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Dust Fallout Characteristics within Baghdad City during 2013

Azhar M. Haleem, Abdul Hameed M.J. Al Obaidy, Rana M. Badri
Environmental Research Center, University of Technology, Baghdad, Iraq
amhjanabi@yahoo.com, jawaddhy@yahoo.co.in, ranam5_2@yahoo.com

Abstract:

The frequency and severity of dust storms have been significantly increased especially in the last decade as a result of regional and local reasons like climate changes and mismanagement of water resources. Within this framework, this study was conducted to analysis the dust fallout characteristics within Baghdad city during February to July 2013. The results of particle size analyses indicate the texture most of samples are ranging from clayey (Mean=14.1%) and silt (Mean=74.35%) with less quantities of sand (Mean=11.99%). Abo-Graib region recorded the highest level of heavy metals concentration among other studied region (Mean=9.9 mg/kg), while Adamiyah gave less concentration (Mean=1.62 mg/kg). The results of dost loading refer to that station B (Kadumyah Mean=0.82kg/m^2) recorded high dust loading from station A (Al-Sena'a street Mean=0.57 kg/m^2), it is worth mentioning that dust loading depending on speed of winds, duration of blowing and altitude of sample collection. From microbial analyses we can observed that *Aspergillus nigerr* recorded high frequency (F= 41.12%) and high occurrence percent (27.6%) at dilution 10^{-3}, from the results *Bacillus spp* the only bacteria have been isolated as spore forming bacteria.

Key words: Dust storm, Dust loading, heavy metals, Baghdad, Iraq

1. Introduction

Due to the considerable impact of dust storm on solar and thermal radiation, aerosols, climate, human health and ecosystem, numerous studies have been conducted world wide using avariety of instrument and techneques to analyses dust storms and their effects on air quality, land use, society and biodiversity [1-5].

Iraq is one of the most affected countries in the Middle East concerning the occurrences of dust storms, the frequency of the occurrence has increased significantly in the last decade and it is increasing continuously. The Ministry of Environment, in Iraq recorded 122 dust storms and 283 dusty days, and sources suggest that within the next ten years Iraq could witness 300 dusty days and dust storms per year [6]. In addition to environmental impacts of dust storms by carring thousands tons of dust for long distance causes drastically changes in topoghraphy, soil Properties and air quality, dust storms can carry many pathogens like bacteria, fungi and viruses that causes health problems and in some times lead to death [7].

The dust storm chemical microbial content varies according to precipitation, wind direction, time of day, season and atmosphere inversion conditions, all affecting survival of total cultivable fungi becouse microbes were capable of surviving long distance transport causes serious health problems [8].

For these reasons it is necessary to identify their chemical and biological composition and physical characteristics in order to understand their behavior and impact. To achieve this, we need availability of data that is as reliable and complete as possible. However, it is considered that the study of dust storms is important and vital in Iraq. The aims of this research were to study the regional dust storms that blowing over Baghdad city, the effect of climatic chnge, source of materials of regional dust storm by analysing the heavy, light, clay, minerals, trace metals, grain size analyses. and microorganisms include the fungal and spore forming bacteria.

2. Materials and Methods

The study area Baghdad city (33°14′-33°25′ N, 44°31′-44°17′ E), is located in the northern part of the alluvial plain at tropical region, associated with dry and hot summer followed by cold winter with little rain , make the study area exposed to dust storms especially in summer and automn seasons frequently. As a result of elevated tropical pressure, temprature increasing, Perpendicular of sunlight all of these, causes thin hot layer performed with 500m in hight causes soil dryness and separated of these particulates. 117 dust samples were collected to cover nine dust storm occurred during Feberuary to July 2013 (Figure 1). All samples were collected using a clean ***polyethylene container*** placed on the roofs of building. Then the samples were dried at 60 ºC for 48 hrs; dried samples were weighed using an electronic scale with 0.001g precision in order to measur the total mass quantities for each dust storm. Climate data were gathered from subscribing to Active weather services for researchers and companies. Grain size analysis was performeds by using sieve method [9]. Ca, Mg, CO3, HCO3, Cl SO4 and heavy metals (Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn) were analysis acoording Page et al. [10]. Fungi and spore forming bacteria were identified follwed the methode described by Jawetz et al. [11].

