Al-Qadisiyah Journal of Pure Science

ISSN(Printed): 1997-2490 ISSN(Online): 2411-3514

DOI: 10.29350/jops

Al-Qadisiyah Journal of Pure Science

Determination the Air pollutants Emitted from Solid Waste Open-air Burning in Al-Diwaniyah Governorate/ Iraq

Ghadir J. Al-Jalihaawi[1], Mohammed K. Al-Kasser[2]

[1] Al-Qadisiyah University, college of science.

Email: scenv.m25.12@qu.edu.iq

[2] Al-Qadisiyah University, college of science.

Email: mohammed.al-kasser@qu.edu.iq

Received: 14/05/2026; Accepted: 17/05/2026.

Abstract

This study investigated and measurement concentrations of certain gases and air pollutants emitted from waste sites open-air burning in four areas of Al-Diwaniyah Governorate, include Al-Shamiya, Al-Daghara, Afak, and Al-Haffar, from January to March 2026. The pollutants studied included carbon dioxide (CO_2), total volatile organic compounds (TVOCs), particulate matter ($PM_{2.5}$ and PM_{10}), and formaldehyde (HCHO). The results showed high concentrations of all measured pollutants at the four study sites, most exceeding the limits permitted by international air quality standards. Afak recorded the highest overall pollution levels compared to the other areas. The highest CO_2 concentration was recorded in Al-Shamiya at 2280 (ppm), while the lowest was recorded in Al-Haffar 438 (ppm). These findings highlight the dangers of unregulated waste burning practices and their negative impacts on air quality and the health of residents living near these sites. The study recommends taking urgent measures to reduce the phenomenon of random burning of waste in Al-Diwaniyah Governorate, and adopting an integrated system for solid waste management that includes sorting, recycling and organized sanitary landfill, in addition to strengthening environmental monitoring and raising the level of community awareness of the dangers of these practices.

Keywords: Waste dump, Waste incineration, open burning, Diwaniyah, Iraq.

1. Introduction

Illegal solid waste dumps are among the most significant environmental challenges facing modern cities. [1] Rapid population growth and urbanization have led to a continuous increase in waste production, whether domestic, industrial, medical, or chemical. This increase is explained by the concept of "urban metabolism," which views the city as a living system that receives resources and transforms them into outputs, including

services, waste, and emissions. This concept is used to assess resource use efficiency and analyze energy flows within cities. [2]

In the absence of proper management, dangerous practices such as open burning and indiscriminate dumping of waste emerge, leading to the emission of pollutants such as greenhouse gases (carbon dioxide and methane), volatile organic compounds, and fine particulate matter ($PM_{2.5}$ and PM_{10}). [3] These pollutants threaten air quality and increase the risk of respiratory and cardiovascular diseases. [4, 1] Globally, waste production exceeds 2 billion tons annually, and projections indicate it will reach 3.8 billion tons by 2050. [5] Each individual generates between 0.74 and 1.42 kilograms of waste daily. [5] E-waste is expected to reach 74.7 million tons by 2030 due to accelerating consumption patterns. [6] Uncontrolled landfills are a source of heavy metals such as lead and cadmium, which leach into groundwater at levels exceeding permissible limits, posing a direct threat to public health. [1, 6]

On the other hand, effective waste management requires an integrated process that begins with production reduction, followed by reuse and recycling, and extends to include biological treatment (composting), thermal treatment, or sanitary landfilling in engineered sites designed to prevent the leakage of pollutants. [7, 8] Hazardous waste (medical and chemical) also requires specialized physical and chemical treatment systems. [9, 10] Open burning remains the most dangerous of these practices due to its production of dioxins and carbon monoxide, two substances that cause cancer and neurological disorders [11, 12, 13].

