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Heavy metals characteristics of settled particles during dust storms in Basrah city- Iraq

Science

KEYWORDS : Dust particles, Geo-accumulation index, Contamination factor, Pollution Load Index, Heavy metals, Basra, Iraq.

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ABSTRACT

The collected dust storms samples were from Basrah city- south Iraq. The heavy metals with the dust storms were studied and it used as indicator for pollution by used three of main indices; geo- accumulation (I- geo), contamination factor (CF), and pollution load index (PLI).The higher concentrations of Co, Zn, Pb, and Ni in Harthah, Qarmmat Ali, Ashar, Fao, and Umm Qasir areas may be as a result to effect of urbanization and industrial processes problems that represented by emission of factory chimneys , household electric power generator, motor vehicle fuel combustion and Impacts of waste flaring associated gas from oil drilling sites. I-geo for Co, Zn, Pb, and Ni in the studied sites shows relatively values of class 1, which indicated the slightly polluted, while I-geo for Fe and Cu shows relatively values of class 0, which indicated no pollution. The contamination factor for Co, Zn, Pb, and Ni classified as class 2, which indicator to moderately contamination, while the contamination factor for Fe and Cu classified as class 1, which indicator for low contamination. PLI values in the all of studied sites classified as class 2 (Deterioration on site quality) indicating local pollution, except in Qurnah (S2 and S3) and Abu Al Khassib (S14 and S15) , that show the range of PLI values between 0.91 to 0.97 which indicate denote perfection with (class 0) and appear no pollution .

1- Study area

The study area is located in Basrah city – south Iraq, including of Qurnah, Harthah, Qarmmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas in the distance of 157Km(Figure1)..

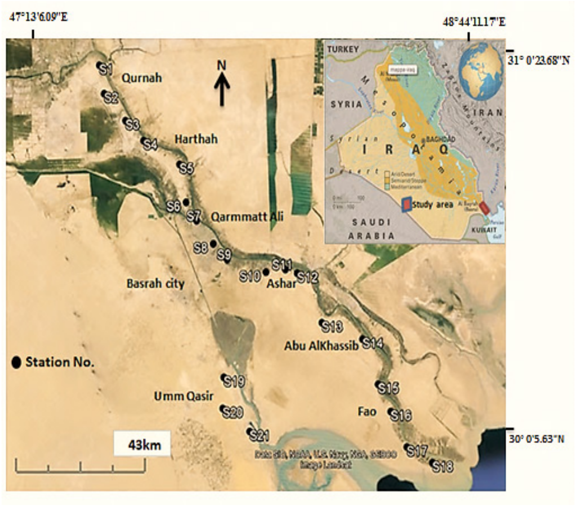


Figure 1- Map of study area

2- Introduction

Dust is known as fine irregular particles which transported as a suspended load in the air to a long distance. Wind erosion is a physical process associated with the capacity of wind to erode soil and capability of soil to sweep (Fryrear, 1990). Wind erosion, is one of the most important geological factors affecting in the sediments surface causing to separation and transportation the sediments and deposition in other places on the earth surface (Plummer et al., 2003). There are many factors that controller the rate and quantity of dust fall, such as gravity, moisture rate, relative of rainfall, speed and direction wind, and rise and decline of the sea level (Al-Khalefa, 2001). Aeolian deposits and dust storms have wide geographic distribution in Iraq and northeastern part of Arabian Gulf. Dust storms are significant phenomena in Iraq and especially in Basrah city which represent a serious natural hazard where the number of day in which dust storms occur is considerable , such phenomenon have a wind speed at least 25 mile/hour , playing an active role in transporting and deposition of material of different sizes led to change in earth surface. These storms are most prevalent in spring and summer when a prevailing north westerly wind knownlocally as the "Shamal " kicks up the fine desert sand and silt along the Tigris and Euphrates rivers basins towards south part of Iraq (Figure2). This phenomenon get on over taken interest owing to their environmental impact on economic activity and human health (Al- Marsoumi and Al-Assadi,2010 , Al-Dabbas and Al-Khafaji,2011). The regional dust storms had bad effect on health of human life which can cause asthma, bronchitis and lung diseases due to their carrying micro-organisms (such as bacteria, fungi, spores, viruses and pollen) and their sharp edge particles (Al-Dabbas and Al-Khafaji,2010).Salih(2013) showed to high probability of contamination by heavy metals due to the availability of source of pollution. Soil receives pollutants from a variety of sources, including automobile exhausted gases, emission of factory chimneys and household electric power generator, dust storm, tire friction, oil burning, and waste incineration. The Middle East and Iraq are affected by climatic change, and it indicated by the rain fall decrease in the last three decades with a remarkable increase in the frequency of regional dust storm that happened in Iraq especially the last ten years.The mean annual temperature in Basra, Iraq is fairly hot at 24.4 °C. The range/ variation of diurnal average temperatures are 13.1 °C. July is the hottest month (very, very hot) having a mean temperature of 45 °C. January is the coolest month (quite mild) having a mean temperature of 12.5°C. Total annual Precipitation averages 161 mm (6.3 inches) which is equivalent to 161 Litters/m^2 (3.95 Gallons/ft^2). On average there are 3319 hours of sunshine per year.

