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Study of Vegetation's Capacity to Reduce of the CO_2 Emissions from Vehicle Engine Contribution in Green Open Space Pinang Masak Campus, Jambi University Reevaluation on Period 2016–2022

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Abstract

The atmosphere's carbon dioxide (CO_2) content raises global temperatures. OGS, or green open space, has the power to absorb carbon dioxide. The OGS of Pinang Masak Campus, Jambi University, too has this potential, although the number of vehicles keeps rising yearly. The reduction of flora at Jambi University's Pinang Masak Campus will result in higher carbon emissions. The three-month study was carried out at the Pinang Masak Campus Jambi University. This study directly measured the crown and counted the number of individual trees. There are 62 species of trees in all, totaling 1455 individuals. Motorcycles are the most common form of vehicle to enter the college area. According to calculations of carbon absorption, the rates of emissions produced by cars, 583,619 kg/hour, and 581,779.330 kg/hour, respectively, are 1,839.667 kg/hour, 583,619 kg/hour, and 581,779.330 kg/hour, respectively. According to these findings, based on positive residual emissions, the Green Open Space of Pinang Masak Campus is less able to absorb carbon emissions from automobiles.
Keywords: *Jambi University, Emissions, Vegetation Capability*

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INTRODUCTION

The atmosphere's carbon dioxide (CO_2) content contributes to the continued rise in global temperatures (Samiaji et al., 2011). Growing carbon dioxide levels could pose a serious threat to the ecosystem's balance (Utina, 2008). Due to rising levels of carbon dioxide (CO_2), methane (CH_4), and other gases in the atmosphere, these shooters may contribute to an increase in the global surface temperature (Pratama, 2019), metana (CH_4) dan beberapa gas lain di atmosfer (Ardhitama et al., 2017). These gases can create the greenhouse effect, which is frequently referred to as global warming and can warm the earth's atmosphere and surface (Abobsesa et al., 2018).

The concentration of carbon dioxide that results from human activity through industrial activities and the combustion of motor vehicle fuels is the primary cause of the increase in carbon in the atmosphere (Banurea et al., 2013). The primary cause of air pollution is the burning of fossil fuels (Kurnia & Sudarti, 2021). Users of motorized vehicles traveling by on the Pinang Masak Campus of Jambi University also use gasoline as a source of energy. Because there are so many motorized vehicles on campus, there is a lot of air pollution there (Aini et al., 2017).

Green open space is crucial for lowering carbon dioxide (Hastuti & Utami, 2008). For the goal of photosynthesis, vegetation in green open spaces may absorb atmospheric carbon dioxide and store extra carbon as biomass (Yao et al., 2015). On the Pinang Masak campus of Jambi University, green open spaces also play a significant role. The Pinang Masak Campus at Jambi University contains a considerable amount of green open space dispersed across every faculty, office building, and important highways. More green open space must go hand in hand with a rise in the number of automobiles, which will raise carbon dioxide emissions. The amount of green open space required corresponds to the level of emissions (Handayani et al., 2020). Makadari must conduct a study on carbon emissions at the Jambi University's Pinang Masak Campus.

Jambi University conducted research on the examination of CO2 absorption capacity earlier in 2016. According to the study by Ihsan et al (2016) , Jambi University's carbon absorption rate was 1571.18 kg/hour, and the associated vehicle emissions were 1360.71 kg/hour. The Pinang Masak Campus of Jambi University saw a number of changes over a six-year period that led to the loss of vegetation. The construction of lecture halls and the inclusion of a parking lot—which had previously been a green open space area—are two examples of these alterations. As a result, it is thought that vegetation's capacity for absorption has changed.

Modifications affect vegetation's ability to absorb carbon dioxide as well as the resulting emission factors. One of the main causes of the rising atmospheric CO_2 concentration is the growing number of motorized vehicles. Thus, a new analysis of vegetation's capacity to absorb CO_2 from motorized vehicles is required at the Pinang Masak Campus of Jambi University.

METHOD

This three-month study was carried out at the University of Jambi's Pinang Masak Campus (Figure 1). The number of distinct trees and crown measurements in the field were counted in this investigation.

