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THE ANTHROPOGENIC EFFLUENTS OF THE HUMAN ACTIVITIES ON THE RED SEA COAST AT HURGHADA HARBOUR (CASE STUDY)

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ABSTRACT

The heavy metal accumulations in the seawater, coral reefs and two effective fractions of underlying sediments (<0.125mm and < 0.063mm) were studied in the coastal and tidal flat zones at the main shipyard near of Hurghada Harbour. The area of investigation is very worse whereas, it is considered tailing outlet for both solid and liquid influents of many human activities in/and surrounding the harbour. The solid phases are of construction remains, paint remains, iron pipe rusts, hydrocarbons, plastic bags, metal and wood remains as well as the artificially conglomerate stones that thrown in the in the marine area. The liquid phase is restricted in the continuous brine water draining to the sea from a huge desalination plant (Capacity 5000 cubic meters of freshwater daily) and the bilge water of the boats cooling engines in the mooring zone inside the shipyard marine area. The recorded metals show significant declination seaward in both seawater and sediments. The highest values of Fe, Mn, Zn, Cu, Pb, Ni and Cd in the seawater were recorded at the outlet point of the desalination plant pipeline while the highest values in the sediments were recorded at the beach zone whereas the dumped materials were concentrated. The finest fraction sediments (<0.63mm) recorded high concentrations of the toxic metals; Zn, Cu, Pb, Ni and Cd than the coarsest one. Pb in sediments recorded high reading in the boat mooring zone in the two sediment fractions relative to the beach zone and inside the sea. The recorded coral reefs are new generations (recruits) mostly of the massive forms. These corals were growing over; conglomerate stones, rusted iron plates, plastic remains and car tires dumped to the zone. The metal concentrations in these corals are high relative to their age and the recorded metals in world. This study indicated that some coastal activities as; the shipyards and desalination plants are environmentally antagonistic and must be monitored continuously in order to decrease their effluents to the tidal flat zones. Also, it is obvious that the new coral generations are able to accommodate with the inconvenient conditions.

1. INTRODUCTION

Many anthropogenic and natural disturbances influence the coral reefs of the Red Sea including the pollution by; oil spills, industrial wastewater and sewage, heated influents of desalination plants, explosives, building activities along the seashore (Mergner, 1984), haypersaline water rejection, navigation and shipping operations, mining and raw material grinding, shipyards, landfilling, dredging operations, domestic wastes as well as salinity increasing due to high evaporation rates, intensive solar radiation and the high exposure due to the fierce low tides as well as many diving sites were overexploited and many other pollutants were dumped to tidal flat areas.

With increasing the urban occupation along the Red Sea coast due to the progressive development in the tourist industry throughout the last three decades, the rapid and uncontrolled human activities along the Red Sea coast were increased intensively in some places causing a series of disturbances and demolish stresses on the tidal flat ecosystem of the Red Sea. Some of them as the prominence constructions have altered the depositional-hydrodynamic pattern as a result of blocking the littoral currents by the protruded constructions (Frihy *et al.*, 2004). Major reef hazards have been carried out in the coral reef communities in Hurghada due to dumping sediments for constructing marina jetties, gardens irrigation with treated wastewater, oil waste pollution resulting from motor boats and the discharge the desalination hot brine effluents (Frihy et al. 1996).

In the marine environment, Sediments act as an important reservoir for heavy metals, which lead to metal uptake to the living organisms (Mountouris *et al.*, 2002). The contamination of sediments by antifouling paints that including Zn and Cu as common constituents has the potential to significantly reduce coral recruitment in the immediate vicinity and that this contamination may threaten the recovery of the resident coral community (Negri *et al.*, 2002). The deposit of fine sediments with high organic matter content produces anoxic environment with abundant sulfate which tend to become sulphides (Barbosa *et al.*, 2001). The ecological risk produced by metals largely depends on their form in water, the capacity of metals for complexing, sedimentation and bioaccumulation (Hoz *et al.*, 2000).

The benthos re-adjustment in the coastal localities after sediment disposal follow three stages; the benthos is barren of invertebrates, recruitments of opportunistic taxa and faunal abundance increases exponentially and the settlement of larger and slower growing species (Blanchard and Feder, 2003). Corals accurately reflect the extent of contamination of the surrounding area, the increased metal concentration in corals are due to either their proximity to a tailing source or to a spill event, and/or to increased erosion/sedimentation in the coastal area (David, 2003). Also, they are subjected to extremely high sedimentation typically show a decline in extension rates and mostly attributable to reduced light penetration as well as the anthropogenic eutrophication (Edinger *et al.,* 2000). The sediment particles may adhere to coral mucus on the upcurrent coral face, subsequently, the metal bearing particles may settle on the coral surfaces (Esslemont *et al.*, 2000).

