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Floristic and Soil Characteristic at The RPH Sentul-Probolinggo Protected Low Land Forest, East Java

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A B S T R A C T

East Java's forest has a less ideal area based on predetermined requirements. Therefore rehabilitation was done to meet these requirements and to improve the quality of existing forests. This research was conducted to identify the character of protected forest in *Resort Pemangku Hutan* (RPH) Sentul area, about vegetation structure and abiotic factor of lowland forest area with low rainfall. The research was conducted by explorative method with plot making for tree plant, sapling and ground cover to inventory and determine the forest vegetation structure inside the area, also by measuring the environmental parameters (temperature, humidity and light intensity) and making soil sampling to analyze biophysical condition. Data were analyzed descriptively both on vegetation condition and physical condition of land and its environment. The result showed that there were identified 84 species from 39 plant families either as trees, sapling or ground cover, with species of Moraceae as the largest contributor. The diversity index of the three types of vegetation shows a medium categorized, while the index of evenness indicates a good categorized that is close to one. Based on the existence of exotic species, especially on ground cover, within protected forest areas, this area has been degraded although not large. However, the physical condition of the soil and environmental conditions in the forest still indicate that this area is still quite good when used as a reference area on rehabilitation program with similar geographical conditions.

1. Introduction

Forest is an environmental services provider that utilized by all other organism, especially humans. Several categories of environmental services provided by forests based on the Millennium Ecosystem Assessment (2005) include provide clean water, regulate microclimate within the area, habitat for various fauna, as well as recreational areas. In addition to these environmental services, there are many other functions of forest that make forests as an important area to continue to be preserved.

Based on the East Java Forestry Official report on 2012, forest area in East Java was about 28% of the total land area, which is below the ideal forest criterion as mandated in Forestry Law No. 41 of 1999 which is told that the ideal forest area is 30% when compared with the land area. Given that the existing forest area in East Java is still below the ideal standard required, conservation efforts must be maximized in addition to rehabilitation efforts against critical areas or vacant lands. It is based on the forest is a source of natural wealth that gives great benefits for human life both ecological, social, cultural and economic, therefore sustainability must be maintained (East Java Forestry Official, 2012).

East Java lowland forest have largely shifted their function to both residential and agricultural areas. Several rehabilitation efforts undertaken on either degraded forest areas, or vacant land to be reforested resulted to be less than optimal. It is only small number of research were held in remaining lowland forest on the Java island, especially East Java, which can serve as a reference area for rehabilitation activities undertaken by the government or non-governmental organizations, the remaining forest and research mostly located in the mountain. While East Java has Brantas Watershed area with wide area covering from low to

high altitude which the forest area need to be preserved for its sustainability (Fiqa *et al*., 2005).

The Sentul RPH protected forest, which is under coordination of Perhutani, is an example of a lowland forest area that still can be used as a reference for areas to be rehabilitated in the lowlands, especially in East Java. Thus, this research is important to be held. This research was held to find out the structure and diversity of vegetation and also the supportive abiotic factor in the natural forest at the foot of Argopuro Mountain at an altitude of <800 m asl.

2. Materials and Methods

2.1. Study Site

This research and vegetation survey was conducted in the RPH Sentul Protected Forest Forests, which is under the administrative area of BKPH Bermi, KPH Probolinggo. This research is focused on area 7b and 9c which have an area of approximately 80 ha each, about 10% of the total protected forest, with relatively low rainfall, about 215 mm / month. These plots are located in Rabunan Village, Batur Village, Canggaan Block, Probolinggo Regency (Figure 1).This two area were chosen due to their condition that represents the whole condition of protected forest which are sloping in some places and steep hilly in other areas. Moreover, this area also located at altitudes not more than 800 m asl which is suitable as an vegetation plot.

2.2. Vegetation analysis

Vegetation observation was done by plot method based on structure, which is 20m^2 for trees, 10m^2 for sapling and 2m^2 for groundcover (Soerianegara and Indrawan, 1982). Plot located at the protected forest in the selected area above (Figure 2). Observations were made on a total of 27 plots of vegetation structure. Vegetation structure was analyzed by measuring several parameters, such as species diversity index and index of evenness. Vegetation stratification data in both types of area were obtained from height measurement and plant height diameter at plot and inventory of each species.

