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CONTRIBUTION TO THE KNOWLEDGE OF THE BATHYMETRY AND THE SPATIAL DISTRIBUTION OF N, P, K OF THE MUD OF LAKE OUBEIRA (EXTREME NE ALGERIAN)

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Abstract

Lakes around the Mediterranean, and particularly those of North Africa, have degradation qualitative and quantitative, resulting from natural constraints (precipitation, runoff, siltation) and anthropogenic (withdrawals, discharges). This degradation has consequences on the structure and functioning of ecosystems. The Oubeira Lake which is the subject of this study is located in the NE of Algeria. This extremely precious environmental indicator, with an area of 21.73 km^2, may disappear because of the bulkiness of the water by the vegetation (Yellow water lily, Meriophyle, Chestnut of water…), discharges of waste water from smaller surrounding communities, the pumping of water during low water period (speculative crops) and fire in the watershed, which lead to a development of soils and increases erosion. These actions have effects on some physico-chemical properties of the water (temperature, conductivity, pH, turbidity,...) and mud (levels of nitrogen, phosphorus, potassium, calcium…). Samples of mud were made along a twenty vertical, distributed along six transects. The results covering all the stretch of water, shallow, show the mudding of the lake and a sandy texture of the mud along the east bank, a clay texture in the center and a sandy loam trend for the rest of the lake . Chemical analysis proved a significant contribution to identify high levels of nitrogen, potassium and phophorus and the accumulation in the center of the lake of these elements, which are responsible for degradation of the aquatic ecosystem, by the proliferation of aquatic vegetation. The correlations between the different parameters of the mud and water are lost and can not be determine with precision, the equations that govern the relationship between elements dissolved in mud.

Keywords: Lake, bathymétry, Oubéira, mudding, nitrogen, phosphorus.

1. INTRODUCTION

The lake Oubeira which is the object of this study is located NE of Algeria (Fig. 1). This lake has an area of 21.73 km^2, receives waste water discharges from small towns in the dry season and suffered withdrawals for irrigation. These actions have for the moment a few effects on the physicochemical characteristics of water (temperature, conductivity, dissolved oxygen…) Inputs of the dry season of the rivers are usually weak and unable to provide intense disturbances in the water mass, because of its location in the northern African zone, submitted to the Mediterranean climate, the region is characterized by very high evaporation losses.

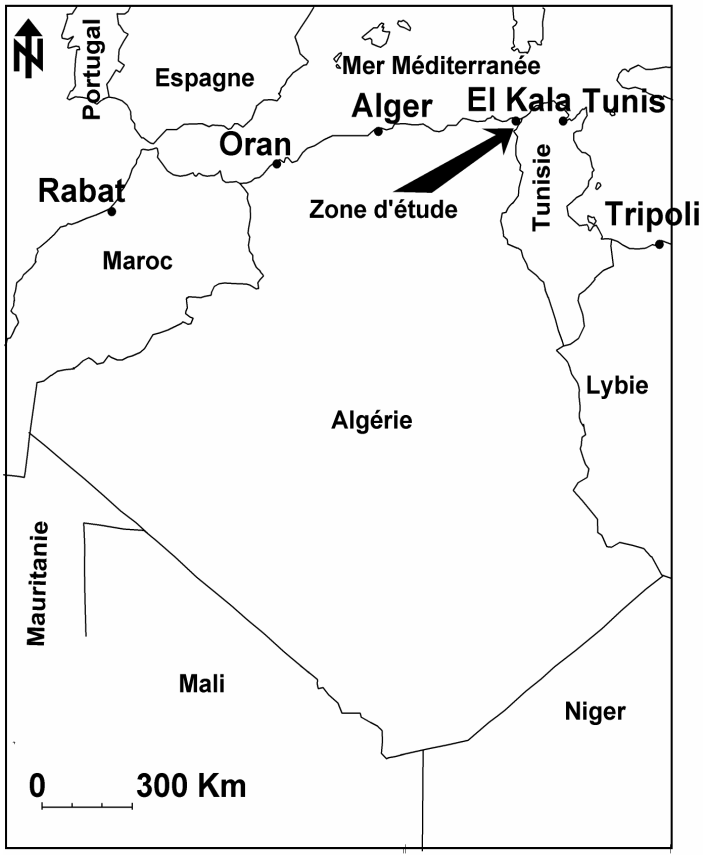

Fig. 1 : Location map of the study area

The endoreic lake of Oubeira owes its durability in a subtle balance between an evaporation of approximately 1500 mm / year and a pluvial food of approximately 850 mm rain / year (Alayat, 1991). The watershed size and the considerable contribution of groundwater in the dry season can

compensate for losses and sustain of the lake. The imbalance between contributions and evaporation at this time of year, following the taking away anthropic, the strong insolation and the high temperatures (Anonymous, 2001), the strong sunshine and high temperatures generates each year a temporary contracting of the lake (Anonymous, 2001). The water recedes about 100 to 200 m and sometimes more, especially to the NW and NE.

