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Assessment of Heavy Metals Pollution in the Sediments of Iraqi Coastlines

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ABSTRACT

Twenty three samples were collected from the sediments of Iraqi coastlines, from seven sites, Fao, Raas AlBishah area, Khor Abdullah, Khor Shytianah, Hacham Island, Khor AlZubair, and Shatt AlBasrah. The collected samples has been assessed for Fe, Co, Zn, Cu, Ni, and Pb metals to detected the sediments pollution in the study area by used three of main indices; geo- accumulation (I- geo) , contamination factor (CF), and pollution load index (PLI). The results reflect that the average concentrations of the studied heavy metals were relatively lower in Khor Abdullah, Khor Shytianah , and Hacham Island sites than the other studied sites. I-geo shows that the studied heavy metals have relatively values of (class 0 and 1) in the studied sites reflect unpolluted to slightly polluted areas .The CF for Fe and Ni classified as class 2 which indicate moderately contamination in all samples. While, CF for Pb, Cu, Zn and Co classified as class 1 and 2 (Low to Moderate contamination). The Contamination factor (CF) for Co in all the studied sites classified as class 1 representing a low contamination. PLI values in the studied sites are ranges from 1.05 to 1.57 classified as class 2 (Deterioration on site quality) indicating local pollution, except for Khor Shytianah site that show the range of PLI value of 0.74-1.32 indicates denote perfection with (class 0) and appear no pollution to deteriorating on site quality . The indication of slightly to moderately pollution of sediments in the studied area may be as a result to anthropogenic activities, oil spelling, and daily toxicity wastes that throw for the main rivers in Basra city.

1. Introduction

There is a high probability of contamination by heavy metals, due to the availability of sources of pollution. Soil receives pollutants from a variety of sources, including automobile exhaust gases, and emissions of factory chimneys, household electric power generators and dust storm. Soil is a crucial component of rural and urban environments, and in both places land management is the key to soil quality.

Marine pollution is a global environmental problem. Human activities in the coastal area and marine water contribute to the discharge of various kinds of pollutants such as heavy metals (Fe, Zn, Cu, Co, Pb, and Ni) into the marine ecosystems (Censi*et al.,* 2006, Al-Jaberi, 2013). Pollution can be considered as the main and most dangerous factor of anthropogenic impact on the hydrosphere. First, pollution accompanies most kind of human activities, including offshore oil and gas production and marine oil transportation. Second in contrast with land ecosystem, in the water environment, pollutant quickly spread over large distances from sources of pollution (Al-Saad et al., 2009). The main reason for the metal contamination is considered as persistent and due to their toxic properties, could create several problems for different kinds of marine ecosystems and could be accumulating in marine organisms (Boening, 1999).Heavy metals contamination in soil is a major concern because of their toxicity and threat to human life and the environment (Begum et al., 2009). Toxic heavy metals entering the ecosystems may lead to geo- accumulation, bio- accumulation, and bio- magnification. Pollutants enter the marine environment by three ways; first by direct discharge of effluents and solid wastes into the seas and oceans (industrial discharge, municipal waste discharge, coastal sewage and others); Second by land runoff into the coastal zone, mainly by rivers, and third by Atmospheric fallout of pollutants transferred by the air mass onto the seas' surface (GESAMP, 1993). Quantitative estimates of these processes are difficult because of the lack of reliable data and the extreme complexity of the natural processes, especially at the sea-land and sea-atmosphere boundaries (Al-Saad et al., 2009).Monitoring of chemical components and heavy metals in marine environment as especially coastal zone is very important to assess the contamination in the marine environment (Babukutty and Chacko, 1995, Cravo, et al, 2004). Traditional monitoring of heavy metals in the aquatic environment involves determining and comparing the metal in water, sediment and biota (Al-Dabbas, et al, 1984, Nicholson and Lam, 2005).

Iraqi coasts and surrounding areas (south parts of Shatt al Arab River in Fao city and Shatt AlBasrah rivers) were witnessing rapid industrialization and urbanization that contribute to heavy metal loads in the coastal and marine habitats. Continuous inputs of heavy metals from different anthropogenic sources in the Arabian Gulf could be critical for both the naturally stressed marine ecosystems and humans that rely on marine resources for food, recreation and industry.

