The distribution of non-timber forest products in the protected areas (case study at PT Toba Pulp Lestari concession)

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Abstract. The protected areas in the concession of PT Pulp Toba Lestari (TPL) is allocated mainly for maintaining the high-value conservation areas. Since the areas are adjacent to the local community which has long time accessed and utilized non-timber forest products (NTFPs), it is necessary to take forest management efforts to ensure a sustainable protection function while the needs of the community around the forest are fulfilled wisely. One of the critical parts of forest management is to define the distribution of NTFPs clearly to allow effective governance of natural forest area. A stratified systematic sampling survey was applied to find the type of NTFP and its location within the protected areas for each estate. GIS technology was used to map the distribution of NTFPs. 26.67% of incense was most widely distributed by in the Germ-Plasm Protection area of Aek Nauli Estate, and 20.00% was in the Riparian zone area of Habinsaran Estate. At the pole growth stage, 20.00% of incense was often found in the Green Belt area of Aek Nauli Estate, and 28.00% was in the Buffer Zone area. Rattan is widespread in the all the type of protected areas in Tele Estate. It was mostly found in Germ-Plasm area (100.00%) followed by the Riparian Zone area (95.00%) and Biodiversity area (92.26%). Aek Nauli Estate was the second best place to find rattan in the Green Belt area (82.86%) and the Riparian zone area (76.00%). Sugar palm and bamboo were not distributed well and 17.14% of them were mostly found in the Green Belt area of Aek Nauli Estate.

1. Introduction

Production forest management is applied by referring to the principles of sustainability of all benefits provided by forest both as a natural resource and ecosystem function. PT Pulp Toba Lestari (TPL) implements sustainable forest management practices by defining two mainland allocations, the first one is allocated for the production area, and another one is the protection area. There are 49,000 hectares land dedicated for protection purposes having a function as maintaining the high conservation value areas. The areas are adjacent to the surround local community, which has a long time accessed and utilizing non-timber forest product (NTFP). NTFP is a result of both vegetable and animal forest products with derivative products and cultivation except wood. Ministry of Forestry [1] reported that...
types of NTFPs consist of eleven groups and 553 species of plants and animals, such as rattan, bamboo, sugar palm, and incense. Even though the use of NTFPs has long been practiced, the main problem is lack of data stock and distribution potency of NTFPs in the protected area within PT TPL concession.

Given the limited data on diversity, potential, and distribution of NTFPs in the PT TPL concession area, the process of surveying potential NTFPs is very important as a basis for sustainable management. Forest management is a necessity to ensure a sustainable protection function while the needs of the community around the forest on non-timber forest product are wisely fulfilled. Determining a clear distribution of NTFPs is the critical part of forest management for effective governance of remain natural forest area.

The objective of the study is to identify and analyze the kind and the distribution of non-timber forest products on the protected areas within PT Toba Pulp Lestari industrial timber concession. The NTFPs focuses on four main products, namely: incense, rattan, bamboo, and sugar palm.

The results of study are expected to be used in preparing recommendations for sustainable forest management, especially within the protection area, and as the basis for monitoring community-based NTFPs.

2. Methods

2.1. Location and time of study
The research was conducted from August 15th to September 13th, 2018. The research was carried out in a protected forest area of PT Toba Pulp Lestari, an industrial timber concession. The protection area includes 5 (five) estates stretched out in 5 districts namely Toba Samosir, Humbang Hasundutan, Simalungun, Tapanuli Utara, and Tapanuli Selatan, Province of North Sumatra. Estates or sectors assessed are Aek Nauli, Aek Raja, Habinsaran, Tele, and Tapanuli Selatan.

2.2. Materials and equipment
At the field site, some equipment used was GPS which was used for coordinate location recording, tallysheet, compass, camera, rope, marker, plastic bag, map, and satellite imagery. A GIS appliance is used for spatial analysis and mapping the distribution of NTFPs within the study area.

