Original article

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Assessment of air pollutants at the Fuel Stations in Al-Nassiriyia in the Republic of Iraq

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ABSTRACT

Introduction. *Globally, pollution is an issue impacting on the health of mankind. An individual's health connected to hygiene of their living environment, as a result of the rapid growth of industries, the pollution happens when the balance between the structures and functions of an environment are disrupted by changes in the components of it.*

This study aimed *to measure the concentration of some air pollutants (nitrogen oxide, sulfur dioxide and ozone) in fuel stations located in Al-Nassiriyia city.*

Materials and methods. *The samples were collected from four stations. The results of current study were compared with the seasonal air pollutant levels at fuel stations. Analysis of air pollutants (NO_2, SO_2, O_3) was conducted by using a multi-gas analyzer.*

Results. *A rise in nitrogen oxide and sulphur oxide concentration (0.013, 0,007 ppm, correspondingly was registered in winter at sites S1 and S2. The highest ozone concentration was recorded in the autumn season (0.133 ppm) in S3, while the lowest concentration – in the winter (0.057 ppm) in the same station.*

Limitations. *Small sample size and short time of study are the two major issues. The other are government agreement.*

Conclusions. *In winter air pollutants were higher than in autumn due to weather changes such as lower temperatures and high humidity, vehicle emissions, car exhausts, and high traffic. Concentrations of NO_2, SO_2 and O_3 were greater in fuel stations compared to the control station due to their distance from pollution sources.*

Keywords: *air pollutants; fuel stations; Thi-Qar; Rural Area; ozone; nitrogen oxide; sulphur oxide*

Compliance with ethical standards. *This study was approved by the biomedical ethics committee, Department of Biology, Collage of Science, University of Thi-Qar (3/11/1850 in 27/12/2023) and (3/11/1849 in 27/12/2023).*

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Исследование уровня загрязнения воздуха на автозаправочных станциях в городе Аль-Насирия в Республике Ирак

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РЕЗЮМЕ

Введение. *В глобальном масштабе загрязнение является проблемой, влияющей на здоровье человечества. Здоровье человека связано с гигиеной среды его проживания, в результате быстрого роста промышленности происходит загрязнение, нарушается баланс между изменениями структуры компонентов и функциями среды.*

Цель исследования *– измерение концентрации некоторых загрязнителей воздуха (оксида азота, диоксида серы и озона) на заправочных станциях, расположенных в городе Аль-Насирия.*

Материалы и методы. *Образцы были собраны на четырёх станциях. Результаты текущего исследования были сопоставлены с сезонными уровнями загрязняющих веществ в воздухе на заправочных станциях. Анализ загрязняющих веществ в воздухе (NO_2, SO_2, O_3) был проведён с использованием многогазового анализатора.*

Результаты. *Повышение концентрации оксида азота и оксида серы (0,013, 0,007 ppm соответственно) зимой зафиксировано на площадках S1 и S2. Самая высокая концентрация озона была зафиксирована осенью (0,133 ppm) на S3, а самая низкая концентрация – зимой (0,057 ppm) на той же станции.*

Ограничения исследования. *Небольшой размер выборки и короткое время исследования являются двумя основными проблемами. Другие – правительственное соглашение.*

Заключение. *Зимой загрязняющих веществ в воздухе было больше, чем осенью, из-за изменений погоды, таких как более низкие температуры и высокая влажность, выбросы транспортных средств, выхлопные газы автомобилей и интенсивное движение. Концентрации NO_2, SO_2 и O_3 на заправочных станциях были выше, чем на контрольной станции, из-за их удалённости от источников загрязнения.*

Ключевые слова: *загрязняющие вещества в воздухе; заправочные станции; Ти-Кар; сельская местность; озон; оксид азота; оксид серы*

Соблюдение этических стандартов. *Это исследование было одобрено комитетом по биомедицинской этике колледжа науки факультета биологии Университета Ти-Кар (3/11/1850 от 27.12.2023 г. и 3/11/1849 от 27.12.2023 г.).*

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Конфликт интересов. Авторы декларируют отсутствие явных и потенциальных конфликтов интересов в связи с публикацией данной статьи.

