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EVALUATION OF SURFACE WATER QUALITY AND CONTAMINATION STATUS OF THE ZEREMNAVALLYSUB-BASININTHE SKIKDA REGION (NORTH-EASTERN OF ALGERIA)

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Abstract : *The purpose of this paper isto assess the quality and status of organic and metal pollution of surface waterof Zeremna vally sub bassin in the Skikda. , used the water quality index (WQI), the organic pollution index (OPI), the pollution index (PI) and the metal index (MI) according to the uses of drinking water, irrigation and aquatic life.The results of WQI revealed that 80% of the samples indicate a poor quality to non-drinking water, present a strong to very strong organic pollution for all use, except for the samples of the upstream of the study area (S1) and (S2) which present respectively good quality water and moderate pollution for all use, in S3 and S4 of the poor quality water with moderate organic pollution for drinking water and aquatic life and good for irrigation. The metal index (MI) and pollution index (PI) were calculated to assess the contamination of the water of Zeremna vally by metals (Cr^{+}, Pb^{+2} and Zn^{+2}).The values of MI and PI indicate aslight pollution of the water of the river, which is described as serious in the stations S9 and S10. This anthropic environmental degradation recorded downstream of the two urban communes due on the one hand to the intensive use of nitrogen and phosphate agricultural fertilizers and the absence of septic tanks in the neighboring anarchic settlements and on the other hand to the impact of leachates loaded with various pollutants from the Zef-Zef wilaya of Skikda.*

Keywords : *Surface water, WQI water quality index, organic pollution index OPI, pollution index PI, metal index MI, Zeremna vally.*

1. Introduction :

Water is a natural resource essential for life throughout the ecosystem [1,2].In Algeria, the issue of water is one of the main environmental problems, due on the one hand to the health and economic consequences of water pollution and insufficient sanitation and, on the other hand, pressure exerted on resources due to the increase in water needs.The annual volume of wastewater discharges hasdoubled from 16.79 Hm^3 / year to 31.25 Hm^3 / year from 2015 to 2020 [3-5]. This is explained by the increase in the urban population, the increase in the supply and individual consumption of drinking water as well as the significant use of water by the industrial sector. The study region is experiencing rapid urban expansion with the production of large volumes of wastewater, posing a threat to the environment.In this region, themunicipalities located along the Zeremna vally contribute for their part to the pollution of the receiving environment through the direct discharge of wastewater. The quantity of waste generated in the Zeremna vally sub-basin is 340 Ton / Day[2,6]. The physico - chemical characterization and quality control of

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surface water in the Zeremna vally provides a global view of the risks, in order to ensure the protection of resources and to determine the possible origin of alteration in the quality of the water. For the clear application of water quality, different methods used to assess the quality of surface water. The WQI Global Water Quality Index, Organic Pollution Index (OPI), Metal Quality Index (MI) and Pollution Index (PI) were very useful tools to make the right decision and assess in a comparative way the water quality and the degree of pollution in time and space at the scale of the sub-watershed [7,8].The objective of the index is to transform complex data on water quality into information that is understandable and usable by the public [9].

This study is based on the use of indices of global water quality (WQI), organic pollution (POI), pollution(IP) and metal quality (MI) according to the physico-chemical parameters of the water surface areas of the catchment area of the study region. The objective is to assess the quality and state of organic and metal pollution of surface water at ten stations located upstream downstream during a campaign in 2021.The final thematic distribution maps of the WQI, PI, MI, and POI were constructed using the GIS geographic information system and golden surfer 13 logiciel.

2. Materials and methods

2.1. Study area

The Zeremna river sub- basin is situated in Algeria's northern east, and the coastal portion is the western part of the Saf-Saf bassin. About 36°-37° North latitude and 6°30' and 7° East longitude, the research region is situated in North-East Algeria ;with an area of 168 km², the research area is part of the Saf-Saf river basin, and its natural boundaries are the Mediterranean Sea in the north, the eastern extension of the Saf-Saf river as well as the municipalities of Hamadi Krouma and Hamrouch Hamoudi, in the south the municipality of Bouchtata Mahmoud and the Mounts ofKsir-Sasi in the west. The study area is divided into three main municipalities : Bouchtata Mahmoud, Elhadaiek and Skikda (Fig.1). Length of zeremna river is 30Km, takes its source from the Staiha mountains, an altitude of 550 m and flows into the Mediterranean. The climate is a Mediterranean type, with an average annual precipitation of 803 mm, and an average annual temperature of around 19.7 C °, during the period from 1994 to 2016[2,10],which allows the development of an abundant vegetation cover propagating on the ground by the density of the forests of cork oaks and variety of agricultural activies (citrus fields…) [3,5].

