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Monitoring of pollutant trends in the Oran coast in western of Algeria by assessing the physicochemical quality of waste water discharges

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Key words: Marine pollution, Urban wastewater, Physicochemical parameters, Oran coast

Abstract

The Oran coast is like a Mediterranean basin, a region of high population density undergoes permanent aggression, including the release of domestic and industrial waste water into the sea without prior treatment. This study focuses on the quality of urban water rejection along the Oran coast in western of Algeria. This study is based on the analysis of the physicochemical parameters of waste water effluent discharges. Our samples of water were collected in two different sites: Western of Oran (1): Andalusian complex which is a tourist area and Eastern of Oran (2): Arzew complex which is an urban industrial area during the year of 2013 and 2015 to evaluate the physico chemical parameters. The mean values of parameters analyzed of water samples were: T°: 21,57-20,85°C, pH: 7.75-7.36, dissolved oxygen: 4.91-7.63mg/l, COD: 265.57-525.789mg/l, BOD: 72.95-798.1mg/l, SM: 1524-1971mg/l and Total phosphorus: 3.06-6.14mg/l respectively in site (1) and (2). This result shows that the waters of the two sites are very impacted by the discharge of wastewater and show the presence of a significant pollution. From the results obtained the contents of the parameters analyzed are very high and much higher than the levels certified by the World Health Organization and the Algerian standards for direct discharges which were very impacted by urban wastewater and required a pretreatment before being discharged directly into the seawater.

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Introduction

Characterized by a great maritime traffic and by an agglomeration of important industrial units, the Oran coastline does not escape this form of pollution which constitutes an imminent danger for the region. In this respect, the present work is part of a research project of the Laboratory Networks of Environmental Monitoring (LRSE), whose objective is:

To establish an assessment of the quality of wastewater discharges and their impact on the marine environment using a multi-mark approach based on the monitoring of physicochemical parameters. In this context, we conducted this study to diagnose the state of marine pollution caused by the waste water discharged to the Oranean coast. This investigation is carried out by analyzing the physicochemical parameters in the raw discharges dumped along the Oranan coast.

The environmental problems have no borders, from the beginning of the century, they became an international concern, and their rapid development has led the community of nations to develop legal instruments environmental protection as environmental conventions and international protocols (PNUE/PAM, 2004, RNO, 2006).

Became the receptacle of wastewater from industrial, urban and agriculture, streams in Algeria in recent years have reached an alarming level of pollution (Grimes,2003; Boutiba *et al.*, 2003; Taleb, 2009; Grimes *et al.*, 2010; Belhouari *et al.*, 2011; Hachemi Rachedi, 2012). Different sampling sites were selected based on the importance of waste dumped at sea (industrial, household). Became the receptacle of wastewater from industrial, urban and agriculture, streams in Algeria in recent years have reached an alarming level of pollution (Grimes,2003; Boutiba *et al.*, 2003; Taleb, 2009; Grimes *et al.*, 2010; Belhouari *et al.*, 2011; Hachemi Rachedi, 2012; Benaissa and *et al.*, 2015).

Materials and methods

Presentation of the study area

The Oran coast along 124 km, or 1/10 of the National coastline has been interested by many scientists as the theme concerned which is today increasingly assaulted nowadays by various forms of pollution: industrial activities, intensive tourism and massive urbanization, with the corollary an ever increasing extent of pollution of domestic origin (Dermeche *et al.*, 2006; Remili *et al.,* 2010. Rouane Hacenne, 2012).

Our sampling area is spread over a strip (Fig. 1) of coast between the:

Western of Oran (1): Andalouses complex is a touristic site subject to sewage effluents.

Eastern of Oran (2): Arzew complex is a very broad and wide area and includes several urban and industrial wastes.

