RES MILITARIS
REVUE EUROPEENNE D ETUDES EUROPEAN JOURNAL OF MILITARY STUDIES
Social Science Journal

# The spatial and temporal variation of the concentration of gaseous pollutants in the air of Al-Waziriya region

**By**

**Athra Walid Abdel-Aziz Hassan1**
University of Baghdad, College of Education ibn Rushd/ Iraq
Email: Azraa.Waleed1204h@ircoedu.uobaghdad.edu.iq

**Ali A. Kazem Al-Waeli2**
University of Baghdad, College of Education ibn Rushd/ Iraq
Email: Prof.dr.ali.alwaeli@ircoedu.uobaghdad.edu.iq

## Abstract

This study aims at investigating the air pollution caused by polluting gases, its spatial and temporal variation, and its impact on human health in Al-Waziriya region in Baghdad, as it is one of the big important cities. The study of air pollution with polluting and harmful gases is one of the most important studies, because air is the most important element for survival. A human may be able to go for several days without food and water, but not without air, which is necessary for breathing. There is an urgent need to study air pollutants and their effects on humans, whether in terms of health or psychologically. The polluting gases were identified (ch4, co) and the diseases caused by these gases such as asthma, allergies, anemia, lung disease, shortness of breath, respiration, overall nervous system, kidney, fetal malformation, heart disease, nervous system and other diseases. In addition to harming people, these gaseous pollutants also harm plants and animals. This study, which is accompanied by tables and pictures, investigates the concentration of gaseous pollutants in the air of the study area in Al-Waziriya region. The modeling process in this region was carried out by monitoring each month of the year from. A year is 12 months, but the climatic station was operated for five months, from January to May. Additionally, the annual rates of pollutant gas concentrations were recorded from the year (2007- 2019) to detect the concentration of three gases, namely (CH4, NMHC, CO).

**Keywords**: concentration of pollutants, methane gas, hydrocarbons, carbon monoxide.

## Introduction

Environmental pollution is currently one of the most major global and local issues; nevertheless, what is unique in this situation is a notable increase in the intensity of pollution. Iraq is one of the first Arab countries to think about the environment and how to protect it from deterioration and the formation of the Higher Commission for the Human Environment in 1974. Iraq participated in many conferences, including the Stockholm Conference on the Human Environment. Because of the wars that happened to Iraq and suffered from, the Iraqi cities have suffered from many problems, especially the city of Baghdad, which is one of the largest cities with a large population concentration and the increase in the number of cars and various human and industrial activities (Al-Jussani, 2011).

The explosions and fires that Iraq experienced in its oil depots and chemical storage facilities following the second Gulf War, and the repercussions that persisted into the 1990s and into the present, increased the scope of this problem, which was made worse by the previous conflict (ibid, 284). The problem has also been exacerbated by terrorist bombings,

and the use of private generators to compensate for the shortfall in (national) electric power, as well as the increase in the number of means of transportation from the number of cars that are not pre-studied, and their environmental effects. Moreover, the decline in agricultural activity in Iraq in general as a result of the lack of government support, and the great urban expansion at the expense of green spaces and agricultural lands in general, also had a role in exacerbating the problem. Part of the pollution in Iraq is also due to the spread of the industrial movement in most Iraqi cities, especially in the city of Baghdad, which alone includes more than 65% of the total industrial establishments actually existing in Iraq (Al-Falahy, 2005; Caliskan & Zhu, 2020).

Factories, laboratories and power stations are major sources of air pollution, as all factories, laboratories and power stations make use of burning coal or oil to generate heat and power produce major pollutants such as smog, sulfur dioxide, sulfur oxides, and others. The difference in general is that the pollutants vary from one industry to another. The pollution of the petroleum refining industry is considered as air pollution (Mousa, 1990; Handoyo et al., 2021).

***Research problem***

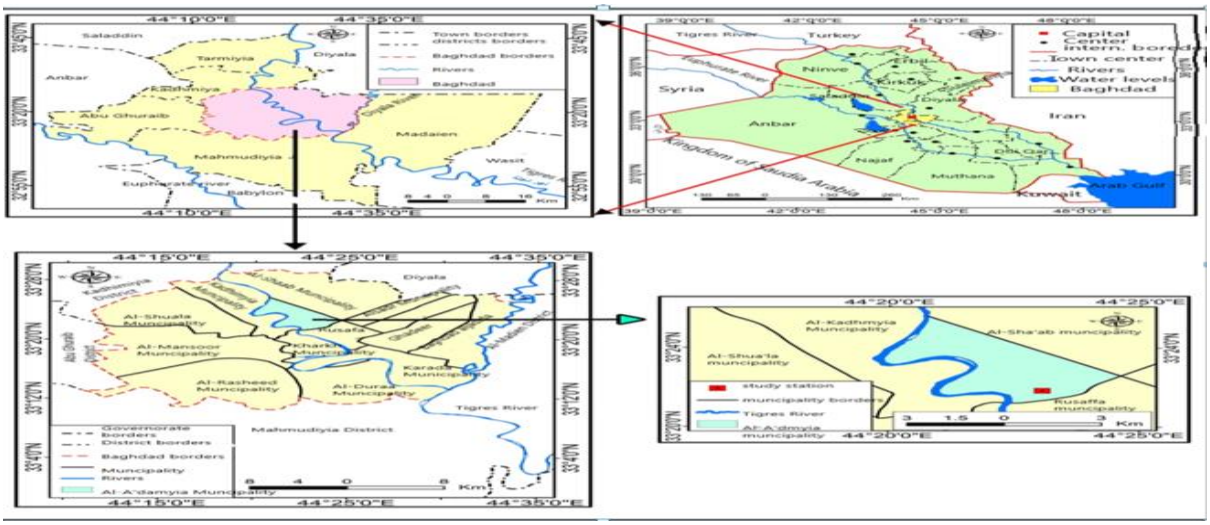
Is there a temporal and spatial variation in the concentrations of gaseous pollutants in the air of Al-Waziriya region?

