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Assessment of the water quality of the reservoir Bab Louta (Taza, Morocco)

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Abstract

Considering the limitation of groundwater, population growth, socio-economic development and growing demand for drinking water, as well as drought, Morocco, a country with a semi-arid climate, has launched since the 1960s a program of mobilization of surface waters through the construction of several reservoir dams. Currently, 65% of drinking water is produced from surface resources, mostly dam reservoirs. Nowadays, these structures are confronted with various environmental problems. The result is an alteration in the quality of the water which affects its uses, in particular the production of drinking water. The present work carried out at the Bab Louta dam, whose primary vocation is the supply of drinking water to the city of Taza, aimed to study the water quality of this reservoir. The evolution of physicochemical parameters (Temperature, pH, the electrical conductivity, Dissolved oxygen transparency, the suspended matters, Nitrates, Orthophosphates, and total phosphorus) and the biological descriptor (Chlorophyll *a*) was followed by a vertical sampling at the deepest point of the reservoir, over a period of 04 months, from May to August 2016. The obtained results show large spatio-temporal variations of the parameters studied, with a water quality ranging from good to excellent.

1. Introduction

Water has become a strategic global issue, the management of which must imperatively integrate itself into a political perspective of sustainable development. Some say it will be, in the third millennium, an issue of wars as oil has been and still is today [1].

Competition between agriculture, industry and the drinking water supply for access to limited water supplies is already undermining the development efforts of many countries [2]. In this context, Morocco, a country with a semi-arid climate, has embarked since the 1960s on a program to mobilize surface water through the construction of several reservoir dams. Currently, 65% of drinking water is produced from surface resources, mostly dam reservoirs [3].

However, surface waters represent a vulnerable resource to pollution and the degradation of its quality. Dam water is not an exception; it is subject to pollution problems that could impair their quality, and subsequently to health, thus influencing mortality in both humans and animals [4]. Therefore, in order to guarantee the necessary water supply to our country at all times, it was necessary to control and safeguard the quality of the water retained by these dams [5], and to be aware of the importance of the rational management of these resources and their protection against all pollution likely to affect their quality.

The population of the province of Taza is estimated at 743,237 inhabitants according to the 2004 surveys, of which 55% is served drinking water [6], 80% mainly urban (Taza), is fed largely from Dam Bab Louta , Drilling operations and Ras El Ma and AinN'sa sources [7].

In order to meet the needs of the population, a study of the characterization and evaluation of the quality of the dam is necessary. In the current state of knowledge, no work has been done on the water quality of this dam. The aim of this work is to characterize the waters of this reservoir and to evaluate their quality for a period extending from May to August 2016.

2. Materials and methods

2.1. Description of study area

The Bab Louta dam is a part of the Sebou drainage basin, the impoundment of the dam was carried out in 1999, the main purpose of the dam is the supply of drinking water. The Bab Louta dam is located on the Oued bousbâa, and controls a watershed of 124 km^2. It is located in an outcrop of the schisto-quartzitic basement, surrounded by clays of the triassic and marly limestones of the Upper Cretaceous. Average rainfall in the catchment area is estimated at 900 mm / year. With its reservoir of 37 Mm^3, this dam permits to regulate 8 Mm^3 in order to ensure the supply of drinking water to the city of Taza and the neighboring centers without deficit until 2020 [8].

2.2. Stations and sampling frequency

In limnology, the deepest point of the lake serves as a standard sampling site for the physicochemical parameters of water, because the results of the collection are more representative of the whole lake [9]. For our study, a sampling point was selected directly from the deepest point. The sampling campaigns were held twice a month, during four months from May to August 2016.

The stations selected are: Surface (S), - 2.5m (P1), -5m (P2), -7.5m (P3), -10m (P4), -12.5m (P5), -20m (P7), -25m (P8), and -30m (P9).

2.3. Samples and methods of analysis

The sampling is carried out using standardized techniques, using a two-liter Van Dorn bottle. The samples are stored in coolers to maintain the temperature at 4 °C and are then transported to the Laboratory of Natural Resources and Environment of the Polydisciplinary Faculty of Taza for analysis.