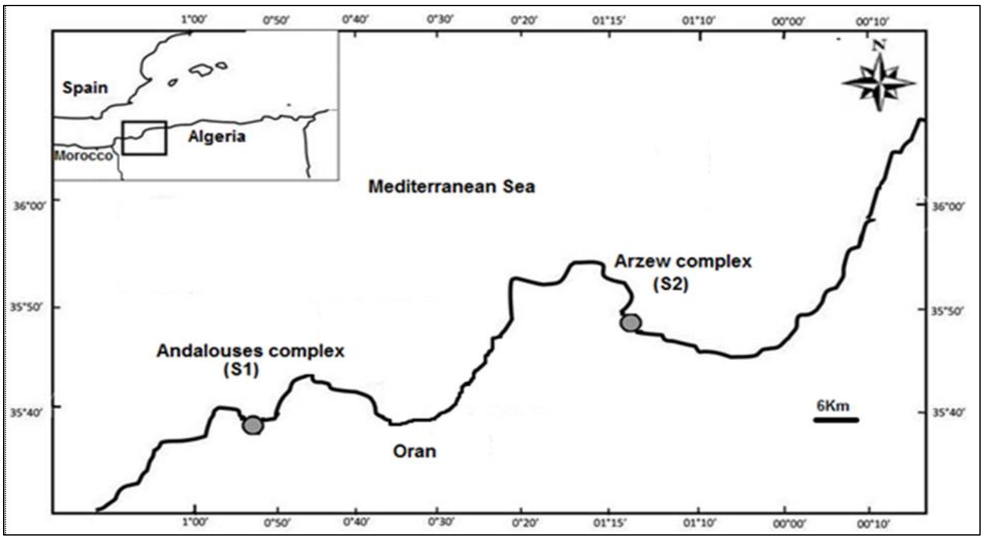

Fig. 1. Location of study area.

Sampling and water analysis

For meaningful analytical results, it is very important to know the fate of the sample between collection and analysis. The most common way of conservation of water samples is to keep them in an isothermal temperature of between 0 and 4°C until their arrival at the laboratory within the time not exceeding 24 hours.

The physicochemical parameters were analyzed according to Rodier's analysis protocol (Rodier, 1996). The following parameters: T°, pH, dissolved oxygen and salinity were performed *"in situ"* the using multi parameter apparatus: WTW 340i. Suspended matters were determined by filtering a volume of water on cellulosic filter (0.45 micron meter). Chemical Oxygen Demand (COD) was determined using colorimetric method (K2CrO4) and Biological Oxygen Demand (BOD) was determined by manometry and was measured after 5 days (BOD_5).

The determination of levels of elements: Nitrates, nitrites, ammonium and elements concentrations were assessed by spectrophotometry (Rodier, 2009).

Statistical analysis

The test Ki 2 used to analyze significant and not significant result of samplings of the study area. To assess organic pollution and biological quality of Oran coast receiving domestic and industrial discharges from Oran town, we evaluated a share of organic pollution index OPI: Organic Pollution Index (Leclercq & Maquet, 1987) is based on four physicochemical parameters: BOD5, ammonium, nitrite and phosphate we can replaced phosphates with total phosphorus (Table 1).

The principle is to spread the values of the pollutant into five classes and to determine from its own actions the class number corresponding to each parameter and then average them.

Table 1. Organic pollution index OPI classes limits (Leclercq and Maquet 1987).

Class \ Parameters	BOD5	Ammonium	Nitrites	Phosphates
Class 5	<2	<0,1	5	15
Class 4	2-5	0,1-0,9	6-10	16-75
Class 3	5,1-10	-2,4	11-50	76-250
Class 2	10,1-15	2,5-6,0	51-150	251-900
Class 1	>15	>6	>150	>900

OPI = average number of classes of the 4 parameters (at best):
= 5.0 - 4.6: no organic pollution
= 4.5 - 4.0: low organic pollution
= 3.9 - 3.0: moderate organic pollution.
= 2.9 - 2.0: organic pollution.
= 1.9 - 1.0: very strong organic pollution.

Results

The measurement of physicochemical prameters (T°, pH, dissolved oxygen, COD, BOD5) and analysis of some elements (ammonium, nitrites, nitrates and total phosphorus), we have identified the following observations (Table 2 and Fig 2)**:**

The results obtained of temperature are stored below 30°C (Fig 2 (a)) considered limit as direct discharge into the receiving environment (JORA, 2006). In this investigation, the coastal water temperature varied between a minimum of 16°C during autumn 2013 at Site.1 and a maximum of 31, 5°C during summer 2014 at the same station and also at site 2 with 33°C (Table 2).

