DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

IJES
Indonesian Journal of Environmental Sustainability

Published by : Center For Environmental Studies UIN Ar-Raniry Banda Aceh

CAPABILITY OF GREEN OPEN SPACE VEGETATION REDUCING CARBON EMISSIONS IN THE TRANSPORTATION SECTOR (CASE STUDY OF THE SIMPANG JAM AREA IN BANDA ACEH CITY)

Zya Dyena Meutia[1]*, Suci Trimafika[2], Yeggi Darnas[2],
[1]*Departement of Architecture Faculty of Sciences and Technology, University of Islamic State Ar-Raniry Banda Aceh, Indonesia*
[2]*Departement of Environmental Engineering Faculty of Sciences and Technology, University of Islamic State Ar-Raniry Banda Aceh, Indonesia,*

**Email Correspondence: zya.meutia@ar-raniry.ac.id*

Received : 16 May 2024 Accepted : 27 July 2024 Published : 31 July 2024

ABSTRACT

The area of Bundaran BNI 46 Simpang Jam in Banda Aceh is an area that is often crowded with motorized vehicles. Motor vehicles produce CO as their exhaust gas. Excessive levels of CO in the air can harm human health. CO can turn into CO_2 in the air. Overrated CO_2 in the environment can cause greenhouse gas effects and global warming. CO_2 can be absorbed by plants for their use in the photosynthesis process. The absorption of CO_2 for each vegetation is different starting from very high to low. This research is a quantitative study to determine the total absorption capacity of vegetation in the area of Bundaran BNI 46 Simpang Jam on CO_2 emissions which was done on April 2020. Calculating vehicle emissions and vegetation absorption using manual counts method at peak hours and calculations based on literature. From the research, it is known that the total number of vehicles passing through the area is 3250 motorized vehicles/hour with total emissions of 7,343,017,347 Kg/year. The total absorption capacity of 351 vegetation in that area is 614,410.30 kg/year. Accordingly, the area's vegetation is unable to absorb CO_2 emissions optimally. To optimize CO_2 absorption, vegetation replacement must be carried out. The tree combinations that can be selected to absorb all of the area's CO_2 emissions are 320 Trembesi, 326 Kasia, 340 Glondokan, 305 Kenanga and 215 Beringin.

Keywords: Transportation Carbon Emissions, Vegetation Absorption, Urban Green Open Space

ABSTRAK

Kawasan Bundaraan BNI 46 Simpang Jam Kota Banda Aceh adalah Kawasan yang sering dipadati kendaraan bermotor. Kendaraan bermotor menghasilkan CO sebagai gas buangnya. Kadar CO yang berlebihan di udara dapat mengganggu kesehatan manusia. CO dapat berubah menjadi CO_2 di udara. CO_2 yang berlebihan di lingkunganpun dapat menyebabkan efek gas rumah kaca dan pemanasan global. CO_2 dapat diserap oleh tumbuhan untuk digunakan dalam proses fotosintesis. Daya serap CO_2 tiap vegetasi berbeda ada yang sangat tinggi sampai dengan rendah. Penelitian ini merupakan penelitian kuantitatif untuk mengetahui total daya serap vegetasi di Kawasan Bundaran BNI 46 Simpang Jam terhadap emisi CO_2 di kawasan tersebut yang dilakukan pada April 2020. Menghitung emisi kendaraan dan daya serap vegetasi menggunakan metode manual counts pada jam puncak (peak hours) dan perhitungan berdasarkan literatur. Dari hasil penelitian diketahui total kendaraan yang melewati kawasan tersebut adalah 3250 kendaraan bermotor/jam dengan total emisi 11.539.027 Kg/Tahun. Total daya serap 351 vegetasi pada kawasan tersebut adalah 614.410,30 Kg/Tahun. Dengan demikian, vegetasi kawasan tersebut tidak mampu menyerap emisi CO_2 secara optimal. Untuk mengoptimalkan penyerapan CO_2 harus dilakukan

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

penggantian vegetasi. Kombinasi pohon yang dapat dipilih untuk menyerap seluruh emisi CO_2 kawasan tersebut adalah 320 Trembesi, 326 Kasia, 340 Glondokan, 305 Kenanga dan 215 Beringin

Kata kunci: *Emisi Karbon Transportasi; Daya Serap Vegetasi; Ruang Terbuka Hijau*

Introduction

According to Miharja et al (2018) the population is increasing over time. The increase in population affects many things in every sector of life. Things that are affected include the increasing need for shelter, food and work. The increasing population is accompanied by unequal welfare in remote areas and central government areas. This has resulted in people in the regions choosing to migrate to the central government area or what is called urbanization. Urbanization that cannot be avoided has resulted in the central government area and its surroundings becoming dense big cities (Khoiroh, 2014).