Many of authors have paid their attention to study dust storm phenomena via various means, for instance they utilized satellite observation to describe the large scale dust loading in Iraq, Such as study of Mohammed and Alomari (2012), illustrated the movement of dust storms from central and east parts of Iraq toward Basrah city for year 2009 by used Sun Synchronous polar orbit satellite (Aqua and Terra) (Figure 3).Al-Ali (2000) concluded that the texture of dust fall out in Basrah city is sandy clay and sandy silt. Al-Marsoumi and Al-Assadi (2010) elucidated that light minerals in the dust fall out in Basrah city were more than heavy minerals, and the concentrations of Pb, Cd, Fe, Cu, and Ni were 149, 8, 7569, 72, and 121 ppm respectively. Furthermore, Jasim and Al-Jaberi (2010) demonstrated that the texture of dust fall out in Khor Al-Zubair area was sandy silt whereas the textures of Qurna, Ashar , Abu Al-Khassib, and Fao areas were silty clay , and opaque minerals were the main of heavy metals in these storms, in addition to, the dust accumulate in Basrah city for period of May to October in 2008 was 222.7 to 411.7 gm/m^2. Moreover, Al-Dabbas and Al-Khafaji(2011) estimated that the texture of dust fall out ranged from sandy clayey silt and clayey sandy silt , whereas the quartz, feldspar, and calcite were most of light minerals, and chlorite, illite, montmorillonite, palygoreskite and kaolinite were most of clay minerals in the dust fallout. Atmosphere pollution is one of the major sources of heavy metal contamination. Elemental content of airborne particulate matter can provide important information on the degree of atmospheric pollution and further evaluation of the potential health risk to the population (Aydin et al., 2011). Several epidemiological studies have shown positive correlation between different aerosol characteristics and increased human morbidity and mortality (Curtis et al., 2006). Exposure to heavy metals in the dust storms can occur by means of ingestion, inhalation, and dermal contact. The source of heavy elements can be divided into two sources, natural and artificial. Urbanization and industrial processes development and increase extraction of oil and the subsequent burning of associated gas especially during the past five years in Basrah city , these exerts formed a heavy pressure on its urban environment. For these reasons it is necessary to know the main of heavy metals in the dust storm in order to understand their behavior and impact. The objective of this study is to elucidate the concentrations and distribution of heavy metals (Fe, Zn, Cu, Co, Pb, and Ni) and assessment of heavy metals pollution in the dust particles of Basrah city by using the geo- accumulation (I-geo), contamination factor (CF) ,and Pollution load index (PLI) as first attempt to evaluate the heavy metals pollution in the dust particles in Basrah city.

