Physicochemical Approach to Ouiouane Lake (Mid-Atlas Morocco)

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Abstract: The Moroccan Middle Atlas is one of the best-watered areas of the entire kingdom. This feature makes Khénifra region one of the areas with a significant number of wetlands. Among these areas is Ouiouane Lake, which comprises one of the most important lake ecosystems; also it is a tourist site and sport fishing spot par excellence.

The purpose behind this study is to analyse the quality of the lake's types of water by a physicochemical approach while following the spatial and temporal evolution of the water quality during a period spread over 12 months (from January to December 2015) . Sampling was done monthly at the deepest point of the lake at different depths.

During this study, Ouiouane Lake showed water's problems since the transparency of water is less than 2 m for a maximum depth of about 14 m. This water is poorly oxygenated, alkaline with a pH> 7. Its electrical conductivity varies between 611 and 778 µs / cm.

The examination of the vertical temperature profiles shows that Ouiouane Lake has stratification according to the period of time. The concentrations of the organic pollution indicators (nitrogen and phosphorus compounds), allow to conclude that Ouiouane lake presents a polluted area of water which requires an intervention of emergency so as to preserve this natural inheritance.

Keywords: Ouiouane; Lake; Quality; Physicochemical; nitrogen; phosphorus compounds

1 INTRODUCTION

Morocco - the North African country - is best equipped in continental water. The great spatial variability of climatic and geological conditions accentuates this richness by creating varied types of aquatic ecosystems. From lakes, rivers, (fountainhead) springs and limestone mountains to Saharan Merjas and Sebkhas[2], and socio-economic mainly in the field of ecotourism.

Ouiouane Lake is part of the most important wetlands in the Moroccan Mid-Atlas. It is considered to be one of the tourist flagships of the Middle Atlas. It is located in the rural municipality of EL Hamamm 68 km from Khénifra. It is 1630 m above sea level and covers an area of 40 hahnium. It is a lake of artificial origin fed by nearby sources. This lake is rich in fish such as pike, perch, carp and roach. It is surrounded by vegetation composed of holm oaks, poplars and black locusts, etc.

Ouiouane Lake is shallow (14 meters), yet the richness of its fauna and flora (aquatic and underwater) makes it a very attractive site [1]. Despite its importance, this wetland is not immune to major ecological threats due to uncontrolled water exploitation. The objective of this study is to determine Ouiouane's water quality by physico-chemical approach in order to

acquire a database on the functioning of this ecosystem.

2 MATERIAL AND METHODS

2.1 Sampling stations

The choice of sampling points was made so as to have more precise information on the lake sector (Figure 1). Moreover, it was important to be able to carry out the follow-up campaign that was carried out in a boat in one day. Thus, 5 sampling points have been defined at the centre of the lake where water stays more in 5 levels of depths 0m, 2m, 5m, 10 and 14m.

Figure 1: Geographical location of Ouiouane Lake

2.1 Sampling and measurement of physicochemical parameters

Type of sampling

Sampling is carried out during the previous twelve studies (January, 2014), It is an instantaneous sampling which is done directly with polythene bottles prepared in advance and washed with water from each station before use .

Some physicochemical parameters of water were measured on the spot by portable devices (Table 1), which are:

- Dissolved oxygen is measured by an Orion oximeter, model 330.1
- The hydrogen potential (pH) is measured thanks to an Orion pH meter model 260.
- The temperature is measured thanks to a thermometer.
- The electrical conductivity is measured by an Orion type 130 conductivity meter.

Water samples are taken back to the laboratory for analysis of nitrogen and phosphorus compounds: ortho phosphate, total phosphorus, nitrite, nitrate, ammonium, total nitrogen.

Analyzes are performed by approved methods (RODIER, 1996)

TABLE1: MEASURED PHYSICO-CHEMICAL PARAMETERS AND METHODS USED FOR THEIR ANALYSES

Parameter	Measurement Methods
pH	pH-meter
Temperature	Thermometer
Conductivity	Conductometer
Dissolvedoxygen	Oximeter
Transparency	Secchi's record
Nitrite	537 nm colorimetricassay
Nitrate	415 nm colorimetricassay
Ammonium	Colorimetricassayat 630 nm
Total nitrogen	415 nm colorimetricassay
Orthophosphate	Colorimetricdeterminationat 800 nm
Total phosphorus	Colorimetricdeterminationat

