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MAPPING OF CO_2 EMISSIONS TO IMPROVE THE FUNCTION OF GREEN OPEN SPACE (RTH) IN KEDIRI CITY

LISANUDIN RAHMAN[1], MOHAMMAD RAZIF[2], SAMSUDIN AFFANDI[3], MOCHAMAD JUNAIDI HIDAYAT[4], SATRIA FADIL PERSADA[5] AND PRAWIRA FAJARINDRA BELGIAWAN[6]

[1,2,3] Environmental Engineering Master Program, Institute Technology of Adhi Tama Surabaya, Jl. Arief Rahman Hakim 100 Surabaya 60117, Indonesia
[4] Product Design Department, Institute Technology of Adhi Tama Surabaya, Jl. Arief Rahman Hakim 100 Surabaya 60117, Indonesia
[5]Department of Business Management, Institute Technology of Sepuluh Nopember Kampus ITS Sukolilo Surabaya 60111, Indonesia
[6]School of Business and Management, Institute Technology of Bandung Jl. Ganesha 10 Bandung 40132, Indonesia

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ABSTRACT

This study aims to calculate CO_2 emissions from the transportation, household, and industrial sectors to be compared with the absorption capacity of CO_2 by vegetation in public green open spaces in Kediri City. It is expected to improve the function of public green open spaces. The method of calculating CO_2 emissions in the transportation sector was calculated from the value of the emission factor and the number of vehicles from the 2019 data. The method of calculating CO_2 emissions from the household and industrial sectors was based on emission factors and fuel consumption. The calculation of CO_2 emissions from the transportation sector in 2019 was 59,740,551 tons/year, while CO_2 emissions from the household sector in 2019 were 4,110,028,315 tons/year. CO_2 emissions from the industrial sector in 2019 were 3.19774x1,012 tons/year. Based on the results of observations and calculations, the CO_2 absorption capacity of the vegetation in the public green open space in 2019 was 159,283,042 tons/year. It means that the ability to absorb 3.8% of CO_2 emissions was produced by the transportation and residential sectors. Meanwhile, from the area of public green open space currently, it only reaches 8% of the total area of Kediri City. Based on the Regional Regulation of Kediri City Number 2 of 2004, the minimum area of public green open spaces is 20% of the total area of Kediri City. From the results of these calculations and observations, three clusters have been compiled to improve the function of green open space. R1cluster, in 17 sub-districts, needs to maintain the vegetation quality. Then, the R2 cluster, in 12 sub-districts, needs to improve the quality of its vegetation by adding vegetation that has a high ability to absorb CO_2. R3 cluster, in 13 sub-districts, needs to planaplant new area of green open space by planting new vegetation with high CO_2 absorption capabilities.

KEY WORDS : Green Open Space, CO_2 Emission, Transportation, Household, Kediri city

INTRODUCTION

The President of the Republic of Indonesia at the G-20 meeting in Pittsburg on 24 September 2009 agreed to reduce greenhouse gas emissions in Indonesia by 26% on his own and 41% if he received international assistance in 2020. In addition, Indonesia has also ratified the Paris Agreement through Law No. 16 of 2016 (Anonymous, 2016). The Paris Agreement aims to hold the global average temperature rise below 2 degrees Celsius and continue the efforts to reduce the temperature rise to 1.5 degrees Celsius above pre-industrialization levels. In 2023, Indonesia has a target to reduce greenhouse gas (GHG) emissions by 29% with its own efforts or 41% with international

