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### RESEARCH ARTICLE

#### LAKE FITRI IN CHAD: SOCIO-ECONOMIC, ENVIRONMENTAL AND TECHNICAL ASPECTS OF FISHING AND DETERMINATION OF SOME PHYSICO-CHEMICAL WATER PARAMETERS

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#### Abstract

Lake Fitri is the second largest lake ecosystem in terms of area after Lake Chad. The purpose of this study was to assess the socio-economic, technical and environmental aspects of fishing and to determine some physico-chemical characteristics of the waters from Lake Fitri in Chad. Surveys were carried out from March 03 to April 08 and from July 10 to August 06, 2019 among 400 fishermen, processors and merchants from four islands of Lake Fitri where there is a high level of fishing activity. Standard methods were applied for the physico-chemical analysis of the water. The results revealed that fishing was mainly practiced by 74%, 10%, 15% and 1% respectively of Chadians, Nigeriens, Nigerians and Cameroonians. Marketing is carried out by 60% of Chadians, 20% of Nigerians and 20% of Nigerians. The study found a use of a variety of fishing gear and techniques, including 26% of longlines, 16% of standing nets, 25% of nets with polystyrene floats and 39% of nets. Financial contributions show that fishing represents a significant source of currency for this department. The water of the 4 islands of Lake Chad had mean pH, temperature and conductivity values of  $8.90 \pm 0.66$ ,  $25.61 \pm 1.75$  °C and  $363.26 \pm 75.41$  mS/cm respectively. Water turbidity ranged from 0.33 to 0.90 with a mean of  $0.55 \pm 0.17$  NTU, dissolved oxygen ranged from 13.46 to 19.17 mg/L with a mean of  $17.04 \pm 1.68$  mg/L. There was a significant difference between the values for temperature, turbidity and dissolved oxygen ( $p < 0.0001$ ), but no difference was observed for pH and electrical conductivity. Catches remain below the potential indicated by the FAO for water bodies of this type (between 100 and 750 kg.ha<sup>-1</sup>.year<sup>-1</sup>), which shows that there may be room for increasing fish production of this lake. The very lax management and use of fishing gear (traps) observed in these sites could constitute a threat to the maintenance of biodiversity and the productivity of natural ecosystems.

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## Introduction:-

Africa is a large continent endowed with considerable resources, but most of them are very unevenly distributed. In many places resources of all kinds are not fully known. It is necessary to ensure that improvements in living standards depend on research to discover new wealth and on the exploitation of this wealth. Lake Fitri is an endorheic lake, the second largest lake in Chad by area (around 70.000 km<sup>2</sup>), after Lake Chad. The unique Bahr batha flows, pours its waters into a vast flat plain, without outlet, on an average area estimated at 420 km<sup>2</sup> during low water periods (Courel et al., 1997; Magrin et al., 2011).

Fishing contributes to the survival of populations living near of rivers and lakes by providing them with food supplement and monetary income. The populations living along the shores of Lake Fitri in the Sahelian zone practice this activity along with agriculture and livestock farming (Ahidjo, 2010; Lemoalle, 2014). The recent arrival of professional fishermen from Bornou and Haoussa country is upsetting ancestral practices based on reduced and seasonal harvesting, using often rudimentary tools (Dagou et al., 2005). Newcomers are introducing powerful tools and techniques, increasing catches which are not only sold on local markets, but also exported to Nigeria and Cameroon. Fishing is practiced in a traditional way, closely linked to the functioning of the lake. Lake Fitri is a unique, very special and fragile ecosystem, extremely rich in natural resources, representing a biodiversity reserve of global interest. This is justified by the number of species living in this area. There are approximately 21 species of fish in Lake Fitri (Courel et al., 2005; Raimond et al., 2014). The fish species that inhabit Lake Fitri are adapted to shallow and warm waters (29 °C): high temperatures can threaten the life of some species. The water, forests and fisheries agency of YAO has identified the following species: *Mormyrus sp.*, *Alestes nurse*, *Clarias lazera*, *Clarias anguillaris (silures)*, *Gnathonemus niger*, *Polypterus sp.*, *Protopterus annectens*, *Schilbemystus*, *Synodontis sp.*, *Tilapia sp. (carpes)* (Lévêque et al., 1990; Courel et al., 2005).

