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The Diversity of Wood Vegetations along the stream of Hot Water Spring of Momiwaren Protected Forest in South Manokwari

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Abstract

The Momiwaren protected forest area is one of the areas in South Manokwari Regency that has hot springs. This area is not in the volcano area. However, the resulting hot springs cause sulfur aromas surrounding the area. This area is a protected forest overgrown by various species of trees. For this reason, it is necessary to determine the structure and composition of plants in this area due to the presence of hot springs in its location. This research was carried out in the South Manokwari, Momiwaren Village. The results showed that the number of vegetation types in the area along the hot water stream was as many as 106 types which were divided into several levels: Seedling phase consisting of 35 species with 88 individuals and was dominated by Vatica rassak with important value index (IVI) of 35,770%; sapling phase consists of 55 species with 129 individuals and was dominated by Vatica rassak with IVI of 27.506%, Pole phase consists of 29 species with 45 individuals and was dominated by Vatica rassak with IVI of 28,069%, and tree phase consists of 22 types with individual numbers 56 and was dominated by Vatica rassak with IVI of 59,803%. The results of this study indicated that the spread of Vatica rassak exists at all levels of plants and was a dominant species along the stream of hot water spring.

Keywords: *Hot Water Spring Area, Momiwaren, South Manokwari, The diversity of tree*

1. Introduction

The lowland tropical forest in Papua has extremelly high biodiversity, especially large number of difffrent plants [1]. This is probably due to the varied site and topography of the regions in Papua. For instance, the two closed regions which is differed by topography elevation will show diffrent biota. But, on the other hand, the number of families found is relatively small [2]. The association between flora diversity and topography had already been studied by researchers, in which the diversity of flora species will decrease with the increasing of elevation [3].

The Momiwaren protected forest area is one of forest areas in South Manokwari that has diverse topography. The area is belong to the type of lowland wet tropical forest which has a complex type of vegetation. [4] assert that this type of forest generally characterized by an irregular composition of tress and is ussually more open as well as overgrown by lower trees.

The composition, structure and development of vegetation in an area are closely related to enviromental factors. [5] state that vegetation growth is strongly influenced by climatic factors (temperature, rainfall, climate and humidity) and edaphic factors (soil and their types). The Momiwaren protected forest area is considered unique due to it has a potential hot spring water, eventhough the are is not a part of volcanic area. In addition, the water flow that comes out of the hot

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spring water runs and forms a smalll river which eventually pours out into the Ransiki river. Generally, the pH at the hot spring water is relatevely neutral, which is about 7 to 7.5, with the water temperature ranges from 70°C to 85°C. Moreover, the vegetation's condition around the hot spring water is completely diverse. How is the vegetation's structure and composition surounding the hot spring water in Momiwaren protected forest area and what are types of vegetation that dominate this area. Hence, it is necessary to conduct the research that aims to study the types of species and potential wood vegetations that establish the area..

2. Research Methods

The research was carried out in the protected forest of Momiwaren, The South Manokwari Regency, for a week. Several tools were used in the study area i.e map of research area with scale of 1:80.000, Global Positioning System (GPS), Phiband, Raffia, Hagameter, Compass, Machete, Tally Sheet, Tree Identifier, Camera, and Clinometer. While, the material used is the writing tools.