Corresponding author's email: razif@itats.ac.id

assistance, which is a change in the GHG emission reduction target from 26% in 2020. There is also Presidential Regulation No. 61 of 2011 (Anonymous, 2011), which contains the National Action Plan for reducing greenhouse gas emissions, including the energy and transportation sector, with a 26% emission reduction target of 0.038 Gigatons CO_2e and for 41% emission reduction of 0.056 Gigatons CO_2e. As a follow-up, the Minister of Environment Regulation Number 15 of 2013 was issued (Anonymous, 2013). The increased economic growth in Java Island and the flow of urbanization to big cities have significantly increased the number of motorized vehicles operating in Java, including in Kediri. If the action plan for reducing vehicle emissions by designing mass vehicles as a substitute for private vehicles is not effectively implemented, the existence of public green open space is still very much needed. Public green open spaces with vegetation in big cities have played a role in the absorption of air pollution from motorized vehicles, industrial activities, and households. The increasing number of private vehicles, industrial, and household activities each year will increase the CO_2 emissions borne by the city. The prediction of an increase in the number of vehicles makes it possible to predict emissions from CO_2 (Razif and Santosa, 2016). This study aims to calculate CO_2 emissions compared with the CO_2 absorption capacity of vegetation in public green open spaces. The function of public green open space in Kediri City can be improved. The types of GHG in the atmosphere, having the potential to cause global climate change consist of CO_2, CH_4, N_2O, HFCs, PFCs, SF6 (IPCC, 1990). Of all these types of gases, the main GHGs are CO_2, CH_4, and N_2O. CO_2 is the gas with the most content in the atmosphere at 72%, while the composition of CH_4 and N_2O is 18% and 9%, respectively. Although in terms of the highest concentration of CO_2 in the atmosphere, the potential to create global warming (Global Warming Potential) is the smallest. N_2O, which has the highest potential to create global warming, is 310 times that of CO_2. CH_4 has the potential to be 21 times more than CO_2 in producing global warming. The concentration of CO_2 in the air has experienced a significant increase in average over the past ten years, namely 1.9 ppm per year or an increase of about 3% per year, according to the IPCC (1990). In 2014, Indonesia's total GHG emissions reached 1,808 million tons of CO_2e. It shows an increase in emissions from 2000-2013 by 3.5% per year (Anonymous, 2015). The Energy sector (including transportation) is in second place at 31.93% of the total national GHG emissions. In 2014, GHG emissions in the energy sector reached 577 million tons of CO_2e, an increase compared to 298 million tons of CO_2e in 2000 (Anonymous, 2017). Reducing greenhouse gas emissions is an important issue to protect our environment (Modak *et al.,* 2017). The rise of the phenomenon of public transportation based on online applications that provide easy-to-cost mobilization, as well as the shopping style of people who switch to e-commerce and the goods delivery services, has caused the large consumption of energy from transportation. Regarding emissions from households, Rong *et al.* (2020) stated that the promotion of family life and a low-carbon lifestyle, and effective guidance on appropriate behavior and preferences would play an important role in reducing the carbon emissions of urban settlements. Aerts *et al.* (2020) revealed that green spaces could improve cardiovascular health by increasing physical activity and reducing air pollution, noise, and heat. Chen *et al.* (2019) stated that tree coverage was effective in reducing $PM_{2.5}$ concentrations and more significant with higher ambient $PM_{2.5}$ levels. Aram *et al.* (2019) concluded that markets with green spaces have a higher visit rate than environments without green spaces. Campagnaro *et al.* (2020) stated that vegetation structure and the presence of features associated with human recreational use are important factors in planning and designing urban green spaces. Park and Guldmann (2020) affirmed that urban greening programs need to diversify in terms of green types and locations to address local deficits in a broad urban spectrum. Urban green spaces provide various ecosystem services to urban residents and are considered an important element of social-environmental justice (Enssle and Kabisch, 2020). The 2030 Agenda for sustainable development developed by the United Nations (UN) proposes to make cities and human settlements inclusive, safe, resilient, and sustainable. Hotspot analysis can provide valuable input into discussions regarding the application of spatially targeted, specific measures for sustainable urban planning (Kaprowska *et al.,* 2020). Zhao *et al.* (2020) argued that in general, the higher the coverage of timber crops, the fewer the mosquitoes, thus serving as a guide for the design and management of mosquito repellent landscapes. On the other hand, Pan et al. (2019) have provided a framework and case studies for using urban green spaces as micro-protection for endangered species. Wijaya (2015) detected changes in land use with Landsat imagery and Geographical Information Systems with a case study in the Bandung metropolitan area. He also concluded that vegetated land as an absorbent for air pollutants is decreasing, while transportation as a source of emissions is increasing. The increase in transportation is partly due to urbanization, in which, according to UNESCAP (2015), in Southeast Asia increased by 48% in 2010. In Indonesia, the sector that contributes to greenhouse gas emissions is shown in Table 1. From the Central Bureau of Statistics, data on the growth of the number of vehicles in 2012-2016 are obtained, as which is shown in Table 2. Then, Table 3 shows the growth of the number of vehicles in Kediri City in 2017-2019.

