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Assessment of water quality bounamoussa river in el tarf region using water quality index (Algeria)

Abstract

Water quality is an important standard in matching water require and contribute. Abundant degree of freshwater is prominent for biological requirements and is a vital surface of incorporated environmental managing and sustainable development. The quality of water indices evaluation enterprise particular value which reduce the immense quantity of parameters and simply characterize data. The aim objective of the present study is to assess the suitability of surface water of Bounamoussa River situated in El-Tarf city located in the Algerian's extreme northeast, for drinking purpose based on calculated water quality index standards. Per methodology, WQI is a significant parameter to check the quality of water, and its calculation was carried out by using relations given in the water quality index computation which twelve selected parameters (pH, EC,TH, Ca, Mg, Na, K, Cl, NH_4, SO_4, NO_2, NO_3) have been considered, which were measured at nine stations along the river during two sampling campaigns (winter and summer seasons). The results showed that the computed WQI values of Bounamoussa River surface water extend from 32,80 to 65,77 with an average 46,76 in winter and fluctuate from 35,86 to 97,46 with an average of 47,25 in summer, in general, the study region in both seasons is under excellent to good category. Water from almost all the sampled sites can be careful as suitable for drinking purposes. It's recommended to continue monitoring the water of this ecosystem to facilitate the establishment at all levels to supervise and defend the natural resources of the region.

Keywords: surface water quality, drinking purpose, water scale, seasons, suitability

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Introduction

A great amount of nations, favour the WQI method to assess general river status, because of being single appreciated and easy to comprehend.[1–5] WQI is one of the main helpful kits to supply advice on the quality of water to the strategy makers and environmentalists.[6] In effect, natural procedures such as temperature and rainfall along with anthropogenic aspects that disturb the river water quality and steer to different characteristics between periods.[7] Opinion obtainable that irrigation accounts for approximately 70 percent of thz water with drawl across the world and consumptive water use being about 90 percent. Accordingly, precipitation flood is more probable to happen in an urban areas while snow transport lowers the degree of snow thaw overflow.[8] The nature of surface water is a delicate issue and it is an incredible ecological concern around the world. It is critical for long-term economic development, social welfare, and environmental sustainability. Some physicochemical parameters, some hydrogeochemical parameters calculated from the water quality parameters and a few graphical representations determine the suitability of the river water for agricultural use.[9,10] Horton[11] was the most researchers who proposed the profit of using the WQI and later, many studies concerning water index have been describe daway for the diverse marine system. Later on, Peace et al.[12] also proposed a WQI process that used by numerous scientists such as Weight Arithmetic Water Quality Index.[13–19] These indexes have been useful for assessment of water quality in a specific region.[20–22] These indices degree the quality of water from its basins due to the issues that affect them. Thus, Inclusive River water quality assessing is a helpful device not only to evaluate the suitability of surface water for irrigation, but also to verify an effective administration of water resources and the safety of aqua systems.[5,22,23] The main objective of the current research is to examine the suitability of Bounamoussa River surface water for drinking purposes based on calculated water quality index values in dissimilar seasons and at a diverse segment of the River.

Materiel and methods

Characteristics of the research area

Bounamoussa river across El-Tarf city is located in the Algerian's extreme northeast and prolonged on a space of 2.891.63 Km^2. It has a 90 km of coastline (Figure 1). This river is contained in El-Tarf and Annaba municipalities, which 90% restricted in El-Tarf city with its communities of Besbes, Echatt, Zerizer, Asfour, Ben M'Hidi, and Chebaita Mokhtar and the 10% for Annaba city reserved at both communities El-Hadjar, El-Bouni only.[25] the focal sources of employment are agriculture, cultivation, and animals, most of them perform required labor, though the other sectors are the food industry primarily tomatoes and oranges, wheat factories, stone squashing. The study area subjected to a Mediterranean climate characterized by two dissimilar periods: one rainy, marked by high precipitation and low temperatures from October to May, and other dry and warm with high temperatures arriving their highest in August with low precipitation. Usual southerly winds upset off the sea through the winter; and in summer, the hot Sirocco blows in a south-south-westerly way, resounding with it a freshening effect that strongly felt during a one-month of period.[26] The contextual research will concern Bounamoussa River, which is utilized for drinking propose. The water from the dam presents appropriate quality for irrigation.

