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Study of the change in the direction of dust phenomena and its effects on asthma diseases in Iraq

A B S T R A C T

Climate change is currently regarded as one of the most significant challenges facing humanity, as it emerged as an inevitable consequence of the transformations that have affected the Earth's surface since the mid-twentieth century due to the Industrial Revolution and the associated changes in solar radiation levels. These changes have led to a gradual increase in temperatures that intensified over time. Such transformations have directly impacted ecosystems, causing numerous environmental changes, most notably desertification and the increasing occurrence of dust phenomena, particularly dust storms, suspended dust, and rising dust (Al-Khazaali, 2020, p. 21). These phenomena have clear impacts on human health and various human activities, as they are associated with increased incidences of respiratory diseases, especially asthma, with their effects becoming cumulative depending on the duration and frequency of exposure (Kadhim, 2019). Furthermore, the study conducted by Hameed and Al-Rikabi (2023, pp. 140–143) demonstrated a significant statistical relationship between the frequency of dust storms and the increasing number of asthma cases in Wasit Governorate, confirming the growing health impacts of dust phenomena in Iraq, particularly in regions experiencing high frequencies of dust storms and suspended dust. This highlights the necessity of investigating the spatial and temporal trends of these phenomena and their associated environmental and health impacts.

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دراسة التغير في اتجاه الظواهر الغبارية وتأثيرها على أمراض الربو في العراق

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الملخص:

يهدف البحث إلى توضيح التوزيع المكاني للعواصف الغبارية والغبار العالق والغبار المتصاعد في المحطات المناخية قيد الدراسة، فضلاً عن توزيعها الزماني من حيث المعدلات الشهرية والسنوية، للكشف عن طبيعة الاتجاه العام لهذه

الظواهر الغبارية. كما يهدف إلى بيان التغيرات الإيجابية والسلبية التي شهدتها محطات الدراسة خلال المدة (١٩٧٢–٢٠٢٢). ويعكس هذا التغير حالة التدهور التدريجي في الأغطية الأرضية والبيئية في بعض مناطق إقليم الدراسة. ومن أبرز النتائج التي توصلت إليها الدراسة أنه عند تطبيق معادلة الاتجاه الخطي للتغير، أظهرت القيم الموجبة وجود اتجاه متزايد للظواهر الغبارية بمختلف أنواعها. كما بينت نتائج البحث وجود تباين زمني في أعداد الإصابات بمرض الربو خلال مدة الدراسة، إذ سجل عاما ٢٠١٨ و٢٠١٩ أعلى أعداد للإصابات، تلاهما عاما ٢٠١٦ و٢٠١٧، في حين سجل عاما ١٩٩٥ و٢٠٠٤ أدنى أعداد الإصابات.

الكلمات المفتاحية: التغير المناخي، الظواهر الغبارية، الغبار العالق، الغبار المتصاعد، الربو.

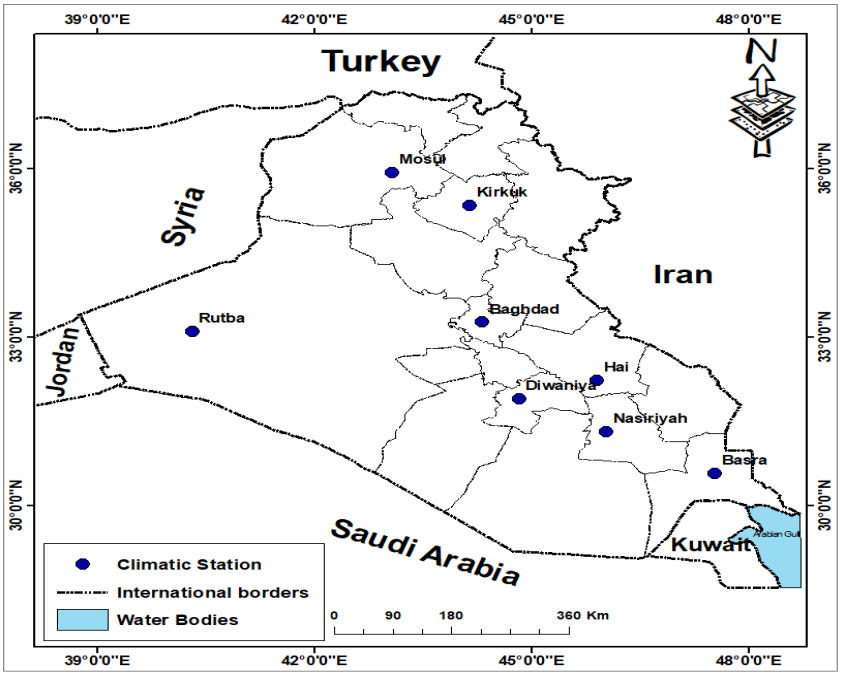
Introduction:

Research Problem:

What is the nature of the trend of shifting dust phenomena in Iraq, and what is their impact on asthma incidence?

Limits Spatial and Temporal:

Astronomically, the Republic of Iraq lies between latitudes 29°5′–37°23′ north and longitudes 38°45′–47°57′ east. This is the research area. This location affects the daily and monthly thermal parameters. Except for its southern region, which overlooks the Arabian Gulf, Iraq is a landlocked country in southwest Asia. Due to its location, it has become a battleground for the various weather systems and air masses that influence daily temperature fluctuations. Refer to Map (1). The monthly averages and annual total of dust storms (per day) at the study sites for the 1972–2022 period serve as the temporal bounds.



