Spatial Variation of Tropical Urban Carbon Dioxide Concentration: A Case Study of KualaLumpur

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Abstract

Many of the studies related to air pollution in urban areas also consider the role of carbon dioxide (CO_2) in determining the level of urban air pollution, especially in urban areas with high rates of motor vehicle use. Therefore, this study aimed to study the level of carbon dioxide concentration in the city of Kuala Lumpur by looking at the patterns of carbon dioxide concentration in the room at night and during the day. The study results and the steps to reduce this amount of CO_2 can be done in the right place. This study uses data collected from field studies with Handled Temp / RH / CO_2 tools to obtain carbon dioxide concentration data in six urban zones of Kuala Lumpur. Each zone will be represented by two sampling stations whose criteria are in the urban area and not in the open area. For this reason, most of the stations selected are in the open parking area. Sampling times are at night (1-4am) and daylight (1-4pm). Descriptive statistics and regression interpolation are used with the help of geographic information system software ArcGIS version 9.3. The findings showed that the average concentration of carbon dioxide at station 1 (Dataran Merdeka) was highest at night with an average reading of 458.125 part per million (ppm), and during the day, its reading was 420.125 ppm. The lowest carbon dioxide concentration was at night at Station 11 (Tesco extra Cheras) at 396 ppm and during the day at station 10 (Bukit Jalil Stadium) at 397.625 ppm. The overall average for night and day was at Station 1 at 436.31 ppm and Station 10 with a mean of 396.5 ppm. Carbon dioxide concentration levels were determined based on previous studies. The highest levels were 415.26 ppm, medium-high 401 ppm to 415.25 ppm, and the lowest was 400 ppm. It is found that urban zones have the highest levels of carbon dioxide concentration compared to other zones.In conclusion, this station needs to be reduced in carbon dioxide as it can have adverse effects if not curbed as it impairs health and can lead to increased greenhouse gases. Effective steps need to be taken so that carbon dioxide emissions can be controlled and minimized and to address the problem of global warming. The study implies that in Kuala Lumpur, the concentration of carbon dioxide is at a relatively high level.

Keywords: *carbon dioxide, Kuala Lumpur, concentration*

I. Introduction

Research on climate change is escalatingamong academics. Besidesthe attention of the public regardless of the head of state until the ordinarypublic people. Although the theme of this research on climate change is enormous, one of the critical points of the research is the increase in the amount of carbon in the atmosphere. In some opinion,the increase is associated with the increasing number of greenhouse gases each year. Among the greenhouse gases that are paying attention is carbon dioxide (CO_2). Increasing the amount of CO_2 as one of the greenhouse gases is said to be one of the causes of climate change contributing to global warming. This situation causes the earth's atmosphere to be warmer, the climate zone shifting, increasing glacial melt due to carbon dioxide and methanethe increase. The CO_2increasing may start from a small area, spreads to a larger area with a high magnitude of the CO_2. CO_2 is a gas that can be naturally converted through the photosynthesis process by the presence of plants that convert CO_2 to oxygen.

For urban areas, this warming and rising temperatures are due to the formation of greenhouse gases that can cause urban heat island events (Christopherson, 2010). Greenhouse gases are a mixture of various gases and other substances present in the atmosphere. The gas allows sunlight (shortwave) and heat to enter and reach the surface of the earth through the atmosphere. However, there are some natural processes such as heat transfer to the atmosphere that does not occur, which cause the atmosphere to heat up. Excessive CO_2 emissions are one of these conditions, which in the long run, will result in the greenhouse effect, urban heat island and micro and macro heating. Lockwood (2012) states that since the onset of the industrial revolution, human activity has increased trace gas in the atmosphere, such as carbon dioxide. Whereas before the start of the industrial era (in 1750), atmospheric CO_2 concentrations were only about 280 parts per million (ppm) for several hundred years. In 2007, it reached 380 ppm. The annual growth rate of CO_2 has been higher over the past ten years at 1.9 ppm/year from 1995 to 2005 than it has been since continuous atmospheric measurement of 1.4 ppm/year from 1960 to 2005. The unexpected increase in CO_2 concentration is vital due to the scenario latest releases that inform the agenda of global and national climate change that rarely include production data. However, not all of this heat will be emitted back into the atmosphere as these greenhouse gases absorb and radiate back to earth. Some types of gases in the atmosphere can absorb heat. Greenhouse gases are produced by natural processes and human activities. Measure the concentration of CO_2 in the atmosphere in parts per million or parts per million (ppm) for one part of CO_2 per million parts of air.

Between 1850 amid the industrial revolution and 2011, the average atmospheric CO_2 concentration ranged from 285 ppm to 393 ppm (Myers & Spoolman, 2014). The 393 ppm level is too high for humans and should prevent CO_2 levels from rising above 450 ppm. In 2011, the most significant contributors to CO_2 were China, the United States, the European Union (with 27 countries), Indonesia, Russia, Japan and India. Global warming has recently become a phenomenon that is often affecting developing or developing countries. Scientists say the cause of rising temperatures is indirectly linked to human activity. Growth in the industrial sector and increased greenhouse gas production in developed and developing countries are the leading causes. These global warming phenomena can lead to climate change, such as extreme weather, which caused extreme drought and increased frequency of cloud formation, which results in major floods. Also, sea-level rise occurs in the event of global warming. For urban areas, this warming and the increasing temperature is due to the formation of greenhouse gases in urban areas that can become urban heat island. Greenhouse gases are a mixture of many chemicals in the atmosphere. The gas allows sunlight (shortwave) and heat to reach the surface of the earth through the atmosphere. Infrared light and heat will emit into the atmosphere through long wavelengths that cannot be seen by the human eye. However, not all of this heat will be emitted back into the atmosphere as these greenhouse gases absorb and radiate back to earth. Some types of gases in the atmosphere can absorb heat. Greenhouse gases are produced by natural processes and human activities. The main gases in greenhouse gases are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and industrial gases, including hydrochloride, perfluorocarbons and sulfur hexafluoride. The concentration of some essential greenhouse gases has increased on a large scale since the industrial age of 200 years ago (Doll & Baranski, 2011).

According to PLAN Malaysia (2019), a process of change or application of urban characteristics is a municipality formed in an urban area is a process that involves the migration of rural areas, changing economic activities, the development of urban areas and the addition of services or municipal facilities. Also, traditional social change has taken place in terms of value and character to more modern society as well as land-use change as a whole. Rapid urbanization has changed the carbon dioxide cycle and led to an increase in carbon dioxide directly. This change is due to land-use changes for a new development, which led to the reduction of vegetation area. These plants are essential for reducing carbon dioxide reduction as they are used for photosynthesis. This disruption has caused this carbon dioxide gas to be neutralized back to its original state. The urbanization is booming, especially in urban areas and areas that have been the focus of various sectors such as industrial, housing, business and the like. As a result of this sector, rapid development such as tall buildings and housing as well as business buildings. Concrete areas increase compared to non-concrete and vegetative areas. Most of the development took place in physical form that reduced the view of physical lands such as hills and valleys. This development has harmed the air environment due to the accumulation of greenhouse gases and the heat island. In mitigating the effect, the urban areas need to be organized and organized, and some areas can neutralize the gases.