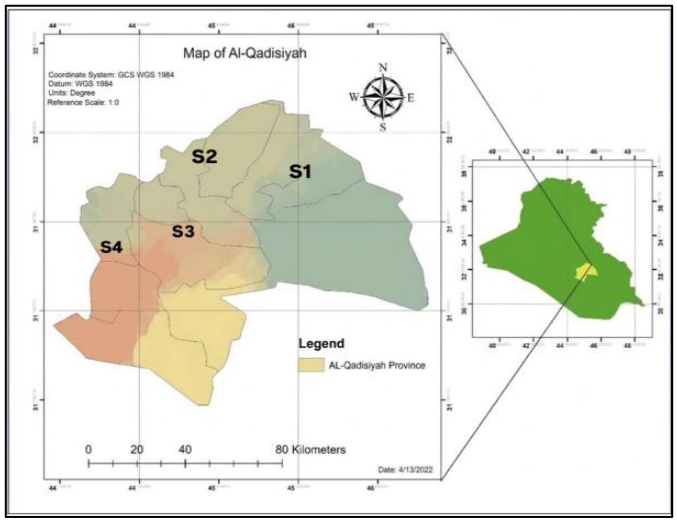
At the local level, studies in Al-Diwaniyah Governorate indicate a structural deficiency in waste management, where open burning is practiced as an alternative solution due to a lack of advanced systems [1]. This exacerbates air pollution in the arid climate [3]. The emissions (carbon dioxide and particulate matter) lead to a decline in public health, agriculture, and food security [4, 13].

This study aims to highlight the waste crisis in Al-Diwaniyah Governorate as a comprehensive environmental and health crisis, and to assess the extent of pollution resulting from illegal practices such as open burning [11]. It also aims to develop modern strategies for waste management and reducing associated emissions, ensuring the formulation of sound and applicable scientific solutions to protect human health and achieve environmental sustainability in the region [5,8].

2. Materials and methods

The Diwaniyah Governorate is located in the central part of southern Iraq, within the alluvial plain region [14], and is geographically defined between longitudes 44° and 46° east and latitudes 31° and 32° north [15]. Its location is of strategic importance as a link between the governorates of Babylon, Najaf, Wasit, and Muthanna [16]. Climatically, the region lies within the desert zone, characterized by very hot summers, with temperatures reaching and sometimes exceeding 45°C [17], and mild, dry winters with low annual rainfall [18]. Agricultural activities in the governorate depend primarily on the Euphrates River as a vital source of irrigation [19].

Some areas of the governorate suffer from environmental problems due to unregulated waste dumps where open burning occurs. This leads to the emission of polluting gases that affect air quality and public health, particularly respiratory illnesses, in addition to soil and water pollution. For the purpose of this study, field



measurements were conducted using an air quality monitoring device (Air Quality Monitor, Model: DM125) at several locations (Afak, Daghara, Al-Haffar, and Al-Shamiya) to determine pollution levels and compare the impact of open burning in these areas.

Figur 1: Map of Diwaniyah showin the study locations.

Figure 2: Open burning in the Daghara area

Figure 3: Open burning in the Shamiya area

Figure 4: Open burning in the Afak area

Figure 5: Random dump in the Al-Hafar area

3. Results and Discussion

Analysis of measurig data in Al-Diwaniyah Governorate from January to March 2026 (Table 1) reveals a clear variation in air quality among the four sites (Afak, Al-Daghara, Al-Shamiya, and Al-Haffar). This variation is directly related to burning operations and weather conditions.

In Afak, carbon dioxide (CO_2) increased from 498 to 1711 (ppm), and $PM_{2.5}$ reached 88 µg/m³, dropping to 30 µg/m³ within one kilometer away from the center of the burning. This indicates that pollution is concentrated at the burning site and dispersed by wind.

In Al-Daghara, carbon dioxide (CO_2) levels reached approximately 1277 ppm, while formaldehyde (HCHO) rose to 0.29 mg/m³, suggesting the presence of plastic and chemical materials in the burning waste [20]. Al-Shamiya recorded the highest pollution levels, with CO_2 reaching approximately 2280 ppm and total volatile organic compounds (TVOC) reaching approximately 0.990 mg/m³, reflecting the intensity of burning and the influence of wind on pollutant concentration [21].

Conversely, the well site (a monitoring location away from burning sources) was the least polluted due to the absence of burning activities, with values remaining low and stable; fine particulate matter ($PM_{2.5}$) did not exceed 28 µg/m³, while TVOC and HCHO remained at very low levels (0.030 and 0.013 mg/m³, respectively) [22].

Overall, the results confirm that open burning is the primary factor in the deterioration of air quality in Afak, Al-Shamiya, and Al-Daghara, while the well site reflects better environmental conditions. Wind also plays a crucial role in transporting pollutants over distances of up to one kilometer, as indicated in Table 1 [23, 24].

