can be productively sustainable [9]. Selection of suitable land requires methods and methods for evaluating land suitability that are more actual and more reliable as guidelines in efforts to manage land to achieve normal productivity [10].

Rice as food crops is consumed by approximately 90% of the total population of Indonesia for daily staple food [11]. Increasing productivity and rice production must continue to be carried out to increase the income and welfare of farmers and ensure food security. The use of superior rice varieties that have high yield potential and improved farming quality, such as tillage, fertilization and planting methods have succeeded in increasing rice productivity [12]. Basically, an increase in production can be achieved through an intensification, extensification and diversification approach. Increasing rice production by intensification is one of the efforts to use existing land intensively. Several studies have been conducted using GIS for mapping land suitability in several locations in North Sumatera [13-17]. Thus the target will be achieved if production factors such as fertilizer use, use of superior varieties, availability of irrigation are needed in sufficient and balanced quantities [18].

The efforts made by the government to maintain food self-sufficiency are improving the quality of the intensification, extensification, diversification and rehabilitation programs of agricultural land. Expansion of the planting area (extensification) is one of the choices to increase the production of various commodities including lowland rice [19]. Rice fields have the main characteristic, the land is always flooded. In its management, the standard treatment provided is fertilization and irrigation. Irrigation water sources are usually from river flows around rice fields [20]. The amount nutrients or lime that must be given land and plant systems can be determined precisely by knowing the level of soil fertility that can be done by evaluating the soil level of land suitability for crops such as rice paddy can be done with how to compare the characteristics of existing land in the field, with the ideal level of highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N) [21,22].

Low soil fertility will certainly require a lot of input so that in turn the cost of farming becomes more expensive. Thus, of course in an effort to develop agriculture it is important to know the characteristics and quality of the land [23], so that best management alternatives can be provided [24]. Therefore, it is important to evaluate land suitability for superior commodities in the APL area of Siempat Rube District, Pakpak Bharat Regency to find out the potential of the land.

2. Materials and methods

This research was conducted in January 2018 until March 2018 conducted in the field and laboratory. Research in the field was carried out on dry land and other land (dry land agriculture mixed with shrubs, shrubs, open untapped land) outside the forest area or other Use Areas (APL) in Siempat Rube Sub district, Pakpak Bharat Regency, North Sumatra Province. Then continued with soil analysis at the Soil Fertility Laboratory, Faculty of Agriculture, University of North Sumatra.

The study was conducted using a survey method consisting of 5 stages, namely preparation, pre-survey, main survey, soil analysis in the laboratory and data processing. Taking soil samples is done by drilling in the land unit area. Land units are selected based on a map of land use units. Based on the use of the map, there are as many as 6 sample points after being compiled. Determining the value of land
characteristics for soil samples was carried out using a soil drill at a depth of 0-30 cm, and 30-60 cm. Determination of soil chemical properties was carried out by soil analysis in the Research and Technological Laboratory of the USU Faculty of Agriculture, Medan. Soil samples taken from the field, dried and then analysed in the laboratory. Parameters observed in the laboratory were soil texture, soil pH, total N, P₂O₅, K₂O, CEC, and DHL.

The soil analysis method used for each parameter in the laboratory. Evaluation of land suitability was carried out by a matching method, namely by matching and comparing between land characteristics data from the field and the laboratory with the land suitability criteria for wetland rice. The land suitability criteria used refer to LREP II [25].

The research data obtained were interpreted into criteria for soil fertility level of land suitability [26]. The land evaluation process is determined by matching between the characteristics of the land with the requirements for growing durian plants, which are formulated in the technical guidelines for evaluating land for agricultural commodities [27,28]. The results of land suitability of crop commodities are displayed in the form of actual and potential land suitability tables using GIS software and mapped actual land suitability and suitability of potential land

