Diversity of Flora as Affected by Time Consequences of Revegetation Age in Post Coal Mine Area at PT Berau Coal Tbk, East Kalimantan Indonesia

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Abstract. This study aims to examine the diversity of flora in various age classes of revegetation of post-mining coal. This research was conducted at PT. Berau Coal, Binungan block, East Kalimantan. Sampling plots were applied on revegetation land of post-mining coal aged 0, 2, 4, 6, 8 and 10 years, and natural forest as a control. Flora observations were carried out on sample plots of size 25m x 40m for sapling, poles and trees, while sub-plots 1m x 1m for seedlings and understorey. In natural forests observations were made on sample plots measuring 20m x 20m for trees with sub plot 2m x 2m for understorey and seedlings, 5m x 5m for saplings, 10m x 10m for poles. The analysis results show that the highest individual density per ha is found in natural forests (seedlings, saplings and poles). The highest of flora index of diversity, richness and evenness were found in natural forests. The flora from revegetation of eight-year has been able to approach to natural forests conditions. The species of plants that predominate in some revegetation age classes are Rhynchospora corymbose (understorey), Senna siamea (seedling, sapling, pole and tree). Acacia mangium and Macarangan hyleoea grow naturally in some revegetation age.

1. Introduction
Indonesia has a forest with a fairly high contribution of biodiversity of flora and fauna. Some flora and fauna including endemic species only be found in certain regions of Indonesia. Kalimantan is one of the largest islands in Indonesia which has a large forest area. According to Mukhtar and Heriyanto [1], Kalimantan’s forest have high flora richness with varied species diversity. However, the existing of richness and diversity species were continue to decreases along with the increasing forest disturbance. Forest disturbances are to the changes in tree structure and composition variation.

One of the forest disturbances in Kalimantan is the existence of mining activities that occur in several areas, especially in East Kalimantan. East Kalimantan has a high reachness of natural resources, one of them is coal. Generally coal mining activities in Indonesia are operated by using conventional techniques
namely open mining [2], [3], [4]. Open mining activities are one of the causes of forest degradation and land damage [5]. Open mining activities have big impacts on the changes of environment. The impacts are include of the changes in topography, soil surface damaged, high soil erosion, loss of flora and fauna, changes in hydrological systems and ecosystem stability [6]. According to Cooke and Johnson [7], the existence of coal mining can reduce existing of biodiversity.

Rehabilitation and revegetation activities are leading to restore the post-mining land condition. In addition, post-mining rehabilitation and revegetation activities are expected to be able to restore biodiversity and increase the land’s productivity in the long term [8]. Post-mining land recovery will occurs along with the age of revegetation processes. As times goes by and age revegetation is increasing, it will leading to the changes in physical characteristics of the environment which will establish supporting to the succession process. According to Candra [9], showed that the increasing of vegetation status will occur along with the ages of revegetation on post-mining land.

One of the revegetation techniques that are generally adopted on post-mining lands is by using local pioneers with typical species of fast-growing, intolerant, produce a large amount of litter and easily decomposed, have a good rooting system and capable to symbiosis with microorganisms [10]. Local species can support the inclusion of other types that tend to be able to restore the environmental conditions of the ecosystem which is close to its original condition [11]. The success of revegetation activities depends on the choice of adaptive plants species and able to grow on infertile soils, such as post-mining lands [12]. Over time, these species which is resulted from revegetation will form forest ecosystem as similar as natural forests. The dynamics of plant communities in revegetation land can occur until the ecosystem reach the climax stage. This study aims to examine the diversity of vegetation in various age classes of revegetation land post-coal mining.

2. Material and Method

2.1 Study site

The study was conducted in October 2018 that located at PT. Berau Coal, Berau Regency, East Kalimantan. Geographically, PT Berau Coal is located between 01°52'26.67"LU-02° 2.5'09.78" LU and 117°07'44.52" BT-117°38'26.46" BT. PT. Berau Coal has a concession area of 118,400 hectares consisting of three sites which are Lati, Sambarata, and Binungan. The study was conducted in the Binungan block and in several revegetation age classes ranging from unvegetated, 0, 2, 4, 6, 8 and 10 years. While natural forests are used as controls or comparisons. The research location can be seen in Figure 1.