800 nm

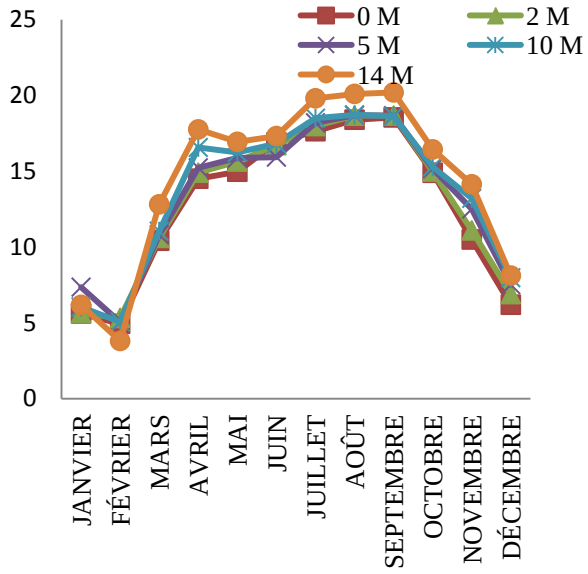

Figure 2: Spatio-temporal variation in temperature in Ouiouane Lake

3 Results and Discussion

3.1 Temporal evolution of the temperature

Water temperature is a critical ecological factor, affecting many other parameters as well as chemical and biochemical reactions; also, the development and growth of living organisms in water, especially microorganisms. In the study area and for the depth of 14 meters, the lowest values mark winter period with a minimum of 3.81 ° C, recorded during February 2015, while the maximum is 20.1 ° C was recorded during August 2015 (Figure 2). These temperatures are favourable for the development of cyprinids. The statistical treatments of the results show that time has a highly significant effect on the temperature ($F = 313.56$, $ddl = 11$, $P \leq 0.001$). On the other hand, no difference was recorded at the depth level ($F = 0.43$, $ddl = 4$, $P \geq 0.05$).

3.2 Temporal evolution of pH

In each natural environment, water has its own pH value depending on the subsoil of its watershed. The pH is greater than seven in limestone regions where water is highly mineralized and less than seven in primary subsoil or acidic peatland waters. It decreases in the presence of high levels of organic matter and increases during the period of low water, when evaporation is important [6]. The hydrogen potential (pH) of the lake's water is slightly alkaline. The average values are between 7.1 and 8.27. The minimum values are recorded during the month of March, when climatic conditions are not favorable for photosynthesis. However, the maximum values are recorded during August following the intense use of carbon dioxide through aquatic plants by the phenomenon of photosynthesis (Figure 3). The pH variance analysis shows a highly significant distinction between the various depths studied ($F = 36.39$, $ddl = 4$, $P \leq 0.001$) and a significant difference between months ($F = 1.007$, $ddl = 11$; $P \leq 0.05$).

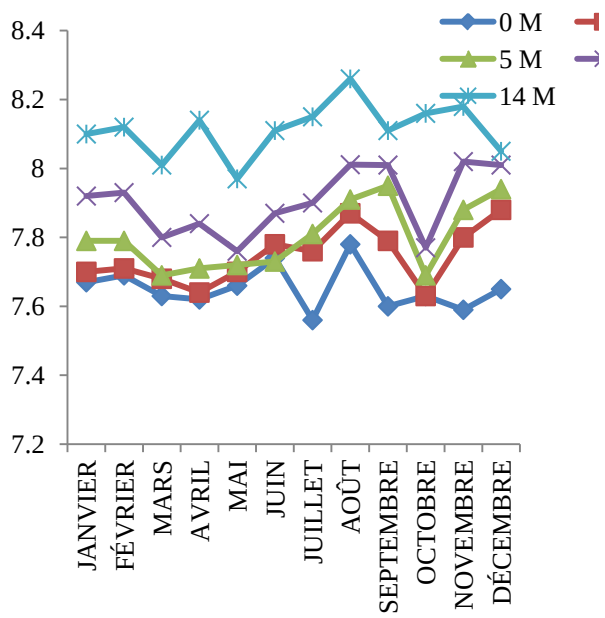

Figure 3: Spatio-temporal variation of pH in Ouiouane Lake

are recorded during the wet period (Figure 4). This could be due mainly to the decrease in water's temperature, since cold water contains more dissolved oxygen than hot water [9]. The statistical analysis of the results obtained for oxygen below shows a highly significant variance between the different months (F = 38.509, ddl = 11, P≤ 0.001). Nevertheless, no difference was recorded between the different depths (F = 2.33, ddl = 4, P> 0.05).

