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Effects of Aqueous Discharges of a Land-Based Source on the Near-Shore Environment, Abu Quir Bay, Alexandria, Egypt

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ABSTRACT. Many activities including industrial, agricultural, fishing, petroleum and dwelling line the coastal border of Abu Quir Bay. One of them dumps its wastes directly into the foreshore zone of the coast. The determination of suspended materials brought by the dumping outlet and its contents of Na, K, Ca, Mg, Fe, Mn, Cu, Pb and Zn was carried out. Both the nature of the bottom sediments and the prevailing physical conditions of the marine environment were analyzed. It is concluded from an environmental impact view that the effluent discharged onto the sea does not have hazardous effect on the environment.

Introduction

Abu Quir Bay is a small body of water lies to the east of Alexandria. This Bay has a volume of 3.32 km^3 while its surface area is 360 km^2. The Bay has a coastline of about 50 km. Generally, the Bay has a shallow bottom (max. depth is 16 m) which consists of sand in the western sector, sandy-mud in the middle and completely mud in the eastern sector. Three main sources dispose their effluents in the Bay are: lake Edku outlet at El-Maadia region (about 3.5×10^6 m^3 of brackish water/day), Tabia (barrage) pumping station ($\approx$ 1,850,000 m^3/day; Tayel and Shriadah, 1992) which collects mixed industrial and agricultural drain waters and re-pump it to the Bay, and Rosetta promontory at the extreme eastern edge (Fig. 1) where an amount of about 3.76×109 m^3 of fresh water goes to the sea annually. In addition to these, there are some scattered industrial activities (electric power station, food canning, paper, fertilizers, petroleum and

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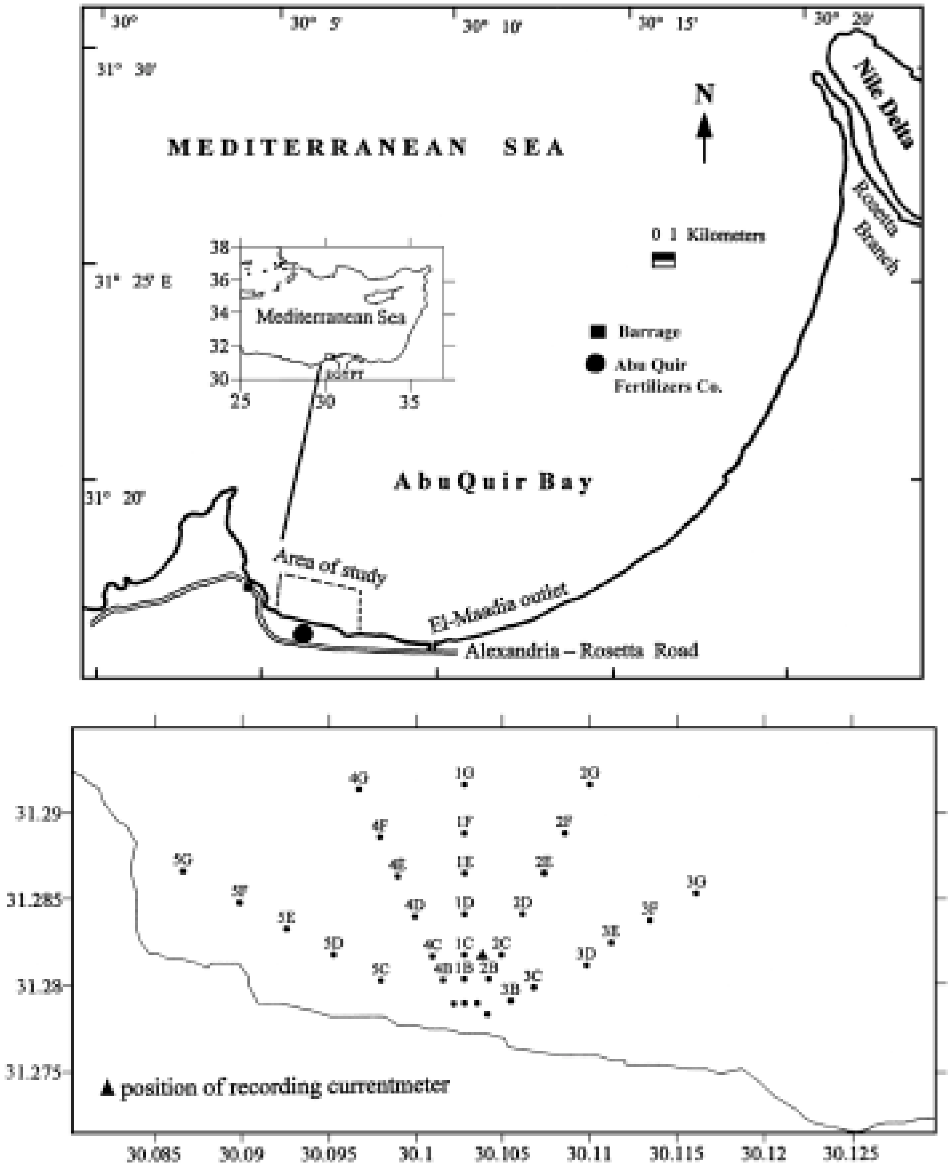

Fig. 1. Area of study and sampling stations.

gas services, local shipyards and fishing) discharge their waste waters directly to the Bay.

