International Journal of Sciences

Research Article Volume 7 – January 2018 (01)

Impact of Intensification of Agropastoral Activities on the Water Quality of Lake Fitri

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Abstract: This study was carried out from December 1st, 2015 to December 31, 2016 with the aim of evaluating the effects of agricultural and pastoral activities on water quality of lake Fitri and its impact on fish. For this, monthly measurements of physicochemical parameters were done in the North-eastern edges and at the center of the lake. Fitri. The principal activities in the neighborhoods of Lake Fitri are agriculture, animal breeding, fishing and plant exploitation. The exploitation of these resources, has increased in recent times due to an increase in population. The pressure exerted by this population, hinders the development of aquatic organisms.To batter evaluate this impact, fish were captured and their weight and size measured in situ alongside other Surveys. It was noted that, physicochemical parameters oscillate around the following values: pH between 7.46 and 8.86 C.U, temperature between 15 and 25°C, conductivity between 108.5 and 184,1 µS/cm, TDS between 0,165 mg/l and 0,278 mg/, dissolved oxygen between 9,9 and 51,8 mg/l, turbidity between 271 and 439 NTU and water transparency between 14 and 15 cm. These results are in accordance with the norms of UE, USA and JECFA FAO/OMS on water used in fish culture except for turbidity and water transparency. Based on other investigations done by various researchers, the results indicate the existence organic pollution from domestic waste and the proliferation of animal manure which can greatly influence water quality (use of pesticides).

Keywords: Lake Fitri**,** Agricultural Activities, Water Quality, Pesticides, Physicochemical Parameters, Fish

Introduction

Chad, like all other countries of the Sahel, has been subjected to recurring dryness for several decades which resulted in a reduction and an irregularity of rains. Lake Fitri represents a true jewel in terms of biodiversity in the center of the Chadian Sahelwith a catchment surface area of 70.000 km², (1). This biotope is very appreciated for its terrestrial, aquaticand especially the avian fauna. The availability of various permanent natural resourcesattract high concentration of men and cattle in the neighborhoods of Lake Fitri. The attractiveness of lake Fitri results in a strong concentration of individuals in the sub-division of Yao (91507 inhabitants), with 97% closer to the lake in the sub-division of, Am Djamena Bilala (18 890 inhabitants), or 75%. However, human activities in this area generates waste and effluents in high quantity and varied nature likely to pollute the environment (2). Occupying a strategic position of interest in the area of Batha, lake Fitri is one of the most significant fisheries of Chad. The fish constitutes the most consumed aquatic ecosystem product by man and the quality of this fish often reflects that of its medium (3).

As for what concern animal breeding, lake Fitri is known for its rich permanent green vegetation and its water availability constitutes an excellent place of reception for wandering hat men. Qualified as a zone of concentration of livestock in the dry season, (4) talk of 100.000 cattle's of which 87% belong to the transhumans. On the 195.000 small ruminants counted at that time, 66.66% belong to trans humans without counting the very old and very young cows. The provisional results of the general census of breeding (5) give a report of 94 million heads of cattle, more than 50% of this manpower would be recorded at the Batha whose principal point of concentration remains the zone of Fitri (6).

Published at: http://www.ijsciences.com/pub/issue/2018-01/
DOI: 10.18483/ijSci.1511; Online ISSN: 2305-3925; Print ISSN: 2410-4477

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The zone of lake Fitri also contains a very rich and varied aquatic and terrestrial fauna.The fish species of this lake are adapted to shallow and hot water.They are mainly the following species: *Mormyrus*sp., *Alestes children's nurse, Clarias will lazera, Clariasanguillaris, Gnathonemus Niger, Polypterus*sp., *Protopterusannectens, Schilbemystus, Synodontis*sp., *Tilapia* sp. Because of intensification of the agro-sylvo-pastorales activities around Lake Fitri, some of this fish species has today disappeared *(Altes children's nurse* and *Mormyrus*sp.) or are rare such as *Synodontis*sp.(7). The animal manure contribute in a considerable way to the deterioration of quality of water. The waste diffuse in the form of uric acid, phosphorus and other metabolites in the case of the breeding, transhumant and sedentary of the zone of study. Agricultural activities pour pollutants in the form of organic fertilizer residues or mineral manures. The phytosanitary products contribute to pollution by streaming towards surface water or by infiltration towards subsoil waters. From where the risk of the eutrophication of the water level, which results in the destruction of living organisms, imbalance of the physical environments, biological and of the aquatic ecosystems.

