Diversity of meranti (Shorea spp) in secondary forest of tropic area in Mempawah District, West Kalimantan, Indonesia

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Abstract. The demand for the wood as basic human need is increasing in line with the population growth worldwide. Meranti (Shorea spp.) is a species of commercial tree that has been traded since the start of forest exploitation. This plant easily grows in various habitats, including tropics areas, such as secondary tropical rain forest located in Mempawah District, West Kalimantan (Borneo), Indonesia. The purpose of this study is to determine and reviewing the diversity of Shorea spp in secondary forest in Mempawah District, West Kalimantan. The observation was carried out by a survey method using a combination of path and line square methods. The paths were put with a purposive sampling method in many areas of that secondary forest that have Shorea spp in each site of observation. Following to the result, there were four species of meranti (Shorea spp), including Shorea platyclados (Meranti Batu), Shorea leprosula (Meranti Bunga), Shorea pinanga (Meranti Merah), Shorea bracteolatadyer (Meranti Putih) in each growth stage from seedling, stake, pole, and tree, but not dominate in the secondary forest of Mempawah District. The observation found that those Shorea spp there had the Dominance Index in seedling, stake, pole, and tree stages was less than 0.5, the Species Diversity Index was overflowing (H 1 ≤ H ≤ 3), while the Species Abundance was less than 1.

1. Introduction

One of the basic human needs is a board related to the need for a place to live. This refers to the need for building materials, one of which is wood. Apart from being the primary building material, wood is also needed in secondary forms, including in the form of furniture, pulp, paper, and others. When viewed from 1998 to 2003, timber trade in both primary and secondary forms increased sharply globally [1].

The need for wood is very high and continues to increase in line with the increasing of the world population [2,3]. Therefore, it is necessary to supply raw materials coming from timber-producing countries, specifically from the production forests they manage. One of the wood supply areas for the world's needs in Southeast Asia, which is dominated by Indonesia, Malaysia, Myanmar, and Vietnam. The types of wood that are the target market from tropical regions include Meranti (Shorea spp.) [4,5].

Shorea spp or known as Meranti is a species of commercial tree that has been traded since the start of forest exploitation in 1970. In the secondary forest, it can be found about 4 species of Shorea spp such as Shorea platyclados (Meranti Batu), Shorea leprosula (Meranti Bunga), Shorea pinanga (Meranti Merah), Shorea bracteolatadyer (Meranti Putih). The market of Shorea spp is unlimited, not only in the domestic market but also in the international market. Shorea spp has become important...
commodities of forest products, but until now, the production still depends on natural forests. However, this plant quickly grows in various habitats, including tropics area [6]. Those including secondary tropical rain forest in Mempawah District, West Kalimantan (Borneo), Indonesia.

Secondary forest is a type of forest that develops naturally from the previously damaged forest. Secondary forests have various functions, such as preserving nature and supporting the economy of the surrounding community. Regarding nature preservation, this type of forest can be a place for flora and fauna, apart from maintaining the natural balance such as secondary mangrove forest in the coastal area, which also functions to keep coastal abrasion [7]. On the socio-economic side, the secondary forest can be managed to provide a variety of food and non-food products that are usually obtained by traditional smallholders from primary forest, in addition to providing environmental benefits such as a primary forest. Thus, the secondary forest area, including secondary forest in Mempawah District, can become a source of livelihood for the surrounding community. Those could be a source of wood raw material for humans; one of them is meranti logs which is one of world commercial trading wood.

The purpose of this study is to determine and reviewing the diversity of Shorea spp in secondary forest in Mempawah District, West Kalimantan.

2. Materials and Methods
The study was carried out in a secondary forest of tropics area located in Mempawah District, West Kalimantan, Indonesia (00°29'34.32"N and 109°04'47.14"E). The observation was carried out by a survey method using a combination of path and line square methods following the procedure conducted by [8,9]. The paths were put with a purposive sampling method in so many areas that have Shorea spp in each location of observation.

Data analysis was based on the Shorea spp available in the encountered area of each quadrat. All the information, including frequency, density, an abundance of the seed, stake, pole, and tree of species, were identified in accordance with [10], while the importance value index was assessed according to Phillips (1959) [11]. The density was assessed using Shannon’s diversity index (\( H=-\sum P(n_i/N) \log (n_i/N) \)) [12] and dominance using Simpson's index (\( C_d = -\sum P(n_i/N)^2 \)) [13], where \( n_i \) = importance value index of species i, N = sum of importance value index for the community.