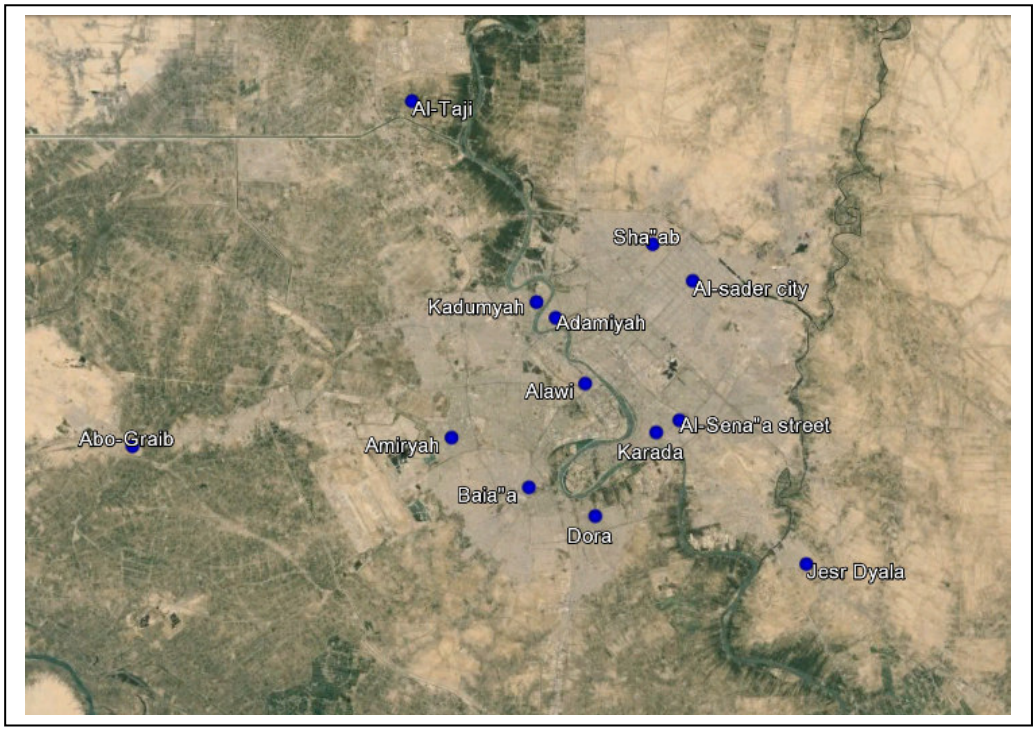

Figure 1: Sampling Locations within the study area

3. Results and discusion

3.1. Meteorological Information

Dust storm recurence and repitation associated with climate elements like temprature, wind speed and direction, rianfall, relative humidity, sunhours and evaporation. The Baghdad city located in the northern part of the alluvial plain in the semiaride tropical region, with long hot summer and little rain cold winter. From sunhours curve (Figure 2), can be observe that summer months (Jun, Jul, Aug) have most length and intensity of

sun ray becouse of perpendicularity of sun in the tropic of cancer lead to elevated of soil temprature to 35.2ºC to 10 cm in deepth, causes rocks extended and fragmented by heating accompanied by the decomposition of soil organic matter that are easily moving by winds. From the avarage mean annual temprature of thirty years (1971-2002) reflect that there is a remarkable increase of avarage mean for Baghdad from 21.9ºC to 22.9ºC for the last thirty years, causes increase in dust storm raising within Baghdad city to 277 day in avarage 10 day/year [12].