In this study we report the elevated heavy metal levels in sediments, seawater and coral reefs in the main shipyard embayment off Hurghada, which considered one of the highly stressed areas along the Red sea coast in order to rehabilitate the area in/and around Hurghada Harbour. Also, the present aims to provide the suitable environmental management for the human activities in the coastal areas.

2. MATERIALS AND METHODS

The investigated site represent the main shipyard of Hurghada city, it is located directly between the fishing and the passenger harbours at 27° 13′ 48″N; 33° 50′ 37″ E (Fig. 1). Longtime ago this site was used to repair, maintain and construct fishing ships. Recently, the construction and maintaining operations in this shipyard were develop to repair, maintain and construct safari, diving ships for and yachts. Ten years ago, the southern part of the shipyard beach was used to drain the brine water of the huge desalination plant of the city (Production ≈ $5,000 m^3$ freshwater daily). The beach is covered with of terrestrial sand while the tidal flat contains a mixture of terrace shatters of different sizes, gravel and sands.

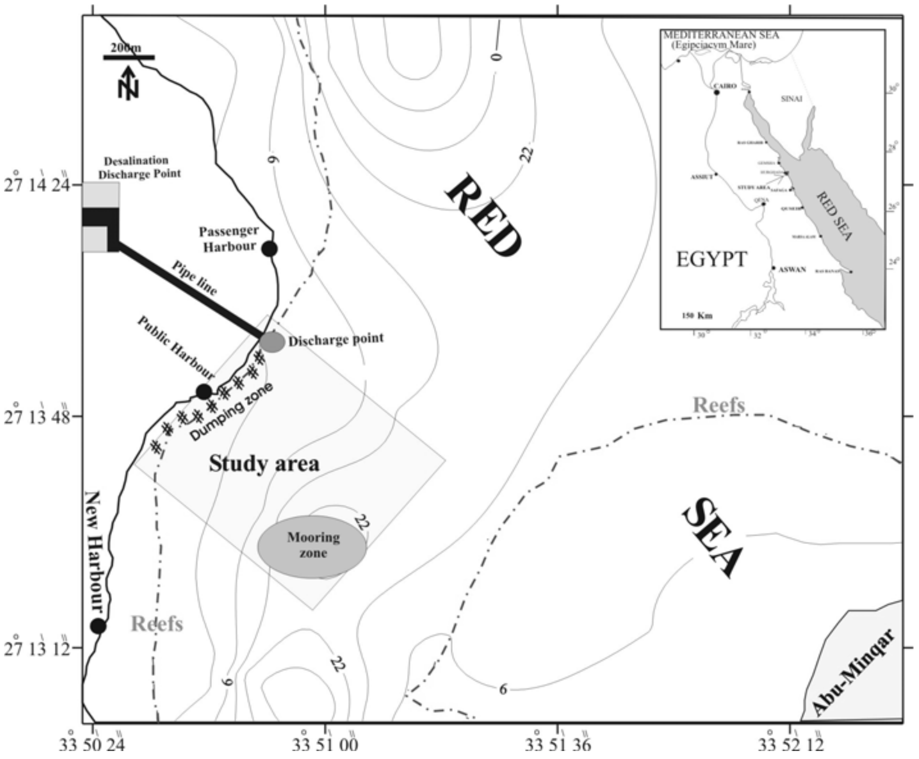

Fig. (1). Location Map of Hurghada Harbour.

Ten sediment samples were collected in from the beach, interidal and subtidal zone at right angle transect to the shoreline of the disposal embayment that used by the main shipyard of Hurghada City (Fig. 1). These samples were washed and dried then sieved using mechanical shaker every one Ø interval (Folk, 1974) to estimate the main sediment constituents. The finest fractions (<0.125mm and 0.063mm) of each sample were used to determine the anthropogenic heavy metal accumulations in the embayment. 0.5gm of each sub-sample was digested in Teflon cup using a mixture of HF, HNO_3 and $HClO_4$ acids (Chester *et al.* 1994) to the complete dissociation then diluted with de-ionized distilled water to about 25ml. Fe, Mn, Zn, Cu, Pb and Cd have been determined in µg/g by the AAS (Atomic Absorption Spectrophotometer, GBC 932, Ver 1.1). The measurement accuracies were obtained by applying three replicates in each measurement with reading variation less than 5%.

