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Effect of sewage water discharge on the Red Sea and shore

Water and soil chemical characteristics

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ABSTRACT

Jeddah City Saudi Arabia sewage water (untreated and treated) is discharged into the Red Sea water south of the city. The discharged water may contain harmful toxic elements that may affect the living organisms in the seawater, and also the coastal habitat particularly naturally growing plant species. A study was undertaken to assess and evaluate the concentrations of the macro-and micro-elements, the heavy and toxic metals, salts, and to determine acidity and conductivity of the Red Sea water and soil a, and the shore water and soil and compare them with results collected from an unpolluted area away from this affected area. The results indicated a highly significant accumulation of salts, macro, and micro-elements, and heavy and toxic metals in the sea and coastal water and soil compared to the unpolluted site. Out of all Ca, Na and Cl in the sea and shore water expressed no significant differences between the polluted and unpolluted sites. For the sea and shore water, the highest concentrations were for Mg, K, and P, while for their soil the highest concentrations were for Ca, Mg, K, P, Na, and Cl. AS for the heavy metals Cu, Mn, Cr, Al, Zn, and Co dominated in the sea and shore water, while for the sea and shore soil the domination was for Cu, Mn, B, Cr, and Al. Some of these elements, Ca, Mg, Na, K, Cl, Cu, Cr, and Ni are concentrated at levels above that suggested and recommended by the Metreological Environmental Protection Agency (MEPA), Ministry of Water and Electricity (MWE) and Food and Agricultural Organization (FAO, 1985).

Key Words: Sewage water, Red seawater, Shore soil, macro-micro-elements

INTRODUCTION

Sewage water normally is discharged into seawater, and this practice creates a global problem. Sewage effluent discharge and human activities in the

coastal areas and marine water led to the dumping of various kinds of pollutants such as heavy metals into the marine ecosystems (Censi et al. 2006; Pote

et al. 2008). The high concentrations of metals and other elements in seawater cause several problems through their accumulation in the body of marine animals and organisms (Wen et al., 2007; Wcisio et al., 2008). In his comparison of the concentration of the metals Al, Fe, Mn, Cu, Zn, Cr, Cd and Pb in the Red Sea water southern Corniche area of Jeddah taken 1999 with those taken 2009 (Basaham et al. 2009) to see the effect of sewage effluent dumping in this area, and found that concentrations of these heavy metals were doubled during this period. The sewage water discharged into the Red Sea water is partially treated as polluted water, and the Al-Khumra treatment plant in south Jeddah city which receives daily about 200,000-300,000 m³ sewage water partially treats this water (El-Sayed and Niaz,1999). The mean concentrations of the heavy metals Zn, Mn, Cu, Cd in the Red Sea water in front of Jeddah City reached 8.00, 2.43, 1.7, and 1.09 µg/g respectively (Saad and Fahmy,2009). The Red Sea coastal area water in the southern area of Jeddah City near the sewage effluent discharge was analyzed and the trace metals Zn, Cu, and Ni were found the metals with the highest concentrations (Radwan et al., 2009). In Jeddah City, there are 177 discharge points along Jeddah coast receiving treated and untreated sewage which is dumped directly into the Red Seawater and the most important of the effluent is that of Al-Khumra Sewage Treatment Plant (KSTP) which discharges its wastewater south of Jeddah with a daily amount of (300,000 m³) (El Sayed 2002b). On the other hand, the daily volume of sewage water discharged into the Red Sea waters in the vicinity of Jeddah city as declared by National Water Company reaches up to 375000 m³ (El-Riyadh Newspaper,7-5-2012). The average concentrations of Fe, Cu, and Zn in the sediment of the sewage effluent discharged in the Red Sea water were estimated by El-Yami (2010) as 8574, 112, and 1557 µg/g. El-Nakhlawy et al., (2016) mentioned that wastewater irrigated areas produced the highest concentration of toxic metals in plant and soil samples compared to irrigated sites with normal water. The discharge of the industrial wastewater in seawater near the city of Zonguldak beaches was assessed by Coban et al. (2009) and found to have the following concentrations Mn 15.0±0.98, Cr 12±8.6, Mg 715±8.3, Cu 122± 1.5, Ni 142±10.6, Pb 39±9.0 and Zn 834±4.1. This study aims to estimate the concentration of chemicals,

elements, salts, trace, and heavy metals in sewage water, Sea and shore water of Red Sea south of Jeddah City, Saudi Arabia as affected by sewage water discharge and compare it with unpolluted location 30 km away.

