

# The Role of Tanjung Bersinar Park Green Open Space in Reducing CO<sub>2</sub> Emissions

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## ABSTRACT

Global climate change, driven by increasing greenhouse gas emissions—particularly carbon dioxide (CO<sub>2</sub>)—poses a major environmental challenge in urban areas. Green Open Space (GOS) plays a crucial role in absorbing emissions through vegetation. This study aims to estimate CO<sub>2</sub> emissions from transportation activities surrounding Tanjung Bersinar Park, analyze the carbon absorption capacity of the vegetation, and evaluate the adequacy of the park's absorption in mitigating these emissions. The methodology includes traffic volume surveys, CO<sub>2</sub> emission calculations using emission factors and specific energy consumption, and absorption estimations based on tree species and land cover. The findings reveal that total CO<sub>2</sub> emissions reached 305,379,253.3 kg/year, while the vegetation's absorption capacity was only 2,004,836.6 kg/year—equivalent to just 0.66%. This indicates that the park's contribution to emission reduction remains minimal. Therefore, optimization strategies such as planting high-absorption species like *Samanea saman* and *Swietenia mahagoni* and expanding the GOS area are recommended as local climate mitigation measures.

**Keywords:** Green open space, CO<sub>2</sub> emissions, vegetation absorption, transportation, climate mitigation.

## INTRODUCTION

Global climate change has become a pressing environmental issue in various parts of the world, including Indonesia. One of the main causes of climate change is the increase in the concentration of greenhouse gases (GHG) in the atmosphere, especially carbon dioxide (CO<sub>2</sub>) which comes from human activities, such as the burning of fossil fuels in the transportation and industrial sectors. According to data from the Intergovernmental Panel on Climate Change (IPCC, 1996), the transportation sector contributes more than 20% of total global CO<sub>2</sub> emissions. Tabalong Regency, especially Tanjung City, has experienced rapid growth in the economic sector and population density. This growth has also driven an increase in the number of motorized vehicles, which has a direct impact on high CO<sub>2</sub> emissions in urban areas. Based on data from the Central Statistics Agency (BPS, 2025), the number of vehicles in Tabalong has almost doubled in the last six years. This situation puts pressure on air quality and has an impact on public health and environmental sustainability.

Tanjung Bersinar Park is one of the strategic green open spaces located in the center of Tanjung City. It is 1,401 m<sup>2</sup> in size and is located in an area with high vehicle traffic. This green open space has a potential role in reducing CO<sub>2</sub> emissions from transportation activities around it. However, until now there

has been no comprehensive study that quantitatively evaluates the effectiveness of this green open space in absorbing CO<sub>2</sub> emissions produced by motorized vehicles around it. Tanjung City, located in Tabalong Regency, South Kalimantan. has strategic value. This city is located on the growth triangle between provinces, namely Central Kalimantan, East Kalimantan, and South Kalimantan. This position allows it to become a center for economic and socio-cultural development growth of the three provinces. Tanjung City is rich in natural production such as mining so that every year it experiences an increase in population. This increase is accompanied by many people from outside the district and province who settle in Tanjung City. Tabalong Regency has an area of 3,767.00 km<sup>2</sup>, with a population of 218,954 people according to the 2010 Indonesian Population Census. In mid-2024, the population of Tabalong Regency reached 264,694 people (BPS, 2025). It is not surprising that the number of companies operating in Tabalong is 877 companies. The increasing population is in line with the large number of companies operating. Automatically absorbs a lot of labor (Kontras X, 2024).

Chaniago (2023) stated that CO<sub>2</sub> emissions in Tabalong Regency are 10,829 tons of CO<sub>2</sub>/year. The impact affects air temperature, solar radiation, air humidity and local wind speed flow so that there is a change in the urban landscape (Rahmadi, 2017). CO<sub>2</sub> emissions in various studies can be absorbed by vegetation from various so that a lot of green open space is needed. The results of research by Edita et al, (2021) that green open space on the Diponogoro University Campus is able to absorb 7562 tons of CO<sub>2</sub> gas/year which reduces the CO<sub>2</sub> emissions produced by 739 tons/year. The percentage of green open space absorption capacity against carbon dioxide emissions is 1023%. Research by Sarasidehe et al, (2022) that the amount of CO<sub>2</sub> emissions in the area of the governor's office of West Kalimantan generated from motorized vehicles in the area is 3,298 tons/year and the total

vegetation absorption capacity for CO<sub>2</sub> is 938,416 tons/unit. The percentage of green open space absorption capacity for carbon dioxide emissions is 28454%. These studies show that the concentration of CO<sub>2</sub> in the air helps reduce GHG. CO<sub>2</sub> emissions are converted into O<sub>2</sub> from vegetation (Miharja et al, 2018).

