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Assessment of Seawater Quality of El-Dekhaila Harbor, Alexandria, Egypt

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ABSTRACT: Water quality of El-Dekhaila harbor was monitored seasonally at nine samples covered the harbor surface water during 2011-2012. The chemical parameters of surface water reveal that pH, dissolved oxygen, oxidizable organic matter, chlorophyll and total alkalinity were in the range 7.70- 9.16, 1.07-7.54 mgO_2/l, 0.16- 9.92 mgO_2/l, 0.002-0.23µg/l and 2540.3-4668.8µmol/l respectively. Nutrients salts showed large variations 1.7-51.15, 0.17-12.5, 0.4-14.9, 0.09-17.1 and 10.3-77.3 (µ M) for ammonia, nitrite, nitrate, reactive phosphate and reactive silicate respectively. Depending on DIN/P ratio of seawater samples, phosphorus was the limiting factor for the Harbour water productivity. Principle component analysis (PCA) which was used to develop water quality index (WQI) revealed that, stations 1, 2 and 3 is highly polluted by water discharged from EI-Umum drain through EI-Mex pumping station. The ecological evaluation of El-Dekhaila Harbour water quality parameters after 20 years of the constructions of the harbor indicates that, the construction of the harbor decreases surface water circulation pattern out of the harbor leading to increase in polluted water residence time and hence increase the flushing time and decrease harbor water self purification. Moreover increasing shipping activity and waste water directly dumped too the harbor dramatically affect the harbor water quality. This is reflected in large increase in nutrient salt concentration after 20 years from the harbor construction. This is also accompanied by increasing intensity of microbial activity and decrease dissolved oxygen content.

Keywords: El-Dekhaila harbor; Egypt; Alexandria; water quality and PCA.

INTRODUCTION

Degradation of water quality due to land-based pollution is a serious problem in Mediterranean coastal areas. Many semi-closed bays and coastal areas in the Mediterranean are exposed to land based pollution sources, mainly from agricultural, domestic and industrial effluents and/or river runoff. Changes to ecosystems as a result of pollution stress have led to the search for means of quantifying such changes[1].

El-Dekhaila Harbor is a semi-enclosed basin constructed recently after 1986 on the western side of El-Mex bay[2] for the export of manufactured iron and steel. It is economically one of the most important Harbors in Egypt. It plays an important role in the export and import of other goods such as minerals, ores, fertilizers, salts and grain. According to Abdalla et al.[3] and Fahmy et al.[2], the Harbor´s water is subjected to several types of pollution resulted from different sources of wastewater especially those dumped from the ships traffic to and from the harbor which continuously affect its water quality. Moreover the harbor is subjected to the untreated industrial waste water discharged directly to the Harbor from Chloro Alkali Plant, Tanneries and Alexandria Petrolum Company. More over the great effect on the Harbor water quality is resulted from the huge volume of brackish water that discharged into El-Mex Bay through El-Umum drain (average $6.7\times10^6 m^3 day^{-1}$) loaded with industrial, agricultural and domestic wastes[4]. All these pollutants contaminate were driven to the Harbor water by the clock wise surface circulation current of El-Mex Bay surface water. The Harbor water quality state is of great interest for many researchers, Ramadan et al.[5], Amany and Dorgham[1], and Fahmy et al.[2]. Tayel et al.[6] and Abdalla et al.[3], studied the water quality characteristics of El-Dekhaila Harbor for the seek of assessment of the effect of all these different pollutants.

Previous studies[4] confirmed that the construction of El Dekhaila Harbor increases the residence time of the Bay water 10 times than before. Residence time increased from 1.2days during 1983 -1984[7] to 11.32days during 2004[4]. The construction affects the near shore current and decreases the free connection with sea water, So it increases the residence time and increases the flushing time which lead to a very slow rate of the water self purification of pollutants.

Pollution assessment needs to correlate all the effective variables and to fully interpret the measured data in addition to comparing with the previous available data sets. Principal component analysis is successfully applied tool to sort out hydrographical and chemical from commonly collected water quality data to establish spatial and temporal variations in water quality[8]. It is a technique from statistics for simplifying a data set. It aimed to reduce the dimensionality of multivariate data whilst preserving as much of the relevant information as possible.

This work aims to study and analyze the impact of the pollution sources (industrial, agricultural and domestic discharge) and shipping activity and different pollutants on water quality of El-Dekhaila harbor and evaluate the ecological state of the harbor.

MATERIAL AND METHODS

Study area: El-Dekhaila harbor is located at the western part of El-Mex Bay at latitude 29° 47' and longitude 31 ° 10' (Figure 1) with a surface area of about 12.5 Km^2. Its water depth ranges between 6 and 19 m with an average of 12.4 m. Surface water samples were collected seasonally from nine stations during the year 2011/2012 covering the ecologically different parts of the Harbor (Figure 1).

