Species composition and plant diversity of logged-over forest in Sikundur, Gunung Leuser National Park, North Sumatra

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Abstract. Sikundur forest area is located at Gunung Leuser National Park (GLNP), in Aras Napal, Langkat, North Sumatra Province, representing mixture forest of lowland Dipterocarpaceae. Two 0.5 ha permanent plots of 50 x 100 m were established at twenty-two years old logged-over Sikundur Forest and located subjectively according to topography and river bank. This dryland forest was logged for the first cycle in 1978 by forest concession right. This study aimed to identify the species composition and to determine the diversity index of plants after 22 years logged over area. The results showed that significant tribes were Dipterocarpaceae, Euphorbiaceae, and Myrtaceae which are the richest family in two permanent plots. The horizontal structure of forest indicated that the diversity index of Dipterocarpaceae family in two plots tended to be centered, showing the high value of diversity index of Dipterocarpaceae family. The present study suggested the periodic activities on natural regeneration, and the measurement of the dynamics stock plant are highly recommended.

1. Introduction

Gunung Leuser National Park (GLNP) is one of the largest tropical rainforest reserves in the world. In Sikundur forest, there is a mixed Dipterocarp Forest located in a well-drained land and rich of alluvial soil [1]. The forests were situated at fringing the rivers of Besitang River area. This forest was logged in 1977 to 1980 using selective logging under Forest Concession Right (Hak Pengusahaan Hutan) system. About 13,000 ha were logged in GLNP [1]. The selective logging allowed cutting a commercial tree with a diameter of 50 cm and above. The cutting cycle is 35 years, and the forests have been carried for felling at least 25 trees of commercial species per hectare [2].

Logging has destroyed several areas since the early seventies, and the most severe damage was in the late twenties century [1, 3]. The land-use change increased the carbon dioxide and deforestation rate as well [4–6]. This damaging process continues in some parts of the park, notably in Sikundur Forest [1]. This condition related to exploitation and destruction has reduced the extent of Dipterocarp forest in Indonesia by shifting cultivation and currently intensive mechanized logging [1, 2]. The cages established at high cost have rotted away in the meantime and forest has regenerated to some extent [1–4].

To get more insight into the quality of natural forest regeneration monitoring and to support management of the national park, a periodic survey on the permanent plot is therefore needed. The
present study aimed to analyze the species composition and plant diversity index in a twenty-two years old logged-over Sikundur forest, GLNP, Langkat, North Sumatra, Indonesia.

2. Materials and method

Two 0.5 ha permanent plots of 50 x 100 m were established at twenty-two years old logged-over Sikundur Forest and located subjectively according to topography and river bank. The plot was divided into 50 subplots A and 50 subplots B of 10 m x 10 m, and each was marked with the permanent red painted ‘PVC’ stakes as earlier reported [7].

Trees with a diameter at breast height (dbh) which was higher than 10 cm were measured, labeled, and numbered in a continuous sequence and then were recorded, and identified within 10 m² subplots basis. Aluminum labels were nailed at 30 cm above the level of dbh measurement. Specimens for all trees were collected to verify field identification. The data collected were analyzed using previously described [1].

3. Results and discussion

The lowland rain forest in Sikundur forest, North Sumatera typically denoted to a mixed Dipterocarp forest, by feature of the vast diversity of Dipterocarpaceae which dominates, particularly the canopy, is collected in its lower strata by other tree tribes such as the Annonaceae, Euphorbiaceae, Lauraceae, Meliaceae, Myristicaceae, Myrtaceae, and Rubiaceae.

From this study, we recorded 100 species in 77 genera and 32 families of trees ≥10 cm dbh in plot A whereas we found 88 species in 71 genera and 36 families in plot B (table 1). Dipterocarpaceae, Euphorbiaceae, and Myrtaceae were the richest families of a specific individual. Abdulhadi et al. [8] found 867 trees over 10 cm dbh in two ha (200 x 100 m) in five years after logging into the same study area.

In plot A, Dipterocarpaceae, Euphorbiaceae, and Myrtaceae had the highest density in our 0.5 ha at 42, 32, and 22 respectively and furthermore Euphorbiaceae, Myrtaceae, and Dipterocarpaceae also had the highest density in 0.5 plot B at 32, 21, and 18 respectively (table 1). More than 75 % of Dipterocarpaceae density was dominated by Dipterocarpus grandiflorus Blanco, Shorea sp.1, and S. leprosula Miq. Dipterocarpaceae is the most economically significant family in the forests of Indomalesia, generating more timber than the trees of all other families in combination. With very few exemptions, Dipterocarpaceae is medium-sized or large to huge trees, and its economic value is contingents on the many beneficial kinds of timber they produce [9].

