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HYDROGRAPHIC, HYDROCHIMIC DYNAMICS OF THE LAKE SYSTEM OF THE BASIN OF LAKE-FITRI

Loukman Bichara*[1], Nakolendousse Samuel[1], Pierre Deschamps[2], Paulin Chloé[2], Mahamat Seid Ali[3] and Nguinambaye Mberdoum Memti[3]

[1]Laboratory GEORESSOURCES, Unit of Formation and Research/Earth and Life sciences. University Ouaga1 Pr. Joseph Ki-zerbo:03 LP 7023 Ouagadougou 03, Burkina Fasso.
[2]Aix Marseilles University, CNRS, IRD, College of France, Umr-cerege, Mediterranean Technopôle of the Alpine laburnum, Aix-en-Provence, France.
[3]Laboratory of Systematic Botany and Vegetable Ecology, University of Djamena, LP 1027, Chad.

***Corresponding Author: Loukman Bichara**
Laboratory GEORESSOURCES, Unit of Formation and Research/Earth and Life sciences. University Ouaga1 Pr. Joseph Ki-zerbo:03 LP 7023 Ouagadougou 03, Burkina Fasso.

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ABSTRACT

The principal objective of this study consists in determining the hydrous assessment and to make the state of the chemical quality of water of the aquifer. It specifies the sources of food of the lake, and determines its genesis. The hydrological and physicochemical analyses of water were carried out on 22 water points distributed as follows: 2 water samples of well, 18 drillings with human motricity and 2 samples of the lake Fitri. The samples were composed and balanced. Measurements in-situ (temperature, conductivity and pH) were made by the WTW350i multi-parameter. The food of the lake is annually assured during two or three months by seasonal rivers. The flows, precipitations and evaporation constitute the principal factors of the assessment of the water of the lake. The average temperature of water of the lake taken is of 25°C. That of subsoil waters turns around 29°C. They vary from 24.5°C with Amgogana and Ngaré with 32,4°C with Djamena-.Bilala, ATI-Ardébé, Mangbatoa and Beptongo. These values seem to be controls by the exothermic physicochemical reactions. The values of electric conductivity are very heterogeneous and lie between 125 µS/cm and 14085 µS/cm. The increase in these values in the direction of the flow, is controlled by the influence of lithological nature more or less evaporitic. In the whole of sampled water, the measured average pH is around 7.30. It varies from 6,12 to 8,12. The lowest values are observed in the zone of Taba, Mabardé and Zaladja and highest in the zones of N`Djamena-.Bilala and lake-1.

KEYWORDS: Lake Fitri, Chad, Hydrography, Lake Dynamics, demography.

INTRODUCTION

The department of Fitri located at the center of Chad, in the area of Batha, covers a surface of 2088 km2 with a density of 13,5 hbts/km2 (RGPH, 2011).It is in the watershed of lake-Chad and extends between 1223' and 1535' of Northern latitude and between 1703' and 2028 of longitude Is.

In this department, climatic conditions influential on the natural environment where the pluviometric fall weighs on the refill of the tablecloth. The climate is of intertropical type with one rain season located between June and October. Pluviometry oscillates between 200 to 800 mm. The lake Fitri, vast water level soft, located at the heart of the zone of study, supplied with a catchment area entirely located in semi-arid zone, constitutes a hydrological contrast. This lake becomes an object of covetousness and attracts a number of men and animals come from the more underprivileged zones in the neighbourhoods (Marty *et al.*. 2012). Its geographical situation confers a role to him ecological and socio-economic of foreground in the area. Its hydrous assessment is dominated by the couple ruissellements/ evaporation which determines the variation of the water stock. On the other hand, the hydrographic network made up of several intermittent rivers of which most significant is the Batha river with a basin of 96 000km2 (60% of the contributions), feeds the lake-Fitri (Schuster, 2016) as well as the affluents Melmélé, Zilla, Zerzer and Abourda (BIEP, 1989), supplemented by the rivers coming from the central solid mass tchadien (Moupeng, 2006, SCHUSTER, 2016).

