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Physico-Chemical and Trophic Characterization Of « Dayet Aoua » (Lake –Middle Atlas –Morocco).

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ABSTRACT

The study was done at the Dayet Aoua lake located in the province of Ifrane middle atlas Morocco, during the study period spread over 12 months between March and February 2015, at the deepest point of the lake. The study consists on the physico-chemical characterization of the water quality of the LAKE. The results of 2 times monthly analysis obtained during the period of study , show that water of the lakes is transparent (maximum transparency of 5,3m), well oxygenated until the bottom with an average content oxygen of 9,1 mg/l, the temperatures varies from 7,1°C to 25,6°C according to seasons, and pH remain alkaline with an average of 9,61. The nitrogen and phosphorus analysis of the lake give very low values, and do not detect any kind of pollution of the organic type being able to generate its eutrophication. According to the analysis, chlorophyll "a" (4, 79 µg.L-1), total phosphorus 0,011mg.L-1and transparency 4, 35 m, the current classification of the lake is mesotrophic lakes.

Keywords: Lake, physico-chemical parameters, chlorophyll a, mesotrophic.

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INTRODUCTION

The Moroccan middle atlas contains large natural reserves, forestry and hydrogeological diversified with a wet climate and sub humid favouring the development of lakes, ponds and streams. The lakes are very sensitive and respond quickly to changes in the conditions of environmental and climate change [1].

However its waters of surfaces was more and more exposed to pollution which required a referred to characterize the environment of lakes and to reconstruct changes that have suffered these natural ecosystems [2].

Currently, wetlands are at the heart of any environmental news, they represent a challenge for the management of the quality and quantity of the water, for the preservation of the heritage landscape and cultural, see same History [3].

The lake DayetAoua which is the subject of our study is part of the most important wetlands of the Middle Atlas of Morocco [4]. Despite its importance this area meeting of threat as a result of anthropogenic activity on the one hand since the latter is accessible and on the other hand to the indiscriminate use of groundwater in the field of agriculture.

To study this lake ecosystem it must first put the item on the quality of these waters it is for this reason we are interested in studying the physico-chemical quality of the lake including the whole of the parameters influence on the biological activity of living beings that inhabit this last and therefore, the performance biological.

The physicochemical data of the lake water DayetAoua and therefore, its current quality, will allow us to confirm the character lake trophic to know is what the balance reigns is in the middle.

MATERIALS AND METHODS

Site

The Lake DayetAoua is located in the eastern part of the Middle Atlas. Its coordinates are 32°58'N and 05°27'W (Topographic Map Ifrane) at 49km of the city of Fez, 7 km from the city of Imouzzer of Kandar, 18km of Ifrane, 36 km of Azrou and 75 km from Meknes. Its morphometric characteristics are presented in Table 1[5].

Table 1: Morphometric characters of the lake of Dayet Aoua of Middle atlas Morocco

Altitude(m)	S (ha)	L (m)	l (m)	P (m)	Pmax (m)	Pmoy (m)
1460	140	1255	362	3400	5,3	0,22

S : superficie ; L : longueur ; l : largeur ; P : périmètre ; Pmax : profondeur maximale ; Pmoy : profondeur moyenne

The lake can be classified as river type since it presents a main entrance (Oued El Kantra) and an output at the level of the dam (Fig.1). During these past two decades, the lake has experienced three periods of drying: in 1995, 2002 and 2006 [6].

Uptake

The uptake are carried out two times per month and between March 2015 and February 2016, his last have been carried out at the deepest point of the lake (≈ 5 m), because in limnology, the deepest point of the lake is used, in a standard way, place of sampling the physicochemical parameters of the water and the results sampled are more representative of the whole of the lake depths of 0, 1, 2, and 4 m. Has the assistance of a bottle closing parenthesis of type Van Dorn horizontal, samples have been made to the entrance and the exit of the lake in order to justify the mobilization of nutrients .

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Physicochemical parameters measured in situ are the transparency of the water (Secchi disk), temperature, conductivity, pH and dissolved oxygen (thermometer, pH-meter, conductivity meter and oximeter). The title Complete alcalimétrique, ammonium ions, nitrate, nitrite, ortho-phosphate, total nitrogen and total phosphorus are determined following the standard methods described in Rodier[7]. The determination of the levels of chlorophyll a is made after extraction by the acetone and spectrophotometry reading by the method described by the work SCOR-UNESCO [8].