Previous studies reported that, the hydrographic system and the circulation pattern of the Bay are mainly affected by the wind regime over the area (El-Sharkawy and Sharaf El-Din, 1974). Consequently, the natural processes as sediment transport, erosion and accumulation are a reflection of the prevailing hydrographic regime. Frihy *et al.* (1994) concluded that out of the whole Abu Quir Bay, there are some regions including the area of study that lie under the effect of depositional conditions.

Many hydrographic studies related to physical, chemical, geological and biological aspects of marine pollution in Abu Quir Bay had been carried out by Abbas (1969), El-Samra (1973), Moussa (1973), El-Deeb (1977), Metwally (1977), Said (1979, 1989& 1991), Emara (1982), Abdel Moati (1990) and El-Tabakh (1992). Also the effect of oceanographical and meteorological factors on the transport of pollutants in Abu Quir Bay was discussed in details by Said (1979) and Sharaf El-Din *et al.* (1980). In addition, the coastal transport of pollutants in Abu Quir Bay was studied in details by Said (1991).

Scope of Work

In order to clarify and evaluate the environmental impact of aqueous waste discharge, one of the aforementioned outfalls that dumps its load directly into the shoreline of the Bay was selected and its neighborhood area was investigated. The outfall is from one industrial plant that manufactures fertilizers (urea and ammonium nitrate).

Materials and Method

Thirty-five stations were sampled along five sectors during August 1998. All these sectors start from the dumping point along the shoreline and form a radial pattern (Fig. 1).

At each station, one liter of seawater was sampled in order to obtain the total suspended matter contents. In addition, a bottom sediment sample was collected to determine organic carbon and carbonate contents. The *in situ* measurements included water depth, salinity, temperature, transparency and currents (using AANDERAA device).

The collected suspended materials were digested using concentrated nitric acid and their contents of Na, K, Ca, Mg, Fe, Mn, Cu, Zn and Pb were measured using AAS (Varian 10^{+}).

Physical Proprieties of Water

Temperature, Salinity and Current

The surface temperature of the Bay water varies from 27.45 to 30.00ºC during the period of observation (August 1998). The western region of the area under study has the highest temperature. Temperature at one-meter depth in front of Abu Quir Fertilizer Company is slightly lower than that of the nearby surrounding waters.

The salinity of the seawater at the same depth ranges between 37.72 and 38.63‰. Figure 2 illustrates the aerial distribution of salinity values. It is clear the wide intervals between contour lines (38, 37.9 & 37.8) of the western sector. This situation indicates the effect of dilution by several activities located there.

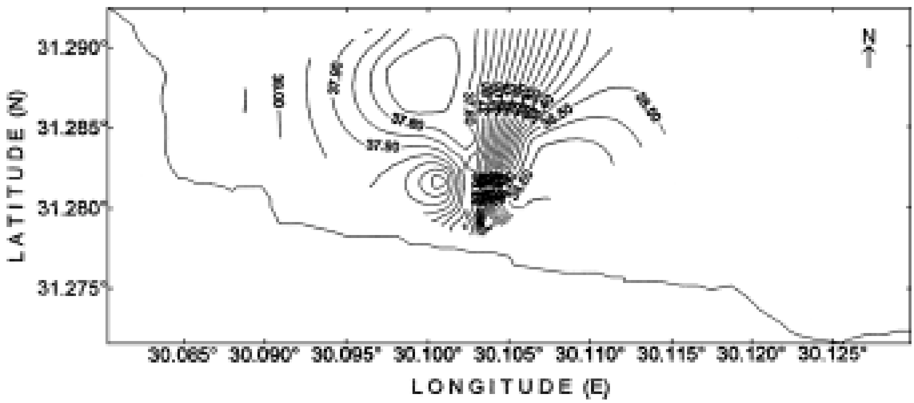

FIG. 2. Horizontal distribution of salinity in front of the study area.

The current pattern in the area of study indicates the existence of an anticyclonic gyre and the current regime was mainly in the NE and SE directions during the period of investigation. Generally, the pattern proves that the water circulation is affected by the coastline configuration. The currentmeter measurements and the statistical analysis of the data (Table 1) show that the eastern current is the more dominant component (52.6%) while the northern one is the less (0.17%). The average speed for all measured currents in all directions, except north, ranges between 10.08 to 12.3 cm/sec. The northern component has the highest speed of 14.17 cm/sec although with the lowest periods of duration.