The study region presents terrains ranging from the Paleozoic to the Quaternary. This study region is dominated by schists, mica schists and gneisses, which gives the region soils rich in silt and clays this lithologically is reflected from the pedological point of view by soils characterized by a texture passing from silt to clay silt and a distribution of fine sands and clays which show the alluvial character of these soils [11, 12].

In the context of this study, the data used include data relating to the physico-chemicalanalyzes of surface water from Zeremna river.

The sampling was carried out during the campaign spread over one month January 2021.The sampling stations were chosen according to the different activities identified in the study area (domestic, industrial and agricultural wastewater).

Thus, 10 water samples were taken from 10 sites in three municipalities spread along the Zeremna river (Fig. 2). Two

stations were chosen upstream of the watershed near the sources of the Zeremna river for stations S1 and S2. They represent reference stations far from anthropogenic domestic, industrial and agricultural inputs.Stations S3, S4 and S5 are located respectively in the agricultural part ofmunicipalities the Bouchtata Mahmoudand Elhadaiek.Thestations S6, S7 and S8 are respectively located downstream of the urban municipality of Skikda. The S8 station is located near the industrial area of Skikda.
Finally, stations S9 and S10 are taken from a tributary of the main river downstream from the Zef-Zef public landfill which treats waste from the seven communes of the Wilaya of Skikda.Water temperature, electrical conductivity and pH value weremeasured in situ, using Hydrolab, Model (Multi Set 430iWTW) and the biological oxygen demand after 5 days (BOD_5), Ortho phosphates (PO_4^{3-}), Ammonium (NH_4) and Nitrates (NO_3), COD, NO_2^-, Zn, Pb and Cr analyzed in the laboratory using spectrophotometry. The evaluation and visualization of the results

were carried out using Excel 2010 software, Aquakit software and software for the geographic information system GIS (Arc GIS, QGIS) and golden surfer 13 logiciel.

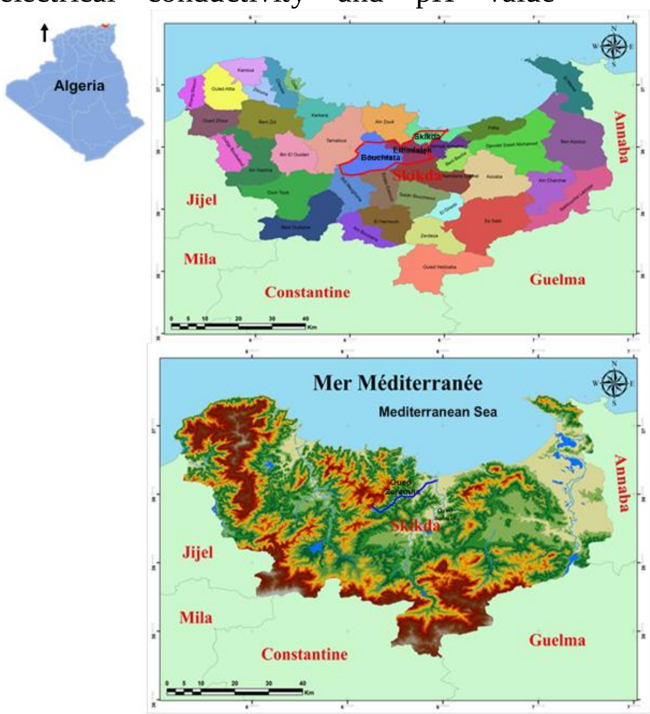

Fig. 1 The geographic situation of the study area

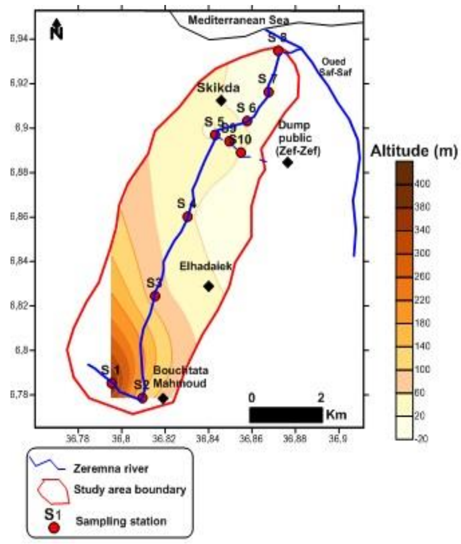

Fig.2. Sample locations in study area

2.2. Water quality index WQI :

Nine important parameters (pH, COD, EC, T°C, BOD_5, PO_4^{3-}, NH_4 and NO_3^- and NO_2) were selected to calculate the WQI Water Quality Index. This index is a water quality classification technique based on the comparison of water quality parameters with Algerian standards in our case of study.In other words, the WQI summarizes large amounts of water quality data in simple terms (Excellent, Good, Poor, Very Poor, etc.).This method was originally proposed by Horton (1965) and Brown andal (1970) [13,14].In this study the WQI index was applied to estimate the influence of natural and anthropogenic factors on the basis of several parameters of the surface water chemistry of Zeremna river.This index was calculated following the weighted arithmetic index method [14-17]. In this approach, a numerical value called relative weight (Wi), specific to each physicochemical parameter, is calculated (Table 1) according to the following formula :

