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Comparative Study of Falling Dust Particles Pollutant in Basrah Province during 2019-2023

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Abstract - This study aimed to compare the amount of air pollution by aerosols particulate in Basrah government during 5 years. It is known that aerosols particulate is one of the major causative of air pollution. We collected the falling dust data was collected by the Basrah Environment Directorate. The collection is done through special dust collection containers. The containers are distributed on three different sites in Basrah government including Abi Al-Khaseeb, Al-Ashar, and Basrah Environment (city center). The collection process starts from January until December for successive five years starting from 2019 till 2023, and the average concentration of falling dust in the containers is measured by (g/m2/month).

دراسة مقارنة لجسيمات الهباء الجوي الملوثة في محافظة البصرة خلال الأعوام (2019-2023)

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المستخلص - هدفت هذه الدراسة إلى مقارنة كمية تلوث الهواء بالهباء الجوي في محافظة البصرة خلال السنوات الخمس الماضية. ومن المعروف أن جزيئات الهباء هي أحد الأسباب الرئيسية لتلوث الهواء. قمنا بجمع بيانات الهباء الجوي التي تم جمعها من قبل مديرية بيئة البصرة. يتم الجمع من خلال حاويات خاصة لجمع الغبار. تتوزع الحاويات على ثلاثة مواقع مختلفة في محافظة البصرة بما في ذلك أبي الخصيب والعشار وبيئة البصرة (مركز المدينة). بدأت عملية الجمع من كانون الثاني إلى كانون الاول لمدة خمس سنوات متتالية بدءًا من عام 2019 حتى عام 2023، ويتم قياس متوسط تركيز الغبار المتساقط في الحاويات بـ (غم / م^2 / شهر).

كلمات مفتاحية: جودة الهواء، تلوث الهواء، الهباء الجوي، الغبار العالق، البصرة، والعراق.

Introduction

The environment encompasses the medium including numerous elements around humans, including both living and inanimate items, or it serves as the framework within which individuals reside and engage in diverse activities (Kadhim, 2024).

Air pollution is defined as the release of gases, fine solids, and liquids into the atmosphere A thigh rates that exceed the environment's ability to dissipate, dilute, or absorb them, and the concentrations of these substances in the air may cause many health and economic problems, as well as some aesthetic problems in the unwanted environment (Sokhi, 2008).

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Air pollution can occur naturally through gasses from volcanoes and fires, pollen, microorganisms, and dust, or industrially through fuel use and pollutants produced from automotive exhaust, as well as gases from home waste and particulates (Kadhim *et al*., 2020).

Airborne dust overall atmospheric pollution, and motor vehicle emissions are often the primary source of ultra-fine particles in the metropolitan environment. The smoke generated by these vehicles is a combination of particles and gaseous substances with various physical and chemical characteristics. Furthermore, dust is the largest contributor to ambient particulate matter, particularly in the coarse particle category (Al-Zubaidi and Naje, 2018).

Kadhim *et al*. (2020) recognized the recent advancements in science that have resulted in a substantial rise in air pollutants, including various elements and compounds. This has disrupted the natural equilibrium of the environment, causing both quantitative and qualitative alterations in atmospheric components, rendering the environment incapable of assimilating these new substances. Air pollutants consist of a mixture of solid and gaseous particles in the atmosphere, such as emissions from exhaust systems automobile, chemicals from factories, pollen and dust (Kadhim *et al*., 2020).

Hassan *et al*. (2016) referred to industry as one of the largest sources of air pollutants especially if they dependent on fossil fuels, oil and natural gas as the main source of energy. Earlier in, Al-Dabbas *et al*. (2015) mentioned that these enterprises would provide greater hazards when located within city borders or urban areas. Shihab (2021) focused his research on the suspended solids particle, which are air pollutants trapped in the air with a small volume ranging from (0.01-200) (µm), researching such particles is significant because of their extended survival periods in the atmosphere, unlike the other huge particles which will settle down more swiftly. The World Health Organization WHO guidelines state that annual average concentrations of PM 2.5 should not exceed 5 µg/m^3, while 24-hour average exposures should not exceed 15 µg/m3 more than 3-4 days per year.

The risk of air pollution on human health was estimated Rabee (2015), where he mentioned that air pollutants are in the form of solid particles whose atmosphere (air) is a catalyst for their vertical movement from the bottom to the top or vice versa, or they are horizontal with the direction of the wind and parallel to the extension of the earth's surface. Air quality tests in Iraq since 2008 have revealed dangerously high weights of fine particulate matter (Hassan *et al*., 2016).