Map (1) Monitoring stations approved in the study
The researcher based on: 1_ Geographic Information Systems software (Arc Gis 10.7.1)

Study Methodology:

The study utilizes statistical techniques and an experimental approach to analyze theclimatic data. The study will adhere to a set of methodological steps, specifically:

1. Using monthly and annual climate data for climatic elements and phenomena from eight Iraqi meteorological monitoring stations (Table 1) for a 50-year period that spans from 1972 to 2022 to detect the trend of change.

2. Finding the overall trend of the time series of variations in wind and solar radiation in the research region, as well as whether the series is trending upward or downward.

3. Using the following statistical formula to determine the yearly change in solar radiation, wind, and energy production over the study period (Abu Zaid, 2010, p. 311).

4. Researching the impact of shifting dust phenomenon trends on asthma.

C = (bi/y) * 100, where y is the element's arithmetic mean, bi is the trend coefficient, and C is the rate of change. The rate of change during the research period is equal to the annual rate of change * the number of years.

5. Asthma was selected as a key indicator due to its high sensitivity to airborne dust particles and its strong association with environmental conditions. Baghdad was chosen because it provides the most consistent and long-term health records in Iraq, in addition to being a densely populated urban area frequently exposed to dust events. Focusing on a single city ensures data reliability and analytical consistency, while offering a representative model for understanding the environmental–health relationship in arid regions.

Research Novelty and Significance : This study provides a long-term spatiotemporal analysis of dust phenomena (dust storms, rising dust, and suspended dust) in Iraq over the period 1972–2022. The novelty lies in integrating climatic trend analysis with public health data, particularly asthma incidence, to examine the relationship between environmental changes and respiratory diseases.

Unlike previous studies that addressed dust phenomena or health impacts separately, this research combines temporal trends, spatial variability across multiple stations, and different types of dust events within a unified framework. This approach offers new insights into the dynamics of dust activity and its potential health implications.

The study is significant in supporting environmental management and public health planning by identifying patterns of dust exposure and associated health risks in arid regions such as Iraq.

Table (1) Meteorological monitoring stations included in the study

Climate Station	Latitude (degrees north)	Longitude (degrees east)	Anemometer	Altitude above sea level (m)
Mosul	**36‹32**	**43‹15**	**608**	**223**
Kirkuk	**35‹47**	**44‹40**	**624**	**331**
Baghdad	**33‹23**	**44‹23**	**650**	**31,4**
Rutba	**33‹03**	**40‹28**	**642**	**34**
Al-Hayy	**32‹17**	**46‹05**	**665**	**17**
Diwaniyah	**31‹98**	**44‹98**	**672**	**20**
Nasiriyah	**31‹08**	**46‹23**	**676**	**7.6**
Basra	**57 30**	**47 47**	**689**	**2,4**

Reference: Iraqi General Authority for Meteorology and Seismic Monitoring, Iraq Climate Atlas (1961-1990), Baghdad, p. 5

- Dust phenomena: The process of elevating dust particles above the Earth's surface, which impairs visibility, is known as a dust phenomenon. Winds do this in addition to applying pressure to the Earth's surface that is greater than the surface's gravitational pull, which causes dust to be stirred up and lifted off the surface (Abu Rahil and Ahmed, 2015). These occurrences are widespread throughout Iraq, in general, and the study area, in particular, and are typical of arid and semi-arid climates. Physical weathering activity and the predominance of dry climate conditions are the causes of this increase (Kadhim, 2024). The primary driver of dust emission and transportation, which endangers agricultural operations and turns the majority of lands into low-productivity zones, is weather (Al-Marsoumi, 2010).

First:- dust storms, which are clouds made of dust that move with the air. During a dust storm, the density of the dust grows to the point that visibility is decreased to less than 1 km. The wind speed is at least 7 m/s (Al-Lami, 2012: 6). The dust storm can carry up to 4000 tonnes of dust per cubic mile and varies in height, density, severity, and size, ranging from 1 to 500 meters (Strahler, 1974: 413). The wind's heat and dryness cause the soil to become dry, which in turn causes the surface layer to move and the soil to erode, resulting in dust storms. In particular, the African tropical (Sudanese) depression and the Indian seasonal depression influence the generation of dust storms (Ghanem, 2003: 98).

The numerical data displayed in Table 2, Figure 1, and the Map demonstrate that the climatic stations exhibit both regional and temporal variation, which is contingent upon several elements and controls that impact dust storm recordings and frequencies. The stations in Nasiriyah and Baghdad had the highest frequencies of dust storms at the spatial level, with respective days reaching 23.79 and 9.16. This is because, in addition to being encircled by desertified areas, these two stations are situated in the path of dust-laden winds. With frequencies of 7.79, 7.26, and 4.90 days, respectively, the Basra, Diwaniyah, and Rutba stations come next. On the other hand, with 3.07, 1.88, and 1.76 days of dust storms each, the Al-Hayy, Kirkuk, and Mosul stations had the lowest frequencies of dust storms. This is because these stations are far from the sources of dust phenomena in the research area, both external and local. For June, July, and May, the days progressively grow at a pace of 1.20, 1.15, and 1.11 days, respectively, on a temporal level. As a result of rising temperatures and the onset of global warming, which causes soil disintegration and a weakening of its cohesiveness, they peak in March, April, and August (0.99, 0.68, 0.68). Additionally, northwesterly and westerly breezes predominate, picking up pace when the downpour stops. On the other hand, due to decreased temperatures, precipitation, and wind speeds, dust storms become less frequent as autumn and winter approach. During the study period, the months with the lowest frequency of dust storms were November, December, and January, with respective counts of 0.16, 0.17, and 0.20 days per month.