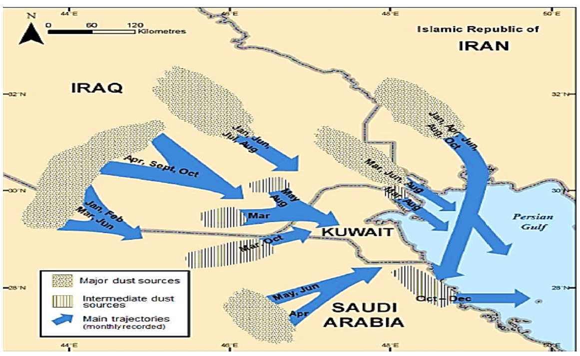
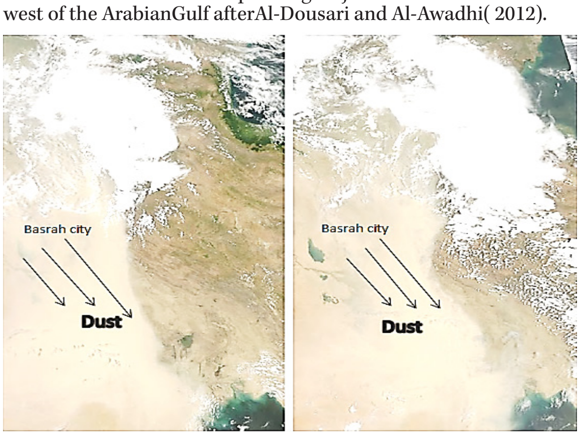


Figure 2- Approximate locations of major and intermediate sources of dust and their corresponding trajectories over areas northwest of the ArabianGulf afterAl-Dousari and Al-Awadhi(2012).



Aqua Satellite **Terra Satellite**

Figure 3- Dust storms on central and south parts of Iraq by Aqua and Terra Satellites (The clouds (white color) and dust (light brown color) after Mohammed and Alomari (2012).

3- Material method

Twenty one samples of dust particles were collected from seven sites in Basrah city as following ;Qurnah (S1, S2, and S3), Harthah (S4, S5, and S6) ,Qarmmatt Ali (S7,S8, and S9), Ashar (S10, S11, and S12) , Abu AlKhassib (S13, S14, and S15) , Fao (S16, S17, and S18), and Umm Qasir sites (S19, S20, and S21) during may in 2014. These samples collected by use the dust container. All samples were transferred to the laboratory of geochemistry in the geology department in Uppsala University and subjected to drying processes by an oven at a temperature of 60˚C, thereafter, 10 g of the sample, in powder form, to detect the Fe, Co, Zn, Cu, Ni, and Pb elements by Inductively coupled Plasma – Mass spectrometry (ICP-MS).Method of Singh et al (2002) was used with little modification.

4- Result and discussion

A-Heavy metals

Metals, a major category of globally-distributed pollutants, are natural elements that have been extracted from the earth and harnessed for human industry and products for millennia. Metals are notable for their wide environmental dispersion from such activity; their tendency to accumulate in select tissues of the human body; and their overall potential to be toxic even at relatively minor levels of exposure. Some metals, such as copper and iron, are essential to life and play irreplaceable roles in, for example, the functioning of critical enzyme systems. Other metals are xenobiotics, i.e., they haveno useful role in human physiology (and most other living organisms) and, even worse, as in the case of lead and mercury, may be toxic even at trace levels of exposure. Even those metals that are essential, however, have the potential to turn harmful at very high levels of exposure, a reflection of a very basic tenet of toxicology--"the dose makes the poison. Exposure to metals can occur through a variety of routes. Metals may be inhaled as dust or fume (tiny particulate matter, such as the lead oxide particles produced by the combustion of leaded gasoline).Metals may also be ingested involuntarily through food and drink (Howard Hu, 2002). The source of heavy elements can be divided into two sources, natural and artificial. The source of heavy metals in dust storms are mainly natural, include geologic sources such as rocks formation, soils and transported sediments by winds and dust storms, while the artificial sources include industrial sources that supply the heavy metals to the air and causing contamination of the atmosphere (Al-Dabbas and Al-Khafaji,2011). Six common heavy metals are discussed in this brief: iron, cobalt, zinc, copper, lead, and nickel in the dust particles of the studied area (Table1).Discussion of these heavymetals is as follows:

1- Lead

As a result of human activities, such as fossil fuel burning, mining, and manufacturing, lead and lead compounds can be found in all parts of our environment. This includes air, soil, and water. Environmental Protection Agency (EPA) has determined that lead is a probable human carcinogen. Lead can affect every organ and systemin the body. Long-term exposure of adults can result in decreased performance in some tests that measure functions of the nervous system; weakness in fingers,wrists, or ankles; small increases in blood pressure; and anemia.Exposure to high lead levels can severely damage the brain and kidneys and ultimately cause death.In pregnant women, high levels of exposure to leadmay cause miscarriage. High level exposure in men can damage the organs responsible for sperm production (CHSR). The human body may take the lead through air which ranges between less than (4 Mg /day) and more than (200 Mg/ day) according to area where he lives. The averages concentrations of Pb in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are 19, 31, 28, 27, 24, 26, and 27 ppm respectively (Table 1).

2- Copper

Copper – Copper toxicity is a much overlooked contributor to many health problems; including anorexia, fatigue, premenstrual syndrome, depression, anxiety, liver and kidney damage, migraine headaches, allergies, childhood hyperactivity and learning disorders (CHSR). The averages concentrations of Cu in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are19, 31, 28, 27, 24, 26, and 27ppm respectively (Table 1).

3- Iron

Iron – Ingestion accounts for most of the toxic effects of iron because iron is absorbed rapidly in the gastrointestinal tract. The corrosive nature of iron seems to further increase the absorption. Target organs are the liver, cardiovascular system, and kidneys. Elevated blood pressure; cognitive and neurobehavioral effects in children & adults. Iron exposure in utero, in infancy and childhood may result in low birth rate, anaemia, neurological impairment, IQ deficits, renal alterations, colic, growth retardation or impaired metabolism of vitamin D (CHSR). The averages concentrations of Fe in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are 0.21, 0.23, 0.21, 0.22, 0.21, 0.23, and 0.23 % respectively (Table 1) .

4- Zinc

Zinc has been reported to cause the same signs of illness as does lead, and can easily be mistakenly diagnosed as lead poisoning (McCluggage, 1991). Zinc is considered to be relatively non-toxic, especially if taken orally. However, excess amount can cause system dysfunctions that result in impairment of growth and reproduction (Nolan, 2003). The clinical signs of zinc toxicities have been reported as vomiting, diarrhea, bloody urine, icterus (yellow mucus membrane) ,liver failure, kidney failure and anemia (Fosmire, 1990). The averages concentrations of Zn in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are 110, 119, 117, 118, 111, 118, and 123 ppm respectively (Table 1).

5- Nickel

Nickel element has bad effects on human and cause bronchial carcinoma or Nasal Carcinoma due to nickel gasses. The nickel carbonate (Ni) which results from interaction with carbon monoxide producing complex which is carcinogenic to human and animals which result in respiratory system rapid damage its large doses cause many health affection like infection of other layer of skin beside it effect kidneys and causes vertigo, bronchitis,Asthma (CHSR). The averages concentrations of Ni in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are 111, 121, 116, 116, 110, 118 and 119 ppm respectively (Table 1).

6- Cobalt

Element is important for human and animals, because it enters in chemical construction of hemoglobin. If cobalt rate decreases it will affect the oxygen transport through hemoglobin but its increase rats will cause disturbances in some important organism (CHSR). The averages concentrations of Co in dust particles of Qurnah, Harthah, Qarmatt Ali, Ashar, Abu AlKhassib, Fao, and Umm Qasir areas are 18, 25, 25, 23, 16, 22 and 29 ppm respectively (Table 1).

Observed from the concentrations of heavy metals in the dust particles of studied sites (Table 1) , that significantly increase of these metals in the Harthah, Qarmatt Ali, Ashar, Fao, and Umm Qasir compare with Qurnah and Abu AlKhassib sites, this increase may be due to urbanization and industrial processes problems, represented by manufacturing ,waste flaring associated gas from oil drilling sites, and from vehicle emission.

