Vegetation Diversity and Conservation Implications on Habitat of Taxus (*Taxus sumatrana* Miq. De Laub) in Northern Sumatra

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Abstract: *Taxus sumatrana* is an important medicinal plant as a source of cancer drugs and indicated to cure various cancer. However, information about habitat and population especially in Northern Sumatra is very limited. This research aimed to observe the population and habitat of *Taxus sumatrana* in three locations (Gunung Tujuh, Gunung Kerinci and, Sibuaton) and implication in conserving this species. Data was collected by creating a plot analysis with strip transect method and data were analyzed by analysis of Important Vegetation Index, species diversity index, community similarity index and abundant index. The result showed that taxus population in all location was not in normal distribution which was lacking seedling, sapling, and poles level of stands. The overall diversity of the three study sites was still high enough so that the condition remains relatively stable. All the study sites have a low similarity value so it can be used as a location for genetic protection of plant distribution. As an implication, taxus habitat should be highly protected by a special rule to protect its existence as well as species enrichment to reduce growth level of this species.

1 INTRODUCTION

Taxus is one species of tree that has been proven as a raw material for the treatment of cancer, especially breast cancer (Wani, et al., 1971; Erdemoglu et al., 2004). Extracts from this plant, paclitaxel (Taxol^{TM}), is used to inhibit the growth of cancer cells in particular ovarian cancer (Markman, 1991) and breast cancer and has also been tested for treatment of certain other types of cancer (Rajendran, et al., 2013). Aside from being a cure for cancer, Taxus also has potential as an anticonvulsant and antipyretic (Nisar, et al., 2008) and also as an analgesic (Nisar *et al.*, 2008) (Dutta, et al., 2010).

Taxus consists of 24 species and 55 varieties (Spjut, 2007). The natural distribution of the genus Taxus in Asia is only found in several countries, such as *Taxus cuspidata* (found in Japan), *Taxus chinensis* (found in China), and *Taxus sumatrana* (found in Indonesia, Taiwan, Vietnam, Nepal and Tibet) which the condition of the current population is already threatened with extinction (Chi-chun, et al., 2008). According to Farr (2008), there are five species of Taxus in Asia, the Philippines and Indonesia, and has been listed in CITES Appendix II (Farr, 2008),. Taxus species found in Indonesia is the type of *Taxus sumatrana* Miq. De Laub. and, spread in North Sumatra, South Sumatra, Lampung and Sulawesi (Harahap and Izudin, 2002). *Taxus sumatrana* is potential for cancer drugs, and it has been studied to treat various types of cancers such as human liver carcinoma (Hepa59T / VGH), human large cell carcinoma of the lungs (NCI), human cervical epithelioid carcinoma (HeLa), human colon adenocarcinoma (DLD-1) , human medulloblastoma (Med) cell lines, human PC-3 tumor cells (Shen et al., 2002; Shen et al., 2005; Wang, et al., 2009; Luh, et al., 2009).

Although it has been included in CITES Appendix II, data on potential and distribution of *T. sumatrana* is still very rare. Research on the ecology, cultivation and production aspects of this type of *T. sumatrana* also has not been completed. The absence of ecological studies on *T. sumatrana* allegedly because of this type of co-dominant, limited distribution and the type that is less well known and less used by local communities in Northern Sumatra. Besides, the locations where Taxus growth are in the forest highlands with very low accessibility (Pasaribu, et al., 2010). The absence of this

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information will complicate the management of habitat and efforts should be made to preserve this species. Ecological research on the type of Taxus elsewhere has been done as to the type of *Taxus brevifolia* in North America (Busing, et al., 1995), *Taxus baccata* in the UK (Linares, 2013) in Italy (Piovesan *et al.*, 2009) and in Denmark (Svenning and Maga, 1999), *Taxus chinensis* in China (Zhang et al., 2010) and *Taxus canadensis* in Canada (Windels and Flaspohler, 2011).

This study aimed to obtain information on the abundance, plant composition, species diversity and similarities of habitat *Taxus sumatrana* and conservation implications in three locations in Northern Sumatra. The results are expected to provide information for the development of conservation and cultivation of *T. sumatrana*.