$$W_i=k/S_i \quad (1)$$

Where: k = constant of proportionality and can also be calculated using the following equation:

$$k=1/\sum_{i=1}^{n}(1/S_i) \quad (2)$$

n is the number of parameters ;
Si is the maximum value of the Algerian surface water standard (2011)[18] for each parameter in mg/l except for pH, T°C and electrical conductivity.Next, a quality rating scale (Qi) is calculated for each parameter by dividing the concentration by the standard for that parameter and multiplying by 100 as in the following formula:

$$Q_i= (C_i/S_i) \times 100 \quad (3)$$

Qi: quality assessment scale for each parameter.
Ci: the concentration of each parameter in mg/l.
Finlay, the global water quality index is calculated by the following equation :

$$WQI= \sum_{i=1}^{n} Q_i\times W_i/ \sum_{i=1}^{n} W_i \quad (4)$$

Five quality classes can be identified according to the values of the WQI water quality index (Table1).

Table 1.
WQI Water Classification and Possible uses [8]

WQI Class	Water quality	Possible uses
0-25	Excellente	Drinking water, irrigation and industry
>25 – 50	Good	Drinking water, irrigation and industry
>50 – 75	Poor	Irrigation and industry
>75 – 100	Very poor	Irrigation
> 100	Unsuitable for drinking purpose	Appropriate treatment required before use

2.3. Calculation of the Organic Pollution Index (OPI)

The Organic Pollution Index (OPI) of Leclercq (2001) [19]was also used to assess the organic load in the river.The principle of the POI is to divide the values of the polluting elements in 05 classes (Table 2).This index is obtained by means of the values of ammoniums, BOD_5andphosphates.The principle of the calculation is to divide the values of the three pollutants into five classes and to determine, from the values obtained in the study, the corresponding class number for each parameter using the average data in Table 2.The final organic pollution index is the average of the pollution classes for all parameters (Table 2).

Table 2

Grid of organic pollution index classes (OPI)[19]

	NH_4^+ (mg N /l)	NO_2^- (µg N /l)	PO_4^{3-} (µg P /l)	DBO_5 (mg O_2/l)	OPI	Organic pollution
Class 5	< 0.1	< 6	< 16	<2	5 – 4.6	Null
Class 4	0.1 – 0.9	6 - 10	16 – 75	2 – 5	4.5 –4.0	Slight
Class 3	1.0 – 2.4	11 – 50	76 – 250	5.1 – 10	3.9 – 3.0	Moderate
Class 2	2.5 – 6.0	51 –150	251 - 900	10.1 –15	1.9 –1.0	Strong
Class 1	>6	> 150	> 900	>15		Very strong

2.4. Calculation of the Pollution Index (PI)

Two different quality indices are used to determine the metal contamination of Zeremna river.

(1) Pollution index (PI) is based on individual metal calculations and categorized into 5 classes (Table 3) according thefollowing equation [20].

$$PI= [(Ci/Si)^2_{max} + (Ci/Si)^2_{min}]^{1/2} /2 \quad (5)$$

Ci : the concentration of each element ; *Si* : metal level accordingto national water quality criteria.

(2) The metals index (MI) is based on a total trend assessment of current status. The higher the concentration of a metal compared to its respective MAC value, the worse the water quality [5] (Table 4). According to [21,22], the MI is calculated using the following formula :

$$MI= \Sigma ni=1Ci/(MAC)\ i(6)$$

Ci : the concentration of each element,
MAC : maximum allowable concentration.

Table 3

Water pollution index categories (PI) [20]

Classes	PI value	Categories
1	<1	Null
2	1-2	Slight
3	2-3	Moderate
4	3-5	Strong
5	>5	Very strong

Table 4.

