*International Research Journal of Environment Sciences*_____ ISSN 2319–1414
Vol. **3(6),** 75-80, June **(2014)** *Int. Res. J. Environment Sci.*

Evaluation of physicochemical and bacteriological quality of Oued Merzeg (Suburbain of Casablanca, Morocco)

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Available online at: www.isca.in, www.isca.me
Received 27th May 2014, revised 15th June 2014, accepted 22nd June 2014

Abstract

The aim of this study was to determine the physicochemical and microbiological quality of Oued Merzeg. The analyzed waters present an organic pollution represented by the concentration of the organic (DBO5, DCO, Pt, PO4 and NH4). However, analysis of physical parameters and indicators of mineralization, conductivity, salinity, chlorides, sulfates, and water sampled showed a significant mineralization. Parameters monitoring fecal contamination, total coliforms (TC), fecal coliforms (FC) and fecal streptococci (FS), reveal a significant fecal contamination. Water quality of Oued Merzeg pleads for non-conformity of water to be used directly in all areas because they exceed the normative limits generally accepted. The principal component analysis (PCA) evaluated and interpreted complex water quality data sets and apportioned of pollution sources to get better information about water quality of Oued Merzeg.

Keywords: Oued Merzeg, physicochemical, bacteriological, PCA.

Introduction

The quality of the river basins is degraded due to the indiscriminate disposal of anthropogenic wastes and leaching of pollutants due to development of an area, which sees an increase of population, urbanization and industrialization[1]. Thus, it is important to carry out river quality monitoring in order to detect the changes of the water quality and to identify the pollution sources[2]. There are various water quality parameters to be measured and considered in order to determine the health of the river water and to develop a water quality index[3]. These parameters can be categorized as physicochemical and biological.

In Morocco, the situation of the river becomes increasingly worrying because of the large amounts of untreated discharges pollutants which are discharged into the aquatic ecosystems. To study the situation closely, we chose a peri-urban watercourse which knows a growing demography and a continuous development of industry along Oued Merzeg shores and its tributary Oued Sierni. Oued Merzeg receives treated waters from the WWTP Berrechid treating a flow of about 1850 m3 /j, while its tributary Sierni receives industrial discharges Had Soualem[4].

This work is aimed to assess the degree of pollution of the Oued Merzeg through a characterization of physicochemical and bacteriological water of six stations from upstream to downstream. To highlight the overall quality of these waters and its spatio-temporal evolution in the studied streams, we found interesting to make a synthesis of these results by the statistical method (components main ACP analysis), to identify the relationship between the different variables and also to study the spatial distribution of the study sites[5].

Material and Methods

Study area: Oued Merzeg is located 20km south-east of Casablanca, on the coastal Chaouia. It is bounded on the north by the Atlantic Ocean, to the south and west by the province of Settat and east by the province of Médiouna. The river is part of the watershed of Oued Coastal Atlantic, covering an area of 157.8 km^2 [6]. The climate of the coastal Chaouia is semi-arid with an oceanic influence. The average annual rainfall is 400 mm, while the average temperature is 25°C[7]. The river is located near industrial areas, notably Had Soualem whose discharges are drained by its tributary oued Sierni (SO) and a few scattered throughout the units of Khyayta region.

Sampling and analysis methods: Six stations were selected along the stream according to the nature of wastewater (sewage, natural waters), ease of access and collection and also the situation of sampling over pollutant release points (figure-1). 14 samples were completed during a period from February 2011 to March 2012.

The State of Oued Merzeg is apprehended from measurements of 16 variables physicochemical and bacteriological. The methods used to determine these variables are those advocated by AFNOR. The measures in situ of pH, electrical conductivity (CE), dissolved oxygen (do) and turbidity (Turb) have respectively been carried out thanks to a pH meter WTW, conductivity WTW, WTW Oximeter and a turbid meter EUTCH TN-100.