Table (2) Monthly rates and annual total of dust storms (day) at the study stations for the period (1972-2022)

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Mosul	0.00	0.08	0.12	0.19	0.33	0.16	0.12	0.16	0.18	0.33	0.06	0.02	1.76
Kirkuk	0.04	0.14	0.16	0.27	0.29	0.18	0.11	0.07	0.09	0.42	0.07	0.05	1.88
Baghdad	0.43	0.67	0.96	1.43	1.63	1.25	1.27	0.35	0.24	0.47	0.14	0.31	9.16
Rutba	0.14	0.43	0.68	0.84	1.12	0.42	0.07	0.24	0.23	0.40	0.14	0.19	4.90
Al-Hayy	0.08	0.25	0.33	0.54	0.63	0.46	0.37	0.25	0.04	0.04	0.04	0.04	3.07
Diwaniyah	0.38	0.84	1.31	1.47	1.39	0.41	0.27	0.04	0.16	0.33	0.39	0.25	7.26
Nasiriyah	0.28	0.86	1.37	2.31	2.37	5.33	5.55	3.67	1.14	0.51	0.24	0.16	23.79
Basra	0.22	0.19	0.54	0.90	1.12	1.41	1.47	0.66	0.50	0.26	0.22	0.30	7.79
Total	0.20	0.43	0.68	0.99	1.11	1.20	1.15	0.68	0.32	0.35	0.16	0.17	7.45

Reference: Researcher based on information from the Ministry of Transport and Communications, the General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.

Al-Nasiriyah station recorded the highest annual rate during this period, amounting to (-2.45)%, with a change rate of (-129.34)% during the study period, as shown in Table 3. Kirkuk station followed, with a change rate of (-2.16)%, reaching a low of (-97.27)%. The annual changes that occurred in the study stations during this period varied, as evident from Figure 1, which shows that the trend lines all point towards a decrease in the rates of dust storms at the study stations. Next in line was the Baghdad station, which had the third-highest yearly rate at -1.38% and -70.31 70.31% for the research period. During the research period, the Basra station recorded an annual rate of (-1.05)%, equivalent to a decrease of (-53.57)%. During the research period, the Al-Rutba station recorded a change rate of -40.52 percent, with an annual change rate of -0.92 percent. Then, the Mosul station recorded an annual change rate of (-0.40)%, reaching (-20.25)% during the research period, whereas the Al-Hay station reported an annual rate of (-0.78%%), with a change rate of (-39.74)%. However, one station, Al-Nasiriyah, had a direct trend line with an annual change rate of 0.35% and a change rate of almost 17.80% for the research period.