***Research hypothesis:***

There is a temporal and spatial variation in the concentrations of polluting gases in the air of Al-Waziriya region.

***Research limits***

Spatial boundaries: the spatial boundaries of the study area are (Al-Waziriya) is located in the center of the city of Baghdad. As a result of the large number of factories and public and private cars, in addition to the variation in weather disturbances associated with the variation of climatic elements during the year, it results in a discrepancy in the percentage of pollutants in the study area. Al-Waziriyah district is located in the center of Baghdad city, to the south of Al-Adhamiya district, near Al-Kasra district. It is administratively affiliated to Al-Adhamiya district. The location of Waziriyah region is astronomically between 44°19'54.188"E longitude to 44°24'39.651"E longitude, and from latitude 33°21'12.22"N N to latitude 33°25'35.025"N N.




**Map (1).** The spatial boundaries of Waziriyah district in Baghdad

Source 1: Using Arc GIS 10.8.2.

***Temporal limits for the study*:** The temporal limits for the study were represented by a major climatic cycle for a period of (33) years from the year (1988-2021).

C- Specific limits: The study dealt with the concentration of gaseous pollutants in the two regions (Al-Karrada and Al-Waziriyah) and it included (CH4, NMHC, Co). The measurements were for five months per year and at the level of 13 to 14 days per month in two stations affiliated to the Ministry of Environment.

**Table (1).** *Monthly averages of polluting gases in the air of Al-Waziriya area*

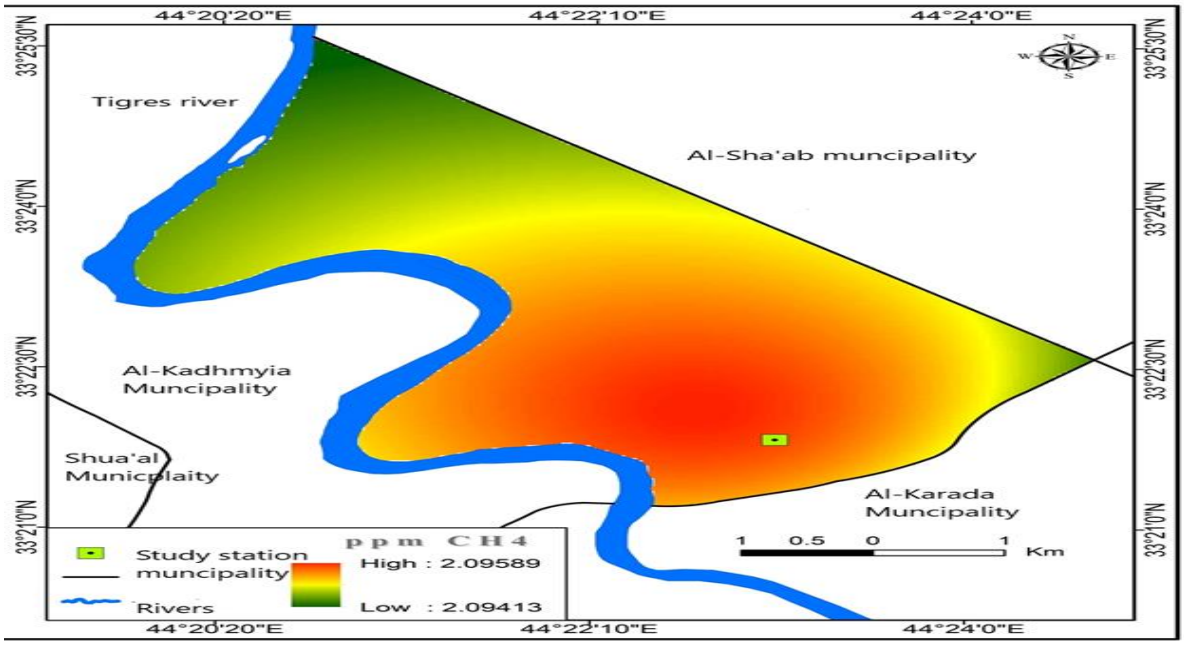
| Months Elements | January | February | March | April | May |
|---|---|---|---|---|---|
| CH4 methane | 1.873343 | 2.18903 | 2.106181 | 2.165416 | 2.145482 |
| NMHC Hydrocarbons | 4.387286 | 4.178685 | 2.559942 | 3.907969 | 3.691666 |
| CO carbon monoxide | 503.4604 | 678.5293 | 597.0529 | 593.0142 | 640.4152 |

Source: The table is made by the researcher depending on Table (2)