2.3. Data collection
Data collection wasmade by survey with reference on Ministry of Environment and Forestry [2]. A stratified systematic with random start sampling method was applied to inventory the type of NTFP and its location within the protected areas for each estate with total areas of 49,000 Ha. A number of sampling plots in each stratum were allocated according to the size of each stratum proportionally. Distribution of stratum follows five classes of protected forests that have been determined by PT TPL’s management. The strata are riparian area (SS), buffer zone (BZ), germ-plasm protection area (KPPN), biodiversity area (BD), and green belt area (GB).

Inventory method used was by rectangular and circle combinations. This method is used if the landform is relatively more spacious and wide, and is preferred to be more evenly distributed [3]. In this study, the sampling intensity used was 0.25% considering for operational level application. The plots used quadrats 100x100 m size with 3x3 km wide in between, as shown in figure 1.
Inventory plot was placed in a square cluster with a size of 100 mx 100 m with five circular sub-plots 0.1 ha size and 17.8 m radius. Four sub-plots were placed at each corner of the cluster, and another one took the center of the cluster. Design of sampling subplots is shown in figure 2.

The number of sampling clusters/plots for each stratum and the distribution can be seen in table 1 and figure 3.

Table 1. The proportion of cluster distribution in each stratum.

| Estate                  | Sampling area (Ha) | SS  | BD  | GB  | KPPN | BZ  | Number of clusters |
|-------------------------|--------------------|-----|-----|-----|------|-----|-------------------|
| Aek Nauli (AEN)         | 13.77              | 5   | 13  | 7   | 3    | 0   | 28                |
| Aek Raja (AER)          | 36.69              | 2   | 48  | 24  | 0    | 0   | 74                |
| Habinsaran (HBS)        | 21.35              | 5   | 21  | 17  | 0    | 0   | 43                |
| Tele (TEL)              | 43.83              | 8   | 31  | 41  | 3    | 5   | 88                |
| Tap. Selatan (TAS)      | 8.21               | 0   | 6   | 10  | 0    | 0   | 16                |
| Total                   | 123.85             |     |     |     |      |     | 249               |

2.4. Data analysis

Data analysis was carried out by vegetation analysis to see the potential and distribution of each kind of NTFP. Vegetation analysis was carried out to obtain individual values of N/ha for each kind of NTFP surveyed in each stratum class. Distribution percentage was represented by the frequency for each NTFP found in subplots in the stratum.

Based on such data tabulation analysis, a spatial attributing and rasterizing analysis were run in GIS application to obtain the spatial distribution of each NTFP within the estates.
3. Results and discussion

3.1. Aek Nauli Estate

Aek Nauli Estate has four strata of protected areas. The distribution of all NTFPs for each stratum is shown in table 2.

Table 2. Distribution of NTFPs in protected areas of AekNauli Estate.

| No. | Kind of NTFPs | Distribution (%) | KPPN | SS | BD | GB |
|-----|---------------|------------------|------|----|----|----|
| 1.  | Incense       |                  |      |    |    |    |
|     | Pole          |                  | 13.33| 0  | 3.08| 5.71|
|     | Tree          |                  | 26.67| 0  | 6.15| 5.71|
| 2.  | Rattan        |                  |      |    |    |    |
|     | Young         |                  | 73.33| 92.00| 80.00| 97.14|
|     | Mature        |                  | 40.00| 76.00| 52.31| 82.86|
| 3.  | Sugar palm    |                  | 0    | 4.0 | 9.23| 17.14|
| 4.  | Bamboo        |                  | 0    | 16.0| 4.62| 0 |

Incense Toba (*Styrax sumatrana*) and Durame (*Styrax benzoin*) were found in the Aek Nauli Estate. The distribution of incense at the tree stage and pole stage was mostly found in KPPN area with...
26.67% at tree stage, and 13.33% at pole stage. The number of incense trees in KPPN was not evenly distributed but grouped at a certain location. The presence of incense in the biodiversity area was fairly evenly distributed, but only a few were found, with a distribution of 6.15% at tree stage and 3.08% at pole stage. Meanwhile, the distribution of incense both tree and pole stage in the green belt area was 5.71%.

KPPN is an area that has abundant incense regeneration and is fairly evenly distributed throughout the area. Distribution map of incense in Aek Nauli estate is shown in figure 4.