![Figure 1. Location map research.](image)

2.2 Procedure
Determination of the sample plots to determine the diversity of vegetation adapted to the condition of vegetation. The sampling intensity (IS) used is 5% [14]. The plot used for homogeneous vegetation measuring 0.1 ha (25m x 40m), the plot was placed by purposive sampling in each stand age class. Observations made on the 25m x 40m plot include: seedlings, saplings, poles and trees, while the understorey is counted in the sub plot 1m x 1m made in the corner of the plot. For heterogeneous vegetation (natural forest) used plots 20m x 60m, meanwhile seedlings and understorey are observed on a sub plot of 2m x 2m, saplings in sub plot 5m x 5m, the pole on the sub plot of 10m x 10m and trees in the sub-plot 20m x 20m.

2.3 Data Analysis

Data are analysis by using method of quantitative descriptive. Analysis of vegetation diversity index value is calculated to find the important value index (IVI) which is used to determine the species composition and dominance of a species on a stand. IVI calculation is based on the summation of relative density, the relative frequency and relative dominance [15] [16].

Density (D) = \( \frac{\text{Number of individuals of species}}{\text{Sample plot area}} \)

Relative density (RD) = \( \frac{\text{Density of a species} - \text{i}}{\text{Density of all species}} \times 100\% \)

Frequency (F) = \( \frac{\text{Total of subplot that found a species}}{\text{Total number of sub-plots examples}} \)

Relative frequency (RF) = \( \frac{\text{Frequency of species} - \text{i}}{\text{Frequency of all species}} \times 100\% \)

Dominance (D) = \( \frac{\text{Basal area of a species}}{\text{Sample plot area}} \)

Relative dominance (RD) = \( \frac{\text{Dominance of a species} - \text{i}}{\text{Dominance of all species}} \times 100\% \)

Important Value Index (IVI) = RD + RF + RD (for saplings, poles and trees)

Important Value Index (IVI) = RD + RF (for understorey and seedlings)

a. Species diversity index (H')

The species diversity index is used to show the relationship between the number of species and the number of individuals who make up a community. Index values for species diversity can be classified into three categories namely low (H '<2), medium (2' H '' 3) and high (H '> 3) [17]. Besides, the diversity index can show the stability of a community. According to Kent and Paddy [18], when the value of H '<1 then the community is said to be less stable, if the value of 2' H '' 3 then the community is said to be stable and if the value of H '> 2 then the community is said to be very stable. The species biodiversity index calculation uses the Shannon-Wiener equation [19].

\[
H' = - \sum \left( \frac{n_i}{N} \right) \cdot \ln \left( \frac{n_i}{N} \right)
\]

Where, H': species diversity index; pi : proportion of individual species; ni : total of individual species and N: total of all individual species.

b. Species richness index (R)

The species richness index shows the number of species found in a community. According to Magurran [17], species richness index values can be categorized into three categories, when R <3.5 indicates low species richness, if 3.5 ≤ R ≤ 5 indicates medium species richness and if R > 5 shows high species richness. The species wealth index is calculated using the Margalef index [19].

\[
R = \frac{(s - 1)}{\ln N}
\]

Where, R: species richness index; s: total of species; N: total of individual.
c. Species evenness index (E)

The species abundance index is used to see the distribution of a species in a community. According to Magurran [20], species abundance values can be categorized into three categories, when the value of $E < 0.3$ indicates low evenness, if $0.3 \leq E \leq 0.6$ indicates moderate species evenness and if $E > 0.6$ indicates high evenness. The species abundance index is calculated using the Margalef index [19].

$$E = \frac{H'}{H_{\text{max}}} = \frac{H'}{\ln(S)}$$

Where, $E$: species evenness index; $H'$: species diversity index, $S$: number of species and $\ln$: log base.

