Identification of highland peat vegetation in the Sub-district of Lintong Nihuta, Humbang Hasundutan Regency, North Sumatera, Indonesia

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Abstract. This study aims to identify the structure, composition, and current status of highland peat vegetation in the Lintong Nihuta Sub-district, Humbang Hasundutan Regency, North Sumatra Province. The research conducted from December 2020 to April 2021. This study uses a survey method. The plots were laid using the purposive sampling method considering that the observed plots were those with naturally growing vegetation and accessible terrain. Sampling used the double plot vegetation analysis method with a plot size of 4 x 4 m for seedlings and 20 x 20 m for saplings obtained by measuring the minimum area of the plot. The data obtained were analyzed for frequency calculations, important value index (IVI), and Shannon-Weiner diversity index (H'). The results of the vegetation analysis showed that from the four existing growth classes, only two growth classes were found at the research site, namely seedlings and saplings with a total of 23 species. The vegetation composition is dominated by shrub habitus which indicates that this peatland has been degraded. The dominant species in the study site were Lepinoria mucronata Rich. and Dicranopteris linearis (Burm.) F. Underw. The value of the biodiversity index (H') is 0.8 with a low criterion which means the vegetation ecosystem at the study site is unstable

1. Introduction

Peatlands are natural resources that have the potential to be utilized for human welfare. Peat is also a reliable store of carbon and water reserves [1]. However, peat is vulnerable to change (fragile), relatively infertile, and can become irreversibly dry because its inherent nature is that it is wetter/flooded all the time [2]. The inhibiting factors of peat soil are complex. When the soil is in a flooded condition, the acidity of the soil is high enough that not all plants can grow. On the other hand, can be irreversible in dry conditions so that it is vulnerable to fire and plants also cannot grow [3].

Indonesia has peatlands with an estimated area of 13.5 – 26.5 million ha which is the largest tropical peatland in the world. Indonesia's peatlands are spread over the islands of Sumatera, Kalimantan, and Papua, most of which are lowland peatlands. Besides lowland peat, there is also highland peat in Humbang Hasundutan Regency, North Sumatra. Humbang Hasundutan (Humbahas) peat area reaches 2,988 ha spread over three sub-districts, namely Doloksanggul (1,578 ha or 52.81%), Pollung (931 ha or 31.16% ha), and Lintong Nihuta (479 ha or 16.03 ha). %) [4, 5].

Biodiversity conservation is another important function of peatlands, because peatlands are unique ecosystems, where specific species (flora and fauna) develop [6]. The highland peat ecosystem in Lintong Nihuta Sub-district is estimated to have been disturbed due to intensive human activities so that
this has a bad impact on the sustainability and the peat ecosystem such as the environment for the growth of vegetation, animals and microorganisms that can live in the peat area. Whereas the peat ecosystem is very important to be maintained and conserved. Based on this description and the lack of studies on vegetation in the peatlands of the Lintong Nihuta highlands, this study was conducted to determine the structure, composition and current status of the peatland vegetation in Lintong Nihuta Sub-district, Humbang Hasundutan Regency, North Sumatra Province.

2. Materials and Method

2.1. Study sites and vegetation analysis

The research was conducted at Lintong Nihuta Sub-district, Humbahas Regency, with 1,000-1,500 m above sea level from December 2020 to April 2021. The materials and tools were plant specimens, 70% alcohol for preserving plants, map of Lintong Nihuta peat soil, books and references for determining plant species, equipment for making herbarium sets, Global Positioning System (GPS) as directions in surveys, meters, and other tools that support the research.

This study uses a survey method. The Lintong Nihuta Peat Area was divided into several grids with an area of 50 ha/grid and 6 observation grids were obtained. Some of the peat areas are rice fields and vacant land without vegetation so they were not analyzed. The plots were laid using the purposive sampling method considering that the observed plots were those with naturally growing vegetation and accessible terrain. Sampling was carried out using the double plot vegetation analysis method. The vegetation was measured by growth class (stem diameter class). The growth classes measured were trees with a diameter of > 35 cm, poles with a diameter of 25 – 35 cm, saplings with a diameter of 10-25 cm,
and seedlings with a diameter of < 10 cm. Determination of plot size was carried out by measuring the minimum area of the plot using the species-area curve method, on the basis that if the addition of the plot area did not cause an increase in the number of species by more than 5% then that was the size of the plot area that would be used [7].