![Figure 4. Incense distribution in Aek Nauli estate.](image1)

Both rattan young and mature age were distributed evenly in each stratum of protected area. Young rattan was very often found in green belt areas with a spread of 97.14%, and 92% was in riparian areas of all subplots. Meanwhile, mature rattan was mostly found in green belt areas with a distribution of 82.86%, then followed by riparian zone areas (76%). The distribution of rattan, both mature and young was commonly found in green belt areas. The distribution map of rattan in the Aek Nauli estate is shown in figure 5 above.

The distribution of sugar palm was uneven and occupied a small part of the existing cluster. Riparian zone area was only 4% distributed, biodiversity area was 9.23%, and green belt area was 17.14%. Seeing the relationship between the distribution and the number of clumps of palm sugar, we can conclude that the green belt area is the best area to harvest sugar palm in the Aek Nauli estate.

Bamboo was only found in four sub-plots of riparian zone areas and three sub-plots of biodiversity area so that the distribution of bamboo presence was fairly uneven. The distribution rate of bamboo in riparian zone areas was 16.00%, while 4.62% was for biodiversity area.

### 3.2. Habinsaran Estate

Incense species often found in the Habinsaran estate was Toba (*Styrax sumatrana*) and few of Durame (*Styrax benzoin*). The habinsaran estate has threesetra of protected areas. The distribution of all NTFPs for each stratum is shown in table 3.
Table 3. Distribution of NTFPs in Protected Areas of Habinsaran Estate.

| No. | Kind of NTFPs | Distribution (%) |
|-----|---------------|------------------|
|     |               | SS   | BD   | GB   |
| 1.  | Incense       |      |      |      |
|     | Pole          | 16.00| 4.76 | 20.00|
|     | Tree          | 20.00| 9.52 | 20.00|
| 2.  | Rattan        |      |      |      |
|     | Young         | 44.00| 30.48| 34.12|
|     | Mature        | 32.00| 24.76| 27.06|
| 3.  | Sugar palm    | 0    | 0.95 | 0    |
| 4.  | Bamboo        | 0    | 0.95 | 0    |

Distribution of incense in all strata was quite evenly distributed as in table 3. Incense both at pole and tree stage was mostly distributed in the green belt area with 20%. In the riparian zone, the distribution rate was 20% at the tree stage and 16% was at the pole stage. Biodiversity area was the lowest distribution of incense, with only 9.52% at tree stage and 4.76% at pole stage. Thus, the most potential and well-distributed incense in Habinsaran estate were in the green belt area and the riparian zone area. Map of the incense distribution in Habinsaran estate can be seen in figure 6.

The existence of rattan in the Habinsaran estate was very abundant and found in every stratum of protected forest. Distribution of young rattan in the riparian zone area was 44% of all sub-plots, and the distribution of mature rattan was 32%. In the biodiversity area, young rattan was 30.48% and mature rattan was 24.76%, whereas, in the green belt area, the distribution of young rattan was 34.12% and 27.06% was for mature rattan. This data showed that rattan potency was very significant in the Habinsaran estate. The distribution map of rattan in Habinsaran estate is shown in figure 6.

Distribution of sugar palm was only found in 1 subplot of a total of 105 sub-plots or 0.95% of the entire biodiversity area. It means that sugar palm is not significant in the Habinsaran estate. Likewise, bamboo was only found in biodiversity areas in 1 subplot of a total of 105 sub-plot observations. Thus the distribution of the existence of bamboo was low with only 0.95% distributed in the whole strata so that the presence of bamboo was not potential in the Habinsaran estate.
3.3. Aek Raja Estate

Incense species found in Aek Raja estate was Toba (*Styrax sumatrana*), and few of Durame (*Styrax benzoine*), and Bulu (*StyraxbenzoinevarHilferum*). Aek Raja estate has three strata of protected areas. The distribution of all NTFPs for each stratum is shown in table 4.