Computation of the Individual Tree Count

Counting one identified tree to get the total number of individual trees using the census method. Each tree's crown length is measured in the X and Y cardinal directions (Sadono, 2018). For calculating the area of the crown cover, it is assumed that the tree crown has the shape of an ellipse. As a result, the formula for the area of an ellipse is used to get the area:

$$(L = \pi \times a \times b)$$

Information:
L= Canopy cover area (m^2); π= Constant (3,14 atau 22/7); a=X header length (m^2); b= Y header length (m^2)

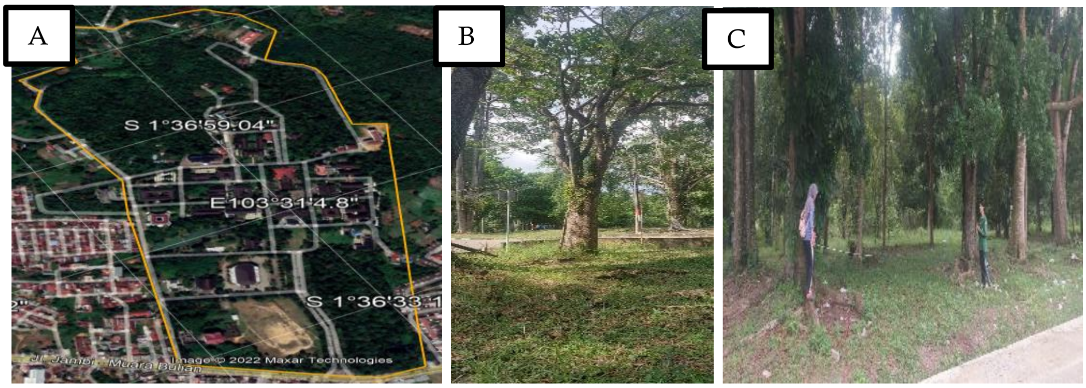

Figure 1. (A) Jambi University's Pinang Masak Campus, (B), (C) Green Open Space Area

Motorized Vehicle Calculation

Motorized vehicles that enter the UNJA Mendalo campus, including as motorcycles, cars, buses, lorries, and others, are counted. This is done at periods of high vehicle entry and exit from the two major gates of the Jambi University Pinang Masak Campus. The estimate of the number of vehicles was done three times over the course of three days using mechanical counting using a counter in order to remove bias and enhance the data.

Table 1. Factors affecting motor vehicle emissions dependent on fuel type

Vehicle type/fuel	Factors affecting motor vehicle emissions (gr/liter)			
	CH_4	CO	N_2O	CO_2
Gasoline	0,71	462,63	0,04	2.597,86
Passenger Vehicles	0,71	295,37	0,04	2.597,86
Small commercial vehicle	0,71	281,14	0,04	2.597,86
Large commercial vehicle	0,71	281,14	0,04	2.597,86
Motorcycle	3,56	427,05	0,04	2.597,86
Diesel				
Passenger Vehicles	0,08	11,86	0,16	2.924,90
Small commercial vehicle	0,04	15,81	0,16	2.924,90
Large commercial vehicle	0,024	35,57	0,12	2.924,90
locomotive	0,024	24,11	0,08	2.964,43

Note: Gasoline is equivalent to one liter. Source: (IPCC, 1996) in (Ihsan et al., 2016).

Table 2. Motor vehicle specific energy consumption

No	Vehicle type	Specific energy consumption (liter/100km)
1	Passenger car	
	Gasoline	11,79
	Diesel/Solar	11,36
2	Big Bus	
	Gasoline	23,15
	Diesel/Solar	16,89
3	Medium bus	13,04
4	Minibus	
	Gasoline	11,35
	Diesel/Solar	11,38
5	Bemo, bajaj	10,99
6	Taxi	
	Gasoline	10,88
	Diesel/Solar	06,25
7	Big Trucks	15,82
8	Medium Trucks	15,15
9	Mini trucks	
	Gasoline	08,11
	Diesel/Solar	10,64
10	Motorcycle	02,66

Source: BPPT in (Ihsan et al., 2016)

Data analysis

Using the formula, the amount of emission is computed (Banurea et al., 2013):

$$Q = Ni \times Fei \times Ki \times L$$

Information:
Q: Total emission (kg/hour)
Ni: Number of motorized vehicles type-I (vehicle/ hour)
Fei: Motor vehicle emission factor type-I (gr/liter)
Ki: Vehicle fuel consumption type-I (liter/100 km)
L: Road length (km)

The formula is used to determine the absorption capacity of parks and greenbelts. (Rachmawati & Mangkoedihardjo, 2020):

$$CO_2 \text{ absorption} = CO_2 \text{ absorption rate} \times \text{Vegetation cover area}$$

