

## Anthropic and Natural Actions of Sanding up in Natron Cuvettes in the Lac Region in West Chad

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### ABSTRACT

This article deals with the anthropogenic and natural actions that are at the origin of the silting up of the Natron basins in the Lac region in western Chad. Indeed, the vulnerability of this region given its geographical location exposes it to many natural phenomena. These different actions are the factors of the silting up of the Natron basins in the Lake region which have harmful effects on the development of the Natron sector and the exploiting populations.

Moreover, human actions are real causes of environmental degradation in the Lake. To this end, man, both the peasant and the pastor, the city dweller or the political decision-maker, plays, through his activities and his developments, an essential role triggering wind erosion.

The methodology used in this study consists of interviewing ninety (90) Natron actors to collect their opinions on the factors of the invasion of Natron basins. Forty-one (41) interviews were conducted with the authorities and environmental and mining officials of the Lac region in order to know their opinions on the degradation of the ecosystem at the Lac in general and in the Natron basins in particular. Then, climatic data were collected at the ANIM (National Meteorological Agency) in N'Djamena to determine the actions of nature on the occupation of the Natron basins at the lake.

**Keywords:** anthropogenic and natural actions, sand encroachment, Natron basins, Lac region, Chad

### INTRODUCTION

For more than 100 years, miners have been exploiting Natron in the basins of the Lac region (Mbaiedji, 2010, p. 16). This Natron generated significant monetary income for the actors (Bayang, 2009, pp. 65-70) and was intended for human, animal and industrial consumption (Couty, 1966, pp. 119-131; Bayang, 2009, pp. 61-63).

However, it must be emphasized that wind speed, rainfall deficits, oppressive heat, etc. in the Lac region, natural actions have caused the silting up of Natron basins in this western part of Chad (Field surveys, 2021; ANAM, 2008; Bayang, 2023). To these natural phenomena, it must be said that the man of the Lake by these various actions through the agro pastoral and other activities that he carries out for his survival degrades the environment (Field surveys, 2021; Bayang, 2023, pp. 133-148). What leads the man participated in the silting up of the Natron basins of the Lake.

Anthropogenic and natural actions are the obvious causes of filling of Natron basins in the Lake region. This is how this silting impacts on the production, export and consumption of Natron in the Lac region through the two actions (Bayang, 2023, pp. 201-208).

### MATERIALS AND METHODS

#### Study Area

The study area is located in western Chad. It is limited to the north by Kanem; to the east and south by the Hadjer Lamis; to the West by Niger, Nigeria and to the South-West by Cameroon. It is one of the 23 regions of Chad whose capital is Bol. It corresponds to the former

Prefecture du Lac. The isolation of the Lake penalizes the socio-economic development of the region, in particular the constraints linked to the export of agro-pastoral products, Natron and the movement of people from the Lake to other regions of Chad and neighboring countries. The Lake was established as a region by ordinance n° 01/PR/2003 of September 23, 2003, thus creating decentralized territorial communities. The study area, which is the Lake region, is located between 10°21' and 14°40' North Latitude and between 13° and 15°30' East Longitude. It has an area of 22,320 km<sup>2</sup> or 2,232,000 hectares for a population of 451,369 inhabitants in 2009 according to the RGPH, with an average density of 20.22 inhabitants per square kilometer. It comprises five Departments: Mamdi, Wayi, Doum-Doum, Kaya and Fouli (Figure 1). This population, mostly made up of farmers and breeders, plays an important role in the degradation of the environment of the Lac region through their activities.