According to the Regulation of the Minister of Home Affairs No.1 of 2007 (Anonymous, 2007), the functions of urban green open spaces are: protecting the existence of urban protected areas, controlling pollution and soil, water and airdamage, protecting germplasm and biodiversity, controlling water management and enhancing the aesthetics of urban areas. Green open space is an elongated and/or grouped area, whose use is more open, a place to grow plants that grow naturally, and those that are intentionally planted (Anonymous, 2008). Aram *et al.* (2019) stated that markets with green open spaces are more visited than markets without green open spaces.Many researchers have studied the ability of plant vegetation to absorb CO_2. Lailati (2013) observed 15 types of vegetation having the ability to absorb CO_2. Laksono (2014) summarized several studies and observed 35 types of CO_2 absorbing vegetation. Roshinta and Mangkoedihardjo (2016) also listed 44 types of CO_2 absorbing vegetation. Sa'iedah (2018) mentioned 36 types of CO_2 absorbing vegetation. Based on the above-mentioned studies, Table 4 shows the 25 types of vegetation that absorb the highest CO_2.

MATERIALS AND METHODS

The data on the number of vehicles in Kediri City in 2019, a calculation of CO_2 emissions from the transportation sector,was calculated by considering the type of vehicle, emission factor, and road length. Meanwhile, for the household sector, the calculation of CO_2 emissions was carried out from energy use, fuel, and emission factors. Specifically, for the industrial sector, the calculation of CO_2 emissions was not carried out with the assumption that the CO_2 emissions produced can be absorbed by private green open space, which covers 10% of Kediri city or an area of 634 ha. Industries that can produce CO_2 emissions are the food and beverage industry, the tobacco processing industry, and the repair service industry and the installation of machines. For public green open space, observations were made related

Table 1. Greenhouse Gas Emission Contributing Activity Sector in Indonesia

Sector	CO_2eEmission (Gg)	Percentage of Total GHG Emissions%
Forestry and land use	315.290,19	42,5
Energy and transportation	303.829,95	40,9
Agriculture	99.515,24	13,4
Industrial Process	17.900,50	2,4
Waste	6.039,39	0,8
Total	742.575,26	100

Source: Anonymous (2017)

Table 2. Growth in the Number of Vehicles in Indonesia, 2012-2016

Type of Motor Vehicle	Number of Vehicles (unit)				
	2012	2013	2014	2015	2016
Passenger car	10,432,259	11,484,514	12,599,038	13,480,973	14,580,666
Bus car	2,273,821	2,286,309	2,398,846	2,420,917	2,486,898
Freight cars	5,286,061	5,615,494	6,235,136	6,611,028	7,063,433
Motorcycle	76,381,183	84,732,652	92,976,240	98,881,267	105,150,082
Total	94,373,324	104,118,969	114,209,260	121,394,185	129,281.079

Source: Anonymous (2017)

to the type and amount of vegetation with a high enough CO_2 absorption ability to absorb CO_2 emissions from 20 main roads in Kediri City. From the amount of existing vegetation, the total absorption capacity of vegetation in the publicgreen open space of Kediri City was calculated. Based on the total CO_2 emissions and the ability to absorb CO_2 by vegetation, the function of Green Open Space at the village scale from the existing green open space can be improved.

Calculation of Specific Emission Factors

The equation for the FES calculation was obtained from:

FES (ton CO_2/physical unit) = Total Emission (ton CO_2)/unit to be determined (number of vehicles or

Table 3. Growth in the Number of Vehicles in the City of Kediri in 2017 - 2019.

Sub-district	Year-end	Passenger car	Bus Car	Freight car (Truck)	Motorcycle	Total
Mojoroto	2017	6,819	51	1,401	55,545	63,186
	2018	7,286	57	1,418	56,347	65,108
	2019	7,771	68	1,463	57,271	66,573
Kota	2017	7,752	88	4,163	48,687	60,690
	2018	8,078	90	4,301	49,276	61,745
	2019	8,358	93	4,443	49,267	62,161
Pesantren	2017	5,041	180	1,539	41,277	48,037
	2018	5,455	202	1,666	42,174	49,497
	2019	5,749	210	1,740	42,801	50,500
Kediri City	2017	19,612	319	7,103	145,509	172,543
	2018	20,819	349	7,385	147,797	176,350
	2019	21,878	371	7,646	149,339	179,234

Source: Anonymous (2019)