3. Result and Discussion

3.1 Result

3.1.2 Density of vegetation on various age classes

The density of the vegetation can describe the structure of the vegetation structure in the ecosystem. Vegetation density shows the number of plants in one hectare. Vegetation density in the natural forest has the highest value than revegetation land on various age classes except on understorey growth rate (Table 1). Understorey density in revegetation age classes is higher than in natural forests. At the seedling level, the increasing of revegetation’s age will reduce the individual density per ha. This situation is caused by the seedlings that exist at the beginning of revegetation had been grown and developed into saplings. At the growth rate of tree, the highest level of the tree density is found in the age of 8 years revegetation. This shows that the presence of revegetation activities can improve tree density per ha. Revegetation activities on the revegetation age class of 8 years have been able to approach the density of individuals per ha in natural forests.

Table 1. Vegetation density per ha of growth rates in various age classes of revegetation.

| Growth rate | 0 year | 2 year | 4 year | 6 year | 8 year | 10 year | Natural forest |
|-------------|--------|--------|--------|--------|--------|---------|----------------|
| Understorey | 250000.00 | 335714.30 | 288571.40 | 240000.00 | 237500.00 | 120000.00 | 5833.33 |
| Seedling    | 185.00  | 62.86  | 25.71  | 35.00  | 15.00  | 0.00    | 15000.00      |
| Sapling     | 515.00  | 475.71 | 575.71 | 595.00 | 185.00 | 202.00 | 5333.33        |
| Poles       | 0.00    | 102.86 | 27.14  | 250.00 | 240.00 | 174.00 | 633.33         |
| Tree        | 0.00    | 0.00   | 5.71   | 10.00  | 675.00 | 120.00 | 141.67         |

3.1.2 Composition of species on various age classes

The species composition shows the species which is set the ecosystem or community. Based on observations, the number of species in natural forests is higher than in revegetation age classes, except at the understorey level (Table 2). In revegetation age classes, the number of species tends to increase along with the increasing revegetation ages. The number of species in the revegetation age class at 8 years has the highest value among the other revegetation age classes. Those conditions indicated that the revegetation age class of 8 years was able to approach the condition of natural forests. The number of individual species that exist in each revegetation age class can be seen in Table 3.

Dominant species are species that have the highest important value index (IVI) values in each age class revegetation. Three dominant species were found in each revegetation age class and natural forest at the understorey growth rate as shown in Table 3. At the level of understorey species of *Rynchospora corymbose* be the most dominant species that found in revegetation age class 0, 4, 6, 8 and 10 years old (Table 3). *Centroccema pubescens* and *Calopogonium mucunoides* are cover crop types that dominate the revegetation age at in 0 and 2 years revegetation age classes. *Cyrtococcum patens* is another species of poaceae family that is also found and dominates in the 10-year revegetation age class. *Mikani micrantha*
also dominates in revegetation age classes 2 and 6 years of revegetation age class and *Dicranopteris linearis* dominates the revegetation age classes of 6 and 8 years. Besides, there are other types of plants that are only found in one age class such as *Melastoma malabatricum*, *Nephrolepis biserrata*, *Dicranopteris linearis* and *Cymbopogon sp.*. In a natural forest, *Korthalsia rostrata* is dominant species at the understorey growth rate.

| Table 2. Number of species of growth rates in various age classes of revegetation |
|-----------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
| **Growth rate** | **Revegetation age class** | **0 year** | **2 year** | **4 year** | **6 year** | **8 year** | **10 year** | **Natural forest** |
| Understorey | | 5 | 11 | 13 | 8 | 13 | 13 | 1 |
| Seedling | | 6 | 6 | 7 | 6 | 3 | - | 14 |
| Sapling | | 2 | 7 | 11 | 10 | 18 | 14 | 23 |
| Poles | | 0 | 5 | 3 | 2 | 9 | 8 | 11 |
| Tree | | 0 | 0 | 1 | 2 | 6 | 3 | 17 |

