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Assessment of marine sediments quality of El-Dabaa area, north-western Mediterranean coast of Egypt

Shaimaa M. Magdy [1], Ghada O. Mohamed [2], Ahmed N. Shabaka[3] and Amani Badawi [1,*]
[1] National Institute of Oceanography and Fisheries, Egypt.
[2] Institute of Graduate Studies and Research, Department of Environmental Studies, Alexandria University, Egypt.
[3] Nuclear Engineering Department, Military College, Kobry El Kobbah, Cairo, Egypt.
[*]Corresponding Author: amani_badawi@yahoo.com

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ABSTRACT

The assessment of the sediment quality and degree of contamination of El-Dabaa region along the Mediterranean coast, which comprises an area selected for developing a nuclear power plant (NPP) in Egypt, is important to provide background contaminant levels of coastal sediments. Determination of 21 heavy metals concentrations (Th, U, Na, Mg, Al, K, Ca, V, Ag, Sb, Mo, Co, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn), and geochemical analysis of bottom sediments collected from five selected stations along El-Dabaa area were studied. Contamination factor indices have been applied. Results of the correlation between the five stations reveal insignificant variations reflected homogenous environment, associated with similar terrestrial inputs and hydrodynamic systems. Grain size texture dominated by fine sand, suggested an active depositional process, influenced by longshore sediment transport, corresponding to the magnitude of wave energy. Sediments are characterized by carbonates structure, with significant high calcium carbonate, mainly pure oolitic carbonate, consistent with high Ca metal concentration, corresponding to the geologic composition of hydrographic basins, influenced by the carbonate natural geogenic sources of the area. Low total organic matter content is related mainly to the semi-arid climate of the region, the absence of Nile river input, and the strong hydrodynamic effect. In General, concentrations of heavy metals were low compared with the eastern Mediterranean coast of Egypt, it verified below the threshold effects level according to international sediment quality guidelines. The contamination factor reveals a high degree of Ag and Sb, anticipated to be traced from dense mining and rock processing activities nearby El-Dabaa region in the Western Desert.

INTRODUCTION

Marine sediments are the most sensitive indicators of the aquatic environment in the contaminants monitoring process **(Pekey *et al.*, 2004)**. Whereas, sediments are considered the final destination of minerals because of their ability to adsorption, absorption, precipitation, diffusion processes chemical reactions, biological activity, and the incorporation of all these phenomena into marine environment. As bottom sediments are one of the main components of the aquatic environment, which supplies the organisms within it with foodstuffs, they are considered a reservoir for all kinds of contaminants within this environment and are also considered as a record of catchment inputs in aquatic ecosystems **(Malferrari *et al.*, 2009).** Sediments are the main indicator of pollution of an aquatic ecosystem, where the distribution of contaminants within them can provide important information about the pollutant and its transmission paths **(Wang *et al.*, 2012)**. In addition, marine sediments are considered as an important basin for retaining heavy metals in their texture **(Du Laing *et al.*, 2009; Benson *et al.*, 2018).** The surface layer of sediments is the first environment of interaction between pollutants and benthic organisms, where the exchange that occurs of pollutants and minerals between water and sediments **(Nemr *et al.*, 2006; Nemr *et al.*, 2007)**. Disturbance in the mechanism of accumulations and interfering of anthropogenic sources of heavy metals leading to high heavy metal concentration, might reach to toxic level of aquatic system **(Chen *et al.*, 2010)** that threaten and damage the overall ecological marine environment.

Baseline Environmental Assessment (BEA) is a comprehensive, proactive process that identifies and assesses environmental impacts and the sustainability status important to planning and prepares specific policies to ensure that they are fully considered and addressed in the early stages of decision-making **(Verheem and Tonk, 2000)**. BEA typically involves the setting of an overarching environmental vision and objectives for a particular geographic region and activities within that region **(Noble, 2000)**. BEA enables the identification and characterization of the existed and potential sources of pollution.

El Dabaa area is located in the southern part of the Mediterranean coastal, along the Northern West Coast of Egypt, approximately 6km away from the town of El Dabaa and approximately 130km northwest of Cairo.

El-Dabaa Site comprises an area selected as the most suitable for developing a nuclear power plant (NPP) in Egypt, on the Egyptian Mediterranean coast, it was necessary to conduct studies dealing with the environmental characteristics of the chosen site. The assessment of the marine environmental baseline for the El-Dabaa region prior the establishment phase of the nuclear power plant would be useful as environmental reference throughout the projects phases to monitoring the environmental impact of the nuclear plant on the surrounding environment. El-Dabaa NPP Site has been subject for detailed studies and various expert studies of relevant various aspects, in particular the safety and reliability of the nuclear reactor design. It is essential to assess the environmental baseline of marine sediments in the El-Dabaa region, pre- establishment of the nuclear power plant, enable to tracking and monitoring the influence of the nuclear power plant on marine environments quality through time.