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Introduction

Pollution has become a global issue due to its significant impact on the health of the human body [1]. An individual's health is interconnected with the safety and hygiene of their living environment, as a person grows increasingly susceptible to its risks through his surrounding environment [2, 3]. Rapid industrial growth, particularly in sectors relying on hydrocarbons and trace elements, has become a significant trend [4, 5]. Pollution occurs when the balance between the structure and function of an environment is disrupted due to a change in the components of that environment [6, 7]. An environment can be considered 'polluted' if it contains harmful substances. Although pollution can take many forms, the three most common categories are air, water, and soil [8]. The main reason for focusing on air pollution is the size and severity of its effects on human health. The human is becoming more aware of the problems caused by air pollutants every day [9]. Air pollution is the introduction of biological substances or chemicals into the atmosphere [10, 11]. These substances harm humans or other organisms, including plants [12, 13].

Exposure to air pollutants causes many diseases, including allergies', respiratory diseases, lung disorders, asthma, heart diseases, cough, bacterial and viral infections [12, 14]. Many developing countries have experienced the problem of air pollution, and Iraq is one of them [15, 16]. The main sources of air pollutants in Iraq are fuel stations, power plants and vehicles, and vehicle exhausts [17, 18]. Natural gas and oil burning are also sources of air pollutants [19]. This study aims to quantify the levels of air pollutants (NO_2, SO_2, O_3) in fuel stations in AL-Nasiriyah City also assesses the dispersion of air pollutants around the city and compares it to local and international levels.

Materials and methods

Study area. Four sampling locations were employed in this research (S1, S2, S3, and S4), with three sites situated along a major, heavily trafficked thoroughfare within the central urban area of Thi-Qar province, specifically at the Thi-Qar, Al-Noor, and Al-Raya fuel stations, while the fourth site was positioned remotely, far away from the city centre.

Criteria. This study included oil stations located within the administrative boundaries of Thi-Qar Province that experience consistently high daily vehicular traffic, while excluding gas stations situated outside these boundaries or in remote and low-traffic areas, such as highways.

Measuring points location:

1. Station 1 (Thi-Qar station) is located approximately to east of the city, on high way road with passage of high number of vehicles and presence of trucks and all type of cars that across through this road.
2. Station 2 (AL-Noor Station) is located in the western part of northern Nasiriyah at the entrance to Sadr City.
3. Station 3 (Al-Rayat Station) – south of the city, located on the subway at the intersection of two important main streets.
4. Station 4 (control station) remote rural areas far from sources of pollution and urban congestion [(Al-Bu Alyan, Al-Shuwailat, Al-Ammar) is considered control stations because they are rural areas and far from sources of pollution].

Analysis of some air pollutants. Air pollutant concentrations were analyzed using a Thermo Scientific NMA-260 analyzer (USA), which features a measurement range spanning from 0–50 parts per billion (ppb) to 0–100 parts per million (ppm), with a detection limit of <0.4 ppb.Three gases were measured (NO_2, SO_2, O_3), and the level of each gas was measured three times for each of the three stations for two seasons (Autumn and Winter).

The Limits for atmospheric air, in Iraq is presented in Table 1.

Weather parameters. Autumn was characterized by temperatures ranging from 30.1 to 33.3 °C and a concurrent level of humidity, in contrast, winter exhibited a lower monthly average temperature of 19 °C coupled with an increase in humidity reaching 59.2 g/m³.

Table 1 / Таблица 1

Concentration limits for atmospheric air of gaseous pollutants in Iraq

Пределы концентрации газообразных загрязнителей атмосферного воздуха в Ираке

Air Pollutants Загрязнители воздуха	Intermittent exposure Прерывистое воздействие	Air quality limits Пределы качества воздуха		Measurement analysis method Метод аналитического измерения
		µg/m³ мкг/м³	in ppm миллионные доли	
O_3 Ozone Озон	1 hour / ч	211	0.1	UV Absorption УФ-абсорбция
	8 hours / ч	127	0.06	
	24 hours / ч	–	–	
	1 year / год	–	–	
SO_2 Sulfur oxide (IV) Оксид серы (IV)	1 hour / ч	422	0.15	UV Fluorescents УФ-флуоресценция
	8 hours / ч	–	–	
	24 hours / ч	169	0.06	
	1 year / год	56	0.02	
NO_2 Nitrogen oxide (IV) Оксид азота (IV)	1 hour / ч	200	0.1	Chemiluminescence's Хеми-люминесценция
	8 hours / ч	–	–	
	24 hours / ч	100	0.05	
	1 year / год	40	0.02	