In addition, this department is confronted with enormous difficulties going of the weak pluviometry and an unequal distribution of the South with the North of precipitations. The weakness of the rains in the basin-slope, the surface flows are sufficient to maintain the lake on an annual scale permanently. However, the long

periods of dryness in 1901, 1913, 1973 and 1985 have it affected during these last decades. This draining could not frequently arrive if there was a significant underground food of the lake. Since this one, necessarily slower than the surface food would have prevented an annual draining by buffer effect. It is thus not obvious that the ground water which is located at the North and the West of the lake can communicate with this one in the vertical or horizontal direction. However, the questions of water remains a problem of public health.

Vis-a-vis the deficiencies of the data and technical difficulties, it will be judicious to undertake thorough studies which could serve future work approaching of the more specific aspects.

I. MATERIEL AND METHODS

1. Localization of the Zone of study

The Area of Batha located at the center of Chad, of a surface of 84 000 km2 is made up of three departments: Western Batha (ATI), Batha Is (Oum Hadjer) and Fitri (Yao) where the zone of study is. The department of Fitri is in the watershed of the lake Chad and covers a surface of 2.088 km2 with a density of 13,5 hbts/km2 (RGPH, 2011).It extends between 1223? and 1535? of Northern latitude and between 1703? and 2028?of longitude Is. This department is limited to North by Batha-Is, the area of Guéra in South-west, the area of Hadjer-Lamis and that of Bahr El-gazelle is in the East.