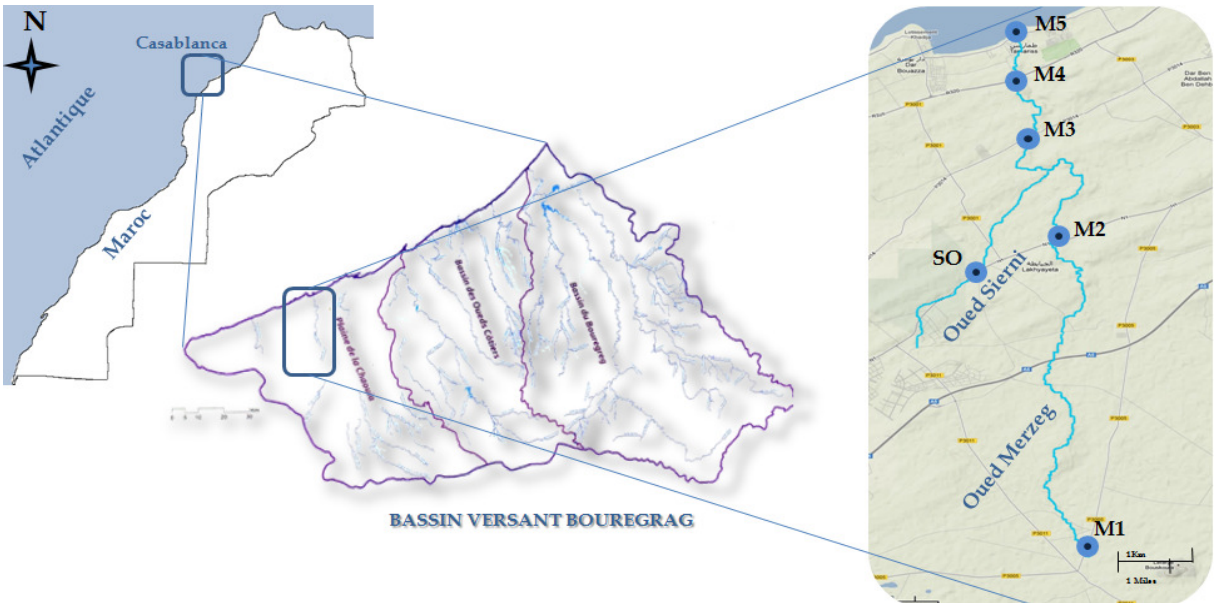

Figure-1
Study area and water quality sampling sites

Chemical analyses are: chlorides (Cl), sulfates (SO_4), nitrate (NO_3-), nitrite (NO_2), ammonium (NH_4), ortho-phosphate (PO_4), total phosphorus (PT), BOD5 and COD. The enumeration of indicator bacteria of fecal contamination have dealt totals (CT) coliforms and fecal coliforms (FC), as well as fecal streptococci (SF).

Results and Discussion

Physicochemical characterization: PH, Conductivity, Salinity: The spatial variation of pH at Oued Merzeg shows little fluctuation (± 0.52) with alkaline waters where a minimum is observed in SO (8.14) and a maximum in M4 (8.66). The maximum values of the EC and salinity are recorded of downstream in M5 (3.47 mS/cm and 1.28 g /l, respectively) (Fig.2a), which is influenced by the proximity of the marine environment.

COD and BOD5: At Oued Merzeg, there is a gradient of cod and BOD5 from upstream to downstream, which testifies the self- purifying effect of the river. The contents of COD and BOD5 of treated wastewater of the WWTP Berrechid respectively from 80.79 and 50.46 mg O2/l M1 to 29.57 and 8.27 mgO2/l M5 (figure 2b) or an abatement rate of approximately 83.61% for BOD5 and 63.40 % for COD. Nevertheless, an organic enrichment is observed at the level SO due to the discharge of Had Soualem and M3 which is close to a farm where the animals have free access to the waterways.

Turbidity: The spatial variation of turbidity varies from one station to another. The maximum levels are recorded in SO (134.11 NTU), as industrial discharges. In Had Soualem, turbidity is marked by a very dark color from textile industries; whereas at M3 (88.69 NTU) (figure 2c), we note a leaching of the surrounding agricultural land.

Total phosphorus and orthophosphate: A phosphorus pollution is observed upstream of the river where the values of total phosphorus and orthophosphate are of the order of 6.02, 3.53 mg/l in M1 and 5.46, 2.37 mg /l in M2 (figure 2d). A decreasing gradient was observed with a reduction in downstream respectively of the order of 57.47% and 53.82%. In addition, the pollution load drained by the SO station shows that discharges from Had Soualem has low levels of phosphorus compounds (2.65 mg /l PT and 1.38 mg /l PO_4).

