BioOne COMPLETE

Gaseous Pollutants in Basra City, Iraq

Authors: Douabul, Ali Abdul Zahra, Maarofi, Sama Sameer Al, Al-Saad, Hamid Talib, and Al-Hassen, Shukri

Source: Air, Soil and Water Research, 6(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/ASWR.S10835

BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

Air, Soil and Water Research

OPEN ACCESS
Full open access to this and thousands of other papers at http://www.la-press.com.

ORIGINAL RESEARCH

Gaseous Pollutants in Basra City, Iraq

Ali Abdul Zahra Douabul[1], Sama Sameer Al Maarofi[2], Hamid Talib Al-Saad[1] and Shukri Al-Hassen[3]

[1]Department of Environmental Chemistry, Marine Science Center, University of Basra, Basra, Iraq. [2]Department of Biology, University of Waterloo, Waterloo, Ontario, Canada. [3]Environmental Analyses and Research Lab, Department of Geography, College of Arts, University of Basra, Basra, Iraq. Corresponding author email: adouabul@mscbasra.org

Abstract: This study aimed to detect the present levels and distribution of CO, CO_2, SO_2, NO_2, and total hydrocarbons gases (HCs) produced from different industrial plants in Basra city, Iraq. Measurements were carried out in the winter and summer of 2011. CO, SO_2, NO_2, and HC concentrations were measured using a Drager CMS portable detector, while CO_2 concentrations were measured using a RI-411A portable detector. The average minimum concentrations of CO, CO_2, SO_2, NO_2, and HCs were 2.0 mg/L, 250.0 mg/L, 4.0 mg/L, 0.4 mg/L, 0.5 mg/L, and 0.3 mg/L, respectively. Their average maximum concentrations were 18.0 mg/L, 280 mg/L, 0.9 mg/L, 1.3 mg/L, and 1.3 mg/L, respectively. The results indicate that stations close to the electrical power plant and oil refinery have higher levels of pollutants when compared to the urban station. According to the standards guidelines reported by the World Health Organization's Environmental Protection Act, the detected concentrations of CO for short-term exposure and the average concentrations of NO_2 and SO_2 for short-term and long-term exposure pose serious health hazards, especially in the industrial areas.

Keywords: gaseous pollutants, air quality, Basra city, health hazards

Air, Soil and Water Research 2013:6 15–21

doi: 10.4137/ASWR.S10835

This article is available from http://www.la-press.com.

© the author(s), publisher and licensee Libertas Academica Ltd.

This is an open access article. Unrestricted non-commercial use is permitted provided the original work is properly cited.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

Introduction

The atmosphere is generally defined as a complex, dynamic, natural gaseous system that is important in order to support life.[1] The quality status of air is of crucial importance not only to healthy human life but also for wildlife, vegetation, water, and soil.[2,3] Generally, air quality is rated and can be ranked as being good quality (which refers to clean, clear, unpolluted air) or poor quality (which occurs when pollutants are present at a level considered to be dangerous for the health of humans and the environment).[4,5] Bad air quality generally results from increasing levels of gaseous pollutants, which are mainly considered toxic for humans and other living organisms due to their extensive natural or anthropogenic activities.[6] Natural gaseous pollutants are classified as natural-primary pollutants (which are released mostly from volcanic eruption), carbon monoxide gas from motor vehicle exhaust, and as sulfur dioxide released from factories, or they can be natural-secondary pollutants like ground-level ozone.[6] These pollutants can also be released as primary or secondary pollutants from different anthropogenic activities.[7] The most common primary anthropogenic pollutants produced by human activity are: (1) sulfur oxides (SO_x), especially sulfur dioxide (SO_2), which is produced mainly in power stations; (2) nitrogen oxides (NO_x), especially nitrogen dioxide (NO_2), which is released primarily via high temperature combustion; (3) carbon monoxide (CO), which is the major product of incomplete fuel combustion; (4) carbon dioxide (CO_2), which is released from combustion, cement production, and respiration; and (5) ammonia (NH_3), which is released primarily via agricultural processes.[8]