Some measurements were carried out in situ, namely, temperature, pH, conductivity using a multi-parameter analyzer Type CONSORT- Model C535, dissolved oxygen using an oximeter Type HACH, and transparency using a Secchi disc of 20 cm in diameter. For the other parameters (Suspended matter, Nitrates, orthophosphates, total phosphorus) they was analyzed using the protocol of the ONEP laboratory in controlling water quality and the standard standards [10, 11].

Chlorophyll *a* was extracted in boiling ethanol (95%), and the absorption at 665 nm and 750 nm were read in a spectrophotometer. Chlorophyll *a* present in the extract was calculated using the equation of Marker *et al.* (1980) [12].

3. Results and discussion

3.1. Physico-chemical parameters

The obtained results during the study period show that the temperature presents similar variations during the 04 months of study on the whole water column (Figure. 1A), Showing a decreasing gradient from the surface to the bottom. As it shows, a gradual increase from one month to another, with maximum values at the surface (S). In fact, the variation of the temperature of the water is related to that of the seasonal atmospheric temperature and the vertical stirring [13]. These variations influence the lacustrine ecosystem, causing alternating phases of stratification and thermal homogenization. However, it is noted that the depth of the thermocline is observed from the depth of 7.5 meters (P3), thus differentiating an epilimnion (S to P3), a metalimnion (P3 to P5) and a hypolimnion (P5 to P9).

In above Figure.1B, it can be observed that the pH values vary between 8.72 and 7.57 respectively in June (in S) and August (in P9). The pH changes follow the same pattern as the temperature. During the study period, the waters of the dam have a slightly alkaline character, with the highest pH values recorded in June. These results are consistent with those of other studies [14, 15]. This alkaline character could be attributed to the photosynthetic activity of phytoplankton, including cyanobacteria, and / or to high concentrations of bicarbonate in the medium [16].

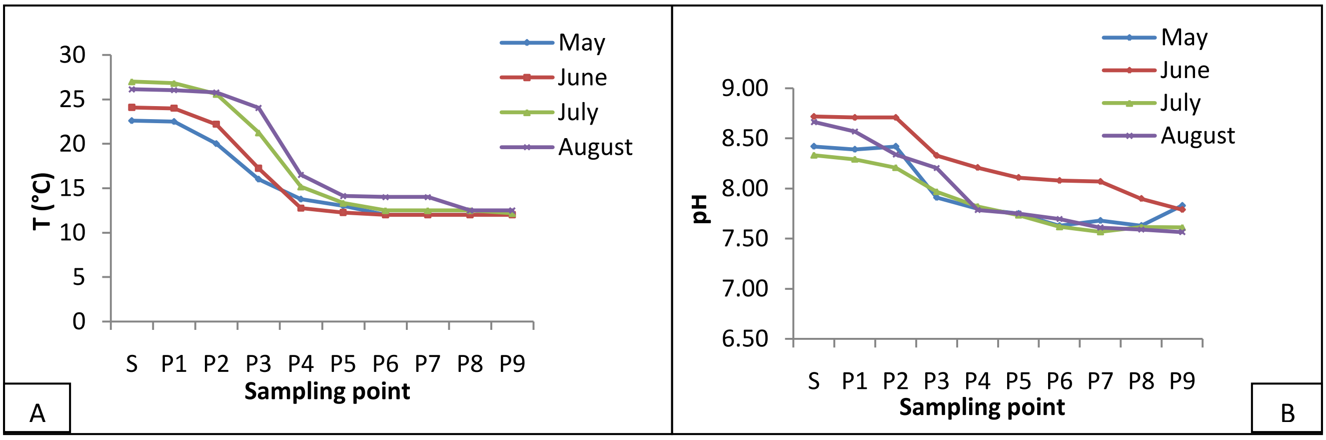

Figure 1: Spatio-temporal variations of temperature (A) and pH (B).

