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Air Quality Index (AQI) within Al-Qassim City

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Abstract

Many countries in the world are witnessing a serious problem that is getting worse day after day, which is air pollution due to the increase in sources that increase the concentrations of emanating pollutants and their spread to nearby areas. The spread of these pollutants is accompanied by the emergence of many diseases from which Human beings are suffering. Such diseases have even become more widespread doubly and significantly, which threatens of great dangers in the future when the increase in the concentrations of these pollutants continues.

The aforementioned statement also applies to the study area in particular as part of the world in general. The study area has become suffering from this problem. The results of the present study reveal the magnitude of the danger and the negative health impact of these pollutants, which are represented by respiratory diseases in addition to heart diseases and eyes sensitivity because these parts of the human body are the most connected to the external surroundings through the process of breathing and contact. Through this context, the present study focuses on the air quality index and its impact on the people living in the city of Al-Qassim by focusing on carbon monoxide, nitrogen dioxide, and sulfur dioxide, comparing them with the ranges that were challenged by the World Health Organization, and analyzing the results. The present study is an attempt to identify whether the living conditions in the study area are suitable for human health or they represent a source of concern. The study is concluded with a set of conclusions and recommendations That provide appropriate solutions in order to eliminate or reduce this problem.

Keywords: Air pollution, air quality index, gases.

Introduction

Air represents one of the most important means of living for living organisms, without which life would be lost. Therefore, any defect in its components leads to an imbalance in the ecosystem due to the negative effects that affect living organisms. Humans are singled out for being the first responsible for the occurrence of this imbalance through various activities practiced on the surface of the earth in general and in the study area in particular, in addition to being the most in contact with the pollutants emanating from its main sources. The negative effects are represented in the spread of many diseases that a person may suffer from for periods that may be long or short, or they become chronic diseases that are difficult to treat or get rid of (such as asthma, heart disease, and allergic eyes in addition to other diseases where air pollution is a cause of spread. Therefore, it is indispensable to provide means of limiting air

pollution or reducing the increase in gas emanation , which constitute a danger for humans and their health when their concentration increases.

The Problem Statement

The research problem can be stated through the question about whether Al-Qassim city suffers from air pollution or not. Other questions may include:

Are there spatial and temporal variations in the concentrations of pollutants in Al-Qassim city?

The Study Hypothesis

Like other Iraqi cities, Al-Qassim city suffers from air pollution as a result of the diversity of urban land uses, which causes spatial and temporal variations in the concentrations of pollutants in Al-Qassim city.

The objectives of study

The present study aims to identify and evaluate air pollutants within the neighborhoods of Al-Qassim city, which includes 19 residential neighborhoods. The study also aims to clarify the health impact of air pollution on the residents of Al-Qassim city. In addition, it is important to reveal the most important concentrations of air pollutants in the study area.

The Methodology

The researcher used the descriptive approach to reveal the reality of the city and its spatial dimensions. The analytical approach was also adopted in analyzing the results of the air quality index and clarifying the most influential pollutant in the study area. Finally, the present study followed the quantitative approach, which depends on the language of numbers in analyzing the data.

