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LAKE CHAD BASIN COMMISSION

ANNUAL MONITORING REPORT (AMR) OF THE LAKE CHAD BASIN

Hydrological year 2017 - 2018

german cooperation
DEUTSCHE ZUSAMMENARBEIT

Implemented by

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

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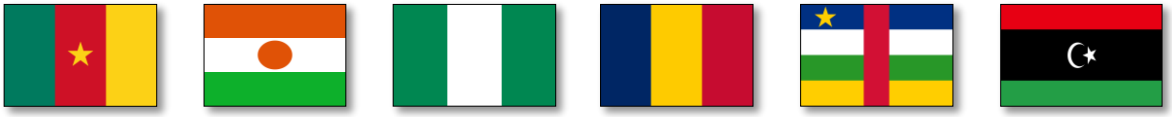

Executive Summary

The Lake Chad Basin Commission (LCBC) is mandated to facilitate the sustainable and equitable management and use of Lake Chad waters and other transboundary water resources in the Lake Chad Basin, to protect and conserve ecosystems, to promote regional integration and to preserve peace and security in the Conventional Basin in order to assist in the preparation and choice of decisions by all stakeholders.

With this mandate, the LCBC considers it necessary to prepare an **Annual Monitoring Report (AMR)** that provides an overview of the status of the natural and socio-economic resources monitoring system in the Lake Chad Basin. The AMR is a technical report, presenting the available data related to integrated water resources management (IWRM) collected in the Member States during the previous hydrological year for the purpose of monitoring the key indicators in the basin. These data include meteorological indicators (precipitation and temperatures data), basic socio-economic indicators (population numbers and HDI and food security), water resources (water levels and water quality) and biodiversity (protected areas and species composition) of the basin.

This report helps to identify gaps in the monitoring system and to be in a position to control and monitor the maintenance process and to react to changes.

In terms of meteorological, hydrological and hydrogeological data, the collection of available data of all monitoring stations by sub-basin shows that they are only a few data available and that monitoring stations are in a dilapidated state. The absence of monitoring and maintenance missions for the monitoring system cause significant gaps in the observed data series.

The deficient rainfall situation observed in the upper Lake Chad basin had a significant impact both on the water conditions of the rivers supplying the Lake and on the recharge of groundwater aquifers. Thus, the total volume of water recorded in the Lake in 2018 is 31.59 km^3, which corresponds to the small Lake in terms of water surface area (about 2,500 km^2).
The data collected from the few automatic dataloggers of groundwater stations in Chad show that the evolution of the groundwater level is mainly controlled by rainfall and flood periods in the various rivers. Moreover, there is no abnormal change in the groundwater level in the regions studied. The results of chemical analyses of groundwater show that the overall quality of groundwater is good. However, the levels of some elements (nitrate, arsenic, fluoride and/or faecal bacteria) are higher than the standards accepted by WHO and deteriorate the quality of the groundwater.

The development of this first AMR has not been completed without difficulties. Among the difficulties, we can mention the current insecurity in Nigeria, CAR and the vicinity of Lake Chad which has considerably affected the functioning of the States' technical services and thus makes it difficult, if not impossible, to collect some data that are crucial for the AMR and thus are still missing for the respective period. This is the case for actual census population data, groundwater and surface water abstraction data, hydrological and meteorological data from the Nigerian and Central African portions of the basin as well as reliable food security data (e.g. fishery production). Other difficulties are related to the inaccessibility of some data or the differences in data surveys and structures in the Member States.

This first Annual Monitoring Report was entirely prepared by the LCBC experts, with the support of the German technical cooperation GIZ and the consulting firm AHT GROUP AG, mandated by GIZ.

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List of Abbreviations and Acronyms

AFD	French Development Agency
AfDB	African Development Bank
AMR	Annual Monitoring Report
ANAM	National Meteorological Agency
ASECNA	Agency for Aerial Navigation Safety in Africa and Madagascar
BDR	Regional Database
BGR	Federal Institute for Geosciences and Natural Resources, Germany
BMZ	Federal Ministry for Economic Cooperation and Development
BUCREP	Central Bureau for population census and survey
CAR	Central African Republic
FAD	African Development Fund
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GEF	Global Environment Fund
GIZ	German Corporation for International Cooperation GmbH
GNI	Gross National Income
HDI	Human Development Index
IBA	Important Bird Area
IDP	Internally displaced populations
IRD	French Research Institute for Development
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
KBA	Key Biodiversity Area
LCB	Lake Chad Basin
LCBC	Lake Chad Basin Commission
LIS	Lake Chad Information System
NGO	Non-governmental organization
OAU	Organisation of African Unity
OIM	International Organization for Migration
OMM	World Meteorological Organization
PPP	Purchasing power parity
PULCI	Emergency Flood Control Project
RGPH	General Population and Housing Census
SOB	Report on the State of the Lake Chad Basin Ecosystem
STE	Société Tchadienne d'eau (Chadian Water Society)
UN	United Nations
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNHCR	Office of the United Nations High Commissioner for Refugees

1. Introduction

1.1 General Characteristics of the Lake Chad Basin

The Lake Chad Basin is located in Central Africa between 5th and 25th degrees north latitude and 5th and 25th degrees east longitude. The entire hydrological basin as a whole covers an area of 2,397,420 km² and extends as far as Algeria and Sudan. The conventional part of the Lake Chad Basin (the LCBC's intervention zone or the territory defined by the Fort Lamy Convention (now N'Djamena) in 1964) covers an area of 967,000 km^2, or about 40% of the whole watershed.

Rainfall in the basin varies from 100 mm to 1,400 mm from north to south, reflecting the presence of four types of climate: Sudano-Guinean, Saharan, Sudanian and Sahelian.

The geology of the basin consists mostly of Tertiary and Quaternary sedimentary formations. The Lake Chad Basin is surrounded by important landforms which give to the Lake Chad located in the centre of the basin an endorheic character, since it has no outlet. Soil of the Lake Chad Basin mainly developed during the Quaternary period. Furthermore, soil formation is dependent on the various landforms which exist in the Lake Chad Basin. Thus, we can distinguish soils with armoured surfaces, halomorphic soils and hydromorphic soils formed in the beds of rivers.

The hydrography of the Lake Chad Basin is dominated by the two main sub-basins: the Chari-Logone basin, which covers an area of about 690,000 km², and the Komadugu-Yobe basin, with an area of about 148,000 km². The contributions of its two rivers are vital for Lake Chad, apart from the direct precipitation it receives. In addition to these, there are smaller basins (on average 15,000 km² per basin): the Yedseram, Ngadda and El Beid basins.
Also included in this hydrography are floodplains, small lakes and ponds that provide important socio-economic and eco-system services, including aquifer recharge.

The Lake Chad Basin is rich in fauna and flora, characterized by many species of fish and migratory birds of various origins, especially in Lake Chad.
Protected areas of global importance have been created to protect them, but they are often poorly managed by state services because of lacking resources.

The human population in the Lake Chad Basin is characterized by great ethnic diversity. The same group can be found on either side of national borders.

The Lake Chad is now an important resource for most of the rural population, which is growing very rapidly, because it supplies agricultural and pastoral lifestyles as well as fish farming. Beyond these aspects, it is important to highlight the role of the Lake especially in the ecological balance of the subregion. The Lake Chad Basin is a transboundary basin in a region that has been and continues to be affected by climate change (temperature and evaporation rising and extreme weather events like recurrent droughts). Rigorous and balanced planning and management of the Lake Chad Basin are therefore essential whereby many important economic sectors such as fisheries, tourism, agriculture, but also transhumance and migration, must be taken into account.

1.2 Objective of the AMR

The Lake Chad Basin Commission (LCBC), established on 22 May 1964 by four riparian countries of the Lake Chad, namely Cameroon, Chad, Niger and Nigeria, which were joined by the Central African Republic in 1996 and Libya in 2008, has the mandate to facilitate the sustainable and equitable management and use of the waters of Lake Chad and other transboundary water resources in the basin, protect and conserve ecosystems, promote regional integration and preserve peace and security in the Conventional Basin in order to assist in the preparation and choice of decisions by all stakeholders.

With this mandate, the LCBC considers it necessary to prepare an Annual Monitoring Report (AMR) that provides an overview of the status of the monitoring system in the Lake Chad Basin and helps to identify gaps and to be in position to control and monitor the maintenance process and to react to changes. The AMR is a technical report, presenting the data collected in the Member States during the previous year for the purpose of monitoring the key indicators of the basin.

In addition, on 30 April 2012, the LCBC adopted a Lake Chad Basin Water Charter as a complementary treaty instrument to the Convention establishing the LCBC of 22 May 1964. The purpose of this instrument is to provide the LCBC and its member countries with a modern conventional legal text to ensure the sustainable management of the Lake Chad Basin in a context of increasing scarcity of water resources and environmental degradation, increased competition between the States for the control of the resources, with the risk of conflict that may arise from this situation.

The collection, exchange and storage of data in the Member States and the LCBC are defined in two legal texts. In accordance with Article 66 of the Water Charter (see Chapter 6) ratified by 4 Member States, it is stated that "*a Regional Database (RDB) is hereby established within the Commission and under its control, including data and information relating to the Basin, provided mainly by the Member States and intended to meet the needs of the Commission, the Member States, their partners or any other users. This database is managed by the Lake Chad Basin Observatory*"**.** Previously, it is stated in Chapter 10 of the Water Charter and in Articles 64 and 65 respectively that *States Parties have the obligation to regularly collect the data and information on their respective territories necessary for a better knowledge of the water resources and environment of the Basin* and also that *States Parties have the obligation to regularly exchange their data* and information available on the Basin, through the Commission in the context of sustainable management of the Basin, in order to improve their knowledge from the hydrological, environmental and socio-economic point of view.
In addition, the Basin Observatory will ensure the establishment of a Regional Database at the LCBC and a mechanism for data exchange between Member States. To fulfill this commitment, the Member States of the Commission also signed a Memorandum of Understanding in March 2008 on the exchange of data and information on various aspects concerning water resources in the basin.

The AMR is a technical report. More specifically, it is the collection of all available data for integrated water resources management (IWRM) for a hydrological year in the Lake Chad Basin. It has been developed on the basis of data and information collected in the LCBC Member States. These data also include basic socio-economic indicators, meteorological data, information about water resources and biodiversity of the basin. This report helps to identify gaps and to be in a position to control and monitor the maintenance process and to react to changes.

It is used not only by the Executive Secretariat for in-depth analyses, especially for the preparation of the next Report on the State of the Lake Chad Basin Ecosystem Report (SOB), but also as a basis for all Member States for more detailed analyses and for example the future planning of hydraulic infrastructure, irrigation perimeters as well as decision-making to face future challenges.

1.3 Methodology and Structure

The first Annual Monitoring Report was entirely prepared by the LCBC experts, with the support of the German technical cooperation GIZ and the consulting firm AHT GROUP AG, mandated by GIZ.

This Annual Monitoring Report (AMR) provides an update on the monitoring of the various water resource management related data in the Lake Chad Basin during the year 2017 and 2018. The Annual Monitoring Report for the period 2017-2018 highlights the work done by all LCBC stakeholders (Member States, Executive Secretariat, collaborators and partners...) in collecting data for integrated water resources management in the basin.

The report is divided into 7 chapters, 4 of which present the collected data in the Lake Chad Basin. These four technical chapters cover the following themes:

1. Meteorology with measured precipitation and temperature data in the Lake Chad Basin for the years 2017 and 2018;
2. Water resources with subdivisions in quantity and quality as well as surface and groundwater, and
3. Environment with data on protected areas, endangered species and ongoing initiatives for the conservation and implementation of wetland management plans in the basin, and
4. Basic socioeconomics with the number of people and refugees living in the Lake Chad Basin and data on food security (number of livestock, fisheries production and agricultural crop yields) by region.

In addition to these four technical chapters, there is a chapter on the status of implementation of the Lake Chad Basin Water Charter with its entry into force following the ratification of four (4) of the six (6) LCBC member countries. Following this chapter, the AMR provides a brief overview of projects and programs under implementation between 2017 and 2018 at LCBC. These projects include PRESIBALT, PURDEP, BIOPALT, the Regional Stabilization Strategy, the GIZ and BGR Partnership, etc.

It should be noted that the development of this first AMR was not completed without difficulties. Among the difficulties we can mention the current insecurity in the basin making it difficult or even impossible to collect some data, which are crucial for the AMR. This is the case for hydrological and meteorological data from the Nigerian and Central African portion of the basin. Other difficulties are related to the inaccessibility of some data that are subject to a charge, the very short time required to collect data from LCBC experts, the lack of human and temporal resources for data collection and analysis, and the limited exchange between the LCBC and the competent authorities of these member countries.

1.4 Events between 2017 and 2018

In terms of rainfall, the situation in the Lake Chad Basin during 2018 was characterized by heavy rainfall in the Sahel region of the basin. Excess cumulative rainfall with a normal tendency is recorded in the N'Djamena area. Thus, the total recorded precipitation at N'Djamena Airport station was 754.5 mm in 2018 compared to 423.8 mm in 2017, an excess of 330.7 mm or 44% compared to 2017.
Compared to the normal 1980-2017, the precipitation recorded in N'Djamena in 2018 remained 28.16% higher than normal.
However, the situation is particularly different in the southern part of the basin in the Sarh and Moundou region of Chad, where a significant rainfall deficit has been recorded. For example, at the Sarh meteorological station in southern Chad, cumulative rainfall of 501.4 mm was recorded in 2018 compared to 1337.4 mm in 2017, a decrease of 64.61%. Compared to the normal 1980-2017, the rainfall situation in Sarh also remained in deficit at 47.58%, or 501.4 mm against 956.5 mm.
In addition, in Moundou, rainfall close to normal (1980-2017) with a slight surplus was recorded, i.e. a total of 1061 mm against 1029.8 mm or 0.49%. Compared to 2017, overall rainfall in 2018 was slightly below expectations by 31.2 mm or 0.5%. (ANAM Chad 2018).

Overall, rainfall in 2018 declined in comparison to 2017. The poor rainfall situation observed in the southern Lake Chad Basin had a significant impact on the water conditions of the rivers supplying the Lake and also on the recharge of groundwater aquifers. This information is confirmed by satellite images of the Lake (see Figure 6 and Figure 7). This situation suggests a period of severe low water levels during the dry season in the main wetlands of the basin. Thus, the total volume of water recorded in the Lake in 2018 is 31.59 km^3 which corresponds to the small Lake in terms of water surface area (~2500km^2).

From a hydrogeological point of view, the evolution of the water level at groundwater observation points in the southern part of the Lake Chad Basin is marked by a seasonal fluctuation. This results in low drawdowns, which generally do not exceed one meter in the dry season. The recharge of the groundwater following precipitation at the beginning of the winter season, is of the order of one centimeter per meter on average at all the piezometers monitored.

Concerning groundwater, several sampling and monitoring campaigns in the Lake Chad Basin, including the Komadugu Yobe basin in Nigeria, Salamat, Yaéré, North of the Lake and N'Djamena, were carried out by the LCBC in collaboration with the "Sustainable Groundwater Management" project implemented by the BGR. The results of the chemical analysis (major anion and cations) show that most samples have concentrations below the WHO acceptable limits for safe drinking water.
However, there are cases where concentrations of nitrate, arsenic, fluoride and/or fecal bacteria are higher than the limit for drinking water recommended by the WHO. These sites are located in Jimbam, Gashua, Maiduguri (in the Komadugu Yobe basin), N'Djamena, Bahr El Ghazal, Salamat and Yaéré.
In view of this situation, it is strongly recommended that the competent authorities raise awareness of the risk among the population, treat contaminated water, prohibit its use through government regulation or provide new sources of drinking water and thus receive a good health education.

In terms of agricultural factor, most samples based on the percentage of sodium (Na) are of good and acceptable classes. Ultimately, groundwater quality in the study areas is generally

very good for agricultural activities.

It should be also noted that the Lake Chad region, bordering Cameroon, Chad, Niger and Nigeria, is an area affected by recurrent climate shocks.
For several months, it has also been confronted with a major security crisis and migratory flows, resulting in the degradation of the area's natural resources.
Climatic hazards, combined with violence linked to attacks by armed groups, have forced more than 2.4 million people to move, causing one of the largest population movements ever recorded on the African continent. Most of these displaced persons have lost their livelihoods and are now in the poorest areas of the 4 countries concerned. Seventeen million people are affected by the conflict, including 7 million people who are food insecure (Source: UNHCR Portal 2018).
In addition, the region faces structural development challenges, particularly in terms of youth employment, social cohesion and strengthening links between institutions, when it is confronted with insufficient good governance.

2. Meteorology

This chapter presents for each member country the state of the meteorological monitoring network located in or around the Lake Chad Basin.

2.1 Meteorological Monitoring Network in Cameroon

In addition to the national meteorological monitoring network managed by the National Meteorology Directorate (DMN), several other operators manage their own meteorological data collection networks, most of which are composed of rainfall data. These include, in particular:

- Research Institutes and Agencies: IRAD, CRH, ASECNA, CCAA
- Agro-industrial companies: SODECOTON, SEMRY, PHP, CARBAP
- Hydroelectric companies: AES-SONEL

In the absence of a nominative list of weather stations, we give the number of these stations. Indeed, the meteorological network of the Cameroonian portion of the basin counts:

- Two (2) climatological/synoptic stations;
- Thirty-two (32) rainfall stations;
- Four (4) agrometeorological stations.

Meteorological instruments are obsolete, insufficient or even non-existent even in the few stations which are still in operation. Inspection and maintenance logistics are non-existent, as are telecommunications facilities. These weaknesses, in terms of minimum service, remain relevant.

With regard to the operational status of this monitoring network, it should be noted that only the network managed by ASECNA operate in compliance with WMO standards and practices; elsewhere, there is still a lack of equipment and qualified staff in terms of number and quantity. It should also be noted that the meteorological observers are either already retired or in the process of exercising their retirement rights. The vast majority of those working in meteorological stations have never attended refresher courses despite innovations in observation methods.

Table 1: List of meteorological stations in Cameroon in the Lake Chad Basin

N°	Name	Code	Latitude	Longitude	Type	Sub-basin
1	Afadé	NA[1]	NA	NA	NA	Lake Chad
2	Amchidé	NA	NA	NA	NA	Logone
3	Bebongo	NA	NA	NA	Rainfall station (PULCI)	NA
4	Bogo	NA	10.7336	14.60928	NA	Logone
5	Bourrah	NA	NA	NA	NA	Yedseram 2
6	Doukoula	NA	NA	NA	NA	Outside of the Lake Chad Basin

[1] NA – Information not available

N°	Name	Code	Latitude	Longitude	Type	Sub-basin
7	Fotokol	NA	12.3775	14.2305	NA	Lake Chad
8	Gazawa	NA	NA	NA	Automatic weather station (PULCI)	Outside of the Lake Chad Basin
9	Goulfey	NA	NA	NA	NA	Chari
10	Guider	6485800	9.93417	13.94861	NA	Outside of the Lake Chad Basin
11	Homé	NA	NA	NA	Rainfall station (PULCI)	Outside of the Lake Chad Basin
12	Kaikai	NA	NA	NA	Rainfall station (PULCI)	NA
13	Kaélé	6485500	10.083	14.450	NA	Outside of the Lake Chad Basin
14	Kousseri	6485000	12.07689	15.03063	NA	Chari
15	Logone Birni	NA	NA	NA	NA	Chari
16	Maga	NA	NA	NA	Automatic weather station (PULCI)	Logone
17	Maga	NA	NA	NA	Rainfall station (PULCI)	Logone
18	Makari	NA	NA	NA	NA	Lake Chad
19	Maroua	NA	10.59095	14.31592	Parc meteo ASECNA	Logone
20	Maroua-Salak	6485100	10.45	14.25	UNEP Cameroon	Logone
21	Meiganga	6488200	6.53	14.37	NA	Outside of the Lake Chad Basin
22	Mindif	NA	10.39757	14.43626	NA	Logone
23	Mokio	NA	NA	NA	NA	NA
24	Mokolo	NA	10.73978	13.80188	NA	Logone
25	Mora	NA	11.04611	14.14011	NA	Logone
26	Mouda	NA	NA	NA	Rainfall station (PULCI)	NA
27	Moulvoudaye	NA	NA	NA	NA	NA
28	N'Gaoundere	6487000	7.35	13.57	Parc météo ASECNA	Logone
29	Pouss	NA	NA	NA	NA	Logone
30	Tchatibali	NA	NA	NA	Automatic weather station (PULCI)	Outside of the Lake Chad Basin
31	Touboro	NA	7.783	15.36	NA	Logone
32	Yagoua	6485140	10.34107	15.23288	NA	Logone
33	Waza	NA	NA	NA	NA	Logone

Source (https://geographic.org/global_weather/cameroon/index.html National Climatic Data Center)

2.2 Meteorological Monitoring Network of Central African Republic

The meteorological monitoring network in the Chari-Logone Basin in CAR counts:

- Eight (8) climatological stations;
- Forty-five (45) rainfall stations;
- Four (4) synoptic stations.

We do not hold the entire nominal list of the network.

Table 2: List of meteorological station in CAR in the Lake Chad Basin

N°	Name	Code	Latitude	Longitude	Type	Sub-basin
1	Bambari	1060002800	5.85	20.65	NA	NA
2	Birao	1060007000	10.28	22.78	NA	Bahr Aouk
3	Bossangoa	1060008500	6.48	17.43	NA	Bahr Sara
4	Bossembele	6460500	5.27	17.63	NA	ND
5	Bouar	1060009100	5.9703975	15.627502	NA	Bahr Sara
6	Bria	1060010300	6.53	21.98	NA	NA
7	Ndele	NA	8.39999	20.649999	NA	Bahr Aouk

The main operators running this network are:

- the Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA), for stations that are installed near aerodromes for flight protection purposes,
- the Meteorology Department, which operates the climatological, agrometeorological and rainfall network.

With regard to the operating status of the meteorological network, we note the following points:

- Insufficient staff and obsolete measuring instruments;
- Vandalism and closure of many of these stations, following multiple politico-military conflicts. All the Chari-Logone basin stations have been in a state of cessation of operation since 2013.
- Non-payment of fees to the observers, who have besides disappeared with all the equipment.
- Occupancy of the stations by dwellings.

In conclusion, we like to point out that no weather station is functioning; rehabilitation is needed.

2.3 Meteorological Monitoring Network of Chad

The meteorological monitoring network of the Lake Chad Basin on the Chadian side consists of synoptic stations, agro-climatological stations and rainfall stations (Direction Générale de la Météorologie Nationale 2016):

- Eighteen (18) synoptic operational stations and one (1) operational climatological station, often located on main and secondary aerodromes for immediate air navigation needs,
- Four (4) operational agro-climatological stations, equipped with the same types of instruments as the secondary (climatological) stations,
- 87 operational rainfall stations that record only the rainfall heights that have fallen in the localities where they are installed,
- Three (3) LCBC telemetry stations installed in 2015 by the NASA project

The network is essentially made up of conventional equipment that does not allow real-time data transmission for forecasting purposes.

The inventory of the meteorological monitoring network is based on previous work. Indeed, as part of its activities, the PULCI Project evaluated in 2015 the state of the meteorological network of the Logone sub-basin. It appeared that the Chari-Logone meteorological network is not in good condition: most meteorological stations are completely or partially destroyed or are no longer monitored due to lack of resources. Only a few synoptic stations still under the control of the Agency for Aerial Navigation Safety in Africa and Madagascar (ASECNA) have an average condition in some places.

The lack of weather stations in the country means that many large regions and populations vulnerable to climate disasters are not covered by monitoring.

Table 3: List of meteorological stations in Chad in the Lake Chad Basin

N°	Name	Code	Latitude	Longitude	Altitude	Type	Sub-basin
1	Abéché	1460000500	13.8498	20.8482	NA	NA	Borkou
2	Adre	1460001800	13.46667	22.2	NA	NA	Barh Azum
3	Am-Timan	1460004200	11.03124	20.27416	NA	NA	Chari
4	Ati	1460001400	13.21667	18.31667	NA	NA	Fitri
5	Baibokoum	1460008200	7.73333	15.68333	NA	NA	Logone
6	Ba-Illi	1460004700	10.51667	16.43333	NA	NA	Chari
7	Bandaro	1460009900	12.23333	18.71667	NA	NA	Fitri
8	Baro	1460003000	12.2	18.96667	NA	NA	Fitri
9	Bebedjia	1460007400	8.66667	16.56667	NA	NA	Logone
10	Bedjondo	1460019900	8.63333	17.18333	NA	NA	Ouham
11	Bekan	1460008500	7.73333	15.68333	NA	NA	Logone
12	Bekao	1460008400	7.91667	16.06667	NA	Automatic station (PULCI)	Logone
13	Bessada	1460013800	8.95	17.7	NA	NA	Chari

N°	Name	Code	Latitude	Longitude	Altitude	Type	Sub-basin
15	Bitkine	1460003900	11.98333	18.21667	NA	NA	Fitri
16	Bol Matafo	06-01969	13.5028097	14.6929417	287.8	NA	Lac
17	Bongor Prefecture	1460004500	10.28333	15.36667	NA	NA	Logone
18	Bougoumene	1460010200	11.46667	15.36667	NA	NA	Chari
19	Dadouar	1460002800	12.13333	18.45	NA	NA	Fitri
20	Delep	1460016800	12.68333	18.63333	NA	NA	Fitri
21	Deli	1460007000	8.71667	15.86667	NA	NA	Logone
22	Doba aéroporte	1146007500	8.66667	16.85	NA	Automatic station (PULCI)	Logone
23	Doba Prefecture	1460013900	8.65	16.85	NA	NA	Logone
24	Donia	1460007300	8.4	16.41667	NA	NA	Logone
25	Dono Manga	1460006500	9.23333	16.91667	NA	NA	Chari
27	Gassi	1460010300	12.06667	15.15	NA	NA	Chari
28	Gore	1460008600	7.93333	16.63333	NA	NA	Logone
29	Goz-Beida	1460003300	12.23333	21.41667	NA	NA	Chari
30	Guelendeng	1460004600	10.91667	15.55	NA	NA	Chari
31	Ham	1460010800	10.01667	15.7	NA	NA	Logone
33	Kinkin	06-01968	11.568838	15.2093513	303.6	NA	Chari
34	Koumra CT	4160013700	8.91667	17.51667	NA	NA	Ouham
35	Krim-Krim	1460015000	8.96667	15.8	NA	NA	Logone
36	Kyabe CT	1460006800	9.43333	18.93333	NA	NA	Barh Keita
37	Lai aéroporte	1460006300	9.4	16.3	NA	Automatic station (PULCI)	Logone
39	Madana	1460010900	9.0	16.66667	NA	NA	Logone
40	Mangalme	1460003100	12.36667	19.61667	NA	NA	Chari
41	Mao	1460000800	14.119529	15.31054	NA	NA	Dagana
42	Melfi	1460003700	11.06667	17.93333	NA	NA	Fitri
43	Moissala CT	1460007900	8.38333	17.78333	NA	NA	Ouham
44	Moito	1460002500	12.58333	16.55	NA	NA	Dagana
45	Mongo	1460002900	12.18333	18.68333	NA	NA	Fitri
46	Moundou	1460066000	8.5560346	16.0653076	NA	Automatic station (PULCI)	Logone
47	Moukoulou	1460003800	11.86667	18.2	NA	NA	Fitri
48	Moussoro	1460008900	13.65	16.5	NA	NA	Dagana
49	N'Djamena Aéroport	06-01913	12.1386049	15.0459152	295.3	ASECNA	Chari
50	Ngoura	1460016300	12.88333	16.45	NA	NA	Dagana

N°	Name	Code	Latitude	Longitude	Altitude	Type	Sub-basin
51	Ngouri	1460001300	13.63333	15.38333	NA	NA	Dagana
53	Nokou	1460014500	14.56667	14.78333	NA	NA	Chitati
54	Pont-Carol	1460018200	9.3	15.5	NA	NA	Logone
56	Tapol	1460014200	8.5	15.6	NA	NA	Logone
57	Yao	1460011400	12.85	17.56667	NA	NA	Fitri

2.4 Meteorological Monitoring Network of Nigeria

In the Nigerian part of the Lake Chad Basin, the meteorological monitoring network includes about 120 stations distributed as follows:

- 7 synoptic stations,
- 7 agro-meteorological stations,
- 12 climatological stations,
- and 95 rainfall stations.

The stations are managed by various agencies such as the Federal Department of Meteorological Services (FDMS), the Ministry of Agriculture (MOA), the Chad Basin Development Authority (CBDA), the Lake Chad Research Institute (LCRI) and various schools. The data is generally sent to Lagos without on-site copy retention. The operation of the network poses serious problems in terms of equipment maintenance and observer remuneration.

Table 4: List of meteorological station in Nigeria in the Lake Chad Basin

N°	Name	Code	Latitude	Longitude	Type	Sub-basin
1	Bauchi	6505500	10.28	9.82	ND	Outside of the Basin
2	Gusau	6501500	12.17	6.7	ND	Outside of the Basin
3	Ibi	6514500	8.18	9.75	ND	Outside of the Basin
4	Jos	6513400	9.87	8.9	ND	Jamaare
5	Kaduna	6501900	10.6	7.45	ND	Outside of the Basin
6	Kano	6504600	12.5	8.53	ND	Hadedja
7	Katsina	6502800	13.02	7.68	ND	Outside of the Basin
8	Nguru	6506400	12.88	10.47	ND	Hadedja
9	Potiskum	6507300	11.7	11.03	ND	Komadugu Gana
10	Sokoto	6501000	13.02	5.25	ND	Outside of the Basin
11	Yola	6516700	9.23	12.47	ND	Outside of the Basin
12	Zaria	6503000	11.13	7.68	ND	Outside of the Basin
13	Madaiguri	NA	NA	NA	ND	Yedseram 2

2.5 Meteorological Monitoring Network of Niger

The meteorological monitoring network of the Lake Chad Basin in Niger includes 21 stations

- 6 synoptic stations,
- 4 climatological stations
- and 11 rainfall stations.

In this network, 4 rainfall stations are outside the Conventional Lake Chad Basin.

Table 5: List of meteorological station in Niger in the Lake Chad Basin

N°	Name	Code	Latitude	Longitude	Type	Sub-basin
1	Agadez	6102400	16.96991	7.980056	NA	Komadugu Yobe
2	Bilma	6101700	18.67851	12.91607	NA	Komadugu Yobe
3	Maine Soroa	6109600	13.20679	12.02975	NA	Komadugu Yobe
4	N'Guigmi	6104900	14.25014	13.12018	NA	Komadugu Yobe
5	Zinder	6109000	13.78260	8.982147	NA	Komadugu Yobe
6	Diffa	NA	NA	NA	NA	Komadugu Yobe
7	Goudoumaria	NA	NA	NA	NA	Komadugu Yobe
8	Gouré	NA	NA	NA	NA	Komadugu Yobe
9	Magaria	NA	NA	NA	NA	Komadugu Yobe
10	Zinder	NA	NA	NA	NA	Korama

2.6 Overview of Meteorological Stations located in the Conventional Lake Chad Basin

The following map shows the gauging stations in the Conventional Lake Chad Basin. The LCBC disposes over precipitation or temperature data for the hydrological year 2017 to 2018 for only 55 stations located in the Chari-Logone and Komadugu Yobe basin (highlighted in dark blue Figure 1). These data, most of which are incomplete, are presented in Chapter 2.7.

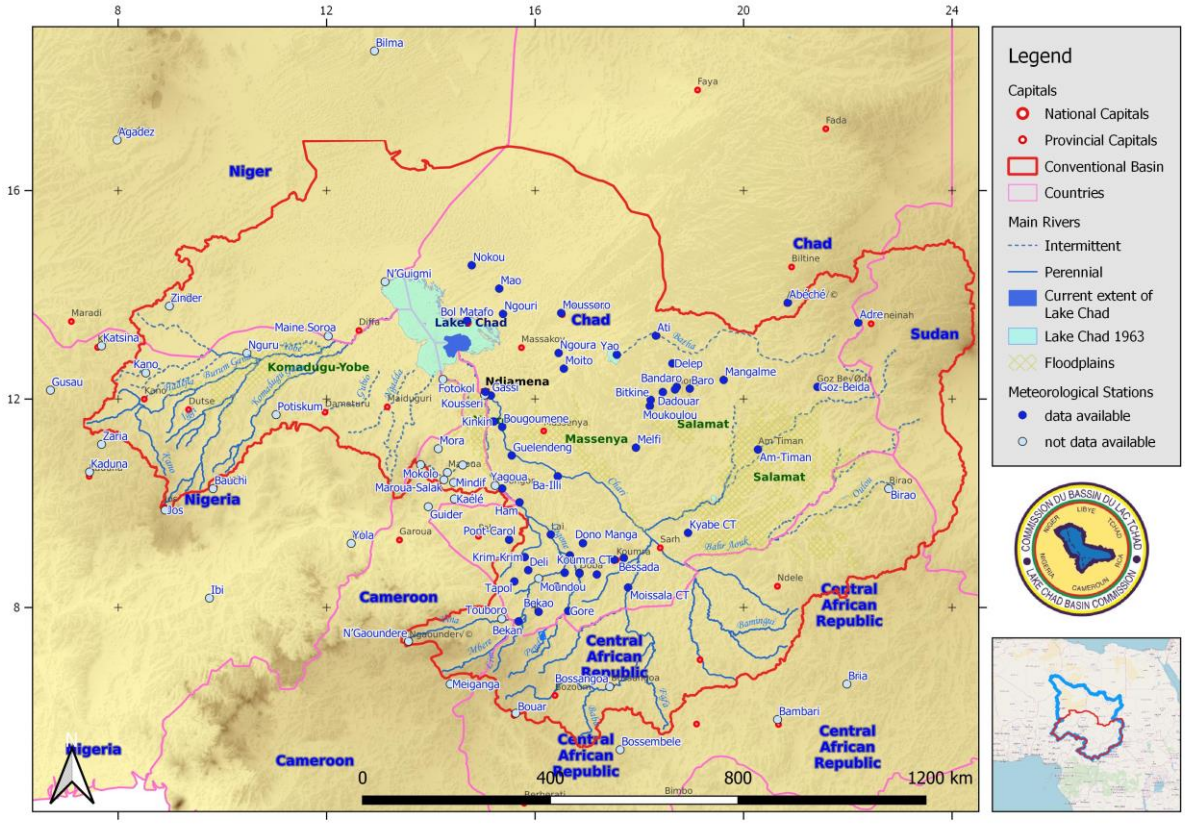
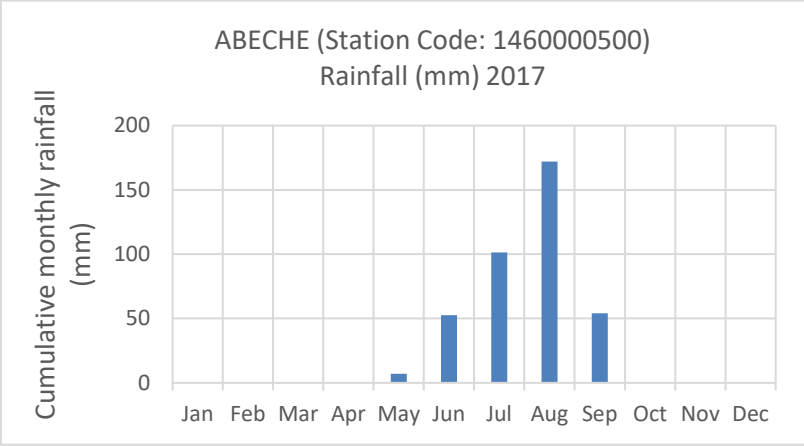


Figure 1: Map of the location of meteorological stations in the Lake Chad Basin in Chad with available data for 2017 and/or 2018

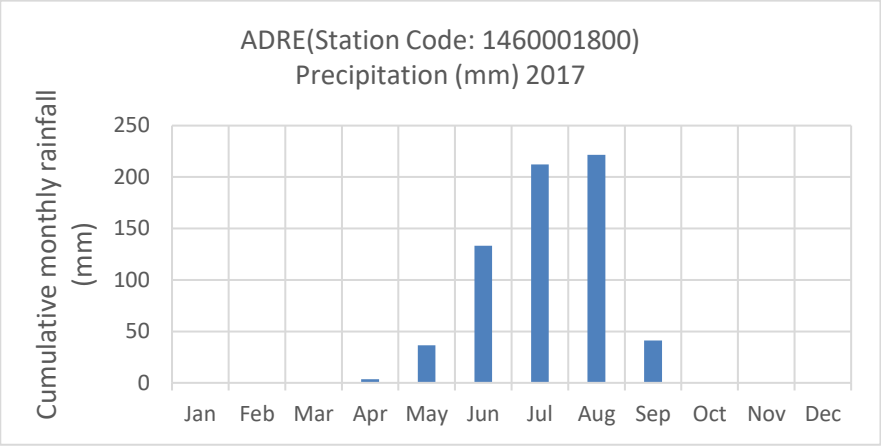
2.7 Precipitation and Temperature Data from Meteorological Stations located in the Lake Chad Basin

2.7.1 Bourkou - Barh Azum - Barh Keita Sub-Basins

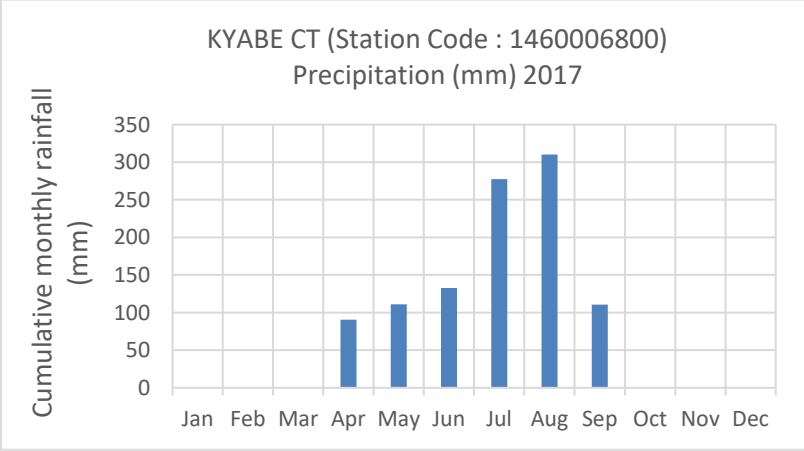
Meteorological station of Abéché (Location 13.8498/20.8482) monthly precipitation data of 2017



Meteorological station of Adre (Location 13.46667/22.2) monthly precipitation data of 2017

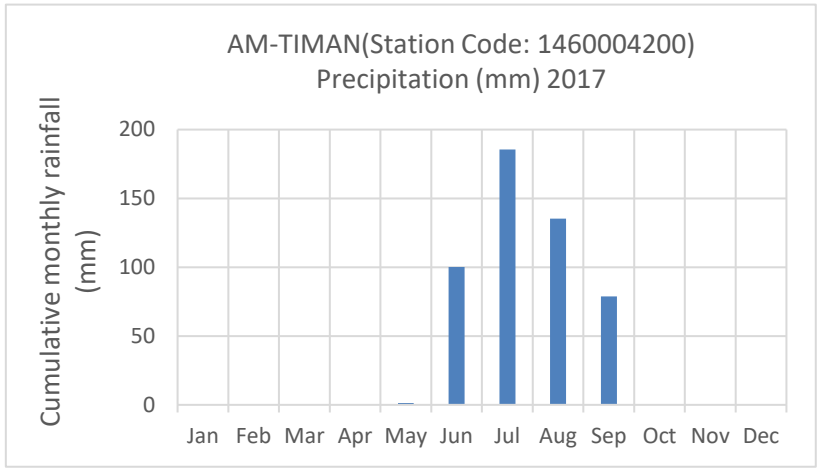


Meteorological station of Kyabe CT (Location 9.43333/ 18.93333) monthly precipitation data of 2017

