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An Analysis of The Adequacy of Green Lane Vegetation In Absorbing The Carbon Monoxide (CO) of Transportation Activities

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Abstract: *Jenderal Sudirman Street is a national road with a length of 1.510 km and serves as an arterial road located in Maros Regency with an average of 8,030 motorcycles and 5,314 units of cars at peak hour. The purpose of this research was to determine the adequacy of green lane vegetation in absorbing carbon monoxide (CO) released by motor vehicle traffic on the Jenderal Sudirman road segment Maros. This research method using descriptive analysis of quantitative and qualitative involves taking the data of the number of motor vehicles passing through the road at peak hour and the number and type of vegetation of Sudirman Street. The results showed that emissions generated from motor vehicles reached 1,759.69 tons/year and absorption of existing vegetation of 1,204.19 tons/year. Green Open Space (GOS) and Green Lane on the road are not able to absorb CO emissions from transportation activities evidenced by the remaining emissions of 556.49 tons/year or can only absorb CO emissions of 68.43% of the sector transport. There is a need to plant and increase the amount of vegetation on the green lane that is able to reduce the CO concentration well, which has the physical characteristics of wide, leafy leaves and solid leaf mass such as Ketapang (tropical almond), Angsana (amboyna) and Mahogany besides being able to absorb pollution also has interesting leaves and flowers namely Puring (Croton) and Oleander.*

Keywords: *Carbon Monoxide Emissions, Vegetation Absorption, Green Open Space*

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I. Introduction

Transportation is necessary in supporting the progress of big cities in the world, but on the other hand, this increase will also bring unintended negative effects [1]. Planning factors of the transportation system greatly affect the spread of pollution emitted following the planned transport routes [2]. Air pollution negatively affects human health due to pollutants emitted by motor vehicles, from some types of pollutants produced; carbon monoxide is one of the most pollutants emitted by motor vehicles [3].

Jenderal Sudirman Street is the primary arterial road located in the Maros Regency city center with various activities spread, ranging from offices, shops, restaurants, markets, and places of worship. Based on data from Samsat Maros Regency, the number of vehicles in Maros Regency until the end of 2016 reached 69,065 units, consisting of 59,156 two-wheeled vehicles and 9,909 four-wheeled vehicles. The number continues to grow compared to the previous, which is 62,380 units of vehicles (2015), 53,817 units (2014). Indirectly, the growth of motor vehicles contributes to global warming and climate change. The solution to solve the vehicle emission problem is to use the vegetation technology for CO_2 absorption [4]. Roadside vegetation can serve as an emission/ pollutant emitting load, trees often referred to as urban lungs and a number of broadleaf trees are believed to absorb air pollutants [5, 6].

The green open spaces around the urban areas are dwindling will lead to increased concentrations of carbon dioxide and decreased oxygen concentration in the air. Efforts to prevent the condition from occurring or at least be offset require a sufficient green open space for the amount of carbon sinks to be equal to the amount of air pollutants so that the environmental quality is maintained properly [7]. Plants to be planted should have many benefits of ecological, aesthetic, safety, and road users [8].

II. Methodology

Data needed in this research is primary data and secondary data. Primary data is data obtained through direct observation in the field while secondary data is data obtained from literature studies, previous research, or from government agencies or organizations/other bodies. Primary data are taken for this research is data of the number of motor vehicles passing on the Jenderal Sudirman Street. The data are taken using a counter, the survey results the number of vehicles calculated to obtain CO emissions. The vehicle survey was conducted for three days, Monday, October 2nd, 2017, Friday, October 6th, 2017 and Sunday, October 8th, 2017. The Deconcentration Technical Directive of Air Pollution Control Source Moves that to obtain a full day vehicle volume in a traffic stream, at peak hour is limited to 4 hours is morning (06:00 to 08:00), noon (11:00 to 13:00), afternoon (at 16:00 to 18:00) and evening (19:00 to 21:00) [9]. Types of motor vehicles calculated at the time of the survey were light-gasoline and diesel vehicles, heavy goods transport vehicles, buses and motorcycles.