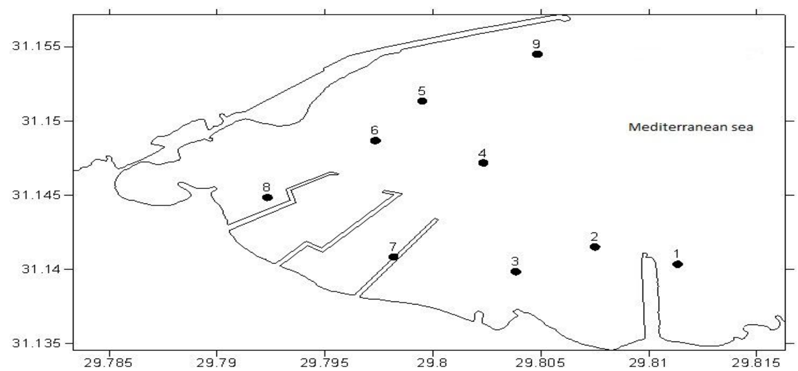

Figure 1: Investigated area (EL-Dekhaila Harbor) and position of stations

Sample Collections: Surface water samples were collected using Niskin's bottle. Physico-chemical analysis were carried out for the collected water samples to measure the following variables (Table 1): temperature, measured by an ordinary thermometer accurate to 0.1 ºC, the pH – value, was measured by Metrohm (827 pH) pH electrode calibrated with TRIS buffer on total scale (pHT) following Dickson et al.[9], Total alkalinity (TA) was measured following Sarazin et al.,[10]. Certified reference materials (CRM batch 19) that used to calibrate and establish correction factors for TA measurements were obtained from Professor Andrew Dickson at the Marine Physics Laboratory of the Scripps Institute of Oceanography, University of California San Diego. Dissolved oxygen (DO) was analyzed according to the modified Winkler method, (Strickland and Parson)[11], oxidizable organic matter (OOM) was measured according to Carlberg method[12]. Nutrients salts (nitrite, nitrate, ammonia, phosphate and silicate) were analyzed spectro-photometrically according to the recent oceanographically methods described by Grasshoff[13] using a Shimadzue double beam spectrophotometer. Chlorophyll content was determined spectro-photometrically according to Strickland and Parsons[11].

RESULTS AND DISCUSSION

Water quality parameter of the surface water sample of El-Dekhaila Harbor was interoperated in the Figures (2-12). The seasonal variations of the ranges and average ± SD of different parameters were presented and tabulated in Table 1.

Table 1: Seasonal variation of the average concentration, minimum and maximum values of chemical parameters and corresponding standard deviation in El –Dekhaila Harbor.

Parameter		Winter	Spring	Summer	Autumn	Annual Average
pH	Ranges	8.17-7.88	8.17-7.87	9.16- 8.46	8.34-7.7	-
	Average ±SD	-	-	-	-	-
Total alkalinity (µmol/l)	Ranges	2972.4-2540.3	4668.8- 3051	3754.9-3321.8	4070.2-3256.7	-
	Average ±SD	2673.7±141.6	4206.6±468.2	3540.3±173.7	3684.3±257.2	3530.38± 628.99
Chlorophyll (µg/l)	Ranges	0.079- 0.016	0.23-0.045	0.067-0.0085	0.016- 0.0021	-
	Average ±SD	0.040±0.02	0.158±0.07	0.028±0.019	0.0024±0.005	0.058±0.068
DO (mgO_2/l)	Ranges	7.54- 5.65	-	2.34- 7.26	6.62- 1.07	-
	Average ±SD	6.65±0.65	-	4.71±1.64	2.69±1.60	4.68±1.98
OM (mgO_2/l)	Ranges	3.84- 0.16	8.24-0.32	9.92- 4.32	5.12- 0.24	-
	Average ±SD	2.22±0.99	5.3±2.68	7.27±2.19	4.19±1.53	4.75±2.11
Total hardness g/l	Ranges	2.14-1.56	2.22-1.56	1.98-0.86	3.59-2.42	-
	Average ±SD	1.98±0.17	1.77±0.23	1.45±0.44	2.97±0.33	2.05±0.66
Ammonia (µM)	Ranges	5.1-1.7	-	37.8-7.4	51.15-13.35	-
	Average ±SD	3.55±1.15	-	13.9±9.36	29.52±12.02	15.66±13.07
NO_2 (µM)	Ranges	7.40-3.08	12.45-5.58	2.25-0.175	12.5-5.8	-
	Average ±SD	4.51±1.28	9.07±2.5	0.45±0.28	9.07±2.56	3.53±4.21
NO_3 (µM)	Ranges	11.84-6.36	7.57-1.03	5.4-0.4	14.9-8.4	-
	Average ±SD	8.76±1.98	4.06±2.36	1.5±1.5	11.83±2.4	6.54±4.63
Silicate (µM)	Ranges	40.7-21.4	77.35-27	32.3-11.98	52.3-10.3	-
	Average ±SD	26.3±6.02	53.4±15.86	23.29±7.47	33.83±13.51	34.21±13.54
Phosphate (µM)	Ranges	10.4-7.82	17.10-8.21	0.7-0.13	1.32-0.08	-
	Average ±SD	8.59±0.79	13.82±2.66	0.34±0.18	0.33±0.39	5.77±6.62
DIN (µM)	Ranges	22.8-13.3	-	45.40-8.43	72.7-33.43	-
	Average ±SD	16.58±2.92	-	17.83±11.41	50.9±12.78	28.44±19.46

pH: pH values plays an important role in many marine life processes. It may also reflect the redox potential, productivity and pollution level of the aquatic environments. In highly polluted estuarine areas with limited circulation, natural processes, such as enhanced primary production and organic matter degradation are causes of pH fluctuation[14]. In the study area, despite the absence of proportionality, the lowest value 7.70 in autumn at station 1 is associated with the lowest salinity reflecting the effect of brackish water that discharged from El-Umum drain which affects El-Dekhaila Harbor due to the clockwise surface water current that allow the discharged water from El-Umum Drain to move west ward entering Eldekhaila Harbor. Maximum pH = 9.16 was recorded in station 3 in summer due to the influence of the alkaline water discharged from Chloro Alkali Plant Factory. The pH of discharged water from this company is always in the alkaline side, it ranges between 8.9 and 9.5 all over the year and the volume of discharged water increase dramatically during summer in consistence with tanks washing processes causing discharge of huge amount of high pH ~ 9.5 waste water[15]. The distribution of pH at different stations during different seasons was investigated in Figure 2.