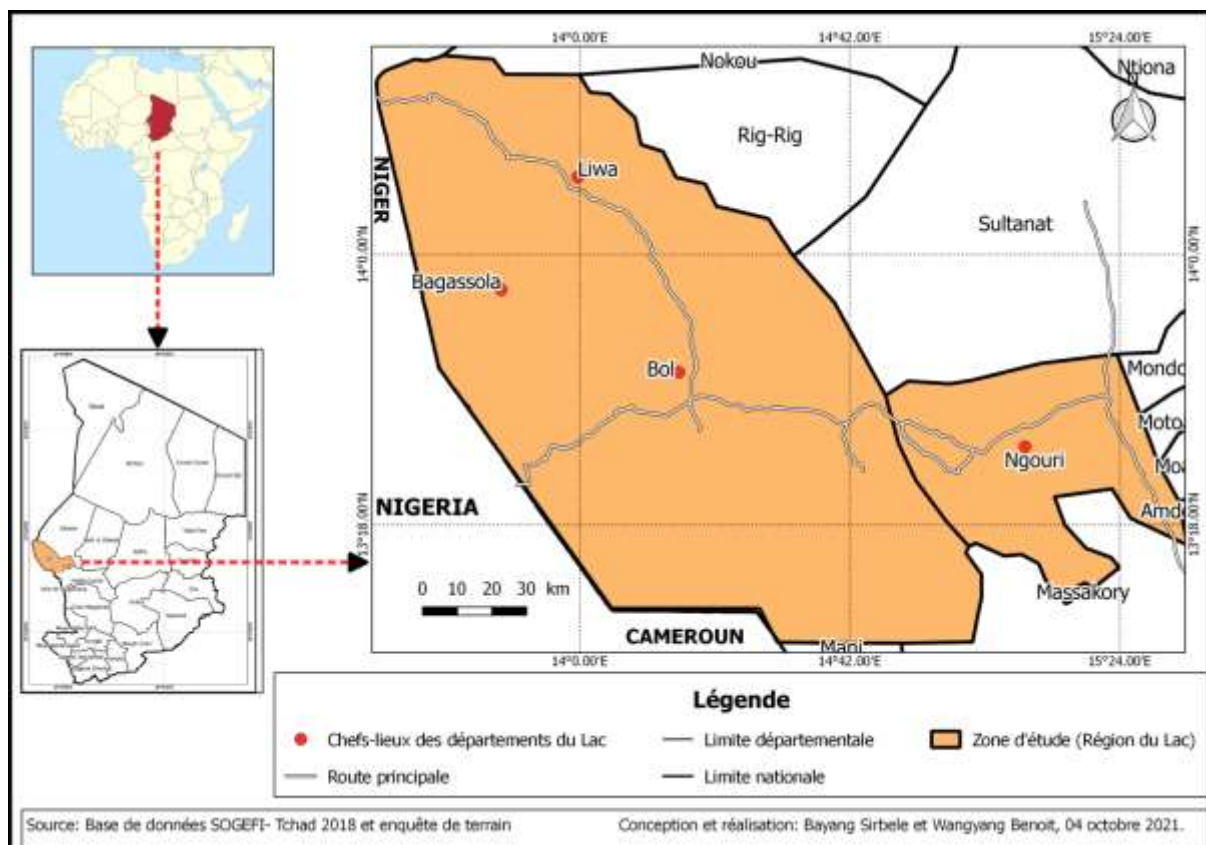


Figure 1. Situation and location of the Natron basins of the Lake

In Figure 1, the Natron basins are mainly located in the Bagassola and Liwa areas. These Natron basins experience the phenomenon of silting caused by anthropogenic and natural actions. It is in these two areas that surveys and interviews were carried out. Ngouri and Bol also have Natron called bourbour (powder). However, interviews with administrative and customary authorities, mining, water and forest officials took place in these localities.

### Methodological Approach

Several methods were combined in this study:

- Field work: this work consisted of collecting data on the factors of the silting up of Natron basins from the authorities and managers of mines, energy, water and forests in the region and the departments with guides from group interview;

- The surveys were conducted and data collected on the anthropogenic and natural actions of the invasion of the wadis with Natron from the actors of the Natron of Bagassola, Ngouri, Bol and Liwa with a survey sheet;
- Statistical data on rainfall, temperature and wind were collected at ANAM and in the libraries of CNRD, CEFOD, and CCU of N'Djamena.
- Using the GPS, the geographical coordinates of the Natron sites, the shots and other points relating to the factors of the silting up of the Natron basins were noted.

## RESULTS

### **Anthropic Actions of the Silting of the Natron Basins**

The plant formation of the Lac region is of the steppe type. She knows more and more these days a degradation. This degradation is due to agricultural, pastoral and logging activities in the region.