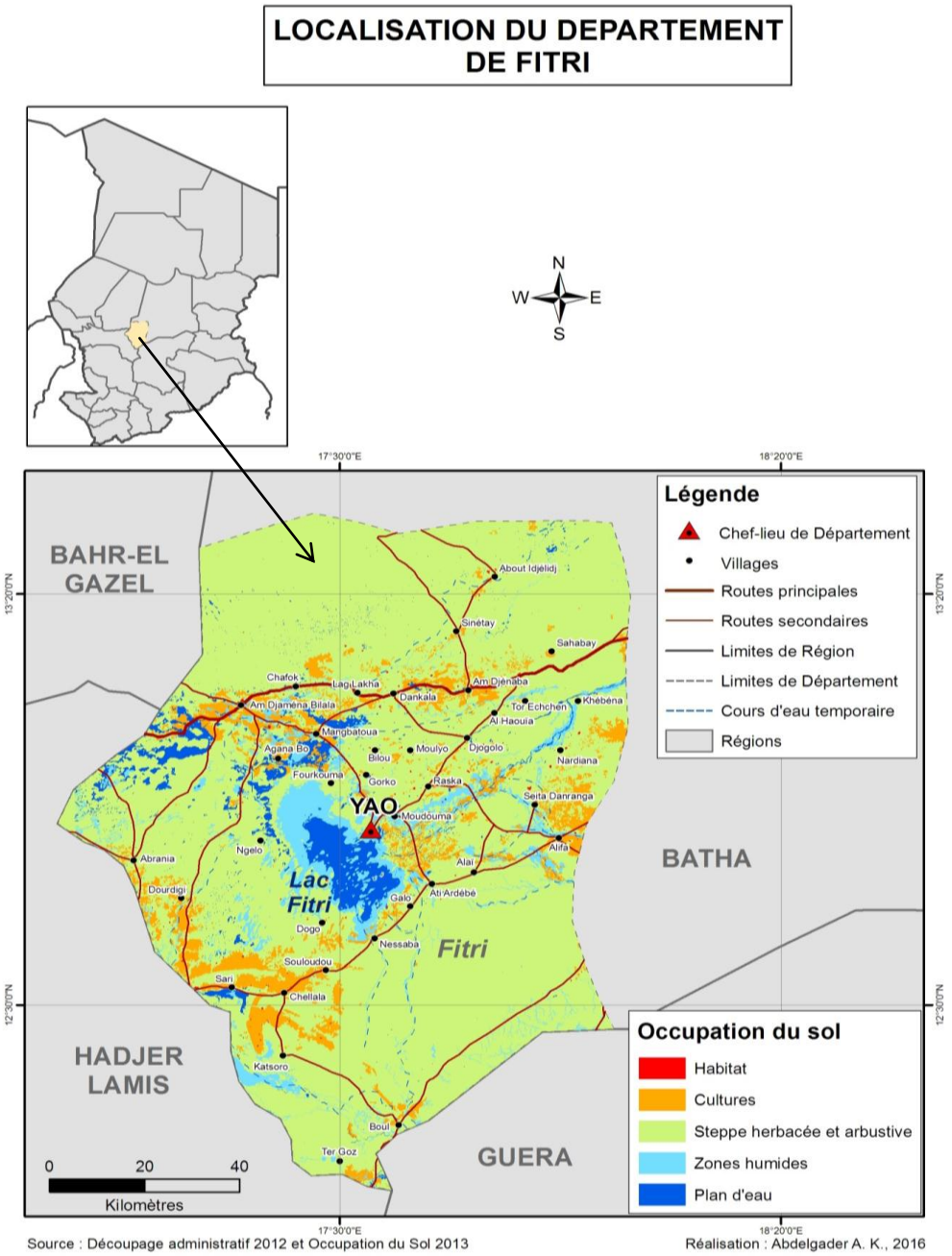

Figure 1: Localization of the site of study.

I.2. Material

During this research task, one used on the ground:

- "Total Positioning System: GPS "or the system of total positioning GARMIN 72
- a topographic chart 1/200 000
- Charts of the water points, on which information is consigned.
- The Kit multi-parameter WTW for measurements of the physicochemical parameters.
- The teledetection made it possible to chart the surface formations and the dynamics of the lake basin.
- The satellite images (SPOT) allowed the catch of air sights.
- A numerical Camera was used for to make photographs at the zone of study.
- Documents: Theses, reports/ratios, memories, articles, newspapers, reviews for a bibliographical study.

I.3. Methods

In-situ measurements and the test sample selections were carried out from the 20 to September 30, 2017 on the various sites. Several difficulties were encountered during the course of the study in-situ. On the other hand, opposite the insufficiency of the numerical data and their gaps sometimes, tended, must one use or not the methods of interpolation and extrapolation of the data?(Yao, locality of the lake, do not have measurements of evaporations).In addition, the choice of the points to be sampled was not always also simple and most of the statements of the sedimentary profiles come from the occasional observations. Indeed, during this shortest possible period, we made measurements of the various piezometric levels of the whole of the zone charted. Our measurements were taken on the level of the lake, in the various works (well and drillings) located all around the lake-Fitri. To take measurement, one locates (determination of the satellite co-ordinates) the work using the GPS, one introduces the nozzle of the probe into the work to determine the depth of water. Then, one measures the height of curbstone (surélèvement carried out around the work to protect it, it is generally, in our zone of study, consisted of a wall of breeze block; of a stacking of tires of truck) to determine the real level of water compared to topographic surface. One calculates thereafter the coast of water in the work according to a topographic reference mark. In a grid, one defers the name of the place, the number of the well of measurement where the work is, the height of curbstone, the piezometric level.

In addition, one indexed and selected the water of the lake, eighteen (18) points of water of drillings with human motricity and two (02) wells left again in the zone of study. These various works (well and drillings) were selected not only according to their proximity of the lake Fitri but also compared to possible the sources (discharges; latrines; etc.) of underground water pollution. Moreover, of the follow-ups and controls of the variation of the subsoil water level in the various works and of the its affluent and river (Batha river) were made during the period going from 19 to September 30 of the year 2017.The physicochemical parameters (pH, temperature and electric conductivity) were carried out in situ with the balanced made up sample and a probe multi-parameter WTW. The samples were taken in plastic bottles (1,5 liters) extremely clean and rinsed 3 times with water to analyze. For manual pump drilling, a pumping long enough was carried out to rinse the suction pipes. Then, the samples were filled and closed hermetically in water to avoid the bubbles of air in the bottle which could support the outburst of certain gases dissolved in water. All these samples were preserved cold then conveyed at the National Laboratory of Water (LNE) of the ministry for the breeding and hydraulics for the chemical analysis. However, the analysis of the hydrological data of the catchment area was proceeded and made it possible to arise an equation of a hydrological assessment. Consequently, the data collected in this basin caused interrogations on the variation of the lake, its food (precipitation, evaporation and infiltration) and on its dynamics current and passed.

I.4. Data processing

Our data are treated by:

- The spreadsheet Excel 2010 made it possible to treat the data and was used for calculation of the piezometric dimension (Zp) of the works.
- The Software of cartography ARCGIS 10 made it possible to exploit an Operating system Geographical (SIG).