After measuring the minimum area of the plot, the plot size for the seedlings was 4 x 4 m. For the sapling growth class, only 1 species was obtained in an area of 20 x 20 m, so this size was used for the sapling growth class plot. Meanwhile, pole and tree growth classes were not found in the research area, so no vegetation analysis was carried out. After obtaining the plot size, 1 plot and 1 replication were made on each grid so that 12 observation plots were obtained. Vegetation data collection was carried out directly by counting each plant species in the plot. Then a specimen of each plant species in the form of a plant body is taken including roots, stems, leaves, flowers, and fruit (if any) to be identified and used as a herbarium collection.

2.2. Data analysis
The data that has been obtained in the field is then analyzed by calculating the value of relative frequency and frequency, important value index (IVI), and Shannon-Weiner species diversity index (H') [7].

3. Results and Discussion

3.1. General description of Research area
The research location is at Lintong Nihuta Sub-district, Humbang Hasundutan Regency, North Sumatra Province. Astronomically, Humbang Hasundutan Regency is located at 02°4'20" - 2°16'15" North Latitude and 98°52'40" - 98°56'20" East Longitude. The area of peatland at Lintong Nihuta Sub-district is 479 ha or 16.03% of the total peat area of the Humbang Hasundutan Regency [8]. Some of the peat areas in this area are still original (flooded) and the community has used some by taking undecomposed wood or the peat soil itself to be used as charcoal or fuel and also there is peatland which is used as a location for processing stone mining products in this area. Drainage has also been carried out at this location causing the peat to lose a lot of water.

According to climate data obtained from the Climatology Station Class 1 Sampali Medan for the last 10 years from 2011-2020, it appears that the research area has a very wet climate (Type A) obtained from the Schmidt and Ferguson climate calculation method. The dry season in this area occurs from April to August and the rainy season usually occurs from September to March. This area has a temperature of around 17°C – 29°C and an average humidity of 85.94 % [8].

Some of the characteristics of peat soil in the study area are presented in table 1. It can be seen that the peat soil in this area has an acidic pH. Its bulk density is low and its decomposition stage is classified as sapric peat. The water content is relatively high compared to mineral soils because there are still found flooded peat in this area.

### Table 1. Value of some peat properties

| Plot | Bulk Density (gr/cm³) | Water Content (%) | Decomposition Stage | pH  |
|------|----------------------|-------------------|---------------------|-----|
| 1.1  | 0.26                 | 295.0             | Sapríc             | 3.6 |
| 1.2  | 0.44                 | 162.0             | Sapríc             | 3.9 |
| 2.1  | 0.23                 | 345.7             | Sapríc             | 3.9 |
| 2.2  | 0.29                 | 260.9             | Sapríc             | 4.1 |
| 3.1  | 0.35                 | 208.9             | Sapríc             | 4.0 |
| 3.2  | 0.44                 | 161.9             | Sapríc             | 4.6 |
| 4.1  | 0.53                 | 113.0             | Sapríc             | 5.1 |
| 4.2  | 0.27                 | 281.5             | Sapríc             | 3.7 |
| 5.1  | 0.27                 | 292.2             | Sapríc             | 3.5 |
| 5.2  | 0.44                 | 158.0             | Sapríc             | 4.2 |
| 6.1  | 0.3                  | 232.0             | Sapríc             | 3.7 |
3.2. Vegetation Structure and Composition

The results of the analysis of vegetation showed that there were 23 species found in the study site. There are 22 species for seedling growth class and 1 species for sapling growth class.

Table 2. Vegetation found in the study site

| Growth Class | Division & Class | Order | Family | Species |
|--------------|-----------------|-------|--------|---------|
| I. Seedling  | I. Spermatophyta| 1. Caryophyllales | 1. Nepenthaceae | 1. Nepenthes mirabilis (Lour.) Druce |
|              | 1. Dicotyledonae| 2. Myrtales | 2. Myrtaceae | 2. Rhodomyrtus tomentosa (Aiton) Hassk. |
|              |                  | 3. Melastomataceae | 3. Leptospermum flavescens J. sm |
|              |                  | 4. Lythraceae | 4. Melastoma malabathricum L. |
|              |                  | 5. Dipsacales | 5. Cuphea elliptica Koehne. |
|              |                  | 6. Rosales | 6. Lythraceae | 6. Viburnum odoratissimum Ker Gawl. |
|              |                  | 7. Moraceae | 7. Thrips scandens (Lour.) Hook & Arn |
|              |                  | 8. Eriocaulaceae | 8. Ficus deltoidea Jack. |
|              |                  | 9. Eriaceae | 9. Vaccinium variagifolium Miq. |
|              |                  | 10. Malpighiales | 10. Salix sp. |
|              |                  | 11. Aipialae | 11. Centella asiatica (L.) Urban |
|              |                  | 12. Gentianales | 12. Borreia alata Aubl. DC. |
|              |                  | 13. Rubiaceae | 13. Zizania aquatica (L.) |
|              |                  | 14. Poaceae | 14. Hygroriza aristata (Retz) Nees ex Wight & Arn. |
|              |                  |                  | 15. Lepinoria mucronata Rich. |
|              |                  |                  | 16. Thoricophorum cuspidatum (L.) Hartm. |
|              |                  |                  | 17. Smilax sp. |
|              |                  |                  | 18. Denstaedtiaceae | 18. Smilax sp. |
| II. Sapling  | I. Spermatophyta| 1. Pinulales | 1. Pinaceae | 1. Pinus merkusii |
|              |                  | 1. Pinus | 1. Pinus | 1. Pinus merkusii |