Materials and Methods

Collection of water samples:

Seawater samples were collected from twelve points along the coastal region from a depth of 30 cm and placed in sealed clean glass bottles with all the information's written, and taken to the laboratory

The water samples (5 L) were filtered through filter papers and put into clean bottles for analysis. Also, water samples were collected from the sewage water discharged into the seawater, finally treated, secondarily treated, and untreated.

Collection of soil samples:

Soil samples were collected from twelve points inside the Red Sea coastal water, and twelve points along the shore at depth of (0-30 cm) and placed in plastic bags and taken to the laboratory. The samples were dried at 60°C in an oven for 24 hours and passed through a sieve 2mm aperture, and then mixed thoroughly. To prepare soil filtrate 50 gm were taken in a flask and 250 ml of distilled water were added and the flasks closed and placed in a vibrator for 6 hours. The filtrate was then filtered through Whitman filter paper and placed in bottles and put in the fridge for analysis.

Analysis of the samples:

pH value:

pH value was analyzed using the pH-meter Titrator Mettler DL55.

EC;

It was determined using the EC-meter model Mettler MC 226.

Determination of macro-elements and heavy metals:

Many instruments were used for the determination of macro-elements and heavy

metals, like Atomic Absorption Spectrophotometer, Model Analyst 800, Perkin Elmer (USA). The instrument Inductively Coupled Plasma, Optical Emission Spectrometer, Model Optima 4100 DV Perkin. The following formula was used to calculate the concentration in mg/kg of SPM mg/kg (Dry weight) = Concentration* Dilution / Dry weigh .

TDS:

The amount of TDS in a water sample is measured by filtering the sample through a 2.0 µm pore size filter, evaporating the remaining filtrate, and then drying what is left to a constant weight at 180°C.

Statistical analysis

The collected data were statistically analyzed using the analysis of variance (ANOVA) and mean comparisons (Least Significant Difference (LSD) test) according to El-Nakhlawy (2008), using SPSS (Statistical Package for the Social Sciences) version 13.0.

RESULTS

The concentration of the main elements in normal water

and sewage water semi-treated and untreated:

Table (1) illustrates the mean concentrations of the main elements analyzed in the tap water and the semi-treated and untreated sewage water. Sewage water does not affect the pH of the water and it remained 6.5 as in the tap water. The total dissolved solids (TDS) increased in the untreated sewage water to a very high rate of 2450 mg/L and doubled to 94.2 times compared to tap water TDS concentrations. The total suspended solids (TSS) concentration also increased to a high level in sewage water reaching 362 mg/L or 67 times greater than tap water with only 5.4 mg/L. The carbonates (HCO₃) are very high in sewage water with a concentration of 415 mg/L compared to tap water with only 5.9 mg/L. The sulfates (SO₄) are very high in the sewage (1296 mg/L) and semi-treated sewage 1108 mg/L water compared to tap water (246 mg/L). The phosphates are high in the untreated sewage water (25.5 mg/L) and 0.1< in the tap water. Ammonium (NH₄), nitrates (NO₃), and nitrites (NO₂) are also low in the tap water compared to untreated sewage water. The macro-elements Ca, Mg, K, Fe are high in the sewage water compared to tap water, while Na and Cl are very high in sewage water (576 and 768 mg/L) compared to tap water with 0.1< mg/L.