This lake has continued since the Quaternary and has dried up completely at the end of the summer 1990, following significant pumping for the EPA and to a sequence of dry years. Therefore, even if the water potential is sufficient and not inexhaustible, knowing that mud can guide the selection of development projects, particularly in agriculture and aquaculture and in the long term to avoid a serious destabilization of the lake. The objective of this preliminary work, which is part of the management of aquatic environments, is to determine the spatial distribution of bathymetry, siltation and major nutrients N, P and K which are causing the proliferation of plants. The samples were taken at times of high water, from 13 to 17 April 2011, using an equipped boat.

2. GENERAL CONTEXT GÉOLOGIQUE

The many geological investigations in Algeria had made for the main goal to improve knowledge and to facilitate the identification and the localization of layers (of subsoil waters, mining, oil...). According to many work's which exists (Joleaud, 1936; Kieken, 1961; Durand Delga, 1969; Raoult, 1974; Vila, 1980;...) the geology of the area is very complex because of many surfaces of overlapping and faults which had the many rejeux one and especially disturb the primarily sedimentary successions of formations during alpine phases.

The numidian (Oligocene to Burdigalian age) appears in the catchment of the Oubeira lake. It is represented by a sandstone formation that comports at its base and top, numidian clay and clays associated with supra-numidian marl (fig. 2). The Pleistocene is visible in the Est of the lake. It is composed of sand that has been mumbled from the numidian sandstone under the influence of the hydromorphy. The realized pedologic profiles at the bank have shown a saturation during the whole year (perched aquifer) and the presence of reduced gley.

The marks of oxydo-reduction in the ground are often intense because of the seasonal fluctuations of the underground water. The quaternary is generally clayey-silty formation. It is associated with conglomerates in its western extension. The visible faults are very few in the

catchment and they are sometimes associated with the hydrographic network.

3. MATÉRIEL AND METHODS

Six parallel transects were conducted at Lake Oubeira (Fig. 3), based on a tight grid. Twenty measurement points have been made to better identify bathymetry, siltation and spatial evolution of physicochemical parameters.

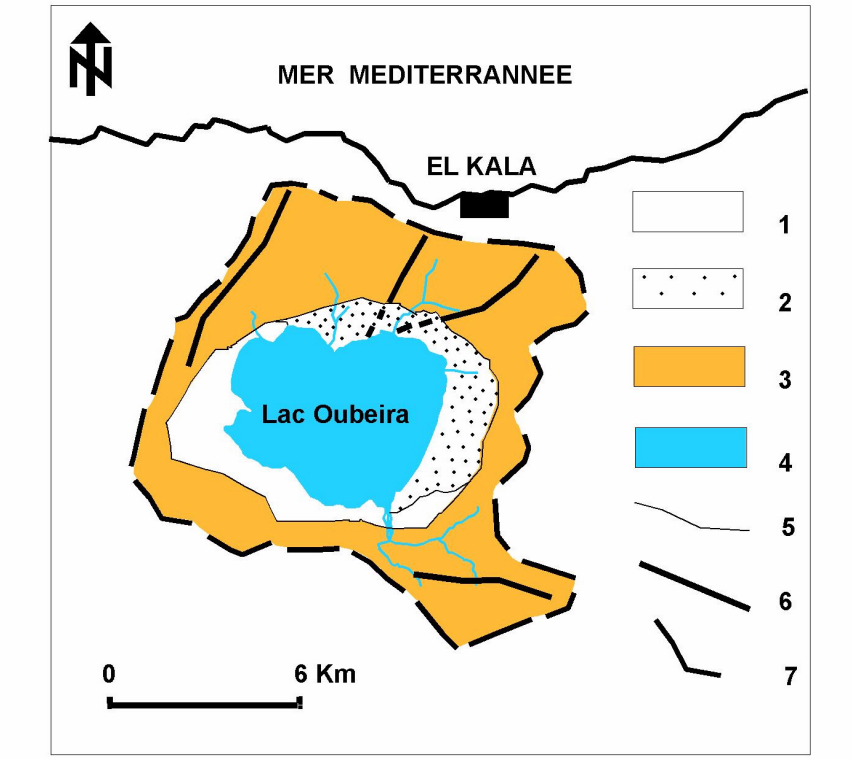

Fig. 2 : Geologic sketch map of the region (vila 1980) 1 : Quaternary ; 2 : Peistocene; 3: Undifferentiated flysch (especially sandstones; numidians and basic clays) ; 4 : Stretch of water ; 5 :Geologics contacts; 6 : Fault ; 7 : Limits of the catchment area; 7 : Limites du bassin versant