**Table (2).** *Annual averages of polluting gases concentrations in the air of Al Waziriyah region*

| Years | Ch4 Methane | NMHC Hydrocarbons | CO carbon monoxide |
|---|---|---|---|
| | Ppm | ppm | ppm |
| **2006** | **1.751392** | **3.544578** | \ |
| **2007** | 1.756722 | 3.524872 | \ |
| **2008** | 1.758196 | 3.620476 | \ |
| **2009** | 1.739259 | 3.488384 | \ |
| **2010** | 2.127539 | 3.738223 | \ |
| **2011** | 2.885352 | 3.99134 | \ |
| **2012** | 1.573139 | 3.361179 | \ |
| **2013** | 2.402895 | 3.917725 | \ |
| **2014** | 1.8754 | 3.778022 | \ |
| **2015** | 2.290571 | 4.07015 | \ |
| **2016** | 2.081427 | 3.780349 | \ |
| **2017** | 2.290571 | 4.07015 | \ |
| **2018** | 2.402895 | 3.917725 | \ |
| **2019** | 2.885352 | 3.99134 | \ |
| **2020** | 1.989252 | 3.676829 | \ |

The table is made by the researcher depending on the Ministry of Environment, Air Quality Department, the results of laboratory tests for the location of the study area for the period (2006-2020) unpublished data.




**Map (2)**. The spatial variation of methane gas concentrations in the air of Al-Waziriya area
Source 2: This work is based on Table (1) by using Arc GIS 10.8.2.

***1- Methane ch4:***

Methane is a simple hydrocarbon and is a chemical compound. It is an odorless gas, but when mixed with quantities of sulfur compounds that are used commercially, it has a distinctive smell, for example, ethyl mercaptan. It has dangerous effects if there is a gas leak. Methane contributes to pollution despite its negligible amount in the atmosphere. It contributes 18% of the total global warming gases impact and has the ability to raise the Earth temperature, because it has the ability to trap the heat that is emitted from the Earth by about 20 times the amount of carbon dioxide capacity (Al-Rubaie, 2002; Heland-Kurzak, 2020).

Through the Map (2), it is clear that the concentration of methane gas in Al-Waziriya region varies from one place to another. We note that in the north of the region the rates are low, as it was (2,09413) ppm. In the south of Al-Waziriya, the concentration of methane was high which was (2,09589) ppm. Methane is mainly formed from the combustion processes of fossil fuels for transportation, industry, stoves, furnaces and others. Methane is one of the simplest hydrocarbons, which is produced by bacterial decomposition of organic matter in swampy and marsh sites. Plants have an important role, as this type of hydrocarbons are released, and human household uses such as fuel use in cooking and heating contribute to 15% of the methane release into the atmosphere. The means of transportation are also main, as they alone release 50% of this type of hydrocarbons. Therefore, their concentrations are high in the atmosphere of cities (Mousa, 1990).

It can be noticed from Table (1) and Figure (1) that the monthly rates of methane gas were noted for January at a monthly rate of 1.873343, while in February it was recorded at 2.18903. In March, the monthly average was 2.106,181. In April, the annual average was 2.165416. As for May, it was 2.093736.

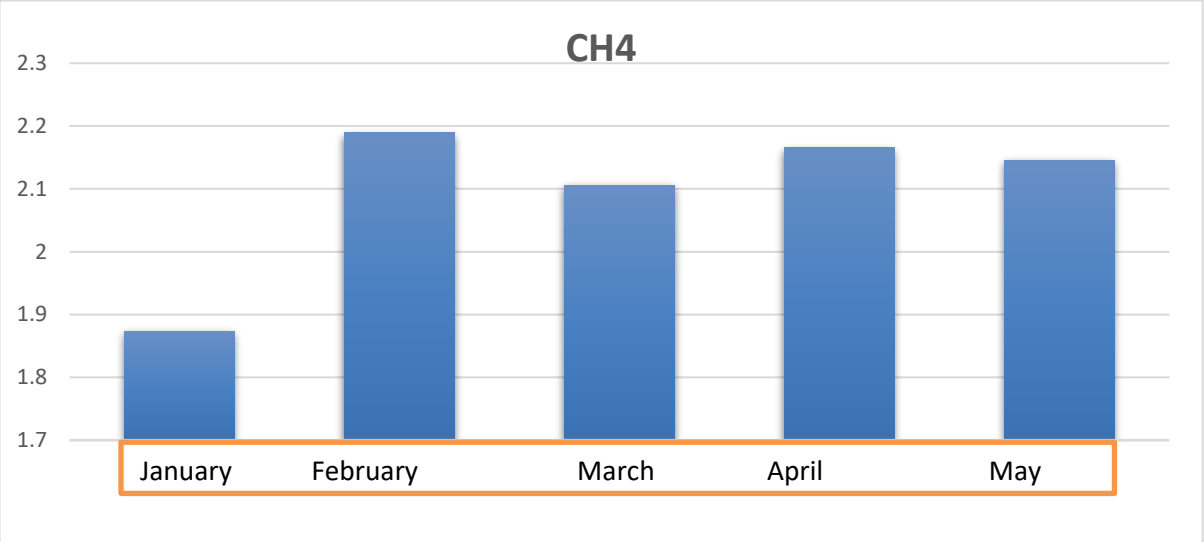



**Figure (1)** Monthly averages of methane gas concentration in the air of Al-Waziriya region for the months (January-May)
Source3: the diagram is made by the researcher depending on table (2)

It becomes clear from Table (2) and Figure (1) that the average for the year 2007 was 1.756722ppm. As for the year 2008, the average was (1.758196) ppm. In 2009, the average was (1.739259) ppm, while the average for 2010 was (2.127539) ppm. In 2011, the rate was (2.885352) ppm. In the year 2012 the average was (1.573139) ppm. In 2013, the rate was (2.402895) ppm, while the average for 2014 was (1.8754) ppm. In 2015, the average was (2,290571) ppm. In 2016, it was at a rate of (2.081427) ppm. In the year 2017 (2.290571) ppm.

