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Analysis of The Need for Green Open Spaces in Reducing CO_2 Carbon Dioxide Emissions in the Bahteramas Hospital Area of Southeast Sulawesi Province

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A R T I C L E I N F O

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A B S T R A C T

This study aims to determine CO_2 emissions resulting from transportation sources, residents, electricity and the ability of green open spaces (RTH) to reduce CO_2 gas emissions in the Bahteramas Hospital Area. This research was conducted in December 2022-January 2023 at Bahteramas Baruga Hospital, Kendari City, Southeast Sulawesi Province. The results showed that the highest CO_2 emission load was generated from the use of electricity with a total of 54,119 kg/day, then population emissions were 4,933 kg/day, while the lowest emission load was generated from CO_2 transportation emissions of 4,437 kg/day. The total emission generated in the Bahteramas Hospital Area is 63,489 kg /day. The ability of green open space to reduce CO_2 emissions is 8,399 kg/day so that it still has residual CO_2 emissions that have not been able to be absorbed by the existing green open space of 55,090 kg/ day.

INTRODUCTION

Green open space is part of the urban spatial planning arrangement which has the function of providing a balance between environmental quality and the progress of a city. The RTH itself consists of 20% public green open space and 10% private green open space from the area of the city's administrative area. Functionally, its existence will provide beauty, comfort, education, protection and maintain the ecological stability of the city itself. Public RTH is a green space

that is open to the public and can be utilized by the general public as a space for interaction and communication between communities (Dewanti *et al.* , 2009).

RTH is the preparation of space as open land planted with various types of plants and plantss for shade or protection. The main function of RTH is to overcome environmental conditions such as air pollution where green open spaces have the ability to produce oxygen (O_2) and absorb carbon dioxide (CO_2) through the process of photosynthesis (Febriansyah *et al* ,. 2022)

Open space in the hospital area is a form of implementing *the green hospital policy* . *The green hospital* policy is a hospital (hospital) that is designed, built/renovated and operated and maintained taking into account the principles of health and a sustainable environment, the *green hospital policy emphasizes the importance of* environmental management to create a healthy and safe environment.

Referring to Permenkes No. 7 of 2019 , About health environment House sick . *Green hospital* policy emphasizes the importance of environmental management to create a healthy and safe environment. Among them are adding green open spaces and creating a smoke-free hospital area which is expected to contribute to improving air quality in and around the hospital .

House Sick Regional General Hospital (RSUD) Bahteramas standing above land area of 17.5 Ha. Whole area building is 50,540 m^2, Realized building area until with end in 2021 is 49,537 m^2. Existing building have level very high activity. Grouping room based on function so that become four group, that is group activity hospital services, groups activity support medical group activity non- medical support , and groups activity administration . Expected environment is safe , orderly, clean and comfortable for patients, visitors and hospital staff .

Bahteramas Hospital is a central hospital reference biggest in the Southeast Sulawesi region. Energy sector is contributor biggest house gas glass especially CO_2 compared sector transportation, biggest CO_2 emissions from use electricity originate from activity in the building as well Healthy services. Condition currently is a built-up area as well as use material burn fossils and gases as source CO2 emission keep going increase will but this condition is not offset with green space area. The added amount Bahteramas Hospital staff and patients need to adding RTH for capable absorb $CO2$ gas in the Bahteramas Hospital area. The location of Bahteramas Hospital which is in the area congested traffic usually have indicated RTH For place activity employees, patients, and society . However almost part big center Education, offices and hospital areas are lacking notice the existence of owned RTH .

Based on this, it is necessary to conduct a study regarding the need for green open space to reduce CO2 emissions at Bahteramas Hospital, Southeast Sulawesi Province. The aim of this research is to know deep Green Open Space capabilities reduce emission CO_2 in the Bahterasmas Hospital and determine recommendation subtraction emission carbon dioxide .

RESEARCH METHODS

Time and Place

This research was conducted at Bahteramas Hospital, Southeast Sulawesi Province. The coordinate points in this study are at 04°01'52" South Latitude 122°29'33" East. This research was conducted from December 2022 to January 2023.