2.3. Abiotic factor

Beside the vegetation, environmental parameters such as temperature, light intensity and humidity were also observed. Temperature and humidity was measured by using thermos-hygrometer, while light intensity was measured by luxmeter. In addition for soil quality, soil samples were taken from the observed plots, for measuring the organic matter content, the soil density, bulk density, soil porosity, and the soil class. Soil samples were taken by ring methods in 0-20 cm depth, while soil sample for the organic matter was taken by disturbed soil method. Soil analysis was conducted in the laboratory after field observation was finished.

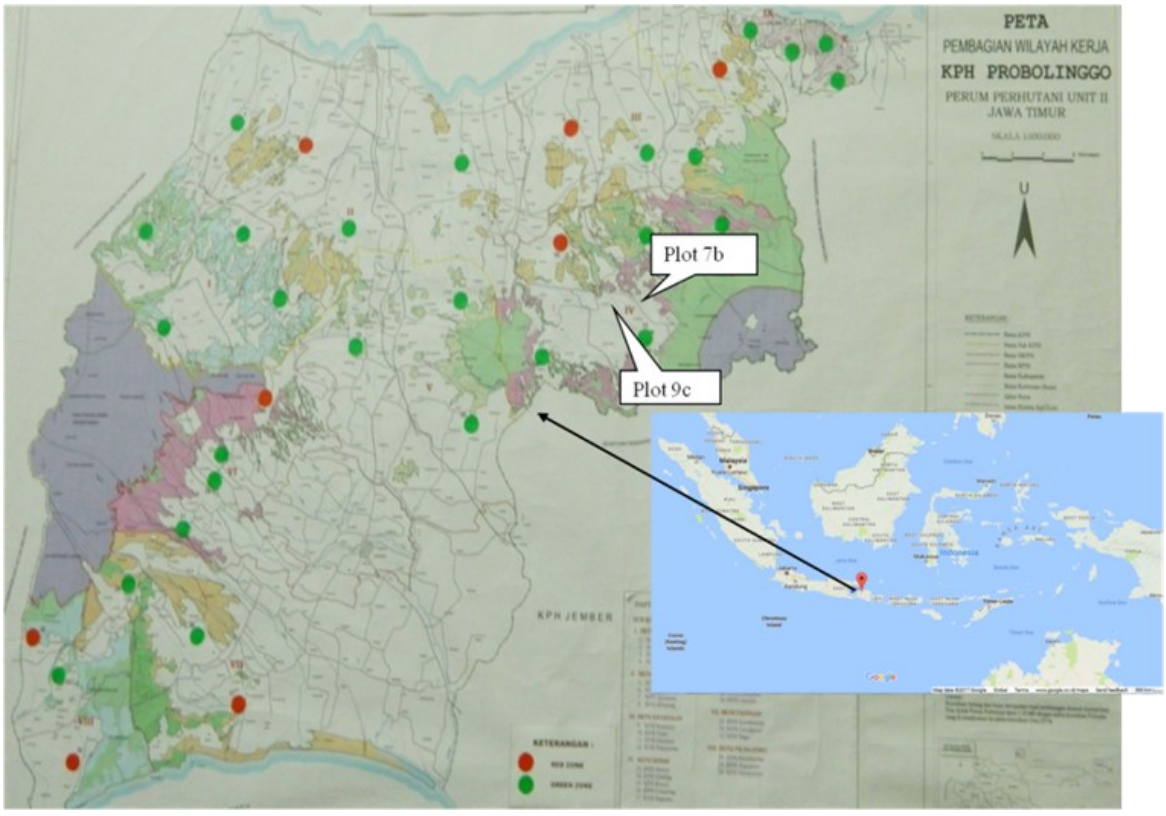

Figure 1. Study Site, RPH Sentul, Bantur Village, Gading Distrct, Probolinggo

Figure 2. RPH Sentul protected forest vegetation cover

2.4. Data analysis

Vegetation quality was analyzed by several indexes, which is Important Value Index by add up the Relative Density (RD), Relative Frequency (RF) and Relative Dominance (RDm) to determine the most influential species in the area. Shannon-Wiener diversity index (H'), with formula where pi is relative abundance of each species calculated as the proportion of individuals of a given species to the total number of individuals in the community to know the vegetation diversity quality in the protected forest. Analysis was also done by measuring the Evenness Index (E'), where S is a number of species which was found during the observation. This index was design to define is there any dominancy in the observed area. The index of species richness (R'), R'=(S-1)/ln(ΣK) with S is the number of species and ΣK is abundance of all species. This index is determined to define the species richness in the area.

Soil physical data and other environmental factors were tabulated and analyzed statistically as complementary information. All data were analyzed descriptively to know floristic characteristics and other abiotic factors in lowland natural forest area in East Java.

3. Result and Discussion

3.1. Floristic Composition

