A Preliminary Biodiversity Survey in Mursala Island: Implication for Conservation

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Abstract. Biodiversity refers to all living creatures, including plants in terms of its genetic variation, ecosystem variation, number of species within an area, etc. However, the high anthropological disturbances in a specific area will bring a negative effect on the biodiversity existence. Mursala Island is the biggest island in Central Tapanuli, North Sumatra that has already known for its timber species richness. The island is experiencing disturbances due to forest conversion and illegal logging in which threatening the vegetation occurrence on this Island. We did a preliminary survey by establishing six plots of 20x20 m in different locations within Mursala Island to investigate the current biodiversity condition on this island, especially its plant species. We calculated density, species diversity, and species richness. We found a total of 77 different species with a total density of 680 stems/ha of the individuals >10 cm in diameter. Based on the Shannon Diversity Index, the species diversity in this area is 1.85 or equivalent diversity as a community with six equally-common species, with the species richness Dmn = 0.33. The results indicated the island has a less diverse community. Hence, our conservation strategies are required to increase the biodiversity value of this island.

1. Introduction

Biological diversity or biodiversity contains all variety and variability life forms on earth and refers to variation at all levels of biological organization [1, 2]. Biodiversity plays an important role in every aspect of human well-being, including economic, food, health, socio-ecological, cultural, etc. Furthermore, there are three basic elements of biodiversity: genetic diversity; organismal or species diversity; and ecosystem diversity in which linked one to another [1].

Biodiversity is susceptible to many kinds of threats, both human and natural disturbances. Most of the anthropological activities might bring negative impact to the biodiversity, which results in biodiversity loss. Moreover, there are five main causes of biodiversity loss: habitat loss, climate change, overexploitation, invasive alien species, and pollution [3]. On the escalation growth of human population, the necessity of resources fulfilment through resources exploitation is also increased [4] which might affected the biodiversity value.

Islands create a unique assemblage of life as the result of isolation which the species concentrate in the small areas with limited genetic diversity and population size. Many island species are endemic, and its endemic proportion is rise with increasing isolation [5]. Island ecosystems have always played a major role in conservation biology [6]. However, the island species are fragile and vulnerable to
extinction due to its small geographic range and population size [7]. It is widely known that the forest degradation occurred almost in tropical region in the world and the most case was forest landscapes conversion to agricultural area which also a major driving of the global biodiversity crisis [8]. This level of forest degradation impact differed enormously between different habitats or island condition.

Mursala Island is the largest island in the Central Tapanuli District, North Sumatra Province, and lies in the south-west of Sibolga Port. The first commercial timber extraction on this island started in the 1980s. It has been stopped in the 1990s due to social conflict between the company and the local people. Mursala forest has been known for its richness in timber species. However, overexploitation through illegal logging and land conversion continuously happen in line with the high demand for timber from this island, which possibly threat its species existence [9]. The preliminary biodiversity survey has been done to investigate the condition of Mursala forest. Furthermore, this study aims to describe the vegetation condition in Mursala Island in term of its species density, species diversity, and species richness to formulate the conservation strategy of this island.

2. Method

2.1. Study site

We conducted the study in Mursala Island. It is located in Central Tapanuli Regency administratively, between Nias Island and the town of Sibolga. Geographically, it is located at 01°35'15" - 2°22'0" N and 98°38' - 37°12' E with total area ± 8000 ha. Its topography is dominated by hilly and bumpy areas (43%) with the range of altitude 0-486 meter above sea level. The average temperature was 26.7°C. This island is surrounded by other uninhabited islands namely Putri, Silabu Na Godang, Kalimantung, Silabu Na Menek, and Jambe Island [9].

![Figure 1](image-url) Figure 1. The study site, Mursala Island, Central Tapanuli District, North Sumatra, Indonesia. Numbers are the plot samplings for analysing species richness, density, and diversity.

2.2. Methods

We established six plots of 20 x 20 m for individual >20 cm in diameter at different locations in Mursala Island. For investigating the smaller individual, we established the smaller plot 10x10 m for individual 10-20 cm in diameter, 5x5 m for individual <10 cm in diameter, and 2x2 m for individual
<1.5 m in height. We investigated the current condition of Mursala Island and calculated the tree density, species richness, and species diversity.

2.3. **Data analysis**

The tree density was calculated for individuals with diameter >10 cm. Moreover, for calculating species richness, we used the Menhinick’s index:

\[ D = s \times N^{1/2} \]

where D is known as species richness, s equals to the number of different species represented in the sample, and N equals the total number of the individual organism in the sample.

We calculated species diversity using Shannon index:

\[ H = \sum (pi) \ln pi \]

where \( pi \) is the proportion of the total number of individuals in the population that are in species i.

3. **Result and discussion**

3.1. **General overview of Mursala Island**

Mursala Island is known for its timber species diversity which is proven with the establishment of a timber concession in the 1980s for the period 25 years. However, in the 1990s, the concession duration should be stopped due to some social conflicts before it was officially ended. That was related to the escalating number of the human population, which had led to an increase in their needs. Hence, it results in resources exploitation including Mursala forest. In the past few years, there were several threats in Mursala Island such as illegal logging and forest conversion, which brought negative effects to the Island’s biodiversity, including the plant species diversity.

Illegal logging is continuing happened as timber extraction is the main source of living of the Mursala people. The people tend to cut the good trees with diameter >50 cm. Mostly, they exploited the trees which grow in the lower and middle area of the Island of Mursala and leave the trees in the upper part [9]. The easy access was underlying the decreasing number of big diameter trees in the lower area.

