Structure and similarities of Understorey Vegetation Communities in the mining area of PT. Indocement Tunggal Prakarsa Tbk. Palimanan Unit, Cirebon

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Abstract. The success of post-mining ecosystem reclamation is determined by a successful succession process. An Understorey is a group of vegetation that grows in the early stages of succession. This study aims to determine the structure and similarity of communities in various types of ecosystems in the mining area of PT. Indocement Tunggal Prakarsa Tbk. Palimanan Unit. The data collection method used line transect with a size of 1 m x 1 m at 7 (seven) locations, namely AKGB, TDP, TLP, AP, ASB, SD, APS. The number of plots is 140 plots. Data collection was carried out in the rainy and dry season. Found as many as 181 species of Understorey. Dominant and index H’ species Commelina benghalensis in Rainy season and Cynodon dactylon dry season. The similarity of Understorey communities between observation locations in the rainy and dry seasons varies. In the observation of the rainy season, the observation location with the highest community similarity was between AP and SD (48.13%). The lowest community similarity in the rainy season was found between AKGB and APS locations (1.95%). In the dry season observation, the location with the highest similarity was between TLP and AP (74.18%), and the location with the lowest similarity was TDP and TLP (0.18%).

1. Introduction

The obligations of mining business permit (IUP) holders to carry out reclamation activities have been regulated under Law no. 4 of 2009 concerning Mineral and Coal Mining (Minerba Law). Reclamation is the process of converting disturbed land into productive lands. The purpose of ex-mining reclamation is ecosystem restoration. Ecosystem restoration reclamation provides 4 (four) main functions to the ecosystem, namely biomass production, nutrient cycling, water filtration, and plant biodiversity habitat. The success of ecosystem restoration reclamation begins with the ability to grow plants in an open land as ground cover plants. One of them is Understorey. Lower plants, including the pioneer plant group, occupy layer D stratification, have a height <4.5 m and a stem diameter of about 2 cm.

Lower plants are annual, biennial, perennial and their distribution patterns can occur randomly, in groups, or evenly. In general, Understorey is included in the Poaceae, Cyperaceae, Araceae, Asteraceae, and ferns. The high diversity of Understorey will provide good resistance to disturbance,
and preferably. The existence of Understorey will increase the biomass which will increase soil fertility. The purpose of this study was to determine the structure and similarity of plant communities in 7 (seven) different locations in the mining area of PT. Indocement Tunggal Prakarsa, Tbk Unit Palimanan, Cirebon.

2. Methodology
The research was conducted in the mining area of PT. Indocement Tunggal Prakarsa Tbk. Palimanan Unit, Cirebon. Observations were made at 7 (seven) different locations based on the type of ecosystem. In detail, the location of the observations is described in Table 1 and Figure 1.

| No | Location of Observation                      | Coordinate                  | Ecosystem Type |
|----|-----------------------------------------------|-----------------------------|----------------|
| 1  | Conservation Area Blindis Hill (AKGB)         | 108°23’26.65”E 6°42’46.43”S | Naturally      |
| 2  | Vegetation Community in The Factory Area (TDP)| 108°23’49.21”E 6°42’24.95”S | Artificial    |
| 3  | Vegetation Community in The around Factory (TLP)| 108°24’34.33”E 6°42’35.60”S | Artificial    |
| 4  | Buffer Zone (AP)                              | 108°24’23.05”E 6°42’58.19”S | Artificial    |
| 5  | Shrubs Area (ASB)                             | 108°24’32.85”E 6°42’46.62”S | Naturally      |
| 6  | Lake Side Area (SD)                           | 108°24’16.03”E 6°42’37.62”S | Artificial    |
| 7  | Field Rice Area (APS)                         | 108°24’24.72”E 6°42’43.31”S | Artificial    |

The data collection method used in line transect [10]. Observation plot size 1 m x 1 m with 20 m intervals. The number of observation plots at each location is 20 plots so that the total observation plots are 140 plots. The type of data collected was the name of the species and the number of individuals of each Understorey. Data analysis carried out included: Important Value Index (IVI); Shannon-Wiener Index (H’); and the Morisita Community Similarity Index. The formula for the community equality index is as follows [4]:

$$M_{jk} = \frac{2 \sum_{i=1}^{S} X_{ij} X_{ik}}{\sum_{i=1}^{S} X_{ij}^2 + \sum_{i=1}^{S} X_{ik}^2}$$

