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Assessment of Heavy Metals Pollution in Tide and Shelf Zone Sediments along the Southern Part of Gaza Strip Coast, Palestine

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Abstract

This study investigated the grain-size distribution of the sands in two lines survey, the tide and shelf zones along southern part of the Gaza Strip Coast, Palestine. In addition; the study evaluated the concentrations of Zn, Pb, Mn, Cu, Co, and Cd in the sands in the study area. Ten sampling sites were selected divided between the tide and the shelf zones. The grain-size distributions of the sand samples were determined by sieving method. While, the heavy metal concentrations were determined and analyzed by Flame Atomic Absorption Spectrophotometer.

The predominant grain size of sands in the tide zone was medium to fine-grained while in the shelf zone was fine- to very fine-grained. The concentration of Zn, Pb, Mn, Cu, Co, and Cd in the sands of tide zone in the study area range from 5.25 to 20.66, 13.54 to 16, 12.57 to 41.96, 0.8 to 1.46, 2.52 to 3.14, and 0.68 to 1 mg/kg respectively; while the concentrations of these elements in the shelf zone were 12.78 to 19.06, 12.85 to 19.5, 123.8 to 407.1, 0.26 to 3.86, 4.84 to 6.91, and 1.25 to 1.45 mg/kg respectively. The high level concentrations of the selected heavy metals were found in shelf zone, except the Zn its high level was in the tide zone.

The pollution of the selected heavy metals in the sands of the study area were under the limits with respects the EPA and the Ontario standard limits. While for Cd concentration was above the limit with respect to the EPA and the Ontario standard limits. Domestic untreated wastewater discharges and fishing activities in the area may possibly the major source of the observed higher levels of heavy metals pollution, especially the cadmium.

Keywords:
Gaza Strip,
Grain-size distribution,
Heavy metals,
Pollution

1. Introduction:

1.1. General Introduction:

Heavy metals are considered among the most serious contaminants of aquatic ecosystems, due to their high potential to enter and accumulate in the food chain. Under certain environmental conditions in aquatic systems, heavy metals may accumulate to reach a toxic concentration and cause ecological damage. The main sources of heavy metal pollution are the run-off from agricultural and urban areas, discharges from mining, factories and municipal sewer systems, leaching from dumps and former industrial sites, and atmospheric deposition (El-Serehy et al., 2012).

Sediments are the final destination of trace metals, as a result of adsorption, precipitation, diffusion processes, chemical reactions, biological activity and a combination of those phenomena. Sediments can become a source of metals, releasing them into the overlying water column. Metals in minerals and rocks are generally harmless and only become potentially toxic when they dissolve in water. Marine organisms can accumulate trace metals from the dissolved phase and from ingested food. Metals enter the environment naturally as a result of chemical and physical weathering of rocks, leaching of soils, vegetation, and volcanic activity, and as a result of urbanization, industrial and agricultural activities. Both anthropogenic and natural processes can contribute to the trace metal contamination in the coastal sediments. On the other hand the trace metal variability in the sediments has been found to be related to grain size, mineralogy, and organic carbon (Mansour et al., 2013).
The aim of this study is to determine the grain size distribution and the concentrations of Zn, Pb, Mn, Cu, Co and Cd in sediments of tide and shelf zones of the study area.

1.2. The Study Area:

The study area is located in the southern part of the Gaza Strip Coast. The coastal zone of the Gaza strip (Figure 1) is 42 km long, while the width of the Strip is between 6 and 12 km covering an area of 365 km^2. It is situated in the southwestern part of Palestine and Southeast Mediterranean Sea and occupied by 2 million populations. The coastal zone of the Gaza strip is defined as a band of water and a land extended along the seashore of the eastern Mediterranean Sea. The coastal zone includes the sand dunes in the south and north, the coastal cliffs (exposed Kurkar Ridges) in the middle to north. The land band of the coastal zone covers about 74 km^2 of which 2.7 km^2 are beaches (Al-Agha, 2000; Ali, 2002; Ubeid, 2010; Ubeid & Al-Agha, 2016).

2. Methodology:

2.1. Field Work:

To investigate the distribution of heavy metals in tide and shelf zones along the southern part of the Gaza Strip Coast, ten samples were collected from Rafah in southern border to Khan Youns. Five samples collected from the tide zone; and five samples were collected in shelf zone. The samples in the shelf zone located at 350 m from shoreline (Figure 1).The samples were collected in February 2015 during winter season from upper 20 cm sands depth along approximately 14 km of the Gaza Strip Mediterranean Sea. Sediment samples were placed in polyethylene bags, tightly closed, and transported to the laboratory.