Transparency

All types of drainage waters discharged from different sources to the Bay contain several varieties of suspended materials, which subsequently increase the turbidity. However, transparency increases in the seaward direction (Table 2).

Table 1. The statistical analysis of the measured current (one meter below water surface) in Abu Quir Bay.

Direction	Average speed (cm/sec)	Percentage of occurrence
N	14.17	0.17%
NNN	12.3	1.20%
NE	10.08	1.20%
NEE	10.42	10.67%
E	10.64	52.66%
SEE	11.39	32.70%
SE	11.74	1.37%

Suspended Matter

The suspended materials under investigation are introduced as a fluvial or aeolian or both into the surface water. The analyzed samples showed that the surface water of the study area has suspended particles with an average of 13.11 mg/l within a range between 7.30 and 35.80 mg/l (Table 2). The highest value was encountered in the western side (station 5C) of the area under investigation where a huge amounts of effluents drain in while the lowest value (station 2F) was traced in the northeastern direction where dilution with clearer sea water takes place offshore direction. However, moving out of the sampled area northward or northeastward directions one attains the usual level of suspended particles. As the study area was sampled along five sections, all these sections have nearly the same density of suspended matter (≃11 mg/l except the western section, which has 21.58 mg/l. The relatively wide difference between the two values is clear and observable in the field. This refers to the presence of several outlets lie directly on the shore and belong to some industrial plants in addition to that western sector is the shallower (Fig. 3A).

The microscopic examination of the suspended materials collected on the membrane filter paper after drying showed that salty crystals are the main component. Some of these crystals are holding other objects composed of very fine particles of brown color. The brown color is observed in most of the examined filter papers. The intensity of brownish color becomes lighter as the samples are located farther offshore (Filter papers of samples A & B are darker than filter papers of samples E & F). It was also observed under the microscope that some patches, which consist of coagulated particles, are solidified together.

Figure 3B represents the density and distribution of suspended matter in the area under investigation, showing that near-shore water in the western part of the area has the highest contents of suspended matter and the surrounding water has more normal contents.

TABLE 2. Concentrations of different elements determined in the study area.

Station	Depth (m)	Transp. (m)	Susp. mat. (mg/l)	Bottom mud (%)	Bottom CO3 (%)	Bottom organic carbon (%)	Na%	K%	Mg%	Ca%	Fe%	Mn%	Cu (ppm)	Pb (ppm)	Zn (ppm)
1A	3	1.5	16.6	37.66	35.6	1.9	5.76	0.9	0.21	0.55	0.61	0.16	45.18	58.19	328.01
1B	3.75	1.5	10.2	17.38	16.1	1.5	9.11	1.07	0.34	1.21	0.21	0.03	49.02	55.78	67.94
1C	4	1.5	9	8.83	12.9	1.2	9.65	1.1	0.37	0.89	0.12	0.09	25.25	31.79	165.00
1D	5	3	12.5	3.58	9.2	0.1	8.28	1.16	0.43	1.03	0.47	0.06	40	87.19	1326.60
1E	5.5	3.5	10.5	3.04	ND	ND	10.23	1.54	0.54	1.31	0.64	0.06	142.86	90.37	2314.71
1F	6.3	4.5	9.9	13.04	ND	ND	10.18	1.15	0.28	0.56	0.25	0.07	25.25	84.57	1100.00
1G	6.5	4.5	11.6	5.08	ND	ND	9.6	1.14	0.47	1.23	0.45	0.06	0	49.85	1706.90
2A	3.3	1.5	13.1	11.26	17.8	0.4	7.49	1.06	0.52	1.05	0.69	0.08	57.25	0.00	230.5
2B	3.5	1.5	10.6	14.59	18.75	1.2	8.52	0.94	0.63	1.61	0.64	0.34	117.92	192.34	798.54
2C	4	2	11.5	1.68	24.8	0.3	9.34	1.03	0.74	1.58	0.48	0.06	21.74	77.65	185.09
2D	6	3.5	12.2	19.96	30	1	8.26	0.88	0.52	1.22	0.40	0.05	20.49	45.24	89.26
2E	6.5	4.5	9.1	39.14	ND	ND	11.08	0.95	0.45	1	0.10	0.05	0.00	53.33	70.71
2F	6.75	5.5	7.3	12.7	ND	ND	13.81	1.21	0.56	1.7	0.10	0.05	0.00	34.83	549.25
2G	6.5	4.5	8.2	5.79	ND	ND	12.61	1.08	0.57	1.27	0.04	0.03	0.00	25.90	392.38
3A	3.5	1.5	15.5	17.03	72.44	1	6.5	0.91	0.52	1.83	0.40	0.24	48.39	0.00	67.06
3B	4	2.5	11.7	25	27.25	2.4	7.27	1.2	0.52	1.53	0.25	0.08	24.74	122.97	21.51
3C	4	1.25	12	15.61	22.38	1.7	7.19	0.78	0.71	2.5	0.33	0.07	291.67	108.66	317.63

Table 2. Contd.