Indeed, the degradation of nature results from the human action which practices agriculture by the fence of thorns. The overexploitation of woody vegetation is explained by the need to protect the fields (korelo) using thorn fences or kalyi to fight against the incursions of a relatively large livestock in the region. Cultivation on the dune concerns pearl millet. For fencing their fields, farmers generally use thorny acacias such as acacia seyal, acacia nilotica, etc.

### ***Galloping Demography at the Lake***

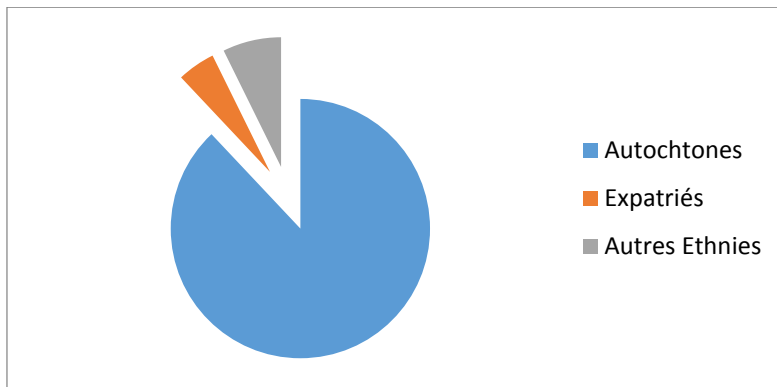
Humanly speaking, the population of the Lac, like other attractive regions of Chad, continues to increase. This is because of the natural potential available to the Lake Region. This is how many Chadians qualify the lake as one of the breadbaskets of Chad.

Its approximate population was 88,911 inhabitants in 1962. In 1968, an administrative survey was carried out and this calculated the population of the lake at 92,801 souls. In 1989, it was 127,974 inhabitants. With the 1st General Census of Population and Housing (RGPH) which took place in Chad in April 1993 and which lasted 6 months, the population of Lac is 248,226 inhabitants. It was the real census of the history of Chad carried out by the BCR (Bureau Central du Census). Sixteen (16) years after the 1st census, that is to say in 2009, the 2nd census was carried out. At this last census, the population of the Lake is 451,369 people counted. From 1993 to 2009, we see that the population of the lake has almost doubled. Because it went from 248,226 souls to 451,369 souls. The population has almost doubled from 2009 to 2021. It has gone from 451,369 souls to 804,165 inhabitants / this is what draws attention to the fact that the population of the Lake is indeed changing. It is made up of sedentary people and nomads. The Kanembou and the Boudouma are the majority in the region.

### ***✓ Migrant population at the Lake***

The Lake is a cosmopolitan region because its population includes several African nationalities (Senegalese, Malian, Nigerian, Nigerian, Cameroonian, Beninese, Ghanaian, etc.). Nigerians are the most numerous and the most mobile. These Africans who live in the region are attracted by the fishing which is favorable to Lake Chad. They are located much more in the islands such as Kinaserom, Tetoua, Fitiné, Koulfoua, Tchongolé, etc.

For the Chief of the Canton of Bol, Youssouf Mbodou Mbami said that: "the islands are very much exploited by foreigners who engage in intensive fishing and export the products to Nigeria". But because the profitability of fishing is no longer good, some of the foreign islanders grow sugar cane and potatoes. Others have become lumberjacks. This is the case of returnees and refugees. Among this foreign population there are also Chadians from other regions (Figure 2).



**Figure 2. Distribution of the Lake population in percentage**

Source: Laoro, 2001 and OCHA (2021)

Figure 2 shows that the natives represent more than 87.98%. The other ethnic groups from Chad to the Lac are representative at 7.3% and expatriates are at 4.72%.

The population of the Lac region increased in 2015 with the arrival of refugees, returnees and displaced persons (Table 1) due to the Boko Haram sect.

