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Evaluation of Air Quality and Major Pollutants in Al-Zubair City, Southern Iraq

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ABSTRACT

Atmospheric contamination presents a significant danger to urban areas and community well-being, requiring methodical surveillance of environmental air standards. Consequently, the current research sought to evaluate significant atmospheric pollutants in Al-Zubair City throughout 2025–2026. Air quality indicators were assessed at four important sites, with two seasonal repetitions carried out during spring, summer, autumn, and winter. The results indicated clear regional and seasonal discrepancies among contaminants. Nitrogen dioxide (NO2) reached a maximum concentration of 2.0ppm in the Al-Askari district in spring, while its minimum level of 0.1 ppm was observed in Al-Mazare' and Al-Shamaliyah during autumn and summer. Carbon monoxide (CO) peaked at 1.6 ppm in Al-Askari during the winter season, whilst the lowest concentration of 0.18 ppm was recorded in Alamir in the autumn. Total suspended particle matter (TSP) peaked at 102 µg/m³ in Al-Shamaliyah in winter and dipped to 18.9 µg/m³ in Al-Mazare' in spring. In contrast, sulphur dioxide (SO2) was consistently found at undetectable amounts throughout all sites and seasons. In summary, urban endeavors in Al-Askari and seasonal climatic conditions markedly increase localised pollution concentrations, especially in winter and spring. Consequently, ongoing air quality surveillance and targeted emission regulation strategies are highly advised to alleviate public health hazards.

Keywords: Carbon Monoxide Gas, Nitrogen Dioxide Gas, Particulate Matter, And Sulphur Dioxide Gas

INTRODUCTION

Pollution is characterized as the infusion of materials that induce adverse alterations to the atmosphere, biosphere, lithosphere, or hydrosphere due to human engagement, either directly or indirectly, which can lead to detrimental consequences for the environment; these byproducts or surplus energy are categorized as environmental pollutants (Byblos, 2017). Pollution indicates the discharge of detrimental substances into the natural surroundings, leading to negative impacts on ecosystems and human well-being. to humans and other living organisms. Human activity has left its mark on the environment in more than one way. Drinking water is contaminated, the air is polluted, and the soils that vegetation depends on are degraded. Meanwhile, climate change and global warming are transforming ecosystems: food security is under threat, ice sheets and glaciers are melting, species are disappearing, and plant life is being damaged (Karl et al., 2009; Marlon et al., 2019). The health consequences of air pollution are wide-ranging. Vulnerable and sensitive individuals can be affected even on days when pollution levels are low. Short-term exposure to airborne pollutants has been significantly associated with chronic obstructive pulmonary disease (COPD), coughing, dyspnea, wheezing, asthma, and other respiratory disorders, as well as with more hospital admissions, which serve as an indicator of morbidity (Eze et al., 2014). Nitrogen dioxide (NO2) is no minor hazard to human health. Epidemiological studies have tied exposure to it to bronchitis among asthmatic children and to reduced lung function (Mortimer et al., 2008). Detrimental biological contaminants include bacteria, viruses, and fungus, whereas chemical pollutants consist of formaldehyde (CH2O), benzene (C6H6), ozone (O3), nitrogen oxide (NO), nitrogen dioxide (NO2), particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), carbon dioxide (CO2) and total volatile organic compounds (TVOCs) (Fazli et al., 2021). It is a highly reactive gas and a member of the family of nitrogen oxides (NOx) in chemical families. Its principal sources are vehicle exhaust, power generation plants and industrial machinery. After inhaled, NO2 irritates the airways of the human respiratory system. The health effects of short-term exposure and long-term exposure to NO2 are different, and therefore are treated separately here. NO2 is an oxidizing gas that is present in the outdoor air of many urban and industrial locations and accumulates in homes where combustion appliances are used. At present it is included as a "criteria" pollutant by the EPA (Pandey & Singh, 2021). Acute exposures have been linked to deteriorated respiratory status including asthma and other pulmonary diseases (Hesterberg et al., 2009). This is by no means unique to NO2: other traffic pollutants behave likewise, and the concentration of ambient carbon monoxide (CO) has been seen to rise during peak traffic periods (Chen et al., 2007). A concern is also raised about the level of Sulphur dioxide (SO2). There are many epidemiological studies that have investigated the effects of short-term exposure on human health, including on mortality risk, and they have been summarized in a variety of systematic reviews and meta-analyses (Shah et al., 2015; Yang et al., 2014; Shah et al., 2013;Atkinson et al.,2012;Stieb et al.,2002;).Another significant constituent of ambient air pollution, particulate matter (PM), is associated with millions of premature deaths globally annually (Apte et al., 2015; Lelieveld et al., 2015; Cohen et al., 2017). Most analyses of either short- or long-term health impacts of PM focus on PM mass concentration, although particle size and composition are also known to affect the health impact (Valavanidis et al., 2008).