However, in the research of Sasmita and Fatatulkhairani (2019), it was stated that the green open space in Mandau District, Riau has not fulfilled the absorption of CO<sub>2</sub> emissions as seen from the percentage of the absorption capacity of existing public green open spaces to CO<sub>2</sub> emissions of 7.55%. Tabalong Regency has green open spaces covering an area of 775.35 hectares. One of the large green open spaces located in the city center with an area of 1,401 m<sup>2</sup> is Tanjung Bersinar Park. Therefore, this study measures emissions generated from motorized vehicles in the city center around the Tanjung Bersinar Park green open space. After that, measure the absorption of CO<sub>2</sub> emissions from vegetation in the green open space and measure the absorption capacity of the green open space.

## LITERATURE REVIEW

### CO<sub>2</sub> Emissions

The release of CO<sub>2</sub> gas into the air, the definition of CO<sub>2</sub> emissions. CO<sub>2</sub> emission sources can be classified into four types, namely the first is moving sources such as motor vehicles, airplanes, trains, motor ships, and gasoline handling/evaporation. The second source is stationary sources such as housing, trade areas, power, and industrial marketing, including steam power used as energy by industry. The third emission source is industrial processes such as chemical processes, metallurgy, paper, and oil mining. The fourth source is waste disposal including household waste, trade, mining products, and agriculture. According to the IPCC (1996) CO<sub>2</sub> emissions based on their sources are divided into two, namely primary CO<sub>2</sub> emissions and secondary CO<sub>2</sub> emissions. Primary CO<sub>2</sub> emissions are CO<sub>2</sub> emissions that come from the combustion of

fuels, such as gasoline, diesel, coal, and LPG. Secondary CO<sub>2</sub> emissions are CO<sub>2</sub> emissions that come from the use of electrical energy. Increasing CO<sub>2</sub> emissions can increase geothermal heat. Carbon dioxide has contributed 1.5 - 4.5 °C or about 60% of the cause of geothermal heat. The increase in temperature in the atmosphere can reach three times if not addressed. This can happen because CO<sub>2</sub> gas accumulates into a radiation wave trap so that some of the geothermal heat that should be reflected into the atmosphere is trapped in the earth. If this process occurs repeatedly, the average temperature on earth will continue to increase (Abdullah, 2009).

### CO<sub>2</sub> Emissions from Motor Vehicles

Motor vehicles are one of the main contributors of carbon dioxide (CO<sub>2</sub>) emissions in urban areas. These emissions mainly come from the combustion process of fossil fuels (gasoline and diesel) used by vehicle engines as an energy source. According to the Intergovernmental Panel on Climate Change (IPCC, 1996), each type of vehicle has a different emission factor value depending on the type of vehicle and the fuel

used. The transportation sector contributes more than 20% of global CO<sub>2</sub> emissions, and is expected to continue to increase with population growth and urbanization (Wang et al., 2017). In Indonesia, based on the Regulation of the Minister of Environment No. 12 of 2010, motor vehicles are classified as a significant source of mobile emissions in contributing to greenhouse gases (GHG) in urban areas.

### The Ability of Green Open Space Vegetation to Absorb CO<sub>2</sub> Emissions

Research conducted by Pertamawati (2010) states that photosynthesis is a biochemical process in plants that functions to produce usable energy (nutrients), under the influence of light (photons), CO<sub>2</sub>, and water are converted into organic compounds. Each plant has an important role in reducing ambient CO<sub>2</sub> loads. Plants have different abilities to absorb CO<sub>2</sub>. The absorption capacity of plants for CO<sub>2</sub> can be seen in Table 1, while the absorption capacity of vegetation cover types for CO<sub>2</sub> can be seen in Table 2.

**Table 1 CO<sub>2</sub> Absorption Capacity of Each Tree**

No	Plant Type	Scientific Name	CO <sub>2</sub> Absorption Capacity (kg CO <sub>2</sub> /tree/year)
1	Trambesi <sup>1</sup>	<i>Samanea saman</i>	28448,39
2	Pinus <sup>2</sup>	<i>Pinus merkusui</i>	135,25
3	Pucuk Merah <sup>4</sup>	<i>Oleana syzygium</i>	123,87
4	Ketapang <sup>2</sup>	<i>Terminolia catappa</i>	30,95
5	Bintaro <sup>2</sup>	<i>Cerbera manghas</i>	4509
6	Ketapang <sup>4</sup>	<i>Terminalia mantaly</i>	23,48
8	Kencana	<i>Pterocarpus indicus</i>	11,12
10	Angsana <sup>2</sup>	<i>Ficus benjamina</i>	535,9
11	Chinese Banyan <sup>1</sup>	<i>Manilkara zapota</i>	36,19
12	Sapodilla <sup>4</sup>	<i>Mimusops elengi</i>	48,03
13	Palem <sup>2</sup>	<i>Swettiana mahagoni</i>	295,73
14	Mahogany <sup>1</sup>	<i>Mimusops elengi</i>	162,89
15	Tanjung Tree <sup>1</sup>	<i>Areca catechu</i>	104,15
16	Areca Nut <sup>3</sup>	<i>Ravenala</i>	48,03