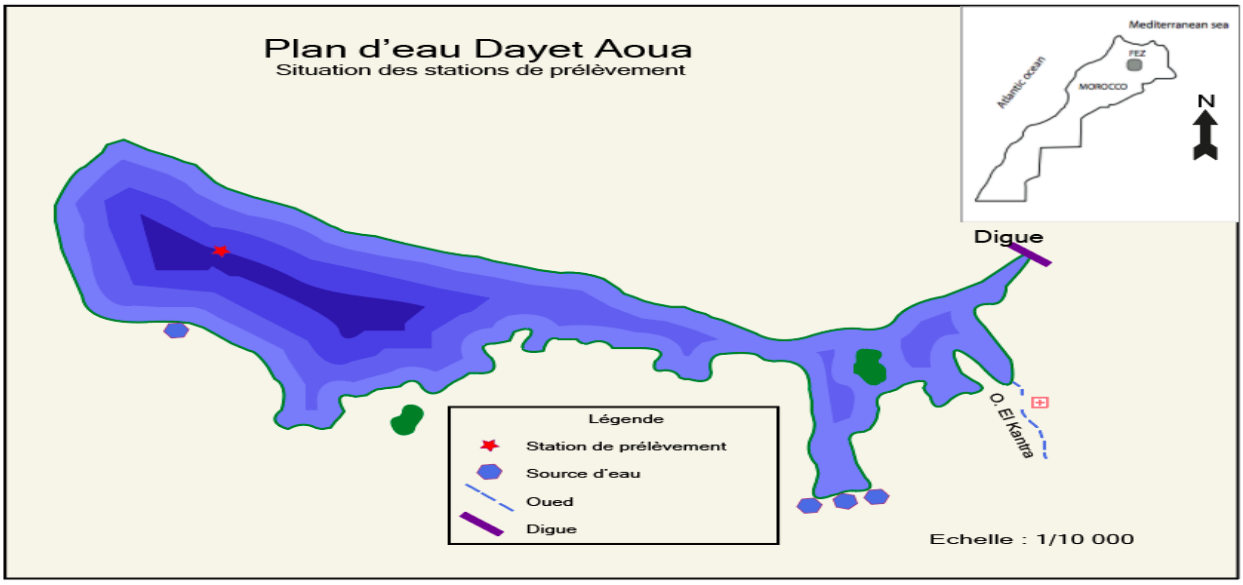

Figure 1: Site and point of the uptake.

RESULTS AND DISCUSSION

Transparency

The maximum depth is 5, 3 m presents the clear waters in the whole period of the study(Fig.2). In effect the transparency varies from 3.1 to 5.2 m the lowest values are recorded in the autumn period by against the maximum values are recorded in the summer period.

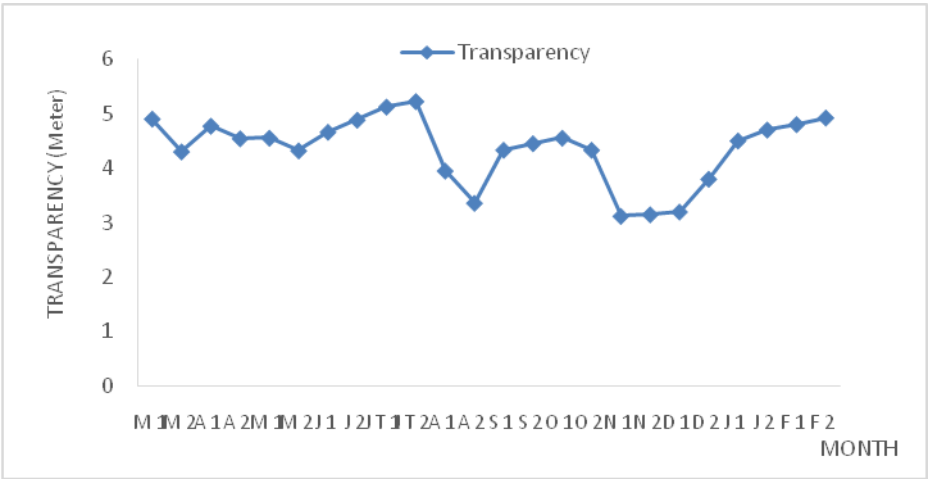

Figure 2: Variation of transparency at Dayet Aoua lake as a function of time

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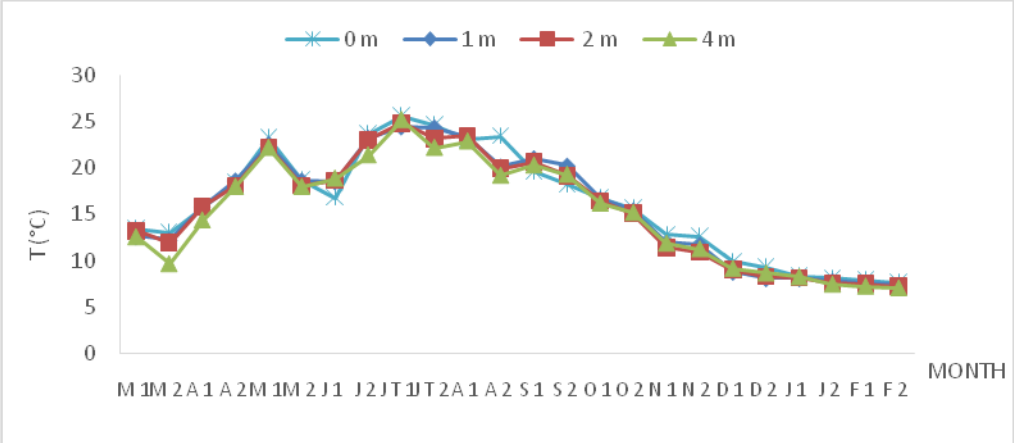

Figure 3: Temperature variation in Dayet Aoua lake at depths 0m, 1m, 2m and 4m as a function of time

Temperature:

The temperatures ranged from 7.1°C during the month of February to the depth 4m to 25.6°C in the month of July near the surface (Fig.3). This shows that there is a large amplitude variation between the cold season and the hot season. The review of vertical profiles shows no remarkable variation of the temperature values between the surface and the bottom, this makes this lake a non-stratified homothermal medium.