Station	Depth (m)	Transp. (m)	Susp. mat. (mg/l)	Bottom mud (%)	Bottom CO3 (%)	Bottom organic carbon (%)	Na%	K%	Mg%	Ca%	Fe%	Mn%	Cu (ppm)	Pb (ppm)	Zn (ppm)
3D	4.5	1	10.9	5.11	13.88	1.8	0	0.75	0.58	1.41	0.29	0.07	91.74	24.75	145.32
3E	5	3.5	11.3	17.79	19.38	2.1	7.17	0.62	0.49	1.56	0.27	0.1	44.25	31.83	87.61
3F	6	5.5	10.3	20.99	27.5	1.22	9.53	0.88	0.5	0.85	0.07	0.01	0.00	9.03	24.03
3G	5.75	2	11.6	25.67	25.44	2.93	8.8	0.84	0.44	0.62	0.07	0.03	21.55	45.98	89.61
4A	3	1.5	14.6	22.31	16.4	0.35	6.54	0.79	0.31	0.79	0.45	0.1	51.37	39.29	6.78
4B	3.75	1	13.1	17.69	32.6	0.6	7.49	0.99	0.31	0.67	0.56	0.07	38.17	56.45	2584.58
4C	4	1.8	13	22.49	32	2.3	7.75	1.01	0.33	1.23	0.51	0.03	19.23	34.35	609.23
4D	5	2.5	8.3	15.81	18.2	0.9	10.56	1.1	0.49	1.23	0.47	0.05	120.48	49.69	429.40
4E	4.5	3	12.7	3.35	ND	ND	7.21	0.68	0.02	1.73	0.30	0.02	19.69	32.23	31.18
4F	5.5	4	9.7	24.81	ND	ND	10.39	1.41	0.51	1.39	1.17	0.06	51.55	32.61	91.86
4G	6	4	9.2	36.85	ND	ND	16.11	2.1	0.34	2.03	1.10	0.03	163.04	61.34	107.61
5B	2.5	0.5	17.3	32.17	26	4.4	6.21	0.97	0.29	0.75	0.95	0.04	43.35	81.28	154.51
5C	3	0.8	35.8	80.15	10.4	3.8	3.55	0.77	0.21	0.23	0.95	0.04	76.82	8.14	406.51
5D	3	1	33.4	61.71	12.8	3.7	3.81	0.76	0.34	0.85	1.04	0.03	89.82	26.97	320.12
5E	3.5	1.8	31.1	38.15	20.6	2	7.29	1.08	0.39	1.99	0.77	0.02	76.34	43.90	332.52
5F	3.5	2	15.8	11.89	ND	ND	7.05	0.98	0.26	0.96	0.97	0.03	47.47	42.90	140.98
5G	3	2	14.1	1.19	ND	ND	5.15	0.77	0.35	2.67	1.00	0.04	124.11	29.86	228.19

(ND : not determined)