The construction of this tall building is made up of large urban areas such as the city called metropolitan areas that combine several areas and make it the capital of a country. For example, in Malaysia, the capital is Kuala Lumpur. In this area, most buildings have a height of more than 30 floors and a maximum of 100 floors. The development of this area is compact between one building and another. Besides, industrial areas are also located in the city, which leads to the release of fossil fuels. As a result,increasing carbon dioxide gas and other gases on the surface of the atmosphere. This urban area in Kuala Lumpur is one of the most visible areas of carbon dioxide emissions from other areas. This situation is due to a large population, and human activities carried out in the area. The production of carbon dioxide gas is higher than the sampling of carbon dioxide from plants as a result. Although Kuala Lumpur has specially designed areas to control carbon emissions such as the Bukit Nenas forest reserve, this area is not sufficient to absorb the release of carbon dioxide gas.

CO_2 is indeed present in the atmosphere by 1%. In everyday life, humans release carbon dioxide gas and will be absorbed by plants through photosynthesis, while plants will release oxygen gas to humans through respiration. Therefore, indirectly, human activities can be carried out well, such as economic activities and services. The government has also taken steps to address the excess carbon dioxide gas released in urban areas. The area is filled with buildings, but some areas can absorb gases such as carbon dioxide gas, the Bukit Nenas

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forest reserve, which is an area filled with vegetation. Also, activities are undertaken by the government to control carbon dioxide, such as reducing the use of vehicles using fossil fuels or industry as well as greening the area.

Nevertheless, in reality, this process of carbon dioxide gas has increased dramatically from its shoes, which have had a negative impact. The main area to be seen in Malaysia is the City of Kuala Lumpur, which has undergone rapid urbanization and has become a metropolitan city. Landmark buildings such as the Kuala Lumpur Twin Towers (KLCC) and the Tun Razak Exchange have a height of over 80 floors. However, the increase in population has indirectly encouraged the urbanization process to be rapid and has optimized land use. As a result, carbon dioxide gas continues to rise in the area as a result of population growth and urbanization that is not balanced by the rate of sampling by plants and reflected the atmosphere.

This study aims to identify the amount of CO_2 concentration in densely populated areas in Kuala Lumpur City. At the same time,CO_2 concentration in space is predicted using regression techniques in geographic information systems. Therefore, this study was conducted to look at the concentration of carbon dioxide gas in the urban areas of Kuala Lumpur. In previous studies conducted in the City of Kuala Lumpur or the vicinity, most of the research areas with large industrial areas such as Petaling Jaya. The focus is more on whether carbon monoxide (CO) is a polluting agent or CO_2 as an element in urban heat island formation.

The article has four essential sections, the first of which will discuss the relevant highlights of CO_2 and its concentration in urban areas. Next, is a discussion of the methodology used and the analysis techniques used. The resulting presentation is also discussed and summarized in the next section. This article concludes with a discussion of the need for ongoing research on CO_2 and the current importance of physical development planning, especially in high-density areas.

II. Literature review

Christopherson (2010) states that CO_2 is natural gas in the process of life. This gas is a component of the atmosphere. In this atmospheric carbon dioxide gas is only 0.039%. CO_2 gas is vital for maintaining global temperatures, but over the last 200 years,CO_2 has increased as a result of human activities, especially fossil fuels. Reynolds, Rohli, Johnson, Waylen and Francek (2015) also stated that carbon dioxide is an atmospheric gas present in trace amounts measured in parts per million or parts per million (ppm). The gas is also colourless and odourless. The amount of CO_2 in the atmosphere has increased as global warming from the last glacier has increased. Some of the CO_2 released into the atmosphere comes from natural sources and human activities such as volcanic eruptions and natural vegetation fires, as well as fossil fuels and forest fires.

In contrast to Miller and Spoolman's (2019) view that carbon dioxide is a colourless, odourless gas. About 93% of the carbon dioxide in the atmosphere is a result of the natural carbon cycle, and the rest comes from human activities such as the burning of fossil fuels that also contribute to the removal of forests and grasslands that can help remove excess carbon dioxide from the atmosphere. Carbon dioxide is classified as an air pollutant because it has reached a high enough level to heat the atmosphere and bring about climate change and affect human health.

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CO_2 is a greenhouse gas that absorbs heat. This gas is heated by sunlight, soil and ocean by continuously emitting infrared heat energy. Carbon dioxide is critical in the long-term greenhouse gases on earth. It absorbs less heat per molecule than other greenhouse gases such as methane or nitrous oxide but more and stays in the atmosphere longer. Increased carbon dioxide in the atmosphere is responsible for about two-thirds of the energy balance that causes the earth's temperature to rise (Lindsey, 2019). CO_2 is a gas found in the atmosphere consisting of a combination of two oxygen atoms and one carbon atom, forming a chemical formula of CO_2. This gas is an odourless, almost non-acidic, non-flammable gas with a slight taste (Topham et al., 2014). Also, gas can be liquid or solid, depending on temperature and pressure. At normal temperatures, carbon dioxide gas is less reactive, and some decomposition can occur when high temperatures are used, ultraviolet light or electrical discharge.

At the same time, the atmosphere has a variety of gases around the earth, and carbon dioxide accounts for 0.03% of the atmosphere. The exact level of carbon dioxide extraction depends on the exact position on the surface of the earth, where during the sampling, there is plant quantity and time or day due to higher levels at night. The amount of carbon dioxide is 2.3x1012t. Many processes release carbon dioxide into the atmosphere. Among them are the evolution of gas from the earth through springs, wells, volcanoes and various other carbon dioxide-producing mechanisms. Besides, carbon dioxide gas is produced by combustion of carbonated materials, respiration of plants and animals, degradation of organic matter and industrial processes such as the burning of limestone, hydrogen production and ammonia. Subsequently, the process of air purification, photosynthesis and synthesis by bacteria is the process of releasing carbon dioxide through the air. The total carbon dioxide content in the sea is 1.4 × 1014t taken on average for different marine areas. In the sea, carbon dioxide exists as carbonate, hydrogen carbonate, carbonic acid and as a solvent. A dynamic equilibrium exists where the cooler parts of the ocean absorb carbon dioxide, and the warmer parts release into the atmosphere.