This study aims to determine the dust pollutants of the air as suspended particles that are later deposited in the monitoring sites. Also, compared our results with that in other regions in Basrah governorate during five years ago to understand broader dust and its effect.

Materials and Methods

The study included the collection of air samples from Basrah environment affairs, where all the measurements were carried out using an instrument, which is like a container made of metal supported by iron supports that are installed on floors, buildings or sites from morning until evening. The falling dust is collected in it and calculated. Figure (1) shows the setup of this instrument.

Fieldwork:

The falling dust was collected by installing smooth-walled metal cylinders called (dust collection container) that are resistant to weather conditions and their height was twice of their diameter to avoid the effects of air follow on the dust that falls inside them and they were placed in the designated locations within the study area at a height of 1-2 (meters) to avoid the effects of

passers-by and children tampering with them. As mentioned earlier, the setups were distributed in three different places in Basrah Government. Figure (2) shows the map of Iraq map, and the areas of study.

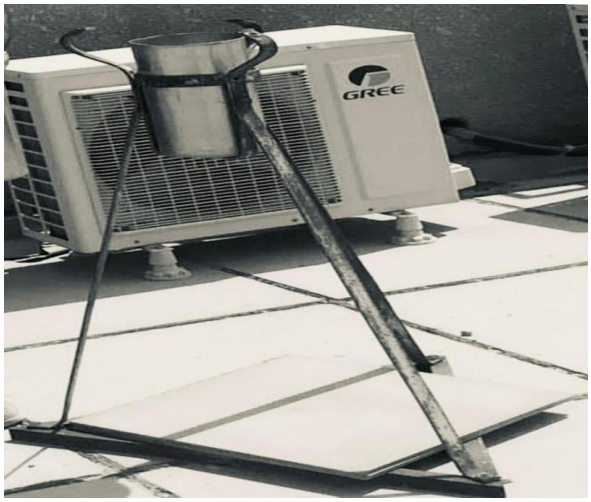

Figure 1. The setup of dust collector instrument

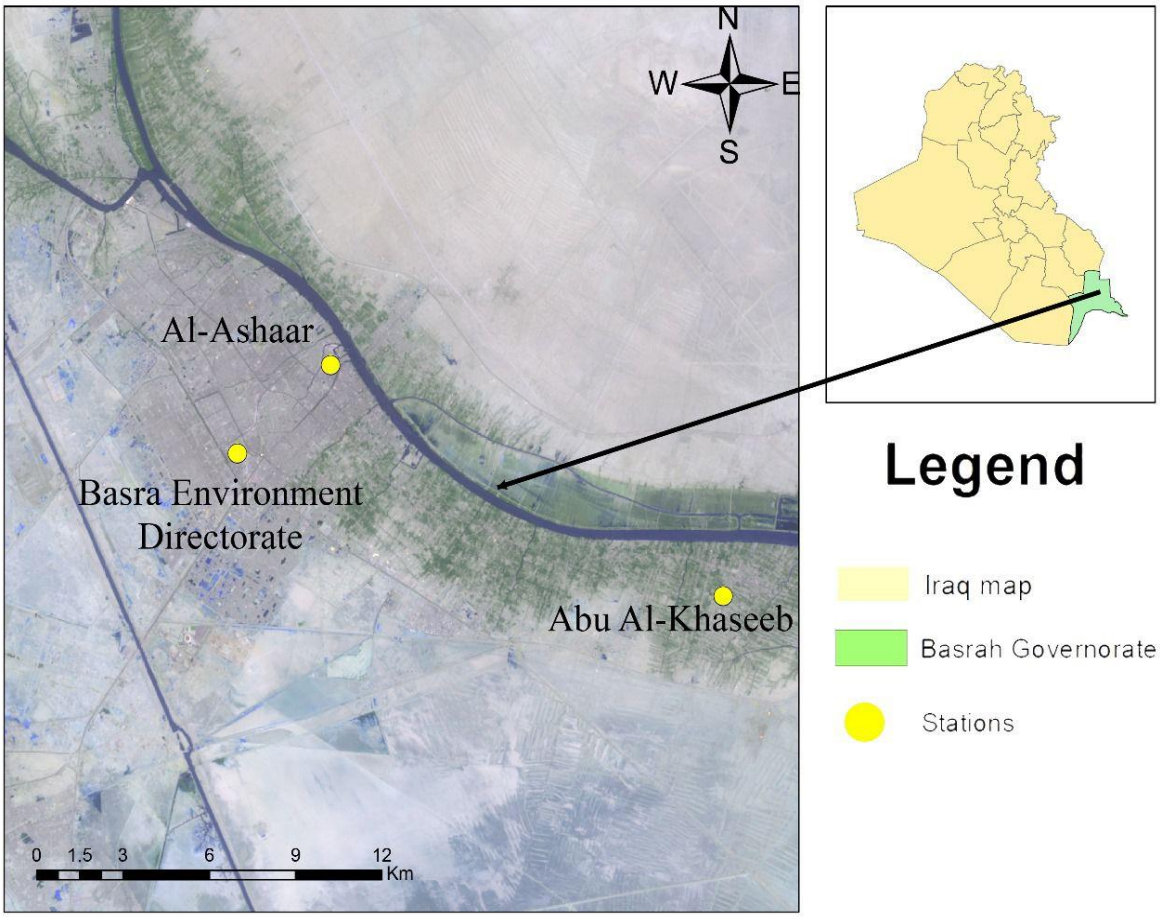

Figure 2. Map of Iraq, Basrah Governorate, and measurement locations In the study area

Laboratory Work:

The laboratory work included collecting dust cylinders from the studied locations and transporting them to the laboratory and drying them at a temperature of 50 ºC for 12 hrs. to remove moisture and then the cylinders of collecting dust were cleaned well to be weighed accurately.

To measure the amount of monthly falling dust, the following steps were adapted according to the approved method ASTM (1998), where the weight of the cylinders was recorded while they were empty before being placed in the mentioned locations (W1). In the next step, the second weight of the dust was recorded after a period of one month (W2). The net weight of the falling dust was calculated using the following equation:

$$Wn= W2-W1$$

Weight of dust inside the cylinder (g) = W2-W1

The amounts of monthly falling dust were calculated using the following equation:

Weight of monthly falling dust (g/m2/month) = Falling dust (g) / Cylinder area (m2) the area of the circle was calculated according to the equation:

$$A = \pi r^2, \text{ where } \pi = 3.14., r^2 = (0.5)^2 \text{ m}$$