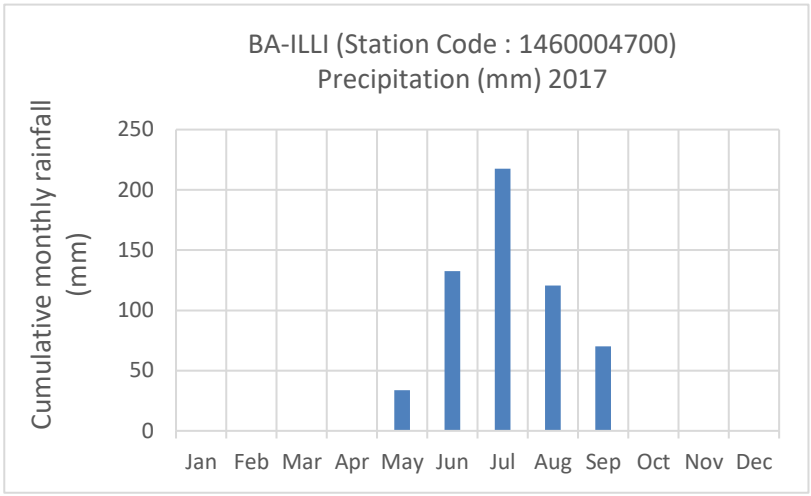


2.7.2 Chari Sub-Basin

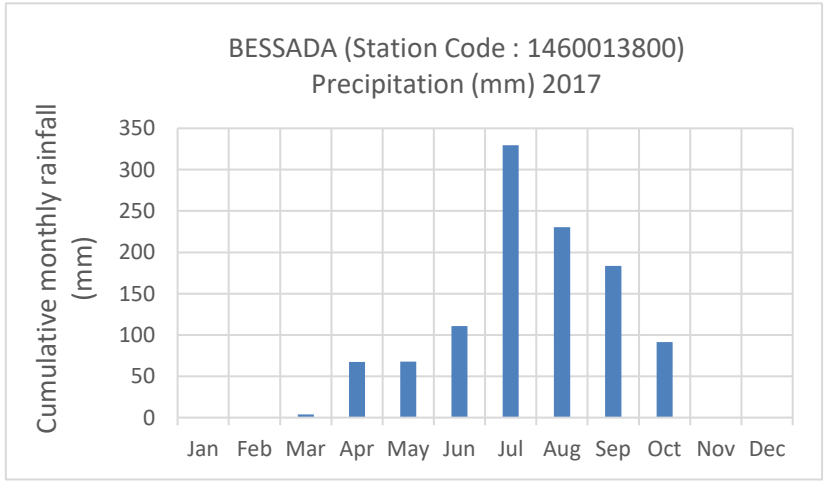
Meteorological station of Am-Timan (Location 11.03124/20.27416) monthly precipitation data of 2017



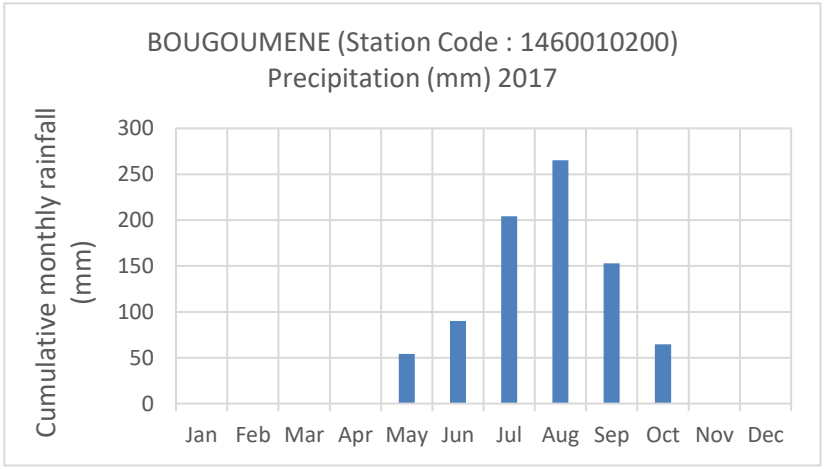
Meteorological station of Ba-Illi (Location 10.51667/ 16.43333) monthly precipitation data of 2017



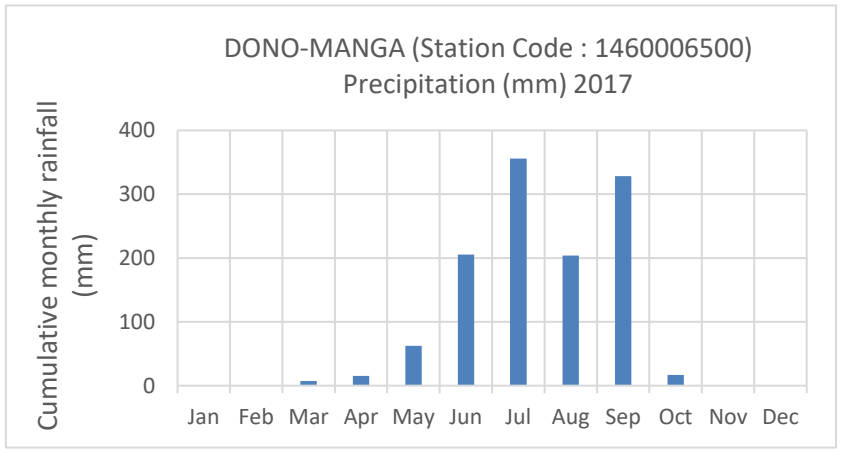
Meteorological station of Bessada (Location 8.95/ 17.7) monthly precipitation data of 2017



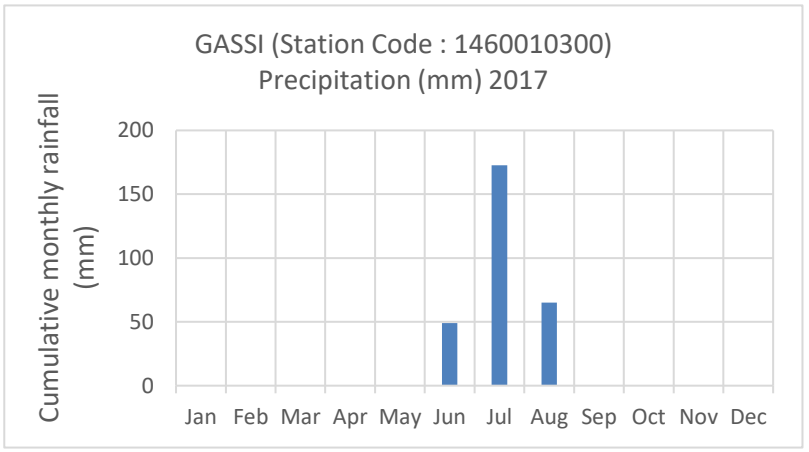
Meteorological station of Bougoumene (Location 11.46667/ 15.36667) monthly precipitation data of 2017



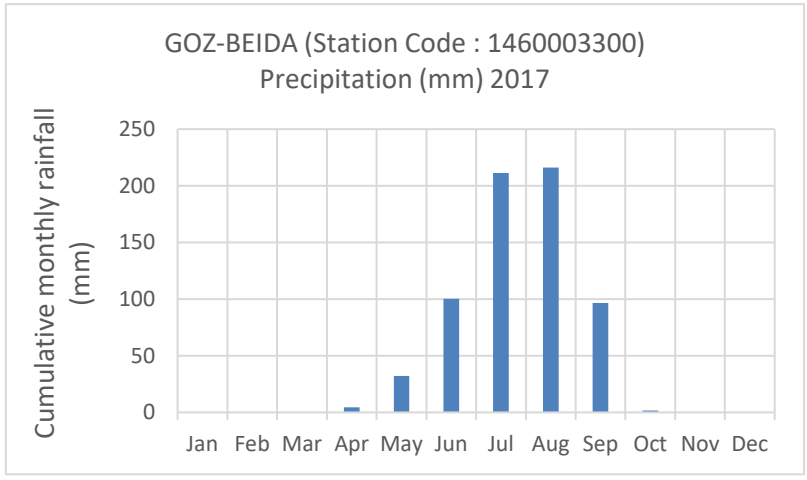
Meteorological station of Dono Manga (Location 9.23333/ 16.91667) monthly precipitation data of 2017



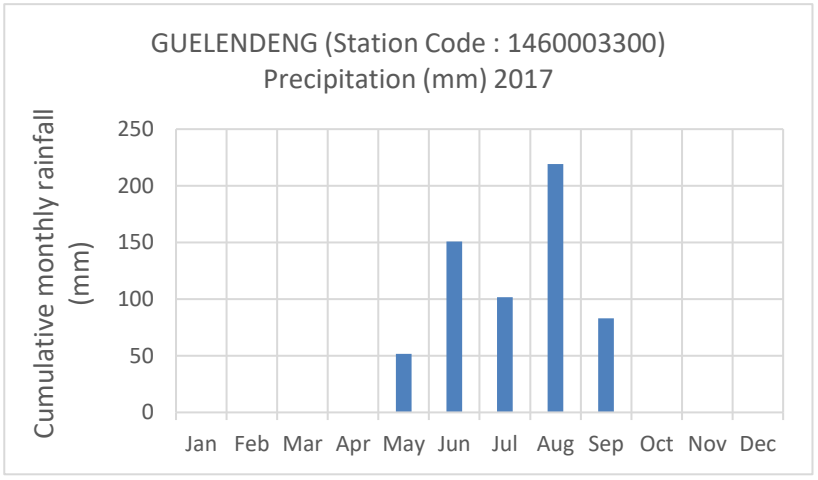
Meteorological station of Gassi (Location 12.06667/ 15.15) monthly precipitation data of 2017



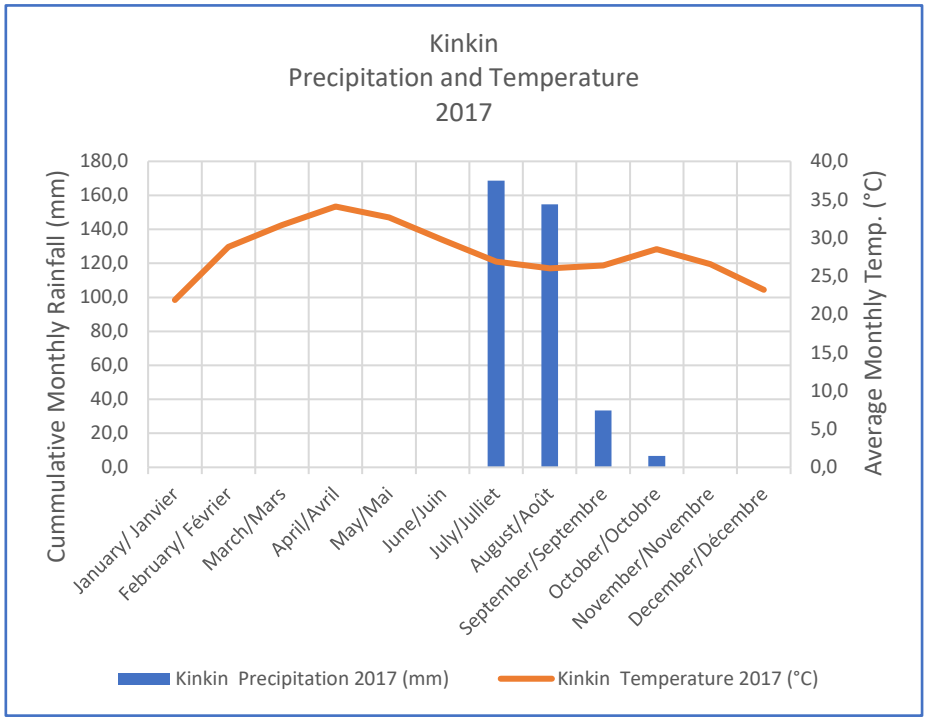
Meteorological station of Goz-Beida (Location 12.23333/ 21.41667) monthly precipitation data of 2017



Meteorological station of Guelendeng (Location 10.91667/ 15.55) monthly precipitation data of 2017

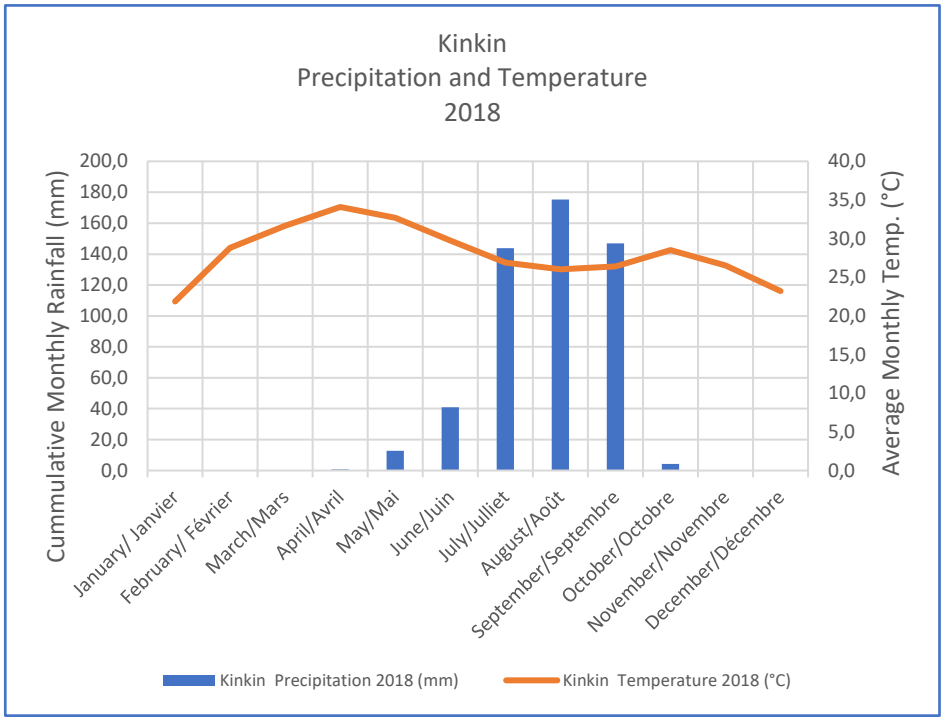


Meteorological station of Kinkin (Location 15.045833/12.138500) monthly temperature and precipitation data of 2017



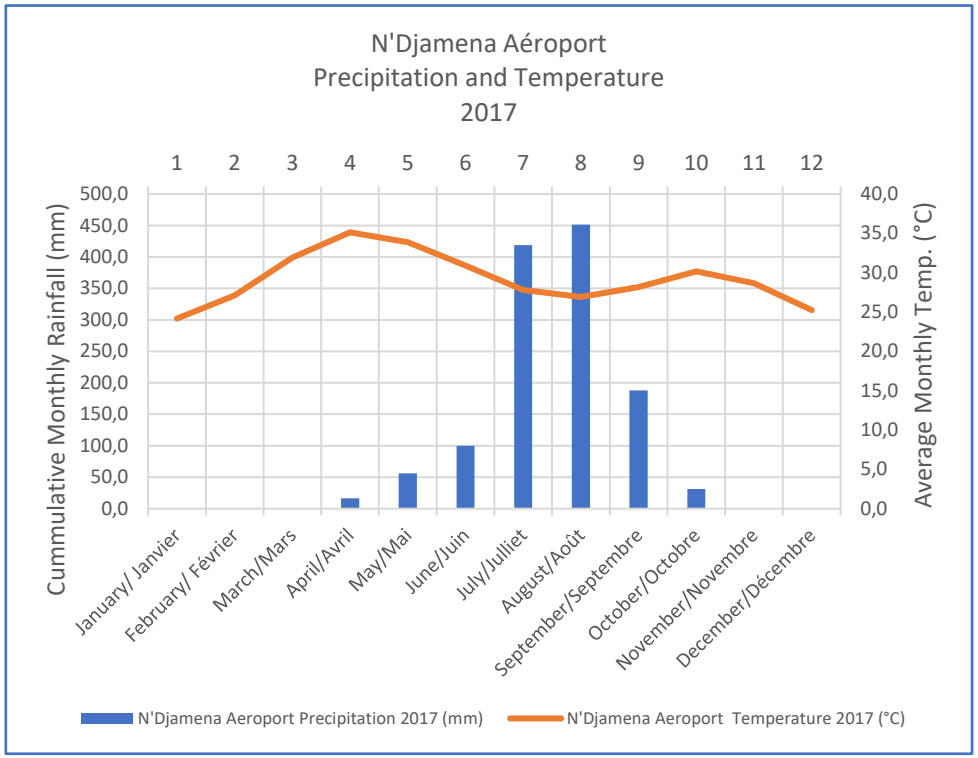
Precipitation values recorded up to June 27, 2017 are missing. The station data are therefore not complete for reliable annual precipitation analysis. The month with the most precipitation was July, with a total of 168.6 mm. The temperature profile recorded at the Kinkin station follows a normal annual trend with maximum temperatures recorded on April 15, 2017 (36.0°C), minimum temperatures of 20°C and an annual average of 28°C.

Meteorological station of Kinkin (Location 15.045833/12.138500) monthly temperature and precipitation data of 2018



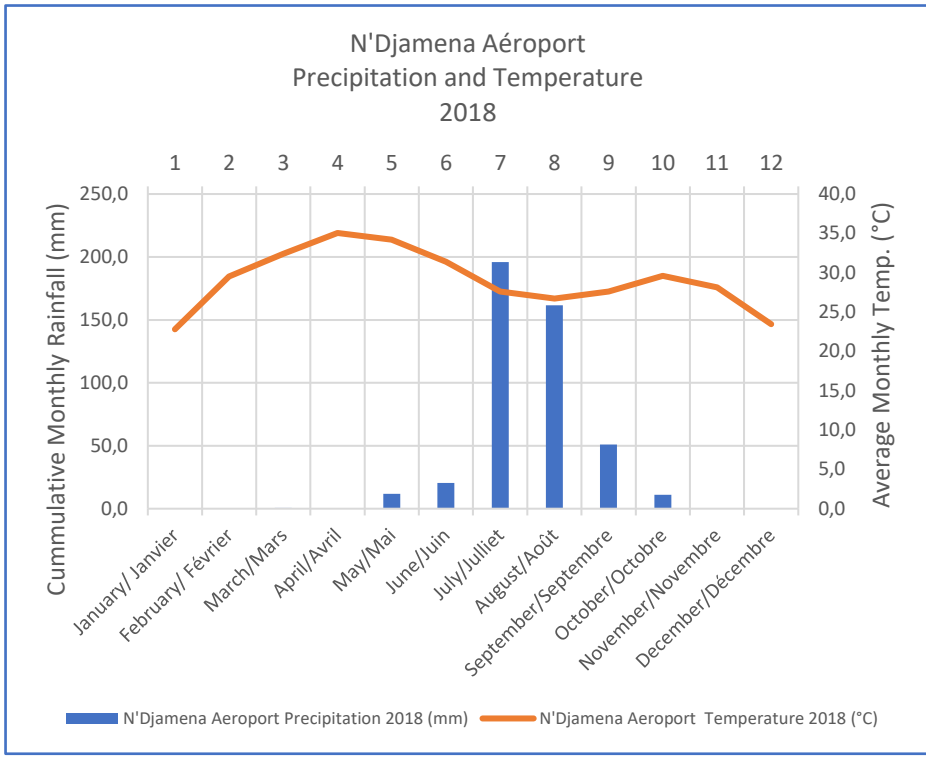
The Kinkin station recorded its first rainfall in 2018 on 26 April 2018 with total annual rainfall of 524.9 mm and a maximum of 65.3 mm. The month with the most precipitation was August, with a total of 175.4 mm. The temperature profile recorded at the Kinkin station follows a normal annual trend with maximum temperatures recorded on May 7, 2018 (36.0°C), minimum temperatures of 20°C and an annual average of 28°C.

Meteorological station of N'Djamena Aéroport (Location 15.0459152/12.1386049) monthly temperature and precipitation data of 2017



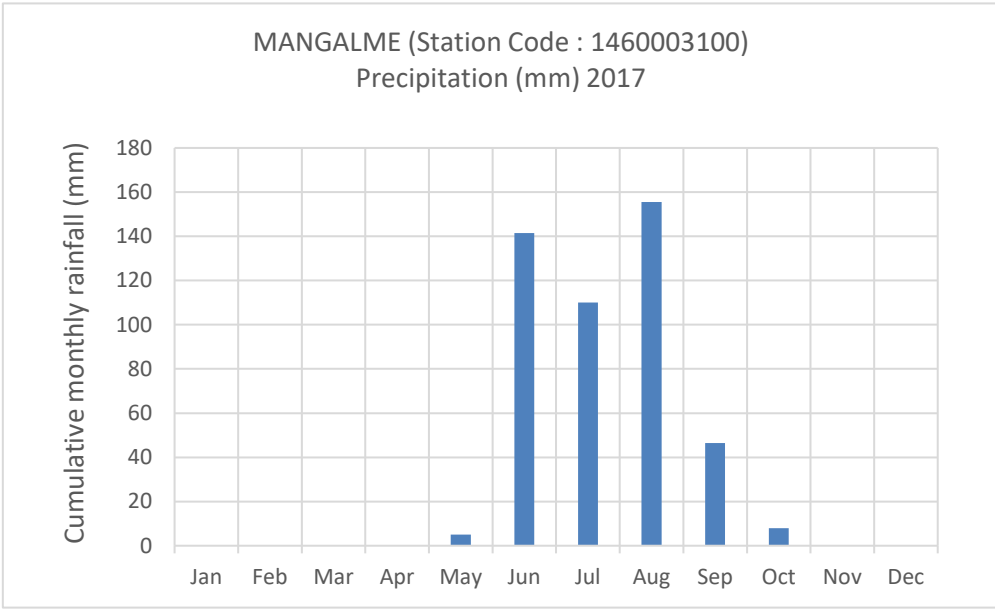
The N'Djamena Airport station recorded its first rainfall in 2017 on 18 April 2017 with total annual rainfall of 1262.3 mm and a maximum of 73.1 mm. The month with the most precipitation was August, with a total of 451.3 mm. The temperature profile recorded at the N'Djamena Airport station in 2017 follows a normal annual trend with maximum temperatures recorded in April (36.0°C) and an annual average of 29.2°C.

Meteorological station of N'Djamena Airport (Location 15.0459152/12.1386049) monthly temperature and precipitation data of 2018



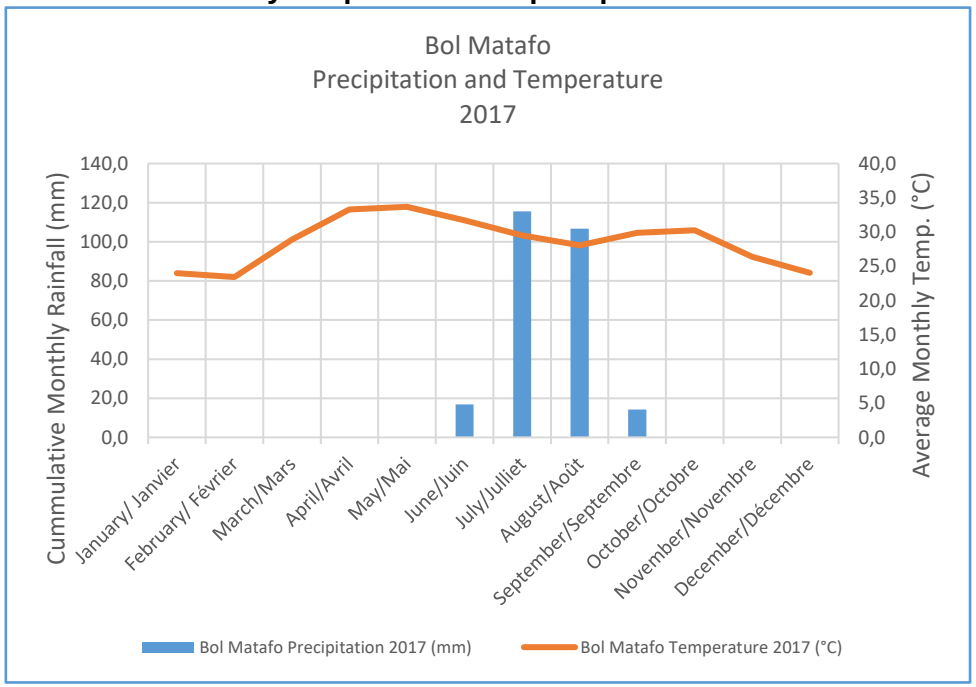
The N'Djamena Airport station recorded its first rainfall in 2018 on 4 May 2018 with total annual rainfall of 452.3 mm and a maximum of 52.1 mm. The month with the most precipitation was July, with a total of 196 mm. The temperature profile recorded at the N'Djamena Airport station in 2017 follows a normal annual trend with maximum temperatures recorded in Mao (37.2°C) and an annual average of 29.0°C

Meteorological station of Mangalme (Location 12.36667/ 19.61667) monthly precipitation data of 2017



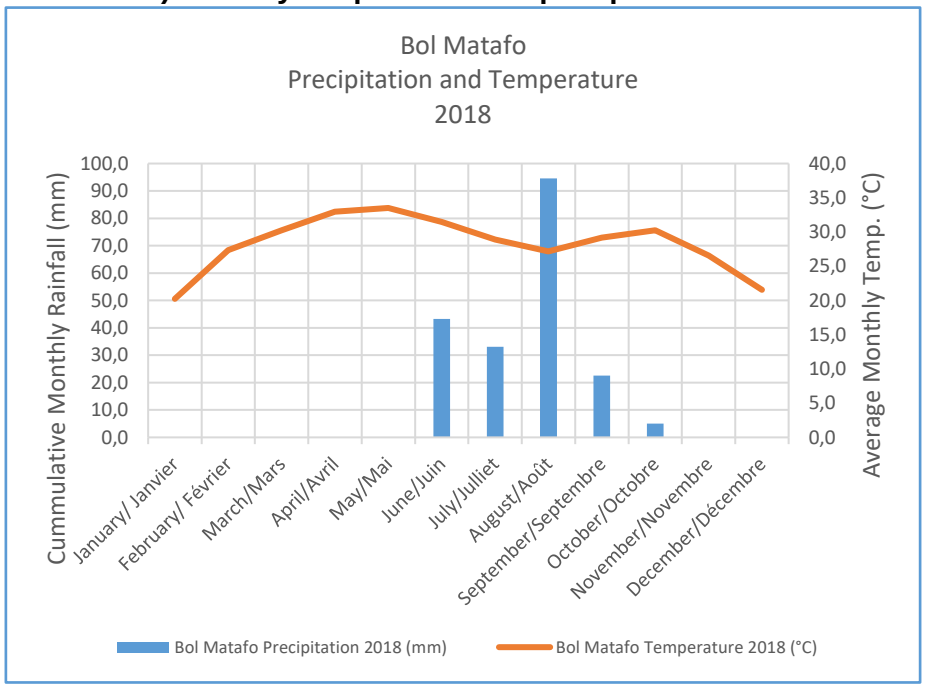
2.7.3 Chitati – Dagana – Lake Chad Sub-Basins

Meteorological station of Bol Matafo (Location 14.6929417/ 13.5028097 monthly temperature and precipitation data of 2017



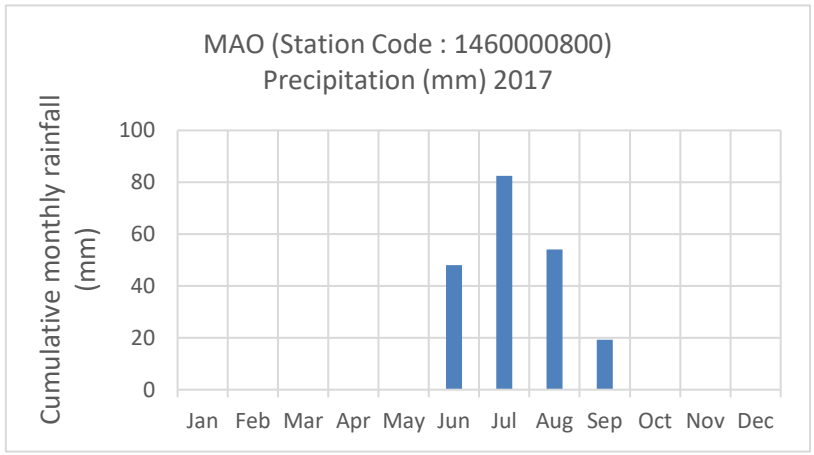
The Bol Matafo station recorded its first rainfall of 2017 on May 25, 2017. Total annual precipitation was 253.6 mm with a maximum of 67.4 mm. The month with the most precipitation was June, with a total of 115.6 mm. The temperature profile recorded at Bol station follows a normal annual trend with maximum temperatures recorded in May (36.2°C), minimum temperatures of 18.8°C and an annual average of 28.6°C.

Meteorological station of Bol Matafo (Location 14.6929417/ 13.5028097) monthly temperature and precipitation data of 2018

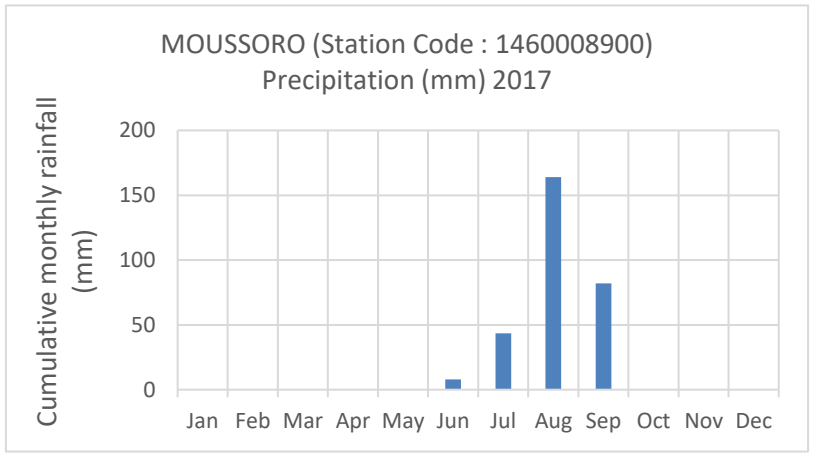


The Bol Matafo station recorded its first rainfall in 2018 on May 25, 2018. The total annual rainfall was 198.7 mm with a daily maximum of 32.8 mm. The month with the most precipitation was August, with a total of 94.6 mm. During the rest of the rainy season, the sensor recorded several missing values in July. The temperature profile recorded at Bol station follows a normal annual trend with maximum temperatures recorded in May (35.9°C), minimum temperatures of 18.1°C and an annual average of 28.3°C.

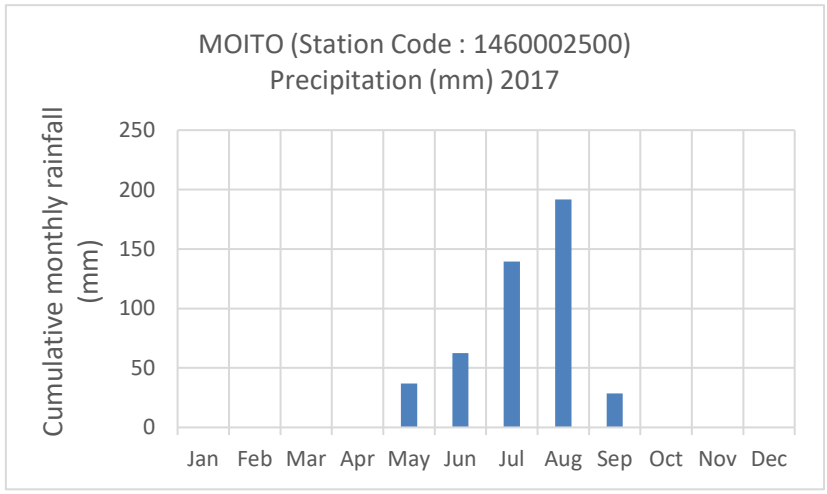
Meteorological station of Mao (Location 14.119529/ 15.31054) monthly precipitation data of 2017



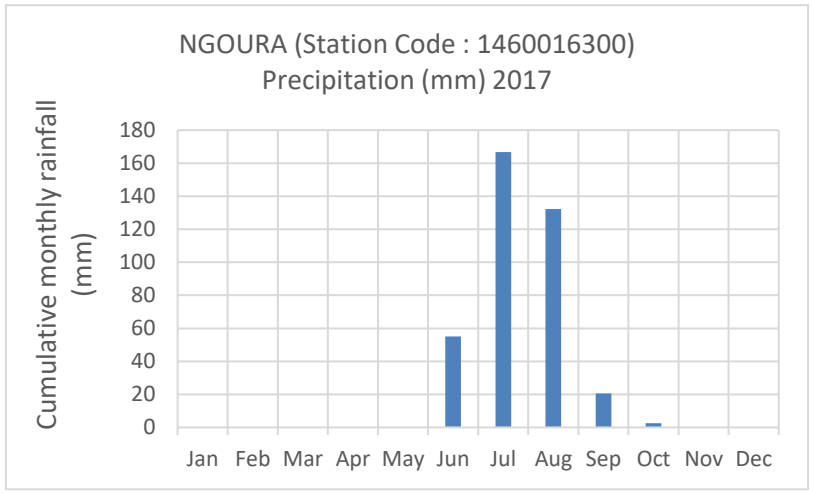
Meteorological station of Moussoro (Location 13.65/ 16.5) monthly precipitation data of 2017



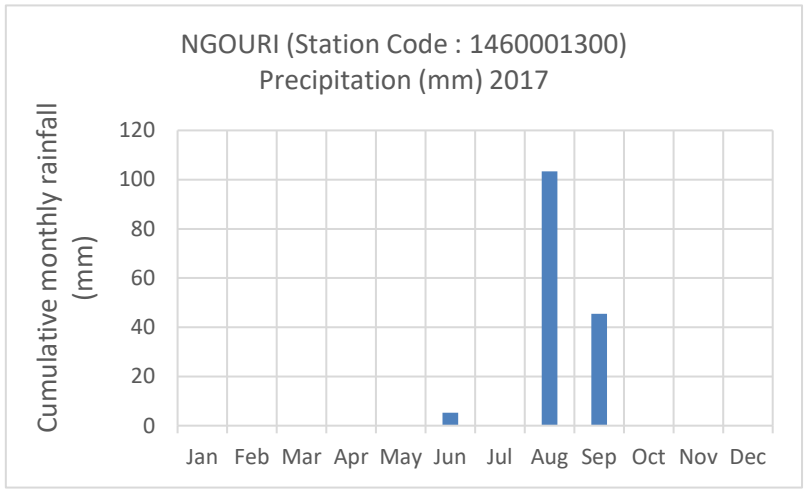
Meteorological station of Moito (Location 12.58333/ 16.55) monthly precipitation data of 2017



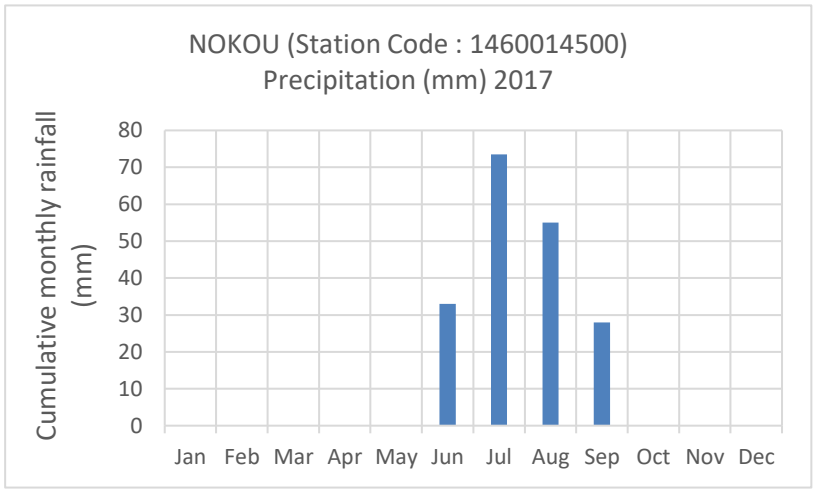
Meteorological station of Ngoura (Location 12.88333/ 16.45) monthly precipitation data of 2017



Meteorological station of Ngouri (Location 13.63333/ 15.38333) monthly precipitation data of 2017

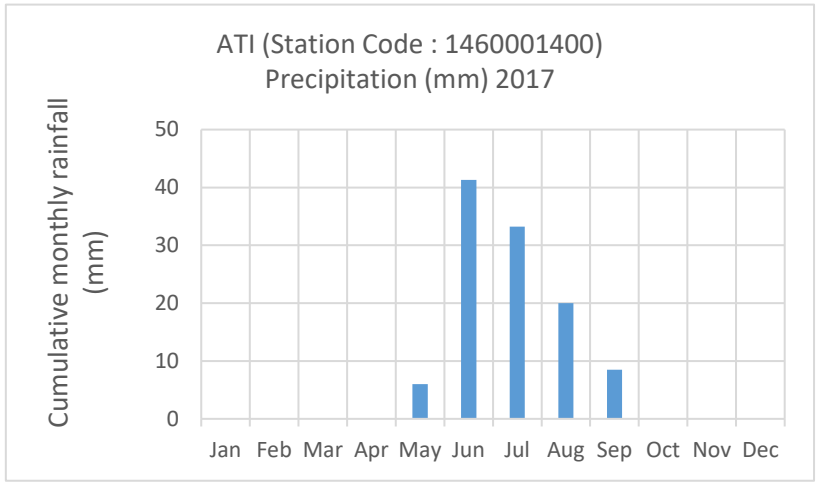


Meteorological station of Nokou (Location 14.56667/ 14.78333) monthly precipitation data of 2017

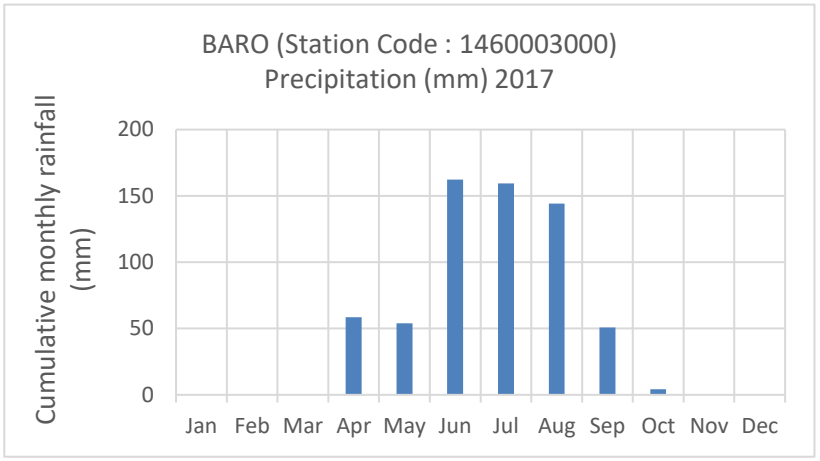


2.7.4 Fitri Sub-Basin

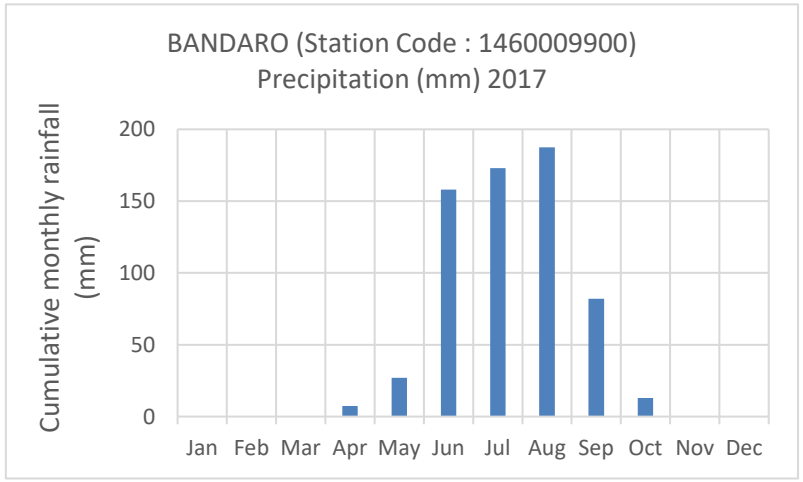
Meteorological station of Ati (Location 13.21667/18.31667) monthly precipitation data of 2017



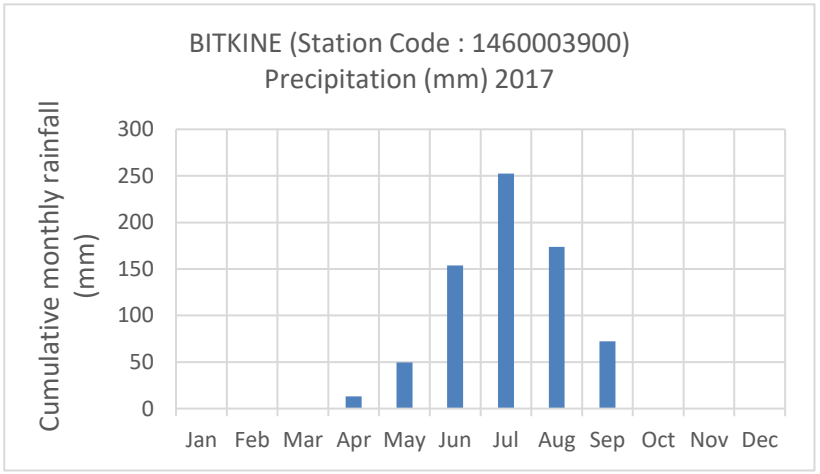
Meteorological station of Baro (Location 12.2/ 18.96667) monthly precipitation data of 2017