On the whole water column, the most important values of conductivity are found at the epilimnion and the lowest at the bottom (Figure.2 C). These results disagree with those reported by Mehanned *et al.* (2014) [17].
Compared to the other months of the study period, the month of June shows the most important values of conductivity over the whole water column, but which still retain a weakly mineralized character. These conductivity values remain well below the values recorded in other dams [17, 18].
As it is shown in Figure.2 D, the vertical variation of dissolved oxygen show that it follows the same pattern as temperature, with higher concentrations in surface water and decrease with depth. In addition, there is a coincidence between the most important values of temperature and those of dissolved oxygen. This could be explained by a very intense photosynthetic activity, and / or by atmospheric exchanges allowing the dissolution of oxygen from surface air [19].

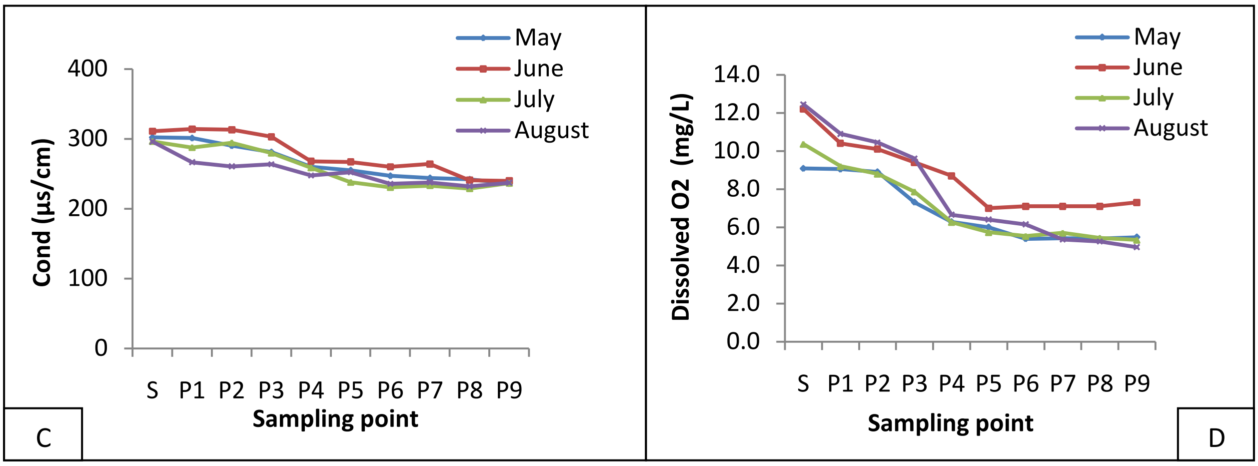

Figure 2: Spatio-temporal variations of electrical conductivity (C) and dissolved oxygen (D).

The suspended matters show considerable fluctuations on the whole water column (Figure.3.E), recording the high values at the bottom. As they show a tendency towards the increase from one month to another during the study period. However, the evolution of the transparency of the studied waters (Figure.3.F) is inversely proportional to that of the suspended matters contents. The same observation was made by El Haouati *et al.* (2013) [19].

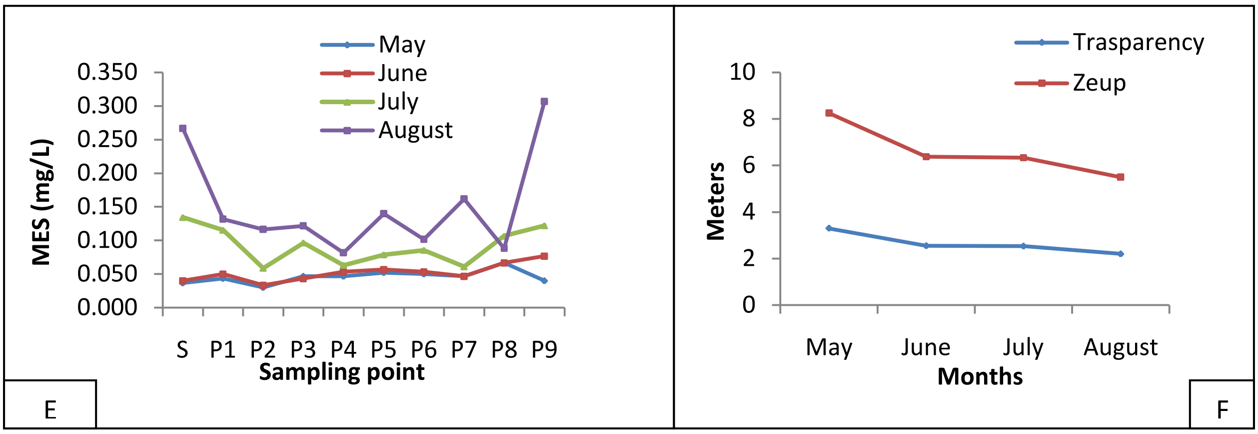

Figure 3: Spatio-temporal variations of suspended matter (E) and transparency (F).