Results and Discussion

The results show variation in dust concentrations from season to another and from year to another also. Figure (3) expressed the different concentrations of dust in the three selected sites in Basrah government during every month in 2019, Abi Al-Khaseeb, Al-Ashar, and Basrah directorate. In over all, Abi Al-Khaseeb showed the lowest dust concentration among the other two sites. The dust concentration in Abi Al-Khaseeb was greatly lower in comparison with Basrah directorate and Al-Ashar. In Abi Al-Khaseeb, the dust concentration in January was around 9.44 g/m^2/month, while in February it was raised to 9.52 g/m^2/month. From March to May, the dust concentrations in Abi Al-Khaseeb were about 10 g/m^2/month, this increase in dust concentrations weights in these three months, were to be due to the sand storm in spring season that are known to be loaded with large amount of dust (Hashim, 2012; Berhi and Al-Saadi, 2024). In June, the dust concentration level in Abi Al-Khaseeb was decreased to 9.41 g/m^2/month. In July it became 9.47 g/m^2/month, in August it was slightly raised to 9.64 g/m^2/month. From September to December the dust concentration weights ranged between 9.7 to 9.73 g/m^2/month, these results are in agreement with weather conditions in Basrah in this season (Al-Kasser, 2021; Mahmood and Eassa, 2020). On other hands, dust concentration level in Al-Ashar site in January was 10.71 g/m^2/month and it was increased significantly in February, March and April to reach around 11 g/m^2/month, which expressed the same reason for the dust concentration increasing in Abi Al-Khaseeb, due to the sand and dust storms in this period between winter and spring seasons (Sissakian *et al*., 2013). Although these storms were among the normal climatic phenomena in Iraq due to the location in an area with widespread deserts, this cause several health problems due to air pollution with dust (Khidher, 2024; Nageeb *et al*., 2023). Starting from May, the dust concentration level began to decrease gradually in Al-Ashar and the record was 10.89 g/m^2/month, and the decrease reached its significant values around 10.3 to 10.1 g/m^2/month in June, July, August, September and October. This decrease may be due to the stability in weather conditions in seasons between summer and autumn (van der Does *et al*.,

2021). November and December months represented the lowest values of dust concentration weights in Al-Ashar, where the weights were around 10 g/m^2/month in 2019. These records were in agreement with dust storms distribution in Basrah government (Attiya and Jones, 2020).

