JURNAL GEOGRAFI
Geografi dan Pengajarannya
ISSN : 1412 - 6982
e-ISSN : 2443-3977
Volume 20 Nomor 2 Desember 2022

DAILY CO2 CONCENTRATION IN NORTHERN SURABAYA CITY

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Abstrak : Konsentrasi CO2 merupakan salah satu parameter kualitas udara yang ditetapkan oleh WHO. Penelitian ini bertujuan untuk mengungkap dinamika konsentrasi CO2 di Surabaya bagian utara yang merupakan pusat aktivitas perkotaan di Surabaya. Jenis penelitian ini adalah deskriptif analitik dengan pendekatan kuantitatif. Populasi yang digunakan adalah berdasarkan pembagian wilayah administratif di bagian u tara Surabaya. Pengambilan sampel dilakukan secara purposive, dimana setiap penggunaan lahan diambil lima lokasi. Teknik pengumpulan data menggunakan pengukuran dan observasi. Teknik analisis data yang digunakan adalah deskriptif. Hasil analisis data menunjukkan adanya perbedaan rata-rata konsentrasi CO2 pada pagi dan sore hari. Semua lokasi penelitian memiliki konsentrasi CO2 di atas ambang aman konsentrasi CO2 yang ditetapkan WHO. Terjadi peningkatan konsentrasi CO2 pada pagi dan sore hari secara bervariasi. Konsentrasi CO2 rata-rata pada pagi hari tercatat sebesar 436,05 ppm dan meningkat pada malam hari menjadi 518 ppm. Konsentrasi CO2 tertinggi pada pagi hari terjadi di jalan Colombo sebesar 467 ppm dan terendah 345 ppm di jalan Bangunsari. Konsentrasi CO2 rata-rata tertinggi pada malam hari terjadi di jalan Morokrembangan sebesar 558 ppm dan terendah di jalan Bangunsari sebesar 460 ppm.
Kata Kunci: Konsentrasi CO2, polusi udara, Surabaya utara

Abstract : CO2 concentration is one air quality parameter set by WHO. This study aims to reveal the dynamics of CO2 concentration in northern Surabaya, which is a center of urban activity in Surabaya. This type of research is descriptive analytic with a quantitative approach. The population used is based on the division of administrative regions in Surabaya u tara section. Sampling is carried out in a purposive way, where each land use is taken five locations. Data collection techniques use measurement and observation. The data analysis technique used is descriptive. The results of the data analysis showed that there was a difference in the average CO2 concentration in the morning and evening. All research sites have CO2 concentrations above the safe threshold of CO2 concentrations set by WHO. There is an increase in CO2 concentrations in the morning and evening variably. The average CO2 concentration in the morning was recorded at 436.05 ppm and increased at night to 518 ppm. The highest CO2 concentration in the morning occurred on Colombo road at 467 ppm and the lowest at 345 ppm on Bangunsari road. The highest average CO2 concentration at night occurred on Morokrembangan road, which was 558 ppm and the lowest on Bangunsari road was 460 ppm.
Keywords: CO2 concentration, air pollution, northern Surabaya

A. INTRODUCTION

Surabaya is the capital of East Java and the second largest city after Jakarta. Surabaya is the center of government, business, work and culture in East Java, and the center of development of eastern Indonesia. The changing nature of people's lives and jobs led to the rapid development of the city of Surabaya (Amrullah, 2015). The increase in the

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physical development of the community and the level of travel in the northern city of Surabaya has resulted in reduced air quality.

Air pollution is defined as the presence of substances in the air in sufficient concentrations to cause health problems, especially in humans, animals, plants, and materials. This substance can be a gas, a liquid substance, or a solid particle. The Surabaya City Government strives to maintain good air quality by conducting regular monitoring. One of the monitored parameters is CO2 (Carbon Dioxide). Carbon dioxide is considered a pollutant if the CO2 in the air increases and exceeds the tolerance threshold so that it can also increase the greenhouse effect that can cause global warming (Aji, 2018). High levels of carbon dioxide in the body can cause poisoning (Yazid, 2021). The health disorders in question such as nausea, vomiting, dizziness, headaches and increased heart rate.

Population growth in the northern city of Surabaya will result in an increase in the area of built-up land. This has led to a decrease in green open land which on the other hand has a role in CO2 absorption (Watkins, 2007). Vegetation that absorbs CO2 gas has an impact on decreasing ambient air temperature (Peichl and Arain, 2007). Based on this background, this study is aimed at determining the dynamics of CO2 concentration in Surabaya.