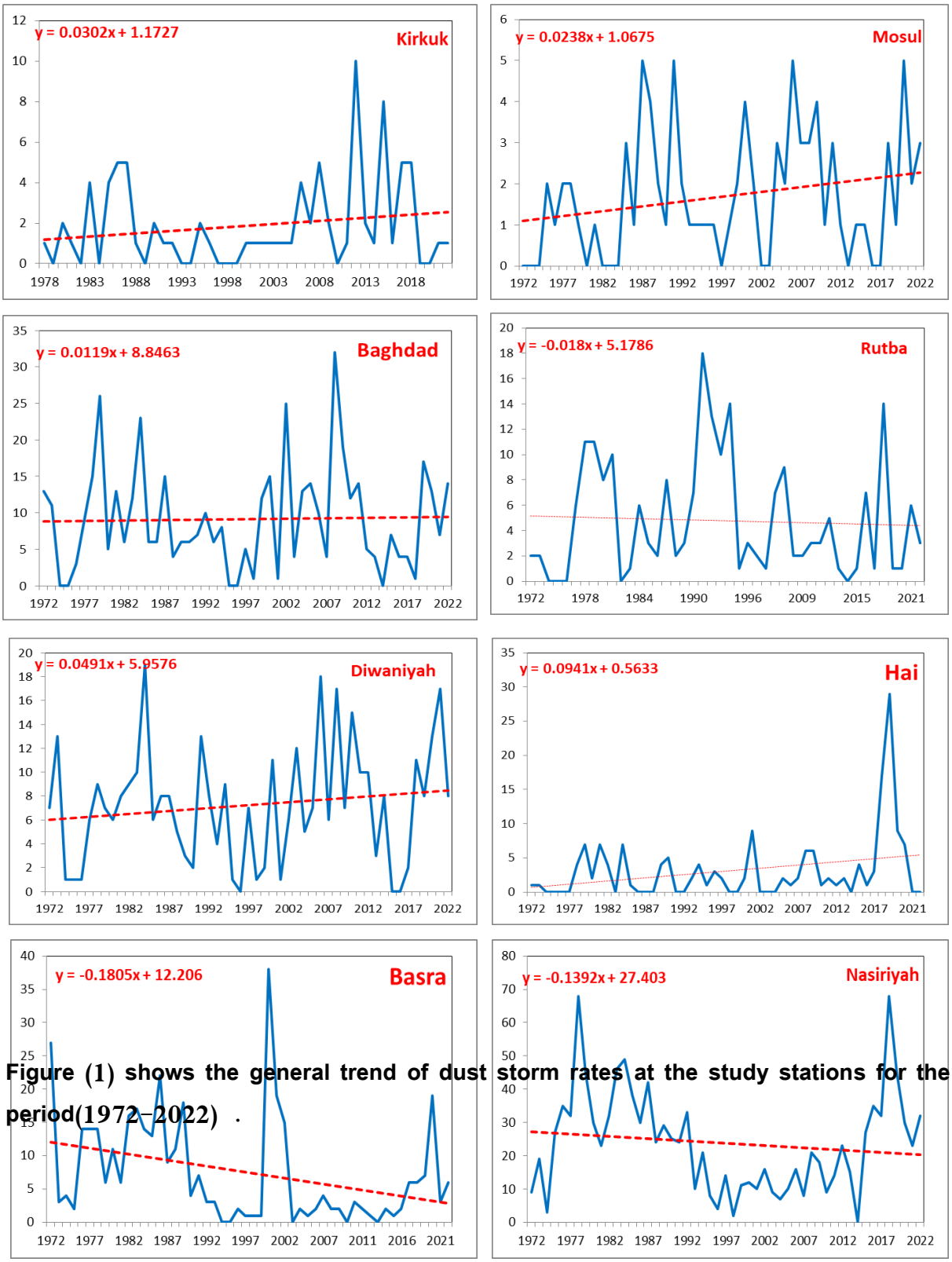


Figure (1) shows the general trend of dust storm rates at the study stations for the period(1972–2022) .

Figure (1) shows the general trend of dust storm rates at the study stations for the period (1972-2022).

Table (3): Linear relationship coefficients to determine the change in dust storm rate values (day) at the study stations for the period (1972-2022)

Station	Average annual dust storms	Number of years	Constant term (ai)	Trend coefficient (bi)	Trend (%) value	Rate of change over the study (%) period	Annual rate of change (C)
Mosul	13.98	51	15.423	-0.0555	12.5925	-20.25	-0.40
Kirkuk	15.28	45	22.886	-0.3303	8.0225	-97.27	-2.16
Baghdad	56.25	51	76.417	-0.7755	36.8665	-70.31	-1.38
Rutba	45.90	44	55.42	-0.4227	36.8212	-40.52	-0.92
Al-Hayy	82.45	51	99.157	-0.6425	66.3895	-39.74	-0.78
Diwaniyah	65.80	51	109.19	-1.6687	24.0863	-129.34	-2.54
Nasiriyah	130.62	51	118.77	0.4559	142.0209	17.80	0.35
Basra	52.57	51	66.926	-0.5522	38.7638	-53.57	-1.05

Reference: The researcher relied on:

1- Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.
2- Linear variation equation C=(bi/y)*100

B- Rising Dust: Temperature increases and abrupt shifts in pressure gradients promote atmospheric instability, which in turn produces rising dust. Dust particles are swiftly raised to the surface by air vortices created as a result. The horizontal visibility extends from 1 to 10 km, and wind speeds of 8 m/s or higher are responsible for this (Hadi, 2018: 3). If the dust particles are medium or large in size and the wind speed is between 15 and 20 km/h, they can be lifted to 15 meters. They can be raised to 1,000 meters, though, if the particles are tiny and the wind speed exceeds 50 km/h (Yassin, 2008, p. 61). The visibility of ascending dust particles varies from 1 to 4 km, and their diameters range from 1 to 10 micrometers. Notably, the duration of atmospheric instability determines how long the increased dust production will persist. This has caused the rising dust issue to return because Iraq experiences atmospheric instability regularly throughout the year (Al-Azzawi, 2015, p. 329). The research area's frequency of rising dust varies both spatially and temporally, according to the numerical data in Table 4, Figure 2, and the map (?). Several variables cause this variation. Geographically, the Nasiriyah, Al-Hayy, and Al-Diwaniyah stations see the highest frequency of rising dust, with totals of 130.71, 82.68, and 65.94 days, respectively. With respective totals of 57.08, 52.78, and 46.16 days, the Baghdad, Basra, and Rutba stations come next. For the Kirkuk and Mosul stations, the corresponding total rising dust levels were at their lowest at 15.69 and 14.64 days, respectively. The temporal variance peaks in April, May, and March, while the steady increase may start in July and June with roughly 8.72 and 8.49 days, respectively. At roughly 1.61 and 1.75 days, respectively, the winter months of December and January had the lowest frequency of dust rising in the survey locations. Wintertime brings low temperatures, high humidity, poor evaporation rates, and rainfall, all of which contribute to the decline in frequency rates during this time of year. All of this helps the soil retain its moisture content, which increases the cohesiveness of its particles and prevents them from disintegrating. In addition, the natural growth of plants during this season helps to shield the soil from erosion, which in turn lessens the process of wind erosion during this season (winter).