2 METHOD

2.1 Research Location

This research was conducted in the area of Kerinci Seblat National Park in Jambi Province (Mount Kerinci and Gunung Tujuh) and Sibuaton protected forest in North Sumatra Province. Observation plots were determined by the presence of Taxus stands that were found.

2.1.1 Gunung Tujuh

Research plots in Gunung Tujuh located at coordinates -1°42'23,8" South latitude and 101°22'54,8" East longitude until -1°42'22,9" South latitude and 101°23'01,6" East longitude and is located at an altitude of 1800-2100 meters above sea level.

2.1.2 Mount Kerinci

Research plots at Mount Kerinci located at coordinates -1° 44'27,2 " South latitude and 101°15'34,2" East longitude until -1°44'02,3" South latitude and 101°15'34,4" East longitude and is located at an altitude of about 1900-2350 meters above sea level.

2.1.3 Sibuaton

Research plots at Mount Sibuaton located at coordinates 02°52 '35.6" North Latitude and 98°29' 48.0" East up to 02°52 '28.2" North Latitude and 98°29'38, 4" East and lies at an altitude of 1600-1660 meters above sea level.

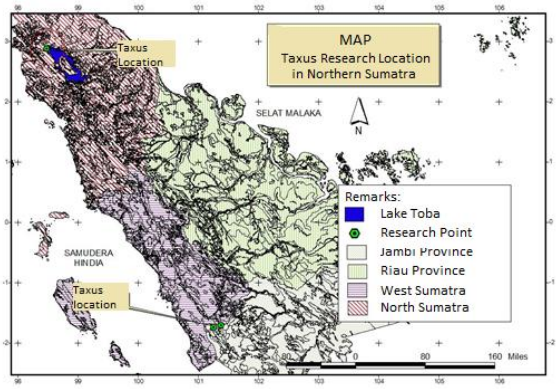

Fig. 1. Research Location at North Sumatra and Jambi Province.

2.2 Materials and Tools

Vegetation around T. sumatrana habitat was the material in this research. Working map scale of 1: 50,000, Global Positioning System (GPS) receivers, measuring tape, rope, machete, tally sheet, camera, and stationery were tools of this research.

2.3 Data Collection

Vegetation line method terraced (strip transect method) was a plant observation procedure in Taxus habitat. This procedure was carried out by creating a plot analysis of the vegetation line method terraced (strip transect method) according to (Kusmana, 1997; Amjad, et al., 2014). The total amount of analysis plots as much as 10 plots for each location. Observation plot of tree-level measuring 20 m x 20 m, poles measuring 10 m x 10 m, saplings measuring 5 m x 5 m and seedlings and undergrowth measuring 2 m x 2 m (Mandal and Joshi., 2014).

2.4 Data Analysis

Data were analyzed quantitatively. The equations used in data analysis include:

a. Analysis of important vegetation index value (IVI).

IVI is the sum of Dominance Relative, Relative Density and Relative Frequency for tree-level and summation Density Relative to Relative Frequency for belta level, seedlings and, plants under (Odum, 1998; Mandal and Joshi, 2014).

b. Species Diversity Index (SDI)

SDI is an index to determine the diversity of species used formula Shannon and Weaver (Ludwig & Reynolds, 1988; Odum, 1998; (Amjad et al., 2014)

c. Community Similarity Index (CSI)

CSI is an index to determine the extent of similarity/unsimilarity between the research sites used Sorensen Community Similarity Index (Mueller-Dombois and Ellenberg, 1974).

d. Abundance Index Type (AIT)

AIT is calculated to determine the abundance of species in a community is calculated using Hill formula (Hill, 1973).

e. Descriptive Analysis to formulate strategies to improved conservation priorities Taxus sumatrana.

3 RESULT AND DISCUSSION

3.1 Importance Value Index (IVI)

Table 1 presented the analysis of important value index in Taxus habitat.