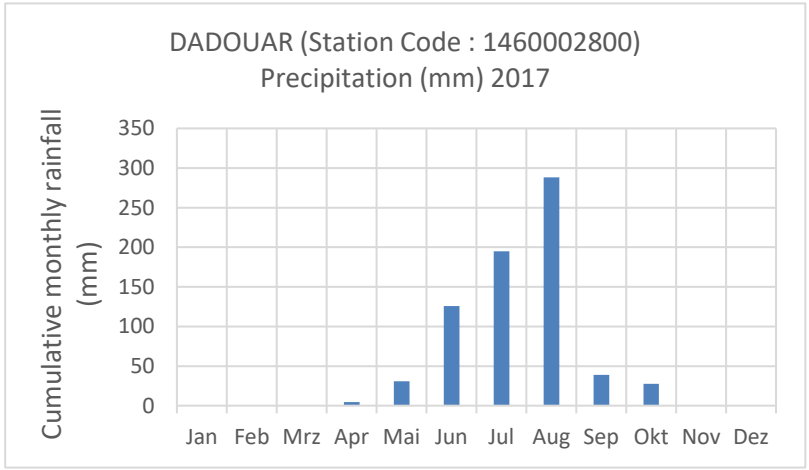
Meteorological station of Bandaro (Location 12.23333/ 18.71667) monthly precipitation data of 2017



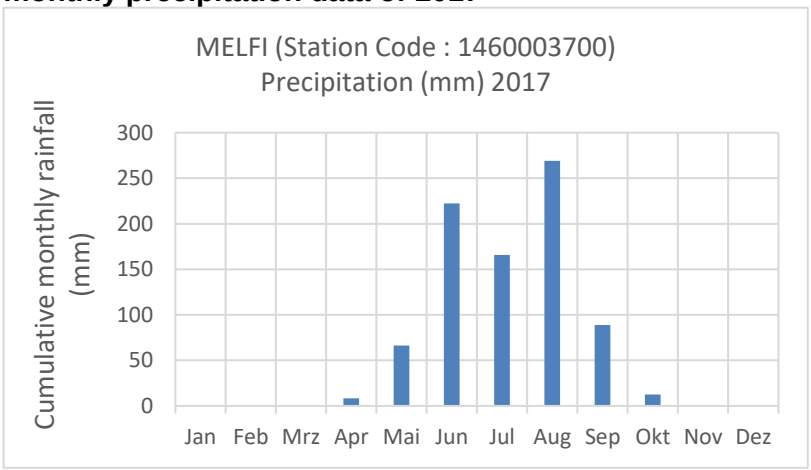
Meteorological station of Bitkine (Location 11.98333/ 18.21667) monthly precipitation data of 2017



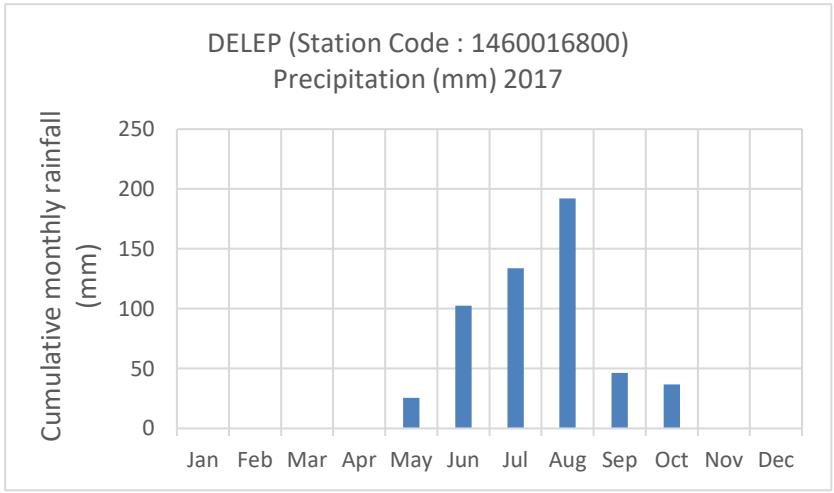
Meteorological station of Dadouar (Location 12.13333/ 18.45) monthly precipitation data of 2017



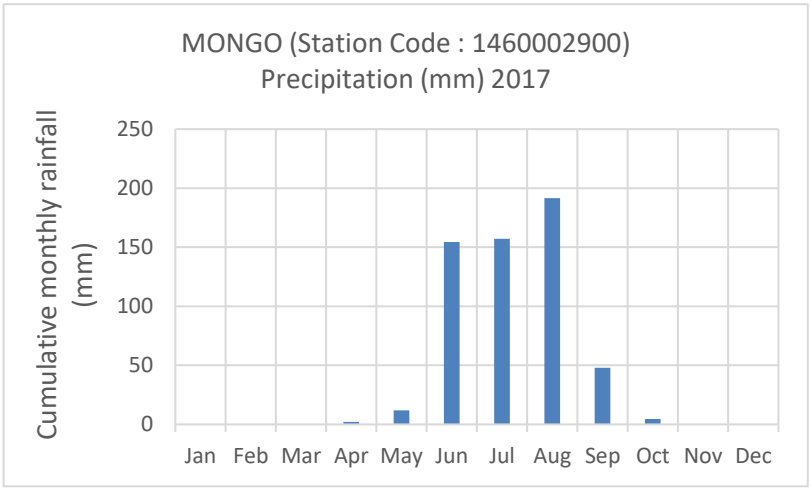
Meteorological station of Melfi (Location 11.06667/ 17.93333) monthly precipitation data of 2017



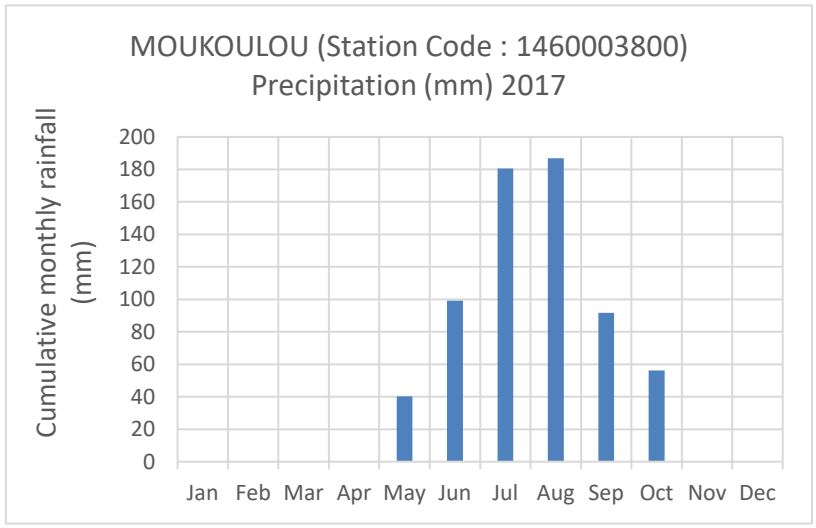
Meteorological station of Delep (Location 12.68333/ 18.63333) monthly precipitation data of 2017



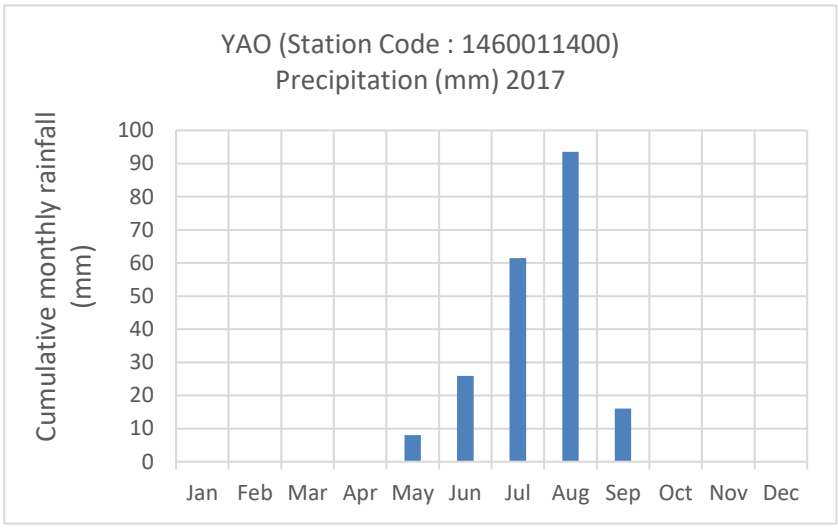
tation Météorologique de Mongo (Location 12.18333/ 18.68333) monthly precipitation data of 2017



Meteorological station of Moukoulou (Location 11.86667/ 18.2) monthly precipitation data of 2017

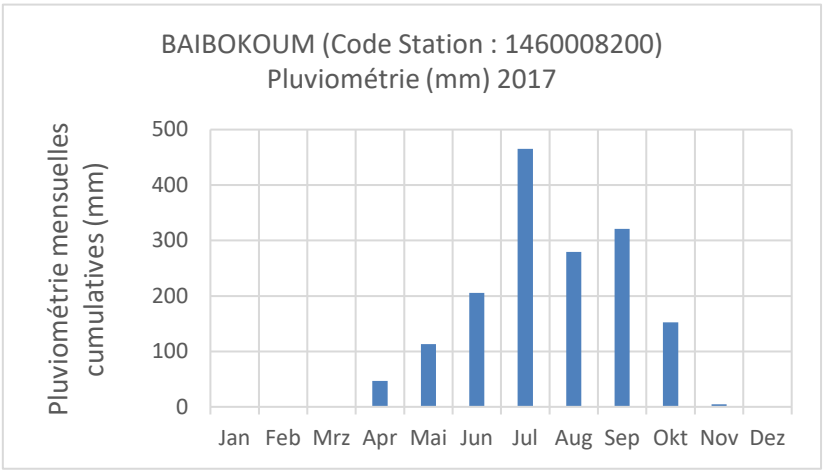


Meteorological station of Yao (Location 12.85/ 17.56667) monthly precipitation data of 2017

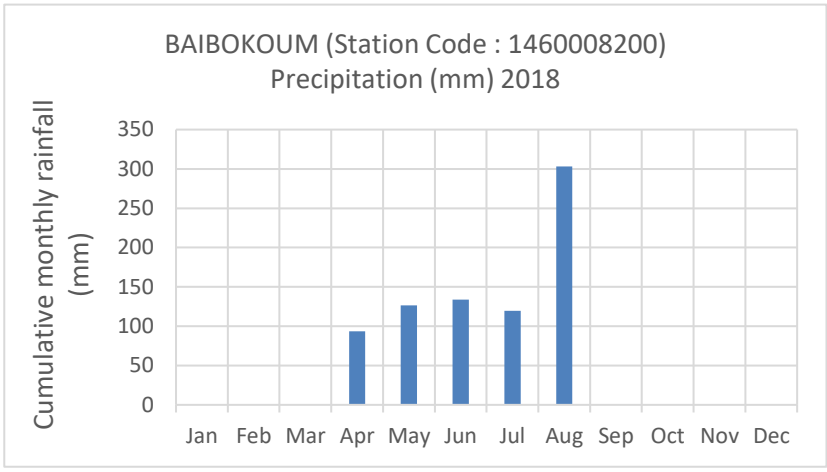


2.7.5 Logone Sub-Basin

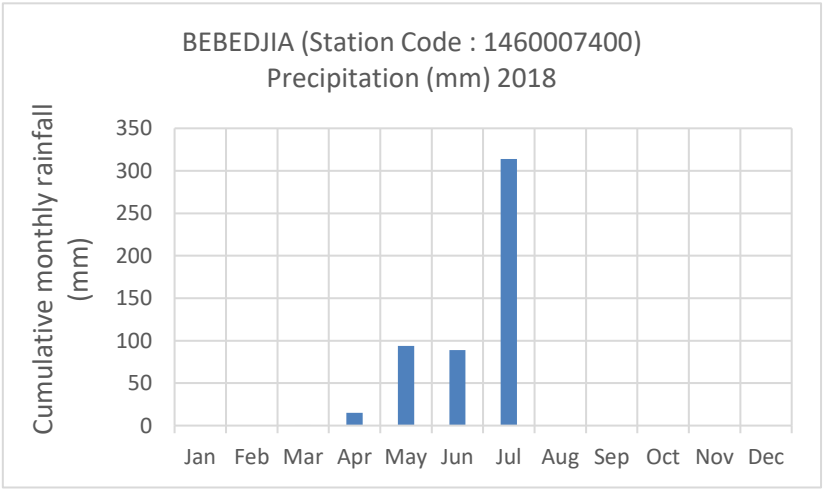
Meteorological station of Baibokoum (Location 7.73333/ 15.68333) monthly precipitation data of 2017



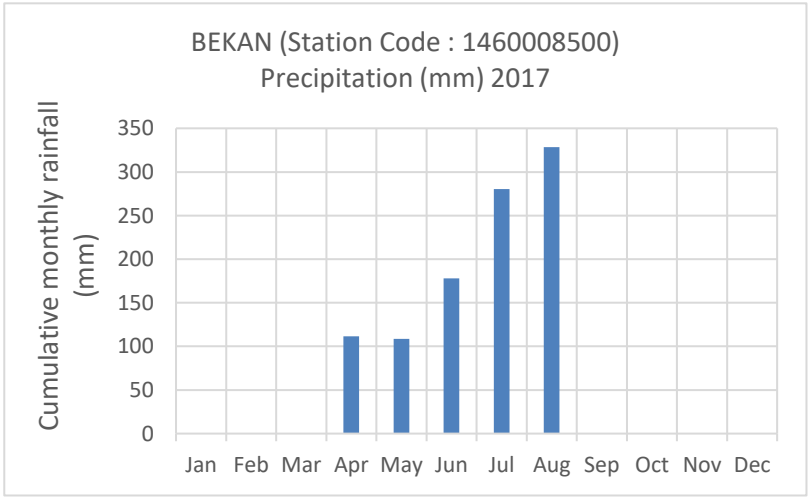
Meteorological station of Baibokoum (Location 7.73333/ 15.68333) monthly precipitation data of 2018



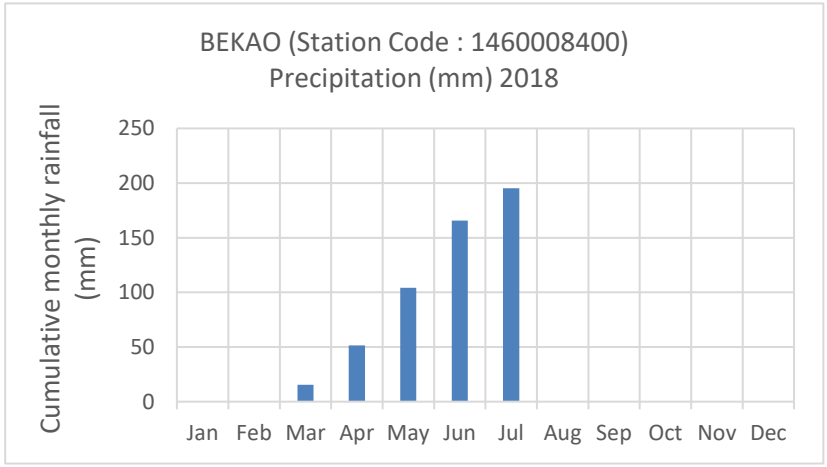
Meteorological station of Bebedjia (Location 8.66667/ 16.56667) monthly precipitation data of 2018



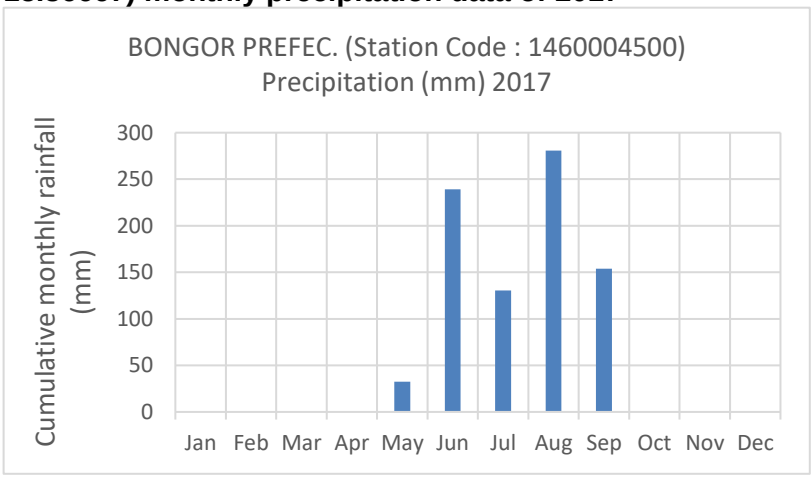
Meteorological station of Bekan (Location 7.73333/ 15.68333) monthly precipitation data of 2017



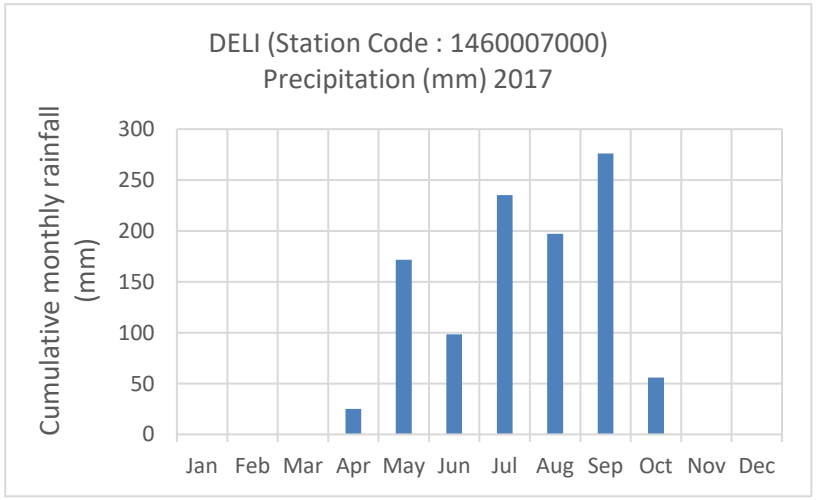
Meteorological station of Bekao (Location 7.91667/ 16.06667) monthly precipitation data of 2018



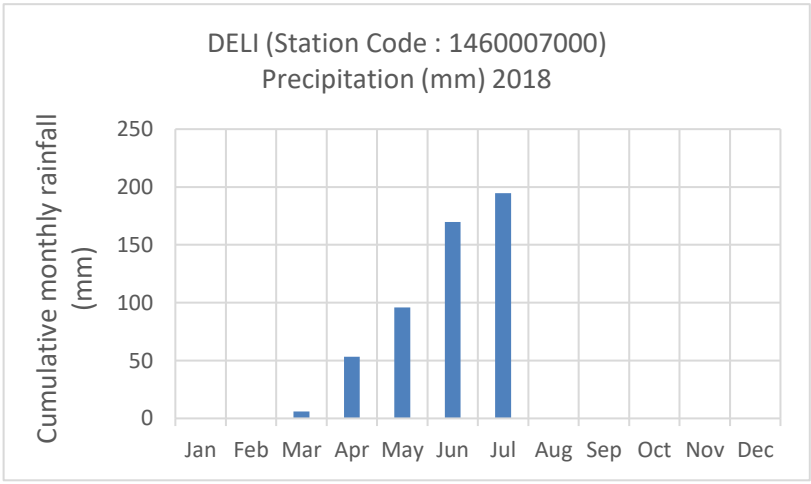
Meteorological station of Bongor Prefecture (Location 10.28333/ 15.36667) monthly precipitation data of 2017



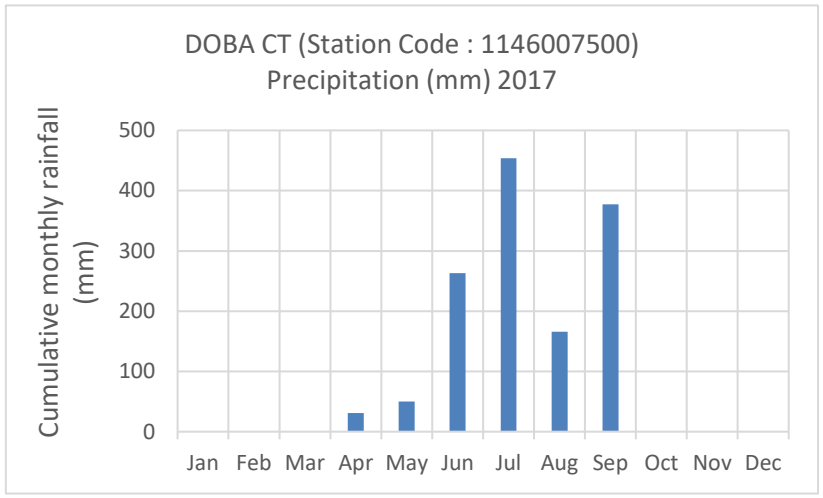
Meteorological station of Deli (Location 8.71667/ 15.86667) monthly precipitation data of 2017



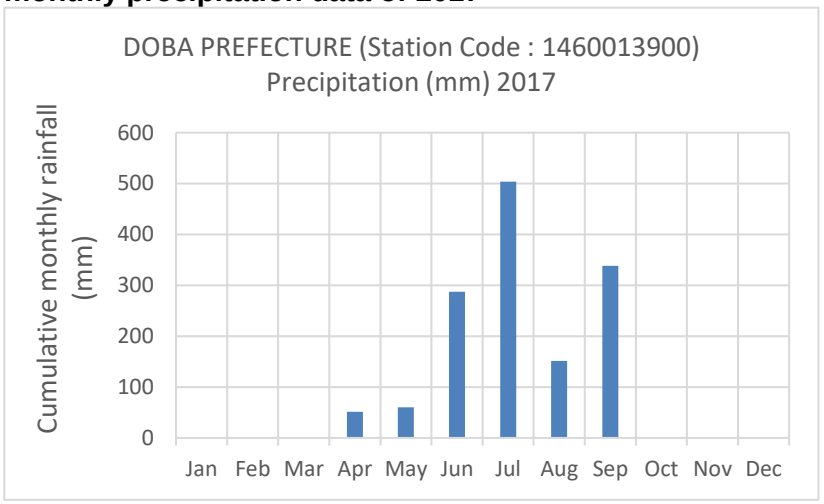
Meteorological station of Deli (Location 8.71667/ 15.86667) monthly precipitation data of 2018



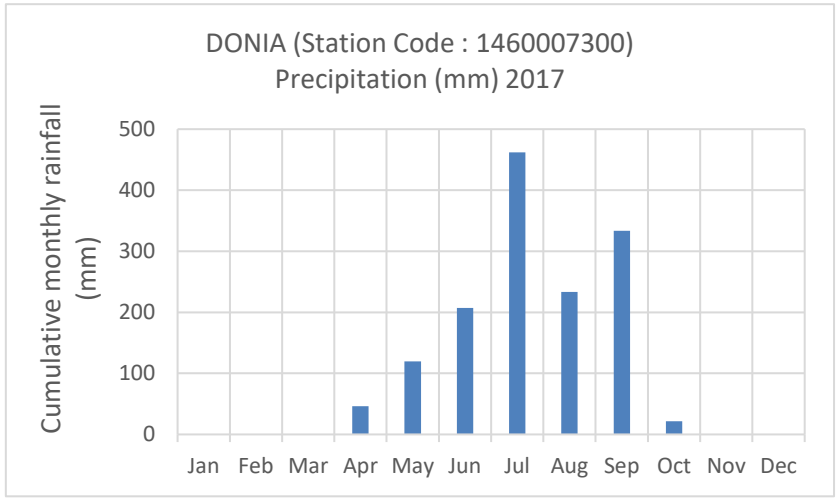
Meteorological station of Doba CT (Location 8.66667/ 16.85) monthly precipitation data of 2017



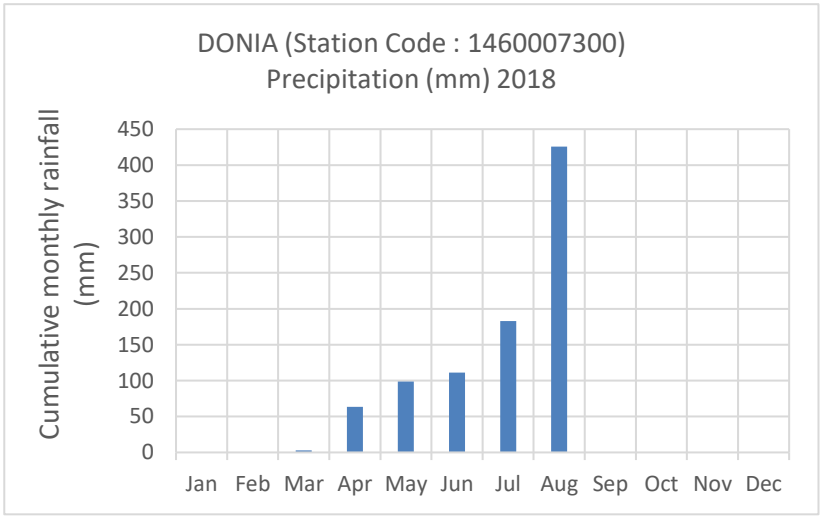
Meteorological station of Doba Préfecture (Location 8.65/ 16.85) monthly precipitation data of 2017



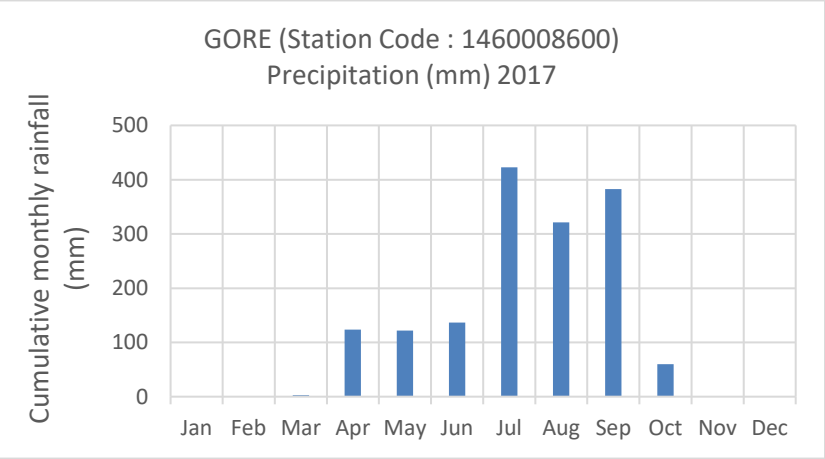
Meteorological station of Donia (Location 8.4/ 16.41667) monthly precipitation data of 2017



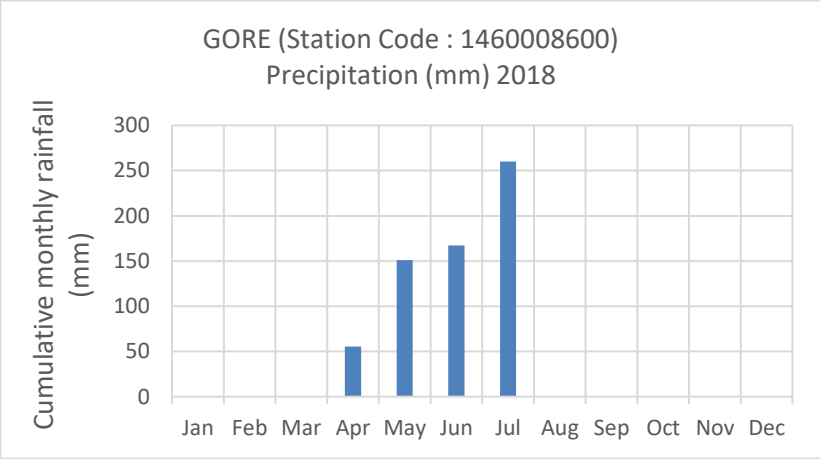
Meteorological station of Donia (Location 8.4/ 16.41667) monthly precipitation data of 2018



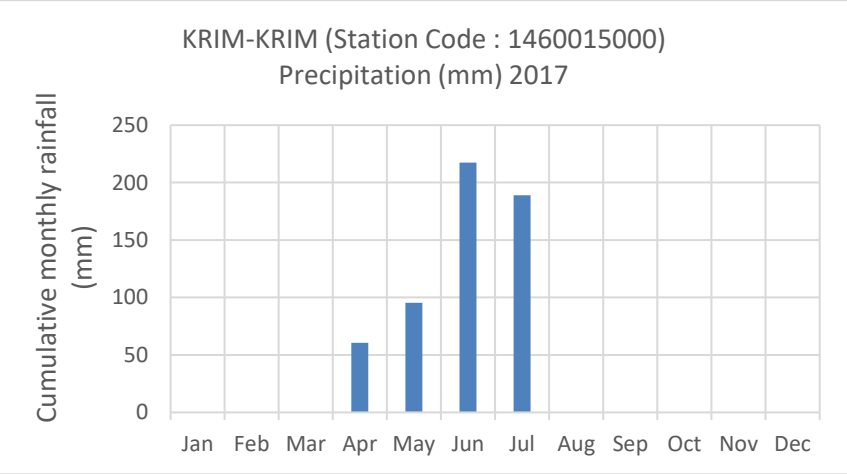
Meteorological station of Gore (Location 7.93333/ 16.63333) monthly precipitation data of 2017



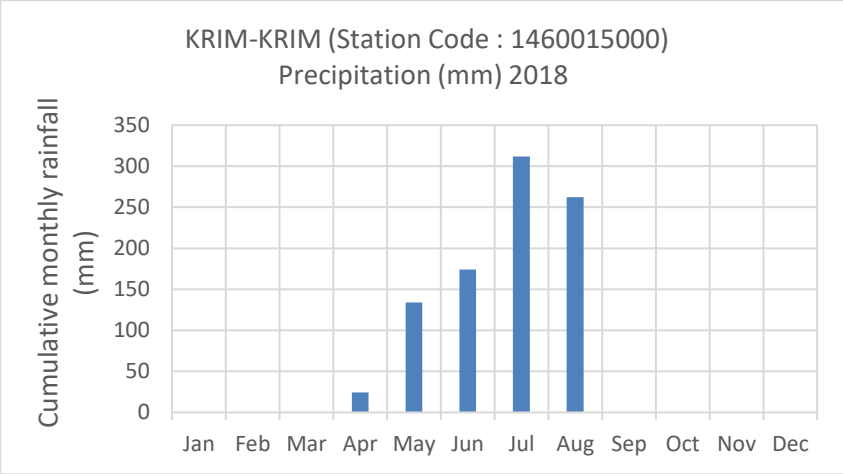
Meteorological station of Gore (Location 7.93333/ 16.63333) monthly precipitation data of 2018



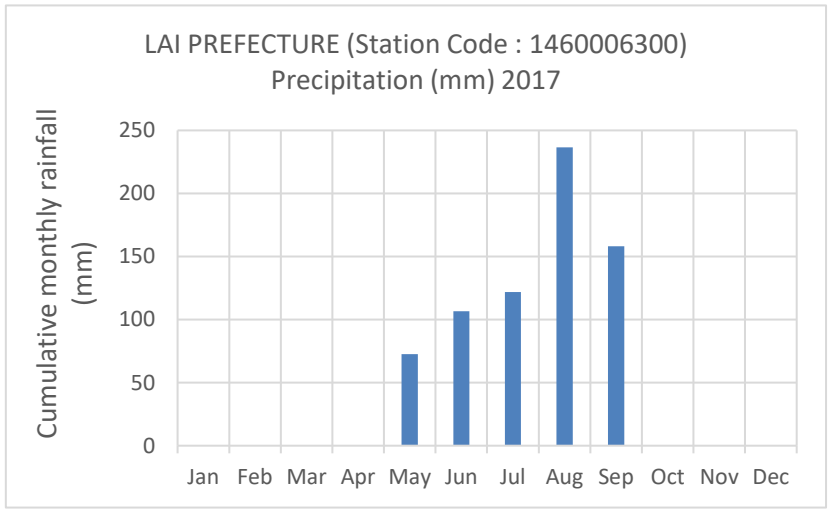
Meteorological station of Krim-Krim (Location 8.96667/ 15.8) monthly precipitation data of 2017



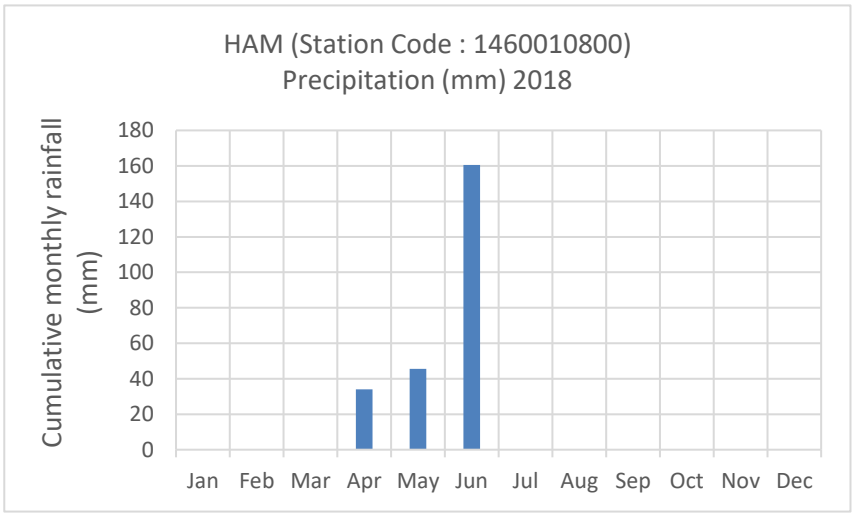
Meteorological station of Krim-Krim (Location 8.96667/ 15.8) monthly precipitation data of 2018



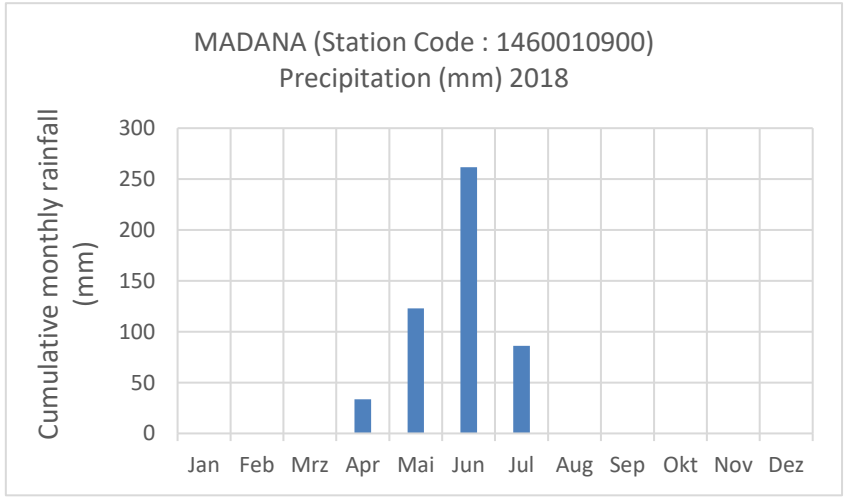
Meteorological station of Lai Préfecture (Location 9.4/ 16.3) monthly precipitation data of 2017



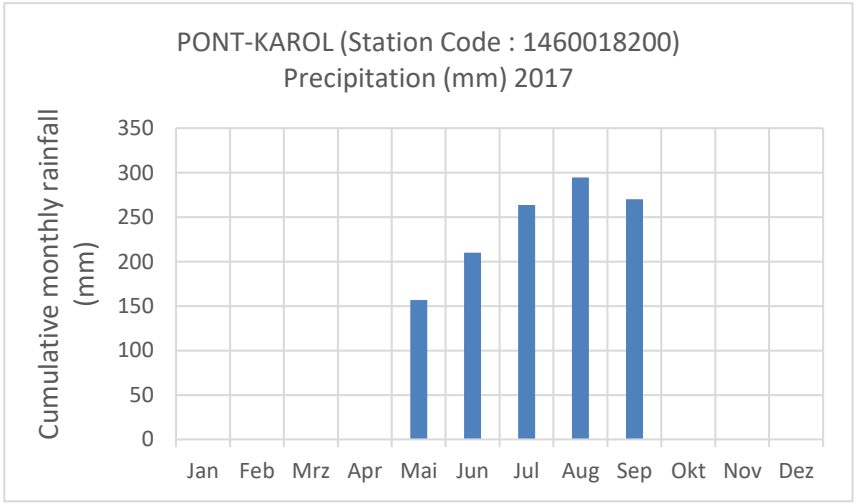
Meteorological station of Ham (Location 10.01667/ 15.7) monthly precipitation data of 2018



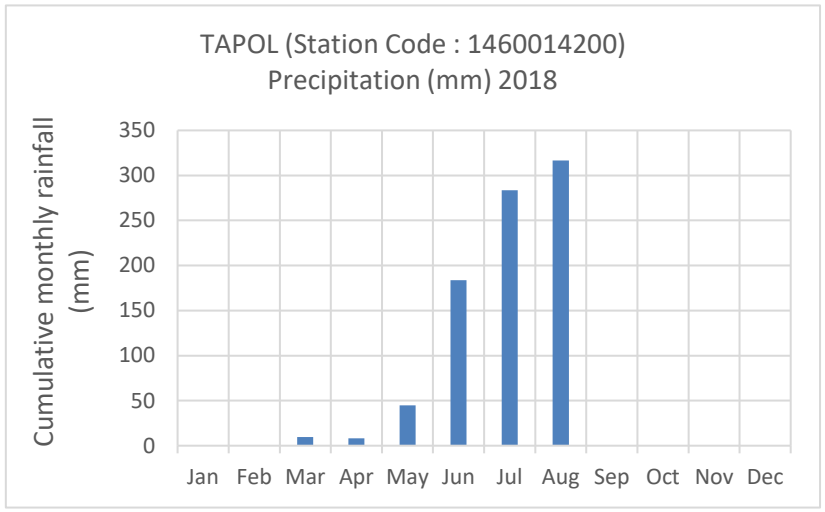
Meteorological station of Madana (Location 9.0/ 16.66667) monthly precipitation data of 2018



Meteorological station of Pont-Carol (Location 9.3/ 15.5) monthly precipitation data of 2017

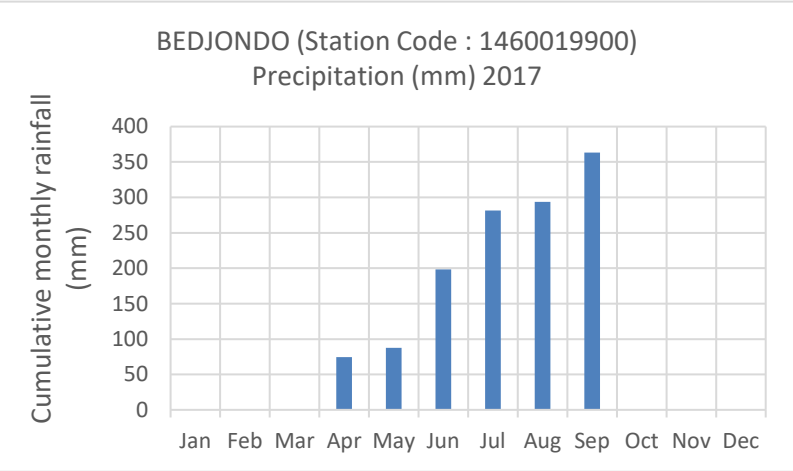


Meteorological station of Tapol (Location 8.5/ 15.6) monthly precipitation data of 2018

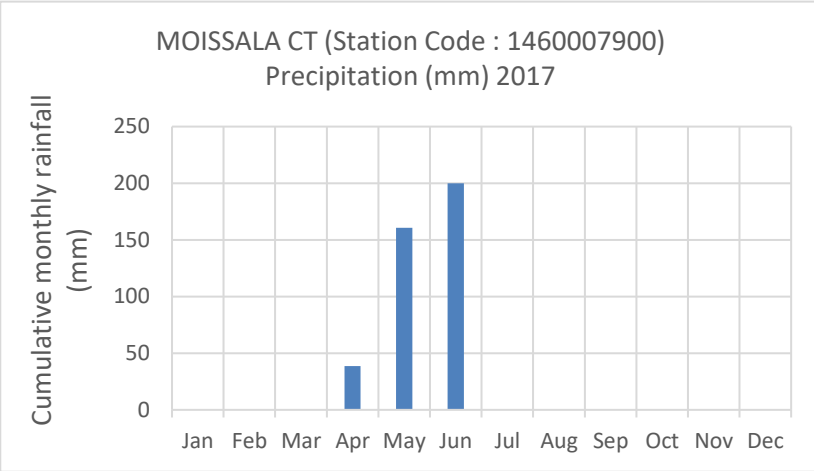


2.7.6 Ouham Sub-Basin

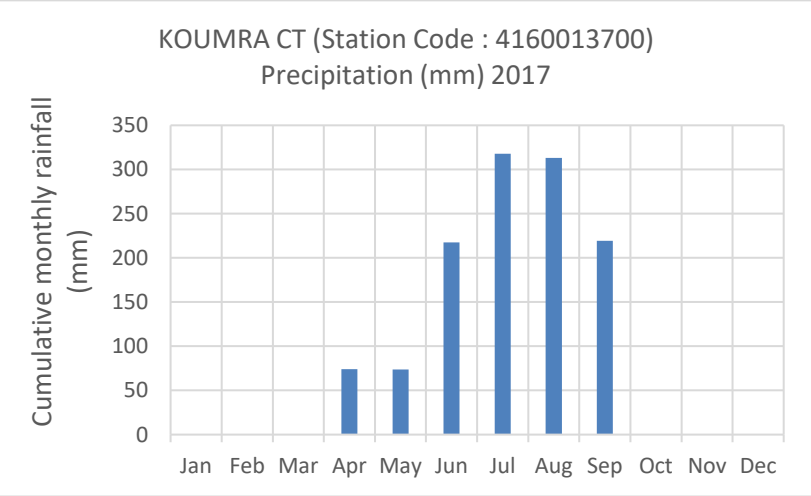
Meteorological station of Bedjondo (Location 8.63333/ 17.18333) monthly precipitation data of 2017



Meteorological station of Moissala CT (Location 8.38333/ 17.78333) monthly precipitation data of 2017



Meteorological station of Koumra CT (Location 8.91667/ 17.51667) monthly precipitation data of 2017



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2.8 Conclusion of the meteorology chapter

The inventory of all weather monitoring stations by sub-basin shows that they are in a dilapidated state. Most of the stations are completely or partially destroyed or are no longer monitored due to lack of resources. Only a few synoptic stations still under the control of the Agency for the Safety of Air Navigation in Africa and Madagascar (ASECNA) have an average condition in some places, but the LCBC does not have free access to these data.