Marine ecosystem is one of the environments that are expected to be affected by the construction of nuclear plants. Bottom sediments are an important basin for retaining pollutants in their texture. In the event of seabed texture disturbance, pollutants released and become a source of threats to marine ecosystem. Whereas, sediments are considered as the final destination of contaminants because of their ability to adsorption, absorption, precipitation, diffusion processes chemical reactions, biological activity, and the incorporation of all these phenomena into their texture. **(Du Laing *et al.*, 2009)**.

The main objective of this study is to build a baseline environmental assessment of the marine sediments, as a background reference prior establishment of the Nuclear Plant, to be consider as a basis for future development of environmental effective sustainable management plans. To achieve this objective, five sites within the NPP zone have been selected to collect and analysis bottom sediments samples along the study area. The analysis included determination of geochemical properties of the sediments samples. Knowing that previous data on sediment contamination for study area were limited, evaluation of the level of heavy metals concentrations in sediments have been done. Results of this study will report existed base line and assess possible anthropogenic inputs in the area, enable to detect future potential anthropogenic source of pollution, corresponding to establishment and operation of Nuclear Plant, and develop sustainable environmental management plan of El-Dabaa region.

MATERIALS AND METHODS

Study area

El-Dabaa area as shown in Fig. 1., is located on the northwest coast of Egypt near Matrouh Governorate, about 160 km away from the city of Alexandria, and 140 Km of the city of Marsa Matrouh, the capital of Matrouh Governorate. Its boundary extends from 28° 21' 33" E to 28° 35' 11" E and 30° 58' 50" N to 31° 05' 22" N, it is about 21.5 km long and 11.8 km wide and occupies an area of about 254 km^2. The sampling area was within the Nuclear Power Plant (NPP) zone. Station coordinates are illustrated in Table 1.

Table 1. Sampling coordinates

No	Description	Latitude	Longitude
1	Sediments (S1),	31° 02' 34′′ N	28° 33' 58′′ E
2	Sediments (S2),	31° 03′ 01′′ N	28° 31′ 54′′ E
3	Sediments (S3),	31° 03′ 26′′ N	28° 29′ 53′′ E
4	Sediments (S4),	31° 04′ 29′′ N	28° 28′ 14′′ E
5	Sediments (S5),	31° 05′ 09′′ N	28° 26′ 16′′ E

Five sites within the NPP zone along the investigated region of the Egyptian north coast have been chosen to collect 5 bottom sediments samples, as shown in Fig. 2.

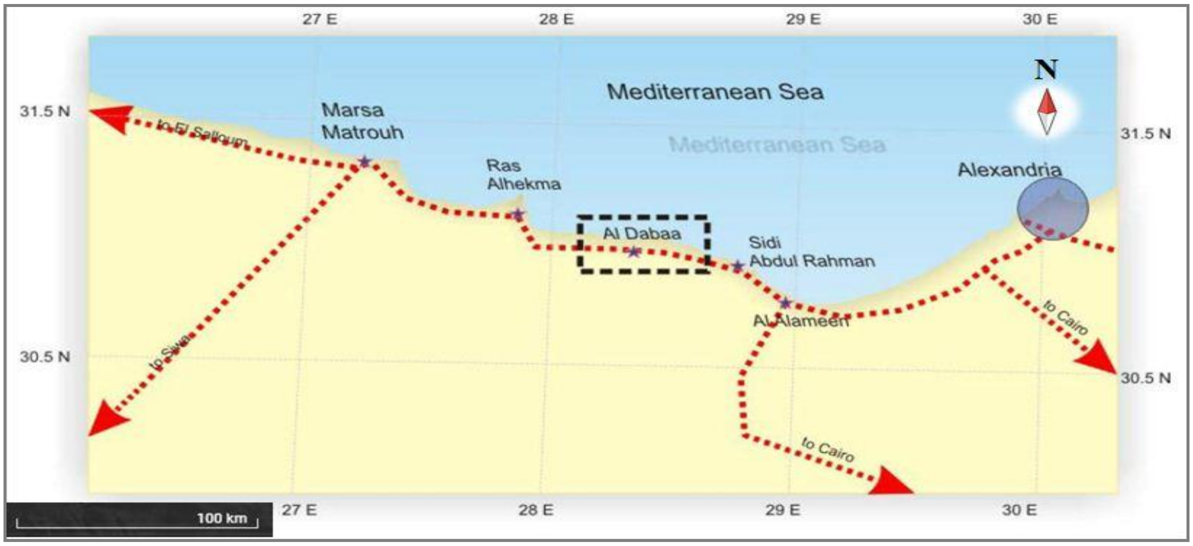

Fig. 1. Map showing the location of El-Dabaa region on the north coast of Egypt.