Classification of water quality based on the Metal Index (MI) [20]

MI	Class	Water quality
<0.3	I	Very pure
0.3–1.0	II	pure
1.0–2.0	III	Slightly affected
2.0–4.0	IV	Moderately affected
4.0–6.0	V	Strongly affected
>6.0	VI	Seriously affected

3. Results and discussion

3.1. Descriptive statistics

The descriptive statistical characteristics of the physico-chemical variables used in this study concerned the minimum and maximum values, mean and standard deviation. The results show that the pH is slightly alkaline, and varies between 7.6 and 8.85. The temperature varies between 12.1 and 14.3°C. The mineralization of water is relatively high with an electrical conductivity varies between 556 and 7380 µS/cm (Table 4).The concentration ofdissolved oxygen demand COD is very high and exceeded the permissible standards for the majority of stations, with a minimum value recorded upstream from the river. As regards Nitrates and Ammonium, the results increase respectively from 34 to 1280 and from 0.14 to 169.2 mg/l. The samples with high concentrations of Ammonium and Nitrates are accompanied by a high pollutant load (50 mg/l of BOD_5).The contents of heavy metals (Pb, Zn and Cr) oscillate between 0.011 to 2.5 mg/l, 0.12 to 5.6 mg/ and 0.05 to 4 mg/l respectively (Table 5).

Table 5.

Descriptive statistics of physico-chemical parameters related to the sampling campaign 2021

January 2021	pH	CE(µs/cm) 25C°	T°C	NO_3 mg/l	NO_2 mg/l	NH_4 mg/l	PO_4 mg/l	Pb mg/l	Cr mg/l	Zn mg/l	DBO_5 mg/l	DCO mg/l
Means	8	2047.9	13.37	283.96	1.24	27.92	12.16	0.37	1.23	0.65	10.04	330.3
Max	8.85	7380	14.3	1280	5.2	169.2	54	2.5	5.6	4	50	2020
Min	7.6	556	12.1	34	0.09	0.14	2.5	0.011	0.12	0.05	0.5	20
Standard deviation	0.42	2536.74	0.62	483.23	1.84	54.06	18.56	0.78	2.13	1.25	15.7	626.56

3.2. Water Quality Index WQI :

In this study, the overall quality of surface waters of Zeremna river was assessed by the WQI method. The relative weight (Wi) of each physico-chemical parameter and the proportionality constant k were first calculated using the maximum values of the Algerian standard drinking water (2011)[18] of the physico-chemical parameters studied (Table 6). Indeed, 9 important parameters in the study of surface water quality : pH, T°C, EC, COD, NH_4, NO_3, NO_2, PO_4 and BOD_5 were taken into account in the calculation of the WQI value.After the calculation of the overall quality index WQI using the resultsof physico-chemical analysis and the national standard values of Algerian drinking water (2011)[18], the water quality class is determined for the 10 samples related to the 10 sampling stations. Thus, the class of good quality was identified for the stations located in the mountains of Bouchetata Mahmoud (S1), (S2). The class of poor quality was recorded respectively in the stations of the commune of Bouchtata Mahmoud (S3) and the commune of Elhadaiek (S4).Thus the class of non-drinking water was found respectively at the commune of Elhadaiek (S5), (S9) and (S10) and the commune of Skikda (S6), (S7) and (S8). (Fig.3).

3.3. Organic Pollution Index OPI :

After the calculation of the organic pollution index OPI using the results of analysis of the pollution indicator parameters (NH_4^+. BOD_5. PO_4^{3-}. NO_2^- and NO_3), the water quality class is determined for the 10 samples related to the 10 sampling stations (Fig.5). Thus, three classes of organic pollution (moderate. strong and very strong organic pollution). The analysis followed in the different stations was the subject of a data processing by the establishment of thematic maps of organic pollution of surface waters of Zeremna river during the sampling campaign. The class of moderate organic pollution was identified in the stations (S1). (S2). (S3) and (S4).

Table 6.
Weight of physico-chemical parameters and Algerian standard of surface water quality

Parameters	*Si* (maximum	1/*Si*	*Wi*
pH	9	0.11	0.017
T (°C)	25	0.04	0.006
Cond	2800	0.000	0.000
COD mg/l	30	0.14	0.022
NH_4 mg/l	4	5	0.77
NO_3 mg/l	50	0.02	0.003
NO_2mg/l	0.1	0.33	0.051
PO_4mg/l	2	0.5	0.077
DBO_5mg/l	7	0.33	0.051
		Σ=11.59	Σ=0.29
	k=1/Σ (1/S_i)	0.086	

3.4. Calculation of the PI pollution index

The PI and MI index for drinking water was calculated using the guidelines of (Algerian drinking water quality standards. 2011) [18]. The guidelines of (FAO. 1994) [23] were used to calculate the PI and IM value for irrigation water.

Aquatic environment protection lifetime was calculated using the guidelines of (CCME. 2007) [24].Three metals (Pb. Zn and Cr) are selected to assess the metal pollution of the study area.according to the pollution index (Table 7) which is based on calculations of individual metals.weight of physicochemical parameters and Algerian standards of surface water quality (2011) [18]. The measured metals show a differentdegree of pollution in the water of Zeremna river for different uses. Another index is used to estimate the metal pollution of the waters of Zeremna riverfor different uses. The metal index refers to the evaluation of the trend of the current state by calculating all measured metals (Table 8).