II Materials and methods

2.1 Choice of study sites

Our choice of this study site is justified by the intensity of agro pastoralactivities, the North-east side of the lake which is considered as the densest zone was retained for the data collection figure 1. The prospection began on the 1st of December 2015 and ended on December 31, 2016.

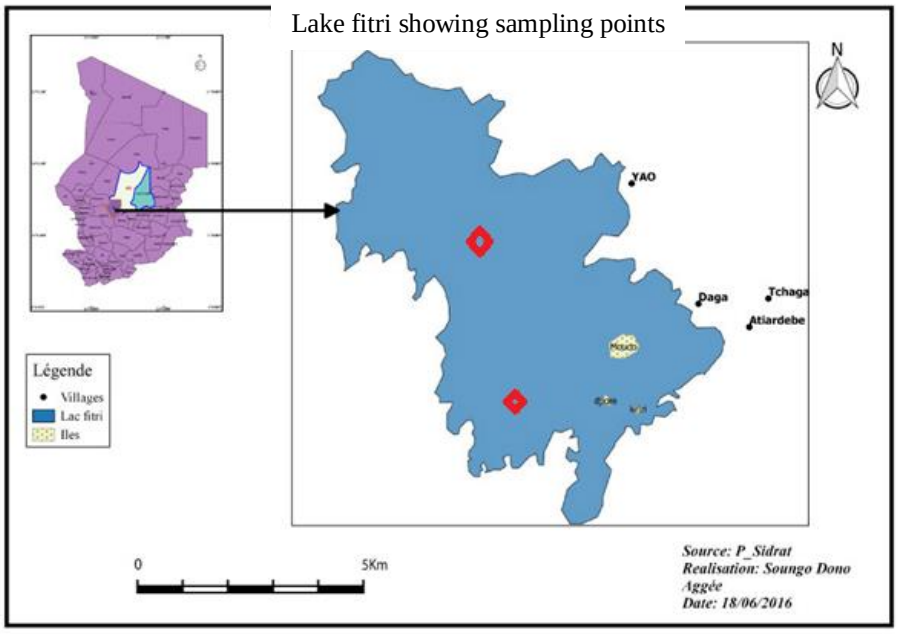

Figure I : LakeFitri.

1 Choice of sampling points

Two (2) sampling points were chosen and corded P1 and P2. The point P1 located at the edge of the lake and is closer to the town of Yao while the point P2 is located close to the center of the lake. These two points were sampled twice each month.

The relief at the study zone is made up of plain and valleys overhung by some hills playing a determiningrole in the pedagogical coverage and the drainage of run off. The soil types vary with the topography, however the lake occupies less than 8% of the remaining surface area. The climatic variations of our days controls rain fall at the level of lake Fitri, thus annual precipitations oscillate around 200 mm in the North and more than 600 mm in the South, with two contrasting seasons: one dry season and a rainy season, whose extreme temperatures are around 25°C in the dry season and 52°C in rainy season (8).

The hydrographic network of the studied zone is dominated by Lake Fitri which constitutes the only permanent running water source. This lake is a vast, flat-bottomed basin, not very deep with an annual amplitude of 1.5 to 2m. It is regarded as "the Lake Tchad in miniature" (9;10).Lake Fitri is then more sensitive to inter annual climatic variations. The vegetation in the study zone consists of aquatic and air fodder. These vegetation is related to pluviometry and is closely characterized by the presence of several species among which are the graminaceous and leguminous plants. It is obvious that this lake and

its wetland play a major role in human activities and constitutes a refuge for its biodiversity (7).

2.3 Methods

2.3. Physico-chemical Parameters

Measuring of physical and chemical parameters of water at the different sampling points was done according to (11) and (12). Temperature (°C), pH, conductivity and percentage of oxygen saturation were measured in situ. In the laboratory, phosphates and nitrates values were determined by colorimetry using HACH DR/2800 spectrophotometer.