Aim of the Study

Assessments of seasonal gas pollution fluctuations in Al-Zubair City are notably scarce. Mitigating this information deficiency is crucial because of the burgeoning urban and industrial endeavours that may endanger public health. Consequently, this research intends to methodically assess the ambient air quality in several urban areas of Al-Zubair . The primary aims are to measure seasonal fluctuations of {NO2}, {CO}, {SO2} and {TSP} at four key sites and to provide baseline pollution profiles. It is posited that localized human-generated emissions, along with seasonal weather variations, may result in significant concentration surges during certain seasons, especially in areas with high population density and activity levels.

MATERIALS AND METHODS

Experimental Procedure

Locations of sampling sites

Air samples were gathered from the ambient atmosphere along the roadside at four sites situated in the Al-Shamaliyah, Al-Amir, Al-Mazare', and Al-'Askari districts. The roadside monitoring locations were chosen based on elevated traffic density.

Study Area Description

Basra Governorate is in southern Iraq and has a population of between 4 and 5 million. Basra is one of the most important cities for oil extraction in Iraq, hence it is one of the most polluted cities, whether air, water or soil pollution.

Al-Zubair is a city in Iraq that serves as the administrative seat of the Al-Zubair district, part of the Basra Governorate in southern Iraq. Its populace surpasses one million. It serves as a pivotal geographical site that links the Rumaila and Zubair fields to the Iraqi ports (Umm Qasr and Khor al-Zubair), establishing it as a logistical center for the conveyance of raw materials and heavy machinery through road and rail systems. The city of Al-Zubair is home to the Al-Zubair oil field, counted among the world's super-giant oil reserves. The field runs on the latest production, isolation, and water injection technology, the last of which helps maintain reservoir pressure. Gas flaring in the neighbouring fields is the main source of persistent emissions, since incomplete combustion of natural gas releases large amounts of gaseous substances and particulates. The geographical division of the research area in Al-Zubair City for environmental monitoring comprised four main districts: Al-Shamaliyah, Al-Amir, Al-Mazare', and Al-Askari. Air samples were routinely gathered during all four seasons (spring, summer, autumn, and winter), with two seasonal repetitions conducted at each sampling location to guarantee data reliability.

The apparatus in the experiment

employed two varieties of instruments to assess air pollution metrics in the city of Al-Zubair.

Portable Combustion Gas Analyzers

Portable combustion gas analyzer - diagnostic instruments for detecting and quantifying the emissions of combustion systems like boilers, furnaces and gas turbines. They exhaust gases directly from the combustion stack and thus are able to determine the chemical composition of the exhaust gases and to estimate the efficiency of the combustion process. Concentrations of CO, NOx and SO2 are also measured using the analyzers. The device is made up of two components. Sampling probe is a metal tube, that is heat-resistant and is inserted into a chimney to extract the exhaust gases. A water trap and particle filters are installed in the sample processing and filter unit and protect the sensors from moisture and dust. The instrument has a number of features that make it very practical in the field. Easy to carry between fieldwork sites and industrial sites due to its lightweight design. Super Protection (CO Protection) function, it will protect the CO sensor by turning off the pump/gas flow when the CO level rises. At last, the analyzer is purged to a purified air standard during the initial purging, effectively self-recalibrating the analyzer.

Personal Data Ram (PDR).

Personal Data RAM (PDR) is a small, portable electronic measuring device that quantifies and stores actual-time, on-site (breathing zone or near field) concentrations of breathing zone, suspended particulate matter and dust. It is called the Personal Dust Ram or the Personal Dataram in environmental monitoring and occupational safety. The instrument is based on the principle of light scattering (nephelometry). The laser beam (usually yellow or red) is oriented toward the sample as it is drawn through a precision pump into the measuring chamber. The light then scatters when it encounters the particles and aerosols, and the scattered light is measured by high accuracy photodetectors, which are converted to a mass concentration value.

RESULTS AND DISCUSSION

The concentrations of air pollutants in Al-Zubair area were measured at four representative sites of the ambient atmosphere of Al-Zubair district namely Al-Shamaliyah, Al-Amir, Al-Mazare', and Al-'Askari. Air samples were taken seasonally, in spring, summer, autumn and winter. The four districts collected two samples of each pollutant (CO, NOx, SO2, and PM) in 2025-2026.1, and the results were as follows: N2O2 gas:

The concentration of nitrogen dioxide (NO2) gas was measured during four seasons in four areas of Al-Zubair city and the results are represented in the subsequent figure. During the spring months the highest concentration of the gas was in the Al-Askari area, reaching 2 ppm.