Hydrogen potential

The pH of the water remains alkaline varies between 7.77 and 11.45 (Fig.4).These levels are considerably higher than those reported, on the same medium, [6].but are of the same order of magnitude as those recorded by [9].This may be explained on the one hand by the nature-carbonate Calcium and magnesium from the parent rock and the effect of the wind which standardizes the middle with the absence of vertical profiles of the other part.

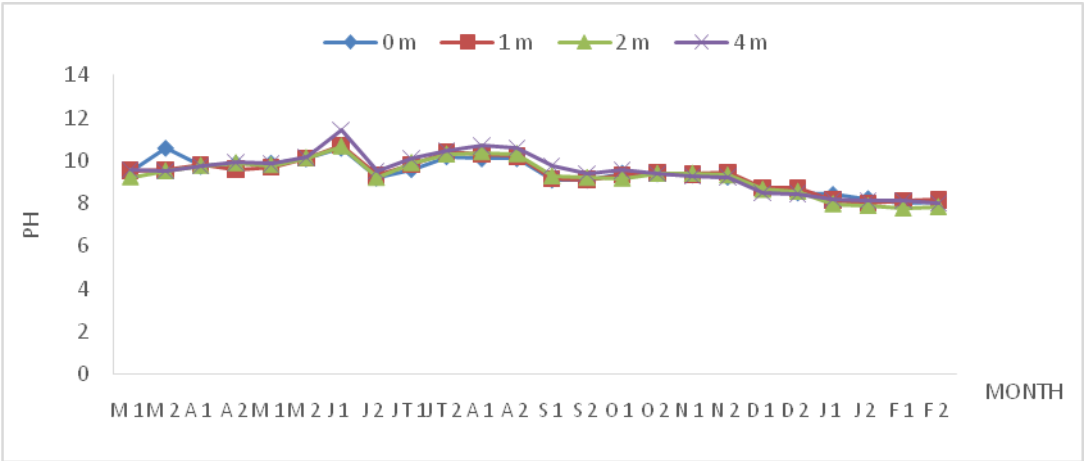

Figure 4: Hydrogen potential variation in Dayet Aoua lake at depths 0m, 1m, 2m and 4m as a function of time

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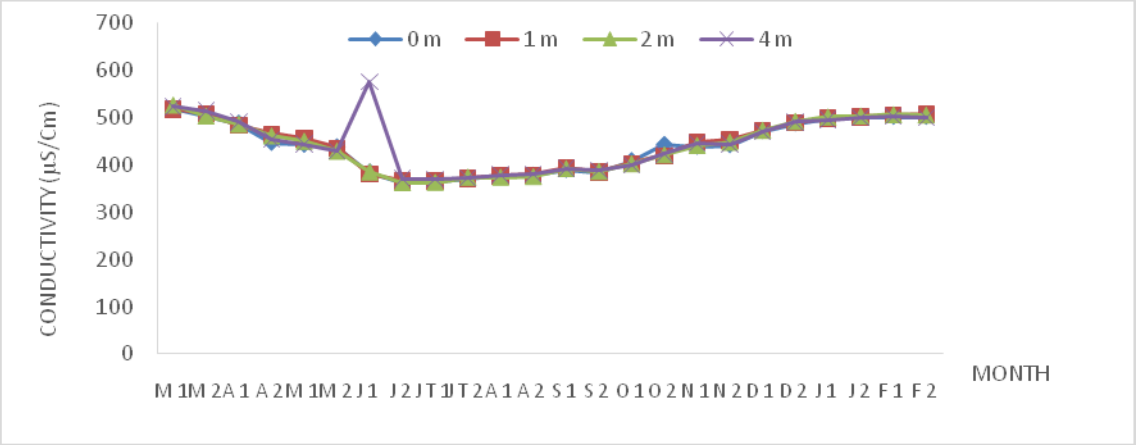

Figure 5: Conductivity variation in Dayet Aoua lakeat depths 0m, 1m, 2m and 4m as a function of time

Conductivity

Electrical conductivity recorded during the period of study has ranged from 362 to 520 µs.cm^{-1}(Fig.5), this parameter is influenced, in our case, by the variations of the flow rate of the water of the main tributary (Oued El Kantra) in which we have always recorded values significantly higher (M = 700 µs.cm^{-1}) to those measured at the middle of the lake [6].

Dissolved Oxygen

Dissolved oxygen is a very important element by the fact that it affects the status of several mineral salts, the degradation of the organic matter and the life of aquatic animals [10]. For the whole of the levies, dissolved oxygen present significant variations from one point to another and participates in the majority of chemical and biological processes in the aquatic environment [11]. During the period of the study, the results obtained show that the lake is slightly oxygenated. In general, the low values of the Dissolved Oxygen promote the development of pathogenic germs [12].