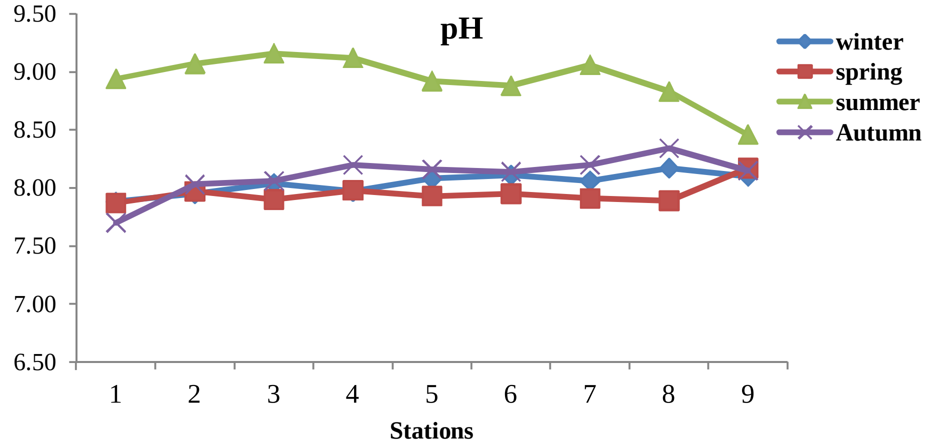

Figure 2: Seasonal variation of pH in El-Dekhaila Harbor stations 2011-2012

Total Alkalinity: Total alkalinity is simply expressed as the sum of equivalents of carbonate, bicarbonate and borate ions and it is a good indication of the water buffering capacity and the pollution. The annual mean values of total alkalinity in the surface water of El-Dekhaila Harbor was 3530.38 µmol/ kg, which is highly matched with the values recorded for such polluted areas[3,16, & 17]. Total alkalinity vales flocculated from 4668.8 µmol/ kg in spring (station 1) to 2540.3 µmol/ kg in winter (station 9) (Figure 3). Increasing alkalinity in spring is accompanied with increasing of chlorophyll which confirms the relation between alkalinity and phytoplankton standing crop[3]. The increase photosynthetic activity consumes large amount of dissolved carbon dioxide causing increasing in alkalinity as a result of carbonate –bicarbonate equilibrium shift. In addition the contribution of High concentration of phosphate, silicate and ammonia in the discharged waste water in alkalinity must also be considered which result in high alkalinity value in spring[18].

Dissolved Oxygen: Dissolved oxygen is considered as one of the most important and useful parameters in identification of different water masses and in assessing the degree of pollution especially with organic pollutants which affects fish and other marine life through oxygen reduction or depletion. The absolute surface dissolved oxygen content was fluctuated between highest value recorded during the winter (7.54 mgO_2/l) , while the lowest value was in autumn (1.07 mgO_2/l) at station 2 which is highly affected by the brackish water from El-Mex Bay. In general the high values of DO in winter can be attributed to lower water temperature as well as agitation of water by strong winds[19], both increases the oxygen dissolution in surface water and decrease degassing. The annual average of dissolved oxygen content DO is 4.68 mgO_2/l. Statistical analysis showed that, DO are negatively correlated with high value of ammonia during Autumn (table 1) confirming the great impact of discharging waste water high in ammonia on the level of oxygen content since dissolved oxygen is used in oxidation of discharged pollutants. The seasonal variations of DO at different stations in El Dekhaila harbor water during 2012 are presented graphically in Figure 4.

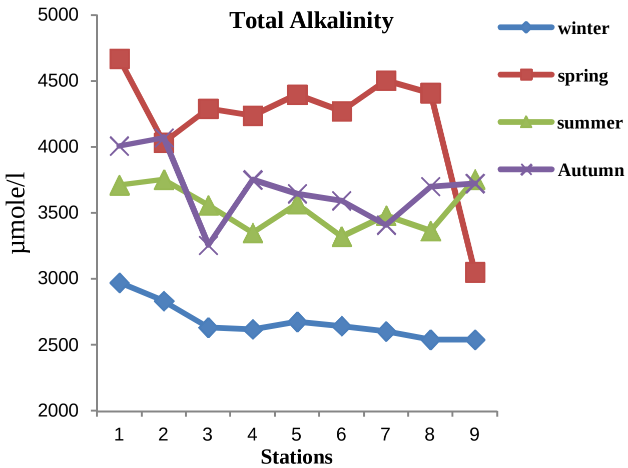

Figure 3: Seasonal variation of Total Alkalinity (µmole/l) in El-Dekhaila Harbor 2011-2012.

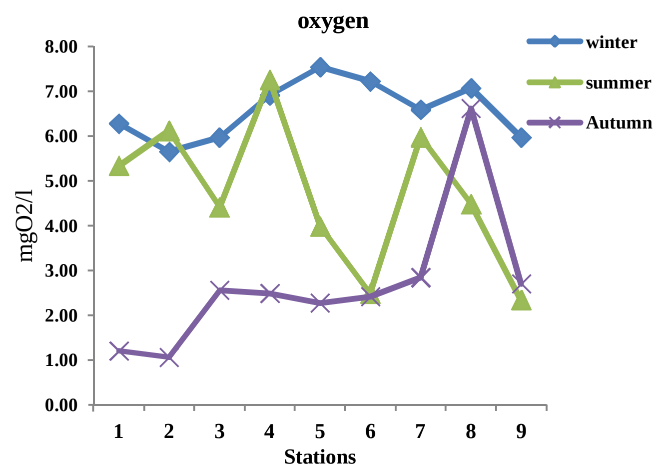

Figure 4: Seasonal variation of dissolved oxygen concentration DO_2 (mg O_2/l) in El-Dekhaila Harbor 2011-2012.