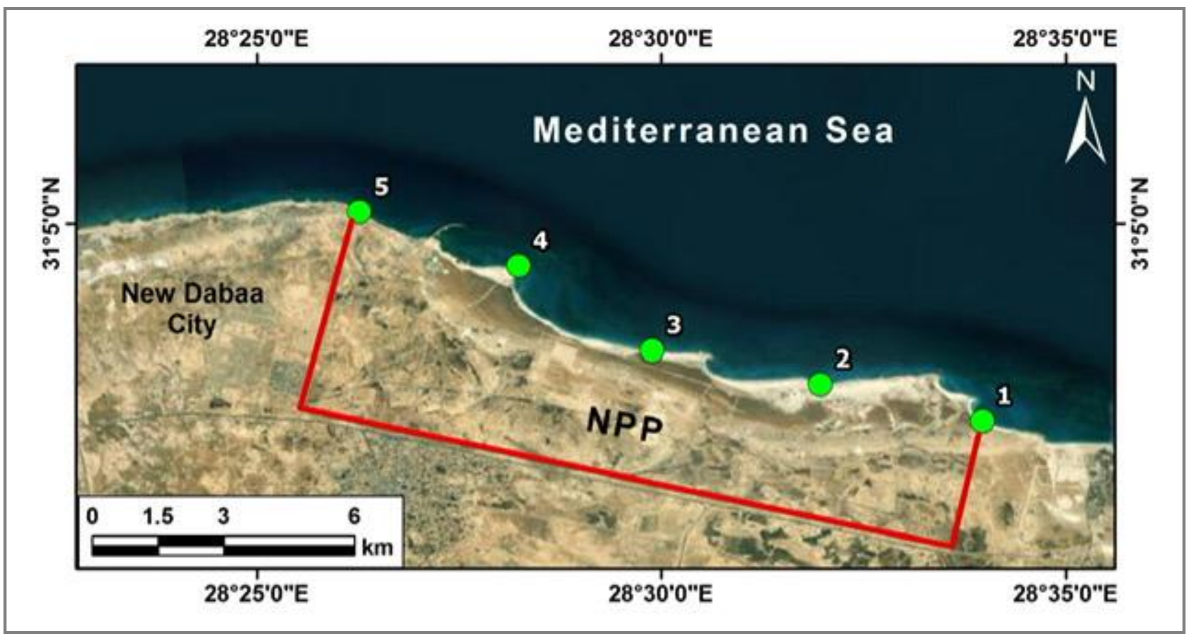

Fig. 2. Location map for the investigated site.

Sediment collection

Bottom marine sediment samples (S1- S2- S3- S4- S5) were collected, during summer season, from the surface layer (first 5 cm) with average water depth of 80 cm. In-situ physical properties of sea water of the selected stations recorded average Ph of 8.12, average salinity of 38.31 PSU and average temperature of 28.55^{o}C.

Collected samples were placed in clean labeled polyethylene bags and transferred to the laboratory for the analysis.

For Geochemical analysis, the samples were dried for 5 days in the oven at a temperature of 60 °C. Part of each sample was saved for use in particle size distribution analysis, and another part was milled (to obtain equal particle size) and sieved with less than 63 μm for the geochemical and heavy metals analysis.

Analysis of sediment samples

Several geochemical methods were used to assess the sediments samples properties, included pH measurements, Grain size analysis, calcium carbonate (CaCO3), total organic matter (TOM), and concentration levels of 21 heavy metals (Th, U, Na, Mg, Al, K, Ca, V, Ag, Sb, Mo, Co, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn), of sediments samples.

The mechanical analysis was used to determine the Grain size of sediments by using the conventional sieving method according **(Folk and Ward, 1957)**. Standard set of sieves (4, 2, 1, 0.50, 0.250, 0.125, 0.063 mm) have been used, corresponding to the phi classes of (-2, -1, 0, 1, 2, 3, 4, 5) respectively, where phi (Φ) is the symbol for the negative logarithm to the base 2 of particle diameter in millimeters. Where 60 g of the dried sample was placed in the upper sieve, and mechanically shaken for 15 min. Then the sample was weighed in each sieve and the weight percentage and cumulative weight were calculated. The percentage of grain size in the sediment was calculated by dividing the weight of the sediment for each sieve by the total weight of the sample. The cumulative weight percentage was plotted on phi (Φ) probability paper to produce accurate cumulative curves for calculating grain size parameters.
Sediments pH were measured according to **(Yan *et al.*, 2010).** Ca carbonate percentage ($CaCO_3$%) was measured according to **(Machette, 1986).** Total organic carbon (TOC %) was determined according to Walkely-Blak’s wet oxidation method **(Baruah and Barthakur, 1997).**

Concentrations of 21 heavy metals (Th, U, Na, Mg, Al, K, Ca, V, Ag, Sb, Mo, Co, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Pb, and Zn) in five sediments samples were measured. sediment samples were analysis according to **(Oregioni and Aston, 1984).** Sediment samples were complete dried at 60°C, then 0.5 g of each dry sediment sample was weighed and grounded to < 63 μm. The samples were digested with a mixture of hydrofluoric acid (HF), nitric acid (HNO_3), and chloric acid ($HClO_4$) with a ratio (3: 2: 1) then heated at 80 °C for two days until complete digestion. Each digested sample was completed to a final volume of 25 ml with concentrated hydrochloric acid (HCl) 10%. The metal concentrations in each sample were measured by inductively coupled plasma emission spectrometry (ICP/AES), Agilent 7700X ICP-MS model. Standard Quality control procedures and instrument calibrations have been done. The concentration of each metal in the sediment sample was calculated in mg/kg.