At the lake level, fishing appears to be the most important economic activity. It would bring in around 26 billion CFA francs to households (Anihouvi et al., 2005; Lemoalle, 2014) against 15.5 billion CFA francs per year for growing crops, 8.6 billion CFA francs/year for livestock, 6.3 billion CFA francs/year for small irrigated areas and 5.5 billion CFA francs/year for large irrigated areas. According to the International Union for Conservation of Nature UICN (2008), Lake Chad is a highly productive ecosystem. The fishing gear used is generally the same on the lake and in the floodplains and results from a mix of more or less modern techniques (Eberschweiler, 2011). Fishing is a sector which has a significant impact on the economy of the populations living around Lake Fitri as well as on their food security. It provides income for the populations but also food self-sufficiency. More than a third of the fish caught in Chad comes from the lake and it is destined for the national market but also for markets in neighboring countries (FAO, 2009,2014). The growing population means that the department has growing needs to meet in terms of schooling, literacy, hygiene, employment, vocational training, drinking water supply, fuelwood, etc.

Population growth in developing countries is accompanied by an often poorly managed problem: the management of solid and liquid waste. These wastes continue to be dumped untreated into the rivers (lagoons), and water bodies (lakes) of some major cities in West Africa, posing serious health problems according to the report of the Assessment of Progress towards Sustainable Development in Africa (Lamizana et al., 2008). In some ecosystems, these chemicals can cause the disappearance of certain animal and/or plant species and therefore cause the malfunctioning of the food chain (Gold, 2002). Water is often considered to be the reservoir of many chemical pollutants (Yao et al., 2010). Africa is home to 15% of the world's population, but has only 9% of the world's renewable water resources, which are unevenly distributed across the region (Wang et al., 2014). Global water quality has greatly deteriorated in recent years, due to uncontrolled industrial discharges and the intensive use of chemical fertilizers in agriculture. The latter produce a chemical modification of the water and make it unsuitable for the desired uses (Rouabhia et al., 2004, 2010). One of the sources of pollution of water bodies is agricultural runoff, which contains agrochemicals as well as plant waste and livestock residues. In most African cities, rainwater carries solid household waste and other pollutants into rudimentary drainage systems and then into nearby rivers and groundwater (Taiwo, 2011). This situation is further aggravated by the insufficient application and non-compliance with urban planning regulations and principles (Osibanjo and Majolagbe, 2012). Lake Fitri in Chad is also confronted with these multifaceted pollution problems, as it receives inflows from rivers coming from neighboring countries like Sudan that travel long distance and urban industrial discharges without prior treatment from a highly industrialized and urbanized city (Ayada, 2003). This study was carried out with the aim of determining the different aspects of fishing and some physicochemical characteristics of the waters of Lake Fitri in Chad.

## Material And Methods:-

### Realization of survey

The study was conducted from March 03 to April 08 and from July 10 to August 06, 2019 in the department of Lac Fitri. Interviews with producers focused on the number of canoes/islands (Doumourou, Maguite, Moudou and Birgumi), gear and means of production, nationality, ethnicity, age, sex, level of education and religion. These data were collected from individual semi-structured surveys as described by Savoie-Zajc (1997).

### Physico-chemical analysis of water from Lake Fitri

Physicochemical parameters including temperature, pH, electrical conductivity, turbidity and dissolved oxygen were measured in the field with a WTW Multi-Parameter Kit equipped with Thermometer, pH meter, Conductivity meter, Turbidimeter and Oximeter. A total of 36 water samples were collected on the four islands of Lake Fitri (Doumourou, Maguite, Birguimie, Moudou) at a rate of nine (9) samples per year per island during the months of April to December from 2015-2018. The water samples were taken according to the method described by Chouti et al. (2010). At these four sites, the deepest area of Lake Fitri was set at approximately 4 m, before sampling was carried out using a pole with a polyethylene container suspended at one end. A sufficient amount of water was collected at a depth of approximately 50 cm and transferred to sterile 1-litre bottles while avoiding air entrapment in the bottles.

### Statistical analysis

The survey data collected were analyzed manually using the Epi-info software, version Eureka 2003. The data related to the physico-chemical parameters of the water were entered with the Excel 2016 software and then analyzed using the XLSTAT 2016 software. The analysis of variance (ANOVA) was performed using the Fisher's test (LSD) with a 95% confidence interval. The difference between the values was considered significant when  $p < 0.05$ . Principal component analysis (PCA) was performed using the Pearson (n) test.

Figure 1 shows the geographic location of the study area.