Oxidizable Organic Matter, OOM: Oxidizable organic matter, OOM, is far known as one of the most criteria to assess sewage pollution and organic loading. It is expressed as a measurement of the oxygen equivalent to the amount of organic matter oxidized by a strong oxidizing agent. The source of OOM in the Harbor water is from biological activities of living organisms, the decomposition products of died organisms and from the water discharged from EI-Umum Drain into EI-Mex Bay. Maximum value of OOM content in surface water was recorded in summer 9.92 mgO_2/l at station 3 which lies near the connection of the harbor opining with El-Mex Bay. It is reported that increasing organic supply introduced into El-Mex Bay under relatively slow rate of self-purification[2 & 4] results in elevation of OOM content[20]. The minimum OOM value was 0.16 mgO_2/l recorded in winter at station 6 (Figure 5). The seasonal average was varied from 2.22±0.995 mgO_2/l during winter due to the influence of mixing by entrainment in addition to the turbulence by winds and waves to maximum average content 7.27±2.19 mgO_2/l during summer in consistence with the highest recorded water residence time 13.3days during summer[4]. The annual average content of OOM is 4.745 mgO_2/l (Table 1).

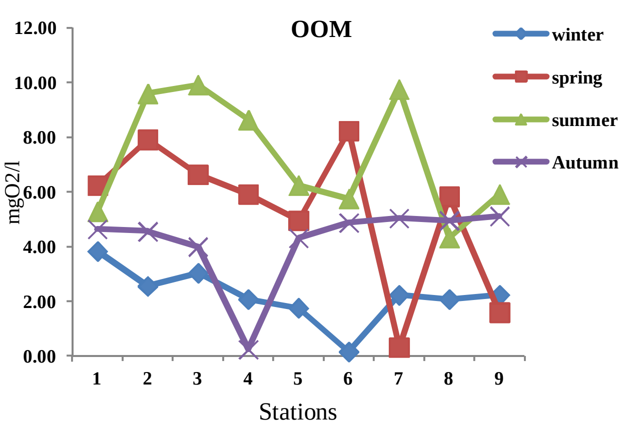

Figure 5: Seasonal variation of OOM (mgO_2/l) in El-Dekhaila Harbor 2011-2012.

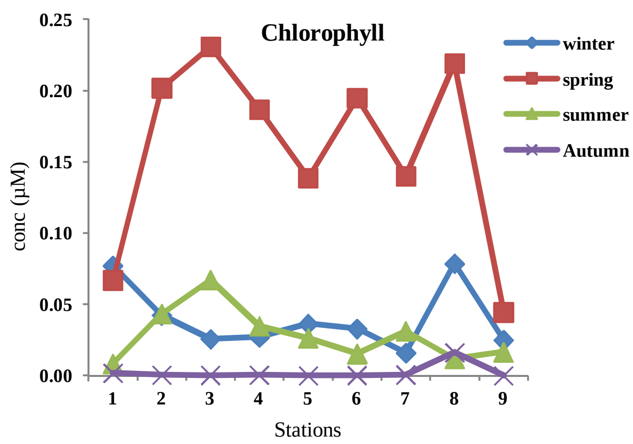

Figure 6: Seasonal variation of chlorophyll (µM) in El-Dekhaila Harbor 2011-2012.

Chlorophyll A: Chlorophyll A is considered as an essential component responsible for the photosynthesis processes and can be consider as a good easy tool for measuring water productivity. Measurements of chlorophyll A in El-Dekhaila Harbor surface water varied from approximatly zero at station 5 during autumn to a maximum content of 0.23µg/l at station 3 during spring (figure 6). the seasonal average showed that the highest production of the harbour was during spring with the highest average chlorophyll content (0.158±0.066µg/l) in consistence with high photosynthetic activity while the lowest (0.002±0.005µg/l) recorded during autumn in spite that the surface water had the highest NO_3 and NO_2 content indicating that low chlorophyll is directly correlated to low phytoplankton community. The recorded annual average of chlorophyll content in El-Dekhaila Harbor during 2011-2012 is 0.0576µg/l.

Total Hardness: Calcium, magnesium and total hardness varied from minimum (Ca=0.32 g/l, Mg=1.24 g/l and total hardness= 1.56 g/l) during spring at station 1 to maximum (Ca=0.521g/l, Mg=3.06 g/l total hardness= 3.588 g/l) at station 2 during autumn (Figure 7). Regarding seasonal average lowest content (Ca=0.382±0.04 g/l, Mg=1.39±1.91 g/l total hardness= 1.77±0.23 g/l) while the highest was recorded during autumn (Ca=0.46±0.03 g/l, Mg=2.51±0.33 g/l total hardness= 2.97±0.33 g/l).