Measurements of pH identified in the two sites range from 7,75 and 7,34 (Fig 2(b)) the values of potential hydrogen fluctuated around 6.6 during spring 2015 at site 2 and 8.27 during autumn 2013 at site 1 (Table 2), showing the character slightly alkaline water of the coastal of Oran. Our observations indicated salinity variations between 21,21 and 20,42 PSU in two sites (Fig. 2(c). The variations during 2013 and 2015 were with found a minimum 11,68 PSU in site 2 during autumn 2013 and a maximum 29,78 PSU at the same site in Spring 2015 and 28,12 PSU during winter 2015 at site 1 (Table 2). Dissolved oxygen varied between 4,91 and 7,64 respectively in site 1 and 2 (Fig 2(d) with a minimum 0,1 during summer 2014 at the sites 2 and a maximum 22,68 at the same site in Spring 2014 and 8,28 in site 1 at the same season (Table 2) . For SM we observed that it represent the highest values 2938,29 in site 1 and 3685,06 in site 2 (Fig 2(e)).

We note that the values of COD are relatively high to the recommended standard 265,57 and 525,78 in site 1 and 2 (Fig. 2. (f)) with a minimum 48 in site 1 during spring 2014 in site 1 and a maximum 1498 in site 2 during Spring 2015. We also note for the sampling. points chosen, the analytical results show a high

Organic load expressed as BOD5 corresponding to 72, 96 in site 1 and 798,1 in site 2 (Fig. 2. (g)). In site 1 and 2, the Measurements of nitrites and nitrates values range from 0,98 and 2,8 for nitrites (Fig. 2. (h)).

with a minimum 0,25 during winter 2015 in site2 and a maximum 3 during winter 2013 in the same site (Table 2), 27,14 and 25,18 for nitrates (Fig. 2. (i)) with a minimum 10,64 during Autumn 2013 in site 2 and a maximum 40 during in summer 2014 in two sites.

As shown in (Fig. 2. (j)). Table 2) the values of ammonium varied between 4, 54 and 22,38 in site 1 and 2 with a minimum 0,03 during winter 2015 in site 2 and a maximum 21,2 during spring 2015 at the same site.

The total phosphorus results are stored between 3,06 and 6,14 (Fig. 2. (k)). with a minimum 0,67 in site 1 during Autumn 2013 and a maximum 19,62 and 13 in summer 2014 in site 1 and 2 (Table 2) .

The measurement of IOP was shown the following observations (Fig. 3):

Our result shown that the two sites are characterized by an OPI index that varies between 3.25 and 3 during the warm period, this is indicates a moderate level of organic pollution.

Table 2. Seasonal fluctuations of the physico-chemical parameters in the study area during 2013 and 2015.

Andalouses complex : (1)	Autumn 2013	Winter 2013	Spring 2014	Summer 2014	Autumn 2014	Winter 2015	Spring 2015
Temperature C°	16	17	21	31,5	29	19	17,5
pH	8,27	7,52	8	7,35	7,46	7,85	7,8
Salinity mg/l	20,34	13,97	19,89	18,3	24,87	28,12	22,98
Dissolved oxygen mg/l	8,5	5,8	4,6	4,7	2,6	7,8	0,4
SM mg/l	138	1098	28	11068	4450	886	2900
COD mg/l	48	86	160	460	885	57	163
BOD_5 mg/l	8,7	17,7	48,6	157	222,5	19,6	36,6
Nitrate µmol/l	35	23	19	40	26	30	17
Nitrite µmol/l	1,6	0,7	0,68	0,24	0,92	0,6	2,1
Ammonium µmol/l	2,4	1,6	0,75	10	6,8	4,2	6
Total phosphorus mg/L	0,67	4,1	1,48	13	0,53	0,28	1,37

Arezw complex : (2)	Autumn 2013	Winter 2013	Spring 2014	Summer 2014	Autumn 2014	Winter 2015	Spring 2015
Temperature C°	19	17	22	33	27	19	23
pH	7,31	7,27	7,6	7,34	7,4	7,9	6,6
Salinity mg/l	11,68	15,73	22	19	17,98	26,78	29,76
Dissolved oxygen mg/l	22,68	2,8	12,1	0,1	0,6	2,34	7,43
SM mg/l	887	13371	1670	3144	1234	516	4976
COD mg/l	123	18,5	127	773	238	903	1498
BOD_5 mg/l	662,4	816	432	2796	58,2	254,1	568
Nitrate µmol/l	10,64	27	15,6	40	38	19	26
Nitrite µmol/l	2	3	2	0,31	12	0,25	0,1
Ammonium µmol/l	0,22	0,03	0,25	86	47,5	1,2	21,5
Total phosphorus mg/L	1	1	0,89	19,62	0,58	13,4	7,4

