Adequacy measurement of public green open space (GOS) in absorbing carbon dioxide (CO$_2$) emissions from transportation activities in Tampan district, Pekanbaru

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Abstract. Green Open Space (GOS) is one of the efforts to deal with increasing greenhouse gas (GHG) emissions because it can absorb CO$_2$ emissions. Transportation activities cause high CO$_2$ emissions, and the lack of public green open space, which results in the ability of green open space to absorb emissions, is not optimal. The intensity of traffic activity is getting more and more crowded, which will impact the surrounding community. This study aims to determine the level of adequacy of public green open space (GOS) in absorbing carbon dioxide (CO$_2$) emissions from transportation activities. This study uses a literature review approach. The results obtained are the adequacy of public green open space in absorbing emissions from transportation and so that solutions are obtained to carry out policies in reducing air pollution produced by vehicles, and the importance of green open spaces (GOS).

1. Introduction

More than half of the world's population lives in cities, where the right transportation system in one place, especially at the peak of congestion, often causes congestion [1]. Transportation produces carbon dioxide gas (CO$_2$) which is the most important greenhouse gas [2], and the interaction with global warming and climate change sectors [3]. According to Shaheen (2007), the transportation sector is the main contributor to greenhouse gas emissions. Transportation sector emissions are predicted to increase very rapidly in the next few decades.

The population in Pekanbaru City is increasing rapidly, especially in the Tampan District, with a population in 2018 reaching 307,947 people, an increase from 2017 of 6.96% [4]. An increase follows in the number of motorized vehicles, which directly determines the air quality of Pekanbaru City. On a practical day, the number of vehicles on Jalan H.R. Soebrantas, an arterial road in Tampan District, reaches 118,227 vehicles [5]. The heavy traffic in Tampan District can occur because several roads in Tampan District are also used as Sumatran cross paths, resulting in many motorized vehicles every day. The fast economy also increases climate change, especially CO and CO$_2$ emissions, using motorized vehicles as transportation capital [6].

CO$_2$ emissions resulting from transportation activities must be addressed because they cause negative impacts on the environment and living things. With the availability of Green Open Space (GOS), it is necessary for a city with a vital role in the environment. Green open space is helpful as the city's lungs and as a water catchment area, filtering air pollution, reducing noise levels, recreation areas, and habitat
for various animals, especially birds. Green open space is one of the essential elements that can control
the quality of the urban environment [7].

GOS is an area that a city must provide. It is in line with the provisions in Law number 26 of 2007
concerning Spatial Planning article 29, which states that the proportion of green open space in the city
area is at least 30% of the city area. GOS consists of public and private green open space where the
proportion of public green open space is at least 20% and private green open space is 10% of the city
area. According to article 30 of the Spatial Planning Law, the distribution of green open space is adjusted
to the distribution of the population and the hierarchical structure of urban space. Based on these
considerations, green open space is considered the right way to reduce CO₂ emissions, the most
significant greenhouse gas emission (GHG).

2. Methodology
The tools used in this research are manual counter, camera recorder, stationery, and computer
equipment (Google Earth, Google Maps, and Microsoft Excel) [8].

3. Results and discussion

3.1 Public GOS data collection

3.1.1 Type and amount of public green open space. Measuring tree diameter is carried out by measuring
the tree trunk's diameter as high as data/diameter at breast height (DBH) or 1.3 m above ground level
and tree diameter 20 cm [9].

3.1.2 Type and amount of vegetation. This data collection is done by identifying what types and
vegetation there are in the study location.

3.2 Daily Traffic Data (LHR)
The number of motorized vehicles passing through the study location will be obtained by calculating
traffic counting. Traffic counting is a method in traffic surveys. In this method, traffic volume
calculations are carried out on roads which are grouped into types of vehicles, namely: Light Vehicles
(LV), Heavy Vehicles (HV), and Motorcycles (MC), and the period is carried out at peak hours.

3.3 Calculation of conversion of the number of vehicles to passenger car units (SMP)
The calculation is carried out in the following way (MKJI, 1997):
\[ n = m \times FK \] (3.1)

Information:
\( n \) = number of vehicles (SMP)
\( m \) = number of vehicles
\( FK \) = conversion factor (SMP/Vehicle)

3.4 Calculation of conversion of the number of vehicles to passenger car units
From the results of primary data measurements and supported by secondary data from the results of
measuring the number of vehicles at the study location, then the data will be processed to obtain CO₂
concentrations, using the equation:
\[ Q = n \times FE \times K \times L \] (3.2)

Information:
\( Q \) = Total emission (Kg CO₂)
\( n \) = Number of Vehicles (SMP)
\( FE \) = Emission factor (Kg CO₂/liter)
\( K \) = Fuel consumption (Liters/100km)
\( L \) = Road Length (km)
An emission factor is defined as the average rate of pollutant emission released against the activity level. The emission factor is a factor to estimate the amount of emission from an air pollutant source.

### 3.5 Calculation of absorption power of existing green space

Processing of existing green space data based on the number and type of protective trees in the existing green open space that can absorb carbon dioxide (CO$_2$) by calculating using the following formula:

$$ C = A \times B $$ (3.3)

**Information:**
- $A$ = CO$_2$ absorption (according to tree type)
- $B$ = Number of trees (grouped by type)
- $C$ = Total CO$_2$ absorption by trees

The calculation of the absorption of the existing green open space is based on the total number of shade trees that can absorb carbon dioxide using the following formula:

$$ D = C_1 + C_2 + C_3 + \text{etc} $$ (3.4)

**Information:**
- $C_1$ = Total CO$_2$ absorption by tree 1 (example: Mahoni)
- $C_2$ = Total CO$_2$ absorption by tree 2 (example: Beringin)
- $C_3$ = Total CO$_2$ absorption by tree 3 (example: Jati)

### 3.6 Green open space absorption capacity (GOS) on carbon dioxide emissions.

The percentage of Green Open Space Absorption Power (GOS) on carbon dioxide emissions was analyzed by comparing the amount of carbon dioxide emissions produced by transportation activities with the absorption of carbon dioxide by green open space in Tampan District.

$$ \% \text{ GOS} = \frac{\text{absorption GOS}}{\text{CO}_2 \text{ emission}} $$ (3.5)

### 4. Conclusion

The amount of CO$_2$ emissions resulting from transportation activities in Tampan District is 5,760,587.31 kg CO$_2$/day or 2,102,614,367 kg CO$_2$/year, while the absorption capacity of public green open space is only 7,979,245.86 kg CO$_2$/year. So, there are remaining CO$_2$ emissions that have not been absorbed, which is 2,094,635,121 kg CO$_2$/year. The percentage of CO$_2$ emission absorption by public green open space in Tampan District is only 0.38% [2]

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