Source

1: Lukita, 2015

2: Rambaradellangga et al., 2018

3: Haruna, 2020

4: Febriansyah et al., 2022

**Table 2. CO<sub>2</sub> Absorption Capacity of Vegetation Cover**

No	Vegetation Cover Name	CO <sub>2</sub> Absorption Capacity (Kg CO <sub>2</sub> /m <sup>2</sup> . year)
1	Grassland	2,40024
2	Brush	11,00256

## MATERIALS & METHODS

### General Condition of the Research Area

This research was conducted in April 2025 – June 2025 at the RTH Tanjung Bersinar Park. This RTH is easily accessible and has become a new icon for the City of Tanjung Bersinar.

obtaining the number of each type of vehicle, the CO<sub>2</sub> emission value was calculated. In addition, it also calculates the absorption capacity of the vegetation in the Green Open Space. Next, an evaluation was carried out on the percentage of the green open space's absorption capacity against CO<sub>2</sub> emissions.

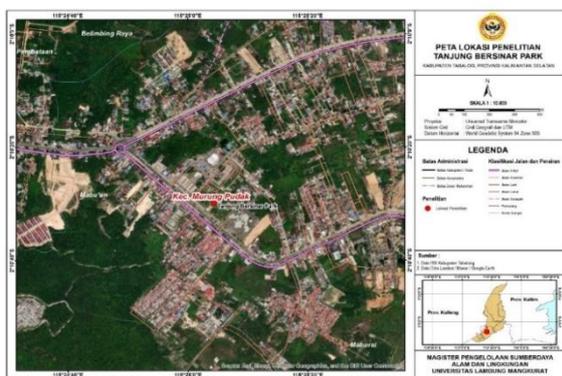


Figure 1 Research Map in RTH Tanjung Bersinar Park



Figure 2 Map of City Roads (Jalan Pelita) and Provincial Roads (Jalan A. Yani, Dahai-Mabuun) around RTH Tanjung Bersinar Park

### Tools and Materials

The tools and materials used in this study for data collection, namely writing instruments to record and write data from observations in the field, a camera for documentation and a laptop for data processing.

## RESEARCH METHODS

The research method used in this study in analyzing CO<sub>2</sub> emissions produced by motorized vehicles from the area around the Tanjung Bersinar Park Green Open Space by calculating motorized vehicle traffic. The time of data collection refers to the research of Susan et al, (2023) namely on Saturday representing half a working day, and Sunday representing a holiday, Monday representing a working day. Data collection was carried out at peak hours, namely in the morning when people start their activities at 07.00 - 08.00 WIB, afternoon when people rest, namely at 12.00-13.00 WITA, and evening when people finish work or activities, namely at 17.00-18.00 WITA. After

## RESULT & DISCUSSION

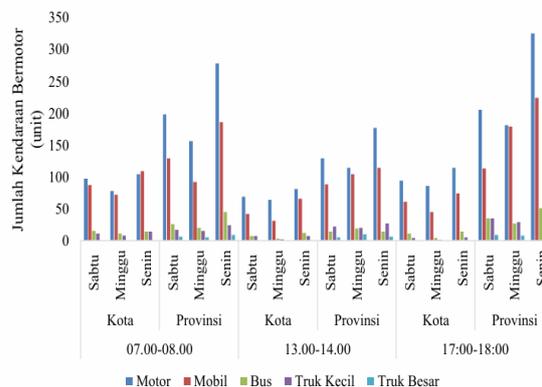
### Motor Vehicle Traffic Calculation Around Green Open Space Tanjung Bersinar Park

The calculation of the amount of CO<sub>2</sub> emissions around the Tanjung Bersinar Park Green Open Space was carried out by first calculating the number of vehicles. The calculation method uses the traffic counting method which is carried out at peak hours. The time chosen was also chosen to represent the emission load produced by motor vehicles as the maximum emission load. Data collection was carried out in the morning, afternoon, and evening on Saturday, Sunday, and Monday. These three days were chosen because Saturday represents half a working day, and Sunday represents a holiday, Monday represents a working day (Susan et al, 2020). Traffic counting was carried out at two points on the road section representing city and provincial

roads with road lengths of 0.15 meters and 0.20 meters respectively. The city road is on Jalan Pelita and the provincial road is on Jalan Ahmad Yani (Dahai-Mabuun).