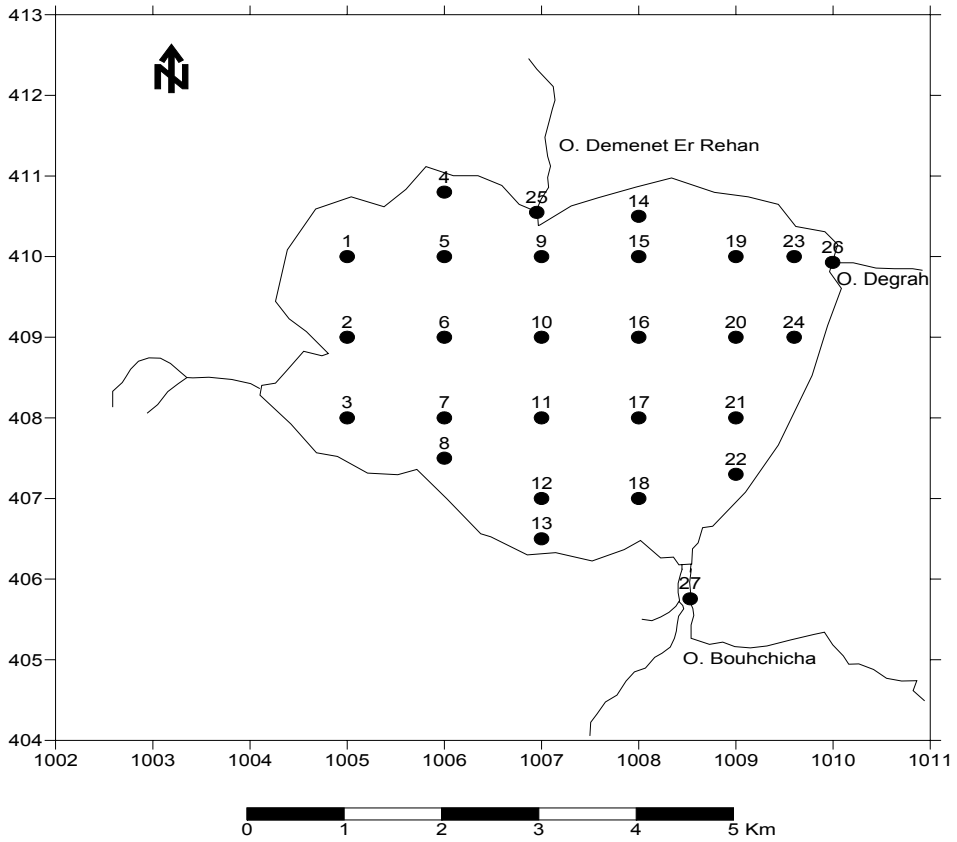

Fig. 3 : The bathymetric transects map

3.1. Measurements and sampling

The measurements are realized in-situ:

- The location of measuring stations and sampling with a Garmin GPS 72
- The height of the water layer and the thickness of the vessel with a graduated pole

The mud samples for physicochemical analyzes in the laboratory allowed the determination of the texture and the concentrations of N, P and K, after drying and grinding:

- The determination of particle size classes is done by densitometry
- The determination of total nitrogen is done with a device Foss Kjeltec 2400
- The phosphorus determination is made using a Skalar photometer.
- The potassium assay was done by flame spectrophotometer.

4. PRÉSENTATION AND DISCUSSION OF THE RÉSULTS

4.1 The bathymetry

The objective of bathymetry is to obtain a graphic representation of the lake bottom in the form of a whole of isobaths, this study makes it possible to identify topographic anomalies (Hinschberger F. and al. 2003). The geomorphology of the Lake deducted from the contours shows stability of the Fund, with an increase in the depth of the banks to the Center, and the absence of high background or bottom bottom (Fig. 4). The observed maximum depth is on the order of 2 m, in the middle of the Lake.

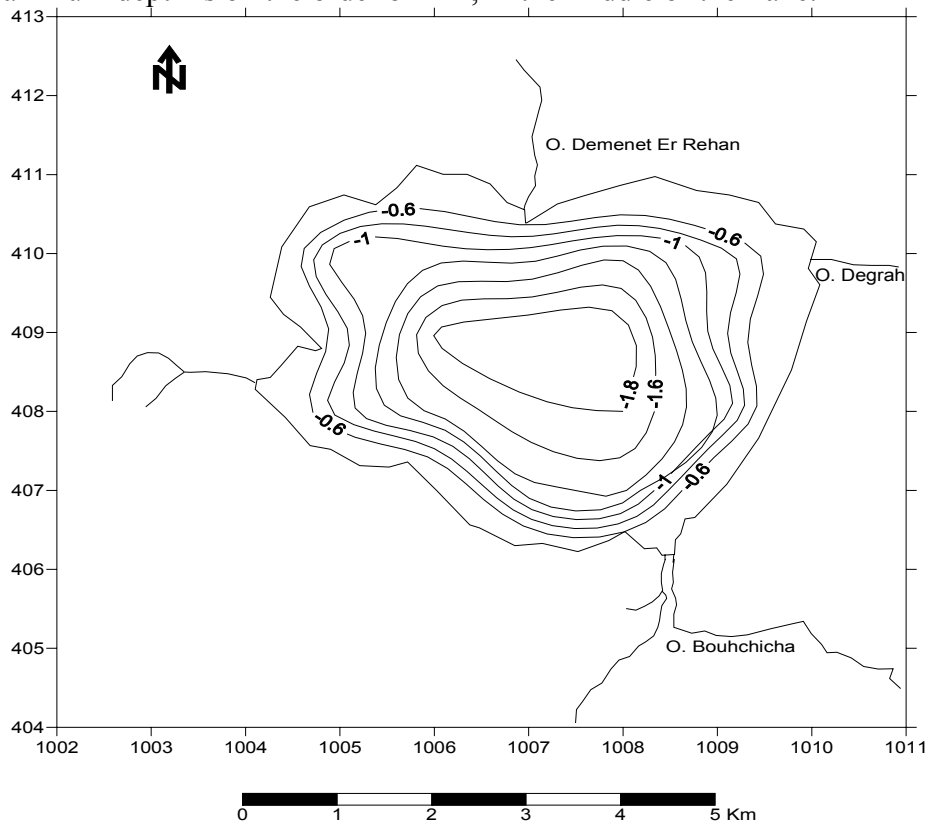

Fig. 4 : Isobathic map of the lake Oubeira

4.2 The mudding

The isopach map of the mud lake Oubeira shows that the lake bottom is covered with a thick blanket of mud, which reaches its maximum power at the center (Fig. 5). The distribution of mud matches that of the bathymetry. It reaches its maximum power at the center of the lake, more

