The Characteristic of Teak Growing in Three Areas (Mine, Non-Mining, and Ex-Mining) Forest Management Unit Parengan Bojonegoro, Indonesia

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Abstract. Bojonegoro Regency has an oil mining location where it is estimated that Indonesia's crude oil reserves are 25 % of national needs. The location is in Forest Management Unit (*Kesatuan Pengelolaan Hutan* - KPH) Parengan which has a teak forest (*Tectona grandis* L.) with a very close oil mining radius. The aim of the research is to determine the differences in the characteristics of teak growing places and to determine the types of petroleum fractions in active oil mines, former oil mines and those without oil mines. The research method uses a circle plot (17.8 m) with a Sampling Intensity (IS) of 20 % with data analysis results using a one sample test and a Least Significant Difference (LSD) alpha test of 5 %. The characteristics of the teak growing area at each location have different values for height, P content, C content, number of oil fractions and temperature. The types of petroleum fractions in active oil mines are naphtha, kerosene, fuel oil and wax. Ex-oil mines contain gasoline (premium), kerosene, aviation fuel, light gas, fuel oil, lubricating oil, wax and asphalt. In locations without oil mines there is kerosene, aviation fuel, gasoline (premium) and light gas.

Keywords: Mine pollution**,** polluted landscape, *Tectona grandis* L.

1 Introduction

Ecosystems include various kinds of natural relationships in the forest, the atmosphere from the canopy to the bottom, namely the soil layer that is influenced by the roots and nature [1]. The problem is the development of the times in the 21st century and along with the increase in human population. Forests are important to manage their natural resources to maintain community needs while maintaining the function of ecological systems [2]. Humans play a role in forest management. However, in the context of anthropogenic

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influences on the research area [3]. Forest lands are increasingly threatened by anthropogenic activities. Thus, between 1984 and 2019, the proportion of forest in the landscape has decreased markedly. In addition, the problem of forest management has adverse impacts such as carnivores in the Atlantic Austral forests [4] and birds in the tropical thorn forests of Punjab Pakistan [5] forest land use and changes land cover [6]. Various consequences that are accepted as a result of anthropogenic activities that need to be studied. One of them is the use of productive areas with activities where previously managed forest land has the potential to add oil to the area. This case occurred in the area of Forest Management Unit (*Kesatuan Pengelolaan Hutan* - KPH) Parengan. There are several active and former oil mines in the area. This is an interesting study material where teak forests grow in the area. The causes of decreased plant growth in areas contaminated with mining activities have been studied [7].

Based on the analysis of the problems above, studies on mining, ex-mining and non-mining areas need to be carried out. This study has several objectives, among others, to determine differences in the characteristics of teak (*Tectona grandis* L.) growing sites in active oil mines, ex-oil mines and mining mines and to determine the type of petroleum fraction based on teak growing sites in active and ex-mining mines oil and without oil mining in the KPH Parengan Bojonegoro area, East Java, Indonesia.