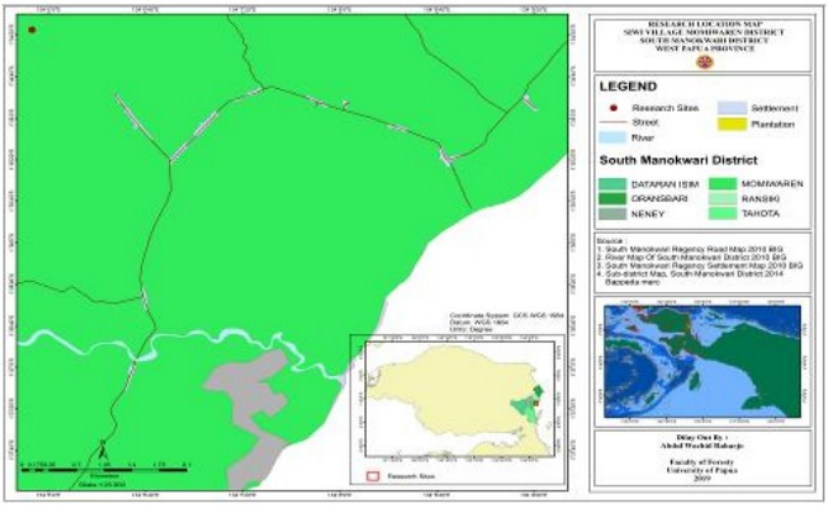

Figure 1. Location of the study site in Momiwaren Protection forest

The object of this study was forest vegetation vertically and horizontally, with variables observed and calculated were density, frequency, dominance, Importance Value Index (INP) and diversity index using Shannon-Wiener and Margalef formulas to determine the abundance/richness of vegetation. Four (4) observation lines were made using plot line sampling method; in which 2 lines to the east and 2 lines to the west with length of line was 60 m and distance between the line was 20 m. The collecting data were done as follow: in each line of observation, observation plots were made with size of plot 2x2 m^2 for the seedlings, 5x5 m^2 for samplings, 10x10 m^2 for the poles and 20x20 m^2 for the trees. Therefore, for observation of vertical structure, the species were taken from existing plots with length of 60 m and width of 20 m to picture the forest diagram profile. Data collected from measurement and observation were analyzed using the formula density, relative density, frequency, relative frequency, dominance and

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relative dominance. The formula of vegetation analysis is based on [5], as follows:

$$\text{Density (D)} = \frac{\text{total individual species}}{\text{wide of plot permanent}}$$

$$\text{Relative Density (RD)} = \frac{\text{density of a species}}{\text{density of all species}} \times 100\%$$

$$\text{Frequency (F)} = \frac{\text{number of plot of a species is found}}{\text{total all observation plots}}$$

$$\text{Relative frequency (RF)} = \frac{\text{frequency of a species}}{\text{frequency of all species}} \times 100\%$$

$$\text{Dominance (D)} = \frac{\text{total of basal area of a species}}{\text{wide of plot permanent}}$$

$$\text{Relative Dominance (RD)} = \frac{\text{dominance of a species}}{\text{dominance of all species}} \times 100\%$$

Important Value Index (INP)

Important Value Index (INP) is a quantitative parameter that can be used to determine the level of dominance of species in a plant community, using indicator of INP value of the species.

Important Value Index (INP) :

INP = KR (%) + FR(%) + DR (%) (applied for poles and trees)

INP = KR (%) + FR (%) (applied for seedlings and samplings)

Where : INP = Important Value Index

KR = Relative Density

FR = Relative Frequency

DR = Relative Dominance

The Basal Area (LBD)

The Basal Area is defined as the cross-sectional area of diameter of the stem. The formula used to calculate the Basal Area is as follows:

$$LBD = \tfrac{1}{4}\pi(D)2$$

Where : LBD = The Basal Area

$\frac{1}{4}\pi$ = a constant

$(D)^2$ = Diameter

Diversity Index and Species Richness

To determine the Species Diversity Index/Species Richness, formula used is Index of Shanon-Wiener :

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$$H' = \sum_{t=1} Pi^{Ln}\ Pi$$

Where : H' : Shanon-Wiener Diversity Index
Pi : proportion of species i
Ln : logaritme nature
Pi : ∑ ni/N (comparison of total individual of a species with total of all species)
N : Total individual of all species
n : Total individual of species i

The Criteria of Diversity Index based on Shanon- Wierner (Krebs, 1989) is as follows :

H' < 1 : low diversity: distribution number of each species is low, stability of community is low and water is heavy polluted.

1 > H' < 3 : medium diversity: distribution number of species or genera is moderate, stability of community is medium and water is moderately polluted.

H' > 3 : high diversity: distribution number of species or genera is high and and water is clean or not yet polluted.