4. Conclusions and Recommendations

Based on the study's findings and a comparison with World Health Organization (WHO) standards, clear violations of air pollutant concentrations were found at unregulated landfill sites in Al-Diwaniyah Governorate, posing a direct environmental and health risk to the population [25, 26]. The results confirmed

that open burning is the primary source of these pollutants and the main factor in the deterioration of air quality [27, 25].

The study recommends an immediate halt to open burning through strict legal measures, the implementation of a continuous environmental monitoring system, the establishment of buffer zones of at least two kilometers between landfill sites and residential areas, and a 12-month air quality monitoring program using fixed and mobile stations [26].

It also calls for the adoption of a sustainable waste management system that includes the establishment of sanitary landfills, leachate treatment, biogas collection, and waste sorting at the source [28,29], along with the environmental rehabilitation of existing sites [30].

Table 1: Shows the emission concentrations in the study sites.

Landfill Site	Location Details	$PM_{2.5}$ ug/m³	PM_{10} ug/m³	CO_2 (ppm)	HCHO mg/m³	TVOC mg/m³	Temp.	Humidity
Afak	Start of Dump	41	52	498	0.007	0.304	16°C	39%
Afak	Middle of Dump	54	78	519	0.009	0.393	19°C	36%
Afak	Burning Area	88	90	1711	0.013	0.762	20°C	47%
Afak	1km Away	30	47	462	0.010	0.201	17°C	38%
Al-Daghara	Start of Dump	38	45	598	0.099	0.406	17°C	40%
Al-Daghara	Middle of Dump	26	33	870	0125	0.595	17°C	46%
Al-Daghara	Burning Area	46	61	1277	0.290	0.673	19°C	48%
Al-Daghara	1km Away	23	26	714	0.210	0.622	18°C	47%
Al-Shamiya	Start of Dump	44	53	965	0.245	0.698	19°C	33%
Al-Shamiya	Middle of Dump	46	66	2256	0.559	0.990	20°C	42%
Al-Shamiya	Burning Area	68	87	2280	0.446	0.647	21°C	46%
Al-Shamiya	1km Away	35	41	791	0.132	0.520	18°C	39%
Al-Haffar	Start of Dump	12	18	522	0.009	0.022	24°C	32%
Al-Haffar	Middle of Dump	17	21	530	0.013	0.030	23°C	30%
Al-Haffar	1km Away	14	11	438	0.008	0.015	24°C	33%

5. Reference

[1] Ferronato, N., & Torretta, V. Waste Mismanagement in Developing Countries: A Review of Global Issues. Sustainability, Vol. 11, No. 5, Art. No. 1501, (2019).