Chlorides and sulphates: The spatial evolution of chlorides and sulfates goes hand in hand with that of the EC by Oued Merzeg. There is an increasing gradient respectively ranging from the M1 upstream to the downstream M5 (301 to 360 mg/l and 66.53, 67.55 mg/l).While the SO site marks the lowest values (250.78 and 60.42 mg/l) (figure 2e).

Nitrates, nitrites and ammonium: Along the river Merzeg, the average nitrate levels evolve according to an increasing gradient (1.64 mgNO3 / l in M1 and 12.57 mg NO3 / l in M4). The increase in nitrate concentrations in the latter station would probably result from the self-purifying effect of rivers but also to amendments of fertilizer by farmers in the region. Unlike the nitrates, averages for nitrite and ammonium follow a gradient descending from upstream to downstream of the Oued Merzeg (13.85 mg NO2 / l, 26.50 mg NH4 / l in M1 and 1, 68mg NO2/ l, 1.78 mg NH4 /l in M5) these values are significantly higher than those measured in the Oued Bouskoura (figure 2f)[8].

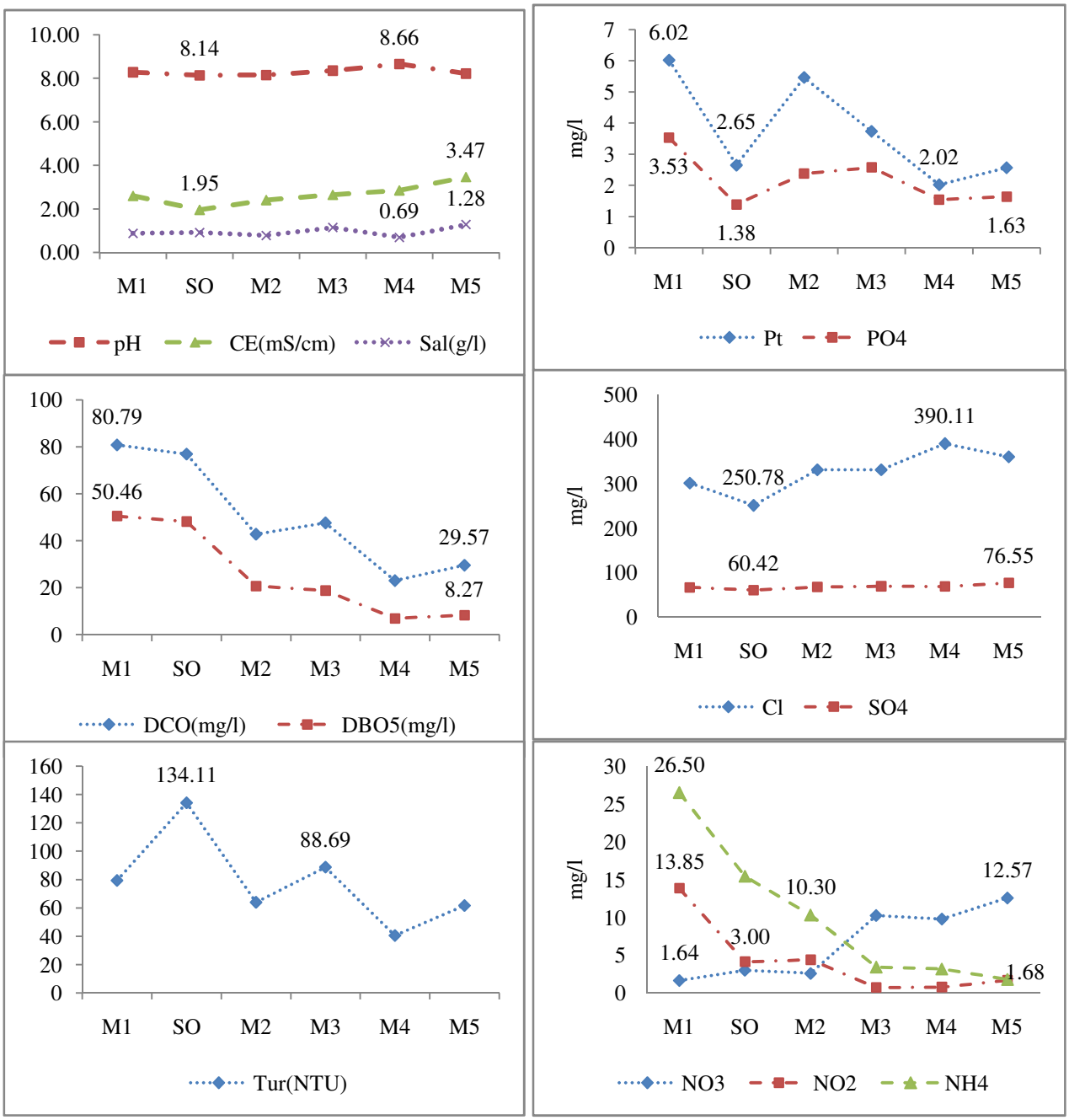

Figure-2

Spatial Evolution of physicochemical parameters (a): pH, electrical conductivity (EC), salinity (Sal). (b) chemical oxygen demand (COD) and biological oxygen demand (BOD5). (c): turbidity. (d) total phosphorus (Pt), orthophosphate (PO_4). (e) chloride (Cl), sulfate (SO_4), (f): nitrate (NO_3), nitrite (NO_2) and ammonium (NH_4).

Bacteriological characterization: Microbiological analysis indicated that the microbial load is very important and it reveals that there are signs of contamination fecal. The space variation of the load in TC, FC, FS in the various stations located on the Oued Merzeg shows important differences between the upstream and the downstream, and reveals the existence of a gradient decreasing of the upstream towards the downstream. The highest concentrations of bacterial charge (TC, FC, FS) are recorded respectively in SO (5, 62, 5,47, 4,48 Log10CFU) and are decreased in M4 (4,39, 3,95, 3,03 Log10CFU) (figure 3) as a result of the phenomenon of self-purification of streams. However, these results reveal a clear deterioration of the quality of the Oued Merzeg, while the abundance of the fecal germs values largely exceeds the standards of the water intended for consumption and irrigation.

Statistical Analysis: The principal component analysis (PCA) has allowed us to better understand the functioning of the Oued Merzeg from annual monitoring based on 16 variables measuring, physicochemical and bacteriological[9,10]. The PCA results indicate that the axis F1 explains 59.78% of the total variance in the data. The F2 axis indicates 20.64% of the total variability in the data (figure 4). Thus, 80.42% of the variability of the data table is extracted by factorial F1X F2.

The circle of correlation (figure 4) shows that the variables positively structuring F1 are pH, EC, Sal, Cl, SO_4 and NO_3, reflecting a mineralization of waters and a significant presence of oxidized nitrogen forms (NO_3). While those negatively structuring F1 are PT, NH_4, NO_2, BOD_5, cod, PO_4, Turb, CF, TC ad FS. These variables describe pollution of organic type and a fecal bacterial contamination. Thus, the F1 axis can be likened to an axis translating a gradient of pollution, mineralization and fecal contamination. Whereas, the PT and PO_4 variables contribute to the formation of the F2 axis reflecting pollution phosphoric original household.

Based on factorial map F1 x F2 (figure 5), the results show that different stations are positioned (to F1) depending on the degree of pollution of their water. Thus, stations in the most polluted study (M1, M2, M3, and SO) lie on the negative side of F1, while the least polluted M4 and M5 stations lie on the positive side.

