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Research Article

Spatial Analysis for the Preparation of the Ulin Growing Requirements (*Eusideroxylon zwageri* T. & B.) in the Forest Area of Tabalong District, South Kalimantan, Indonesia

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Abstract: The natural forest in Tabalong District has been degraded, proved by the fact that Ulin trees (*Eusideroxylon zwageri* T. & B.) are rarely to be found. Ulin is in the status of endangered species, thus it must be protected and under the development efforts. Therefore, it needs information of the optimum growing requirements. The aim of this research is to analyze the relationship between land characteristics with the presence of Ulin. The data required are primary data collected by sampling method and secondary data by indirectly through institutions. Sampling was done by line observations followed the mapping unit representation which consists of land system majority, elevation, and slopes. Transects made the cut contour, thus the line observation represent the condition of ecological site from the lower land to the upper land. Data collection include data spatial of Ulin, relief, climate and soil sample. Land system and relief spatially analyzed using geographic information systems, while the land characteristics analyzed in the laboratory.

The results of this study are optimum growing requirements on the attributes Ulin temperatures ranging from 25-32 ^{o}C, the availability of water (w): the number of dry months <3 month per year, rainfall >2000 mm per year, rooting medium (r): soil permeability is medium class, soil texture is sandy clay, soil effective depth >50 cm,

soil porosity 55-65 percent, field capacity water >45 percent, nutrient available (n): does not require sufficient nutrient supply with low-grade organic C and relief (s) of slope <25 percent.

Keywords: growing requirement, habitat, land characteristics, Ulin.

INTRODUCTION

South Kalimantan Province and particularly Tabalong District is loaded with natural forest, besides Tanah Laut and Kotabaru District. However, current conditions have changed, because the forest utilization did not concern on the aspects of conservation. As a result of these events, indications of damage to the environment are: the degradation on potential of luxurious and well-known timber species in Borneo (Kalimantan), i.e. Ulin *(Eusideroxylon zwageri* T. & B.*)*, landslides, river siltation, muddy river water, floods, and droughts. Tabalong is a district in South Kalimantan which considered as the remaining natural forest for Ulin habitat. However, Ulin tree is hard to be found even in Tabalong District and currently found only in remote areas which were difficult to reach. Previous research on the logged forest showed very small number of potential Ulin in the forest as stated by Arifin and Itta[1] that they found very low number Ulin per hectare in Tanah Laut and Kotabaru District of South Kalimantan. Currently, there is one active concessionaire in the area. Ulin habitat destruction occurred due to concession holders in the area and illegal logging activities, which is still going out of control. This conditions certainly made Ulin tree to be rare species sooner or later. Therefore, there must be some efforts on the protection and development of Ulin species. For these efforts, we need the knowledge about the growing requirements of Ulin trees.

Preservation efforts of Ulin identical to the cultural survival of the people of Borneo. This is in accordance with the opinion of Wahjono and Imanuddin[2] that the Ulin is a special tree species in Borneo that must be protected and preserved. According to research Effendi[3], Ulin including one of the original type of Borneo that must be preserved, because it has been used since hundreds of years ago by people, particularly in rural areas, while planting efforts Ulin not comparable to logging activities, efforts should be made conservation efforts are in in-situ or ex-situ. Site conditions along the slopes of the valley to the peak are not the same, as a result of several factors that affect the growing area explained by Soerianegara[4], i.e. climate, soil, topography, biotic factors, and other environmental factors. The soil properties will affect the types of plants that grow and it is reflected by the dominant species in the concerned ecosystem[5].

Conservation efforts in-situ or ex-situ conducted so far have not given the expected results. This is in line with the statement Sidiyasa[6], that the management efforts on an ongoing basis have been made by various parties, but the results cannot be said to be optimal, and even some of them fail. Therefore, it still needs to be done further research related to habitat Ulin to better understand the growing requirements for the development Ulin in-situ or ex-situ. Study of Ulin land quality include soil texture, soil porosity, soil drainage, effective depth of soil, soil moisture, content of organic C and so has been done elsewhere, but the growing requirements Ulin for optimum growth until now has never existed as a reference basis for formulating Ulin conservation model in-situ or ex-situ.