Table (1): Concentration of the main elements (mg/L) in normal water and sewage water semi-treated and untreated:

Element	Tap water	Sewage water	
		untreated	Semi-treated
pH	6.5	6.3	6.5
TDS	25.8	2450	25.8
TSS	5.4	362	5.6
HCO ₃	5.9	415	60.2
SO ₄	246	1296	1108
PO ₄	0.1<	25,5	0.1<
NH ₄	9.1	23.8	20.5
NO ₃	7.3	22.4	10.2
NO ₂	0.2	0.34	0.6
Ca	5.2	86.8	6.6
Mg	11.5	25.4	23.7
K	0.1<	21.4	0.1<
Fe	0.1<	0,1	0.1<
Na	0.1<	576	0.1<
Cl	0.1<	768	0.1<

The concentration of micro and heavy metals in normal water and sewage water semi-treated and untreated:

Table (2) illustrates that 8 of the heavy metals zinc (Zn), copper (Cu), manganese (Mn), boron (B), chromium (Cr), nickel (Ni) arsenic (As), and barium (Ba) present in the untreated sewage water at concentrations significantly higher than their concentrations in the tap water, with B attaining very high concentration (1296 mg/L) in the untreated SW and 1108 mg/L in the semi-treated SW. The heavy metals molybdenum (Mo), mercury (Hg), cadmium (Cd), silver (Ag), aluminum (Al), cobalt (Co), selenium (Se) concentrations in all types of water are negligible (0.1<).

There is no significant difference in the concentration of Pb between tap and sewage water.

Table (2): Concentration of micro and heavy metals (mg/L) in normal water and sewage water semi-treated and untreated:

Element	Tap water	Sewage water	
		untreated	Semi-treated
Zn	3.3	25.8	25.8
Cu	2.8	5.6	5.4
Mn	0.9	60.2	5.9
B	4.8	1296	1108
Mo	0.1<	0.1<	0.1<
Cr	1.6	20.5	9.1
Ni	4.1	10.2	7.3
Pb	0.5	0.6	0.2
As	0.13	6.6	5.2
Ba	10	23.7	11.5
Hg	0.1<	0.1<	0.1<
Cd	0.1<	0.1<	0.1<
Ag	0.1<	0.1<	0.1<
Al	0.1<	0.1<	0.1<
Co	0.1<	0.1<	0.1<
Se	0.1<	0.1<	0.1<

Mean values of pH in seawater and shore water, and sea soil and shore soil:

There are no significant differences between values of the pH in the samples of water of the polluted and unpolluted sites in the sea and the shore and coastal areas.

Table (3): pH values in the sea and shore water and soil (means + standard deviation):

	Type of sample	Polluted site	Unpolluted site	Significance
Water	Sea water	7.,8±0,01	7.7±0,001	0.781
	Shore water	7.9±0,001	7.8±0,001	0.712
Soil	Shore soil	7.9±0,01	7.4±0,21	0.217
	Coastal soil	7.8±0,1	7.6±0,04	0.351

Mean values of EC in the sea and shore water, and sea and shore soil:

Table (4) illustrates that the site polluted by sewage water exhibited high electric conductivity (EC) in both Seawater and soil and both shore water and soil compared to the unpolluted site, with the shore water giving the highest EC (8.6 mm/cc).

Table (4): EC values in the sea and shore water and soil (millimole/cm) (means + standard deviation):

	Type of sample	Polluted site	Unpolluted site	Significance
Water	Sea water	5.7± 0.19	4.4±0.01	0.031*
	Shore water	8.6±0,01	5.1±0.001	0.032*
Soil	Shore soil	7.3±1.3	5.9±1.1	0.029*
	Coastal soil	6.9±0.4	5.4±0.01	0.026*

The concentration of macroelements in Sea Water and shore water In polluted and unpolluted sites :

Table (5) illustrates that the concentrations of the macro-elements Mg, K, and P are significantly high in the Sea Water and shore water is polluted site compared to the unpolluted site, but Ca, Na and Cl show no significant variation in concentration in polluted and unpolluted sites. Sodium (Na) and Cl gave very high concentrations in the Sea and shore waters in polluted and unpolluted sites, and the high concentrations of Cl and Na in the soil may be related to a high concentration of soluble salts. The concentration of the six macro-elements in the shore water is higher than their concentration in the Seawater.