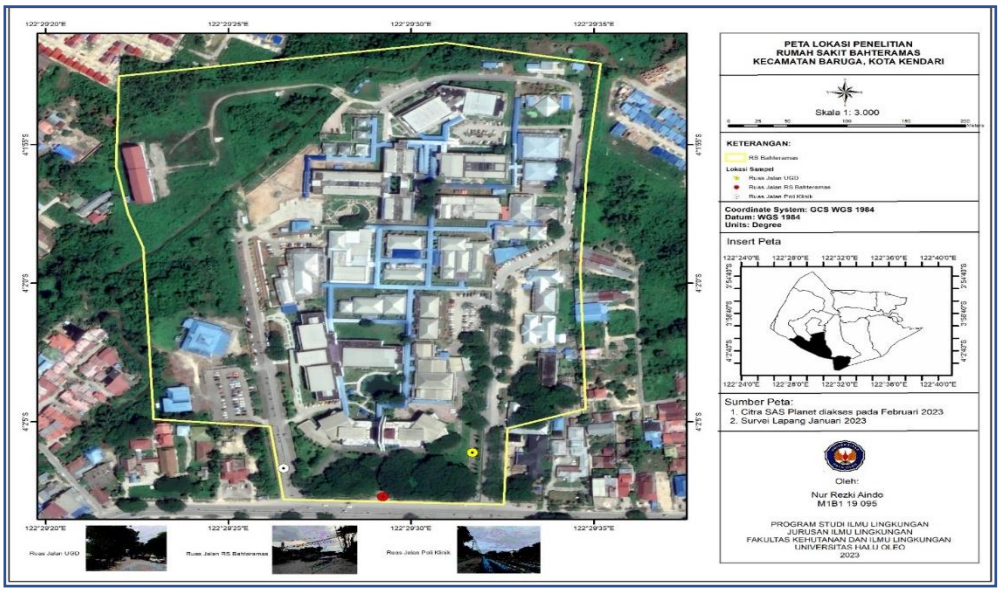

Figure 1. Map of Research Locations

METHOD OF COLLECTING DATA

Types of research data in this research is quantitative data. Quantitative data in this research is amount emission carbon CO_2 generated in motor vehicle, respiration human, electricity use, quantity and type of the existing vegetation on the site research . Data collection techniques are observation and direct measurement.

DATA ANALYSIS

1. Observation direct in the field see how much big vehicles passing through the Bahteramas Hospital.
2. Analysis the resulting Carbon Dioxide emissions of motor vehicle with method *traffic counting method* (Roshinta , 2016).

$$Q = Ni \; x \; Fi \; x \; Ki \; x \; L$$

Where Q is amount of CO2 emissions (g/hour), Fi is number of type – I motor vehicle Tipe- I (vehicle/hour), Ki is specific energy consumption of type I vehicles, and L is road length.

3. Analysis of Carbon Dioxide emissions produced by Man Respiration (Laras , 2020)

CO_2 emission = n x FE

Where Fe is Emission Factor, and n is number of object

4. Analysis the resulting CO_2 Carbon Dioxide emissions use electricity (Fidayanti , 2016)

CO_2 emissions = kWh of use ability x factor emission

5. Calculation ability vegetation in the existing green open space done with especially formerly do calculation to type plantss in the existing RTH in absorb CO2 emissions (Barrel _ *et* al., 2021)

absorb CO2 Ability in Existing RTH = absorb ability of CO2 by Plants Type x number of Plants

6. RTH Evaluation
   After know Ability absorb the existing RTH furthermore calculate the total emissions remainder (Lestari *et al.,* 2021).

Total emissions remainder = total of emission x total of absorb ability

RESULTS AND DISCUSSION

Open Space Capabilities green in reduce emission carbon CO_2 dioxide is seen from this research namely the resulting CO_2 emissions from vehicle motor, respiration human, use electricity and amount and type existing vegetation in the Bahteramas Hospital of Southeast Sulawesi Province.

CO2 emission Transportation

Transportation sector have important role in pollution air and main source pollution air. Use material burn oil in the sector transportation specifically gas will emit compounds such as CO (carbon monoxide), THC (total hydrocarbons), TSP (dust), Nox (nitrogen oxides), Sox (sulfur oxides) and also carbon dioxide (CO_2) (Nurjidah , 2014).

