International Journal of Biological, Life and Agricultural Sciences
ISSN: 2415-6612
Vol:10, No:3, 2016

Land-Use Suitability Analysis for Merauke Agriculture Estates

Sidharta Sahirman, Ardiansyah, Muhammad Rifan, Edy-Melmambessy

***Abstract*—**Merauke district in Papua, Indonesia has a strategic position and natural potential for the development of agricultural industry. The development of agriculture in this region is being accelerated as part of Indonesian Government's declaration announcing Merauke as one of future national food barns. Therefore, land-use suitability analysis for Merauke need to be performed. As a result, the mapping for future agriculture-based industries can be done optimally. In this research, a case study is carried out in Semangga sub district. The objective of this study is to determine the suitability of Merauke land for some food crops. A modified agro-ecological zoning is applied to reach the objective. In this research, land cover based on satellite imagery is combined with soil, water and climate survey results to come up with preliminary zoning. Considering the special characteristics of Merauke community, the agricultural zoning maps resulted based on those inputs will be combined with socio-economic information and culture to determine the final zoning map for agricultural industry in Merauke. Examples of culture are customary rights of local residents and the rights of local people and their own local food patterns. This paper presents the results of first year of the two-year research project funded by The Indonesian Government through MP3EI schema. It shares the findings of land cover studies, the distribution of soil physical and chemical parameters, as well as suitability analysis of Semangga sub-district for five different food plants.

***Keywords*—**Agriculture, agro-ecological, Merauke, zoning.

I. Introduction

MERAUKE district in the province of Papua, Indonesia is covering 4.68 million hectares, which consist of two million hectares of non-cultivated land area. Various types of food crops (mainly rice, corn, beans, and grains) are well developed in this area. In recent years, Merauke becomes the largest rice barn in Papua with rice planting area of 27 thousand ha and rice production about 125-kilo ton each year. Not surprisingly that Merauke was proclaimed by the Indonesian President as the Future National Food and Energy Barn. Therefore, necessary efforts to accelerate the development of agriculture in Merauke have to be done to be able to reach the Government goal of realizing food self-sufficiency with a minimum level of 90 percent of domestic needs in Papua [1], [2]. To support these efforts, the authors are interested in conducting a research on land suitability and zoning of food production in Papua. A pilot study in Semangga district, Merauke was conducted as a starting point, with the final goal of building an agriculture-based industry clustering for Merauke.

Sidharta Sahirman is with Jenderal Soedirman University, Purwokerto, Indonesia (corresponding author; phone: (62) 813 9894 8615; e-mail: sidhartas@ gmail.com).

A. Ardiansyah and Muhammad Rifan are with the Jenderal Soedirman University, Purwokerto, Indonesia (e-mail: ardi.plj@gmail.com, m.rifan.unsoed@ gmail.com).

Edy-Melmambessy is with Musamus University, Merauke 99661, Indonesia (e-mail: edymelmambessy@ yahoo.co.id).

II. Research Methodology

The research was primarily based on a field survey, in which various analyses as well as soil sampling were performed at selected sampling sites for each zone in the district Semangga, Merauke. The parameters surveyed include soil, water, temperature regime and topography. At 50 point locations, soil samples were taken in four layers by using a soil sampler (auger) to delineate soil texture and chemical properties. Samples of water were also taken to examine the levels of pH and electrical conductivity. The analysis results of the samples combined with other important information were used to analyze land suitability for various food crops. Agro-ecological zoning – a methodology commonly used to study the potential of land as outlined by FAO –which solely based on physical environment as a factor supporting and limiting the planting of a commodity in a particular region is combined with satellite imagery to come up with preliminary zoning. The methodology is depicted in Fig. 1.