II.RESULT AND DISCUSSION

1. Physicochemical Parameters in-situ

Table I presents the variation of the physicochemical parameters between the various points of the taking away. It is of T, the pH and EC.

Table 1: Physicochemical Parameters in-situ.

In-situ measurements Dates : 23-10-2015/16 Place: Lake Fitri (chad)				
N°	**Points de prélèvements**	**PH**	**T (°C)**	**Cond. (µS/cm)**
1	Abranga	7.01	32.5	4012
2	Lac Fitri 1	8.50	23.2	123
3	Lac Fitri 2	7.76	23.9	136
4	Am-gogana	7.89	32.0	1023
5	Mbé-Manga	7.30	32.5	8053
6	Mangbatoa	7.33	32.4	6410
7	Mabardé	6.22	31.1	14085
8	MBé-farkma	7.92	30.4	1012
9	Dogo	7.54	31.8	1165
10	Ati-Ardep	7.22	32.3	1298
11	Beptongo	6.75	32.9	4120
12	Ngaré	7.83	32.3	1882
13	Tabah	6.02	32.4	12892
14	Yao (château)	7.80	32.0	3327
15	Tchoukounou	8.01	30.6	5700
16	Tchoukounou (puits)	8.45	27.6	701
17	Korlosso	7.18	31.8	864
18	Dini	7.47	32.2	1901
19	Zao	5.67	32.0	20600
20	Yao Sultanat-palais	7.65	32.1	1258
21	Yao Ecole Doumourou	7.14	32.2	832
22	Yao Nang-Yolo	7.68	32.4	953
23	N'Djamena Bilala	8.42	31.0	723
24	Danranga	7.34	32.0	715
25	Aguil bourma	7.35	32.4	793
26	Tarbaga	7.72	32.7	2480
27	Gambir	7.66	31.6	4030
28	Mouliyo	8.00	28.7	779
29	Kilguim wadé	7.74	32.2	17600
30	Khébéna	7.06	30.9	99,5
31	Amsiyala	7.00	31.5	5330
32	Dankoutch	7.36	32.4	828
33	Zaladja	6.25	32.2	12325

2. Hydrogen potential (pH)

In our work, the hydrogen Potential (pH) as well presents values far from different between water from the lake and the ground water. The pH measured is not very heterogeneous and are around neutrality. These values evolve/move between 6,12 to 8.12 with an average of 7.30.The lowest values are observed in the zone of Taba, Mabardé and Zaladja and highest in the zones of Djamena-.Bilala and the lac1.The pH highest are characteristic in sodic bicarbonated water. This increase would be due to a progression of the facies of water which passes from bicarbonated calcic to bicarbonated sodic.

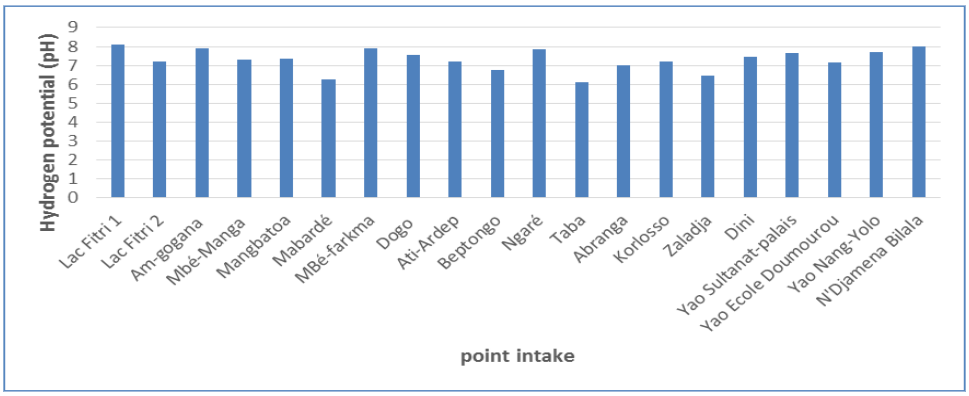

Figure 2: Histogram of pH.