than 2 m. This silting could eventually lead to a serious destabilization of this lake which is an extremely invaluable environmental indicator (Babault J. et al. 2005).

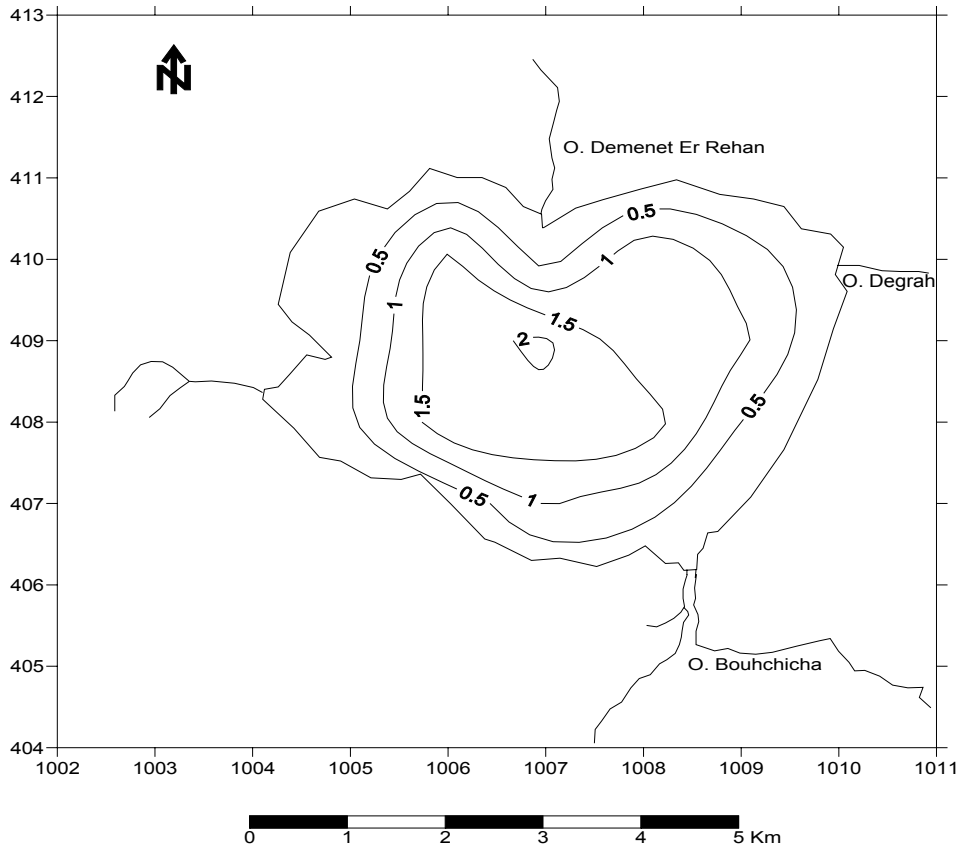

Fig. 5 : Iso-thickness vase map of the lake Oubeira

4.3 The texture

The soil texture is defined by its relative proportions in sand, silt and clay. There are many models of triangular representation, but the principle is always the same, that the triangle is equilateral or rectangle (Baize, 2000). The size of the mud Lake of Oubéira shows that the texture varies from one point to the other (fig 6). According to their texture, the vase is described as sandy, sandy-loam, loam-sandy, loam, clay and loam-clay. These results emerge a trend Sandy along the eastern shore, a clay trend towards the centre and a trend sandy-loam for the rest of the Lake