Nitrate contents show higher values (3.75 mg / L) in May at the bottom (P9), and lesser values (0.42 mg / L) in August at the surface (S). Generally, the spatio-temporal evolution of nitrate shows an irregular and progressive decrease according to the months of sampling (Figure. 4).
Concentrations of orthophosphate in the water column are extremely varied (Figure.5.G). They show very low values, ranged from 0.02 mg / L to 0.12 mg/ L, with an increasing gradient from surface to bottom.
The total phosphorus also shows low values but higher than those of orthophosphates (Figure.5.H). It follows the same vertical gradient (increasing surface-bottom gradient). This gradient could be explained by a process of release, this comlex process depends on several physical, chemical and biological mechanisms [20, 21].

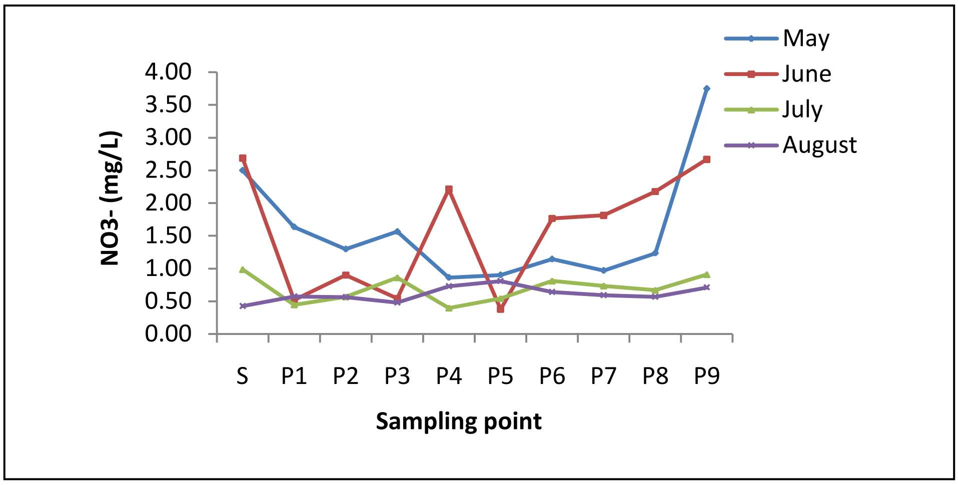

Figure 4: Spatio-temporal variations of nitrates.