In 2018, the average was (2.402895) ppm. In the last two years 2019 and 2020, the rates were (2.885352) ppm, and (1.989252) ppm.

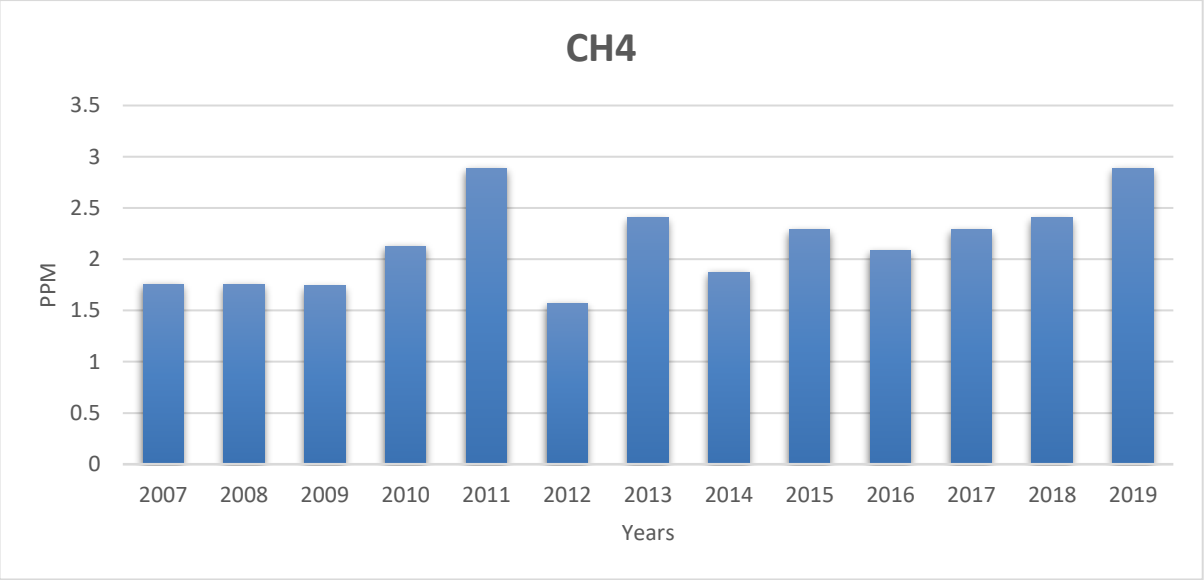



**Figure (2**) Annual averages of methane (PPM) concentration in the air of Al-Waziriya region for the period (2007-2019)

Source4: This work is made by the researcher depending on Table (1)

*Ppm refers to parts per million

***2- Hydrocarbons***

Hydrocarbons are defined as organic compounds consisting primarily of the elements hydrogen and carbon arranged in chains of carbon atoms, and connected to each other by single-molecular, two-molecular or three-molecular bonds. When they interact with each other, the compound becomes more stable. The molecular shape of the compound is expressed in the form of the arrangement of carbon atoms, the shape of vertices and connections in the form of lines, as well as its uniqueness in many properties, and the boiling point of organic compounds is more than 100 degrees Celsius (Mousa, 1990).

Hydrocarbons are divided into types: Saturated hydrocarbons, which are one of the simplest types and may have double or triple bonds and be devoid of any rings and have a formula (CnH2n+2). This type is basic in petroleum products. As for the second type, unsaturated hydrocarbons consist of one or more covalent bonds and are known as double bonds and are called alkenes and their general formula is (CNH2N). As for compounds that are made of triple bonds (CNH2 n_2) As for the third type, aromatic hydrocarbons are also called aromatic compounds, and their structure is stable and with one ring, and the benzene ring is part of its composition. The last type of cycloalkanes consists of one or more carbon rings and hydrogen atoms are attached to it.

***Risks of Hydrocarbons***

Although hydrocarbons have a variety of uses, they can cause serious harm to nature, especially human health. Of these harms is inhaling large amounts of hydrocarbons can lead to drug addiction, which can lead to nerve and muscle damage. (Jabir, N.D.). As a result, movement is impaired and stammering due to slurred speech and brain cell damage due to substances that contain saturated fats can lead to loss of memory and concentration, anemia and bone marrow damage, severe sleep addiction. Inhalation of large amounts of hydrocarbon gases leading to heart problems or suffocation and weak lungs may cause coma or clots. He may have hoarseness and nose or eye infections. Because the hydrocarbon gas emitted by a

vehicle is 50% in the air, the increase is directly proportional to the speed. This percentage also increases in direct proportion to the vehicle exhaust emission rate. When the car speed is in the range of 85-90 kilometers per hour, the gas emission rate is very low due to the high efficiency of the engine car, unlike cities where the car speeds are low, the efficiency increases due to the almost complete combustion of fuel.

The carcinogenic compound benzoprene comes from a variety of sources, most notably the fuel combustion industry, rubber, and cigarettes. Inhaling it in large quantities is equivalent to smoking dozens of cigarettes. Statistics published in the northern city of Detroit, USA, show that the amount of inhaled benzopyrene is equivalent to about 37 cigarettes per day. In Birmingham, UK, the amount of benzopyrene is equivalent to 50 cigarettes per day. It has been reported that an increase in its percentage in the air contributes to global warming (Mousa, 1990).