The classes of strong and very strong organic pollution were observed respectively instations (S5). (S6). (S7). (S8). (S9) and (S10) (Fig.4).

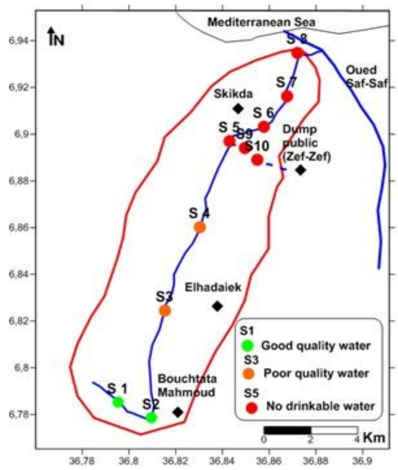

Fig 3 .Thematic map of the water quality index WQI of surface waters of Zeremna river during the campaign January 2021.

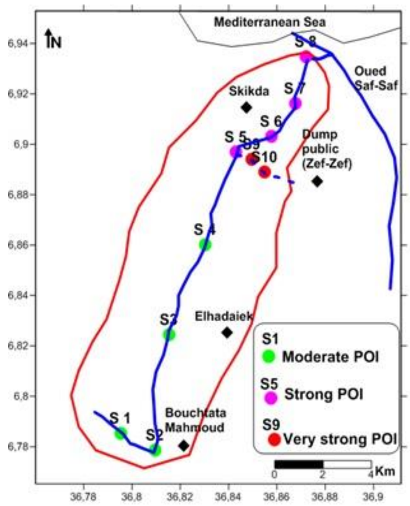

Fig .4. Thematic map of the organic pollution index POI of surface waters of Zeremna river during the campaign January 2021.

3.5. Metal Index (MI)

According to the metal indexvalues. 80% of the stations (8 stations) selected along Zeremna river are moderately threatened by metal pollution for the protection of aquatic life (MI> 2), except for two stations (S9 and S10) highly affected or MI reaches 58.5 and 136 at station 9 and 55 and 94 at station 10 for irrigation and aquatic life, respectively.

3.6. Discussion

The deterioration of water quality from upstream to downstream rivers is thought to be mainly related to urban and industrial wastewater discharges and/or the impact of agricultural activities [25, 26, 27].

Table 7

Pollution index of metals measured in the water of Zeremna river according to the indicative levels of drinking water, irrigation and aquatic life 2021.

Station	IP drinking water	Drinking water effect	IP Irrigation	Irrigation effect	IP Life Aquatic	Effect Aquatic Life
Pb^{+2}						
S1	0.16	No effet	0.016	No effect	1.39	Slight effect
S2	0.19	No effect	0.018	No effect	1.56	Slight effect
S3	0.13	No effect	0.013	No effect	1.13	Slight effect
S4	0.11	No effect	0.011	No effect	1	Slight effect
S5	0.32	No effect	0.032	No effect	2.78	Moderate effect
S6	0.17	No effect	0.018	No effect	1.56	Slight effect
S7	0.14	No effect	0.014	No effect	1.22	Slight effect
S8	0.13	No effect	0.013	No effect	1.33	Slight effect
S9	25.12	Serious effect	2.51	Serious effect	217.97	Serious effect
S10	11.65	Serious effect	1.16	Serious effect	101.14	Serious effect
Zn^{+2}						
S1	0.5	No effect	0.04	No effect	0.5	No effect
S2	0.42	No effect	0.012	No effect	0.5	No effect
S3	0.59	No effect	0.01	No effect	0.7	No effect
S4	0.68	No effect	0.021	No effect	0.8	No effect
S5	0.59	No effect	0.018	No effect	0.7	No effect
S6	0.85	No effect	0.026	No effect	1	Slight effect
S7	0.67	No effect	0.021	No effect	0.8	No effect
S8	0.5	No effect	0.016	No effect	0.6	No effect
S9	34.04	Serious effect	1.077	Slight effect	40.19	Serious effect
S10	17.02	Serious effect	0.53	No effect	20.09	Serious effect
Cr^{+}						
S1	1.56	Slight effect	1.56	Slight effect	1.56	Slight effect
S2	1.9	Slight effect	1.9	Slight effect	1.9	Slight effect
S3	1.34	Slight effect	1.34	Slight effect	1.34	Slight effect
S4	1.56	Slight effect	1.56	Slight effect	1.56	Slight effect
S5	1.9	Slight effect	1.9	Slight effect	1.9	Slight effect
S6	2.12	Moderate effect	2.12	Moderate effect	2.12	Moderate effect
S7	2.23	Moderate effect	2.23	Moderate effect	2.23	Moderate effect
S8	2.45	Moderate effect	2.45	Moderate effect	2.45	Moderate effect
S9	62.6	Serious effect	62.6	Serious effect	62.6	Serious effect
S10	60.73	Serious effect	60.73	Serious effect	60.73	Serious effect

