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Spatial Analysis of the Air Quality Index of Nitrogen Dioxide Gas in Karbala City

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Abstract

That the air quality in the city should be a health indicator with a positive indication of the health, purity and freedom of air from gases harmful to the population, there are several factors that contributed to the low air quality index of nitrogen dioxide gas in the city of Karbala, including the lack of green spaces, as well as the emission of gas from various sources, including industrial activities, the increasing number of vehicles and the large number of private generators in the city, maintaining the cleanliness of the ambient air is one of the most prominent challenges faced by the city, the research includes the definition of the air quality index for nitrogen dioxide, then study the spatial and temporal variation of the air quality index of nitrogen dioxide gas in the city of Karbala within the studied sites, the locations of the study area were marked by certain colors, each color indicates a specific situation and then represent them with color gradient maps and for the summer and winter seasons using modern technologies (geographic information systems) in order to know temporal and spatial changes.

Keywords: *Air Quality Index, Nitrogen Dioxide.*

INTRODUCTION

RESEARCH PROBLEM

1- Is there a spatial and temporal variation in the variation of the quality index of air for carbon dioxide (NO2) in the city of Karbala?

2- Has this disparity (spatial and temporal) affected environmental pollution in the city and the health of the population?

RESEARCH OBJECTIVES

1- Knowing the levels of variation in the air quality index for gas ((NO2) in the city of Karbala.

2- Knowing the extent to which the low air quality index of nitrogen dioxide gas affects the health of residents and the environment in the city.

RESEARCH TOOLS: The modeling process was carried out by selecting (10) sites from different urban uses (industrial, traffic, residential and mixed), it varied in their characteristics and land uses, where it was classified between sites (residential, industrial, commercial, traffic and mixed), the observations were carried out during the winter and summer using the Gasmet device, and then use the linear interpolation equation to know

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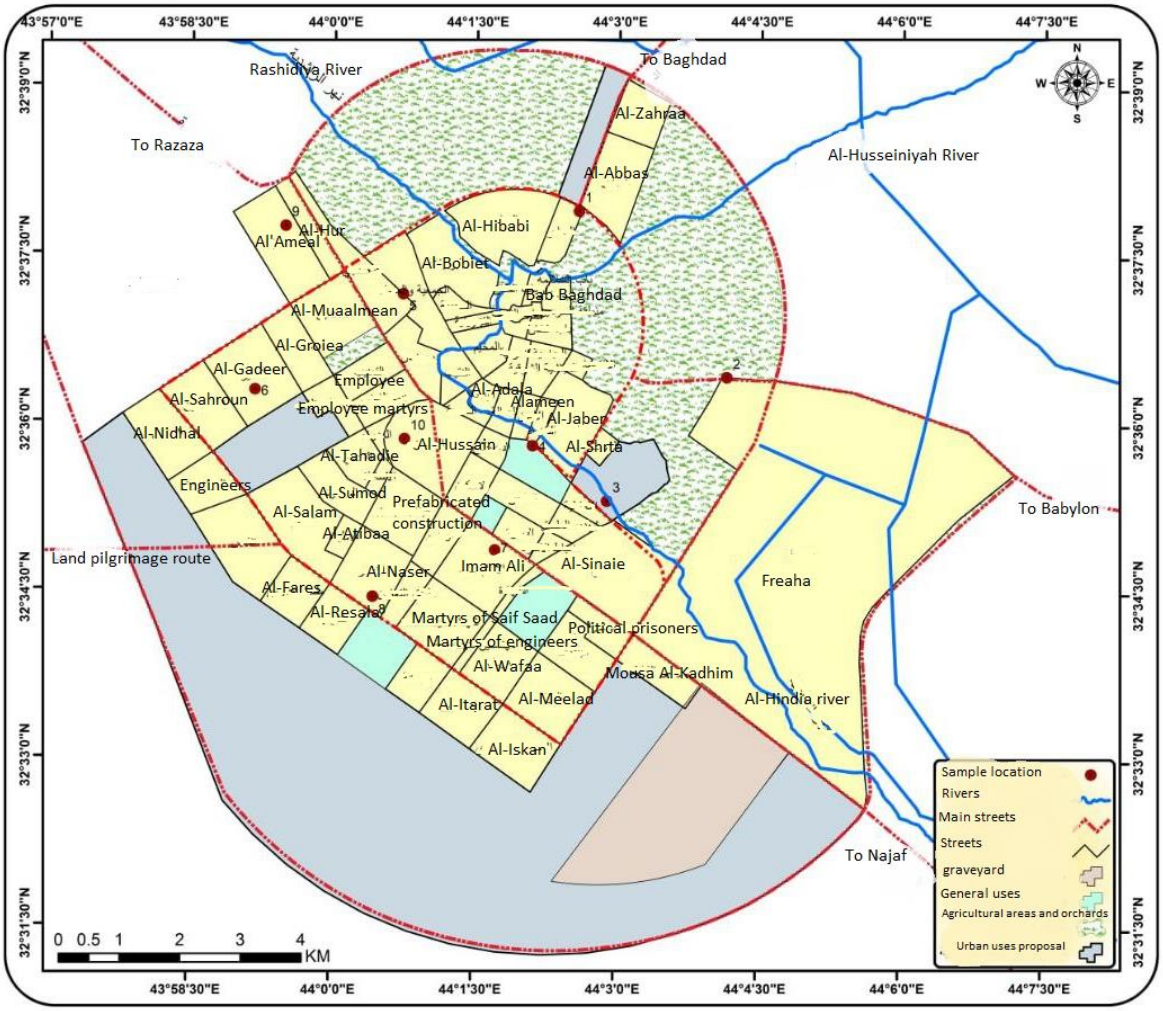
the air quality index and its impact on the city's environment, and the use of geographic information systems (GIS) in cartography, see map (1).