III. Results and Discussion

Survey was conducted in Semangga District, Merauke in May 2015 to obtain the following:

- Soil samples from 50 points, which were subject to nutrient content analysis performed in UNSOED, Purwokerto.
- Soil infiltration analysis
- pH and EC of water at each sample point

In general, landform in the research sites belong to Tidal Flat, part of Marin Group, which consist of Mud Tidal Flat in the southern site and Tidal Back Swamp in the middle and northern sites. The type of soil in the study site based on Soil Taxonomy System [7] belongs to orders: Inceptisols, suborders: Aquepts, Great Groups: Sulfaquepts, Epiaquepts, and Endoaquepts, Subgroups: Fluvaquentic Epiaquepts, Aeric Epiaquepts, Mollic Epiaquepts, Aeric Endoaquepts, Typic Endoaquepts, and Typic Sulfaquepts.

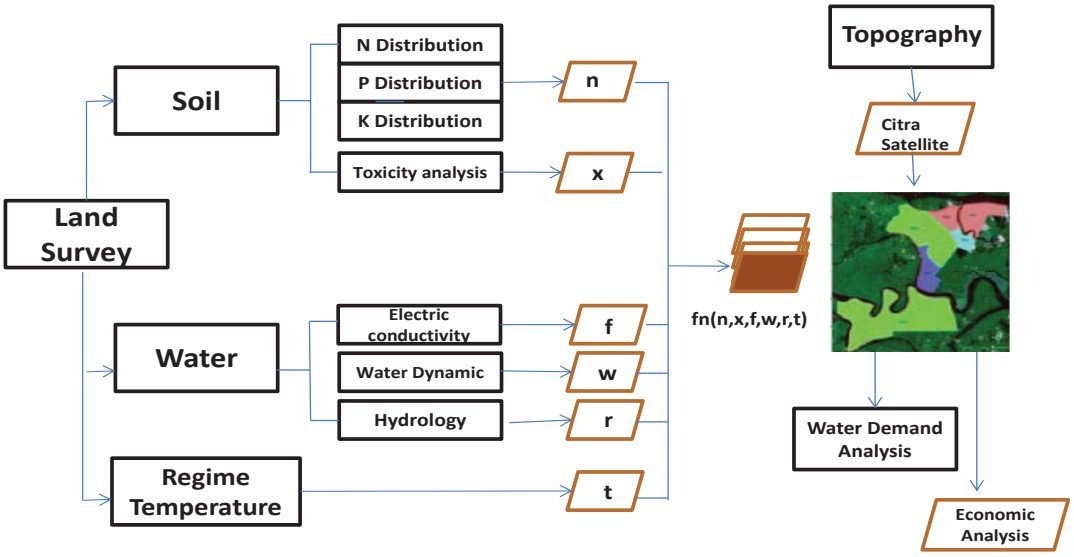

Fig. 1 Research flow chart

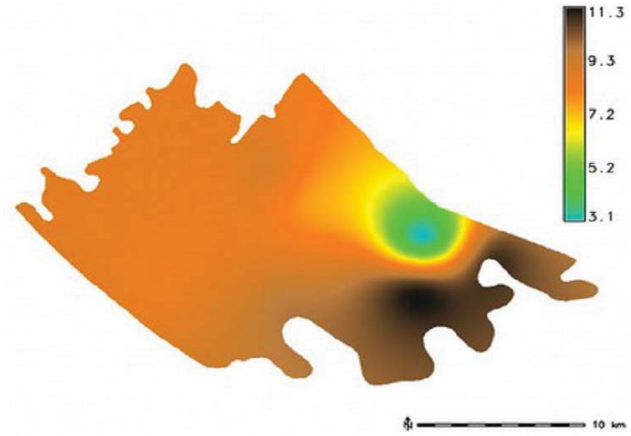

Fig. 2 Distribution of pH values in Semangga district

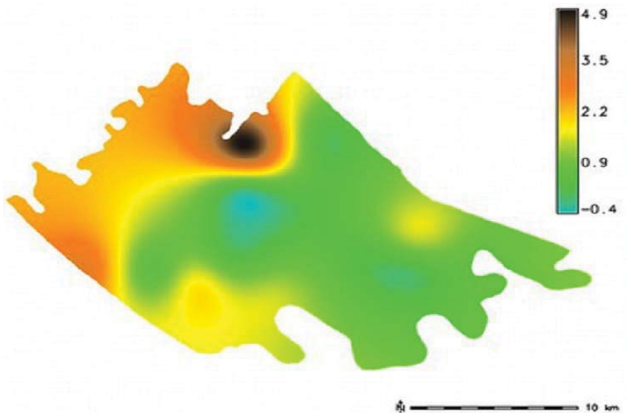

Fig. 3 Distribution of EC values (dS/m) in Semangga district

Chemical properties of soil which are analyzed include pH H_2O, KCl pH, electrical conductivity, cation exchange capacity, DC-Organic, Aluminum-dd, available Fe, available S, total S, total N, total P, and total K. The value of pH H_2O ranged from very acidic to slightly alkaline. The cation exchange capacity mostly high, with low to high values of organic C content. Values of pH and electrical conductivity in research sites are depicted in Figs. 2 and 3. N total in the area mostly low to very high in the upper soil, and lower in the bottom part. P available mostly is very low to low in both upper and bottom soil, while K available in the area ranges from low to moderate with few exceptions which have high to very high values. The distribution of total N, available P, and K in Semangga district are depicted in Figs. 4-6.