**Table 1. New migrants to the Lake**

Migrants	Number
Refugees	16 277
Returned	30 356
<b>Total</b>	<b>46 633</b>

Source: OCHA, 28 July 2021

Table 1 presents the new migrants to the Lac. These are refugees who number 16,277 people. The returnees number 30,356. This gives a total number of 44,633. The refugees in the Dra Salam camp number 15,911 people. Internally displaced people number 45,951.

Given the evolution of the Chadian population which is 3.23% and given the number of refugees and returnees to the Lac, the population of the Lac region in 2021 is 804,165 inhabitants. This population has almost doubled in 20 years from 2009 to 2021. The growth of the population of the Lake has a very strong influence on the natural resources of the Region and the silting up of the Natron valleys.

***Growing energy needs of the population***

The predominantly rural population of the lake consumes firewood (tchikako nnouyé) and charcoal (kourmouli), which are the only sources of energy. Indeed, firewood and charcoal represent more than 95% of the energy consumed in the rural and urban areas of the Lake. This means that firewood and coal are the basis of everything. Whether in Ngouri, Ngarangou, Bol, Bagassola, Liwa, Daboua, Kinasserom, Ngouboua, Koulfoua, Doum-Doum, Kouloudia or anywhere else on the lake, to cook, the inhabitants of these different localities use firewood or coal. In addition, this eradication of ligneous species from the region obeys much more to financial ends. It is therefore the loggers who engage in this activity (Photo 1).



**Photo 1. Image of a wood seller in Bagassola**

(Photo: Bayang Sirbéle, 2021)

Bagassola, August 01, 2021 (N 13°52'3.3'' and E 14°15'55.4'')

Photo 1 shows a young Mbororo in the town of Bagassola looking for customers to sell the wood transported by the dromedary. This wood is mainly used to make sheds, etc. It costs 3,000 FCFA per unit. Fulani men, they cut the branches of trees for sheds or roofs of houses. Camels provided transport to where they wanted to sell. The most affected species are doum palms, *Balanites aegyptiaca*, etc. (Photo 1). These young Mbororo men travel several dozen kilometers to arrive in the towns of Bagassola, Liwa, etc. to sell wood

The felling of trees in the Lake region is not only the work of the Mbororo but also of the wives of the soldiers, the Boudouma women, the Fulani, etc.

Deforestation intensifies for use as firewood or charcoal (cooking). It increases soil erosion by wind and rain. This environmental degradation causes droughts in the region, the main factor of climate change. This means that in the absence of vegetation, the soil is devoid of nutrients and therefore degraded and then bare.

#### ***Overgrazing of livestock***

In addition, the lake is a region conducive to breeding. However, this breeding is subject to excessive grazing resulting in a gradual reduction in the plant cover of perennial species and the trampling of the soil. Overgrazing is one of the essential factors responsible for the process of silting up at the lake. This is why Saleh (2008, p. 12) revealed that the animal plays an important part in the process of environmental degradation: "it is not the animal that poses the problem, but it is its management by the action of the man who owns it," he underlined. Bonfils (1987, p. 22) declares in relation to the impact of animals on the environment that: "everyone agrees in recognizing that domestic animals compromise the plant cover of the Sahel, sometimes by razing bare the herbaceous cover protecting wind erosion, and by initially destroying the shoots of young trees, whether these are spontaneous or planted. Much has been said about the damage caused by goats, which is indeed considerable, but other animals are also involved". From this statement, it follows that goats are the most destructive. And that the plant cover destroyed by domestic animals consists of grasses and shoots.

#### ***Congregation of livestock around water points***

During the dry season, the field survey found that there are significant gatherings of livestock around water points, herbaceous and shrubby vegetation. There, the ground is

constantly trampled and all the vegetation disappears. Consequently, the geographer Courrel (1985) said that: “it is mainly to trampling that we owe the aureoles of denudation around villages and water points”. The trampling of livestock leads to compaction, impermeability of the soil and then acceleration of the runoff phenomenon.

Where animal and anthropogenic action manifests itself, the plant cover decreases or disappears, and the ground, pulverized, is subject to water or wind erosion.