Iraqi Coasts of the Arabian Gulf, Khor Zubair, Shatt Al-Arab and Shatt AlBasrah are developing areas (Fig.1). Water discharge by boats and ships, marine transportation and ballast water discharges are main sources of pollutants in this area. While, wastewater, industrial and agricultural discharges and dredging are another sources of pollutant in this coastal area. These activities along the Iraqi coasts have caused this area to be exposed to different kinds of pollutants especially heavy metals.

Many authors had been studied the heavy metals as polluted indicator in Basra city and surrounding areas using the traditional analytical methods, but no one use the contamination factor (CF) , geo- accumulation (I-geo) and Pollution load index (PLI) as indicator to pollution (Khwedim et al (2009) ; Raaheem (2009).

Therefore, the objective of this study is to elucidate the distribution of heavy metals (Fe, Zn, Cu, Co, Pb and Ni) and the sediments contamination in the Iraqi coastline 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 sediments of Iraqi coastlines.

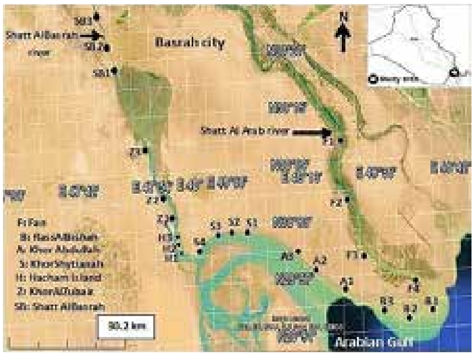

Figure 1- Map of study area

2. Material methods

Twenty three samples were collected from the sediments of Iraqi coastlines, from seven sites, these are Fao (four samples), Raas AlBishah area (three samples), Khor Abdullah (three samples), Khor Shytianah(four samples), Hacham Island (three samples), Khor AlZubair (three samples), and Shatt AlBasrah(three samples). These sediments are situated on the recent - quaternary unconsolidated sediment of the Mesopotamian plain formed mainly from river sediments (sand, silt and clay).

The collected samples has been assessed for Fe, Co, Zn, Cu, Ni, and Pb metals to detected the sediments pollution in the study area by used three of main indices; geo- accumulation (I- geo) , contamination factor (CF), and pollution load index (PLI). 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 – Atomic emission spectrometry (ICP-AES), and Inductively coupled Plasma – Mass spectrometry (ICP-MS).Method of Singh et al (2002) was used with little modification.

3.Result and discussion

A-Heavy Metals

In order to assess the metal content in the sediments, it's important to establish the natural levels of these metals. Apart from natural contribution, heavy metals may be incorporated into system from anthropogenic source such as solid and liquid waste of industries, the oil spill from the oil tanker to the sea water in the studied areas that considered as important commercial line of the world transportation tankers.

The range of the measured heavy metals concentrations (Fe, Co, Zn, Cu, Ni, and Pb) in the sediment at depths 0-15 cm of the studied area in 2011 shown in table (1). The results reflect that the average concentrations of the studied heavy metals were relatively lower in Khor Abdullah, Khor Shytianah , and Hacham Island sites than the other studied sites (Table 1). The maximum average concentrations area is the Fao site which shows high concentrations of the measured heavy metals Co, Zn, Cu, Ni, and Pb, with average concentration of 16.4, 126, 40,116 and 17 ppm respectively. While the lowest concentration are present in Khor Shytianah site, where the heavy metals Fe, Co, Zn, Cu, Ni, and Pb, have the average concentration of 2.93, 13.57, 57, 28.5, 92.7, and 8 ppm respectively (Table 1). Discussion of these heavy metals is as follows:

1-Cobalt (Co): Cobalt is an important and essential element for living organisms (plant and animal nutrition) even though it is present at lower trace level (Hem, 1985). The Co seems to be associated with clay minerals and organic matter. The roles of clays are of significance because of their great sorption capacity and their relatively easy release of Co (Pendias and Pendias, 2001). It was found in this study that the minimum average Co concentration was 13.5 ppm in Khor Shytianah site and the maximum was 16.4ppm in Fao site.