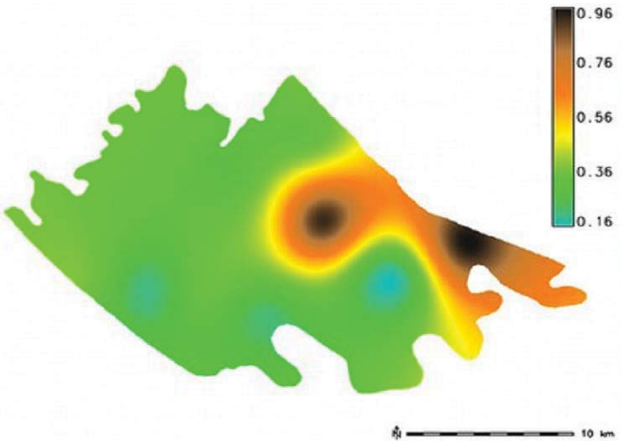

Fig. 4 Distribution of Total N (%) in Semangga district

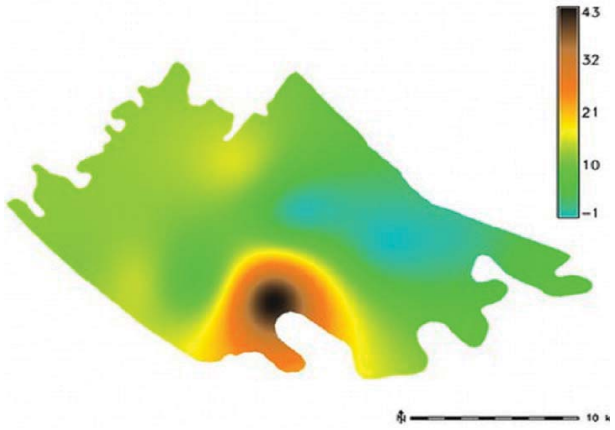

Fig. 5 Distribution of P available (ppm) in Semangga district

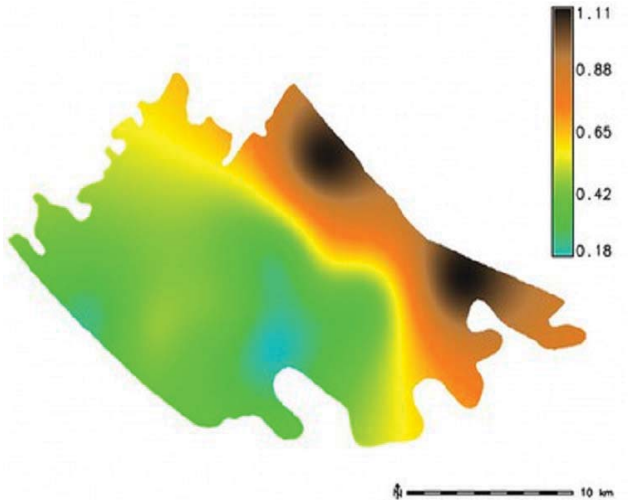

Fig. 6 Distribution of K available (me%) in Semangga district

Physical properties evaluated include horizon thickness, concentration, texture, structure and consistency of the soil, percentage of sand, silt and clay. Soil texture and hydraulic conductivity were measured using mini disk infiltrometer to get the value saturated hydraulic conductivity (Ks) at different locations. The results showed there are several classes of soil texture on the location being measured, from clay, sandy clay loam to silty clay. The closer to the coast, the higher the value of hydraulic conductivity.

The total radiation at noon at survey locations is about 26.3 MJ / m, which is relatively high, and sufficient for plants to photosynthesize. Solar radiation in Semangga district is not an inhibiting factor in the development of agriculture. In addition, survey was also carried out as a ground check to learn land cover and land use of the area, which serve as additional info in analyzing satellite data. Satellite imagery was used to determine land use and land cover. Satellite imagery chosen is Landsat 8 OLI / TRS1. The availability of google map image and ground check are helpful in determining the classification using supervised classification method. The final result of supervised classification method application is as follows (Fig. 7).

IV. Suitability Analysis

Land evaluation is an approach for assessing the potential use of land by focusing attention on limiting factors, gains and losses in practical land use for cultivation. The general guidelines applied is as provided by FAO [3]. Land suitability classification performed in this study is the assessment and grouping of land for cultivation for food crops and plantations. The main criterion is the optimal land use, i.e. the exploitation of land which yield maximum profit with the minimal expenditure. Land