Assessment of sediment quality

To evaluate sediments quality and identified the degree of metal contamination level of the 21 metals, measured from the selected sediment samples, contamination factor indices (CF) have been applied. Contamination factor is an effective tool for evaluating the pollution of environment and monitoring pollution over a period of time, **(Tamasi and Cini, 2004)**. There are several methods Contamination factor (CF) is used to estimate the degree of metals contamination reference to measured metals concentrations. The pollution factor is divided into 4 levels of pollution (low $Cf < 1$; moderate $1 \leq Cf < 3$; high $3 \leq Cf < 6$; very high $Cf \geq 6$) **(Hakanson, 1980).** The CF pollution coefficient was calculated using the following equation:

$$CFi = Ci / Bi$$

Where, C_i = the measured metal concentration in the sediment, B_i = the concentration of the metal in the selected background, i = the selected metal, CF_i= a heavy metal contamination factor.

RESULTS AND DISCUSSION

In General, the results of the sediments geochemical properties (pH, Grain size analysis, calcium carbonate (CaCO3), and total organic matter (TOM), measured in five samples along study area of El-Dabaa region are tabulated in Table 2, reveal insignificant variations between the five samples reflected homogenous environment with good water circulation and high dynamic depositional system.

Table 2. Geochemical analysis of the sediment samples of study area

Samples	Grain size analysis			$CaCO_3$ %	TOM %	pH
	Sand%	Silt &Clay %	Texture			
S 1	100	0	Fine sand	94.7	0.35	8.23
S 2	99.99	0.01	Fine sand	94.7	0.35	8.23
S 3	99.99	0.01	Fine sand	94.6	0.35	8.23
S 4	99.99	0.01	Fine sand	94.6	0.34	8.23
S 5	99.98	0.02	Fine sand	94.5	0.34	8.22
Min	99.98	0.00	-	94.50	0.34	8.22
Max	100.00	0.02	-	94.70	0.35	8.23
Average	99.99	0.01	-	94.62	0.35	8.23

The pH average values of the measured sediment samples was 8.23, reflects alkaline condition. The importance of measuring the pH values in sediments is due to their effect on the state of the bonding of minerals to the sediments **(Smith, 1994)**.

The analysis of the grain size of the five samples revealed that the dominant sediment texture in that area is fine sand, with an average of 99.99%. These results are consistent with the results of the area surrounding the study area ***(El Nemr et al., 2007; Okbah et al.*, 2014)**. The convergence of the grain size textural and morphological characterization, dominant by fine sand along the entire study area indicate high dynamic depositional system, influenced primarily with longshore sediment transport corresponding to magnitude of wave energy which strike the nearshore zone.

Calcium carbonate ($CaCO_3$) content recorded average of 94.62% in the investigated samples, consistent with the results of the western region of the Egyptian Mediterranean shore, extends from Alexandria to Salloum through El-Dabaa region, which characterized by high content of pure oolitic carbonate **(Anwar *et al*., 1984; Okbah *et al.*, 2014).** The study area is away from Nile river discharge, close to the Western Desert, which primarily consists of calcite, which consider as a source and diffusion of terrestrial materials. The total organic matter (TOM) measured in the samples showed low values with average of 0.35%, influenced by the absence of river input and almost lack of vegetation, relevant to semi-arid climate that characterized El-Dabaa region. In addition to strong hydrodynamic system, where wind-generated waves driven strong near shore currents may negatively affect organic matter, transported it off the shore. It is expected that low organic matter content favors un-bonding of some heavy metals, where the high organic matter content in the sediments causes a rise in the level of metals where it can be forming strong metal complexes and make them immobile **(Masoud *et al.*, 2007)**.

Heavy metals concentrations

The results of the concentration of 21 heavy metals (Th, U, Na, Mg, Al, K, Ca, V, Ag, Sb, Mo, Co, Ba, Cd, Cr, Cu, Fe, Mn, Ni, Pb and Zn) in sediment samples for the study area, is listed in Table 3 and Fig. 3.