Analysis of vegetation results in three research sites on natural habitats showed that most of *T. sumatrana* were found in tree-level. Small trees were found only in two research plots which were in Gunung Tujuh and Gunung Kerinci while for saplings, seedlings and lower plants were not found in these research plots. The absence of *T. sumatrana* at the level of seedling and saplings might indicat that this species has a structure that is not progressive in growth and thus susceptible to extinction in the wild. *T. sumatrana* were also indicated as an old aged tree with an average diameter at breast height was over 60 cm. When these old trees naturally died, it is feared that there is no longer *T. sumatrana* in the region. These conditions were caused by several things such as the long dormancy period of seeds and very slow growth rate of the tree compared to other conifers growth rate (Pilz, 1996). It was reported that *Taxus baccata* growth rate in England is between 2-12 mm per year (Hindson, 2007).

The extinction of some types of Taxus had occurred in some countries as happened in India and Pakistan as a result of uneven stand structure and overexploitation (Joshi, 2009). This situation made the type of *Taxus wallichiana* become one of the protected priorities species to avoid extinction. Growth structure of Taxus at three locations could cause rapid extinction if people already realized that many benefits of this species.

The IVI is used to describe the level of mastery given by a species of the community, the greater the IVI of a species, the greater the level of mastery of the community and vice versa (Soegianto, 1994). A type of species is playing a role if it has the IVI score of more than 15% at the level of pole and tree. According to Table 1, the Taxus indicated has an important role in the community, especially at the level of the tree, with IVI more than 30% in each location.

Habitat condition of *T. sumatrana* should be maintained to continue its existence in natural habitat. The lack of seedling and sapling level was a warning of its extinction within the next 30 years. According to Rachmat (2008), *T. sumatrana* found in a very limited spread because some reasons, which are it only exist in high elevation (above 1,500 above sea level), high slope terrain even at the edge of cliff, well drainage soil with low pH, loamy sandy in soil texture, high C organic compound and high C/N ratio.

Table 1: Importance Value Index of dominant plant species at the level of seedlings, saplings, poles, and trees in the habitat of *Taxus sumatrana*.

Location	Growth level	Local Name	Botanical Name	IVI (%)
Gunung Tujuh	Seedling	Pakis	*Diplazium proliferum*	29,71
	Sapling	Kecubung Hutan		18,57
	Poles	Langsat Hutan		79,96
	Tree	Taksus	*Taxus sumatrana*	55,60
Gunung Kerinci	Seedling	Pakis	*Diplazium proliferum*	24,38
	Sapling	Pinang	*Areca catechu*	23,45
	Poles	Kelat Putih		69,52
	Tree	Taksus	*Taxus sumatrana*	43,28
Sibuaton	Seedling	Cakara ayam	*Schizaea dichotoma*	37,02
	Sapling	Medang Pokat	*Litsea sp.*	21,08
	Poles	Medang Kuning	*Litsea veluntina*	24,91
	Tree	Taksus	*Taxus sumatrana*	33,47

In Europe, *Taxus baccata* become endangered due to their excessive exploitation, land use change and increase the density of the forest where the growth of *Taxus baccata* thus losing compete for the light (Lewandowski, et al., 1995; Linares, 2013). In Italy and Denmark, Taxus populations tend to grow with the management of good forest management (Piovesan et al., 2009; Svenning and Maga, 1999) and good management of forest helped *Taxus chinensis* var. *meirei* stand structure in China increased (Zhang and Zhou, 2013).

High utilization of Taxus for cancer drugs by taking raw materials from the natural resulted in highly threatened of this species (Prasad and Bhattacharya, 2003). In Jambi, some people have already known the efficacy of this species and they took Taxus bark to make medicine. This activity will naturally disrupt fertilization and even kill Taxus trees, as found in the Gunung Kerinci Protected Forest. The loss of trees will reduce the level of the forest canopy and change the microclimate necessary for the regeneration of young plants, seedlings, and saplings (Bondarchuk, 2015).

3.2 Plant Diversity and Abundance

Identified vegetation at study areas were as many as 121 species in Sibuaton, 80 species in Gunung Tujuh and 76 species Gunung Kerinci. The highest species diversity index value at seedling level was found in the Gunung Kerinci forest area of 3.47 while the lowest at sapling level was also in Gunung Kerinci of 2.07. These values were categorized as middle to high (Fig. 2). However, the overall diversity of the three study sites were still high enough so that the condition relatively stable.