The Sentul protected forest has diverse local plant species that can be seen from its diversity index. Trees index reaching 3.02 which are in medium category (Figure 3). This condition is similar with the Shannon-Wiener diversity index in Sempu Island Nature Reserve (SINR), which is on scale medium with average value value 2.59. The condition in Bawean Island Nature Reserve (BINR) showed different result, research reported that Shannon-Wiener diversity index for trees is categorized as high with value more than 4. Sapling and groundcover in the protected forest had the same category which is medium and similar with SINR with value 2.70 for sapling and 2.13 for ground cover (Abywijaya, 2014; Trimanto, 2014).The level of vegetation diversity is an important parameter in an ecosystem, the more diverse the species in an ecosystem, the better and more stable the ecosystem (Isbell *et al*., 2011; Turner *et al*., 2013; Wu *et al*., 2013).

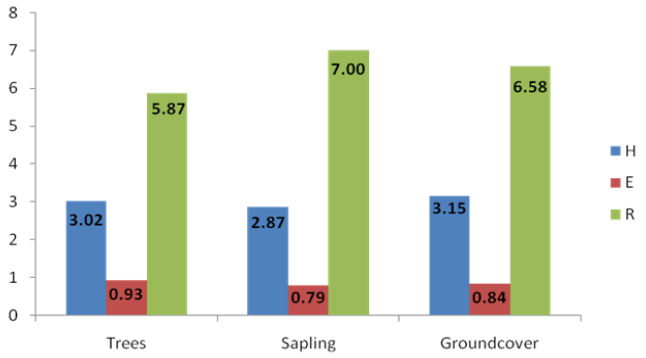

Figure 3. Diversity index of Shannon-Wiener and evenness index of Pielou's in the RPH Sentul Protected forest

However, Evenness Index both in Probolinggo (trees: 0.93; sapling: 0.79; ground cover; 0.84) and SINR (trees: 0.9; sapling: 0.85; ground cover: 0.87) showed no domination, can be seen from the value that close to 1 both on trees, sapling and ground cover. Low land Java's forest based on Whitten et al., (2000), characterized by no domination of certain plant species, but could be recognized by the presence of *Artocarpus elaticus*. *Artocarpus elasticus* in this protected forest was found as a tree (emergent tree) and also found as

sapling. Species richness on Sentul protected forest in all vegetation type showed high with value >5, better than in SINR which has moderate categorized on sapling while in the other two type vegetation is high. Species richness, evenness and diversity index are categorized based on Magurran, 1988.

Thus, RPH Sentul protected forest still have good quality since its show no significant different vegetation quality with the SINR, however BINR has the highest quality of vegetation. As an illustration, BINR Reserve is hilly, mountainous and bumpy, with elevation between 5-75%. Such a condition makes the vegetation of Bawean Island untouched by humans so that its preservation approaches the original forest (Trimanto, 2014).