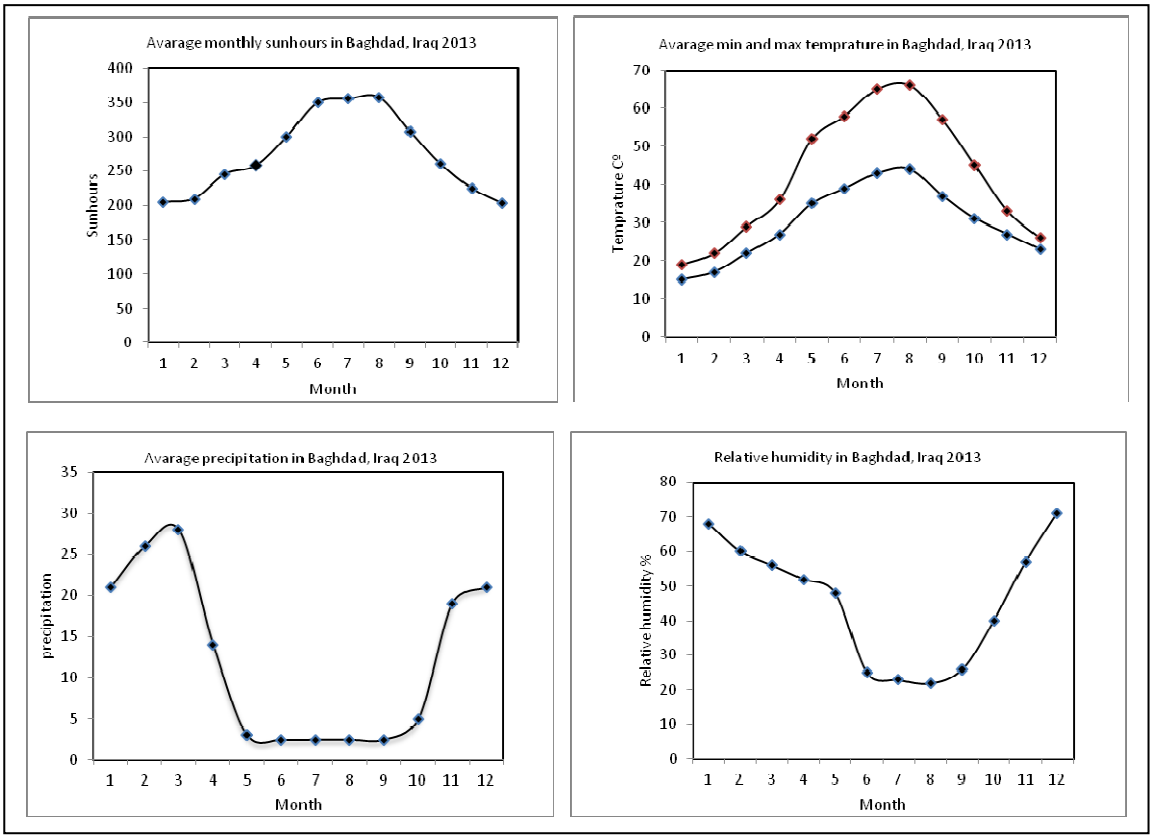

Figure 2: Climate information of study area during 2013

3.2. Partical Size of Dust Samples

The results of particle size analyses indicate that the dust samples composed mainly of silt (Min = 64.3%, Max = 84.4%, Mean = 74.35%), sand (Min = 7.66%, Max = 16.33%, Mean = 11.99%), and clay (Min = 7. 64%, Max = 20.46%, Mean = 14.1%). The most of dust texture are clay and silt with less quantities of sand, actually the causes of this content dependent on speed of winds (motivating factor) that form the dust storm by carring the particles less than 63 micron during the dry seasons. Besides volumetric analysis of dust samples shown in Table 1, some chemical analyses of dust sample was conducted, pH ranging from 6.96-7.87 neutralized to slightly alklaine this reflected the properties of sources of this dust, Dust fallout in Baghdad area is predominantly silt and clay silt and is mostly composed of light minerals, the findings of present study agreed with the results of [2,13], the occurrence of silt size particles is attributed to erosion and land degradation of local surface deposits, aeolian deposits of central and southern Iraq can be correlated with that of Tigris and Euphrates flood plain and older deposits.