In General, the results showed convergence between the concentrations of each element in the five sampling points, reflects similar terrestrial inputs, depositional conditions and hydrodynamic process along the area of study **(Yan *et al.*, 2010)**. Ca showed the highest concentrations in sediments sampled with average value of 176,348 µg/g, followed by Mg and Na with average value of (2870, 1568 µg/g, respectively), followed by Fe and Al with average value of (257, 175, respectively). While the rest of measured heavy metals in the five sediments samples of the study area recorded lower values. The distribution pattern of heavy metals in the sediments followed the sequence of Ca > Mg > Na > Fe > Al > Zn > Mn > Ba > Cr > Ni > U > Pb > V > Cu > Co > Mo > Sb > Th > Ag > k > Cd.

Sediments of El Dabaa area are characterized by carbonates structure, with high Calcium carbonate (CaCO3) content and significant high Ca concentration, while metals content are low, corresponding to geologic composition of hydrographic basins.

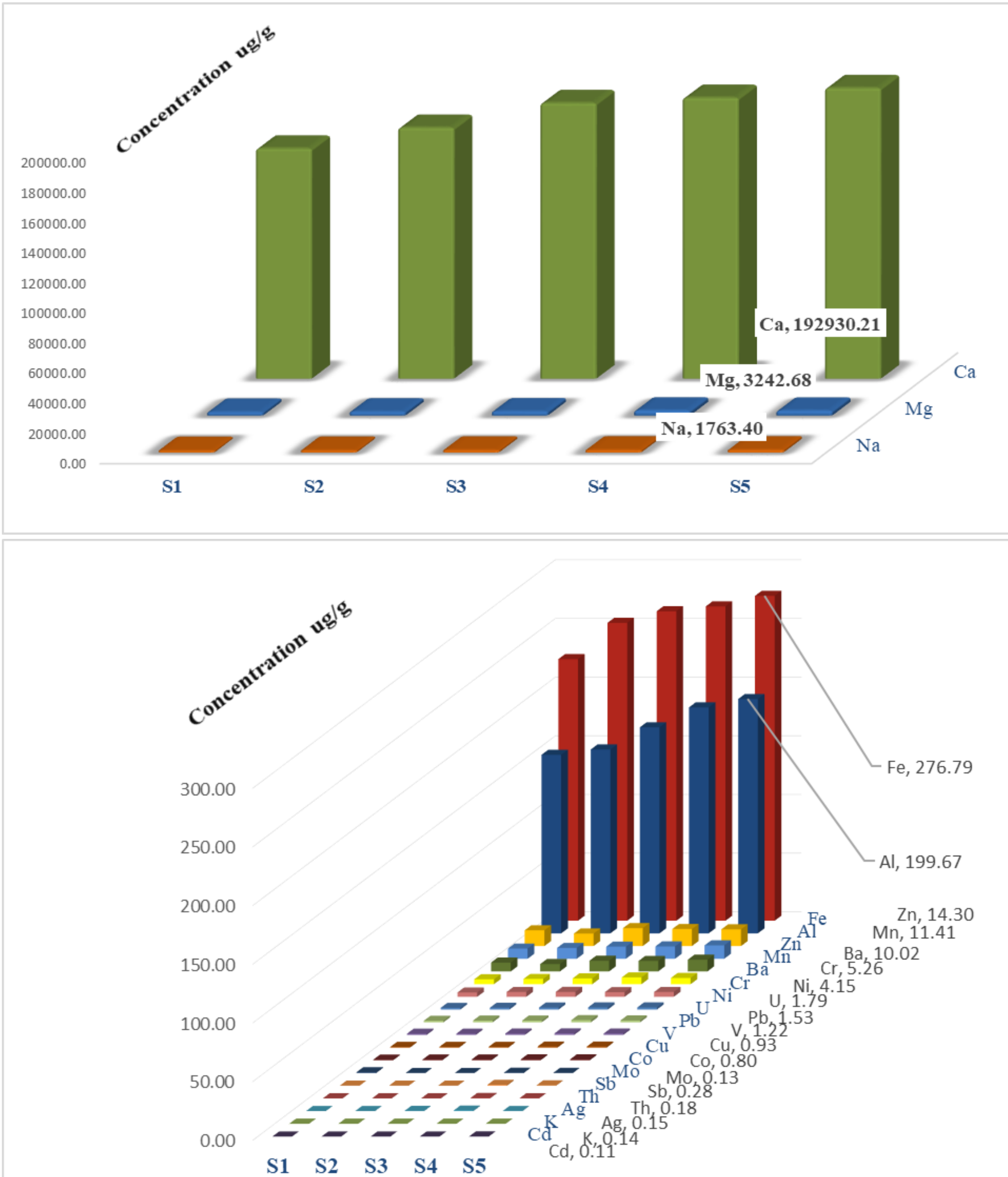

Fig. 3. Heavy metals concentration (µg/g) in five stations sediments of the study area

In addition, lack of river discharge close to El Dabaa area has direct effect on the concentration of heavy metals of the sediments comparing with eastern Coast of Egypt, where Nile river input increase heavy metal content of sediments. In addition to the effect of the existed dense anthropogenic activities influenced the eastern coast of Egypt, **(El Nemr *et al*., 2007 and 2012; Soliman *et al.*, 2015; Badawi and El-Menhawy 2016; Badawi *et al.*, 2022).** The co-precipitation of carbonate minerals is of great importance for some minerals such as Zn and Cd **(Forstner and Wittmann, 1979)**.