Spatial limits of the present study

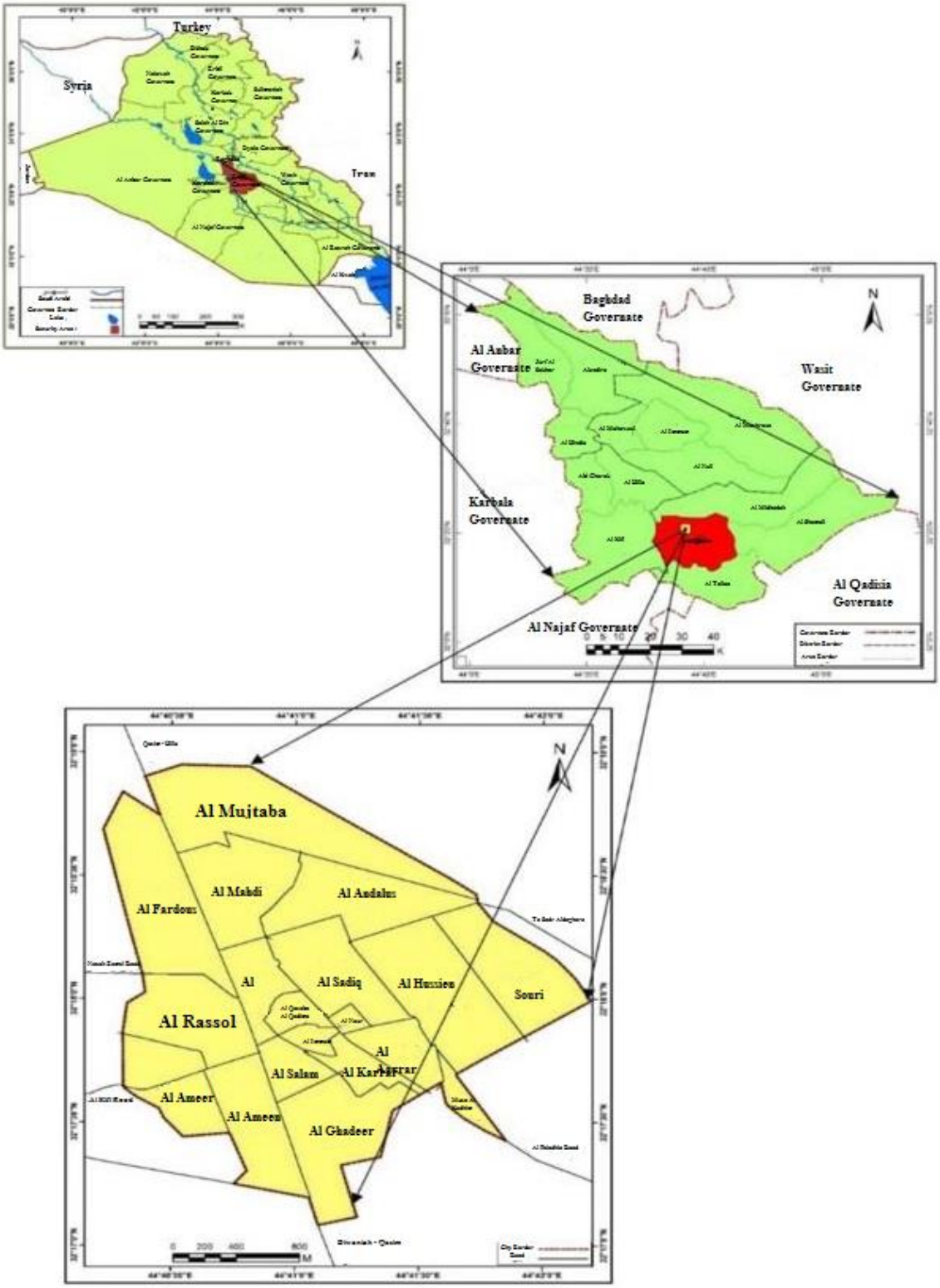
Al-Qassim city is located between the latitudes (30 15 32) and (0 30 32) in the north, and between the longitudes (0 30 44) and (30 45 44) in the east. It occupies an area of (43.394 km2) of province of Babylon. In the north, it is bordered by Hashimya and Midhatya, from the east, it is bordered by Shomali, from the west, it is bordered by Al-Kifl, and from the south, it is bordered by Al-Tali'a. Al-Qassim city contains (19) residential neighborhoods divided into (9) neighborhoods according to the administrative divisions of the municipality of Al-Qassim as shown in Table (1) and Map (1).

Table (1): Administrative divisions of Al-Qassim city for the year (2020)

Name of Residency	Neighborhoods
First Residency	Al-Qasaba Al-Qadeema, Al-Ansar, Al-Imam
Second Residency	Al-Mahdi, Al-Hamran 1,2
Third Residency	Al-Andalus
Fourth Residency	Al-Mujtaba, Al-Wihda, Al-Firdaws
Fifth Residency	Surat Al-Shuhada
Sixth Residency	Al-Sadiq, Al-Noor, Al-Ahrar, Al-Karrar
Seventh Residency	Al-Hussein 1,2,3, Musa Al-Kadhim
Eighth Residency	Al-Ghadeer, Al-Salam
Ninth Residency	Al-Rassool, Al-Ameen, Al-Ameer
Total	19 Neighborhoods

Source; Republic of Iraq, Ministry of Municipalities and Public Labors, Directorate of Al-Qassim Municipality, unpublished data, 2020.

Map (1): The geographical location of Al-Qassim city from the map of Iraq



Source; The researcher based on;

Republic of Iraq, Ministry of Municipalities and Public Labors, Directorate of Al-Qassim Municipality, Division of (GIS), unpublished data, 2021.

Health impacts of the air quality index in Al-Qassim City

Air is one of the most important human needs that mostly affects human health. Due to a number of natural and human factors, air quality has significantly decreased in all parts of the world. The nature of using land in a particular area is an important issue that should be focused on as it is related to air quality (www.moccae.gov.ae). Due to health effects resulting from the impurity of the air and its saturation with various pollutants, studies tended to develop an air quality indicator to identify and indicate health impacts. World Health Organization used an index that is based on measuring concentrations of (PM10), (PM2.5), (O_3), (CO), (SO2), and (NO2) in order to obtain accurate results about the real cause behind the exacerbation of diseases, especially those affecting the respiratory system that have become common nowadays. Thus, the present study is based on These indicators, which were measured and read at many monitoring points within Al-Qassim city as follows:

Carbon monoxide

Carbon monoxide enters the bloodstream through the lungs and binds to hemoglobin, which is the substance that carries oxygen in the blood. Thus, it reduces the process of oxygen transport. People with heart disease are most at risk as they suffer from chest pain and others Cardiovascular disease while inhaling carbon monoxide, especially during exercise. The same applies to people who suffer from cardiovascular and respiratory diseases, such as congestive heart failure, anemia, chronic obstructive pulmonary diseases, and cerebrovascular diseases, even if they are infants or fetuses. Such people are at greater risk when they are exposed to carbon monoxide. As for healthy people, the effect of gas on mental alertness and vision occurs when they are exposed to long periods of high concentrations of gasses (http://www.epa.gov/iaq).