Where:

- $M_{jk}$ = Morisita similarity index between community i with community k
- $X_{ij}$ = The abundance of species i in community j
- $X_{ik}$ = The abundance of species i in community k
- $S$ = Total species

Figure 1. Map of the Research Location
3. Result and Discussion

3.1. Structure of Understorey Vegetation

The types of the Understorey in the area of PT. Indocement Tunggal Prakarsa Tbk. Palimanan units consist of 184 species from 66 families. During the rainy season, there were 181 species from 66 families and in the dry season, 33 species from 14 families were found. All understorey species were found during the rainy and dry seasons, except for Digitaria sanguinalis L. (TLP), fimbritylis miliacea (APS), and Solanum diphyllum (SD) which were only found in the dry season. APS is the location with the highest number of species (69 species). Meanwhile, TDP is the location with the lowest number of species (34). The number of species at each observation location is shown in table 2.

| No | Observation Location | Σ Species in Rainy Season | Σ Species in Dry Season | Σ Total Species |
|----|----------------------|--------------------------|------------------------|-----------------|
| 1  | AKGB                 | 57                       | 11                     | 59              |
| 2  | TDP                  | 34                       | 4                      | 34              |
| 3  | TLP                  | 32                       | 11                     | 40              |
| 4  | AP                   | 54                       | 9                      | 56              |
| 5  | ASB                  | 47                       | 7                      | 47              |
| 6  | SD                   | 46                       | 12                     | 48              |
| 7  | APS                  | 67                       | 10                     | 69              |
|    | Total Species        | 181                      | 33                     | 184             |

The number of Understorey species in the rainy season and dry season at each observation location were very significant variations. The variation depends on the ability of the species and environmental conditions [21]. The mine area of PT. Indocement Tunggal Prakarsa Tbk., Unit Palimanan has an annual rainfall of 1919 mm per year [13]. o that in the dry season the environmental conditions are very dry and only a few types of Understorey are able to grow. Except in areas where water is still found, such as AKGB, TLP, SD, and APS. The species of Understorey that dominates during the rainy season is Commelina benghalensis and is scattered throughout the observation location, except for SD locations. Meanwhile, in the dry season, Cynodon dactylon is also found in all observation locations except TLP. Species of Commelina benghalensis and Cynodon dactylon are indicators of organic pollution in the area where it grows [8].

The diversity index is calculated based on the Shannon-Wiener Index (H’). The species of Understorey with the highest H’ index in the rainy season is Commelina benghalensis (1.05) and in the dry season, the highest H’ index is Chromolaena odorata (1.30). The highest H’ index value indicates that the growing environment is suitable for Understorey species.

Table 3. Five species of Understorey plants with the highest IVI at each observation location