Table 1- Concentrations of heavy metals in the dust particles

Heavy metals							
Sites	Sample No.	Fe_2O_3 %	Co ppm	Zn ppm	Cu ppm	Ni ppm	Pb ppm
Qurnah	S1	0.212	20	112	20	112	38
	S2	0.21	16	110	21	113	32
	S3	0.22	18	108	16	110	39
	Mean	0.21	18	110	19	111	36
Harthah	S4	0.23	25	121	31	120	44
	S5	0.22	28	120	30	122	45
	S6	0.24	24	118	32	121	48
	Mean	0.23	25	119	31	121	45
Qarmatt Ali	S7	0.215	23	118	28	116	40
	S8	0.22	25	117	27	114	44
	S9	0.2	27	119	29	118	42
	Mean	0.21	25	117	28	116	42
Ashar	S10	0.222	21	116	26	114	48
	S11	0.221	23	118	28	118	49
	S12	0.22	26	121	30	116	48
	Mean	0.22	23	118	27	116	48
Abu AlKhassib	S13	0.21	18	114	24	111	40
	S14	0.2	16	110	25	110	42
	S15	0.22	15	111	23	109	41
	Mean	0.21	16	111	24	110	41
Fao	S16	0.22	22	118	25	117	45
	S17	0.23	23	117	26	119	44
	S18	0.24	22	119	27	118	43
	Mean	0.23	22	118	26	118	44
Umm Qasir	S19	0.23	28	120	28	120	48
	S20	0.22	29	122	25	121	47
	S21	0.25	30	126	29	118	49
	Mean	0.23	29	123	27	119	48

B-Assessment of contamination:

There are many pollution indices that can be used to assess the level of contamination in the dust particles by heavy metals. For this purpose and to meet the objectives of this study , three indices were selected to evaluate the contamination level of Fe, Co, Zn, Cu, Ni, and Pb in the dust particles . These are Geo accumulation index (I- geo), contamination factor (CF) and Pollution Load Index (PLI) (Tables 3 and 4).

1- Geo- accumulation index (I- geo):

The index of Geo accumulation (I-geo) means the assessment of contamination by comparing the levels of heavy metal obtained to a background level originally used with bottom sediments (Muller, 1969). It was widely used by many authors (Gowdet al., 2010). Geo-accumulation index (I- geo) was determined by the following equation according to Muller (1969) which was described by Boszke et al (2004) in Rabee et al (2011).

$$I\text{- geo} = \log_2 (C_n/1.5 B_n)$$

Where:

C_n = the measured concentration of the heavy metals in the sediments and

B_n = the geochemical background concentration of the heavy metals (crustal average) (Taylor and McLennan, 1985).

Lu et al (2009) defined the constant 1.5 as a constant introduced to minimize the effect of possible variations in the background values which may be attributed to lithologic variations in the sediments. Muller (1969) designed a classification for the Geo-accumulation index. This application was considered by many researchers like Huu et al (2010).The values of this index vary from subzero to more than 5 having 7 grades (Table 2). The highest grade (6) reflects a 100-fold enrichment and (0) reflects the background concentration.

The Fe_2O_3 was found negative in all the sites, ranging from -3.65 to -3.98 (Table 3), These results are of (class 0) which indicated that the concentrations of Fe_2O_3 in the dust particles of studied sites are unpolluted and lower than the background (Table 2).

The Co was found positive in the Harthah and Umm Qasir sites, mean values between 0.006 and 0.05 respectively (Table 3) , these results are of (class 1) which indicated that the concentrations of Co in the dust particles of these sites are slightly polluted. While Co in the other sites of the study area had negative values ranging from -0.028 to -0.76. These results are of (class 0) which indicated that the concentrations of Co in dust particles of these sites are unpolluted and lower than the background (Table 2).

The Zn had positive values in the all of studied sites , ranging from 0.02 to 0.24 (table 3) , these results are of (class 1) which indicated that the concentrations of Zn in the dust particles of these sites are slightly polluted (Table 2).

The Cu was found negative in all the sites, ranging from -0.22 to -1.22 (Table 3). These results are of (class 0) which indicates that the concentrations of Cu in the dust particles of studies sites are unpolluted and lower than the background (Table 2).

The Ni was found positive in all the sites, ranging from 0.72 to 0.88 (Table 3), these results are of (class 1) which indicated that the concentrations of Ni in the dust particles of studied sites are slightly polluted (Table 2).

The Pb had positive values in the all of studied sites, ranging from 0.32 to 0.94 (Table 3); these results are of (class 1) which indicated that the concentrations of Pb in the dust particles of these sites are slightly polluted (Table 2).