Emissions Expense Analysis

The amount of carbon monoxide emissions is obtained from the calculation of the number and type of vehicle passing through the road during peak hours multiplied by the emission factor of each vehicle [10]. The resulting emissions are the maximum emission load. The emission calculation will be calculated by the following formula:

Q = n x FE x K x L ………………………………………………………………. (1)

Where:
Q = emission strength (grams/hour)
N = number of vehicles (unit/hour)
FE = emission factor (gram/liter/vehicle)
K = fuel consumption (liter/100 km)
L = length of road (km)

Analysis of Vegetation Absorption Power

The primary data collection of vegetation was carried out by direct observation of green lane green space along the Jenderal Sudirman Street, which will then be classified based on the type and amount of vegetation and its absorption. The value of tree absorption using the previous research results is presented in Table 1. For the existing tree vegetation not contained in Table 1, the vegetation is classified and searched for close relatives of vegetation in Table 1 and then its absorptive value follows the vegetation of close relatives. This vegetation classification analysis can use the online website of plantamore.com which provides information on various vegetation and its close relatives.

Table 1. Capability of CO2 absorption by plants {11}

Name	**Scientific name**	**CO_2 Absorption Power (kg/tree/year)**
Trembesi	Samanea saman	28.448,39
Cassia	Cassia sp	5.295,47
Kenanga	Canangium odoratum	756,59
Pingku	Dysoxylum excelsum	720,49
Banyan tree	Ficus benyamina	535,90
Krey umbrella	Fellicium decipiens	404,83
Matoa	Pornetia pinnata	329,76
Mahogany	Swettiana mahagoni	295,73
Saga	Adenanthera pavoniana	221,18
Bungkur	Lagerstroema speciosa	160,14
Teak	Tectona grandis	135,27
Jackfruit	Arthocarpus heterophyllus	126,51
Johar	Cassia grandis	116,25
Soursop	Annona muricata	75,29
Puspa	Schima wallichii	63,31
Acacia	Acacia auriculiformis	48,68
Flamboyan	Delonix regia	42,20
Sawo kecik	Manilkara kauki	36,19
Cape	Mimusops elengi	34,29
Peacock Flowers	Caesalpinia pulcherrima	30,95
Sempur	Dilena retusa	24,24
Khaya	Khaya anthotheca	21,90
Merbau beach	Intsia bijuga	19,25
Acacia	Acacia mangium	15,19
Amboyna	Pterocarpus indicus	11,12
Asam kranji	Pithecelobium dulce	8,48
Handkerchief	Maniltoa grandiflora	8,26
Red dadap	Erythrina cristagalli	4,55

Rambutan Sour Kempas	Nephelium lappaceum Tamarindus indica Coompasia excels	2,19 1,49 0,20

III. Results And Discussion

Calculation of Carbon Monoxide Emissions

The calculation of motor vehicle volume for 3 days aims to determine the number and types of vehicles that pass and will be calculated carbon emissions generated according to the type of vehicle. The number of vehicles on Jenderal Sudirman Street is shown in Figure 1.