Seawater was sampled using water sampler (PVC tube ≈ 3L), 8 samples were also collected at right angle transect to the shoreline of the disposal embayment, the first sample bottled near the outlet of the discharge pipeline of the desalination plant then the sequence completed seaward. The heavy elements were determined in (µg/L) using the AAS technique according to Martin (1972). One liter of each sample was filtered through 0.45µ membrane and adjusts the pH in the range 4-5 with HCl. The trace metal contents of each sample were catch within ammonium pyrrolidine dithiocarbamate (APDC) and methyl isobutyl ketone (MIBK) complex and then extracted using 6N HNO_3 acid. The extracted solution is digested on hot plate to near dryness then solved in about 10 ml of de-ionized water for the trace metal determinations.

Thirteen new coral generations settling the different solid disposal substrates represent four coral forms; branching (*Stylophora pistillata* and *Pocillopora verucosa*), massive (*Favia pallida*, *Favia rotundata*, *Favites abdita*, *Favites persi*, *Goniopora tenella* and *Porites solida*), encrusting (*Echinopora gemmacea*, *Gardineroseris planulata* and *Leptoseris mycetoseroides*) and oscillatory (*Ctenactis echinata* and *Cycloseris doederleini*) were collected from the embayment and identified according to Sheppard and Sheppard (1991) and Veron (2000). The collected specimens were cleaned in running water to remove the adhering fauna, flora and the strange materials, dried in the sunlight and powdered, then 0.5gm of each sample was digested a mixture of HF, HNO_3 and $HClO_4$ acids (Chester *et al.* 1994). After the complete digestion, each sample was diluted to 25ml and the trace metals were determined as (µg/g) using AAS technique (GBC 32, Ver. 1.1). The measurements accuracy was checked by applying three replicates in each sample.

3. RESULTS AND DISCUSSION

Longtime ago, Hurghada Harbour locality was intensively used as fishing port and as shipyard for the small boats. With increasing the tourist activities, commercial movements and the population settlements; the renewing human activities were enlarged inside and around the harbour as; repairing, maintaining and buildup ships up to 40m long and 6m drift, increasing the navigation activities including passenger travels between Egypt and Saudi Arabia, tourist feeding industries as the main desalination plant of Hurghada city and the fuel stations that deposit the hydrocarbon wastes in the coastal and tidal flat zones. There are 21 plants are present in the northern Red Sea with a total desalination capacity of 1,579,664 m^3/d, of which 96% are distributed along the shoreline of the Kingdom of Saudi Arabia. The Gulf of Aqaba has an installed capacity of 30,171 m^3/d (2% of the total) compared to only 4,225 m^3/d in the Gulf of Suez, not including the plants in Hurghada and Sharm El Sheikh with a production of 10,500 and 22,900 m^3/d respectively (Hoepner and Lattemann, 2002).

Shallow embayments act as sediment traps that preserve the signature of the source (Preda and Cox, 2005). The main pollutants of the shipyard scrapping industry and its associated wastes are chiefly heavy metals, petroleum hydrocarbons and bacterial contaminants (Tewari *et al.,* 2001; Reddy *et al.*, 2003). The heavy metal contaminations in the sediments of the shipyard embayment are derived from the repairing, maintaining, antifouling paint remains and ship building up. These stressors are causing acrimonious ecological risk on the marine ecosystem components; sediment nature inside and outside the tidal flat of the shipyard, seawater quality and the benthic communities in the embayment.

Heavy metal contents in these items are considered the real sensor to the problem severity. Some heavy metals that may influence by anthropogenic sources accumulate together mostly in the fine grained sediment fractions (Aloupi and Angelidis, 2001), therefore the degree of pollution is depending up on the fraction percentages relative to the other fractions. Also, these fractions are able to leach by the wave winnowing and tidal currents to the nearby sedimentation basins other sheltered places as the coastal lagoons and back reef zones. Reddy *et al.* (2004) recorded that the heavy metals were greater in the fine fractions than in bulk fraction sediments (2-19 times) due to the high surface area and the presence of complex organic materials. The total percentage of the two fractions (<0.125mm and <0.063mm) is varying between 1.35% at the beach and 51.71% in the tidal flat area (Table 1), also, the fraction (<0.125mm) has significant occurrence relative to the finest one (1.34% to 43.10%).

Subsequently the two fractions are considerably effective in the contaminants accumulation and transfer to the marine ecosystem. The studied trace metals concentrations are fluctuating between the two fractions. Fe content recorded subeqaul values between the two fraction without any abrupt change between the beach (1555.60 ppm) and the tidal flat end (1403.10 ppm) along the transect of study. Mn is varying between 12.4ppm and 313.5ppm, it has the same iron trend along the transect (Table 2). The metals; Zn, Cu, Ni and Cd recorded their higher contents at and near the beach and decreasing gradually seaward. Zn, Cu and Ni recorded 349.60ppm, 1862.80ppm, 21.42ppm and 3.73ppm respectively at the beach decline to 98.40ppm, 57.90ppm, 4.60ppm and 1.78ppm respectively (Figs. 2; 3). Conversely, Pb is decreasing landward, it recorded 74.80ppm at the beach increases to 104.00 at the transect end. It is more related to the (<0.125ppm) fraction. The highest values of Pb in the two fractions 206.6ppm and 105.50ppm in the midpoint of the transect. This zone is used as boats mooring; subsequently the bilge water, engine cooling water and washing wastewater are draining daily as well as the low engine efficiencies. Kishe and Machiwa (2003) attributed the high Pb concentrations in Mwanza Gulf shoreline to the use of leaded petrol in outboard boat engines.