The absence of monitoring and maintenance missions for the monitoring system (observers, equipment) and the non-payment or irregular payment of observers' allowances cause significant gaps in the observed data series, because the observers neglect or abandon daily observations. Among these difficulties listed, it is necessary to add the security situation prevailing in Nigeria, CAR and the vicinity of Lake Chad, which has considerably affected the functioning of the States' technical services. In view of this observation, the LCBC, supported by its technical partners, intervenes in areas where access is possible for the rehabilitation of the network, the payment of bonuses and the provision of observers with telephones, observation books to make the minimum monitoring network operational.

The data presented in this document are the consequences of LCBC's involvement in monitoring meteorological parameters.
As for the rainfall situation, overall, the rainfall in 2017 is close to normal. The year is considered as an average year.

3. Water Resources

3.1 Water Quantity

3.1.1 Water Supplies to the Lake Chad

Lake Chad is a closed lake, with no surface water outlet except at its highest levels. The water balance consists of river inflows, direct rainfall and groundwater, and evaporation losses and low infiltration into the surrounding groundwater. When the inflows of a year exceed the losses, the lake level rises and its surface area increases, which increases evaporation losses and tends to restore a new balance to a slightly higher level.

The active watershed of the lake, which contributes to its water supply, consists of the Chari Basin, with its main Logone tributary in the south (610,000 km^2) and the Komadugu-Yobe Basin in the west (174,000 km^2). In addition, there are the small basins of El Beïd, Yedseram and Ngadda in Nigeria (about 30,000 km^2) located south of the lake between the two basins mentioned above.

The Chari and Komadugu-Yobe Basins contribute very differently to the supply of Lake Chad because of their position in the north-south rainfall gradient of this region of Africa. In the time of a "Medium Lake Chad", Komadugu-Yobe contributes 0.9% to the total water supply of the lake, while the Chari provides 82% (Lemoalle, 2012).

The main variable to be considered is therefore the supply of the Chari to the Lake Chad, estimated from observations made at the N'Djamena TP hydrological station.

At the time of publication of the AMR, the LCBC disposes only water level data from the N'Djamena TP measuring station until 2017.

3.1.2 Hydrometric Network of the Lake Chad Basin

This chapter presents for each member country the state of the hydrometric monitoring network of the Lake Chad Basin.

3.1.2.1 Hydrometric Network of the Chari-Logone Basin in Cameroun

There are two main hydrometric measurement networks in Cameroon:

- The national hydrological network monitored by the Hydrologic Research Center (CRH) of Cameroon;
- The AES SONEL network monitored by the company in charge of electricity production and transmission in Cameroon (AES SONEL).

Cameroon's national hydrometric network, monitored by the CRH, was gradually set up because of the necessity imposed by various hydroelectric developments and hydro-agricultural projects, mainly, and the desire to systematically study the country's resources. Thus, even before the intervention of ORSTOM hydrologists (now IRD) in the 1950s, some gauging stations had already been installed. Therefore, the years 1951 to 1953 marked an important stage in the creation of this network, which continued to grow even after the monitoring of surface water resources was taken over in 1972 by Cameroonian hydrologists.

In 1980, Cameroon's basic hydrometric network included seventy-four (74) stations in operation. Unfortunately, it began to weaken in the mid-1980s, a process that intensified from 1990 onwards with the intensification of the economic crisis and the country's budgetary restrictions. Government funding for scientific research has virtually ceased and as a result, the hydrometric network has been abandoned. During this period of shortages, observations were reduced, in most cases, to a minimum network and its monitoring was very irregular, it took place only when specific studies were carried out.

Since 2008, a timid recovery has been observed and an optimal network of around thirty stations has been rehabilitated. To date, the Cameroonian portion of the Chari-Logone Basin has eight (8) stations which, in reality, are not all functional. They are mainly equipped with limnimetric scales.

Table 6: List of gauging stations in the Chari-Logone basin in Cameroon

N°	Station code	Name	River / Basin	Longitude	Latitude	Monitored area (km²)	Status
01	1050301503-1	Berem - Gob	Bini / Logone	13.9476	7.5441	1590	Rehabilited
02	1050802506-1	Bogo	Mayo-Tsanaga / Logone	14.6004	10.7370	1534	Rehabilited
03	ND	Darguila	Mayo-Boula / Logone	14.6045	10.5262	NA	Rehabilited
04	1050303004-1	Logone Birni	Logone / Logone	15.1	11.766	NA	NA
05	105802509-1	Maroua	Mayo-Sanaga/Logone	14.3333	10.5833	852	Rehabilited
06	1337200	Mbéré	Mbéré / Logone	15.4880	7.5170	NA	Destroyed

N°	Station code	Name	River / Basin	Longitude	Latitude	Monitored area (km²)	Status
07	1050303002-1	Pouss	Logone/ Logone	15.0833	10.8333	NA	Rehabilited
08	1050301509-1	Toubouro	Vina / Logone	15.3608	7.7466	12200	Rehabilited
09	1050301503-1	Vounaloum	Logone / Logone	15.2593	10.3505	NA	Rehabilited

Unfortunately, the LCBC does not have data on surface water levels at the 9 existing stations in Cameroon for the years 2017 and 2018.

3.1.2.2 Hydrometric Network of the Chari-Logone Basin in the Central African Republic

The first measurements of water bodies in CAR were made in 1890 as part of inland navigation. From 1952 onwards, ORSTOM, which acts as the Hydrological Service, set up a hydrometric network comprising 76 stations throughout the CAR. In 1976, the Hydrology Section (SH) of the River Infrastructure Service (SIF) took over from ORSTOM following its withdrawal.

In 1982, hydrological activities were entrusted to the National Meteorological Directorate and a network rehabilitation project was launched (UNDP/WMO). Financial assistance, through several successive projects, last until 1992. In 1993, the network had 56 stations, only 40 of which were operational. The basic equipment consisted of batteries of metric enameled metal elements. Only 12 stations were equipped with paper-based water level gauges.
Since the end of the UNDP/WMO project, the hydrometric network deteriorated very rapidly with the cessation of observer remuneration and site maintenance. In addition, the conflicts and politico-military events that took place between 1996 and 2003 also contributed significantly to the degradation of the network and the cessation of measurements at the majority of existing hydrological stations.

Currently, only a few limnimetric scales are still regularly read in the country. These are mainly the scales managed by SCEVEN, for the purposes of navigation on the Ubangi (i.e. Bangui and Zingua), and some scales for specific needs such as hydropower with ENERCA.

The part of the Chari-Logone Basin includes ten (10) hydrometric stations which, at present, are not all functional, due to lack of financial resources and especially due to instability in the country. The entire northern part of the CAR, which includes the Chari-Logone Basin, is subject to a civil war that has destroyed the entire network. Indeed, due to cash flow issues, the State was unable to provide the compensation due to observers and the surveys no longer reached the Meteorology Department, which centralized the data collection. To this problem must be added the many acts of vandalism and looting carried out at these installations during political and military events.

Therefore, the rehabilitation of the entire network is necessary.
As a result, the LCBC does not have data on water levels from gauging stations in the Central African Republic.

Table 7: List of gauging stations in the Chari-Logone basin in CAR

N°	Station code	Name	River / Basin	Longitude	Latitude	Start of observation	Area (km^2)	Status
01	1060203510	Bamingui	Bamingui / Chari	20.1833	7.5667	1956	4328	Poor
02	1060206503	Bangoran	Bangoran / Chari	20.3500	8.0833	1952	2514	Poor
03	1060202505	Batangafo	Ouham / Chari	18.2800	7.3000	1951	44700	Poor
04	1060202515	Bossangoa	Ouham / Chari	17.4500	6. 4667	1951	23150	Poor
05	1060204005	Bouca	Fafa / Chari	18.2667	6.5000	1952	6750	Poor
06	1060202520	Bozoum	Ouham / Chari	16.3500	6.3333	1952	8100	Poor
07	1060207505	Koukourou	Koukourou /Chari	20.0167	7.2000	NA	5720	Poor
08	1060204510	Markounda	Nana Barya / Chari	16.9667	7.6333	NA	7700	Poor
09	1060201510	Crampel	Gribingui /Chari	19.1833	7.0000	NA	5680	Poor
10	1060200205	Golongosso	Bahr Aoûk / Chari	19.1500	9.0167	1952	134775, 0781	Station entirely destroyed

3.1.2.3 Hydrometric Network of the Chari-Logone Basin in Chad

In the early 1950s Chad's hydrometric network was installed by ORSTOM (now IRD), which operated it until 1978. Due to a contract between WMO and ORSTOM, ORSTOM had to gradually transfer the management of the network to the National Hydrological Service. Unfortunately, the civil war in Chad in 1979 forced the organization to leave the country in a hurry. There was an interruption of hydrological activities which were taken over in 1982 by the National Hydrological Service, thanks to the Agrhymet Project, with WMO funding.

The functional hydrometric network consists of 36 stations, equipped with limnimetric scales, requiring the presence of an observer. The limnimetric scales are the reference equipment of the Chari-Logone hydrometric network; all stations in the network must be equipped with them for the continuation of regular data collection and also for inter-station correlation needs.

The inventory of the hydrometric network is based on previous assessments. As part of its activities, the LCBC assessed the state of the Chari-Logone hydrometric network in 2014, for the purpose of its rehabilitation. Also, in 2015, the PULCI Project carried out an evaluation of the Logone sub-basin network.

From these two assessments, it appears that the hydrometric network of the Chari-Logone is not in good condition: the ladders or installations are rusty, inclined or vandalized. Despite the rehabilitation by the LCBC in 2015 of about fifteen hydrometric stations, the overall situation is not better, because the rehabilitation of a network needs to be carried out annually.

Table 8: List of gauging stations in the Chari-Logone basin in Chad

N°	Station code	Name	River / Basin	Longitude	Latitude	Start observation	Area (km^2)	Status
01	1460300163	Logone-gana	Logone / Logone	15.1500	11.5500	1953	88434	Medium
02	1460300172	Moundou Pont	Logone / Logone	16.0667	8.5333	1935	33618	Medium
03	1460300171	Moundou-region	Logone / Logone	16.0833302	8.56000042	NA	33970	NA
04	1460302506	Doba	Pendé / Logone	16.8500004	8.64999962	NA	16649	NA
05	1460302507	Doba Cotonfran	Pendé / Logone	16.8333	8.6500	1947	16649	Medium
06	1460300112	Bongor	Logone / Logone	15.365	10.275	1948	67440	Medium
07	1460300103	Baïbokoum	Logone / Logone	15.6667	7.7500	1951	23388	Medium
08	1460301403	Ouli Bangala	Lim / Logone	15.8333	7.8333	1952	7149	Poor
09	1460302712	Tchoa	Tandjilé / Logone	16.0833	9.3333	1954	6179	Good
10	1460300124	Ere	Logone / Logone	15.8333	9.7500	1935	72 000	Good
11	1460300145	Katao	Logone / Logone	15.0833	10.8333	1948	79501	Poor
12	1460300154	Koumi	Logone / Logone	15.2000	10.5167	1953	68157	Very poor
13	1460300157	Laï (mission)	Logone / Logone	16.3000	9.4000	1953	57056	Good
14	1460300148	Kim	Logone / Logone	15.9167	9.7250	1948	ND	Very poor
15	1460302509	Goré	Pendé / Logone	16.6167	7.9500	1955	12 020	Poor
16	1460302706	Bologo	Tandjilé / Logone	15.8000	9.1167	1950	3850	Good
17	1460300173	Pandzangue	Logone / Logone	15.7667	7.9333	1935	33 000	Station entirely destroyed
18	1460302003	Argao	Nya / Logone	15.6167	8.2667	1963	2 840	Station entirely destroyed
19	1460300164	Nguely	Logone / Logone	15.05	12.083	1984	77 650	Medium
20	NA	Moulkou	Ba Illi / Logone	15.5333	10.5333	1955	NA	Poor
21	1460200118	Sarh	Chari / Chari	18.4167	9.1500	1938	22477	Good
22	1460203501	Am Timan	Bahr Azoum / Chari	20.3000	11.0667	1953	92948	Very poor
23	1460201406	Kyabé	Bahr Keita / Chari	18.95000	9.4000	1952	16527	Poor

N°	Station code	Name	River / Basin	Longitude	Latitude	Start observation	Area (km^2)	Status
24	1460201403	Gotoberi	Bahr Keita / Chari	18.7833	09.3500	1954	14 000	Very poor
25	NA	Boum Kébbir	Lac Iro / Chari	19.3833	10.1667	1958	ND	Station entirely destroyed
26	1460200130	Héllibongo	Chari / Chari	16.3167	9.2500	1962	230594	Medium
27	1460202603	Tarangara	Bahr Salamat / Chari	18.3333	9.6000	1955	145560	Station entirely destroyed
28	1460201906	Moissala	Bahr Sara / Chari	17.7667	8.3333	1951	68921	Good
29	1460201903	Manda	Bahr Sara / Chari	18.2000	9.1800	1951	87244	Good
30	NA	Kouno	Chari / Chari	17.6667	09.8000	1990	444 643	Medium
31	1460200106	Bousso	Chari / Chari	16.7167	10.4833	1936	478761	Station entirely destroyed
32	1460200124	Guelendeng	Chari / Chari	15.55	10.9167	1952	501197	Good
33	NA	Lignia	Bahr Ligna / Chari	15.1500	12.0500	1968	ND	Station entirely destroyed
34	1460200133	Maïlao	Chari / Chari	15.2833	11.6000	1953	513276	Good
35	1460200109	Chagoua	Chari / Chari	15.0833	12.0833	1954	516144	Good
36	1460200121	N'Djaména TP	Chari / Chari	15.0333	12.1167	1933	605890	Good
37	1460200112	Djimtilo	Chari / Chari	14.5667	12.8333	1953	NA	Good
38	1460209701	Ile De Kalom	Lac Tchad	14.5666704	13.1833296	NA	NA	NA
39	1460209702	Ile De Kindjeria	Lac Tchad	13.6833296	13.9499998	NA	NA	NA
40	1460209705	Bol	Lac Tchad	14.6999998	13.4499998	NA	NA	NA

3.1.2.4 Hydrometric Network of the Komadugu Yobe, Yedseram, Ngadda et El Beid Basins (Nigeria)

The hydrometric network of the Nigerian part of the conventional basin of Lake Chad includes 51 stations distributed by sub-basin as follows:

- Komadugu Yobe = 37
- El Beid = 4
- Yedseram = 4
- Ngadda = 4
- Lake Chad = 2

The majority are gauging stations (40); only 11 stations are purely limnimetric.

The network is operated by Water Resources Engineering Engineering Construction Agency (WRECA) for the upper Komadugu by the Borno and Yobe State Water Board (YSWB, BSWB) for the lower Komadugu and the other rivers mentioned above.

Information on the state of the network in this part of the Lake Chad Basin, especially on the upper reaches of the Komadugu Yobe River, is insufficient, but the part of the network controlled by BSWB is generally in a very critical state despite the rehabilitation of the stations in 1992-93 by the LCBC/UNDP project (RAF/88/029).

The limited data collected by the LCBC expert do not correspond to the publication period of this AMR.

Table 9: List of gauging station in the Komadugu Yobe basin in Nigeria

N°	Station code	Name	Basin / River	Longitude	Latitude	Area (km²)
1	1334000101-1	Yau	Komadugu Yobe / Yobe	13.57	13.25	8410000
2	NA	Daya	Komadugu Yobe / Yobe	13.50	13.17	8400000
3	1334000104-1	Damasak	Komadugu Yobe / Yobe	13.13	12.52	82561
4	1334000105-1	Geidam	Komadugu Yobe / Yobe	12.88	11.92	58495.1992
5	1334000106	Gashua	Komadugu Yobe / Yobe	12.87	11.05	87448
6	1334001001	Dapchi	Komadugu Yobe / Komadugu-Gana	12.448	11.448	15168
18	133401	Challawa Dam	Komadugu-Yobe / Challawa	11.7416697	8.07222176	3893
19	133402	Tiga Dam	Komadugu-Yobe / Kano	11.4683304	8.40750027	6511
20	133403	Chai Chai	Komadugu-Yobe / Dudurun Gaya/Warwade	9.2683	12.015467	1945
21	133404	Iggi	Komadugu-Yobe / Iggi to Katagum R	11.5279703	9.33661747	1332
22	133405	Kari	Komadugu-Yobe / Komadugu-Gana	11.2539301	10.5571804	5908
23	133406	Gwarzo	Komadugu-Yobe / Watari	11.9633303	8.40839958	1434

N°	Station code	Name	Basin / River	Longitude	Latitude	Area (km²)
24	133407	Bunga	Komadugu-Yobe / Jama'are	10.93002 99	9.60564995	7181
25	133408	Foggo	Komadugu-Yobe / Jama'are	11,42403 03	9.95083332	9877
26	133409	Katagum	Komadugu-Yobe / Jama'are	12.28089 05	10.3676701	20381
27	133410	Wudil	Komadugu-Yobe / Hadejia	11.79714 97	8.83406639	16939
28	133411	Ririwai	Komadugu-Yobe / Kano	10.75389	8.81472206	967
29	133412	Chiromawa	Komadugu-Yobe / Kano	11.61137 01	8.37733364	7056

Table 10: List of gauging stations in the Yedseram, Ngadda and El Beid basins

N°	Code	Name	Basin / River	Latitude	Longitude	Area (km²)
1	NA	Mbuli	Yedseram / Yedseram	12.03	13.97	NA
2	NA	Bama	Yedseram / Yedseram	11.53	13.68	4750
3	NA	Uba	Yedseram / Yedseram	10.47	13.20	NA
4	NA	Madube Bridge	Yedseram / Yedseram	11.25	13.30	NA
5	NA	Maiduguri	Ngadda / Ngadda	11.25	13.17	6509
6	NA	Logejeri	Ngadda / Ngadda	11.67	13.20	NA
7	NA	Alau	Ngadda / Ngadda	11.68	13.23	NA
8	NA	Mulkina	Ngadda / Ngadda	NA	NA	NA
9	NA	Wulgo	El Beid / El Beid / El Beid	12.50	14.17	NA
10	NA	Tunakalia	El Beid / El Beid / El Beid	12.43	14.18	NA
11	NA	Gambaru Bridge	El Beid / El Beid / El Beid	12.37	14.20	1620000

3.1.2.5 Hydrometric Network of the Komadugu Yobe Basin (Niger)

The hydrometric network of the Nigerien part of the Lake Chad Basin is very small; it includs 5 stations, two of which were equipped with limnigraphers.

Despite the creation of a new station in 1989, only 3 stations are currently operated and only one is equipped with a limnigrapher.

Currently only the Bagara Diffa station is operational.

Table 11: Liste of gauging stations in the Komadugu Yobe basin (Nigerien part)

N°	Station code	Name	Basin / River	Latitude	Longitude	Altitude	Area (km²)
1	NA	Gueidam Tchoukou	Komadugu	13.09	12.49	NA	1100000
2	1324000103	Bagara Diffa	Komadugu	13.2778101	12.6210604	NA	142797
3	1324000106	Gueskerou	Komadugu	13.48	12.85	293	120000

3.1.2.6 Overview of Gauging Stations in the Chari, Logone, Komadugu Yobe, Yedseram, Ngadda et El Beid Basins

The following map shows the gauging stations with existing data for 2017-2018 in the Chari, Logone and Komadugu Yobe, basins. The LCBC has water level data for 2017 and 2018 for only 23 stations in the Chari-Logone and Komadugu Yobe basins (highlighted in blue in Figure 2). These data, most of which are incomplete, are presented in Chapter 3.1.3.

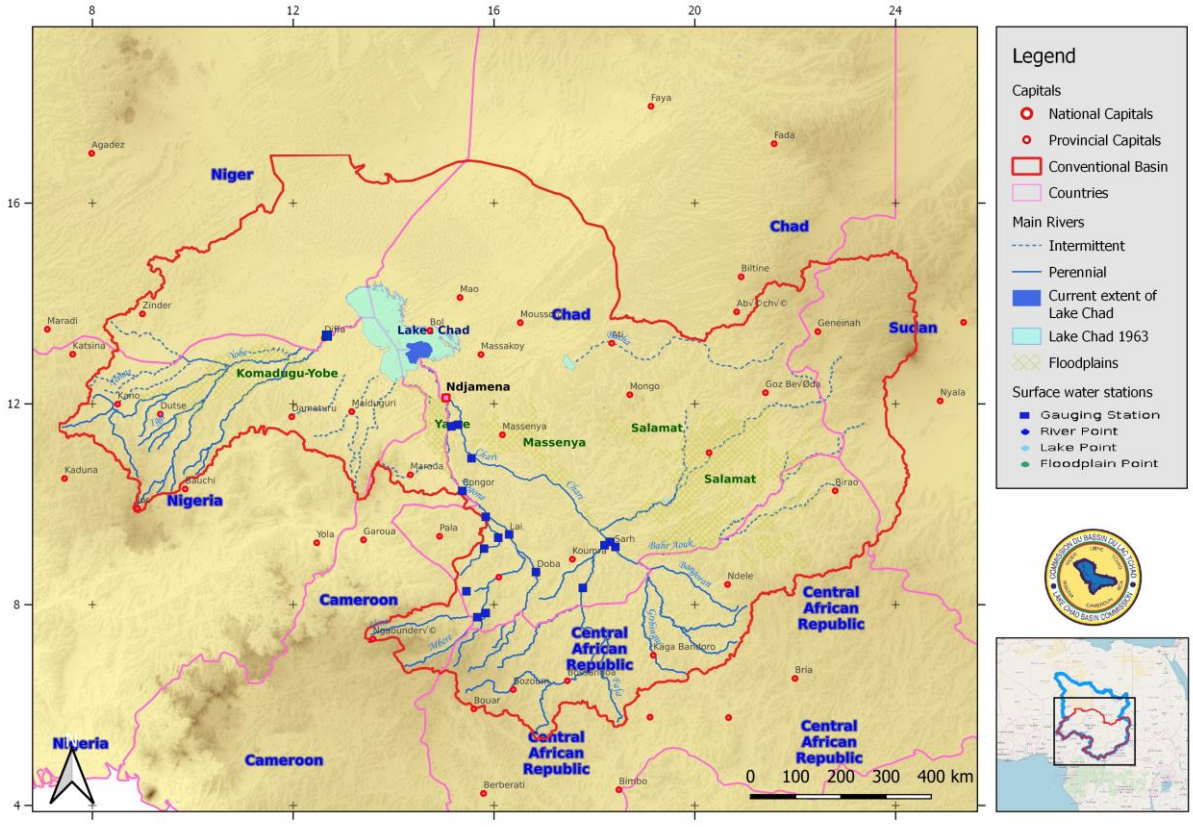
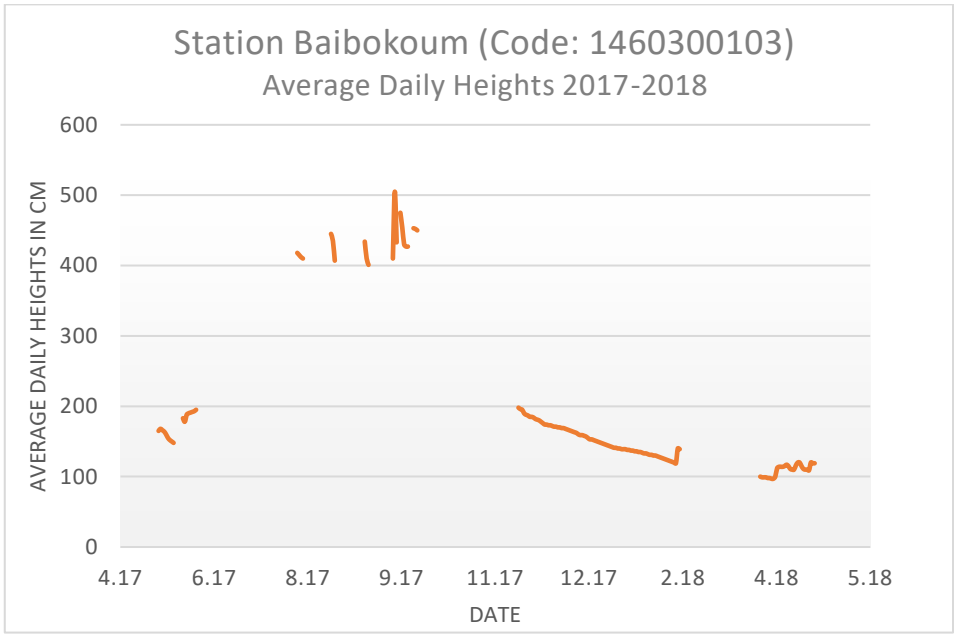


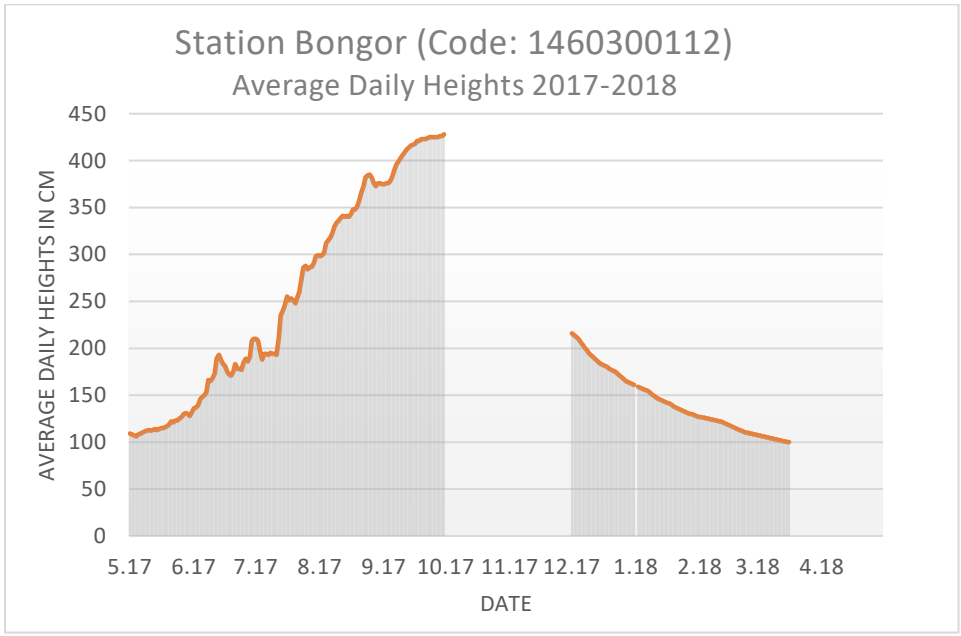
Figure 2 : General map of gauging stations in the Lake Chad Basin with measurement data for 2017 and/or 2018 available

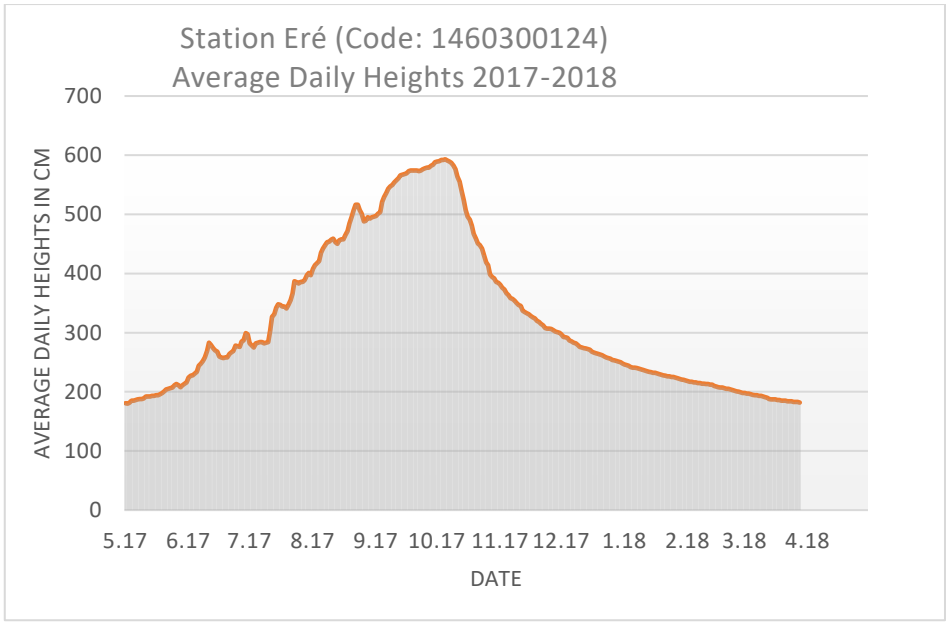
3.1.3 Water Level Data for Gauging Stations in the Chari and Logone and Komadugu Yobe Basins for the Hydrological Year 2017-2018

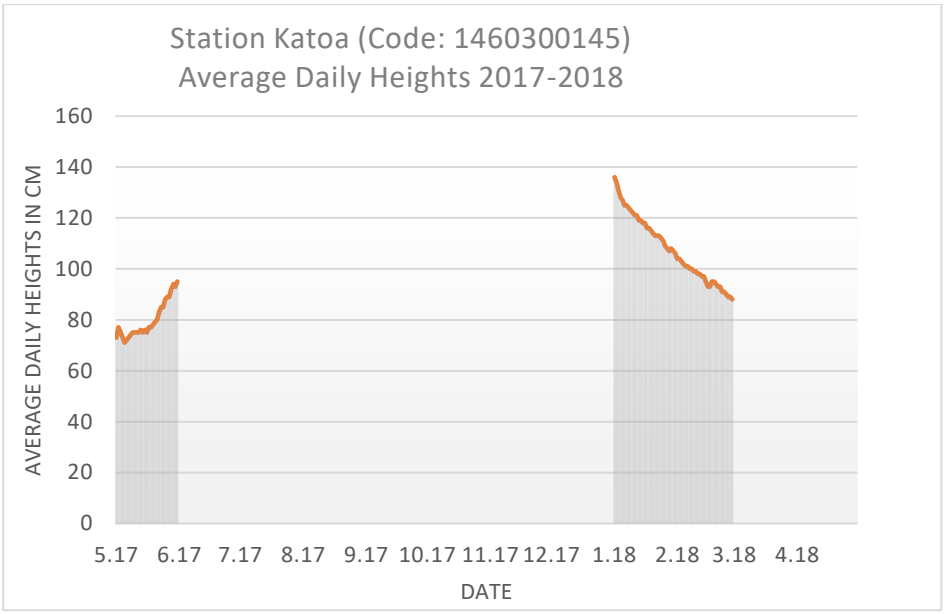
Below are presented the average daily water levels recorded in 2017 and 2018 at 23 gauging stations in the Chari and Logone basin, Chadian part and one station in the Komadugu Yobe basin in Diffa, Niger. As the LCBC has only a few calibration curves, which are often not up-to-date, the water level data cannot be converted into a discharge value.

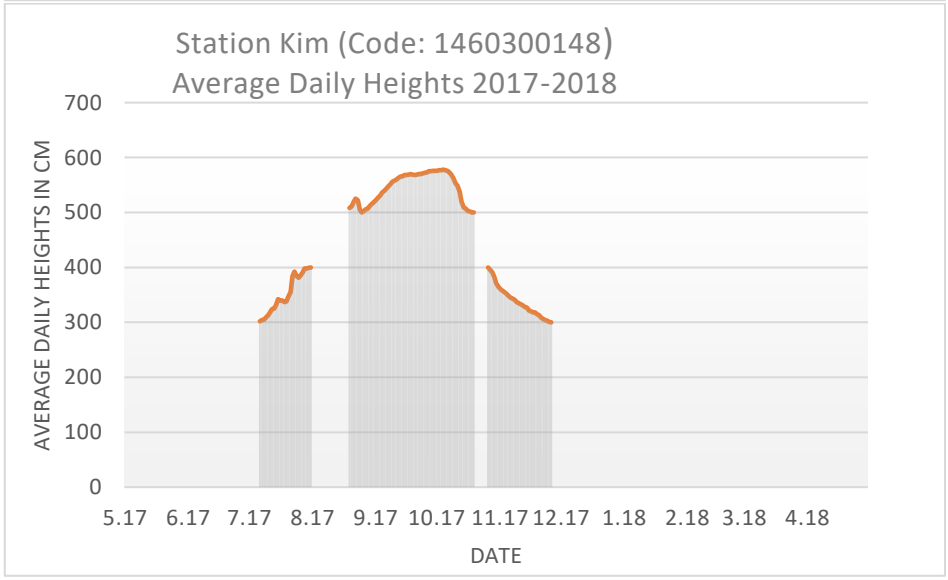
3.1.3.1 Logone Sub-Basin

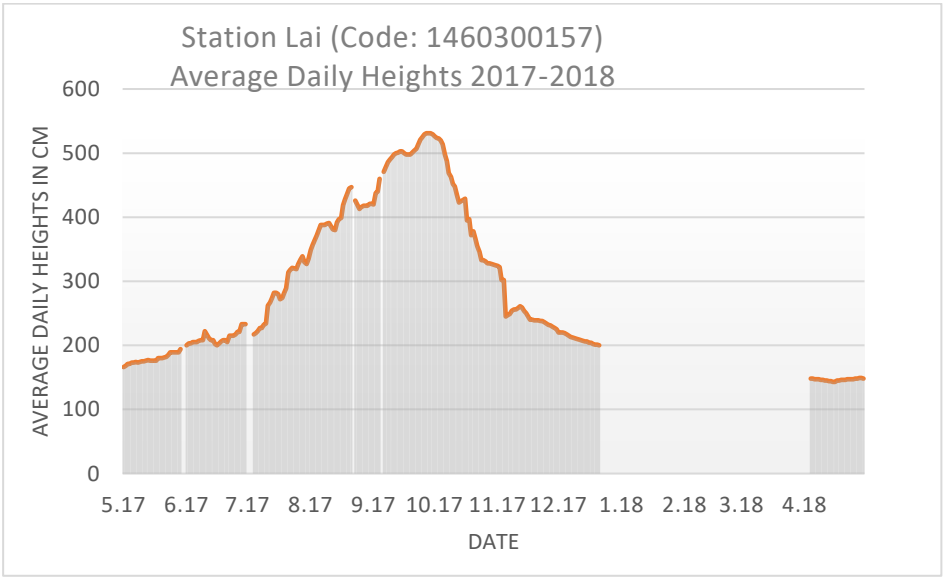


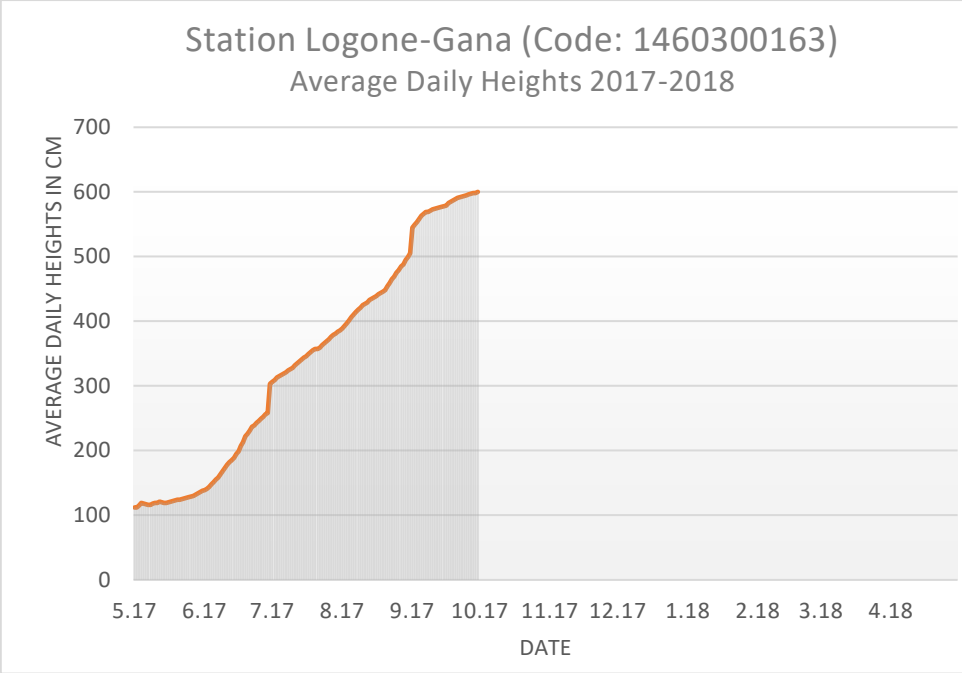


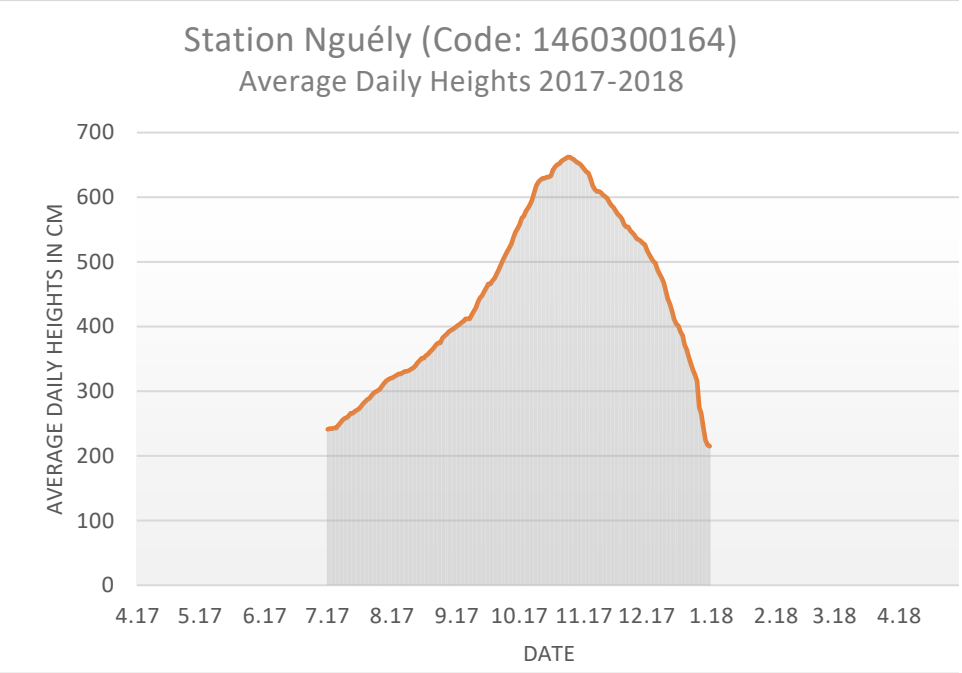

Station Eré (Code: 1460300124)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE


Station Katoa (Code: 1460300145)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
160
140
120
100
80
60
40
20
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

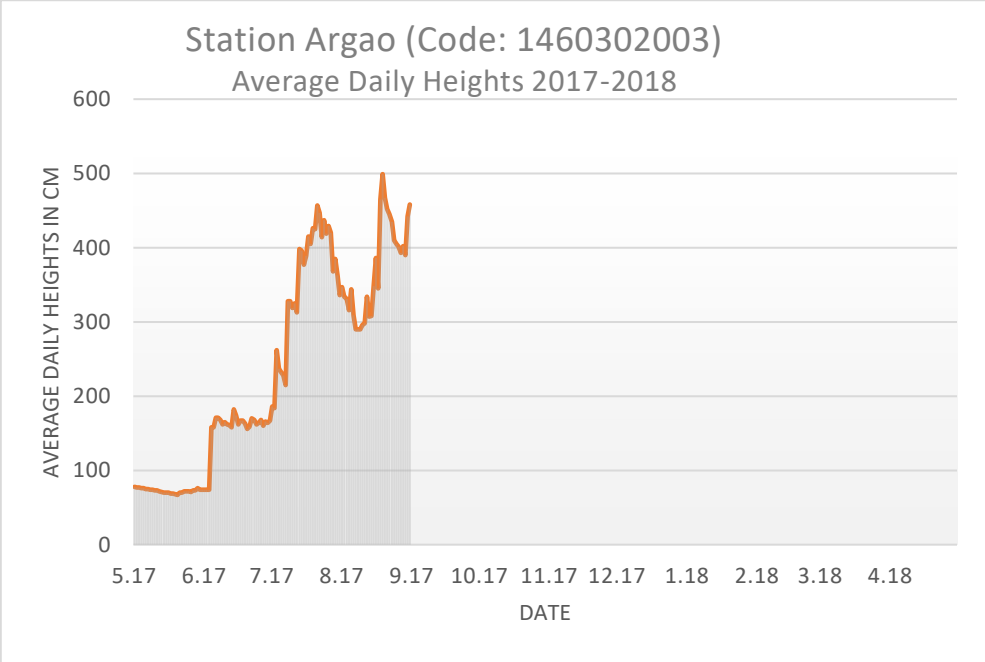

Station Kim (Code: 1460300148)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

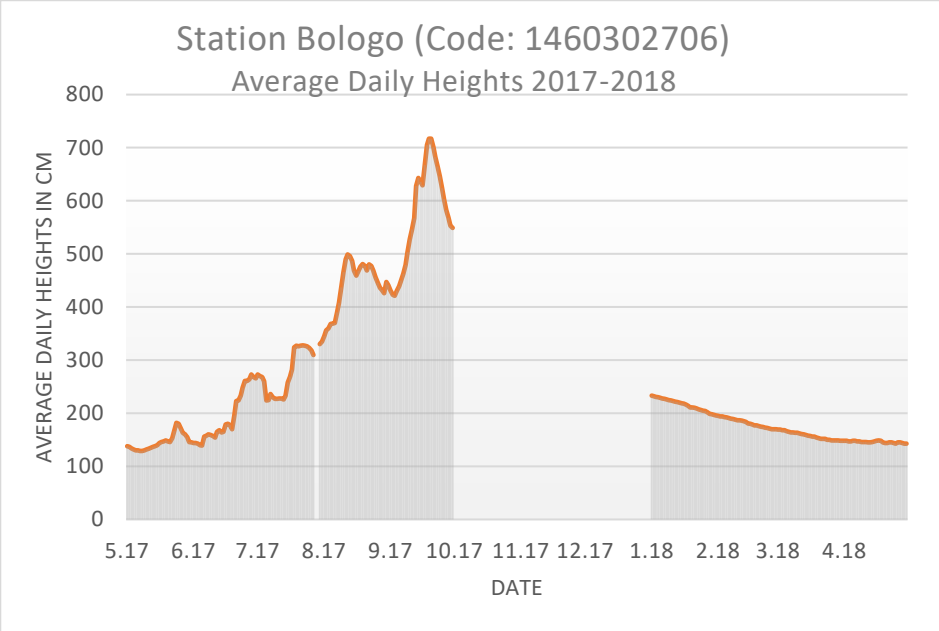

Station Lai (Code: 1460300157)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

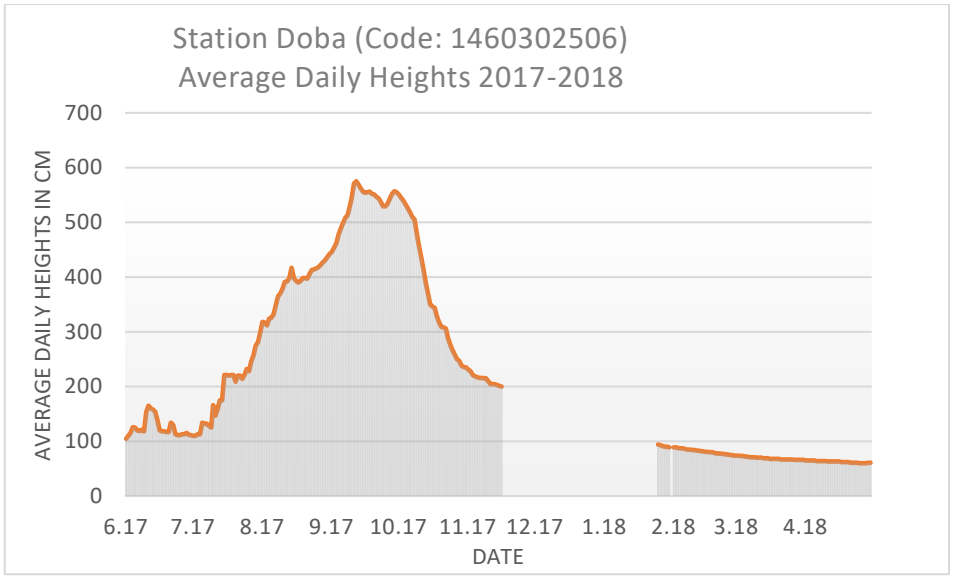

Station Logone-Gana (Code: 1460300163)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

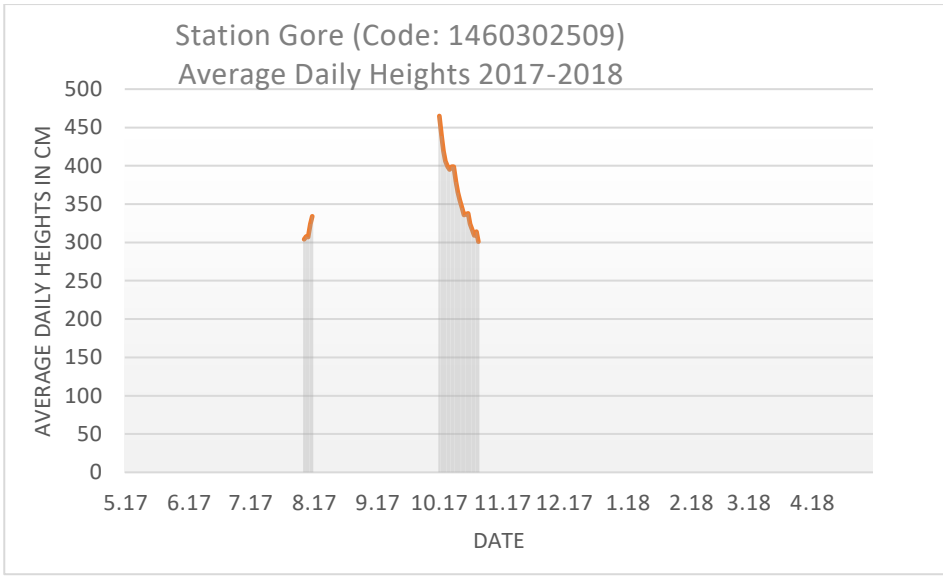

Station Nguély (Code: 1460300164)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
4.17 5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

3.1.3.2 Lim-Pendé-Tandjilé and Nya Sub-Basin






Station Doba (Code: 1460302506)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE


Station Gore (Code: 1460302509)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
500
450
400
350
300
250
200
150
100
50
0
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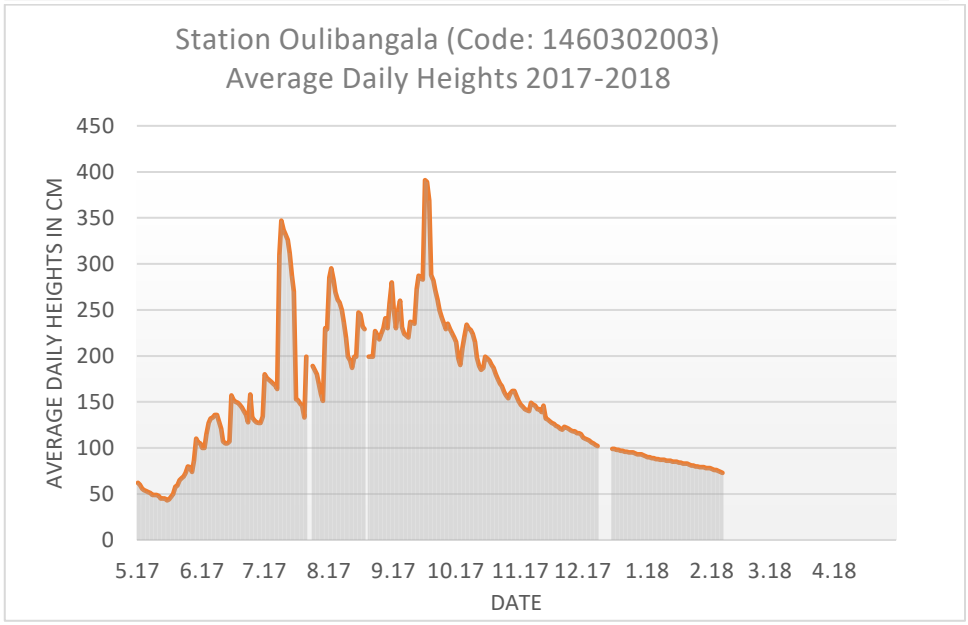
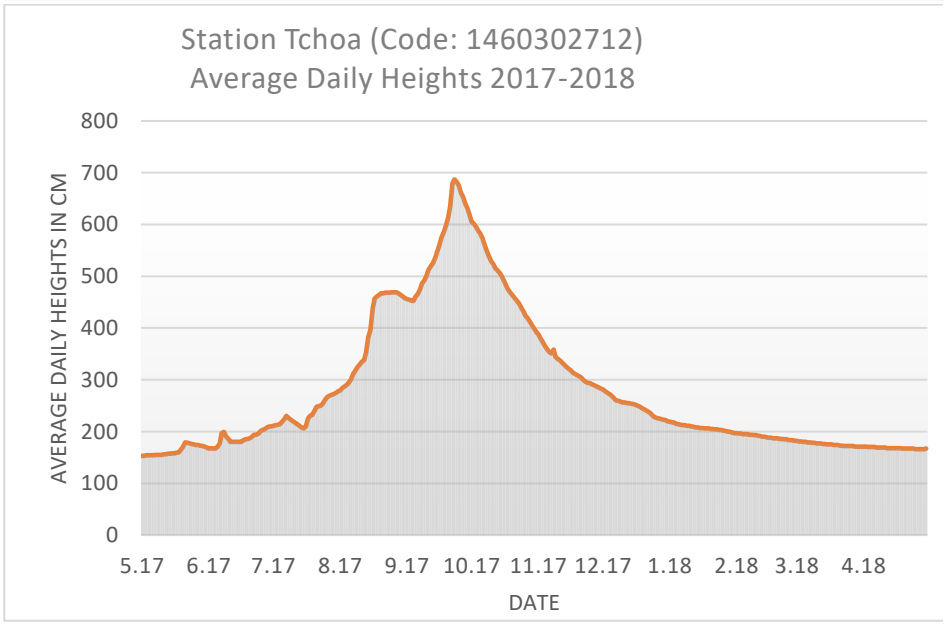
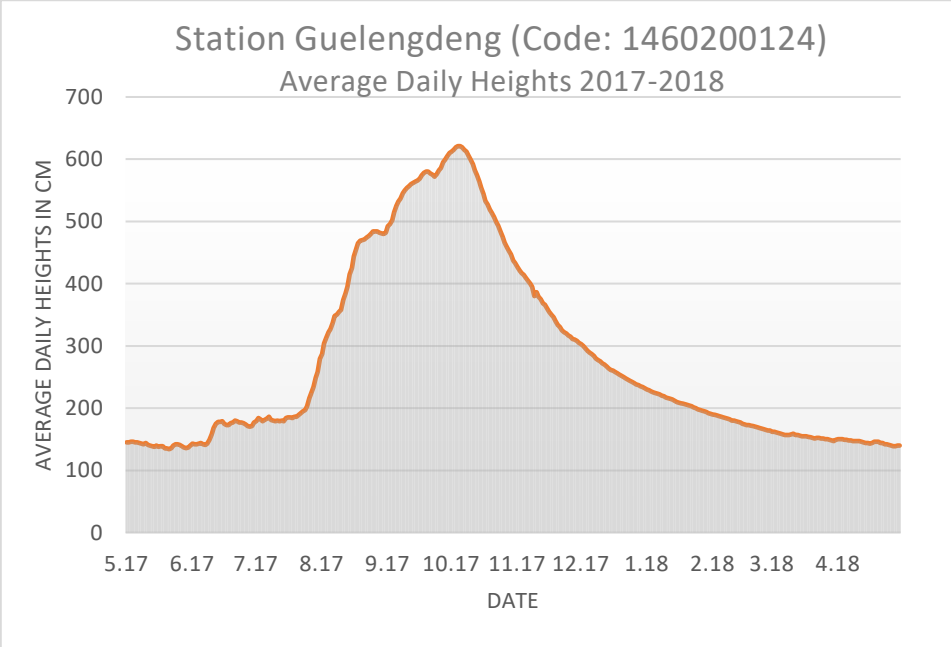
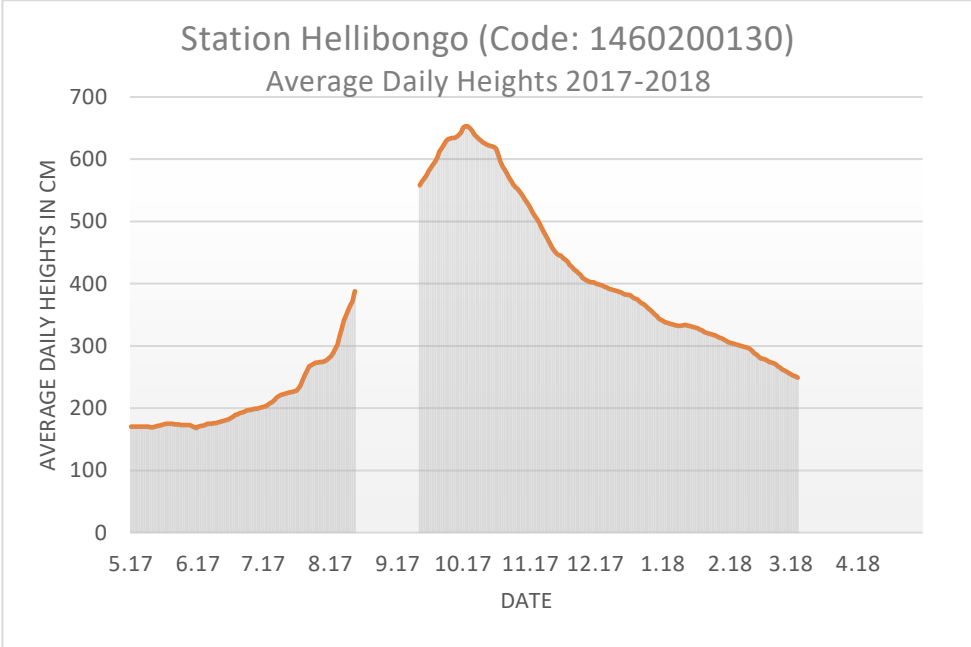
DATE

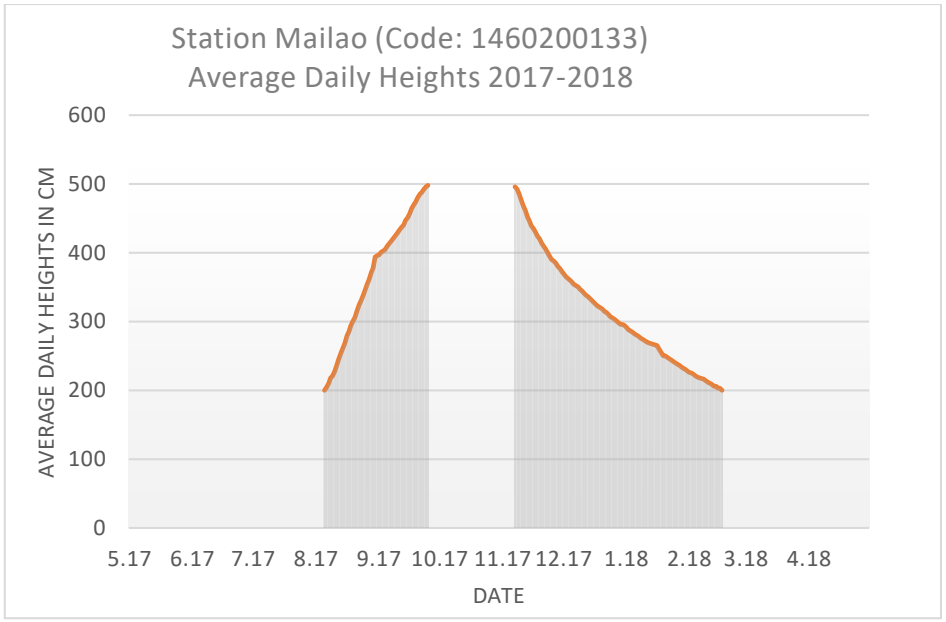

Station Oulibangala (Code: 1460302003)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
450
400
350
300
250
200
150
100
50
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

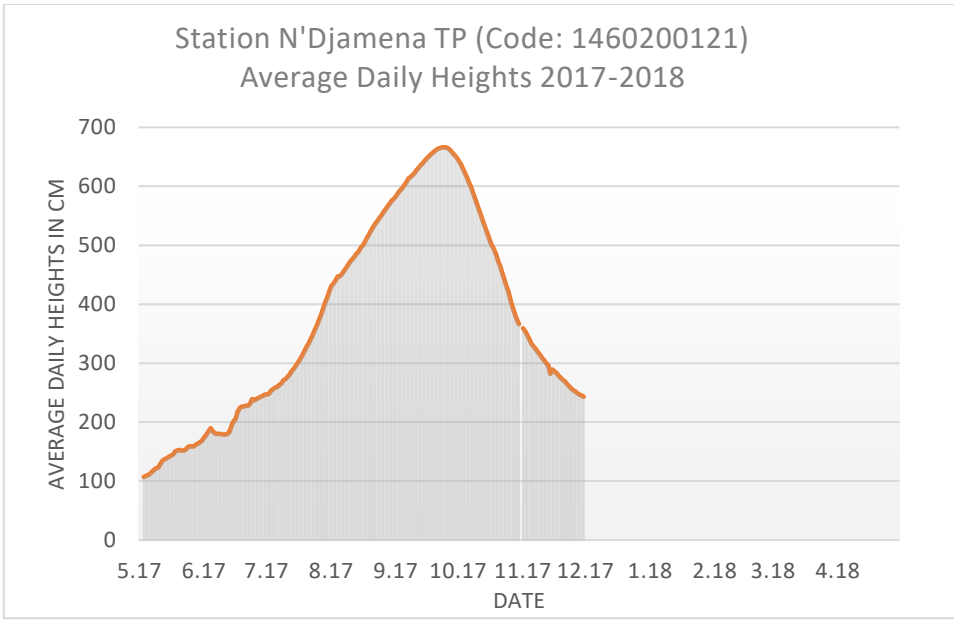

Station Tchoa (Code: 1460302712)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
800
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

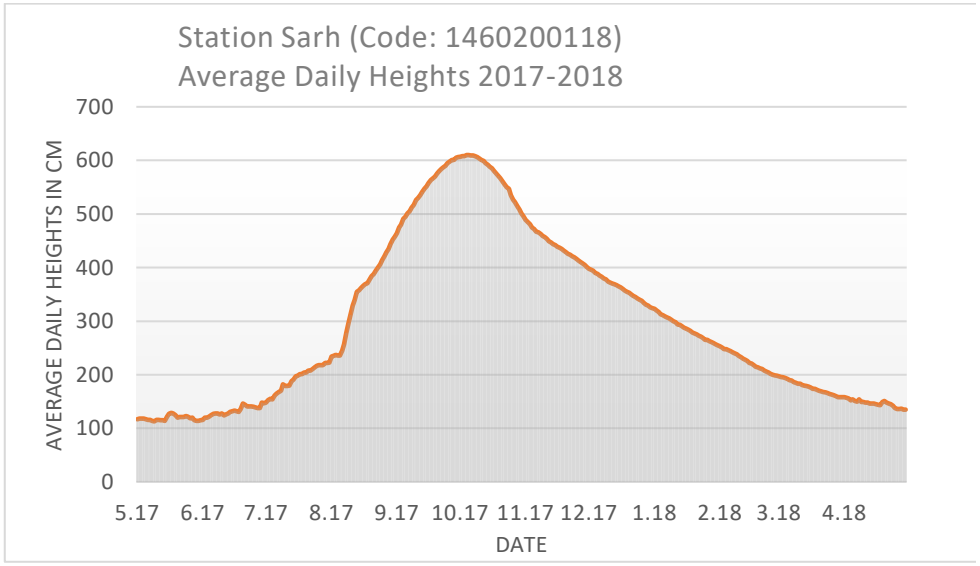
3.1.3.3 Chari Sub-Basin



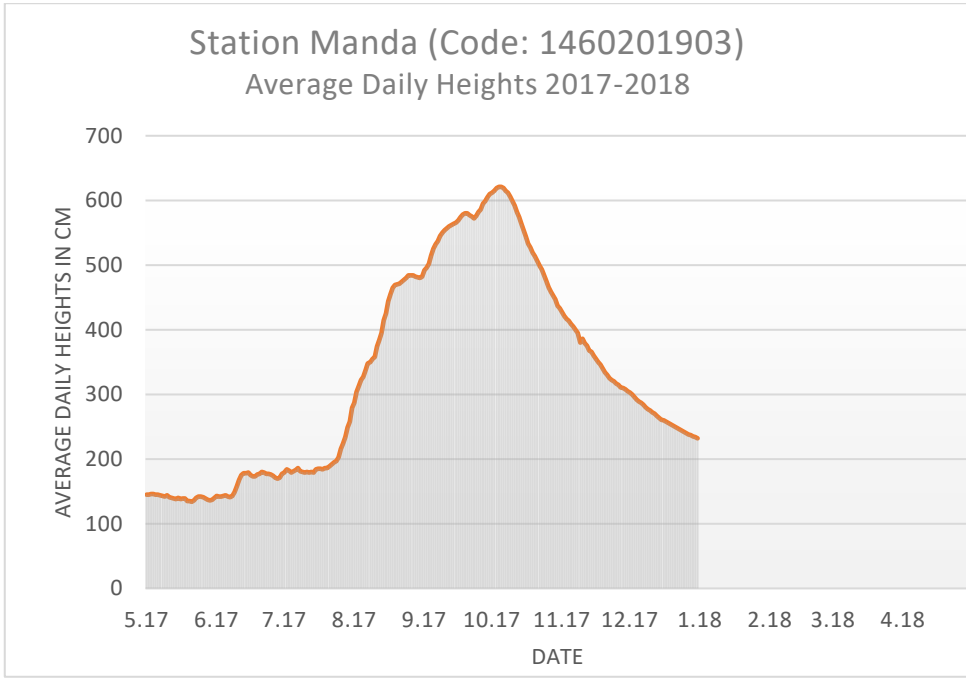


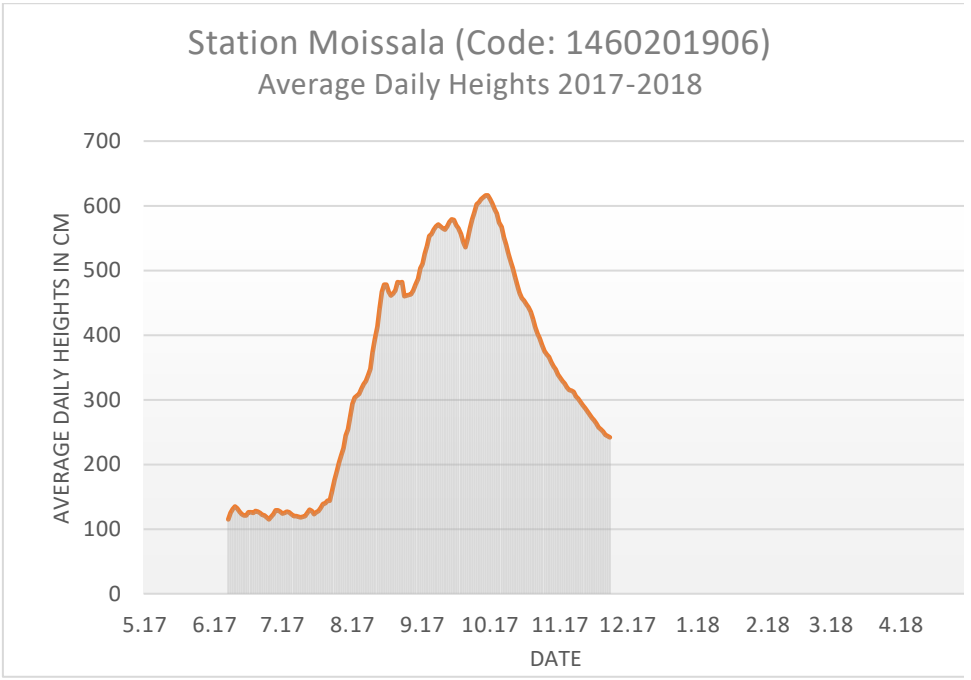

Station Mailao (Code: 1460200133)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE


Station N'Djamena TP (Code: 1460200121)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

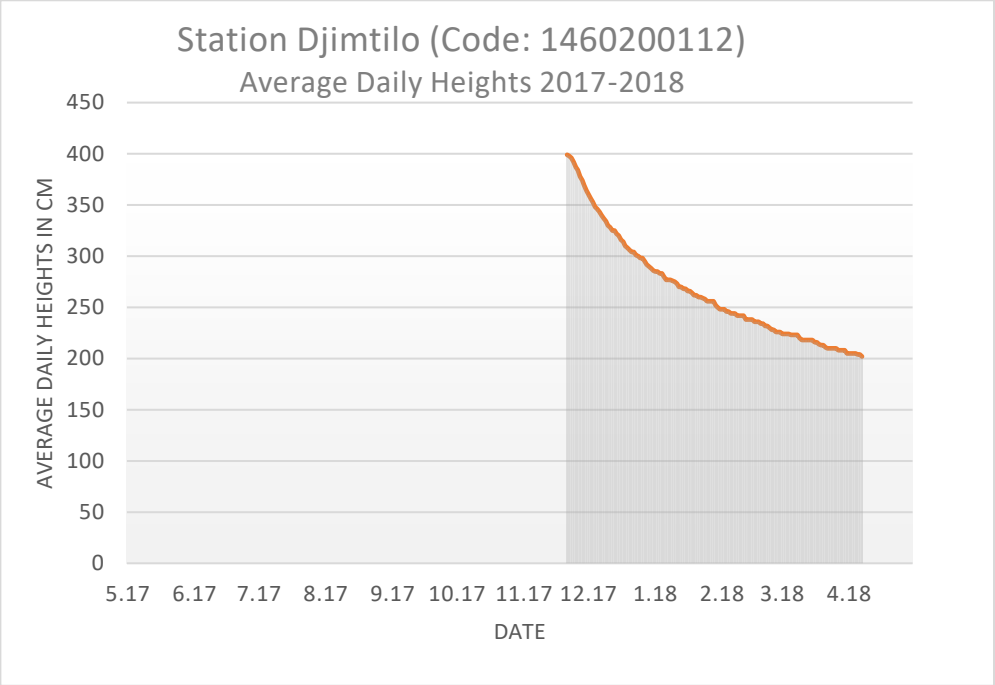

Station Sarh (Code: 1460200118)
Average Daily Heights 2017-2018
AVERAGE DAILY HEIGHTS IN CM
700
600
500
400
300
200
100
0
5.17 6.17 7.17 8.17 9.17 10.17 11.17 12.17 1.18 2.18 3.18 4.18
DATE

3.1.3.4 Le Bahr Sara Sub-Basin

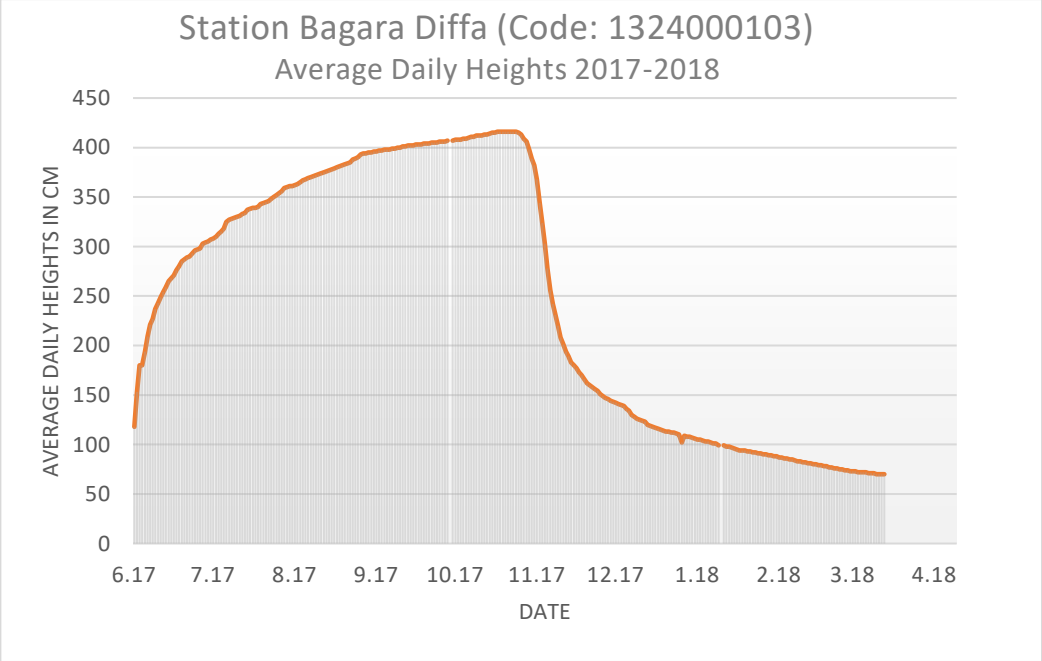




3.1.3.5 Lake Chad Sub-Basin



3.1.3.6 Komadugu Yobe Basin



3.1.4 Conclusion about Hydrometric Data for the Hydrological Year 2017-2018

Of all the existing parameters of a hydrological regime, the most commonly used one to study the inputs is the mean annual discharge Q (discharge in m³/s or l/s).
The available time series of the average annual flow at the Ndjamena TP gauging station covers the period from 1934 to 2018 with a percentage of gaps of 21%.
Figure 1Figure 3 presents the ratio of its annual flow compared to its interannual average. This measure simply compares the stream flow to a "normal" year.

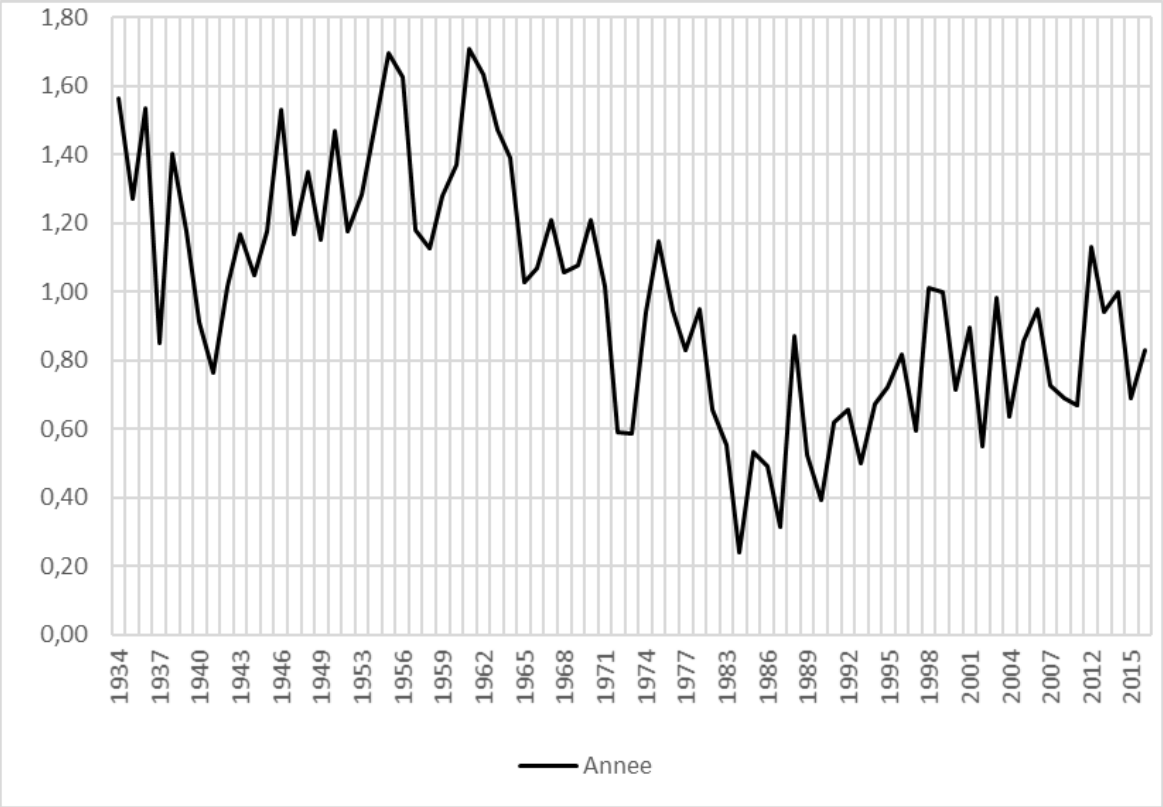


Figure 3: Evolution of annual discharge compared to its interannual average from the Chari at the N'Djamena TP station in Chad

The hydrological situation in the Chari Logone Basin during the hydrological year 2017-2018 is characterized by an average flow of 815 m^3 /s, which is lower than the interannual flow over the period mentioned above.
Figure 3 also shows that the ratio of average annual flow compared to is normal of the hydrological year 2017-2018 is above the ratio in 1984, which was considered to be a dry year.

In the Komadugu Yobe basin, the evolutionary curve of the average annual discharge compared to its interannual average of the Bagara Diffa station (Figure 4) shows a clear increase of flows, with a ratio for the hydrological year 2017-2018 being equal to 1.3 times the interannual ratio over the period 1963 to 2018.

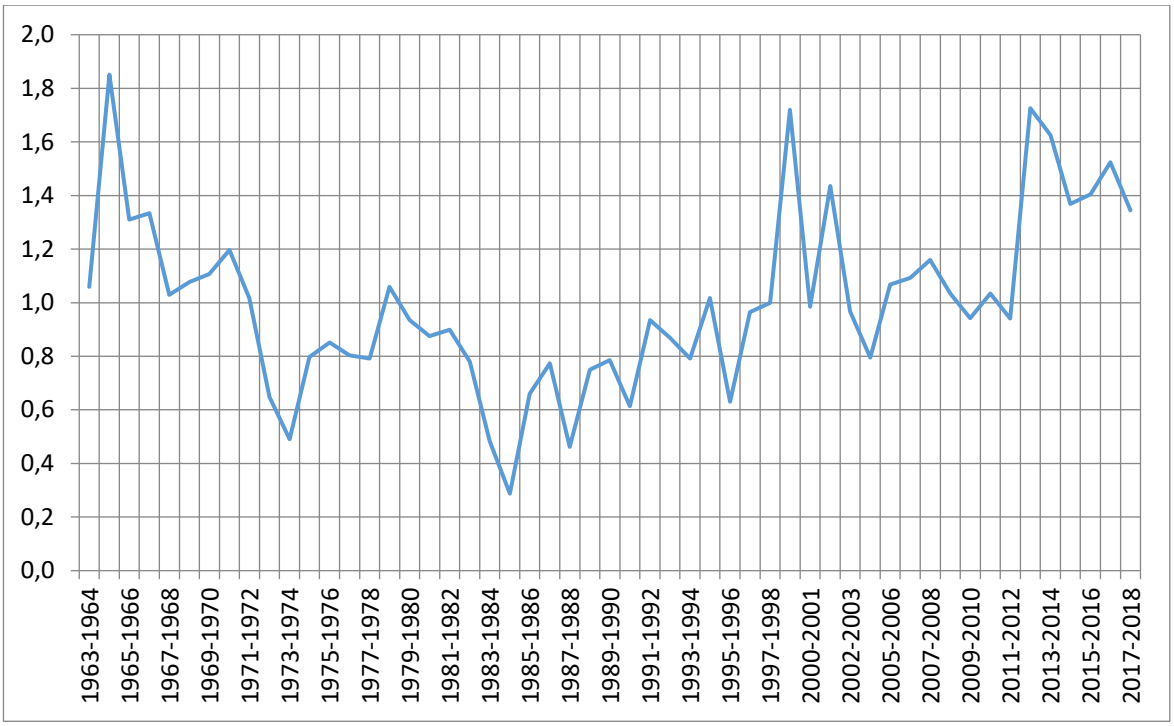


Figure 4: Evolution of the annual discharge compared to its interannual average of the Komadugu Yobe at the Bagara Diffa station in Niger

Since 2014, in regard to develop the hydrological yearbook each year, the LCBC has been responsible for hydrological monitoring, in particular for the payment of bonuses and the provision with work equipment to the observers, the rehabilitation of hydrological network stations and the collection of data in the basin. To this end, the quantity and quality of the data available in its regional database is gradually improving.

3.1.5 Characteristics of the Archetypes in Lake Chad

The main feature of Lake Chad is its variability. The lake has experienced wet and dry periods covering several time scales (geological, annual and seasonal). In 1928, Tilho proposed a classification into three archetypes for the lake: Small Lake Chad, Middle Lake Chad and Greater Lake Chad. These different states depend directly on changes in precipitation in the Chari Basin. The following table 44 describes the main characteristics of the Small and Dry, Small, Medium and Greater archetypes for Lake Chad.

Table 12: Main Characteristics of the Archetypes in Lake Chad (IRD 2014)

State of the Lake Chad	Small and dry	Small	Medium	Greater
Flow rate of the Chari-Logone River (km^3/year)	< 15	15 – 34	35 – 43	> 43
Water level (altitude meters)	The northern lake is dry	Different water levels	280 – 282	> 282,5
Number of water bodies	Many	Many	One	One
Underwater lake area (km^2)	2 000 – 6 000	2 000 –14 000	15 000 – 19 000	20 000 – 25 000
Area of the lake underwater in its northern part (km^2)	0	0 – 8 000	9 000	10 000

In the 1950s, after a wet period, the lake was referred to as Greater Chad. It consisted of a single body of water of about 20,000 km^2. Between 1957 and 2008, the lake was in a Little Chad or Small and Dry Lake Chad state two thirds of the time, and in a Middle Chad or Greater Chad one third of the time (Bader et al., 2011). The years 1985, 1987, 1988 and 1991 correspond to a Small and dry Lake Chad with a dry northern basin all year round. The northern basin dried up during part of the years 1975, 1977, 1982, 1984, 1990, 1992, 1993 and 1994. The northern basin retained some water in 1989 and from 1995 to 2013.