| No. | Kind of NTFPs | Distribution (%) |
|-----|---------------|------------------|
|     |               | SS   | BD   | GB   |
| 1.  | Incense       |      |      |      |
|     | Pole          | 10.00| 26.25| 11.67|
|     | Tree          | 10.00| 26.67| 10.83|
| 2.  | Rattan        |      |      |      |
|     | Young         | 0    | 2.50 | 4.17 |
|     | Mature        | 0    | 3.75 | 5.00 |
| 3.  | Sugar palm    | 0    | 2.08 | 8.33 |
| 4.  | Bamboo        | 0    | 0.83 | 2.50 |

Distribution of incense in Aek Raja estate was scattered because it was only found in a small number of sample sub-plots, which was under 50% distributed. Both tree and pole stage was in the riparian zone area with a distribution of 10% respectively, meanwhile in the Green Belt area was 26.25% at pole stage and 10.83% at tree stage. Incense was mostly found in the biodiversity area with a distribution of 26.25% at pole stage and 26.27% at tree stage. Distribution map of incense in Aek Raja estate is as shown in figure 7.

![Figure 8. Incense distribution in Aek Raja Estate.](image)

Distribution of rattan in the Aek Raja estate, both young and mature, is very limited. Distribution of young rattan in the biodiversity area is 2.5% of all clusters and for mature rattan is 3.75%, whereas in the green belt area the distribution of young rattan is 4.17% and for mature rattan is 5%. Presence of rattan in Aek Raja estate is sporadic and dispersed.
Distribution of sugar palm in the green belt area is distributed 8.3%, and in the biodiversity area is distributed by 2%. Given that number, the green belt area is the best area to find sugar palm in Aek Raja estate, although it is not significant. Distribution of bamboo was fairly uneven, with only 2.5% found in the green belt area.

3.4. Tele Estate

Type of incense found in Tele estate is Toba (*Styrax sumatrana*). Tele estate has five strata of protected areas. The distribution of all NTFPs for each stratum is shown in Table 5.

**Table 5.** Distribution of NTFPs in protected areas of Tele Estate.

| No. | Kind of NTFPs | Distribution (%) |
|-----|---------------|------------------|
|     |               | KPPN  | SS   | BD   | GB   | BZ   |
| 1.  | Incense       |       |      |      |      |      |
|     | Pole          | 20.00 | 5.00 | 16.13| 14.15| 28.00|
|     | Tree          | 6.67  | 0    | 9.68 | 6.34 | 8.00 |
| 2.  | Rattan        |       |      |      |      |      |
|     | Young         | 100.00| 95.00| 92.26| 0    | 76.00|
|     | Mature        | 100.00| 95.00| 90.32| 0    | 76.00|
| 3.  | Sugar palm    | 0     | 0    | 0    | 0    | 0    |
| 4.  | Bamboo        | 0     | 0    | 0    | 0    | 0    |

Incense spread eventually and was generally found in the entire of all strata, except in the riparian zone areas for tree stage. Incense distribution in KPPN area was 6.67% at the tree stage, and 20% was at the pole stage. In the riparian zone area, distribution of pole stage was 5% that means incense has limited growth in the riparian zone. Distribution of incense in the biodiversity area was 9.68% for tree stage and pole stage was 16.13%. Distribution of incense trees in the green belt area was 6.34%, and the pole stage was 14.15%, whereas, in the buffer zone area, distribution of tree incense was 8% and 28% was at the pole stage. Given the data, the greatest potential for incense in the Tele estate was in the green belt area for pole stage and biodiversity area for tree stage. Distribution map of incense in Tele estate is shown in figure 8.

**Figure 9.** Incense distribution in Tele Estate. **Figure 10.** Rattan distribution in Tele Estate.
Distribution of rattan, both young and mature was very high in all protected areas (strata) except at the green belt area. Distribution of young and mature rattan in KPPN area reached 100%, since rattan was found in all sub-plots. Distribution of young and mature rattan in the riparian zone area was 95%, meanwhile, in the Biodiversity area, the distribution of young rattan was 92.26%, and mature rattan was 90.32%. Buffer zone areas was the third with 76% for both young and mature rattan.