3. Result and discussions

| Land characteristics | Land Unit 1 (0-30 cm) | Land Unit 2 (30-60 cm) | Land Unit 3 (30-60 cm) |
|----------------------|---------------------|----------------------|----------------------|
| Average Temperature (°C) | 16.95 | 16.95 | 21.07 |
| Place height (mdpl) | 1558 | 1558 | 872 |
| Rainfall (mm) | 2920 | 2920 | 2920 |
| Zone Agroclimate (Oldeman) | D1 | D1 | D1 |
| Dry Moon Length | 30 cm | 30 cm | 30 cm |
| Humidity (%) | 83.28 | 83.28 | 83.28 |
| Availability of oxygen | Good | Good | Good |
| Texture | Clay | Clay | Clay |
| Nutrient Retention /nr | 6.75 | 7.15 | 7.01 |
| CEC of clay (cmol) | >100 | >100 | >100 |
| Base saturation (%) | 34.44 (T) | 19.92 (S) | 24.84 (S) |
| pH H₂O | 19.49 (SR) | 19.59 (SR) | 21.14 (R) |
| Alkalinity/ESP (%) | 5.87 (AM) | 6.1 (AM) | 6.24 (AM) |
| Nutrient Availability /na | 3.24 | 3.17 | 3.19 |
| N-total (%) | 0.23 (S) | 0.19 (R) | 0.27 (S) |
| P2O5 Bray II (ppm) | 13.02 (R) | 4.88 (SR) | 9.07 (SR) |
| K-exchange (mg/100g) | 1.457 (ST) | 1.069 (ST) | 1.243 (ST) |
| Sodicity /xn | 1.22 (SR) | 1.63 (SR) | 2.06 (R) |
| Alkalinity/ESP (%) | 3 | 3 | 6 |
| Erosion hazard/eh | Very light | Very light | Very light |
| Slope (%) | F0 | F0 | F0 |
| Erosion hazard | 0 | 0 | 0 |
| Flood hazard/fh | 0 | 0 | 0 |

Siempat Rube District is a hilly area, located at the height of the air temperature in Siempat Rube District, Pakpak Bharat Regency, ranging from 16,950-21,070°C. The air humidity in this area is 83.20%. While the annual rainfall in this area is 2,920 mm / year. High temperatures and rainfall tend to accelerate
weathering. The characteristics of the land in the APL in the Siempat Rube Sub district, which was previously a forest and agricultural land area. The results of the field survey and analysis of soil samples in the laboratory are presented in Table 1. Base on Table 1 and Table 2, the location of observations and sampling of these soils can be grouped into six land units, with land characteristics for depths of 0-30 each is presented in Table 1.

Table 2. Recapitulation of land characteristics in land units 4 - 6 in Siempat Rube District, Pakpak Bharat Regency