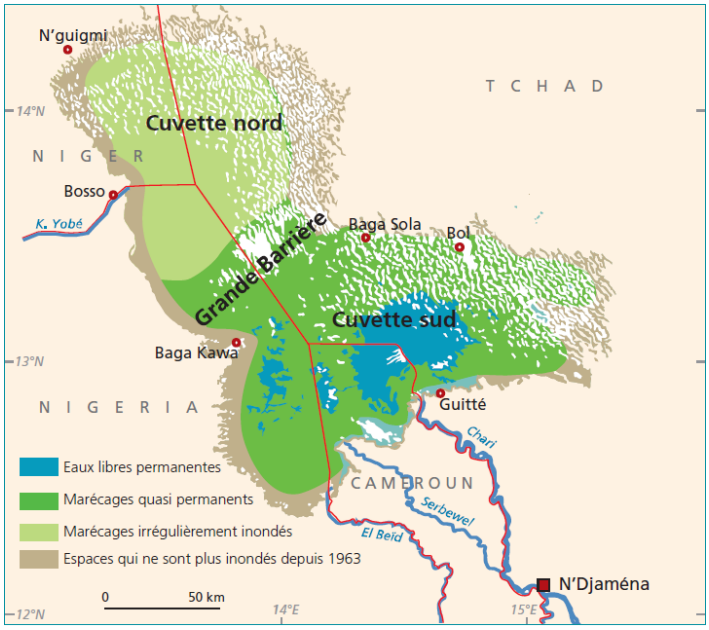


Figure 5: Schematic map of the average situation of Lake Chad ((IRD 2015)

The current extent of Lake Chad is presented in the next chapter.

3.1.6 Lake Chad Water Occurrence (2017 and 2018)

With the help of satellite data, open water is easily accessible identifiable in a near-infrared channel and its surface is easy to quantify. The Lake Water Extent for 2017 and 2018 has been calculated via Sentinel 2 satellite data by the LCBC Modelling and Remote Sensing Expert Mohammed Bila.
The calculated open water extent in 2017 was 3331 km² (Figure 6) and in 2018 only 2538km² (Figure 7) which characterizes the status of the Lake as a little Lake.

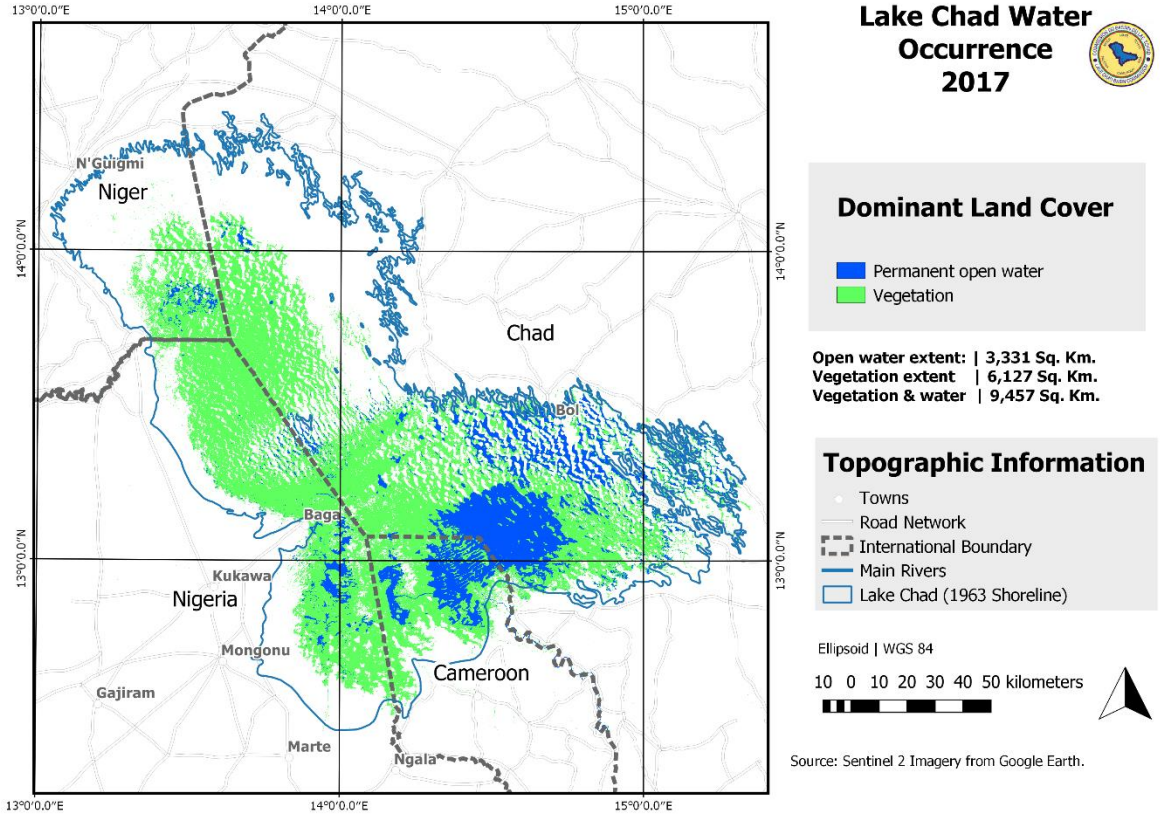


Figure 6: Lake Chad Water Occurrence in 2017 calculated via satellite images by Mohammed Bila, LCBC Expert

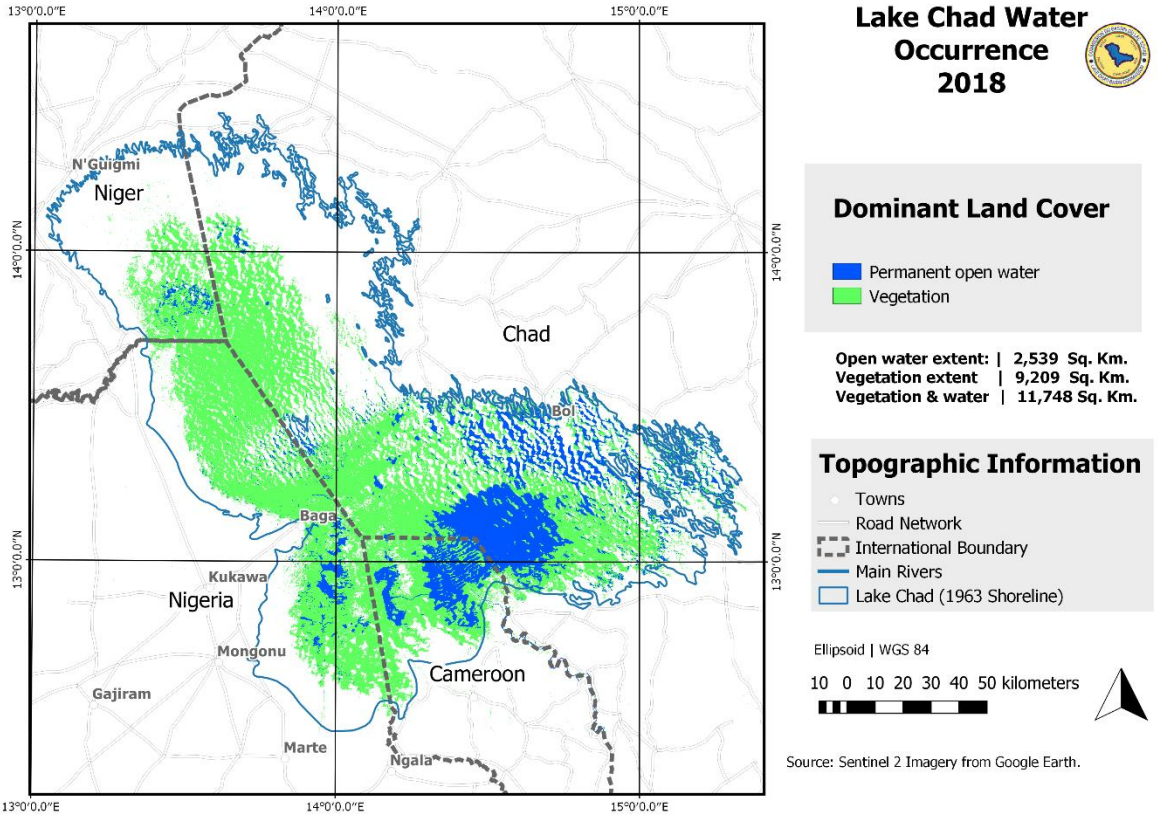


Figure 7: Lake Chad Water Occurrence in 2018 calculated via satellite images by Mohammed Bila, LCBC Expert

Unfortunately, the Lake Chad consists of a part of open water and a portion of water covered with swampy vegetation. The swamp areas are in this estimation not considered, so that these values cannot be seen as total surface areas of the Lake Chad.
These swamps, when flooded, should be considered as aquatic ecosystems since they participate in particular in the production of fish; for the residents, who use the canoe to move around, they belong to the Lake.

3.1.7 Extent of flooding areas in the Lake Chad Basin

The seasonal floodplains, which can reach 90,000 km² in the Lake Chad Basin, play an important role in its ecology, in the services provided to societies and in regulating Lake Chad's water supply. As such, they are an important element of water management.

The floodplains near Lake Chad, such as the Great Yaéré and the floodplain between Chari and Logone, the Massenya plain, the Hadejia-Nguru floodplains on the Komadugu-Yobe in Nigeria near the border with Niger or the lower Ngadda, Yedseram and El Beïd rivers in Nigeria, are almost completely dry during part of the year.

There are no estimates of the water surface of the wetlands in the Lake Chad Basin for 2017 and 2018 available, but for the Yaéré wetland the BGR in the framework of the LCBC-BGR project estimated the minimum, maximum and average flooding extent of the lower Logone based on MODIS time series (2000-2014). This work is presented below.

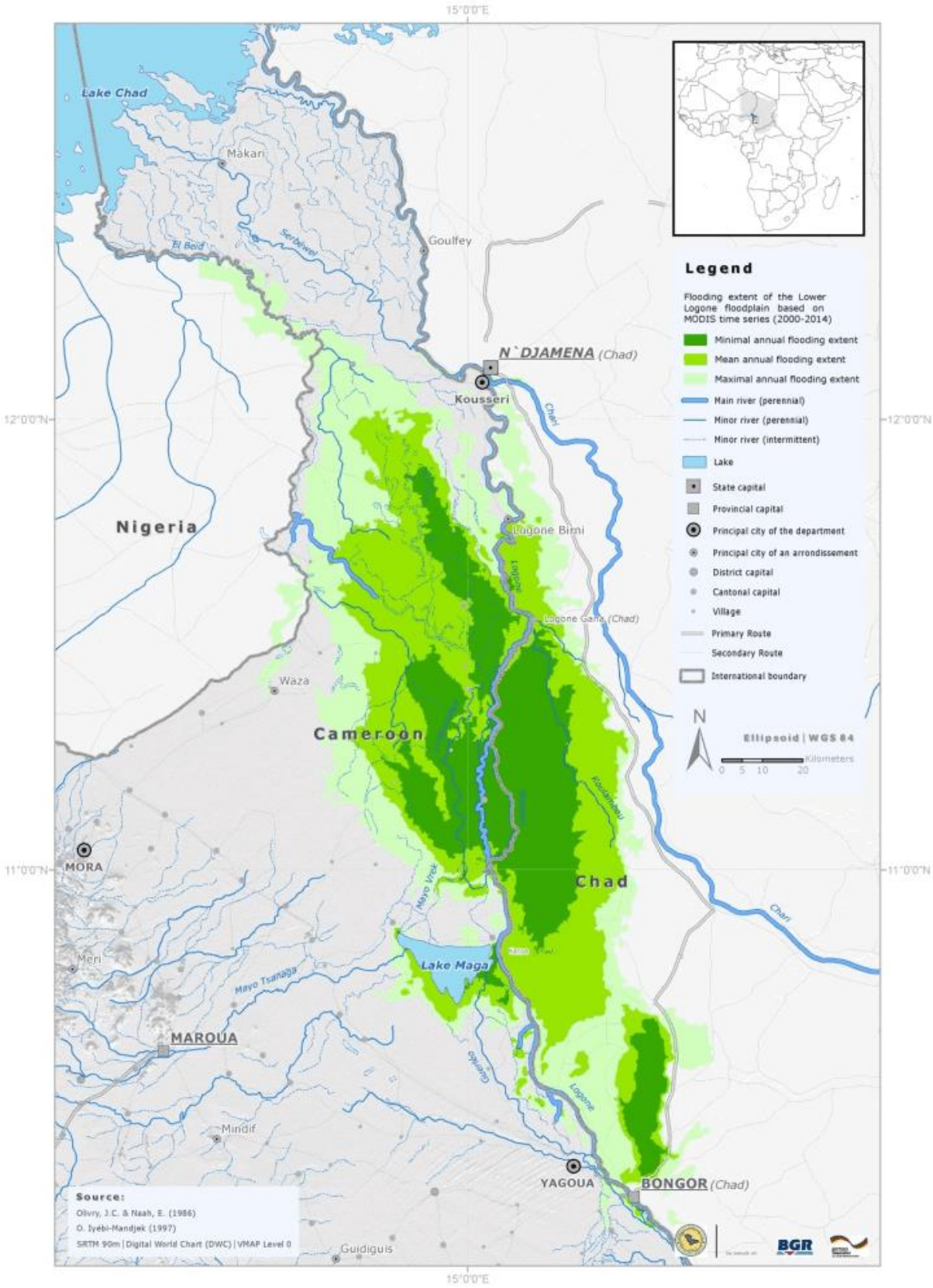


Figure 8: Minimum, maximum and average extent of the floods of the Logone River in the Yaéré plain, based on data from MODUS time series recorded between 2000 and 2014 (S.Vassolo, C. Wilczok, D. Daïra 2016)

3.1.8 Groundwater Monitoring Network in the Lake Chad Basin

The sedimentary bedrock of Lake Chad is composed of aquifers of unequal importance and distinct by their lithologic nature, depth and power. Groundwater is mainly contained in aquifers located in the Continental Terminal (Oligo-Mio-Pliocene) and Quaternary deposits.
The deposits of the Continental Terminal are very well represented in the Chadian basin but covered by those of the Quaternary. The Quaternary formations cover most of the Lake Chad Basin. The chronology of their deposits is consistent with lake level variations related to climatic variations over the last million years. These are sandy and clayey detrital sediments, often reworked, fluvial, lacustrine or deltaic and eolian, which show rapid lateral and vertical variations in facies. Their thickness is low (20 m along watercourses and 50 m or even more than 100 m in the center of the basin).

The quantitative monitoring of the basin's groundwater resources is a fundamental exercise for the control and use of water by the various Member States with a view to effective and efficient groundwater management. As such, within the framework of the project "Sustainable management of water resources in the Lake Chad Basin" implemented since 2008 in cooperation with the Federal Institute of Geosciences and Natural Resources (BGR), the LCBC has steered its policy for managing the quantity and quality of water starting an installation processes for the regular monitoring of groundwater resources in the Lake Chad Basin on the basis of existing piezometers equipped with automatic recorders (data loggers).

The fluctuation of the piezometric level of the Quaternary aquifer is currently monitored very regularly every twelve hours (12h) through 10 piezometers installed in the basin and equipped with automatic recorders. This monitoring activity is carried out by the department of the Basin Observatory of LCBC.

Within the framework of the LCBC-BGR project, information on existing piezometers in the basin are presented in the following table:

Table 13: Information on existing piezometers in the Lake Chad Basin

	Country	**Number of piezometers**	**Number of piezometers equipped with data logger**	**Number of functional piezometers**
1	Chad	90	10	10
2	Cameroon	8	1	1
3	Niger	161	22	16
4	Nigeria	4	4	4
5	CAR	0	0	0

The fluctuation of the piezometric level of the Quaternary aquifer is monitored through 31 piezometers installed and functional in the basin and equipped with data logger. The 11 data loggers installed in the piezometers in Chad and Cameroon are monitored by the LCBC Basin Observatory.

Table 14: List of functional piezometers equipped with data loggers in the Lake Chad Basin

Code	Name (Village)	Country	X	Y	Altitude	Conndition	Measurement
PZ1-TCD	Aboussouf	Chad	15.71333	12,23944	296.8	Functional	Automatic
PZ2-TCD	Albadie	Chad	16.17	12,41	291	Functional	Automatic
PZ3-TCD	Am Ndjamena Koura	Chad	15.22388	12,00049	299.77	Functional	Automatic
PZ4-TCD	Anibeg Fadoul	Chad	15.46935	12,86911	288	Functional	Automatic
PZ5-TCD	Guelendeng	Chad	15.55	10,92	318	Functional	Automatic
PZ6-TCD	Katoa	Chad	15.09074	10,82467	309	Functional	Automatic
PZ7-TCD	King-King	Chad	15.20909	11.5685	297	Functional	Automatic
PZ8-TCD	Loutou	Chad	15.378	10,7679	316	Functional	Automatic
PZ9-TCD	Massenya CL	Chad	15.55670	10,9171	331.5	Functional	Automatic
PZ10-TCD	Toura	Chad	15.3034	10,5026	317.32	Functional	Automatic
NA	Tildé	Cameroon	14.75213	12,12530	292.5	Functional	Automatic
NA	Hadejia	Nigeria	10.05779	12.45209	359	Functional	Automatic
NA	Damaturu	Nigeria	11.96385	11.74214	328	Functional	Automatic
NA	Bama	Nigeria	13.68559	11.51433	334	Functional	Automatic
NA	Maiduguri (FIR office)	Nigeria	13.11541	11.83366	337	Functional	Automatic
796298	Apke Dioumbouté NP	Niger	9.71276	13.535945	385.2	Functional	Automatic
796301	Malam Ganari NP	Niger	9.905381	13.179109	361	Functional	Automatic
796291	Baykori NP	Niger	8.94497	13.231782	414.5	Functional	Automatic
796292	Bakadoubou NP	Niger	9.047971	12.972727	384.5	Functional	Automatic
796294	Bassansani Karama NP	Niger	9.724778	12.911691	362	Functional	Automatic
796296	Wacha NP	Niger	9.282541	13.365825	377.3	Functional	Automatic
796289	Zongon Awakass NP	Niger	9.13239	13.531361	399.3	Functional	Automatic
796297	Guidimouni NP	Niger	9.522448	13.702809	421.7	Functional	Automatic
NA	Zinder	Niger	8.94915	14.03900	459	Functional	Automatic
NA	Diffa DRH	Niger	12.605694	13.313444	NA	Functional	Automatic
240759	Weltouma Manzo	Niger	12.279278	14.454278	NA	Functional	Automatic
NA	Sayam	Niger	12.630972	13.848639	NA	Functional	Automatic
NA	Goudoumaria	Niger	13.125667	14.242750	NA	Functional	Automatic
NA	Sokor 16	Niger	12.920556	15.604722	362	Functional	Automatic
NA	Koulélé CE1	Niger	13.304167	15.703611	330	Functional	Automatic
796298	DAF1	Niger	12.397222	16.850833	423	Functional	Automatic

The following map presents the location of automatic groundwater level monitoring stations (piezometers) in the Lake Chad Basin:

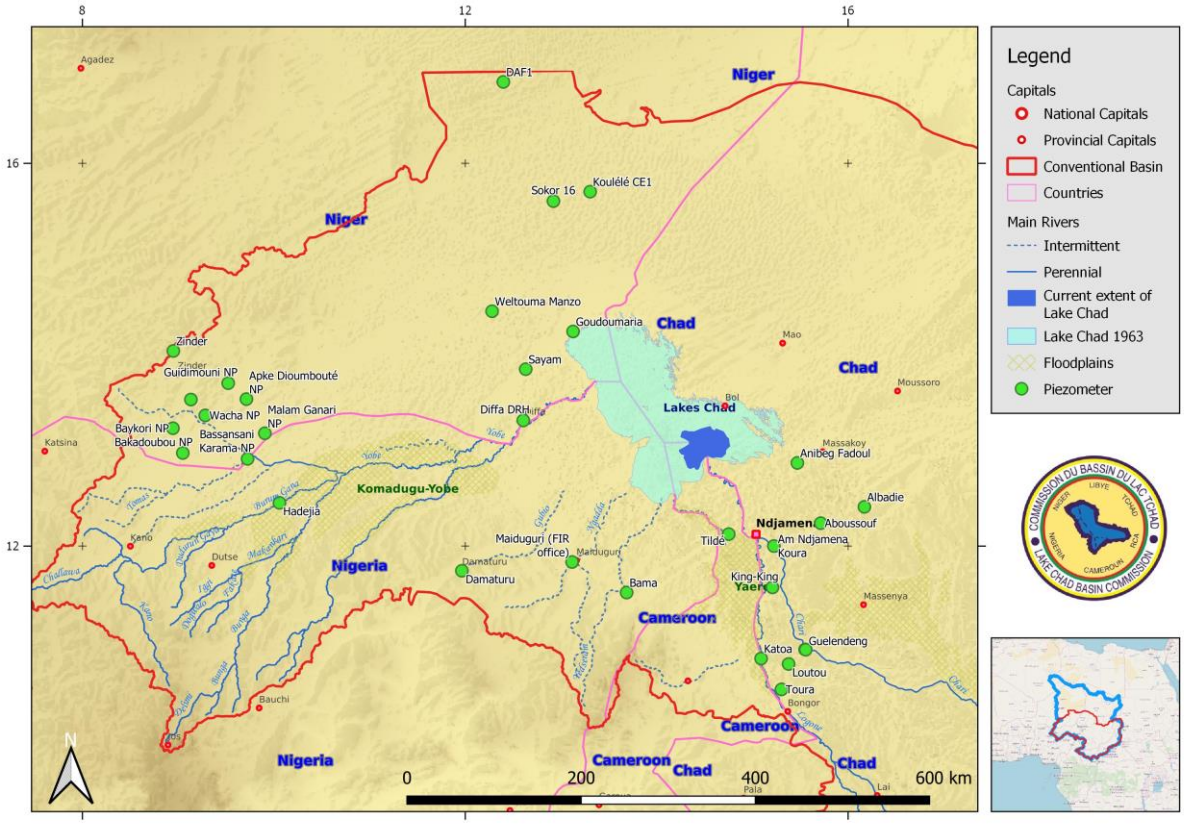


Figure 9: Map of automatic groundwater level monitoring stations (piezometers) in the Lake Chad Basin

3.1.9 Time Series of Static Water Level Measurements

For only 5 of the 10 piezometers, the LCBC has continuous water level data for the years 2017 and 2018. They are presented below.

3.1.9.1 Piezometer of AmNdjamena Koura in Chad

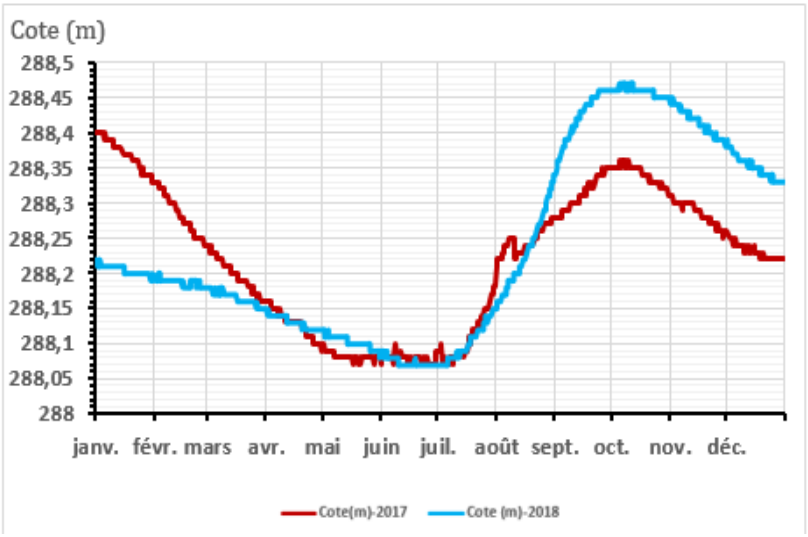


Figure 10: Fluctuation of the water table in the Quaternary aquifer at AmNdjamena Koura piezometer in 2017 to 2018.

The groundwater level of the AmNdjamena Koura piezometer rose from 288.35 m in 2017 to 288.46 m in 2018, an increase of 11 cm at the end of 2018. This increase is believed to be due to the average rainfall recorded in the Sahel band in 2018. However, the groundwater level is subject to the risk of overexploitation, as many projects to develop small irrigated areas are beginning to be put in place in this area located on the south-eastern periphery of N'Djamena.

3.1.9.2 Piezometer of Guelendeng in Chad

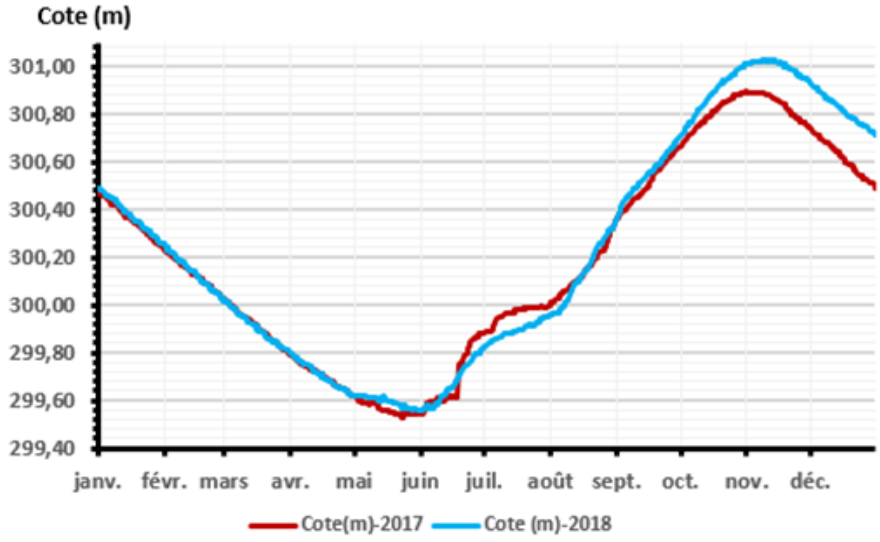


Figure 11: Fluctuation of the water table in the Quaternary aquifer at Guelendeng piezometer in 2017-2018

At this piezometer one can observe an increase of the groundwater level over the years. The groundwater level rose from 300.85 m in 2016 to 301.20 m in 2018, an increase of 35 cm at the end of 2018. This increase would be the response to the recharge in 2017 and 2018 and the rational use of the resource. In the Guelendeng area, irrigation is less developed, the population lives only on agriculture made during the rainy season.

3.1.9.3 Piezometer of Toura in Chad

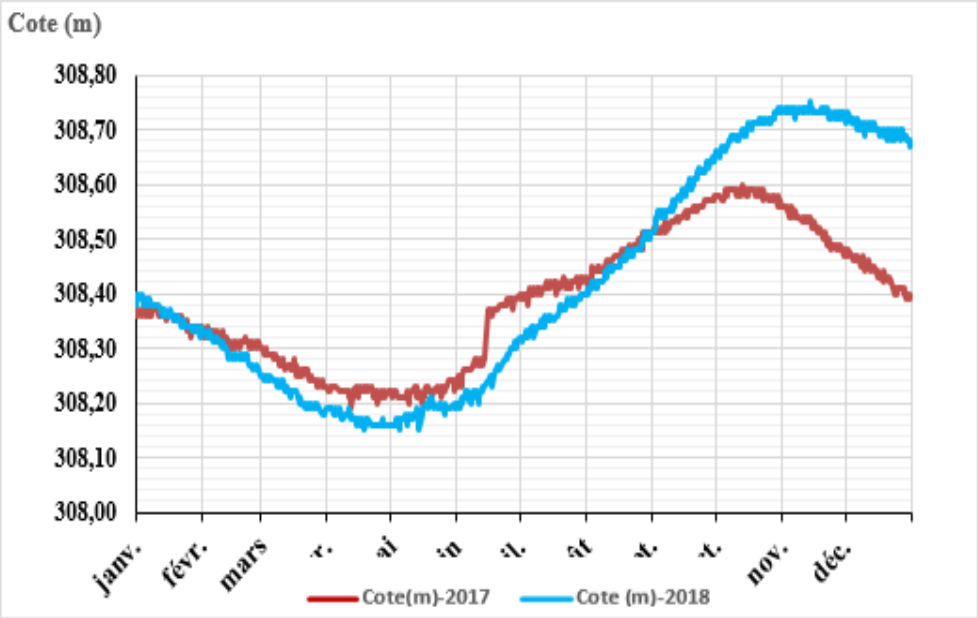


Figure 12: Fluctuation of the piezometric level in the Quaternary aquifer at Toura (2017-2018)

This figure also shows an increase of the groundwater table. The evolution of the groundwater level is mainly controlled by precipitation. The rainfall period at the end of 2018 is very representative of this phenomenon with an increase in the groundwater level of around 19 cm. With this recharge, we can see that since 2016, the water level has increased by 39 cm.

3.1.9.4 Piezometer of Katoa in Chad

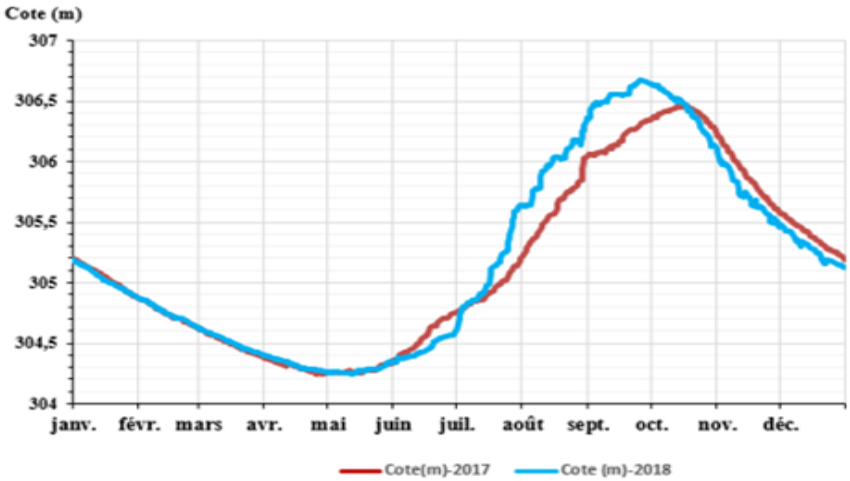


Figure 13: Fluctuation of the piezometric level in the Quaternary aquifer in Katoa (2017-2018)

In this piezometer, the water level reaches its maximum between September and November. The piezometric fluctuations recorded in this piezometer show that the water table in 2018 has increased by 20 cm compared to 2017. This increase occurs on the one hand due to the recharge of the groundwater by meteoric waters and on the other hand due to the moderate use of the 2017 reserve. Indeed, most of the water for agriculture or household uses in the area around the piezometer is pumped directly from the Logone River because of the proximity of the area to this watercourse.

3.1.9.5 Piezometer of Tildé in Cameroon

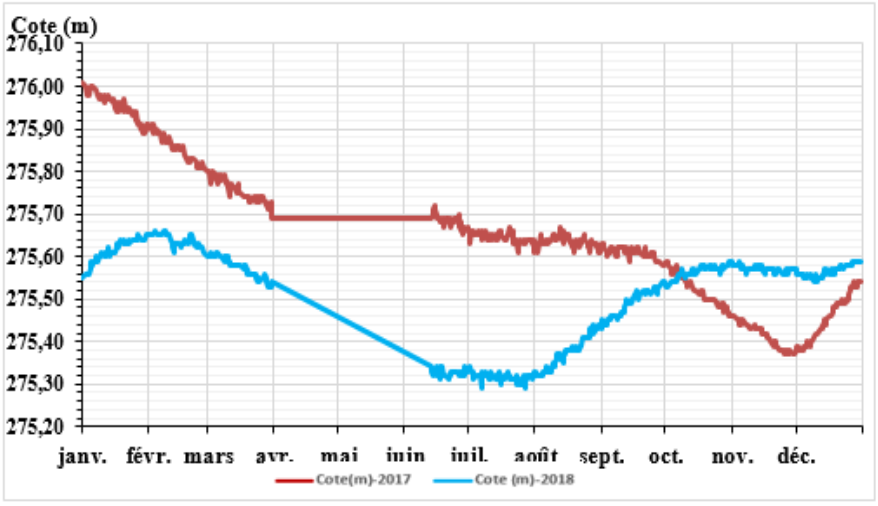


Figure 14: Fluctuation of the piezometric level in the Quaternary aquifer in Tildé (2017-2018)

In this area of the Logone floodplain, groundwater resources appear to be influenced by irrigation pumping and watering of livestock in transhumance. The groundwater monitoring from March 2016 to December 2019 shows that drawdowns during high water periods are in the order of 0.16 m. The development of irrigation in this region has no significant impact on groundwater resources.

3.1.10 Irregular Groundwater Monitoring in the Lake Chad Basin

Between November 2009 and December 2018, the BGR-LCBC project "Sustainable Water Management in the Lake Chad Basin" carried out a series of hydrogeological field missions to the Kanem, Bahr el Ghazal, Lake, Moyen-Chari and Salamat regions, the Komadugu-Yobe Basin in Nigeria, N'Djamena City and the Lower Logone River floodplain, known as Yaéré in Cameroon and Naga in Chad. The main purpose of the surveys was to obtain information on the direction of groundwater flow in the Quaternary aquifer of the Lake Chad Basin region. Field surveys included the location of water points and measurements of water levels. A total of about 500 water points were visited. These various field campaigns made it possible to draw up piezometric maps of:

- Kanem;
- Bahr el Ghazal;
- Moyen Chari;
- Yaéré;
- Komadugu Yobe.

3.1.10.1 Kanem Region

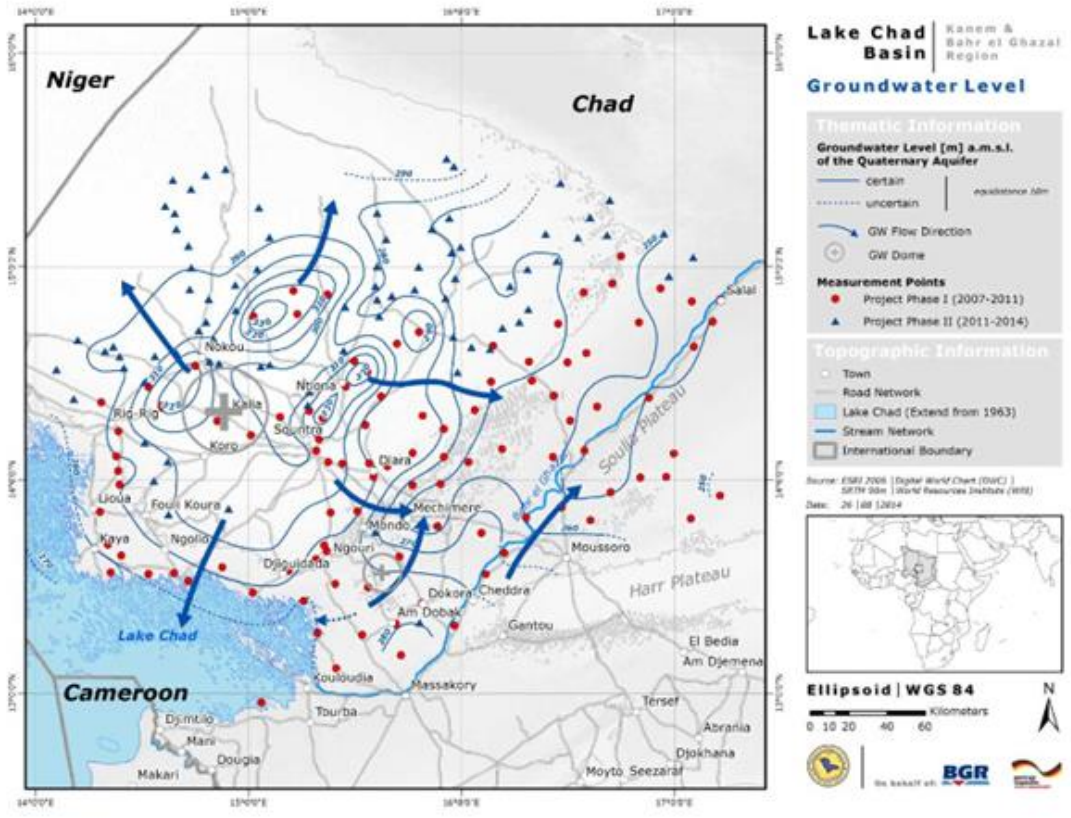


Figure 15 Map of the groundwater level of the Kanem Region, data from 2009 to 2013 (Vassolo et al. 2014)

Although the measurements were made over a 4-year period (2009-2013), seasonal variations in the static level of groundwater are very small (less than 10 cm). The groundwater is at an altitude of 330 m asl, and therefore about 50 m above the current lake level (about 283 m asl). The discharge areas are Lake Chad in the south and Bahr el Ghazal in the south-east.

3.1.10.2 Southern Bahr El Ghazal Area

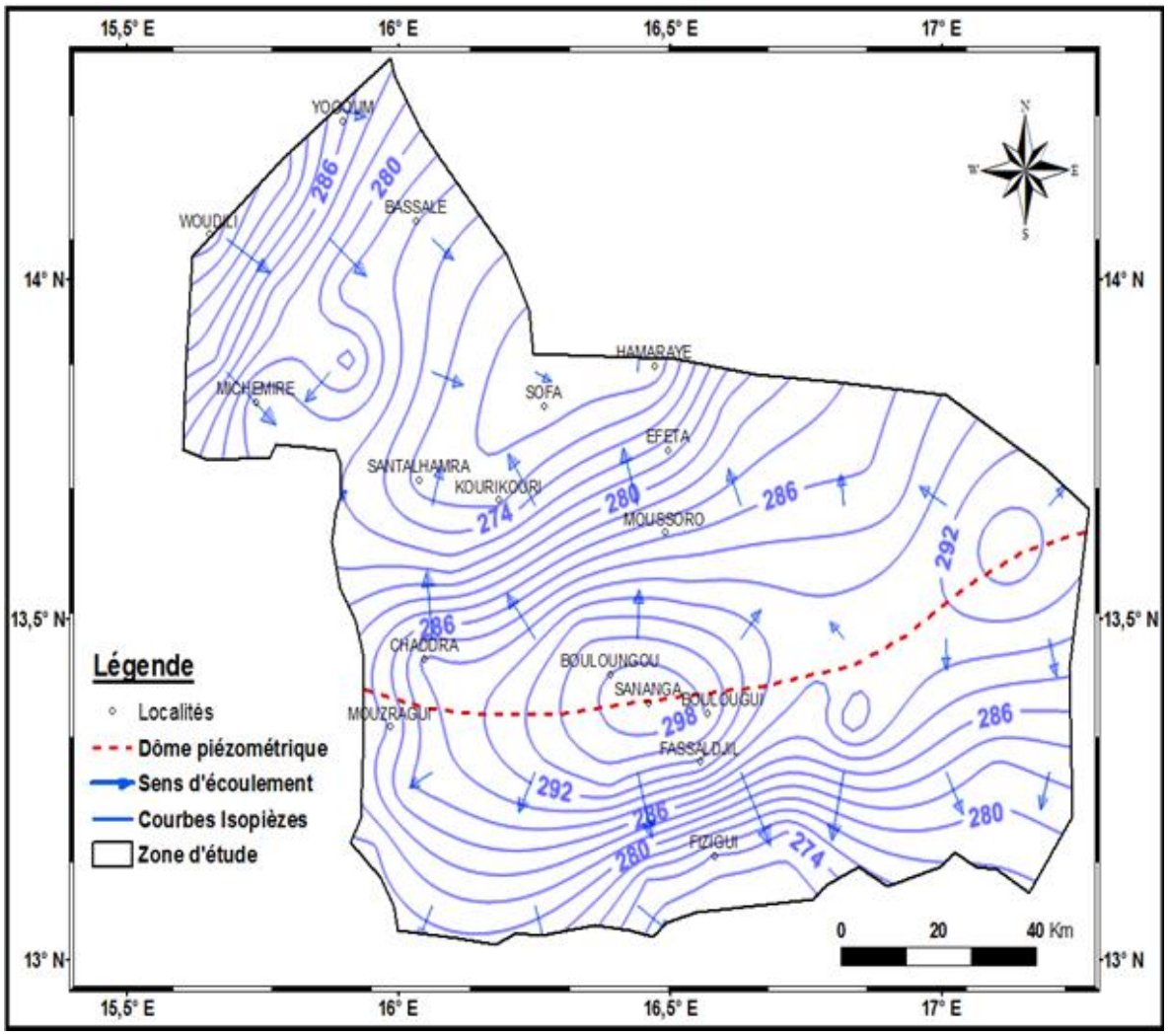


Figure 16: Map of the groundwater level of the Bahr El Gazal area, data 2009-2013 (Data source BGR)

The isolines of the groundwater table in Figure 16 show an increasingly tight behavior on both sides of the Harr dunes. This same behavior is also reported in the extreme west of the Bahr El Ghazal area, highlighting the existence of piezometric dome and depression. In contrast, the most pronounced piezometric depression generally follows the Bahr-El-Ghazal fossil valley, causing water flow to converge towards the valley.