Table 4. The highest type of vegetation to absorb CO2

No	Local Name	Scientific name	CO_2 absorption (Kg/tree/year)
1.	Kopsia	*Koopsia arborea*	41,633
2.	Kenari Solo	*Canarium asperum*	38,964
3.	Rasamala	*Altingia excelsa*	35,336
4.	Pohon Kapur	*Dryobalanops aromatica*	34,101
5.	Trembesi	*Samanea saman*	28,448
6.	Sawo Duren	*Chrysophyllum cainito*	23,670
7.	Meranti merah	*Shorea pinanga*	21,897
8.	Resak rawa	*Vatica punciflora*	12,316
9.	Matoa	*Pometia pinnata*	11,879
10.	Kenari	*Canarium indicum*	10,490
11.	Pohon Ulin	*Eusideroxylon zwageri*	9,968
12	Kapuk Randu	*Ceiba pentandra*	8,806
13.	Cassia	*Cassia sp*	5,295
14.	Mahoni	*Swietenia macrophylla*	3,112
15.	Trembesi	*Samanea saman*	3,252
16.	Daun Kupu-kupu	*Bauhinia purpurea*	1,331
17.	Pulai	*Alstonia scholaris*	1,319
18.	Beringin	*Ficus benjamina*	1,146
19.	Kenanga	*Canangium odoratum*	756
20.	Pingku	*Dysoxylum excelsum*	720
21	Glodokan	*Polyalthia longifolia*	719
22.	Beringin	*Ficus benyamina*	535
23.	Krey Payung	*Fellicium decipiens*	404
24.	Matoa	*Pornetia pinnata*	329
25.	Angsana	*Pterocarpus indicus*	310

production capacity). For the transportation sector, there are three alternatives, namely the fuel consumption approach, the number of vehicles, and the type of road, as follows:

1. The fuel approach.It requires data on fuel consumption and the number of vehicles. This fuel consumption data was used to determine CO_2 emissions. Due to limited data regarding the consumption of each type of fuel, the SMP approach (passenger car unit) was used. Data on the number of vehicles were used as a divider to determine how much emissions are produced from each type of vehicle. FES=CO_2 Emissions/Number of Vehicles. CO_2 emissions were emissions resulting from the use of fuel. The number of vehicles is the number of vehicles based on the type of fuel.
2. The number of vehicles approach. This method used fuel data and vehicle fractions. The emission factor in this calculation was calculated by multiplying the emission factor by the density of the fuel. The FES is the emission factor times the fuel density. Fuel density is the density of the fuel used. Then, the vehicle fraction was calculated by dividing the number of vehicles. Vehicle fraction is the number of vehicles per type divided by the total number of vehicles. After the fraction value was obtained, the CO_2 emissions werecalculated. The calculation of these emissions was differentiated by fuel. To get total emissions, we added the value of gasoline vehicle emissions, and diesel vehicle emissions together.
3. Road type approach. The calculation for the FES value based on vehicle density was calculated by means of GHG emissions (g/hour) equal to the number of vehicles (vehicles/hour) x emission factor (g/kg BBM) x road length (km). The emission factors obtained will be used as a reference for calculating CO_2 emissions in the development of similar areas.

For the industrial and household sectors, the calculation also used the Specific Emission Factor (FES). CO_2 emissions originating from the industrial and household sectors can come from primary energy, namely LPG, and secondary energy, electricity consumption. In the city of Kediri, most industries are the food and beverage industry, the tobacco processing industry, and the repair and machine installation services industry.

RESULTS AND DISCUSSION

Total CO_2 emissions for the transportation sector and households are shown in Tables 1 and 2, and for the industrial sector are shown in Tables 3, 4, 5, and 6.

CO_2 absorption ability of green public open space

From the results of observations on 20 main roads in the city of Kediri, the types and numbers of plants having the function of absorbing CO_2 emissions are obtained. After they are calculated based on the type and number of plants, the complete absorption of CO_2 emissions is shown in Table 7.