The highest Family composing RPH Sentul protected areas is Moraceae, which is consist of seven species, followed by Euphorbiaceae, Urticaceae and Asteraceae in the same number, which is six species. All of them were found in the form of trees, saplings and groundcovers, except for Asteraceae which only exist in the form of ground cover (Figure 4). All of the Moraceae family found in the area is a local plant that characterized lowland forest in Java. From six species which is found in the area, most of them are from Ficus Genera and the other are two species is *Artocarpus*. There are totally 39 family in the protected forest area.The highest Family diversity, which is more than 50% from total family diversity, is contributed by ground cover. This number is lower than Family number found in Dipterocarpaceae forest in Borneo which is found about 77 Family and about 363 genera (Silk *et al*., 2003), and also in Sulawesi which is reported that there are 41 Family found in 1 ha area study (Kessler *et al*., 2005).

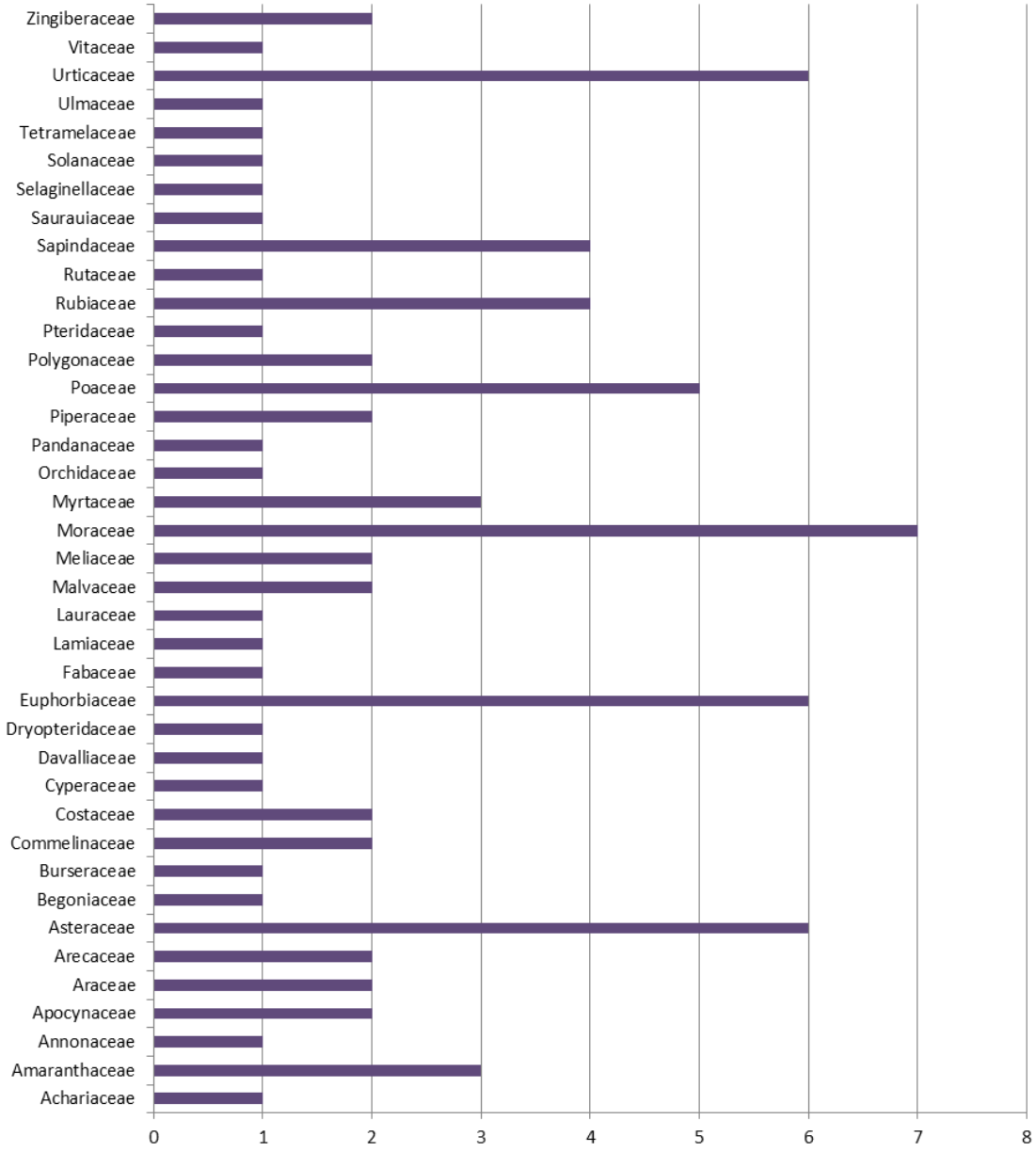

Figure 4. Family Composition in the RPH Sentul Protected Forest

In the protected forest area, an emergent tree is still found to be typical of primary forest with the species encountered, among others, *Artocarpus elasticus* and *Dysoxylum gaudichaudianum* (Table 1). Both are characteristic of Java lowland forest that is found also in protected areas such as in water sources in the Brantas watershed area, in addition, it is also found *Garuga floribunda* whose existence is mentioned as a feature of primary forest with a dry season that lasted for two to four months per year (Whitten *et al*., 2000; Fiqa *et al*., 2005).

Table 1. Vegetation Stratification System in the RPH Sentul Protected Forest (Darmayanti and Goni, 2016)

Strata	Species
Strata A	*Dysoxylum gaudichaudianum, Ficus glabela, Artocarpus elasticus*
Strata B	*Litsea glutinosa, Syzygium acuminatissimum, Bischofia javanica*
Strata C	*Coffea robusta, Garuga floribunda, Microcos tomentosa*
Strata D	*Artocarpus heterophyllus, Polyalthia lateriflora, Ficus septic*
Strata E	*Asplenium nidus, Oplismenus composites, Elatostema repens*