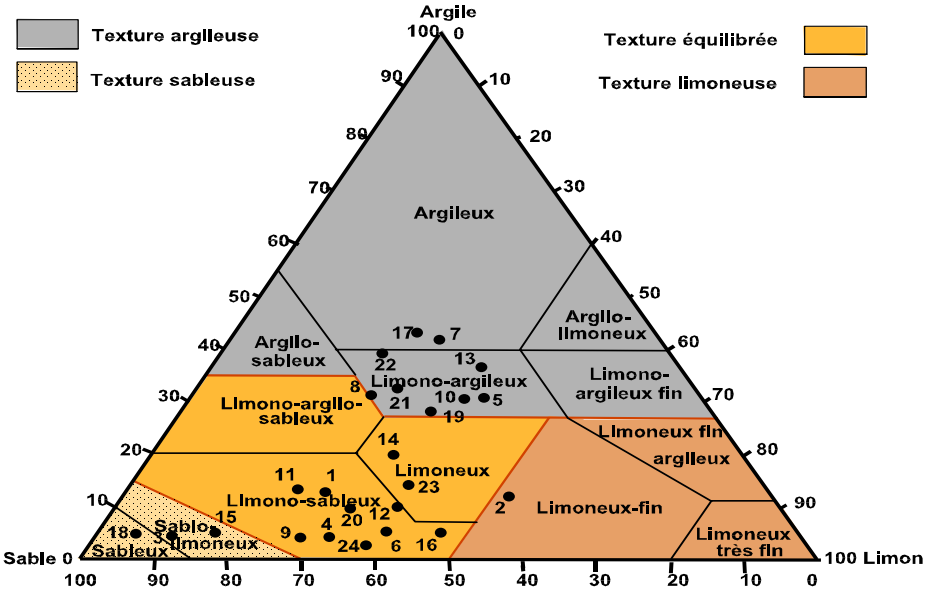

Fig. 6 : Texture de la vase du lac Oubeira

4.4 The nitrogen

Nitrogen is a nutrient for plant growth. Nitrites, nitrates are the two forms of nitrogen assimilated by plants and can also cause problems of eutrophication (Clement, Ouimet, 2004). High concentrations of this element are observed at the level of all stations of sampling, with a maximum of 0.5% to the South of the Lake (Fig. 7). According to the classification in table 1, the mud of the Lake is very rich in nitrogen. The main source of this element is the degradation of biomass, effluent and agricultural runoff.

4.4 The phosphorus

Forms of phosphorus are very different. Phosphorus is an essential nutrient to all plants and animals (Dorioz J.M. et al. 1997). In fresh water, phosphorus presents a very low concentrations, but this concentration can vary considerably depending on the size of the stream and of the characteristics of the ecosystem. Excessive amounts of phosphorus in surface freshwater contribute to eutrophication of rivers and lakes and the proliferation of cyanobacteria, altering the quality of water and restricting consumption or use for swimming and other activities (Carpenter and Coll,) 1998. The levels of assimilable phosphorus or bioavailable vary between 2 and 5 ppm (Fig. 8). According to the classification in table 2, the mud of the

Lake Oubeira is moderately rich in available phosphorus. The main source of this element is the degradation of biomass, effluents and leaching from agricultural land.

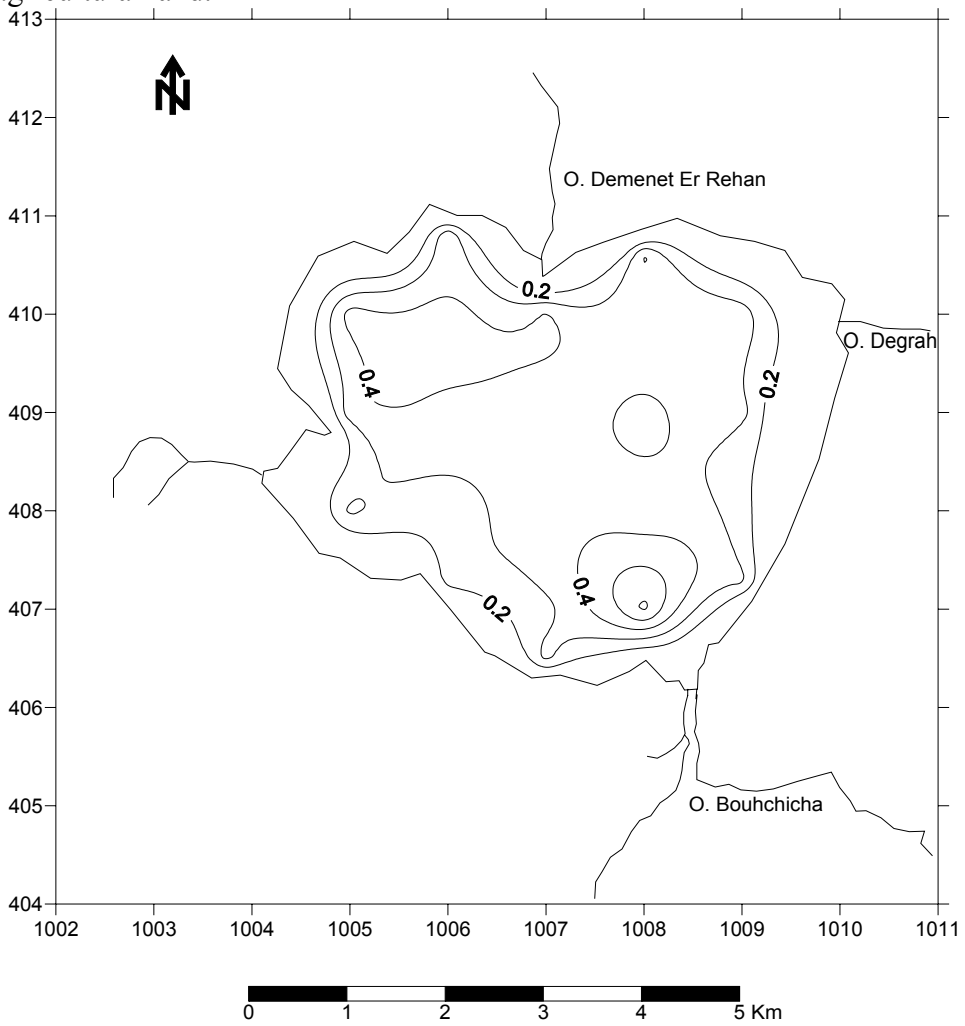

Fig. 7 : Isopleth map of the total nitrogen concentration of the mud lake

Tabl. 1: Classification of qualities of soils in relation to total nitrogen (Calvet and Villemin, 1998)