Table (5): Concentration (mg/L) of macroelements in Sea Water and shore water in polluted and unpolluted sites :

Element	Source	Polluted	unpolluted	Significance
Ca	Sea water	446±96	420±59	0.219
	Shore water	531±107	491±11	0.070
Mg	Sea water	1495±50	121±67	0.010**
	Shore water	1757±19	14 ±147	0.010**
K	Sea water	44.9±3.9	44±4.1	0.001**
	Shore water	60.1±9.9	49±14	0.004**
P	Sea water	18.7±0.6	10.9±0.02	0.051**
	Shore water	28.2±1.2	12.7±1.6	0.032**
Na	Sea water	11561±251	11397±28	0.690
	Shore water	13373±184	11350±218	0.190
Cl	Sea water	15722±122	14312±89	0.102
	Shore water	19702±209	18588±193	0.352

The concentration of macroelements in Sea soil and shore soil in polluted and unpolluted sites :

Table (6) illustrates that the concentrations of the macro-elements Ca, Mg, K, P, Na are significantly high in the Sea soil and shore soil in polluted site compared to the unpolluted site, but Cl shows no significant variation in concentration in polluted and unpolluted sites. Chlorides (Cl) gave very high concentration in the Sea and shore soils in polluted and unpolluted sites, then Na also gave high concentrations. Potassium (K) and P gave the lowest concentrations in both polluted and unpolluted sites in both Sea and shore soils compared to other elements. The high concentrations of Cl and Na in the soil may be related to a high concentration of soluble salts.

Table (6): Concentration (mg/L) of macroelements in Sea soil and shore soil in polluted and unpolluted sites :

Element	Source	Polluted	unpolluted	Significance
Ca	Sea soil	728±38	661±42	0.042**
	Shore soil	1333±32	948±14	0.036*
Mg	Sea soil	1131±35	114±21	0.001**
	Shore soil	1011±28	292±49	0.005**
K	Sea soil	382±3,2	52±4,5	0.002**
	Shore soil	284±1,6	61±2,7	0.001**
P	Sea soil	34.5±0.3	19.3±0.9	0.049**
	Shore soil	38.7±2,7	18.1±0,8	0.37*
Na	Sea soil	10208±108	7773±288	0.035*
	Shore soil	6117±14	5370±22	0.028*
Cl	Sea soil	22281±257	19115±601	0.022
	Shore soil	21001±174	18444±236	0.019

Concentration of trace and heavy metals in Sea Water and shore water in polluted and unpolluted sites :

Table (7) illustrates that the concentrations of the heavy metals Cu, Mn, Cr, Ni, and Al are significantly high in the Seawater and shore water in polluted site compared to the unpolluted site, and the other four metals Zn, Mo, Co, and Fe show no significant variation in concentration in polluted and unpolluted sites. Manganese (Mn) gave high concentration in the Sea and shore water in polluted and unpolluted sites compared to the other metals, and its concentration in water of polluted site in very high (84. Mg/L) compared to its concentration in the unpolluted site (0.14 mg/L), while Zn, Co, Mo, Fe gave very low concentrations in both polluted and unpolluted sites in both Sea and shore water compared to other elements. These results correlated with the results of Gupta et al. (2008) who analyzed the chemical constituents of effluent released from sponge iron industries and distribution of heavy metals in the soil near to effluent discharge channel and found that the concentration of total suspended solids (TSS), total hardness (TH), iron (Fe²⁺), are greater in the nearby water than in water away from this site, and in the soil along the sides of the effluent channel also shows a higher concentration of heavy metals than the background soil.

Table (7): Concentration (mg/L) of heavy metals in Sea Water and shore water In polluted and unpolluted sites :

Element	Water	Polluted	unpolluted	Significance
Zn	Sea water	0.12±0,001	0.1	
	Shore water	0.1	0.1	
Cu	Sea water	0.12±0,001	0.02±0,003	0.001**
	Shore water	0.13±0,002	0.03±0,001	0.001**
Mn	Sea water	84±0,02	0.14±0,001	0.001**
	Shore water	6.27±1,3	0.17±0,001	0.001**
B	Sea water	5.34±0,34	4.08±0,28	0.152
	Shore water	6.57±0,74	5.19±0,28	0.211
Cr	Sea water	0.13±0,001	0,0002±0,001	0.006**
	Shore water	0.13±0,002	0,002±0,001	0.006**
Ni	Sea water	0.14±0,002	0,001±0,001	0.001**
	Shore water	0.11±0,001	0,002±0,002	0.001**
Mo	Seawater	0.1	0.1	
	Shore water	0.1	0.1	
Al	Seawater	1.9±0,001		
	Shore water	2.1±0,01	0.001	0.001**
Co	Sea water	0.01	0.001	
	Shore water	0.002	0.1	
Fe	Sea water	0.1<	0.1	
	Shore water			