Table 3. Heavy metals concentration (µg/g) in five stations sediments of the study area

Samples	Th	U	Na	Mg	Al	K	Ca	V	Ag	Sb	Mo	Co	Ba	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
S 1	0.11	1.45	1328.9	2397.8	152.1 ±5.8	0.11	152784.6	1.07	0.04	0.04	0.69	0.64	7.6 ±0.24	0.00	4.15 ±0.15	0.63 ±0.02	222.9	8.69 ±0.37	3.72 ±0.15	1.25	13.45 ±0.52
S 2	0.12	1.52	1457.8	2593.5	156.7 ±6	0.11	166582.9	1.01	0.06	0.03	0.07	0.70	6.31 ±0.2	0.01	4.43 ±0.16	0.69 ±0.02	253.8	9.26 ±0.39	4.15 ±0.17	1.42	10.7 ±0.41
S 3	0.14	1.68	1617.5	2774.2	175.6 ±6.7	0.11	182976.7	1.14	0.17	0.05	0.08	0.78	9.13 ±0.28	0.02	4.93 ±0.16	0.67 ±0.02	263.6	10.34 ±0.44	4.24 ±0.17	1.45	15.3 ±0.59
S 4	0.35	1.83	1674.4	3343.4	192.6 ±7.3	0.15	186469.8	1.32	0.47	0.70	0.26	0.91	8.96 ±0.28	0.04	5.76 ±0.21	0.96 ±0.03	267.8	10.53 ±0.45	4 ±0.16	1.83	14.54 ±0.56
S 5	0.18	1.79	1763.4	3242.7	199.7 ±7.6	0.14	192930.2	1.22	0.15	0.28	0.13	0.80	10.02 ±0.31	0.11	5.26 ±0.19	0.93 ±0.03	276.8	11.41 ±0.48	4.15 ±0.17	1.53	14.3 ±0.55
Min	**0.11**	**1.45**	**1328.9**	**2397.8**	**152.13**	**0.11**	**152784.6**	**1.01**	**0.04**	**0.03**	**0.07**	**0.64**	**6.31**	**0.00**	**4.15**	**0.63**	**222.9**	**8.69**	**3.72**	**1.25**	**10.70**
Max	**0.35**	**1.83**	**1763.4**	**3343.4**	**199.67**	**0.15**	**192930.2**	**1.32**	**0.47**	**0.70**	**0.69**	**0.91**	**10.02**	**0.11**	**5.76**	**0.96**	**276.8**	**11.41**	**4.24**	**1.83**	**15.30**
Average	**0.18**	**1.65**	**1568.4**	**2870.3**	**175.34**	**0.12**	**176348.8**	**1.15**	**0.18**	**0.22**	**0.25**	**0.77**	**8.40**	**0.04**	**4.91**	**0.77**	**257.0**	**10.05**	**4.05**	**1.50**	**13.66**

Fe compounds precipitate under alkaline conditions in aqueous environments. Likewise, Mn may be deposited on mineral species, organic matter, and Fe-Mn hydroxides **(Masoud *et al.*, 2007)**. Fe and Mn are considered to have the same behavior in seawater, as they are oxidized and transformed into a highly degradable form in the marine environment, so different hydroxide phases have low solubility and are deposited on the surfaces of sediments **(Millero, 2005)**. Zn is considered one of the necessary elements for the growth of marine organisms **(Hayward, 1969)**. However, Zn, Cu and Ni are common pollutants in industrial effluents of some industries, and their accumulation with high concentration are considered as pollution indicators, **(Masoud *et al.*, 2007),** Cu is used in antifouling coatings in ship hulls, and mining industry **(Organization, 1998)**, while Ni is a common pollutant in the mining, paint, , waste incineration, and wastewater industries **(El Nemr *et al.*, 2007)**. High levels of Cr, Co and Cd in marine sediments are indicative for wastewater, manufacturing processes and some metallurgical industries **(Masoud *et al.*, 2007)**.

The sediment mineral concentrations in the study area were compared with the sediment quality guidelines (SQGs), established by the National Oceanic and Atmospheric Administration (NOAA), which are widely used as guidelines to determine whether metals available in sediments create threat to aquatic ecosystems or lead to an adverse biological impacts. The probability of harmful effects increased with increasing concentrations of metals, where Hg, Cd, Ni, Pb, Cu, Cr, As and Zn represent the decreasing sequence of toxicity of most poisonous metal to marine environment (**Long *et al.*, 1995).** Table 4, illustrate Sediment quality guidelines (SQGs), adapted after **Grecco *et al.* (2011),** and **Dimitrakakis *et al.* (2014),** where TEL threshold effects level, below which adverse biological effects are not expected to occur, PEL probable effects level, above which adverse biological effects are expected to occur. The effects range-low (ERL) refer to the concentration at which small percentage of biota is affected, whereas the effects range-medium (ERM) point to greater percentage of adverse effects resulting from metal exposure equal to or greater than this concentration level.