Based on research by Darmayanti and Goni, 2016, plants in RPH Sentul on plot 7b and 9c were plants with various strata, strata A to E. An area sheltered by various strata has abiotic value of land categorized as moderate until good. This is because the various plants that live in it share each other's roles. Some act as supporting slopes, groundwater binders, soil protectors from run-offs, and soil protectors from rainfall droplet (Darmayanti and Goni, 2016). Bulk and soil density are either caused by the indirect rain fall of the soil, but slowly and gradually fall through the branches of trees. Trees that had large branches and wide canopies found in Sentul RPH are *Syzygium polyanthum* and *Schleichera oleosa*. Describe in Darmayanti and Fiqa, 2016 that both of these plants had a high enough interception due to the wide canopy and the first branching not too far from the ground. Various types of *Ficus* mostly also have the dense, rounded canopy and gracefully drooping branches weeping (Gilman, et al., 1993; Halle, et al, 1987). Coffee is also a lot of shading area is a tree with the type of roux architecture, where the trunk of roux model is a monopodial orthotropic axis which shows continuous growth, the plagiotropic branches are inserted continuously. The enclosed canopy is good for avoiding falling rainwater hard enough (Park and Cameron, 2008; Motisi and Reffye, 2015)

Even though this forest area is protected forest areas, in fact these area have also been degraded. Some trees in the forest are known to be exotic plants such as *Alectryon serratus*, *Erithrina subumbrans* and *Aphanamixis polystachia*. Some non-local plants are also found in sapling vegetation type and ground cover. All of species from Asteraceae are exotic plant who invaded the protected forest. The existence of exotic plants in the composition of flora in an area also indicates the environmental quality of an area. Ground cover plants are the most easily visible indicator, when exotic species intervention has been observed there is an indication of the change in environmental quality in it (Sutomo and Fardila, 2013). The existence of exotic species in the forest is the consequence of the degradation of the ecosystem (Hakim and Miyakawa, 2013).

Vegetation analysis in the protected forest shows the existence of intervention from exotic species, although the value is not too large (Figure 5). Ground cover has the highest exotic species composition, while tree is the lowest.