2.1 Physical Reduction Process of Carbon Cycles

According to Myers and Spoolman (2014), the main component of the carbon cycle is carbon dioxide gas, which makes up about 0.039% of the air volume in the troposphere. Also, as a greenhouse gas, this component is a vital component of the atmospheric temperature control system. This situation causes changes in whether or not the average amount of carbon affects the earth's climate for more than three decades. Another component of the carbon cycle is the life-forms of the earth, which all contain carbon. Natural processes such as plants and animals have died, and microbes for millions of years cause these substances to survive under high and hot pressures. Finally, it forms carbon-containing fossil fuels, including coal, petroleum and natural gas that can be burned. When this material is extracted and ultimately burned, the carbon returns to the atmosphere as carbon dioxide. Currently, fossil fuels supply about 85% of the world's energy and are the world's largest human source of pollutants and CO_2.

The component in the carbon cycle is carbon dioxide. The volume of carbon dioxide in the troposphere is formed at 0.040%, and the amount of carbon dioxide including water vapour in the water cycle has a high impact on the temperature of the earth's atmosphere and plays an essential role in determining the climate of the earth (Miller & Spoolman, 2019). Carbon is a biosphere through which a combination of photosynthesis by manufacturers releases CO_2 from the air and water, aerobic respiration by manufacturers, consumers and the decomposition of CO_2 into the atmosphere. Usually, CO_2 stays in the atmosphere for 100 years or longer. Some of the CO_2 in the atmosphere is dissolved in seawater. In the ocean, this decomposition releases carbon stored as carbonate minerals and insoluble sedimentary rocks in the lower sediments for a long time.

2.2 Carbon Dioxide Concentration Increasingly

According to Lockwood (2012), since the industrial revolution, human activity has increased trace gas in the atmosphere, such as carbon dioxide. Before the start of the industrial era (in 1750), the atmospheric CO_2 concentration was approximately 280 per million (ppm) for several hundred years. In 2007, it reached 380 ppm. The annual growth rate of CO_2 has been higher over the past ten years at 1.9 ppm/year from 1995 to 2005 than it has been since continuous atmospheric measurement of 1.4 ppm/year from 1960 to 2005. The unexpected increase in CO_2 concentration is vital due to the scenario latest releases that inform the agenda of global and national climate change that rarely include production data. According to Grace (2012), theCO_2 concentration in the atmosphere has increased from 270 ppm before industrialization and to 380 ppm today. The process of photosynthesis involves the diffusion of CO_2 molecules from the atmosphere through the stoma port into the active site in the leaf for the photosynthesis process, and it is anticipated that an increase in CO_2 concentration will enhance the photosynthesis process. According to Fick's law, the rate of propagation is proportional to the concentration gradient, where increasing photosynthesis can also increase the growth rate and the final yield of the plant. In fact, for commercial cultivation often use high concentrations of CO_2 in the greenhouse to accelerate the production of crops such as tomatoes. The increase in photosynthesis is not as evident as it is when plants have a small stoma, and the stoma becomes relatively closed if CO_2 is high.

Measure the concentration of CO_2 in the atmosphere in parts per million or parts per million (ppm) for one part of CO_2 per million parts of air. Between 1850 amid the industrial revolution and 2011, the average atmospheric CO_2 concentration ranged from 285 ppm to 393 ppm (Myers & Spoolman, 2014). The 393 ppm level is too high for humans and should prevent CO_2 levels from rising above 450 ppm. In 2011, the most significant contributors to CO_2 were China, the United States, the European Union (with 27 countries), Indonesia, Russia, Japan and India. Miller and Spoolman (2019) say that since the onset of the Industrial Revolution in the mid-1700s, human actions, especially fossil fuels, deforestation and agriculture, have led to significant increases in the concentration of some greenhouse gases, especially carbon dioxide. The long-term increase of about 80% of carbon dioxide is a release of human activity that usually stays in the atmosphere for 100 years or more, and about 20% of it lasts up to 1,000 years. After irradiating between 180 and 280 ppm for 400,000 years, the average atmospheric CO_2 concentration reached 404 ppm in 2016, likely to be high at any time. In 2016, the three major sources of CO_2-related energy were China, the United States and India.

According to Bhattacharya and Arunima (2015), the concentration of carbon dioxide in the atmosphere reached from 30 ppm in 1850 to 350 ppm today. Increased carbon dioxide levels due to the burning of fossil fuels. However, changes in the use and management of ecosystems also play a significant role in the release of carbon stored in plants and soil. About 33% of carbon accumulated in the atmosphere over the past 150 years,which comes from deforestation and land-use changes. According to New Straits Time (2019) at the Mauna Lao Sampling Center, Hawaii has detected the highest carbon dioxide concentration since the late 1950s at 415.26 ppm that month. The average increase has reached a high level with last year's increase of 3 ppm, which is an average of 2.5 ppm. This increase has resulted in an average increase in the surface temperature of 1.0 ° C since pre-industrial to human-made pollution.

According to data from the National Oceanic & Atmospheric Administration (NOAA) (2019), the global average monthly show in August 2018 was 404.88 ppm and increased in August 2019 to 407.75 ppm. This average is calculated from the ocean and inland surface of its carbon dioxide concentration. This data report is based on dry air defined as the number of carbon dioxide molecules divided by the sum of all the molecules in the air, including carbon dioxide itself after the water vapour is released. The breakdown of these molecules will be expressed in parts per million (ppm). NOAA-monitored carbon dioxide stations are in Borrow, Alaska, Mauna Loa, Hawaii, American Samoa and the South Pole, Antarctica. Based on these stations, data is available at all times. The latest concentration measurement obtained from the National Aeronautics and Space Administration (NASA) (2019) in November 2019 is 412 ppm. Based on the time series shown the global distribution of carbon dioxide concentrations from 2002 to 2016. Each year carbon dioxide concentrations increased worldwide in early 2016 in North America, and some Asian regions reached carbon dioxide concentration levels between 405 ppm and up to 40%. 425 ppm. Russia has an area that has experienced an increase in carbon dioxide concentration of almost 415 ppm in December 2016.

Concentration levels were determined based on the concentration of carbon dioxide discussed in Mauna Loa, Hawaii, which has been used as a source of high concentration as this area is often higher in carbon dioxide concentration than other areas and has an impact on the surrounding area. Although Mauna Loa is carbon emitted by volcanic eruptions, it is essential to see if the city of Kuala Lumpur is higher or not because here, volcanic activity is not present. Specified levels were above 415.26 ppm, medium-high 401 ppm to 415.25 ppm and low below 400 ppm.