Therefore, for The species abundance/ species richness, formula used was Margalef Index, as follows :

$$R = \frac{(S - 1)}{Ln\ (n)}$$

Explanation : R = Species richness
S = The number of species
n = Total of Individu

3. DISCUSSION

Species Composition

Species composition is used to indicate the presence of trees species in a forest area. The result showed that the total number of species found in the surounding of Momiwaren hot spring water was 89 species. The highest number of species found along the Momiwaren hot spring water is belonged to seedlings dan samplings levels, with the total species of both seedlings and samplings were 35 species (88 individuals) and 55 species (129 individuals), respectively. The number of both species and individuals species at each level of growth is presented in Figure 2.

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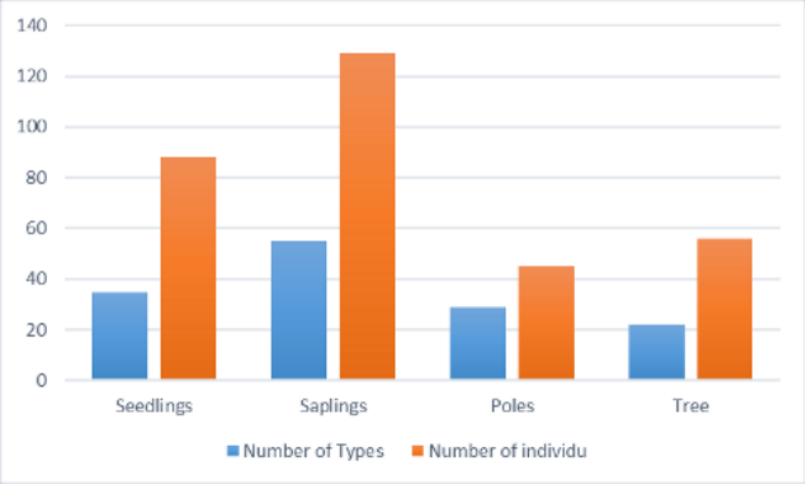

Figure 2. Number of species in each level growth in Momiwaren protection forest

[4] explained that Papua's lowland tropical forest are characterized by high vegetation and species composition. Each level of vegetation's growth is composed by irregular species composition, heterogenic vegetation cover, and varying canopy sizes. Commonly, the forest is more open and it has a gap, which is overgrown by several lower tree species. Therefore, there are several types of trees that grow high and scattered in several locations to form other separate communities.

Density

Based on the vegetation composition along hot spring water in Momiwaren protected forest, the density values obtained at every growth phases for tree per unit space are presented in figure 3.

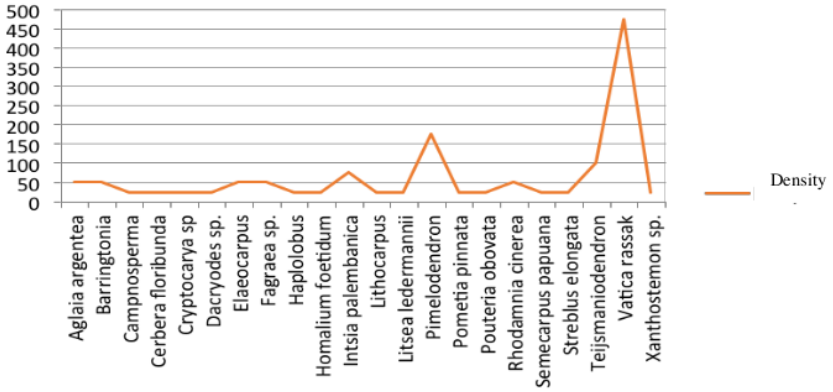

Figure 3. The density of species trees along spring hot water in Momiwaren protected forest area

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Figure 3 shows that *Vatica rassak* had a high tree density level of 475 tress/hectare. This indicates that the species is able to adapt and well grow in the area of study. Genetic and environmental factors are the main factors that greatly effect the ability of soecies to grow and develop on an area [6]. *Vatica rassak* grows naturally in tropical forest of Papua, both in group or individually spread at an altitude of 100 – 150 m above sea level. In addition, this species is commonly found in sandy or clays soils which are periodically inundated by fresh water such as river banks or dry plains [2].