| Table 3. Understorey species dominant on each various age class revegetation |
|-----------------------------------------------|-----------|-----------|
| **Revegetation age class** | **Species** | **INP (%)** |
| 0 year | *Centrosema pubescens* | 95.33 |
| | *Rhynchospora corymbosa* | 28.67 |
| | *Nephrolepis biserrata* | 28.67 |
| 2 year | *Calopogonium mucunoides* | 25.24 |
| | *Centrosema pubescens* | 20.92 |
| | *Mikania micrantha* | 33.58 |
| 4 year | *Melastoma malabathricum* | 28.14 |
| | *Paspalum conjugatum* | 45.32 |
| | *Rhynchospora corymbosa* | 40.14 |
| 6 year | *Dicranopteris linearis* | 37.94 |
| | *Mikania micrantha* | 29.99 |
| | *Rhynchospora corymbosa* | 49.49 |
| 8 year | *Cymbopogon sp.* | 23.72 |
| | *Dicranopteris linearis* | 36.9 |
| | *Rhynchospora corymbosa* | 51.19 |
| 10 year | *Centotheca lappacea* | 13.89 |
| | *Cyrtococcum patens* | 78.89 |
| | *Rhynchospora corymbosa* | 28.33 |
| Natural forest | *Korthalsia rostrata* | 300 |

Seedling, sapling, pole and tree species that dominate in some revegetation age classes are *Senna siamea* (Table 4).

| Table 4. Species dominant on each various age class revegetation. |
| Revegetation on age class | Seedling | Sapling | Pole | Tree |
|---------------------------|----------|---------|------|------|
|                           | Species  | IVI (%) | Species | IVI (%) | Species | IVI (%) | Species | IVI (%) |
|                           |          |         |        |        |         |         |         |         |
| 0 year                    | Senna    | 386.1   |        |        |         |         |         |         |
|                           | siamea   | 1       |        |        |         |         |         |         |
|                           | Syzygium polyanthum | 41.3 |       |        |         |         |         |         |
|                           | Enterolobium cyclocarpum | 69.1 |       |        |         |         |         |         |
| 2 year                    | Hevea    | 61.3    | Falcatoria moluccana | 34.35 |         |         |         |         |
|                           | brasiliensis | 6     | moluccana | 9 |        |         |         |         |
|                           | Swietenia | 59.0   | Senna   | 111.8 |         |         |         |         |
|                           | macrophylla | 9     | siamea  | 77   |         |         |         |         |
|                           | Syzygium polanthen | 45.4 | Enterolobium cyclocarpum | 24.74 |         |         |         |         |
|                           |         | 5       | cyclocarpum | 3 |        |         |         |         |
| 4 year                    | Dryobalanops beccarii | 47.2 | Shorea balangeran | 14.23 | Acacia | 111.0 | Acacia | 300.0 |
|                           | Shorea   | 38.8    | Glicridia | 13.74 | mangium | 63.0 |         |         |
|                           | leprosula | 9      | sepium  | 8    | Neolamarckia cadamba | 29.8 |         |         |
|                           | Shorea   | 44.4    | Senna   | 120.06 | Senna siamea | 49.0 |         |         |
|                           | smithiana | 4     | siamea  | 158.0 |         |         |         |         |
| 6 year                    | Shorea balangeran | 60.6 | Shorea balangeran | 31.63 | Acacia | 29.5 | Acacia | 235.85 |
|                           | Dryobalanops beccarii | 60.6 | Hevea brasiliensis | 18.89 | mangium | 7.0 |         |         |
|                           | Hevea    | 27.7    | Senna   | 43    | Senna  | 270.0 |         |         |
|                           | brasiliensis | 1     | siamea  | 64.15 |         |         |         |         |
| 8 year                    | Shorea   | 25.0    | Senna   | 91.47 | Senna  | 214.0 | Senna  | 79.51 |
|                           | agami    | 0       | siamea  | 40    | siamea | 40.0 |         |         |
|                           | Senna    | 75.0    | Mallotus | 12.75 | Senna  | 214.0 | Senna  | 79.51 |
|                           | siamea   | 0       | paniculatus | 3   | paniculatus | 3   |         |         |
|                           | Dryobalanops beccarii | 100.0 | Vex pinnata | 12.08 | Macaranga gigantea | 22.2 |         |         |
|                           |         | 0       | pinnata | 12.08 |         |         |         |         |
| 10 year                   | Senna    | 25.0    | Senna   | 21.52 | Senna  | 116.0 | Senna  | 65.05 |
|                           | siamea   | 0       | siamea  | 76    | Senna  | 116.0 | Senna  | 65.05 |
|                           | Dryobalanops beccarii | 58.88 | Vex pinnata | 9   | Falcatoria moluccana | 55.3 | Neolamarckia cadamba | 32.35 |
|                           |         | 1       | pinnata | 9   |         |         |         |         |
| Natural forest            | Knema    | 18.2    | Dipterocarpus sublamellatus | 14.40 |         |         |         |         |
|                           | cinerea  | 5       | sublamellatus | 14.40 |         |         |         |         |
|                           | Lithocarpus korthalsii | 23.8 | Cleistanthus caulatus | 10.95 |         |         |         |         |
|                           | Xanthophyllum eurhynchum | 18.2 | Lithocarpus korthalsii | 20.34 |         |         |         |         |
|                           |         | 5       | korthalsii | 20.34 |         |         |         |         |