Azote total (%)	Types de sol
N < 0,05 %	sol très pauvre
0,05 < N < 0,1%	sol pauvre
0,1 < N < 0,15%	sol moyen
0,15 < N < 0,25%	sol riche

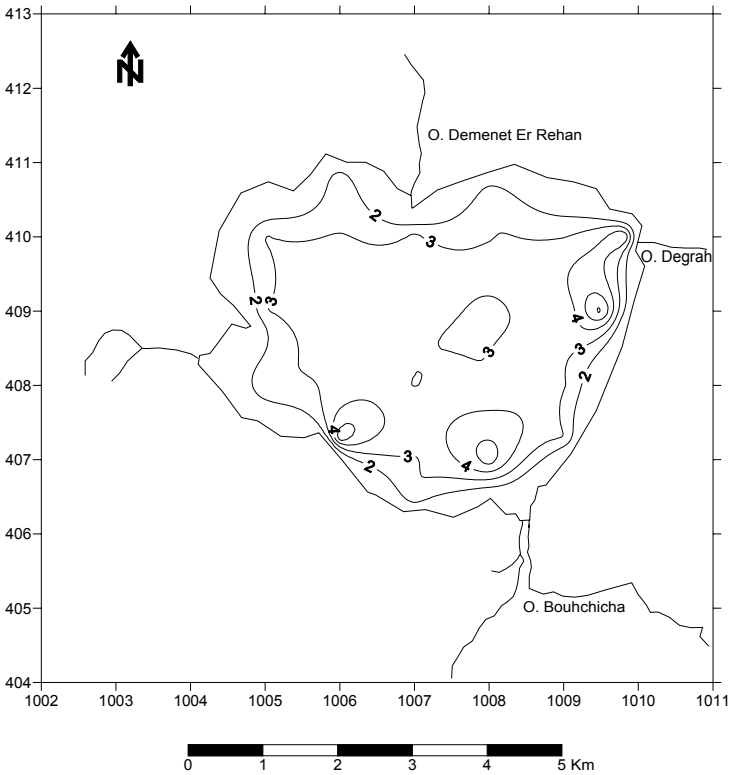

Fig. 8 : Isopleth map of the phosphorus from the mud of Lake Oubeira

Table 2: Classification of qualities of soil in relation to phosphorus (Anonymous, 1977)

Types de sol	P_2O_5 assimilable (ppm)
Sol pauvre	3
Sol moyen	3 à 8
Sol riche	8

4.5 The potassium

Potassium is absorbed by the plant in its ionic form K^+. The high concentrations of this element are observed at all stations in the Lake, particularly at the centre (Fig. 9). According to the classification in table 3, the mud of the Lake Oubeira is very rich in potassium. The main source of this element can not be explained simply by the degradation of biomass, agricultural runoff and effluent.. Moreover, the absence of evaporite on the maps of the region and the low concentrations of sodium argue in favour of a temporal and spatial monitoring of this element to determine its origin which may be related in part to the erosion.

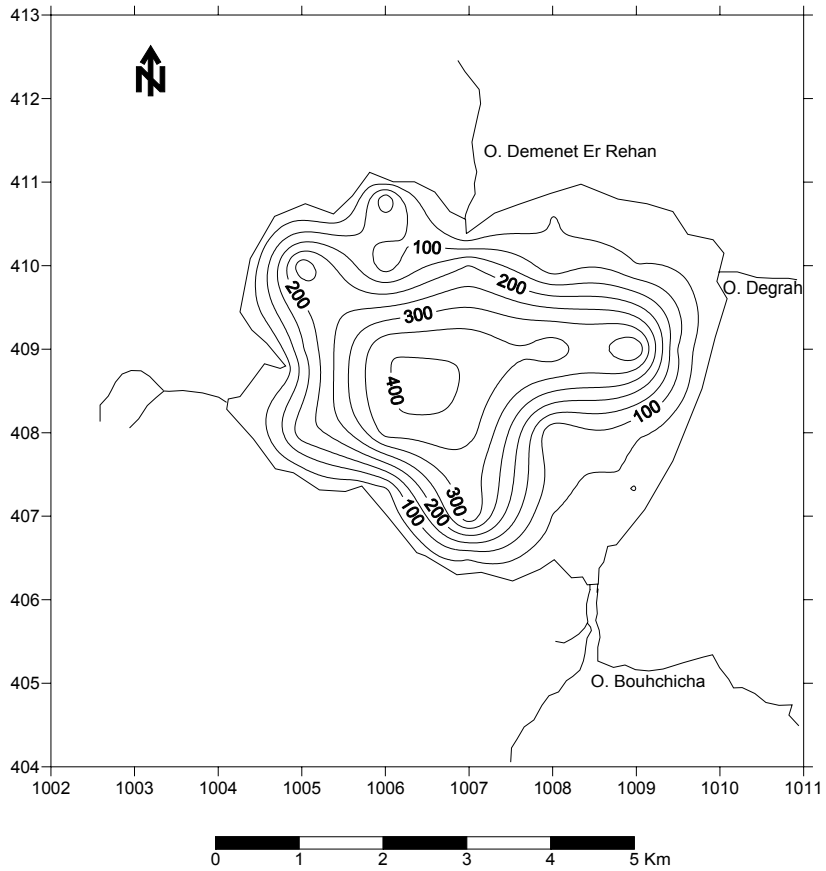

Fig. 9 : Isopleth map of the potassium concentration of the mud lake Oubeira

Tabl. 3 : Classification of qualities of soils in relation to potassium (Mogan, 1977)