Sampling stations

Water sample collection was made for two periods, summer and winter from nine (09) sites selected stations El Tarf City drained by Bounamoussa River. The sampling sites listed found on stable space, with minor deviance relying on the geographic condition and easy access. The water samples collected physically from a depth of 20cm from the surface of the water, especially where the course of water was high, to acquire great homogenized samples. Plastic holders of volume greater than 1500cm^3 utilized for the sampling of each sample in every site and gathered for this research. Sampling, conservation, and transfer of samples to the research laboratory were performed per standard procedures, Rodier[27] and with the procedures delineated in the standard methods described by Motsara et al.[28] and APHA[29] which index scores were determined for twelve selected parameters (Table 1). Their average values are compared with standards of potable water quality suggested by the World Health Organization WHO[30] and used to assess WQI.

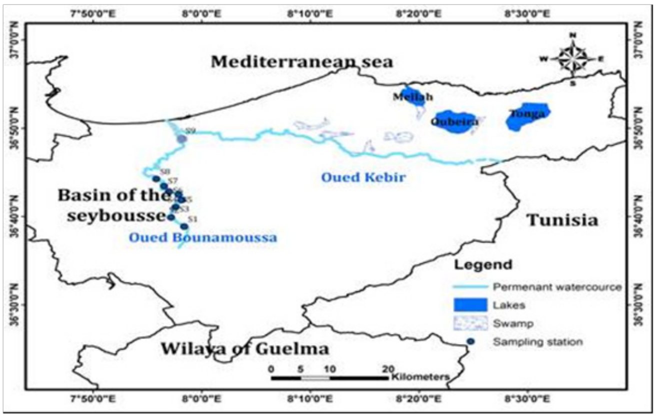

Figure 1 Map of study area location.

WOI calculation

WQI is an effective tool that represents the general water quality at a certain place and time based on physicochemical parameters. In the present study, the water quality index (WQI) has been applied to assess the suitability of surface water quality of the Bounamoussa River for drinking purposes. For this purpose twelve parameters have been selected which are:

The calculation and formulation of the WQI involved the following steps:

The first step to calculate the water quality index is to set specific weights for chemical parameters and their relative importance in drinking water, as shown in Table 1.[31] The highest weight was given to every parameter due to the importance of the role played in water quality than others.

Table 1 Methods used for the chemical analysis of surface water

Chemicals variables	Methods used
pH	Digital pH-meter
Electrical Conductivity, EC (µS/cm)	EC-meter
Calcium, Ca++(mg/l)	Titration with EDTA
Magnesium, Mg++(mg/l)	Titration with EDTA
Total Hardness, TH (mg/l)	Titration with EDTA
Sodium, Na+(mg/l)	Flame photometric method
Potassium, K+(mg/l)	Flame photometric method
Ammonia, NH4+(mg/l)	Spectrophotometric method
Chlorides, Cl-(mg/l)	Titration with AgNO3
Sulphate, SO_4-(mg/l)	Spectrophotometric method
Nitrate, NO_3-(mg/l)	Spectrophotometric method
Nitrite, NO_2-(mg/l)	Spectrophotometric method

The relative weight (Wi) is calculated using the equation number one given below:

$$Wi = {Wi}\Big/{\sum_{i-1}^{n} Wi} \qquad (1)$$

Where, Wi relative weight, wi the weight of every parameter, and n is the number of parameters

$$qi = \left(\frac{Ci}{Si}\right) * 100 \qquad (2)$$

$$SIi = Wi * qi \qquad (3)$$

$$WQI = \sum SIi \qquad (4)$$

The calculated WQI values are classified into five classes to choose the water quality status (WQS) as shown in Table 3.

Results

Applying the previous calculations on the results of water assessment data of the Bounamoussa River, in both seasons WQI for all samples have been designed in Table 2, 3 and 4. In this study, the profiles of the obtained results exposed that, for the winter season, the calculated WQI values varied from 32,80 to 65,77 with an average 46,76, however it oscillates from 35,86 to 97,46 with an average value of 47,25 in summer. In accord to Yadav et al.[32] and to the water quality index values were categorized into five varieties as presented in Table 3. When relating the results of the computed water quality index with the Ramakrishnalah classification; it shows that 33% of the water samples collected from downstream of the river falls in the second category (II) and 67% of the water samples falls in the first category (I) in winter. While, in summer, it designates that 11% of the water samples fall in the second category (II) and 89% of the water samples falls in the first category (I). The general water quality status during the period of study refer to excellent water quality. However, allowing to Yadav classification, in the rainy period, 67% of the water samples falls in the second category (II) which mentions the good quality and 33% of the water samples falls in the third category (III) that signifies poor quality. Although, in the dry period, it designates that 11% of the water samples falls in the third category (III) and 89% of the water samples falls in the second category (II).