This calculation is done by counting the number of motorized vehicles, namely motorbikes, cars, buses, small and large trucks. The actual traffic flow consists of various types of different vehicles so that it affects the composition and overall traffic flow (Febriansyah et al, 2022). This vehicle grouping is done to make it easier to calculate the amount of emissions from each vehicle that has been determined. The results of the traffic counting survey can be seen in Figure 4.1. The survey results show the total volume of vehicles for three days on both roads, namely the city and the province during the morning peak hours at 07:00-08:00 WITA of 1826 units/hour, the afternoon peak hour at 13.00-14.00 WITA 1254 units/hour and the afternoon peak hour at 17:00-18:00 WITA of 1973 units/hour. The dominant type of vehicle is private vehicles in the form of motorbikes and private cars. The morning peak hour is the time when people start their activities, the afternoon peak hour is the time to go home from work. This study is in line with research (Shahbazi et al, 2016) in Tehran City, Iran, that the highest volume of

private traffic vehicles is during the morning and evening peak hours.



**Figure 3 Traffic counting on the road around RTH Tanjung Bersinar Park**

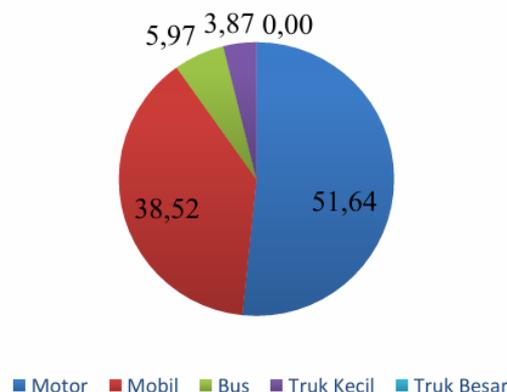
The picture above explains that in the morning, the number of vehicles tends to be higher, especially on weekdays, namely Monday. Motorcycles dominate traffic on both city and provincial roads with the highest number on Monday, which is around 104 units on city roads and 278 units on provincial roads. Cars number 109 units on city roads and 186 units on provincial roads (Table 3). This pattern shows a significant increase compared to Saturday and Sunday, each of which has a lower number of vehicles. This indicates that weekdays trigger increased mobility due to work and school activities.

**Table 3 Types of Vehicles that Contribute the Largest Volume**

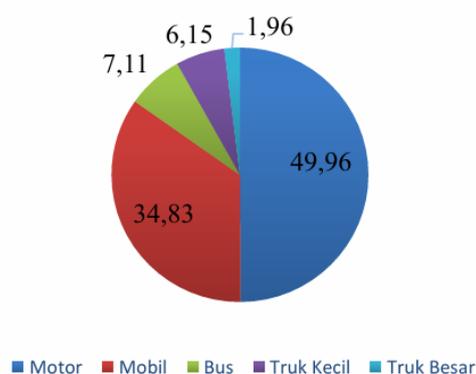
Jenis Kendaraan	Hari	Jam	Kota	Provinsi	Total	
Motor	Sabtu	07.00-08.00	97	198	295	
		13.00-14.00	69	129	198	
		17.00-18:00	94	205	299	
	Minggu	07.00-08.00	78	156	234	
		13.00-14.00	64	114	178	
		17:00-18:00	86	181	267	
	Senin	07.00-08.00	104	278	382	
		13.00-14.00	81	81	162	
		17:00-18:00	114	325	439	
	Mobil	Sabtu	07.00-08.00	87	129	216
			13.00-14.00	42	88	130
			17:00-18:00	61	113	174
Minggu		07.00-08.00	72	72	144	
		13.00-14.00	31	104	135	
		17:00-18:00	45	27	72	
Senin		07.00-08.00	109	186	295	
		13.00-14.00	66	114	180	
		17:00-18:00	74	224	298	
<b>Total</b>			<b>249</b>	<b>524</b>	<b>773</b>	