RESULTS AND DISCUSSION

Richness and Distribution of Vegetation

Common plants are present on the Pinang Masak Campus of Jambi University. Almost all study locations contained *Swietenia mahagoni* and *Alstonia scholaris* plants, which grew at an equal distance from one other. This is likely a result of *Swetenia mahagoni*'s ability to grow and live on a variety of soil types that are neither submerged, arid or marginal, even in extremely dry soil conditions (Kaliky, 2011; Silalahi, 2019). The calculations' findings indicate that the Pinang Masak Campus of Jambi University's green open space area contains 62 species of trees, totaling 1455 individual trees (Table 3).

Table 3. The Pinang Masak Campus in UNJA Green Open Space's vegetation canopy cover, including its type, volume, percentage, and size.

No.	Species name	Total	Percentage (%)	Canopy cover area (m^2)
1	*Swietenia mahagoni* (L.) Jacq.	285	19.6	50483.46806
2	*Alstonia scholaris* R. Br.	118	8.1	18457.95620
3	*Paraserianthes falcataria* L.	16	1.1	13883.80108
4	*Cerbera manghas* L.	111	7.6	7874.749166
5	*Hura crepitans* L.	32	2.2	5963.940474
6	*Terminalia mantaly* L.	55	3.8	5843.529638
7	*Pterocarpus indicus* Wild.	27	1.9	3571.226562
8	*Fragraea fragrans* Roxb.	104	7.1	3398.587478
9	*Ficus benjamina* L.	11	0.8	2339.880586
10	*Syzygium oleana* L.	92	6.3	2297.616814
11	*Acacia auriculiformis* A. Cunn. ex Benth.	9	0.6	1930.441228
12	*Dimocarpus longan* Lour.	19	1.3	1854.043772
13	*Hibiscus tiliaceus* L.	23	1.6	1828.390286
14	*Roystonea regia* L.	83	5.7	1781.25292
15	*Peronema canescens* Jack.	42	2.9	1709.20405
16	*Filicium decipiens* (Wight & Arn.)	11	0.8	1682.349828
17	*Albizia* sp. (L.)	4	0.3	1530.675582
18	*Polyalthia longifolia* Sonn.	91	6.3	1306.697184
19	*Areca catechu* L.	79	5.4	993.282166
20	*Mangifera indica* L.	14	1.0	766.62158
21	*Syzygium paniculatum* Gaertn.	35	2.4	738.773234
22	*Aquilaria malaccensis* Oken.	11	0.8	592.973614
23	*Magnolia champaca* L.	15	1.0	580.734836
24	*Leucaena leucocephala* Lam.	7	0.5	577.649786
25	*Nephelium lappaceum* L.	3	0.2	461.16552
26	*Hevea brasiliensis* (Willd. ex A. Juss.)	3	0.2	410.976388
27	*Thuja orientalis* L.	5	0.3	385.21834
28	*Casuarina equisetifolia* L.	6	0.4	385.090856
29	*Aporosa* sp. (G.) Merr.	5	0.3	373.430466
30	*Syzygium aqueum* (Burm. f.) Alston	6	0.4	360.418934
31	*Pometia pinnata* J. R & G. Forst	4	0.3	336.885262
32	*Dalbergia latifolia* Roxb.	5	0.3	306.458976
33	*Vitex pinnata* L.	2	0.1	269.26599
34	*Diospyros blancoi* A. DC.	4	0.3	200.850728
35	*Bauhinia purpurea* L.	1	0.1	196.15894
36	*Elais guinensis* Jacq.	1	0.1	195.95955
37	*Psidium guajava* L.	3	0.2	179.88903
38	*Jasminum* sp. L.	35	2.4	174.611946