Table 2 Suggested Standards for drinking water quality and evaluated unit weights of specific parameters

Variables	Standards (SI)	Weight (wi)	Relative weight (Wi)
pH	6,5	2	0,045
EC (µS/cm)	300	5	0,114
Ca++ (mg/l)	75	2	0,045
Mg++ (mg/l)	50	2	0,045
TH (mg/l)	300	2	0,045
Na+ (mg/l)	200	2	0,045
K+ (mg/l)	12	3	0,068
NH4+ (mg/l)	0,5	5	0,114
Cl- (mg/l)	250	3	0,068
SO_4- (mg/l)	200	4	0,091
NO_3- (mg/l)	45	5	0,114
NO2- (mg/l)	0,1	5	0,114
		∑ wi = 40	∑ Wi = 1,000

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Table 3 Classification of Surface water quality according to WQI range

Category	Water Quality	WQI Yadav et al.[32]	WOI Ramakrichnaiah et al.[2]
I	Excellent	0–25	< 50
II	Good	26–50	50–100
III	Poor	51–75	100–200
IV	Very Poor	76–100	200–300
V	Unsuitable	Above 100	>300

Table 4 Water quality indices and water quality status at sampling sites during both seasons

Winter				Summer		
Water quality based on the scale suggested by						
Sites	WQI	Yadav et al.[32]	Ramakrichnaiah et al.[2]	WOI	Yadav et al.[32]	Ramakrichnaiah et al.[2]
S1	39,04	Good	Excellent	36,76	Good	Excellent
S2	34,51	Good	Excellent	43,00	Good	Excellent
S3	32,80	Good	Excellent	35,86	Good	Excellent
S4	39,10	Good	Excellent	43,53	Good	Excellent
S5	43,23	Good	Excellent	37,40	Good	Excellent
S6	58,52	Poor	Good	46,85	Good	Excellent
S7	58,04	Poor	Good	44,90	Good	Excellent
S8	49,82	Good	Excellent	39,45	Good	Excellent
S9	65,77	Poor	Good	97,46	Poor	Good

Discussion

Estimation of drinking water quality is a suitable condition among emerging community health problems in this background where accessibility of secure water is at danger unpaid to normal and man-made actions. This cross-sectional research conducted across the study region was expected to measure drinking water quality using WQI which delivered posts on the complex consequence of chemical parameters on water.[33] The general water quality status through both seasons of study refer to good water quality for drinking purpose, excluding at sites S6, S7 and S9 through the wet season, and S9 also during the dry season, which was classified as "poor" water quality and inappropriate for drinking usages as recommended by Brown as per the classification given in Table 3.[34] The capacity is because of severe execution of pollution management rules and regulations on water value for industries and previous commercial sectors and/or the preamble of a few corrective processes engaged by the Bounamoussa River management side.[6] The unsuitability of these water samplings in some sites could be because of the interaction of rainwater with the sedimentary rock in the region leading to the disbanding of ions into the aquifer or could because of different anthropogenic actions, for example, dirt dumping, unused disposal, agricultural actions, the presence of unclean drainage behind the water source, and anthropogenic contamination from the close dump location. Still, these three locations with poor water quality could be appropriate for drinking water uses succeeding a basic decontamination action, such as filtration. Cyclical as well as location-wise difference of index values can be because of distinction in physicochemical attributes of surface water.[35,36] These results were found to be in accordance with other studies such as,[6,37] which use the similar WQI method (Weighted arithmetic Water Quality Index).[38,39]

Conclusion

On the origin of the study carried out in this research, it can be resolved that significant differences in WQI values detected over the periods and across positions with the maximum WQI values (poor quality) in summer on downstream of the River, while the lowest values (better quality) were in winter on upstream of River. The results presented in this paper are based on selected water quality parameters determined in the Bounamoussa River system during the summer and winter season shows the values of WQI increased from more than 30 to almost 65 then to 97 and water quality was better in winter compared to that in summer. Based on these data, the water quality conditions in the Bounamoussa River system are analyzed. Information set issued to estimate a WQI to give an inclusive knowledge of the water quality of the studied area. Generally, the study area in both seasons is under excellent to good category. It's recommended to continue monitoring the water of this ecosystem to facilitate the establishment at all levels to supervise and defend the natural resources of the region. The performance of the character methodologies in a tolerable number of water bodies considered by diverse hydrological and climatic conditions is essential before applying them on a large level.

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Conflicts of interest

None.

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