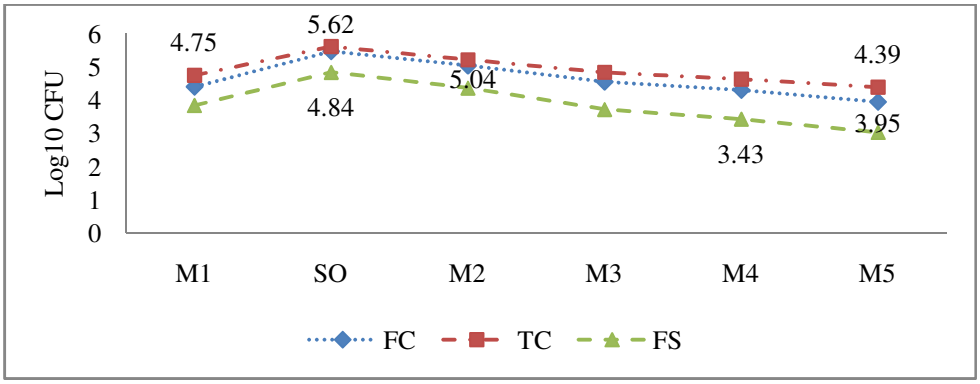

Figure-3
Spatial Evolution of bacteriological parameters TC, FC, FC

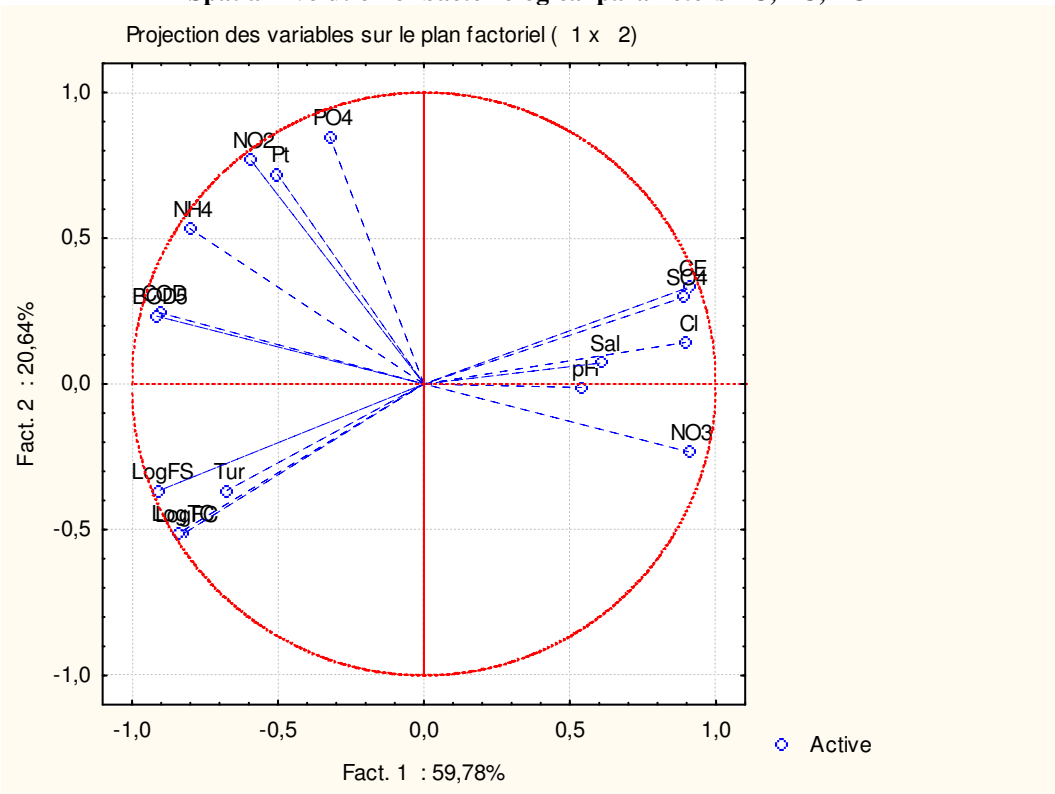

Figure-4
Representation of variables on the plan factorial F1 and F2.