The number of vehicles during the day tends to be lower than in the morning and evening. Motorcycles remain the most dominant type of vehicle, although there is a decrease in the number on all days. This decrease is likely due to the lunch break and reduced outdoor activities. Monday still records the highest number of vehicles compared to Saturday and Sunday, indicating that work activities continue even though they are not as dense as in the morning. In the afternoon, there is a significant increase in the number of vehicles, especially on Monday. The number of motorcycles reached more than 439 units and cars almost reached 300 units. This reflects the pattern of homecoming hours and other daily activities. An increase also occurred in public vehicles such as buses, as well as heavy vehicles such as small trucks and large trucks, although in smaller numbers than motorcycles and cars. The three observation times, Monday always shows the highest number of vehicles, especially in the morning and evening. This proves that weekdays have a denser traffic volume than holidays (Saturday and Sunday). On Sunday, all types of vehicles showed the lowest number, indicating a reduction in traffic activity on holidays. In general, motorcycles were the most dominant type of vehicle at all times and days, followed by cars. Heavy vehicles such as small trucks, large trucks, and buses had a relatively smaller number, but still showed an increasing pattern during peak hours (morning and evening), especially on weekdays. Traffic observation results based on analyzed images show a significant increase in the number of vehicles on weekdays, especially during the morning (07.00–08.00) and afternoon (17.00–18.00) rush hours. This pattern is in line with the results of a study conducted by Putra and Lestari (2021) who studied traffic volume in the urban area of Yogyakarta. In this study, it was found that traffic increased significantly on weekdays, especially during rush hour. Similar to the findings in this graph, the most dominant type of vehicle is motorbikes, followed by private cars.

The volume of vehicles around the RTH Tanjung Bersinar Park based on vehicle type is dominated by motorbikes and then cars (Figure 4)



**Figure 4 Percentage of vehicle volume on city roads**



**Figure 5 Percentage of vehicle volume on provincial roads**

Figures 4 and 5 show the percentage of vehicle volume based on vehicle type to total vehicle volume at three different times, namely morning (07.00–08.00), afternoon (13.00–14.00), and evening (17.00–18.00). These data provide an overview of the proportion of contribution of each type of vehicle to the total traffic at each observation time. The graph shows that motor vehicles dominate traffic volume at all times, with the highest proportion occurring in the morning (07.00–08.00) reaching more than 50% of total vehicles. This shows that motorbikes are the mode of transportation most widely used by the public for morning activities, especially for work and school needs. The

proportion of motorbikes decreases slightly during the day, although they still dominate. Cars are the second largest type of vehicle in terms of traffic volume percentage, with the highest value also occurring in the morning, at around 35%. This figure then decreases slightly during the day. This indicates that private cars are widely used during the morning rush hour for work activities, but their use is not as dense as motorbikes. Vehicle types such as buses, small trucks, and large trucks show a relatively small contribution to the total vehicle volume. The highest percentage of buses occurs in the morning, indicating the role of public transportation in the morning. Small trucks and large trucks are more stable in their distribution, with a slight increase in the afternoon (17:00-18:00), which can be associated with logistics distribution activities towards the evening.

Overall, the time distribution shows that morning time (07.00–08.00) is the time with the highest vehicle volume in terms of percentage, mainly due to the dominance of motorbikes and cars. Afternoon is a period with a relatively more balanced percentage, reflecting a decrease in travel activity. Meanwhile, in the afternoon, there is a tendency to increase again, especially for motorbikes, cars, and buses. The observation results in the figure show that motorbikes and cars dominate traffic volume at all times, especially during the morning rush hour (07.00–08.00). This pattern is in line with the findings in a study by Suryanto and Handayani (2020) which examined vehicle movement patterns in the city of Bandung. They found that motorbikes contributed more than 50% of vehicle volume in the morning, followed by private cars. Both modes of transportation tend to be used for routine purposes such as going to work or school.

This shows that Tanjung City residents tend to use private vehicles (motorcycles and private cars) to carry out activities compared to public transportation. The results of this study are in line with research (Sekaryadi and Sentosa, 2017) on the roads of West Java

Province that the highest vehicle volume is motorcycles at 4,681,244 compared to buses at 43,839. The comparison of the numbers reaches ten times.

### Calculation of CO<sub>2</sub> Emissions of Motor Vehicles Around RTH Tanjung Bersinar Park

The total CO<sub>2</sub> emissions produced by vehicles around the Tanjung Bersinar Park green open space are shown in Figure 6. This road section serves heavy and light traffic such as trucks and buses, and other types of four-wheeled vehicles as well as two-wheeled vehicles for short-distance transportation. The roads around this green open space are provincial roads so that many types of vehicles pass through this road section. Based on the research results, the average total CO<sub>2</sub> emissions were 305,379,253.3 kg CO<sub>2</sub>/year.