During the study period dissolved oxygen varies from 4.12 mg.L^{-1}to 14.1 mg.L^{-1}(Figure 6), the results obtained show that the lake is well oxygenated.

The low values were obtained during the autumn period, as well as the recorded peaks coincide with those of the chlorophyllian pigments, which testify to the importance of the algal biomasses and their photosynthetic activities.

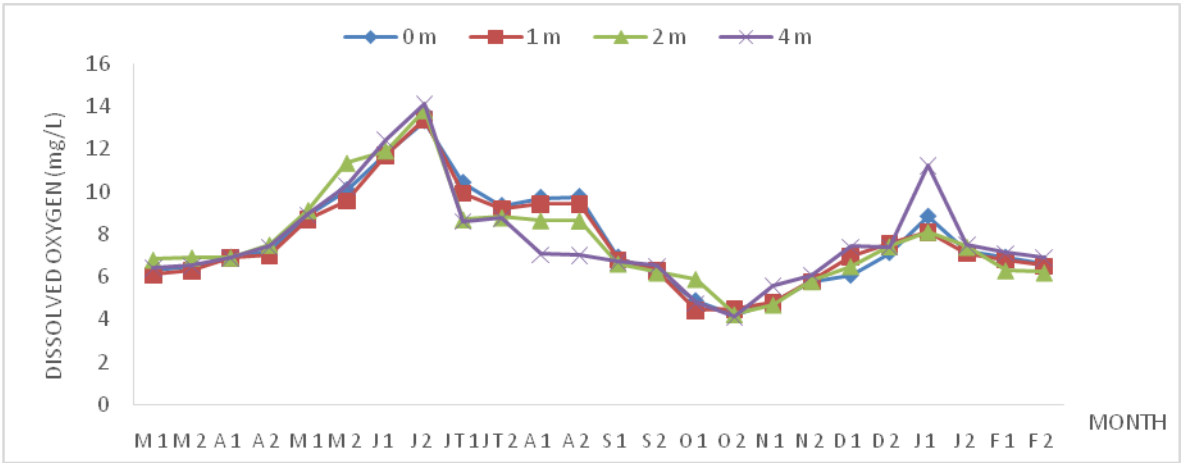

Figure 6: Dissolved Oxygen variation in Dayet Aoua lakeat depths 0m, 1m, 2m and 4m as a functionof time

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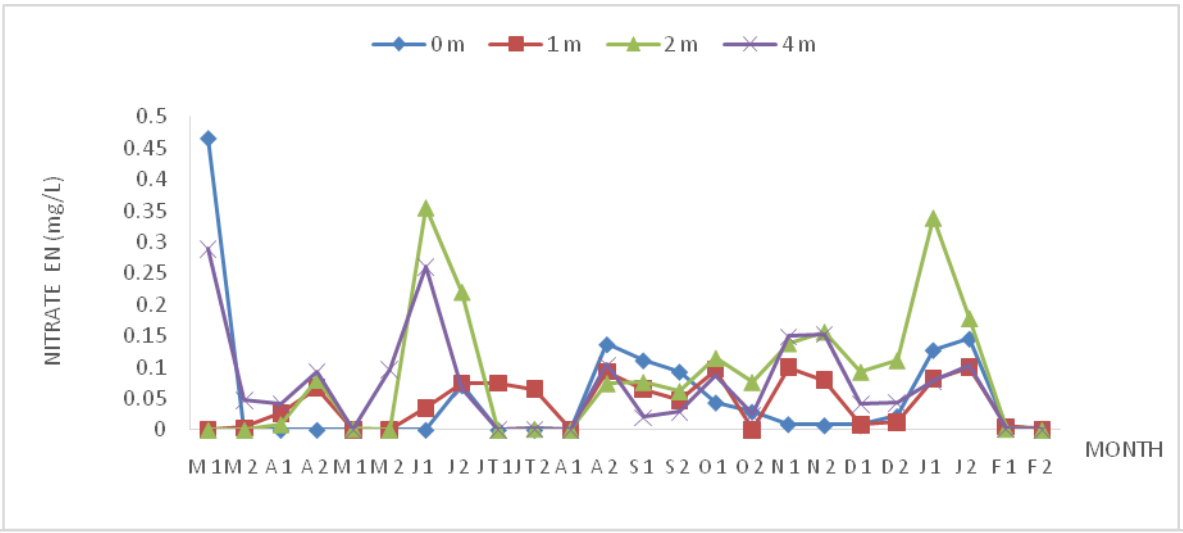