***Field fence with thorns***

Agriculture is undoubtedly the main activity followed by livestock farming and fishing at the lake. Rain fed agriculture is practiced during the rainy season in the Natron area. Traditionally in this area, the population cultivates millet on the dunes in the rainy season. However, the degradation of nature results from human action which practices agriculture by thorn fence (Photo 2).



**Photo 2. View of a fenced field in Bagassola**

(Photo: Bayang Sirbéle, 2021)

Kousseri, July 28, 2021 (N 13°32'9.3'' and E 14°18'49.6'')

This Photo 2 shows that the penicillary fields in Bagassola are fenced. These fences are made of the branches of acacia nilotica and other shrubs. All over the lake, the fields are thus fenced. In addition, it should be noted that the dune fields are located on the outskirts of the villages. These fields have made certain basins particularly sensitive to the phenomenon of silting. Indeed, this type of culture contributes greatly to the degradation of the ecosystem of the Lake Region. This degradation manifests itself through two different processes:

The first consists in fact of an overexploitation of woody vegetation which is explained by the need to protect the fields (korelo) using thorn fences or kalyi to fight against the incursions of a relatively large livestock in the region. Cultivation on the dune concerns penicillary millet. For fencing their fields, farmers generally use thorny acacias such as acacia seyal, acacia nilotica, etc.

This allows us to say in the end that these trees are thus cut down either for coal, the construction of sheds, houses, wood and heating or either for agriculture fenced with thorns. However, woody species bring a number of climatic disturbances to the environment.

**Natural Actions of Sanding up in Natron at Lake Valleys**

***Bare ground***

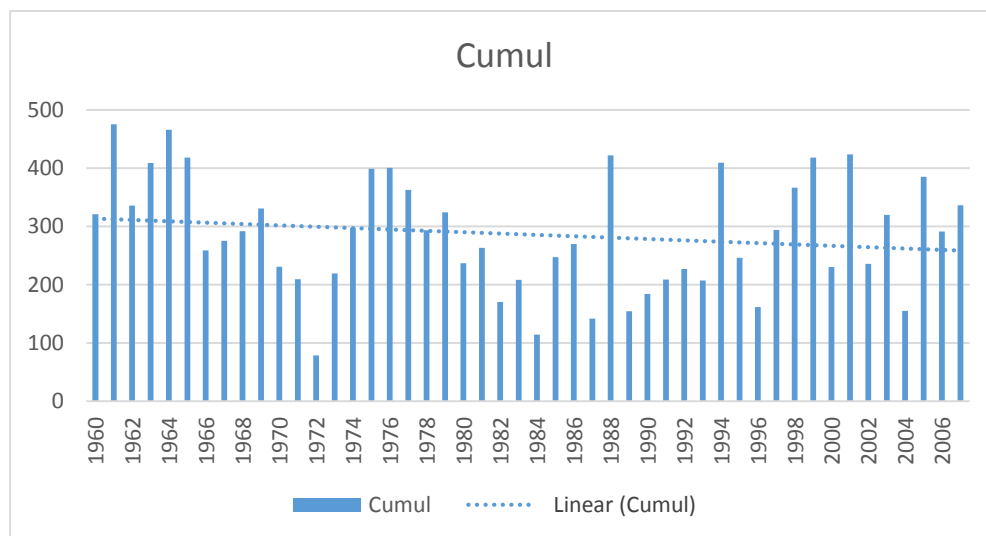
The Lake region has a variety of soils. These soils are called brown or red-brown soils, sandy steppe brown soils, and salty soils. They are poor and erodible.

In addition, in the Lake region, soils such as naga soils (term in Arabic meaning sterile), modern polders, semi-modern polders, traditional polders or false polders, sandy soils and subarid brown soils are distinguished. The soils are increasingly bare and degraded nowadays and erodible by the wind due to natural and anthropogenic actions.

***Recurrent droughts at the lake***

Everywhere else, rainfall is the determining factor of human activities, because it constitutes an essential link in the Sahel in general and in the Natron zone in particular. Rainfall is very poorly distributed over the Lake region. In addition, precipitation and its intensities are irregular and weak. They are most often late and cause droughts (Beauvilain, 1995, p. 8; Koumbaye, 1996, p. 19).