According to both environment protection agency and global World Health Organizations, air pollution can be a serious cause of different health conditions, including respiratory infections and lung cancer.[8–12] Gehring et al[13] indicated that long-term exposure to traffic-related air pollution can cause allergies and that individuals—especially children under the age of 8—are more susceptible to developing asthma.[14] Other studies have also indicated that the risk of developing lung cancer is highly related to air pollution caused by high traffic[15] or long-term expose to nitrogen dioxide.[16] Gaseous pollutants are also considered to be risk factors for stroke[17] and are associated with an increased incidence of and mortality from coronary artery disease. The early indication of air pollution goes back to the twelfth century, when smoke from burning coal (mainly CO and CO_2) caused serious health problems in England. The discovery led King Edward to become the first to ban the use of coal in lime kilns in London in 1307.[18] Along with the increase in number of industrial zones within cities and urban areas, it has been noted that their impacts have significantly affected the surrounding air quality.[1] In 1948, one of the most dramatic air inversions occurred in Donora, Pennsylvania, when a wall of smog killed 20 people and sickened 7,000 more.[18] Additionally, in England two episodes of "killer fogs" claimed the lives of more than 6,000 people in 1952.[19] On the other hand, some environmental variables intensified the dangers of certain gases; for example, in Meuse Valley, Belgium in 1930, the high humidity concentrated the SO_2 gas and increased its release levels, leading to the deaths of 63 people in a space of 5 days.[19]

Recently, the general quality of ambient air in Basra city (southern Iraq) has been decreasing because of an increase in the city's population and high traffic levels, as well as the expansion and establishment of several industrial plants, including petrochemical plants, oil refineries, burned natural gas flames, fertilizer plants, paper and pulp mills, power generation stations, and industrial workshops.[21] These have put the local population in direct daily contact with the different gaseous pollutants that are caused by daily urban activities, mostly by increasing the use of fossil fuel combustion from electrical generators and motors vehicle, as well as exposing the population to industrial activities. Previous studies have indicated high concentrations of CO, NO_2, SO_2, and HCs within the industrial area in Basra city,[21–23] and given that concentrations from these emissions are constantly increasing, these high levels have become hazardous to human health. The lack of management and control of the gaseous discharges and residues in urban and industrial areas has increased the possibility that the air quality has become worse. This study aims to detect the present levels and distribution of CO, CO_2, SO_2, NO_2, and total hydrocarbons gases (HCs) that are produced from different industrial plants in Basra city in southern Iraq. This survey will also serve as background information to help future environmental assessment studies within the region.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

Figure 1. Sampling locations for air pollution in Basra city, southern Iraq.

Materials and Methods

Seven stations were chosen in Basra city—Al-Qurna, Al-Deer, Garmatt Ali, Al-Ashar, Abu Al-Khaseeb, Al-Seeba, and Al-Faw (Fig. 1). These stations were selected in order to monitor the concentrations of CO, CO_2, SO_2, NO_2, and HCs in the ambient air during the winter and summer months of 2011. CO, SO_2, NO_2, and HC concentrations were measured using the portable detection instrument Drager Chip-Measurement-System (Dragerwerk AG & Co, Lubeck, Germany), while CO_2 concentrations were measured using the portable detection instrument RI-411A (RKI Instruments, Inc., Union City, California, USA). The instruments used were calibrated and certified every six months by sending them to the manufacturing company.

The survey took seven days (one day per station) for every season. The gaseous probe detector was fixed to a 1.5 meter stand, which represents the average human height, to ensure that it was possible to measure the average concentrations that most people inhale. The average of two readings was taken between late afternoon and sunset under low to moderate wind speed, in order to capture the amount of traffic during rush hours.

A principal component analysis (PCA) was constructed using the average seasonal reading of each pollutant at each station. PCA plot was developed using the CANOCO program for Windows 7[24] to examine the differences in average levels of gaseous pollutants in the atmosphere across the seven selected stations during the study period. Focus scaling of the data was set on inter-species correlation and the species scores were divided by the standard deviation.

Results and Discussion

The average concentrations of gaseous pollutants measured in the seven stations are listed in Table 1 and are shown in Figure 2. The results indicate that average concentrations of CO, NO_2, and HCs are significantly different ($P < 0.005$) among the studied stations. The results also indicate that the average concentrations of the monitored gaseous pollutants were higher in the winter than those recorded in the summer. This may be primarily attributed to the differences in weather conditions, especially wind speeds and directions,[23] air temperature,[21] and humidity;[22] however, these variation were not statistically significant ($P > 0.005$). During the study period, the concentration of CO ranged from 4.0 mg/L to 18.0 mg/L, with mean concentration at 10.6 mg/L. The concentration of CO_2 ranged from 230.0 mg/L to 280.0 mg/L, with mean concentration at 262.1 mg/L. The concentration of SO_2 ranged from 0.4 mg/L to 0.9 mg/L, with mean concentration at 0.6 mg/L. The concentration of NO_2 ranged from 0.5 mg/L to 1.3 mg/L, with mean

Table 1. Average concentrations (mg/L ± SD) of the selected gaseous pollutants in Basra city during winter and summer of 2011.