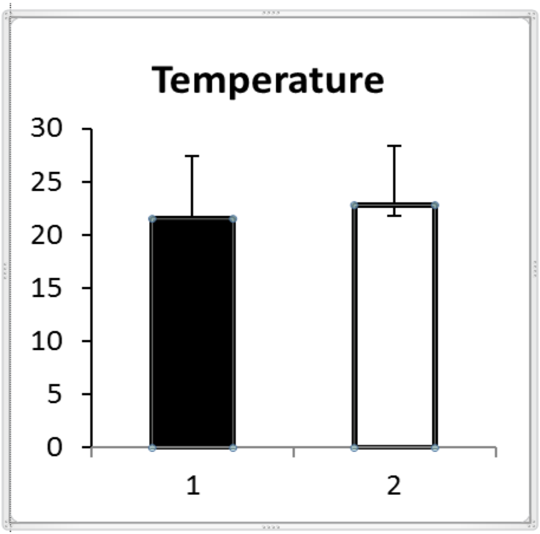

Fig. 2(a). Variations of temperature °C.

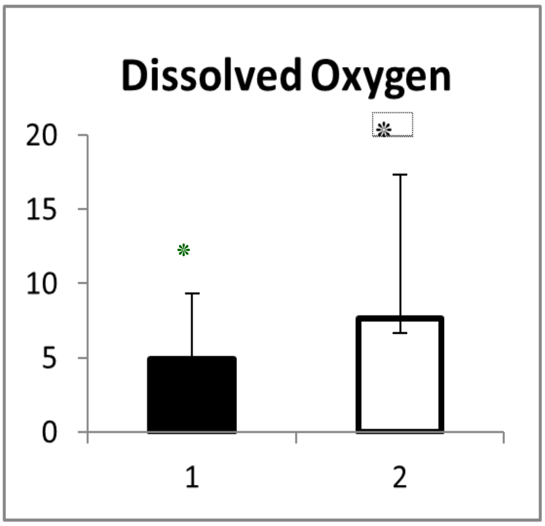

Fig. 2(d). Variations of dissolved oxygene.

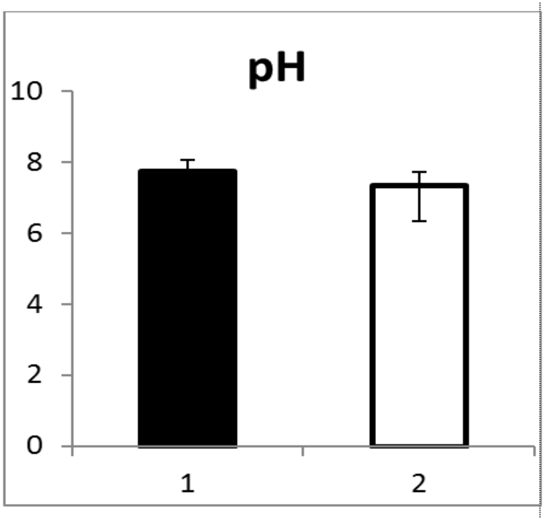

Fig. 2(b). Variations of pH.

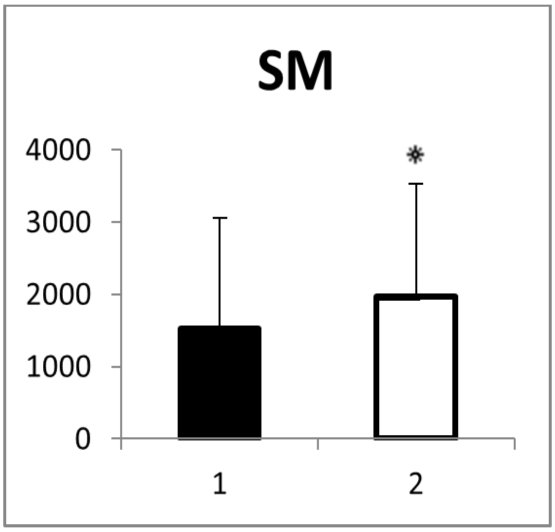

Fig. 2(e). Variations of suspended metter.