2-Nickel (Ni): Nickel can enter to the structure system of clay minerals. The similar ionic radius between Ni^{2+}=0.69A°- Co^{2+}=0.72A° and Fe^{2+}=0.74A°- Mg^{2+}=0.66A° caused to replacement of magnesium and iron by nickel and cobalt in the structure system to the clay mineral .The Ni higher mobility in ionic form increases its toxicity effects compared with Pb (Pendias and Pendias, 2001). Nickel correlates positively with Cu, Pb, and Fe suggesting its presence in clay minerals as well as with Fe – oxides. Nickel content was found in this study that the minimum Ni concentration was about 92.7ppm in Khor Shytianah site and the maximum was 116ppm in Fao site.

3-Zinc (Zn): The most dangerous elements in scale and size of release are Pb and Zn among the elements of the first class of danger and Ni, Co and Cu are among the second class. Currently, 70 to 95% of all heavy metals are transferred to soil from anthropogenic sources; the rest are from natural source .The anthropogenic sources of Zn are related, first of all, to the non-ferric metal industry and then to agricultural practice. Zinc is positively correlated with Fe demonstrating its association with clay minerals as one host. It is noted in low amount in the soils, (Pendias and Pendias, 2001). While, it was found in this study that the minimum Zn concentration was 57 ppm in Khor Shytianah site and the maximum was 126 ppm in Fao site.

4-Copper (Cu): Copper (Cu) forms several minerals of which the common primary minerals are simple and complex sulfides. These minerals are quite easily soluble in weathering processes and release Cu ions, especially in acid environments (Hawks and Web,1962).The Cu concentration in surface soils reflects the bioaccumulation of the metal and also recent anthropogenic sources of the element, the relative enrichment in copper content that could be due to environmental contamination, (Pendias and Pendias, 2001).Contamination of soil by Cu compounds results from utilization of Cu-containing material suchas fertilizers, sprays, and agricultural or municipal wastes as well as from industrial emissions. Some local or incidental Cu input to soils may arise from corrosion of Cu alloyconstruction materials (e.g., electric wires, pipes). Copper is positively correlated with Fe, and Ni suggesting clay minerals as host. It was found in this study that the minimum Cu concentration was 28 ppm in Khor Shytianah site and the maximum was 40 ppm in Fao site.

5-Lead (Pb): The major natural source of Pb in the environment is sulfides minerals such as galena (PbS). The anthropogenic source of Pb is leaded gasoline. The average abundance of Pb in the earth's crust is 20 mg/kg. The accumulation of Pb in the aqueous environments is exposed to various pollution sources and it is of great ecological significance because this metal is known to greatly affect the biological activity in aqueous environments, (Pendias and Pendias, 2001). Lead is present in Pb^{+2} ions are more spread in the aqueous environment. Lead (as Pb^{2+}) forms carbonates, incorporated in clay minerals, in Fe – Mn oxides and in organic matter, (Pendias and Pendias, 2001).Lead is positively correlated with Fe, Zn, and Ni probably suggesting some association with the fertilizers, clay and heavy minerals (Al-Jaberi, 2013). It was found in this study that the minimum Pb concentration was 8 ppm in Khor Shytianah site and the maximum was 17 ppm in Fao site.

6-Iron (Fe_2O_3): It was found in this study that the minimum Fe_2O_3 % was 2.93 % in Khor Shytianah site and the maximum was 4.83 % in Shatt AlBasrah site that may be due to high range of contamination of sea water by this metal. Iron is present in the opaque minerals, and as the presence of iron in the structure of clay minerals such as chlorite, montmorillonte and kaolinite minerals and in the iron minerals (Eslinger and Peaver,1988).

Such high values of the studied heavy metals is believed may be due to high contamination of clay percentages in the studied sediments as well as may be due to the oil and gasoline spill from the oil tanker and ships to the sea water in the studied areas that considered as important commercial line to the world ships that passing in the north and Northwest of Arabian gulf.