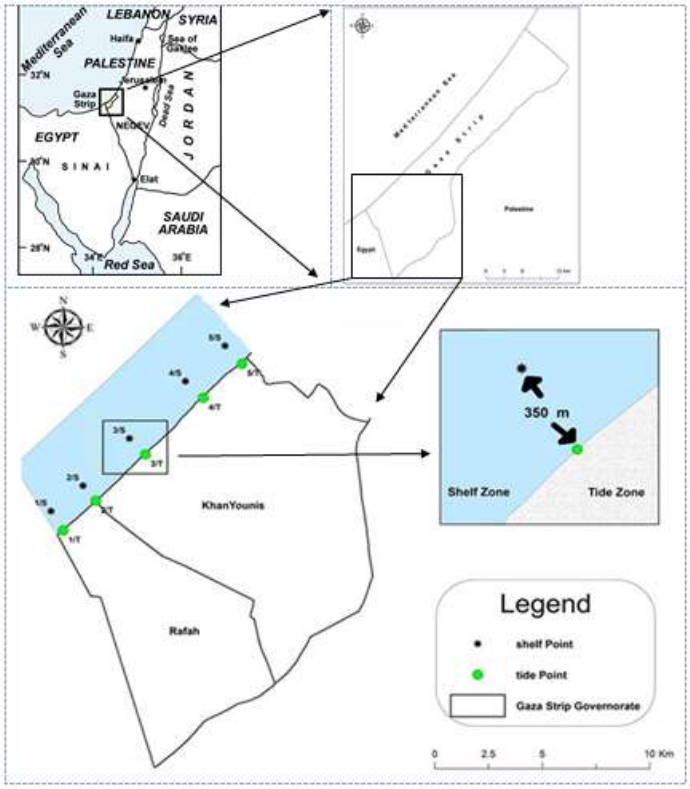

Figure 1 *Location map of the study area*

2.2. Lab Work:

The grain-size distribution were determined after drying the sediment samples at 105 °C for 24 hours in an oven. The sieving method to classify the particle sands, eight sieves were used (2000, 1180, 600, 425, 300, 212, 150, 63 µm).
Around four grams of dried fine-grained sediments (<90 µm) were taken for chemical analysis. The four grams of dried sediment sample were added to 3 ml concentrated nitric acid and 9 ml of hydrochloric acid (Aqua regia) in prewashed beaker by distilled water and digested at room temperature. The sediment samples were then evaporated almost to dryness at moderate temperature 65-70 C° on the hot plate under the clean air-fuming hood. Finally, the samples were diluted up to 50 ml with 2% nitric acid.
Heavy metals (Zn, Pb, Mn, Cu, Co, and Cd) in the sediment samples were analyzed by Flame Atomic Absorption Spectrophotometer (FAAS).

3. Results and Discussion:

3.1. Grain size distribution:

The Table 1 summarizes the grain size distribution in the study area.

Table 1*Grain size distribution of sands along study area*

Sample No.	Very Coarse Sand %	Coarse Sand %	Medium Sand %	Fine Sand %	Very Fine Sand %	Silt + Clay %
1/T	1.0%	13.0%	73.6%	12.1%	0.2%	0.1%
2/T	4.8%	14.8%	51.5%	27.6%	0.9%	0.3%
3/T	1.9%	6.1%	49.1%	41.8%	1.1%	0.0%
4/T	23.1%	27.2%	31.3%	17.6%	0.7%	0.1%
5/T	1.5%	9.4%	65.3%	23.3%	0.5%	0.1%
1/S	23.9%	3.1%	6.5%	27.1%	35.4%	4.0%
2/S	1.5%	1.4%	4.7%	33.1%	50.5%	8.7%
3/S	0.6%	0.9%	3.5%	32.2%	58.9%	3.9%
4/S	2.3%	1.9%	6.7%	34.4%	47.9%	6.9%
5/S	1.3%	1.2%	7.5%	48.8%	35.6%	5.5%

It's clear that the predominant of all site samples in tide zone was classified as medium- to fine sands, which variable from 73.6% to 31.3% of medium-grained, and from 27.6% to 12.1% of fine-grained. Whereas, the predominant grain size of sands in shelf zone was fine- to very fine-grained, which variable from 48..8% to 27.1% of fine-grained, and from 58.9% to 35.4% of very fine-grained. Overall, the grain size shows finning towards the sea direction.

