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THE ABILITY OF TREE IN ABSORBING CARBON DIOXIDE EMISSIONS IN THE CAMPUS OF UNIVERSITAS NEGERI SEMARANG

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Abstract

The existence of carbon dioxide (CO_2) in the atmosphere and global temperatures continues to increase. Plants, especially trees, are known as the main regulators of global climate and have played an important role in climate change mitigation. The purpose of this research is to identify the pattern of tree distribution and analyze the absorption of trees against carbon dioxide emissions on the UNNES campus. The research was conducted at the UNNES campus, with mapping units in 8 Faculties and one Postgraduate Campus. Qualitative research was applied in this study with a phenomenological approach. The focus of the study was on tree distribution patterns and tree absorption capacity of carbon dioxide. The results showed that the distribution pattern clustered on the western side of the campus, while the existence of trees on the eastern side of the campus was not as much. Distribution data in faculties and work units showed that the dominant tree distribution was in the Rectorate area with 54 species of trees totaling 4534 trees. Absorption of trees per faculty showed that the largest absorption capacity of trees was in the type of trembles *tree, mango, and mahogany that were often found in the Faculty of Sport Sciences with emission absorption of 42% or 2,646,253.41 kg/year. There were many academic activities on the UNNES campus and were supported by electronic equipment.*

Keywords: *tree distribution, tree absorption, CO2 emissions, the ability of tree*

1. Introduction

In the last few years, the world has always been worried about the issue of global warming which is increasingly serious. One of the driving factors for global warming is the increasing accumulation of carbon dioxide gas emissions in the atmosphere. According to Kiran and Kinnary (2011), carbon dioxide is the most significant contributor to Greenhouse Gas (GHG) emissions because it is directly related to human economic activities. Global warming is one of the impacts caused by the increasing activity of greenhouse gases. As a result of the accumulation of the number of greenhouse gases that trap these radiation waves, some of the heat that should be reflected in the atmosphere is trapped on earth (Pane, et al, 2016).

The bad air of Semarang is justified by the Head of Air Pollution Control, Solid Waste, and Hazardous and Toxic Materials, *BPLH* Central Java, Adiyanto. This refers to the results of air quality measurements conducted in the middle of last year in the densely populated area of Semarang. In a dense area on Jalan Kali Gawe, then Terboyo Terminal shows 299.8 per gram of cubic Nano. However, the normal threshold is 230. The threshold follows Governor Decree No. 8/2001 concerning air quality in Central Java Province. This means that air quality in Semarang is quite bad(Herawati, 2013). The impact can be affected by Acute Respiratory Infection(ARI) if exposed to dangerous toxic materials, for example,heavy metals. Overtime can be dizzy and poisoned, therefore efforts to clean air quality in Semarang continue to be done. For example, by requiring to plant trees starting from the family environment. Including the car-free day program which is implemented once a week.

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The more congested motorized vehicle is, the more it will impact on the higher level of air pollution in an area. The impact of air pollution through exhaust gases seems to have received the attention of various parties. State Minister for the Environment through Decree No. 35 of 1993 also stipulates the limits on exhaust emissions. The decree stated that the threshold of motor vehicle exhaust emissions is the maximum limit of substances or pollutants that may be removed directly from the exhaust pipe of motor vehicles. Article 2 of the Ministerial Decreestated that the CO (carbon monoxide) content for a 2-step motorbike fueled with octane number 87, is determined to be a maximum of 4.5% and 3,000 ppm for HC (Karianda, 2011).

UniversitasNegeriSemarang (UNNES) isan institution of higher education thathas a vision of conservation and international reputation.Semarang State University Regulation, Number 6 of 2017, on Conservation of UNNES states that the spirit of conservation is supported by 3 pillars, namely: values and character, arts and culture, natural resources and the environment. In the pillars of natural resources and the environment, among others regulating the presence of clean energy on the UNNES campus, related to energy saving and wise use (Setyowati, 2019)

The UNNES campus, which is surrounded by several types of habitats, such as forests, rice fields, fields, mixed gardens, and settlements, has a relatively high level of biodiversity in the form of flora and fauna. The main benefits of biodiversity are ecological functions and productive functions. This ecological function must be conserved. The growth of new buildings is inevitable, as a consequence of the service to students who are accepted every year as the main subjects of campus functions. No less than 7500 new students were accepted by UNNES, with the total number of active students around 36,600 (Prihanto, 2018).

Land use in UniversitasNegeriSemarang, in general, is divided into two,which are Green Open Space (RTH) and Building Land. Land use in the form of green open space is383,633.55 m2 or 71.98% of the total land use in UNNES. Land use in the form of buildings has an area of 149,302.21 m2 or 28.01% of the total land-use area.