2.3 High Carbon Dioxide in Urban Areas

In a study conducted by Okhimamhe and Okurus (2013) in Nigeria said that carbon dioxide emissions at three major intersections exceeded the acceptable international safety limit of 350 ppmin but less than the Occupational Safety and Health Administration (OSHA) of 5,000 ppm. The results showed that the average carbon dioxide emissions at the three major intersections were 2, 856.6 ppm, 2,731.1 ppm and 2,518.1 ppm. Researchers use gas control tools to absorb data, and there are four times to get data. The study concluded that this area is high in the emission of carbon dioxide gas by vehicles. To control this, use the vehicle as low as possible and share the car or the like.

According to Suresh, Pardis, Sudia and Abhijit (2018) stated that carbon dioxide in the atmosphere exhibited the lowest value of 384.98 ppm during the monsoon in 1984 to 401.22 ppm during monsoon 2016. Carbon dioxide in the atmosphere was measured at an altitude of 18 m above ground with a Non-Dispersive Infra-Red (NDIR) gas analyzer equipped with a thermometer from 1984 to 2016 on Sagar Island in western India Sundarbans. The highest air temperature during the monsoon in 2009 may be attributed to the super cyclone passing through the Delta Ganga during the monsoon. Increased carbon dioxide and air temperature due to the rapid industrialization and urbanization of the dominant mangrove ecosystem. This change of land due to the unplanned expansion of shrimp farms using natural mangrove trees is also a strong reason for the large scale increase in carbon dioxide and air temperature. A large-scale mangrove farming can reduce carbon dioxide and reduce air temperature.

According to Abdel Galeil (2015) says that the highest value of carbon dioxide corresponds to a snowfall of 405 ppm, and the lowest of summer to 397 ppm reflects the fluctuation of traffic and human activity.

This study was conducted by Qena, Upper Egypt, from January 2013 to December 2014. On the weekly cycles, high on weekdays and low on weekends while CO_2 concentrations on the hour were low during the daytime hours between 12 and 4.00 pm. This situation affects meteorological variables such as air temperature, relative humidity and wind speed on carbon dioxide concentration. The results show a negative correlation of air temperature with wind speed but with a specific relative humidity.

Furthermore, according to Cetin, Sevik and Isinkaralar (2017), the study was conducted to determine the changes in air quality throughout the day, depending on the weather conditions and traffic density in various parts of Kastamonu city centre. The objective of this study is to look at the changes in 3 different types of particles and the concentration of carbon dioxide from the air based on certain factors. The measurements used were different; for the Extech EA80 carbon dioxide, indoor air quality and particulate matter were measured using 3-Channel Lighthouse 3013. The results show that the amount of carbon dioxide in the forest is 148 ppm while in the city centre the volume is 399 ppm in summer. The increase in carbon dioxide is due to the rapidly developing environment such as schools, shopping malls and hospitals where there are many people. As a result of increased carbon dioxide can cause fatigue and sleep. If carbon dioxide levels above 1000 ppm cause headache, dizziness, fatigue, lack of focus and odour disorders even when over 1500 ppm causes cough, nose pain and sore throat.

Urban areas play a role in the carbon cycle. Therefore, a case study of Shanghai commercial and mainland Chinese cities to look at the patterns and factors of carbon dioxide concentration near the city during the spring. A total of 173 stations covering the entire area of the city were to study the concentration of carbon dioxide across various land uses. Carbon dioxide was measured at the height of 2 meters above the ground between 9 am, and 11 am in April and May 2014. Results show that the carbon dioxide concentration was 409.4 ± 20.8 ppm on average. For land use, the highest value in the transport area was 420.5 ± 33.3 ppm, and the lowest value was agricultural land of 398.9 ± 16.2 ppm. Urban areas with high density and human activity, high carbon dioxide concentration in the urban area were 423.9 ± 29.3 ppm compared to the urban centre area of 417.2 ± 17.5 ppm. In conclusion, this study found that areas with vegetation cover showed the highest correlation of carbon dioxide concentration in the atmosphere compared to urban areas (Liu et al., 2016).

According to Yahaya, Ghazali and Isaac (n.d) in their presentation on carbon dioxide reviews in Malaysia present status and challenges. The most significant carbon dioxide emissions were due to transportation activities of 1,410,134 metric tonnes compared to industries, energy stations and others. In 2009, the number of vehicles of all kinds in Malaysia amounted to 1,902,000. A case study at Danum station to see Global Atmosphere Watch (GAW). The data analyzed for total carbon dioxide concentration at 390 ppm was highest at 2500 in 2010 and lowest at 410 ppm at 500 and below. Dioxide concentration will change over time. As a result, the government has implemented the National Green Technology Policy (NGTP), which has five strategies that include the public's awareness of achieving zero or low greenhouse gas emissions.

III. Data and methods

3.1 Study area

Kuala Lumpur is the largest capital city and city in Malaysia. It is known as the Federal Territory of Kuala Lumpur other than the Federal Territory of Putrajaya and the Federal Territory of Labuan, which is administered directly by the Federal Government of Malaysia compared to other states in Malaysia which have a state administration system. The land area of Kuala Lumpur is 244 km2 (Junaidi et al., 2017) and is a metropolitan area known as the Klang Valley. The Klang Valley also includes part of the State of Selangor due to the overflow of development coming from Kuala Lumpur towards its neighbouring state of Selangor. According to the Kuala Lumpur Structure Plan 2020, the City of Kuala Lumpur is divided into six strategic zones bordered by major road networks, rail and river corridors. These zones are the City Center, Wangju Maju-Maluri, Sentul-Manjalara, Damansara-Penchala, Bukit Jalil-Seputih and Bandar Tun Razak - Iron Valley (DBKL, 2020). In each of these zones, there are two stations designated for data sampling. There are12 stations involved (Figure 1).