Table 2 shows that there are only 2 growth classes found in the research location. Meanwhile, tree and pole growth classes were not found. This is thought to occur because tree and pole growth classes are encountered if the ecosystem or succession in a community is stable or has reached the climax stage [9]. Disturbances that occur from the use of peatland by draining peat and the existence of mining that has been around for a long time, which is more or less since 1992 [10] causes changes in the natural condition of the peat in the study site. Many areas where the peat is dry and experiencing subsidence [11] so this is thought to have an effect on the succession of vegetation in the study area.

Other factors such as soil acidity and low peat fertility also affect the plants that can live in this area. According to [12], peat soils in the Humbahas Regency area are only affected by rainwater without the addition of mineral materials. The climate data also shows that the climate in that location is type A (very wet climate) where the rainfall is very high. Therefore, Humbahas peat is an ombrogen peat with low fertility, which makes it harder for plants to grow. This also causes the composition of the vegetation on the Lintong Nihuta peat tends to be dominated by shrubs. According to [13], peat cover by shrubs is one indicator that the peat has been degraded. It is suspected that the degradation is caused by the use of land for agriculture such as seasonal horticultural crops and mining sites with excessive drainage so that some of the peat soil in the study site has become dry. This can also be seen from the stage of decomposition at the research site that has been sapric. In general, in sapric peat, native peat trees such as Jelutung Rawa (Dyera lowii), Ramin (Gonystylus bancanus), Kempas, or Bengeris (Kompassia malaccensis), Punak (Tetrameristaglabra), etc are found. However, this usually occurs in topogenous
sapric peat in the lowlands that have received additional mineral materials from rivers or the sea so that it is more fertile.

Table 3. Frequency of vegetation found in the study site

| Species                        | Plot | F | % FR |
|--------------------------------|------|---|------|
| **Seedling Growth Class**      |      |   |      |
| Melastoma malabathricum L.     | √    | 1 | 16   |
| Dianella ensifolia (L.) Redoute | √    | 0.83 | 13.3 |
| Lepinoria mucronata Rich.      | √    | 0.75 | 12   |
| Leptospermum flavescens J. sm  | √    | 0.66 | 10.6 |
| Dicranopteris linearis (Burm.f.) Underw. | √ | 0.58 | 9.3  |
| Zizania aquatica (L.)          | -    | 0.5 | 8    |
| Rhodomyrtus tomentosa (Aiton) Has. | √ | 0.41 | 6.6  |
| Blechnum indicum (Burn.) F.    | -    | 0.25 | 4    |
| Lycopodiella cernua (L.) Pic Serm | - | 0.16 | 2.6  |
| Pteridium aquilinum (L.) Kuhn  | -    | 0.08 | 1.3  |
| Nephentes mirabilis (Lour.) Druce | - | 0.08 | 1.3  |
| Hygrocybe aristata (Renz.) Nees ex Wiight & Arn | - | 0.08 | 1.3  |
| Viburnum odoratissimum Ker Gawl | - | 0.08 | 1.3  |
| Thropis Scandens (Lour.) Hook & Arn. | - | 0.08 | 1.3  |
| Vaccinium variagifolium Miq.   | -    | 0.08 | 1.3  |
| Salix sp.                      | -    | 0.08 | 1.3  |
| Smilax sp.                     | -    | 0.08 | 1.3  |
| Ficus deltoidea Jack.          | -    | 0.08 | 1.3  |
| Thilechoporum cespitosum (L.) Hartm | - | 0.08 | 1.3  |
| Cuphea elliptica Koehne.       | -    | 0.08 | 1.3  |
| Centella asiatica (L.) Urban   | -    | 0.08 | 1.3  |
| Borreria alata Aubl. DC.       | -    | 0.08 | 1.3  |
| **Amount**                     | 6    | 5 | 5    |
| **Pinus merkusii**             | -    | 0.08 | 100  |
| **Amount**                     | 0    | 0 | 0    |

Table 3 shows that the distribution of species in the study area tends to be uneven. The most common species found in plot 4.1 were 16 species at the seedling growth class and 1 species at the sapling growth class. This is thought to have occurred because based on the soil properties data in plot 4.1, the soil development in this plot is advanced, the decomposition rate is sapric and the pH is higher than the other plots so that more species were able to grow.