3. Results
The study found there were about 51 vegetation and 34 families. Table 1 shows the species and individuals of each growth stage in observation sites. The growth stages were including the seedling stage, stake stage, pole stage, and tree stage. According to the number of species, the seedling stage was found as the most dominant, followed by the tree, stake, and pole, consecutively. According to the number of individuals, the seedling stage also becomes the highest, followed by stake, pole, and tree. However, under the density stem/ha of the observed site, the pole stage was the most, among others.

| Growth Stage | Number of Species | Number of Individuals | Density Stem/ha |
|--------------|-------------------|-----------------------|-----------------|
| Seedling     | 49                | 3.024                 | 37.800          |
| Stake        | 47                | 1.858                 | 3.716           |
| Pole         | 42                | 1.356                 | 678.000         |
| Tree         | 48                | 1.301                 | 162.000         |

In the secondary forest located in Mempawah District of West Kalimantan, it can be found four species of Shorea spp such as Shorea platyclados (known as Meranti Batu), Shorea leprosula (known as Meranti Bunga), Shorea pinanga (known as Meranti Merah), and Shorea bracteolatadyer (known as Meranti Putih). The density and important value index (IVI) of those species of Shorea spp displayed in Table 2.
Table 2. Density and Important Value Index (IVI) table.

| Species          | Density Stem / Ha | IVI (%)       |
|------------------|-------------------|---------------|
|                  | Seedling  Stake Pole Tree | Seedling Stake Pole Tree |
| S. platyclados   | 875  106  26  3.875 | 4.881  9.790 11.309 7.813 |
| S. leprosula     | 412  60   17  2.125 | 2.422  5.324 7.444  4.323 |
| S. pinanga       | 137  44   26  0.375 | 0.744  4.043 11.065 0.764 |
| S. bracteolatadyer | 100  36   30  0.625 | 0.550  2.641 12.091  1.214 |

Following the result of observation, *S. platyclados* was found about 875 stems/ha in the seedling stage, 106 stems/ha in pole stage, 26 stems/ha in pole stage, and 3.875 stems/ha in the tree stage. *S. leprosula* was found about 412 stems/ha in the seedling stage, 60 stems/ha in pole stage, 17 stems/ha in pole stage, and 2.125 stems/ha in the tree stage. *S. pinanga* was found about 137 stems/ha in the seedling stage, 44 stems/ha in pole stage, 26 stems/ha in pole stage, and 0.375 stems/ha in the tree stage. *S. bracteolatadyer* was found about 100 stems/ha in the seedling stage, 36 stems/ha in pole stage, 30 stems/ha in pole stage, and 0.625 stems/ha in the tree stage.

Among four species of *Shorea spp* found in the secondary forest of Mempawah District, there were several characteristics that can be identified visually on their leaves and stems. The shape of the leaves and stems is displayed in Table 3. Each species has different structures, forms, widths, and colors of the leaves and stems. Therefore, it can be distinguished from each other easily.

Table 3. Pictures of the Leaves and Stems of *Shorea spp*.

| Name       | Leaves       | Stems       |
|------------|--------------|-------------|
| *S. platyclados* | ![Leaves](leaves_platyclados.jpg) | ![Stems](stems_platyclados.jpg) |
| *S. leprosula*    | ![Leaves](leaves_leprosula.jpg)  | ![Stems](stems_leprosula.jpg) |
| *S. pinanga*      | ![Leaves](leaves_pinanga.jpg)    | ![Stems](stems_pinanga.jpg)    |
| *S. bracteolatadyer* | ![Leaves](leaves_bracteolatadyer.jpg) | ![Stems](stems_bracteolatadyer.jpg) |
The dominance, species diversity, and species abundance indexes of *Shorea spp* in the secondary forest of Mempawah, can be seen in Table 4. According to the dominance index, species abundant diversity index, and species abundance index, the pole stage found the most dominant among other stages of those four species, followed by the tree, stake, and seedling, from the high to the low, respectively.

The observation on the Dominance Index in seedling, stake, pole, and three stages for *Shorea spp* showed a low average value, less than 0.5. Those due to the vegetation deployment is not centralized in one species but deployment in all of the species. The analysis on the Species Diversity Index showed the vegetation in every growth stage for *Shorea spp* was overflowing (H 1 ≤ H ≤ 3), it shows with the amount of species diversity index in every growth stage is more than 1 (One). The survey on Result Species Diversity Index for *Shorea spp* was less than 1 (one). It means species diversity is in low transect or not overflowing. In terms of the Species Abundance for *Shorea spp* showed vegetation in every growth stage had species abundance value was less than 1, it means all of the species than have abundance is uneven in every growth stage in the forest. Figures and tables of maximum of three pages should be clearly presented. Number tables consecutively in accordance with their appearance in the text.

Title of a picture is written down below the picture, while title of a table is written above the table. Colored figures can only be accepted if the information in the manuscript can lose without those images; chart is preferred to use black and white images. Author could consign any picture or photo for the front cover, although it does not print in the manuscript. All images property of others should be mentioned source. There is no appendix, all data or data analysis are incorporated into Results and Discussions. For broad data, it can be displayed on the website as a supplement (Table 1).