| Location | Rainy Season | Dry Season |
|----------|-------------|-----------|
|          | Species     | IVI (%)   | Species     | IVI (%)   |
| AKGB     | Eragrostis amabilis | 23.78     | Chromopogon aciculatus | 63.55 |
|          | Setaria barbata | 18.40     | Chromolaena odorata | 41.63 |
|          | Asystasia intrusa | 13.29 | Setaria barbata | 18.30 |
|          | Chromopogon aciculatus | 11.61 | Mimosa pudica L. | 11.10 |
|          | Urceola brachysepala Hook.f | 11.19 | Mikania cordata (Burm.f)B.L.Rob | 11.10 |
| TDP      | Chromolaena odorata | 29.27 | Dinochloa scandens | 85.23 |
|          | Commelina benghalensis | 20.55 | Chromolaena odorata | 83.71 |
|          | Bidens pilosa | 20.02 | Latana camara L. | 15.53 |
|          | Asystasia intrusa | 17.83 | Ipomoea obscura | 15.53 |
| Location | Rainy Season | Dry Season |
|----------|-------------|------------|
|          | Species     | IVI (%)    | Species     | IVI (%) |
| TLP      | *Latana camara* L. | 16.63 | *Asystasia gangetica* | 57.84 |
|          | *Commelina benghalensis* | 40.65 | *Cynodon dactylon* | 42.58 |
|          | *Asystasia gangetica* | 29.95 | *Flemingia macroplella (Willd.) Merr* | 29.97 |
|          | *Eleutheranthera ruderalis* | 16.50 | *Ipomoea obscura* | 14.99 |
|          | *Cyperus rotundus* | 9.60 | *Ischaemum maticum* | 11.90 |
| AP       | *Pollinia cilliata* Trin | 34.08 | *Cynodon dactylon* | 92.77 |
|          | *Ischaemum maticum* | 15.99 | *Chromolaena odorata* | 27.99 |
|          | *Paspalum distichum* | 11.61 | *Imperata cylindrica* | 27.23 |
|          | *Eleutheranthera ruderalis* | 11.46 | *Mimosa pudica* L. | 17.87 |
|          | *Imperata cylindrica* | 9.91 | *Flemingia macroplella (Willd.) Merr* | 11.20 |
| ASB      | *Imperata cylindrica* | 28.52 | *Cynodon dactylon* | 60.34 |
|          | *Eleutheranthera ruderalis* | 15.63 | *Pennisetum purpueum* | 18.49 |
|          | *Setaria barbata* | 14.18 | *Imperata cylindrica* | 14.38 |
|          | *Mimosa pudica* L. | 12.72 | *Chromolaena odorata* | 13.09 |
|          | *Echinochloa colona* | 10.89 | *Ipomoea triloba* | 12.38 |
| SD       | *Chromolaena odorata* | 19.30 | *Flemingia macroplella (Willd.) Merr* | 49.88 |
|          | *Ischaemum maticum* | 17.77 | *Chromolaena odorata* | 34.73 |
|          | *Flemingia macroplella (Willd.) Merr* | 13.62 | *Ipomoea triloba* | 23.52 |
|          | *Pollinia cilliata* Trin | 12.93 | *Waltheria indica L.* | 22.42 |
|          | *Ipomoea obscura* | 9.91 | *Ipomoea carnea* | 14.42 |
| APS      | *Ischaemum maticum* | 39.04 | *Ischaemum maticum* | 63.97 |
|          | *Cynodon dactylon* | 20.92 | *fimbritylis miliacea* | 22.33 |
|          | *Phylanthus niruri* | 10.26 | *Ipomoea obscura* | 20.82 |
|          | *Echinochloa crusgalli* | 8.61 | *Mimosa pudica* L. | 20.62 |
|          | *Phylanthus urinaria* | 8.27 | *Cynodon dactylon* | 17.79 |

Table 4. Five species of Understorey plants with the highest Shannon-Wiener Index (H’) at each observation location.
| Location | Rainy Season | Dry Season |
|----------|-------------|------------|
|          | Species     | H'         | Species     | H'         |
|          |             |            |             |            |
| ASB      | Asystasia gangetica | 0.30       | Asystasia gangetica | 0.35       |
|          | Eleutheranthera ruderalis | 0.22       | Flemingia macrophylla (Willd.) | 0.24       |
|          | Imperata cylindrica | 0.19       | Ischaemum muticum | 0.19       |
|          | Cyperus rotundus | 0.17       | Digitaria sanguinalis L. | 0.17       |
| AP       | Pollinia cilliata Trin | 0.36       | Cynodon dactylon | 0.33       |
|          | Ischaemum muticum | 0.24       | Imperata cylindrica | 0.27       |
|          | Paspalum distichum | 0.23       | Chromolaena odorata | 0.24       |
|          | Eleutheranthera ruderalis | 0.15       | Mimosa pudica L. | 0.19       |
|          | Imperata cylindrica | 0.15       | Cyanthillium cinereum | 0.15       |
|          | Imperata cylindrica | 0.33       | Cynodon dactylon | 0.37       |
|          | Setaria barbata | 0.24       | Imperata cylindrica | 0.23       |
|          | Eleutheranthera ruderalis | 0.23       | Pennisetum purpureum | 0.22       |
|          | Ischaemum muticum | 0.18       | Ipomoea triloba | 0.16       |
|          | Echinocloa colona | 0.18       | Chromolaena odorata | 0.12       |
|          | Ischaemum muticum | 0.25       | Flemingia macrophylla (Willd.) | 0.36       |
|          | Chromolaena odorata | 0.25       | Waltheria indica L. | 0.27       |
|          | Pollinia cilliata Trin | 0.25       | Chromolaena odorata | 0.25       |
|          | Flemingia macrophylla (Willd.) Merr | 0.19 | Ipomoea carnea | 0.16       |
|          | Medicago lupulina | 0.16       | Ipomoea triloba | 0.16       |
| SD       | Ischaemum muticum | 0.36       | Ischaemum muticum | 0.37       |
|          | Cynodon dactylon | 0.28       | fimbritylis miliaceae | 0.27       |
|          | Echinocloa crusgalli | 0.15       | Ipomoea obscura | 0.26       |
|          | Hypochaeris glabra | 0.14       | Cynodon dactylon | 0.22       |
|          | Eleutheranthera ruderalis | 0.13       | Mimosa pudica L. | 0.20       |