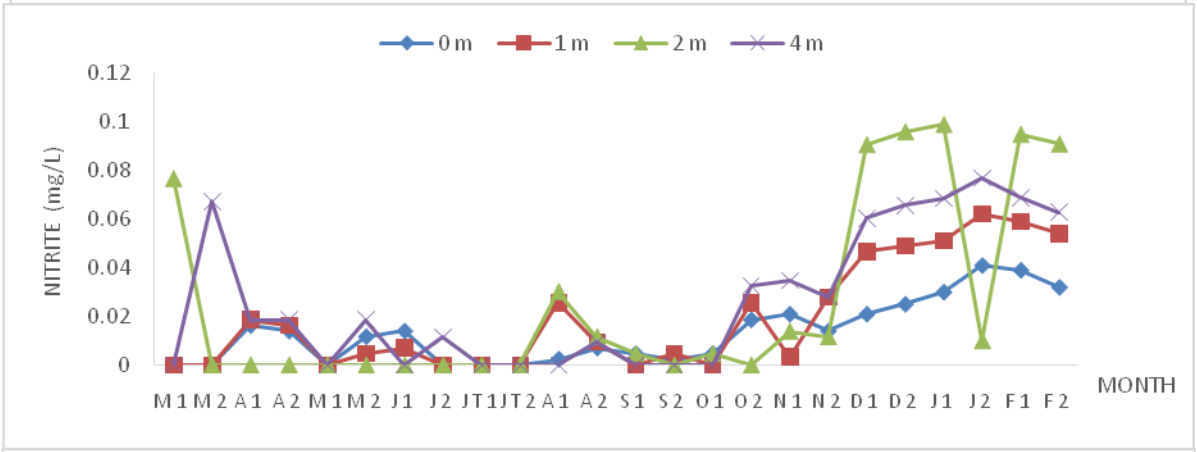

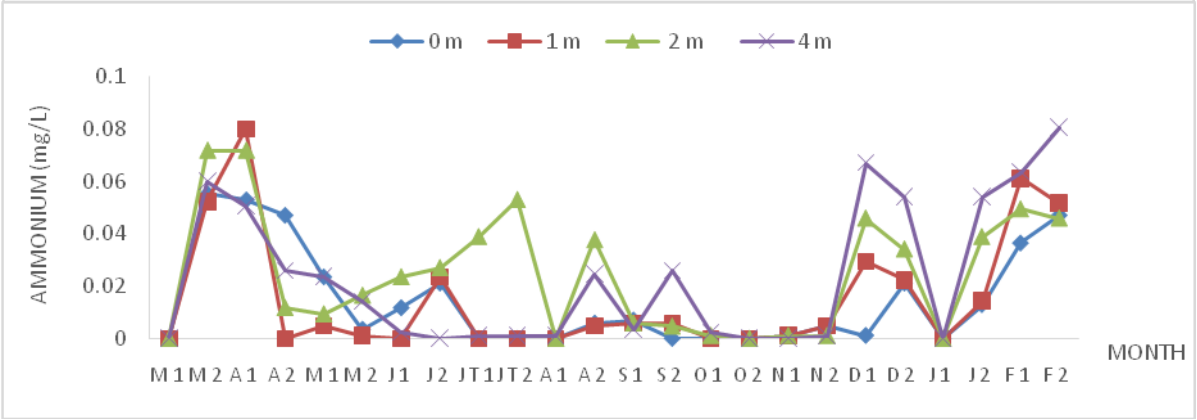

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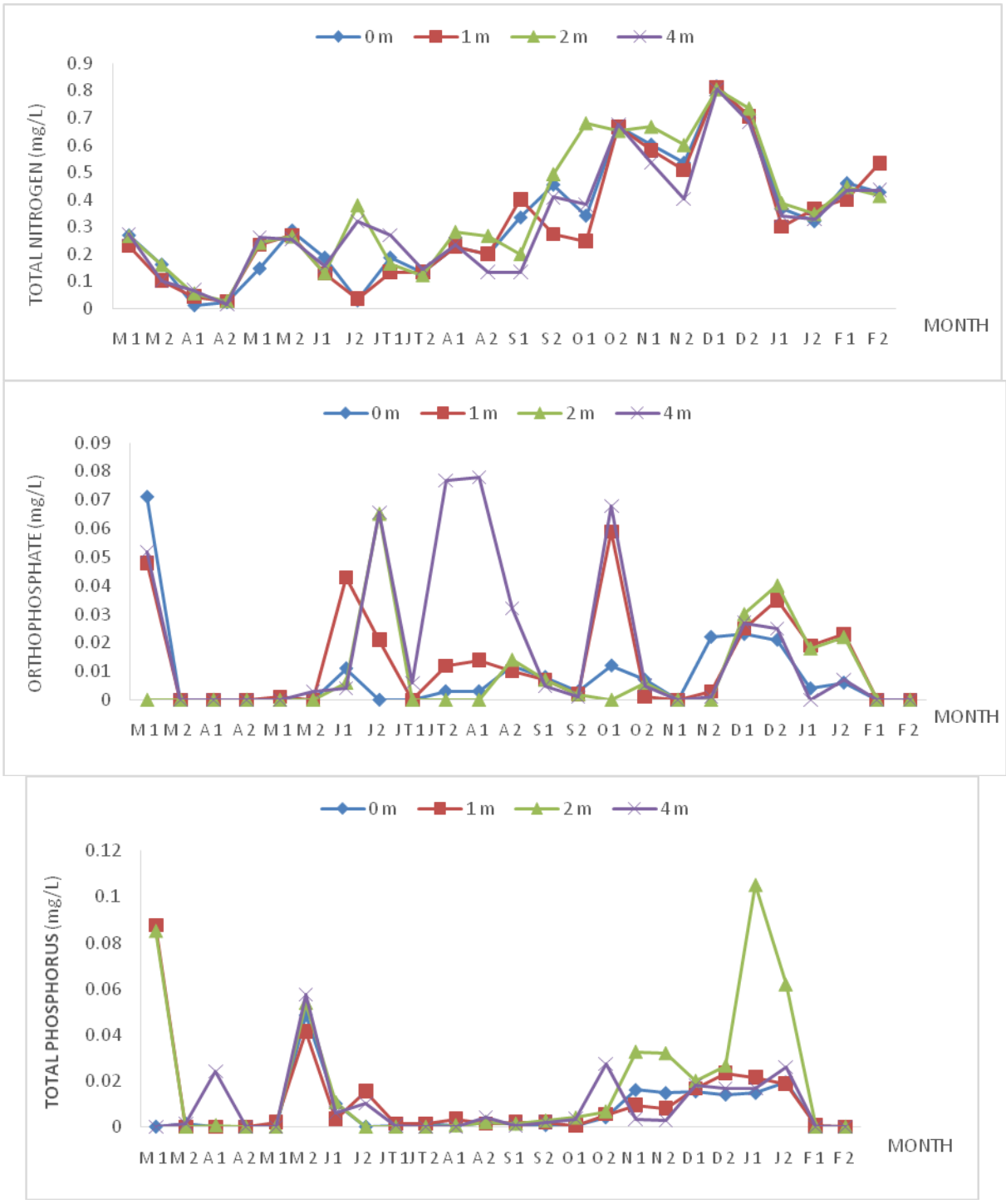