Based on the problem of increasing carbon dioxide gas emissions, accompanied by supporting facts of UniversitasNegeriSemarangas a campus in a big city but committed to environmental conservation, researchers are interested toconduct a research to determine the ability of trees to absorb carbon dioxide emissions in the area of UniversitasNegeriSemarang.The objective to be achieved is to analyze the pattern of tree distribution and analyze the absorption of trees against carbon dioxide emissions on the UNNES campus.

2. Research Methods

The location of this research was within the campus of UniversitasNegeriSemarang, with mapping units in 8 Faculties and the Rector's Area. Qualitative research was applied in this study with a phenomenological approach. The focus of the study was on the distribution pattern of trees and the absorption of trees against carbon dioxide emissions.

The data were divided into two, which were primary data and secondary data, while the methods used were observation, interviews, documentation, surveys of air quality and electricity consumption, and modeling methods. Primary data were collected using **interview and observation methods** to collect data on awareness and energy-saving behavior ofresidents and managers of work units in UNNES.

Survey and measurement methodswere chosen to obtain data on tree species distribution, emissions, air quality, electricity consumption, and tree absorption to carbon emissions. Secondary data in this study were taken using **the documentation method**, in the form of land use data (vegetation and buildings) and data on electricity usage in each building on the UNNES campus.

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Data analysis was performed by: 1) counting the number and type of trees; 2) calculate CO2 emissions from motor vehicles, generators and electricity; 3) calculate the absorption of trees; 4) evaluating the ability of vegetation to absorb CO2, by comparing the results of the calculation of CO2 emissions with the absorption of vegetation. If the results of the calculation of the absorptive capacity of the existing vegetation of each Faculty are less than CO2 emissions the vegetation cannot absorb emissions, it is necessary to reduce CO2 emissions by doing efficiency.
Calculation of vegetation absorption = CO2 absorption x number of trees. Ability of tree absorption = absorption of vegetation - CO2 emissions.

3. Research Results and Discussion

3.1 Distribution of Trees at UNNES

As a campus that has a vision of conservation, UNNES campus environment needs to be analyzed the ability of vegetation against CO2 emissions generated from the transportation sector, generators, and electricity consumption.UNNES as a campus that promotes conservation programs continues to maintain the proportion of its green land. Rare tree species are widely planted, there are at least 97 tree species on the UNNES campus. Tree species in each faculty are different, the Faculty of Mathematics and Natural Sciences (*FMIPA*) has the most tree species, 64 species, followed by Rectorate area 54 tree species, Faculty of Language and Arts (*FBS*) as many as 44 species, Faculty of Education (FIP) 34 types trees, Faculty of Sport Sciences (*FIK*) 32 tree species, Faculty of Social Sciences (*FIS*), Faculty of Economics (*FE*), and Faculty of Law (*FH*) amounting to 30 tree species, and the least number of them is in Faculty of Engineering (*FT*), 28 tree species. Based on the number of trees, the Rectorate area is the greenest because it has a total of 4,534 trees or 37% of the total percentage of trees growing on the UNNES campus. Faculty of Education has 1,153 trees, while Faculty of Mathematics and Natural Sciences only has 556 trees. The 'Educational Tourism Forest', an area adjacent to the Faculty of Mathematics and Natural Sciences, is included under the management of the Rectorate.

Figure 1 presents data on the distribution of the number and types of trees on the UNNES campus. Although it is the greenest area, it does not necessarily make the Rectorate area becomes the area with the highest carbon dioxide absorption.The majority of trees which are planted are hard trees that are used as the absorbers of carbon dioxide from existing motor vehicles to reduce air pollution. In 2019, development has been carried out in the Rectorate area, precisely in front of the main entrance to UNNES, so that the number of trees in this area has considerably decreased.