Table 2 / Таблица 2

NO_2 concentrations in oil station according to season

Концентрации оксида азота (IV) на заправочных станциях по времени года

Stations Станция	NO_2 Mean ± SD, ppm среднее ± среднее квадратическое отклонение, миллионные доли		*p*
	Autumn / Осень	Winter / Зима	
S1	$0.0056^a \pm 0.0001$	$0.013^a \pm 0.001$	< 0.001
S2	$0.0055^a \pm 0.0002$	$0.011^a \pm 0.000$	< 0.001
S3	$0.0035^b \pm 0.0005$	$0.011^a \pm 0.001$	0.007
S4 (control / контроль)	0.0021 ± 0.0013	$0.005^b \pm 0.001$	< 0.001
p	<0.001	< 0.001	–
LSD	0.0004	0.003	–

N o t e: Here and in Tables 3, 4: The fourth station is a control station, which is a remote agricultural area far from the city and there are no industrial factories or gas stations near it; similar small letters above the means indicate the non-significant differences, while different letters indicate the significant differences; the LSD (Least Significant Difference) value is used for determining the significant differences between means in the ANOVA test, where we subtract any two means from the table and compare the result of the subtraction with the LSD value. If the value of the subtraction is equal to or higher than the LSD value, it indicates a significant difference, while if it is less, it indicates that there is non-significant difference.

П р и м е ч а н и е. Здесь и в табл. 3, 4: S4 — контрольная станция, расположенная на отдалении в сельской местности, вдали от города, без промышленных предприятий или заправочных станций поблизости от неё. Одинаковые мелкие буквы над средними значениями указывают на незначимые различия, в то время как разные буквы указывают на значимые различия; значение LSD (минимальная значимая разница (МЗР) используется для определения значимых различий между средними значениями в тесте ANOVA, когда разница между любыми двумя средними значениями в таблице сравнивается с МЗР. Если разница равна или больше МЗР, такое отличие считается существенным, если она меньше, это указывает на незначимую разницу.

Table 3 / Таблица 3

Ozone concentrations in oil station according to season

Концентрации озона на заправочных станциях по времени года

Stations Станция	O_3 Mean ± SD, ppm среднее ± среднее квадратическое отклонение, миллионные доли		*p*
	Autumn / Осень	Winter / Зима	
S1	$0.122^{a} \pm 0.003$	$0.066^{a} \pm 0.000$	0.026
S2	$0.114^{a} \pm 0.009$	$0.064^{b} \pm 0.000$	0.001
S3	$0.133^{a} \pm 0.015$	$0.057^{c} \pm 0.003$	0.001
S4 control	$0.067^{b} \pm 0.014$	$0.008^{d} \pm 0.0011$	< 0.001
p	< 0.001	0.002	–
LSD	0.08	0.003	–

Table 4 / Таблица 4

SO_2 concentrations in oil station according to season

Концентрации оксида серы (IV) на заправочных станциях по времени года

Stations Станция	SO_2 Mean ± SD, ppm среднее ± среднее квадратическое отклонение, миллионные доли		*p*
	Autumn / Осень	Winter / Зима	
S1	0.0038 ± 0.0002	$0.0065^{b} \pm 0.000$	< 0.001
S2	0.0036 ± 0.0003	$0.0063^{b} \pm 0.000$	< 0.001
S3	0.0039 ± 0.0006	$0.0077^{a} \pm 0.000$	0.003
S4 control	0.0036 ± 0.0002	$0.0062^{b} \pm 0.000$	< 0.001
p	0.567	< 0.001	–
LSD	Non-sig	0.003	–

Statistical Analysis. The data of the current study was statistically analysis by using the soft statistic program SPSS version 26, based on the use of One-way ANOVA, LSD (Least Significant Difference) for mean variation, independent sample *t*-test for mean variation, paired sample *t*-test and χ^2 (chi-square) for independent and person coefficient for correlation at *p*-value <0.05.

Results

Concentrations of Nitrogen Oxide in Fuel Stations. The present study observed a substantial increase in all oil stations during winter compared to the same stations in the autumn season, ($p<0.05$), as shown in Table 2.

Concentrations of Ozone in Fuel Stations. The current study recorded a significant increase in autumn season in all oil stations compared with same stations in winter season ($p<0.05$), as in the Table 3.

Concentrations of Sulfur Oxide in Fuel Stations. The current study noted the level of SO_2 increased significantly in the all-oil stations in the winter season compared with the autumn season, as in Table 4.