The results of this diversity analysis showed that the presence of Taxus trees plays a role in the regeneration of other plants so that the ecosystem is stable and capable of regenerating naturally, especially in Sibuaton and Gunung Tujuh, with H' above 3 in average (Irwan 2007). In stable condition, plants which are able to associate with Taxus will regenerate properly (Bondarchuk 2015).

The highest abundance of vegetation was found in Gunung Kerinci of 51.67 (Fig. 3) for seedlings and understorey level and the lowest abundance of species found at the pole level in the Gunung Kerinci area of 13.33. The large number of individuals at each growth rate found in the Gunung Tujuh area has resulted in a fairly high vegetation abundance. This showed that the environmental conditions at Gunung Tujuh are better or conducive because the forest is still well preserved. The abundance of species is not only influenced by the number of species and the total number of individuals, but the proportion of individuals in each species determines (Odum, 1998).

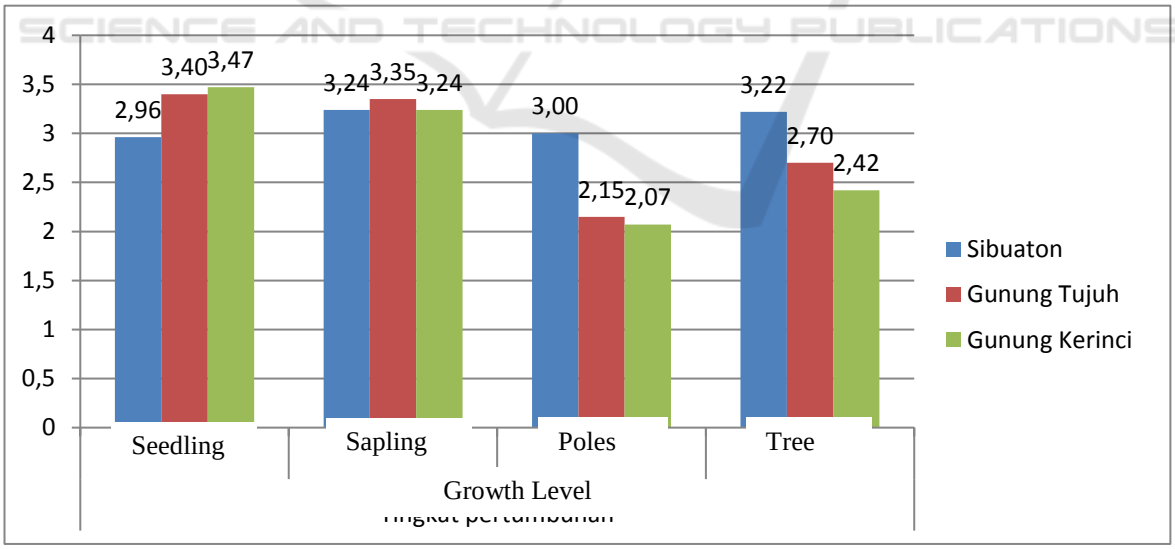

Fig. 2. Diversity analysis result of vegetation type.