Nitrogen dioxide

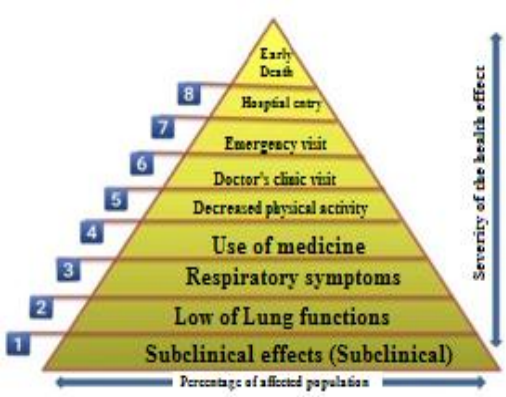
This gas is associated with a number of harmful effects on the respiratory system. It interacts with ammonia, moisture, and other compounds to form small particles that can penetrate deeply into the sensitive parts of the lungs. The health impact and the danger of this gas is due to the extent of exposure. Inhaling nitrogen dioxide For a period ranging from (30 minutes to 24 hours) can damage the respiratory system, including airway inflammation for healthy people and an increase in respiratory symptoms for people with asthma (SEP, 2011).

Sulfur dioxide

This gas irritates the nasal passages during its passage when inhaling. While practicing physical activities in the open air, people with asthma are the most affected ones when inhaling even short-term exposure, causing the air passages to narrow. The effect increases in the occurrence of wheezing and shortness of breath with increasing levels of sulfur dioxide and an increase in respiratory rates. Lung functions return to normal within an hour of the disappearance of the cause. As for long-term exposure to sulfur dioxide gas, it causes respiratory diseases, changes lung defense mechanisms, and exacerbates cardiovascular diseases. Thus, children and the elderly are the most vulnerable to these effects (SEPA, 2011).

The serious health impact of air pollution in urban areas is shown in the increased burden of disease outcomes. Early death and hospitalization are taken into consideration. However, the effects of air pollution on health are broader than this. They include moderate and less serious effects, such as chronic bronchitis and asthma. Researchers state that the less severe outcomes are the more common and they affect a greater number of people. These effects are often expressed by the health hierarchy as shown in Chart (1). The chart explains the prevalence of less serious diseases among the population, which worsens if the causes are not reduced, resulting in hospitalization and in some cases leading to early death.

Chart (1): The health hierarchy associated with air pollution



Source; Health risk assessment of air pollution General principles, EUROPEAN ENVIRONMENT AND HEALTH PROCESS, World Health Organization REGIONAL OFFICE for Europe, 2016.

Air quality index in Al-Qassim City

An index that tells about daily air quality, how clean and polluted the air is, and what health effects are associated with it might be of concern. AQI focuses on the health effects experienced within hours or days after breathing an air that is polluted by EPA-identified pollutants (https://pollution.gov.np).

To calculate the AQI, the common and widely used model adopted by the Environmental Protection Agency (EPA) is used. This modal is used in many countries of the world because it can be applied in different areas with a concentration of one pollutant or a mixture of two or more. Despite the pollutants are different in the formation of the main determinant of (AQI) for that area, the method of calculating the air quality index is done by calculating the index (https://pollution.gov.np) as shown in Table (2) in addition to the value of the pollutant concentration at each monitoring point. The method of calculation is as follows:

IP = ((I_HI-I_LO))/((BP_(HI)- 〖BP〗_LO)) (CP-〖BP〗_LO)+I_(LO)

As;

pollutant index. I p

C P: pollutant concentration measured close up.

I Hi: AQI value corresponding to BPHi.

I Lo: AQI value corresponding to BPLo.

BPHi: breakpoint is greater than or equal to Cp.

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

AQI = Maximum IP

Table (2) Ranges of Air Quality Index (AQI) Pollutants

CO (ppm) 8 – hour	**SO_2** (ppm) 1 –hour	**NO_2** (ppm) 1 –hour	**AQI**	**Category**
BP_{low} - BP_{high}	BP_{low} - BP_{high}	BP_{low} - BP_{high}	I_{low} - I_{high}	
0.0 – 4.4	0 – 0.035	0 – 0.053	0 – 50	**Good**
4.5 – 9.4	0.036 – 0.075	0.054 – 0.1	51 – 100	**Average**
9.5 – 12.4	0.076 – 0.185	0.101 – 0.360	101 – 150	**Unhealthy for allergy groups**
12.5 – 15.4	0.186 – 0.304	0 361 – 0.649	151 – 200	**Unhealthy**
15.5 – 30.4	0.305 – 0.604	0.605 – 1.249	201 – 300	**Very unhealthy**
30.5 – 1004	0.605 – 1.004	1.250 – 2.049	301 – 500	**Dangerous**
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Source; Air Quality Index, New Jersey Department of Environmental Protection, 2018, https://njaqinow.net
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The equation of the air quality index was applied in Al-Qassim city on the (16) monitoring points distributed within the city neighborhoods, on (CO, NO2, and SO2) gasses determined by the Environmental Protection Agency. The results of the equation reveal that that there is a spatial and temporal variation in (co) as shown in Table (3). But, all the results are classified within one category, which is (good). Thus, the assessment of the air in the study area shows that carbon monoxide does not constitute a great harm to the population residing in the city. When delving more into the results of the calculations, it becomes clear that despite the fact that all the results are within the good category, which ranges between (50 - 0), the percentages differ from one place to another and from time to time in the same place. In the winter season, the monitoring point (15) scored the highest percentage in the study with (AQI = 31) because this point is the entrance and distribution of transport routes for the city. It is a center of gravity for the transport movement and witnesses a high traffic density, which results in the spread of exhaust concentrations of cars in high quantities, including Carbon monoxide gas. The monitoring point (2) scored an indicator value of (AQI = 26), which is located on the transport routes and witnesses a very large movement because the mentioned monitoring point is located within a commercial area in addition to its presence on the road linking the study area with the center of the province of Babylon And other provinces. The monitoring point (14) scored the lowest indicator value within this season with (AQI = 5) because it is located within the residential use away from the traffic density and commercial centers that constitute an area of attraction for the population. As for the monitoring points that showed the indicator values of (AQI) =6 - AQI =18), they are all classified within the category of good. In terms of health impact, although the values that appeared in all monitoring points for the winter season are within the good average, their continued presence and human exposure to them in the study area cause health problems for people suffering from asthma, which leads to health risks accompanied by complications affecting the respiratory system as shown in Map (2).