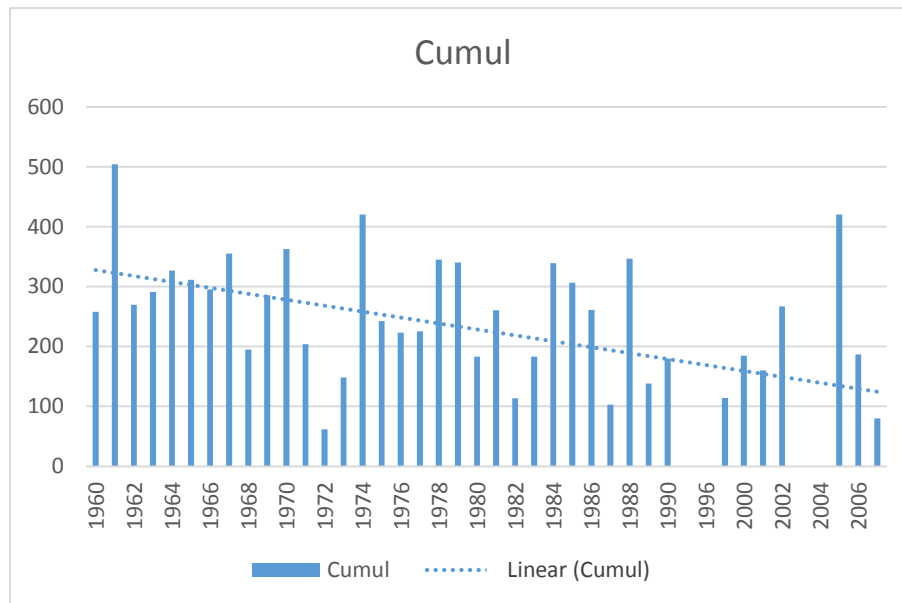
Droughts are frequent in CILSS member countries. At the Lac they are present because the region experiences rainfall deficits almost every ten years. The drought years of 1972 and 1984 in Chad in general and in the Lac region in particular are proof. These periods of drought have attracted the attention of many researchers and governments. At the lake, to better understand the phenomenon of drought, we can observe the low rainfall in Bol and Ngouri to understand the intervals of droughts. Rainfall records for 1972, 1987, 1982, 1998, 2007, etc. in Bol and from 1972, 1984, 1987, 1989, 2004, etc. in Ngouri are clearly in deficit (Figures 3 and 4).



**Figure 3. Low rainfall in Ngouri**

Source: Division of Climatology, DGM/N'Djamena, 2018

Figure 3 presents the data covering the period from 1960 to 2007. This range of years shows that the lowest rainfall was recorded in 1972 (78.6 mm). These weak and irregular rains were also observed in 1984 (114.4 mm), 1987 (141.5mm), 1989 (154.5mm), 2004 (155.1mm) and 1996 (161.7mm). It appears that these years 11972 and 1984 experienced low rainfall. Figure 3 also gives an idea of the low rainfall for eight years in the period 1960-2007, the average of which is 145 mm.



**Figure 4. Low rainfall in Bol**

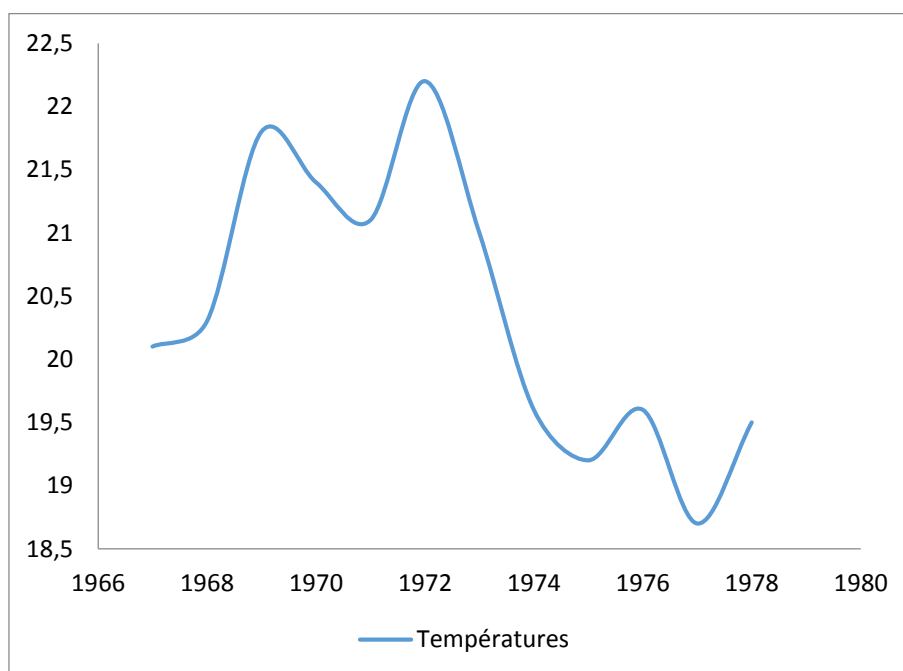
Source: Division of Climatology, DGM/N'Djamena, 2018