Sampling stations	CO	CO_2	NO_2	SO_2	HCs
Al-Qurna	5.0 (±1.0)	255.0 (±5.0)	0.6 (±0.1)	0.4 (±0.0)	0.4 (±0.1)
Al-Deer	9.0 (±1.0)	265.0 (±5.0)	0.7 (±0.1)	0.5 (±0.0)	0.45 (±0.2)
Garmett Ali	13.5 (±1.5)	255.0 (±5.0)	0.8 (±0.2)	0.6 (±0.1)	0.75 (±0.1)
Al-Ashar	17.0 (±1.0)	280.0 (±0.0)	1.1 (±0.2)	0.8 (±0.1)	1.15 (±0.2)
Abu Al-Khaseeb	7.0 (±1.0)	245.0 (±15.0)	0.9 (±0.1)	0.7 (±0.1)	0.8 (±0.1)
Al-Seeba	14.0 (±2.0)	270.0 (±10.0)	1.2 (±0.1)	0.7 (±0.1)	1.05 (±0.2)
Al-Faw	9.0 (±1.0)	265.0 (±5.0)	0.9 (±0.1)	0.5 (±0.1)	0.8 (±0.1)

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

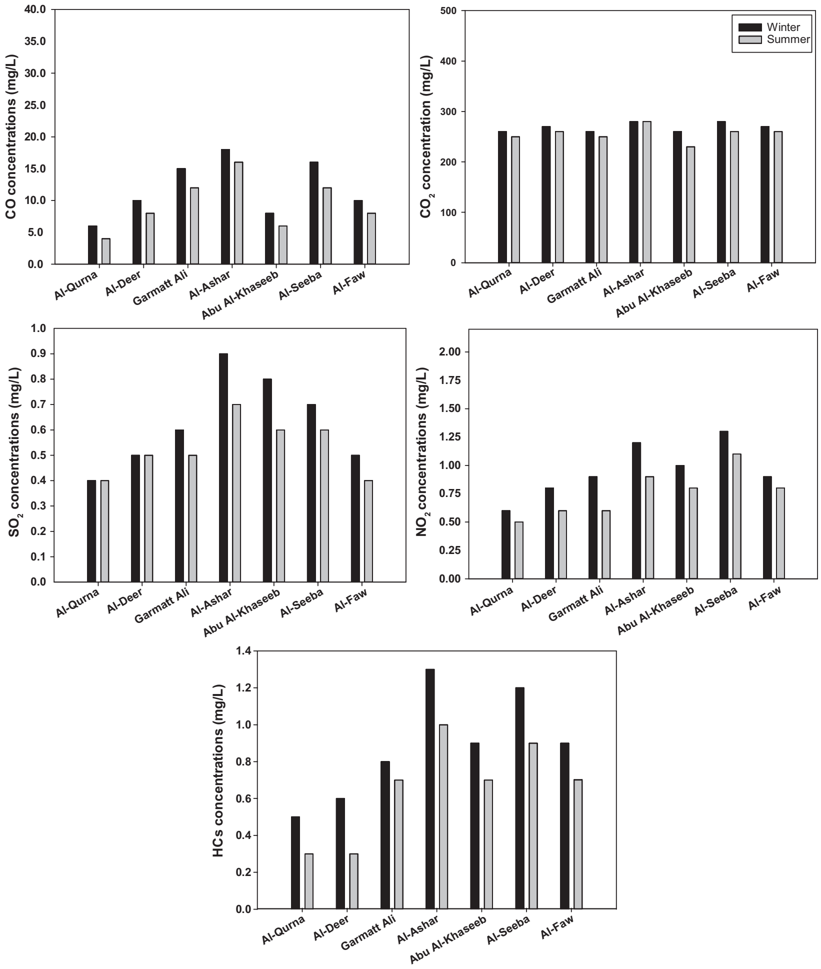

Figure 2. CO, CO_2, NO_2, SO_2, and HCs concentrations of Basra city's ambient air during winter and summer of 2011.

concentration at 0.9 mg/L. Moreover, the concentration of HCs gases ranged from 0.3 mg/L to 1.3 mg/L, with mean concentration at 0.8 mg/L.

