

Application of Water Quality Index for Surface Water Quality Assessment Boukourdane Dam, Algeria

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Abstract

Boukourdane dam in Northern Algeria plays a fundamental role in the local society as a source of irrigation and drinking water. In order to characterize the temporal variability of water quality in the dam lake, monthly monitoring was conducted for a period of 2 years (January 2013–January 2015) at four sites. The water in the dam tended to be alkaline, with the highest pH = 9.95 recorded in the spring of 2013. The highest value of temperature was recorded in summer (37.6 °C). The dissolved oxygen levels varied between 2.58 and 11.61 mg L⁻¹. Nitrates were low and the fecal coliform ranged between 85.60 and 1099.67 UFC mL⁻¹. The overall water quality in the Boukourdane dam is medium to good according to SEQ-EAU (Normes de qualité des eaux des masses d'eau naturelles [4]). To confirm these results, we calculated the water quality index (WQI); during the study period, the WQI varied between 60 and 72. The water quality is frequently impaired; conditions often depart from desirable levels which classified the water quality as medium. There was a general trend of decrease in the summer and autumn of 2014 and this is the result of natural processes (degradation of organic matter as well as the concentration of nutrients in those seasons).

Keywords

Water quality • WQI • Physico-chemical parameters • Boukourdane dam • Algeria

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1 Introduction

The quality of surface water depends primarily on the geological formation of a particular region, and other factors such as leachate from solid waste dumping sites, municipal solid waste, etc. This latter may have a direct effect on the surface water quality, and directly threaten the integrity of the aquatic ecosystems. Recognizing and understanding the relative influence of natural and human-induced processes on hydrological and biochemical functioning are prerequisites for improved water resources management. Therefore, in this study, the water quality index was monitored for 2 years (January 2013–January 2015) at four different stations.

2 Materials and Methods

Boukourdane dam is located on the bed of wadi El Hachem, at the juncture of two principal intermittent wadis, Menacer and Fedjana. The site is 11 km from the Mediterranean Sea in a catchment area of over 177 km². The climate is typically Mediterranean, with a dry and hot period of 5 months, stretching from mid-May to mid-October.

Six parameters were measured, three of them were measured in situ which are water temperature, pH and dissolved oxygen, determined using a Multi 340i/SET WTW analyzer, and two physicochemical parameters, nitrate and phosphate—analyzed in the laboratory using the colorimetric method with a continuous flow on an automated chain (SKALAR). Samples were also analyzed for fecal coliforms according to the protocol described by [3].

National Sanitation Foundation Water Quality Index (NSF-WQI) is used to determine the level of water quality, based on physico-chemical parameters such as: Dissolved oxygen, nitrate, phosphate, temperature, pH, and Fecal Coliform. This technique, developed by [1] using the Delphi method, was done by selecting parameters rigorously,

Table 1 Seasonally environmental variables and fecal coliform summarized with their means (\pm SD), for the Boukourdane lake dataset

Obs		WT ($^{\circ}$ C)	pH	O ₂ d (mg L ⁻¹)	NO ₃ (mg L ⁻¹)	PO ₄ (mg L ⁻¹)	CF (UFC/100 ml)
Winter.13	Moy \pm SD	13.05 \pm 0.65	7.95 \pm 0.28	7.450.34	0.017 \pm 0.007	0.137 \pm 0.008	85.60 \pm 91.16
Spring.13	Moy \pm SD	17.56 \pm 1.85	8.32 \pm 0.69	6.56 \pm 1.09	0.170 \pm 0.179	0.680 \pm 0.677	283.11 \pm 535.86
Summer.13	Moy \pm SD	23.79 \pm 3.30	7.71 \pm 0.32	5.88 \pm 1.65	0.045 \pm 0.031	0.286 \pm 0.545	313.11 \pm 512.55
Autumn.13	Moy \pm SD	20.53 \pm 3.98	7.98 \pm 0.29	6.85 \pm 1.22	0.053 \pm 0.030	0.038 \pm 0.023	1061.59 \pm 1100.98
Winter.14	Moy \pm SD	13.26 \pm 0.63	8.54 \pm 0.29	6.81 \pm 2.10	0.084 \pm 0.049	0.019 \pm 0.018	1099.67 \pm 1086.11
Spring.14	Moy \pm SD	18.02 \pm 3.24	7.96 \pm 0.62	6.00 \pm 1.37	0.452 \pm 0.789	0.086 \pm 0.218	314.00 \pm 579.16
Summer.14	Moy \pm SD	24.46 \pm 3.62	7.83 \pm 0.34	5.13 \pm 1.42	0.047 \pm 0.027	0.037 \pm 0.025	751.33 \pm 975.81
Autumn.14	Moy \pm SD	20.90 \pm 3.45	8.05 \pm 0.32	5.86 \pm 1.15	0.017 \pm 0.010	0.041 \pm 0.008	289.28 \pm 568.85
Winter.15	Moy \pm SD	13.23 \pm 1.67	8.09 \pm 0.10	7.58 \pm 1.13	0.073 \pm 0.014	0.036 \pm 0.010	1426.00 \pm 1123.34

developing a common scale and assigning weights to the parameters.

$$WQI = \sum_{i=1}^n W_i Q_i$$

$$I = \sum_{i=1}^n I_i W_i$$

where, $\sum_{i=1}^n W_i = 1$, I_i = Sub-index of each parameter, W_i = Weighting factor, Q_i = is the rating value of parameter i and n = Number of sub-indices.

3 Results

The water in the dam tended to be alkaline, with the highest pH = 9.95 recorded in the spring of 2013. The highest value of temperature was recorded in summer (37.6 $^{\circ}$ C). The dissolved oxygen levels varied between 2.58 and 11.61 mg L⁻¹. The nitrates were low (Table 1).

We calculated the water quality index (WQI) during the study period, the WQI varied between 60 and 72 (Table 2).

4 Discussion

The overall water quality in the Boukourdane dam is medium to good according to [4]. The water quality is frequently impaired; conditions often depart from desirable levels which classified the water quality as medium. There was a general trend of decrease in the summer and autumn of 2014 and this is the result of natural processes (degradation of organic matter as well as the concentration of nutrients in those seasons) [2].

Table 2 Water quality index values

Season	WQI
Winter 2013	72
Spring 2013	65
Summer 2013	66
Autumn 2013	64
Winter 2014	64
Spring 2014	66
Summer 2014	60
Autumn 2014	61
Winter 2015	66

5 Conclusion

Establishing a network to monitor the water quantity and quality provides the basis for characterizing the lacustrine system as well as the impacts of the domestic discharges on the site and surrounding environment. The data can be used for assessing impacts on downstream aquatic ecosystems, as well as to limit risks of pollution. The 2015–2017 rainfall was relatively low compared to our study period, so there is no significant amount of run-off, which means that the water quality has not significantly changed.

The results of this study could help in pollution management and in projects for the preservation of this Wetland. The use of micro-organisms for their rapid response and evolution related to the environmental changes increases the interest of their ecological follow-up and can be a good method to support the results of WQI for the water quality determination.

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