2 Methods

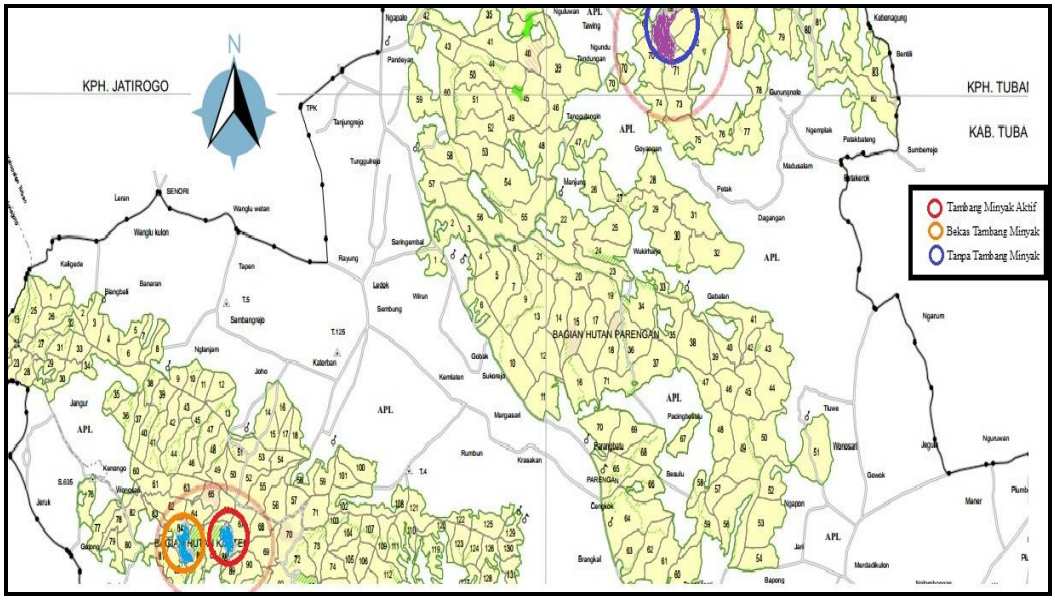

Fig. 1. Forest area map forest management unit Parengan.

2.1 Plotting and number of plots

The form of a circular plot (r = 17.8 m) with a Sampling Intensity (SI) of 20 % based on the consideration of plot area. The formula for determining the number of plots is as Equation (1) [1].

$$n = IS \times N \quad (1)$$

Where,

n = Number of sample units (plot)
IS = Sampling intensity (%)
N = Number of population units

From this formula it can be seen the number of sample units (plots) needed. The number of plots in each plot is based on IS, *i.e.* location (M = Mine, EM = Ex-Mining and NM = Non-Mining). M has two plots, location EM has five plots and location NM has four plots. This plot is used for measuring plant height, sampling points of soil and roots. Determination of the location of the plots in each plot is carried out by purposive sampling with the provision of slopes that can still be reached.

2.2 Sampling

Soil sampling was carried out in a composite manner for each sample taken from five different points on the circular plot. The total soil samples tested were three samples (M = Mine, EM = Ex-Mining and NM = Non-Mining) and each soil sample was extracted to separate the oil from the sample. In addition, soil samples were used to analyze the content of N, P, K, C-Organic and to determine the presence or absence of oil content in the soil at that location.

Root samples were taken using a shovel in the soil and cut the root fibers 15 cm long. Three root samples were taken from each location, so the total number of root samples was nine which would then be extracted to separate the oil. The sample was analyzed for the type of oil fraction using the GC-MS Shimadzu QP 2010 tool (made in Japan). The operation was carried out by programming the temperature from 80 °C to 210 °C at 4 °C min^{-1} for 2 min, then a temperature of 210 °C to 300 °C at 15 °C min^{-1} for 5 min and temperature final hold for 20 min [8].

Measurement of pH using a soil tester is done by cleaning the soil surface from litter and then inserting the soil tester into the soil until the iron barrier is covered with soil and then seeing the results on the needle on the surface of the tool. Soil temperature was measured using a thermometer which was directly inserted into the soil surface and then observed the results on the device. The height of teak as measured in each plot using a haga meter, determining a tree with a fairly good height as the central tree and then measuring the height of all trees included in the plot.

2.3 Research variable

The variables measured in this study included pH, temperature, height, oil content in the soil, oil content in roots, total oil fraction and N, P, K, C content in the soil. Temperature and pH were measured using the Soil Moisture pH Meter Tester VT05. The height of the teak was measured using a Haga Meter. Analysis of the oil contained in the soil and teak roots was analyzed using GC-MS Shimadzu QP 2010 [8]. Soil C-organic was measured using the Black and Walkey method; total N was measured according to the Kjeldahl method; available P was measured by the Bray-1 method; K was measured using the 1 N NH4OAc extraction method [9].

2.4 Data analysis

Analysis of the data used in this study is Analysis of Variance (ANOVA) and the further test used is the Least Significant Difference (LSD) alpha test of 5 % to compare between treatments whether the value of each dependent variable is the same or not. Least

Significant Difference test was chosen because it adjusted to the number of treatments, namely a maximum of less than the same as three treatments.

3 Results and discussion

Based on the results of the analysis (Table 1) with data that has been carried out on plant height, temperature, pH, soil chemical properties (P, C, N and K), oil content in soil, and oil content in roots.