Table (4) Monthly rates and annual total of rising dust (day) at the study stations for the period (1972-2022)

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Mosul	0.13	0.44	0.90	1.44	3.51	2.24	1.90	1.29	1.16	1.17	0.30	0.17	14.64
Kirkuk	0.50	0.95	1.77	2.25	3.16	1.69	1.41	1.33	0.62	1.13	0.64	0.23	15.69
Baghdad	2.14	2.82	4.47	5.65	6.46	8.90	10.98	6.48	3.42	2.52	1.46	1.78	57.08
Rutba	1.93	4.00	5.48	7.20	6.48	4.14	3.43	3.07	2.80	3.45	2.05	2.14	46.16
Al-Hayy	1.76	3.88	6.14	8.06	9.24	13.10	14.49	10.69	6.96	3.96	2.94	1.48	82.68
Diwaniyah	2.28	4.48	6.20	7.69	7.04	9.33	10.25	7.75	4.16	3.00	1.86	1.90	65.94
Nasiriyah	4.00	7.27	8.82	12.29	16.51	18.00	18.61	14.51	11.88	9.39	5.00	4.41	130.71
Basra	1.24	2.57	4.25	5.06	6.61	10.54	8.69	6.12	3.75	1.82	1.41	0.73	52.78
المجموع	1.75	3.30	4.75	6.21	7.38	8.49	8.72	6.41	4.34	3.31	1.96	1.61	58.21

Reference: Researcher based on the Ministry of Transport and Communications, General Authority for Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.

The annual change that occurred in the study stations during this period differed, as it appears from Figure (2) that the trend lines mostly point towards an increase in the rates of the rise, except for the Kirkuk and Basra stations, which tended towards a decrease, as the Mosul station recorded the highest annual rate of increase during this period, amounting to (1.56)%, with a change rate during the study period of (79.35)%, followed by Rutba station with an annual rate of (1.53)% and a change rate during the study period of (67.48)%, while the Diwaniyah station follows with an annual change rate of (1.07)% and a change rate during the study period of (54.57)%, and then comes the Baghdad station with an annual change rate of (0.65)% and a change during the study period of (33.19)%, followed by Al-Hayy station with an annual change rate of (0.53) and during the study period of about (27.05), and the Nasiriyah station with an annual change rate of (0.07) and a change rate during the study period of (3.60)%. As shown in Table (5), the stations of Basra and Kirkuk are on a decreasing trend, with Basra having the highest annual change rate of (-1.27)% and a change rate during the study period of (-64.91)%, and Kirkuk with an annual change rate of (-0.81) and during the study period of (-36.62).

Figure (2) shows the general trend of rising dust rates at the study stations for the period (1972-2022).

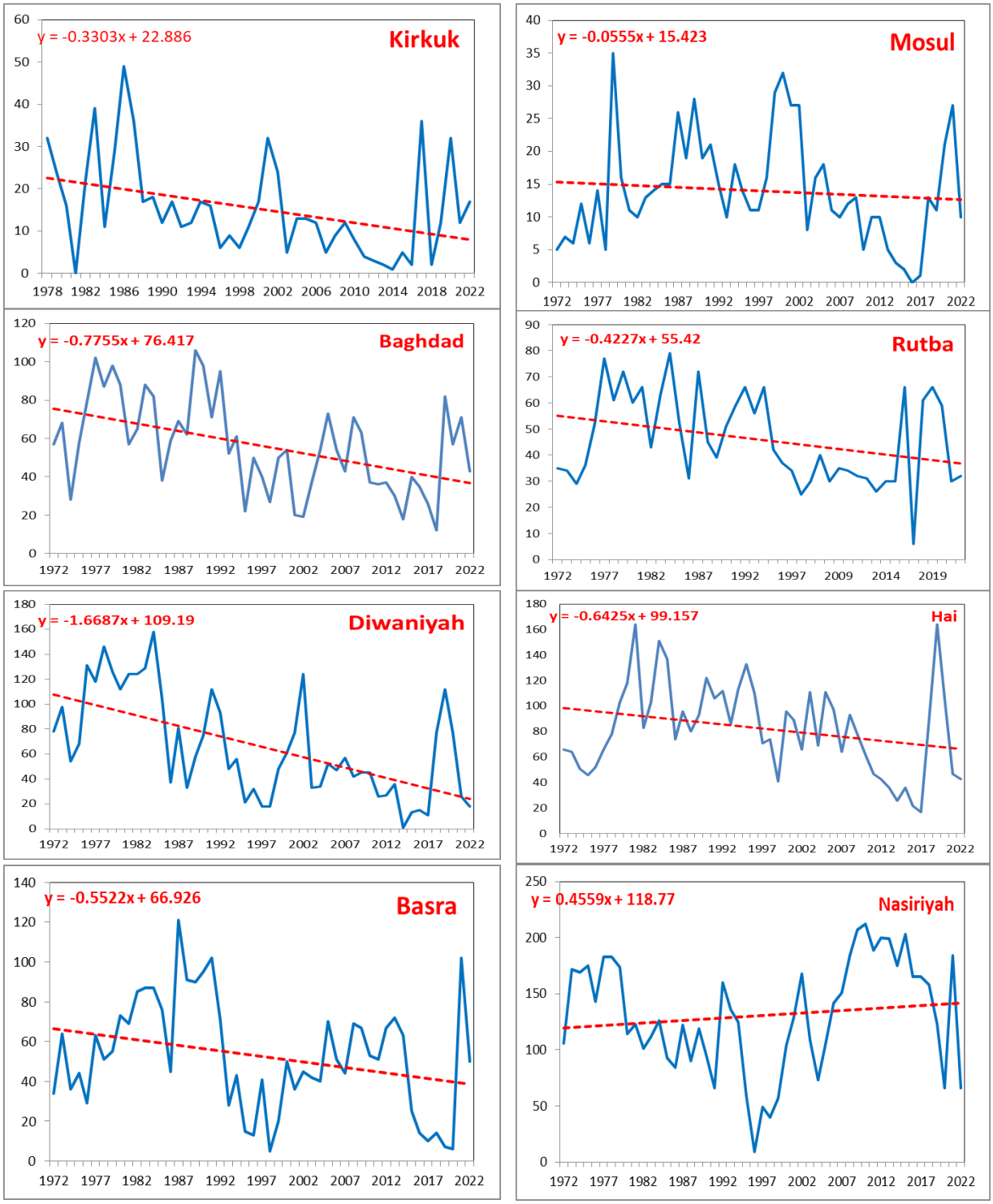


Table (5): Linear relationship coefficients to determine the change in values of rising dust rates (day) in stations