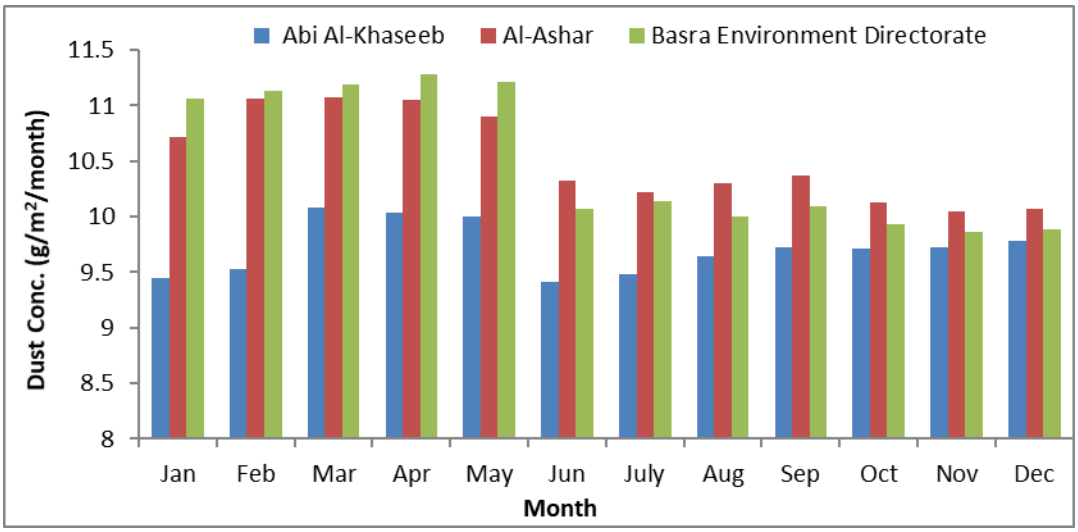

Figure 3. Concentrations of falling dust in 2019

In Basrah directorate, the dust concentration level in January was higher than both Abi Al-Khaseeb and Al-Ashr, which was around 11 g/m^2/month. It increased gradually in months from February to May where the dust concentration weights ranged from 11.1 to 11.27 g/m^2/month.

This increase is also due to the dust storms and weather conditions in Basrah directorate in this season (Muliyah *et al*., 2020; Nageeb *et al*., 2023). Months from June to September were characterized by lower dust concentration weights in Basrah directorate that were around 10 (g/m^2/month), which indicates the stability of weather conditions from summer to early autumn as mention in many literatures (Hooper *et al*., 2019; Al-Omran *et al*., 2022). The dust concentration weights in Basrah directorate in months from October to December were almost stable and ranged from 9.93 to 9.86 (g/m^2/month) which is also a good indicator for the decrease in the air pollution with dust in the end of year in comparison with months in the beginning of 2019 (Hamidi and Roshani, 2023).

To summarize the dust concentration weights during 2019 in the three sites in Basrah Directorate, the dust concentrations in months from January till May in both sites of Abi Al-Khaseeb and Al-Ashar were higher than months from June to December. The lower dust concentration in Abi Al-Khaseeb may be due to the nature of this area; this may be one of the main reasons for the high concentration of trace elements in the falling dust particles in agreement with many of the local area studies. On other hands, the higher dust concentrations in both sites of Basrah and Al-Ashar may be because of the soil that can be from the same area or coming from other places across transported by wind or dust storms essential source of trace elements in dust (Hassan *et al*., 2016).

It was also discovered that total suspended particle concentrations distributed away from the Industrial area, which coincides with the prevailing wind direction during these months, implying that the area approximately 5 kilometers from the industrial area has the greatest influence (Al-Dabbas *et al.*, 2015). A comparison of total suspended particle averages with national and global standards reveals the average suspended particle concentration (Nageeb *et al*., 2023).

In 2020 the measurements of falling dust concentration weights in Abi Al-Khaseeb ranged from 9.79 to 9.91 g/m^2/month in January, February, March and April, which were almost the same in the this site, the dust concentration weights in May to July started to decrease slightly, where records were 9.65, 9.66 and 9.7 g/m^2/month, respectively as shown in Figure (4) which illustrates all results in 2020.