Table 8

Metal Index (MI) in the study area for the different uses drinking water, irrigation and aquatic life 2021

Station	**Drinking water**		**Irrigation**		**Aquatic life**	
S1	0.53	Pure	0.42	Pure	2.4	Moderate effect
S2	0.83	Pure	0.72	Pure	2.7	Moderate effect
S3	1.36	Slight effect	1.23	Slight effect	2.6	Moderate effect
S4	1.58	Slight effect	1.44	Slight effect	3	Moderate effect
S5	1.9	Slight effect	1.74	Slight effect	3.1	Moderate effect
S6	2.13	Slight effect	1.95	Slight effect	3.9	Moderate effect
S7	2.18	Moderate effect	2.04	Moderate effect	3.6	Moderate effect
S8	2.34	Moderate effect	2.23	Moderate effect	3.4	Moderate effect
S9	69	Serious effect	58.5	Serious effect	136.35	Serious effect
S10	60.32	Serious effect	55.23	Serious effect	94.16	Serious effect

The water quality index WQI during the January campaign, of the year 2021 indicates that the majority of the stations (S3, S4, S5, S6, S7, S8, S9 and S10), i.e. 80% of the stations remain of poor qualityto non-potable water (25<WQI≤75) and (WQI >100).

This degradation of water quality is probably linked to domestic discharges in urban areas where the treatment plants are not all efficient and to individual sanitation in rural areas such as station S3. The two remaining stations representing 20% each of all stations, with a good quality (25 <WQI ≤50) for station S1 and S2 of the municipality of Bouchtata Mahmoud that are respected the various uses of water (drinking water,irrigationand protection of aquatic life), the class of excellent quality remains absent (Fig.3). The increasing degree of water degradation between stations S4. S5. S6. S7 and S8 is related to the increasing demographic and urban impact of the municipality of Elhadaiek and the municipality of Skikda compared to that of Bouchtata Mahmoud, these waters used only for irrigation.

The serious contamination of water between stations S9 and S10 is due to the impact of the public dumping of six communes of the wilaya of Skikda.The state of organic pollution of surface waters of Zeremna river, calculated from the organic pollution index OPI, show that 40% of the stations (4 stations) have moderate organic pollution (3 ≤OPI≤3.5) during the campaign of 2021 (January). The exception appears another time at the station (S9) and the station (S10) representing 20% of the stations, which indicate very strong organic pollution (OPI =1) and the rest of the stations (4 stations) that displays waters with strong organic pollution (2≤OPI≤2.25) (Fig.4).

This serious pollution is mainly related to the relatively high concentrations of BOD_5, COD, PO_4 , NO_3, NH_4 and NO_2 which exceed the Algerian standards, these serious contents are probably due to the effect of the public dump of Skikda. The degradation of water quality at stations S5, S6, S7 and S8 respectively of the commune of Elhadaiek and Skikda is due to discharges of domestic and urban origin without any prior treatment. The moderate quality of water between the four stations upstream and the average along Zeremna river is due to agricultural activities by leaching of fertilizers and individual domestic discharges from rural areas. The state of heavy metal pollution of surface waters of Zeremna river, calculated from the pollution index PI and the index of metals MI, the first index PI show 80% of the stations (8 stations) have no pollution to moderate ($0.1 \leq PI \leq 2.45$) during the campaign of 2021 (January). The exception appears another time at the station (S9) and station (S10) representing 20% of stations, which indicate a very strong pollution (PI>5). this severe pollution is always related to the impact of the public landfill of Skikda (Zef-Zef).The second index of metal pollution MI of surface waters of Zeremna river presents a moderate effect for the protection of aquatic life in eight stations (2<MI<4) during the campaign of 2021 (January). At two stations (S9 and S10), which indicate a serious contamination (MI>6), this serious pollution is still related to the impact of discharges highly charged with various pollutants.often toxic and of generally unknown composition of the public landfill Zef-Zef of the wilaya of Skikda.Upstream of the study area (S1 and S2), there is no effect of heavy metals on the water of Zeremna river either for drinking water use or for irrigation. In the middle part of Zeremna river, there is a slight effect of heavy metals on water quality (S3. S4. S5 and S6) for drinking water and water for irrigation.Downstream of the study area (S7 and S8) of the commune of Skikda.A moderate effect of heavy metals on the waters of these stations is recorded; this average pollution is due to uncontrolled domestic discharges and industrial discharges of the industrial zone of the commune of Skikda.The results of the different indices, namely the water quality index (WQI), the organic pollution index(OPI), the pollution index (PI) and the metal index (MI) applied to the surface waters of Zeremna river studied during the campaign of 2021 (January), were tested the degree of concordance and / or discordance between the different methods. The indices WQI., OPI., PI and MI show a complete concordance among all stations. The deterioration of water quality is reflected by an important mineral and organic load of anthropic origin from the urban communes of Elhadaiek and Skikda in the study area. The comparaison with previous work also shows a good agreement with the different indices [3,10]. These waters are very polluted in these municipalities, because of the very high concentrations of COD. NH_4. NO_2 and PO_4 which exceed the Algerian standards and for any use. This degradation is mainly of anthropic origin in relation with the agricultural activities by leaching of the soils very charged in fertilizers and with the discharges of urban waste water. The increase in the degree of pollution in summer would be linked.without doubt, to effluents loaded with domestic and industrial wastewater from the various urban centers (Elhadaiek and Skikda) remain important, and to the impact of the public landfill (Zef-Zef) of Skikda.