According to Rawung (2015) the central government area is often the center of education and the economy. The need to get education and good jobs makes people from villages move to cities. Indirectly, the central government area becomes congested with infrastructure, business premises, housing and so on. To facilitate daily mobilization from these places, people use motorized vehicles. The most commonly used motorized vehicles are motorbikes and four-wheeled vehicles. This is in accordance with Machdar's (2010) statement which states that this could result in the central government area becoming a big city that is prone to traffic jams and pollution.

The transportation sector has a high dependence on energy use. As is known, energy use is the main source that has an impact on environmental health. Almost all conventional energy products and combustion engine designs used for transportation activities produce pollutant emissions into the air. According to Soedomo (2001) the use of gasoline in motorbikes will always produce compounds such as CO, NOx, THC, TSP (dust), and SOx.

Many sectors of human activity have the potential to pollute the air. Of these various sectors, according to Hanum (2006), the main source of pollution is transportation, almost 60% of the pollutants consist of carbon monoxide and around 15% hydrocarbons. In the context of air pollution, motorized vehicles which are a means of transportation are grouped as a source of mobile pollution. Therefore, the distribution of pollutants emitted from motor vehicle sources resembles a widespread spatial distribution pattern.

There are various benefits obtained from the presence of vegetation on roads. Therefore, the government has developed regulations relating to the presence of vegetation on roads. Regulation of the Minister of Public Works of the Republic of Indonesia Number 5 of 2012 concerning Guidelines for Planting Trees in Road Network Systems article 5 states that tree planting is carried out to reduce air pollution, create beauty, comfort, harmony and safety factors. Thus, road space (RUMIJA) planted with plants is also included in green open space. According to the Central Statistics Agency (2019), the percentage of green open space land use in Banda Aceh City in 2018 reached 14.14%. If we look at Law of the Republic of Indonesia No. 26, this amount has not reached half of what is required.

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

In general, plants and vegetation dominate green open spaces (Meutia, 2020). According to Hakim (2008) plants and vegetation have a lot of influence on city air quality. Plants can create a microclimate, namely they can reduce the surrounding temperature, provide sufficient humidity and increase the quantity of O2. This is due to the process of plant assimilation and evapotranspiration. Apart from that, plants can also absorb CO2 produced by various human activities. According to Aji (2018) Trembesi and Cassia are types of plants with very high CO2 absorption capacity. Meanwhile, trees with very low absorption capacity are Angsana and Asam trees.

Methods

The maximum emissions produced in the BNI 46 Simpang Jam Roundabout area, Banda Aceh City, were obtained by counting the number of vehicles passing through Jl. Tengku Abu Lam U, Jl. Sultan Iskandar Muda and Jl. Teuku Umar. Vehicle Volume calculations are carried out in accordance with the Ministry of Environment's Technical Instructions for Deconcentration Control of Mobile Source Air Pollution (2012).

After obtaining the total traffic volume, the calculation of vehicle emissions is adjusted to the literature review for each type of vehicle.According to Khoiroh (2014) emission calculations can be done using the following formula:

$$Q = Ni \times Fei \times Ki \times L \text{ ….....(1)}$$

Information :
Q = Number of emissions (gr/hour)
Ni = Number of type-i motorized vehicles (vehicles/hour)
Fei = Type-i motor vehicle emission factor (gr/liter)
Ki = Motor vehicle fuel consumption (liters/100 km)
L = Length of road (km)

Next, find out the total absorption capacity of carbon emissions by vegetation in the BNI 46 Simpang Jam Roundabout Area, Banda Aceh City. Primary vegetation data collection was carried out by direct observation of green open spaces and green belts in the research area. Then, measure the total carbon emissions absorbed by vegetation in the BNI 46 Simpang Jam Roundabout area, Banda Aceh City. Data regarding the ability of each vegetation to absorb carbon emissions was obtained from research by Aji (2018) and Suryaningsih (2015).