Station	Average annual dust storms	Number of years	Constant term (ai)	Trend coefficient (bi)	Trend (%) value	Rate of change over the study (%) period	Annual rate of change (C)
Mosul	99.90	51	59.488	1.5544	138.7624	79.35	1.56
Kirkuk	90.84	45	107.85	−0.7393	74.5815	−36.62	−0.81
Baghdad	155.80	51	129.44	1.0138	181.1438	33.19	0.65
Rutba	39.43	44	25.826	0.6047	52.4328	67.48	1.53
Al-Hayy	71.57	51	2.7672	0.3796	22.1268	27.05	0.53
Diwaniyah	65.23	51	47.087	0.698	82.685	54.57	1.07
Nasiriyah	128.19	51	125.84	0.0905	130.4555	3.60	0.07
Basra	51.74	51	68.865	−0.6585	35.2815	−64.91	−1.27

Reference: The researcher relied on:
1- Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.
2- Linear variation equation C=(bi/y)*100

C - Suspended Dust

The phenomenon of suspended dust typically occurs after dust storms and the subsequent rise of dust. Fine dust particles remain suspended in the air after the winds have calmed down due to their small size (less than 1 micron). These particles stay suspended until the force of gravity overcomes the still winds, and the dust reaches its final stage, which is sedimentation (Al-Dulaimi, 1989, p. 13). The amount of suspended dust particles per cubic meter ranges between 7460 and 5600 microns/gram (Zankena, 2012, p. 13) and is referred to as aerosols. Its natural origins are no different from dust storms, including the particles resulting from photochemical reactions that remain suspended due to their small size, and the particles eroded by winds and loose, dry soil (Al-Saffar, 2006: 15). Visibility during suspended dust ranges between 1-15 km, and in rare cases, visibility may drop to less than 1000 m (Al-Lami, 2012: 6). Regarding the relationship between the diameter of particles and the height in the atmosphere, there is an inverse relationship between the height of particles and the diameter of dust particles, as the smaller the diameter of a dust particle, the higher its height due to its lightness, and vice versa (Hussein, 2009, p. 13).

December and January) by roughly 2.71 and 2.63 days, respectively. This is because these months experience rainfall in the study stations and have low evaporation values due to the reduced solar radiation arriving. This lowers the temperatures that control the amounts of evaporation and soil moisture. In contrast, the hot summer months had the highest number of suspended dust days, with 12.05, 11.92, and 11.59 days recorded for June, July, and August, respectively. A combination of natural and human factors controls this temporal variation throughout the year, causing the severity of the repeated dust to increase or decrease in one

station more than another. In terms of the spatial variation of the repeated dust, the Baghdad and Nasiriyah stations recorded the highest number of repetitions, with a total of 155.80 and 128.28 days, respectively, followed by the stations of Mosul, Kirkuk, Al-Hayy, and Al-Diwaniyah, with approximately 102.78, 92.73, 71.74, and 65.37 days, respectively, and the lowest were recorded at 53.45 and 39.33 days for each of the Basra and Rutba stations, respectively.

Table (6) Monthly rates and annual total suspended dust (day) at the study stations for the period (1972-2022)

Station	January	February	March	April	May	June	July	August	September	October	November	December	Total
Mosul	1.73	3.06	4.52	7.00	11.32	14.54	16.60	15.18	10.40	9.55	5.48	3.40	102.78
Kirkuk	2.82	2.72	6.80	9.64	13.95	13.44	13.20	9.07	6.82	8.18	3.80	2.30	92.73
Baghdad	0.91	2.11	3.58	5.91	6.58	3.96	2.89	2.42	3.72	4.78	1.32	1.16	39.33
Rutba	6.47	7.61	10.86	14.39	17.94	18.61	19.14	17.45	14.51	14.04	7.63	7.16	155.80
Al-Hayy	1.14	4.48	6.12	8.02	11.39	9.90	9.45	7.43	6.31	5.29	1.02	1.18	71.74
Diwaniyah	2.56	4.46	6.12	8.24	9.90	8.31	7.10	5.47	4.59	4.18	2.39	2.06	65.37
Nasiriyah	4.16	6.92	9.00	11.96	15.61	17.80	18.12	14.39	12.24	9.75	4.69	3.65	128.28
Basra	1.24	2.80	4.49	4.98	6.04	9.82	8.88	6.61	4.10	1.92	1.78	0.80	53.45
Total	2.63	4.27	6.44	8.77	11.59	12.05	11.92	9.75	7.84	7.21	3.51	2.71	88.69

Reference: Researcher based on the Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.