| Family            | # of species | # of genera | # of trees | FIV     |
|-------------------|--------------|-------------|------------|---------|
| Plot A            |              |             |            |         |
| Dipterocarpaceae  | Euphorbiaceae| 7           | 12         | 9       | 42      | 32      | 44.7    | 39.1    |
| Euphorbiaceae     | Dipterocarpaceae| 12         | 5          | 10       | 2       | 32      | 18      | 30.1    | 31.3    |
| Myrtaceae         | Myrtaceae    | 8           | 6          | 2        | 1       | 22      | 21      | 19.6    | 27.4    |
| Lauraceae         | Lauraceae    | 5           | 4          | 4        | 4       | 22      | 15      | 19.1    | 16.4    |
| Moraceae          | Moraceae     | 4           | 3          | 3        | 3       | 17      | 10      | 16.8    | 14.2    |
| Celastraceae      | Tiliaceae    | 1           | 1          | 1        | 1       | 14      | 13      | 16.0    | 13.7    |
| Sapindaceae       | Sapotaceae   | 5           | 4          | 3        | 3       | 15      | 10      | 15.4    | 13.7    |
| Rubiaceae         | Polygalaceae | 3           | 1          | 3        | 1       | 9       | 12      | 13.3    | 12.3    |
| Polygalaceae      | Myristicaceae| 1           | 4          | 1        | 3       | 9       | 9       | 12.6    | 11.3    |
| Meliaceae         | Meliaceae    | 5           | 1          | 4        | 1       | 12      | 7       | 11.0    | 10.5    |
| Others (22)       | Others (26)  | 49          | 47         | 42       | 43      | 97      | 88      | 102.0   | 110     |
| Total             |              | 100         | 88         | 77       | 71      | 291     | 235     | 300.0   | 300     |

Note: FIV (family index value)

It is interesting to note that more than 75 % of Euphorbiaceae density is attributed to Macaranga diepenhorastii, Baccaura deflexa, and B. fanceolata. These pioneer species usually grow in gaps or at
forest edges [1, 8]. They contributed primarily to the lower part of the rainforest canopy. Knowledge of the ecology of pioneer species is, therefore, essential to obtain more understanding of the ecology and management of tropical forest communities [10]. We found that several of non-dominated stands in the taxa (Endospermum, many Macaranga spp., a few Mallotus, and Sapium) grew positively in a logged-over forest, had advanced pioneer features such as germination and seedling survival in open environments, rapid growth, and could thrive in dense pure stands. Among the Myrtaceae, the genus Syzygium is abundantly characterized. The genus is easily documented by its simple, opposite; gland-dotted leaves, habitually with a discrete intramarginal vein, and the most plentiful in the understory of the lowland and hill forests [10].

Importance of families showed a different pattern when density, frequency, and dominance (a basal area at 1.3 m above ground) were jointly considered. Ten families had family importance value indices (FIV) >10. Dipterocarpaceae held the most important position with an FIV of 44.7, followed by Euphorbiaceae with an FIV of 30.1 (plot A). In plot B, Euphorbiaceae, on the hand, had the most critical position with an FIV of 39.1, followed by Dipterocarpaceae with an FIV of 31.3 (table 1).

The practice of selective logging is designed to remove the commercial trees above 50 cm dbh from the forest, leaving the smaller trees (residual) to remain to grow so that they form the next harvest. It is apparent from these work and other researches that many possible future harvestable trees are destroyed by intensive logging activity predominantly where large commercial trees are positioned close together [11–13], an entirely mutual existence in the rainforest of Sikundur, GLNP. Diameter class histograms conventionally signify the horizontal structure of forest formation. Our graph shows a classic ‘L’ distribution (figure 1), a proof that our sample plot has not undertaken a significant disturbance. The selective logging, which was used to exploit this forest, could assure itself regeneration [2].

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The non-Dipterocarp species play a significant function within the tropical rainforest [14, 15]. Either they form the primary component of the understory layer (Euphorbiaceae, Myrtaceae, Myristicacea, Meliaceae, Lauraceae, and Rubiaceae) or they have profitable use, regularly only locally as fruit trees (Euphorbiaceae, Lauraceae, Moraceae, Polygalaceae, Rubiaceae, Sapindaceae) such as rambutan [16]. A third group is formed by those taxa commonly used for commercial timber (Alstonia, Calophyllum, Gonstylus, Lophopetalum, Madhuca, Palaquium, Payena, Pometia), and a fourth group comprises of those species already exploited on a small, usually local scale. They have or will have projections in the future when the woods of Dipterocarp species become rarer and more costly than these species (Artocarpus, Buchanania, Dacryodes, Durio, Gironniera, Gluta, Ochanostachys, Pentace, Pterospermum). Some species are also used as the fundamental constituent in traditional medicine (Thymelaeaceae: Aquilaria malaccensis; Flacourtiaceae: Hydnocarpus kunstleri; Calophyllaceae: Calophyllum inophyllum; Malvaceae: Hibiscus tiliaceus) [17, 18].

Figure 2 depicts that the family diversity index of Dipterocarpaceae was more centered in both plots A and B than other families. This circumstance was shown by the high value of diversity index of the Dipterocarpaceae family. It may indicate the remaining stands of Dipterocarp can establish a better and greater capability to grow under disturbance pressure than other families. Therefore there are three scenarios to be considered in GLNP: conservation, deforestation, and selective use [19].

4. Conclusion
This study inferred that Dipterocarpaceae, Euphorbiaceae, and Myrtaceae were the wealthiest families. Family diversity index of Dipterocarpaceae was more centered in both plots A and B than other families. This data was shown by the high value of diversity index of Dipterocarpaceae family. It may indicate the remaining stands of Dipterocarp can establish a better and greater capability to grow under disturbance pressure than other families. Therefore there are three scenarios to be considered in GLNP: conservation, deforestation, and selective use [19].

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