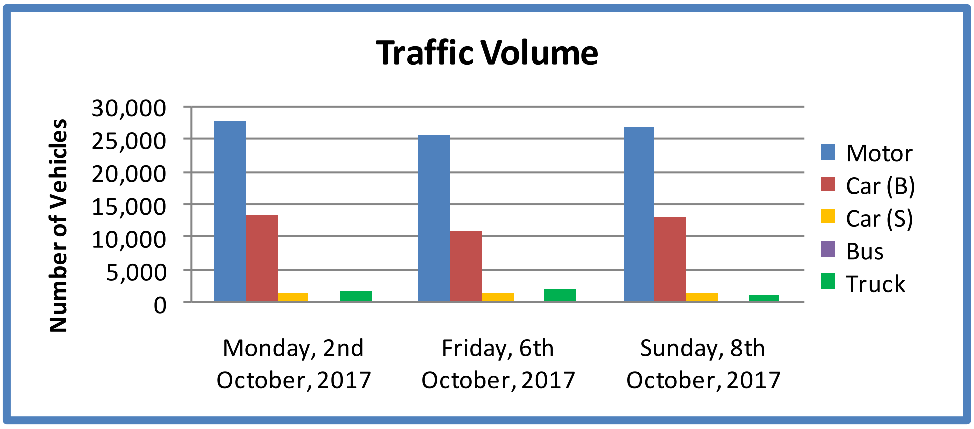

Figure 1. Number of Vehicles per hour

The calculation of the emission load is calculated by the value of the emission factor by type of fuel and the type of vehicle and fuel consumption [12].

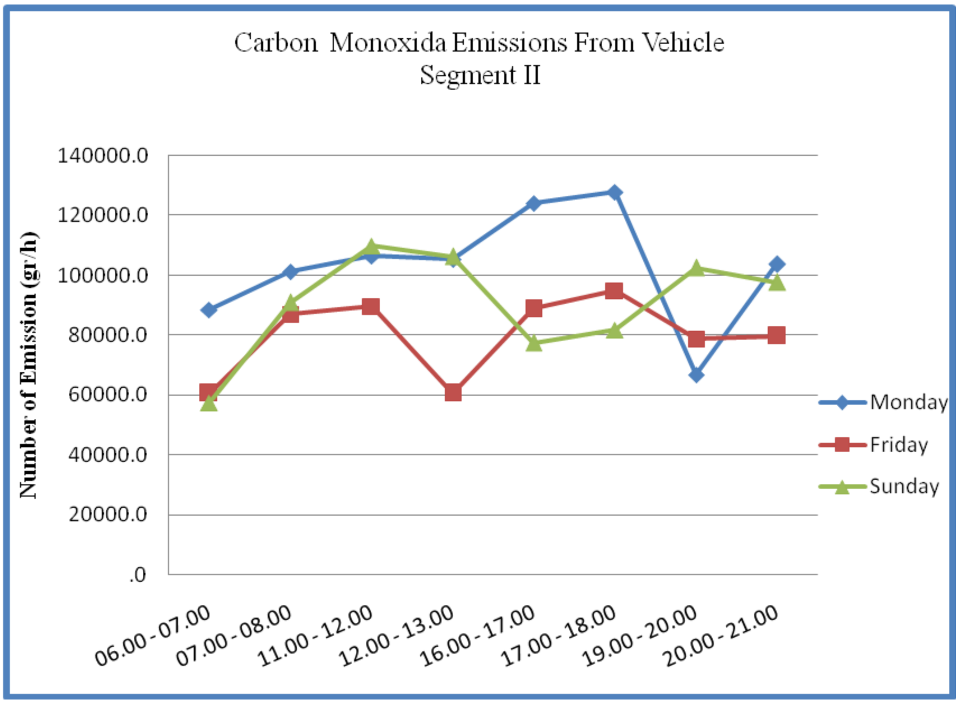

Figure 2. CO Emission strength of Jenderal Sudirman Street

In figure 2 the amount of CO emission at peak hour is 127, 831.03 gram/hour or 1,119,799.84 kg/year converted from CO to CO2, which aims to simplify plant to absorb carbon in the further photosynthesis process. The calculation results from CO to CO2 conversion [13] as follows:

CO2 Emission Concentration (K) = [(1,119,799.84 kg/year)/28) x 44]
= 1.759.685, 47 kg/year or 1,759.69 tons/year

Calculation of Vegetation Absorption Power

Based on the survey results in the green line of Jenderal Sudirman Street Maros along 1.510 km, there are two types of vegetation, namely tree type and bush type. There are 14 species of trees and 7 species of bushes. Vegetation has a different absorbing ability. Calculation of absorption capacity of tree and bush species can be seen in Table 2 and Table 3.