suitability classification based on Land Evaluation Framework [4] consist of three classes in accordance Order (S): S1 (a great fit), S2 (self-accordance) and S3 (match marginal); and 2 classes based on Appropriate (N): N1 and N2. Additionally, sub classes criteria used were based on Technical Guidance on Land Evaluation [5].

Land characteristics and qualities considered in this research to analyze its suitability for certain crops [6] include:

(1) Rooting medium (r), i.e. land drainage, land texture, effective depth of soil
(2) Nutrient retention (f), i.e. soil pH, cation exchange capacity
(3) Salinity (e), i.e. salinity
(4) Nutrient content (n), i.e. N total, P available, K available
(5) Easiness of soil treatment (p), i.e. soil texture, soil structure, soil consistency
(6) Air temperature (t), i.e. average yearly temperature
(7) Water availability (w), i.e. number of dry season (<75 mm), rain fall/year (mm)
(8) Other climate data for analyzing water availability, i.e. wind speed, radiation and relative humidity.

Both actual and potential land suitability analysis were performed. Actual land suitability is based on current condition, while potential land suitability is based on after treatment condition in which land condition was already improved by relaxing one or more limiting factors. Result shared below is for land suitability analysis for rice crops. In addition to rice crops, land suitability for other four different food crops, i.e. corn, soybeans, sweet potatoes, and cassava were also performed. The suitability of land based on same methods were also performed for eight plantation crops: oil palm, coconut, rubber, cocoa, coffee, sugar cane, cloves and bananas

Land suitability analysis for rice showed that most of the sites belong to S3n class with the availability of P as the main limiting factor. This condition can be improved by applying P fertilizer resulting a higher suitability class of S2fn. Should P fertilizing and water drainage system improved as recommended, land area suitable for rice production (S2 class) can be increased from 360 ha to 22,303 ha.