It shows that rattan is very significant and abundant in the Tele estate, especially in KPPN, Riparian zone, Biodiversity zone, and Buffer zones. Both sugar palm and bamboo was not found in all strata in the Tele estate.

3.5. Tapanuli Selatan Estate

In general, NTFPs were very rarely found in Tapanuli Selatan estate since the land has already been opened and cultivated with other crops such as rubber and oil palm by the community. NTFPs distribution in Tapanuli Selatan is listed in table 6.

Table 6. Distribution of NTFPs in protected areas of Tapanuli Selatan Estate.

| No. | Kind of NTFPs | Distribution (%) |
|-----|---------------|------------------|
|     |               | BD | GB |
| 1.  | Incense       |    |    |
|     | Pole          | 0  | 0  |
|     | Tree          | 0  | 0  |
| 2.  | Rattan        |    |    |
|     | Young         | 10.00 | 8.00 |
|     | Mature        | 6.67 | 4.00 |
| 3.  | Sugar palm    | 10.00 | 2.00 |
| 4.  | Bamboo        | 0  | 2.00 |

There was no incense found in all sub-plots. Distribution of rattan was limited and found at a few points. Distribution of young rattan in the biodiversity area was 10%, while mature rattan reached 6.67%. In the green belt area, the distribution of young rattan was 8%, while mature rattan was 4%. Given the data of rattan, the distribution showed that rattan was quite fairly distributed in Tapanuli Selatan estate.

Only 10% of sugar palm was distributed in the biodiversity areas, and 2% was in the green belt areas. The soil conditions can continue the excess water, such as loose soil, volcanic soil on the mountain slopes, and sandy soil around the banks of the river is an ideal land for the growth of sugar palm. Hanafiah [4] reported that the best environmental temperature averages 25°C with annual rainfall of 1.200 mm. Meanwhile bamboo was only found in 1 subplot of a total of 50 sub-plot observations so that the distribution of bamboo only reached 2%. Ministry of Forestry [5] reported that bamboo can grow in tropical regions, subtropics and temperate climates, ranging from lowlands to certain heights.

Management and monitoring of protected areas in PT TPL concession may consider the distribution of NTFPs through the arrangement of NTFP zonation based on its abundance locus and kind of NTFPs. Utilization of incense in Aek Nauli estate and Tele estate could be focused on KPPN area with some security requirements for accessing such core conservation area. Similarly, Biodiversity area of Habinsaran is rich in incense and needs to be wise in collecting.

The high abundance of rattan in Tele estate, Aek Nauli estate and Habinsaran estate was supported by the character of the locations that was very suitable with the growth of rattan. Rattan grows in forests, especially near steep slopes with a height range between 500-1000 m on dry land. Deep soluble, moist and clay structure with a wet climate. Seedlings are found abundantly in hilly forests [6]. Meanwhile, the higher the place of growth the more rarely it is found in rattan [7], and also less in the rocky limestone areas [8] like those in protected areas in Aek Raja estate.

Incense was mostly found in all estates and strata considering the concessions are in the highland Tapanuli area which is traditionally well known as as one of the largest incense producers in...
Indonesia. The cultivation of incense trees in the Tapanuli area has been known for quite a long time, estimated to have begun in the late 1800 [9]. Steenis [10] added that incense trees were found in natural forests, live in groups and mix with other plants.

4. Conclusion
26.67% of based incense was most widely distributed in the Germ-Plasm Protection Area (KPPN) of Aek Nauli Est, and 20.00 % was in the Riparian Area (SS) of Habinsaran Estate. At the pole growth level, 20.00% of incense was often found in the Green Belt Area (GB) of Aek Nauli Est, and 28.00% was in the Buffer Zone Area (BZ).

Rattan was widespread in all the class of protected areas in Tele Estate. It 100% was found in Germ-Plasm area (KPPN), 95.00% was in Riparian Area (SS), and 92.26 % was in Biodiversity Area (BD). The second best place to find rattan was in the Green Belt Area (GB) 82.86% and the Riparian Area (SS) 76.00%.

Sugar palm and bamboo are not distributed well and mostly found in the Green Belt area and Riparian area of Aek Nauli Estate.

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