This finding is accordance with Al-Jaberi (2013) results, where the average percentage texture of the sediments for Fao, RassAlBishah ,Khor-Alzubair and Shatt AlBasrah sites were ranging from 4 to 8 % sand , 37 to 43 % silt and 52 to 58% clay of Silty clay sediment. While the average percentage of texture to the sediments for Khor-Abdullah, Khor Shytianah and Hacham Island sites were ranging from 10 to 19 % sand, 35 to 43 % clay and 45 to 47 % silt of Sandy clayey silt sediment.

Table 1- Values of heavy metals in the sediments of study area

Position	Sample No.	Fe_2O_3 %	Co ppm	Zn ppm	Cu ppm	Ni ppm	Pb ppm
Fao	F1	4.25	16.5	125	40	116	17
	F2	4.24	16.6	126	41	116	17
	F3	4.26	16.8	125	40	116	17
	F4	4.27	16	127	40	117	18
	Mean	4.25	16.4	126	40	116	17
Rass AlBisha	B1	4.25	15.2	60	35	95	16
	B2	4.26	15.1	61	34	95	17
	B3	4.23	15	60	34	95	16
	Mean	4.24	15.1	60	34	95	16
Khor Abdullah	A1	4.16	15.7	50	23	100	13
	A2	4.18	15.6	50	22	99	12
	A3	4.18	15.8	51	23	100	13
	Mean	4.17	15.7	52	22	99	12
Khor Shytianah	S1	2.6	10.6	34	16	77	7
	S2	1.1	11	50	28	81	8
	S3	4	5	55	32	94	9
	S4	4.05	17.7	89	38	119	9
	Mean	2.93	13.57	57	28.5	92.7	8
Hacham Island	H1	3.94	13.5	55	25	117	9
	H2	3.95	13.6	56	25	118	10
	H3	3.94	13.5	55	25	117	9
	Mean	3.94	13.5	55	25	117	9
KhorAlZubair	Z1	4.81	15.3	55	26	115	11
	Z2	4.81	15.2	55	25	115	10
	Z3	4.7	15.4	54	27	114	11
	Mean	4.77	15.3	54	26	114	10
Shatt AlBasrah	SB1	4.84	14.5	110	34	94	15
	SB2	4.83	14.6	111	35	95	16
	SB3	4.83	14.6	111	35	95	16
	Mean	4.83	14.5	110	34	94	15

B- Assessment of contamination:
There are many sediments pollution indices that can be used to assess the level of contamination 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 sediments of Iraqi coastline and surrounding areas. These are Geo accumulation index (I- geo), contamination factor (CF) and Pollution Load Index (PLI) (Tables 2 and 3).

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 (Gowd*et 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- geo = log 2 (Cn/1.5 Bn)

Where:

Cn = the measured concentration of the heavy metals in the sediments and
Bn = 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 Pb was found negative in all the sites, ranging from -1.86 to -0.5 (Table 3). These results are of (class 0) which indicates that the concentrations of Pb in the sediments of these sites are unpolluted and lower than the background (Table 2).

The Ni was found positive in all the sites, ranging from 0.22 to 0.85. These results are of (class 1) which indicates that the concentrations of Ni in the sediments of these sites are slightly polluted (Table 2).

The Cu was found positive in the Fao site, ranging from 0.1 to 0.12, these results are of (class 1) which indicates that the concentrations of Cu in the sediments of these sites are slightly polluted. While Cu in the other sites of the study area had negative values ranging between -0.02 to -0.47 .These results are of (class 0) which indicates that the concentrations of Cu in the sediments of these sites are unpolluted and lower than the background (Table 2).

The Zn had positive values in the Fao and Shatt AlBasrah sites, ranging between 0.04 to 0.25. These results are of (class 1) which indicates that the concentrations of Zn in the sediments of these sites are slightly polluted. And negative values in the other studied sites, ranging from -0.25 to -1.65. These results are of (class 0) which indicates that the concentrations of Zn in the sediments of these sites are unpolluted and lower than the background (Table 2).

The Co was found negative in all the sites, ranging from -0.6 to -1.26. These results are of (class 0) which indicates that the concentrations of Co in the sediments of these sites are unpolluted and lower than the background (Table 2).