From Table 7, the total capacity to absorb CO_2

Table 1. Total CO_2 emissions from the transportation sector in Kediri City in 2019

Sub-district	CO_2 Emissions of Passenger Car (tonnes)	CO_2 Emissions of Bus (tonnes)	CO_2 Emissions of Truck (ton)	CO_2 Emissions Motorcycle (ton)	CO_2 Emissions Total (tonnes)
Mojoroto	6,916,274	97,615	1,865,343	11,500,133	20,379,365
Kota	7,438,710	133,502	5,664,881	9,892,914	23,130,007
Pesantren	5,116,672	301,457	2,218,522	8,594,528	16,231,179
Total	19,471,656	532,574	9,748,746	29,987,575	59,740,551

Table 2. Total CO_2 Emissions from the household sector in Kediri City in 2019

Sub-district	Total population	Number of Households	CO_2 Emissions of LPG (tonnes)	CO_2 Emissions of Electricity (tonnes)	CO_2 Emissions Total (tonnes)
Mojoroto	112,545	22,509	1,474,392,675	93,861,259	1,568,276,443
Kota	91,276	18,255	1,195,745,625	76,122,319	1,271,886,199
Pesantren	91,129	18,226	1,193,846,056	76,001,391	1,269,865,673
Kota Kediri	294,950	58,990	3,863,984,356	245,984,969	4,110,028,315

emissions per year compared with the total capacity in Table 1 (transportation sector) and Table 2 (housing sector) can only absorb 3.8%. If we compare the industrial sector emissions from Table 7, the new absorption capacity can absorb less than 1%. Therefore, the industrial sector needs to create private green open spaces in each area, with 10% of the total area of Kediri City. The Kediri City government needs to disseminate information to the industry so that the type of vegetation planted in private green space can absorb high enough CO_2 emissions. Based on observations, there are ten parks in Kediri, namely: Sekartaji Park, Kediri Memorial Prak, Ngronggo Park, Brantas Park, Joyoboyo Forest Park, Harmoni Park, City Square Park, Simpang Lima Gumul Green Park, Tempurejo Park, and Kilisuci Park. The city park that has the most tree species (15 species) is in the Joyoboyo Kediri Forest Park, which is in the middle of the city. Taman Harmoni is recorded to have only three types of shade trees, namely banyan, yellow palm, and pole. This park is a park that has the narrowest area among all city parks in Kediri.

According to Paulina and Murtedjo (2018), public green open space in Kediri City still reaches 8% or 507.2 ha of Kediri City, which covers 6340 ha. Thus, for this public green open space, an additional 12% of the city area or an area of 760.8 ha is needed. When we compare with the need for a public green open space of 20% or an area of 1268 ha, the existing public green open space area of 760.8 ha has only reached 60% of the required area of public green

Table 3. Estimation of CO_2 Emissions from the Industrial Sector in Kediri City in 2019 from Natural Gas

Type of Industry	Total Energy (tonnes joules/year)	Natural Gas	EF	CO_2 Emissions (kg)
Food	6,425,966.161	3,534,281.3886	70,800	$2.50227\text{x}10^{11}$
Beverage	1,564,872.588	860,679.9236	70,800	60,936,138,594
Tobacco	9,140,395,860	5,027,212,723.0000	70800	$3.55927\text{x}10^{14}$
Repair Services	780,000,117.6	0.0000	70,800	0

Table 4. Estimation of CO_2 emissions from the industrial sector in Kediri City in 2019 from electricity

Type of Industry	Total Electrical Energy (tonnes joules/year)	EF	CO2 Emissions (kg)
Food	1,413,712.555	506.2646	715,712,630.2240
Beverage	344,271.9695	123.2872	42,444,339.4680
Tobacco	4,113,178,137	1,472.9702	6,058,588,954,285.3000
Repair Services	88,980,164,000	31,864.6867	2,835,325,051,065,830.0000

Table 5. Estimation of CO_2 emissions from the industrial sector in Kediri City in 2019 from coal energy

Type of Industry	Total Coal Energy	EF	CO_2 Emissions (kg)
Food	835,375.6009	112,000	93,562,067,304
Beverage	203,433.4365	112,000	22,784,544,888
Tobacco	0		0
Repair Services	0		0