3.2. Heavy metal concentrations:

Table 2 presents the concentrations and the statistical descriptive of the selected heavy metals (Zn, Pb, Mn, Cu, Co, and Cd) in the sands of the study area.

Table 2 *Heavy metal concentrations (in mg/kg) in the sands along the study area*

	Site No.	Zn	Pb	Mn	Cu	Co	Cd
Tide Zone	1/T	5.25	14.96	12.57	0.8	2.68	0.98
	2/T	27.29	14.76	36.57	1.46	2.52	1.0
	3/T	11.08	16.0	41.96	1.17	2.98	0.9
	4/T	20.66	13.54	13.05	0.87	3.14	0.68
	5/T	8.11	14.48	14.92	0.77	3.14	0.87
	Min.	5.25	13.54	12.57	0.77	2.52	0.68
	Max.	27.29	16	41.96	1.46	3.14	1
	Mean	14.48	14.75	23.81	1.01	2.90	0.89
	St. Dev.	9.21	0.89	14.26	0.30	0.28	0.13
Shelf Zone	1/S	14.48	17.81	407.1	3.86	6.91	1.45
	2/S	12.78	18.18	245.62	2.68	4.84	1.33
	3/S	14.11	19.5	185.95	2.65	4.95	1.29
	4/S	19.06	14.31	240.45	0.26	6.28	1.25
	5/S	13.07	12.85	123.8	2.07	3.89	1.07
	Min.	12.78	12.85	123.8	0.26	3.89	1.07
	Max.	19.06	19.5	407.1	3.86	6.91	1.45
	Mean	14.70	16.53	240.58	2.30	5.374	1.28
	St. Dev.	2.54	2.81	105.33	1.31	1.21	0.14
Total Study Area	***Min.***	5.25	12.85	12.57	0.26	2.52	0.68
	Max.	27.29	19.5	407.1	3.86	6.91	1.45
	Mean	14.59	15.63	132.20	1.66	4.13	1.08
	St. Dev.	6.37	2.179	134.43	1.13	1.55	0.24

The results shows that the high level of the Zn found at tide zone, with value about 27 mg/kg, whereas the high level in the shelf zone was up to 19 mg/kg. The Pb high concentration in the sands was about 19.5 mg/kg in

shelf zone, whereas in tide zone the high level was around 16 mg/kg. The high level of the Mn was observed at shelf zone with value about 407 mg/kg, and up to 42 mg/kg in tide zone. The Cu high level concentration found at shelf zone, it was about 4 mg/kg, and about 1.5 mg/kg in tide zone. The Co High level also found at shelf zone, it was about 7 mg/kg, and about 3 mg/kg in tide zone. The high level concentration of the Cd also found at shelf zone with value about 1.5 mg/kg, and around 1 mg/kg in tide zone.

Overall the high level of the selected heavy metal concentrations in the sands of the study area were found in the in shelf zone, except the Zn, where its high level was at tide zone.

The particle size of sediment is a particularly important factor because it significantly affects the concentrations of the associated pollutants. In this study, the concentration of heavy metals increases with the decreases of the average particle size, and the highest concentrations were measured in the finest fraction (Table 1 & 2). Where, the shelf zone which shows higher level of heavy metal concentrations has finest grain-size. The results demonstrate that the heavy metal concentrations were significantly correlated with average particle size which is in agreement with previous studies (Rodríguez-Barroso et al., 2010; Duyusen & Akinci, 2013; Fernandez et al., 2015; Li et al., 2015).

The heavy metal concentration levels in the sediments of the study area were compared with the available international standards (Table 3).

Table 3 *Limits values (in mg/kg) according to EPA (Pekey et al., 2004), WHO (2004), and the results from the study along Gaza Strip Coast in both, tide and shelf zone*

Metal	EPA	Ontario Canada	Present study	
			Tide Zone	Shelf zone
Zn	120	120	5.25 - 27.29	12.78 - 19.06
Pb	31	31	13.54 - 16.0	12.85 - 19.5
Mn	460	——	12.57 - 41.96	123.8 - 407.1
Cu	16	16	0.77 - 1.46	0.26 - 3.86
Co	——	50	2.52 - 3.14	3.89 - 6.91
Cd	0.6	0.6	0.68 - 1.0	1.07 - 1.45

The results shown that the concentration values of the heavy metals (Zn, Pb, Mn, Cu, and Co) in the study area were under the limits with respect to the EPA and the Ontario standard limits. While for Cd concentration was above the limits with respect to the EPA and the Ontario standard limits. Domestic untreated wastewater discharges and fishing activities in the area may possibly the major source of the observed higher levels of heavy metals pollution, especially the cadmium.