Geographical location the city of Karbala is located west of the Euphrates River, which passes through its center almost on the edge of the Western Desert, it is bordered to the northeast by the province of Baghdad and to the east by the city of Hindiya connected to the province of Babylon, and from the South, the province of Najaf, to the west is Lake Razzaza and the Anbar desert.

Map (1) Sampling sites of nitrogen dioxide gas concentrations in Karbala city.



Source: Researcher based on Karbala Municipality Directorate, 2022.

Nitrogen dioxide (NO_2) is one of the most common air pollutants, as it results from the combustion of fossil fuels, it can also be formed as a result of oxidation of atmospheric nitrogen at high temperatures, Nitrogen dioxide affects the human respiratory system when inhaled.

This gas is emitted from industrial activities, especially chemical activities, Nitrogen oxides are naturally formed from the electrical discharge of thunderclouds, atmospheric nitrogen combines with oxygen under conditions of pressure and high temperature when lightning and lightning occur, forming a group of nitrogen oxides, including nitrogen monoxide and nitrogen dioxide, it may result from human activities through combustion processes in the furnace system in factories that require high temperatures (1400 °C)[2],

[2] European Industries. Commission. (2007). Integrated Pollution Manufacturing. Available at (http://eippcb.jrc.es.).

this gas (NO_2) is emitted from the combustion process and the combination of oxygen (O_2) and nitrogen (N_2) gases, therefore, their emission is from all modes of transportation as well as other fixed sources such as power plants and some industries that burn fuel at high temperatures[3].

The Air Quality Index (AQI) is defined as a standardized summary measure used to express ambient air quality in order to clarify health risks related to air pollution, whether by particulate matter or gas, the index, first presented by the U.S. Environmental Protection Agency in 1998, classifies ambient air quality accordingly into the concentrations of major air pollutants are: (NO_2, SO_2, CO, O_3, PM2.5 PM10) this is an indicator of daily air quality that tells you how clean and polluted the air is, and what the health effects associated with it may be[4], in order to know the air quality index (AQI), the following equation is used[5]:

$$IP = \frac{(I_{HI} - I_{LO})}{(BP_{HI} - BP_{LO})} (CP - BP_{LO}) + I_{LO}$$

Whereas:

I p: Pollutants index.

C P: pollutant measurement concentration.

I Hi: AQI value corresponding to BPHi .