Table 1 CO2 absorption capacity based on tree type (Aji (2018) and Suryaningsih (2015))

Latin name	Local Name	CO2 absorption capacity (kg/tree/yr)	Absorption Rate
Samanea saman	Trembesi	28,488, 39	Very high
Cassia sp.	Cassia	5,295, 47	Very high
Canagium odoratum	Memories	756.59	Tall
Ficus benjamina	Banyan	535.90	Tall
Felicium decipiens	Umbrella sunshade	404.83	Somewhat High
Pometia pinnata	Matoa	329.76	Somewhat High

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

Swietenia mahoganii	Mahogany	295.73	Somewhat High
Tectona grandis	Teak	135.27	Currently
Acacia auriculiformis	Acacia	48.68	Currently
Delonix regia	Flamboyant	42.20	Currently
Mimusoph elengi	Cape	34.29	Currently
Acacia mangium	Acacia	15,19	Currently
Pterocarpus indicus	Angsana	11,12	Very low
Pithecelobium dulce	Kranji acid	8.48	Very low
Tamarindus indica	Sour	1.49	Very low
Casuarinaceae	Fir	60	Currently
Polyathia longifolia	Glondokan	1,016	Tall
Mangifera indica	Mango	445	Somewhat High
Arecaceae	Palm	52.52	Currently
Ravenala Madagascar	Banana Fan	1,559.1	Tall
	Tree	1,559.1	Tall

According to Khoiroh (2014) the conversion from CO to CO2 using the equation:

$$K = M \times Mr\ CO2(\frac{M}{Mr\ CO}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

Information:
K = Emissions CO2
M = Mass of CO (kg/year)
Mr = Relative molecular mass (CO of 28 and CO2 by 44)

According to Khoiroh (2014) the emission discharge that can be reduced by RTH in green belt areas can be calculated using simple mathematical calculations as below:

$$\text{Remaining CO2 emissions} = (A - B)(\frac{ton}{tahun})(\frac{ton}{tahun}) \ldots\ldots\ldots\ldots (3)$$

Information:
A = total CO2 emissions (ton/year)
B = total CO2 absorption capacity by plants (ton/year)

After calculating the emissions that can be reduced by RTH, we then obtained information on the addition of green open space vegetation in the BNI 46 Simpang Jam Roundabout area, Banda Aceh City. This is obtained by dividing the total emissionsCO2This area has been provided with vegetation that has absorbent capacityCO2tall. In this way, we can obtain the type and amount of vegetation that needs to be present in the area.

Results and Discussion

Each monitoring point shows different total CO emission results. The highest CO emissions were shown at the Simpang Jam gas station monitoring point in Banda Aceh. This is because this point is the entry point for vehicles from outside the city. The smallest CO emissions were obtained at the Taman Sari point. This is because this point is in the middle of an office area where at that

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

time there was not much employee activity. Total CO emissions in Kg/Year can be seen in **Table 1**.

Table 1. Total CO Emissions in Kg/Year

Calculation point	Total CO emissions				
	Volume of motorized vehicles/hour	CO emissions gr/hour	CO emissions Kg/hour	CO emissions Kg/day	CO emissions Kg/year
Putroe Phang	677	318,665.53	318.67	3,823.99	1,395,755.04
Museum	666	368,356.55	368.36	4,420.28	1,613,401.67
Gas Station	1370	712,090.23	712.09	8,545.08	3,118,955.21
Taman Sari	537	277,375.67	277.38	3,328.51	1,214,905.43
Total	3250	1,676,487.98	1,676.49	20,117.86	7,434,017.35

From converting CO to CO2 in accordance with Khoiroh (2014) the total emissions are known CO2 in the BNI Roundabout area 46 Simpang Jam Banda Aceh is 11,539,027 Kg/year.CO2can be removed or neutralized with vegetation, especially trees. Trees absorb CO2 for photosynthesis. Every tree has absorption capacity CO2 different.

Table 2. Type, Number and Absorption Capacity of Trees in the BNI 46 Simpang Jam Roundabout Area, Banda Aceh

Tree Types	Number of Trees	Absorption (Kg/tree/year)	Total Absorption Capacity (Kg/tree/year)
Tamarind	56	1.49	83.4
Cape	42	34.29	1,440.2
Flamboyant	14	42.2	590.8
Angsana	32	11,12	355.8
Mahogany	10	295.73	2,957.3
Trembesi	15	28,488.39	427,325.9
Venus	13	116.25	1,511.3
Banyan	12	535.9	6,430.8
Fir	11	60	660.6
Glondokan	39	1,016.42	39,640.4
Mango	7	445.11	3,115.8
Palm	17	52.52	892.8
Banana Fan	2	1,559.1	3,118.2
Bamboo	21	1,559.1	32,741.1
Coffee	1	1,559.1	1,559.1
betel nut	14	1,559.1	21,827.4
Tree	45	1,559.1	70,159.5
Total	351	38,894.97	614,410

Based on table two above, there are a total of 351 trees of different types in the BNI 46 Simpang Jam Round about Area, Banda Aceh. The most commonly found trees are Tamarind, Tanjung and Glondokan trees. Tamarind trees are often

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

planted on sidewalks and road medians. There are only fifteen trees in Trembesi, which has the highest absorption capacity of 28,488.39 Kg/Year. The total absorption capacity in the area is 614,410 Kg/Year or 614.41 Tons/Year. The remaining carbon emissions that are not absorbed around the BNI 46 Simpang Jam Roundabout Area in Banda Aceh are10,924,616.7 Kg/year.