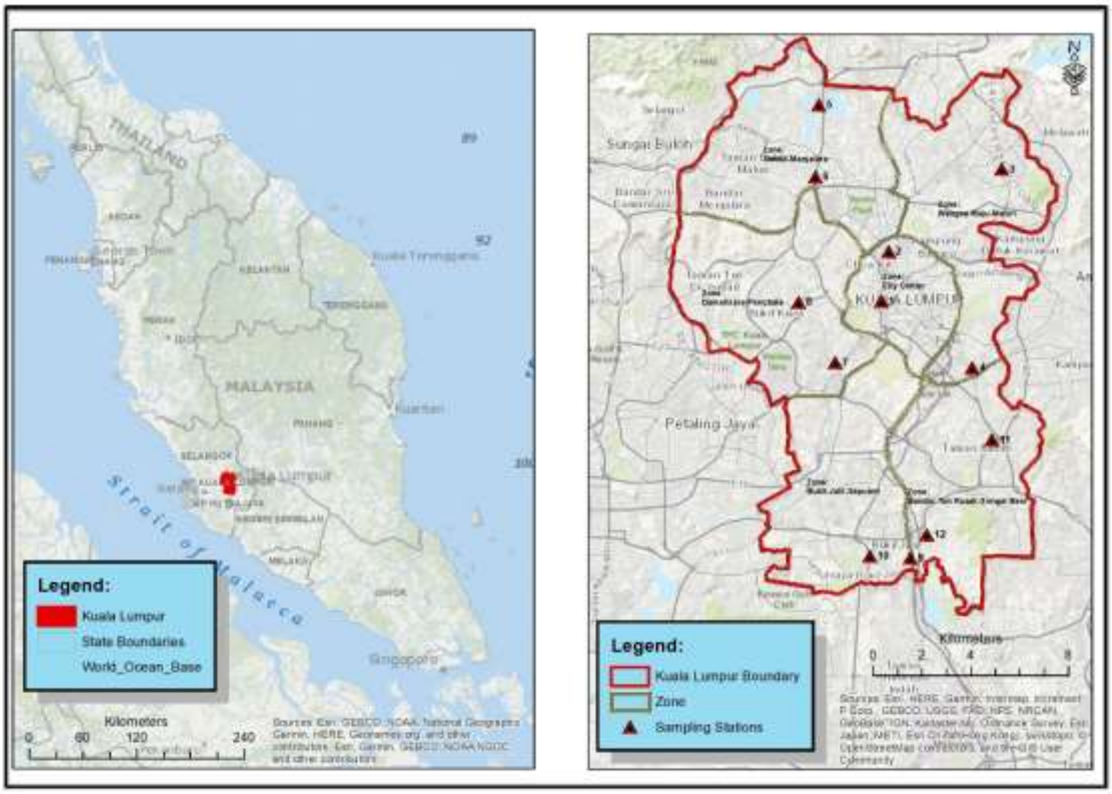

Figure 1. *Sampling Stations Location*

Table1 *Zone, Location of Sampling Stations*

Station	**Zone**	**Lokasi**	**Longitud (X)**	**Latitude(Y)**
Station 1	A (City Center)	Dataran Merdeka	101.693409	3.149980

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Station 2	A (City Center)	Asia Park	101.696091	3.168166
Station 3	B (Wangsa Maju-Maluri)	Sri Rampai	101.737697	3.198496
Station 4	B (Wangsa Maju-Maluri)	Sunway Velocity	101.726811	3.125396
Station 5	C (Sentul-Manjalara)	Sri Utara	101.670420	3.222147
Station 6	C (Sentul-Manjalara)	Jalan Kepayang	101.669224	3.195686
Station 7	D (Damansara-Penchala)	Petron Bangsar	101.676356	3.127313
Station 8	D (Damansara-Penchala)	Pusat Bandar Damansara	101.662936	3.149613
Station 9	E (Bukit Jalil-Seputeh)	Standard Chartered	101.704135	3.055385
Station 10	E (Bukit Jalil-Seputeh)	Stadium Bukit Jalil	101.689191	3.056201
Station 11	F (Bandar Tun Razak-Sungai Besi	Tesco Extra Cheras	101.734154	3.098915
Station 12	F (Bandar Tun Razak-Sungai Besi	Pekan Sungai Besi	101.710104	3.064034

3.2 Data collection

The data used are primary and secondary. The primary data used is by field study method and sampling at the location of the study station. The sampling location is based on several criteria, such as its location within six predefined zones. The location is also not protected from any physical or building features. The location selected is a covered parking lot to avoid elements like CO_2 trapped in just one area. The location of the station is as shown in Table 1. Samplings are held twice a day, day and night. During the day, the sampling is between 1 and 4 pm to get the optimum value, during which time the active photosynthesis process occurs with plants taking CO_2 and releasing oxygen (O). If the Sampling Method uses a carbon detector with time, each sampling at the station is 5 minutes. Sampling methods and photographic methods are essential to provide visual evidence

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that can enhance the validity and reliability of the study results. The secondary data is the reference method and the map study method. Methods such as referencing articles, journals, websites of related departments and books. The map study method is also a method that can give an overview of the study area.

3.3 Data Analysis

The analysis used is descriptive and regression analysis. The descriptive analysis used was to obtain the tendency to concentrate on the CO_2 concentration obtained from the samplings. The average of each sampling station, the average watch time, as well as the overall average, are needed to determine the CO_2 concentration pattern at selected locations in Kuala Lumpur City. Besides, other analyzes involved, such as percentage and standard deviation. Also, spatial regression techniques were developed to identify areas of Kuala Lumpur with varying concentrations based on sampling data using ArcGIS 9.3 software in geographic information systems, interpolation techniques in spatial analysis.

The regression analysis used is in the geostatistic technique, which is the inverse distance weighted (IDW) commonly used to predict a place based on known value of observable value. IDW is one of the techniques used in raster data by predicting the value of a new cell-based on the known value of a cell-based on the distance of the new cell to the known cell.

IV. Results and Discussion

4.1 CO_2 concentration in Kuala Lumpur

The values obtained during the period between August 11, 2019, and August 18, 2019, during the eight days can be seen in Table 2. Samplings were performed at two different times - daylight between 1 pm to 4 pm and night between 1 am to 4 in the morning. Sampling time is based on the assumption that the volume of CO_2 production is reduced due to the photosynthesis process during day time. So the more plants around the station, the less CO_2 will be. In essence, at night, there will be a concentration of CO_2 in this area, and this will cause heat in the upper room as the photosynthesis process does not take place.

Table 2 shows the values of the observed precipitation over the eight days from Sunday morning (August 11, 2019) until the following afternoon (August 18, 2019) for the night. The obtained values ranged from 374 to 610 ppm. The highest values were found at station 1 (City Center) at 610 ppm and the lowest value at station 3 (Wangsa Maju-Maluri) at 374 ppm (day eight). Even in the City Center Zone, this value is higher than 400 ppm obtained on the first day (station 1 = 610 ppm) and second (station 2 = 434 ppm). Average values were between 393 ppm (days five and eight) and 419 ppm (day six). The standard deviation indicates that the inter-day value was not significant, only below 22, except on the first day with a value of 61. The median value showed that the highest values were at 420 ppm and 383 ppm. This record indirectly indicates that this data is likely to be around 400 ppm per day of sampling. The inter-day range also shows a lack of diversity in that the value obtained is approximately 77 ppm to 33 ppm except on the first day.