Discussion

Elevated concentrations of NO_2 were observed during the winter season compared to autumn, a finding consistent with Battista et al. [20], and this study also revealed a negative correlation between NO_2 levels and both solar radiation and temperature. Additionally, vehicle emissions and temperatures were reduced, while higher relative humidity contributed to the values of air pollutants [21]. Concentrations of NO_2 in the present study reach the highest level during the winter season and the lowest level throughout autumn. The order of NO_2 concentration in winter and autumn is S1 > S3 > S2. However, the NO_2 concentration at fuel stations exceeded the limits established by NAAQS (National Ambient Air Quality Standards) and PEQS (Punjab Environmental Quality Standards).

Ozone (O_3) concentrations at fuel stations were observed to be highest in autumn compared to winter, a phenomenon attributed to the photochemical reaction of volatile organic compounds (VOCs) and nitrogen oxides (NO_x) with sunlight, leading to O_3 formation; furthermore, enhanced vehicle emissions and elevated temperatures during autumn likely accelerate the natural convection process, facilitating the mixing of clean air and dispersion of pollutants [22], and these O_3 concentrations also exhibited a correlation with temperature [22], with the spatial distribution in autumn and winter following the pattern S3 > S1 > S2, with levels remaining within the limits established by both NAAQS and PEQS at all stations.SO_2 is more concentrated in winter and lower in autumn. A study by [23] recorded higher SO_2 concentrations in the winter season; this due to low temperatures, leads to reduced dispersion and accumulation of pollutants at lower altitudes due to the cooling of air masses. This results in pollutants being trapped near the ground [22]. Exposure to SO_2 can irritate lung tissue and harm health [24]. The direction of SO_2 concentrations in winter and autumn S3 > S1 > S2. SO_2 values in autumn and winter exceeded the NAAQS and PEQS limits. The most widely utilized fuels in Iraq are petrol and diesel; the sulfur content of petrol is variable, ranging from 0.03% up to 0.5%, whereas diesel has a sulfur content of 500 ppm.The pervasive issue of air pollution from vehicular emissions remains a significant global concern. This article presents a comparative analysis of air pollution at fuel stations across different seasons, with particular attention to the influence of meteorological conditions prevalent in the Middle East region.

Limitations. Small sample size and short time of study are the two major issues. The other are government agreement.

Conclusions

Air pollutants were higher in winter than in autumn due to weather changes such as lower temperatures and high humidity, vehicle emissions, car exhausts, and high traffic, concentrations of NO_2, SO_2, and O_3 were greater in fuel stations.

References / Литература

1. Manisalidis I., Stavropoulou E., Stavropoulos A., Bezirtzoglou E. Environmental and health impacts of air pollution: a review. *Front. Public Health*. 2020; 8: 14. https://doi.org/10.3389/fpubh.2020.00014
2. Khairy S., Maktoof A.A. Estimation of hematological parameters in people exposed to environmental pollution in Thi-Qar Governorate. *University of Thi-Qar Journal of Science*. 2023; 10(2): 146–50. https://elibrary.ru/ettlva
3. Amous M.O., Hassan M.A. Heavy metals risk assessment in water and bottom sediments of the eastern part of Lake Manzala, Egypt, based on remote sensing and GIS. *Arab. J. Geosci*. 2015; 8(10): 7899–918. https://doi.org/10.1007/s12517-014-1763-6
4. Litvinenko V. The role of hydrocarbons in the global energy agenda: The focus on liquefied natural gas. *Resources*. 2020; 9(5): 59. https://doi.org/10.3390/resources9050059
5. Wang C., Wang J., Zhou S., Tang J., Jia Z., Ge L., et al. Polycyclic aromatic hydrocarbons and heavy metals in urban environments: Concentrations and joint risks in surface soils with diverse land uses. *Land Degrad. Dev*. 2020; 31(3): 383–91. https://doi.org/10.1002/ldr.3456
6. Kareem N.Q. Impact of oil waste discharge from Al-Nassiriya oil refinery upon physical chemical properties and heavy elements content of vicinity soil. *University of Thi-Qar Journal of Science*. 2021; 8(2): 11–5. https://doi.org/10.32792/utq/utjsci.v8i2.806 https://elibrary.ru/njukkl
7. Sharma S.B., Jain S., Khirwadkar P., Kulkarni S. The effects of air pollution on the environment and human health. *Indian India J. Res. Pharm. Biotechnol*. 2013; 1(3): 391–6. Available at: https://www.ijrpb.com/issues/Volume%201_Issue%203/ijrpb%201(3)%2020%20page%20391-396.pdf