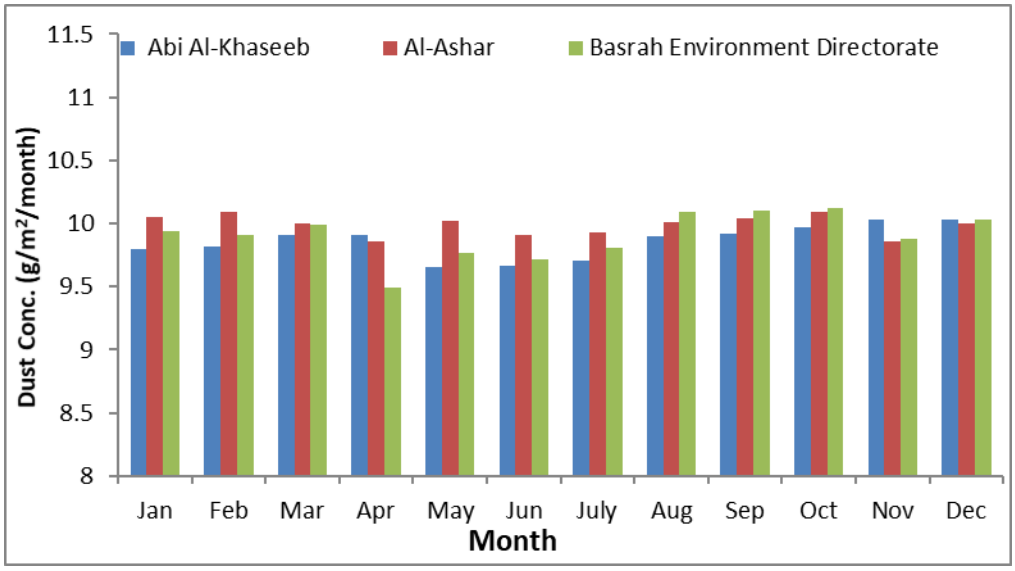

Figure 4. Concentrations of falling dust in 2020

In August to December the dust concentration weights returned to increased gradually from 9.9 g/m^2/month and reached its maximum in December where the record was around 10 g/m2/month, this fluctuating increase and decrease in dust concentration weights during months in 2020 in Abi Al-Khaseeb site may be accompanied with weather conditions from season to another in this site (Al-Omran *et al*., 2022; Ismail *et al*., 2025; Al-Jbury and Al-Kasser, 2023). In Case of Al-Ashar site, the dust concentration weights in every month during 2020 followed the same manner as in Abi Al-Khaseeb, but it increased significantly in May where it reached 10.02 g/m^2/month. It started to decrease in months from June to July where the dust concentration weights were 9.91 and 9.92 g/m^2/month, respectively. The minimum dust concentration level was recorded in November, where it was 9.85 g/m^2/month. The fluctuation in dust weights in Al-Ashar site may be due to the instability in weather conditions from season to another (Berhi and Al-Saadi, 2024; Jahandari, 2020). On the other hand, in Basrah directorate area, which followed the same normal manner like both sites of Abi Al-Khaseeb and Al-Ashar, the most lower dust concentration level was in April, where the record was 9.45 g/m^2/month in comparison with both of Abi Al-Khaseeb and Al-Ashar that recorded 9.91 and 9.85 g/m^2/month, respectively. This result may be due to the lower dust distribution in this area and the decrease in dust wind movement in this month (van der Does *et al*., 2021; Sissakian *et al*., 2013), it is also proposed the stability of weather and wind direction in this area (Hassan *et al*., 2021; Ismail *et al*., 2025). In November, the dust concentration weights were lower in Al-Ashar and Basrah directorate than Abi Al-Khaseeb , this could be due to the wind and storms in this area (Mahdi *et al*., 2020; Salman *et al*., 2024).

The dust concentration weights in 2021 are presented in Figure (5), Abi Al-Khaseeb during 2021 in months from January to June ranged from 10.09 to 10.00 g/m^2/month, while the

concentration weights of dust decreased gradually in months from July to December in the same year and the same site where the records ranged from 9.98 to 9.87 g/m^2/month. The lower dust concentration level was in October where the dust concentration level was 9.87 g/m^2/ month, this may be due to the stability of weather conditions and the decrease of dust storms in autumn season in this area (Attiya and Jones, 2020). In this year, the overall dust concentration level in Basrah directorate was higher than Abi Al-Kaseeb and Al-Ashar. But in May, the dust concentration level was slightly higher in Al-Ashar in than Abi Al-Khaseeb and Basrah, where the records were 9.93, 10.00, and 10.1 g/m^2/month, respectively, this slight increase could be neglected because it has no significant on Data (Mahmood and Eassa, 2020; Berhi and Al-Saadi, 2024; Al-Jbury and Al-Kasser, 2023), while in October, Abi Al-Khaseeb represented the lowest dust concentration area in comparison with Al-Ashar, and Basrah directorate, where they were 9.87, 9.98, and 10.00 g/m^2/month, respectively. This also represented a slight decrease in the records of dust concentrations rather than in September. This decrease may be due to weather changes in this season and the decrease in dust storms (Kadhim *et al*., 2020; Al-Kasser, 2021).