Table 4. Sediment quality guidelines (SQGs) for heavy metals in marine sediments

SQGs	Metals concentration (µg/g)							
	As	Cu	Cr	Cd	Ni	Pb	Hg	Zn
TEL	7.2	18.7	52	0.68	15.9	30.2	0.13	124
PEL	41.6	108	160	4.2	42.8	112	0.7	271
ERL	8.2	34	81	1.2	21	47	0.15	150
ERM	70	270	370	9.6	52	218	0.71	410

Recorded heavy metals concentration in the investigated samples were in good agreement with the permitted levels compared with sediment quality guidelines (SQGs) for heavy metals in marine sediments. All recorded values sited below the threshold effects level, excluded any threaten sources of anthropogenic influence in marine sediments. Where, El Dabaa area is not exposed to direct anthropogenic activities, which generating high levels of heavy metals, consider as toxic ingredients, transported and accumulated in marine sediments, at certain conditions release trigger severe threaten to marine ecosystem.

The result of contamination factor indices (CF), (Table 5 and Fig. 4), which have been applied to assess the contamination level of 21 measured heavy metals from sediments samples collected from 5 stations along El-Dabaa area, reveals that the estimated (CF) values of 18 metals out of the 21 in the investigated samples were less than one, reflect low to nil contamination level.

Table 5. Estimated contamination Factor (CF) of sediments in the study area

Sample	CF																				
	Th	U	Na	Mg	Al	K	Ca	V	Ag	Sb	Mo	Co	Ba	Cd	Cr	Cu	Fe	Mn	Ni	Pb	Zn
S 1	0.01	0.58	0.05	0.18	0.002	0	5.19	0.02	0.79	0.12	0.49	0.06	0.01	0.04	0.12	0.04	0.01	0.02	0.20	0.07	0.26
S 2	0.01	0.61	0.06	0.19	0.002	0	5.66	0.02	1.16	0.10	0.05	0.06	0.01	0.11	0.13	0.05	0.01	0.02	0.22	0.08	0.21
S 3	0.01	0.67	0.06	0.21	0.002	0	6.21	0.02	3.05	0.17	0.05	0.07	0.01	0.17	0.14	0.05	0.01	0.02	0.23	0.09	0.29
S 4	0.03	0.73	0.07	0.25	0.002	0	6.33	0.02	8.58	2.26	0.19	0.08	0.01	0.38	0.16	0.07	0.01	0.02	0.21	0.11	0.28
S 5	0.02	0.72	0.07	0.24	0.003	0	6.55	0.02	2.64	0.91	0.09	0.07	0.02	1.03	0.15	0.07	0.01	0.02	0.22	0.09	0.28
Min	**0.01**	**0.58**	**0.05**	**0.18**	**0**	**0**	**5.19**	**0.02**	**0.79**	**0.10**	**0.05**	**0.06**	**0.01**	**0.04**	**0.12**	**0.04**	**0.01**	**0.02**	**0.20**	**0.07**	**0.21**
Max	**0.03**	**0.73**	**0.07**	**0.25**	**0**	**0**	**6.55**	**0.02**	**8.58**	**2.26**	**0.49**	**0.08**	**0.02**	**1.03**	**0.16**	**0.07**	**0.01**	**0.02**	**0.23**	**0.11**	**0.29**
Average	**0.02**	**0.66**	**0.06**	**0.21**	**0**	**0**	**5.99**	**0.02**	**3.24**	**0.71**	**0.18**	**0.07**	**0.01**	**0.35**	**0.14**	**0.05**	**0.01**	**0.02**	**0.22**	**0.09**	**0.26**

The value of estimated CF can be used to identify the contamination of an individual metal in a basin. According to **Hakanson (1980)**, CF was classified into four groups:

CF <1 = low contamination factor, 1 ≤ CF <3 = moderate contamination factor

3 ≤ CF <6 = considerable contamination factor and CF >6 = very high contamination factor , (Pazi 2011).

CF indices for Ca ranged from 5.19 to 6.55 corresponding to high to very high degree, influenced by the carbonate natural geogenic sources of the area. Ag recorded very high degree of contamination in sample S4 recorded 8.58, while in S2, S3 and S5 it ranges from moderate to high values. Sb recorded moderate degree of contamination in S4.