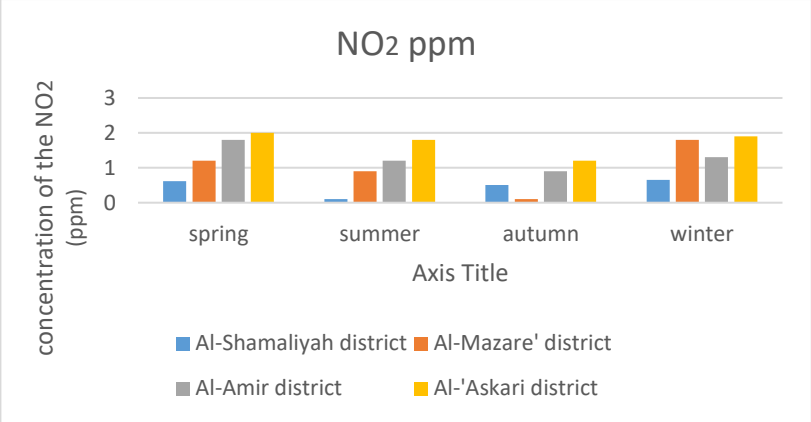


Figure 1: Gas Concentration

Carbon Monoxide Gas

The investigation results indicated that the highest level of carbon were found in the following: In winter, the concentration of monoxide gas in the Al-Askari district was 1.6 ppm.

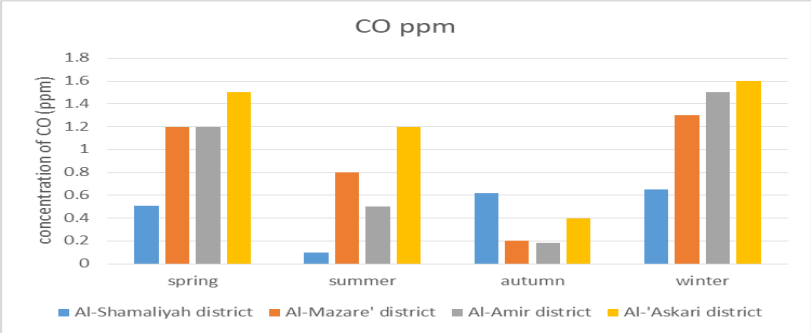


Figure 2: The Levels and Measurements of Carbon Monoxide Gas

Particles Matter(PM)

The experiment and measurement of suspended particle concentration in four seasons in four districts revealed that the highest value was in winter when the concentration in Al-Shamaliyah district was 102 µg/m3.

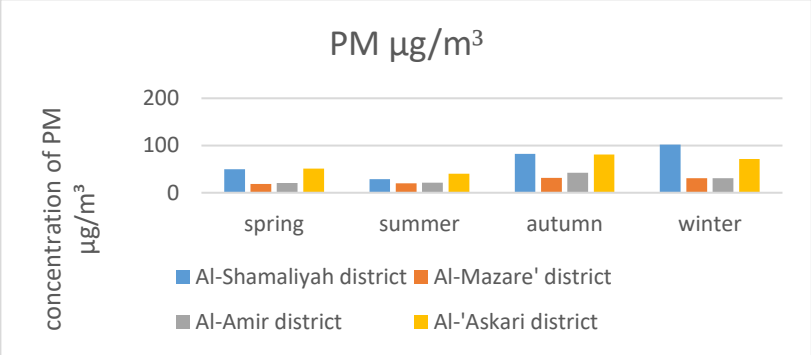


Figure 3: The Values and Concentration of Suspended Particles

Sulfur Dioxide Gas

The concentration of sulphur dioxide gas in four seasons and four regions is zero.

Table 1: The Concentration of Sulfur Dioxide Gas

Districts/seasons	spring	summer	autumn	winter
Al-Shamaliyah district	0	0	0	0
Al-Mazare' district	0	0	0	0
Al-Amir district	0	0	0	0
Al-'Askari district	0	0	0	0

CONCLUSION

The results of this research determined that Al-Zubair is contaminated with air, soil and water due to the influences of the northern and southern Rumaila oil fields. There are a lot of flaring petrol released into the air from the Rumaila fields and a great amount of vehicles in the city which use substandard petrol. Air pollution is the primary air pollutant in Al-Zubair with CO, NO2 and dust being the main pollutants.

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