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39	*Commersonia* sp. J.R & G. Forst	2	0.1	165.122552
40	*Saraca asoca* (Roxb.) Wild.	10	0.7	149.342796
41	*Pterocarpus sp.*	2	0.1	141.527022
42	*Artocarpus integra* (Thunb.) Merr.	3	0.2	139.25272
43	*Bougainvillea glabra* Choisy.	6	0.4	119.80042
44	*Muntingia calabura* L.	6	0.4	116.88022
45	*Arenga pinnata* (Wurmb.) Merr.	1	0.1	109.984152
46	*Plumeria* sp. L.	4	0.3	96.373194
47	*Manilkara zapota* (Mill.) Fosb.	3	0.2	88.035238
48	*Erythrina variegata* L.	4	0.3	81.09678
49	*Cocos nucifera* L.	4	0.3	67.78161
50	*Syzygium jambos* (L.) Alston	1	0.1	64.618688
51	*Handroanthus chrysotrichus* (Mart. ex DC.) Standl.	6	0.4	59.865042
52	*Magnolia* sp. L.	4	0.3	58.031596
53	*Viburnum cassinoides* L.	1	0.1	54.6831
54	*Mussaenda pubescens*	3	0.2	33.003912
55	*Musa paradisiaca* L.	1	0.1	31.14252
56	*Durio zibethinus* L.	1	0.1	29.978208
57	*Vitex pubescens* L.	1	0.1	28.214784
58	*Tectona grandis* L.	1	0.1	24.16858
59	*Averrhoa carambola* L.	1	0.1	20.41
60	*Hibiscus rosa-sinensis* L.	11	0.8	9.054504
61	*Carica papaya* L.	1	0.1	7.004712
62	*Ixonanthes petiolaris* Jack.	1	0.1	3.69264

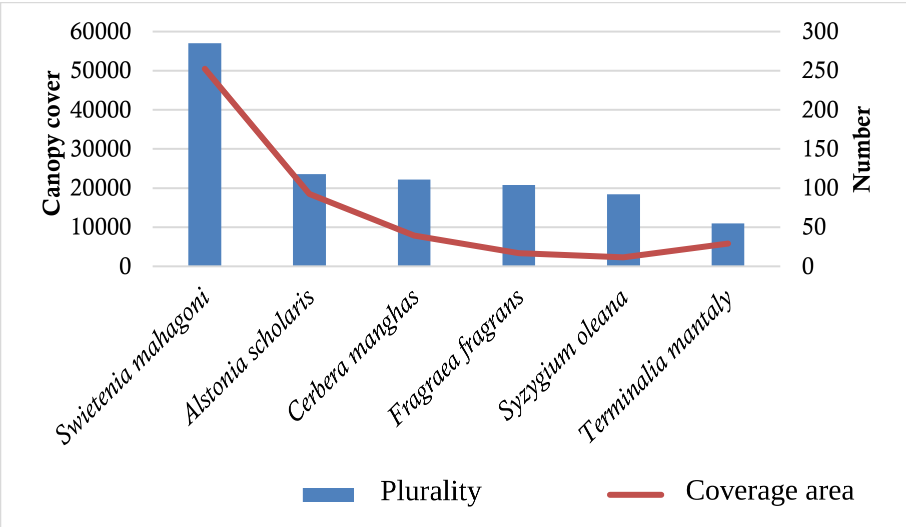
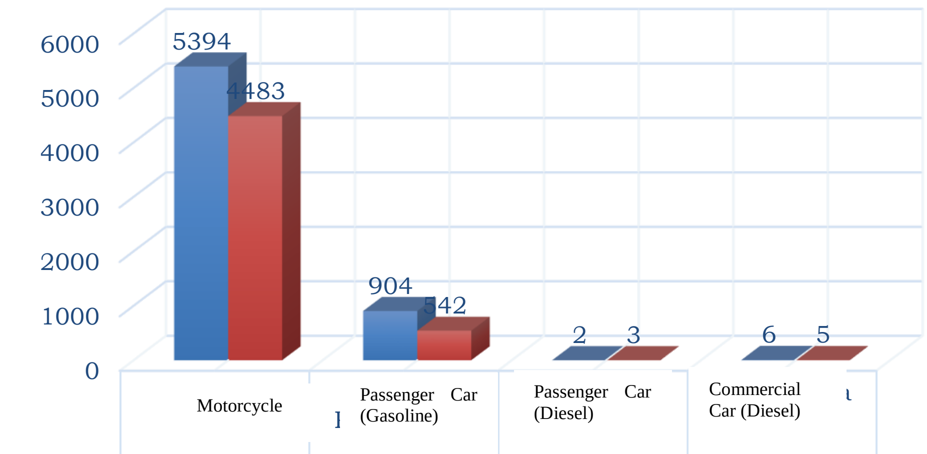


Figure 2. The Green Open Space at the UNJA Pinang Masak Campus had the most plant crowns, both in terms of quantity and coverage.