Table 6. Total CO_2 emissions from the industrial sector in Kediri City in 2019

Type of Industry	CO_2 Emissions (kg)	Natural Gas CO_2 Emissions (kg)	Electricity CO_2 Emissions (kg)Coal	Total CO_2 Emissions/ year (tonnes)
Food	$2.50227\text{x}10^{11}$	715,712,630.2240	93,562,067,304	344,504,902
Beverage	60,936,138,594	42,444,339.4680	22,784,544,888	83,763,127
Tobacco	$3.55927\text{x}10^{14}$	6,058,588,954,285.3000	0	$3.61986\text{x}10^{11}$
Repair Services	0	2,835,325,051,065,830.0000	0	$2.83533\text{x}10^{12}$
Total CO_2 Emissions/year (tonnes)	$3.19774\text{x}10^{12}$			

open space. Thus, an additional 40% of public green open space is needed, which can absorb 62% of total CO_2 emissions per year, considering that only 38% has only been absorbed. The construction of new green open space will be difficult if it must be charged with absorbing 62% of CO_2 emissions per year. Therefore, it is also necessary to take steps to improve green space whose absorption capacity is not optimal by adding plants with very high absorption capacity. According to the Regional Regulation of the City of Kediri Number 2 of 2004 (Anonymous, 2004), it is explained that green open space is an elongated area/pathway and/or in groups, which use is more open, a place to grow

Table 7. Types of plants and CO_2 absorption capacity/year on the main road in Kediri City

No	Street	Types of Plants (in Indonesian) and Number of Plants	Total CO_2 absorption capacity/year (tonnes)
1	Brawijaya	Pinisium (125), Ketepeng (14), Angsana (2), Dadap Merah (2)	73,829
2	Erlangga	Glodok (30), Ketepeng (1), Angsana (3), Trembesi (11), Kersen (2), Waru (1), Sepatu Dea (1), Palem (1)	6,617,627
3	Hayam Wuruk	Waru (3), Glodok (10), Tabepuya (7), Angsana (5), Dadap Merah (6), Kersen (2), Sepatu Dea (34),	486,332
4	Mayor Bismo	Glodok (37), Beringn (1), Tabepuya (7), Sawo (28), Angsana (141), Dadap Merah (3), Trembesi (19), Kersen (2), Waru (5), Palem (20), Nangka (2), Mangga (4), Jambu (2), Pule (1),	13,401,159
5	Letjen Pandjaitan	Sono (11), Tabepuya (15), Angsana (18), Waru (2), Nangka (1), Jambu (1), Pule (1), Sukun (8)	1,032,564
6	PK Bangsa	Pinisum (25), Waru (1) Glodok (54), Beringin (5), Angsana (15), Dadap Merah (6), Trembesi (2), Kersen (1), Waru (6), Sepatu Dea (19), Palem (2), Nangka (1), Mangga (2), Mentaos (5), Bintaro (2), Blimbing Wuluh (1), Sono (8)	3,001,870
7	Mayjen Sungkono	Glodok (5), Tabepuya (49), Kupu-kupu (81), Sawo (32), Dadap Merah (21), Trembesi (10), Kersen (1), Palem (6), Nangka (1), Jambu (1), Sono (43)	9,982,941
8	Letjen Suprapto	Pinisium (4), Bungur (2), Tanjung (14), Glodok (14), Beringin (5), Ketepeng (3), Tebepuya (17), Kupu Kupu (6), Sawo (1), Waru (11), Palem (4), Pule (15), Bintaro (9), Sono (33), Mahoni (2),	9,982,941 4,152,519
9	Letjen Sutoyo	Tanjung (1), Glodok (9), Beringin (2), Tabepuya (31), Angsana (33), Kersen (1), Waru (2), Palem (19), Nangka (1), Mangga (3), Sono (2), Mindi (2),	2,211,083
10	Dr Sutomo	Waru (3), Glodok (37), Angsana (2), Cakaranda (25), Ekor Tupai (4)	712,802
11	Adi Sucipto	Glodok (45), Angsana (4), Mangga (5), Ekor Tupai (6)	865,647
12	Halim Perdana Kusuma	Glodok (49), Mangga (5), Blimbing Wuluh (2), Ekor Tupai (7)	915,495
13	Sersan Suharmaji	Glodok (28), Tabepuya (41), Sawo (13), Angsana (48), Waru (24), Sepatu Dea (21), Palem (21), Mangga (9), Bintaro (29), Ekor Tupai (8), Flamboyan (18)	12,105,730
14	Supersemar	Glodok (44), Sawo (41), Angsana (47), Sepatu Dea (44), Mangga (3), Bintaro (16), Flamboyan (12)	6,787,178
15	Urip Sumoharjo	Pinisium (9), Ketepeng (19), Tebepuya (7), Angsana (11), Waru (14), Sepatu Dea (40), Bintaro (18)	5,760,048
16	Kapten Tendean	Glodok (109), Sawo (18), Angsana (194), Trembesi (37), Waru (54), Sepatu Dea (128), Palem (13), Mangga (13), Pule (11), Bintaro (97), Mahoni (67), Ekor Tupai (15)	54,503,192 17,117,652
17	Yos Sudarso	Kupu Kupu (29), Bintaro (59),	
18	Perintis Kemerdekaan	Glodok (49), Sawo (37), Angsana (16), Sepatu Dea (30), Mangga (5), Ekor Tupai (8)	1,066,744
19	HOS Cokroaminoto	Tabepuya (34), Anggsana (8), Ekor Tupai (4), Budea Levis (87)	1,963,674
20	Pattimura	Angsana (4), Bintaro (57)	16,524,956
	Total		159,283,042