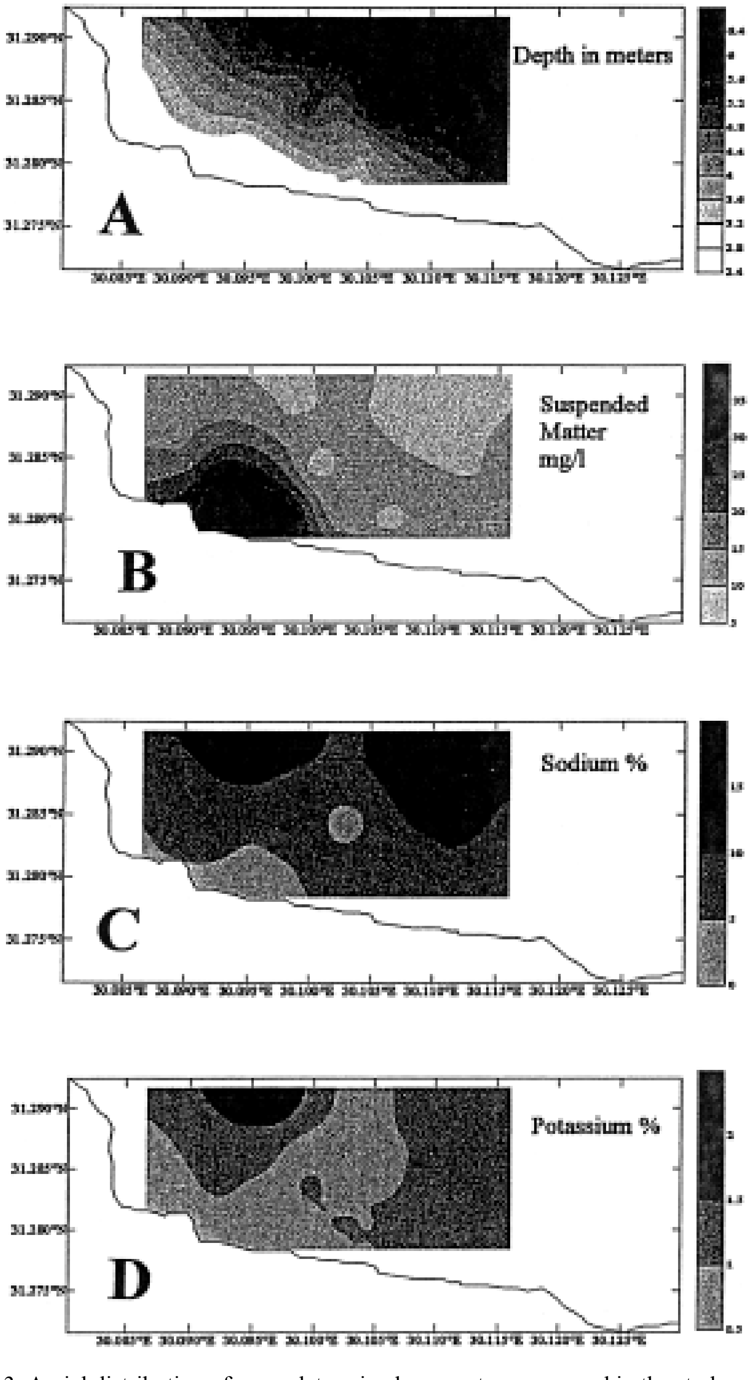

FIG. 3. Aerial distribution of some determined parameters measured in the study area.

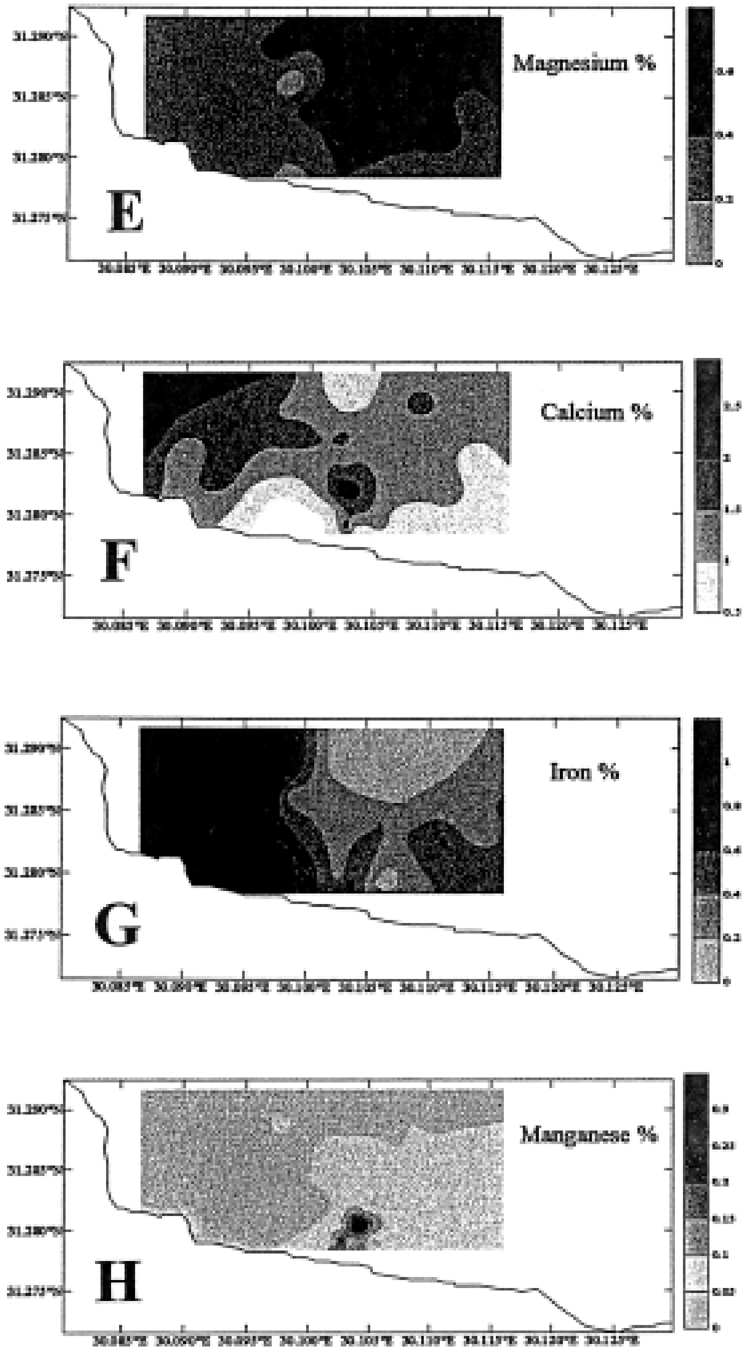

Fig. 3. Contd.