Figure 1: measuring apparatus of the physicochemical parameters

2.3.2. Fishcapturing

In order to capture all fishspecies involved and to have an idea of their relative abundance, the capturing of fish was a necessary stage.A professional fisherman was responsible to regularly provide fish captured at the same place or point. Various measurements related to the weight and size of captured fish where done (figure 2).

2.3.5. Measurement in the ichtyo-meter and Balance:

Measurements of fish in the ichtyo-meter and on the balance were done simultaneously to collectdata on the lengths (cm) and weights (g) of the different species as presented on table II.

Table II: **Ichtyologic statement of the species in lake Fitri**

N°	Family	Speciesname	Localname	size (cm)	Weight(g)	Observation
1	Claridae	Clarias lazeras Clarias anguillaris	« Kandjé »	19 to 52 cm	59 to 1290	++ many
2	Cichlidae	Oreochromisniloticus	« Pforfo »	21 to 30	158,6 to 500	+ many
3	Protopteridae	protopterusanectens	« Koulou »	32 to 60	150,6 to 775,8	++ many
4	Mochokidae	synodontissp	« Guarga »	12 to 15	27 to 44,6	- many
5	Mormyriade	Marcusinuisseneg alensis	« Gouloulou »	10 to 12	12,2 to 21,4	many
6	Schilbeidae	Schilbemystus	« Hélé-hélé »	13 to 23	29,4 to 120,8	average
7	*Polypteridae*	*Polypterussp.*	« Guirndjil »	18 to 25	31 to 70,4	fair

2.4. Statistical treatment of results

The Excel Software was used to generate figures and to establish the coefficients of correlation between the size and weight on one hand and between measurements of the chemical and physicochemical parameters at the center and other part of the lake on the other hand.The coefficients are respectively 0.97 for size and weight, 0.98 for chemical parameters and 0.77 for the physicochemical parameters in the center and the edge of the lake. The respective coefficients show that the size and the weight, evolve in the same direction. It is the same for the chemical parameters in the center and at the edge of the lake, as well as the physicochemical parameters. This observation enables us to consider either the center or the edge of the lake, or the size or the weight to make a study of their variations with the physicochemical parameters and chemical.

Results of physicochemical parameters.