4. Conclusion:

The grain size distribution in the sand sediments along the coast of the southern part of Gaza Strip were predominant by medium- to fine-grained in the tide zone; whereas fine- to very fine-grained in the shelf zone. The heavy metal concentration of Zn, Pb, Mn, Cu, Co, and Cd in the sands of tide zone in the study area range from 5.25 to 20.66, 13.54 to 16, 12.57 to 41.96, 0.8 to 1.46, 2.52 to 3.14, and 0.68 to 1 mg/kg respectively; while the concentrations in the shelf zone were 12.78 to 19.06, 12.85 to 19.5, 123.8 to 407.1, 0.26 to 3.86, 4.84 to 6.91, and 1.25 to 1.45 mg/kg respectively. The high level concentrations of the selected heavy metals were found in shelf zone, except the Zn its high level was in the tide zone.

Comparing the results of the heavy metal concentrations of Zn, Pb, Mn, Cu, Co, and Cd in the sands of the study area with EPA and the Ontario standard limits indicate that no pollution in the study area except the Cd which it was upper the standard limits. Domestic untreated wastewater discharges and fishing activities in the area may possibly the major source of the observed higher levels of heavy metals pollution, especially the cadmium.

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تقييم التلوث بالمعادن الثقيلة في رواسب منطقة المد و الجزر و المنطقة البحرية على طول الجزء الجنوبي من ساحل قطاع غزة، فلسطين

كلمات مفتاحية:
قطاع غزة ،
التوزيع الحجمي للحبيبات ،
المعادن الثقيلة،
التلوث.

قامت هذه الدراسة بالتعرف على التوزيع الحجمي لرمال الساحل على امتداد خطين متوازيين، الأول في منطقة المد و الجزر، و الثاني في اتجاه البحر على بعد 350 متر من الخط الأول، في منطقة الدراسة الواقعة في الجزء الجنوب من ساحل قطاع غزة، فلسطين. كما قامت الدراسة بتقييم تركيز المعادن الثقيلة (الزنك، الرصاص، المنجنيز، النحاس، الكوبلت، و الكادميوم) في رمال الساحل. عشرة عينات من الرمال تم أخذها من مواقع تم اختيارها بعناية. التوزيع الحجمي للعينات تم عمله باستخدام طريقة التنخيل، بينما تركيز المعادن الثقيلة في العينات تم ايجاده بواسطة جهاز قياس الامتصاص الذري.

و قد أظهرت النتائج أن حجم حبيبات الرمال السائد في منطقة المد و الجزر كان الحجم الحبيبي المتوسط، بينما الحجم السائد في المنطقة البحرية كان الحجم الحبيبي الدقيق إلى الدقيق جداً. كما و أظهرت الدراسة أن تركيز الزنك، الرصاص، المنجنيز، النحاس، الكوبلت، و الكادميوم في منطقة المد و الجزر كان يتراوح ما بين 5.25 - 20.6, 13.54 - 16, 12.57 - 41.96, 0.8 - 1.46, 2.52 - 3.14 ، و 0.68 – 1 ملجم/كجم على التوالي، بينما في المنطقة البحرية كان يتراوح ما بين 12.78 - 19.06, 12.85 - 19.5, 123.8 - 407.1, 0.26 - 3.86, 4.84 - 6.91, 1.25 - 1.4 ملجم/كجم على التوالي. أعلى مستوى لتركيز المعادن الثقيلة لوحظ في المنطقة البحرية، ما عدا مستوى تركيز الزنك، كان مرتفع في منطقة المد و جزر.

التلوث بالمعادن الثقيلة التي تم دراستها في الرواسب البحرية في منطقة الدراسة كان اقل من المستوى المسموح به حسب معايير وكالة البيئة الأمريكية و كذلك معايير اونتاريو الكندية، ما عدا عنصر الكادميوم كان أعلى بقليل من المستوى المسموح به. تعتبر المياه العادمة الغير معالجة و كذلك أنشطة الصيد من أهم مصادر العناصر الثقيلة في منطقة الدراسة، و خاصة التلوث بعنصر الكادميوم.