Table 2: Classified grades of I- geo, CF and PLI indices, (after Thomilson et al (1980);

I-geo	CF contamination factor	PLI
≤ 0 (class 0), Practically unpolluted		<1 Perfection (class 0)
0 < to ≤ 1(class 1), slightly polluted	<1 Low contamination (class 1).	=1 Baseline level (class 1).
1< to ≤ 2 (class 2), Moderately polluted	1≤CF< 3 Moderatecontamination (class 2).	>1 Deterioration on site quality (class 2)
2< to ≤ 3 (class 3), moderately severely polluted	3≤ CF≤6 Considerable contamination (class 3).	
3< to ≤ 4 (class 4), Severely polluted	>6 Very high contamination (class 4)	
4< to ≤ 5 (class 5), Severely extremely polluted		
> 5 (class 6), Extremely polluted		

2- Contamination factor (CF):
Contamination factor (CF) was determined following equation according to Thomilson et al (1980).

The level of contamination by metals was established by applying the CF that can be calculated as follows:

CF= Cm Sample/ Cm Background, Table (2).

The contamination factor (CF) for Fe, Co, Zn, Cu, Ni, and Pb was calculated in the study areas, and the results are present in Table (3).

The contamination factor (CF) for Fe_2O_3 in all the studied sites classified as class 1 (low contamination).

The contamination factor (CF) for Co in all the studied sites classified as class 2 a moderate contamination.

Zinc (Zn) in all the studied sites classifies as class 2 representing a moderate contamination.

The contamination factor (CF)for Cu in the all of studied sites classified as class 2 representing moderate contamination , except in Qurnah site which classified as class 1 a low contamination.

The contamination factor (CF) for Ni in the all of studied sites classified as class 2 a moderate contamination.

The contamination factor (CF) for Pb in the all of studied sites classified as class 2 a moderately contamination.

3- Pollution load index (PLI):
The PLI provides a simple but comparative means for assessing a site quality. Pollution load index (PLI) was determined following equation according to Thomilson et al (1980), where (PLI) is expressed as follows:

PLI = n√CF1 x CF2 x CF3 x .....xCFn Where:
n= the number of studied metals in each site, Table (2).

The Pollution Load Index (PLI) for Fe, Co, Zn, Cu, Ni, and Pb was calculated in the study areas, and the results are present in table (3).

PLI values in the all of studied sites classified as class 2(Deterioration on site quality) indicating local pollution, except inQurnah(S2 and S3) and Abu Al Khassib (S14 and S15) , that show the range of PLI values between 0.91 to 0.97 indicates denote perfection with (class 0) and appear no pollution (Table 2).

5- Conclusion
Heavy metals concentrations in the dust storms of Basrah city were observed on May 2014. In this paper we used a procedure for the chemical analysis of element (Fe, Co, Zn, Cu, Pb, and Ni) in the dust particles. The procedure applied the measurement techniques (ICP- MS analysis) to the analysis for the individual samples. The study concluded that the high levels of Co, Zn, Ni, and Pb in the dust particles may be as a result to urbanization problems that represented by emission of factory chimneys, household electric power generator, motor vehicle fuel combustion and Impacts of waste flaring associated gas from oil drilling sites especially in-Harthah, Qarmatt Ali, Ashar, Fao, and Umm Qasir areas. Geo-accumulation index (I-geo) and contamination factor (CF) for the Co, Zn, Ni, and Pb showed the slightly to moderately contamination for these metals in the dust particles. Furthermore, the high level of pollution load index (PLI) in all the studied sites which reflected the deterioration on site quality (local pollution) except in some samples of Qurnah and Abu AlKhassib sites where PLI values were reflected denote perfection (no pollution).

