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Spatial distribution of ulin (*Eusideroxylon zwageri* Teijsm. & Binnend.) based on slope position and its stand structure in the forest area of tabalong district

Suyanto[1*], Luthfi Rayes[2], Sudarto[3], Bambang Joko Priatmadi[4]

[1]*Doctoral Program of Agricultural Sciences, Graduate Program, University of Brawijaya, Malang, Indonesia*

[2,3]*Faculty of Agriculture, University of Brawijaya, Malang, Indonesia*

[4]*Faculty of Agriculture, University of Lambung Mangkurat, Banjarmasin, Indonesia*

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Abstract

Forest resources in Tabalong District has been degraded, proved by the fact that Ulin trees (*Eusideroxylon zwageri*) are difficult 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 on Ulin spatial distribution based on the slope position and its current stand structure. The characteristic of the site along the slopes from the valley to the top position depends on the ecological factors. The purpose of this study was to analysis the Ulin spatial distribution based on the slope position and its stand structure. It used overlay method for the distribution of Ulin by spatial data with slope position, to be analyzed further by tabulation method. Both primary and secondary data showed that the number of Ulin found on the upper slope to the lower slope is increased; the remaining 17% found in upper slopes. Ulin stand structure in the study area did not follow the reverse-J shaped structure of the natural forest stand structure. The primary data showed that Ulin trees with diameters 20-39 cm only found in 18.8%, Ulin with diameter > 40 cm only found in 0.6%. The secondary data showed that Ulin with diameter < 40 cm found for 80.3%, while only 19.7% for diameter of > 40 cm. This means Ulin with a diameter of ≥ 40 cm has generally been cut down.

***Corresponding Author:** Suyanto ✉ suyanto_mp@yahoo.com

Introduction

South Kalimantan Province and particularly Tabalong District is loaded with natural resources 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, i.e. Ulin *(Eusideroxylon zwageri)*, 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 (2013) 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 characteristics of the current stand structure of Ulin.
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 (1996), 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 (Pratiwi and Mulyanto, 2000). Suhendang (1985) in Lathifah (2003) also explained stand structure has a particular form for each place to grow; every habitat has specific type of trees and forest stands condition.

Mathematically, this stand structure can be viewed as a functional relationship between the diameter (X) by the number of trees (N) on the specific unit area, which can be expressed as N = f (X). It found that information on the form of Ulin's stand structure is rare, especially in the study area. This information would ease the determination of management strategies for remaining Ulin. Therefore, the purpose of this study was to analysis the characteristics of Ulin spatial distribution and its stand structure after logging activities.

Material and methods

Study Site

This research was conducted in post-logged forest; second cutting cycle of forest concession which is still active in Tabalong District, South Kalimantan Province with area of 700 ha. This study was conducted from January 2013 to June 2014.

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. Satellite Imagery of ALLOS used for the form of South Kalimantan coverage in September 2012 with a spatial resolution of 2.5 m, which is obtained from the Department of Forestry South Kalimantan.

It used computers for spatial analysis and digital mapping using Geographical Information System (GIS), Shuunto Compass to determine the azimuth direction, Global positioning system (GPS) for spatial position, Clinometer for slope magnitude (%), Altimeter to determine the elevation above sea level (meter), Environment meter to 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.

Line transect

Sampling was done by line observations followed the mapping unit representation which consists of land system components, 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.

Observation plot of vegetation

Vegetation cover scheme are used to give special consideration to the distribution spot of Ulin. Plot observations made at the point we found Ulin which positioned as the centre of plot. From the Ulin as centre, we chose regeneration level of pole and tree, because the succession process has been relatively stable (Fig. 1). The plot is a circle with a radius of 13 m (the farthest width of branches in the natural forest). Ecologically, the plot area contained interaction of Ulin with individual surrounding trees. Species identification of trees surround the Ulin obtained directly at the observation site by the expert in our research team.

Spatial mapping

Spatial mapping is conducted at all Ulin positions in the measure plot. Data collection include data spatial of all individuals Ulin, type and the species name of tree in the measure plot, tree diameter at breast height (dbh 1.30 cm), slope position (Darlymple *et al.*, 1968; Hardjowigeno and Widyatmoko, 2007), and elevation data. Data analysis was performed with tabulation and presentation.

Results and discussion

Spatial distribution of Ulin at each slope position

Spatial Ulin overlayed on slope position were consisted of 170 trees, i.e. 76 individuals (44.7%) grew at a lower slope, 67 individuals (39.4%) grew on the middle slopes and 27 individuals (15.9%) grew on the upper slopes. It found Ulin on the middle and lower slopes for 84.1%, while the remaining 15.9% on the upper slopes. This indicates that most of Ulin grow on middle and lower slopes and only a small number that grows on the upper slopes. Ulin grow unevenly across the slope expanse positions, but tend to grow in the lower slope.