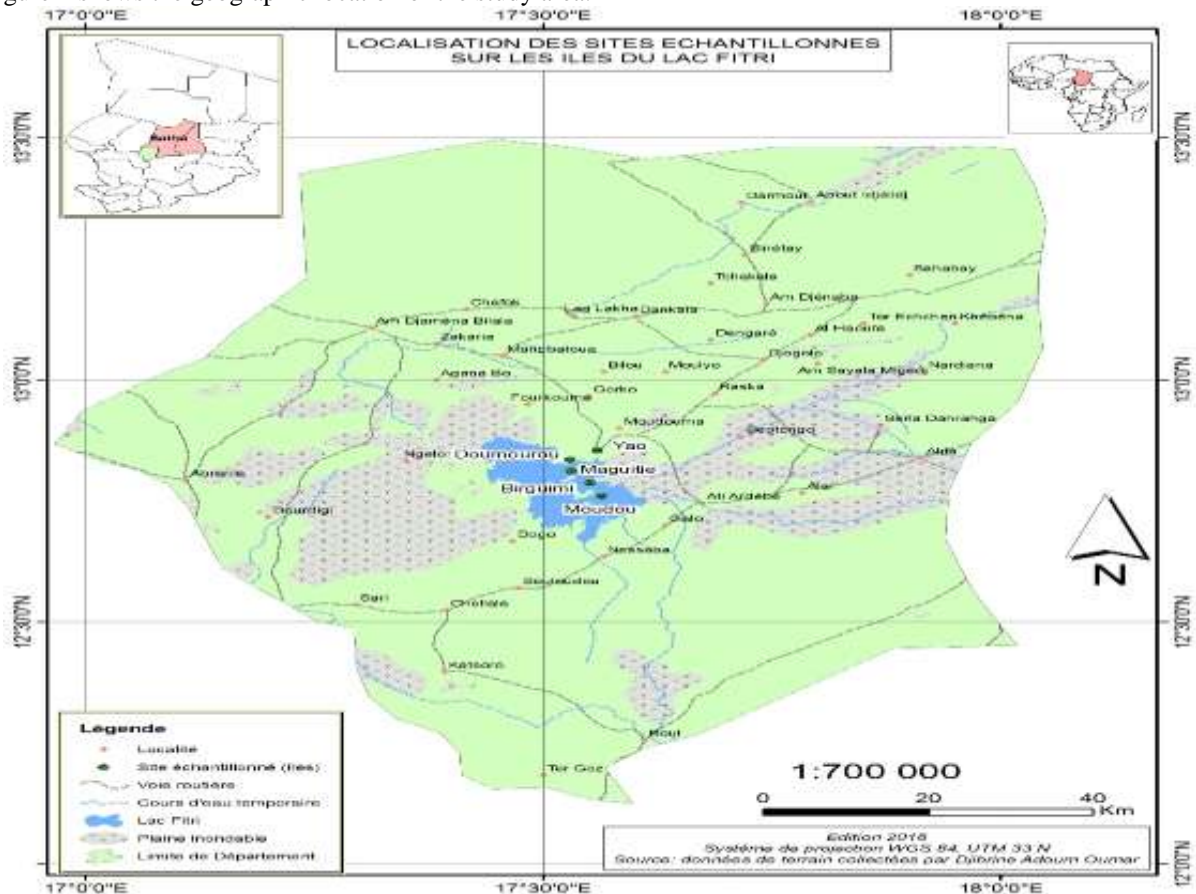


Figure 1:- Geographic location of the study area.

## Results:-

### Sociodemographic characteristics

The socio-demographic characteristics taken into account in this survey were the sex, age and level of education of fishermen, processors and traders. These characteristics, in particular the level of education, can greatly influence fishing practices.

The results obtained for these various characteristics are presented in Table 1.

**Table 1:-** Sociodemographic characteristics of the population studied.

Variable	Category	Fishermen	Processors	Consumers	Total
Age (years)	18-25	30	20	2	52
	25-30	40	30	5	75
	30-45	105	35	25	165
	40 and more	25	65	18	108
Gender	Male	180	135	47	362
	Female	20	15	3	38
Spoken language	French	43	20	14	77
	Arabic	205	100	18	323

### Gear or means used for fishing

In general, the highest concentrations of boats are recorded in the islands of Moudou (150 canoes), Doumourou (100 canoes), Maguite (90 canoes) and Birguimi (70 canoes) (Figure 2).