3.1.10.3 Moyen-Chari Area

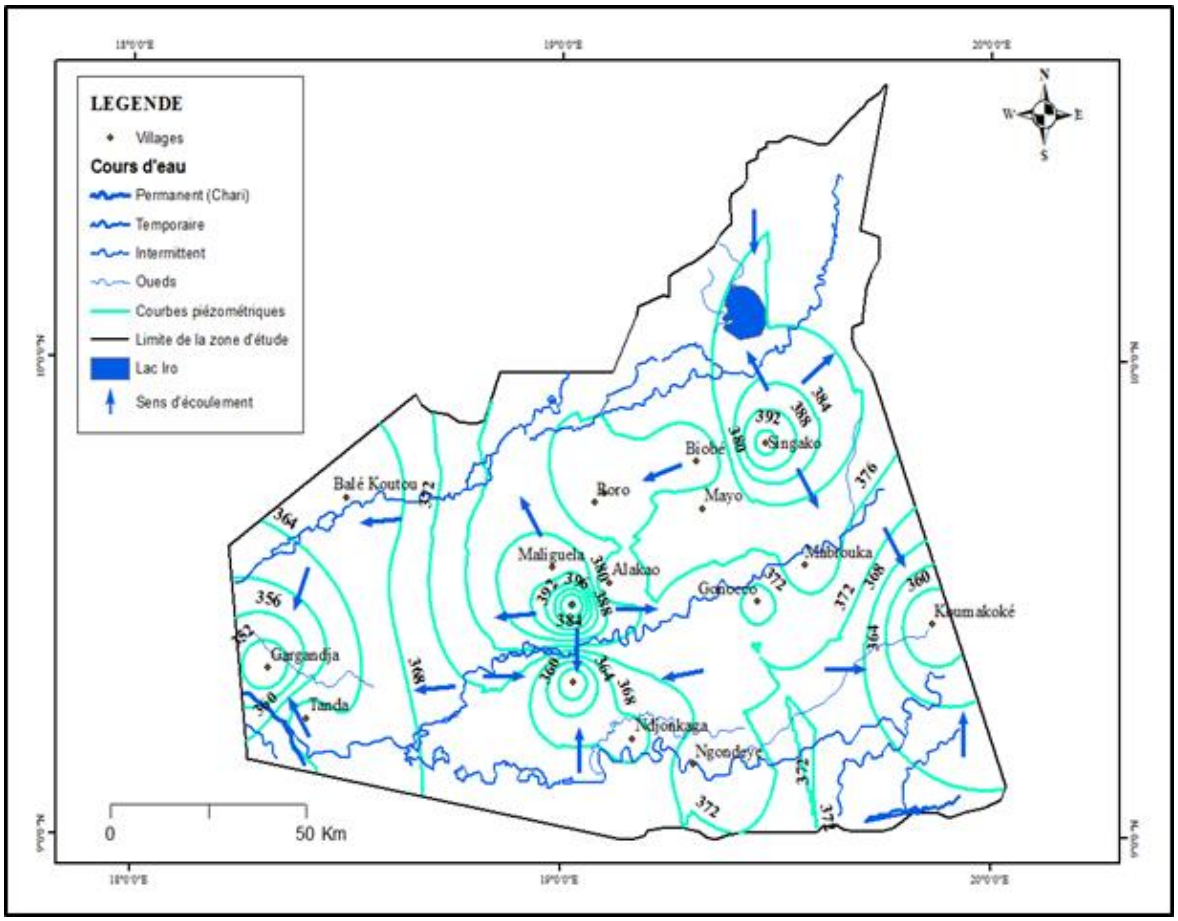


Figure 17: Groundwater table isolines in the wetland of the Middle Chari region, data from 2017 (source BGR)

On this map, there are three piezometric depression (Malkouma, Gargandja and Koumakoké) and two piezometric domes (Uroumbalé and Singako) visible. Furthermore, the groundwater flow has two directions: northwest to southeast and north to south.

3.1.10.4 Komadugu Yobe Plain

The groundwater level map of the Komadugu Yobe area is shown in Figure 18. It was established based on water level measurements from shallow hand-dug wells, since measurements in boreholes equipped with hand-pumps couldn't be realized due to non-accessibility of the water table. Therefore, it does not cover the entire study area. The map shows higher groundwater levels in the areas closest to surface water (wetlands and Kumadugu Yobe River). It also defines the direction of groundwater flow in the area.

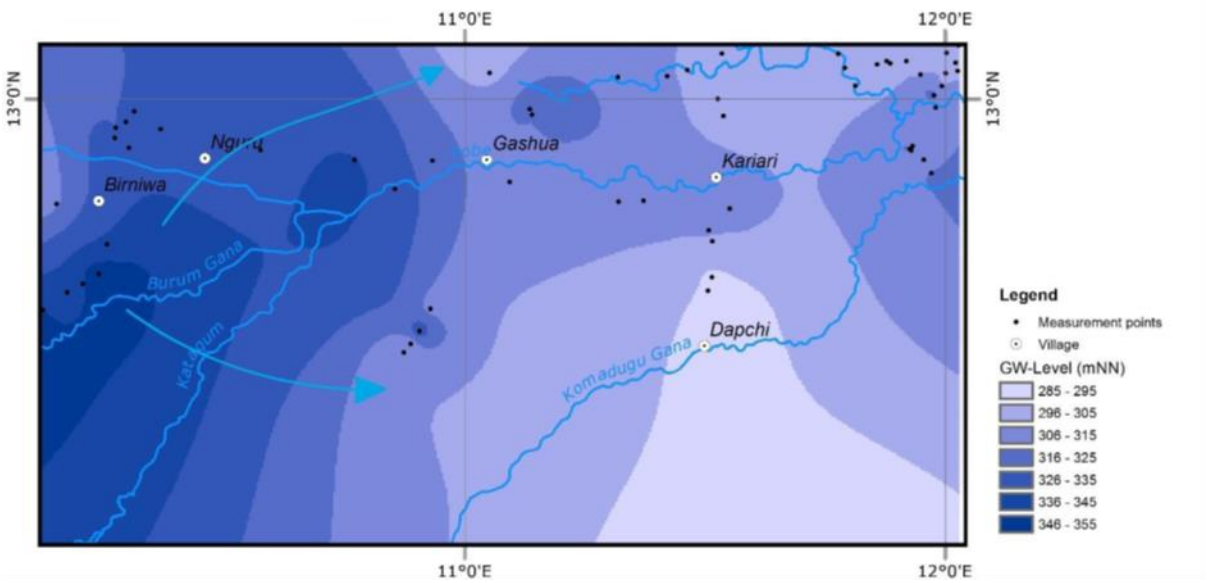


Figure 18: Piezometric map of the Komadugu Yobe plain (prepared by Prof. Baba Goni, Maiduguri University, Geology Department)

3.1.10.5 Yaéré

The piezometric lines of the Yaéré area shown in the following map show the flow of groundwater from Bongor from north to east in the Naga plain, following the direction of the river's water burst.

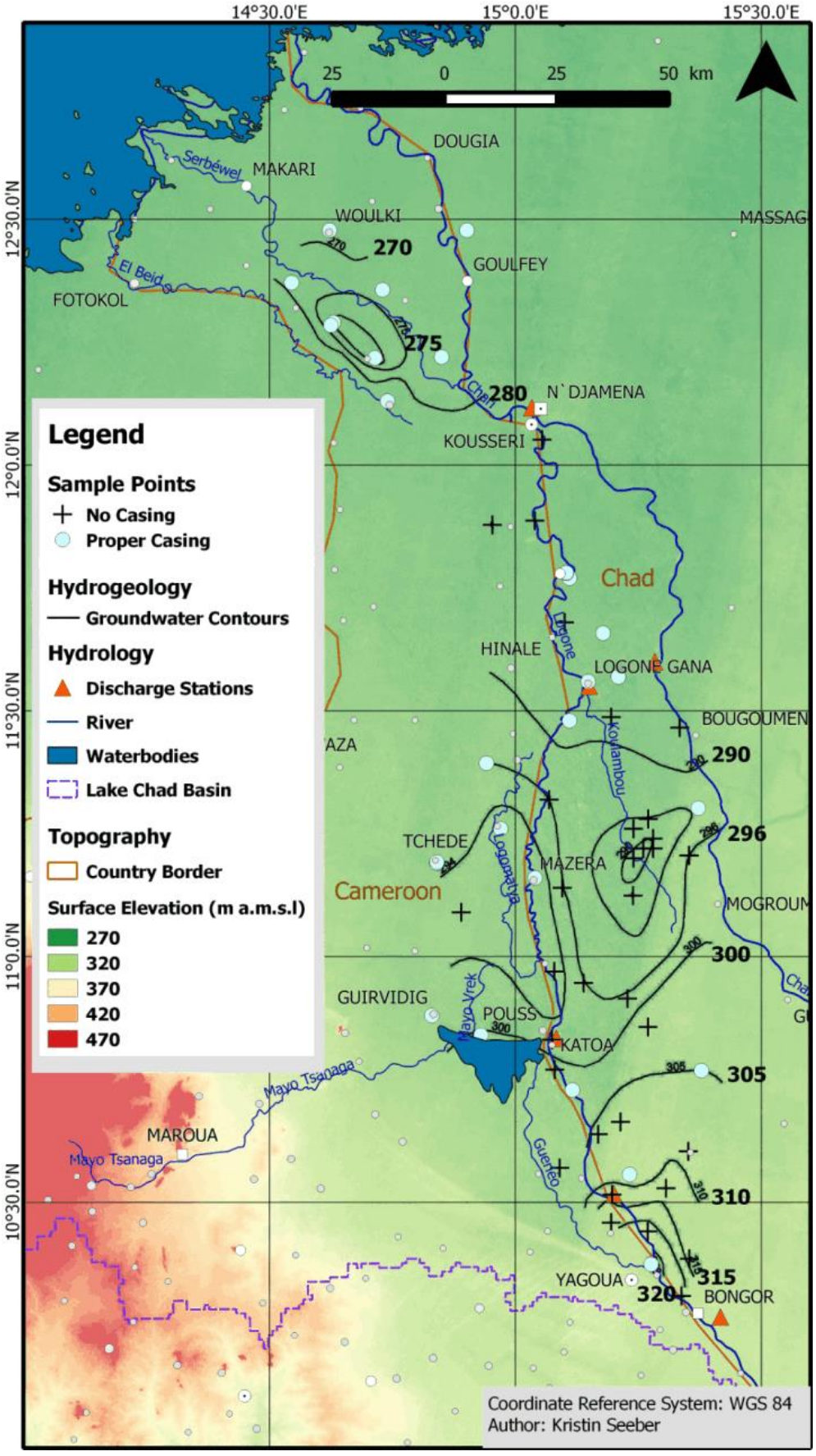


Figure 19: Piezometric surface area of the Yaéré floodplain, 2014 data (K. Seeber, D. Daira, A. Magaji Bala 2014)

3.1.11 Conclusion of Groundwater Level Data in 2017 - 2018

The various field campaigns made it possible to draw up piezometric maps of Kanem, Bahr el Ghazal and Moyen Chari, Yaéré and Komadugu Yobe. It appears from these different maps that:

- ✓ In the Yaéré area, groundwater flows from Bongor from north to east in the Naga plain, following the direction of the bursting of the river water with a high hydraulic gradient;
- ✓ In the Middle Chari, three piezometric depressions appear: Malkouma, Gargandja and Koumakoké and two piezometric domes: Ouroumbalé and Singako. In this area, groundwater flows in two directions: northwest to southeast and north to south.
- ✓ In Bahr el Ghazal, it appears that the hydro-isopiezo curves show an increasingly tight behaviour on both sides of the Harr dunes. This same behaviour is also reported in the extreme west of the Bahr El Ghazal area, highlighting the existence of piezometric domes and depressions and the direction of water flow in the aquifer. In contrast, the most pronounced piezometric depression generally follows the Bahr-El-Ghazal fossil valley, causing water flow to converge towards the latter.

The data collected from the dataloggers show that the evolution of the groundwater level is mainly controlled by rainfall and flood periods in the various rivers. Moreover, there is no abnormal change in the groundwater level in the regions studied where exploitation is carried out only to supply water to the populations of the basin.
However, the irrigation pumping operations near the N'Djamena Koura and Tildé piezometers didn’t caused a very significant drawdown of the groundwater in the wells' radius influence area in 2018, contrary to the year 2017.

3.1.12 Groundwater recharge in the Lake Chad Basin

The Lake Chad Basin is an endorheic transboundary basin that is extremely vulnerable to drought. For sustainable groundwater management, recharge areas must be identified and quantified. There are currently few studies on groundwater recharge and the flow process in the unsaturated zone. Thus, as part of the implementation of these activities, the Sustainable Groundwater Management project at the Lake Chad Basin Commission LCBC-BGR has been conducting studies on groundwater recharge in the Lake Chad Basin since 2016 through the development of soil profiles of stable isotopes.

Between December 2016 and February 2018, 12 soil profiles were carried out in 4 different areas of the basin, namely: The Waza Logone floodplain, (cross-border area between Cameroon and Chad), the Salamat plain (cross-border between Chad and CAR), the northern region of Lake Chad and northern Kanem (see Figure 20).

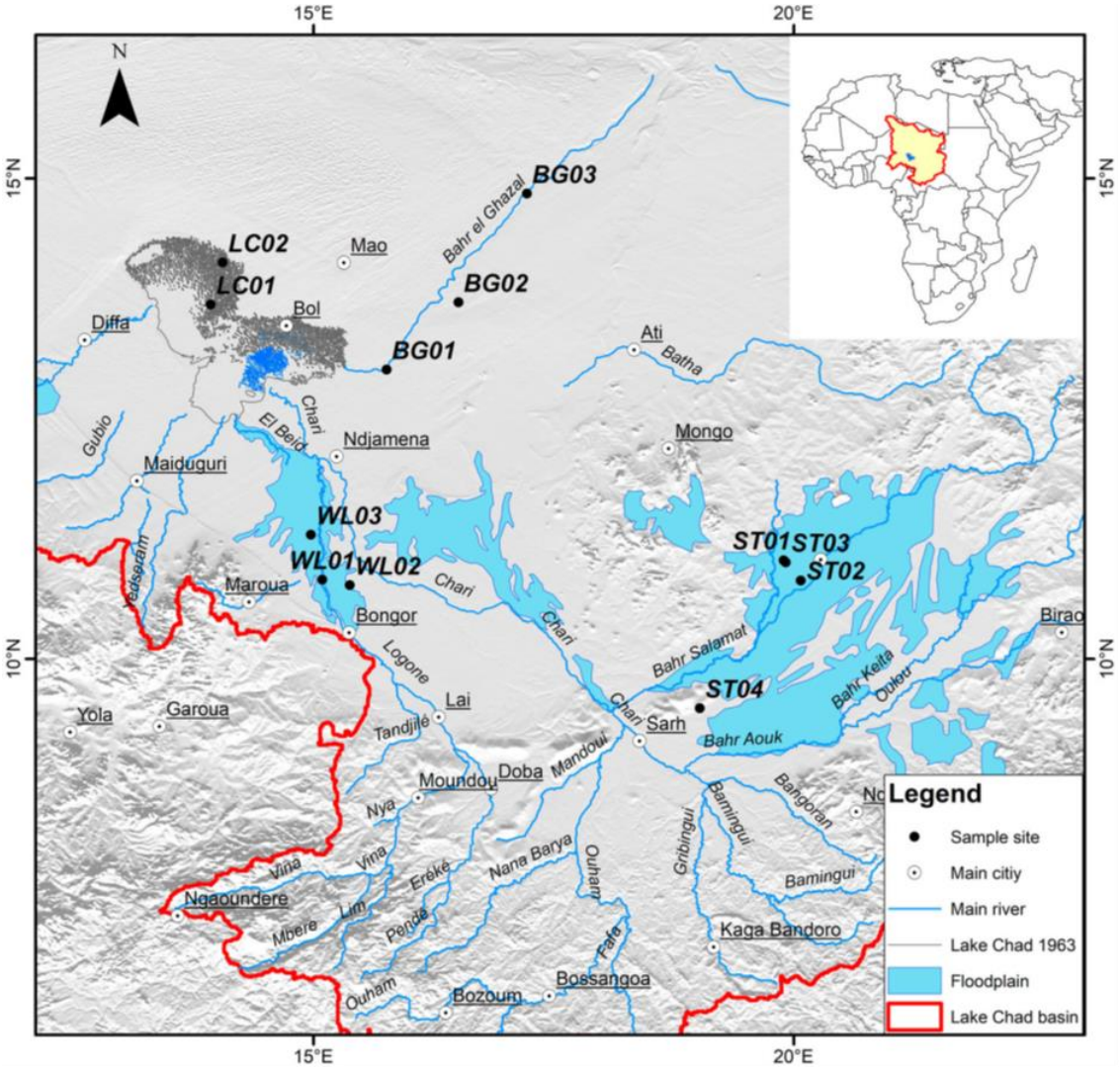


Figure 20: Map of the location of the 12 soil profile points (Source: Rapport BGR, Janvier 2019)

The geographical coordinates and depth of each profile are summarized in the table below.

Table 15: Geographical coordinates and depth of each soil profile point

Profile	X (°)	Y (°)	Z (m)	Study area	Village	Depth (m)	Vegetation
ST01	*19,89644*	*11,02582*	*418*	*Salamat*	*Gos Djarat*	*2,35*	*Sorghum*
ST02	*20,07473*	*10,81649*	*396*	*Salamat*	*Kacha-Kacha*	*2*	*Balanites egyptiaca*
ST03	*19,91689*	*11,00629*	*418*	*Salamat*	*Gos djarat*	*3*	*Herbs*
ST04	*19,0225*	*9,4873*	*384*	*Salamat*	*Ouroumbale*	*4,2*	*Herbs*
WL01	*15,09235*	*10,82505*	*362*	*Waza logone*	*Katoa*	*4*	*Herbs*
WL02	*15,37817*	*10,76815*	*325*	*Waza logone*	*Loutou*	*3*	*Herbs*
WL03	*14,9736*	*11,28855*	*304*	*Waza Logone*	*Zina*	*3,80*	*Herbs*
BG01	*15,7611*	*13,0077*	*289*	*Barh Elgazel*	*Chabakari*	*5*	*Herbs, Balanite Egyptiaca,leptadenia and accacia*
BG02	*16,5090*	*13,7092*	*281*	*Barh Elgazel*	*Tchiri*	*4,20*	*Herbs, Balanite Egyptiaca,leptadenia accacia and shrub*
BG03	*17,2217*	*14,8423*	*267*	*Barh Elgazel*	*Salal*	*2,6*	*Herbs, Balanite Egyptiaca,leptadenia accacia and shrub*
LC01	*13,9295*	*13,6862*	*283*	*North of Lake Chad*	*Kousserie*	*6*	*Accacia and shrub*
LC02	*14,0550*	*14,1254*	*289*	*North of Lake Chad*	*Sabrekouta*	*3,2*	*Accacia and shrub*

The samples of Salamat and Barh El Ghazal were collected at the end of the rainy season in December 2016 and November 2017 respectively. Waza Logone's profiles were taken at the end of the dry season (June 2017) and those of the lake in February 2018.
The main objective of this study is to quantify the evaporation rate based on stable isotope profiles, to estimate groundwater recharge from the chloride content of the soil profiles and to calculate the water balance for each profile.

The fieldwork consisted in making the soil profiles with a hand auger until the groundwater table was reached, but in some areas, it could not be reached because of the hardness of the soil. Soil samples were taken every 10 cm in 50 ml glass vials and also in plastic bags. Infiltration tests using a Guelph permeameter and the double-ring method were performed at each site and a lithological description of each profile was made (see Figure 21).

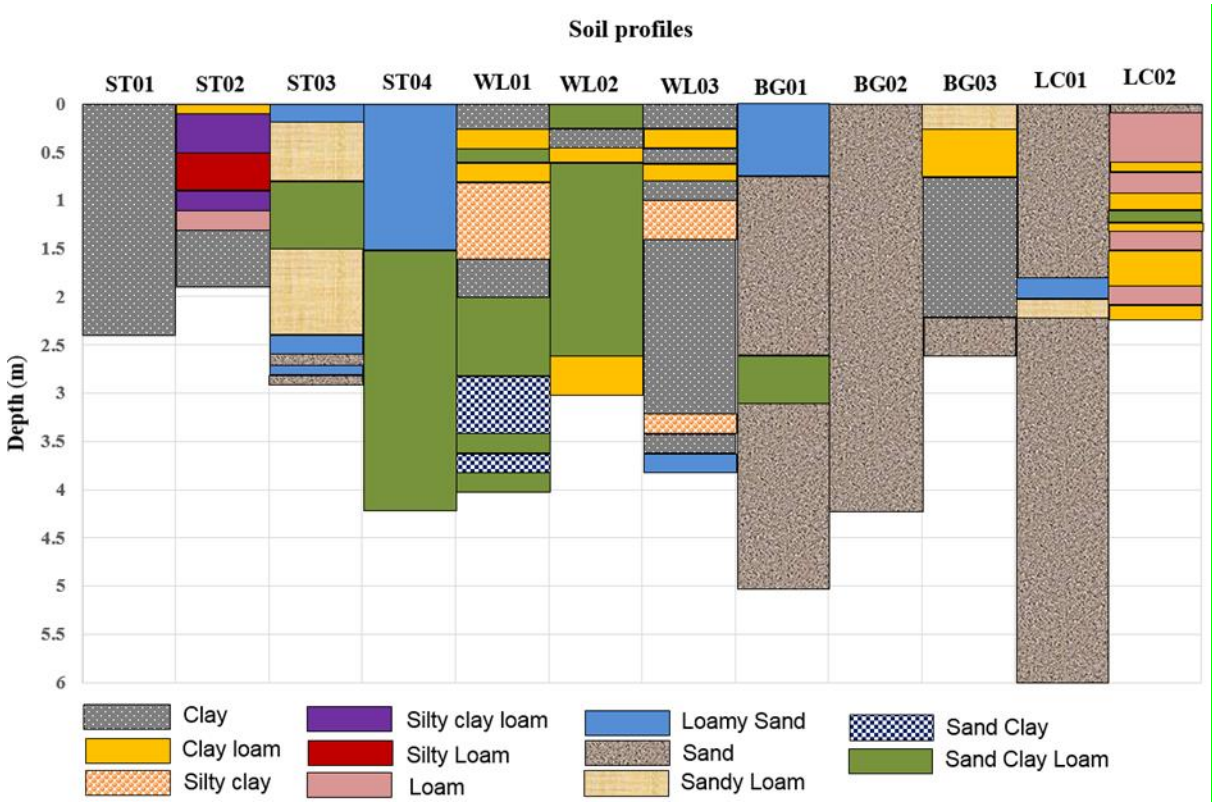


Figure 21: Lithological description of each profile (Source: BGR Report, January 2019)

The analyses were carried out at the BGR laboratory in Hanover where water levels are extracted from the ground to measure stable isotopes (δ18O and δ2H) and the chloride ion.

The two figures below show the oxygen 18, deuterium and chloride ion concentration of each profile.

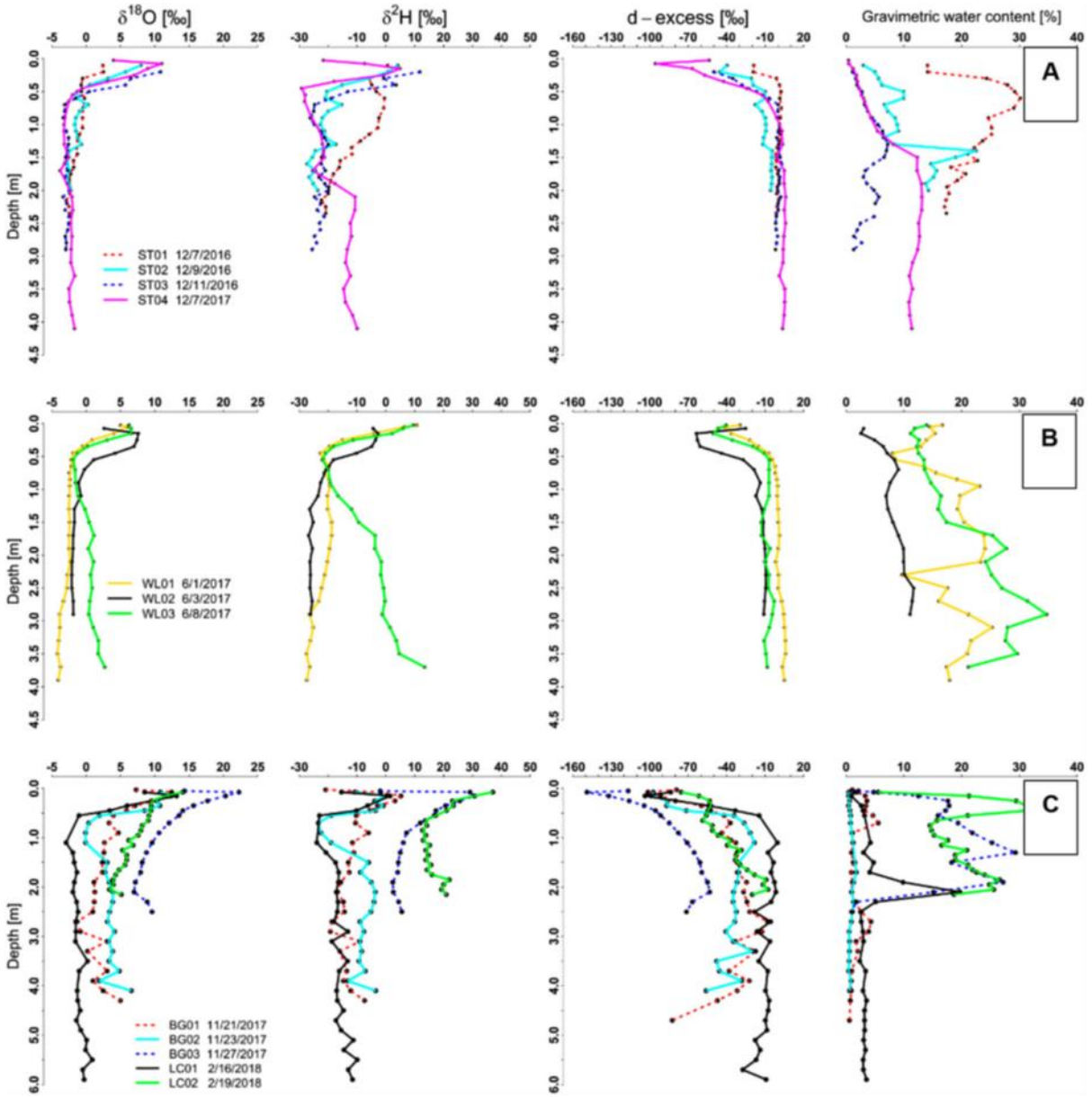


Figure 22 : Oxygen 18 and deuterium concentration of each soil profile in A) Salamat B) Waza Logone plain and C) Bahr El Ghazal an northern Lake Chad region.

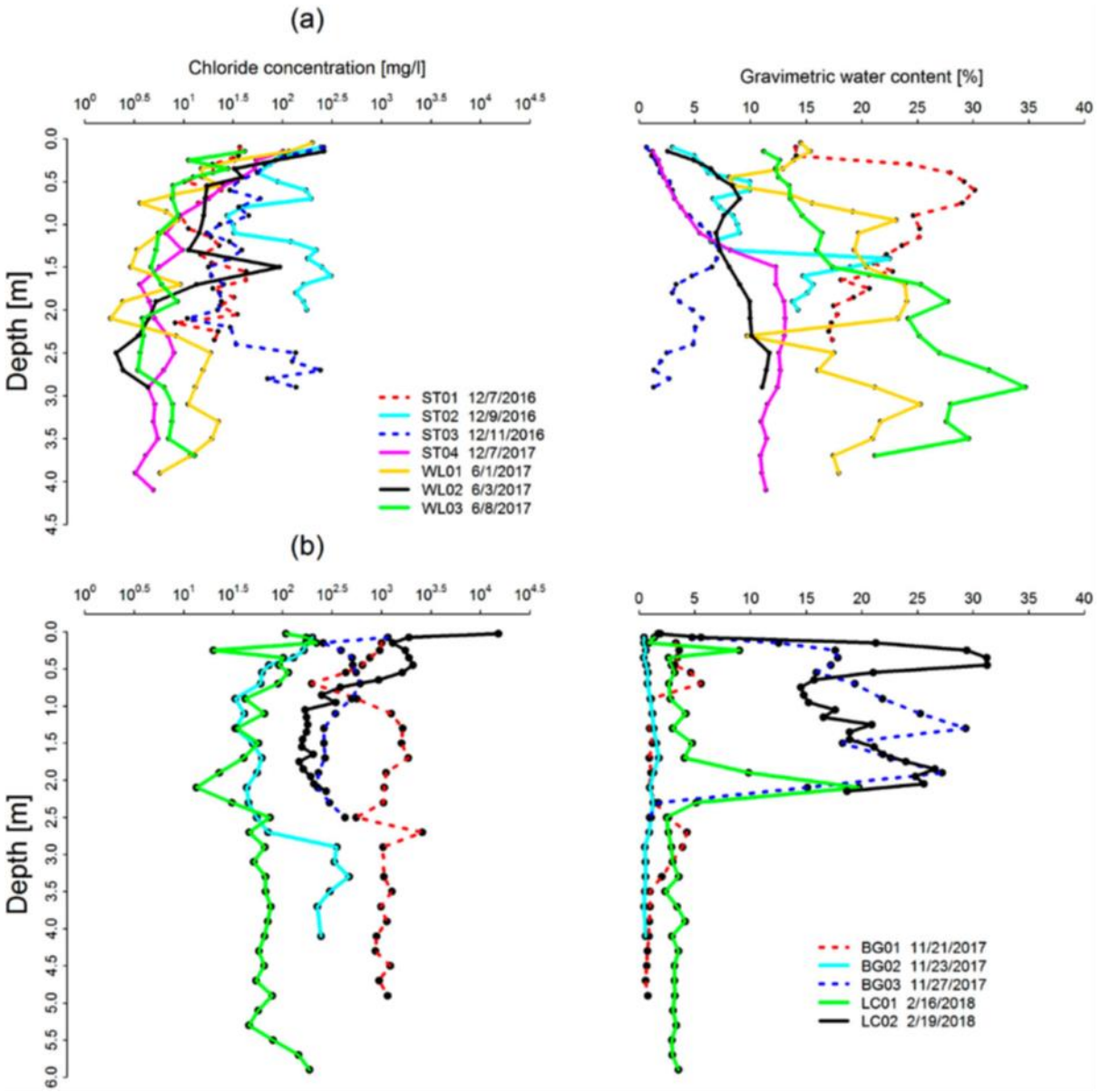


Figure 23 : Chloride ion concentration of each soil profile a) Salamat and Waza Logone and b) Bahr El Ghazal and Northern Lake region.

The results of this research show that the average annual dry-season evaporation rates in Salamat and Waza Logone range from 5 to 30 mm, in Bahr el Ghazal and north of Lake Chad from 14 to 23 mm. The average annual recharge rate is estimated at between 3 and 163 mm at Salamat and Waza Logone and less than 1 mm at Bahr el Ghazal and north of Lake Chad according to the Chloride Mass Balance (CMB).

As a result of this study, the areas of the Waza Logone floodplain and the southern part of the Salamat plain are groundwater recharge areas in the Lake Chad Basin. Therefore, they must be protected against any form of surface pollution. On the other hand, in the areas north of the Salamat plain, northern Lake Chad and northern Kanem, evaporation rates exceed recharge rates, which means that groundwater is not renewed by precipitation water in these areas.

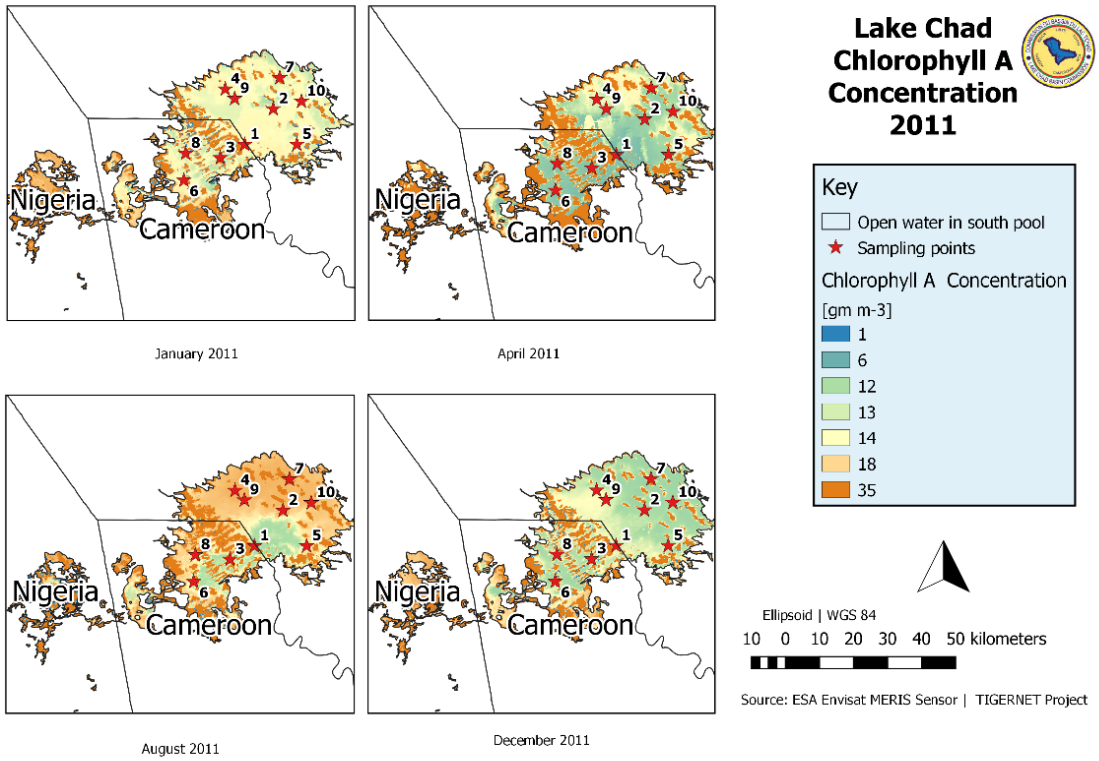
3.2 Water Quality

3.2.1 Surface Water

3.2.1.1 Lake Chad

Chlorophyll A Concentration

The values of Chlorophyll A (CHLA) concentration were processed from a MERIS image from the ESA Envisat Satellite that stopped functioning in April 2012. There is no in-situ measurement station for CHLA in the Lake Chad for quantitative validation, but this chart is useful for showing seasonal trends at virtual sample points 1 and 4. Sample point 1 is located where the River Chari flows into the Lake Chad and Sample 4 is located towards the north shoreline of the south pool open water. At sample point 1, the mean of the rainy season (April – September) is 11 gm/m^3, which is somewhat lower than that of the dry season (October – March) which is 13.3 gm/m^3.



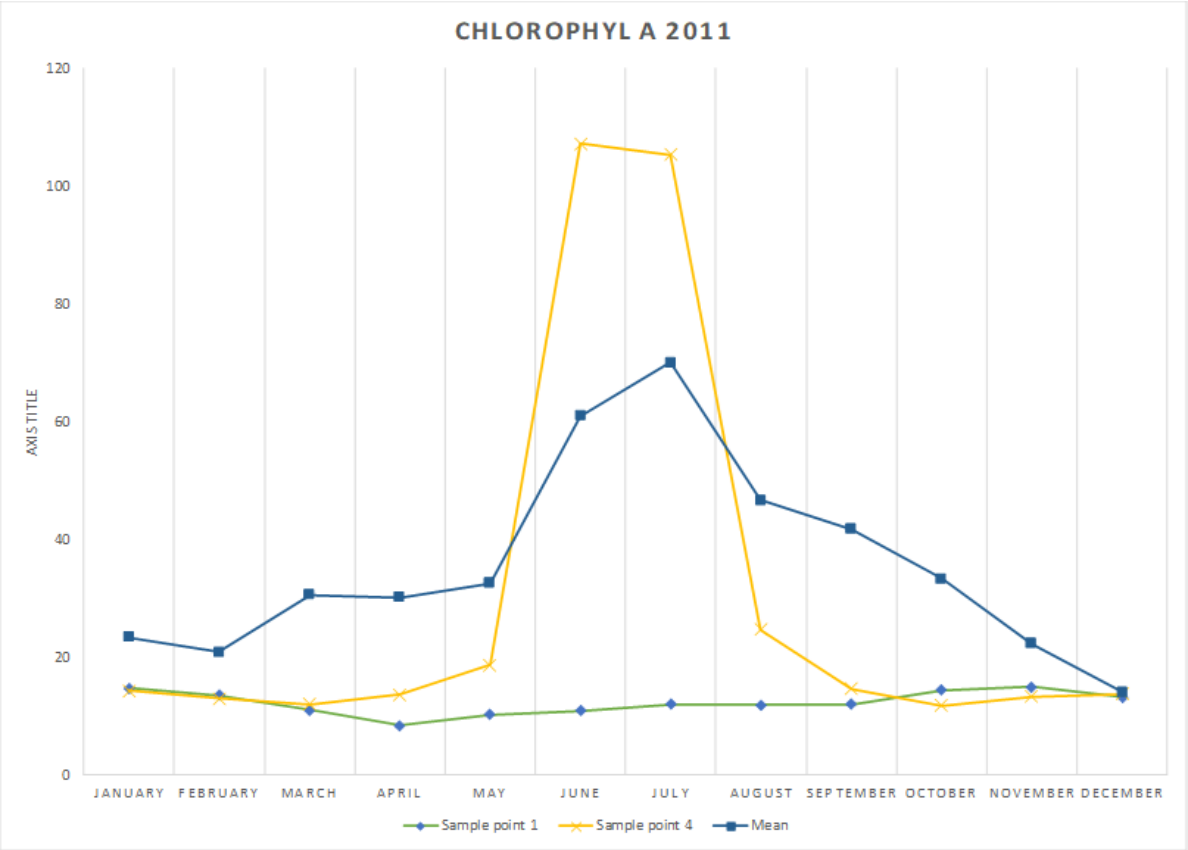
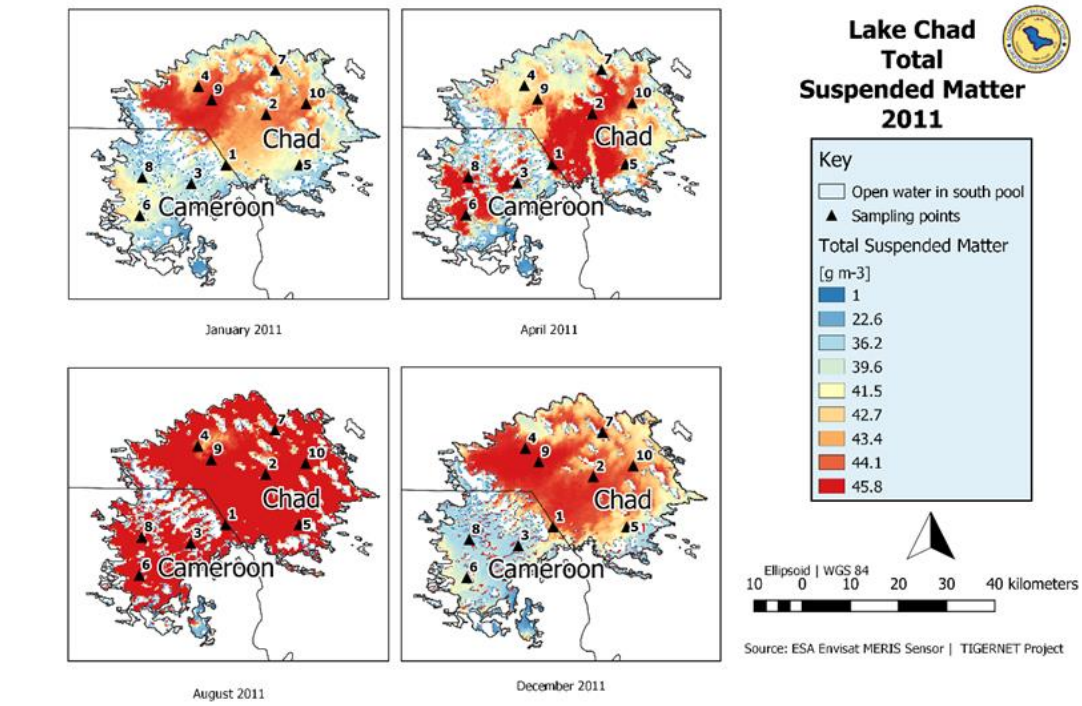


Figure 24 : Seasonal annual variation of Chlorophyll A (CHLA) concentration in the Lake Chad.