EXPERIMENTAL

Study Site: This research was conducted in logged forest; second cutting cycle of forest concession which is still active in Tabalong District, South Kalimantan Province with area of 700 hectares. This study was conducted from May 2014 to June 2015.

Materials: The materials needed in the study include map of land systems (1:250,000 scale), Regional Physical Planning Program for Transmigration (RePPProT) 1987, and digital topographic map (1:50,000 scale). We also used data of Shuttle Radar Topographic Mission (SRTM) from the US geological survey, to derivate the contour and slope class map. Imagery of Advanced Land Observing Satellite (ALOS) used for the form of South Kalimantan coverage in September 2013 with a spatial resolution of 2.5 m, which is obtained from the Department of Forestry, South Kalimantan Province.

We used computers for spatial analysis and digital mapping using Geographical Information System (GIS), Compass to determine the azimuth direction, Global Positioning System (GPS) for spatial position, Clinometer for determine of slope magnitude (percent), Altimeter for the elevation above sea level (meter), Environment meter for measure the micro climate, and soil sampling equipment, i.e. soil auger, plastic bags, and sample ring.

Data Collection and Analysis: The data required in the form of primary data by sampling method and secondary data by utilizing the spatial data from the Concession holder. Primary data collected directly from the field by researcher, while secondary data collected indirectly through another party; either individuals or institutions. Sampling was done by line observations followed the mapping unit representation which consists of land system majority, elevation of sea level, and slopes.

Transect made the cut contour of East-West direction. The main river in the study area flows towards the South, thus the lines are made to represent the condition of ecological site on the lower slope to the upper slope. Spatial mapping is conducted at all Ulin positions in tracks ground observations. Data collection includes data spatial of all individuals Ulin, relief, climate and soil sample. Sistem land and relief spatially analyzed using geographic information systems, while the land characteristics analyzed in the laboratory. Results analysis was performed with tabulation.

RESULTS AND DISCUSSION

Land Quality Based Land System majority: Land system is to describe the same ecological conditions as a result of a combination of rock type, hydroclimate, landform, soil, and organisms. Land system is not something that is unique to a single place, but can be found anywhere with similar environmental characteristics. Land system is reflecting the potential similarities and factors of its boundary. Land system is not partial of one or two components, but of all the components involved as a result of the combination of these components.

Thus, the land system is the smallest unit as a differentiator in making the mapping unit. Based on spatial data, land systems contained in the study area consists of three land systems, the system of hills Maput (MPT), Mountains Pendreh (PDH) and Plains Teweh (TWH). Analysis of the quality of land made to the characteristic values of land obtained from laboratory analysis and field observations.

Soil properties were analyzed in the laboratory consisting of: soil texture, organic C, permeability, porosity and soil moisture, while derived from observations in the field consists of the effective depth of the soil, temperature and humidity micro, then calculated the mean (**Table-1**).

C-organic content as one of the chemical properties showed no difference in value based on test results analysis of organic C in all three land systems ($P > 0.005$). C-organic content based on the dignity or class C-organic has dignity low (1.00 - 2.00 percent) on the three land systems, it indicates that the need Ulin of the organic C was fulfilled in low organic C-class. Ulin in natural forests to grow by relying on organic material produced from closed nutrient cycling in the forest, so that the levels of C-organic low Ulin able to live and thrive.

Table-1: Average Value of the Land characteristic in Three Land Systems.