Mahogany (*Swietenia mahagoni*) trees are the most prevalent and can be found in nearly all regions of open, green land. Dahlan (2007), claims that mahogany has a high potential to absorb carbon, 295.73 kg CO2/tree/year. Then, according to Banurea et al (2013) mahogany is excellent for usage as a shade tree since it has robust roots and stem branches. Alstonia scholaris, the second most common species, can frequently be found on campus green spaces because islands are typically dispersed over lowland and peat regions (Mery et al., 2019). It is usual to discover pulai plants because peat ecosystems are dispersed throughout practically all of Jambi Province.

Emissions from Motor Vehicles at the UNJA Pinang Masak Campus

According to field research findings, automobile inflow occurs between 8 and 9 WIB, and vehicle outflow occurs between 16 and 17 WIB. On weekdays and actual lecture days, the calculation of the number of vehicles was done three times. This is done in order to accurately reflect the daily number of vehicles in the number of registered vehicles. The maximum number of cars is the number of vehicles present during peak hours, assuming that the maximum amount of emissions is also present. The calculation of the number of vehicles performed in November 2022 yields the following (Figure 3).



	Motorcycle	Passenger Car (Gasoline)	Passenger Car (Diesel)	Commercial Car (Diesel)
Entering	5394	904	2	6
Exiting	4483	542	3	5

■ Entering ■ Exiting

Figure 3. Recapitulation of the number of vehicles at the UNJA Pinang Masak Campus for three days in November 2022

According to Figure 3, only motorbikes and passenger automobiles that run on gasoline or diesel are allowed on the Pinang Masak Campus of the University of Jambi. According to observational data collected during rush hour, there are 5,394 motorcycles, or 85.30% of all vehicles, followed by 904 gasoline-powered passenger cars, or 14.57% of all vehicles, 2 diesel-powered passenger cars, or 0.03% of all vehicles, and 6 diesel-powered commercial vehicles, or 0.10% of all vehicles. Around 6,306 vehicles were approaching the Pinang Masak Campus of the University of Jambi on any given day during peak traffic throughout a three-day period.

There were 5,033 vehicles in the peak outflow from the campus area, with the sorts of vehicles in both the inflow and outflow being the same. Motorcycles made up 4,483 vehicles, or 89.07% of all vehicles, followed by gasoline-powered passenger cars (542 vehicles), diesel-powered passenger cars (4 vehicles), and diesel-powered commercial vehicles (5 vehicles, or 0.10%). The most frequent kind of vehicle entering the campus area is a motorcycle. Due to the prevalence of motorcycle ownership among vehicle users, particularly students, motorcycles are the most popular form of vehicle. The second most common kind of vehicle after motorcycles is an automobile powered by gasoline. Most staff members, professors, and some students utilize these vehicles. Compared to motorbikes and gasoline-powered cars, other types of transportation are scarce.

This is seen by the rise in the number of motorized vehicles polluting the air and producing pollutants. Every year, the number of motorized vehicles in metropolitan areas grows, increasing by 9.8% from the year before. Of the many reasons for air pollution, it is clear that traffic emissions, which account for around 85% of the problem, are the main factor. This is clear when you consider that the majority of motorized vehicles have poor exhaust emissions, either as a result of poor maintenance or the usage of fuel of worse quality (Ismiyati et al., 2014).

Carbon dioxide (CO2) and water vapor (H2O), which are formed during the complete burning of fuel and are made possible by the presence of surplus air, are the two major motor vehicle exhaust emissions that are released into the atmosphere in large quantities. Complete combustion conditions in engined vehicles are uncommon, though (Haruna et al., 2019). Figure 3 demonstrates it clearly. The highest inflow of 6,206 cars was derived as the average total of all motorized vehicles throughout the three days of calculation; this number was higher than the peak outflow of 5,033 vehicles. so that 11,239 motorized vehicles were tallied during the busiest times for entry and exit.

The complete length of the road on the Jambi University campus was employed in this study as it is a road that is regularly traveled every day. The main gate, gate two, the library road, the tray road, the hall room (*Balairung)* road, the LPTIK road, and the route to each faculty are all included in the road. With GPS support, the length of the road is measured to establish its overall length. This tool yields an estimated 5.18 kilometers of total road length.