The PCA analysis indicated that Al-Ashar and Al-Seeba stations were highly polluted when compared to the other monitored stations, while Al-Qurna, Al-Deer, and Al-Faw stations were less polluted (Fig. 3). However, according to the standard guideline concentrations of CO, CO_2, NO_2, and SO_2 reported by the global health organizations listed in Table 2, CO_2 concentrations were within acceptable limits. Among the studied areas, average CO concentrations were higher than the levels permitted for short-term exposure, as previously reported.[9,11,20,23] The SO_2 concentrations within the studied locations were also higher than the global limit concentrations allowed for long-term and short-term exposure, also previously reported.[8–11,20,23] The average concentration of NO_2 was higher than the allowable limit recommended for

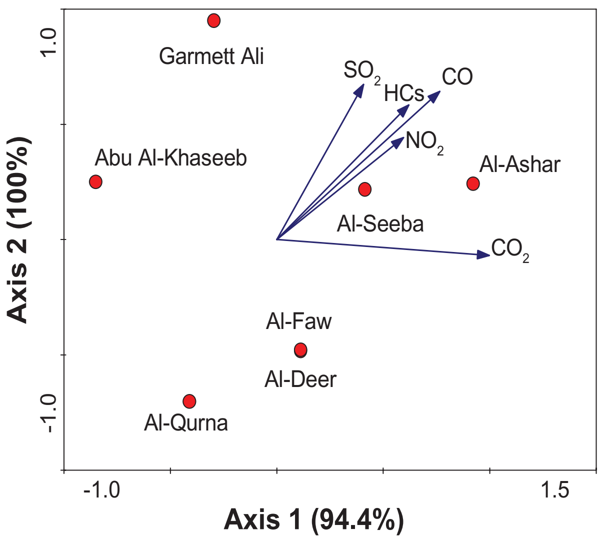

Figure 3. PCA of the average concentrations of CO, CO_2, NO_2, SO_2, and HCs in the ambient air of the seven selected stations in Basra city during the study period.
Notes: Axis 1 accounted for 94.4%, axis 2 accounted for 100.0%, and axis 3 accounted for 100.0% of the total variance. Chloride (Cl^{-1}) had strong positive loadings on axis 1, while sulfate (SO_4^{-2}) had negative loading on Axis 2.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

Table 2. Review of guidance intended to limit ambient air concentrations of CO, CO_2, NO_2, and SO_2 concentrations (mg/L).

Average timing	Pollutants standards concentrations (mg/L)				Area	Reference
	CO	CO_2	NO_2	SO_2		
1 hour	–	–	1.2	0.2	Australia	DEH, 2005
8 hours	9.0	–	–	–		
24 hours	–	–	–	0.08		
1 year	–	–	0.03	0.02		
1 hour	20[a], 35[b]	–	0.18[a]	0.25[a], 0.14[b]	California[a], US National[b]	CEQA, 2012
3 hours	–	–	–	–		
8 hours	9[a,b]	–	–	–		
24 hours	–	–	–	0.04[a]		
1 year	–	–	0.03[a], 0.053[b]	0.03[b]		
10 min	–	–	–	0.2	Europe	WHO, 2000
15 min	90	–	–	–		
30 min	52.4	–	–	–		
1 hour	26.2	–	0.11	–		
24 hours	–	–	–	0.045		
1 year	–	–	0.02	0.02		
1 hour	–	–	0.11 (not to be exceeded more than 18 times a calendar year)	0.13 (not to be exceeded more than 3 times a calendar year)	UK	EP, 2010
8 hours	9	–	–	–		
24 hours	–	–	–	0.048 (not to be exceeded more than 24 times a calendar year), 0.2 (thresholds value)		
1 year	–	–	0.02 (limited value), 2.13 (thresholds value)	–		
1 hour	35[b,c]	–	0.11[a] (not to be exceeded more than 8 times a calendar year)	0.13[a] (not to be exceeded more than 24 times a calendar year)	Europe[a], USA[b], EPA National[c]	DG Environment, 2004
3 hours	–	–	–	0.5[b] (not to be exceeded more than once a year)		
8 hours	9[a–c]	–	–	–		
24 hours	–	–	–	0.045[a] (not to be exceeded more than 3 times a calendar year), 0.14[b,c] (not to be exceeded more than once year)		
1 year	–	–	0.02[a], 0.05[b], 0.53[c]	–		
10 min	–	–	–	0.2	Global	WHO, 2005
15 min	–	30000	–	–		
1 hour	–	–	0.11	–		
8 hours	–	5000	–	–		
24 hours	–	–	–	0.01		
1 year			0.2	–		