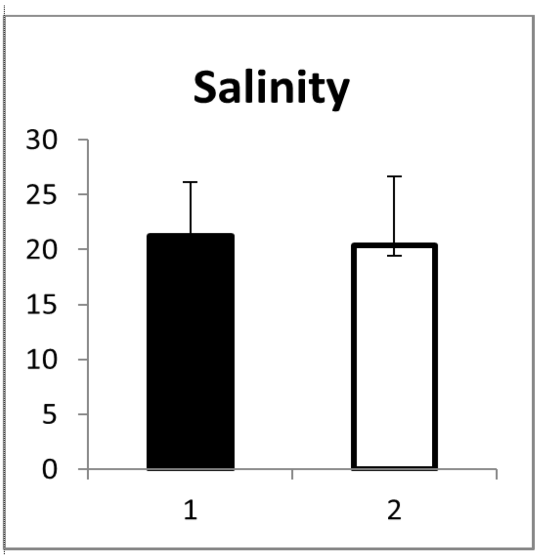

Fig. 2(c). Variations of salinity.

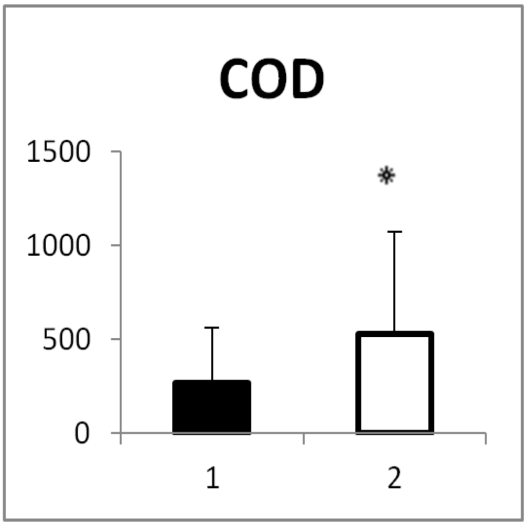

Fig. 2(f). Variation of chemical oxygen demand.

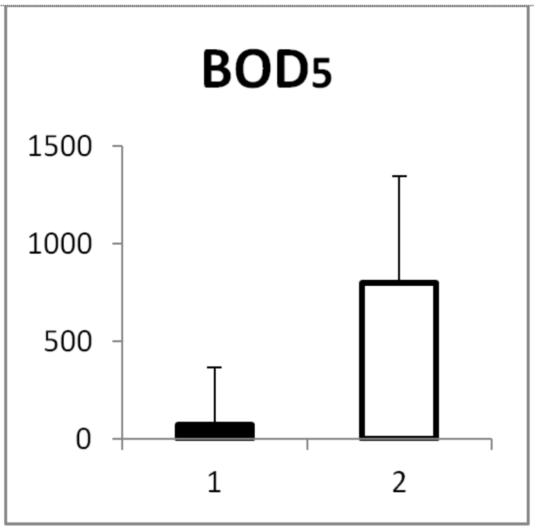

Fig. 2(g). Variation of biochemical oxygen demand.