Table 2 Night CO_2Concentration

Station	Day (PPM)							
			3	4				
1	10	23	40	24	25	58	34	51
2	25	34	18	10	89	22	09	02
3	07	21	09	23	77	19	01	74
4	93	20	11	03	99	10	04	07
5	00	25	04	01	88	05	18	82
6	90	20	01	10	84	01	27	76
7	03	17	13	14	89	35	20	03
8	95	13	13	06	88	04	00	78
9	09	20	51	35	02	23	05	96
10	09	02	16	93	86	02	00	81
11	86	04	03	84	89	29	89	84
12	92	17	23	24	96	14	06	76
Ave.(PPM)	18	18	17	11	93	19	09	93

M ax.	10	34	51	35	25	58	34	51
M in.	86	02	01	84	77	01	89	74
St and. Dev.	1		5	4	2	7	3	2
M ed.	02	20	13	10	89	17	06	83
R ange	24	2	0	1	8	7	5	7
V ariance	449	9	06	92	36	53	52	38

The average daily values do not show too much value, and this is in line with the situation stated by NOAA (2019) with a global average value of 407.4 ppm. It is slightly above the global average due to the position of Kuala Lumpur City in the tropics. However, this value is obtained at night when the original conditions in the tropics will be colder than the daytime temperatures. In addition to other greenhouse gases, CO_2 has the highest contribution of 60% (Yu et al., 2016; Albo et al., 2010; IEA, 2012). CO_2 concentration is high in densely populated areas, such as in large cities. However, the CO_2 concentration will be greatly reduced in the atmosphere when there is also CO_2sampling of forests and oceans such as Indonesia (Samiaji, 2011), Malaysia, Brazil and other tropical countries. CO_2 concentration is high at night because no photosynthesis process or carbon sampling takes place. Even the maximum value of 610 ppm has reached global value.

Table 3 shows the values and variations obtained from daylight hours between 1.00 and 4.00 pm. The average value for eight days was between 393 ppm (day 7) and 417 ppm (day 3). The maximum value obtained by day shows the lowest value on day five (453 ppm at station 5) with the lowest value being 413 ppm (day seven at station 7). Whereas all other stations also exceed 400 ppm values. The lowest values were between 404 ppm (first day at station 10) and 368 ppm (day seven at station 3). The standard deviation shows values between 15 (day 3) and 6 (day 8), indicating no significant difference between the obtained days. Median values showed no significant differences as the median values ranged from 413 ppm (1st and third days) and 392 ppm (7th day). The range values also showed no significant differences, with the highest values being 57 (day five) and 26 (day 8).

Table 3Day CO_2Concentrations

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Station	Day (PPM)							
			3	4				
1	25	00	40	15	53	32	92	04
2	15	00	18	30	14	08	74	05
3	11	88	09	96	29	96	68	02
4	29	06	11	15	14	98	92	02
5	43	01	04	96	13	98	97	09
6	13	95	01	11	98	04	85	05
7	13	11	13	13	01	92	13	07
8	09	94	13	06	98	83	09	00
9	08	13	51	04	06	99	08	08
10	04	96	16	97	96	93	89	90
11	16	00	03	16	21	89	87	09
12	09	24	23	09	01	92	96	16

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(PPM)	Ave.	16	02	17	09	12	99	93	05
	Max.	43	24	51	30	53	32	13	16
	Min.	04	88	01	96	96	83	68	90
Dev.	Stand.	1	0	5	0	6	2	4	
	Med.	13	00	13	10	10	97	92	05
	Range	9	6	0	4	7	9	5	6
	Variance	11	8	06	2	49	41	67	6

Basically, the concentration of CO_2 will be higher during the day. This higher is because the physical process is vibrant. The process of CO_2 gas exchange to O occurs. This process is due to the photosynthesis process by plants other than the sampling of carbon into the oceans. This high concentration is alternated with gas exchange. It is from the difference in values between only the maximum and the minimum compared to the dark times. This value is still high compared to the CO_2 concentration values globally.

Table 4 shows the average values and their variances based on the average daily value per station by looking at the average of night and day values. The average value was not too big, with the highest values being 420 ppm (first day) and 399 ppm (day 8). The maximum value is between 518 ppm (first day) and 417 ppm (day 7). While the minimum value is between 401 ppm (first day) and 385 ppm (day 7). The standard deviation also shows between values 34 (first day) and 7 (day 2). The median value is 412 ppm (day 2) and 396 ppm (day 8). The first-day range is quite broad, with a value of 117 compared to the other days with a low range.

Table 4 Night and Day Average of CO_2

Station	**Day (PPM)**	
	3	**4**
1		

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	18	12	18	20	39	45	13	28
2	50	17	13	20	02	15	92	04
3	09	05	00	10	03	08	85	88
4	11	13	05	09	07	04	98	05
5	22	13	04	99	01	02	08	96
6	02	08	96	11	91	03	06	91
7	08	14	08	14	95	14	17	05
8	02	03	03	06	93	94	05	89
9	09	17	24	20	04	11	07	02
10	07	99	03	95	91	98	95	86
11	01	02	07	00	05	09	88	97
12	01	21	29	17	99	03	01	96
Ave. (PPM)	20	10	09	10	02	09	01	99
Max.	18	21	29	20	39	45	17	28
Min.	01	99	96	95	91	94	85	86

St and. Dev.	4		0		3	3	0	1
M ed.	08	12	06	10	01	06	03	96
Ra nge	17	2	3	5	8	2	2	2
Va riance	040	2	1	7	49	57	0	17

The average value of CO_2 concentration in the tropics is usually high. Depending on the area, whether the forest is high or not. For high-forest areas, the average is low because the photosynthesis process during the day can reduce CO_2 content. For areas that do not have enough forests to process photosynthesis to convert CO_2 to O, then CO_2 concentration will be high during the day and at night. The City of Kuala Lumpur, which has a vegetation area of 243 km2 (DBKL, 2020), is among the areas with vegetation cover, which is still not able to reduce CO_2 concentration. This situation makes the area potentially hot until the heat island is formed.

Table 5 shows the descriptive statistics values for each sampling station. The actual values for each station are as shown in Table 2 (night) and Table 3 (noon). The average value of eight days for all stations shows the average value is between 396 ppm (station 11) and 458 ppm (station 1). The maximum values for stations are 610 ppm (station 1) and 413 ppm (station 8). The minimum value is between 374 ppm (station 3) and 434 ppm (station 1). The highest standard deviation was at station 1 (63), and the lowest was at station 4 (8). The median values show many similarities between stations at around 400 ppm, with the highest values being 437 ppm (station 1) and 389 ppm (station 11). Even the range values do not show much difference between stations except station 1 (187) compared to other stations with the lowest being 27 (station 4).