Table 2. Tree Absorption Ability on Jenderal Sudirman Street

Name	**Category Plant**	**Number**	**Total Absorption (kg/year)**
Trembesi	Big tree	39	1,109,487.21
Angsana	Big tree	61	678.32
Mahogany	Big tree	3	887.19
White teak	Big tree	4	541.08
Red flowering	Medium tree	2	9.10
Bitti	Big tree	81	10,956.87
Bintaro	Medium tree	28	45.029,60
Mast-*Glodokan*	Gmedium tree	27	16,254.81
Cerlih tail palm	Small tree	48	2,103.36
Pucuk merah	Medium tree	121	5,302.22
Mango	Medium tree	5	662.25
Cherry	Medium tree	2	3,216.40
Palem kipas	Small tree	2	357.38
Puring	Small tree	11	7,949.7
Total		**476**	**1,203,435.49**

Source: Result of analysis, 2018

The area of the canopy of bush vegetation is obtained from the length (m) and width (m) of each shrub type. The unit of the canopy area converts to acres to multiply by the absorbency value of a 55,000 kg/ha/year bush type cover [14].

Table 3. Absorption Capability of Bushy Plants

Name	**Scientific name**	**Bush Area** (Ha)	**Absorption** (kg/year)
Bongenville	*Boungenvillea spectabilis*	0.00602	330.88
Lili paris	*Spider plant*	0.00504	277.42
Lidah mertua	*Sansevieria sp*	0.00052	28.6
White Agape	*Agave americana*	0.00028	15.18
Airis	*Neomarica longifolia*	0.00082	45.32
Rombusa	*Passiflora Foetida*	0.00027	14.74
Green Gandarusa	*Justicia gendarussa*	0.00084	46.42
Total		**0.01379**	**758.56**

Based on the result of the sum of absorption of 1,203,435.49 kg/year and the absorption capacity of 758.56 kg/year, the total absorption rate of vegetation is 1,204,194.05 kg/year.

Calculation of Remaining Emissions

After the calculation of total emissions due to motor vehicles and data collection of the number, and type of existing vegetation green open space to know the adequacy of the current vegetation in absorbing CO2 emissions that have been converted into CO2, must be calculated the remaining emissions from processing these two data. Here is the calculation of CO2 emissions remaining [15] on Jenderal Sudirman Street by using emission residual formula:

Remaining emissions = CO_2 emissions (kg/year) - Total absorption of vegetation (kg/year)
= 1,759,685.47 kg/year - 1,204,194.05 kg/year
= 556,491.42 kg / year or 556.49 tons/year

From the calculation, indicating that the existing vegetation in Sudirman road currently has not been able to absorb CO emissions due to good motor vehicle activity due to the remaining emissions on the Jenderal Sudirman Street Maros.

In reducing emissions CO necessary planting and the addition of vegetation, able to reduce the concentration of CO well that *Ketapang* (tropical almond) has the features of the width, *Angsana* (amboynas) and mahogany has a leaf mass solid grown on the edge of the road in Figure 3. The median road need to be the addition of plants, shrubs that can absorb pollution and has a value of leaves and interesting flower that *Puring* (Croton) and *Oleander* in Figure 4.

a b c

Figure 3. The Plants Absorbent Pollution recommended;
a. Ketapang (Tropical almond), b. *Angsana* (Amboyana), C. Mahogany.

Figure 4. The Plants need to the median road recommended;
a. *Puring*, b. *Oleander*

IV. Conclusion

The amount of carbon monoxide emissions generated from motor vehicles in the segment of Jenderal Sudirman Maros reached 1,759.68 tons/year. Ability of existing vegetation is only able to absorb 1,204.19 tons/year so that green road vegetation has not been able to absorb CO emissions due to good vehicle activity with evidenced still the remaining emission on Jenderal Sudirman Street that is equal to 556,49 ton/year or absorbed equal to 68 , 43% CO of transportation sector so it needs to be done planting and addition of amount of vegetation on green lane that able to reduce CO concentration well that is *Ketapang*, *Angsana* and *Mahoni* and also for shrub i.e *Puring* and *Oleander*.

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