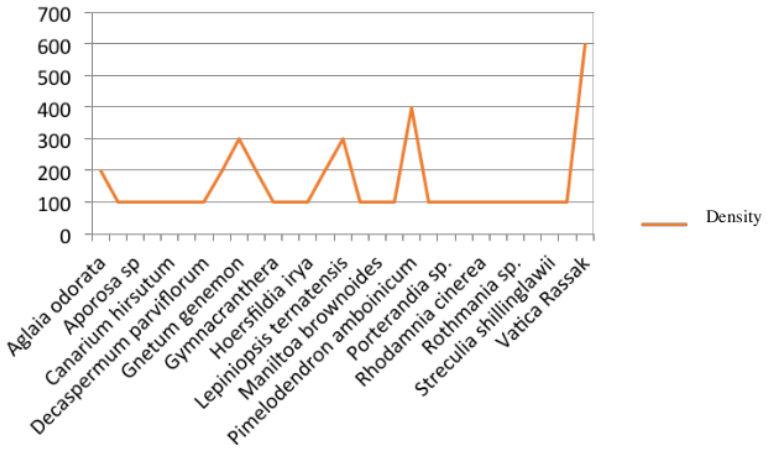

Figure 4. The density of poles phase in the hot spring water Momiwaren

In poles phase, *Vatica rassak* also had large density value, i.e 600 trees/hectare, followed by *Pimelondendron amboinicum* with density value was 400 trees/hectare (shown in Figure 4.). Similarly, in the phases of seedling and sampling, *Vatica rassak* dominated the area that the density values were 50000 trees/hectare and 2300 trees/hectare respectively. *Pimelondendron amboinicum* was in the second place, which had density values at the sampling and seedling phases, 520 trees/hectare and 3455 trees/hectare respectively.

Diversity Index

Based on the forest types, the Momiwaren protected forest is natural lowland forest with a quite variety of topography. [4] reveals that the composition of species in lowland forest of Papua is very diverse, even several of them are endemic species, which have local distribution patterns. The number of diversity index using Shannon-Wiener for forest stand in the study site ranged from 2,2959 to 3,5373. (Table 1)

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Table 1. The degree of species diversity along the hot spring water along the Momiwaren protected forest area

Phase growth	H'
Seedlings	2,6557
Samplings	3,5373
Poles	3,1748
Trees	2,2959

The value of species diversity at seedlings and trees growth rates based on Shannon-Wiener was 1.0>H'<3.0, belong to the medium category. Whereas for the growth rate of samplings and poles, it was included in high category due to the value of species diversity was 'H>3. The value indicates how large the number of species that exist in the community. A community is classified into a high level of diversity when it is composed of many species with an abundance of species that are similar or almost the same. Conversely when a community is composed of few species or a few dominant species, the value of species diversity tends to be low. High species diversity in a community shows that the community has a high complexity. Communities that have high diversity tend to be stable and not disturbed by environmental changes. However, when a community is developing at a level of succession then the amount of species in the community will be lower than the community that has reached a climax. Therefore, if the community is classified in the category of high species diversity it will occur interaction of species which involves energy transfer, predation, competition, and niches [7][8]. The diversity of tree species along the hot spring water in the Momiwaren protected forest mostly occurs in hilly area. It is assumed that several factors such as spatial heterogeneity, competition, environmental stability and productivity become the causes of this condition [9]. If the condition continues to occur in a certain geological period, it will impact on habitat change and cause a number of individual species either unable to survive or it could be survive for a relatively long period of time as a result of an evolutionary process [10].

Species Richness

Calculation of palnt species richness can be carried out using several methods such as Margaled Index, Menhinick Index, Refefaction method and Jacknife estimator (Nahlunisa, 2016). In this research, the data obtained were analyzed using Margalef Index method, as in Table 2.