3. The temperature

The climate of the zone of study results in a long dry season and a short season of rain. Indeed, at the moment of sampling. The monthly average temperature (fig:4) highest is that of April (43,4Ç) whereas the lowest temperature is that of August (31,62 C).These measured temperatures, show that those are lower on north-eastern bank and in the lake that can be explained by strong evaporation due to heat and the winds in this season which will be responsible for the fall of the temperature of water of the lake. On the other hand, water of the ground water is relatively hotter in this same season.

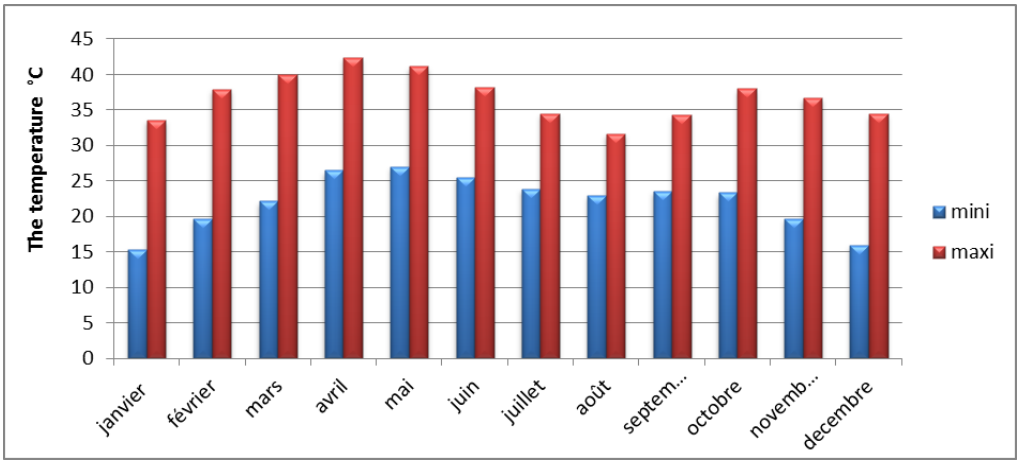

Figure 3: Histogram of the temperatures.

4. Electric conductivity (in µS/cm)

The measurements taken in the zone of etudy (figure.32), show that electric conductivities are very heterogeneous with values ranging between 99,5 µS/cm and 20600 µS/cm and an average of 3289,34 µS/cm higher than the allowed standard in Chad which is of 2500 µS/cm (decree N 616/PR/PM/ME/2010 of bearing 2 August 2010 and follow-up check procedure of the quality of the water intended for human consumption and the texts of 2010 and 2011 setting the standards of quality on drinking water at Chad).The lowest values of conductivity are measured in the lake, in Korlosso, in Aguil, Mafé, Zania and Djamena Bilala and highest is primarily located at the level of drilling at Zao, Mabardé and kilguim wadé (figure 16).These values are due a priori to located factors, the such presence of discharge, the proximity of the latrines and the low thickness of the unsaturated zone. The ranges of variation of conductivity of the broader lake-Fitri are rather heterogeneous (M.Schuster et al., 2015).This result is in agreement with work of Ketchemen-Tandia into 2011 which stipulates that very high conductivities exceeding 1000 µS/cm are due a priori to located factors, the such presence of discharge, the proximity of the latrines and the low thickness of the unsaturated zone. The histogram (figure 32) shows very high conductivities exceeding 1000 µS/cm.