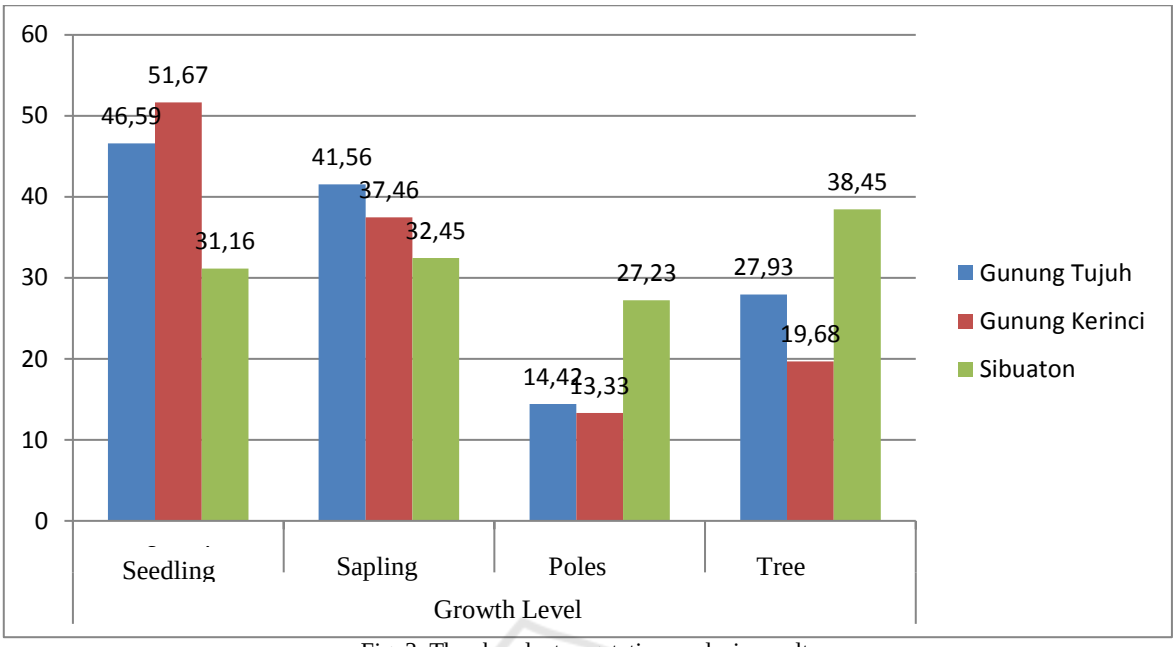

Fig. 3. The abundant vegetation analysis result.

3.3 Community Similarity

Table 2 presented the results of similarity analysis on the habitat of *T. sumatrana* community in three locations.

Table 2: Similarity index value in the habitat of *Taxus sumatrana.*

Location	Similarity index (%)		
	Sibuaton	Gunung Tujuh	Gunung Kerinci
Sibuaton	-	11,76	9,09
Gunung Tujuh	11,76	-	47,44
Gunung Kerinci	9,09	47,44	-

Based on the results of community similarity analysis in Table 2, the three study locations have low similarity values, which are below 50% on average. Similarity values below 50% indicate that there are differences in plant structure at various significant levels of growth in all three study locations. The results of the index analysis of community similarities in the study locations that were significantly different showed that the composition of plants in Taxus sumatrana habitat was also different. With the different composition of plants in each location, it can also be used as a location for the protection of plant distribution of germplasm.

3.4 Conservation Implication Strategy

In the IUCN list (2015) *T. sumatrana* is still included as a Lower Risk with decreasing population. However, based on the results of the above research, the idea of protecting the existence of Taxus in its natural habitat needs to be a priority because the distribution is very limited. Regeneration of taxus that is not progressive / tends to decrease as the difficulty of finding taxus at seedling and sapling levels is feared that in the next 30 years this species will be increasingly scarce because the use of today is very high. Increasing the status of *Taxus sumatrana* from its current status to threatened status is very important to increase the participation of various stakeholders in this type of conservation.

The remaining distribution of Taxus sumatrana was mostly in conservation forests, such as national parks and protected forests, so there is no need to establish new conservation areas in this type of in situ conservation efforts (Hidayat, 2014). Habitat protection efforts can be done through securing the area and patrolling regularly and focused around the habitat of Taxus. This security is also expected to maintain ecosystem stability from the threat of illegal logging and encroachment so that the diversity of species around Taxus's habitat can be increased.

In its natural habitat, Taxus has an important role to maintain the balance of microclimate because of its wide, evergreen canopy cover. Taxus INP values at tree-level which was above 30% and high species abundance proved that Taxus can help regenerate other plants, especially intolerant species (requires shade). In order to improve tree structure in its natural habitat and as in situ conservation, enrichment could be implemented by vegetative propagation as well as generative propagation. This effort should also follow by well-done preserved its habitat from any disturbance especially from human disturbance since these three locations are ecotourism site.

4 CONCLUSIONS

Taxus sumatrana is the most important tree in three locations but there were lacking seedling, sapling and poles level of stands. The overall diversity of the three study sites were still high enough so that the condition remains relatively stable. All the study sites have a low similarity value so they could be used as a location for genetic protection of plant distribution. As an implication, taxus habitat should be highly protected by a special rule to protect its existence as well as species enrichment to increase the number in every growth level of this species.

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