As for the summer season, the values of the carbon monoxide gas index were within the category of good in all monitoring points, but they are spatially different. Monitoring point (9) scored the highest value of (AQI = 36) because this point has a commercial location, a large population, and high traffic density, which made this point score the highest value among the monitoring points during this season. The monitoring point (15) scored the value of (AQI = 29) due to the location of the area in which the monitoring was conducted as mentioned above. As for the monitoring point (3), it scored the lowest value among the monitoring points within the city neighborhoods with (AQI = 2). The reason for this is that the monitoring point is located on the administrative borders of the city in addition to being located near the agricultural areas with the spread of housing units in it. Thus, the monitoring point does not witness high traffic or the spread of crafts that spread gases in high concentrations affecting human health and respiratory system. As for the other monitoring points with an index value that ranges between (AQI = 4 - (AQI = 18), they are all classified within the category of good. From the aspect of health impact, in general, all monitoring points' values were confined to the category of good. Thus, the health impact of carbon monoxide gas was shortened On people who suffer from asthma as they are at more risks than others as shown in Map (3).

With regard to nitrogen dioxide, Table (4) indicates that there is a spatial and temporal variation in terms of index values, as well as the case of indicator categories and their health impact on people within the study area. In winter, monitoring point (7) ranked first with an index value of (AQI = 520) that is classified within the category of (extremely critical) because it exceeded the values of the air quality index set by the Environmental Protection Agency. This reflects the magnitude of the danger that spreads within the space of this point and the people living and working in or near it. The reason for the high nitrogen dioxide At this point is due to the fact that it is a site for car repair, which results in the emission of many pollutants during the process of dismantling and assembling car parts, which affects people with asthma and other respiratory diseases, especially for the elderly and children who are most at risk because of the serious complications that may lead to the death of the individual. As for the monitoring points (11, 9, 2, and 1), they are all under the category of (very unhealthy) with index values that ranged from (AQI = 227 - AQI = 200) because all the mentioned monitoring points are located on transportation routes in addition to commercial use. This results in the emission of many pollutants, including nitrogen dioxide. This affects people who suffer from chronic asthma and other respiratory diseases. The elderly and children are the most vulnerable. While the monitoring points (14, 13, 10, 8, 5, 4, and 3) are under the category of (unhealthy) with index values that ranged between (AQI = 179 - AQI = 172), which is considered an unhealthy local space for the values set by The Environmental Protection Agency. This affects people who suffer from chronic or seasonal respiratory diseases. Children and the elderly are at the

forefront of those affected by it. The high index values in these monitoring points is due to the way of land use, including commercial and industrial transportation routes, in addition to what is produced from household uses within residential areas. The monitoring points (12 and 6) are under the category of (unhealthy for allergy groups) with an index value of (AQI = 138) and (AQI = 109), which are points that were monitored near the industrial area. They all emit large quantities of polluting emissions. Thus, it affects workers in addition to the residents near it. The elderly and children are the people who are most affected, especially those who suffer from respiratory diseases as shown in Map (4).

As for the summer season, the monitoring point (1) came at the forefront in terms of risk. The index value was (AQI = 516), which is within the category of (extremely critical) because the monitoring point is located on the public street that links the province center with other provinces. Thus, transportation is the cause of the rise in nitrogen dioxide within this site. The monitoring points (16, 12, and 5) are within the category of (dangerous) with index values that ranged between (AQI = 453 - AQI = 318). As for the monitoring points (14, 11, 6, 3, and 2), they are under the category of (very unhealthy) with index values that ranged between (AQI = 292 - AQI = 212). The high index values are within these points because they were monitored near transportation roads, commercial areas, as well as an industrial site of doors, windows, and car repairs, in addition to what is produced from housing units by housewives and other uses that raise the concentration of nitrogen dioxide until the stage of (very unhealthy).