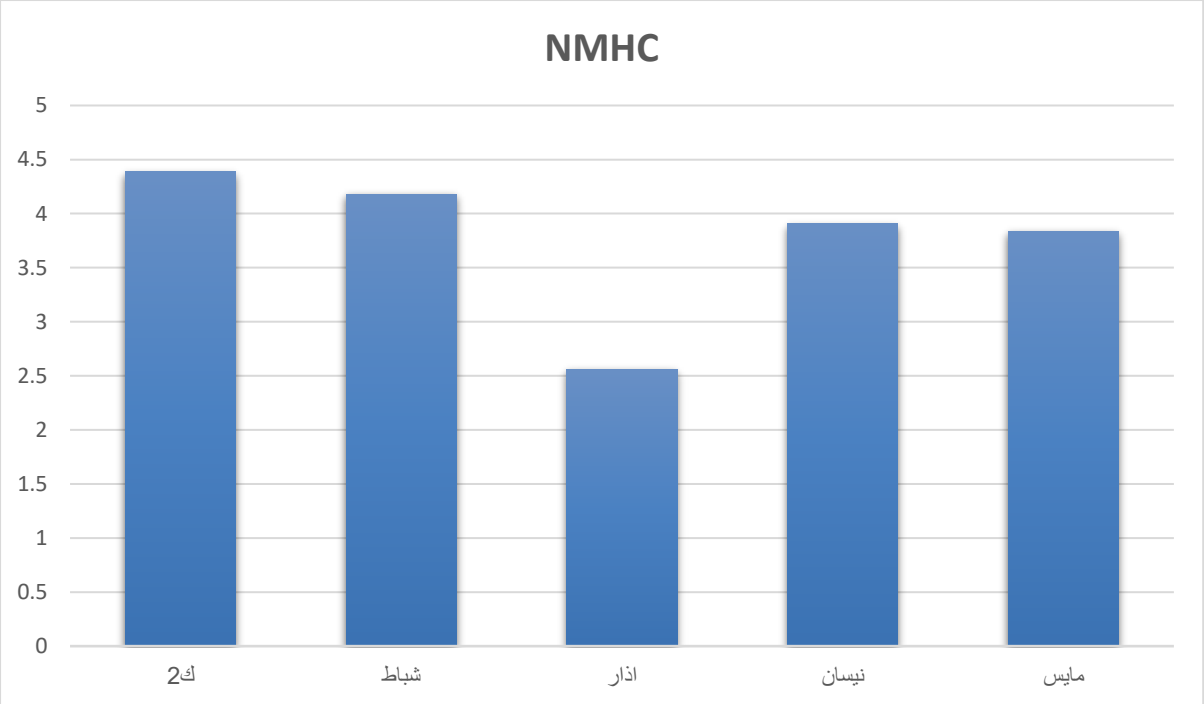



**Figure (3)** Monthly averages of hydrocarbons concentrations in the air of Al-Waziriya region for the months (January-May)
Source5: This work is made by the researcher depending on Table (1)

Through Table (1) and Figure (2), it is clear that the monthly average of hydrocarbons was reported for January to (4.387286) and for February was (4.178685). As for March, the monthly average was (2.559942), while the average for April was (3.907969) and for May was (3.839412).

Through Table (2) and Figure (2), we show the annual rates of hydrocarbons concentrations in the air of Al-Waziriya region. In the year 2007, the rate was (3.524872) ppm. In the year 2008, the average was (3.620476) ppm, while the annual rate for the year 2009 was (3.488384) ppm, and for the year 2010 the rate was (3.738223) ppm. In the year 2011 the average was (3.99134) ppm. In 2012, the annual average was (3.361179) ppm, the rate was (3.917725) ppm for the year 2013, and the average was (3.778022) ppm. In 2014, the average was (4.07015) ppm for the year 2015. In 2016, the average was (3.780349) ppm. In 2017, the average was (4.07015) ppm. In 2018, the average was (3.917725) ppm. In the last two years,

the rates were (3.99134) ppm and (3.676829) ppm.