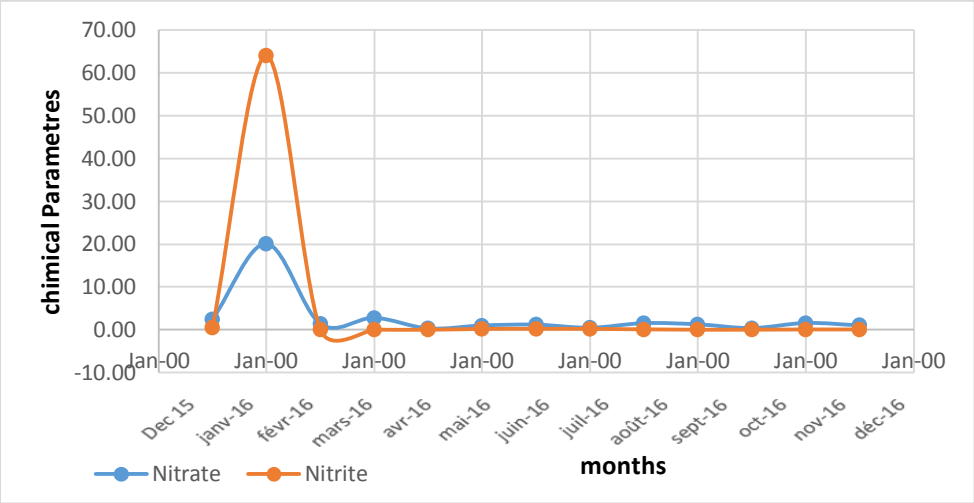

Figure 2 nitrate concentration and nitrite concentration

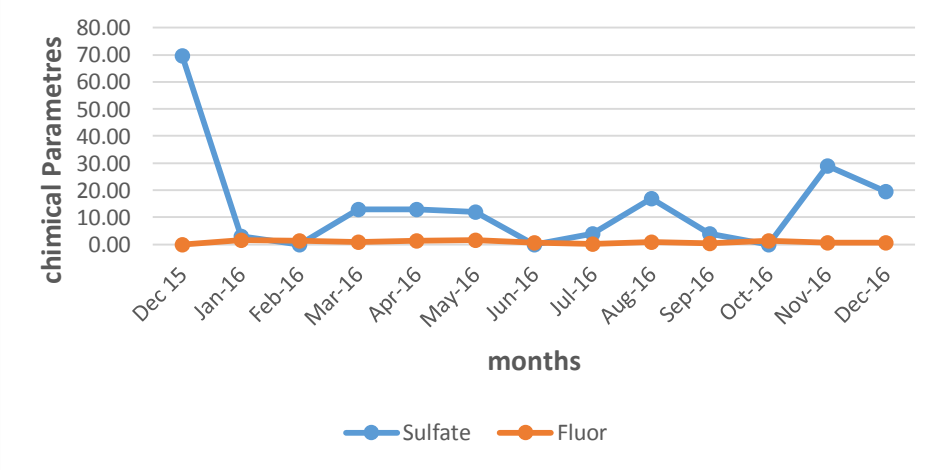

Figure 3 sulphates concentration and fluorine concentration

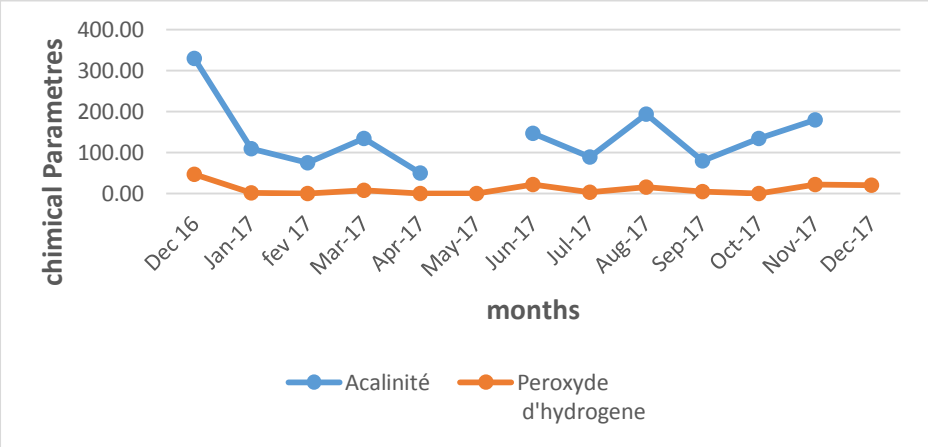

Figure 5 hydrogen peroxide concentration and alkalinity of the lake's water

A high concentration of Nitrates, nitrites, fluorine, sulphates and hydrogen peroxide was noted in April with a slight increase of nitrate in December (*Figure*1 to 5).