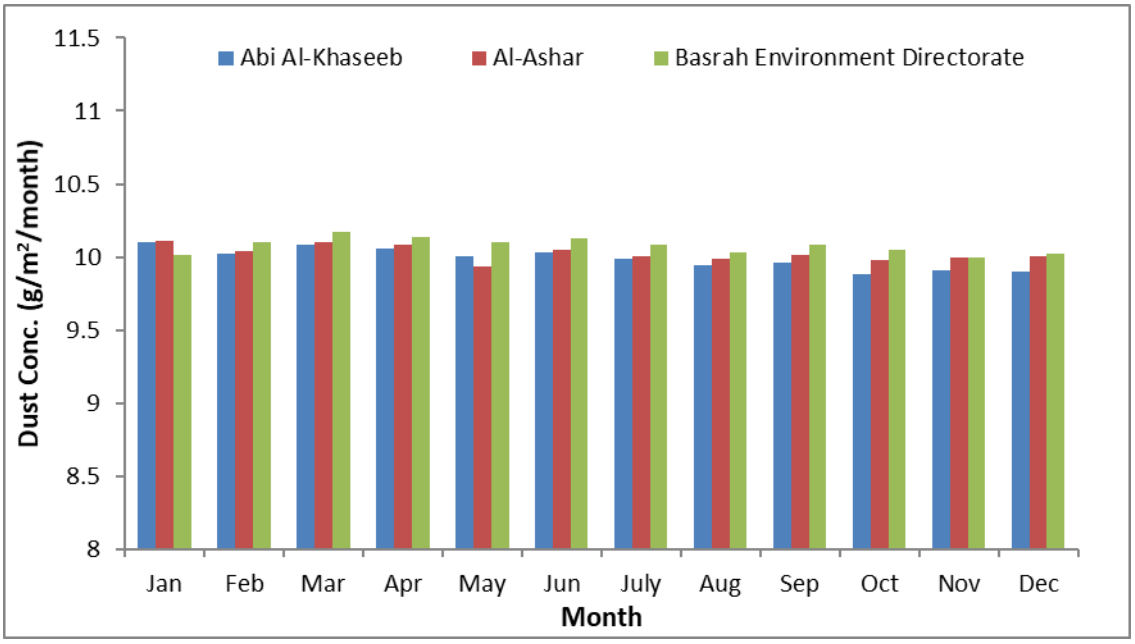

Figure 5. Concentrations of falling dust in 2021

In 2022, falling dust records are presented in Figure (6), where the dust concentration weights in Abi Al-Khaseeb increased gradually from January till April where the records started from 9.79 g/m^2/month and reached 9.91 g/m^2/month, and records decreased from May till July, where the decrease ranged from 9.65-9.7 g/m^2/month. The dust concentration weights increased again from August to December and the increase started from 9.9 and reached 10.03 g/m^2/month in November. In case of Al-Ashar site, the dust concentration weights in January and February were almost the same and they were 10.04 and 10.09 g/m^2/month, respectively. These weights decreased in March and April that were 9.99 and 9.85 g/m^2/month, respectively. The dust concentration level in Al-Ashar was raised again in May and the record was 10.02 g/m^2/month, this may be due to the dust storm characterized this season of the year in this area of Iraq (Berhi and Al-Saadi, 2024). In June and July, the dust concentration weights in Al-Ashar were around 9.9 g/m^2/month. This level increased from August to October, where the dust weights ranged

from 10.01-10.08 g/m^2/month. A significant decrease was recorded in November where the record was 9.85 g/m^2/month. This reading increased in December and the record was around 10 g/m^2/month. The fluctuation in dust concentrations in this area during 2022 is due to the seasonal storms and changes in weather conditions (Ismail *et al*., 2025; Ahbil *et al*., 2024).

In Basrah directorate, the dust concentration weights in January and February were around 9.9 g/m^2/month, while this level decreased significantly in April where the record was 9.45 g/m^2/month. The dust concentrations increased in May, June and July, where the records were 9.76, 9.71 and 9.8 g/m^2/month, respectively. In August, September and October, the dust concentration weights were 10.01, 10.03 and 10.08 g/m^2/month, respectively. These readings decreased in November to 9.85 g/m^2/month.