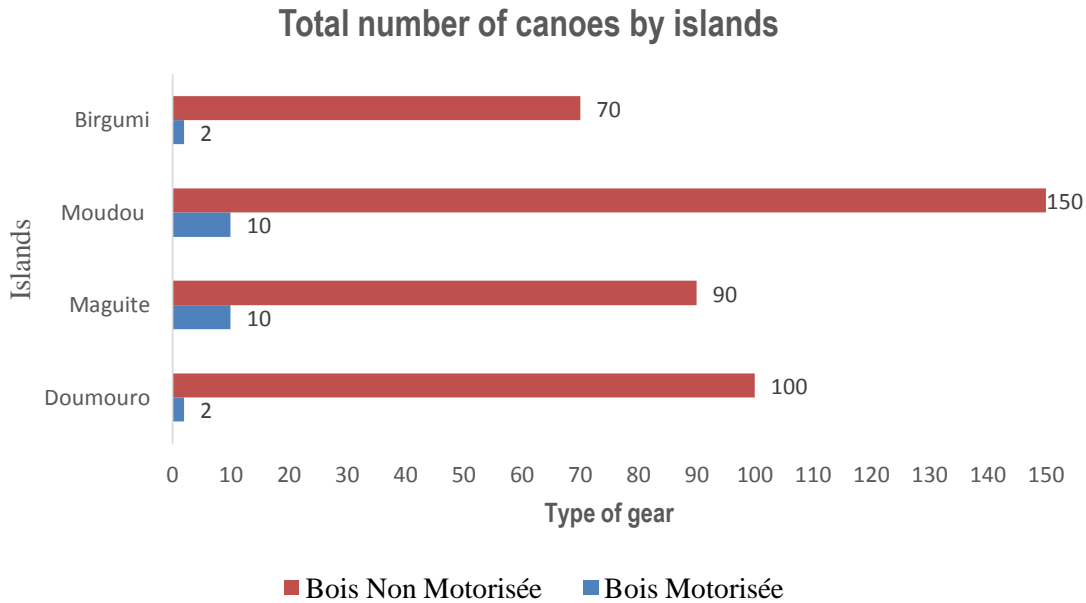


**A: non-motorized canoe**

**B: motorized canoe**

**Figure 2:-** The types of gear used in Lake Fitri.

Figure 3 shows the number of canoes (motorized or not) used by fishermen on each island.



**Figure 3:-** Number and types of canoes used.

#### Type of fish caught

The fish caught belong to 11 families and more than 17 species. The level of precision is sufficient for the present work which does not focus on biological aspects but on the ecosystems studied and their exploitation. Different species of fish such as *Mormyrus sp.*, *Alestes nurse*, *Clarias lazera*, *Clarias anguillaris* and *Gnathonemus niger* are sold on Lake Fitri. In the Yao market, we have *Schilbe mystus*, *Synodontis sp.*, *Tilapia nilotica*, *Tilapia galele* and *Eutropius niloticus* as fish species.

#### Population and activities

The *Bilala* and related ethnic groups represent 74.1% of the population of the Fitri department, followed by the *Massa* (7.83%), the *Haoussa* (4.36%), *Arabe* (0.00%), *Kanuri* (5.66%) and the *Boudouma* (7.86%), and other nationalities (Nigerien, Nigerian and Cameroonian). These populations carry out several activities, the main ones being fishing, agriculture (vegetable and food), salt extraction, weaving mat, etc. and which constitute, to a certain extent, a pressure factor on the ecosystems studied. Many have settled on the lake for two or three generations, more than 75% of these fishermen were born in Chad, except for those who work on the shore of Lake Fitri. Women are less present in catching activities (7% nationally). On the other hand, they are more specialized in post-catch activities, namely fish processing and trade. The Muslim religion is practiced by 90% of the population (360/400). Christians and animists respectively represent 5.5% (22/400) and 4.5% (18/400) of the fishing population. Anthropogenic variants are listed in Table 2.

**Table 2:-** Anthropogenic variants of the populations of the study site.

Variable	Fisherman	Transformer	Consumer	Total
<b>Ethnicities</b>				
<i>Bilala</i>	158	110	35	303
<i>Arab</i>	0	0	0	0
<i>Haoussa</i>	5	10	2	17
<i>Boudouma</i>	10	10	6	26
<i>Massa</i>	15	15	3	33
<i>Kanuri</i>	12	5	4	21
<b>Nationality</b>				
<b>Chadian</b>	148	80	30	258
<b>Nigerien</b>	20	40	10	70

<b>Nigerian</b>	30	28	10	68
<b>Cameroonian</b>	2	2	0	4
<b>Religion</b>				
<b>Muslim</b>	190	130	40	360
<b>Christian</b>	7	9	6	22
<b>Animist</b>	3	11	4	18

**Growth and density: two elements of pressure on ecosystems**

In terms of spatial distribution, the province of Batha presents a fairly homogenous distribution of the population with almost 6.78 % being nomadic against 93.22% sedentary. As a result, the population has a strong hold on the natural resources of the ecosystems, which is likely to lead to an increase in the destruction or even degradation of these phenomena. The population density in the provinces of Batha is shown in Table 3.