Thus, the health impact can be clearly and very quickly noticed on people who suffer from respiratory diseases, especially asthma, which leads to a worsening and deterioration of their health. While the monitoring point (10) is within the category of (unhealthy) with an index value of (AQI = 164) because it is located near the blacksmith's workshops, which results in the volatilization of many pollutants during the process of cutting iron plates or assembling them for welding in addition to the presence of large local generators, which release large quantities of pollutants during their operation, including NO2. This affects those with respiratory diseases, especially children and the elderly due to their low resistance to diseases and their lack of immunity. While the monitoring points (13 and 8) are under the category of (unhealthy for allergy groups) with index values of (AQI = 108, AQI = 121) because they are located within the urban land uses represented by transportation routes in addition to the practice of crafts, such as carpentry that release pollutants within its geographical space and the continuation of their impact to the neighboring places as a result of the process of spreading pollutants in the air. The case is the same for the monitoring point (13). Although the site is a green area, the site is surrounded by transport routes that witness the movement of cars at different times during The day, in addition to lack of afforestation and necessary services that make the site within the desired standards, which led to an increase in the concentration of NO2, affecting the elderly, children, and people suffering from respiratory diseases. As for the monitoring point (7), it is under the category of (average) with an index value of (AQI = 78) despite the fact that the site is a large complex of car repair shops. The reason of No2 low ranges is due to reducing work times during summer because of heat, which results in a decrease in the concentration of pollutants released from these shops despite the fact that the site is within the limits that have an average and acceptable effect. This affects people who suffer from asthma, bronchitis, and other respiratory diseases. Finally, the monitoring points (15, 9, and 4) are within the category of (good) with index values of (AQI = 0).

Although the locations of the monitoring points are transportation routes and commercial areas, they did not form any significant concentration because the traffic during the hot season (summer) is much less than it is in the winter. So, residents prefer to stay homes as a comfortable environment for them to avoid the high summer heat. Thus, exhaust emissions resulting from the movement of cars are reduced, which results in the absence of NO2 gas within them as is the case with the commercial area as shown in Map (5).

As for sulfur dioxide gas, the monitoring points in all the specified locations and during the two seasons (winter and summer) have recorded dangerous results. Necessary measures must be taken to reduce the levels of this gas within the study area because of its health impact on the life of the population in the study area, especially on people with respiratory system diseases as shown in Table (5). In the winter season, the monitoring point (3) scored an index value of (AQI = 1.317), which is within the category of (extremely critical). The reason for this is that many factories spread near it, such as crafts, especially car washing and lubricating stations. It is known that stopping operating cars produce more emissions than it is in the case of driving, which explains why this point is higher than the other monitoring points in the study area. This affects People with asthma. They need to be admitted to hospitals when nitrogen dioxide concentrations accumulate in their respiratory system. Adults and young people are the most affected. The monitoring points (16, 13, 12, 11,and 7) scored index values that ranged between

(AQI = 388 - AQI = 323), which is within the category of (dangerous). The monitoring points (15, 10, 9, 8, 6, 5, 4, and 2) in the study area are within the category of (very unhealthy) with index values ranging between (AQI = 298 - AQI = 209). As for the monitoring point (14), it is within the category of (unhealthy for allergy groups) with an index value of (AQI = 107). This point is less than the other monitoring points because it is located within the residential use, which is dominated by lack of car movement compared to the main streets leading to commercial areas Within the study area. However, the value is still influential because it poses a risk for people who suffer from respiratory allergies. Finally, the monitoring point (1) scored the lowest index value of (AQI = 0) within this season within the category of (good). But, it still affects people who suffer from heart diseases, especially the elderly and children as shown in Map (6).

As for the summer season, the results of the values greatly differed from their levels in the previous season. The risk rate significantly increased to exceed the standards of the Environmental Protection Agency specified with an index value of (500). In this season, all the results are within the category of (extremely critical), except for the monitoring point (1), which is within the category of (dangerous). In more details, the monitoring points (16,15,14,13,12,11,10,9,8,7,6,5,4,3,and 2) are within the category of (extremely critical) with index values that ranged between (AQI = 2.068 - AQI = 1.198) which may be due to lack of rain that washes and purifies the air loaded with pollutants and consequently stabilizes it on the surface of the soil and transfers it to water, in addition to the length of the day, which increases the working hours for some crafts, which results in the accumulation of pollutants in the space of the study area with a greater concentration than in the winter season. As for the monitoring point (1), it is the only point within the category of (dangerous), which is considered the lowest within this season, with an index value of (AQI = 318). But, it is still within the danger circle that affects the respiratory system in general and on people with asthma in particular. To clarify the health impact for this season in general, especially for the first group of monitoring points, which constitute the most dangerous and threatening to the population living or working in the city, the effect is not limited to those with respiratory diseases, but the matter threatens healthy people. With the continuity of inhaling such very dangerous concentrations, the person loses endurance, which consequently results in the emergence of negative symptoms that affect his/her normal body activities. As for patients with respiratory diseases, they must stay home in order to avoid health risks and complications that would lead to early death as shown in Map (7).

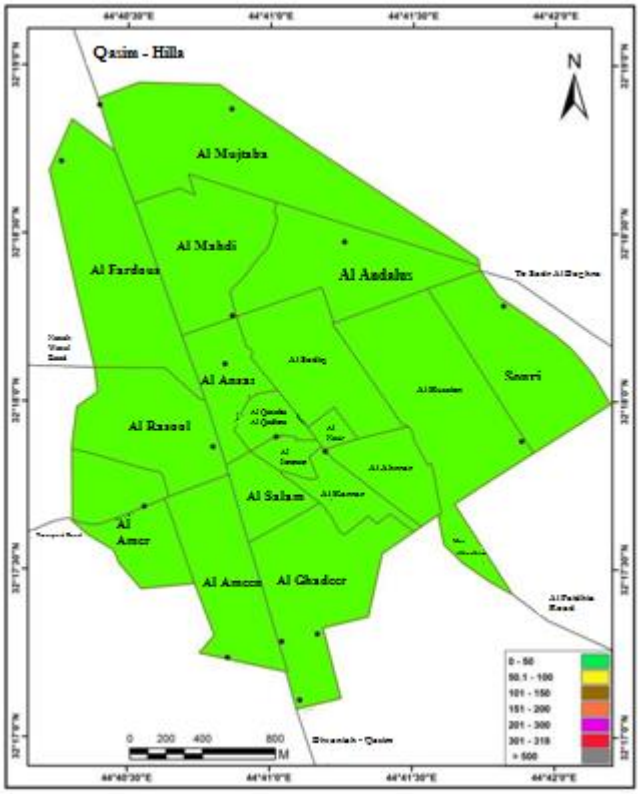
Table (3) Air Quality Index (AQI) for carbon monoxide (ppm) gas within the monitoring points distributed over the neighborhoods of Al-Qassim city (2021)