I Lo: AQI value corresponding to BPLo.

BPHi: The breakpoint is greater than or equal to Cp.

BPLo: breakpoint that is less than or equal to Cp .

AQI = Maximum IP)

This equation is calculated based on the pollutant concentration data and the values shown in Table (1) to compare each indicator, the air quality index is a simplified way to convert data from monitoring stations and air quality monitoring into simple numbers, and classify these numbers into degrees that are shown in the form of specific colors, the higher the concentrations, the higher the index, the air quality scale is divided into seven basic categories[6]: The range of AQI values included six categories "good", "moderate", "unhealthy for sensitive groups", "unhealthy", "dangerous" and "very dangerous" the "good" air quality zone is determined if the air quality indicator is in the range from (0) to (50), the moderate air quality zone is determined if the air quality index is between (51-100) - see Table (2), the air quality zone is determined as very dangerous if the air quality index is between (301 - 500) and the air quality index values are divided into ranges, and each group is assigned a description and color symbolized[7].

Table (1) Air quality index according to the linear interpolation equation.

Zone NO_2	Winter Summer		Air quality index	
			Summer	Winter
1- Al-Abbas District (mixed)	0.5	0.29	174.7	136.8

[3] Barbara J., Finlayson Pitts .on Man Nature & Air pollution, Daedalus, 137(3) (2008), p. 135.
[4] Russel Muhammad Kadhim Al-Jubouri, Air Pollution and its Health Impact in the City of Al-Qasim, PhD thesis, unpublished, College of Arts, Al-Qasim University, 2022, p. 224.
[5] B.R. Gurjar at el, Evaluation of emissions and air quality in megacities, Atmospheric Environment, 42, 2008, P 1595.
[6] https://www.arabiaweather.com/ar/content/%D
[7] Esraa Taleb Al-Rubaie, Spatial Analysis of Air Pollution in Musayyib City and its Health Impact, PhD thesis, unpublished, College of Education, University of Karbala, 2020, p. 161.

2- Qantarat Al-Salam (Traffic)	1.27	0.49	307.2	173
3-Industrial District	0.37	0.15	152.5	110.3
4- Sayd Jaouda (Traffic)	0.64	0.46	198.5	167.8
5- Al-Ma'malji (Industrial Zone)	0.85	1.08	234.3	272.7
6- Al-Ghadeer District (Blacksmith)	1.17	0.64	287.7	198.5
7- Saif Saad (Commercial)	0.72	0.12	212.7	104.6
8- Al-Nasr District (residential)	0.25	0.27	129.2	133
9- Al-Amel District, the main street	0.64	1	198.5	259.3
10 - Al-Hussein District (commercial)	0.34	0.65	146.2	201

Source: 1- The researcher based on the field study.

Table (2) Values and description of the air pollution index of nitrogen dioxide gas and its health effects.

Category	AQI	NO_2 (ppm)	Health Impacts	July Site	January Site
	I_{low} - I_{high}	1- hour			
		BP_{low} - BP_{high}			
Good	0 – 50	0 - 0.053	There isn't any		
Mild	51 – 100	0.054 - 0.1	Very few symptoms for people who are most vulnerable to infection (hypersensitivity)	-	
Unhealthy for sensitive groups	101 – 150	0.101 - 0.360	The appearance of non-acute symptoms in people with allergies or pre-existing diseases, as well as the onset of symptoms in some healthy populations	8-10	1-3-7-8
Very unhealthy	151 – 200	0.361 - 0.649	Increased severity of symptoms among people with pre-existing illnesses as well as increased symptoms	1-3-4--9-	2-4-6

			among healthy people		
Dangerous	201 – 300	0.650 - 1.249	Early onset of some diseases, in addition to worsening symptoms in people most vulnerable to these diseases and reduced endurance in healthy people from the population, which may require emergency measures for patients and members of sensitive groups	5-7-6	-5-9-10
Extremely dangerous	301 – 400	1.250 - 1.649	Healthy people suffer from low stamina and the appearance of negative symptoms that affect normal activity in addition, patients must stay at home, but if it is greater than 500, it can lead to deaths for sick people and the elderly.	2	

Source:

1- Researcher based on Table (1)

2- Ali Karim Hamid Al-Shammari, Spatial Analysis of Air Pollution in Urban Centers and its Environmental Effects in Wasit Governorate, PhD thesis, unpublished, University of Al-Qadisiya, Faculty of Arts, 2020.