Forest conversions are the other threats to Mursala Island. Those activities related to the local people or rural community needs of arable land. On the lowland area, local people of Mursala had converted the area into mix garden and monoculture plantation. Currently, in Sumatra and Kalimantan, monoculture plantation in the form of oil palm or rubber plantation had dominated the area and become the popular choice of local people due to its economic value. Forest conversion, including land use intensification result in substantial losses in biodiversity and related ecosystem functions [10].
This condition also in accordance with Santamari’a and Me’ndez [11] who stated that half of deforestation in tropical areas is caused by livelihood activities such as shifting cultivation by resource poor communities and smallholders [11]. The changing of forest into monoculture plantation affected the vegetation cover and changing the above-ground diversity in location [12-13].

In Mursala Island, there was an occurrence of one of Dipterocarp species in which previously reported extinct, Dipterocarpus cinereus [14]. This finding was important for the aspect of biodiversity conservation. Due to the current condition of the Island with the high-level of disturbances, the attention more required regarding the existence of D. cinereus. The disturbed habitat threatened endemic species of a location. In 1994, [15] recorded of species number decrease for inland forests of 29% due to logging activities and land conversions. But their extinction rates differed enormously between different habitats. This condition might be occurred on D. cinereus's case. Therefore, the awareness of the conservation value needs to be introduced to the local people so that they can participate in protecting this species and Mursala forest in general.

3.2. Vegetation composition, species richness and species diversity

Forest conversion into palm oil plantation and rubber has also threatened the existence of species and will affect floristic composition and population structure of the forest [16]. Tree density, species richness, and species diversity was measured to find out the vegetation condition in this area. Tree density gave an overview of how many trees grow in a particular area and is expressed as a number of trees per hectare. Our research found that the total tree density in Mursala Island for individual >10 cm was 680 individuals per hectare. This number is higher than tree density in Sulawesi, 408 individuals per hectare [17], in Central Sulawesi 543 individuals per hectare [18], and in Pahang National Park 448 individuals per hectare [19, 20]. The result indicated the tree density quite high compare to the other areas, and it was a good indication in a massive human disturbance in this area. However, we need to investigate further regarding its species richness and diversity.

The value of species richness was the expression of diversity. Species diversity and richness of a site experiencing disturbances, therefore, will be a cumulative outcome of differential responses of species to disturbances. Some species may tolerate the disturbances and the others may disappear [21]. The more species found in a sample, the sample is considered to be “rich”. Based on the calculation, the value of species richness was 0.33, and it indicated low diversity in this particular area. We used Menhinick’s index as it represented the diversity in a real form, even if we had small sampling units [22]. The value of diversity may be higher if we have a bigger sampling unit. Furthermore, the result showed that there were 77 different species belong to 27 family and 55 genera. Family Dipterocarpaceae dominated the area (45.95%) followed by Lauraceae family (6.76%), while genus Shorea has the highest frequency (40%). That result supported the previous study which stated that Mursala forest has been known for its richness in timbers species, especially Dipterocarpaceae [9].

In this study, the value of species diversity was 1.85 based on the Shannon Diversity Index. This value means equivalent to a community with six equally-common species. Generally, in most of the ecological studies, the value for the Shannon Diversity Index (H') is between 1.5 and 3.5. The Shannon diversity index 1.85 was in the normal range. The value of diversity index can indicate the level of diversity in a forest. Higher value of H' indicates that the species diversity in the location is high. As the forest community in Mursala Island as our study area was not newly formed forest, the value of species diversity tended to be low. The value of species diversity tends to be high in older and younger communities in the newly formed forest community [23].

3.3. Implication for conservation

Conservation in term of biodiversity conservation is the sustainable use of resources, including protection as well as exploitation. While biodiversity conservation incorporates the preservation, maintenance, sustainable uses (conservation), recovery and enhancement of the components of biological diversity [24]. Since the human activities were the main threats for the changing biodiversity [25] including in the Mursala Island, conservation effort should be able for balancing
between human needs and the Island’s ecosystem. It is important to consider human needs so that they will not try to occupy the area that should be protected or serve as a forest area.

The existence of *D. cinereus* in Mursala Island requires our attention regarding its conservation strategies. The occurrence of Dipterocarps species in many small islands in Sumatera (Lingga, Singkep, Bintan, Batam, and Bunguran Islands) have previously reported and showed high numbers of naturally growing Dipterocarps [26]. However, the species occur in a small island tend to have higher possibilities of extinction due to its small population size and its natural preference to grow in a narrow geographic area [7, 27]. Hence, the biodiversity management of a small Island should considering the occurrence of rare and endangered species. Furthermore, it is known that the main drivers of species extinction were habitat loss and low genetic variation [28]. The possibility of species extinction in this area is higher due to land conversion, especially in the lower part of the Island. The awareness of species extinction should be rose and information should be shared with local people to support the conservation actions.

The information of vegetation composition, including species richness and diversity, will also support the conservation effort of Mursala Island as it indicated the urge action of conservation. Since the result showing the low diversity of species in this area, our effort was trying to manage the current species diversity and conserve the number of endemic species. In-situ conservation alongside with ex-situ conservation can be chosen for maintaining and increasing the vegetation occurrence in the Mursala Island.

4. Conclusion

The vegetation condition in Mursala Island showed a good number of trees density, however very low in species richness and diversity. The effort to reduce some factors which could worsen the biodiversity existence should be supported by all stakeholders who related to Mursala Island’s management. Good cooperation among stakeholders, including the government and local people is a must for a good management of Mursala Island resources. The government’s supports are crucial to ensure the conservation efforts for the Island ecosystem. Overall, the vegetation condition in Mursala Island needs more attention and real conservation actions from all stakeholders for increasing species richness and diversity and protecting its endemic species.

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