The species with the highest frequency is Melastoma malabathricum L. with the value of 1. This is because this species is a pioneer species and was found in all plots.

The results of the important value index (IVI) and diversity index that have been obtained from the research location are presented in table 4. IVI is a parameter that can indicate the dominance of a species in a vegetation ecosystem. Table 4 shows that the species with highest IVI in the study site were Lepinoria mucronata Rich. and Dicranopteris linearis (Burm.) F. Underw. respectively 43.4 % and 39.3 %. Lepinoria mucronata Rich. is a typical swamp plant that can adapt well in flooded areas. This plant has a fast reproduction so it has a high density and hollow stems so that it can adapt to flooded areas. While Dicranopteris linearis (Burm.) F. Underw. is a division of ferns which is a pioneer plant and can invade an area. This plant is also tolerant of acid soil or disturbed soil and is thought to cause an
allelopathic effect so that it can defeat other plants [14]. Meanwhile, sapling growth class has an IVI of 200%. This happens because there are only 1 species for the sapling growth class.

The species diversity index is an indicator of the stability of a community, namely the ability of a community to keep itself stable despite disturbances to its components [15]. Table 4 shows the diversity index (H’) in the study site is low or unstable, namely 0.8 for the seedling and 0 for the sapling. According to [16], this means that in the community there are still few species that can survive. The vegetation of the lintong Nihuta peatlands is difficult to reach a climax succession, presumably due to the large number of human activities and the infertile conditions of the peatlands.

Table 4. Important value index (IVI) and diversity index (H’) in the study site

| Species                                | Growth Class | Seedling | Sapling |
|----------------------------------------|--------------|----------|---------|
| Blechnum indicum (Burm.) F.            | 5,7          | 0        |
| Borreilia alata Aubl DC                | 2,2          | 0        |
| Centella asiatica (L.) Urban           | 2,2          | 0        |
| Cuphea elliptica Koehne.               | 1,5          | 0        |
| Dianella ensifolia (L.) Redoute         | 16,8         | 0        |
| Dicranopteris linearis (Burm.) F. Underw. | 39,3         | 0        |
| Ficus deltoidea Jack.                  | 1,6          | 0        |
| Hygroryza aristata (Retz.) Nees ex Wiight & Arn | 1,3         | 0        |
| Lepinoria mucronata Rich.              | 43,4         | 0        |
| Leptospermum flavescens J. sm          | 19,2         | 0        |
| Lycopodiella cernua (L.) Pic. Serm.     | 3,6          | 0        |
| Melastoma malabathricum L.             | 25,1         | 0        |
| Nepentes mirabilis (Lour.) Druce       | 1,3          | 0        |
| Pteridium aquilinum (L.) Kuhn           | 1,4          | 0        |
| Rhodomyrtus tomentosa (Aiton) Hassk.    | 8,1          | 0        |
| Salix sp.                              | 1,3          | 0        |
| Smilax sp.                             | 1,3          | 0        |
| Thrichoporum cespitosum (L.) Hartm      | 1,6          | 0        |
| Thropis Scandens (Lour.) Hook & Arn.    | 1,3          | 0        |
| Vaccinium variagifolium Miq.           | 1,5          | 0        |
| Viburnum odoratissimum Ker Gawl        | 1,3          | 0        |
| Zizania aquatica (L.)                  | 17,6         | 0        |
| Pinus merkassii                         | 0            | 200      |

| Amount | 200 | 200 |
|--------|-----|-----|
| H’     | 0.8 | 0   |

4. Conclusions

Based on the four growth classes, the vegetation found in the Lintong Nihuta peatland only consisted of 2 growth classes, namely seedlings and saplings. Meanwhile, trees and poles were not found. The dominant species in the Lintong Nihuta peatland is Lepinoria mucronata Rich. and Dicranopteris linearis (Burm.) F. Underw. The Lintong Nihuta peatland vegetation ecosystem is unstable because the value of H’ is low at 0.8.

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