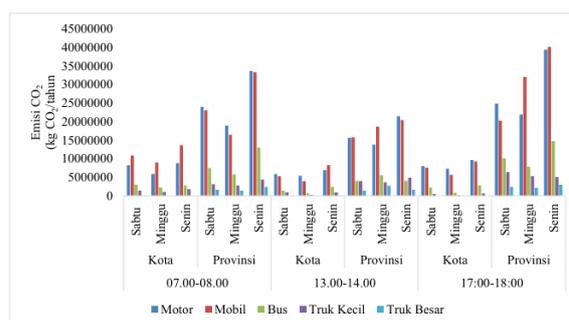


Figure 6 CO<sub>2</sub> emissions of each type of vehicle around RTH Tanjung Bersinar Park

The figure above shows the amount of annual carbon dioxide (CO<sub>2</sub>) emissions (in kg CO<sub>2</sub>/year) produced by various types of vehicles based on the day (Saturday, Sunday, and Monday) and observation time (07.00–08.00, 13.00–14.00, and 17.00–18.00). CO<sub>2</sub> emissions are one of the main indicators in measuring the environmental impact of transportation activities. Based on the graph, the types of vehicles that produce the highest CO<sub>2</sub> emissions are large trucks and cars, followed by motorcycles.

It can be seen that on Monday at 17:00–18:00, the highest emissions are achieved, with large trucks contributing more than 13 million kg CO<sub>2</sub>/year, followed by cars and

motorcycles which also show a significant spike. This indicates that private motor vehicles and logistics vehicles have a major contribution to air pollution, especially on weekdays and afternoon rush hours. The CO<sub>2</sub> emission pattern is consistent, the lowest emissions occur on Sundays, while the highest emissions occur on Mondays, both in the morning and afternoon. This is related to the high mobility of people on weekdays. Morning and afternoon times also show a higher volume of emissions compared to the afternoon, in accordance with the pattern of people's traffic movements for work and home from work. Public vehicles such as buses and commercial vehicles such as small trucks also contribute emissions, but on a smaller scale than large trucks and cars. However, their contribution remains

significant, especially when viewed in the context of the number of fleets and high operational frequencies during rush hours.

### Calculation of CO<sub>2</sub> Emission Absorption Capacity from Vegetation in Green Open Space Tanjung Bersinar Park

The CO<sub>2</sub> absorption capacity of vegetation is calculated using the calculation method of Febriansyah et al., 2022. The calculation of CO<sub>2</sub> absorption capacity by green open space is carried out based on the CO<sub>2</sub> absorption capacity according to the area of vegetation cover in the form of trees, shrubs, and grasslands. CO<sub>2</sub> absorption capacity is measured according to the number and type of trees. Analysis of the CO<sub>2</sub> emission absorption capacity of trees around green open space is presented in Table 4

**Table 4 CO<sub>2</sub> Absorption Capacity of Each Tree in the RTH Tanjung Bersinar Park**

No	Plant Type	CO <sub>2</sub> Absorption Capacity (kg CO <sub>2</sub> /tree/year)	Number of Trees	CO <sub>2</sub> Absorption Capacity (kg CO <sub>2</sub> /year)
1	Trambesi	28448,39	68	1934490,52
2	Pinus	135,25	5	676,25
3	Red Shoot	123,87	27	3344,49
4	Ketapang	30,95	4	123,8
5	Bintaro	4509	9	40581
6	Ketapang Kencana	23,48	7	164,36
8	Angsana	11,12	51	567,12
10	Chinese Banyan	535,9	9	4823,1
11	Sapodilla	36,19	7	253,33
12	Palm	48,03	16	768,48
13	Mahogany	295,73	36	10646,28
14	Tanjung Tree	162,89	23	3746,47
15	Areca Nut	104,15	5	520,75
16	Fan Banana	48,03	6	288,18
Total CO <sub>2</sub> absorption capacity of trees (kg CO <sub>2</sub> /tree/year)				2000994,13

Based on the calculation results, trambesi and bintaro trees make a great contribution to absorbing CO<sub>2</sub> emissions. This is because the number of trambesi and bintaro is much greater than other types of trees. Research conducted by Atmoko et al., (2024) states that trambesi trees with the scientific name *Samanea saman* make a great contribution to CO<sub>2</sub> absorption. Research by Dahlan, 2008 is also in line with this study that trambesi can absorb or reduce carbon dioxide (CO<sub>2</sub>) with an extra high category of 28,488.39 kg/year. While in this study up to 1,934,490.52 kg

CO<sub>2</sub>/year The two types of trees are the types of trees that have the highest absorption capacity for CO<sub>2</sub> emissions. However, this is inversely proportional to the absorption capacity of ketapang trees on the green belt. Although the number of ketapang trees planted is up to 500 trees, the trees do not produce a large absorption capacity like trambesi and bintaro trees. This is because ketapang trees have a much smaller absorption capacity. Based on this, trambesi and mahogany trees can be an

additional absorption capacity of green open space around Tanjung Bersinar Park.