No	**Sample location**	**Winter**	**AQI**	**AQI Index Category**	**Summer**	**AQI**	**AQI Index**
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			
	Sensitive Groups : People with asthm	**Good**		**Sensitive Groups :**People with asthma are the most people exposed			

	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed
	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed
	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed
	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed
	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed
	Sensitive Groups : People with asthm	**Good**	**Sensitive Groups :**People with asthma are the most people exposed

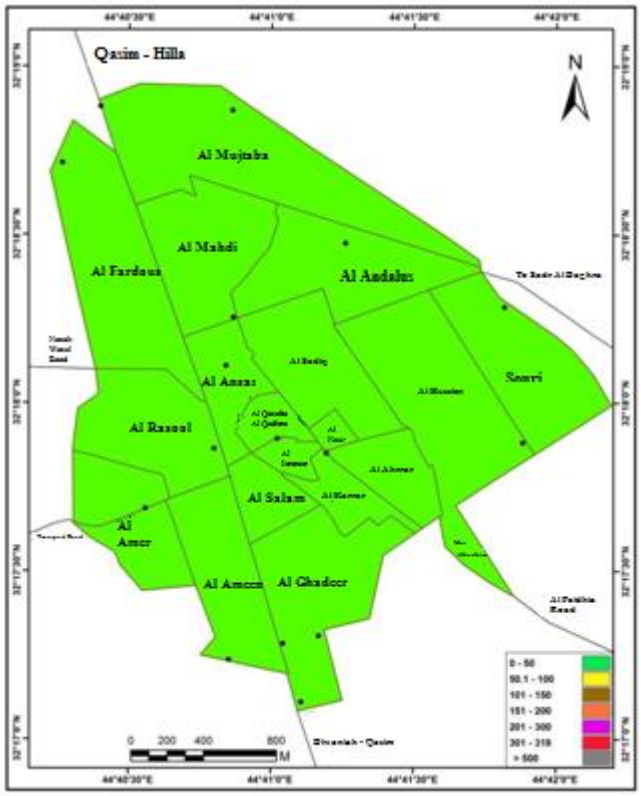
Source; The researcher based on the results of the field study measurements.

Map (2): Geographical distribution of the air quality index (CO) for the winter season in Al-Qassim city



Source; The researcher

Map (3) Geographical distribution of the air quality index of (CO) for the summer season in Al-Qassim city



Source; The researcher

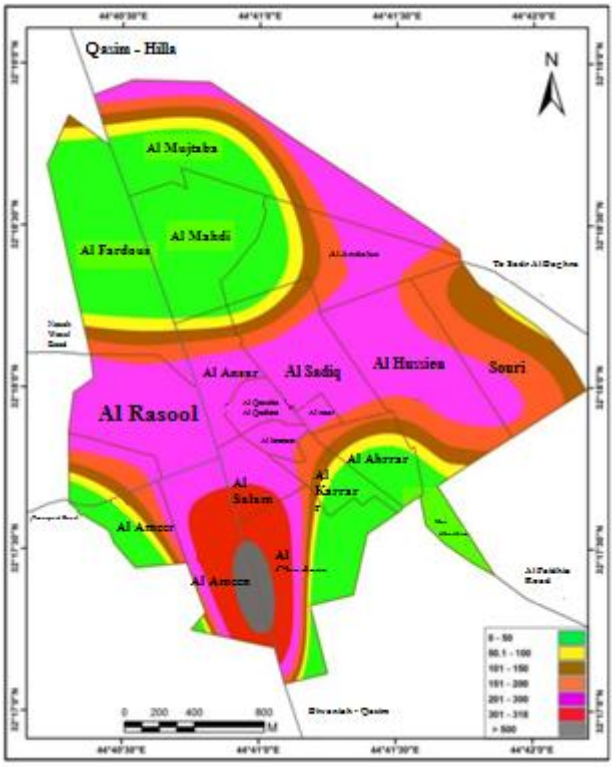
Table (4): Air quality index (AQI) for nitrogen dioxide (ppm) within the monitoring points distributed over the neighborhoods of Al-Qassim city (2021)

no	Sample Location	Winter	AQI	AQI Index Category	Summer	AQI	AQI Index
	Sensitive Groups : People with asthm				**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	2.20 516		**Extremely Critical**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm			**Very Unhealthy**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	1.20 292		**Very Unhealthy**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	0.77 220		**Good**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	0.00 0		**Dangerous**	**Sensitive Groups :**People with asthma or other respiratory system d		
e group	**Sensitive Groups :**People with asthm				**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	1.86 453		**Very Unhealthy**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm				**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	1.05 267		**Average**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	0.08 78		**Unhealthy for Sensiti**	**Sensitive Groups :**People with asthma or other respiratory system d		
	Sensitive Groups : People with asthm	0.21 121		**Good**	**Sensitive Groups :**People with asthma or other respiratory system d		