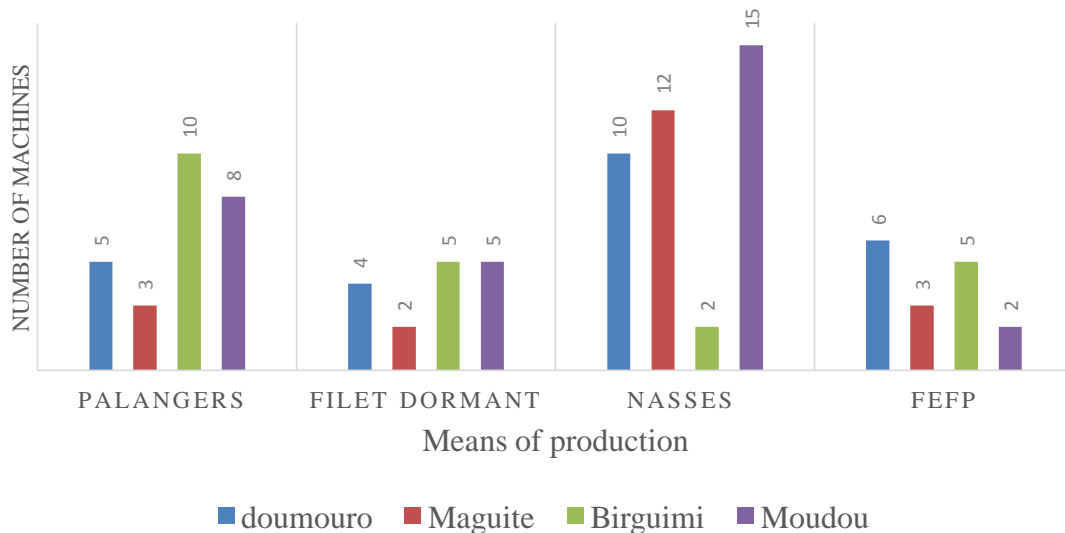
**Table 3:-** Density by department according to lifestyle in Batha provinces.

Department	Nomadic	%	Sedentary	%	Total
Batha West	20876	63.07	176836	38.83	197712
Batha East	3113	9.41	177230	38.92	180343
Fitri	9106	27.51	101297	22.25	110403
Total	33095	6.78	455363	93.22	488458

**Means of production and fishing technics**

Lake Fitri and island fishers use a variety of fishing gear and techniques. The characteristics of which vary according to the fishing zones, the financial capacity of each household or group of households and the degree of influence of innovations brought by foreign fishermen. The main fishing instruments used are: standing nets (16) and nets fitted with polystyrene floats (16), longlines (26) and nets (39). Highly prohibited practices, such as dams and fishing canals, are used respectively in Lake Fitri and islands. Dams consist of superimposing traps to obstruct the movement of fish during migration periods, while canals are open trenches running from the stream to the flood plain and are about seven (7) meters wide, four (4) meters deep and tens of meters long. They are fitted, at the start of the watercourse, with an airtight barrier made of interlaced wooden rods and reinforced with a mosquito net. If most of the gear is made locally (except the very large beach seines which come directly from Nigeria), all the materials used for their assembly (nets of nets, threads, hooks) come from Nigeria which imports them from Japan and from South Korea. Catch capacities differ depending on the gear, the season and the body of water.

There is a predominance of traps (39%); longlines (26%); standing nets (16%) and nets fitted with polystyrene floats (16%). On the island of Moudou, the Nasses remains the dominant gear while in Birguimi, fishermen use only nets and longlines. Figure 4 shows two examples of gear used in Lake Fitri.



**Figure 4:-** Means of fish production.

**Physico-chemical characteristics of water from 4 islands of Lake Fitri**

The Physico-chemical characteristics of Lake Fitri water are shown in Table 4 and 5. The pH values ranged from 8.4 to 9.5 and temperature varied from 21.67 to 28.33 with a mean of  $25.61 \pm 1.75$  °C. The values of conductivity, turbidity and dissolved oxygen ranged from 287.67 to 466.67 mS/cm, 0.33 to 0.90 NTU and 13.46 to 19.17 mg/L respectively.