**Table 5 CO<sub>2</sub> Absorption Capacity of Vegetation Cover in RTH Tanjung Bersinar Park**

No	Vegetation Cover Name	CO <sub>2</sub> Absorption Capacity (kg CO <sub>2</sub> /m <sup>2</sup> . hour)	Area (m <sup>2</sup> )	CO <sub>2</sub> Absorption Capacity (kg CO <sub>2</sub> /year)
1	Grassland	2,40024	652	1564,9565
2	Brush	11,00256	207	2277,5299
Total CO <sub>2</sub> absorption capacity of vegetation cover (kg CO <sub>2</sub> /year)				3842,4864

CO<sub>2</sub> absorption capacity is also obtained from grasslands and shrubs and the total absorption capacity can be seen in Table 4.2. Therefore, the total CO<sub>2</sub> absorption capacity of vegetation in Srth Tanjung Bersinar Park is 2004836.616 kg CO<sub>2</sub> / year.

CO<sub>2</sub> absorption capacity of Tanjung Bersinar Park Green Open Space  
 = CO<sub>2</sub> absorption capacity (trees + grasslands + shrubs)  
 = (2000994.13 + 3842.4864) kg CO<sub>2</sub> / hour  
 = 2004836.616 kg CO<sub>2</sub> / year

**The Adequacy Level of Green Open Space in Tanjung Bersinar Park to Absorb CO<sub>2</sub>**

Evaluation of the adequacy of Tanjung Bersinar Park green open space (RTH) in absorbing carbon dioxide (CO<sub>2</sub>) emissions was carried out by comparing the total CO<sub>2</sub> emissions generated from motorized vehicle activities around the area with the absorption capacity of vegetation in the RTH. The absorption capacity of the vegetation in Tanjung Bersinar Park RTH for CO<sub>2</sub> was able to absorb all emissions. The average amount of CO<sub>2</sub> emissions generated during this research survey from transportation activities was 27,679,848.788 kg CO<sub>2</sub>/year. This shows that motorized vehicles produce emissions that exceed the absorption capacity of vegetation in Tanjung Bersinar Park RTH in reducing CO<sub>2</sub>.

Remaining CO<sub>2</sub> Emissions  
 = Total actual CO<sub>2</sub> emissions – Total CO<sub>2</sub> absorption capacity  
 = 27,679,848.788 kg CO<sub>2</sub>/year – 2,004,836.616 kg CO<sub>2</sub>/year  
 = 25,675,012.171 kg CO<sub>2</sub>/year

This can be caused by the fact that the types of plants planted in the green belt do not all have high emission absorption capacity and

do not balance the amount of pollutants produced by motor vehicles. This is in line with the research of Atmoko et al, (2024) that the emissions produced are greater than the absorption capacity because the research area has a high amount of emissions but the types of plants that have a small absorption capacity for CO<sub>2</sub> emissions. This green open space area has residual CO<sub>2</sub> emissions which indicate that green open space has not been able to maximize its function as a CO<sub>2</sub> emission reducer around the Tanjung Bersinar Park green open space.

These results indicate that the absorption capacity of vegetation in the Tanjung Bersinar Park green open space is still far from sufficient to offset the burden of CO<sub>2</sub> emissions from motorized vehicles passing through the area. This very low absorption percentage reflects the imbalance between the area of green open space, vegetation composition, and traffic density. This low absorption capacity is caused by several factors, namely, first, the limited area of green open space so that the amount of vegetation that can be planted is also limited. Second, the dominance of high-emission motorized vehicles, especially motorcycles and passenger cars. Third, the composition of vegetation is not optimal, both in terms of plant types and the number of high CO<sub>2</sub>-absorbing trees such as trambesi, mahogany, or bintaro. This finding is in line with the study by Sasmita and Fatatulkhairani (2019), which states that in urban areas with dense traffic, green open space tends to be unable to absorb more than 10% of total emissions if the area and vegetation are not managed strategically. Therefore, green open space in the area has not effectively carried out its

ecological function as a carbon emission absorber.

This low level of adequacy has several implications, including the potential for local air quality to decline, which has an impact on the health of the surrounding community. The second implication is the occurrence of an increased local greenhouse effect and can trigger microclimate changes such as rising temperatures and decreasing thermal comfort. The third is dependence on other green systems, such as city parks, city forests, and green lanes in other, wider areas. In order to increase the effectiveness of the ecological function of green space, several strategic steps are needed, first, increasing the area of green space in other strategic locations, especially in dense traffic zones. Second, planting trees with high absorption capacity, such as trambesi, Chinese banyan, and mahogany. Third, revitalizing existing vegetation by replacing or supplementing plant species that are less effective in absorbing carbon. Integrated planning and based on actual emission data, green space management will be more optimal and make a real contribution to mitigating climate change in urban areas, especially Tanjung City.