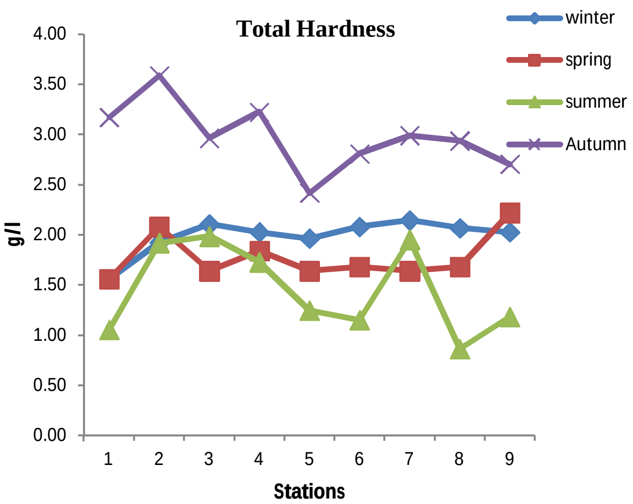

Figure 7: Seasonal variation of Total hardness (g/l) in El-Dekhaila Harbor 2011-2012.

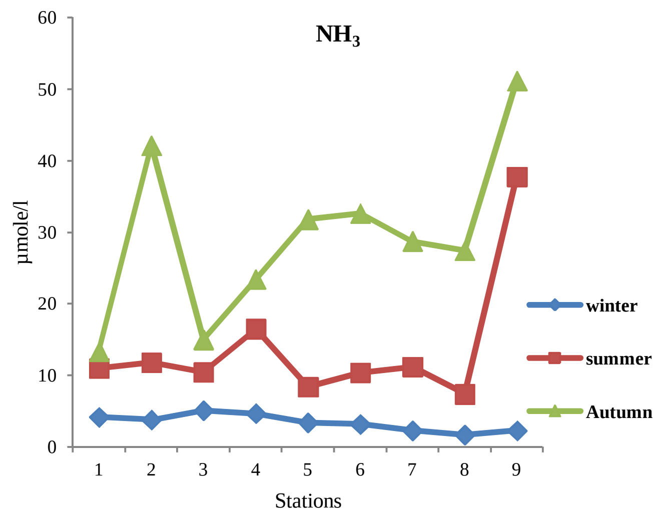

Figure 8: Seasonal variation of NH_3 (µmole/l) in El-Dekhaila Harbor 2011-2012.

Nutrients salts: Sewage and agricultural discharge through El-Umum Drain to El-Mex Bay may consider as the major source of nutrients to El Dekhaila Harbor. Large nutrient discharge may have dramatic ecological consequences. A high anthropogenic input of nutrients under restricted water circulation especially in semi enclosed basin like El-Dekhaila harbor will support a high rate of organic matter accumulated at the sea floor where it is respired and oxygen is depleted due to nutrient regeneration.

The studied nutrients in the present work (nitrites, nitrates, ammonia, phosphate and silicates) measured seasonally and data presented in Table1and their distribution is interpreted in figures. (8-12). In principle, ammonia is the form of nitrogen preferred by algae and only when its concentration is depleted to less than 0.15 µM, nitrates and nitrites will be utilized (UNESCO, FAO, UNEP, 1988)[21]. Ammonia content was varied from 1.7 µM in winter (st.8) to 51.15 µM in autumn (st.9).

Maximum values of NO_2 and NO_3 were detected during autumn (12.5, 14.9 µm/l respectively) and minimum values were measured in the summer, reproductive season, (0.175, 0.4 µm/l respectively). Increasing NO_2 and NO_3 concentrations in autumn accompanied with a decrease in ammonia concentration during autumn may be attributed to nitrification process. This may be confirmed by a dissolved oxygen deficiency during autumn.

Dissolved inorganic nitrogen concentrations DIN (the sum of ammonia, nitrite and nitrate) in the harbor were relatively high (Table 1). Generally the high level of DIN was affected directly by the discharged water from the drains, which contains high amount of domestic sewage and agricultural fertilizers[20].

The environmental significance of phosphorous arises out of its role as a major nutrient for both plant and microorganisms. High value of phosphorous was detected in spring in station 8 (27.1µm/l). Low content of phosphorous was recorded in station 5 (0.088 µm/l) in autumn (Figure11). The high enrichment of water with phosphate during winter–spring period is mainly attributed to the allochthonous huge amount of domestic and drainage effluents enriched with phosphate and other fertilizers discharged into this area[2&22].

According to Chiaudani and Vighi [23], when DIN/P ratio is higher than 6, the marine algae are considered to be P-limited and when it is lower than 4.5, they considered to be N – limited. In the present work, winter data have DIN/P ratio (**1.91**) while summer and autumn have DIN/P value 55.95 and 308.5 respectively .The average of DIN/P for measured seasons for whole stations was 122.2 where phosphorus was the limiting factor. This agrees with the data reported for El-mex bay by shreadah et al.[20].

The variations of silicate concentration were mainly contributed to the supply of silicate from drain water on one hand and its consumption by diatoms on the other hand. Thus, silicate is a good indicator of fresh water dispersion and of the potential for diatom blooms. Silicate and phosphate were highly correlated with each other which indicate the footprint of drain water and brackish water from El Mex Bay. Highest absolute value of silicate was detected in spring at station 5 (77.3 µm/l) while the lowest content of silicate was recorded in station 3 (10.3 µm/l) in autumn. The surface water seasonal average of phosphate and silicate showed maximum content (13.82±2.66 µm/l and 53.4±15.86 µm/l respectively) during spring while the minimum surface average was during summer 0.33±0.18 µm/l for phosphate and 23.29±7.47 µm/l for silicate.