**Table 4:-** Results of physico-chemical parameters of water from different islands of Lake Fitri.

Samples Code	Temp (°C)	pH	Cond (mS/cm)	Turb (NTU)	Doxy (mg/L)
IBS17	25.333 bcdefg	8.833 ab	376.667 abc	0.700 def	18.133 cde
IBA17	27.000 fgghi	9.500 b	433.333 bc	0.600 cde	19.167 e
IBD17	26.333 defghi	9.167 ab	393.333 abc	0.900 g	17.467 cde
IBO17	25.667 cdefgh	8.833 ab	357.667 abc	0.700 def	18.500 cde
IBN17	24.667 bcde	9.167 ab	393.333 abc	0.800 fg	17.500 cde
IMAA16	26.667 efghi	9.333 ab	466.667 c	0.400 ab	18.767 de
IMAS16	24.000 bc	9.000 ab	376.667 abc	0.633 cdef	17.467 cde
IDA15	26.667 efghi	9.500 b	433.333 bc	0.333 a	18.100 cde
IMOA18	27.333 ghi	9.500 b	433.333 bc	0.333 a	18.100 cde
IMAD16	25.000 bcdef	9.333 ab	360.000 abc	0.700 def	17.467 cde
IMOS18	26.000 cdefgh	8.500 a	333.333 ab	0.600 cde	16.867 bcde
IMOD18	26.333 defghi	8.500 a	294.333 a	0.667 cdef	17.467 cde
IDM15	27.667 hi	9.500 b	425.000 bc	0.400 ab	13.467 a
IDS15	24.000 bc	8.500 a	333.333 ab	0.600 cde	16.867 bcde
IMAAO16	27.000 fgghi	9.167 ab	350.000 abc	0.767 efg	16.833 bcde
IBM17	26.333 defghi	9.500 b	387.000 abc	0.533 bcd	16.500 bcd
IMAO16	25.333 bcdefg	9.167 ab	367.667 abc	0.533 bcd	17.467 cde
IMOM18	28.333 i	9.500 b	425.000 bc	0.400 ab	13.467 a
IMAN16	21.667 a	8.833 ab	360.000 abc	0.667 cdef	17.167 bcde
IBAO17	26.000 cdefgh	9.500 b	343.333 ab	0.633 cdef	16.167 bc
IMAJL16	26.333 defghi	9.167 ab	312.333 ab	0.533 bcd	17.500 cde
IMAJU16	26.000 cdefgh	9.000 ab	379.000 abc	0.633 cdef	17.233 cde
IBJU17	26.333 defghi	8.833 ab	333.000 ab	0.700 def	17.533 cde
IMAM16	26.000 cdefgh	8.667 ab	387.000 abc	0.500 abc	14.833 ab
IDD15	24.333 bcd	8.500 a	287.667 a	0.600 cde	17.467 cde
IMON18	24.000 bc	8.500 a	320.000 ab	0.500 abc	16.833 bcde
IDN15	24.333 bcd	8.500 a	320.000 ab	0.500 abc	16.833 bcde
IBJL17	26.333 defghi	8.833 ab	287.667 a	0.733 efg	16.833 bcde
IMOAO18	25.000 bcdef	8.400 a	343.333 ab	0.533 bcd	16.167 bc
IMOJU18	27.667 hi	8.500 a	377.333 abc	0.333 a	17.233 cde
IDJL15	26.333 defghi	8.500 a	358.333 abc	0.400 ab	16.500 bcd
IDO15	23.333 ab	8.400 a	324.667 ab	0.333 a	17.800 cde
IMOO18	24.000 bc	8.400 a	324.667 ab	0.333 a	17.800 cde
IDJU15	26.000 cdefgh	8.500 a	377.333 abc	0.333 a	17.233 cde
IDA015	24.000 bc	8.400 a	343.333 ab	0.533 bcd	16.167 bc
IMOJL18	24.667 bcde	8.500 a	358.333 abc	0.400 ab	16.500 bcd
<b>P value</b>	< 0.0001	0.136	0.476	< 0.0001	0.006

Temp: Temperature; Cond: Conductivity; Turb: Turbidity; Doxy: Dissolved oxygen;

NTU: Nephelometry Turbidity Unit. The values are the averages of three independent analyses. Values with the same letters in the same columns are not significantly different according to the Fisher test; 15: Year 2015 island Doumourou; 16: Year 2016 island Maguite; 17: Year 2017 island Birguimi; 18: Year 2018 island Moudou.