plantsthat grow naturally and intentionally planted. Public green open space is a green open space whose provision and maintenance are the responsibility of the regional government. Green open space planning is part of the RTRW (local communities and local households) that is determined and carried out by considering the harmony, harmony, and balance of environmental functions. Planning for green open space is carried out with an area of at least 30%, with details of public green open space at least 20% and private green open space at least 10%. Utilization of green open space includes city park green area, city forest green area, and conservation area, city recreation green area, cemetery green area, agricultural green area and yard, green lane green area.

Based on the division of green open space clusters from the results of observations, which are also used to make efforts to improve the function of green open space for the city of Kediri as follows:

a. R1 Cluster, which is a cluster where the green open space conditions are very good and meet the requirements by containing plants that have a high ability to absorb CO_2 emissions and will be maintained as a city green open space. This cluster also includes ten existing city parks including in most green open space utilization groups in the form of city park green areas, city forest green areas and conservation areas, city recreation green areas.
b. R2 Cluster, which is a cluster where the green open space is not good, where there is already room for plants, but it is still not optimal to be planted with plants that have a high ability to absorb CO_2 emissions. For the R2cluster, it will be proposed to add plant types that can absorb CO_2 emissions until the conditions reach those in the R1cluster. The R2 cluster covers most of the utilization groups in the form of a green cemetery area, a green farm area, and a home garden.
c. R3 Cluster, which is a cluster in which green open space is not yet available that meets the requirements, in terms of not being prepared with green open space nor from the point of view that plants havinga high ability to absorb CO_2 emissions have not been prepared. For the R3cluster, it is proposed to design a new green open space based on the green open space plant in the R1cluster. R3Cluster covers most of the utilization group in the form of green lane green areas.

The division of the clusters is shown in Table 8.

CONCLUSION

The number of plants recorded is currently only able to absorb 3.8% of CO_2 emissions produced by the transportation and residential sectors. Therefore, the amount of plant vegetation in Kediri City still needs to be increased both through R1, R2, and R3 Cluster as publicgreen open space. Kediri City public green open space, which has only reached 8%, needs to be increased by 12% in order to meet the requirements for the area of a public green open space of 20%. Besides,the efforts to improve the function of green open space are by maintaining the existence of plants absorbing CO_2 emissions in R1Cluster, namely 17 urban villages, which are city green park area, city forest green area, and conservation area, city recreation green area. The addition of plants that absorb CO_2 emissions in R2 Cluster of publicgreen open space, namely 12 sub-districts, are included in the green cemetery area, agricultural green area, and yard. Construction of R3 Cluster public green open space, namely 13 sub-districts, are included in the green lane green zone group. Meanwhile, private green open space is directed to be able to be developed by the industrial sector by increasing the planting area of 10% of the area of the Kediri City with vegetation types that have high CO_2 absorption capacity.

Table 8. Distribution of Urban RTH Clusters in Kediri City

No	Cluster	Name of sub-districts
1	R1	Semampir, Dandangan, Pakelan, Banjaran, Kampung Dalem, Balowerti, Lirboyo, Campurejo, Bandar Lor, Mojoroto, Sukorame, Tamanan, Bangsal, Burengan, Singonegaran, Blabak, Tempurejo (17 sub-districts)
2	R2	Pocanan, Jagalan, Kemasan, Kaliombo, Ngampel, Gayam, Pojok, Bandar Kidul, Jamsaren, Tinalan, Bawang, Ngletih (12sub-districts)
3	R3	Ngadirejo, Ngronggo, Manisrenggo, Rejomulyo, Dermo, Mrican, Banjarmelati, Bujel, Pesantren, Pakunden, Banaran, Tosaren, Betet (13sub-districts)

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