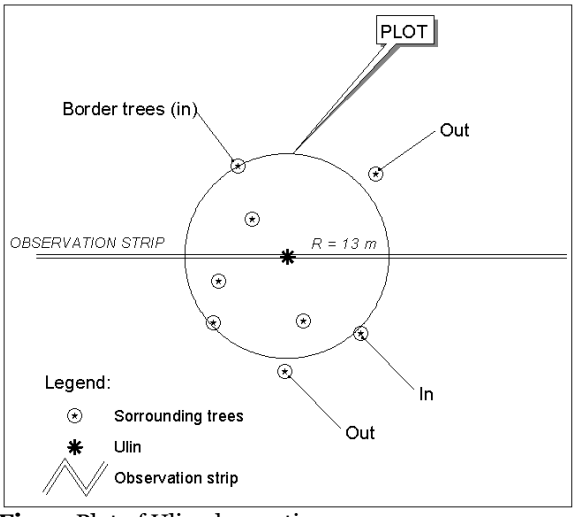

Fig. 1. Plot of Ulin observation.

The results of overlay between slope position and the secondary data of spatial Ulin trees ≥ 20 cm diameter sourced from 203 trees. The secondary data strengthen the results analysis of primary data that Ulin grow unevenly across the expanse of the slopes from the lower slope, middle to upper slope. Secondary data analysis results show that the distribution of the 203 Ulin, majority of Ulin (83.2%) grow in the middle and lower slopes and less Ulin (16.8%) grow on the upper slopes.

Fig. 2 showed a comparison of Ulin stands from primary and secondary data. There are similar distributions of Ulin population at each site. These data is slightly different. The primary data covering all Ulin growth rate of seedlings to mature trees, while the secondary data only cover up to 20 cm diameter Ulin. However, from the spatial aspect

distribution at each slope position, both data sources is almost similar, i.e. the number of Ulin getting increased toward the lower slopes. This emphasized the fact that there is a different Ulin distribution characteristics related with the position of the slopes.

Chi Square test results showed that there is a significant relationship between the positions of the slope with the number of Ulin found in both primary and secondary data. These results supplement the previous studies that Ulin grows well on rolling areas up to the ridge of hill (Sidiyasa *et al.*, 2013) which has not specify the slope position where Ulin often found in the field.

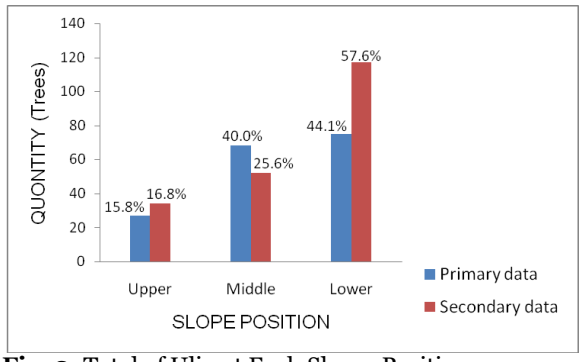

Fig. 2. Total of Ulin at Each Slopes Position.

Ulin population was found more on the lower slopes allegedly due to the nature of Ulin seeds' dispersal. The shape and size of the seeds are suspected to influence the amount of Ulin distribution in various slope positions. Ulin seed size varies with 5 – 15 cm length and diameter of 3 – 5.9 cm and weight 45 – 360 g supported by its round shape. When it fell from the parent tree on the upper slopes will easily roll to the position of the middle and lower slopes because of the influence of gravitation forces and the slope factor. Additionally, distribution of Ulin seeds from the upper slopes to the middle and lower slopes carried away by the flow of rain water.

High population on the lower slopes is also possibly because it carried away by the flow of river water and placed on the river bank during floods, as stated by Sidiyasa (2011) that the low number of Ulin seedling related to the condition of the steep slope topography. The steep slope makes Ulin seed that fell on the forest ground easily to roll, and when the seed has germinated, the seed is still possible to be moved or uprooted because of erosion.

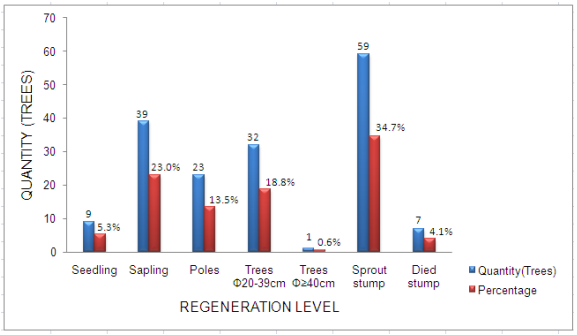

Fig. 3. Stand Structure of Ulin Sourced from Primary Data.