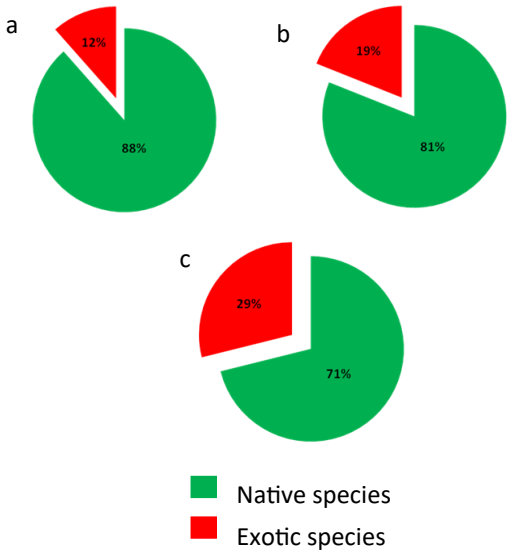

Figure 5. The composition of native and exotic species of RPH Sentul Protected Forest in every vegetation type, a). Trees, b). Sapling, c). Ground cover

Commelina nudiflora is one example of exotic ground cover species with relatively high IVI neither but nor the highest, whereas *Debregeasia orientalis*is an exotic plant that has the highest IVI for sapling vegetation type. *Erythrina subumbrans* is an example of exotic tree species with low IVI. IVI can be used as a quantitative parameter to describe the dominance of a plant species in its community (Indriyanto 2006). Dominant plant species have high IVI values. Plant species of seedlings and sticks with IVI ≥ 10% or trees and trees with IVI ≥ 15% can be said to have a role in the community (Rosalia 2008). IVI plant species that have

Table2. Species found in RPH Sentul protected. Species shown are ten numbers with highest IVI

Category	Species	Family	Local Name	IVI
Tree	*Litsea glutinosa*	Lauraceae	Po ketek	22.068
	Debregeasia orientalis	Urticaceae	Deng udengan	18.819
	Coffea robusta	Rubiacee	Kopi	17.578
	Pangium edule	Achariaceae	Pakem	17.378
	Bischofia javanica	Phyllanthaceae	Gintungan	17.291
	Ficus variegata	Moraceae	Gondang	15.306
	Ficus calosa	Moraceae	Lat ilatan	14.1573
	Dysoxylum gaudichaudianum	Meliaceae	Kedoya	12.708
	Ficus glabela	Moraceae	Iprih	12.288
	Microcos tomentosa	Malvaceae	Ras berasan	11.609
Shrub	*Debregeasia orientalis*	Urticaceae	Deng udengan	32.603
	Elatostema repens	Urticaceae	Kekerlak	20.317
	Litsea glutinosa	Lauraceae	Po ketek	18.372
	Coffea robusta	Rubiacee	Kopi	16.996
	Trema orientalis	Ulmaceae	Angrung	12.434
	Pilea melastomoides	Urticaceae	Poh-pohan	11.695
	Forrestia marginata	Commelinaceae	-	11.167
	Garuga floribunda	Burseraceae	Beruh	10.726
	Macaranga javanica	Euphorbiaceae	Totop	10.416
	Heckeria peltata	-	-	9.206
Ground Cover	*Syzygium sp*	Myrtaceae	Jambu	23.940
	Polygonum chinense	Polygonaceae	Aseman	23.940
	Antidesma bunius	Euphorbiaceae	Buni	9.576
	Trema orientalis	Ulmaceae	Angrung	9.576
	Piper cobubracteum	Piperaceae	-	9.576
	Ctenitis crenata	Dryopteridaceae	Manggi	9.576
	Psychotria angulata	Rubiaceae	-	9.576
	Selaginella plana	Selaginellaceae	Cakar ayam	9.576
	Laportea stimulans	Urticaceae	Pulus	9.576
	Ficus septica	Moraceae	Barabar	9.576

a role in community in RPH Sentul Probolinggo are presented in Table 2.

The tree density of RPH Sentul protected forest is fairly high, which is about 400 trees per ha. Trees density is categorized as high when the value is more than 30 trees per ha (Pagiola *et al*., 2004). Sapling and ground cover density is much higher than trees which is 16,163 per ha and 36,356 per ha respectively (Figure 6). Floristic structure and composition in the RPH Sentul protected forest showed that this forest is still in the good condition although not perfect ideal, especially with the presence of exotic species interventions within the region. Trees with a height exceeding 25 m are still common although in a small species diversity. Trees diameter that reach one meter or more are also still found in many areas there are *Dysoxylum gaudichaudianum*, *Pangium edule*, and *Bischofia javanica*as an examples. Natural forests are generally in fairly good condition, with relatively high densities and with large trees in the big number (Mirmanto, 2010).