Table (1): Sediment fractions distribution along the transect at the marine area off the shipyard.

Transect	fractions (%)						
	>2.0mm	<2mm	<1mm	<0.5mm	<0.25mm	<0.125mm	<0.063mm
HS1	24.94	18.96	19.14	21.90	12.96	1.34	0.01
HS2	10.73	17.35	28.89	25.33	15.11	2.58	0.01
HS3	9.75	11.72	11.59	15.92	23.39	21.64	6.00
HS4	9.22	7.55	8.16	11.46	29.34	30.01	4.28
HS5	0.01	3.80	11.51	20.15	27.39	32.76	4.37
HS6	3.17	9.04	18.87	24.53	26.46	14.11	3.82
HS7	0.75	2.86	8.22	19.68	37.79	27.62	3.07
HS8	0.13	6.26	10.98	13.60	24.40	38.16	6.49
HS9	0.31	2.23	6.56	11.44	27.76	43.10	8.61
HS10	0.25	3.95	8.04	13.28	26.33	40.93	7.24

Table (2): Heavy metal contents in <0.125mm and < 0.063mm fractions.

sample names	Fe *	Mn*	Zn*	Cu*	Pb*	Ni*	Cd*
HS1a	1555.6	206.8	349.6	1862.8	74.8	21.42	3.73
HS2a	1567.9	250.0	325.5	1412.6	174.8	37.51	3.07
HS3a	1593.7	298.9	317.4	1062.5	27.5	12.51	3.04
HS3b	1529.8	183.5	279.1	672.2	111.2	5.73	2.54
HS4a	1438.8	142.8	206.3	375.7	206.9	2.21	2.01
HS4b	1540.9	313.5	240.8	461.1	100.6	3.20	2.10
HS5a	1330.6	126.5	91.7	106.1	102.6	0.00	2.11
HS5b	1511.3	219.1	211.9	312.3	105.5	2.22	1.80
HS6a	1431.4	12.4	177.3	250.1	190.9	2.63	1.51
HS6b	1446.2	270.9	116.2	102.9	102.3	1.54	1.42
HS7a	1371.2	111.0	195.1	247.6	130.6	0.00	1.50
HS7b	1489.2	230.2	142.6	261.1	73.7	6.47	1.70
HS8a	1324.4	97.3	77.2	58.6	92.7	2.84	1.49
HS8b	1428.9	248.2	117.2	57.6	98.7	1.24	1.66
HS9a	1303.5	104.5	85.9	43.8	105.7	3.27	2.13
HS9b	1443.7	236.0	121.5	69.3	101.2	3.00	1.88
HS10a	1309.7	132.9	77.3	34.2	76.4	4.08	1.81
HS10b	1403.1	213.3	98.4	57.9	104.0	4.60	1.78
Av.	1445.6	188.8	179.5	413.8	110.0	6.4	2.1
SD	92.62	80.18	91.24	522.84	43.27	9.28	0.64

* Values in ppm.

Plate (1): Different types of impacts, (a)shipyard, (b) Desalination outlet; (c) & (d) green algae eutrophication, (e) garbage on the coast and (f) mooring zone.

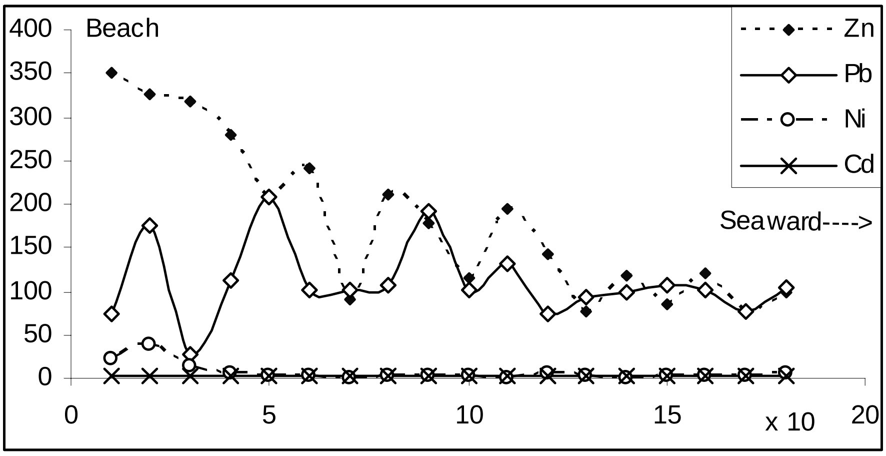

Fig. (2): Zinc, lead, nickel and cadmium in the fine sediment fractions along the transect.