	Sensitive Groups : People w	**0.09**	**Unhealthy**		**Sensitive Groups :**People with asthma or other respiratory system d				
e group	**Sensitive Groups :**People with asth	**0.44 164**	**Unhealthy Very Unhealthy**		**Sensitive Groups :**People with asthma or other respiratory system d				
		0.72 212	**Dangerous**						
		1.48 358							
13	**Green Zone) North East of The City(**	**0.54**	**5**		**Sensitive Groups :**People with asthma or other respiratory system diseases, the elderly, and children are the most categories exposed to danger	**0. 56**	**5**	**0. 56**	**Sensit** or oth the el catego
14	**Residential Use)Al-Andalus Quarter(**	**0.45**	**6**		**Sensitive Groups :**People with asthma or other respiratory system diseases, the elderly, and children are the most categories exposed to danger	**0. 59**	**6**	**0. 59**	**Sensit** or oth the el catego
15	**Residential Use)Al-Andalus Quarter(**	**2.78**	**31**		**Sensitive Groups :**People with asthma or other respiratory system diseases, the elderly, and children are the most categories exposed to danger	**0. 46**	**5**	**0. 49**	**Sensit** or oth the el catego
16	**The Court U Turn + Bakeries**	**0.52**	**6**		**Sensitive Groups :**People with asthma or other respiratory system diseases, the elderly, and children are the most categories exposed to danger	**0. 38**	**2 9**	**0. 34**	**Sensit** or oth the el catego

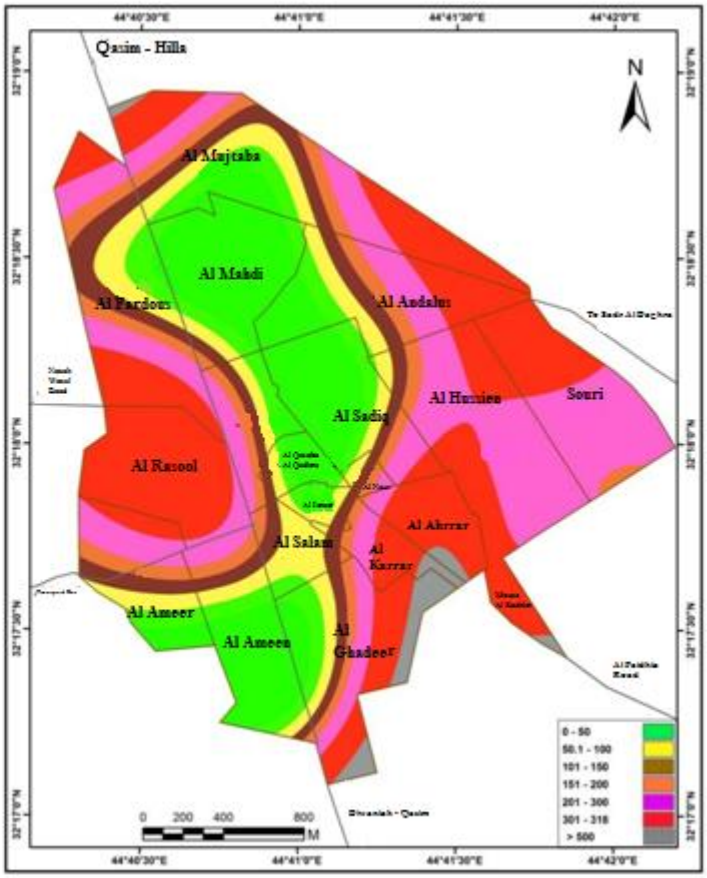
Source; The researcher based on the results of the field study measurements

Map (4): Geographical distribution of the air quality index (NO2) for the winter season in Al-Qassim city



Source; The researcher

Map (5): Geographical distribution of the air quality index of (NO2) for the summer season in Al-Qassim city



Source; The researcher

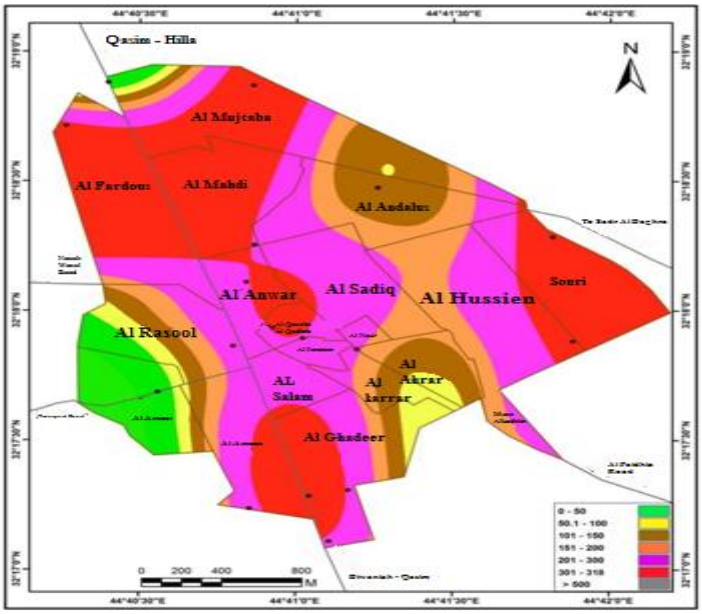
Table (5): Air quality index (AQI) for sulfur dioxide (ppm) within the monitoring points distributed over the neighborhoods of Al-Qassim city (2021)