Land characteristics	Land systems		
	TWH	PDH	MPT
C-organic (percent)[ns)]	1.45	1.00	1.08
Soil effective depth (cm)	65.00[b]	39.00[a]	43.20[a]
Soil permeabelity (cm per hour)[ns)]	3.79	1.00	1.64
Bulk density (g per cubic cm)[ns)]	0.99	1.13	1.14
Particle density (g per cubic cm)[ns)]	2.58	2.46	2.52
Soil porosity (percent)	61.71[b]	53.67[a]	54.68[a]
Field capasity (percent)	52.95[b]	42.97[a]	43.22[a]
Soil Texture[ns)]	clay	clay	clay
Air temperature (^oC)[ns)]	28.48	27.24	28.5
Air humidity (percent)[ns)]	91.64	90.26	90.28
Dry months (month)[ns)]	3	3	3
Annual rainfall (mm per year)[ns)]	2,589	2,589	2,589

Table information:

- [ns)] = not significant
- Effective depth: average = 49.07; LSD = 11.82; SD = 8.22; P <0.001
- Soil porosity: average = 56.69, LSD = 6.42; SD = 4.57; P <0.035
- Field capacity: average = 46.38; P <0.042

Effective depth of the soil has the significant differences of real value to each land system (P <0.005). Effective depth of soil on TWH land system has effective depth the deepest depths with an average of 65 cm compared with land system of PDH and MPT in the range below 50 cm.

The Ulin Growth data on the Teweh land system has an average height and diameter growth higher than Pendreh and Maput land system. This indicates that the effective depth of the soil for the growth of Ulin >60 cm are showing better growth Ulin, and growth will decrease with decreasing the effective depth of the soil. Effective depth of this would be one indicator of the growing requirements Ulin to develop properly.

Permeability of the soil showed no difference in the value of the results of analysis of soil permeability test on the three land systems (P >0.005). Based on soil permeability classes[7] showed that the permeability of the soil on the Teweh land system has medium grade and on the land system Maput and Pendreh have moderate to slow class.

This permeability value indicates that the Ulin able to grow at moderate to slow permeability class, but to show optimum growth Ulin require moderate permeability. Heavy volume and density did not show differences in the value of the respective characteristics of the land on the three land systems (P >0.005). Based on the average that Ulin grows well on land system that has a weight Teweh smaller volume (<1 g per cubic cm), and Ulin growth will decrease with increasing average weight of soil volume.

Value shows that the volume of heavy Ulin require heavy soil with a small volume or high porosity that facilitates the plant roots to penetrate the soil. Soil porosity has the distinction of real value to

each land system (P <0.005). Teweh land system has the highest soil porosity compared with Pendreh and Maput land systems. This indicates that the Ulin to grow well require soil with high soil porosity. Porosity value of this land will inversely proportional with volume weight value, land with high porosity showing heavy volume value is small. Ulin is not like the land are flooded or have small soil porosity[8]. Sandy soil porosity different from the porosity of clayey soil. Sandy soils have coarse pores are more than the clayey soil and soil with plenty of coarse pores difficult to hold the water, so that the soil is dry. Hardjowigeno[9] states that the porosity of the soil is influenced by organic matter content, soil structure and soil texture.

The soil moisture is the amount of water that the soil contained in one unit of soil volume, while the field capacity is the largest amount of water that can be retained land against the pull of gravity. The percentage of water field capacity has a different value in each land system (P <0.005). Water field capacity on Teweh land system showed the highest difference value compared to Maput and Pendreh land systems. This indicates that Ulin in order to grow optimally require high field capacity and growth will decline with a decrease in the percentage of water field capacity.

Ulin habitat require optimum growing requirements on moist soils as stated by Junaidah *et al*.[10] that Ulin can grow on moist soil. But did not mention how much moisture the land in question. The soil texture is dominated by clay fractions in all the land systems. This indicates that the location of loamy texture Ulin habitat is not a limiting factor for the growth of Ulin. This is because the three land systems with clay texture showed differences in both high growth and diameter. Temperatures on the three land systems are an air temperature range of the humid tropics with soil temperature 25-32 ^{o}C value.

Type Ulin is a typical type of wet tropical regions with high temperatures and high humidity. Wet tropical temperatures can be an indicator of the growing requirements Ulin and below the required temperature Ulin will grow not optimal.