This study suggests that there are more population of Ulin towards the lower slope, thus it can be used as a consideration in the effort of ex-situ conservation for rare species, such as Ulin. Planning of planting site should be pay attention to the tendency of its habitat and development. This is in accordance with the recommendations proposed by Nugraha (2006), that the exit conservation should pay attention to the requirement of suitable soil, e.g. the distribution of natural habitat.

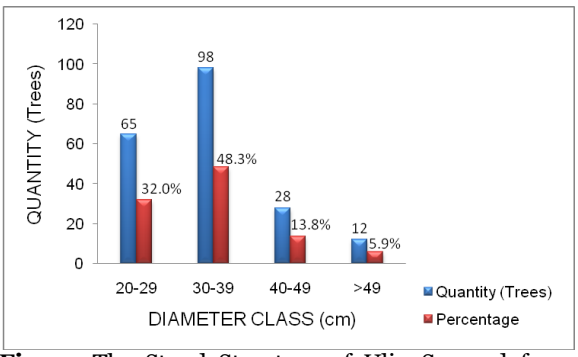

Fig. 4. The Stand Structure of Ulin Sourced from Secondary Data.

Stand structure of Ulin

The results of Ulin observation in the study site showed that the number of Ulin's regeneration and sprout are still fairly a lot. From 170 individuals Ulin, we found the sum of regeneration on the level of seedlings, saplings and poles for 41.8% (71 individual), trees for 19.4% (33 individuals), and Ulin stumps 38.8% (66 individuals, consisted of sprout stumps for 34.7% and died stumps 4.1%). Details can be seen in Figure 3.

The number of Ulin trees only found for a total of 33 individuals (19.4%) indicates the difficulty in finding Ulin tree with diameter ≥ 40 cm in this area. This indicates that Ulin tree has been logging massively in this area, because the demand of Ulin is fairly high, while supervision by the relevant authorities is very weak. The logging of Ulin is characterized by the discovery of sprout stump and died stump. It is very ironic, because according Wahjono and Imanuddin (2011), Tabalong district is actually one endemic habitat for Ulin.

As described in Fig. 3, Ulin seedlings have been found in very small number (5.3%). This indicates a very small degree of regeneration through seedling. The probable cause is due to competition with other plants. According Sidiyasa *et al.* (2009), low levels of Ulin regeneration due to the pressure experienced by the nursery due to competition with other surround vegetation. Ulin has very slow growth allow the crown cover and shaded by other plants seedling, thus it interfere the growth of seedlings, or death by a falling tree branch and others.

The results of secondary data classification by diameter class are presented in Figure 4. The mentioned figure showed from 203 Ulin, majority Ulin tree (80.3%) with diameter <40 cm, while the diameter ≥40 cm only 19.7%. It implied that Ulin diameter class < 40 cm more numerous than the diameter ≥40 cm on all slope positions. It is similar interpretation with 170 individual primary data.

This is also consistent with the study of Arifin and Itta (2013) that Ulin in Tanah Laut and Kotabaru District of South Kalimantan per hectare is very low. The number of natural regeneration ranged from 3 – 5 individuals.ha^{-1} for seedling stage, 3 – 46 individuals.ha^{-1} for sapling, 5 – 6 individuals.ha^{-1} for pole level, and on the level of tree, Ulin was not found. Thus, Ulin has the status of endangered (IUCN, 2011; Hakim and Widyatmoko, 2011).

Under the terms, Ulin is a protected species and allowed to be harvested after reaching a diameter of 60 cm (Ministry of Agriculture, 1972). This regulation does not apply on the logging activities related to the construction of roads, transmigration projects, and agricultural activities (Ministry of Forestry, 1996). In fact, Ulin that reached 40 cm have been cut down. This logging square area recorded the tree on the second cutting rotation. If the logging rules for Ulin strictly implemented, there should be still many Ulin with 40-60 cm in diameter, because Ulin with diameter < 60 cm should not be cut at the first cut rotation. The quantity of Ulin stand continues to decrease rapidly with the increasing needs for various purposes of Ulin wood, e.g. houses, buildings and bridges.

The reversed J shaped stand structure shows little number of trees found for the bigger diameter. This structure is a common phenomenon for natural forest structure (Wahjono and Imanuddin, 2011). This condition reflects that not all seedlings had a chance to live and grow into a large tree reaches its maximum diameter class. Fig. 4 showed that after Ulin enter the 40-49 cm diameter class, the number will sharply decreased. It also imply that Ulin includes as protected species, allowed to be cut only if the diameter ≥40 cm. This needs serious attention of policy makers and relevant authorities of Tabalong District, e.g. Forest Service, Police, and Judiciary.

This issues needs to get the government's attention to the implementation of logging regulations for protected tree species because every concession shall perform maintenance of protected trees. Although the forest protection unit (rangers) is existed, the officer was generally only able to prevent several logging of Ulin. In the other hand, Ulin experienced the excessive logging, while regeneration of Ulin is not running properly. Therefore, it is necessary to increase conservation efforts that have been made by several parties.

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