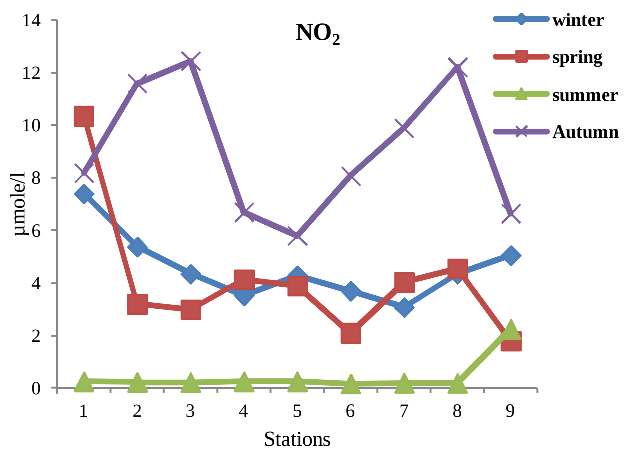

Figure 9: Seasonal variation of NO_2 (µmole/l) in El-Dekhaila Harbor 2011-2012.

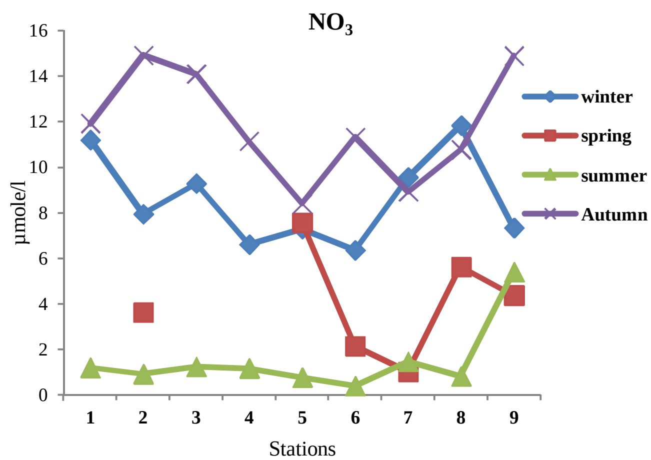

Figure 10: Seasonal variation of NO_3 El-Dekhaila Harbor 2011-2012.

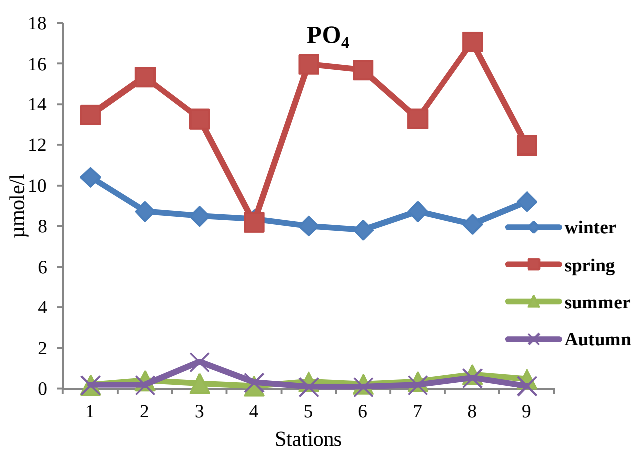

Figure11: Seasonal variation of phosphate (µmole/l) in El-Dekhaila Harbor 2011-2012.

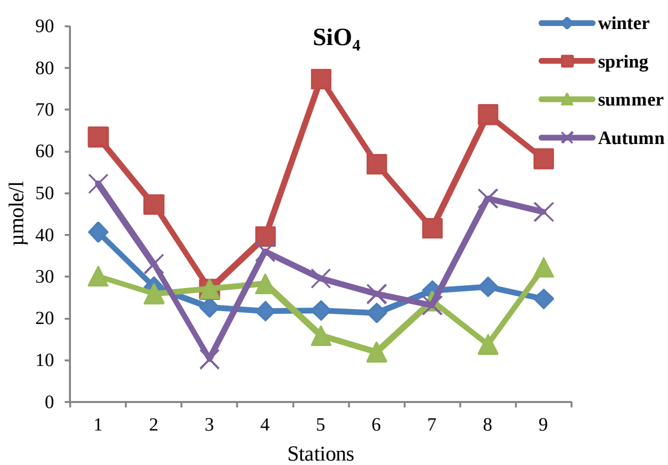

Figure 12: Seasonal variation of silicate (µmole/l) in El-Dekhaila Harbor 2011-2012.

Principal Component Analysis (PCA): Principal component analysis is applied to multivariate data derived from the water quality parameters analysis of the water samples of all stations during the four seasons in El-Dekhaila Harbor. The output data reveals four factors (PC1-PC4) affect El-Dekhaila harbor water quality, association and sources, with cumulative covariance of 83.85%. Varimax rotated components matrix is presented in Table 2 to give an overview on the nature of loading among the parameters. PC1, PC2, PC3 and PC4 have covariance of 23.67%, 21.6%, 19.7% and 18.8% respectively. PC1 represented loading of OOM (0.837) associated with negative loading of silicate (-0.776) which can be demonstrate autochthonous sources of silicate. PC2 had loading for nitrite (0.869) and nitrate (0.834) which demonstrated the positive relation between nitrite and nitrate confirming their allochthonous origin. PC3 represented high loading of dissolved oxygen (0.919) with negative loading of Ammonia (-0.756). PC4 represented high loading of phosphate (0.860) where phosphorus is limiting factor in phytoplankton growth.