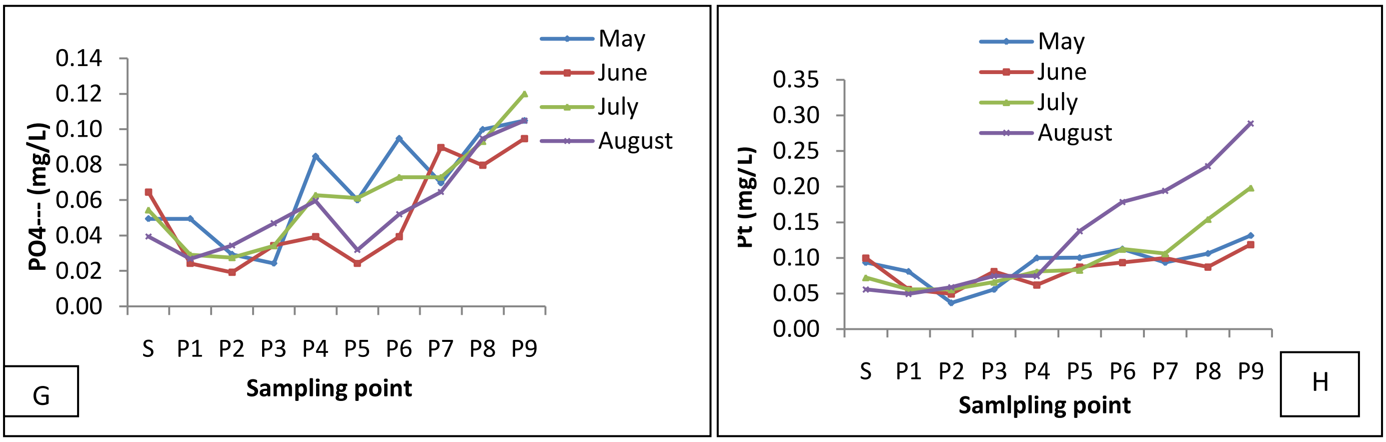

Figure 5: Spatio-temporal variations of orthophosphate (G) and total P (H).

3.2. Chlorophyll a

Chlorophyll *a* is an indicator of the overall algal biomass, not discriminating between the different groups of algae. It responds to the nutritive load and evolves in the cell as a function of the environment.

The spatio-temporal evolution of chlorophyll *a* levels throughout the water column shows (Figure. 6):

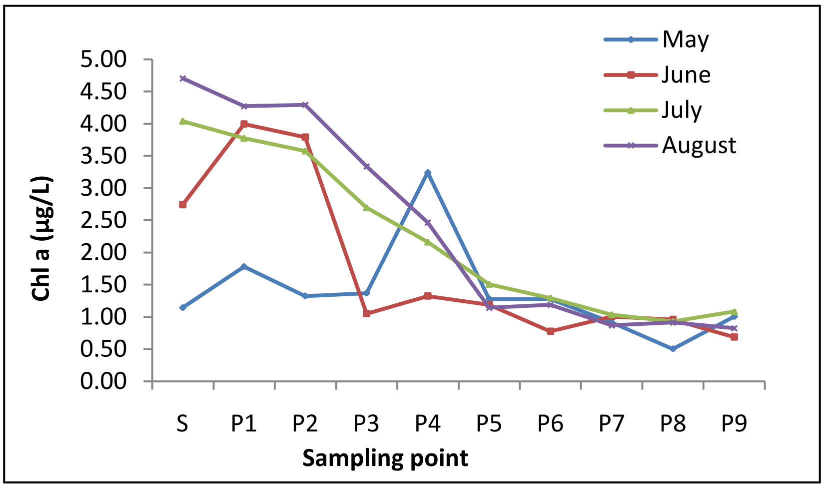

Figure 6: Spatio-temporal variations of chlorophyll *a*.

- A remarkable increase in chlorophyll *a* concentrations since the beginning of the companions of the samples and the month of August which records the most important values in surface water.
- A decreasing gradient that is sharp from the surface to the bottom.

Indeed, this evolution could be explained by the increase of the temperature and the good oxygenation of the superficial waters. Indeed, Skulberg *et al.* (1984) [22], and Carmichael (1990) [23] showed that good water oxygenation favors cyanobacterial proliferation, consequently the growth of these microalgae provides an additional source of this element through their Photosynthetic activity. Moreover, the high values of chlorophyll *a* are recorded during periods of low nutrient levels and especially total phosphorus. Previous work by Abdellaoui *et al.* (1998) [24] reported a relationship between phosphorus concentrations and phytoplankton biomass.

Taking account all the parameters studied, and referring to the Moroccan simplified national grid for assessing the quality of water in lakes and reservoirs [25], the quality of the waters of the whole water column are good to excellent, compared with the water quality of other dams cited in the literature that have polluted waters [26, 27].

Conclusion

The Bab Louta dam is part of the Sebou drainage basin, whose main vocation is the supply of drinking water to the city of Taza. The results of the physicochemical analyzes, conducted in this study, showed the installation of a thermal stratification in the waters of this dam, a good oxygenation of the superficial waters, the reservoir never reached an anoxic stage during the period of study, the alkaline pH and low contents of nutrients and chlorophyll *a*.

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