## Discussion:-

### Survey on fishing aspects

Fishing in the lake is artisanal and individual. It is most often practiced by a single fisherman, sometimes assisted. The catch is sold by the lake, in the village near the reservoir, or in the nearest town. However, a seasonal quantitative collection of catches by fish species is observed. This is not only due to the modification of the hydrological regime and environmental conditions. It is above all a reflection of a fishing effort that varies greatly over time and from one reserve to another. The causes of this variability lie mainly in the numerous conflicts between lake management committees and fishermen and to a lesser extent in the unavailability of fishing instruments (especially the net, often damaged by the many tree stumps). These variations can also result from periodic movements of fishermen to other fishing areas or to their home countries, cases of illness, etc.

The transformation is largely dominated by women, who are generally illiterate. None of the women interviewed actually followed the hygiene rules for food safety in processing activities. Our results are similar to those of the studies reported by Kokou (2010), on the evaluation of the microbiological quality of artisanally smoked fish in Togo, which reported that 6% of the women interviewed had received hygiene training. As fish is a perishable commodity, it must be processed in order to guarantee the health of the consumer. This cannot be achieved without respecting the hygiene rules governing processing. This will enable processors to market a product that is healthy and safe for consumers. Difficulties in the supply of fresh fish are due to fishing practices. Currently, the nets used by fishermen do not allow sustainable exploitation of the resource. Indeed, the meshes of these nets are very small, the juveniles do not reach maturity before being captured. This is an increasing overexploitation (Boncoeur, 2003; Djessouho, 2015). This leads to the lack of large fish on the Chadian market. The population's eating habits lead to a high demand for small fish among processors. This situation accentuates overexploitation. The lack of control over the factors of production (fishing instruments and regulations on the minimum size of fish allowed to be caught) also explains this over-exploitation as all the women interviewed declared that there is no control on the fishing sites.

The results obtained are in agreement with those reported by Eberschweiler (2011). This study shows that the devices used in Chad are identical to those used in many other countries (Paboung et al., 2013; Fougou, 2014). Fishing activity on the sites studied mobilizes a predominantly young population (30-45 years old). This observation corroborates with the results obtained by Boncoeur (2003) for which the age was between 37 and 46 years. The lack of professional qualifications combined with a high unemployment rate offers limited job opportunities for young people. Thus, they engage in this sector which often does not require qualifications as shown by the high illiteracy rate among fishermen in our study areas (65% men and 25% women), there is a 4% literacy rate, 66.6% of men and 20% of women can read in Arabic while 30% of men and 10% of women can read and write in French.

Similar results have been found in Côte d'Ivoire by Dietoa et al. (2007) and in Burkina Faso by DGPSA (2007b). These authors have shown that the majority of fishermen surveyed were illiterate (77.18%) and the remaining 22.82% had an insufficient level of understanding of French. People with a low level of education have difficulty finding a job in the formal sector, which partly justifies their high representation in the fishing industry (Baijot et al., 1994) where the activity does not require specific skills. The average percentage of uneducated women is 89%. The literacy rate of female processors in Chad is therefore 11% which is lower than the literacy rate calculated by UNICEF in 2013 which is 31%. This observation is similar to the study reported previously by Chabi et al. (2014) on the performance of an improved smoking device on the quality of smoked fish in southern Benin.

According to Ribier's (2004) studies on health standards and international trade, women traders in West Africa have not received as much education as their male counterparts. Many ethnic groups live in Lake Fitri, many of them present in several countries; in all, more than 70 ethnic groups are based there, each exploiting its immediate environment according to its activities. Most residents speak several local languages and one official language. The most widely spoken languages in the region reflect the political roles played during the pre-colonial period: *Kanouri*, *Fulfulde*, *Bilala*, *Hausa*, *Boudouma*, *Massa* and *Arabic*. These results are similar to those reported by Paboung et al. (2013) in a study on the Lake Chad basin. This study showed that the three main languages spoken there are *Kanouri*, *Fulfulde*, and *Arabic*.

Neiland and Verinumbe (1990) also reported that the *Kanouri* and *Hausa* ethnic groups are in the majority. This diversity of ethnic groups could be explained by the fact that Chad has almost always been in a situation of crisis and permanent war.