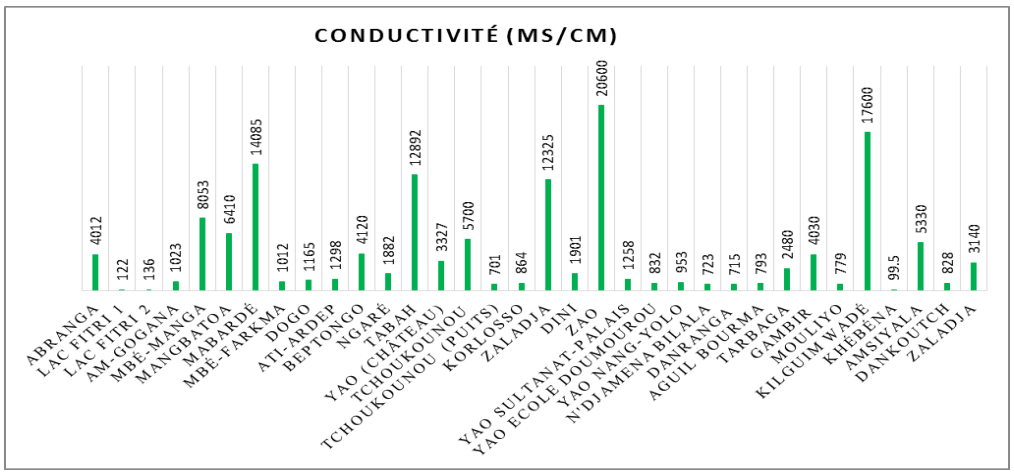

Figure 4: Electric histogram of Conductivity (in µS/cm).

In addition, the heterogeneous distribution of conductivity does not make it possible to visually establish a direct relation between this one and the piezometric surfaces deduced from the measurements taken on the ground. The absence of direct visual correlation between the parameters conductivities and piezometric level can also rise from the sample size used to carry out these interpolations. The spatial distribution

of the values of conductivity interpolated starting from measurements of ground highlights a central zone associated particularly conducting subsoil waters, and values of low conductivities in the east of the zone of study.