Table 5 CO_2 Concentration at Night

St ation	Ave.	ax.	in.	Stand. Dev.	M ed.	ange	Varian ce
1	458	10	23	63	4 37	87	3440
2	414	34	89	14	4 14	5	176

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3	404	23	74	19	08	49	[illegible]	318
4	406	20	93	8	06	47	[illegible]	59
5	403	25	82	14	03	43	[illegible]	174
6	401	27	76	18	01	41	[illegible]	269
7	412	35	89	14	14	46	[illegible]	164
8	400	13	78	12	02	45	[illegible]	130
9	418	51	96	19	15	45	[illegible]	299
10	399	16	81	12	01	45	[illegible]	117
11	396	29	84	16	89	35	[illegible]	211
12	406	24	76	17	10	48	[illegible]	249

The city of Kuala Lumpur, located at 243 km2, is not a large area. The difference in CO_2 concentration per station for eight days of sampling is not vast. The maximum value is only about 400 ppm, and the minimum value is 374 ppm. This situation can be seen from the standard deviation values ranging between 10 ppm and above, and only station one is experiencing a significant increase, and this could be based on the potential human problems with CO_2sampling devices.

Table 6 shows the descriptive results of each station at daylight. The highest average values were obtained at station 1 (420 ppm) and station 10 (398 ppm). The maximum values by station indicate that station 1 (453 ppm) is highest, and station 6.7, and 8 is the lowest (413 ppm). The minimum value is between 399 ppm (station 9) and 368 ppm (station 3), and the standard deviation value is between 21 (station 1) and 8 (station 7). Table 6 shows the average CO_2 values during the day for each station for eight days of sampling. The values for daylight hours (12-4 pm) are used to generate the data in Table 6. The average value obtained is above 400 ppm, except for station 10 only (398 ppm). Even the maximum value was recorded at 453 ppm (station 1) with 368 ppm for the minimum value at station 3. The standard deviation indicates that this sampling data is not too far apart between each station for daytime and low standard deviation.

Table 6 During Days CO_2 Concentration

Station	Ave. (PPM)	ax.	in.	Stand. Dev.	Med	ange	Variance
1	420	53	92	21	420	1	390
2	408	30	74	16	411	6	237
3	400	29	68	18	399	1	281
4	408	29	92	12	409	7	116
5	408	43	96	15	403	7	210
6	402	13	85	9	403	8	71
7	408	13	92	8	412	1	52
8	402	13	83	10	403	0	85
9	412	51	99	16	408	2	230
10	398	16	89	9	396	7	67
11	405	21	87	13	406	4	140
1	409			12	4		124

2		24	92		09	2

As discussed at the beginning of this article, the process of converting CO_2 gas to O occurs during the day. This process makes the concentration value low too. However, this value can be further reduced by re-establishing areas with vegetation cover to ensure that the amount of CO_2 exchanged is sufficient. It helps in lowering temperatures at night with low CO_2 concentrations.

Table 7 shows the overall value of day and night for each station. The highest average CO_2 value was at station 1 (436 ppm), with the lowest average value being 397 ppm (station 10). Station 1 shows the highest values for all samplings, either the average, maximum, minimum, and standard deviation. Thesituation was due to value at station 1 recorded is higher than the other stations.

Table 7 Overall CO_2 Concentration for All Sampling Stations

St ation	Ave. (PPM)	ax.	in.	Stand. Dev.	ed.	M	ange	Varian ce
1	436	18	12	35	24	4	06	1068
2	414	50	92	17	14	4	9	264
3	401	10	85	10	04	4	5	80
4	406	13	98	5	06	4	5	19
5	405	22	96	9	03	4	6	64
6	401	11	91	8	02	4	0	49
7	409	17	95	7	11	4	2	42
8	399	06	89	6	02	4	7	36

							4		[illegible]	
	9	411	24	02	8	10		2		52
	1						3		[illegible]	
0		397	07	86	7	96		1		38
	1						4		[illegible]	
1		401	09	88	7	02		1		38
	1						4		[illegible]	
2		408	29	96	12	02		3		129

Average carbon dioxide concentration at each study area of the city of Kuala Lumpur during the sampling period (Figure 2). The reception was performed twice at different times of night (1.00-4.00 am) and daylight (1.00-4.00 pm) daily for eight days (11/8 / 2019-18 / 8/2019). On average, the concentration of carbon dioxide in the urban area of Kuala Lumpur is higher at ppm at night than during the day.

Based on the average night time, the highest concentration of dioxide was at station 1, the Independence Square, located in the Kuala Lumpur city centre zone of 458.125 ppm. The station is the highest concentration area as it is an area of urban heat island and greenhouse gas, which causes the accumulation of greenhouse gases, carbon dioxide gas. This area also lacks plants capable of absorbing carbon dioxide, which is mostly released by natural processes such as respiration and human activity. While the lowest station at night compared to other stations was station 11, the Tesco Extra Cheras F zone with an average carbon dioxide concentration of just 396 ppm. It is a station located in a residential area and surrounded by vegetation. This area is less likely to be the focus of the night because of the population's economic activities. Therefore, the release of carbon dioxide gas from the respiration process and human activity is not so much the direct release of gas.

The average carbon dioxide concentration during the day showed that station 1 was also the highest station with an average volume of 420,125 ppm less than that of the night. The location of this station is the same as the night is the focus of people and transportation activities. Further, the lowest average during the day is Station 10 (Bukit Jalil Stadium) located in zone E. The station is low in ppm value of 397.625 ppm as it is surrounded by vegetation and is less crowded. This area is the focus of the people when it comes to sports or recreational activities, as it is a leisure and recreation area. Therefore, the emission of carbon dioxide gas is lower than in other areas.

4.2Spatial Variation of CO_2 Concentration

Figure 2 shows the spatial variation of CO_2 concentration according to the regression technique in GIS using the inverse distance weighted (IDW) regression method using ArcGIS 10.3 software. This IDW technique is based on the prediction of the unobserved area based on the observed value. The absorbed value is derived from the CO_2 value of the 12 stations taken for the entire six zones of Kuala Lumpur City. For Diagram 2, the variation is only at night from 1.00 to 4.00 am. The subdivision refers to four major areas, namely, i) areas with less than 389 ppm as the minimum night-time value is 386 ppm (Table 2), ii) areas with between 386 and 400 ppm, iii) areas with concentrations between 400 and 410 ppm and iv) area over 410 ppm. The majority of the areas have concentrations above 400 ppm on days 1, 2, 3, 4, 6.7 and 8. While on average, eight days of night-time exposure indicate that more than 90 percent of Kuala Lumpur city areas have CO_2 concentration values higher than 400 ppm.

Of course, the concentration in Kuala Lumpur City is high at night because of the photosynthesis process, and the gas will remain in the air, and if it is not released to the atmosphere, then the local air will be heated to heat island.