Note: The table shows the IVI (%) for each species in the seedling, sapling, pole, and tree stages at different age classes.
Enterolobium cyclocarpum species predominate at seedling, sapling, and pole of growth rate in some revegetation age classes. Falcataria moluccana species dominate at the growth rate of sapling, poles and trees. Neolamarcia cadammba is dominant at the pole, and tree of growth rate and Albizia samman species only dominate at the tree of growth rate in the eight-year revegetation age class. Other species such as Swietenia macrophylla, Hevea brasiliensis, Syzygium polantheum, Dryobalanops beccarii, Shorea leprosula, Shorea smithiana, Shorea balangeran and Shorea agami are dominate at the seedling and sapling of growth rate in several revegetation age classes. These species are inserts planted in several revegetation age classes. Besides, several local species found growing naturally in several revegetation age classes, such as Acacia mangium, Gliricidia sepium, Macaranga hypoleuca and Mallotus paniculatus. Gliricide sepium and Vitex pinnata are only dominated by the sapling growth rate of four and six years revegetation age classes. Macaranga hypoleuca and Mallotus paniculatus species dominate at the sapling and pole of growth rate in the six and eight-year revegetation age classes, while the Acacia mangium dominant species at the pole and tree growth rate in the four and six-year revegetation age classes. This species of Acacia mangium is one tree species that grow naturally in several age classes of revegetation land.

In natural forests, the species that dominate are different from the species that found in each revegetation age class. The species that dominates at the seedling, sapling, and pole of growth rate are Lithocarpus korthalsii while the Dipterocarpus cf tempehse species dominates at the pole and tree of growth rate. Other species that predominate at the tree level are Syzigium lineatum and Oleo ochera.

### 3.1.3 Species Diversity Index (H')

The species diversity index value varies between revegetation age classes and in natural forests. The species diversity index value is low (H < 1) to moderate (1 ≤ H ≤ 3) in each revegetation age class. In the eight-year revegetation age class, the diversity index value at the tree and sapling growth rate is highest compared to other revegetation age classes (Figure 2) and is classified as medium criteria. The value of species diversity index in the revegetation age class is lower than natural forests. In natural forests, the species diversity index value is classified as high category (H > 3) at the sapling, classified as medium category (1 ≤ H ≤ 3) in the seedling, pole, and tree of growth rate, and is classified as low at the understorey growth rate.

The value of species diversity also illustrates the stability of a community in an ecosystem. In revegetation age classes community conditions vary from very stable (H > 2), stable (1 ≤ H ≤ 2) and less stable (H < 1). Very stable and stable community conditions exist at the understorey growth rate. at the tree growth rate, stable community conditions are found in the eight and 10-year revegetation age classes. While the condition of natural forests as a control tends to have reached a very stable level at the growth rate of seedlings, saplings, and trees, classified as stable at the pole growth rate and unstable in the understorey.