Water Quality Index (WQI): Water Quality Index (WQI) is calculated according to the following formula[24]:

$$WQI=\sum_{n=1}^{n}(\lambda n / \sum \lambda)\, x\ PCn$$

For PC Assessment model where n: The number of effective components, , are the Eigen values of the effective components, $\sum \lambda$ sum of the Eigen values and PCn are the n critical principal component scores[25]. According to calculation of water quality index, station 3 (WQI =0.731), station 2 (WQI =0.673) and station 1 (WQI =0.329) suffer from pollution.
These stations are highly affected by discharged water of El-Umum Drain where oxidizable organic matter, nitrate and nitrite are the effective parameters (Table 3).

Table 2: Varimax rotated component matrix for chemical parameters of El-Dekhaila harbor.

Parameters	Component			
	1	2	3	4
Chlorophyll	0.658	-0.057	0.586	0.19
DO	-0.119	-0.07	0.919	-0.221
OM	0.837	0.35	-0.027	0.392
TH	0.758	0.08	-0.077	-0.513
TA	-0.007	0.518	0.334	0.521
Ammonia	-0.202	-0.104	-0.756	-0.45
Silicate	-0.776	0.524	-0.066	0.161
Phosphates	-0.015	0.135	-0.036	0.86
Nitrite	0.05	0.869	0.205	0.373
Nitrate	0.005	0.834	-0.215	-0.073
Variance	23.673	21.602	19.715	18.863
CV%	23.673	45.275	64.991	83.854

Rotation Method: Varimax with Kaiser Normalization CV: cumulative variance; bold number indicates positive correlation and -ve italic values indicate negative correlation. a. Rotation converged in 7 iterations

Table 3: Principal component factor scores and water quality index, WQI, of water samples in study area.

Hot spots	PC1	PC2	PC3	PC 4	WQI	parameter
Station 3	1.71	0.36	-0.08	0.08	0.73	According to high PC1value, the effective parameter is OOM
Station 2	1.46	0.71	-0.53	0.27	0.67	According to high PC1value, the effective parameter is OOM
Station 1	-0.93	1.82	0.12	0.92	0.33	According to high PC2value, the effective parameters are nitrite and nitrate

Monitoring of seawater quality of El-Dekhaila Harbor during 20 years: –Comparing different environmental water quality parameters in El-Dekhaila Harbor during 20 years from the constructions of the harbor was tabulated in table (4). It is clearly obvious from the table the great impact of the construction on the water quality of the harbor since the increasing residence time of polluted water cause pollutants accumulation. Moreover increasing shipping activity with large organic and inorganic pollutants dumped to the harbor. It is indicated from the table that the pH affected greatly due to accumulation of waste water of low pH inside the harbor. The same is for the high alkaline pH value 9.16 recorded due to the industrial water discharge. Concerning dissolved oxygen, the water is still well aerated except the area f waste water accumulation where dissolved oxygen is used via organic matter mineralization. Slight ncrease in nitrate attributed to effect of waste water, while the very large increase in nitrite and ammonia ontent is related to both domestic sewage accumulation and bacterial activity. The very high phosphate and silicate content in current study comparing to the previous studies is directly correlated to the large amount of industrial, domestic and agricultural waste water discharged from El-Umum Drain and different factories that dumped their untreated wastes directly to the harbor. The worst situation is that all these kinds of pollutants were accumulated in the Harbor under the influence of increasing fresh water residence time after the harbor construction.

Table 4: Comparison between water quality parameters of El- Dekhaila Harbor of the current study and previous studies.

parameters	1990-1991[3]	1993-1994 [6]	2011-2012*
pH	-	8.55-8.63	7.7- 9.16
DO_2	1.47-5.44 mgO_2/l	6.29-7.47 mgO_2/l	1.07-7.54 mgO_2/l
OOM	3.1-18.80 mgO_2/l	4.75-6.69 mgO_2/l	0.16-9.92 mgO_2/l
Chlorophyll	-	-	0.0021-0.23µg/l
Total alkalinity	-	3980-4680 µmol/l	2540.3-4668.8 µmol/l
NO_3	0.52-8.28 µM	-	0.4-14.9 µM
NO_2	1.77-2.16 µM	-	0.17-12.5 µM
NH_3	4.38-14.2 µM	-	1.7-51.15 µM
PO_4	0.3-0.6 µM	-	0.09-17.1 µM
SiO_4	2.40-9.5 µM	-	10.3-77.3 µM

** Present study*

CONCLUSION

El Dekhaila harbor surface water was highly productive during summer as indicating by having the minimum NO_3, NO_2, PO_4 and maximum oxidizable organic matter content. While during winter it showed the highest dissolved oxygen DO_2 content which attributed to high surface water turbulence. Also the low community during summer doesn't consume too much oxygen as confirmed by low oxidizable organic matter content. On the other hand the foot print of the drainage water comes through El-Umum drain was highly detected and showed a maximum effect on El-dekhaila harbor during autumn. This was indicated by the lowest DO_2 content and minimum chlorophyll concentration both accompanied with highest nutrient salts concentration (NO_2, NO_3, PO_4 and Si_2O_3). Stations 1,2 and 3 are polluted area which highly affected by El-Umum Drain and petrochemical companies.