**Table 4.** Dominance, Species Diversity, and Species Abundance Indexes of *Shorea spp*.

| Species        | Index                | Stages       |
|----------------|----------------------|--------------|
|                |                      | Seedling     | Stake | Pole  | Tree  |
| *S. platyclados* | Dominance Index      | 0.0005284    | 0.26887| 0.53923| 0.35024|
|                | Species Diversity Index | 0.03936    | 0.0485| 0.05367| 0.04126|
|                | Species Abundance Index | 0.0233    | 0.0291| 0.0331| 0.0245|
| *S. leprosula*   | Dominance Index      | 0.0001155    | 0.12006| 0.38459| 0.18449|
|                | Species Diversity Index | 0.02321    | 0.03107| 0.03983| 0.02653|
|                | Species Abundance Index | 0.0137    | 0.0186| 0.0245| 0.0158|
| *S. pinanga*     | Dominance Index      | 0.0001203    | 0.10384| 0.51570| 0.03274|
|                | Species Diversity Index | 0.00904    | 0.02521| 0.05286| 0.00661|
|                | Species Abundance Index | 0.0053    | 0.0151| 0.0326| 0.0039|
| *S. bracteolatadyer* | Dominance Index | 0.0000613    | 0.04489| 0.58945| 0.04708|
|                | Species Diversity Index | 0.00704    | 0.01809| 0.05621| 0.00968|
|                | Species Abundance Index | 0.0042    | 0.0108| 0.0346| 0.0058|

**4. Discussion**

The total observation site area where the study took place was approximately 191.33 hectares, a secondary forest in Mempawah District. This is one of the secondary forests in the tropics area. In the tropics region, the diversity of species may vary in each area, which influences by environmental and other disturbances [14–16].

According to Lund (2002) there are many definitions describing the forest. Briefly, the forest is known as an integrated ecosystem in the biosphere dominated by the plant kingdom [17]. The forest itself is a source of life for all living things. Various types of human needs such as food, medicine, and wood can be obtained from forest resources. Especially the need for wood, people generally rely on forests as the main source, beside of plantations which are managed independently. There are several types of forest, one of which is tropical forest.
Currently, most of the world's wood needs are supplied from tropical forests [18], including Indonesia, as one of the suppliers. To meet the demand, then almost all forests over the world suffered from deforestation. Therefore it would need to create a human-made forest called as secondary forest [19]. This forest plantation is developed to improve and repair the natural resource, which may affect the world by its vegetation, soil, or microclimate [20]. This type now exists over the worldwide, following the number of deforestation. As an effort to preserve the natural, this reforestation becomes widespread and increasing the interest according to their function and role [21]. This forest also can be found in the equatorial area including in Indonesia, such as in Mempawah West Kalimantan.

Meranti is one of the popular global commodities. It also grows in the secondary forest of Mempawah and becomes the primary species of tropical forest. Meranti or Shorea spp species belonging to the Dipterocarpaceae family [22]. Purwaningsih and Kintamani E (2018) [6] and Utomo S et al. (2018) [23] reported about 160 Shorea spp species found in the Malesia area, and over 125 species were in Indonesia, and 75% is in Borneo. This family of the tree has strict mast fruiting due to their seed predatory [24], which may influence the number of this species. Thus, it will affect the global supply of this wood. In Java, Sumatera, also Kalimantan (Borneo), these species are known to decline rapidly due to illegal logging and diversion to be oil palm plantations. Nowadays, illegal logging and oil palm plantation invade massively against the forest [25,26], may affect significantly the living things diversity, including Shorea spp.

Hereafter, Regarding the diversity, it describes the abundance of species, genetic composition, and communities that indicate the level of variety in an ecosystem area. Plant diversity is very important to maintain. The level of plant diversity will affect the environment because plants produce oxygen for other living things. This basic function will affect the climate and the sustainability of life. Therefore, the level of plant diversity must be considered, including in the management of commercial timber plants aimed to meet human needs.

Deforestation or illegal logging behavior will reduce the quality of life in the future [27], since, even though it can meet the current demand for wood, it also cause future global warming and climate change [28–30]. The same also for tropical forests in Indonesia, Lungs of the world for their forest ecosystem covering almost all land area of Sumatra, Java, Papua, Sulawesi, and Kalimantan, previously. Efforts should be made to maintain a balance between human needs fulfillment for forest resources, including meranti as commercial timber from forests. Thus, the importance of forest product management, primarily in maintaining the diversity which will then support ecological balance as well as efforts to meet the needs of human life in a sustainable manner.

5. Conclusion
According to the research in secondary forest in Mempawah District, West Kalimantan can be found 4 species of Shorea spp such as Shorea platyclados (Meranti Batu), Shorea leprosula (Meranti Bunga), Shorea pinanga (Meranti Merah), Shorea bracteolatadyer (Meranti Putih) in each growth stage from seedling, stake, pole, and tree, but not dominate in the forest. The Dominance Index in the seedling, stake, pole, and tree stages for Shorea spp have a low average value, less than 0.5. Species Diversity Index for Shorea spp was overflowing (H I ≤ H ≤ 3). While Species Abundance for Shorea spp was less than 1.

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