Types de sol	K_2O (ppm)
Terres pauvres	30
Terres moyennes	30 à 50
Terres riches	50

5. FLORA AND FAUNA:

The vegetation of the Oubeira Lake is diverse, and these speacies are very different (Fig. 10, 11 and 12). We quote the most important: *Juncus maritinus, Phragmites australis, Tupha latifolia, Typha angustifolia, Scirpus lacustris, Myriophylum spicatum, Ceratophylum dermersum, Nymphea alba* and finally *Trapa natans.* (BOUGUESSA, 1993).

Fig. 10 : Chestnut of water (Photo pers., 2011)

Fig. 11 : Meriophyle (Photo pers., 2011)

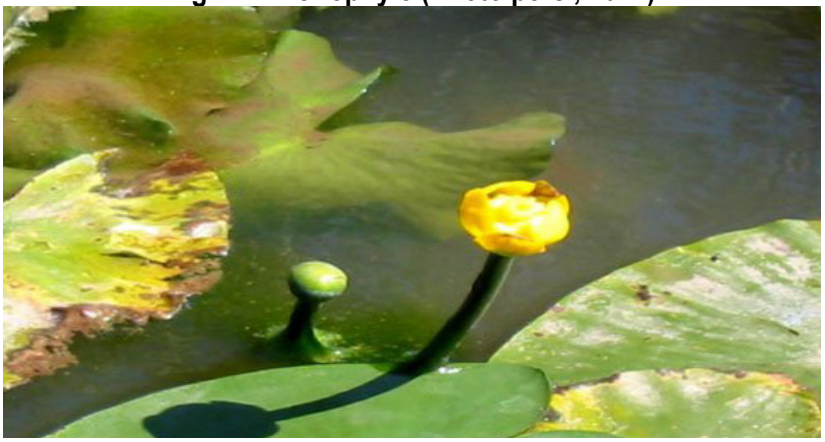

Fig. 12 : Yellow water lily (Photo pers., 2011)

The lake is frequented by a very diverse avifauna (resident and migratory birds). Among these species we quote: Wigeon, Gadwall, Northern Shoveler, Green-winged teal, the pochard, the Duck, the Common Shelduck. Among the species with economic interest and ecological. We quote the most important: *Barbus callensis, Anguilla anguilla, Mugil ramada*, and *Pseudophxinus callensis.*

6. STATICAL ANALYZES

To determine the strength of the bond between the elements contained in the mud and water, we had used the right of least-squares that characterizes the linear model. The pairs (x, y) are reported in a graph after verification of the normality of the data. This approach allows us to determine the equation of the right adjustment and the correlation coefficient. Confidence interval 70% reported on the regression graph indicates the number of data points that come out of it.

Searched for correlations are the following:

• Total nitrogen of nitrates in water vase

• Phosphorus of mud and water,

Correlation coefficients did not reveal tight correlation. However, according to the classification (tab. 4) used, the correlations between total nitrogen and nitrates (Fig. 13), and phosphorus (Fig. 14) are significant

Tabl. 4: Classification used by the software Minitab 13

Coefficient de corrélation	Corrélation
R = 0	Non significative
0.3< R < 0.76	Significative
0.76< R < 0.86	Très significative
0.86 <R < 1	Très hautement significative
R > 1	Non significative