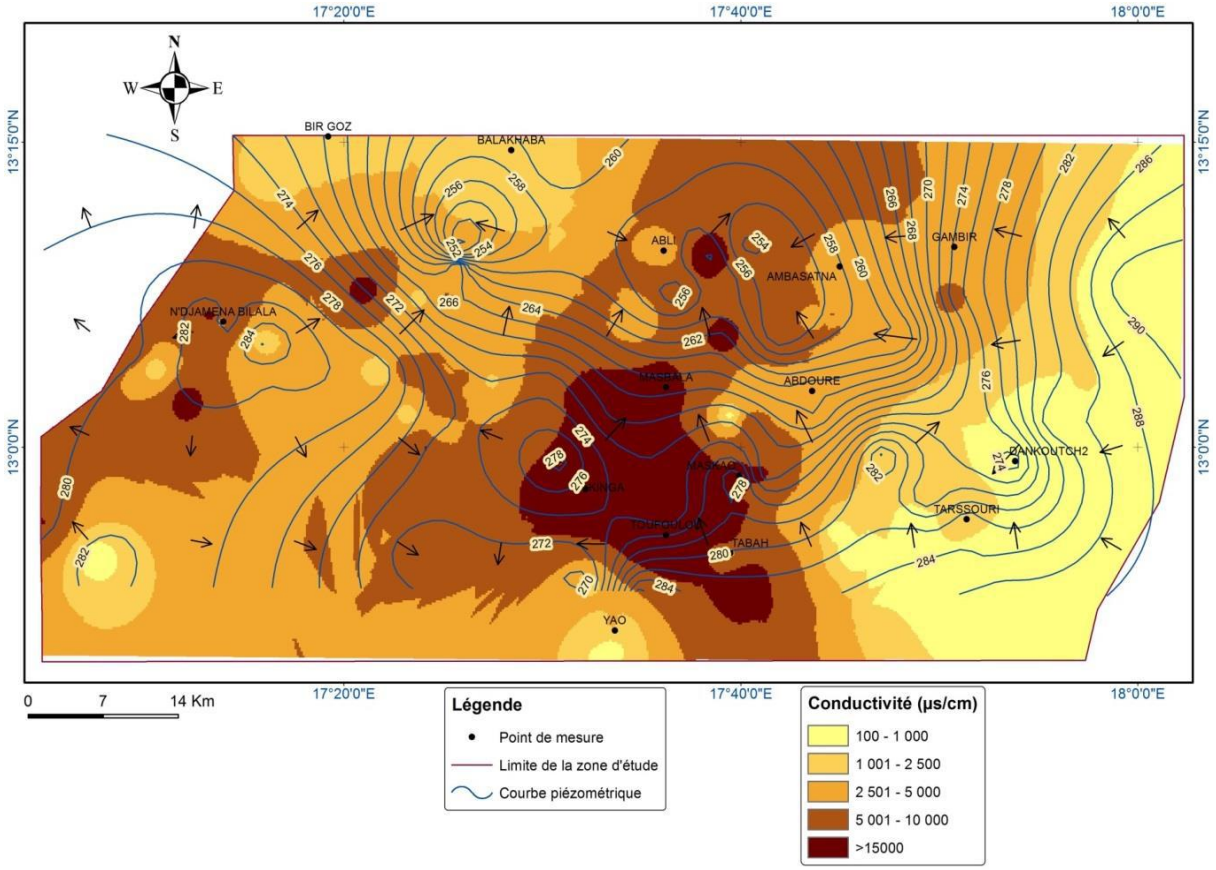

Figure 5: Spatial distribution of the values of conductivities obtained by interpolation of the measurements taken on the ground.

Moreover, increasing it by conductivity in the direction of the flow, allowed to conclude that it is about the influence of lithological nature more or less evaporitic, with the presence of discharge and from the latrines in unsaturated zones. It would be due on the one hand, with the phenomenon of evaporation related to the weak hydraulic gradients and on the other hand, with the dissolution of the granitic arenas and the evaporitic layers. However, the presence of argillaceous levels, observed in the lithostratigraphic logs, could also explain the increase in conductivity. Indeed, because of the slowed down circulation of water in the argillaceous levels, the substances in contact, have time to be put at balance and consequently, to take care out of salts dissolved during their passage in the boxing layers.

5. The current dynamics of the lake

The lake-Fitri was threatened by the increase of the section of water evaporated following the development on the surface of the lake. Current dynamics hydro-sedimentary of Quaternary gave formation of various rivers whose lake Fitri remains very active at the point to modify its form.

The variation in the time of transport of wind and the hydrous flows, generates processes morphodynamic likely to create water levels according to the slopes and the counterslopes thus generated. What corroborates with the work carried out by Mouping(2006) indicating that the sedimentary structure of the area of Fitri suggested mobility in space of the water levels former to Fitri (figure 5). It is noted in addition that the work carried out by Schuster, 2016, shows the existence of blow sands moving significant. We noted in addition, that deposits anthropic (charcoals and bones) close to the village of Zégué, with more than 2 m of depth at the top of a dune. That indicates that the wind sedimentation which covers these deposits is current and testifies to a rather dynamic wind activity.

This wind sedimentation associated the over wash phases and lake could modify in period of low waters, the morphology of the lake basin and transform the lines of shore of the lake (Mr. Schuster, 2015). The work carried out by Schneider in 2001, and taken again by Stopping, C, J et al., 2014, show a superposition of the limits of the lake in periods of low water level and indicates a shift of the bottom of the lake of approximately 12 km towards the South (Figure N 5). In the one half-century space, the

bottom of the lake knew a very significant translation. This translation could have various consequences; inter alia, the distribution of the macrophytes, the reorganization of the easily flooded margins and thus the modification of the space of production. What could induce land conflicts when it is known that these spaces accomodate various economic activities (cultures of Berbéré, truck farming, pastures, fishing etc).

All these elements authorize a reconstitution of the paléoenvironnements lake Fitri: the various sedimentary rehandlings represent significant variations of the comprising streaming of the ruptures and the episodes of great flows. The climatic conditions and hydro-sedimentary hardly varied compared to the current situation. There was certainly, of the variations of intensities of the pluviometry and the force of the winds with consequences amplified in terms of floods or strandings as one can still nowadays observe them in the Sahel. It is in this context that the lake Fitri appears, reconstituted behind the barrier of the erg of Harr in the North-West (Mr. Schuster et al.2015) and occupying the place of good of other lakes before him. The dating's with radiocarbon studied by Mouping in 2006 and taken again by Yalinkun. T in 2016; indicate a very recent sedimentation in the area of Fitri.

This result is in agreement with work of Project SIDRAT., 2010 which stipulates that the youth of the sediments and the follow-up of the topographic plan of the lake basin let appear one current dynamics of the lake which is very remarkable. The cartographic representation of the limits of the lake in low water level to the 50 years interval (1951 to 2001) indicates a translation of the bottom of the lake of approximately 12 km towards the South (Mouping, 2006).This displacement is due to a rather fast filling of the old bottom of the lake by sedimentation argillaceous and organic of type "digs peat" in the broad sense and which would approach the boggy facies described at the bottom of the lake Faguibine (Fréderic, oral communication in 2017).