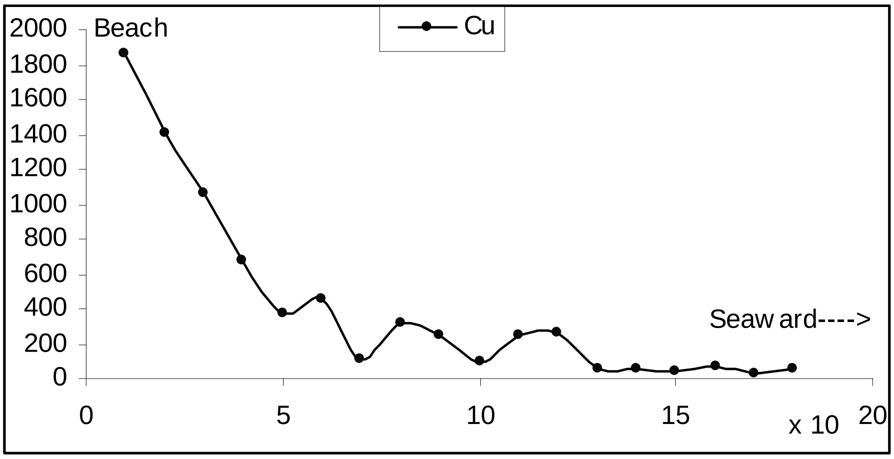

Fig. (3): Copper distribution in the fine sediment fractions along the transect.

Sediments with high levels of copper (400–1500 mg/kg) clearly had a negative effect on colonisation by several taxa (Trannuma *et al.* 2004). Some of Cu and Ni contaminants in the shipyard embayment are derived from the reject water of the desalination plant. Hoepner and Lattemann, (2002) pointed out that the daily chemical discharge amounts from the desalination plants in the Red Sea to 2,708 kg chlorine, 36 kg copper and 9,478 kg antiscalants, when effluent concentrations of 0.25 ppm, 0.015 ppm and 2 ppm are assumed, respectively. They added, copper is only one representative of the mani- fold corrosion products, among which nickel, chromium, molybdenum and iron. These metal ions are removed from the water column and by transport into sediments. In the studied locality, for more than ten years, the desalination plants were used copper sulfate as buffer solution as well as Ni may derived from the pipeline corrosions. The high amounts of Cu, Zn and Fe in the contaminants form new minerals or they may bound in carbonate, phosphate, sulphate and hydroxides (Gade *et al.*, 2001).

Cobelo-Garcia and Prego (2004) documented that, two main factors controlled the metal distribution and concentrations in the seawater of the embayment; contamination point sources and distribution of the organic rich sediments, therefore Zn, Cu and, to a lesser extent Pb, were the metals most contaminated in the embayment. Heavy metal contents in the collected seawater samples from the same locality illustrate that all the highest concentrations of; Fe, Mn, Zn, pb, Ni and Cd were recorded at or directly near the beach (83.51 µg/L, 194.48 µg/L, 10.52 µg/L, 14.74 µg/L, 7.87µg/L, 0.83µg/L and 0.92 µg/L, respectively) and abruptly decreased seaward to the end of the transect (15.76 µg/L, 0.40 µg/L, 3.68 µg/L, 0.10 µg/L, 0.26 µg/L, 0.01 µg/L, 0.54 µg/L) respectively (Table 3; Fig. 4). This is indicating to the presence of direct supplying source of pollutants mainly from the antifouling paints and repairing rusts of the ship maintenances, the desalination plant and boat mooring as well as indirect source restricted in the metal dissociations from the underlying sediments due to the continuous wave winnowing action.

The corals reefs subject to combined anthropogenic eutrophication and sedimentation may have normal extension rates, while other reef health parameters such as live coral cover, coral mortality indices suggest serious degradation (Edinger *et al.* 2000). The contamination of sediments by antifouling paints that including Zn and Cu as common constituents has the potential to significantly reduce coral recruitment in the immediate vicinity and that this contamination may threaten the recovery of the resident coral community (Negri *et al.*, 2002). Copper is considered the most toxic metal to a wide spectrum of marine life, hence its value in antifouling preparations (Trannuma *et al.*, 2004). (Inoue *et al.*, 2004) attributed the high concentrations of Cu, Pb and Zn in the coral skeletons to the industrial activities, municipal wastes and in particular to the coastal marine sediments.