**Figure 2.** Species diversity index in growth rate at revegetation age class.
3.1.4 Species Richness Index (R)
The value of species richness index in revegetation age class is low (R < 3.5) at each growth rate. Eight-year revegetation age classes have a higher species richness value than other revegetation age classes. In contrast to natural forests which have a high species richness (R > 5) at the sapling and tree growth rate, it is classified as moderate (3.5 ≤ R ≤ 5) at the seedling and pole growth rate. The value of species richness index in each revegetation age class can be seen in Figure 3.

![Image: Figure 3. Species richness index in growth rate at revegetation age class.](image)

3.1.5 Species Evenness Index (E)
The values of species evenness index in various revegetation age classes tend to vary from low, medium and high (Figure 4). The value of species evenness in six and eight-year revegetation age classes has a higher evenness value compared to other revegetation classes. Meanwhile, the evenness of species in natural forests is high (E > 0.6) at the seedling, sapling, pole, and tree growth rate.

![Image: Figure 4. Species evenness index in growth rate at revegetation age class.](image)

3.2 Discussion
The condition of natural forest which is the control in the study is classified as normal. This condition is shown by the balanced vegetation structure, where the number of individuals per hectare decreases with increasing growth rates (seedlings > piles > trees) [20]. These conditions are following with normal
tropical rain forests and show the condition of natural forest regeneration is going well [21]. The high individual per ha in the early stages of growth can guarantee the sustainability of standing in the future.

The structure and composition of vegetation can decrease along with the presence of coal mining activities. This condition is shown by the decrease in individual density per ha and the number of species (Table 1 and Table 2). According to Blońska et al. [22], mining activities can reduce the number of species. However, the presence of revegetation activities can increase individual density per ha and the number of species (Table 3 and Table 4). These results are following the study of Hendrychová [23], where the composition of species in the community will increase with revegetation and will greatly affect the age and type of plant. Vegetation planting in post-mining revegetation activities will provide many advantages, namely accelerating the jumps-start process, providing shelter and repairing land damage due to mining activities [24].

The presence of understorey in the reclamation area is greatly influenced by soil conditions and canopy cover conditions [25]. According to Novak and Konvicks [26], communities in ecosystems will be able to develop well in areas close to natural forests (seed sources). The results of the vegetation analysis showed that at the growth rate, Rhynchospora corymbose became the dominant species in some revegetation age classes. Rhynchospora corymbose is a species of sedges that grows mostly in open and closed land. The species of grass can grow and adapt to extreme land (low fertility), such as post-mining land coal [27]. Another understorey that is quite dominant in revegetation land post-coal mining is Mikania micrantha. According to Fernandes et al. [28], Mikania micrantha is one of the species of understorey that grows in Berau, East Kalimantan and is widely used as a natural wound medicine. Mikania micrantha is an understorey that grows in post-mining reclamation in PT Kideco Jaya Agung, East Kalimantan [29].

Generally, several species planted on post-mining revegetation land are types of pioneers that are fast growing and able to adapt to low nutrient conditions [30]. Species of fast growing pioneers can grow quickly and can adapt to infertile lands (post-mining land) [31]. The species of fast growing pioneers are generally derived from the Fabaceae family which can help restore degraded soils through the production and decomposition of leaf litter that is rich in nitrogen and able to symbiosis with rhizobium bacteria that are able to fix nitrogen in the air [32]. According to Duan et al. [33], the species of Fabaceae (Leguminosae) are more effective in reclaiming degraded lands compared to other species. The main species of pioneers planted in post-coal mining land include Senna siamea, Falcatearia moluccana, Enterolobium cyclocarpum, Albizia saman and Neolamarica cadamda. These species are mostly classified into the Fabaceae (Leguminosae) family and are predominantly found in various revegetation age classes (Table 4). Senna siamea is the most dominant species and is found in every revegetation age class. Senna Siamea can grow well on post-coal mining land. Senna siamea is one of the species found in post-coal mining land in India [34] [35]. The results of Komara et al. [36] and Budiana et al. [37] showed that the Cassia siamea, Falcatearia moluccana and Samanea samman species were able to dominate the post-coal land reclamation land in East Kalimantan. Research results by Riswan et al. [8], Falcatearia moluccana is a species that is widely planted in post-mining land and dominates in post-coal reclamation land in South Sumatra.