4. Conclusion

The quality of surface and groundwater has been severely degraded, limiting the actual water potential and leading to significant health and ecological impacts. Urban effluents and the use of agricultural and industrial chemicals.too often discharged without appropriate treatment into the receiving environment, are the main source of surface water quality degradation. Agriculture participates in this degradation by the exaggerated use of nitrogen and phosphate fertilizers,pesticides, herbicides, etc., the phenomenon of water pollution. The monitoring of quality indices (WQI).organic pollution (OPI), pollution (PI) and metal index (MI) of waters during this study shows that surface waters of Zeremna vally sub-basin remain at 20% of good quality and without effect of heavy metals and organic pollution (OPI) moderate for all uses. However, the urban stations show an increasing deterioration of the quality of their waters according to the demographic pressure of the communes. Thus surface waters are of poor quality to non-drinking water with a strong organic pollution in the commune of Elhadaiek and the commune of Skikda and used only in irrigation. In exception the two stations of the arm of Zeremna river S9 and S10 show a serious deterioration of the quality of their waters and a serious effect of heavy metals for any use according to the effect of the public discharge of Skikda.After the evaluation and interpretation of the results we can propose some solutions that would reduce or limit the probleme of contribution of a number of different human behaviors and uses to environmental pollution.in particular surface water represented by Zermna river.Among these solution,we can mention:Reduce the use of pesticides and supervise the use of fertilizers.Stabilization of the landfill site and installation of a leachate drainage network.Treatment of wastewater befor discharge to stop environmental degradation and pollution of surface and groundwater ;regularly control individual sanitation by municipalites.

5. References

[1].TAMPO.L.. GNAZOU.M.. AKPATAKU.V.. BAWA.L.. DJANEYE-BOUNDJOU. G. Application of statistical methods to the hydrochemical study of the waters of a tropical hydrosystem: Case of the Zio River watershed (Togo). European Scientific Journal. 11(14): 204-225. (2015).

[2]. AHER. D. N.. KELE. V. D.. MALWADE. K. D.. SHELKE. M. D. Lake Water Quality Indexing To Identify Suitable Sites For Household Utility: A Case Study Jambhulwadi Lake; Pune (MS). Int.Journal of Engineering Research and Applications. 6(5) : 16-21. (2016).

[3]. DIRECTIONOF WATER RESSOURCE OF SKIKDA (2020).Study report on the hydro-agricultural development of the perimeter of the Elhadaiek plain. Skikda.

[4]. ANONYMOUS 3 INSPECTIONS OF THE ENVIRONMENT WILAYA OF SKIKDA; CEGEP. Environmental impact study of the technical landfill center of Skikda Zef-Zef.57 pages. (2002).

[5]. CEGEP. Report of study: Study of impact on the environment of the center of technical inter-communal burying of Skikda (ZefZef); center of study and management of projects. Alger. 52p. (2002).

[6]. MATE. Information manual on urban solid waste management and disposal –Alger. (2003).

[7]. LALAMI. A. E. O.. MERZOUKI.M.. EL HILLALI.O.. MANIAR.S.. KORAICHI. S. I.. Pollution of surface water in the city of Fez.Morocco: typology.origin and consequences. LARHYSS Journal P-ISSN 1112-3680/E-ISSN 2521-9782. (9). (2011).