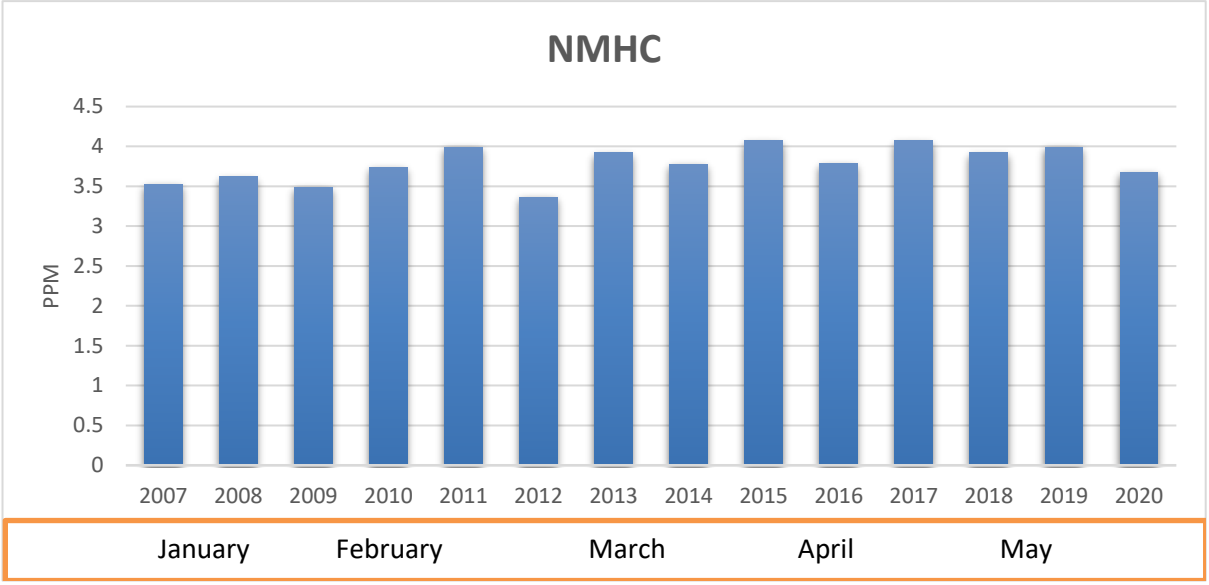
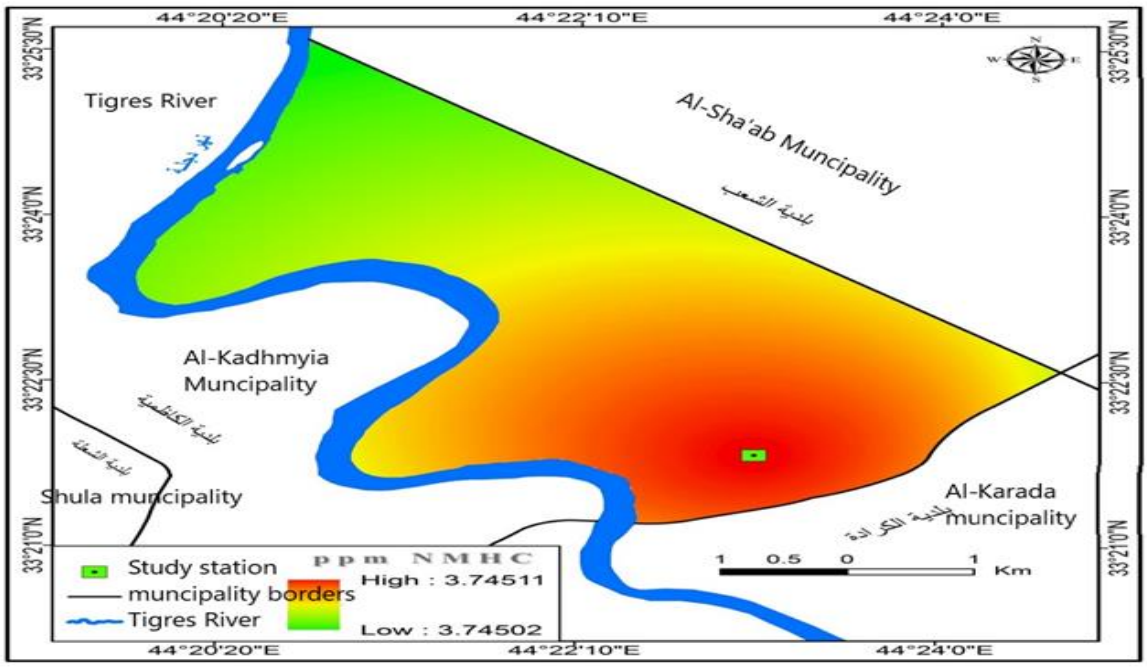



**Figure (4)** Annual averages of hydrocarbons (PPM) concentrations in the air of Al-Waziriya region for the period (2007-2020)
Source6: This work is made by the researcher depending on Table (1)




**Map (2)** of the spatial distribution of hydrocarbons concentrations in the air of Al-Waziriya region
Source7: This work is based on Table (2) by using Arc GIS 10.8.2.

Through the Map (2) and Figure (2), Al-Waziriya region varies in the distribution of hydrocarbons spatially between the parts of the study area. As for the southern parts, the values of this polluted gas were high, it was (3,74511) ppm.

### *2- Carbon monoxide (CO)*

Carbon monoxide is a colorless, odorless, and tasteless gas that is slightly lighter than air and has a very low degree of dissolution in water. It can burn, but it does not help the

combustion, despite the entry of large quantities of this gas into the atmosphere from natural sources represented in the first place. However, the risk of such a kind of gas is represented in cities and industrial areas. It is one of the most toxic gases. When a person breathes this gas, it combines with the red blood hemoglobin known as hemoglobin to form carboxyhemoglobin. It reduces the blood ability to carry and distribute oxygen to all its cells and body tissues (Al-

Saadi, 1999). The main source of CO gas emissions in the study area is from the exhausts of cars and motorcycles. This has been proven by many studies of air pollution (Al-Saadi, 2008).

**Picture (1)** shows the effect of cars and motorcycles on the spread of gaseous pollutants
Source8: A field study photo taken on 06/07/2022

The main reason is due to the combustion of engines and means of transportation resulting from one of the following causes (Al-Rubaie, 2002):

1. Lack of available oxygen.
2. The flame temperature is insufficient.
3. The gas is not kept at this temperature long enough to complete combustion.
4. Breaking down of the combustion chamber as a result of malfunction or consumption.