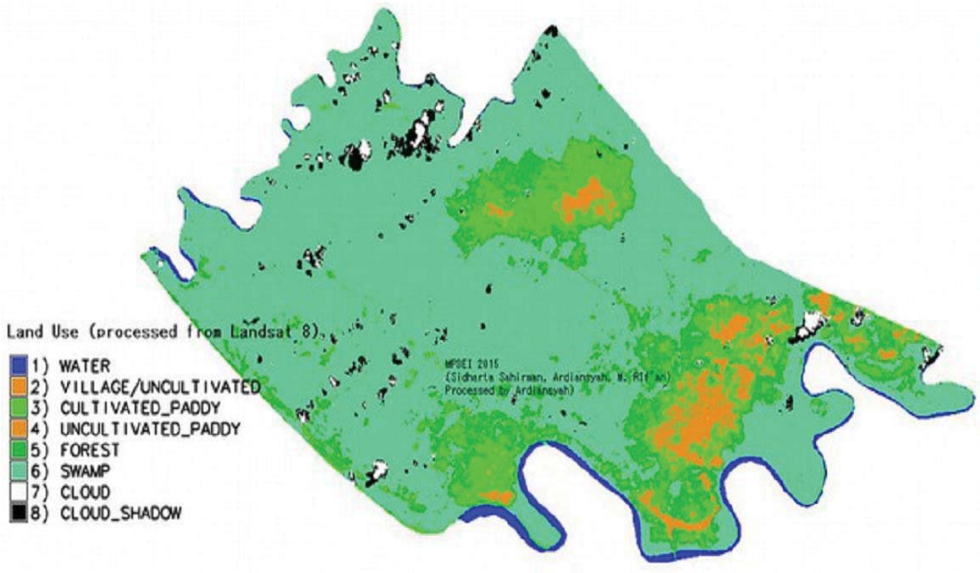

Fig. 7 Supervised classification result for Semangga District

TABLE I
LAND SUITABILITY FOR RICE CROPS

No.	Actual	Area (ha)	Required improvements	Potential	Area (ha)
1	S2wfn	360	Water drainage system, K+	S2f	360
2	S3n	19,511	Water drainage system, P+	S2fn	19,511
3	S3np	2,432	Water drainage system, P+	S2np	2,432
4	N1n	12,359	Water drainage system, P+	S3np	12,359
5	N2f	308	Water drainage system, P+, Water-table regulation	S3fn	308

V. CONCLUSION

Location of the research study mostly consist of Rear Tidal landform, have very acidic soil and very low up to low P content. The actual land suitability for crops mostly belong to class S3, N1 and N2 with nutrient retention inhibiting factor (f), the element nutrients available (n) and ease of processing (p). Most of areas can be used for crop plantations by improving water drainage system, regulating water table and application of fertilizer, especially P fertilizer followed by N and K. In general, Semangga district in Merauke is promising to be the next national food barn with array of required improvements.

REFERENCES

[1] Badan Pusat Statistik Kabupaten Merauke, *Merauke Dalam Angka*. Merauke: Badan Pusat Statistik Kabupaten Merauke, 2011.
[2] Badan Pusat Statistik Kabupaten Merauke, *Merauke Dalam Angka*. Merauke: Badan Pusat Statistik Kabupaten Merauke, 2012.
[3] FAO, *Guidelines: Land Evaluation for Rain fed Agriculture*. Rome: Soils Bulletin No. 52, 1983.
[4] FAO, *Framework for Land Evaluation*. Netherlands: ILRI, 1976.
[5] Puslittanak, *Petunjuk Teknik Evaluasi Lahan*. Bogor: Balitbang Pertanian, Deptan, 1993.
[6] Sahirman, S, M. Rifan, Ardiansyah, *Laporan Studi Kelayakan Budidaya Tanaman Pangan di Food Estate, Bulungan, Kalimantan*. Unsoed: LPPM, 2012.
[7] USDA, *Keys to Soil Taxonomy*. US Department of Agriculture: Natural Resource Conservation Service, 2010.