Figure 3 indicates that, except for the Kirkuk and Nasiriyah stations, which exhibited a discernible increase, all rates of diffuse solar radiation tend to decline over time. According to Table 7, the Mosul station had the highest rate of change in suspended dust rates among the stations' change rates. Its annual change rate was -3.97%, and its study period change rate was -202.47%. As the annual change rate for the results of changing stations' trends reached (-2.54, -1.19, -0.92, -0.78)% for the Diwaniyah, Baghdad, Rutba, and Al-Hayy stations, respectively, the study stations recorded negative change rates. That means that during the study period, the change rates in the rates of suspended dust were in ascending rates of (-129.34, -60.61, -40.52, -39.74)% for the same stations, respectively. The rates of suspended dust at the Kirkuk and Nasiriyah stations showed a positive trend, with annual change rates of 2.16% and 0.35%, and change rates of 97.27% and 17.80%, respectively, during the study period.

Figure (3) shows the general trend of suspended dust rates at the study stations for the period .(1972-2022)

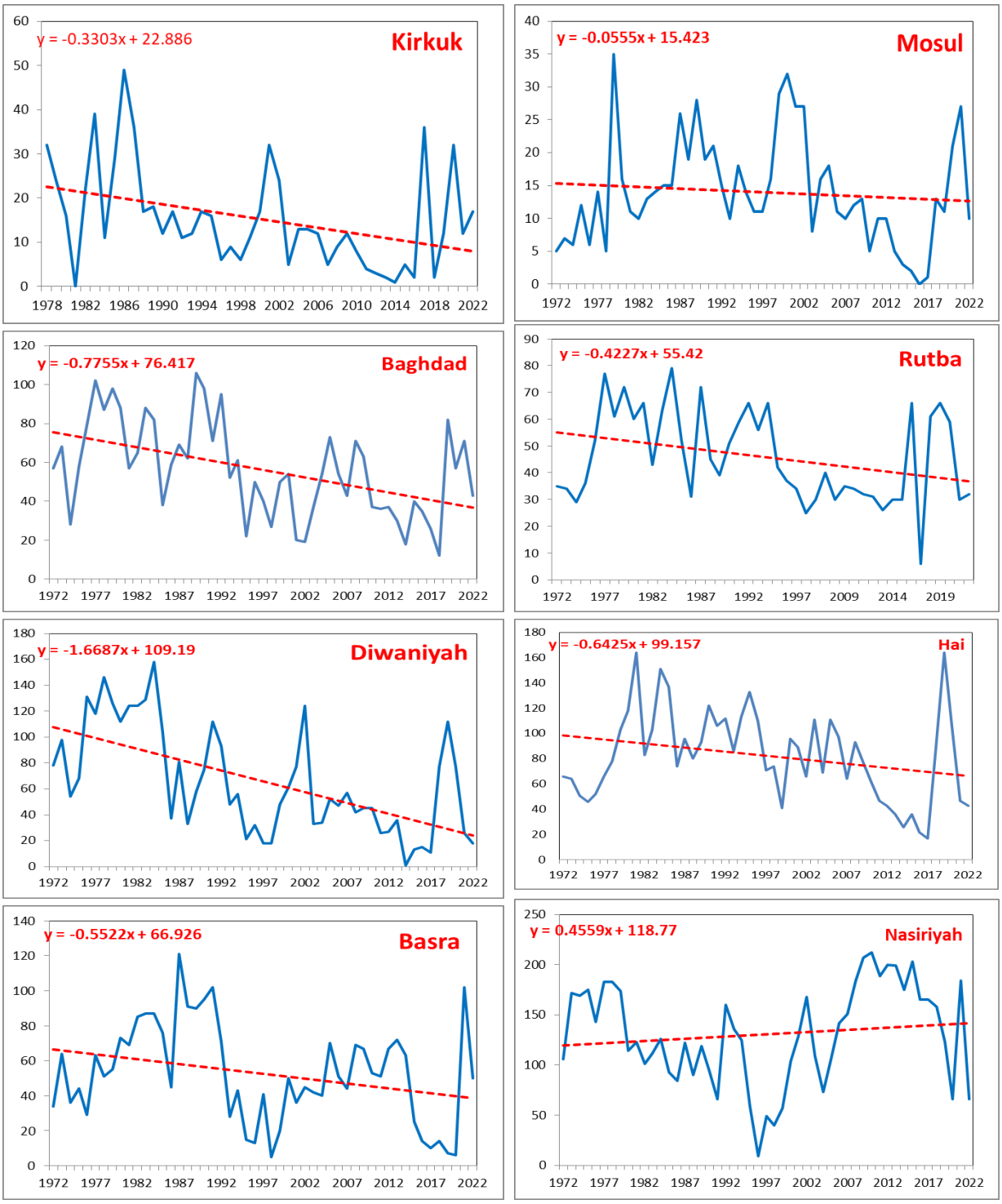


Table (7): Linear relationship coefficients to determine the change in suspended dust rates (day) at the study stations for the period .(1972-2022)

Station	Average annual dust storms	Number of years	Constant term (ai)	Trend coefficient (bi)	Trend value (%)	Rate of change over the study (%) period	Annual rate of change (C)
Mosul	13.98	51	15.423	-0.555	-12.882	-202.47	-3.97
Kirkuk	15.28	45	22.886	0.3303	37.7495	97.27	2.16
Baghdad	65.25	51	76.417	-0.7755	36.8665	-60.61	-1.19
Rutba	45.90	44	55.42	-0.4227	36.8212	-40.52	-0.92
Al-Hayy	82.45	51	99.157	-0.6425	66.3895	-39.74	-0.78
Diwaniyah	65.80	51	109.19	-1.6687	24.0863	-129.34	-2.54
Nasiriyah	130.62	51	118.77	0.4559	142.0209	17.80	0.35
Basra	52.56	51	66.926	-0.5522	38.7638	-53.58	-1.05