Table 4. Highest CO2 emissions from vehicles at the Pinang Masak Campus of Jambi University

No	Vehicle type	Q (Kg/Hour)	Percentage %
1	Motorcycle	350.159	60
2	Passenger Car (Gasoline)	229.541	39,3
3	Passenger Car (Diesel)	1.280	0,2
4	Commercial Car (Diesel)	2.638	0,5
	Total	583.619	

According to Izzah et al. (2019), table 4 depicts the ideal emission values for motorized vehicles studied on the Jambi University campus. These values are around

350,159 kg/hour, or about 60% of the total emissions, with motorcycles accounting for the majority of these emissions, followed by gasoline passengers cars weighing around 229,541 kg per hour, or about 39.3%, diesel electric passenger cars weighing about 1,280 kg per hour, or about 0.2 percent, and electric diesel commercial vehicles weighing about 2,638 kg per hour, or about 0.5%. Total vehicle emissions (Q) in the Jambi University campus area are 583,619 kg/hour.

Green Open Spaces' Capacity to Absorb CO2 at UNJA's Pinang Masak Campus

Finding out about how well green spaces can absorb carbon dioxide requires analysis of carbon dioxide absorption. Calculating the area of the canopy in vegetated regions, whose value is obtained from the capacity of vegetation in the form of trees to absorb carbon dioxide, is one method of determining carbon dioxide intake is seen in figure 4.

The educational forest areas that are specifically protected for educational reasons are not represented in Figure 4. From the front entrance to the campus backyard, there is a forest. In addition, this study also did not consider the ability of columns, seedlings and seedlings to absorb carbon dioxide.

Due to Faculty of Teacher Training and Education's abundance of land for planting trees, compared to other locations, many areas have been largely reduced for new development, resulting in the largest canopy in Faculty of Teacher Training and Education. A straightforward mathematical method can be used to determine the total amount of carbon dioxide absorbed by trees by multiplying the area of land cover in the form of trees, or 20,480 m2, by the value of the carbon dioxide absorption capacity in the form of forest cover proposed by Rawung (2015), which is 129.92 kg/ha/hour.

By multiplying the value of carbon dioxide absorption capacity in the form of tree cover suggested by Rawung (2015), which is calculated to be 129.92 kg/ha/hour, the total area of canopy cover that is conserved is 14, 16 ha, it is possible to calculate the total absorption of carbon dioxide in trees.

CO_2 total absorption = CO_2 absorption x total canopy coverage area
= 129,92 kg/ha/hour x 14,16 ha
= 1.839.667 kg/ hour

The overall CO_2 reduction from trees in green open space is 1839.67 kg/hour, according to a calculation of the green open space's ability to absorb carbon dioxide. The CO_2 emission load generated by motorized vehicles is the best total emission without the main direction (non-dispersed), according to research and calculations done at the Jambi University campus, thus the load achieved is the maximum load. The calculations show that 583,619 kg/hour of emissions are produced.

The maximum value of green open space reduction in the form of trees on the Jambi University Campus is 1839.67 kg/hour, as determined by the predicted value of the distribution of emissions and the area of tree canopy closure. The residual emissions that cannot be reduced in green spaces like the campus of Jambi University's trees make up the gap between the CO2 reduction efficiency number and the overall emission load. The residual motor vehicle traffic emissions that cannot be decreased or absorbed in the form of tree vegetation in the research region make up the difference between the potential

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for carbon dioxide absorption and the carbon dioxide emissions observed. The difference's value can be computed using the formula below:

Remaining emissions = Total Emissions - Green Open Space Absorption Capacity
= 583,619 kg/hour - 1839,67 kg/ hour
= 581.779.330 kg/hour