### **Green Open Space Optimization Strategy with Projection Simulation of Green Open Space Addition**

The road around the Tanjung Bersinar Park green open space produces emissions of 27,679,848.788 kg CO<sub>2</sub>/year while the green open space absorption capacity is 2,004,836.616 kg CO<sub>2</sub>/year. The data shows that the Tanjung Bersinar Park green open space still produces quite large CO<sub>2</sub> emissions compared to the green open space absorption capacity which has a smaller value. The green open space is only able to absorb CO<sub>2</sub> emissions of around 7.24% with the amount of CO<sub>2</sub> emissions that have not been absorbed amounting to 25,675,012.171 kg CO<sub>2</sub>/year. Therefore, planning is needed regarding the addition of green open space area in order to absorb the remaining CO<sub>2</sub> emissions.

The addition of green open space area can be done by calculating the land area using the vegetation absorption value of CO<sub>2</sub> emissions that have not been absorbed. Trees have a CO<sub>2</sub> emission absorption capacity of 2,004,836.616 kg CO<sub>2</sub>/year so that the need for additional green open space area can be determined.

Green open space area = unabsorbed CO<sub>2</sub> emissions / vegetation absorption capacity

Green open space area = 25,675,012.171 kg CO<sub>2</sub>/year / 2,004,836.616 kg CO<sub>2</sub>/year

Green open space area = 12,81 ha

The need for additional green open space area in Tanjung Bersinar Park green open space is

12.81 ha. The ability to absorb CO<sub>2</sub> emissions by green open space is not only determined by the area of the green open space but also by the type and type of vegetation which can also affect the quality of CO<sub>2</sub> absorption. Greening the world and soil has been able to absorb around 40% of the total CO<sub>2</sub> from human activities. There is a process of using CO<sub>2</sub> gas by soil, microbes or chemical reactions that can reduce CO<sub>2</sub> gas. This process is the process of capturing CO<sub>2</sub> gas from the atmosphere and then storing it for a long time in the earth so that the concentration of CO<sub>2</sub> gas in the atmosphere does not increase rapidly, this process can also be called carbon sequestration (Rachmayanti and Mangkoedihardjo, 2020).

### **Green Open Space Optimization Strategy with Policy Implications**

#### **1. Prioritize High Absorption Vegetation Clusters**

Tabalong Regency Government/DLH needs to establish priority regulations for planting high-absorption trees such as Trembesi (*Samanea saman*) and Mahogany (*Swietenia mahagoni*) in green open space and green roads. According to Sasmita et al, 2021 stated that large trees have a significant capacity to absorb CO<sub>2</sub> and support urban sustainability. KLHK also recommends the selection of Dipterocarp and non-

Dipterocarp species according to local ecological conditions for green open space development to optimize ecological functions

## 2. Policy Integration in RTRW & Basic Green Coefficient (KDH)

According to Rismauly et al, (2022), Tabalong Regency still lacks green open space compared to ecological and oxygen needs per capita. Therefore, KDH regulation as a requirement for the development of new areas (commercial, housing, roads) is very necessary to be included in the revision of the RTRW. Tabalong Regency Regulation No. 03/2023 concerning RTRW (2023–2042) has established a spatial planning framework. However, the insertion of special provisions regarding the allocation of CO<sub>2</sub> absorption trees in road corridors and residential areas will be a concrete step.

## 3. Multi-Sector Collaboration & Planting Incentives

- The strategy to strengthen green open space requires collaborative initiatives:
- Partnership with the private sector (CSR), community involvement through the “1 Household 1 Tree” program and seed sponsorship for the development of green belts and public green open spaces
- The Environmental Service can provide incentive funds for developers who implement KDH provisions and maximum vegetation as part of the licensing.

## 4. Local Emission Monitoring and Measurement

Support the capacity development of the local Environmental Service or UPT to conduct quantitative monitoring of emissions and absorption periodically. Adoption of national standards similar to carbon net sink (KLHK 2030) helps Tabalong include CO<sub>2</sub> reduction targets in the next RPJMD.

## CONCLUSION

Based on the research results, the conclusions of this study are as follows:

1. The amount of CO<sub>2</sub> emissions generated from transportation activities around the Tanjung Bersinar Park green open space is 27,679,848.788 kg CO<sub>2</sub>/year.
2. The ability of RTH Tanjung Bersinar Park to absorb CO<sub>2</sub> emissions is 2,004,836.616 kg CO<sub>2</sub>/year
3. The green open space of Tanjung Bersinar Park has not been able to meet the absorption of CO<sub>2</sub> emissions with the remaining emissions produced by motorized vehicles amounting to 25,675,012.171 kg CO<sub>2</sub>/year. Therefore, the vegetation in this green open space cannot reduce optimally and leaves CO<sub>2</sub> emissions around the green open space.

## Declaration by Authors

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