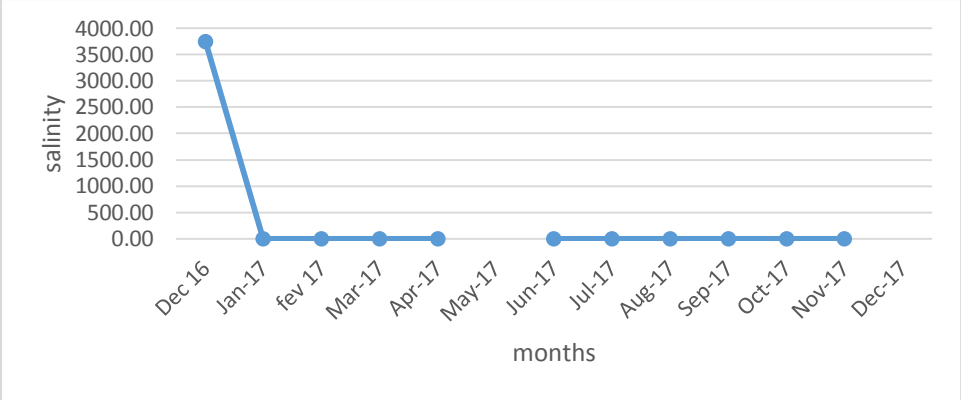

Figure 7 lake salinity

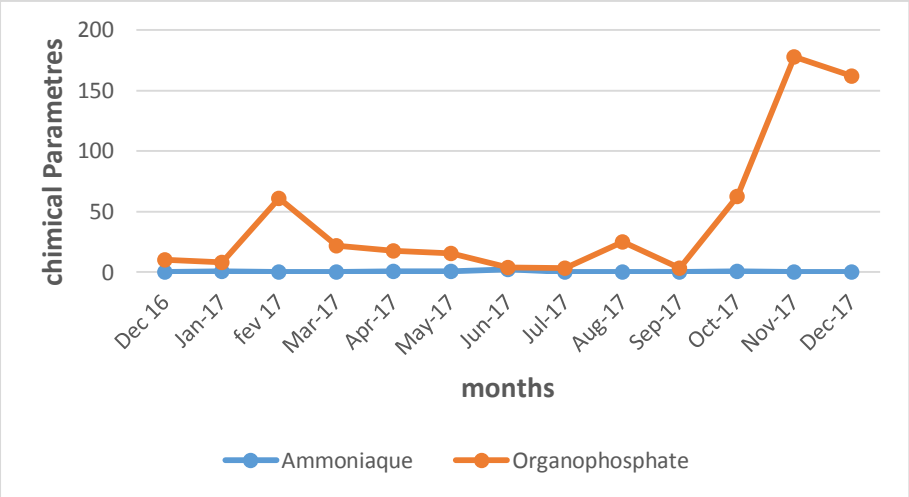

Figure 8 concentration of ammonia and organophosphates concentration

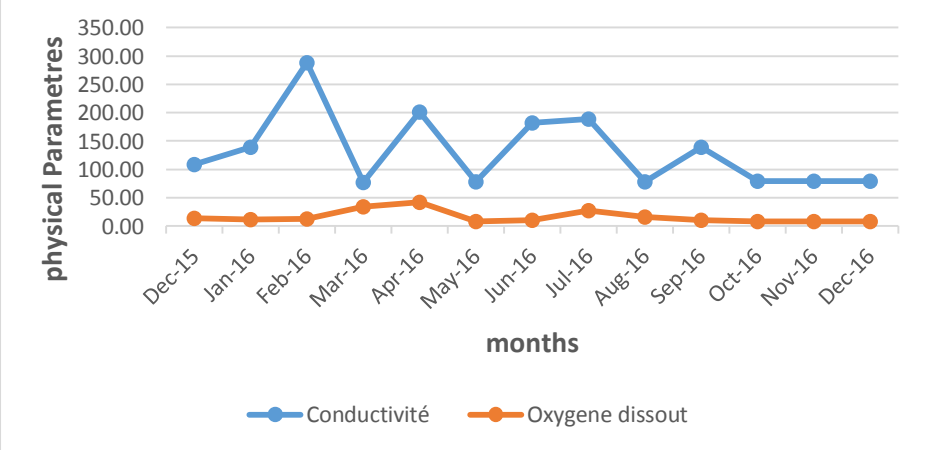

Figure 10 Electrical conductivity and dissolved oxygenconcentration

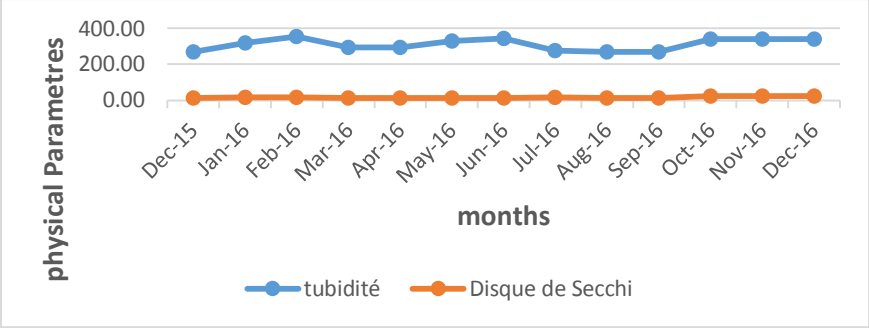

Figure 12 turbidity and secchi disc

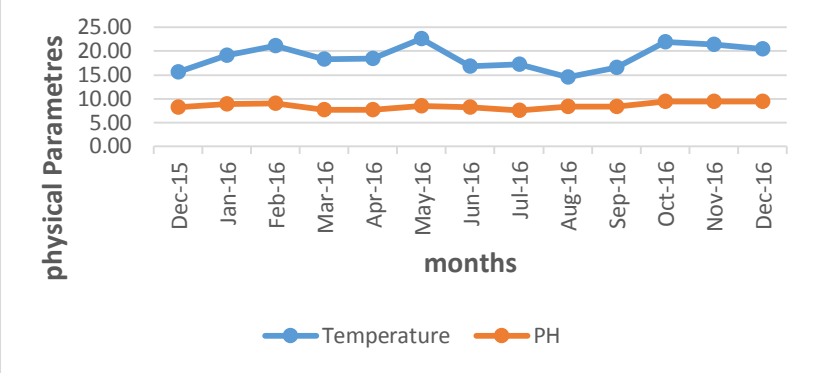

Figure 14 pH and temperature

This physico-chemical results shows a high concentration of ammonia in September and organophosphates decrease in concentration from December to January as seen on *Figure* 8 and 9). This period marked by significant surface run off from rain into the lake. This run off enriches the lake in various chemical elements and also led to an increase in Lake water level. As for alkalinity and salinity, thereincreases from January to March with the highest value observed in March (*Figure* 6 and 7). We also noted an increase in electrical conductivity, dissolved oxygen and turbidity from March to April (*Figure* 10-12). The decrease in various parameters from March could be explain bythe decrease in water level in the lake couple to the discharge of domestic waste and the deposit of animals faeces and urines in and around the lake.

2.5.Variation of ichtyologic parameters with chemical and physicochemical parameters.

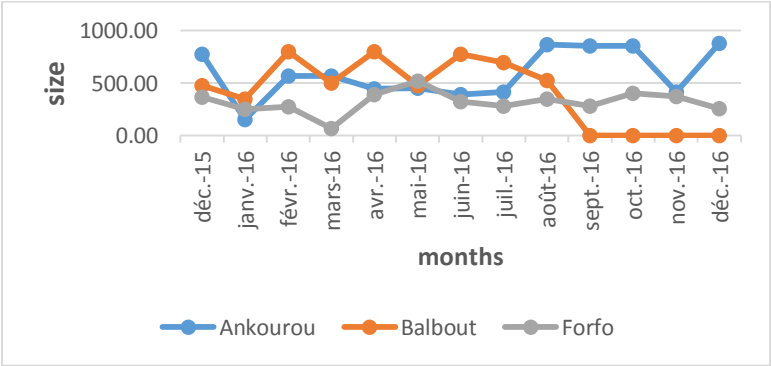

Figure 16 variation in size of Orechromis, proterus anectens and Clarias

These measurements shows that, the size of *Propterus anectens*is (Ankourou) lowest in January and gradually increasesto stabilizesin March, it further increases with a maximum value in December 2016as seen on Figure 16.The evolution in the size of *Clarias lazeras* (balbout) was not steady. The size fluctuated between months with a minimal size value observe in January 2016 (*Figure* 16). As for *Oreochromis niloticus* (Forfo), it size drop from December 2015 to a minimum value in march before increasing to a maximum value in May 2016 the variation is shown on (*Figure* 16). The reduction in size of the five fish species from October to Marchcan be explain by the reduction in lake water