The Fe_2O_3 was found positive in the Fao ,Rass AlBishah, Khor Al-Zubair, and Shatt AlBasrah sites, ranging from 0.32 to 0.616 , these results are of (class 1) which indicates that the concentrations of Fe_2O_3 in the sediments of these sites are slightly polluted. While Fe_2O_3 in Khor Shytianah site had negative and positive values ranging from -0.151 to 0.36. These results are of (class 0 and class 1) which indicate that the concentrations of Zn in the sediments of these sites are unpolluted to slightly pollute.

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).

Lead (Pb) in all the studied sites classified as class 1 representing a low contamination, except Pb in Fao site which classified as class 2 representing moderate contamination (Table 3). Lead is known to come from the use of leaded gasoline.

The Contamination factor (CF) for Cu in all the studied sites classified as class 2 a moderate contamination, except in Khor Abdullah site and sample No.1 in Khor Shytianah site which classified as class 1 a low contamination. The higher copper content in the sediments may be due to the disposal of copper-containing wastewater from factories and hospitals in Basrah city to Shatt Al-Arab and Shatt AlBasrah rivers caused to increase of copper content in the sediments especially in Fao and Shatt Al Basrah areas.

The Contamination factor (CF) for Zn in all the studied sites classified as class 1 (Low contamination), except in Fao and Shatt AlBasrah sites classified as class 2, a moderate contamination. Zn is come from toxic waste from industrial sources (Thorpe and Harrison, 2008).

The Contamination factor (CF) for Co in all the studied sites classified as class 1 representing a low contamination, except in sample No. 4 in Khor Shytianah classified as class 2 (moderate contamination).

The Contamination factor (CF) for Ni and Fe in the studied areas is classified as class 2 (Moderate contamination).

The CF for Fe and Ni classified as class 2 which indicate moderately contamination in all samples. It is believed that considerable part of nickel and iron finds its way into the environment as a result of the burning of diesel oil and oil spilling in the south part of Basrah city from the oil field or from the pipes carried oil that spread in this area caused to increase both of nickel and iron in the sediments.

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 .....x CFn
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 studied sites are ranges from 1.05 to 1.57 classified as class 2 (Deterioration on site quality) indicating local pollution, except for Khor Shytianah site that show the range of PLI value between 0.74 to 1.32 indicates denote perfection with (class 0) and appear no pollution and class 2 (Deterioration on site quality) indicating local pollution.

Higher values of PLI factor may be result from effect of the sediments in the studied area by oil spilling, because Basrah city considered as oil rich city caused to enriched the sediments by some of heavy metals, in addition to effect of un-treatment toxic waste that discharge to the main rivers in Basrah city from the industries, hospitals and some anthropogenic activities caused to contaminated the soil by zinc, copper and lead.

Table 2: Classified grades of I- geo, CF and PLI indices, (after Thomilson et al (1980) ; and Boszke et al (2004) in Rabee et al (2011).

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		

4. Conclusions
The concentration of heavy metals (Fe, Co, Zn, Cu, Ni, and Pb) in the study areas can mainly be attributed to due to high contamination of clay percentages in the studied sediments as well as may be due to the oil and gasoline spill from the oil tanker and ships that considered as important commercial line to the world ships that passing in the north and Northwest of Arabian gulf. It is clear that the pollutant affected the Fao, Rass AlBishah, Khor AlZubair, and Shatt AlBasrah sites that have relatively high Clay % in the sediment more than the in Khor Abdullah, Khor Shytianah and Hacham Island sites that have relatively high Sand % in the sediment. Concluded that the sediment pollution with these heavy metals thought to be due to different sources such as urban wastes, oil refineries, industrial effluents, land washout and boats activates.