The concentration of micro and heavy metals in Sea soil and shore soil in polluted and unpolluted sites :

Table (8) shows that there are significant differences in heavy metal concentrations between Sea soil and shore soil except for Zn, Cr, and Fe, and concentrations are low except for Mn with (8.74 mg/L) and (3.21 mg/L) in Sea and shore soil and B (6.91 mg/L) in Shore soil.

Table (8): Concentration (mg/L) of heavy metals in Sea soil and shore soil In polluted and unpolluted sites :

Element	Water	Polluted	unpolluted	Significance
Zn	Sea soil	0.1<	0.1<	
	Shore soil	0.1<	0.1<	
Cu	Sea soil	0.07±0,00004	0.02±0,003	0.025*
	Shore soil	0.9±0,001	0.03±0,001	0.015*
Mn	Sea soil	8.74±0,92	0.24±0,06	0.001**
	Shore soil	3.21±1,7	0.37±0,02	0.001**
B	Sea soil	0.1±0,06	2.49±0,03	0.009**
	Shore soil	6.91±0,02	2.48±0,03	0.007**
Cr	Sea soil	0.1<	0.1<	
	Shore soil	0.1<	0.1<	
Ni	Sea soil	0.13±0,001	0.001±0,0001	0.006**
	Shore soil	0.12±0,001	0.001±0,0001	0.006**
Mo	Sea soil	0.01		
	Shore soil	0.01		
Al	Sea soil	0.02		
	Shore soil	0.08		
Co	Sea soil	1.3±0,002	0.03±0,001	0.007**
	Shore soil	0.24±0,003	0,001	0.004**
Fe	Sea soil	0,003	0,001	
	Shore soil	0,002	0,001	

DISCUSSION

pH value:

pH is an indicator of the acidity or basicity of water but is seldom a problem by itself. The normal pH range for irrigation water is from 6.5 to 8.4; pH values outside this range are a good

warning that the water is abnormal in quality. The results indicated no significant differences in pH values in the sewage water and tap water and it ranged between (6.3-6.5), and also in Sea and shore water, and Sea and shore soil and ranged between (7.4-7.9). So pH reduced in sewage water compared to tap water and this agrees with the finding of

Alghobara et al. (2014), but not with the findings of Ghafoor et al. (1995) who mentioned an increase of pH value in sewage water compared to normal water. On the other hand El-Khateeb et al.

(2012) found pH in sewage water to range between (8.01 to 8.40). It seems that pH value in sewage water varies according to elements and constituents dumped in the sewage water.

Electrical conductivity (EC):

Electrical conductivity (EC) is widely used to indicate the total ionized constituents of water. It is directly related to the sum of the cations (or anions), as determined chemically, and is closely correlated, in general, with the total salt concentration. Electrical conductivity is significantly high (≤ 0.05) in Sea and shore water and Sea and shore soil in the polluted site compared to unpolluted soil and is highest in the polluted shore soil (8.6 ds/m). This finding agrees with that of Alghobara et al. (2014) who found an increase in EC of soil irrigated with sewage water, and an increase in EC is due to salt input.

Macro-elements in sewage water and tap water:

Sewage water is mainly comprised of water (99.9%) together with suspended and dissolved organic and inorganic solids. The physicochemical characters studied are total dissolved solids (TDS), total suspended solids (TSS), calcium, magnesium, chloride, potassium, iron, sodium, chlorides. An increase in TDS concentrations in polluted waters often result from industrial effluent, changes to the water balance (by limiting inflow, by increased water use or increased precipitation), or by the salt-water intrusion. The total dissolved solids (TDS) in untreated sewage water is very high (2450 ds/m) compared to tap water (25. ds/m), also the sulfate (SO_4) is very high in sewage water (1296 ds/m) compared to tap water (246 ds/m). This is