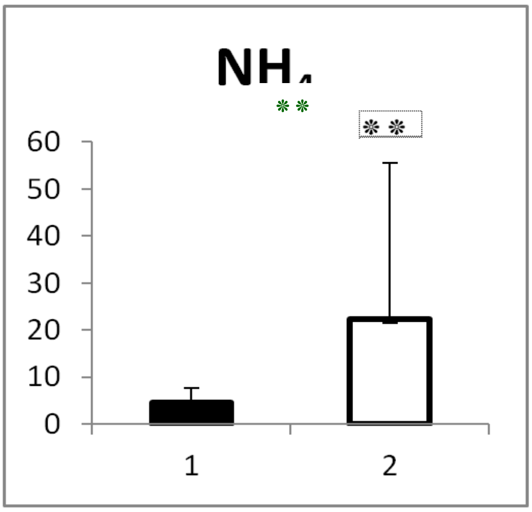

Fig. 2(h). Variation of ammonium

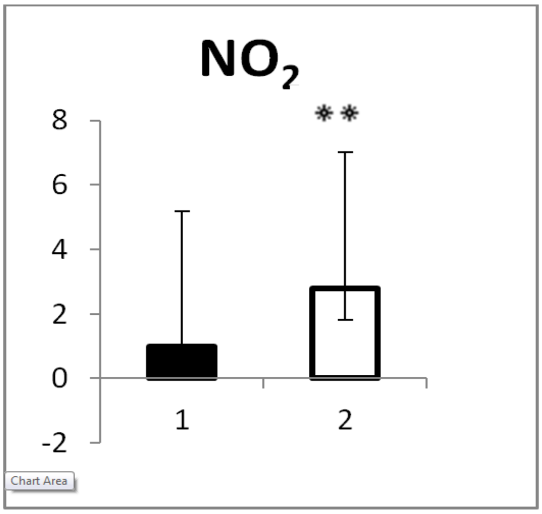

Fig. 2(i). Variation of nitrites.

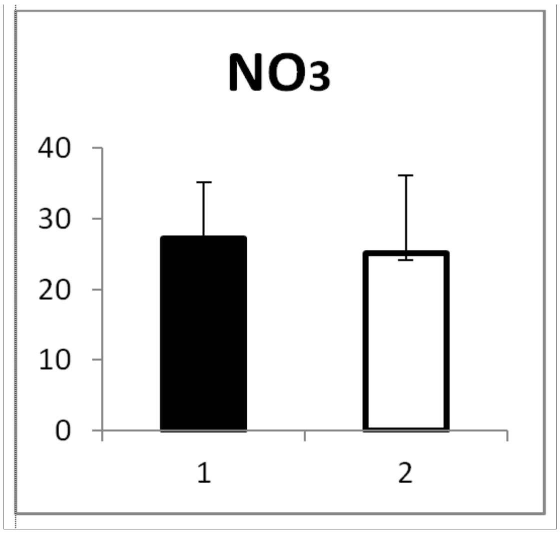

Fig. 2(j). Variation of nitrates.

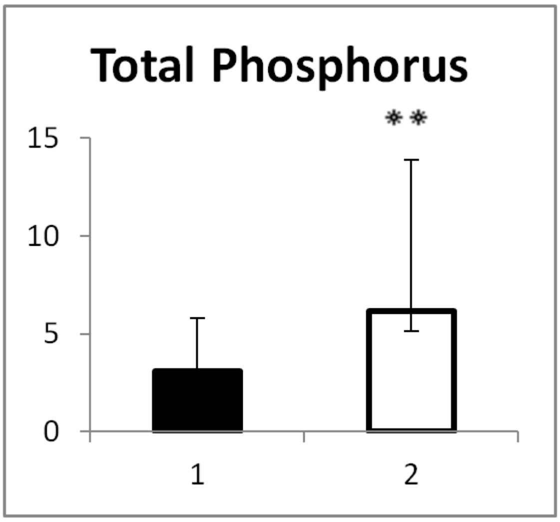

Fig. 2(k). Variation of total phosphorus.

Fig. 2. Evolution of physicochemical parameters in waters of Oran coast with test Ki2. * < 0,05, **< < 0,05.

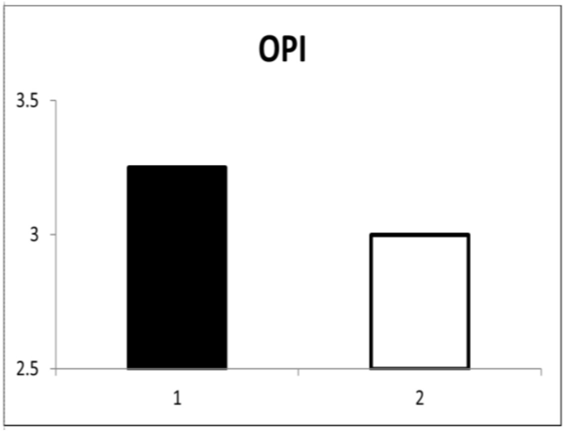

Fig. 3. OPI variations in two sites.