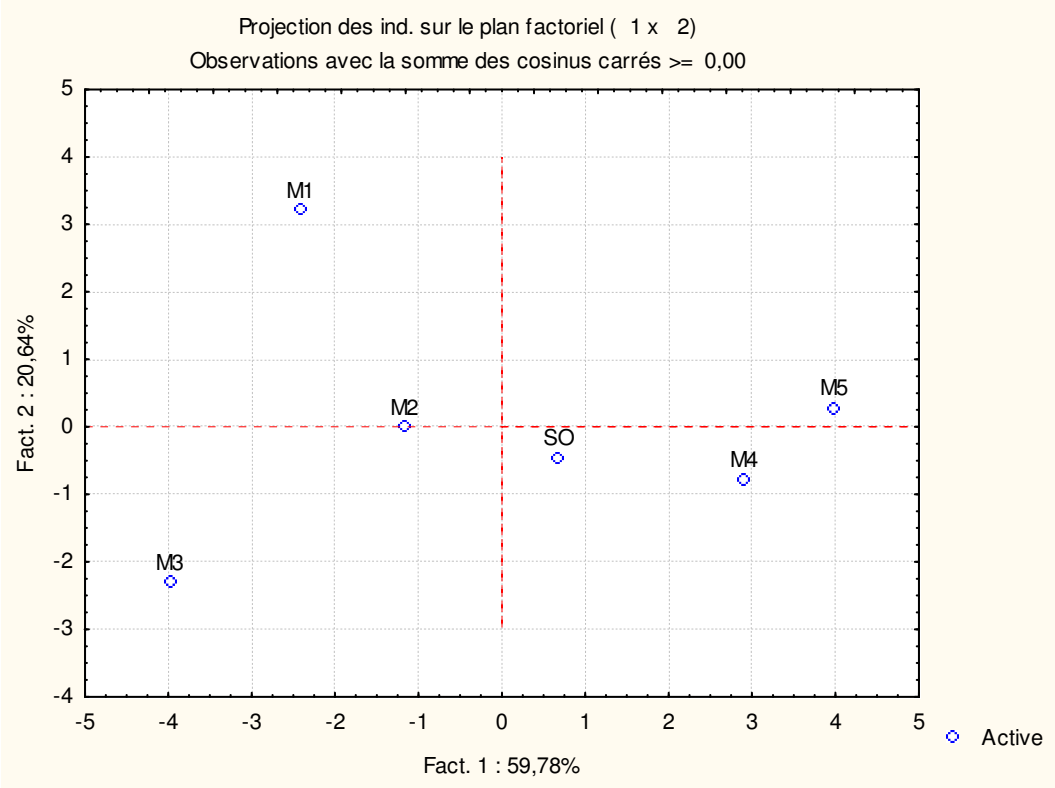

Figure-5
Representation of sampling stations on the factorial plan F1 x F2.

Analysis of the spatial variation of these parameters allowed us to identify the following types of stations studied:

In the upstream sector, M1 station draining the clean waters of the STEP Berrechid distinguished by water impacted by domestic pollution is rich in phosphorus compounds (Pt, PO_4) and nitrogen (NH_4 and NO_2). The contribution of the latter has led to a significant increase in algae very noticed by the green colour of the water and can cause eutrophication. This pollution decreases gradually toward M2 and estimated organic loads are comparable to other water systems, like Oued Bouishak and Ouislane [11].

In addition, the SO site is characterized by turbid waters with high BOD and cod levels relatively high NH4 and NO2, NO3 very low, reflecting the pollution from the industrial area of Had Soualem release. However, COD/BOD5 ratio of 1.43 agenda, which gives these releases a character of biodegradability, allows a biological purification. The pollution load of SO increases the turbidity and fecal pollution in terms of M3 located after the confluence of the waters of M2 and SO.

In the downstream (M4 and M5) waters record high electrical conductivity, salinity, chlorides and sulfates, demonstrating a significant mineralization. This is consistent with the findings of other authors who mentioned that the concentration of chlorides increases continuous and proportional manner in the effect of urbanization and depending on the nature of the land crossed but still under the effect of the contributions of the tablecloth as evidenced by the work of Zerouali *et al.*[12-16]. However, high nitrogen materials (NO3) recorded at Oued Merzeg levels support the work of the ABHBC, highlighting the degradation of the quality of the coastal chaouia tablecloth by NO3, the results of this work are comparable to those reported by El ouali alami and al., higher than those reported by Abouelouafa *et al.* [17, 18]. However, low organic pollution (COD, BOD5, Pt, PO4, NH4, NO2) and fecal (TC, FC, FS) recorded in this sector, shows an improvement of the quality of the water according to an upstream-downstream gradient, with rebates up to 83% for cod and BOD5, under the effect of the self-purifying phenomenon of the watercourse.

Conclusion

The present work represents a first contribution study of the quality of Oued Merzeg waters (sub-urban rivers in Casablanca) and its tributary Oued Sierni.

This study allowed us to assess the degree of pollution generated by the discharge and the STEP of Berrechid and the industrial zone of Had Soualem.

The results of physico-chemical and bacteriological analyses show that qualitatively, the waters of this river are characterized by:
Significant mineralization, as evidenced by the high values of electrical conductivity, chloride and sulphate at the level of all stations of the watercourse Merzeg.

A high organic load and very significant fecal contamination, which persists along the waterways, resulted in the high bacterial germs concentrations of (TC, FC and FS) generated by the waters of the STEP of Berrechid and liquid effluents from the industrial area of Had Soualem.

However, results obtained shows that the waters of Oued Merzeg are classified between bad and very bad quality standard of water surfaces. These results must be taken into conservation to preserve this stream, which is situated in a zone with significant tourisms, industrial and agricultural activities.

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