Table 1: Physical and chemical properties for dust samples

Study sites	Soil texture	Content gm/kg			pH	Ca^{++}	Mg^{++}	Cl^{-}	$HCO_3^{=}$	$CO_3^{=}$	$SO_4^{=}$
		Clay	Silt	Sand							
Al-Taji	Silty	133.98	745.34	120.68	7.21	114.8	23.04	94.5	45.77	Nil	155.32
Abo- Graib	Silty	156.38	718.45	125.17	7.43	103.9	20.9	88.5	73.12	8.6	164.6
Sha'ab	Silty	125.65	788.45	85.9	7.56	110.7	21.8	91.3	25.76	Nil	145.2
Kadumyah	Silty	144.34	726.43	129.23	6.97	63.45	15.6	97.7	58.87	9.3	121.4
Adamiyah	Silty	118.23	766.24	115.53	7.32	122.9	19.22	87.2	66.89	5.2	134.7
Alawi	Silty	88.56	798.18	113.26	7.11	77.5	20.33	82.7	34.76	Nil	146.8
Al-Sader city	Silty	76.45	801.87	121.68	7.12	87.45	18.4	91.4	56.76	3.1	187.3
Amiryah	Silty	94.32	800.27	105.41	7.66	121.7	25.4	75.9	45.31	Nil	228.6
AlSena'a Street	Silty	123.94	754.23	121.83	7.44	98.34	19.65	69.5	41.34	Nil	213.4
Karada	Silty	118.16	718.45	163.39	7.15	76.7	23.06	75.4	36.16	Nil	174.6
Baia'a	Silty	126.19	787.99	85.11	7.87	58.6	24.91	78.2	52.21	4.4	223.5
Dora	Silty	204.67	643.21	152.12	7.32	74.9	18.9	52.6	54.81	6.3	212.76
Jesr Dyala	Silty	78.18	845.17	76.65	7.13	96.6	21.56	78.9	42.12	Nil	146.7

- All metals with mg/kg

3.3. Dust loading measurments:

Dust activity is a function of several parameters, such as topography, rainfall, soil moisture, surface winds, regional meteorology, boundary layer height and convective activity [14,15]. The dust loading measured at the two sites that were located close Al-Sena'a Street (Risafa station A) and Kadumyah (karkh station B) and for several dust events during the period from February to July 2013 are plotted in Figure 3. The results of the average dust loading measured at five meter heights at station A and at ten meter heights at station B reflects great variation, ranging from ~0.16 to ~1.67 Kg/m^2. The average dust loadings for all the examined days were found to be 0.57 Kg/m^2 (station A) and 0.82 Kg/m^2 (station B), which do not exhibit a statistically significant difference. In general, the highest dust loading is observed for dust events occurring in summer, but intense dust storms can also take place in winter, since Baghdad is located in an active dust source region throughout the year. The dust loading is highly correlated with the duration of the dust storms, apart from the strong linkage to the duration of dust storms, the dust loading at both stations also seems to have a dependence on the daily mean and maximum wind speeds. However, this dependence was found to be more obvious and statistically significant (at the 95% confidence level) at station B, which is located closer to the dust source, whereas for station A the correlation was not found to be statistically significant. This finding emphasizes the strong effect of the wind speed on dust erosion and transportation, as well as on dust loading, at least for areas close to dust sources. However, the results show that the main factor that controls the dust loading at both stations is the duration of the dust storms, and secondly the wind speed.