Figure 4, on the other hand, shows the case of the Bol station (1960-2007), the lowest rainfall dates from 1972 with a rainfall height of 62.0 mm, low compared to that of Ngouri (Figure 3). These light rains had also occurred in 2007 (80.1 mm), 1987 (102.8 mm), 1982 (113.4 mm). The average of these light rains over thirteen (13) years is 141.3 mm (Figure 4). The irregular rainfall observed in Ngouri is also found in Bol.

The low amount of rain in the region has a negative impact on production.

***High temperatures and evaporation***

The temperatures help to distinguish between the warm period and the cold period. They are constantly high, which causes intense evaporation and dries out the soil (Figure 5).

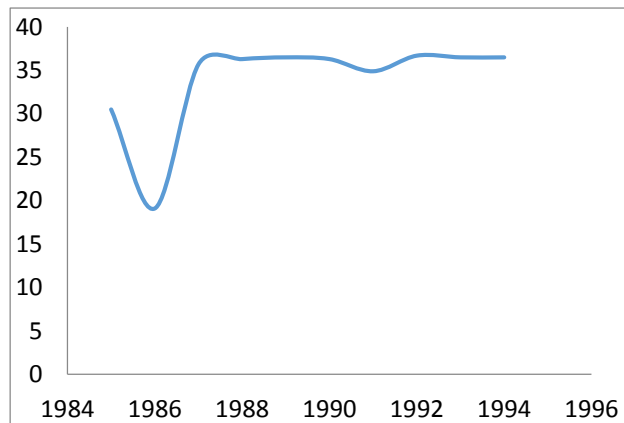


**Figure 5. Thermometric variation in Ngouri**

Source: Climatology Division, DREM /N'Djamena (2009)



Figure 5 presents the maximum temperature data in the locality of Ngouri (1967-1978). The observation leads to say that in 1969 and 1972, are the warmest years with a temperature of 22.0°C and 22.5°C. A similar situation is observed in Bol (Figure 6).



**Figure 6. Maximum temperature at Bol**

Source: Division of Climatology, DREM/N'Djamena (2009)

Figure 6 shows the temperatures for the decade (1985-1994) which are almost constant. They are between 30.5 and 36.7°C except for the year 1986 which had a temperature of 19.1°C.

The height of water evaporated per year in the Lake region is very high. The temperature is maximum in Bol, especially in March (36.6°C) and April (39.3°C) when the air is dry. This means that these are the two hottest months in Chad and in the Lac region.

***Increasingly dry and violent winds in the Lake region***

Overall, it should be noted that the intertropical zone is the domain of the trade winds, including the harmattan or boreal trade winds. It is a dry wind that considerably dries up nature. Then this wind carries fine particles (sand, silt, etc.) giving rise to dry mists. It comes from the Saharan anticyclone. It carries winds from the east and northwest of the Sahara to the southwest and dominates during the dry season. According to the Natron operators, the wind generally blows from November until February or March.

Another type of wind that prevails in the Lake region is what is called the monsoon. It is a maritime wind loaded with humidity. It is moving in the opposite direction of the harmattan. Among these two air masses, it is above all the harmattan which is at the origin of the silting up of the Natron valleys at the lake (Table 2).