[8]. EL HMAIDI A.. TALHAOUI A.. MANSSOURI I.. JADDI H.. OUSMANA H.. Contribution of the pollution index and GIS in the assessment of the physico-chemical quality of the surface waters of Moulouya River (NE. Morocco).

La Houille Blanche. 3 : 45–54. https://doi.org/10.1051/lhb/2020028. (2020).
[9]. BAKAN.G.. BOKE OZKOC.H.. TULEK.S.. CUCE.H.. Integrated environmental quality assessment of Kızılırmak River and its coastal environment. Turk. J. Fisheries Aquat. Sci. 10 : 453–462. (2010).
[10]. BOUGLOUFM.. Contribution to the management and valorization of solid and household waste in Skikda (North-East Algeria). (2014).
[11]. VILLA. J M.. The alpine chain of eastern Algeria and the Algerian-Tunisian confines. Thesis Doct; Univ Pierre et Marie Curie. Paris VI. 655. (1980).
[12]. BOUCENNA. Impact of public discharge on ground water quality case of Zef- Zef (SKIKDA) magister thesis university of Annaba. (2007).
[13]. HORTON. R. K..An index number system for rating water quality. Journal of Water Pollution Control Federation. 37(3) : 300-306. (1965).
[14]. BROWN. R. M.. MCCCLELLAND. N. I.. DEININGER. R. A.. TOZER. R. G.. A Water Quality Index- Do We Dare Water and Sewage Works. 117 : 339–343.(1970).
[15]. BROWN R.M.. MCCLELLAND N.I.. DEININGER R.A.. O'CONNOR M.F.. A Water Quality Index - Crashing the Psychological Barrier.In: Thomas W.A. (eds) Indicators of Environmental Quality. Environmental Science Research. (1) : 173-182.. Springer. Boston. MA. https://doi.org/10.1007/978-1-4684-2856-8_15. (1972).
[16] . CHATTERJI.C.. RAZIUDDIN.M.. Determination of water quality index of a degraded river in Asanol Industrial area. Raniganj. Burdwan. West Bengal. Nature. Environment and Pollution Technology. 1 (2) : 181-189. (2002).
[17] YIDANA. S. M.. YIDANA.A.. Assessing water quality using water quality index and multivariate analysis. Environmental Earth Sciences59(7) :1461-1473. (2010)https://doi.org/10.1007/s12665-009-0132-3.
[18]Official Journal. Standard of Algerian surface water. (2011).
[19] LECLERCQ L.. Running water: characteristics and means of study.in wetlands. Conference proceedings organized in 1996 by the Ministry of the Walloon Region as part of the World Year of Wetlands. Legs. Walloon Region.DGRNE: 67-82. (2001).
[20]. CAERIO.S.. COSTA. M.H.. RAMOS. T.B.. FERNANDES.F.. SILVEIRA.N.. COIMBRA.A.. MEDERIOS.G.. PAINHO.M.. Assessing heavy metal contamination in Sado Estuary sediment: an index analysis approach. Ecolog. Indicators (5) : 151–169. (2005).
[21]. TAMASI.G.. CINI.R.. Heavy metals in drinking waters from Mount Amiata. Possible risks from arsenic for public health in the province of Siena. Sci. Total Environ. 327 : 41–51. (2004).
[22]. EL-SAYED. S.M.M.. Physicochemical studies on the impact of pollution up on the River Nile branches. Egypt (M.Sc. Thesis). Faculty of Science. Benha University. Egypt. 248. (2011).
[23]. FAO (The Food and Agriculture Organization of the United Nations).. MANUAL OF IRRIGATION TECHNIQUES UNDER PRESSURE.(2008).
[24]. CCME (Canadian Council of Ministers of the Environment).for the protection of aquatic life In : Canadian environmental quality guidelines. 1999. Canadian Council of Ministers of the Environment. 1999. Winnipeg. (2007).
[25]. ŞENER.Ş.. ŞENER.E.. DAVRAZ.A.. Evaluation of water quality using water quality index (WQI) method and GIS in Aksu River (SWTurkey). Science of the Total Environment. 584 : 131-144. (2017).
[26]. IZOUGARHANE.M.. MANSOURI.D.. EL IBAOUI.H.. CHAKIRI.S.. Fadli.M.. Physico-Chemistry And Metal Contents Of The Wadi Sebou Estuary Waters During Years Of Sand Dredging/ 2007. 2014. 2015. 2016. European ScientificJournal. 12(30) : 127-151. (2016).doi: 10.19044/esj.2016.v12n30p127.
[27]. KHAMAR M.. BOUYA D.. RONNEAU C.. Metallic and organic pollution of water and sediments of a Moroccan river by urban liquid discharges. Water Quality Research Journal. Canada 35 (1) :147- 161. (2000).