B. METHOD

This research uses a type of survey research. Data analysis using quantitative descriptive. This research was located in Surabaya, a part of the utara which consists of four sub-districts, namely Semampir District, Krembangan District, Bulak District, and Kenjeran District. The tools used in this study are 1) *Carbon Monoxide Meter* used to measure the concentration of CO2 in the air. 2) GPS is used to determine coordinate points in the field which will then be mapped. 3) Stationery writing to record measurement results in the field. 4) QGIS software for creating maps, and 5) Office software for calculation and report generation.

The population in this study was air in the northern city of Surabaya. Samples were taken purposively based on the shape of the land cover. The sample locations are based on the NDVI value as a reference for the density of vegetation in that place. The location of the sample distribution can be seen in Figure 1.

Figure 1 shows the distribution of sampling site plans in this study. The sample point is indicated by a yellow dot. The sample location code is indicated by numbers and letters in yellow. Themeasurement was carried out at 20 research sites based on a map of the

distribution of samples in the study area. The location of the sample in the field is achieved by basing on the coordinates indicated by the GPS.

Figure 1. Distribution of research samples

Measurements are carried out at 06.00 – 12.00 and 18.00 – 23.00 WIB for one day. The concentration of CO2 collected will be searched for its average value in one day. Measurement of CO2 concentration at each sample point is carried out using a *Carbon Monoxide Meter* for one minute in accordance with the procedure for using the tool. CO2 concentration data is obtained based on the numbers shown on the *Carbon Monoxide Meter* screen .

Data is processed using Office tools through data tabulation techniques, average calculations, and graph visualization. The analysis was carried out by interpreting data on thehighest CO 2 concentrations, terendah, average, changes in morning and evening measurements, as well as the trend of increasing CO2 concentrations spatially.

C. RESULTS AND DISCUSSION

C.1. RESULTS

The results of measuring CO2 concentration in northern Surabaya there are variations in CO2 concentration spatially between one location and another. The results of calculations in this study indicate that in addition to location factors, variations in CO2

concentrations are also influenced by time. There is a difference in CO2 concentration in measurements taken in the morning with measurements at night. CO2 concentrations at the study site can be seen in Table 1.

In general, CO2 concentrations in the study area stretched between 345 ppm to 467 ppm in the morning, and between 460 ppm to 558 ppm in the evening. The highest CO2 concentration in the morning was found in sample 5b, namely Colombo road at 467 ppm and the lowest at 345 ppm at Bangunsari road which was dominated by land cover in the form of settlements without vegetation. The highest concentration of CO2 at night is on analysis units 10a and 10b, namely Morokrembangan road of 558 ppm and the lowest is 460 ppm at location 1a, namely on Bangunsari road because it is dominated by land cover in the form of settlements without vegetation.

Table 1. CO2 concentration at the study site

Sample Number	Morning **(ppm)**	Night **(ppm)**
1	345	460
2	436	466
3	453	490
4	422	480
5	459	491
6	360	493
7	459	500
8	420	551
9	441	491
10	467	520
11	424	550
12	466	528
13	440	515
14	463	520
15	433	553
16	465	540
17	436	548
18	451	550
19	431	558
20	450	558
Average	**436**	**518**

Source : field measurement results

The measurement results showed that the average concentration of all sample locations was 436 ppm in the morning and 518 ppm in the evening. The results of these measurements indicate that the concentration of CO2 at night is always higher than in the morning. This condition occurs in all research sample locations.

Based on Table 1, it is known that the majority of study sample locations have concentrations that exceed the safe threshold of CO2 concentrations set at 350 ppm. This condition occurs both in the morning and evening measurements.

One location that shows a CO2 concentration below the safe threshold is sample location 1 from the measurement results in the morning. This location is in the form of a residential area with very minimal vegetation cover conditions in the settlement. Vegetation cover with very low density, dense residential land use and relatively high motor traffic conditions.

The results of CO2 concentration measurements in the morning and evening showed an increase in CO2 concentration figures at all study sites. The average increase in concentration is 18% of the CO2 concentration in the morning. Variations in the increase in CO2 concentrations between study sites can clearly be seen in Figure 2. Figure 2 shows the percentage of increased CO2 concentrations (brightly hued stems) and the mean values of CO2 concentrations from all sample sites (dark-hued stems).