The XRD examination of the suspended material collected on the membrane filter paper revealed two modifications of Ca-carbonate minerals, calcite and vaterite (Fig. 4), the former is a stable mineral while the latter is a metastable one crystallized under specialized conditions. In the present case, vaterite formed just as a result of the dryness of the wet filter paper.

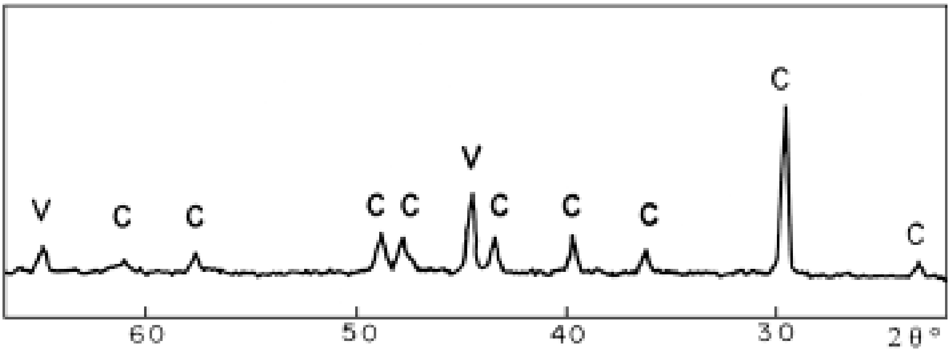

FIG. 4. Diffractogram of the suspended matter (C = calcite & V = vaterite).

Bottom Sediments

The bottom sediments of this region of the Bay vary between medium sands and mud (Table 3). The bottom sediments containing fine-grained material (silts and mud) are observed in higher frequency nearby the shoreline particularly to the southwestern direction. The sand fractions of the bottom sediments follow a counterpart distribution where they attain maxima toward open sea.

TABLE 3. Results of grain size analysis of bottom sediments of the study area.

Station no.	Sand %	Silt %	Mud %	Mean size	Sorting	Remarks
1A	7.69	54.65	37.66	6.93	1.74	Fine silt, bad sorted
1B	51.06	31.56	17.38	4.40	2.96	Fine silt, bad sorted
1C	69.54	21.63	7.83	2.86	2.53	Fine sand, very bad sorted
1D	95.63	0.79	3.58	1.66	1.07	Medium sand, bad sorted
1E	94.30	2.66	3.04	1.86	1.27	Medium sand, bad sorted
1F	73.55	13.41	13.04	2.90	1.03	Fine sand, bad sorted
1G	90.74	4.18	5.08	2.10	1.88	Fine sand, bad sorted
2A	85.02	3.72	11.26	2.60	1.83	Fine sand, bad sorted
2B	60.00	25.41	14.59	3.50	2.82	Very fine sand, bad sorted
2C	95.43	2.89	1.68	5.53	2.39	Medium silt, very bad sorted

TABLE 3. Contd.

Station no.	Sand %	Silt %	Mud %	Mean size	Sorting	Remarks
2D	28.26	51.78	19.96	1.95	1.22	Medium sand, bad sorted
2E	25.83	35.03	39.14	6.83	1.75	Fine silt, bad sorted
2F	80.13	7.17	12.70	3.20	2.78	Very fine sand, very bad sorted
2G	91.58	2.63	5.79	2.10	1.86	Fine sand, bad sorted
3A	1.37	81.60	17.03	6.88	1.88	Medium silt, bad sorted
3B	0.54	74.46	25.00	7.13	1.10	Fine silt, bad sorted
3C	62.05	22.34	15.61	3.66	3.01	Very fine sand, very bad sorted
3D	87.90	6.99	5.11	2.80	1.68	Fine sand, bad sorted
3E	71.92	10.29	17.79	3.78	3.23	Very fine sand, bad sorted
3F	56.69	22.32	20.99	4.55	2.75	Coarse silt, very bad sorted
3G	48.47	25.86	25.67	4.60	3.09	Fine sand, bad sorted
4A	73.97	3.72	22.31	3.01	3.30	Fine sand, very bad sorted
4B	39.76	42.55	17.69	4.95	2.80	Coarse silt, very bad sorted
4C	65.95	11.56	22.49	2.90	2.31	Fine sand, very bad sorted
4D	77.20	6.99	15.81	2.40	2.05	Fine sand, very bad sorted
4E	95.59	1.06	3.35	1.50	1.05	Medium sand, bad sorted
4F	69.70	5.49	24.81	2.80	2.26	Fine sand, very bad sorted
4G	61.01	2.14	36.85	1.66	1.07	Medium sand, bad sorted
5B	8.33	59.50	32.17	6.86	1.66	Fine silt, bad sorted
5C	1.27	18.58	80.15	8.28	0.78	Mud, well sorting
5D	16.63	21.66	61.71	7.30	2.07	Very fine silt, very bad sorted
5E	32.11	29.74	38.15	5.90	2.53	Very fine silt, very bad sorted
5F	78.32	9.79	11.89	1.50	2.02	Medium sand, bad sorted
5G	97.75	1.06	1.19	1.16	0.85	Medium sand, well sorted