Planting trees with absorbent capacity CO2 the high rate must be done immediately. However, the green open space in the BNI 46 Simpang Jam round about area in Banda Aceh cannot accommodate large numbers of new trees. The government can overcome this by replacing existing trees that are failing CO2 it is low with new trees having the power to fall CO2 tall one. According to Aji (2018) trees that have very high-rather high falling power are Trembesi, Cassia, Banyan, Kerai Payung, Kenanga. These trees are also included in the vegetation options for planting according to the RTH guidelines in 57 PERMENPU NUMBER 5 of 2012 concerning Guidelines for Planting Trees in Road Network Systems.

To absorb all emissions CO2 in the BNI 46 Roundabout area, Banda Aceh City, 405 Trembesi trees/ 2,179 58 Kasia trees/ 11,357 Glondokan trees/ 15,263 Kenanga trees/ 21,568 Banyan trees are needed. These five trees are trees with absorption capacity CO2 highest so it is suitable to choose. Apart from that, these trees are included in the recommended vegetation options for planting in RTH and Road Network Systems according to Minister of Public Works Regulation Number 5 of 2012 concerning Guidelines for Planting Trees in Road Network Systems. The government can combine several of these trees to fulfill the elements of usefulness, beauty and convenience of green open spaces.

Conclusion

In April 2020, the BNI 46 Simpang Jam Roundabout area in Banda Aceh City was passed by a total of 3250 motorized vehicles/hour. Total emissions in the area are 11,539,027 Kg/Year. The total vegetation in the area is 351 trees of different types with the largest type being Tamarind (Tamarindus indicae). The total absorption capacity of vegetation in this area is 614,410.30 Kg/Year. The remaining CO2 emissions that are not absorbed are 10,924,616.7 Kg/year. To overcome the total CO2 emissions in the area, 405 Trembesi or 2,179 Cassia or 11,357 Glondokan or 15,263 Kenanga and/or 21,568 Beringin are needed.

References

Aji, Ditya. Anggoro. (2018). Evaluation of the Potential Function of Plants as Absorbers of CO2 Gas Pollutant in the Bogor City Regional Ring Road Road Landscape. Thesis. Bogor: Bogor Agricultural Institute.

Central Bureau of Statistics. (2019). Banda Aceh City in Figures 2019.

Hakim, R and Hardi U. (2008). Landscape Architectural Design Components (Principles of Design Elements and Applications). Jakarta: PT. Literary Earth.

Hanum, L. (2006). Chemical environment. Banda Aceh: Syiah Kuala University Press.

Khoiroh, M. And Alia Damayanti. (2014). Analysis of the Ability of Green Road Roads as Public Green Open Space (RTH) to Absorb Carbon Monoxide

DOI : 10.22373/ijes.v2i1.4835
ISSN 3046-885X

(CO) Emissions from Motorized Vehicles in Sukolilo District, Surabaya. Surabaya: Sepuluh November Institute of Technology.

Machdar, I. (2010). Ecology and Environmental Pollution. Bandung: Citapustaka Media Printing.

Meutia, Z.D. (2020). Desain Lansekap sebagai mitigasi bencana. UNIMAL Press.

Miharja, et al. (2018). Analysis of the Need for Green Open Space as an Absorber for Carbon Gas Emissions in the City and Buffer Areas of Malang City. Journal of Sustainable Environmental Management. 2 (3). 165-174.

Ministry of Environment. (2012). Technical Instructions for Deconcentration for Air Pollution Control.

Ministry of Public Works. (2012). Minister of Public Works Regulation Number 5 of 2012 concerning Guidelines for Planting Trees in Road Network Systems.

Rawung, FC (2015). Effectiveness of Green Open Space (RTH) in Reducing Green House Gas (GHG) Emissions in the Boroko Urban Area. Matrasain Journal. 12(2). 17-32.

Soedomo, M. (2001). Air pollution. Bandung: ITB Publishers.