long-term exposure.[9–11,21,23] However, the maximum concentration levels of NO_2 that were recorded in the Al-Seeba station were also higher than the recommended concentrations allowed for short-term exposure, as previously reported.[9,11]

Health hazards associated with total HCs were mostly related to the proportion of petroleum hydrocarbon gases (PAHs) that conceded as carcinogenic pollutants.[25] In terms of daily HC intake, the range would normally span from less than 10 ng to more than 100 ng.[25] In general, the average concentrations of the HCs among the studied locations were high and fell within the hazard range for human and environment health.[25] Generally, the concentrations of CO, NO_2, SO_2, and HCs recorded by the previous studies for the last ten years in the region were high. Al-Mayahi[20] reported that CO concentrations ranged from 10 mg/L to 80 mg/L, while Al-Hassan[23] stated

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

that the average concentration was 27 mg/L. Al-Saad et al[21] indicated that SO_2 concentrations ranged from 10 mg/L to 15 mg/L. In Al-Hassan,[23] the average concentration of CO_2 and NO_2 were 300 mg/L and 3 mg/L respectively. In addition, Al-Saad et al[21] and Al-Hassen[23] reported that the average HCs concentrations were 5 mg/L and 2 mg/L, respectively.

The current concentrations of measured gaseous pollutants in this study were lower than the levels indicated in the previous studies, especially the studies done during the first and second Gulf War. However, the relative reduction in the current concentrations of gaseous pollutants, which are primarily due to a lack of management and technical support of the secondary power plants, did not—with the exception of CO_2 levels—prevent the temporal risk to human health in the Basra region, this according to European, American, Australian, and WHO guidelines.

Conclusion

The present data may serve as background levels of gaseous pollutant, as most industries currently are on halt. The survey indicates that the impacts from the remaining working electrical power plant in Al-Najibyia and from Abadan's oil refinery are significantly affecting the air quality in the Al-Ashar and Al-Seeba stations, respectively. The recent improvement of the local economy of Basra can play a significant role in changing the environmental structure of the city by building more industrial plants and expanding the original ones. Thus, these changes can have a direct affect not only on the atmosphere of the region but also on the water and soil.

Acknowledgements

The researchers wish to acknowledge the Marine Science Center (University of Basra) for providing laboratory facilities. We also acknowledge the effort of Mr. Tom Hill for English editing of the manuscript.

Author Contributions

Conceived and designed the experiments: Sh A, HA. Analysed the data: Sh A. Wrote the first draft of the manuscript: SA. Contributed to the writing of the manuscript: SA, AD. Agree with manuscript results and conclusions: AD, SA, HA, Sh A. Jointly developed the structure and arguments for the paper: SA, AD. Made critical revisions and approved final version: AD, SA, HA, Sh A. All authors reviewed and approved of the final manuscript.

Funding

Author(s) disclose no funding sources.

Competing Interests

Author(s) disclose no potential conflicts of interest.

Disclosures and Ethics

As a requirement of publication author(s) have provided to the publisher signed confirmation of compliance with legal and ethical obligations including but not limited to the following: authorship and contributorship, conflicts of interest, privacy and confidentiality and (where applicable) protection of human and animal research subjects. The authors have read and confirmed their agreement with the ICMJE authorship and conflict of interest criteria. The authors have also confirmed that this article is unique and not under consideration or published in any other publication, and that they have permission from rights holders to reproduce any copyrighted material. Any disclosures are made in this section. The external blind peer reviewers report no conflicts of interest.