Esslemont (2000) noted that lead and copper accumulated in the coral skeletons in direct response to the environmental availability. The ability of coral larvae to settlement is subjected to high level of sedimentation has clear adaptive advantages, since sedimentation is leading cause death for newly settled corals (Babcock and Davies, 1991).

Corals accurately reflect the extent of contamination of the surrounding area, subsequently the higher Cu, Fe, Mn and Zn concentrations in *Porites* corals are due to either their proximity to tailings source or to spill event (David, 2003). The recorded and selected corals are of young colonies and new recruit species. The recorded metals in these corals are relatively high compared with their ages and the measured trace metals in adult colonies under different stresses around the world (Table 4).

Table (3): Heavy metal contents in the seawater along the transect.

sample names	Fe *	Mn*	Zn*	Cu*	Pb*	Ni*	Cd*
HW1	83.51	2.43	10.52	14.74	7.87	0.83	0.92
HW2	81.65	194.48	4.58	4.63	1.94	0.01	0.66
HW3	29.03	0.40	11.41	2.55	4.68	0.00	0.73
HW4	20.06	0.51	8.17	1.93	0.00	0.00	0.51
HW5	15.40	0.00	2.65	0.00	2.66	0.51	0.72
HW6	11.70	0.00	4.70	0.16	1.64	0.10	0.53
HW7	7.22	0.53	3.00	0.33	0.90	0.00	0.51
HW8	15.76	0.40	3.68	0.10	0.26	0.00	0.54
Av.	33.0	24.8	6.1	3.1	2.5	0.2	0.6
SD	31.23	68.55	3.46	4.99	2.63	0.32	0.14

Values in µg/l.

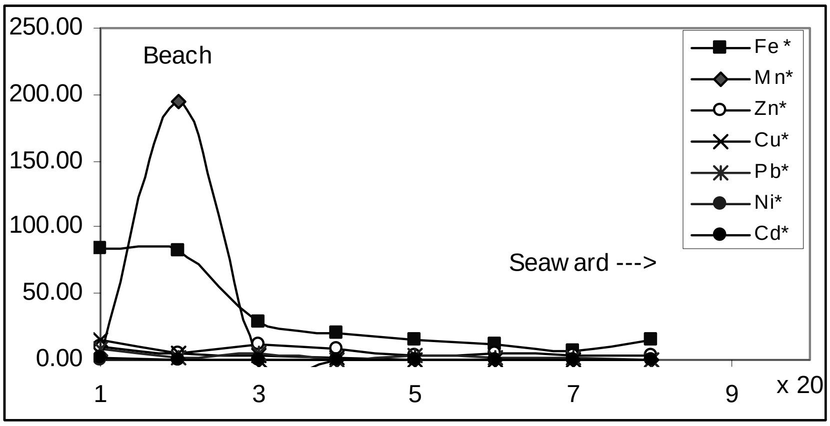

Fig. (4): heavy metal distribution in the seawater along the transect.

Table 4: Heavy metal contents in the coral recruits of the studied area in comparison with some other localities in the world:

Coral species	Locality	Fe	Mn	Ni	Cu	Zn	Cd	Pb	Reference
Stylophora pistillata	Hurghada Harbour, Red Sea	203.45	6.42	1.94	1.81	13.93	1.0	7.69	The present study
Pocillopora verrucosa		65.42	3.41	1.76	1.07	18.57	1.16	7.39	
Ctenactis echinata		55.74	1.90	1.22	3.54	17.63	1.10	16.07	
Echinopora gemmacea		147.39	2.27	1.30	1.78	13.81	0.94	11.53	
Favites abdita		56.74	2.17	1.17	2.25	14.85	1.11	4.92	
Favites peresi		71.74	2.97	1.30	3.10	36.27	0.94	16.61	
Favia pallida		731.69	2.92	0.96	3.02	14.71	1.13	5.45	
Favia rotundata		112.63	4.15	1.42	2.25	16.08	0.95	6.54	
Gardineroseries planulata		196.0	4.61	1.21	3.59	19.10	0.96	20.91	
Leptoseris mycetoseroides		48.58	4.82	1.96	2.68	14.49	1.03	7.44	
Goniopora tenella		223.41	7.73	2.10	6.39	26.60	1.02	20.24	
Cycloseris doederleini		39.55	2.69	1.45	5.02	17.54	1.04	20.74	
Porites solida		81.39	3.93	0.28	2.10	27.26	0.95	4.72	
Porites asteroids	Caganhao Reef	-	0.80	-	0.70	1.00	-	-	David, 2003 (Philippines)
	Ulan reef	-	1.00	-	3.10	1.80	-	-	
	Ihatub Reef	-	0.80	-	1.40	2.00	-	-	
Porites <1982	Misima Is. - PNG	-	0.19	-	-	0.70	-	0.24	Fallon et al. 2002
Porites >1982			0.49	-	-	19.9	-	0.47	
Porites asteroids	Punta Bravo	62.05	-	-	16.33	10.67	-	0.208	Bastidas and Garcia, 1999 Venezuela
	Bajo Caiman	18.09	-	-	12.52	9.12	-	1.037	
Colpophyllia amaranthus	Alina's reef – Florida Keys	26.0	-	-	3.0	-	<0.2	7.4	Glynn *et al.* 1989
Diplora clivosa		38.0	-	-	5.7	-	<0.2	5.0	
Diplora strigosa		30.0	-	-	9.2	-	<0.2	8.0	
Montastrea annularis		23.3	-	-	10.7	-	<0.3	<1.0	
Porites astreoides		51.0	-	-	33.7	-	<0.3	9.3	
Siderasterea siderea	Beche Shoal (near Miami) - Florida Keys	40.3	-	-	5.7	-	<0.3	9.0	Glynn *et al.* 1989
Colpophyllia amaranthus		58.0	-	-	11.0	-	<0.3	<1.0	
Colpophyllia natans		55.0	-	-	10.5	-	<0.3	<1.0	
Diplora clivosa		53.0	-	-	8.0	-	<0.3	<1.0	
Montastrea annularis		52.0	-	-	8.3	-	<0.3	<1.0	
Porites astreoides		52.0	-	-	11.3	-	<0.3	<1.0	
Acropora formosa	Lizard Is.	-	-	0.56	0.21	0.90	0.14	<0.38	Denton and burdon-Jones, 1986
Funia concinna		-	-	0.09	0.38	1.30	0.02	<0.30	
Acropora formosa	Orpheus Is.	-	-	0.12	0.16	0.57	0.08	<0.30	
Funia concinna		-	-	<0.05	0.30	0.75	0.02	<0.68	
Acropora formosa	Heron Is. (Australia)	-	-	0.38	0.20	1.10	0.14	<0.35	
Funia concinna		-	-	<0.15	0.27	0.74	0.09	<0.58	

* Values in ppm.

The massive species recorded the highest Fe content 731.69ppm in *F. pallida*, Mn 7.73ppm (Fig. 5) and Cu 6.39ppm in *G. tenella*, Zn 36.27ppm in *F. persi*. Pb showed subequal high contents (20.91ppm, 20.24ppm and 20.74ppm) in three different species; *G. planulata* (encrusting), *G. tenella* (massive) and *C. dederleini* (oscillatory) respectively (Fig., 6). The lowest recorded trace metal contents are restricted in oscillatory and encrusting corals may be due to the ability of these species to reject the excess metals. These data illustrated that the massive corals in locality are able to assimilate the highest concentrations of contaminates rather than the other coral forms. Also, the recorded high diversity of the different coral forms indicates that the recovered coral species have strong mechanism to resistant pollution as well as the locality is able to receive more coral recruits if the surrounding conditions treated and the different stresses are diluted.

4. CONCLUSION

Hurghada Harbour locality was intensively used in environmental antagonistic activities; shipyard, boats mooring, desalination water rejection as well as hydrocarbon waste receptors. The heavy metal contaminations in the sediments of the shipyard embayment are derived from the repairing, maintaining, antifouling paint remains and ship building up. These stressors are causing acrimonious ecological risk on the marine ecosystem components; sediment nature inside and outside the tidal flat of the shipyard, seawater quality and the benthic communities in the embayment.

The fine fraction sediments (<0.125mm and <0.063mm) are considerably effective in the contaminants accumulation and transfer to the marine ecosystem. Zn, Cu, Ni and Cd recorded their higher contents in sediments at and near the beach and decreasing gradually seaward. Pb is decreasing landward, the highest values of Pb is recorded at the boats mooring zone, while some of Cu and Ni contaminants in the shipyard embayment are derived from the reject water of the desalination plant..

The recorded and selected corals are of young colonies and new recruit species. The recorded metals in these corals are relatively high compared with their ages and the measured trace metals in adult colonies under different stresses around the world. The massive corals are able to assimilate the highest concentrations of contaminates rather than the other coral forms. Also, the recorded high diversity of the different coral forms indicates that the recovered coral species are able to resistant pollution as well as the locality is able to receive more coral recruits if the surrounding conditions are treated and the different stresses are diluted.