							Dangerous	

lthy	AQI Index Category .				
lthy	**Sensitive Groups :**People with asthma or other respiratory				**Extremely Critical**
	Sensitive Groups : People with asthma or other respiratory				**Extremely Critical**
	Sensitive Groups : People with asthma or other respiratory				**Extremely Critical**
	Sensitive Groups : People with asthma or other respiratory				**Extremely Critical**
or sensitive Gr	**Sensitive Groups :**People with asthma or other respiratory				**Extremely Critical**
Critical	**Sensitive Groups :**People with asthma or other respiratory				**Extremely Critical**
	Sensitive Groups : People with asthma or other respiratory				**Extremely Critical**
lthy	**Sensitive Groups :**People with asthma or other respiratory				**Extremely Critical**
	Sensitive Groups : People with asthma or other respiratory				**Extremely Critical**
lthy	**Sensitive Groups :**People with asthma or other respiratory				**Extremely Critical**
or sensitive gro	**Sensitive Groups :**People with asthma or other respiratory				

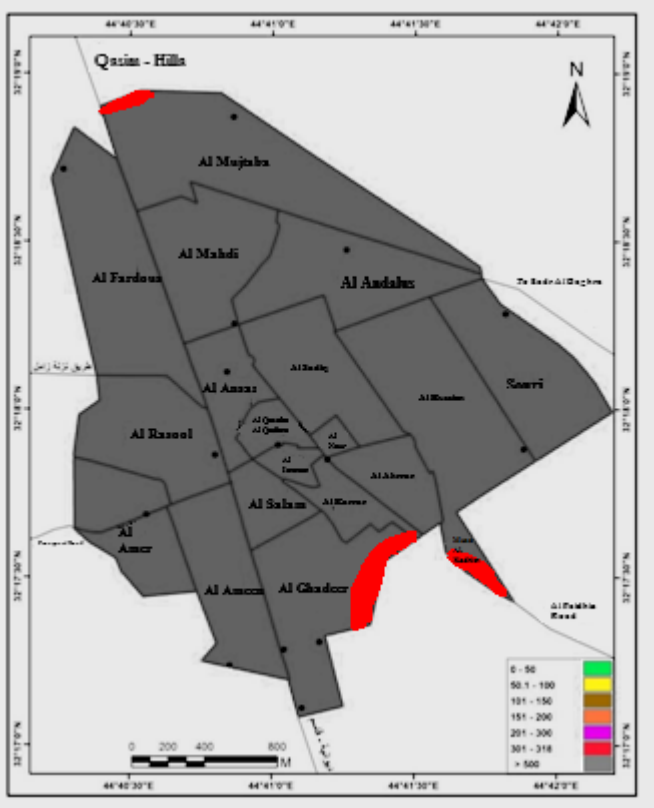
Source; The researcher based on the results of the field study measurements

Map (6): Geographical distribution of air quality index of (SO2) for the winter season in Al-Qassim city



Source; The researcher

Map (7): Geographical distribution of air quality index of (SO2) for the summer season in Al-Qassim city



Source; The researcher

Conclusions

1. The Air Quality Index (AQI) is one of the important things that must be taken into account to know the nature of air, in addition to knowing the type of pollutants that spread and affect human health and cause health complications without knowing the reasons.
2. The index is a measurement that is based on several pollutants in its classification of air, including (NO2, SO2, CO, O3, PM2.5, and PM10).
3. The results of the air quality index of (CO) during winter and summer are within one category, which is (good), which means that this gas did not record a negative health impact in the study area.
4. The results of (NO2) showed a great variation during winter and summer. Most of the results ranged between (unhealthy for allergy groups and very dangerous), which explains the presence of dangerous gas concentrations affecting the living population within the study area.
5. The results of (SO2) during winter and summer are within the category of (extremely dangerous), which reflects human activity that has a major role in increasing the concentration of this gas within the city neighborhoods, in addition to its negative repercussions on the health of Residents of Al-Qassim City, which may lead to death without knowing the causes in the long run and exposure.

Recommendations

1. Issuing health instructions through written and audio media in order to show the negative impact that these gases have on human health, especially the respiratory system because it has the most impact at this stage. Pollutants are stabilized in the respiratory tract causing bronchitis. They may stabilize in the lungs, which increases the risk because it leads to many chronic diseases that are difficult for a person to treat or get rid of. Such diseases may be fatal and impossible to treat, such as cancerous diseases.
2. Conducting educational tours through special workshops in which the dangers of air pollutants on the environment in general and on the study area in particular are shown.
3. Afforesting the area in order to reduce the spread of pollutants in the air from its origin to other nearby places.
4. Reducing the emissions of car engines, which are the most important source of air polluting gases, through following-up by the responsible authorities within the study area by enacting a law requiring car owners to

install filters, which would reduce the emissions emitted from the vehicle.

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