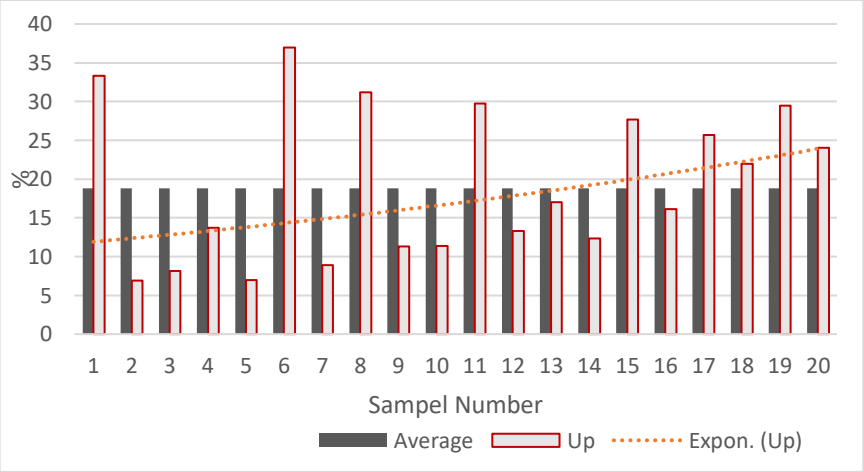

Figure 2. The rate of increase in CO2 concentration from morning and evening measurements. Source : calculation results

Based on Figure 2, it can be seen that there are several locations that have an above-average percentage increase as exemplified in sample locations 1, 6, 8, 11, 15, 17, 18, 19, and 20. The highest concentration increase was 36.9% which

occurred at sample site 6. At that location, the CO2 concentration in the morning was 360 ppm, increasing to 493 ppm at night. Locations that have an increase in CO2 concentrations above average generally have low density vegetation cover conditions, dense residential land use and relatively high motor traffic conditions.

The graph shown in Figure 2 also shows a tendency to increase CO2 concentrations spatially from left to right. The sample group with a low concentration increase is characterized by very low to low vegetation density, traffic conditions are not crowded and the percentage of vegetation cover is less than 50%. As for areas with increased CO2 concentrations tend to be high, they are characterized by very high to very high vegetation density, crowded traffic conditions and a percentage of vegetation cover of more than 50%.

C.2. DISCUSSION

Thedifference in land cover and human activities at the research site. Land cover has a role in increasing CO2 concentrations, this is in line with research (Dewa dan Sejati, 2019; Ardiansyah, 2017) land cover change has an impact on reducing carbon stocks in fast-growing areas. Human activities using fossil fuel vehicles will create a carbon footprint. Fossil fuel vehicles that are increasingly used will add more carbon footprint releases into the air, this is in line with (Cahyono, 2022; Prismulanda, 2022) which states that the congestion that occurs will cause the engine to heat up quickly and release emission gases into the air. In addition, the difference in the use of electrical energy and water can contribute to the increase because electrical energy still comes from the combustion of fossil fuels inpower plants.

In the morning and at night there are differences in meteorological conditions both from temperature, solar irradiation, wind speed, air humidity and wind direction, which affects the absorption of CO2 gas in plants. In line with the study (Efbertias et al, 2022) The ability to absorb CO2 gas by vegetation will affect the variation of CO2 in ambient air. In the morning vegetation tends to use CO2 to carry out the process of photosynthesis, so that CO2 in the ambient air is reduced.

This condition is influenced by solar irradiation and the types of plants that can absorb CO2. Measurements and data collection are carried out at 06.00 to 12.00, where the solar energy radiation at that hour is about seven percent captured by plants and then the union of CO2 to form carbohydrates will take place.

The ability of plants to absorb CO2 will vary. Therefore, CO2 concentrations during the day are lower at night. This research is in line with (Mansur, 2017) which states that CO2 absorption in

plants is carried out during maximum daylight hours and high solar intensity to be used as a photosynthesis process. The results of this study are in line with (Zakiyah, Manurung and Wulandari, 2018) which states that in the morning plants need CO2 to carry out the photosynthesis process, high photosynthesis activity can guarantee the speed of plant growth.

The percentage increase is above average because at night CO2 is getting higher and vegetation absorbs oxygen and emits CO2. CO2 gas absorbed by vegetation has a minimum value if the intensity of sunlight is low, so the CO2 of ambient air also tends to be high. The results of this study are in line with (Wardhani et al, 2018; Septiandani, 2022) who explained that the average value of CO2 concentration increases at night on the Bogor Ring Road due to traffic congestion.

Location of the 1st study had a very low vegetation density to a high vegetation density at the 20th study site. In the 1st location, namely Jalan Bangunsari, it has an NDVI value of 0.00, while in the 20th location, namely green land in Pakuwon, it has an NDVI value of 0.45. Research sites dominated by the activities of factories, warehouses, offices and settlements will have higher concentrations of CO2 . In line with research (Yilmas and Mumcu, 2022; Arisanti et al, 2022) locations that have more vegetation will be able to absorb CO2 in the air, the selection of the right type of plant will also affect the reduction of air pollution. Vegetation that has a pattern that ecologically acts as a reduction in air pollution and a decrease in the microclimate.

D. CONCLUSION

Based on the measurement results in this study, it is known that:

1. All research sites have CO2 concentrations above the safe threshold of CO2 concentrations set by WHO.
2. There is an increase in CO2 concentrations in the morning and evening variably

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