In December 2022, the dust concentration level in Basrah directorate was around 10.00 g/m^2/month. The increase and decrease in dust concentrations during 2022 in Basrah directorate may be due to traffic (van der Does *et al*., 2021), seasonal storms (Attiya and Jones, 2020) and weather conditions (Hamidi and Roshani, 2023). The significant increase in June in the three selected areas, where it recorded 10.37, 10.54 and 10.61 g/m^2/month in Abi Al-Khaseeb, Al-Ashar and Basrah directorate, respectively, while in September, the dust concentration weights increased in Basrah directorate, where the dust concentration level was around 11.00 g/m^2/month. This may be due to the sand storms in this period of the year (Elminir, 2005; Jahandari, 2020).

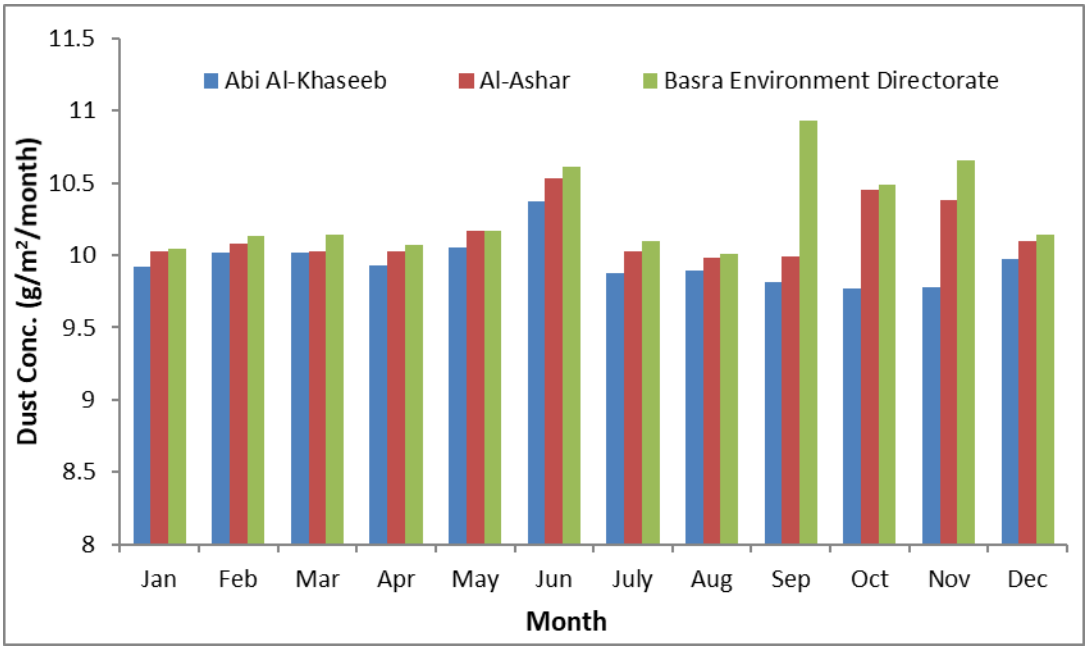

Figure 6. Concentrations of falling dust in 2022

In 2023, weights of falling dust are presented in Figure (7), where the dust concentration weights in Abi Al-Khaseeb in January, February and March were 9.8, 9.98 and 10.02 g/m^2/month, respectively. The dust concentration weights began to decrease gradually from April to June, where records were 9.38, 9.01 and 8.79 g/m^2/month, respectively.

The dust concentration weights from July to December fluctuated between 8.82 and 8.88 g/m^2/month. This fluctuation in reading could be due to the changes in weather condition and the distribution of dust storms from summer to autumn seasons (Attiya and Jones, 2020; Ismail *et al*., 2025).