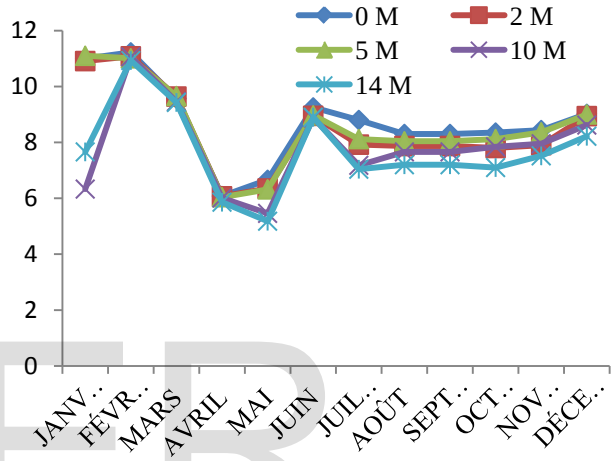

Figure 4: Spatiotemporal variation of dissolved O2 in Ouiouane Lake

3.3 Temporal evolution of dissolved oxygen

Oxygen is a key factor and an excellent indicator of water quality. Its value informs us about the degree of pollution and consequently on the degree of self-purification of a watercourse. The solubility of oxygen in water is related to several factors, in particular: temperature, atmospheric pressure and salinity. Dissolved oxygen is also a function of the origin of water; surface water may contain relatively large amounts close to saturation. Deep water often contains only a few milligrams per liter [5]. A water content of 4 to 6 mg of O2 per liter characterizes water that is of good quality. The seasonal evolution of dissolved oxygen shows us that the highest concentrations

3.4 Temporal evolution of electrical conductivity

Most of the dissolved materials in water are in the form of electrically charged ions. As a matter of fact, the electrical conductivity makes it possible to evaluate the overall mineralization and to estimate the totality of the soluble salts in water, It is also a function of the temperature of water. It is more important when the temperature increases (Figure 5). These results show that time has a significant effect on the conductivity. (F = 0.01, ddl = 11, P≤ 0.001). On the other hand, the depth has no effect (F = 1.17, ddl = 4, P> 0.05).

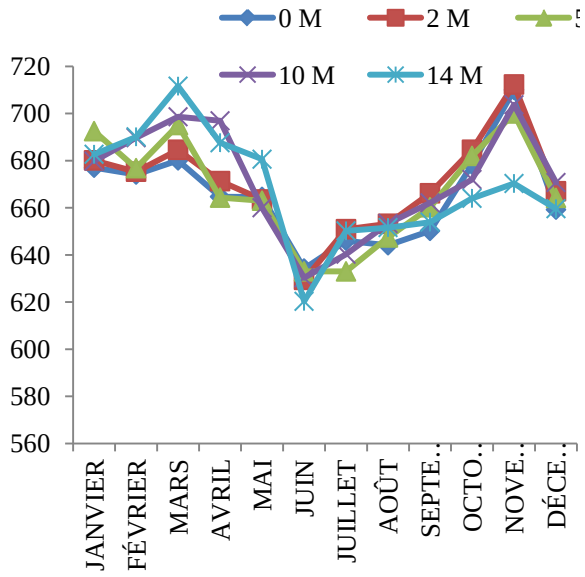

Figure 5: Spatiotemporal variation of electrical conductivity in Ouiouane Lake

3.5 Temporal evolution of ammonium ions

On the lake surface ammonium concentrations range from 0.002 mg.l-1 to a maximum value of 0.0575 mg.l-1. Ammonium concentrations show a peak in March and then a drop due to the dilution effect with the contribution of rainwater. From November, the installation of the dry season favors by concentration effect the beginning of the increase in concentrations. The highest concentrations are observed at 14m and 5m depths (Figure 6). The statistical treatment of the results for the ammonium content revealed a highly significant effect for the time factor (F = 32.48, ddl = 11, P≤0.001). However, the depth shows no difference (F = 0.78, ddl = 4, P≥0.05).