3.2. Similarities of Understorey Plant Communities

Plant communities at the growth rate of Understorey between observation locations in the rainy and dry seasons vary. In the observation of the rainy season, the observation location with the highest community similarity was between AP and SD (48.13%). The lowest community similarity in the rainy season was found between the AKGB and APS locations (1.95%). In the dry season observation, the location with the highest similarity was between TLP and AP (74.18%), and the location with the lowest similarity was TDP and TLP (0.18%).

| Location | Community Similarity in Rainy Season (%) | Community Similarity in Dry Season (%) |
|----------|------------------------------------------|----------------------------------------|
|          | T | T | A | A | S | A | T | S | A | T | S | A | T | S | A |
| AKGB     | 2 | 1 | 3 | 1 | 5 | 1 | 95 | 3 | 7 | 3 | 1 | 3 | 1 | 44 |
| TDP      | 0,61 | 4,00 | 69 | 4,85 | 09 | 1 | 5 | 1 | 95 | 3 | 7 | 3 | 1 | 3 | 1 |
| TLP      | 1 | 2 | 8 | 2 | 2 | 0 | 2 | 1 | 6 | 2 | 7 | 1 | 1 | 7 | 1 |
| AP       | 9,43 | 1,98 | 0,18 | 2,68 | 4,18 | 0,22 | 2,29 | 6,41 | 2 | 4 | 2 | 7 | 1 | 1 |

| Location | Community Similarity in Rainy Season (%) | Community Similarity in Dry Season (%) |
|----------|------------------------------------------|----------------------------------------|
|          | T | T | A | A | S | A | T | S | A | T | S | A | T | S | A |
| AKGB     | 5,38 | 8,13 | 9,92 | 3,60 | 03 | 2,03 | 4,18 | 0,22 | 2,29 | 6,41 | 2 | 4 | 2 | 7 | 1 | 1 |
Based on hierarchical cluster analysis on the growth rate of the Understorey in the rainy season. There are 2 large clusters of the similarity of Understorey communities, namely cluster I, which classifies the locations of TLP, SD, and AKGB observations as locations that have similar communities. Cluster II, which classifies AP, APS, TDP, ASB as locations that have the same community. In the observation of Understorey in the dry season, the similarity of the Understorey community is divided into 4 clusters, namely cluster I (AKGB, APS, TDP); cluster II (AP, SD), cluster III (TLP); and cluster IV (ASB).

**Figure 2.** Dendrogram of Understorey Plant Hierarchy Cluster Analysis (a) Observations in the Rainy season; (b) Observations in the dry season

4. Conclusion

The number of Understorey species found in the mining area of PT. Indocement Tunggal Prakarsa Tbk. Palimanan units consist of 184 types from 66 families. Commelina benghalensis is the species with the highest dominance and diversity index during the rainy season. In the dry season, Cynodon dactylon species are the species with the highest dominance and diversity index. The highest community similarity in the rainy season is between AP and SD (48.13%), and there are 2 large clusters of the similarity of Understorey communities. In the dry season, the highest community similarity was between TLP and AP (74.18%), and there were 4 clusters of Understorey.

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