Figure 7 : Nitrogen and phosphorus elements variationin Dayet Aoua lake at depths 0m, 1m, 2m and 4m as a functionof time : (a) nitrites, (b) nitrate, (c) ammonium, (d) total nitrogen, (e) orthophosphate, (f) total phosphorus

Nitrogenous elements and phosphorus

Nitrate levels in the course of the cycle of study varies between 0 $mg.L^{-1}$and 0,46$mg.L^{-1}$ (Fig. 7a). The maximum value has been registered during the month of March near the surface [13].There has been a slight elevation of the concentrations of nitrates in the course of the winter season may be explained by the external inputs mainly due to precipitation and the decomposition of the organic matter. In effect the peaks of the

dissolved oxygen levels coincides with those of chlorophyll pigments, this attest to the importance of the algal biomass and their photosynthetic activities.

Nitrites is an unstable form which is rapidly transformed into nitrate from the blow it is present to values well less than the nitrates during the cycle of study. The maximum value recorded is 0.009 mg/L during the month of January (Fig. 7b). The low concentrations of the nitrous nitrogen at the level of all stations during the course of the cycle of study reflect the proper functioning of the cycle of nitrogen, of the fact that this form is oxidized in the presence of oxygen by the aerobic bacteria to give the nitrate form [13].

The ammonium in the water usually reflects a process of degradation incomplete of organic matter. The levels of ammoniacal nitrogen in function of the depth varies between 0 $mg.L^{-1}$and 0.08 $mg.L^{-1}$(Fig. 7c). The maximum value has been recorded during the month of February by against the decline has been recorded in the month of October is this is due to the late precipitation on the one hand and on the other hand is explained by the significant assimilation of ammonium by the phytoplankton and the bacteria.

For the total nitrogen the recorded values are low between 0.012 $mg.L^{-1}$and 0.81 $mg.L^{-1}$(Fig. 7d). This shows as the reported ABBA et al. [9] And FAZUL et al [6] that there is no trace of organic pollution in the environment.

The concentrations of orthophosphate obtained at the level of different depths show variations during the whole cycle of study between 0 $mg.L^{-1}$and 0.07 $mg.L^{-1}$ (Fig. 7e). The maximum value is recorded in the month of March near the surface and this is due to the exogenous inputs due to the laundry.

For total phosphorus the values found remain to state of trace with a maximum value of 0.08 $mg.L^{-1}$(Fig. 7f). This is generally due to the strong decomposition of the organic matter that coincides with the reduction of the volume of the water in particular during the summer period.

Chlorophyll a

Seasonal variations reveal that in spring period, the values are relatively high, the maximum concentration of 8.68 $\mu g.L^{-1}$ is registered in the month of April (Fig.8).