RECOMMENDATIONS

The contaminating sources control and degradation of the water body is essential for effective environmental rehabilitation (Barbosa *et al.,* 2001). The existing stressors as; the shipyard, desalination plant, boat mooring and the runoff of the other neighbor activities as well as the potential of the continuous development along the shoreline contribute to high risk on the important marine habitats; coral reefs, mangrove ecosystem, seagrass beds and the different benthos types. Providing the trained environmental mangers for assessing the effects of potential and observed sources of stresses on the receptors (habitats, communities and individual organisms) in the marine environment (Blanchard and Feder, 2003).

Problems of habitat degradation are still an important issue to be addressed, it is agreeing a sustainable management plan for natural coastal resources conservation and utilization, and subsequently many efforts are required to solve the degradation of marine habitats. Shipyard, desalination plant and the mooring zone require pronounced solutions to minimize or prevent the tidal habitat degradation.

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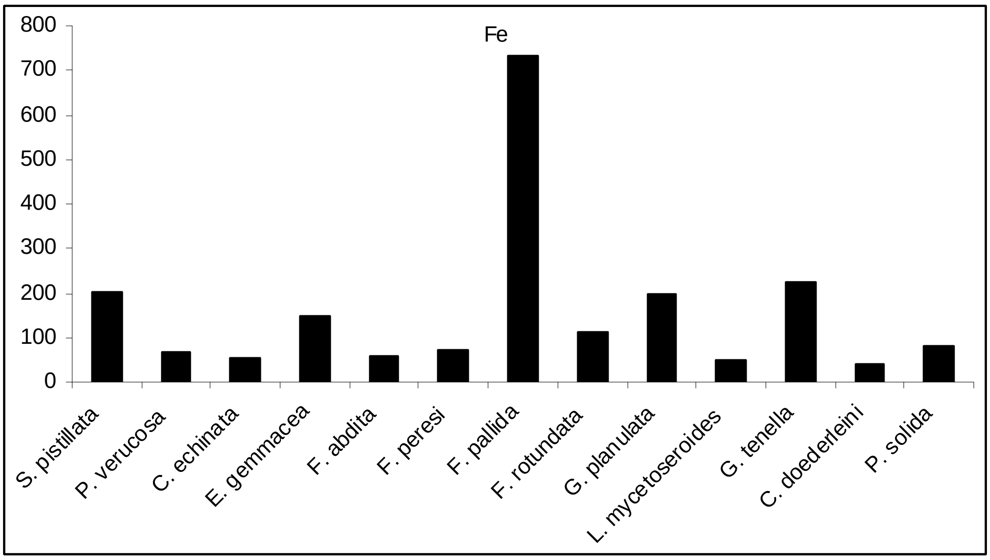

Fig. (5): Iron distribution in the different coral species.

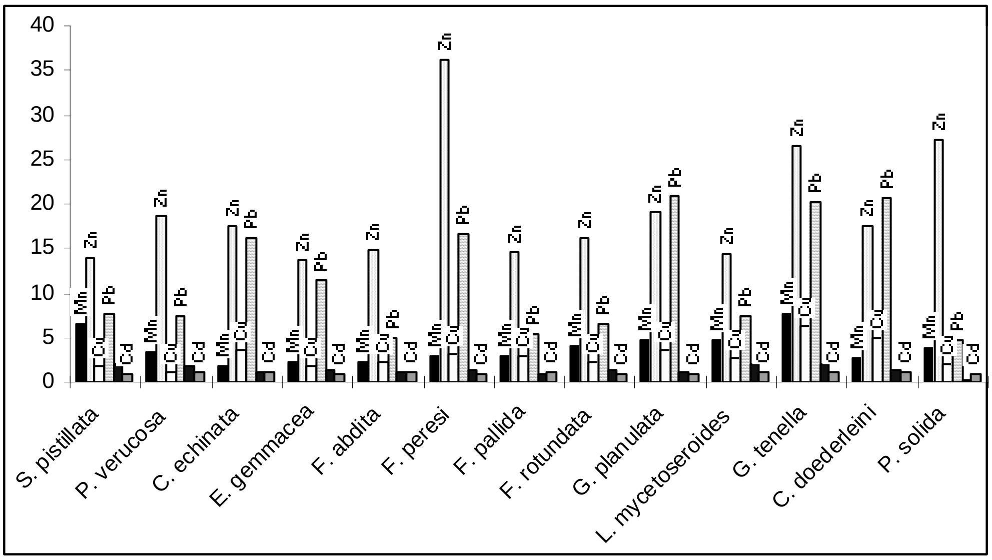

Fig. (6): Heavy metal occurrences in the studied coral species.

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