[2] Kennedy, C., Pincetl, S., & Bunje, P. The study of urban metabolism and its applications to urban planning and design. Environmental Pollution, Vol. 159, No. 8-9, pp. 1965-1977, (2011).
[3] World Health Organization (WHO). Air quality guidelines. WHO Technical Report, (2010).
[4] World Health Organization (WHO). WHO global air quality guidelines. WHO Global Report, (2021).
[5] Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Urban Development Series*, (2018).
[6] Forti, V., Balde, C. P., Kuehr, R., & Bel, G. The Global E-waste Monitor 2020: Quantities, flows and the circular economy potential. UNU/UNITAR Report, (2020).
[7] Guerrero, L. A., Maas, G., & Hogland, W. Solid waste management challenges for cities in developing countries. Waste Management, Vol. 33, No. 1, pp. 220-232, (2013).
[8] United Nations Environment Programme (UNEP). Global waste management outlook. UNEP Report, (2015).
[9] World Health Organization (WHO). Safe management of wastes from health-care activities. WHO Guidelines, 2nd Edition, (2014).
[10] European Parliament. Directive on waste and hazardous materials management. EU Official Journal, Directive 2008/98/EC, (2008).
[11] Lemieux, P. M., Lutes, C. C., & Santoianni, D. A. Emissions of dioxins from open burning of waste. Journal of the Air & Waste Management Association, Vol. 54, No. 9, pp. 1050-1059, (2004).
[12] Gullett, B. K., Touati, A., & Oudejans, L. Characterization of emissions from open waste burning. Environmental Science & Technology, Vol. 44, No. 1, pp. 1-7, (2010).
[13] Wiedinmyer, C., Yokelson, R. J., & Gullett, B. K. Global emissions from open burning of waste. Environmental Science & Technology, Vol. 48, No. 16, pp. 9523-9530, (2014).
[14] Al-Lami, A. K., & Al-Rubaie, A. M. Geomorphological Analysis of the Mesopotamian Plain: A Case Study of Central Iraq. Iraqi Journal of Science, Vol. 61, No. 4, pp. 890-902, (2020).
[15] Al-Hasani, H. J. Spatial distribution and administrative boundaries of Al-Qadisiyah Governorate using GIS. Journal of Al-Qadisiyah for Computer Science and Mathematics, Vol. 13, No. 2, pp. 45-58, (2021).
[16] Salih, S. A., & Al-Abadi, A. M. The strategic geographical location of Al-Diwaniyah city and its impact on regional development. Journal of Arts and Social Sciences, Vol. 8, No. 1, pp. 112-125, (2019).
[17] Al-Fatlawi, M. A., & Al-Hadithi, M. T. Analysis of temperature fluctuations and heatwaves in southern Iraq. Iraqi Journal of Desert Studies, Vol. 10, No. 1, pp. 22-35, (2020).
[18] Al-Sudani, Z. A. Climate classification of the middle Euphrates region based on rainfall and evaporation rates. Journal of Geography and Geology, Vol. 12, No. 3, pp. 77-89, (2020).
[19] Al-Maamori, F. H., & Al-Khuzaie, H. A. Evaluation of water quality of the Euphrates River for irrigation purposes in Al-Diwaniyah Governorate. Al-Qadisiyah Journal of Agriculture Sciences, Vol. 8, No. 2, pp. 150-165, (2018).
[20] Al-Jiburi, H. K., & Al-Idrisi, M. A. Monitoring of toxic gas emissions from open waste burning in Middle Euphrates cities. Iraqi Journal of Chemical and Petroleum Engineering, Vol. 22, No. 3, pp. 15-28, (2021).

[21] Salman, A. D., & Al-Nasrawi, A. K. Spatial analysis of air pollutants (CO2 and TVOC) in urban residential areas: A case study of Al-Diwaniyah. Al-Qadisiyah Journal for Engineering Sciences, Vol. 14, No. 1, pp. 102-115, (2021).
[22] Hassan, F. M., & Al-Obaidy, A. M. Environmental baseline study of air quality in non-industrial zones of Southern Iraq. Baghdad Science Journal, Vol. 17, No. 4, pp. 1150-1162, (2020).
[23] Al-Sultani, K. S., & Al-Musa, H. J. Impact of wind speed and direction on the dispersion of pollutants from illegal landfills. Journal of Engineering and Sustainable Development, Vol. 25, No. 2, pp. 44-59, (2021).
[24] Wiedinmyer, C., Yokelson, R. J., & Gullett, B. K. Global emissions from open burning of waste: Methodology and dispersion patterns. Environmental Science & Technology, Vol. 48, No. 16, pp. 9523–9530, (2014).
[25] Lemieux, P. M., Lutes, C. C., & Santoianni, D. A. Emissions of dioxins from open burning of waste. Journal of the Air & Waste Management Association, Vol. 54, No. 9, pp. 1050–1059, (2004).
[26] World Health Organization (WHO). WHO global air quality guidelines. WHO Global Report, (2021).
[27] Wiedinmyer, C., Yokelson, R. J., & Gullett, B. K. Global emissions from open burning of waste: Methodology and dispersion patterns. Environmental Science & Technology, Vol. 48, No. 16, pp. 9523–9530, (2014).
[28] Kaza, S., Yao, L., Bhada-Tata, P., & Van Woerden, F. What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050. World Bank Urban Development Series, (2018).
[29] Guerrero, L. A., Maas, G., & Hogland, W. Solid waste management challenges for cities in developing countries. Waste Management, Vol. 33, No. 1, pp. 220–232, (2013).
[30] Ferronato, N., & Torretta, V. Waste Mismanagement in Developing Countries: A Review of Global Issues. Sustainability, Vol. 11, No. 5, Art. No. 1501, (2019).