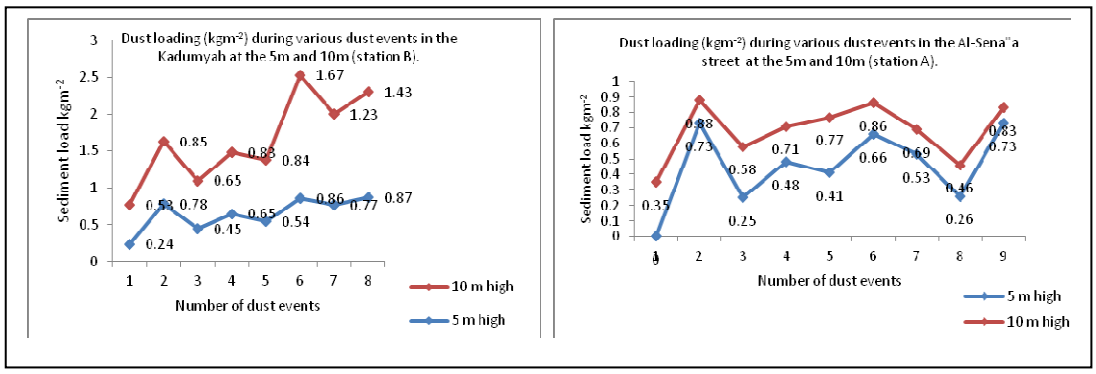

Figure 3: Dust loading (kg/m^2) during various dust events within Baghdad city at 5m and 10m high from earth surface at (station A) and (station B) for 24 hours

3.4. Heavy metal analyses

Elemental contents of airborne particulate matter can provid important information on the dgree of atmospheric pollution and further evaluation of the potential health risk to the population, several studies have shown positive correlation between different aerosol charactrestics and increased human morbidity and mortality (17,18). Two main sources of heavy metals, natural from rocks fragmented and soil erosion and man made source from industerial process, both types of heavy metals transported by winds far from their generatio area causes a potential atmospheric pollution and health risk. A total 117 dust samples collected different area of Baghdad city during 6 months were shown in Table 2. Eight heavy elements were studied they include Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn the metal analysis showed high variety in the elements concentration from site to site, in general Zn and Mn gave high concentration among other elements, these elements are known to be toxic, metals are an important and emergent class of carcinogenes. The minimum value of Cr was 0.029 in site no. (11) while the greatest value was recorded in the site no. (3) 0.895 mg/kg, Cu gave maximum value in region site no. (12) 0.921 mg/kg while the minimum was in region no.(1) 0.279 mg/kg, Cd gave low concentration in region no. (1) 0.150 mg/kg the maximum concentration in region no. (13) 0.420 mg/kg. Fe record high level in region no. (9) and (10) 2.2 mg/kg and decreasing value in region no. (12) 0.673mg/kg. Generally there is wide contrast in heavy metal distribution from site to site and the regions followed the sequence Abo-Graib>AlSena'a Street>Jesr Dyala>Baia'a>Karada>Dora>Amiryah>Kadumyah>Al-Sader city>Alawi>Al-Taji>Sha'ab>Adamiyah, from above results we can observed low concentration of heavy metals in the dust sample as acompared with metal concentrations in the soil of Baghdad city [18], it may be due to the extraction methode (only Soluble) or due to high gravity of these elements which need high energy to transfer them from site to site.

Table 2: Heavy metal concentration (mg/Kg) of Dust storm samples

Area	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn	Mean±SD
1. Al-Taji	0.150	0.886	0.279	0.714	1.601	4.852	0.312	10.915	2.46±3.5
2. Abo- Graib	0.225	0.590	0.393	0.938	21.909	6.439	0.766	48.257	9.9 ±16.05
3. Sha'ab	0.190	0.895	0.407	1.304	1.519	6.646	0.723	4.344	2.00±2.14
4. Kadumyah	0.252	0.743	0.507	1.752	3.681	7.503	0.463	27.370	5.28±8.65
5. Adamiyah	0.198	0.829	0.579	1.773	1.601	7.122	1.155	0.377	1.62±2.12
6. Alawi	0.247	0.714	0.607	0.816	1.571	1.328	0.874	24.113	3.78±7.7
7. Al-Sader city	0.243	0.571	0.793	1.101	3.292	2.153	1.350	21.910	3.92±6.85
8. Amiryah	0.269	0.067	0.621	1.773	14.491	2.503	0.982	42.954	7.95±13.95
9. AlSena'a Street	0.265	0.181	0.779	2.221	17.666	2.915	0.787	49.534	9.29±16.16
10. Karada	0.313	0.162	0.721	2.200	16.724	3.138	0.679	46.410	8.79±15.12
11. Baia'a	0.371	0.029	0.736	0.694	19.050	1.534	0.679	49.598	9.08±16.45
12. Dora	0.384	ND	0.921	0.673	18.108	1.169	1.566	46.977	8.72±15.5
13. Jesr Dyala	0.420	0.295	0.893	0.918	18.108	2.407	1.090	48.821	9.12±16.02