| Land characteristics | 4  | 5  | 6  |
|----------------------|----|----|----|
| **Land Unit**        | 0-30 cm | 30-60 cm | 0-30 cm | 30-60 cm | 0-30 cm | 30-60 cm |
| **Average Temperature (OC)** | 19.43 | 19.43 | 19.77 | 19.77 | 20.34 | 20.34 |
| **Place height (mdpl)** | 1145 | 1145 | 1088 | 1088 | 993 | 993 |
| **Rainfall (mm)** | 2920 | 2920 | 2920 | 2920 | 2920 |
| **Zone Agroclimate (Oldeman)** | D1 | D1 | D1 | D1 | D1 | D1 |
| **Dry Moon Length Months** | 1 | 1 | 1 | 1 | 1 | 1 |
| **Humidity (%)** | 83.28 | 83.28 | 83.28 | 83.28 | 83.28 | 83.28 |
| **Availability of oxygen** | Good | Good | Good | Good | Good | Good |
| **Texture** | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay | Sandy Clay |
| **Nutrient Retention (nr)** | 7.84 | 9.68 | 4.30 | 3.34 | 5.39 | 5.90 |
| **CEC of clay (cmol)** | >100 | >100 | >100 | >100 | >100 |
| **Base saturation (%)** | 31.44 (T) | 26.16 (T) | 25.08 (T) | 24.00 (S) | 20.24 (S) | 22.52 (S) |
| **pH H2O** | 11.27 (SR) | 12.21 (SR) | 19.53 (SR) | 19.97 (SR) | 25.52 (R) | 22.05 (R) |
| **C-organic (%)** | 6.07 (AM) | 5.67 (AM) | 5.62 (AM) | 6.34 (AM) | 5.61 (AM) | 6.01 (AM) |
| **Nutrient Availability (na)** | 1.15 (R) | 3.19 (T) | 1.00 (R) | 3.60 (T) | 3.68 (T) | 2.44 (S) |
| **N-total (%)** | 0.44 (S) | 1.39 (ST) | 0.05 (SR) | 0.72 (T) | 0.38 (S) | 0.72 (T) |
| **P2O5 Bray II (ppm)** | 10.58 (R) | 9.88 (SR) | 8.60 (SR) | 6.86 (SR) | 8.80 (SR) | 11.47 (R) |
| **K-exchange (mg/100g)** | 1.264 (ST) | 1.098 (ST) | 1.264 (ST) | 1.064(ST) | 0.938 (T) | 1.009 (ST) |
| **Sodicity (xn)** | 1.74 (SR) | 2.40 (R) | 2.19 (R) | 2.15 (R) | 2.51 (R) | 2.22 (R) |
| **Alkalinity/ESP (%)** | 8 | 8 | 22 | 22 | 40 | 40 |
| **Erosion hazard (eh)** | Low | Low | Low | Low | Low | Low |
| **Slope (%)** | F0 | F0 | F0 | F0 | F0 | F0 |
| **Erosion hazard** | 0 | 0 | 0 | 0 | 0 | 0 |
| **Flood hazard (fh)** | 0 | 0 | 0 | 0 | 0 | 0 |

Siempat Rube sub district, Pakpak Bharat Regency has 4 wet months (> 200 mm) in a row and no dry months (<100 mm) respectively. So that Siempat Rube Sub district, Pakpak Bharat Regency can be classified in the Oldeman D1 agroclimate zone (Appendix 4). In the Oldeman D1 agroclimate zone, short-lived rice can be planted once and usually with high production due to high radiation flux density. In areas with the Agro-climate zone, Oldeman D1 has a long time to plant palawija.
3.1. Recapitulation of land suitability for *Oryza sativa* L

The recapitulation of improvement efforts based on the results of the evaluation of the suitability of wetland rice fields in Siempat Rube District, Pakpak Bharat Regency is presented in Table 3 and the land suitability class for *Oryza sativa* is presented in Table 4. The limiting factors that can be improved are soil drainage, base saturation, organic C, total N, P2O5, slope, and erosion hazard level.

Table 3. Recapitulation of land suitability for *Oryza sativa* L. in Siempat Rube District, Pakpak Bharat Regency

| Land Unit | Actual land suitability | Estimated Improvement Effort | Potential land suitability |
|-----------|-------------------------|------------------------------|---------------------------|
| Land Unit 1 | N tc, rc | - Improvement of soil drainage conditions  
- Addition of organic matter  
- Addition of 5.96 kg P2O5 / Ha or 16.56 kg SP36 / Ha  
- Improved slopes by making terraces | S3-tc, rc, eh |
| Land Unit 2 | S3 tc, rc, nr, na, eh | - Improvement of soil drainage conditions  
- Addition of organic matter  
- Addition of 13.86 kg P2O5 / Ha or 38.50 kg SP36 / Ha  
- Improved slope of making terraces | S3-tc, rc, eh |
| Land Unit 3 | N eh | - Improvement of soil drainage conditions  
- Addition of organic matter  
- Addition of 1000 kg N / Ha or 2222.22 kg Urea / Ha  
- Addition of 18.52 kg P2O5 / Ha or 51.44 kg SP36 / Ha  
- Improved slopes by making terraces | S3-tc, rc, eh |
| Land Unit 4 | S3 tc, rc, nr, na, eh | - Improvement of soil drainage conditions  
- Addition of organic matter  
- Addition of 1.2 tons of C-Org / Ha or 2.07 tons of Organic Materials / Ha  
- Addition of 10.18 kg P2O5 / Ha or 30.11 kg SP36 / Ha  
- Improved slopes by making terraces | S3-tc, rc, eh |
| Land Unit 5 | N eh | - Improvement of soil drainage conditions  
- Addition of 4.2 tons of C-Org / Ha or 7.24 tons of Organic Material / Ha  
- Addition of 1000 kg N / Ha or 2222.22 kg Urea / Ha  
- Addition of 14.80 kg P2O5 / Ha or 41.11 kg SP36 / Ha  
- Improved slopes by making terraces | S3-tc, rc |
| Land Unit 6 | S3 eh | - Improvement of soil drainage conditions  
- Addition of organic matter  
- Addition of 14.40 kg P2O5 / Ha or 40.00 kg SP36 / Ha  
- Improved slopes by making terraces | S3-tc, rc, eh |