Table 3- CF, I-geo and PLI index for the sediments in the study area

Site		Fe_2O_3		Co		Zn		Cu		Ni		Pb		
		CF	I-geo	CF	I-geo	CF	I-geo	CF	I-geo	CF	I-geo	CF	I-geo	PLI
Qurnah	S1	0.1	-3.89	1.76	-0.67	1.57	0.072	0.8	-0.9	2.54	0.76	2.23	0.57	1.03
	S2	0.1	-3.89	0.94	-0.35	1.54	0.046	0.84	-0.83	2.65	0.77	1.88	0.32	0.91
	S3	0.104	-3.9	1.05	-0.502	1.52	0.02	0.64	-1.22	2.5	0.73	2.29	0.61	0.92
	Mean	0.101	-3.89	1.25	-0.537	1.57	0.046	0.76	-0.98	2.56	0.75	2.13	0.47	0.95

Harthah	S4	0.109	-3.77	1.47	0.134	1.7	0.18	1.24	-0.27	2.72	0.86	2.58	0.78	1.15
	S5	0.104	-3.7	1.64	-0.028	1.69	0.172	1.2	-0.32	2.77	0.88	2.64	0.81	1.15
	S6	0.114	-3.98	1.41	-0.087	1.66	0.147	1.28	-0.22	2.75	0.87	2.82	0.91	1.17
	Mean	0.109	-3.81	1.506	0.006	1.68	0.16	1.24	-0.27	2.74	0.87	2.68	0.83	1.15
Qarmatt Ali	S7	0.714	-3.87	1.35	-0.028	1.66	0.147	1.12	-0.42	2.63	0.81	2.35	0.64	1.49
	S8	0.104	-3.97	1.47	-0.148	1.64	0.135	1.08	-0.47	2.59	0.78	2.58	0.78	1.1
	S9	0.095	-3.84	1.58	0.082	1.67	0.16	1.16	-0.37	2.68	0.83	2.47	0.71	1.11
	Mean	0.304	-3.89	1.46	-0.031	1.65	0.14	1.12	-0.42	2.63	0.8	2.46	0.71	1.23
Ashar	S10	0.105	-3.82	1.23	-0.148	1.63	0.12	1.04	-0.52	2.59	0.78	2.82	0.91	1.08
	S11	0.105	-3.84	1.35	-0.28	1.66	0.147	1.12	-0.42	2.68	0.83	2.88	0.94	1.12
	S12	0.104	-3.89	1.52	0.028	1.7	0.147	1.2	-0.32	2.63	0.81	2.82	0.91	1.15
	Mean	0.104	-3.85	1.36	-0.152	1.66	0.138	1.12	-0.42	2.63	0.8	2.84	0.92	1.11
Abu AlKhassib	S13	0.69	-3.9	1.05	-0.67	1.605	0.098	1.96	-0.64	2.52	0.75	2.53	0.64	1.56
	S14	0.095	-3.84	0.94	-0.502	1.54	0.046	1	-0.58	2.5	0.73	2.47	0.71	0.97
	S15	0.104	-3.97	0.88	-0.76	1.56	0.059	0.92	-0.7	2.47	0.72	2.41	0.68	0.95
	Mean	0.29	-3.9	0.95	-0.64	1.56	0.067	1.29	-0.64	2.5	0.73	2.47	0.67	1.16
Fao	S16	0.73	-3.84	1.29	-0.148	1.66	0.147	1	-0.58	2.65	0.82	2.64	0.81	1.48
	S17	0.109	-3.71	1.35	-0.21	1.64	0.135	1.04	-0.52	2.7	0.85	2.58	0.78	1.09
	S18	0.114	-3.77	1.29	-0.21	1.67	0.16	1.08	-0.47	2.68	0.83	2.52	0.75	1.1
	Mean	0.317	-3.77	1.31	-0.189	1.56	0.147	1.04	-0.52	2.67	0.83	2.58	0.78	1.22
Umm Qasir	S19	0.76	-3.77	1.64	-0.185	1.69	0.172	1.12	-0.42	2.72	0.86	2.82	0.91	1.62
	S20	0.104	-3.65	1.7	0.134	1.71	0.196	1	-0.58	2.75	0.87	2.76	0.88	1.14
	S21	0.119	-3.84	1.76	0.23	1.77	0.24	1.16	-0.37	2.68	0.83	2.88	0.94	1.22
	Mean	0.32	-3.75	1.7	0.05	1.72	0.2	1.09	-0.45	2.56	0.85	2.82	0.91	1.32

REFERENCE

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