Carbon monoxide concentrations in the average city are estimated to be about 300 million tons of carbon monoxide released into the atmosphere each year. Temperature has an effect on increasing the concentration of Co gas, because of its reasons for increasing the quantities of fuel consumed, especially in the summer, to fill the energy shortage due to the use of private electric generators spread in residential neighborhoods on the one hand and the operation of cooling devices in cars on the other hand due to high temperatures. The concentration of CO gas in the study area is at traffic, commercial and mixed sites, which makes the residents of Karrada area vulnerable to many diseases, poisoning with this chronic gas and other diseases. This gas is dangerous because it is not seen, and its presence cannot be sensed because it is an odorless gas.

The body systems are affected when this gas is inhaled, and it is absorbed by the

bloodstream. It combines with hemoglobin to form carboxyhemoglobin. The function of hemoglobin in the blood is to transport oxygen from the human lung to the brain and the rest of the blood, and to return carbon dioxide from the cells to the lung to get rid of it. In the case of exposure to gas, hemoglobin replaces oxygen in the lung, and taking Co gas will decrease the percentage of O2 gas present in the blood. This deficiency may cause headache and dizziness, and then death (Al-Awadatt, 1998).

It can be noted from Table (1) and Figure (4) that the monthly rates of carbon monoxide gas were reported at a rate of 503.4604 for January. The rate was 678,5293 for February. The average was 597.0529 for March. As for the monthly average in April, it was 593.0142. In May, the average was 640.4152.

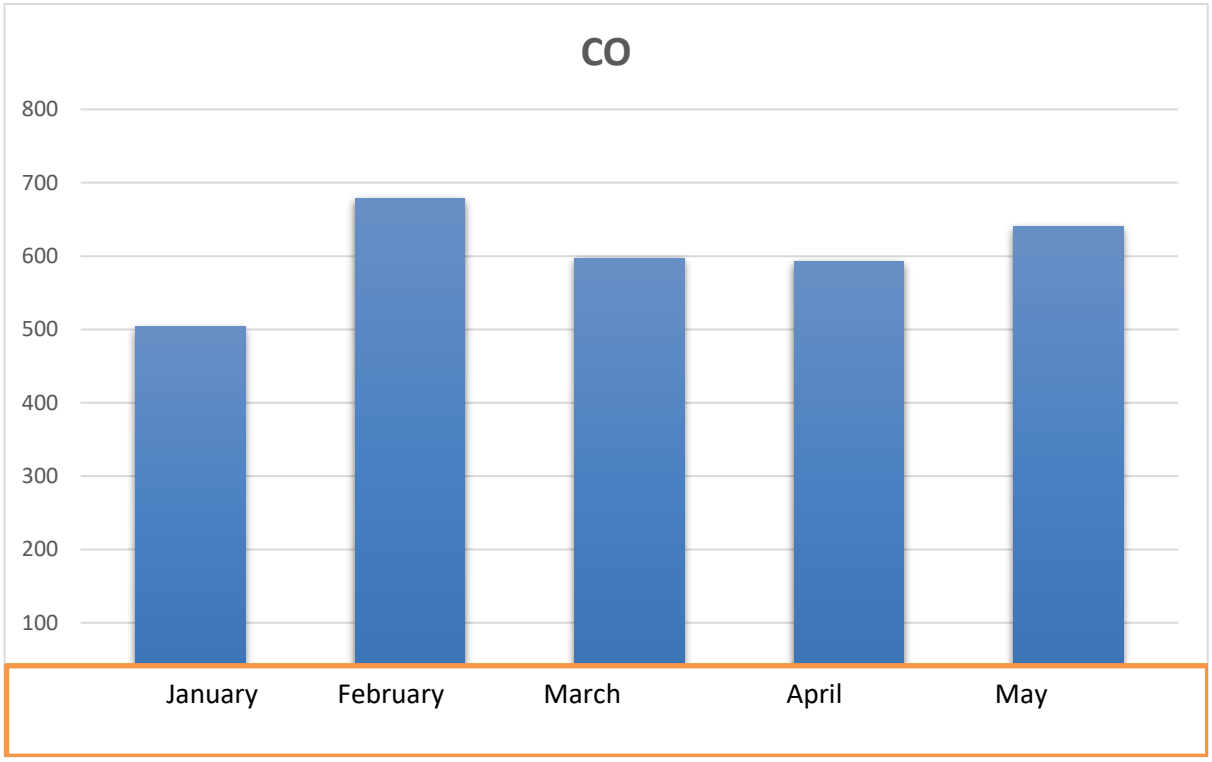



**Figure (4)** The monthly average of carbon monoxide concentration in the air of Al-Waziriya region for the months (January-May)
Source9: This work is made by the researcher depending on Table (2)

* Table (2) shows the annual rates of carbon monoxide, as it was unknown and unavailable because the station did not measure it. This gas is emitted from the incomplete combustion of fuel and internal combustion machines of vehicles, as it depends on the quality of the fuel and the efficiency of the engine. Gasoline-powered cars, for example, Volkswagen cars, Peugeot and Fiat, have high emissions of such a kind of gas. This rise depends on the speed, age and efficiency of the engine, unlike the rest of the diesel-fueled vehicles, the amount of gas emitted from the exhausts of these cars that have fuel combustion in the internal machines. In other words, old vehicles emit more gases polluting the air compared to their counterparts, especially in crowded places. This increases their impact on the people and as well as those people on the roadsides. This leads to an increase in negative effects on humans. The concentration of CO gas in the study area is at traffic, commercial and mixed sites, which makes the residents of Al-Waziriya region vulnerable to many diseases, poisoning with this chronic gas and other diseases. This gas is dangerous because it is not seen, and its presence cannot be sensed because it is an odorless gas and body systems are affected. Its effects begin with headache, dizziness, apathy and heart palpitations, resulting in inevitable death in high

concentrations that reach (1000) parts of a million or more (Mousa, 1990).