Reference: The researcher relied on:

1. Ministry of Transport and Communications, General Authority of Meteorology and Seismic Monitoring, Climate Department, unpublished data, Baghdad, 2023.
2. Linear variation equation C=(bi/y)*100

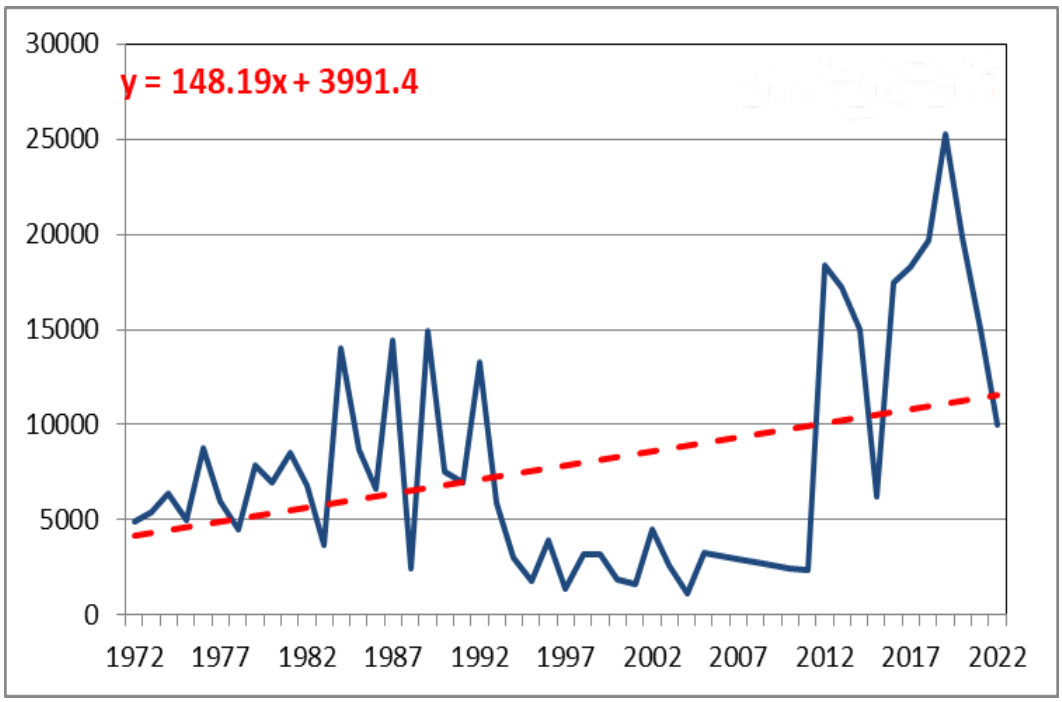
The impact of frequent dust storms on asthma incidence:

According to medical research and statistics, the majority of asthma cases occur among individuals living in areas with a high frequency of dusty days. As a result of increased health awareness and the availability of numerous treatment options, developed nations have made significant strides in combating many of these diseases, which could eventually lead to their eradication. According to the numerical data that shows the total annual number of asthma cases, the study stations had the highest number of cases (25,284, 19,714, and 18,396 cases) in 2019 and 2018, followed by 2017 and 2016 with roughly 18,252, 17,485, and 17,218 cases, and 1995 and 2004 with the lowest number of cases (1,775 and 1,171 cases). The total number of asthma cases in Baghdad has been increasing throughout the entire time series, as shown in Table 8 and Figure 4. The Mosul station had the most significant rate of change in suspended dust rates, with an annual change rate of 1.89% and a change rate of 1,140.9 % during the study period.

Table (8): Linear relationship coefficients to determine the change in asthma incidence values in Baghdad for the period (1972-2022)

Station	Average incidence of asthma	Number of years	Constant term (ai)	Trend coefficient (bi)	Trend (%) value	Rate of change over the study (%) period	Annual rate of change (C)
Baghdad	7844	51	3991.4	148.19	11400.9	94.46	1.89

Figure (4) The general trend of asthma cases in Baghdad for the period (1972-2022).



Conclusions:

1. Nasiriyah and Baghdad stations recorded the highest frequency of dust storms, with 23.79 and 9.16 days, respectively. This is due to the location of these stations in the path of dust-laden winds, in addition to their surrounding decertified lands.

2. The trend lines all indicate a decrease in dust storm rates at the study stations. Nasiriyah station recorded the highest annual rate during this period, at -2.45%, with a change rate of -129.34% during the study period.

3. The lowest frequency of rising dust was recorded at the study stations during the winter months of December and January, at approximately 1.61 and 1.75 days, respectively. This decrease in frequency rates during the winter is due to the season's characteristics, which include rainfall, low temperatures, low evaporation rates, and high humidity levels.

4. The trend lines mostly indicate an increase in the rising rates, except for the Kirkuk and Basra stations, which tended to decrease. Mosul station recorded the highest annual increasing rate during this period, amounting to (1.56) %, with a change rate of (79.35) % during the study period.

5. The months with the least frequency of suspended dust are the winter months (December and January), with approximately 2.71 and 2.63 days, respectively. This is because these months witness rainfall at the study stations and low evaporation values due to the low solar radiation, which leads to a decrease in the temperatures that control evaporation rates and soil moisture.

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