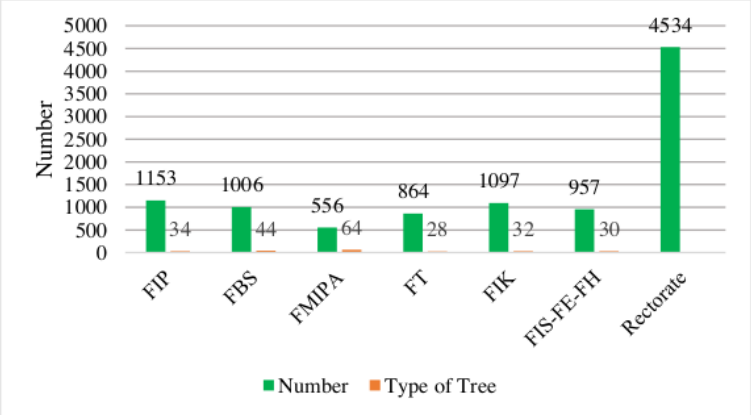

Figure 1. Distribution of Number and Type of Trees on UNNES Campus

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Various types of trees were planted in the UNNES campus area. The majority of trees planted around the UNNES campus include tree species such as teak tree, *sengon*, mahogany, acacia, *ketapang*, and*trembesi*. In addition, various types of fruit plants such as mangoes, jackfruit, rambutan, sapodilla, longan, orange, rose apple, guava, cashew fruits are planted on the campus of UNNES. The trees planted on the UNNES campus not only function as a barrier or absorbent of carbon dioxide but also as an embodiment of the mission of the UNNES campus to become a campus that promotes conservation. Tree planting is one of the annual agendas on the UNNES campus, each student is required to plant at least one type of tree around the UNNES campus area. Tree planting culture is expected to be able to foster concern for the surrounding environment. Each faculty has different numbers and types of trees.

3.2 The Absorption of Trees against Carbon Dioxide Emissions

The calculation of carbon dioxide emissions shows that there are three types of carbon dioxide emitting sources at UNNES, such as emissions from motor vehicles (gasoline fuel emissions from motorcycles, gasoline fuel emissions from cars, diesel fuel emissions from cars), from the use of diesel fuel for generators, as well as from electricity consumption. The highest amount of emissions from motor vehicles comes from the combined *FIS-FE-FH* with a percentage of 18% or 245,055.84 kg/year. The lowest amount of carbon dioxide emissions comes from *FIP* with a percentage of 8% or 113,121.44 kg/year. The high amount of emissionsthat motor vehicles produced is directly proportional with the number of motorized vehicles that are existed as well as the consumption of fuel used. The highest amount of emissions from electricity consumption comes from the Rectorate area which includes Buildings G and H, Auditorium, *UPT ICT*, *LP2M*, and *LP3*, with a percentage of 25% or 1,613,388.36 kg/year. The lowest emission data came from *FIK* with a percentage of 7% or 428,280.00 kg/year.

The factor that influences the amount of electricity consumption on the UNNES campus is a large number of electronic equipment that uses electricity to be operated. The biggest electricity consumption in every faculty at UNNES comes from the use of electricity for air conditioning.

Table 1. Absorption of Trees against Carbon dioxide Emissions on the UNNES Campus

Faculty / Region	Number of trees	Absorption of CO_2 Emissions (kg/year)	CO_2 emissions (kg/year)	Remaining Absorption (kg/year)	Information
Faculty of Education	1153	697.972,02	634.668,08	63.303,9	able to absorb
Faculty of Language and Arts	1006	428.422,64	940.262,20	- 511.839,56	unable to absorb
Faculty of Mathematics & Natural Sciences	556	204.248,05	862.318,88	- 658.070,83	unable to absorb
Faculty of Engineering	864	409.928,93	1.161.306,56	- 751.378,03	unable to absorb
Faculty of Sport Sciences	1097	2.646.523,41	653.127,52	1.993.395,05	able to absorb
Faculty of Social Sciences-Faculty of Economics-Faculty of Law	957	644.144,94	1.830.682,56	- 1.186.541,22	unable to absorb
Rectorate	4534	1.348.592,78	1.779.915,72	- 431.323,02	unable to absorb
Total	10.167	6.379.832,77	7.862.281,52	- 1.482.453,71	unable to absorb

Source: Analysis of 2018 research results

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Each type of tree has a different absorption of carbon dioxide emissions. Not all trees in the faculties at UNNES can absorb CO_2 emissions generated from motor vehicles, generators, and electricity (Table 1). There are only 2 faculties that can absorb the emissions they produce, which are *FIP* and *FIK*. The inability of trees in every faculty and work unit at Universitas Negeri Semarang is due to a large number of indirect emissions from electricity consumption.If the absorption is calculated only from direct emissions from motor vehicles and generators, all faculties and work units at UNNES can actually absorb emissions.