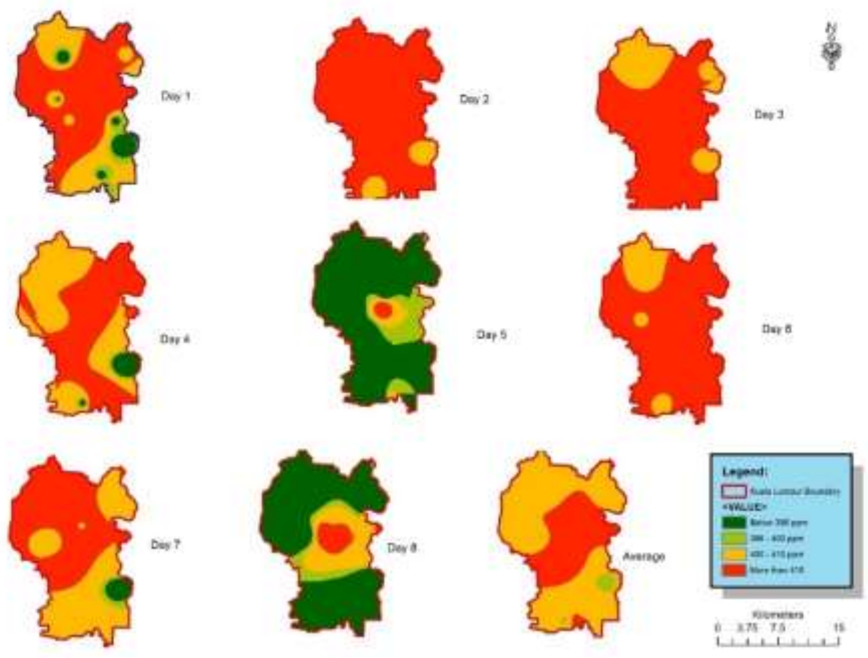

Figure 2. Spatial Variation of CO_2 Concentration at night

Figure 3 shows different values of CO_2 concentration based on the same regression technique but during the day. The sampling value is from 1.00 pm to 4.00 pm, which is at the height of the sun's rays to the earth. All days indicated that the majority of the areas had a high concentration of C02 for days 1, 2, 3,4,5 and 8.

The diversity of this space shows that the process of CO_2 gas exchange is indeed happening in Kuala Lumpur. However, there is one zone that is the city centre zone that has a higher concentration on the day than the other. Most days indicate that CO_2 concentration is high, with values above 400 ppm for most areas except for specific days.

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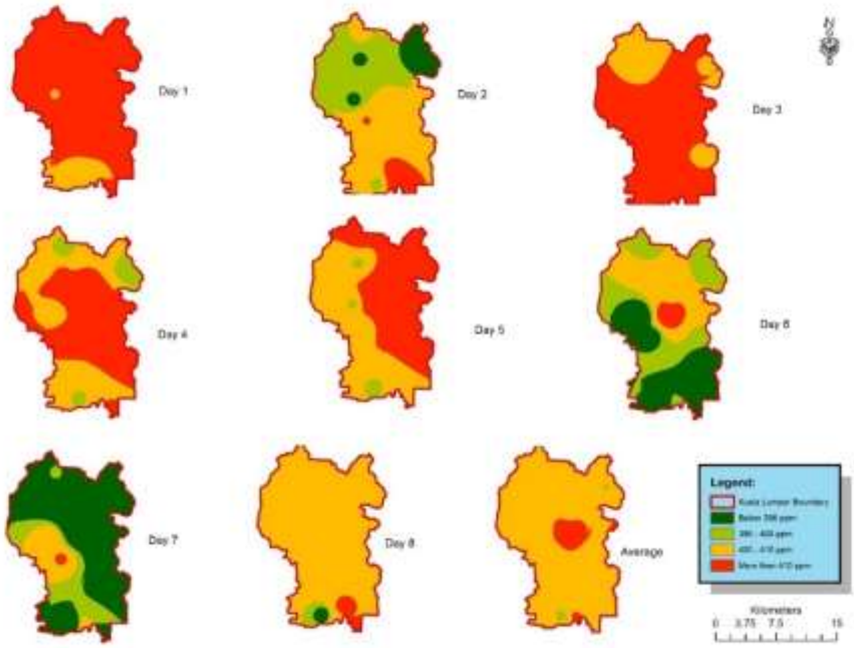

Figure 3. Spatial Variation of CO_2 Concentration DuringDay

Figure 4 shows the area of concentration for the average value obtained from night and daytime values.Most days indicate that the concentration value is high by more than 400 ppm for all areas of Kuala Lumpur.

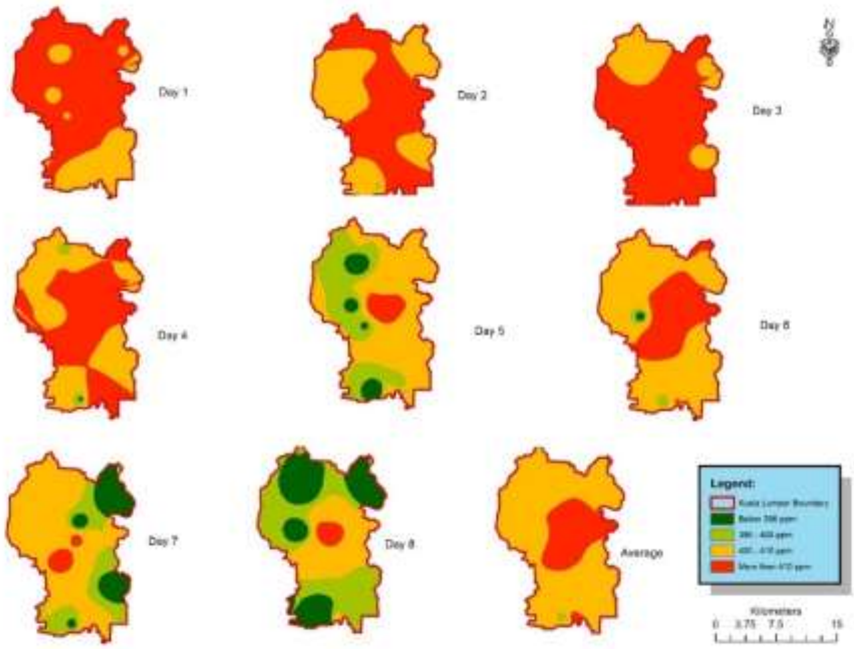

Figure 4. Spatial Variation of Average CO_2 Concentration during night and day

V. Conclusion

Overall, the concentration of carbon dioxide in the city of Kuala Lumpur at selected stations has shown changes in the night and day time. Also, analyzing the pattern of dioxide concentration at night, during the day and overall shows that certain areas have high and low ppm values. Further, the analysis in the study of the concentration of carbon dioxide concentration in the room showed that some areas were in reasonable condition, and others were near danger level and above the specified level. The use of this GIS software indicates that changes to the stations involved can facilitate the determination of carbon dioxide concentration levels.

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