Table 1. ANOVA test results soil temperature, soil pH, oil content (roots and soil).

Location	Teak height (m)	Root oil (%)	P (mg L^{-1})	C-organic (%)	N (%)	K (Cmol (+) kg^{-1})	Soil oil (%)	Soil temperature (°C)	Soil pH
Mine	9.16b	1.09a	8.00b	1.07a	0.02a	0.09a	0.29a	30.00a	5.00a
Ex-mining	8.85a	1.02a	6.00b	0.91a	0.01a	0.10a	0.23a	31.00a	5.00a
Non-mining	11.33b	0.58a	3.00a	4.29b	0.02a	0.11a	0.05a	34.00a	7.00a

The height of teak plants from the different locations of active, ex-mined and non-oil mines showed significant differences. Plant growth shows the criteria for the plant to grow well. The characteristics of the place to grow become an important factor for plant growth. Teak growth is also supported by external conditions, namely the environment where temperature is one of the supporting factors for good tree growth. The results of the analysis in Table 1 show temperatures that have significant differences. Soil temperature here is related to humidity where the higher the temperature, the lower the humidity and vice versa. M and EM sites have significant differences from NM sites. Optimization of soil moisture that affects teak physiology [10]. While the soil pH was not significantly different, the pH in the M and EM areas had a pH of 5 acid where measurements in the area studied by Enya *et al*. [11] with a pH value of 5.7 classified as acidic. In soil conditions that contain heavy metals such as EM and M, the pH of the soil is acidic as the data measured and studied by Jia *et al*. [12].

The P content in the M and EM areas was significantly different from that NM. In land areas that contain heavy metals such as mines and ex-mining it is possible for P nutrients to survive in these conditions based on research conducted by Huang *et al.* [13] shows that P and N nutrients can survive in heavy metal conditions so that they can restore plant conditions in areas where the land is contaminated with heavy metals. However, nitrogen requires several factors that can support the amount of nitrogen in the soil, namely water availability and soil microbes [14]. Nitrogen has a function, the presence of organic nitrogen in the soil has a positive impact on accelerating the degradation of organic pollutants [15]. The application of biochar can maintain the presence of N and P in contaminated soil, but you need to pay attention to the amount of biochar applied [16].

C-organic in the soil is affected by the condition of heavy metals in the soil, based on research findings Enya *et al.* [11] in the treatment dose of soil administration (low, medium, and high) and control there are differences. These results support the finding that there are significant differences in the M, EM and NM areas where the M and EM areas are significantly different from the NM areas.

Table 1 shows that based on the Indonesian Soil Research Center, Bogor, the soil in the research area is categorized as low fertility and very low in nutrients N, P, K, and C organic [17, 18]. However, C-organic in non-mining is classified as high. This condition requires a more detailed study.

The oil content in the three areas (root and soil) is shown in Table 2. The oil content in M area is naphtha, kerosene, fuel oil and wax. In EM area there are gasoline, kerosene,

avtur, light gas, fuel oil, lubricating oil, wax and aspar oils. While in NM area, there are kerosene, avtur, gasoline and light gas. Of the three locations, the ex-mining area has the highest type of oil content compared to others.

Table 2. Oil content at mine, ex-mining and non-mining sites.

Location	Oil content
Mine (M)	Naphtha, kerosene, fuel oil, wax.
Ex-mining (EM)	Gasoline/premium, kerosene, avtur, light gas, fuel oil, lubricating oil, wax, asphalt.
Non-mining (NM)	Kerosene, avtur, gasoline/premium, light gas.

4 Conclusion

Characteristics of growing places for teak at locations A (active oil mine), B (former oil mine) and C (without oil mine) have different values for height, P content, C content, amount of oil fraction and temperature. The best height growth of teak stands is at location C (without oil mining). The types of petroleum fractions found at location A (active oil mine) are naphtha, kerosene, fuel oil and wax. At location B (former oil mine) there is gasoline (premium), kerosene, aviation fuel, light gas, fuel oil, lubricating oil, wax and asphalt. At location C (without oil mining) namely kerosene, aviation fuel, gasoline (premium) and light gas. The highest oil content is at location A (active mine) where it is found in the soil and absorbed by teak roots.

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