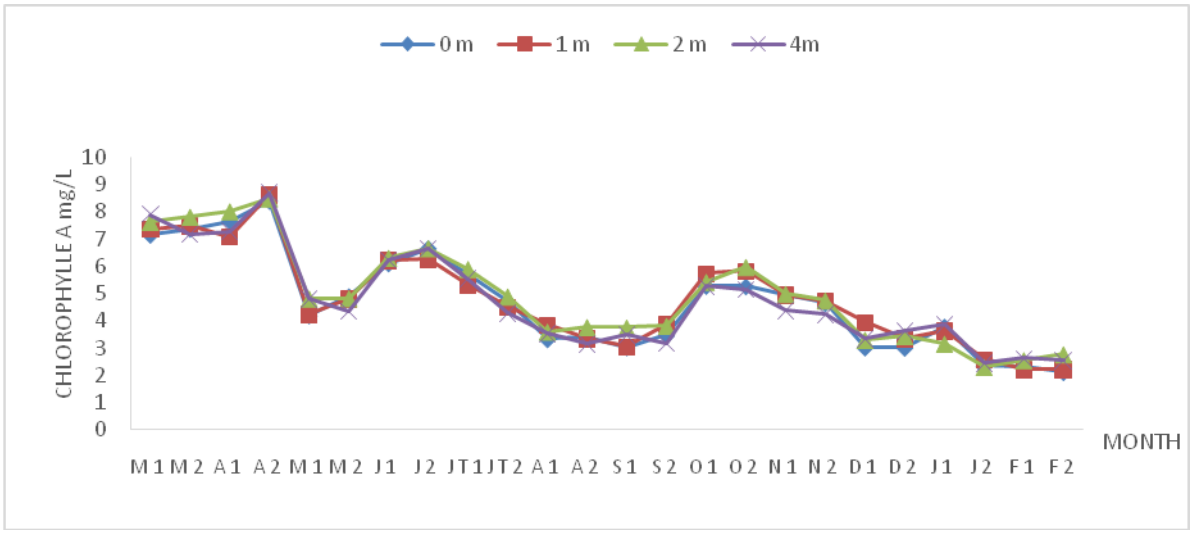

Figure 8: chlorophylle a variation in Dayet Aoua lake at depths 0m, 1m, 2m and 4m as a functionof time

In summer and winter periods there has been a decline in the levels of chlorophyll a the minimum concentration is recorded in the month of February 2.1 $\mu g.L^{-1}$ in depth 4m.

In the fall season is particularly the month of October there was a slight elevation of the chlorophyll content has the maximum value recorded is 5.7 $\mu g.L^{-1}$, due to the development of several species on the one hand and the late precipitation on the other hand which has fostered the phytoplankton activity.

Statistical analysis

The data obtained were analyzed statistically (ANOVA and PCA) to find the variability existing between the different depths studied. The data was processed using SPSS 19 software. A comparison test of averages was done whenever there was a significant factor effect studied by the ANOVA.

Analysis of variance ANOVA

The Table (2) represents the results of the test analysis of variance bivariate fixed model applied to each of the 11 variables measured during the campaign studied in March 2015 to February 2016 at the level of the site DayetAoua. The analysis of variance ANOVA bivariate has for purpose to determine the existence between the different settings following the month or rather the seasons in the period studied.

Table 2: Analysis of variance

Paramètres	Profondeurs			Saisons		
	F	P value summary	Significant	F	P value summary	Significant
Temperature	0,81	0,97 ns	*No*	*99,78*	*0****	*Yes*
pH	1,72	0,915 ns	No	139,14	0***	*Yes*
Conductivity	1,26	0,945 ns	No	73,11	0***	*Yes*
Dissolved oxygen	0,10	0,999 ns	No	40,05	0***	*Yes*
TAC	0,23	0,995 ns	No	6,19	0,001***	*Yes*
Total nitrogen	0,26	0,853 ns	No	43,25	0***	*Yes*
Nitrate	1,32	0,273 ns	No	1,32	0,710 ns	No
Nitrite	1,33	0,269 ns	No	1,33	0***	*Yes*
Ammonium	1,19	0,317 ns	No	1,19	0***	*Yes*
Orthophosphate	1,95	0,220 ns	No	1,95	0***	*Yes*
Total phosphorus	3,42	0,199 ns	No	3,42	0***	*Yes*
Transparency	0	1 ns	No	5,18	0***	*Yes*
Chlorophylle a	0,009	0,960 ns	No	43,83	0***	*Yes*

p > a = 0,05 : (ns) differences not significant ; p < a = 0,05 : (*) just significant differences ; p < a = 0,01 : (**) highly significant differences; p < a = 0,001 : (***) very significant différences ; F: valeur F de Fisher

The table represents variables that are significant for seasons and non-significant for depths. The time factor influences all parameters except nitrite and this is explained by the climate in the region and the flora and fauna that play a key role in the characterization of the lake environment according to the seasons. While the depths do not influence the parameters, that means, there is not a remarkable difference between the depths, therefore the absence of the thermocline at the level of the column, water and the homogeneity that prevails the environment.

PRINCIPAL COMPONENT ANALYSIS (PCA)

The analysis in main component allows to analyze the digital data Quantitative to reduce the dimensionality to the main factors of interactions between variable and graphically represent the interrelationships.

In order to determine Generally the correlations that exist between the different parameters abiotic following this study and in order to give a synthesis, this analysis has been carried out on the whole of the variables (11 environmental parameters) using the SPSS software.