3.2. Abiotic Factors

The altitude affects on the air temperature and the light intensity. The higher altitude, the lower temperature and light intensity. Daily average temperature, light intensity and humidity in the forest are 29.4°C, 947 Lux, and 79.60% respectively. This value almost similar with the condition in West Java limestone forests, although with different rainfall and soil class (Satyanti and Kusuma, 2010). East Java tends

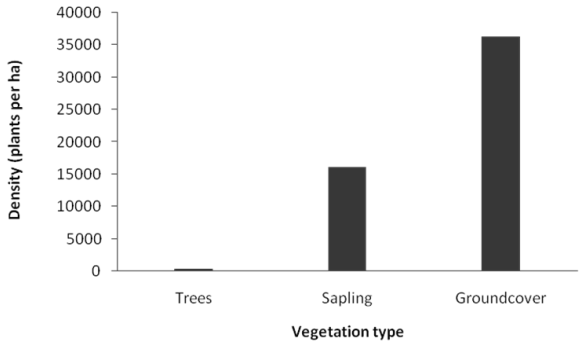

Figure 6. Plants density in the RPH Sentul protected forest

to be drier when compared to other areas of Java, with temperatures ranging from 24°-33°C (Whitten *et al*., 2000).

The result of observation on the abiotic condition (Table 3) of the area obtained the value that the water soil content in the research area is quite big, that is 44.89 $g.g^{-1}$, even more than the water soil content in Cangar forested area (Yulistyarini & Fiqa, 2017). This indicates that the presence of plants in RPH Sentul has more characteristics as water storage than plants in Cangar forested forest. This great value is strongly influenced by the porosity of the land whose value is 49.12%. Soil porosity is influenced by organic matter content, soil structure, soil texture, and bulk density. Soil porosity is high when organic matter is high (Hardjowigeno, 2003). However, the content of soil organic matter this time is low (3%), the possibility of this large porosity is influenced by the heavy weight of the soil / bulk density is low enough that is 1.03 $g.cm^{-3}$. Bulk density is a clue of soil density. The more dense a land the higher the bulk density, the more difficult it is to continue the water or penetrate the roots. In general, bulk density ranges from 1.1-1.6 $g.cc^{-1}$ (Hardjowigeno, 2003). The content of clay on the ground of RPH Sentul is rather high followed by dust content so it is categorized as dusty-clay soil. In clay soil, micro pores play a role and low water conductivity so that infiltration ability decreases (Hidayah *et al*., 2001). Root plant activities such as the formation of cracks increase the number of soil pores so that percolation improves

Soil conditions in forest areas are classified in dusty-clay, with high soil and bulk density values compared to natural forests in the Pujon area (Prasetya *et al*., 2014), but almost the same as restored forest in Cangar (Yulistyarini and Fiqa, 2017). Cangar reforested area has the same soil class that is dusty clay, but has bigger soil porosity and soil organic matter, however it has lower soil water content.

Table 3. Abiotic parameters value in the RPH Sentul Protected Forest

Soil Parameters	RPH Sentul Protected Forest
Soil organic matter	3.02%
Water soil content	44,89 $g.g^{-1}$
Bulk density	1,03 $g.cm^{-3}$
Soil density	2,18 $g.cm^{-3}$
Soil porocity	49,12 %
Soil Class	dusty-clay

4. Conclusion

RPH Sentul protected forest is the example of Java lowland forest with low rainfall. There is no domination in the floristic structure of the forest that could be seen from the evenness index. The diversity index both of trees, sapling and ground cover are categorized as medium. The exotic species already existed in the area, even though in the small number. Family plant found in the area such as Moraceae, Urticaceae and Euphorbiaceae, is the native species commonly found in the Java low land forest. The complete forest strata and the abiotic factor shown that this protected forest is a good example for the rehabilitation in the East Java low land area to get at least the same quality or even better forest.

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