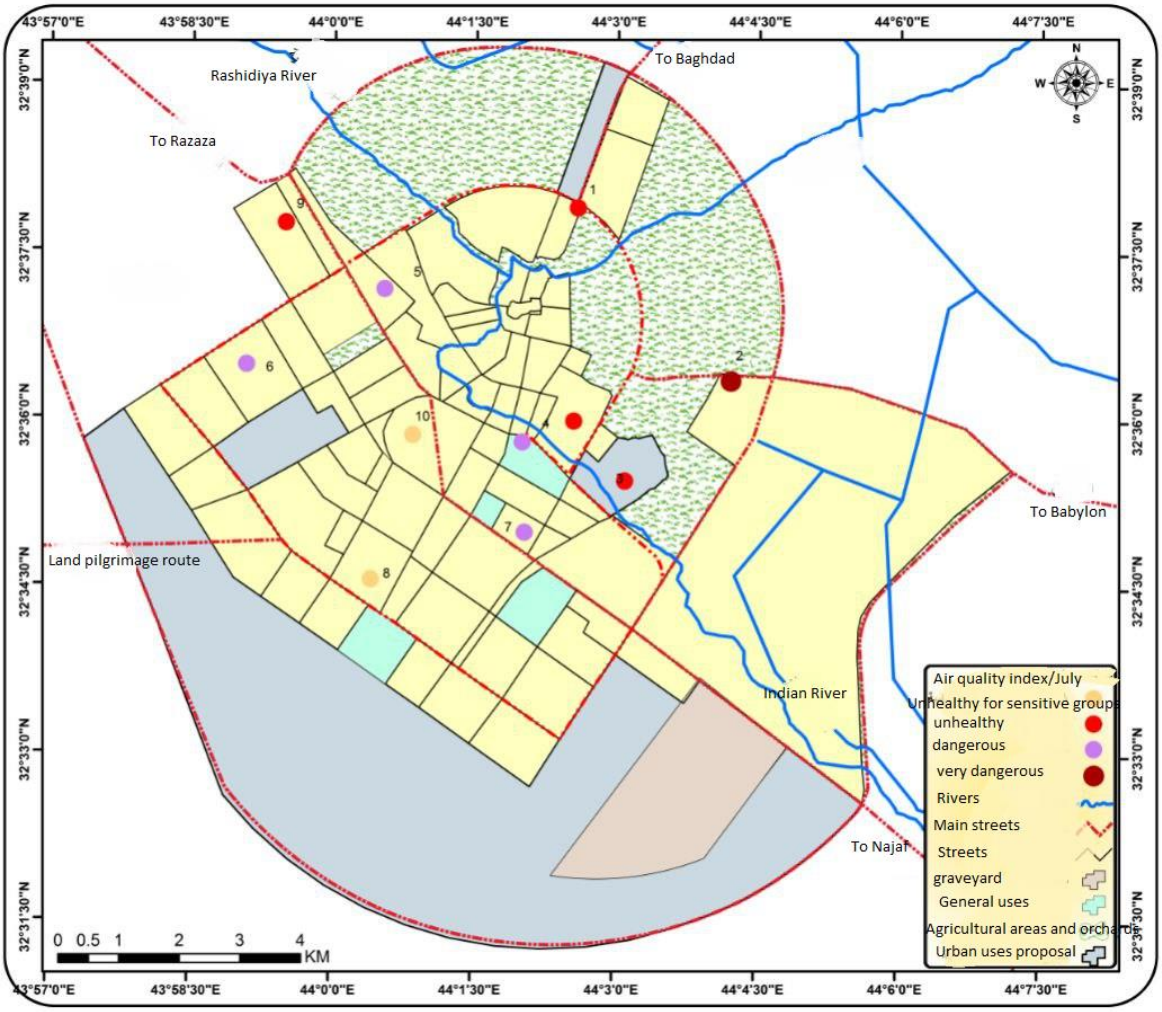
Table (2) shows that the air quality index (AQI) of nitrogen dioxide gas in the study area, ccording to the air quality classification formula, the values of the (AQI) index in the study area range from (unhealthy to dangerous), according to the locations of the studied area, the values vary significantly spatially and temporally to vary in return the categories to which it belongs, thus, the assessment of air pollution and its health effects based on the values recorded, the results of calculating the values and categories of the AQI index for No2 gas for the month of July ranged between (unhealthy - dangerous), the site (S8) was recorded because it falls within the residential use that is overturned by the lack of movement and commercial activities, the lowest index was recorded for other sites in the