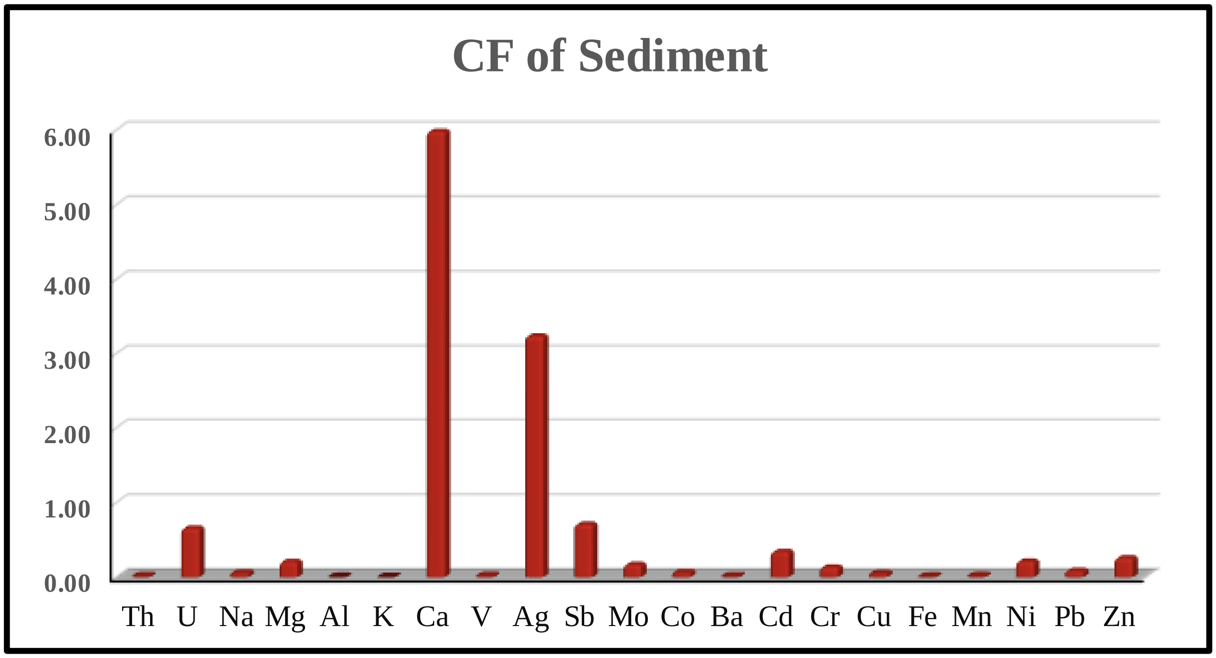

Fig. 4. The average of contamination factor (CF) for sediment in the study area

The potential source of pollution of Ag and Sb is anticipated from dense mining **(Saijun Zhou *et al.*, 2019)** and rock processing activities nearby El-Dabaa region in the Western Desert, controlled by weathering and erosion effects. This aspect need further studies and evaluation.

CONCLUSION

This study provides background contaminant levels of 21 heavy metals and geochemical analysis of sediments of El-Dabaa area that can be used for the future monitoring of the region. El Dabaa area is characterized by homogenous environment associated with similar terrestrial inputs and active hydrodynamic system concluded from the convergence of the physical and geochemical data sets analyzed from five stations along the area. Grain size texture dominated by fine sand indicate active depositional process, influenced by longshore sediment transport corresponding to magnitude of wave energy, which strike the nearshore zone. High content Calcium carbonate consists mainly of pure oolitic carbonate reflect the carbonates structure of the area, which resulted in very high Ca metal concentration associated with very high contamination grade which refer to geologic composition of hydrographic basins, influenced by the carbonate natural geogenic sources of the area. Total organic matter reveals low values, influenced by the absence of river input, almost lack of vegetation, relevant to semi-arid climate that characterized El-Dabaa region, and strong hydrodynamic system, where wind-generated waves driven strong near shore currents may negatively affect organic matter, transported it off the shore. It is expected that low organic matter content favor mobility of heavy metals.

For heavy metals concentrations, in general recorded low values of El-Dabaa sediments comparing with eastern coast of Egypt, might be related to lack of Nile river discharge, enriched with heavy metals, and the existed of dense anthropogenic activities along the eastern coast of Egypt.

Heavy metals concentrations recorded in El-Dabaa area were in good agreement with the permitted levels, verified below the threshold effects level according to sediment quality guidelines (SQGs) for heavy metals in marine sediments.

The potential source of sediments contamination with Ag and Sb related to high estimated contamination factor is anticipated from dense mining and rock processing activities nearby El-Dabaa region in the Western Desert, controlled by weathering and erosion effects, which generating higher levels of certain heavy metals transported and accumulated in sediments, provide indicative indices for marine pollution. This aspect need further studies and evaluation. However, general contamination values were generally low compared to international sediment quality guidelines. It is highly recommended to develop sustainable environmental management plan of El-Dabaa region.

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