In addition, the géosystème of the lake Fitri seems a concentrate of natural resources in an unfavourable physical environment. If its ecological balance seems to be preserved until now, it is that it is protected naturally by a difficult access and a favorable usual management (Baohoutou, L 2007). But that could not perdurer opposit the demographic pressure and with the increase in loads of the cattle.

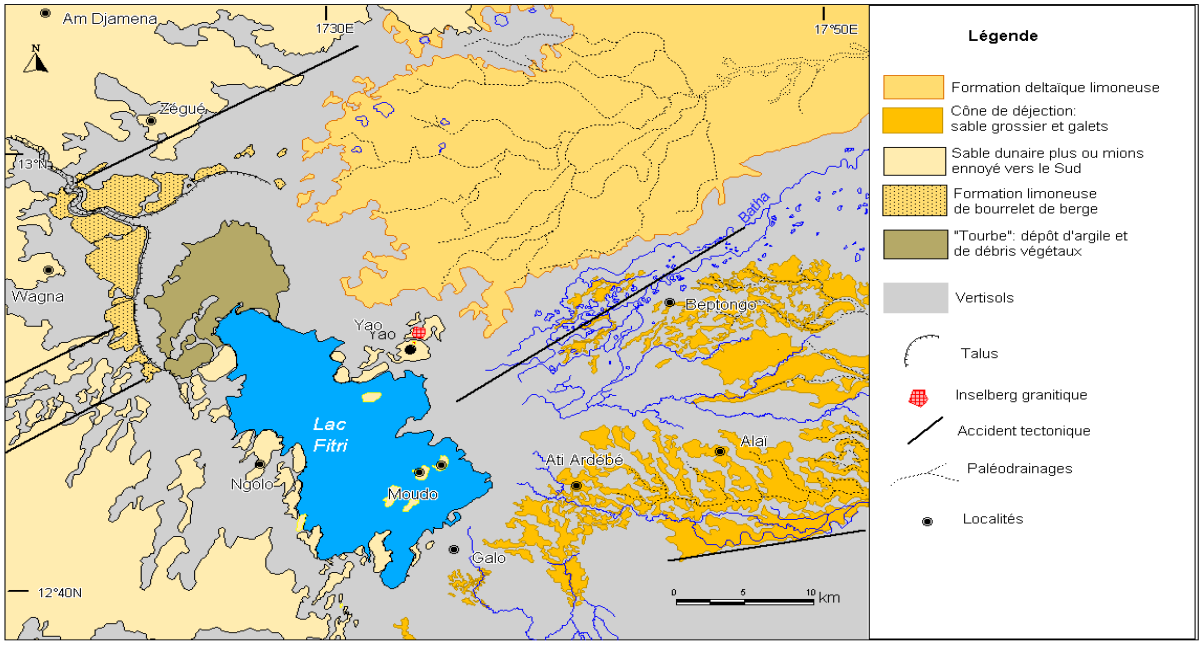

Figure 6: Chart of the surface formations of the area of the lake Fitri, source: Mouping, 2006.

CONCLUSION

The present study meets significant needs. It consists in determining the sources of food of the lake, to establish the hydrous assessment, and also to observe the current dynamics of the hydrosystème. The analysis of the hydroclimatic data, the exploitation of the air, space and cartographic documents, the examination of the sedimentary profiles as well as the chemical analyses of water, contributed to light the tracks of research. The analysis of the sedimentary profiles and their surface distribution made it possible to identify the alternation of the deposits hydro-sedimentary and wind. The sediments are primarily alluvia of fluviatile or wind sands often mixed, and of the paludous or lake deposits like those observed around the Lake Chad. These deposits are often inserted in organic layers, évaporites, deposits (shells) and a level of diatomite's confirming the existence of vast water levels. The hydrochimic study, shows that calcic bicarbonated water comes exclusively from the

zones of refill (meteoric or fluviatile contributions).This water undergoes an evolution very tended towards a sodic bicarbonated facies. The conductivity of subsoil waters of this zone increases in the direction of the flow. What made it possible to say that it is about the influence of lithological nature, with located factors, the presence of discharge, the proximity of the latrines and the low thickness of the unsaturated zone.

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