category (101-150 AQI) unhealthy for sensitive groups, while the sites (1-3-4-9-10) were registered under the category (151-200 AQI) that is not very healthy, due to the diversity of uses between transportation, industrial and commercial uses, as for the sites (5-7-6), they fall within the category (201-300 AQI) dangerous due to the presence of the industrial area and the large number of workshops, blacksmithing and furnaces left by NO_2 emissions, which are indicated in purple, while the location (2S) was in the very dangerous category (301-400) looking at the map (3) due to the large number of means of transportation and heavy traffic, and the lack of green spaces and the absence of rainfall that works to concentrate this gas No_2 Healthy people suffer from low endurance and the appearance of negative symptoms that affect normal activity, in addition, patients must stay at home, but if it is greater than 500, it can lead to deaths in the sick and elderly population.

As for the air quality index for the month of January, it also recorded a variation within the categories of the air quality index, ranging between (Unhealthy for sensitive groups – unhealthy and – very unhealthy) see map (1).

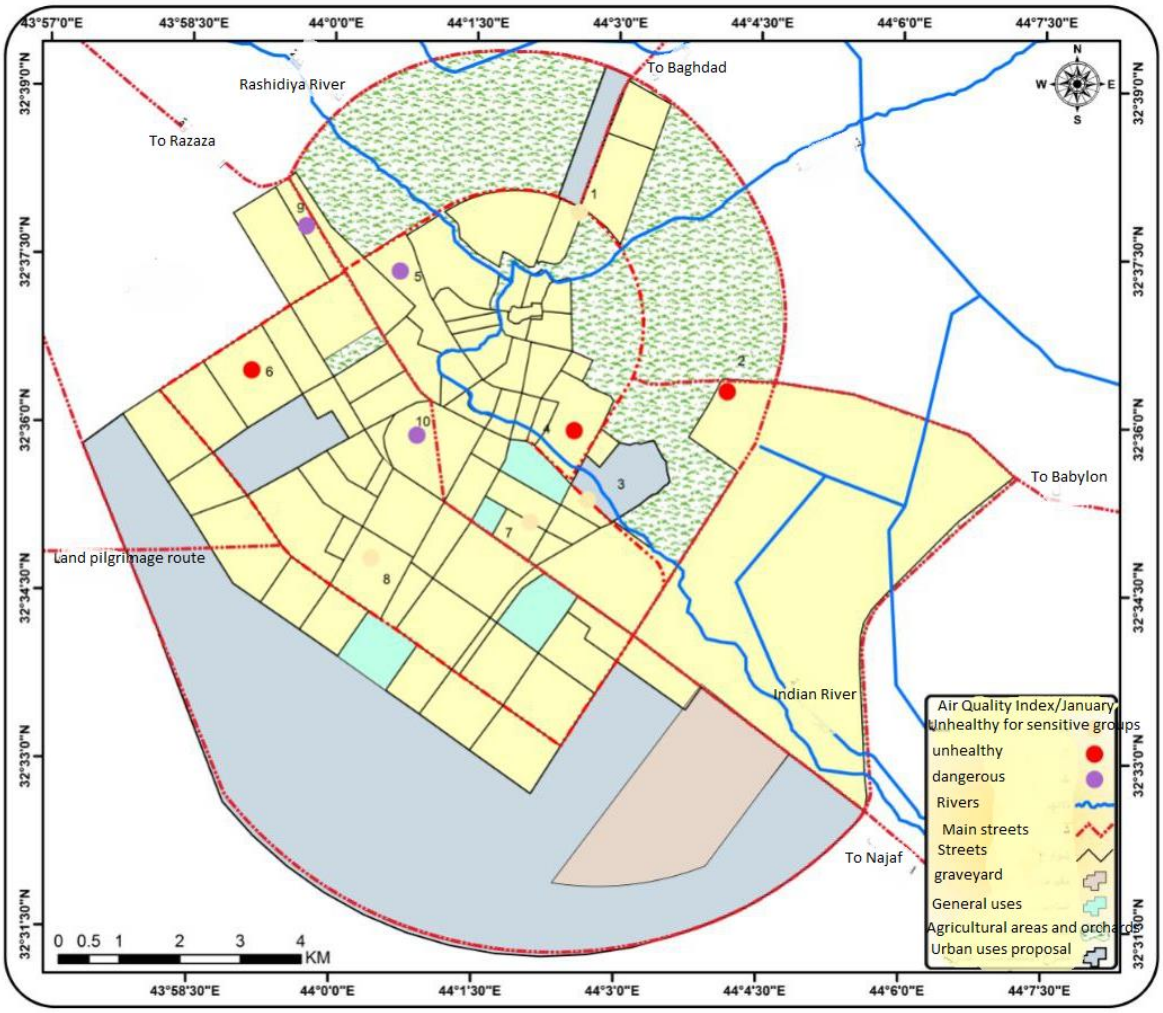
The site record (1-3-7-8) under category (101-150 AQI) is unhealthy for sensitive groups, the sites (2-4-6-) in the category (AQI151-200) are very unhealthy, the 5-9-10 AQI sites were in the 201-300AQI category, which is risk.