### Physico-chemical of water from islands of Lake Fitri

Water temperature is a parameter of major importance in the life of aquatic ecosystems. It has an influence on several physical, chemical and biological processes, in particular its density, its viscosity and the speed of chemical reactions. In the study area, the results obtained show that the difference was significant between the different water samples from the islands of Lake Chad. The average temperature is 25.61 °C. These values are similar to those recorded in the Chaouia region (Morocco) and the Biskra zones in Algeria (Guergaz, 2005). The pH of the water sums up the stability of the balance established between the different forms of carbonic acid. It is linked to the buffer system developed by carbonates and bicarbonates. It depends on the diffusion of carbon dioxide from the atmosphere as well as the origin of the water, the geological nature of the medium crossed, the discharge of wastewater, etc. In the case of the study region, the pH values of the lake waters show no significant variations, with an average value of 8.90, which indicates a slight alkalinity. The guidelines set by the World Health Organization (WHO) are 6.5 <math>pH < 9.5</math>. This allows us to conclude that the values obtained in our study are within the tolerable limit. According to Merceron et al. (1999), a pH which tends to be basic is not very favorable for the development of fish which lose their flesh and become skeletal at maturity. This result is similar to that found in different Moroccan regions such as Ouarzazate, Oujda, Kenitra and Chaouia (Boutayeb et al., 2012; El Hamouri et al., 1993; Oulkheir, 2002). Similarly, these pH values obtained in our study are close to those reported in other African regions (Guergazi and Achour, 2005; N'Diaye et al., 2013; Endamana et al., 2003). The pH values measured between 6.5 and 8.5 are acceptable according to Moroccan standards for the quality of wastewater used for irrigation (Boutayeb et al., 2012; Sonnenberg et al., 1998).

Water conductivity is an indicator of changes in the composition of materials and their overall concentration. It is proportional to the quality of dissolved ionizable salts (Nisbet and Verneau, 1970). It provides information on the degree of overall mineralization of surface waters. According to the European standard, the conductivity limit is fixed at 1500  $\mu S/cm$  for moderately polluted waters. The conductivity of water indicates its ability to conduct current, which depends on the mineral salt content of the water. Conductivity is closely related to the dissolved salt content of the water according to Pimpec (2002). Turbidity is a very important physical parameter which makes it possible to specify the visual information of the color of the water. Turbidity is caused by particles suspended in the water (organic debris, clays, microscopic organisms, etc.). It indicates a greater probability of the presence of pathogenic elements. Turbidity disrupts disinfection, the ultraviolet treatment is ineffective. Organic matter, associated with turbidity, promotes the formation of biofilms in the network, therefore, the development of bacteria insensitive to chlorine; in particular, the most important health-related effect of turbidity is probably its capacity to protect bacteria and viruses (Ould Mohameddou, 2006). The mean turbidity value in Fitri Lake water (0.55 NTU) is within the WHO recommended limit (<math>< 5</math> NTU) (WHO, 1996). However, above-standard turbidity values (between 6 and 9 NTU) were found in the water of Birguimi Island of Lake Fitri.

Dissolved oxygen is very important because it conditions the state of several mineral salts, the degradation of organic matter and the life of aquatic animals. It plays a key role in the maintenance of aquatic life and in the self-purification of watercourses with the help of microorganisms (Pimpec, 2002). Its presence in natural waters is mainly determined by the respiration of organisms, by the photosynthetic activity of the flora, by the oxidation and degradation of pollutants and finally by air-water exchanges. For all samples, dissolved oxygen varies considerably from one point to another. In general, low dissolved oxygen values favor the development of pathogenic germs. The low dissolved oxygen values were noted in the islands of Doumourou and Moudou, ie 13.47 mg/L. This can be explained by the high presence of organic matter in these islands. Dissolved oxygen is an extremely important parameter for assessing the impact of organic pollution.

### Conclusion:-

This study provided a better understanding of the different types of gear and means of production used in Lake Fitri and the islands, and an understanding of the impact of fishing on the environment and natural resources. The results showed that two types of canoes are found in the department of Lake Fitri and the Islands. These include non-motorized frame canoes (made of nailed boards) (5.53%) and motorized canoes (94.47%). The fishing nets used in Fitri Lake are not of regulatory mesh (less than 20 millimeters from one knot to another). Major difficulties were encountered, in particular the difficult accessibility of certain fishing sites and the non-collaboration of certain fishermen. The support of the Research Commission in Chad for the implementation of a sampling strategy based on the results of this study will make it possible to periodically assess the actual production of fishery products.

The results of the physico-chemical analysis, reveals a notable difference in the contents measured with a slightly alkaline pH (8.89) on average, a high average temperature (25.6 °C), a conductivity and turbidity and dissolved oxygen acceptable according to the WHO recommended standards. However, the waters of the islands of Lake Fitri are not suitable for consumption. Finally, measures must be taken to safeguard the environment next to the lake, which can transport chemical waste over long distances.

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