References

1. Vallero DA. *Fundamentals of Air Pollution*. 4th ed. London: Elsevier Inc.; 2008.
2. Ayres JG. Health effects of gaseous air pollutants. In: Hester RE, Harrison RM, editors. *Air Pollution and Health*. Cambridge: The Royal Society of Chemistry; 1998:1–20.
3. Schwela D. Air pollution and health in urban areas. *Rev Environ Health*. 2000;12(1–2):13–42.
4. Gittins MJ. Air pollution. In: Bassett WH. *Clay's Handbook of Environmental Health*, 18th ed. London: E & FN Spon; 1999:729–76.
5. Megainey C. Introduction to environmental protection. In: Bassett WH. *Clay's Handbook of Environmental Health*. London: E & FN Spon; 1999: 684–703.
6. Harrison RM. Air pollution: sources, concentrations and measurements. In: Harrison RM. *Pollution: Causes*, *Effects and Control*, 4th ed. Cambridge: RSC; 2001:169–92.
7. World Health Organization. *Air Quality Guidelines for Particulate Matter, Ozone, Nitrogen Dioxide and Sulfur Dioxide: Global Update*. Copenhagen: World Health Organization Regional Office for Europe; 2005.
8. Department of the Environment and Heritage. *National Standards for Criteria Air Pollutions in Australia*. Canberra: Department of Sustainability, Environment, Water, Population and Communities; 2005.
9. World Health Organization. *Air Quality Guidelines for Europe*, 2nd ed. Copenhagen: World Health Organization Regional Office for Europe; 2000.
10. Environmental Protection. The Air Quality Standards Regulations 2010. http://www.legislation.gov.uk/uksi/2010/1001/made/data.pdf. Updated 2010.
11. Bay Area Air Quality Management District. *California Environmental Quality Act*. *Air Quality Guidelines*. San Francisco: Bay Area Air Quality Management District; 2012.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use

12. Gehring U, Wijga AH, Brauer M, et al. Traffic-related air pollution and the development of asthma and allergies during the first 8 years of life. *Am J Respir Crit Care Med*. 2010;181(6):596–603.
13. Gasana J, Dillikar D, Mendy A, Forno E, Ramos Vieira ER. Motor vehicle air pollution and asthma in children: A meta-analysis. *Environ Res*. 2012; 117:36–45.
14. Raaschou-Nielsen O, Andersen ZJ, Hvidberg M, et al. Lung cancer incidence and long-term exposure to air pollution from traffic. *Environ Health Perspect*. 2011;119(6):860–5.
15. Clapp RW, Jacobs MM, Loechler EL. Environmental and occupational causes of cancer: new evidence 2005–7. *Rev Environ Health*. 23(1): 1–37.
16. Mateen FJ, Brook RD. Air pollution as an emerging global risk factor for stroke. *JAMA*. 305(12):1240–1.
17. Andersen ZJ, Kristiansen LC, Andersen KK, et al. Stroke and long-term exposure to outdoor air pollution from nitrogen dioxide: a cohort study. *Stroke*. 2012:43(2):320–5.
18. Anderson HR, Ponce ADL, Bland JM, Bower JS, Strachan DP. Air pollution and daily mortality in London: 1987–92. *BMJ*. 1996;312(7032):665–9.
19. Devra DL. *When Smoke Ran Like Water: Tales of Environmental Deception and the Battle Against Pollution.* New York: Basic Books; 2002.
20. Al-Mayahi IK. *An Environmental Analysis on the Factors Affecting the Air Pollutants Quality at Basra Province [dissertation]*. Basra: College of Education, University of Basra; 2005.
21. Al-Saad HT, Al-Imarah FJM, Hassan WF, Jasim AH, Hassan IF. Determination of some trace elements in the fallen dust on Basra. *Basrah Journal of Science*. 2010;28(2):243–52.
22. Garabedain SAK. Levels of some trace metals in falling dust of Basra. *Mesopotamian Journal of Marine Science*. 2008;23(2):279–86.
23. Al-Hassen SI. *Environmental Pollution in Basra City [dissertation]*. Basra: College of Arts, University of Basra; 2011.
24. Braak TCJF. *CANOCO-a FORTRAN Program for Canonical Community Ordination*. Microcomputer Power, Itaca, New York, USA; 1992.
25. Larsen JC, Larsen PB. Chemical carcinogens. In: Hester RE, Harrison RM, editors. *Air Pollution and Health*. Cambridge: RSC; 1996:44–52.

Downloaded From: https://bioone.org/journals/Air,-Soil-and-Water-Research on 11 Nov 2024
Terms of Use: https://bioone.org/terms-of-use