3.5. Microbial analyses:

From Table 3 and Figure 4, it can be seen that *Aspergillus niger* have highest frequency percentage (F%) and occurrence Percentage% among other microbes (41.12%, 72.1%) respectively, while *Mucor sp.* gave less F% (5.38%) in dilution 10^{-3} and *Fusarium sp.* gave less occurrence Percentage% (10.25) in the same dilution (10^{-3}), the present results agreed with [19,209] that are *Aspergillus, Cladosporium, Penicillium* and *Bacillus* common airborne fungi, this diversity of fungi in dust storms indicate multiple sources of pollution in sites that passes by, that may be opportunistic pathogens in immune- deficiency persons causes respiratory tract infections and may cause mortality in most cases.

Table 3: microbial analyses of dust storm samples

Microbes	Frequency percent		Occurrence Percentage%	
	10^{-3}	10^{-4}	10^{-3}	10^{-4}
Bacillus sp	6.5	6.87	17.1	-
Aspergillus niger	41.1	33.67	72.6	75
Fusarium sp.	10.3	6.41	10.25	-
Penicillium sp	23.5	31.65	21.55	-
Cryptococcus	13.2	21.34	16.45	21.3
Mucor sp	5.38	-	11.2	-

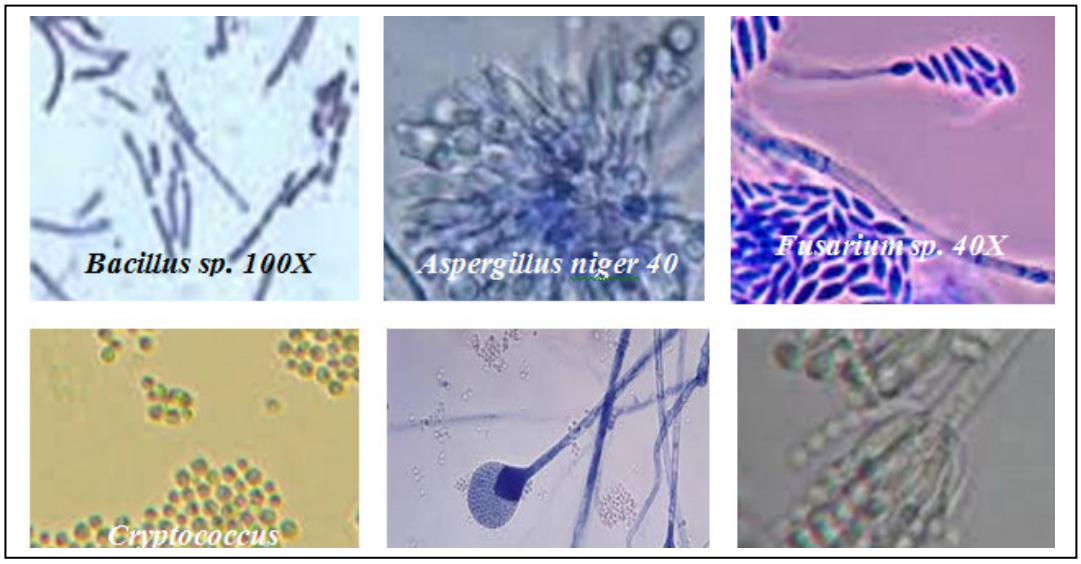

Figure 4: Some microorganisms isolated from dust samples

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