Discussion

The physic-chemical quality of biotope plays an important role in the determination of the biologic quality and the degree of pollution in the aquatic area, it's also plays a vital role in the metallic behavior at all levels (water, object). Indeed It's governs the adsorption and the desorption phenomenon in the rain fall of metals in its supports (Jaffe and Walters, 1977; Benemessaoud, 2007).

In deed the Algerian western coast is relatively polluted. All the indicators whether they are benthic or pelagic present variable concentrations follow the individual and samples sites (Boutiba and *et al*., 2003). This pollution is the combination of many elements however the spilling of water waste none treated is the important element one More (Hamel and Fekir, 2011).

The surface water temperature is usually influenced by the intensity of solar radiation, evaporation and insulation and the low temperature during monsoon. This could be due to strong sea breeze and cloudy sky (Behrenfeld and *et al*., 2006).

The pH values of samples values hydrogen fluctuates around 6.5 and 8.5 (JORA, 2006), The pH measurements at both sites indicate a receiving environment with carbon dioxide equilibrium (CO_2) similar to that of the world ocean and whose hydrogen potential fluctuated around 6.88 and 8.89.

In the Mediterranean sea , the salinity is between 37.8 and 39.3 PSU (Rodier, 2005). It is observed that the values of salinity are relatively low, can be explained by the great mass of fresh water mobilized and used and then removed to the coast, and also compared to the winter season that tends to heavily dilute coastal waters.

The low of dissolved oxygen can be explained levels by the presence of oxidizable organic metter (Roddier, 1996). The dissolved oxygen in water is usually depending on its temperature and salinity. It is also depending on a considerable degree on the quantity of organic matter present in the aquatic environment.

If the decomposition of organic matter is in great proportion, it will absorb too much of the dissolved oxygen in water (Shakweer *et al*., 2003). As these low values of dissolved oxygen favor the development of pathogenic germs.

Assay results show that SM exceeded beyond (JORA2006) standard which is 35mg/l. High levels of suspended solids can be considered a form of pollution. Such an increase can also lead to a warming of water, which will deduce the quality of habitat for organisms (Hebert and Legare, 2000). For COD content not exceeding 120mg/l and 35mg/l for BOD. The lowest values are largely exceeded the standards. These levels indicate excessive that the two sites of the coastal of Oran received a charges pollution relatively high, which is confirmed by the highest concentrations in COB and BOD during all seasons. COD values are due to discharges into these urban or industrial areas, these concentrations shows an excessive consumption of dissolved oxygen to chemically oxidize the organic loads discharged into the studied areas (Bonte *et al*., 2008).

For the sampling points chosen, the analytical results show a high organic load expressed as BOD5. However, significant values of BOD can be explained by the phenomenon of self-purification of the resulting degradation of the polluting organic load (Roddier, 1996). The low concentrations of nitrites encountered in wastewater effluents of the studied could be explained by the fact that nitrite ion (NO_2^-) is an intermediate compound between ammonium and nitrates. Nitrates are one of many forms of nitrogen present in the water, while providing generally the most abundant form of mineral nitrogen. At the study area, Compared, the Algerian limits set at 50 mg NO_3^-/l (JORA, 2006), nitrate contents targeted stations are much lower.

The high ammonium levels are explained by the enrichment of those places in nitrogen compound that comes from the discharge of domestic and industrial wastewater, and also by the bacterial decomposition of organic nitrogen compounds, bacterial mechanism called ammonification (Lisec 2004).

The total phosphorus concentration in urban waste water varied between 15 et 25 mg/l (Laheurte and Boeglin, 1993). (Buttler and *et al.*, (1995) has compiled a summary of the origin of the pollution load of some domestic water in concluding that detergents provide more than half of the phosphorus in these water.

Most of the organic phosphorus comes from 50 to 70% of detergents (laundry) and 30 to 50% of organic materials of human origin, which main the wastes of protein metabolism and its elimination as phosphates in Urine by man (Florentz, 1982). (Buttler and *et al.*, 1995) summarized the origin of the pollutant load of some domestic waters, concluding that the laundry extract contains more than half of the phosphorus contained in these waters.

Acknowledgements

This work represents a continuation of the collective environmental concerns of Environmental Monitoring Network Laboratory (LRSE). Pollution from urban waste water, industrial is considered a major problem especially in coastal urban areas, which is the case in our study area.

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