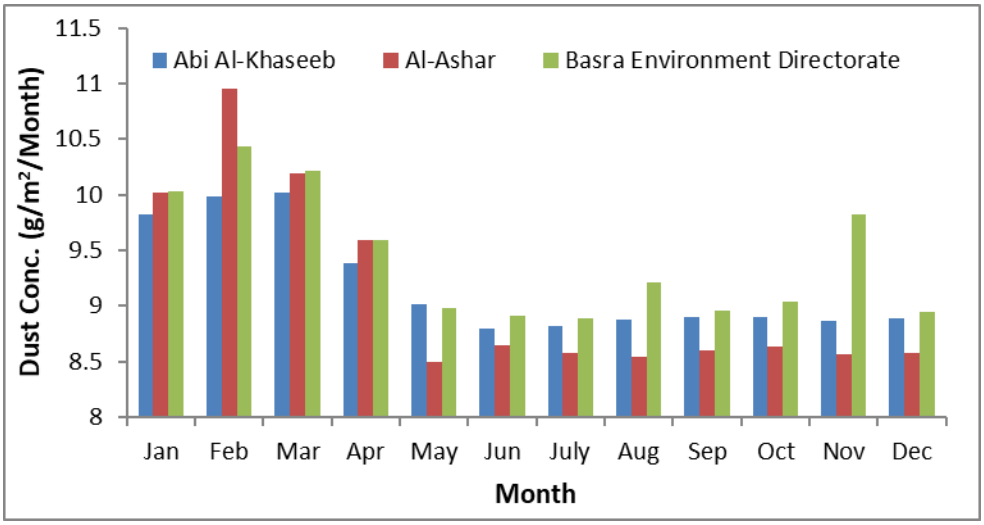

Figure 7. Concentrations of falling dust in 2023

February was slight higher in Al-Ashar than Abi Al-Khaseeb and Basrah directorate, where the records were 10.49, 9.98, and 10.43 g/m^2/month, respectively. It is worthy observed that the dust concentrations level in the three areas under study in January till April were higher than dust concentration weights in the same areas from May to November. This may be due to seasonal changes from wither to summer (Al-Zubaidi and Naje, 2018; Othman *et al*., 2022). In December, Basrah directorate dust concentration level recorded the higher value compared to dust concentrations weights in both Abi Al-Khaseeb and Al-Ashar, as the values were 9.82, 8.86 and 8.56 g/m^2/month, respectively. This may be due to the change of weather in December and the desert nature of Basrah directorate that differs than other sites in this study (Nageeb *et al*., 2023; Ismail *et al*., 2025).

In Al-Ashar site, the dust concentration weights in January, February and March were 10.01, 10.94 and 10.19 g/m^2/month. As it can be observed, the dust concentration level in February was higher than other two months in winter season. This may be due to the dust storms in this period of season. The dust concentration weights decreased to 9.59 g/m^2/month in April, and increased significantly in months from May to December, where its values ranged between 8.49 and 8.65 g/m^2/month. This decrease in dust concentration weights in Al-Ashar site may be due to reduction of air pollution sources around this site and the stability of weather conditions affecting dust storms (Al-Dabbas *et al.*, 2015; Ismail *et al*., 2025).

The dust concentration weights in Basrah directorate recorded the maximum level in winter season, where the calculated values in January, February and March were 10.03, 10.43 and 10.21 g/m^2/month, respectively. These values decreased in April to 9.59 g/m^2/month, increased gradually in months from May to July from 8.97 to 8.88 g/m^2/month. It was raised again in August to 9.21 g/m^2/month. It decreased again in September to 8.96 g/m^2/month. A slight increase in dust concentration level was observed in October where the value was 9.03 g/m^2/month, while the significant increase in dust concentration level was recorded in November and it was around 9.8 g/m^2/month. This value decreased again in December to 8.95 g/m^2/month.

We concluded, through this study on air pollutants and suspended gases in the city of Basrah, that the study area suffers from air pollution, based on the results of the field study, which showed the variation of the studied dust concentration weights that exceeded the international health determinants. The study also discovered that the quantities of various gases in the air vary

from month to month, as does the quantity of suspended dust. Furthermore, we discovered via this study of polluting dust in various locations in Basrah Governorate and knowledge of their spatial fluctuation that there is variance in the concentrations of pollutant dust in the air, with recorded values in certain areas above the acceptable limits.

The results confirm the role of vegetation in the Abu Al-Khaseeb area in reducing the levels of aerosols and falling dust. Green belts lead an important role in reducing the percentage of dust and purifying it, especially plants planted in cities and on both sides of the road, as trees retain between (40-80) of the amount of dust suspended in the air (Abdul Hamid and Abdul Majeed, 1996).

Conclusion

This research focused on studying the air pollution with dust in Basrah government in Iraq in years from 2019 to 2023. It also concluded the correlation between dust concentration weights in each site during each month in the year and the effects of weather conditions, geographical nature, and sources of dust storms on the concentrations of falling dust. It is clear that the geographical and weather greatly affect the dust pollution in the areas under study. The dust concentration weights in 2019 and 2020 were higher than 2021 and 2022, while in 2023 the dust concentration weights decreased significantly in the three sites under study. That is why cultivating trees is highly recommended to decrease air pollution and dust distribution in the urbane air.

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