Conditions of humidity of air evenly with high humidity, it indicates that the humidity is above 80 percent is the humidity area forest vegetation is still relatively natural, or at least are secondary forest, so humidity >80 percent indicates growth requirements Ulin the humid tropics, The results of the few areas in Kalimantan show that the microclimate and soil conditions are directly collected in the field to have the humidity is relatively high (69.2-95.3 percent), the relatively high temperature[11] at 27.1-29.9 ^{o}C.

Rainfall is measured based on data from the Meteorology, Climatology and Geophysics Agency (BMKG), the amount of rainfall in the study had an annual rainfall of 2,589 mm per year. Ulin require high rainfall for optimal growth between 2,000-3,000 mm per year.

Ulin growing requirements is based on the characteristic value of land that has been presented (**Table-1**) and indicators of land characteristics after the observation data through statistical tests.

The results of the preparation of the growing requirements Ulin still drafts and conformance criteria of land in need of correction with 15 soil samples representing the land unit in the area of research, which is based on the class of the slope, so that a growing requirement Ulin correction (**Table-2**).

The final result of the growing requirements Ulin correction is then described as land suitability extrapolating on the map. Land suitability map of the research area of 700 hectares, when broken down showed that the suitability of land at the level of the land suitability review the suitable class (S) covering an area of 285.5 hectares (41 percent), appropriate conditional (CS) covering an area of 414.5 hectares (59 percent) and is not suitable (N). This indicates that the study area is a habitat for the growth of Ulin. Land suitability of appropriate conditional (CS) can then be broken down into

compliance with the limiting factor conditional rooting (CSR): permeability, effective depth, porosity land area of 139.6 hectares (20 percent), while the limiting factor in the form of both factors rooting and slope factor (CSRs) covering an area of 247.9 hectares (35 percent). Thus, the study area of 700 hectares there is nothing not suitable (N), all of which allow Ulin can grow, although in some places there is a factor of its boundary.

Table-2: Criteria of Growing Requirements and Land Suitability for Ulin (Source: FAO, 1984 modified[12]).

Land Quality (Land Characteristics)	Land Suitability Class		
	S	CS	N
1. Temperature (t)			
- average annual air temperature (°C)[1)]	25 – 32	Td	<24 or >33
2. Availability of water (w)			
- dry months (month)[1)]	<3	Td	>3
- rainfall (mm per year)[1)]	>2,000	1,000-2,000	<1,000
3. Rooting medium (r)			
- soil permeability [2)]	2,0-6,3 (moderate)	<0,5 and >6,3 (slow - fast)	Td
- soil texture [2)]	sandy clay, silt clay	Td	Td
- soil effective depth (cm)[3)]	>50	30-50	<30
- soil porosity (percent)[2)]	55-65	55-45	<45 >65
- field capacity water (percent)[2)]	>45	35-45	<35
4. Nutrient available (n)			
- C-organic (percent)[2)]	1-2,0 (low)	Td	Td
5. Relief (s)			
- slope (percent)[4)]	0-15 percent 15-25 percent	>25 percent	Td

Table Information:

- Td = not aplicable; CS = appropriate conditional; S = suitable
- The area flooded, swamps, peat and limestone area is the limiting factor remains, that includes land that is not suitable (N)

1) Climate data last 10 years (BMKG[13], 2014)

2) The results of the laboratory analysis, 2014

3) The results of field observation, 2014

4) The results of spatial analysis, 2014

CONCLUSSION

Based on the discussion that has been presented, it can be concluded that the optimum growing requirements on the attributes Ulin are temperatures ranging from 25-32 °C, the availability of water (w) the number of dry months <3 month per year, rainfall >2,000 mm per year, rooting medium (r): soil permeability is medium grade, soil texture is sandy clay, soil effective depth >50 cm, soil porosity

55-65 percent, field capacity water >45 percent, nutrient available (n) does not require sufficient nutrient supply with C-organic low grade and relief (s) slope <25 percent.

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