8. Ukaogo P.O., Ewuzie U., Onwuka C.V. Environmental pollution: causes, effects, and the remedies. In: *Microorganisms for Sustainable Environment and Health*. Elsevier; 2020: 419–29. https://doi.org/10.1016/B978-0-12-819001-2.00021-8
9. Rutter A.P., Griffin R.J., Cevik B.K., Shakya K.M., Gong L., Kim S., et al. Sources of air pollution in a region of oil and gas exploration downwind of a large city. *Atmos. Environ*. 2015; 120: 89–99. https://doi.org/10.1016/j.atmosenv.2015.08.073
10. Camargo J., Pumarega J.A., Alguacil J., Sanz-Gallén P., Gasull M., Delclos G.L., et al. Toenail concentrations of trace elements and occupational history in pancreatic cancer. *Environ. Int*. 2019; 127: 216–25. https://doi.org/10.1016/j.envint.2019.03.037
11. Seinfeld J.H., Pandis S.N. *Atmospheric Chemistry and Physics: From Air Pollution to Climate Change*. John Wiley & Sons; 2016.
12. Settimo G., Manigrasso M., Avino P. Indoor air quality: A focus on the European legislation and state-of-the-art research in Italy. *Atmosphere*. 2020; 11(4): 370. https://doi.org/10.3390/atmos11040370
13. Hashimi M.H., Hashimi R., Ryan Q. Toxic effects of pesticides on humans, plants, animals, pollinators and beneficial organisms. *Asian Plant Res. J*. 2020; 5(4): 37–47.
14. Bălă G.P., Râjnoveanu R.M., Tudorache E., Motişan R., Oancea C. Air pollution exposure – the (in)visible risk factor for respiratory diseases. *Environ. Sci. Pollut. Res*. 2021; 28(16): 19615–28. https://doi.org/10.1007/s11356-021-13208-x
15. Mashkhool M.A., Azeez N.M., Abduljaleel S.A. Monitoring of Total Hydrocarbons and Particulate Matters in AL Nasiriya City, South of Iraq. *University of Thi-Qar Journal of Science*. 2021; 8(2): 6–10. https://elibrary.ru/odkinq
16. Kadhem J.A., Reza K.S., Ahmed W.K. Alternative fuel use in Iraq: A way to reduce air pollution. *Eur. J. Eng. Technol. Res*. 2017; 2(5): 20–30.
17. Jumaah H.J., Ameen M.H., Mahmood S., Jumaah S.J. Study of air contamination in Iraq using remotely sensed Data and GIS. *Geocarto Int*. 2023; 38(1): 2178518. https://doi.org/10.1080/10106049.2023.2178518
18. Hannun R.M., Razzaq A.H. Air pollution resulted from coal, oil and gas firing in thermal power plants and treatment: A review. In: *IOP Conference Series: Earth and Environmental Science*. 2022; 1002(1): 012008. https://doi.org/10.1088/1755-1315/1002/1/012008
19. Gartland N., Aljofi H.E., Dienes K., Munford L.A., Theakston A.L., van Tongeren M. The Effects of traffic air pollution in and around schools on executive function and academic performance in children: a rapid review. *Int. J. Environ. Res. Public Health*. 2022; 19(2): 749. https://doi.org/10.3390/ijerph19020749
20. Battista G., de Lieto Vollaro R. Correlation between air pollution and weather data in urban areas: Assessment of the city of Rome (Italy) as spatially and temporally independent regarding pollutants. *Atmos. Environ*. 2017; 165: 240–7. https://doi.org/10.1016/j.atmosenv.2017.06.050
21. Ipeaiyeda A.R., Adegboyega D.A. Assessment of air pollutant concentrations near major roads in residential, commercial and industrial areas in Ibadan City, Nigeria. *J. Health Pollut*. 2017; 7(13): 11–21. https://doi.org/10.5696/2156-9614-7-13.11
22. Tabinda A.B., Abbas S., Yasar A., Rasheed R., Mahmood A., Iqbal A. Comparative analysis of air quality on petrol filling stations and related health impacts on their workers. *Air. Qual. Atmos. Health*. 2019; 12: 1317–22. https://doi.org/10.1007/s11869-019-00757-x
23. Elminir H.K. Dependence of urban air pollutants on meteorology. *Sci. Total. Environ*. 2005; 350(1–3): 225–37. https://doi.org/10.1016/j.scitotenv.2005.01.043
24. Daly A., Zannetti P. Air pollution modelling – an overview. *Ambient Air Pollution*. 2007: 15–28.

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