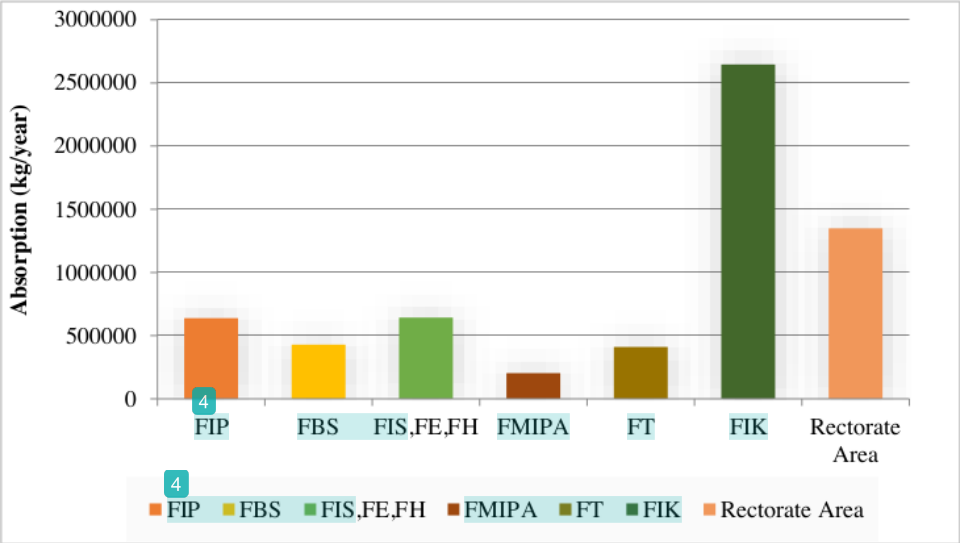

Figure 2. Absorption of Carbon Dioxide Emissions by Trees

The highest absorption capacity of carbon dioxide emissions at UNNES is 42% or 2,646,253.41 kg/year in *FIK*.The high emission absorption capacity of trees is due to a large number of trees that have high absorption, such as *trembesi*, mango and mahogany trees. The faculties which had the lowest emission absorption were in the Mathematics and Natural Sciences by 3% or 204,248.05 (Diagram 2). The low emission absorption capacity of trees in the Faculty of Mathematics and Natural Sciences is due to the species of trees in this faculty are trees that have a low absorption capacity for emissions.

The results showed that leaf surface area was not a determining factor in the level of carbon dioxide uptake of a plant but rather the combined surface area of leaves, the amount of stomata and stomata opening activity became a combination that greatly influenced the level of carbon dioxide absorption from the air (Pane). The tamarind tree is able to absorb 28.5 tons of carbon dioxide (CO2) equivalent gas per year, Cassia sp. A flowering plant able to absorb 5.3 tons of CO2 gas per year, the banyan tree is able to absorb 0.53 tons of CO2 equivalent gas / year (Dahlan, 2008; Kallarackal and Roby, 2012). Trembesi leaves have a high effectiveness as an adsorbent, especially if used in absorbing exhaust emissions (Sentyaki, et al, 2018).

Tree species such as Tectonagrandis, Polyalthialongifolia, Oroxylumindicum, Cassia fistula, Ficusrecemosa, Terminalia spp, Butea monosperms, Saracaasoca and so on can be planted for carbon assimilation and better air quality in and around the University campus (Rane, et al. ., 2017). According to Nugraheni (2018), the role of vegetation is to reduce the level of pollutants around the road by diluting pollutant concentrations (Patra, 2002). Through measurements

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conducted in UNNES Campus, it is increasingly confirmed that the ability of vegetation to absorb CO_2 is different and many factors influence it. But the dominant tree that has a high absorption is a large tree with a wide canopy.

Based on the data obtained, it can be seen that from all faculties and work units in UNNES that the total emission absorption capacity of trees in each faculty and work units in UNNES is 6,319,802.77 kg/year or 6,319. 80 tons/year. This means that with the amount of emissions absorption of 6,319,802.77 kg/year or of 6,319.80 tons/year, the trees in UNNES cannot absorb the total emissions generated from motor vehicles, generators, and electricity in every faculty and work unit available at UNNES which amounting to 7,862,281.52 kg/year or 7,862.28 tons/year. This means that there are still emissions of 1,542,478.8 kg/year or 1,542.48 tons/year that have not been absorbed by the trees in UNNES.Widodo (2014) said that the ability of vegetation or plants to absorb carbon dioxide emissions has to do with the ongoing activity of photosynthesis. The link is that in the process of photosynthesis required carbon dioxide and water which are the main ingredients of the photosynthesis process. The results of the photosynthetic reaction equation are glucose (C6H12O6) and oxygen. Glucose in this case is assumed to be energy which is also green biomass. The size of the ability of vegetation to absorb carbon dioxide emissions is also determined by the size of the green biomass produced.

4. Conclusions

The ability of trees to absorb carbon dioxide emissions on the UNNES campus as a whole with a total of 10,163 trees is unable to absorb carbon dioxide emissions from transportation activities, generators, and electricity consumption. The types of trees that absorb carbon dioxide emissions the best is *trembesi*, mango, and mahogany. The existence of trees in *FIP* and *FIK* can absorb the carbon dioxide emissions produced. On the other hand, the Rectorate, *FT*, and the combined *FIS-FH-FE* have the largest amount of carbon dioxide emissions. The type of laboratory activity, space, and work intensity in each faculty or Rectorate area is related to electricity consumption. Meanwhile, the number of students is related to emissions from transportation.

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