The dominant hydraulic factors affecting the area under study leads to coagulation of fine particles and consequently to poor sorting of the sediments under study, therefore, the distribution of sorting values appears random.

Elemental Analysis

The concentrations of the alkali elements Na, K, Ca & Mg in addition to the heavy metals Fe, Mn, Cu, Pb & Zn were determined in the suspended matter (Table 2).

Sodium concentration ranges from 3.55 to 16.11% with an average of 8.22% in the suspended matter. The very near-shore zone of the sampled area has the lowest Na concentrations (5.51%) while the highest ones are encountered at the northwestern and northeastern sections (Fig. 3C). Moving away from the discharge point, the sodium concentration gets relatively high values, indicating that the discharge pipe is not the source. The same result can be concluded, in regard to the western area where a huge amount of industrial effluents are introduced to the se, *i.e.*, Na is not an industrial pollutant.

The correlation matrix (Table 4) indicates that sodium concentrations increase with increasing bottom depth below sea level, and its high concentration does not affect transparency, on the other hand, sodium concentrations increase with decreasing suspended materials.

TABLE 4. Correlation matrix of the measured data.

	Depth	Transp.	Susp. mat.	Bottom mud	Bottom CO3	Bottom O C	Na	K	Mg	Ca	Fe	Mn	Cu	Pb	Zn
Depth	1.00														
Transp.	0.90	1.00													
Susp. mat.	–0.56	–0.49	1.00												
Bottom mud	–0.27	–0.25	0.74	1.00											
Bottom CO3	–0.02	0.04	–0.14	–0.11	1.00										
Bottom O C	–0.29	–0.33	0.57	0.73	–0.10	1.00									
Na	0.68	0.70	–0.55	–0.21	0.08	–0.45	1.00								
K	0.39	0.38	–0.30	–0.07	0.01	–0.33	0.71	1.00							
Mg	0.29	0.19	–0.37	–0.34	0.08	–0.42	0.20	0.11	1.00						
Ca	0.02	0.09	–0.21	–0.38	0.22	–0.26	0.14	0.13	0.38	1.00					
Fe	–0.47	–0.35	0.51	0.38	–0.13	0.41	–0.20	0.26	–0.27	0.08	1.00				
Mn	–0.27	–0.25	–0.11	–0.10	0.38	–0.25	–0.12	–0.12	0.26	0.09	–0.02	1.00			
Cu	–0.27	–0.34	0.12	0.07	–0.18	0.06	–0.12	0.14	0.23	0.50	0.38	0.13	1.00		
Pb	–0.04	–0.08	–0.23	–0.16	–0.15	–0.05	0.15	0.20	0.28	0.16	0.00	0.45	0.33	1.00	
Zn	0.17	0.09	–0.07	–0.22	–0.02	–0.26	0.12	0.26	0.02	–0.18	0.05	0.06	0.05	0.28	1.00

It is evident that sodium contents neither belong to the suspended matter nor to the bottom sediments.

Potassium concentration among the suspended material of the area under study varies from 0.75 to 2.1% and averages 1.02%. The spatial distribution of K concentrations is irregular but indicates that the discharge pipe is not the source as well. Statistical treatment of the obtained data points to that potassium behaves the same way as sodium (Fig. 3D), it has direct proportion against depth and transparency in addition to Na (Table 4).

Magnesium content of the suspended particles ranges between 0.02 and 0.74% with an average of 0.43%. However the eastern half of the investigated region is richer in Mg than the western one (Fig. 3E).

Magnesium has a direct proportion against Cu, but it has reverse ones against suspended matter concentration and organic carbon contents of the bottom sediments. This supports the possibility of an anthropogenic point as a source

Calcium concentration varies from 0.23 to 2.67% and averages 1.27%. The highest Ca concentration is located to the extreme west of the study area as a result of the many industrial activities there (Fig. 3F). In contrast the lowest Ca values are traced to the east direction.