Map (2) Air quality index for nitrogen dioxide gas during the month of July in the city of Karbala for the year (2023).



Source: Researcher based on Table 2 data.

Map (3) Air quality index for nitrogen dioxide gas during the month of January in the city of Karbala for the year (2023).



Source: Researcher based on Table 2 data.

CONCLUSIONS

1- Air quality indicators for nitrogen dioxide gas vary spatially and temporally, the sites (8 S-10S) were recorded during the month of July among the unhealthy indicators for sensitive groups to be compared to the sites (1 S-3 S-7 S-8S) during the month of January for the same indicator.

2- The site (S2) was recorded within the very dangerous index during the month of July.

3- These indicators have health effects on people, as each indicator has a certain impact on human health.

4- The air quality index (AQI) of nitrogen dioxide gas in the study area, according to the air quality classification formula, the values of the AQI index in the study area range from (unhealthy to dangerous).

5- The air quality index for the month of January was recorded, as it also recorded a discrepancy within the categories of the air quality index, it ranges from (unhealthy for sensitive groups - unhealthy and - very unhealthy).

References

1- European Industries. Commission. (2007). Integrated Pollution Manufacturing. Available at (http://eippcb.jrc.es.)

2- Barbara J., Finlayson Pitts .on Man Nature & Air pollution, Daedalus, 137(3) (2008).

3- https://www.arabiaweather.com/ar/content

4- Russell Muhammad Kadhim Al-Jubouri, Air Pollution and its Health Impact in the City of Al-Qasim, PhD thesis, unpublished, College of Arts, Al-Qasim University, 2022, p. 224.

5- B.R. Gurjar at el, Evaluation of emissions and air quality in megacities, Atmospheric Environment, 42, 2008.

6- https://www.arabiaweather.com/ar/content/%D

7- Israa Taleb Al-Rubaie, A spatial analysis of air pollutant concentrations in the city of Musayyib and its health effects, doctoral thesis, unpublished, College of Education, University of Karbala, 2020.

8- Ali Karim Hamid Al-Shammari, Spatial analysis of air pollution in urban centers and its environmental impacts in Wasit Governorate, doctoral thesis, unpublished, Al-Qadisiyah University, College of Arts, 2020.