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

Position	Sample No.	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
Fao	F1	2.02	0.43	0.97	-0.62	1.76	0.24	1.6	0.1	2.63	0.81	1	-0.58	1.56
	F2	2.02	0.42	0.97	-.0.61	1.77	0.24	1.64	0.12	2.63	0.81	1	-0.58	1.56
	F3	2.03	0.43	0.98	-0.6	1.76	0.24	1.6	0.1	2.63	0.81	1	-0.58	1.56
	F4	2.03	0.43	0.94	-0.67	1.78	0.25	1.6	0.1	2.65	0.82	1.05	-0.5	1.57
	Mean	2.02	0.43	0.96	-0.63	1.77	0.24	1.6	0.1	2.63	0.81	1	-0.56	1.56

RassAlBishah	B1	2.02	0.43	0.89	-0.74	0.84	-0.82	1.4	-0.09	2.15	0.52	0.94	-0.67	1.27
	B2	2.03	0.43	0.88	-0.75	0.85	-0.81	1.36	-0.14	2.15	0.52	1	-0.58	1.28
	B3	2.02	0.42	0.88	-0.76	0.84	-0.82	1.36	-0.14	2.15	0.52	0.94	-0.67	1.26
	Mean	2.02	0.42	0.88	-0.75	0.84	-0.82	1.37	-0.12	2.15	0.52	0.94	-0.67	1.27
Khor Abdullah	A1	1.98	0.4	0.92	-0.69	0.7	-1.09	0.88	-0.76	2.27	0.59	0.76	-0.97	1.11
	A2	1.99	0.41	0.91	-0.7	0.7	-1.09	0.88	-0.77	2.25	0.58	0.7	-1.08	1.19
	A3	1.99	0.41	0.92	-0.68	0.77	-0.95	0.92	-0.76	2.27	0.59	0.76	-0.97	1.14
	Mean	1.98	0.4	0.92	-0.69	0.73	-1.03	0.89	-0.76	2.26	0.58	0.75	-1.08	1.12
KhorShytianah	S1	1.23	-0.27	0.62	-1.26	0.47	-1.65	0.64	-1.22	1.75	0.22	0.41	-1.86	0.74
	S2	0.52	-1.51	0.64	-1.21	0.7	-1.09	1.12	-0.42	1.84	0.29	0.47	-1.67	0.78
	S3	1.9	0.34	0.88	-0.76	0.77	-0.95	1.28	-0.22	2.13	0.51	0.52	-1.5	1.05
	S4	1.92	0.36	1.04	-0.52	1.25	-0.25	1.52	-0.02	2.7	0.85	0.52	-1.5	1.32
	Mean	1.39	-0.1	0.79	-0.93	0.8	-0.9	1.16	-0.39	2.1	0.49	0.47	-1.67	1
Hacham Island	H1	1.87	0.32	0.79	-0.92	0.77	-0.95	1	-0.25	2.65	0.82	0.58	-1.35	1.09
	H2	1.88	0.33	0.8	-0.91	0.78	-0.92	1	-0.25	2.68	0.83	0.58	-1.35	1.1
	H3	1.87	0.32	0.79	-0.92	0.77	-0.95	1	-0.25	2.68	0.83	0.58	-1.35	1.11
	Mean	1.87	0.32	0.79	-0.92	0.77	-0.95	1	-0.25	2.67	0.83	0.58	-1.35	1.09
KhorAlZubair	Z1	2.29	0.61	0.9	-0.73	0.77	-0.95	1.04	-0.25	2.61	0.8	0.64	-1.21	1.18
	Z2	2.29	0.61	0.89	-0.74	0.77	-0.95	1	-0.25	2.61	0.8	0.58	-1.35	1.15
	Z3	2.23	0.57	0.9	-0.72	0.76	-0.97	1.08	-0.47	2.6	0.78	0.64	-1.21	1.18
	Mean	2.27	0.59	0.9	-0.73	0.76	-0.97	1.04	-0.41	2.6	0.79	0.62	-1.35	1.17
Shatt AlBasrah	SB1	2.1	0.61	0.91	-0.92	1.54	0.04	1.36	-0.14	2.13	0.51	0.88	-0.76	1.39
	SB2	2.3	0.616	0.85	-0.91	1.56	0.05	1.4	-0.1	2.16	0.52	0.94	-0.67	1.43
	SB3	2.3	0.616	0.85	-0.91	1.56	0.05	1.4	-0.1	2.16	0.52	0.94	-0.67	1.43
	Mean	2.2	0.61	0.87	-0.91	1.54	0.04	1.36	-0.11	2.13	0.51	0.88	-0.67	1.4

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