levels as well as the high influx of animals around and into the lake and The high turbidity values couple with low dissolved oxygenconcentration. All these has an influenceon the growth of this fish species. (Figure 12)

3.2. Discussions

The variations in secchi disc values varies with an increase in lake water levels. During this periods of rise in water levels, the pH of water is definitely high (basic) which differ from results obtained by (13) and (14). During the twelve months of this work, the average temperatures recorded in the various points are respectively 15 and 25 ^{o}C. These values are in accordance with the work of (15).According to (16); (17), these temperatures values are compatible with a good pisicultural production. The values 15C and 25C are very far from been alimiting factor (6.5 C and 42.5C) for several fish species. The low temperature values (Figure 15) could be due to cold climatic conditions during this season.Water temperatureis an importance parameter in the life of aquatic organisms. It influence several physical, chemical and biological processes (18; 19).

The electrical conductivity of water is an indicator of the changes in composition of the materials and their total concentration.It is proportional to the quality of dissolved ionizable salts (20; 21).It shows the degree of total mineralization of surface waters.From this results, we can affirm that, agro sylvo pastoral activities could affect water quality of lake Fitri. However, (22) noted, that water quality of rivers and lakes varies with season, place and with the intensification of anthropic activities. Thus, the rarefaction of certain species in the lake can be explained by the deterioration of water quality by human activities. This same phenomenon was observed by (14) at the level of lake Selengué and Manantali in Mali.