positively correlated with the finding of Al-Salem (1987) were the total dissolved solids IN AMMAN, JORDAN ranged up to 1170 mg/l, while in other places it is low, Krishnan et al. (2007) registered TDS in sewage water to be 200 mg/L in three different places of Sivakasi. This indicates that TDS concentration in sewage water varies with variations in organic and inorganic materials deposited in the water. The term TSS is often used to describe the concentration of solid-phase material suspended in a water-sediment mixture and usually expressed in milligrams per liter (mg/L). The total suspended solids (TSS) in sewage water are also high (362 mg/L) compared to tap water (5.4 mg/L), and is in correlation with the results of Krishnan et al. (2007) who got high TSS in sewage water reaching 150 mg/L, and with results of Al-Salem, (1987) who detected 900 mg/L TSS in wastewater in Amman, Jordan, also with the results of (Sulthana et al. 2013; Ghafoor et al. 1995). Carbonate (HCO_3) concentration in the sewage water is very high (415 mg/L) compared to tap water with only (5.9 mg/L). On the other hand, the phosphate (PO_4), ammonium (NH_4), nitrate (NO_3), nitrite (NO_2), are high in sewage water compared to tap water. This is in agreement with the results of [Ghafoor et al. 1995] who advocated high values of pH, hardness, alkalinity, total soluble salts, nitrates, nitrites, and cations like sodium, potassium, calcium, and magnesium in sewage water compared to normal water. As for the macro-elements Ca, Mg, K, Na, Cl their concentrations are significantly high in sewage water compared to normal water, and the highest concentration is for the chloride (Cl) and sodium (Na). This is positively correlated with the findings of Krishnan et al. (2007) and Abdel-Ghaffar et al. (1988) who registered concentration of Cl in wastewater up to 222.1 and 320 mg/L, and Na up to 205 mg/L, Ca up to 128 mg/L, Mg up to 96 mg/L, K up to 35 mg/L. Iron (Fe) is negligible in both sewage and tap water.

Macro-elements in Sea and shore water in polluted and unpolluted sites:

The macro-elements calcium (Ca), magnesium (Mg), potassium (K), phosphorus (P), sodium (Na),

chlorides (Cl) analyzed in Sea and shore water gave variable concentrations in these waters, and all gave higher concentrations in polluted site compared to the unpolluted site, with significant differences in concentrations between the two sites in both Sea and shore water in the case of Mg, K and P. Chlorides (15722 mg/L and 19702 mg/L) and sodium (11561 mg/L and 13373 mg/L) attained very high concentrations in both Sea and shore water in polluted and in unpolluted sites. This is positively correlated with the values obtained by (Anthoni, 2006) who found that chlorides (Cl) and sodium (Na) in seawater had attained the highest concentrations (19345 and 10752 mg/L respectively). This result can also be correlated with the results of (Rump,1999) who said that Sodium (Na) is one of the elements in natural waters and its concentration varies and reaches more than 1000 mg/L in salty waters and its content increases in sewage water. Ca reached (416 mg/L) and Mg is high reached (1295 mg/L), and as (Rump, 1999) said Mg is one of the elements found in abundance in the earth crust. The concentration of the elements is higher in the shore water compared to the Seawater. This is because the shore water is not subjected to mixing with other water like seawater.

Macro-elements in Sea and shore soil in polluted and unpolluted sites:

Concentrations of the macro-elements (Ca), (Mg), (K), (P), (Na), (Cl) in Sea and shore soil show significant differences between the polluted and unpolluted sites and also between Sea and shore soil concentrations. Chlorides and sodium attained very high concentrations in both Sea and shore soils in polluted and in unpolluted sites, Cl gave (22281 mg/L in polluted and 19115 mg/L in unpolluted Sea soil, and 21001 mg/L in polluted and 18444 mg/L in unpolluted shore soil) and Na attained (10208 mg/L in polluted and 7773 mg/L in unpolluted Sea soil, and 6117 mg/L in polluted and 537 mg/L in unpolluted shore soil). Mg, K, Na, and Cl gave higher concentrations in Sea soil compared to the shore soil, while concentrations of Ca and P are significantly high in shore soil than in Sea soil.