Note: temperature regime (tc), root media (rc), nutrient retention (nr), nutrient availability (na) and erosion hazard (eh)
Rice plants require a somewhat obstructed or moderate drainage condition. Soil drainage can be improved by adding organic matter and lubrication. Organic material will increase the holding power of the water and accelerate aggregate formation during the drying process. While the lubrication will reduce percolation water loss due to reduced coarse pores and increased fine pores.

Base saturation in the study area ranges from very low to low so it needs to be increased by the addition of exchange bases, namely through the provision of organic matter and ash remaining combustion. Total N and P$_2$O$_5$ are repaired through fertilization according to plant needs. While the slope and erosion hazard level are improved by making a terrace. Making terraces serves to reduce surface flow rates and increase infiltration so as to reduce erosion. Table 3 shows the land area for land suitability for wetland rice in Siempat Rube district, Pakpak Bharat Regency. The actual land suitability for lowland rice is N tc, rc (29.31 Ha or 0.90%), eh (2600.13 Ha or 79.57%), and S3 tc, rc, nr, na, eh (638.26 Ha or 19.53%). The suitability of potential land for lowland rice is N tc, rc (29.31 Ha or 0.90%), S3 tc, rc (638.26 Ha or 19.53%), S3 tc, eh (2314.45 Ha or 70.83%), and S3 tc, rc, eh (285.68 Ha or 8.74%).

Table 4. Land suitability class for *Oryza sativa* L. in Siempat Rube District, Pakpak Bharat Regency

| Land Unit | Actual land suitability | Potential land suitability | Area (Ha) | Percentage (%) |
|-----------|-------------------------|---------------------------|-----------|----------------|
| 1         | N tc, rc                | N tc, rc                  | 29.31     | 0.90           |
| 2         | S3 tc, rc, nr, na, eh   | S3 tc, rc                 | 457.52    | 14.00          |
| 3         | N eh                    | S3 tc, eh                 | 496.12    | 15.18          |
| 4         | S3 tc, rc, nr, na, eh   | S3 tc, rc                 | 180.74    | 5.53           |
| 5         | N eh                    | S3 tc, rc, eh             | 285.68    | 8.74           |
| 6         | N eh                    | S3 tc, eh                 | 1,818.33  | 55.65          |
| Total     |                         |                           | 3,267.70  | 100.00         |

Efforts to improve which can be done to improve the suitability of N-total nutrient availability classes to be quite suitable (S2) required the provision of 1.32 tons N / ha or equivalent to 2.87 tons of Urea / ha. Efforts to improve limiting slope factors can be done by making a terrace. The results of the analysis obtained can be seen in Table 2.

4. Conclusions

Soil characteristics in Siempat Rube Sub district, both physical and chemical, have very diverse characteristics so that it becomes a limiting or supporting factor in the development of agricultural crops, especially the development of lowland rice plants so as to limit and improve the rice paddy (*Oryza sativa* L) were temperature regime (tc), root media (rc), nutrient retention (nr), nutrient availability (na) and erosion hazard (eh). For improvement efforts in the development of agricultural crops, especially rice fields can be done, such as: making drainage, making terraces or planting parallel contours, calcification of CaCO$_3$, providing organic materials and fertilizing for the temperature regime cannot be repaired efforts in Siempat Rube Sub district, Pakpak Bharat District.

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