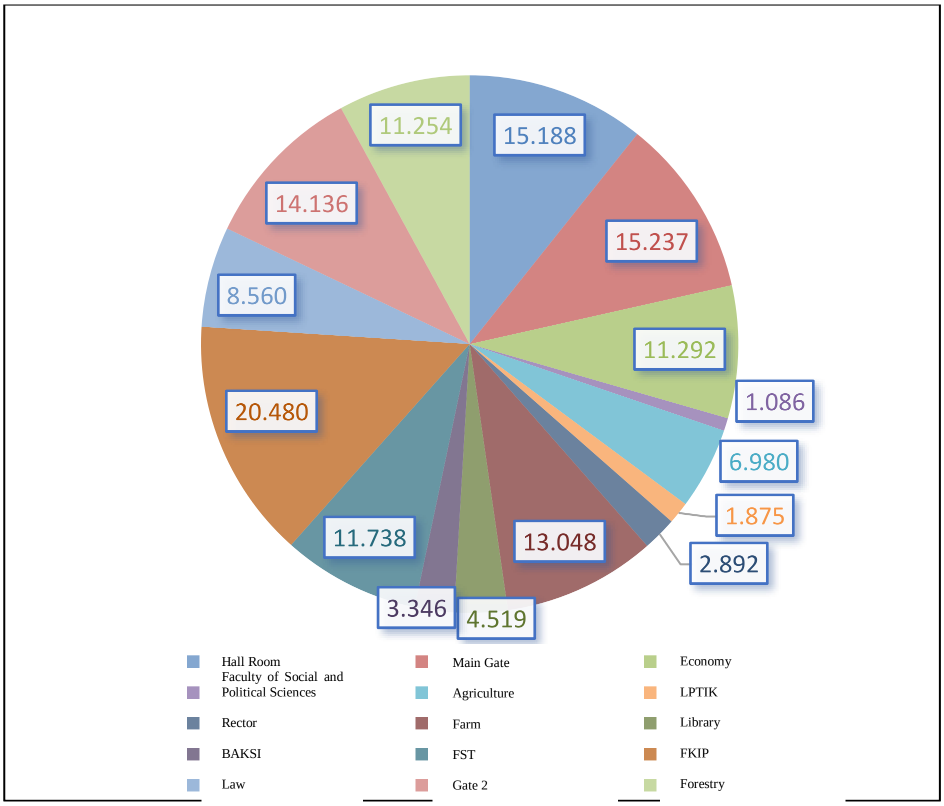

Figure 4. The Stats of Each Area Canopy cover (m2)

These calculations show that the Pinang Masak campus of Jambi University's green open space, represented by trees, has not been able to lower CO2 emissions. It is important to employ open places and to enhance the vegetation. The type and purpose of vegetation must be taken into consideration by vegetation (Yuniati et al., 2018). Selecting the appropriate kind ensures optimum carbon uptake. According to the distribution and size of existing green spaces, this information is crucial for planning planting directions for the development of parks and campus woods.

As stated by (Banurea et al., 2013), The University of North Sumatra (USU) has 4,254 unique trees from 68 species, including mahogany (*Swietenia mahagoni*), tanjungo (*Mimusops elengi*), and tamarind trees (*Tamarindus indica*) predominating. In comparison to the Pinang Masak UNJA campus, which has a carbon dioxide absorption of 1,839.667 kg/hour and 1,455 samples from 62 tree species, the USU campus has a potential for carbon dioxide absorption through green open space of 3,327.25 kg/hour. These two locations, however, are still unable to reduce carbon dioxide emissions from motorized vehicles. In the USU campus, the emission load is 2,760.89 kg/hour, and on the UNJA at Pinang Masak campus, it is 581,779.330 kg/hour. The vast differences in each green space's individual tree count and vehicle density are to blame for this discrepancy.

It is vital to plant in order for the reduction process to go as smoothly as possible in order to maximize the potential for carbon dioxide absorption (Banurea et al., 2013). Therefore, it is necessary to choose tree species for greening green spaces that have the capacity to absorb high CO2, such as trembesi (*Samanea saman*) (Haska et al., 2011), Singapore Cherry (*Muntingia cakabura*), dadap (*Erythrina crista-galli*) (Mansur & Pratama, 2014), acacia (*Acacia* sp.) (Indrajaya, 2016), banyan (*Ficus benjamina*) (Aji, 2018), fern tree (*Filicium decipiens*) (Suryaningsih et al., 2015), mahogany (*Swietenia mahagoni*), bullet wood (*Mimusops elengi*) dan tamarind (*Tamarindus indica*) (Banurea et al., 2013).
This is in line with Rijal (2008), assertion that green space development can be accomplished by enhancing and enlarging it. The first method of enhancement is by adding vegetation to places that already have green planning in order to enrich and raise the standard of that planning. The expansion approach is an additional option. The construction project's goal is to create more green places where it is still feasible to do so.

CONCLUSION

1. The Green Open Space at the Pinang Masak Campus of Jambi University absorbs 1,839.667 kg of carbon every hour from vegetation.
2. In the Pinang Masak Campus of the University of Jambi, motorized vehicle emissions total 583,619 kg/hour.
3. The Green Open Spaces at Jambi University have an hourly capacity of 581,779.330 kg to absorb carbon dioxide emissions from motorized vehicles. This claims that, as shown by the residual positive value emissions, the Pinang Masak Campus' Green Open Space is less able to absorb carbon emissions from motorized vehicles

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