N_{total} = 0,11 NO_3- + 0,25

avec R = 0,35 et I.C = 70%

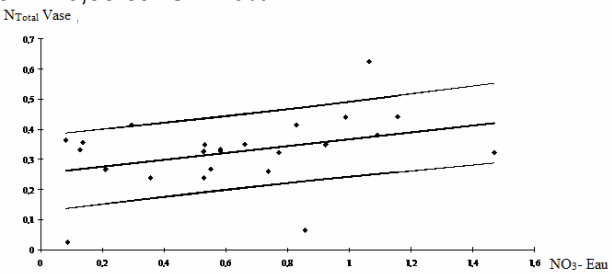

Fig. 13 : Correlation between the nitrogen of the mud and water nitrates

$P_{Vase} = 0{,}43P_{Eau} + 1{,}76$
avec R = 0,3696 et I.C = 70%

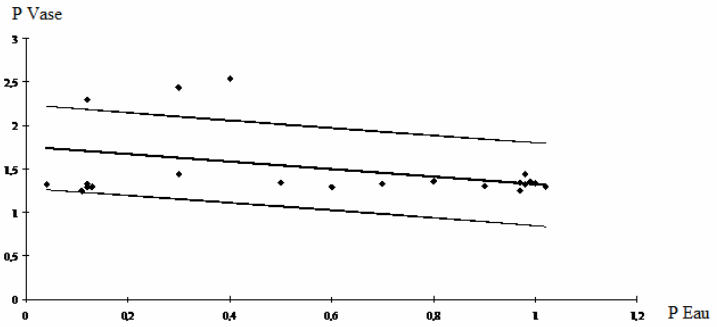

Fig. 14 : Correlation between phosphorus from the mud and phosphorus from water

7. CONCLUSION

Bathymetry revealed that Oubeira Endorheic Lake with an area of 21.73 km^2 is shallow. The geomorphology of the basin is smooth and gives the lake a flat bottom, covered with a thick layer of mud, which can reach a power of 2m. The water column, changes the banks toward the center, reaching a maximum height of 2 m at period of high water

The sandy texture observed along the bank stemming from the erosion of numidiens stonewares of low (weak) extension. On the other hand, the limono-sandy texture stemming from the erosion of clays above - numidiennes and stonewares is dominant and covers the vast surface. Finally, the clayey texture limits itself in the center of the lake

The chemical analysis revealed the enrichment level of the mud lake nutrient, shoreline toward the center. Transfer solid particular contribute to the enrichment of the lake nitrogen, phosphorus and potassium. Moreover, there is an accumulation in the center of the lake which is causing degradation of the aquatic ecosystem, the proliferation of aquatic vegetation. A spatio-temporal monitoring of potassium is necessary to determine the dynamics of this element.

Correlations between certain parameters of the mud and those of water are significant, but other companions of analysis will allow to better understanding the relationship between the elements dissolved to those of the vase, to determine the equations that govern it.

Fish activity is limited to Chinese carp and eels. Today there is no restocking program for extensive or intensive exploitation. Finally, the Lake Oubeira is an extremely valuable environmental indicator that integrates

many hydroclimatic parameters which react quickly. The siltation of the Lake is a major problem that will result in the modification of the ecosystem and eventually disappearing. Dredging is required!

REFERENCES

Alayat H. (1991) – *Les eaux superficielles et la nappe phréatique de la plaine d'Annaba*. Th. Doct., Univ. de Nancy II, 382p.

Alayat H. (2006) – Evolution spatio-temporelle du chimisme des eaux thermo minérales des monts de la cheffia (NE algerien). *Kartologia*, *n° 48, pp. 23-28.*

Anonyme, (2001) – Réalisation d'une station de reproduction piscicole : Lac Oubeira, *Wilaya d'El Tarf. Rapport final.*

Babault J., Van Den Driessche J., (2005) – L'érosion des chaînes de montagnes. *C. R. Géoscience 337, pp.1431-1438.*

Baize, (2000) – Guide des analyses en pédologie. *Quae Ed.* 266p.

Bouguessa S. (1993) – Contribution à l'étude de bioécologique des Anisoptères (Odonates) du lac Oubéira. Th. Magister. Dep Bio. Inst Sci. Nat. Univ. Annaba.70pp

Carpenter et al., (1998) – Ecological and social dynamics in simple models of ecosystem management. *249-264-* www.ecologyandsociety.org/vol3/iss2/art4.

Clement, Ouinet, (2004) – Plan du lac Maskinongé www.villemont-tremblantqcca

Dorioz J.M., Trevisan D., Vanstelant J. Y., (1997) – Transfert diffuse de phosphore des basins agricoles vers les lacs. « L'eau dans l'espace rural » INRA Ed. *pp. 249-264.*

Gaujous D. (1998) – La pollution des milieux aquatiques. *Quae Ed.* 217p.

Durand Delga M. (1969) – Mise au point sur la structure du Nord-Est de la Berbérie. Publ. Serv. Carte géol. Algérie, N.S., *Bull. soc. Géol.fr., (7), xiii, p. 328-337, 7 fig.,* Paris.

Hinschberger F, Malou J. A., Rehault J. P., Burhanuddin S., (2003) – Apport de la bathymétrie et de la géomorphologie à la géodynamique des mers de l'Est-indonésien. *BULL. Soc.Géol.Fr. n°6, pp. 545-560.*

Joleaud L. (1936) – Etude géologique de la région de Bône-la Calle. *B.S.G.A. (2), n°12, 199 p., 25 fig., 2 tabl., 4 pl.*

Kieken M., (1961) – Les traits essentiels de la géologie algérienne. In livre Mém. Prof. P. Fallot, Mém. h.-sér. *Soc.Géol.Fr.*, (1960-1962), I, p. 545-614, 6 pl.

Raoult J.-F. (1974) – Géologie du centre de la chaîne numidique (Nord du constantinois, Algérie). Thèse Sc. Paris. Mém. *Soc.Géol.Fr.,* N.S., LIII, mém. n° 121, p 1-163, 62 fig., 9 pl.h.t., carte géol.h.t., Paris.

Vila J.M. (1980) – La chaîne Alpine d'Algérie orientale et des confins Algéro-tunisiens. Thèse de doctorat ès sciences naturelles, Université Pierre et Marie Curie (Paris VI), 2 t, 665 p., 199 fig., 40 pl.