Revegetation activities can improve the condition of the post-coal mining land. In addition, the existence of vegetation planting for revegetation can encourage and accelerate the succession process. According to Yao et al. [38], each species has a different adaptability to post-mining land conditions. Only certain types can grow and develop on coal mining areas. The results showed that local pioneers, such as Gliriside septum and Acacia mangium have begun to grow at the age of four years revegetation land (Table 4). Besides, the increasing age of revegetation can encourage the pioneers species to grow. According to Chodak and Niklinska [39], changes in vegetation in an ecosystem are strongly influenced by soil properties. The presence of vegetation can affect soil characteristics (physical, chemical and
biological), including soil fertility [40]. Increasing the age of revegetation can improve soil properties, so that it can encourage local species to grow. Local species that grow naturally and dominate in various age classes of revegetation include Acacia mangium, Macaranga hypoleuca, Vitex pinnata and Mallotus paniculatus. Acacia mangium was able to dominate the post-coal mining land in PT. Singlurus Pramata of East [41], PT. Bukit Asam of South Sumatera [8] and post-coal reclamation land in Kutai District of East Kalimantan [42]. Acacia mangium and Acacia auriculiformis are the species commonly found in post-mining coal fields in India [34]. Macaranga gigantea are quite abundant in the post-coal reclamation area in East Kalimantan [43]. According to Nussbaum et al. [44] and Zakaria et al. [45], macaranga is pioneer species, fast growing and able to grow throughout the year. The distribution of a vegetation is influenced by animal species and the distance between the reclamation area and the nearest seed source (natural forest) [46].

The increasing age of revegetation can increase the value of species diversity index, species richness index [47] [48] and species evenness index (Figure 2 to Figure 4). The highest species diversity index value in natural forests compared to each revegetation age class. This shows that the condition of natural forests tends to be quite stable to stable. According to Wirakusumah [49], a high species diversity index value indicates that the community tends to be more stable. The species richness index value indicates species richness in a community. The species richness index value is strongly influenced by the number of species found in a community. Several species on the natural forests is greater than on revegetation land at various classes (Table 2), so the value of species richness in natural forests is higher. A number of species is showing proportional relation with species richness index, the higher the number of species is found, the species richness index also will be high [50]. The species evenness index shows the spread of a type within a community and also illustrates the stability of a community. Evenness of species in natural forests tends to be evenly and stable compared to revegetation in post-coal mining areas. This is indicated by the evenness index value that is close to one. The higher the value of species evenness in the community, the diversity of species in a community is more stable and vice versa when the value of species evenness is low the more unstable species diversity [51]. The existence of differences in dominant species can cause differences in species evenness between natural forests and revegetation land. According to Setiadi [52], species evenness will be maximum and homogeneous when the number of individual species found at the same observation location.

Revegetation activities can improve the condition of the post-coal mining land. Revegetation age classes 8 and 10 years have been able to approach the condition of natural forests if observed by the result of individual density per ha, number of species, diversity index value, wealth and evenness of species. Post-mining land conditions can recover along with the increase in revegetation age [53]. Lei et al. [54] shows that the time needed for revegetated land to reach conditions close to the condition of natural forests is between 23-25 years. According to Holl [55], the increasing age of reclamation will be able to decimate the condition of natural forests, which is indicated by the increasing diversity of species and number of species and several new types that colonize reclaimed land.

4. Conclusion
Revegetation activities can improve the condition of the post-coal mining land. The plantations of variety vegetation are able to encourage and enhance the process of succession. The increase on age revegetation can increase the number of individuals per ha, number of species, index value of diversity, rechness and evenness of species. Revegetation age 8 and 10 years have able to approach the condition of natural forest. The main species that dominate the land post-coal mining are Senna siamea, Falcataria moluccana, Enterolobium cyclocarpum, Albizia saman dan Neolamarcia cadamda. In addition, there are pioneer species that grow naturally, such as Acacia mangium, Macaranga hypoleuca, Vitex pinnata, and Mallotus paniculatus.
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