REFERENCES

1. Amany A. Ismael, and Mohamed M. Dorgham (2003) Ecological indices as a tool for assessing pollution in El-Dekhaila Harbour (Alexandria, Egypt), OCEANOLOGIA, 45 (1), 121–131.
2. Fahmy, M. A., Tayel, F. T. & Sheriadah, M. M., (1997) Spatial and seasonal variations of dissolved trace metals in two contaminated basins of the coastal Mediterranean Sea, Alexandria, Egypt., Bulletin of the Faculty of Science, Alexandria University, 37, (2), 187-198.
3. Abdalla, R. R., Zaghloul, F. A., Hassan, Y. A. & Moustafa, H. M., (1995) Some water quality characteristics of El-Dekhaila harbour, Alexandria, Egypt. Bulletin of National Institute of Oceanography and Fisheries, *A. R. E.*, 21, (1), 85-102.
4. Shaltout N. A. (2008) Inorganic carbon cycle of Alexandria coastal water, Ph.D. Thesis, chemistry department, faculty of science, Alexandria University, Egypt, 257.
5. Ramadan S. H. E., Kheirallah A. M., and Abdel- Salam KH. M., (2006) Factors controlling marine fouling in some Alexandria Harbours, *Egypt, Mediterranean Marine Science*, 7(2), 31-54.
6. Tayel F. T. R., Fahmy M. A. and Sheridah M. M. A. (1996) Studies Of The Physic Chemical Characteristics Of Mex Bay And New Dehkhaila Harbour Waters Of Alexandria, Egypt. Bull. Nat. Inst. Of Oceanograph. & Fish., *A.R.E.*, 22, 1-18.
7. El-Gindy A. A., Aboul-Dahab O. And Halim Y. (1986) Preliminary estimates of water and trace metals balances in El-Mex Bay, West of Alexandria, *Egypt. Rapp. Comm. Int. Mer Medit.*, 30 (2), 127.
8. Olobaniyi s. and Owoyemi F., (2006) Characterization by factor analysis of chemical facies of ground water in deltaic plain sands aquifer of Warri, western Niger Delta, Nigeria, *Afr. J .sci. Technol.*, 7(1), 73-81.
9. Dickson, A. G., Sabine C. L., and Christian J. R., eds. (2007) Guide to Best Practices for Ocean CO_2 Measurements. PICES Special Publication 3, 191.
10. Sarazin G., Michard G. and Prevot F. (1999) A rapid and accurate spectroscopic method for alkalinity measurements in sea water samples, *Water Research*, 33, 290–294.
11. Strickland, J. D. M. and Parsons T. R. (1972) A practical Handbook of Seawater Analysis", 2nd ed., Bull. Fish. Res. Bd. Canada, 310.
12. Carlberg, S.R. (1972) New Baltic Manual, Intern. Coun. For the Explo. Of the Sea.Cooperative Res. Rep. Series A N. 29, Copenhagen.
13. Grasshoff, K. (1976) Methods of Seawater Analysis, Verlage Chemie. Weinheim, New York, 317.
14. El-Sayed M.(2002) Distribution and behavior of Dissolved Species of nitrogen and phosphorus in two coastal Red Sea Lagoons Receiving Domestic Sewage, *J.K.A.U.: Mar. Sci.*, 13, 47-73.
15. Mahmoud Th. H., Masoud M. S. and shaltout N. A. (2007) Distribution Of CO_2 Surface Partial Pressure And Air Sea CO_2 Flux In El Mex Bay Alexandria, Egypt. Proceeding Of The Eighth International Conference On The Mideterreanen Coastal Environment, MEDCOAST 07, 13-17 November, Alexandria, Egypt.

16. Nessim, R. B. and Tadros A. B., (1988) Effect of pollution on the chemical composition of the Western Harbour waters (Alexandria) 1st. Proc. Nat. Conf. Environ. Studies and Res., Cairo, 548 - 559.

17. Nessim, R. B., (1994) Environmental characteristics of Mex Bay. 1st. Proc. Arab Conf. on Marine Envir. Protection. Alexandria, 5-7 February, 221-243.

18. Ramzy B. Nessim, Ahmad R. Bassiouny, Hermine R. Zaki, Madelyn N. Moawad and Kamal M. Kandeel, (2010) Environmental studied at El-Mex Region (Alexandria-Egypt) During 2007-2008, *World App. Sci. J.*, 9(7), 779-787.

19. Nessim, R. B. and Zaghloul F. (1990) Nutrients and Chlolrphyll-a at Kait-Bay Region Alexandria, *Bulletin of Institute of Oceanography and Fisheries, Egypt*, 16 (3), 71-80.

20. Shreadah Mohamed A., Mamdouh S. Masoud, Abdel-Rhman M. Khattab and Gehan M. El Zokm, (2014). Impact of different drains on sea water quality of El-Mex bay (Alexandria,Egypt), *J. Ecology and the Natural environment.*, 8(8), 287-303.

21. UNESCO, FAO, UNEP (1987) Eutrophication in the Mediterranean Sea, Report and Proceeding of a scientific Workshop, Bologna, Haly, 2-6 March, 32.

22. Said M. A, El-Deek M. S., Mahmoud T. H., Shriadah M. A. , (1994) Effect of pollution on the hydrochemical characteristics of different water types in El-Max Bay area, west of Alexandria, Egypt, Acta Adriatica, 34 (1/2), 9-19.

23. Chiaudani, G. and Vighi M. (1978) Metodologia Standard Di Saggio Algare Per 10 Studio Dello Acque Marine, Journal of Quaderni Dell Instituto Di Ricerca Sull. Acque, 39, 120.

24. Davis, J. C., (1986) Statistics and Data analysis in Geology. John Wiley and Sons. Inc., Nealysis New York.

25. El-Iskandarani, M., Naser S., Okbah M. and Jensen A., (2004) Principal component analysis for water quality assessment of the Mediterranean costal modeling and simulation Techniques in Enterprises (AMSE), Modeling C-2004, 65(2), 69-83.