**Table 2. Average Wind Speed (m/s) for Mao**

Year	J	F	M	A	M	J	J	A	S	O	N	D	T
1970	2.1	2.5	2.3	2.3	2.0	2.0	2.0	1.6	1.9	2.3	2.5	2.6	2.2
1971	2.4	2.4	2.3	2.3	2.2	2.3	2.2	1.6	1.7	2.3	2.6	2.7	2.3
1972	2.2	2.7	2.7	2.0	1.9	1.9	1.9	2.1	1.9	2.1	2.8	2.5	2.2
1973	2.5	2.5	2.7	2.4	2.4	2.1	2.3	1.7	1.9	2.3	2.9	2.5	2.4
1974	3.1	2.8	2.8	2.1	2.3	2.3	2.1	1.7	1.8	2.0	2.6	2.7	2.4
1975	2.6	2.3	2.4	2.1	2.0	2.2	1.9	2.0	1.8	2.1	2.2	2.6	2.2
1976	2.3	2.5	2.2	2.3	2.0	2.1	2.2	2.0	1.6	1.8	2.1	2.2	2.1
1977	2.3	2.8	3.2	2.4	2.0	2.1	2.3	1.6	1.6	2.2	2.1	2.4	2.3
1978	2.2	2.1	2.4	1.9	1.8	2.1	2.1	1.6	1.6	1.5	2.1	2.1	2.0
1985	3.0	3.2	3.5	3.0	2.9	2.2	1.9	2.1	1.8	2.0	2.1	1.9	2.5
1989	3.1	3.3	3.9	2,2	2,2	2,7	2,7	2,4	1,8	3,6	4,7	3,8	3,0

Source: DGM of N'Djamena (2019)

In Table 2, we find that the average wind speed in Mao varies according to the seasons. Thus, the maximum average speed oscillates between 1.6 m/s and 1.9 m/s. The absolute maximum speed recorded at Mao is 4.7 m/s in November 1989.

The lack of data on the wind speed in the Lac region made it possible to collect Mao's data in the Kanem region, neighboring the Lake region. In addition, the old data on rainfall and temperature are due to the lack of data available at the level of the General Directorate of Meteorology.

### DISCUSSION OF RESULTS

In this study, man and nature are the "two conductors" of environmental degradation in the Lake region and in the Natron basins. The results in this work are similar to that of Barry (1997, p 55), in which he mentions that the causes of the siltation of Africa are due to human actions, animal acts and climatic disturbance. Mahamat (1997, p. 135), meanwhile, recognizes that the arid climate is a consequence of the desertification of Chad. According to him, this phenomenon degrades the natural environment (vegetation, soil). He also notes that food crops on the slopes and excessive overgrazing are the causes of the silting up of the wadis in the Kanem prefecture. This leads to say that the results of Mahamat's work have similarities with this study.

In this work, quantitative measurements relating to recurrent droughts, temperature increases and active winds in the Lake region and in the Natron basins were recorded to determine the effects of these natural phenomena on the degradation of nature. Thus, the lowest rainfall in the region was 78.6 mm in 1972 in Ngouri and 62.00 mm the same year in Bol. The maximum temperature was notified in Bol in 1988 with 39.3°C. And finally, the absolute maximum speed recorded in Mao is 4.7 m/s in 1989.

### CONCLUSION

Ultimately, the study concludes that local phenomena (of anthropogenic and climatic origins) are the main causes of the silting up of Natron basins.

From the outset, it should be emphasized that droughts are not the only factors in the degradation of natural resources but also animals and people. Not only do these herds contribute to the destruction of the ecosystem but man as such intervenes directly in the modification of the landscapes of the Lake in a very important way. This with the aim of collecting firewood, coal, etc., which leads to deforestation linked to human agglomerations and their extension.

Then, should it also be said that climatic hazards such as droughts have become endemic.

However, if this ecosystem is degraded, the consequences of this degradation are very heavy for humans. For the lake mine, it is above all the silting up of the Natron basins.

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