Table 2. The recapitulation of species richness index

No	Level of Growth	Ln (n)	S	R
1	Seedlings	4.4308	35	5.37
2	Samplings	4.8751	55	7.75
3	Poles	3.8066	29	5.14
4	Trees	4.0073	22	3.66
	∑			21.92

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Based on the calculation result of species richness in the study site, the abundance of sampling was higher than the other level of trees growth, namely 55 species with value of Margalef Index of 7.75. While the value of species richness for seedlings, poles and trees were 5.37, 5.14 and 3.66, respectively. Number of species found in a study area is directly propotional to the value of species richness using Margalef Index. If the observed plot area is expanded, then Margalef Index value will be greater and show a higher diversity value [11].

Stand structure

In the study site, it appeared that the canopy stratas for all types of stands were almost uniform. The canopy stratas consisted of two layers, layer with a height about 20 – 30 m (strata B) and canopy layer with tree height 4 up to 19 meters (strata C) [5]. Stand structure defines the condition of growth and development of stands in a forest area, in which the structure of the stand can be seen based on the height of canapoy as well as level of species density.

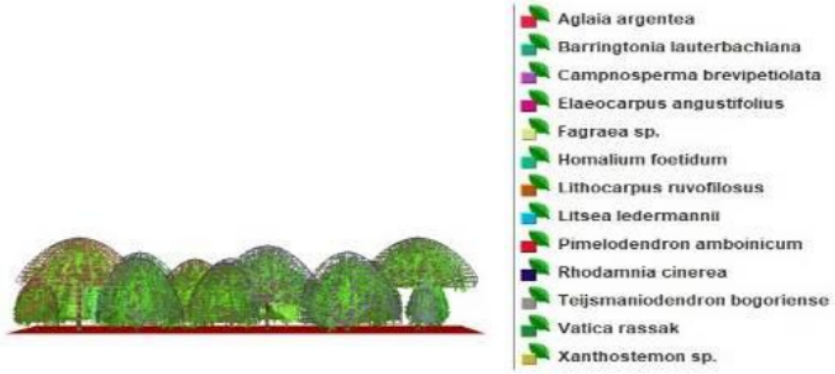

Figure 5 Stand Structure of the canopy strata in the hot spring water Momiwaren

Canopy stratification is closely related to dominance of a stand on its habitat, which is influenced by the amount of sunlight energy, availability of ground water and mineral nutrient required by plants to grow. Several species belonged to stratum C were *Aglaia argentea, Barringtonia lauterbachiana, Campnosperma brevipetiolata, Elaeocarpus angustifolius, Fagraea* sp, *Homalium foetidum, Lithocarpus ruvofilosus, Litsea ledermannii, Pimelodendron amboinicum, Rhodamnia cinerea, Teijsmaniodendron bogoriense, Vatica Rassak,* and *Xanthostemon* sp. While *Pometia acuminate* and *Intsia palembanica* were generally high and included in stratum B.

Generally, structure of forest layers formed was a result of plants reaction to the enviroment, which possibly occurred due to differences in the ability of plants to absorb solar energy, nutrients and water as well as character of an individual plant to compete with the others. Moroever, the condition of study site which is flowed by hot water that contains sulfur had caused the structure of vegetation around the site was quite diverse.

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Papua's forests have a very complex natural forests' structure due to natural disturbance that occurs to old trees. This condition thus has created a gap or open space in the forest. As a result, seedlings and juvenile trees that have been mostly depressed due to lack of growing space will immediately grow to fill the gap or open space in the forest. The condition will possibly also develop a combination of new plants in the area [10].

The level of dominance of a species in the community extremely impacts the formation of vegetation structure in an area. Species that has the largest Importance Value Index (INP) is considered as the most dominant species, which means the species is more adaptable and suitable in the growing area than other species. In the forest communities, certain species are more dominant than others as a result of competition in nature. Tall trees from the top stratum (layer) will dominate and suppress the lower trees which they ultimately will characterize and determine the surrounding forest community [5].

4. Conclusion

Vatica rassak and Pimelodendron ambonicium are species that dominate the location of hot spring water in the Momiwaren protected forest area. The Diversity Index of sampling and pole phases showed high value of species diversity in the location. The species abudance was particularly found in sampling phase. If we viewed the structure layers of forest area which forms stands along the Momiwaren hot spring water, we found that the forest was composed by two strata, strata B and C.

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