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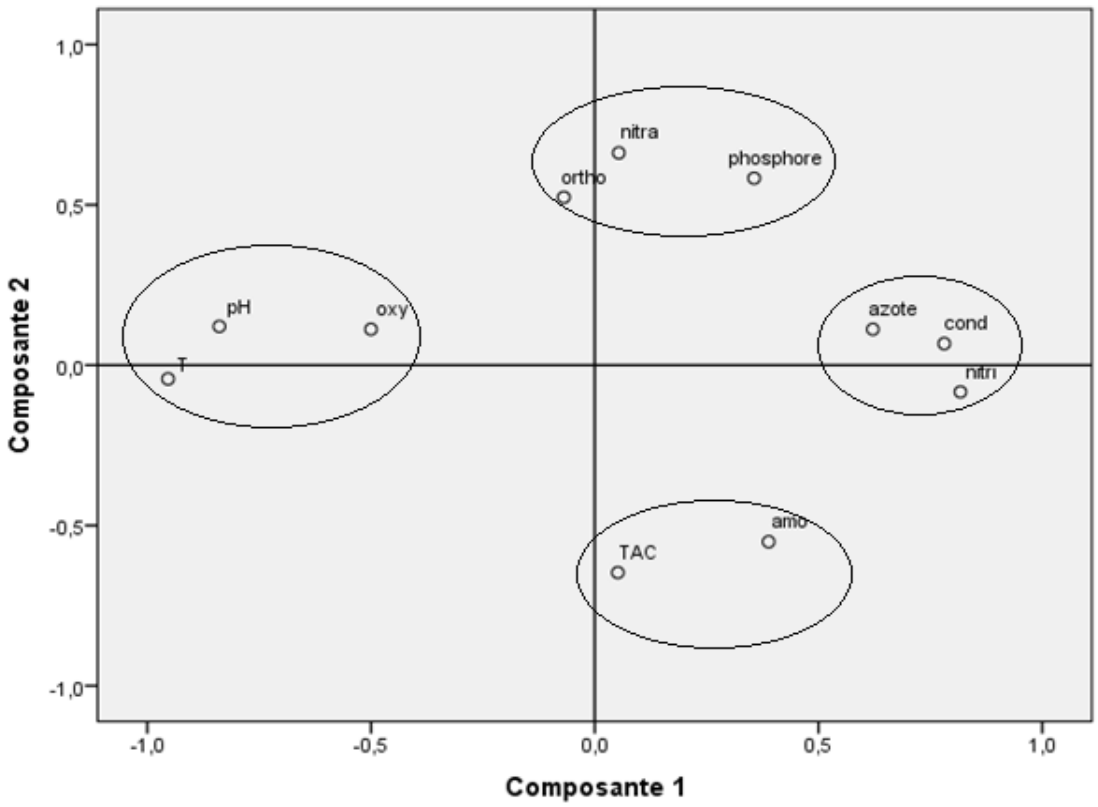

Figure 9: Distribution des paramètres physicochimiques sur le plan factoriel de l'ACP (C1 x C2), T° = temperature, Cond. = conductivity, O2 = dissolved oxygen, pH =potential hydrogen, NH4 = ammonium, NO3 = nitrates, NO2 = nitrites, NT = total nitrogene, PO4 = ortho phosphates, TAC = titre alcalimétrique, PT = phosphore total

Figure 9 presents respectively the correlations between the parameters measured and pins (F1 and F2). The two axs explain 51,29% of the information contained in the data matrix. Based on the criterion of Kaiser who said that during a PCA This measure gives an overview of the overall quality of the inter correlations items. The index KMO is 0.7 (Table 3), we can judge that the correlations between the items is good represent according to the correlation matrix[14]. The test result of sphericity of Bartlet is significant ($p < 0.0005$), we can conclude that the correlations are not all equal to zero, the variables are dependent on each other.

Table: 3KMO index and Bartelet test

Mesure de précision de l'échantillonnage de Kaiser-Meyer-Olkin.		0,727
Test de sphéricité de Bartlett	Khi-deux approximé	468,914
	Ddl	55
	Signification de Bartlett	0,000

Nitrogen, conductivity and nitrite strongly contribute to the construction of the main axis 1, and individualize son this last positive rating. Temperature, pH and dissolve de-oxygen participates to the contribution of the same axis but individualizes the negative rating.

Nitrate, orthophosphate and total phosphorus contribute positively to the construction of the secondary axis and oppose negatively on the same axis with alcalimétrique and ammonium.

The grouping and the positioning of the variables in the circles of correlations allows us to distinguish four groups of variables, on the plan of the first 2 factorialaxs of the CPA to a matrix "Seasons-depths"

.Therefore the main axis that represents 34,73% of the inertials explained by factor seasons and the secondary axis that represents 16,61% of the overall inertia explained by depth factor .

CONCLUSION

The results of this work are a contribution to the spatio-temporal study of the lacustrine system in the Moroccan Middle Atlas. According to the classification standards of the state of lakestrophie, we can classify Day et Aoua as mesotrophic lake during the study period, differently from what has been announced by Abba et al. and by Fazul et al, during the sampling campaigns conducted in 2005 and 2011. This designation is confirmed not only by the physico-chemical analysis but also by the concentration of chlorophyll a. The conditions which have favored this state of trophie are the lowp recipitation recorded duringour period of levies. This situation can get worse if measures are not taken, because the process of eutrophication may increase and lead toward a not desirable trophic status

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