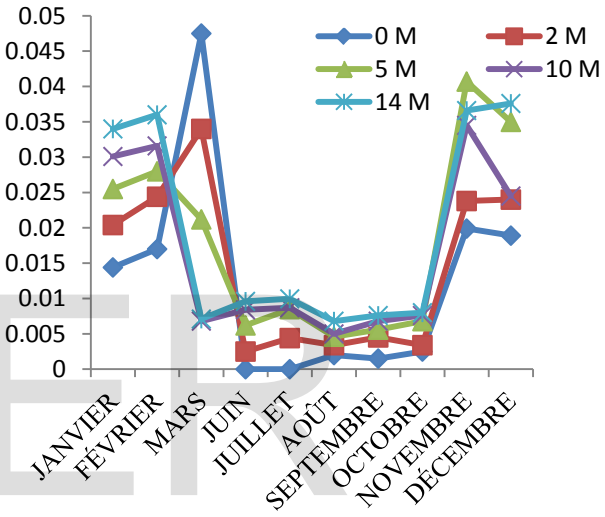

Figure 6: Spatio-temporal variation of the ammonium in Ouiouane Lake

3.6 Spatiotemporal evolution of nitrate

The concentrations of N-NO3- are higher than the concentrations of N-NH4 +, which demonstrates the nitrification of ammoniacal nitrogen. The highest concentrations of nitrates are observed in April, for which very high concentrations of ammoniacal nitrogen were not observed despite the high eutrophication of this zone (Figure 7). The results obtained for the nitrate content show that there are highly significant differences for the time factor (F =

169.69, ddl = 11, P ≤ 0.001). The depth factor has no effect (F = 0.33, ddl = 4, P≥0.05).

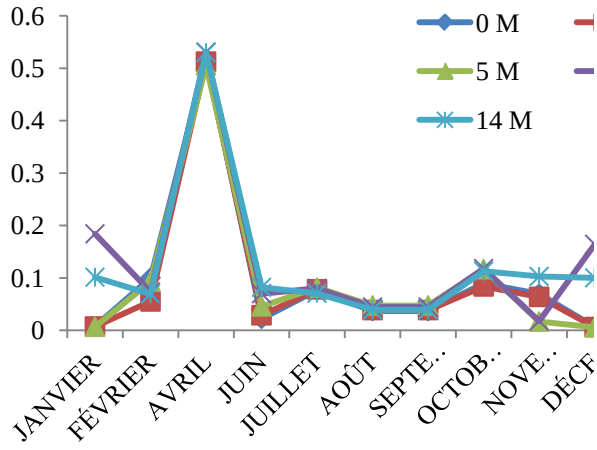

Figure 7: Spatio-temporal variation of nitrate in Ouiouane Lake

3.7 Spatiotemporal evolution of total nitrogen

The spatiotemporal evolution of total nitrogen concentrations is relatively comparable to that described for nitrates. This probably reflects the predominance of nitrates in total nitrogen; the maximum values were measured in May in spring, while the lowest values were recorded in December (Figure 8). The effect of depth on total nitrogen content is insignificant (F = 1.84, ddl = 4, P> 0.05) ,where as highly significant differences were recorded between the different months (F = 9.94, ddl = 11, P≤0.001).

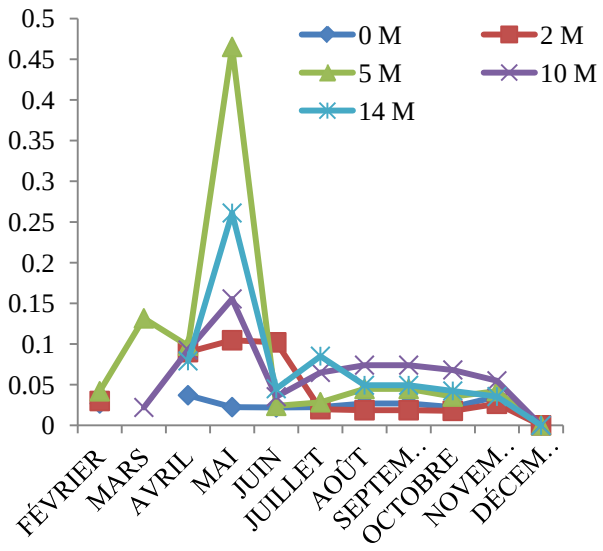

Figure 8: Spatiotemporal variation of total nitrogen in Ouiouane Lake

3.8 Spatiotemporal evolution of total phosphorus

It is an important parameter of the fertilization of the water-bodies; it plays a vital role in the planktonic growth. This nutrient is a relevant indicator of the trophic level of water. Total phosphorus concentrations are non-existent at 14 m in January and reach 141 µg.l-1 at 5 m in June of the same year (Figure 9).