The concentrations of dissolved oxygen (O_2) ranging between 9.9 and 27.86 mg/l at the edge and 7,8 mg/l and 51,8 mg/l at the center respectively. This dissolved oxygen is a fundamental element which intervene in a majority of biological processes. However, for a normal development of aquatic organizations, one needs a concentration of dissolvedoxygen for a threshold higher than 5 mg/l (23). Considering the results obtained during our research period, we could say that lake Fitri is well oxygenated: the concentrations are above the threshold of 5 mg/l without obstructions fornormal development of the aquatic life.

Looking at turbidity, the values were high in lake Fitri and beyond the standards established by the USA, UE, FAO and WHO for water used in fish culture. This high turbidity would be link to the massive presence of cattle grazing in the marshy zones around and in the lake. The results of these parameters disturb the dynamics of Lake Fitri. According to (24);(25), an increase in the load of water suspended solid and of the muddy deposits in the lakes and rivers, has many consequences on aquatic life among which we have the reduction in water transparency, which intend affect planktonic or benthic photosynthesis. This suspended solids can block the gills systems of fish or cause irritations. The muddy deposits deteriorate significantly the quality of the substrates on the surfaces of reproduction.

NO_3 constitute the final stage of the oxidation of nitrogen.When nitrate concentrations exceed the 12 mg/l, it indicates form of pollution (26; 19).In this studies we noted highconcentrations of nitrates.These NO_3 comes mainly from agricultures activities (nitrate fertilizers), domestic waste and sometimes from gold mining exploitation which are carried into the lake and rivers by run-off.

It is obvious that, the massive exploitation of fish in lake Tchad and the recent exploitation of gold around lake fitri constitute a threat to the ichtyo-fauna already threatened by agro-sylvo-pastoral activities. The research shows that, the biodiversity of the lake is made up of 18 species of fish divided into 08 families and 12 general, which is similar to the results obtained by (27). The principal fish species in the lake by order of importance are: *Clarias*sp (silures), *Tilipia sp*, *Shilbe mystus* (of very small size), *Protopterus anectensis* (mudcat fish), *Gnatonemus Niger*, *Polypterus sp* (with hard scales) and *Synodontis* (28). The analysis of fish size twice a month reveals that, most of the species are more than 18cm in length (*Claridae*19-52 cm, *Protopteridae*32-60 cm) except for species such as *Mochokidae*, *Mormyriade*. This high number of species can be explain by electrical conductivity which rangesbetween 80 and 300 µSm, this values are favourable for fish development as shown by Benech *et al (date of)(29)*;(30) in Nigerian (another part of lake Tchad), according to their study a conductivity lower than 400 µSm is favorable for the growth of *Mormyriade*. As for Species such as *Claridae*, there easily adapt water of low oxygen concentration. These ecological conditions can allow just the development of rustic species such as Clarias, Synodontis, Protopteres etc (31).

Conclusion

Taking into consideration this analysis, it is clearly established that agro-sylvo-pastoral practices do not constitute a handicap for water quality of lake Fitri at this time. Except for particular cases, the surface water in Lake Fitri is of good quality and relatively fresh. Their usage by families is however not

recommended nor for family consumption because of biological reasons (parasitic and microbial). The clearing of aquatic vegetation for cultivation does not pose problems when the lake profits from a "normal" rising in water level. In fact, the quantity of pesticides used in garden cultivation and for the food crops is still relatively very low to have an immediate impact on the water quality of lake Fitri. Its impact on the aquatic environments is not detectable on the scale of the basin.

During this study, it was not possible to confirm the hypothesis 1. The study also cancelled hypothesis 2. We would be dubitative for the third hypothesis the capture of immature stages of fish was prohibited and has a significant effort on fishing. The new fishing nets capture fish which is sold in great agglomerations such as ATI, Abéché and Ndjamena could explain the capture of the immature fish of smaller sizes.

In all, the state of water quality of lake Fitri is not alarming, but requires an increased vigilance and a permanent attention. However, significant efforts need to be make in terms of the quantitative and qualitative protection of these water resources in view to promote agricultural production, pastoral and halieutic system in this ecosystem.

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