Heavy metals and trace elements in Sea and shore water in polluted and unpolluted sites:

These are elements which normally present in relatively low concentrations, usually less than a few mg/l. Heavy metals are a special group of trace elements and the ten studied here included Zinc (Zn), Copper (Cu), manganese (Mn), boron (B), Chromium (Cr), nickel (Ni), molybdenum (Mo), aluminum (Al), cobalt (Co), iron (Fe). These are called heavy metals because, in their metallic form, their densities are greater than 4g/cc. Concentrations of most of these trace and heavy metals in the Sea and shore water are low less than one (≤ 0.1 mg/L), with exception of Mn with 8.4 mg/L in Seawater and 6.27 mg/L inshore water, B with 5.34 mg/L in Seawater and 6.57 mg/L in shore water and Al with 1.9 mg/L in Seawater and 2.1 mg/L inshore water. Concentrations of Cu, Mn, Cr, Ni, Al in Sea and shore water at the polluted site are significantly higher than their concentration in an unpolluted site, while Zn, B, Mo, Co, and Fe showed no significant differences between their concentrations in Sea and shore water between the polluted and unpolluted sites. These results are in positive correlation with the results of (Alghobara et al. 2014) who found a significant increase ($p < 0.05$) of Fe, Mn, Cu, Zn, and Pb in an area subjected to sewage water compared to an area not subjected to sewage water.

Heavy metals and trace elements in Sea and shore soil in polluted and unpolluted sites:

Concentrations of most of the trace and heavy metals in the Sea and shore soil are low less than one (≤ 0.1 mg/L), with exception of Mn with 8.74 mg/L in Sea soil and 3.21 mg/L in shore soil, B with 2.49 mg/L in Sea soil and 6.91 mg/L in shore soil and Co with 1.3 mg/L in Sea soil and 0.24 mg/L in shore soil. There are significant differences between concentrations of Cu, Mn, B, Ni, Co in Sea and shore soil at the polluted site and unpolluted site, while Zn, Cr, Co, and Fe showed no significant differences between their concentrations in Sea and shore water between the polluted and unpolluted sites. Zinc, Cr and Fe concentrations are very low in both Sea and shore soil, and Cu and B concentrations are

high in shore soil, but Mn concentration is high in Sea soil. It can be noted that the trace and heavy metal concentrations in Sea and shore water are higher than their concentrations in the Sea and shore soil except for Co. Ali et al. (1996) mentioned that sewage water contains significant amounts of toxic metals such as arsenic, chromium, cadmium, copper, lead, nickel, zinc, cobalt, magnesium and iron compared to soil.

CONCLUSION

There is an overall increase in the total dissolved solids (TDS), total suspended solids (TSS), bicarbonates, sulfates, phosphates, ammonium, and nitrates in the untreated and semi-treated sewage water compared to tap water. Calcium (Ca), Mg, K, Na, Cl concentrations are higher in untreated and semi-treated sewage water than in tap water, particularly chlorides, sulfates, TDS which gave very high concentrations in sewage water. Sewage water untreated and semi-treated dominated tap water in concentrations of trace and heavy metals Zn, Cu, Mn, B, Cr, Ni, As, and Ba. The EC in Sea and shore water and soil in the polluted site are significantly higher than in unpolluted site. The concentrations of Mg, K, and P in Sea and shore water and Ca, Mg, K, P, and Na in Sea and shore soil in the polluted site is significantly higher than in the unpolluted site. Sodium (Na) and Cl concentrations are very high in Sea and shore water and soil in both polluted and unpolluted sites. The concentrations of Cu, Mn, Cr, Ni, Al in Sea and shore water and Sea and Cu, Mn, B, Ni, Co, shore soil are significantly higher in polluted sites than in unpolluted sites. The dangers of discharging sewage water into the Red Sea water will pollute the Seawater and Shore soil, and this will be having adverse and toxic effects on fishes and other organisms living in Seawater, and these toxic metals will find their way into the fishes and consequently into the human body feeding on these fishes. Also, forage plant species growing in the vicinity of these areas will accumulate toxic heavy metals and when animals graze on them they will reach the human bodies. Discharge of industrial wastewater in seawater generally can lead to the accumulation of heavy metals in the tissues of the organisms (Gochfeld, 2003; Yi et al 2008).

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