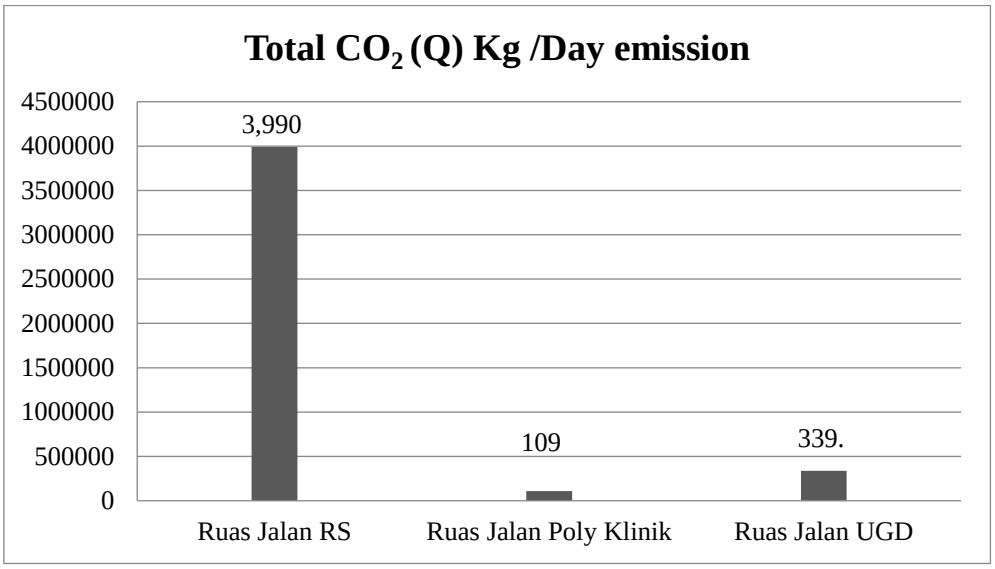

Figure 1. Total emission each path per location study

Based on results study the resulting emissions from source vehicle motorized highest is on the segment road Bahteramas HospitalSoutheast Sulawesi Province of 3,990 kg CO_2/ day.

Human CO_2 Emission

Respiration man capable produce carbon dioxide of 3.2 kg CO_2 / day soul or equivalent to 0.13 kgCO_2 / hour of life , Laras (2020).

Table 1. Total CO_2 Emissions of Human Respiration

No	Resident	Amount	Total Emissions kg CO_2 Person/day
1	Employee	1063	3,317
2	Outpatients	332	1036
3	Inpatients	43	134
4	Commuters (Visitors 10%)	143	446
	Total	1581	4,933

Source : *Primary Data (Results of Analysis , 2023.)*

Based on results study the resulting CO_2 emissions respiration people in the hospital Sourced Bahteramas from Employee of 3,317 kg CO_2 souls/ day, patient take care road as big 1,036 kg CO_2 souls/day , patient take care stay 134 kg CO_2 jiwa/day and commuter 10% 446 kg CO_2 souls/day of total sourced emissions from respiration man of 4,933 kg CO soul/day.

Electric CO_2 Emissions

Indonesia in 2011 , obtained results that people living in urban areas big is contributor house gas emissions glass the largest in the country and almost 40 to 50%, greenhouse gas emissions glass That originate from use tool electronics . Even for DKI Jakarta, greenhouse gas emissions glass caused by use goods electronic reached 75.3% of the total emissions (Rizki *et al* ., 2016).

Source emission carbon the dioxide successfully identified in the Bahteramas Hospital area on use electricity each daily average consumption 75,269 kWh/ day.

Table 2. Total CO_2 Emissions Electricity Usage

Use kWh electricity	Factor emission	CO_2 emission kg kwh/ day
75,269	0.719	54,119

Source : *Primary Data (Results of Analysis), 2023.*

Existing green open space absorption capacity

There are a large number of trees, but if the absorption capacity is not high enough it will not be able to reduce existing emissions. Based on results study there are 2 types plants that has Ability high CO_2 absorption that are mahogany and trambsession, Trambesi has an average diameter and height more than other plants. However, there is no direct suspicion that plant height and diameter are an impact on the plant's ability to absorb CO_2 emissions according to research by Superales (2016).