**Picture (2)** The effect of cars on the spread of polluting gases in the air of Al-Waziriya region. Source 10: A field study photo taken on 6/6/2022

## Conclusions and Recommendations

The study (*the temporal and spatial variation of gaseous pollutant concentrations in the air of Al-Waziriya region*) reached the following conclusions:

1. There is a discrepancy in the amount of air polluting concentrations in Al-Waziriya area in the city of Baghdad. The reason is that the natural and human characteristics and the source of their emissions are varying.
2. The study demonstrates that the quantity of air pollution caused by human sources varies depending on the source nature and whether it is mobile or fixed. Cities, their centers, and locations with heavy traffic intensify the first type. The size, kind, and location of the polluting source affect the second type of impact.
3. High concentrations of carbon monoxide associated with mobile air pollution sources represented in cars and motorcycles. Traffic stations recorded the highest concentrations, especially in the summer, with an average concentration of 6.96 ppm, compared to agricultural stations that were below the detected limit. In addition, 30% of the study sites had concentrations above nationally and globally permissible limits.

***Recommendations***

The current study presents a set of general and specific recommendations that we believe, if adopted, will go a long way towards reducing air pollution in the city of Baghdad. All measures must be taken, including technical and control measures that explain the burning of fuel inside internal combustion machines, through many measures. The relevant official authorities (the Ministry of Interior and the Ministry of Environment, and the General Traffic Directorate) must be addressed to impose laws that compel car

owners to carry out an annual inspection and abide by the following points:

1. The effectiveness of engines that run on gasoline and kerosene must be examined, their emissions must be assessed, and a chart indicating the bare minimum efficiency that is permissible must be created. An annual examination card, which is represented by a pass paper and functions similarly to other documents, is used to do all of this.
2. It is necessary to ensure the effectiveness of the (catalytic converter), which is located at the beginning of the gas exit from the engine, which absorbs polluting gases (some people lift this stone from the car).
3. Installing special devices in areas of traffic jams and intersections in order to draw air and treat it through the treatment unit. These devices should be small and contain a chemical auxiliary that converts CO gas into CO2.

## References

Al-Awadat, M. (1998) *altalwuth wa himayat albiaya [Pollution and Environmental Protection]*. Al-Ahali for Printing, Publishing and Distribution, Syria, Damascus p. 244.

Al-Falahi, Q, S. (2005) altalawuth alsinaeiu fi aleiraq wasubul muealajatihi [Industrial Pollution in Iraq and Ways to Treat It, *Al-Mustansiriya Center Journal*. p. 190

Al-Jassani, N, A. A. (2011) altalawuth alhawayiyu fi albiyat aleiraqiat musabibat wanatayija [Air Pollution in the Iraqi Environment, Causes and Consequences]. *Al-Qadisiyah Journal for Human Sciences*, Volume 14, Issue, p. 284

Al-Rubaie, A, Y, M. (2002) altalwuth albiyi [*Environmental Pollution]*. National Library for Publishing and Distribution. Ministry of Higher Education and Scientific Research, Baghdad.

Al-Saadi, A, A. (1999) taluwth alhawa fi Baghdad wa dawahiha [*Air Pollution in the City of Baghdad and Its Suburbs with Carbon Monoxide and Heavy Metals]*. Master Thesis, Department of Earth Sciences, University of Baghdad.

Al-Saadi, M, T, M. (2008) *altather almanakhi litalwuth alhawa fi madinat Baghdad awadim alsiaratt [Climatic Effects of Air Pollution in the City of Baghdad by Car Exhaust for the Period (1996-2006) Using GIS]*. Master Thesis, Department of Geography, College of Education ibn Rushd, University of Baghdad.

Al-Sarawi, A. (05/5/2016), "*hydrocarbons"*, almerj

Caliskan, A., & Zhu, C. (2020). Organizational culture and educational innovations in Turkish higher education: Perceptions and reactions of students. *Educational Sciences: Theory & Practice, 20*(1), 20-39. https://doi.org/10.12738/jestp.2020.1.003

Heland-Kurzak, K. (2020). Bad practice affecting and limiting the education of students: A study of pedagogical myths in pedagogy students. *Educational Sciences: Theory & Practice, 20*(4), 36-50. https://doi.org/10.12738/jestp.2020.4.003

Handoyo, E., Mukhibad, H., Tusyanah, T., & Ekaningsih, L. (2021). Lecturers' Performance in Pandemic Era Based on Online Pedagogical Practices in Universitas Negeri Semarang (UNNES), Indonesia: A Cluster Analysis-Based Approach. *Educational Sciences: Theory & Practice*, *21*(4), 138-154. http://dx.doi.org/10.12738/jestp.2021.3.009

Jaber, D. (n.d.) *"A comprehensive and detailed research on hydrocarbons":*

Mousa, A, H. (2017) *almanakh altadbiki [Applied Climate]*. College of Arts, Damascus University, first edition.

Musa, A, H. (1990) Altalwauth alhawaii [*Air Pollution]*. Dar Al-Fikr, first edition. p. 55

Website from the Internet https://www.google.com/search