Variance analysis for total phosphorus content revealed a highly significant effect for the time factor (F = 3.74, ddl = 11, P≤0.001). On the other hand, the depth factor does not record any difference (F = 0.89, ddl = 4, P> 0.05).

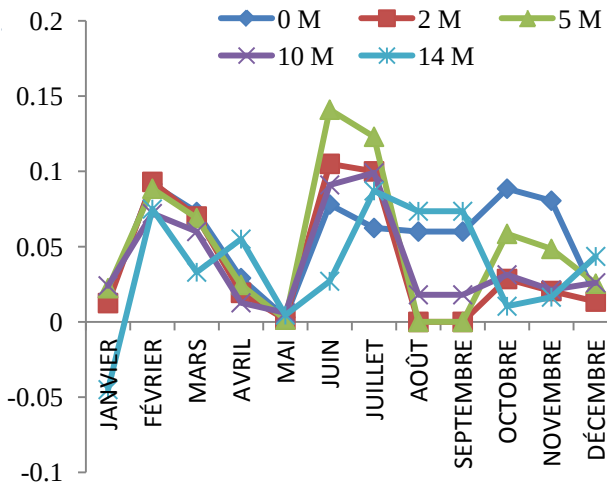

Figure 9: Spatio-temporal variation of total phosphorus in Ouiouane Lake

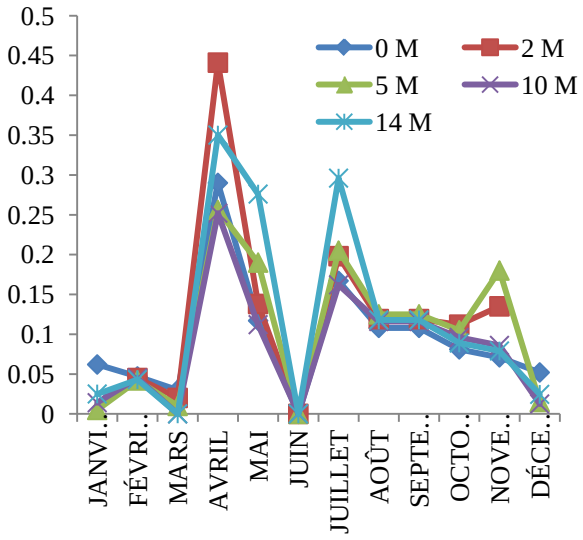

Figure 10: Spatio-temporal variation of orthophosphate in Ouiouane Lake

3.9 Spatio-temporal variation of orthophosphates

It is recognized that of all forms of phosphorus into all types of water, the ortohophosphate ion is the only useful form that can be utilised for algal metabolism. In fact, this element has very low levels, sometimes below the thresholds of sensitivity of the assay, ranging from 0µgr.-1 recorded various times, to a maximum value reached in April. High levels of orthophosphates recorded near the bottom (from January to April), these levels then decrease and homogenize until July. These low levels are mainly due to the direct and quick assimilation of this element by the phytoplankton and bacteria [10] and / or its calcium complexation in the form of apatite (Figure 10). The statistical treatment of the results obtained allowed us to reveal highly significant distinctions between the various months studied ($F = 3.94$, $ddl = 11$, $P \leq 0.001$). Depth showed no effect ($F = 0.85$, $dof = 4$, $P > 0.05$) on the orthophosphorus content.

CONCLUSION:

Water quality is a fundamental component that conditions life and development of any living organism. The assessment of the quality of surface water is based on the measurement of physico-chemical parameters as well as on the presence or absence of aquatic organisms and microorganisms, indicators of a more or less good quality of water. Dissolved oxygen concentrations comprise together with temperature values and the Hydrogen (pH) potential, one of the most important water quality parameters for aquatic life. For the types of water of Ouiouane lake, the results obtained show that these parameters are influenced by ambient factors (temperature and sunshine), as well as photosynthetic and respiratory activity of fish [8].

Ouiouane's types of water present a calcic and magnesian carbonated hydro-chemical facies at

all the study stations. This reflects the geological nature of the Moroccan Middle Atlas [11].

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