Table 3 shows the results of calculating the types and number of trees in the Bahteramas Regional Hospital area and data on the absorption capacity of each type of tree. It is known that the type of tree that has the highest absorption capacity for CO_2 gas emissions in the Bahteramas Regional Hospital Area is the trambesi tree with a total absorption capacity of 7,638 kg/day with a total of 98 trees. Meanwhile, the type of tree that has the lowest absorption capacity for CO_2 emissions is bougainvillea with an absorption capacity of 0.074 kg/day from 12 trees. Based on the results of calculating the total absorption capacity of tree species in the green open space in the Bahteramas Regional Hospital area, it was found that the total CO_2 gas emissions that can be absorbed by trees in the existing green open space is 8,399 kg/day.

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Table 3 Survey results Type plantss in the Existing Green Open Space

No	PlantsName	Latin name	CO_2 Absorbency (Kg/Hour)	Number of Plantss	Total CO_2 Absorption Capacity (Kg/Day)
1	Trembesi	*Samanea Saman*	3.24 75	98	7 638
2	Squirrel tail palm	*Wodyetia Bifurcata*	0.00039	53	0.496

No	PlantsName	Latin name	CO_2 Absorbency (Kg/Hour)	Number of Plantss	Total CO_2 Absorption Capacity (Kg/Day)
3	Pole poles	*Polyathia Longifolia*	0.1044	59	147,83
4	Ketapang	*Terminalia Catappa*	0.0242	7	4 ,06
5	Cape plants	*Mimusops Elevate*	0.1944	30	139, 96
6	Red shoots	*Syzygium Sinubanense*	0.15558	58	216.56
7	Spruce	*Casuarinaceae*	0.1044	4	10 .022
8	Mang o	*Mangifera indica*	0.02416	10	12.48
9	Golden crabs	*Terminalia Mantaly*	24,16	31	1 7,97
10	coconuts	*Cocos Nucifera*	0.0918	20	44 ,06
11	teak	*Tactona Grandis*	0.01241	4	1 ,19
12	Banana plants	*Musa Paradisiaca*	0.0174	3	1.25
13	Yellow palm	*Dypsis Lutescens*	0.00039	8	0.7 4
14	Princess palm	*Veitchia Merillii*	0.0055	12	0.79
15	Bintaro	*Cerbera odollam*	0.0969	6	13.95
16	Maho gany	*Swietenia Mahagoni*	3.11243	2	149 ,3
17	MacArthur palm	*Ptychosperm*	0.0055	6	0.792
18	Bougainvillea	*Bougainvilleas*	0.00 026	1 2	0.074
	Total				8,399

Source : *Analysis Results, 2023*

Remainder Carbon Emissions

Based on results of study, remainder emission carbon dioxide generated in the hospital ark reached 55,090 kg CO_2/day. This is appropriate with research conducted by the *Institute For Essential Reform* (IESR) Indonesia in 2011, obtained results that people living in big urban areas is the largest contributor of greenhouse gas emissions in the country and nearly 40% to 50%, greenhouse gas emissions originate from use electronic tools. Even for DKI Jakarta, greenhouse gas emissions caused by use electronic reached 75.3% of the total emissions (Rizki *et al*., 2016). With addition type of vegetation that can reduce emission of CO_2 in the atmosphere through the process of photosynthesis. Plants as element of landscape have more capability to absorb and store CO_2 (in biomass plants) compared to the other type of plants (Lukmanniah and Fatima, 2016).

Table 4. Remains CO_2 emissions

Total Emissions (Kg CO_2 / Day)	Absorption _ (Kg CO_2 / Day)	Remainder Emission (Kg CO_2 / Day)
63,489	8,399	55,090

Source : Primary Data (Results of Analysis), 2023

Glodokan (*Polyalthia longifolia*) has abilitymto absorb high CO2 emissions, so that suitable used as plant shade road. According to results study by Hastutiningrum *et al*., (2018) Glodokan plants (*Polyalthia longifolia*) is very good in absorb Pb and CO_2 in the air.

CONCLUSION

Based on results of study, Amount of CO_2 gas emissions produced in the Bahteramas Hospital Area are from emission of vehicle motorized with 4,437 kg CO_2/day, Human respiration by 4,933 kg CO_2/day, and CO_2 emissions from electricity by 54,119 kg CO_2/day. The total amount of CO_2 emissions in the Bahteramas Hospital Area is 63,489 kg CO_2/day. The existence of green open space in the Bahterasmas Hospital area has not been able to reduce all CO_2 gas emissions, as much as 55,090 kg CO_2/day CO_2 emissions that have not been absorbed in the Bahterasmas Hospital Area.

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