Calcium has only one negative correlation against the bottom mud indicating absence of any effect evolved by the bottom sediments on Ca concentration in the suspended matter. On the other hand Ca has direct proportion against Mg and Cu. This means that Ca partially flows from the same source (pipe) as Mg and Cu, and in the same time the pipe is not the sole source of calcium among the limited area of study.

Generally, the metals (Fe, Mn, Cu, Pb & Zn) of the suspended matter investigated have similar behaviors excepting some minorities.

The spatial distribution of the concentrations of the heavy metals denotes to a decreasing trend from the discharge pipe to the offshore directions concerning sectors 1, 2 & 3. In contrast, the western sectors have the highest Fe concentration in an opposite trend, *i.e.*, from offshore direction especially from the western side where a relatively higher concentration of metals flows from some industrial plants (Fig. 3G). This situation includes Cu and Zn as well. It is clear that Fe higher concentrations are not coming from the discharged pipe.

The first station of each of the study sectors has the highest Mn content indicating the main influence of the discharge pipe, but Fig. 3H illustrates the effect of the remote industrial activities on the western half of the study area as mentioned above.

The Pb concentrations have irregular trends, therefore the high and low values occupy up and down streams and near and apart sites relative to the discharge pipe.

Factor Analysis

All the obtained parameters (geological and geochemical) were subjected to statistical analysis, where we got four factors. These factors control the characteristics of the suspended materials under investigation. The first factor includes the suspended matter concentration, its Fe content, the bottom mud fraction and its organic matter content from one side and the following parameters from the other side: transparency, depth, Na and Mg contents of the suspended matter. The second factor includes Cu, Pb, Ca and Mn. The third factor includes K and Zn concentrations of the suspended matter, while the fourth factor is represented by the carbonate content of the bottom sediments.

Summary and Conclusion

It is well known that the Abu Quir Bay receives some polluted waters disposed from certain activities that did not follow the environmental protection measures up till the beginning of this study. So the noticeable areas – even by the naked eye – do not need an investigation, but those areas located down the polluted stream deserve to be investigated. The goal of this work is to investigate only the effect of discharging effluent of an industrial plant producing fertilizers (urea & ammonium nitrate). This effluent pours its contents into the sea via a pipeline. Mainly the discharged output introduced into the sea is turbid waters. The degree of turbidity was determined in addition to the concentration of Ca, Na, K, Mg, Fe, Mn, Cu, Pb and Zn. The relatively high concentration of the suspended particles of the pipeline effluent (112 mg/l) has very limited influence on the marine environment for two reasons: a) the flow rate of the pipe is very low and b) as the effluent water mixes quickly with the seawater, the turbidity promptly attains minimum values. The grain size analysis of the bottom sediments under concern shows absence of any tiny particles may be brought with the disposed effluent. The spatial geographical distribution of the measured elements (concentrated in the suspended matter) demonstrates that some elements have their maximum concentrations just out of the pipeline as Mn, Cu, Pb and Zn, and other elements attain their maximum levels to the west or northwest as Na, K, Ca and Fe. However, because of the relatively active hydrodynamic conditions prevailing throughout the area under study, the discharge effluent by the pipe does not affect the marine environment. This is very obvious and cleared by permanent and continuous fishing in the area.

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تـأثير أحـد المصبات الأرضية على البيئة البحريـة القريبة من الشـاطيء بخـليج أبي قـير – الإسـكندرية – مصر

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المستـخلص. توجـد أنشـطة عـديدة بمحـاذاة سـاحـل خليج أبي قـير ، تشمـل هذه الأنشطة مجـالات الشركـات الصناعيـة ، والزراعة ، والصيد ، وخدمات وتسهيلات شركات البترول ، وكـذلك عـديد من التجمعـات السكانيـة. أحـد هـذه الأنشطة الصناعـيـة يقـوم بصـرف دائم لميـاه تم استخدامهـا فى عملية إنتاج الأسـمدة. حيث يتم ضخ مياه الصرف هذه مباشرة في مياه البحر ، وتحديدا فى المنطقة القريبة من الشاطيء.

لبيان مدى تأثير دخول مياه الصرف هذه على البيئـة البحرية ، تم تعيين كل من كمية المواد العـالقة في مياه البحر في منطقة الدراسة ، وكذلك تم قيـاس محتوى المواد العالقـة من الصوديوم ، والبوتاسيوم ، والكالسيوم ، والمغنسيوم ، والحديد ، والنحاس ، والرصـاص ، والزنك . كما تم التعرف على نوعيـة رواسب القـاع والظروف الإقيانوغـرافية السـائدة في منطقـة الدراسة.

أظهـرت النتائج أن نوعيـة مياه الصرف هذه ليس لهـا تأثير سلبي على البيئة البحرية .