Total Suspended Matter

The values of Total Suspended Matter (TSM) were processed from a MERIS image from the ESA Envisat Satellite that stop functioning in April 2012. There is no in-situ measurement station for TSM in the Lake Chad for quantitative validation, but this chart is useful for showing seasonal trend at virtual sample points 1 and 4. Sample point 1 is located were the River Chari flows into the Lake Chad and Sample 4 is located towards the north shoreline of the south pool open water. At sample point 1, the mean of the rainy season (April – September) is 48.1 gm/m3 somewhat higher than that of the dry season (October – March) which is 44.1 gm/m3. The seasonal trend shows a stable inflow of TSM in accordance with the inflow of the River Chari in the south pool. Thereafter, the TSM values falls in the dry season with the reduction of inflow into the lake.



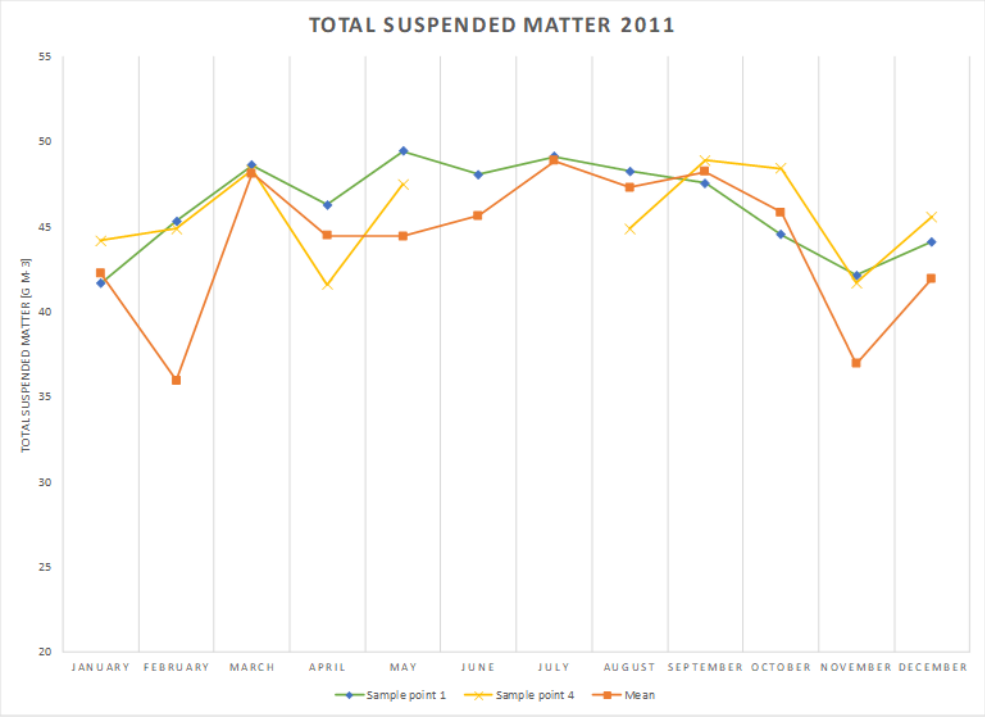
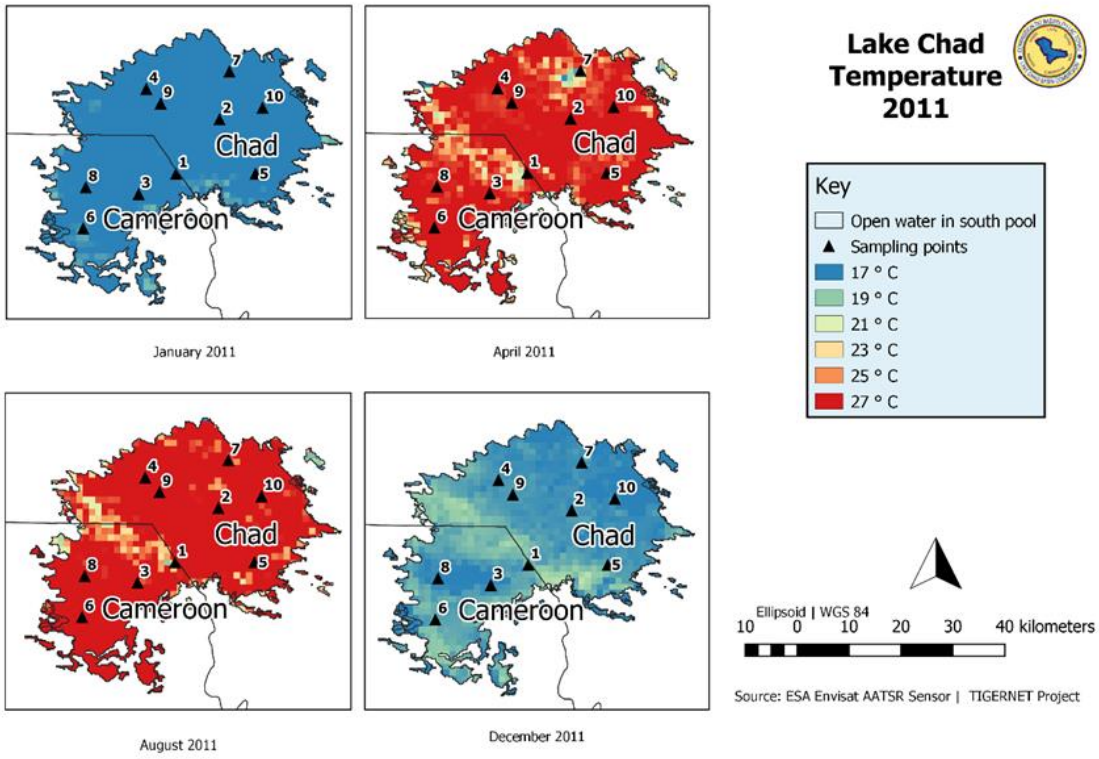


Figure 25: Seasonal annual variation of Total Suspended Matter (TSM) in the Lake Chad.

Temperature

The surface temperature values were processed from AATSR images from the ESA Envisat Satellite that stop functioning in April 2012. The graph is based on virtual sample points 1 and 4 and shows seasonal trend with an increase of surface water temperature from January to September and then decreasing towards the end of the year. Sample point 1 is located were the River Chari flows into the Lake Chad and Sample 4 is located towards the north shoreline of the south pool open water. At sample point 1, the average rainy season (April – September) temperature is 27.8 °C, which is higher than that of the dry season (October – March) with 23.8° C. At Sample point 4 located away from where the River Chari flows into the Lake Chad, the average rainy season (April – September) temperature is 29.9° C, which is clearly higher than that of the dry season (October – March) with 22.9 °C.



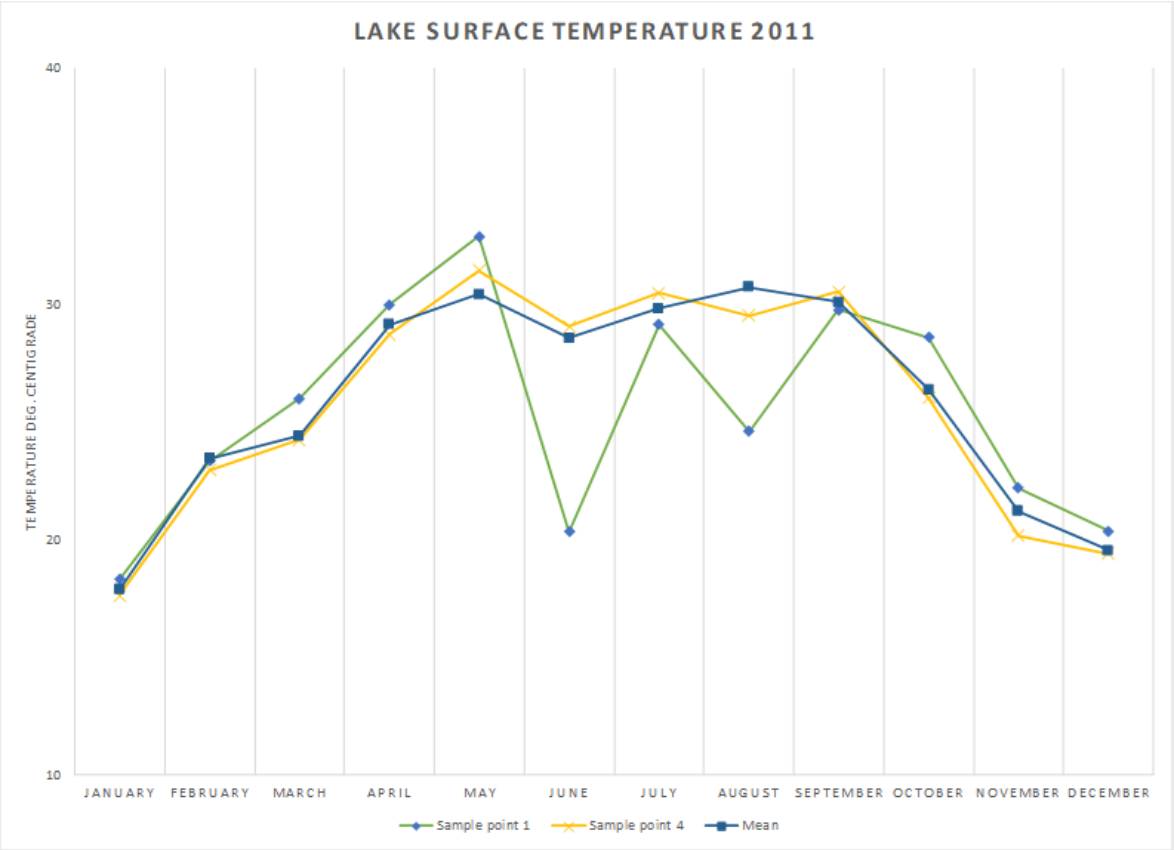


Figure 26 : Seasonal annual variation of Lake Surface Temperature (LST) in the Lake Chad.

3.2.1.2 Rivers

In terms of monitoring the quality of surface water in the Chari and Logone basin, a sampling campaign was carried out by LCBC in June and October 2015. The first results of chemical analyses of major anions and cations and heavy metals show the absence of high concentrations of heavy metals, but the existence of high values for iron and aluminium. Therefore, there is a potential for surface water pollution due to fertilizers used in agricultural areas and drained into rivers feeding the Logone or Chari, or due to industrial and domestic wastewater discharges.

It is recommended to continue to monitor surface water quality in the rest of the rivers of the Chari-Logone sub-basin and to extend the range of parameters analyzed to pesticides, COD or BOD, for example. This would make it possible to identify the sources of pollution.

The following maps show the points monitored in 2015 and the values of electrical conductivity (in µS/cm), iron concentration (mg/l) and aluminium concentration(mg/l) measured in October 2015 (Data source BGR-LCBC Project)

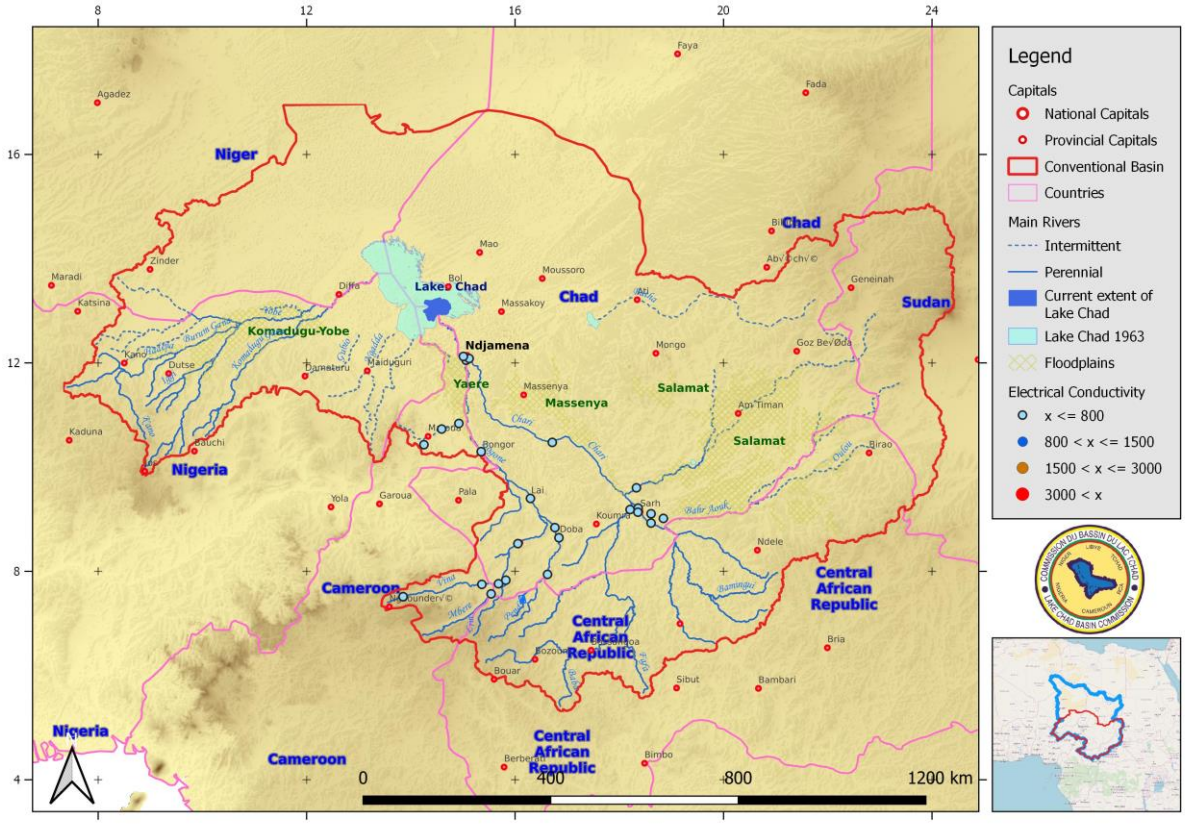


Figure 27: Electrical conductivity Map of surface water points in the Chari-Logone basin in 2015

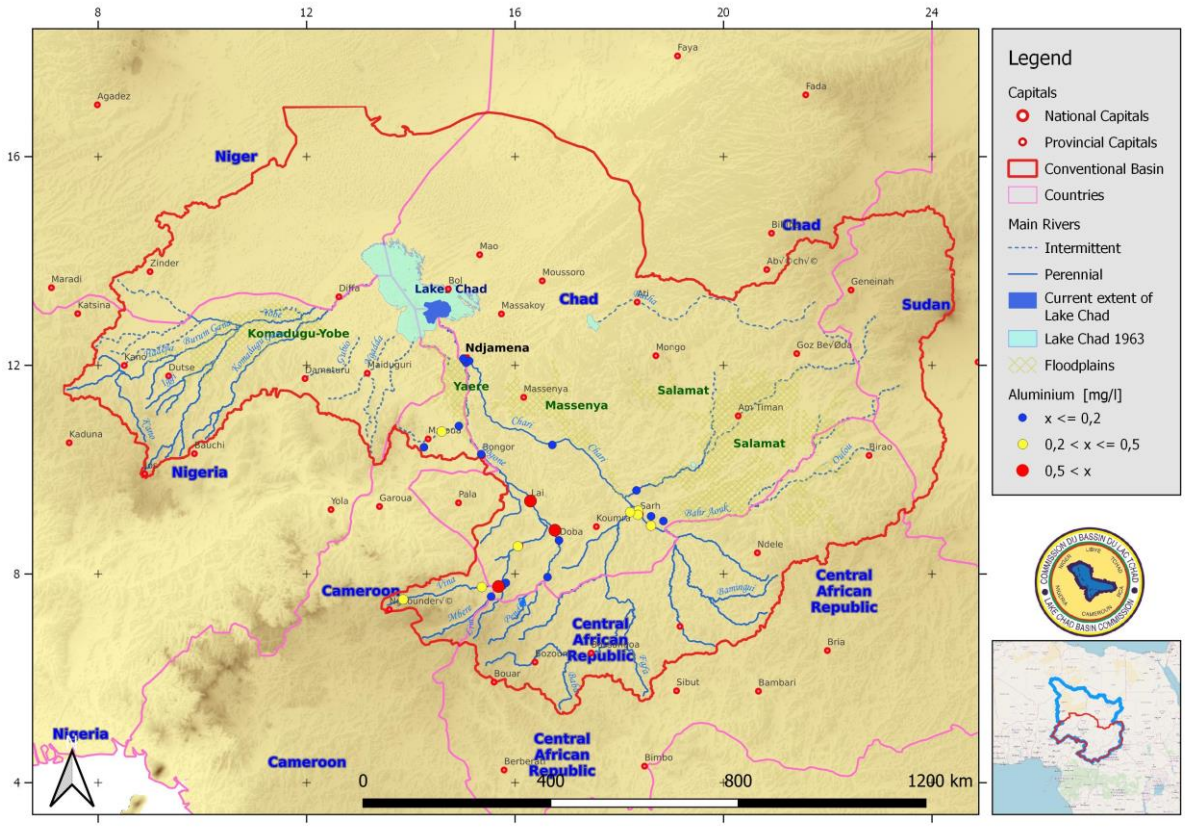


Figure 28 : Aluminum concentration (mg/l) of surface water sampled in the Chari-Logone basin in 2015

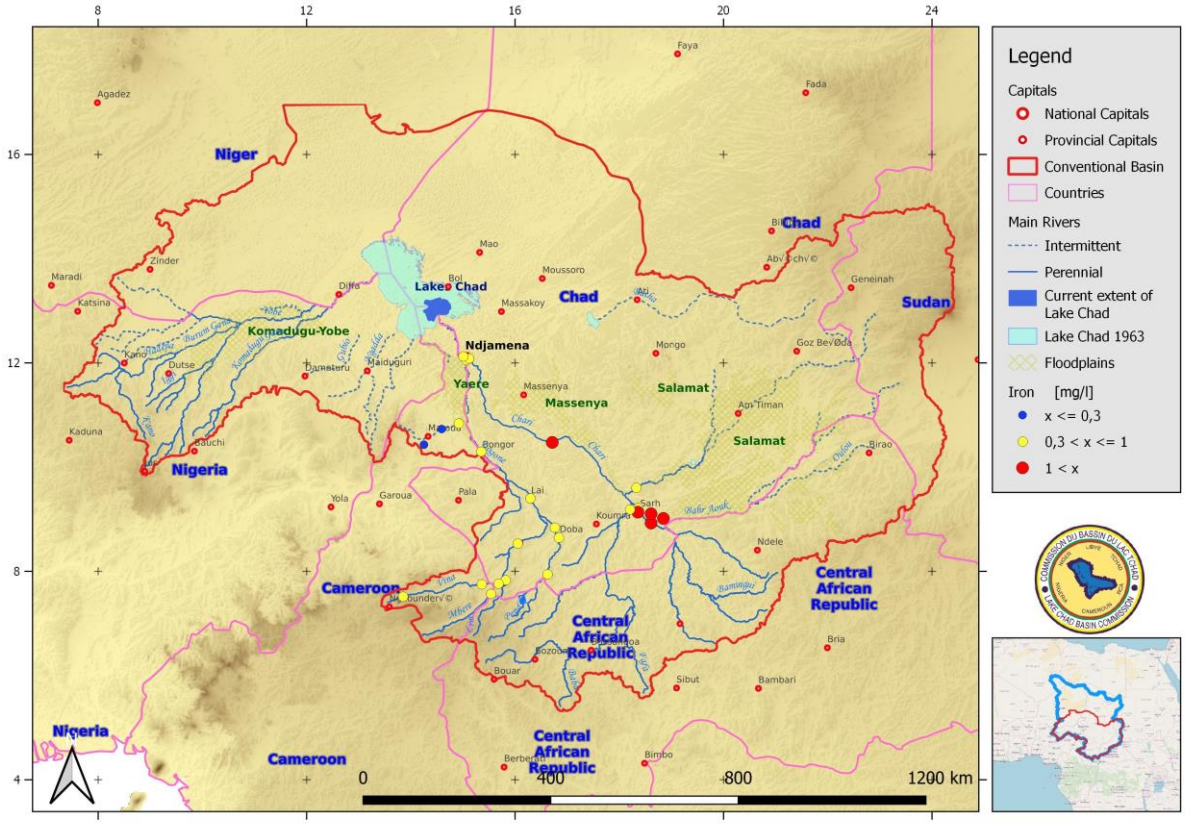


Figure 29 : Iron concentration (mg/l) of surface water sampled in the Chari-Logone basin in 2015

3.2.1.3 Conclusion Water Quality of Surface Water

Initial results from chemical analyses of surface water taken from the Chari and Logone Rivers that supply the Lake Chad and the fact that there is still no state control of industrial water discharges in the member countries of the LCBC suggest that this resource is affected by environmental pollution. Therefore, regular monitoring of the resource during high and low water periods is necessary for better surface water management.

3.2.2 Groundwater

3.2.2.1 Groundwater Sampling Points between 2012 and 2018

Between November 2009 and December 2018, the BGR-LCBC project "Sustainable Water Management in the Lake Chad Basin" carried out a series of hydrogeological field missions to the Kanem, Bahr el Ghazal, Lake, Moyen-Chari and Salamat regions, the Komadugu-Yobe Basin in Nigeria, N'Djamena City and the Lower Logone River floodplain, known as Yaéré in Cameroon and Naga in Chad.
The studies focused on the origin of groundwater, flow paths, quality, and the interaction between the Logone, its floodplain and the aquifer system.

- For Kanem and Bahr el Ghazal, a total of 195 points between 2009 and 2013 and in November 2017 were measured and sampled for chemical and isotopic analyses;
- For the lake, approximately 60 points were measured and sampled for chemical and isotopic analysis in February 2017;
- The missions carried out in the Moyen-Chari have made it possible to collect 23 samples for chemical and isotopic analyses;
- The groundwater measurement and sampling campaigns carried out in Salamat made it possible to take samples from 67 points in 2016 and 2017;
- For the floodplains in Chad and Cameroon, 76 points were subjected to chemical and isotopic analyses in June 2017;
- The city of N'Djamena was the subject of a hydrochemical and bacteriological study with approximately 60 boreholes visited in August and September 2018.
- In the Komadugu-Yobe basin, 191 points were the subject of hydrochemical analyses in March 2018

In total, approximately 600 groundwater samples were sampled and chemically analyzed in the laboratories of the BGR in Hanover, Germany. The following map shows the measurement points for groundwater analysis.

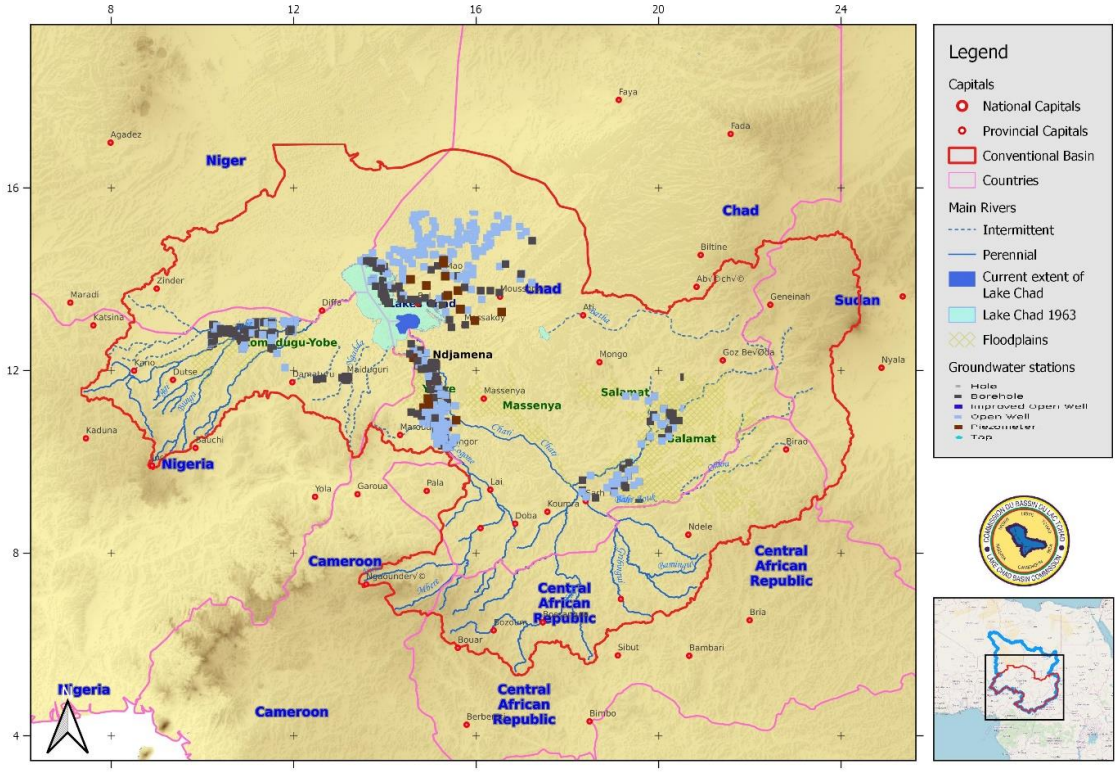


Figure 30: Groundwater measurement points in the Lake Chad Basin between 2012 and 2018

3.2.2.2 Hydrochemical Analyses of Groundwater Samples

The hydrochemical analyses presented below include the presentation of anions and cations composition of groundwater samples in the form of Piper diagrams, as well as the distribution of individual chemical parameters (e.g., electrical conductivity, nitrates, arsenic, fluoride and E. coli bacteria) in the form of maps.

Piper diagrams

Water hydrochemistry can be quickly interpreted using a Piper diagram (PIPER 1944). This graph shows the contents of major cations and anions in the form of triangles on the left and right. The diamond in the center of the image represents the composition of both anions and cations. The diagram also classifies the type of water (see Figure 31).

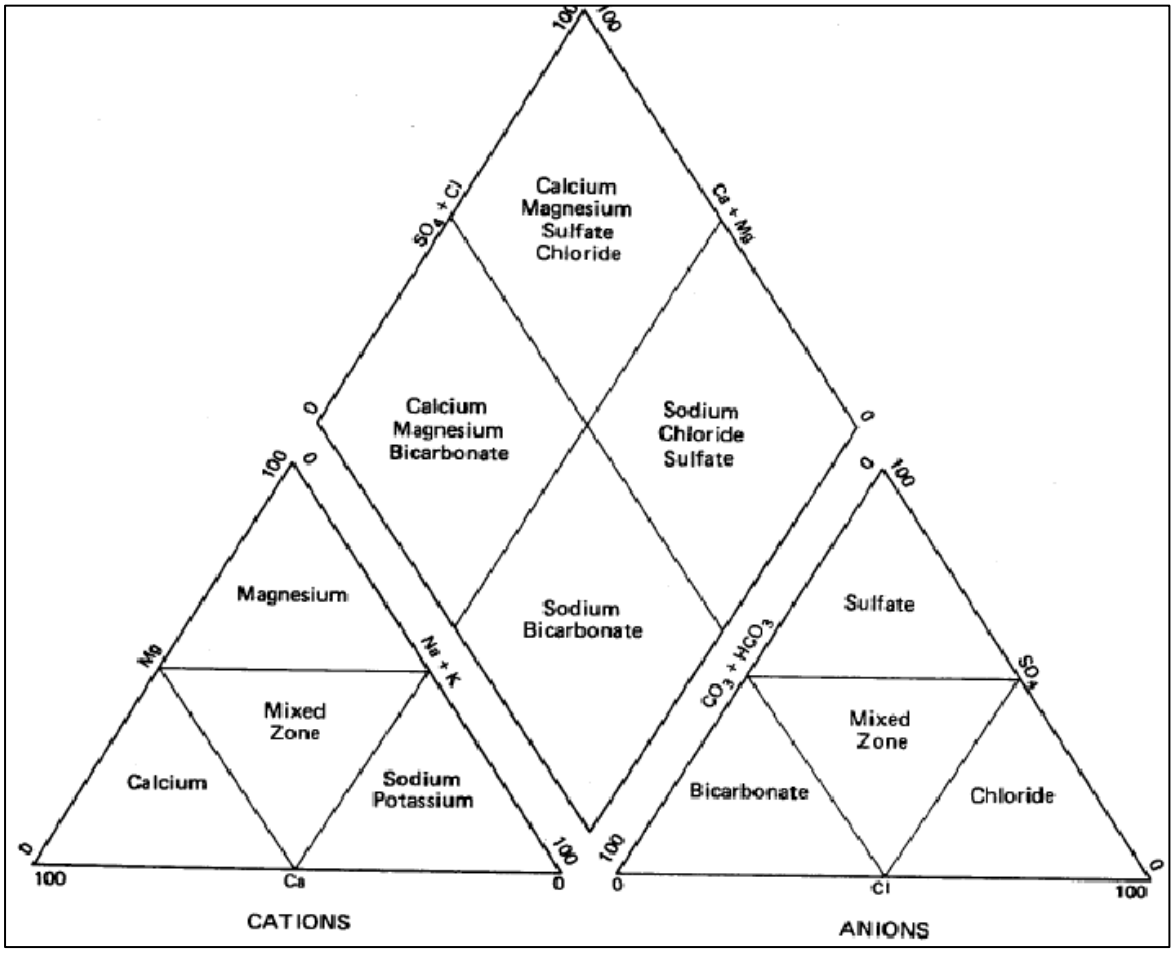


Figure 31: Piper Diagram

Electrical conductivity

Conductivity is the ability of water to converge an electric current, and dissolved ions are the conductors. The main ions contained in water are inorganic dissolved solids such as carbonate, bicarbonate, sulfate, chloride, nitrate and phosphate (all anions, negatively charged ions) or sodium, potassium, magnesium, calcium, iron and aluminum (all cations, positively charged ions).

Although higher levels of EC do not appear to pose health problems, the WHO suggests that drinking water (classified as fresh water) should not exceed 1,500 µS/cm. Water containing more than 5,000 µS/cm is too salty even to water livestock.

Nitrates

Nitrate is naturally present in the environment and is an important element for plants. Nitrates can occur in surface and ground water as a result of agricultural activities (use of fertilizers and manure), sewage disposal and oxidation of nitrogen-based products in human and animal faeces, including septic tanks. For example, high levels of nitrate in groundwater indicate faecal pollution of human or animal origin and/or overuse of fertilizer products in agriculture. When ingested, nitrates are transformed into nitrites. Nitrite oxidizes the iron present in red blood cells, forming methemoglobin, which, unlike hemoglobin, is not able to bind oxygen molecules. This can lead to methemoglobinemia (blue baby syndrome), where the blood is no longer able to carry oxygen to the cells, causing blue coloration of the veins and skin and sometimes leading to asphyxiation in infants. In addition, excessive prolonged exposure to high nitrate levels is carcinogenic. For this reason, the WHO recommends that a level of 50 mg/l in groundwater should not be exceeded.

Fluoride

High fluoride concentrations in groundwater occur in active volcanic areas associated with geothermal activities, aquifers located in the rock complex (Fantong et al, 2010) and arid sediment basins (Pauwels & Ahmed, 2007). High concentrations are also found in waters with high concentrations of sodium and bicarbonate and low calcium and magnesium, as calcium limits the mobility of fluoride by forming calcium fluoride. Such waters generally have high pH values (above 7).

Long-term exposure to high concentrations of fluoride in drinking water may pose another health risk. The WHO recommended limit for the concentration of fluoride in drinking water is 1.5 mg/l.

Arsenic

Arsenic is a chemical element that is toxic to humans and can contaminate drinking water. The most frequent symptom occurring after a period of at least 5 years is skin lesions (WHO, 2004). In addition, consuming water contaminated with arsenic increases the risk of skin, bladder and lung cancer and vascular disease. For this reason, the WHO has set its limit at 0.01 mg/l for drinking water. Natural arsenic is present in some 200 mineral species, contained in pyrite (sulphide iron) for most of the time (IPCS, 2001). These minerals are problematic in areas where sediments of organic origin from the Holocene era have been buried under other layers too quickly and cannot be properly removed (Winkel et al., 2008). High concentrations of arsenic (above the WHO limit) are found on the slopes of the fossilized Bahr el Ghazal Valley. It is assumed that the pollution in Bahr el Ghazal originates from Labdé's series (Servant & Servant, 1970), which date back to the Holocene and are believed to be rich in organic sediments due to the influence of Paleo Lake Chad.

E. Coli

E. coli is a rod-shaped bacterium found in the intestines of hot-blooded animals, including humans. Unlike other coliform bacteria, this bacterium is not naturally present in soils and vegetation, they are found almost exclusively in faeces, and therefore, when their presence is found in water, it is evidence of faecal contamination. The WHO recommends drinking water free of all *E. coli* bacteria.

Hydrochemical Analyses of Groundwater in the Lake and Kanem Area in 2017

In November 2017, 12 Kanem wells and 60 wells north of Lake Chad were examined for the main anions and cations as well as for heavy metals. The results of the hydrochemical analyses are presented below. The results of the sampling campaigns conducted in Kanem and Bahr El Ghazal between 2009 and 2013 are not part of the reference period of this AMR and are therefore not explained in detail but can be consulted in the first SoB of LCBC.

Piper diagram of Kanem samples in 2017

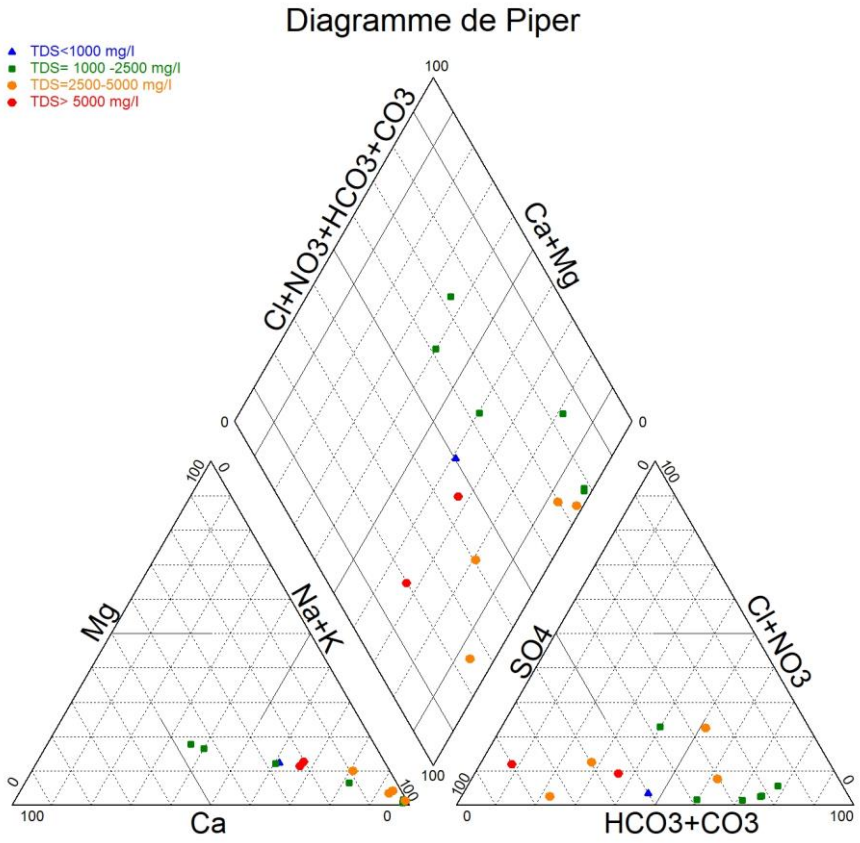


Figure 32: Chemical facies of groundwater sampled in the Kanem area in 2017. (Source of data: BGR)

The projection of chemical data from the Kanem region in the piper diagram shows three types of facies, namely:

- A sodium and potassium bicarbonate facies represented by 5 samples
- A sodium and/or chlorinated sodium and potassium sulphated facies also represented by 5 samples
- Calcium and magnesium chlorinated facies represented by two samples

Piper diagram of samples from the North Basin of the Lake area in 2017

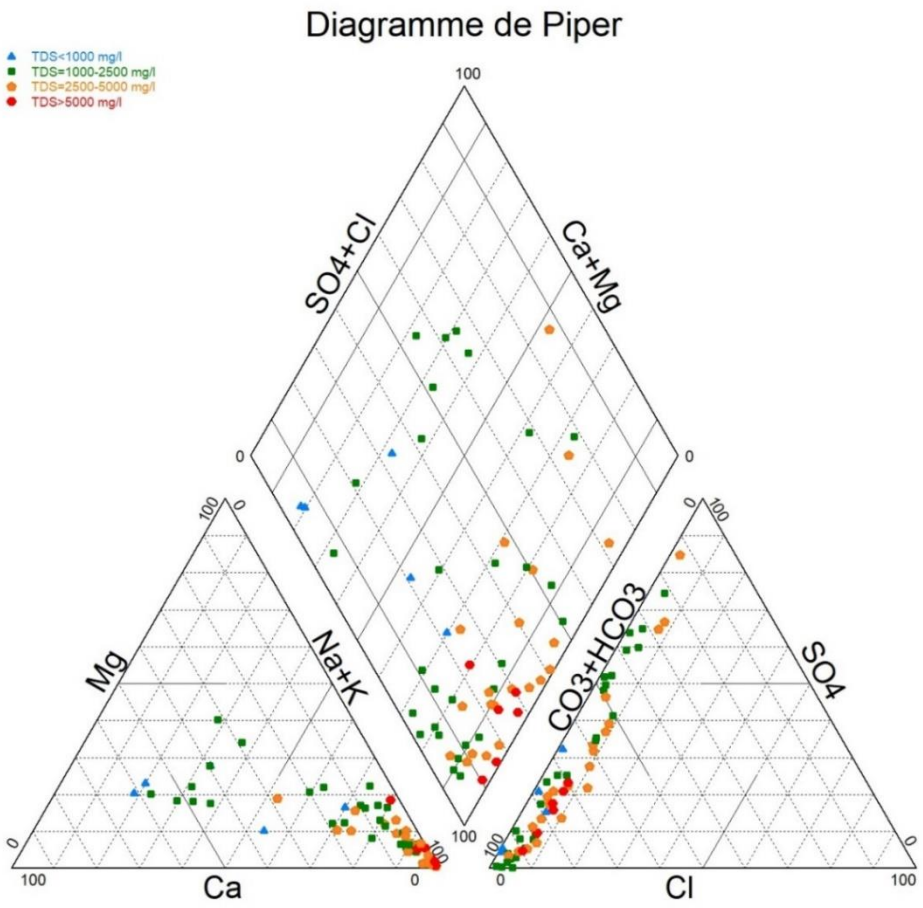


Figure 33: Chemical facies of groundwater in the wetland of the Lake area in 2017 (Source of data: BGR)

Groundwater chemistry north of the Lake generally shows a dominance of bicarbonate and sodium ion. However, sulphate remains the dominant element in some areas.

Thematic map of electrical conductivity

The distribution of electrical conductivity in the Lake and Kanem area is shown in the following Figure 34.

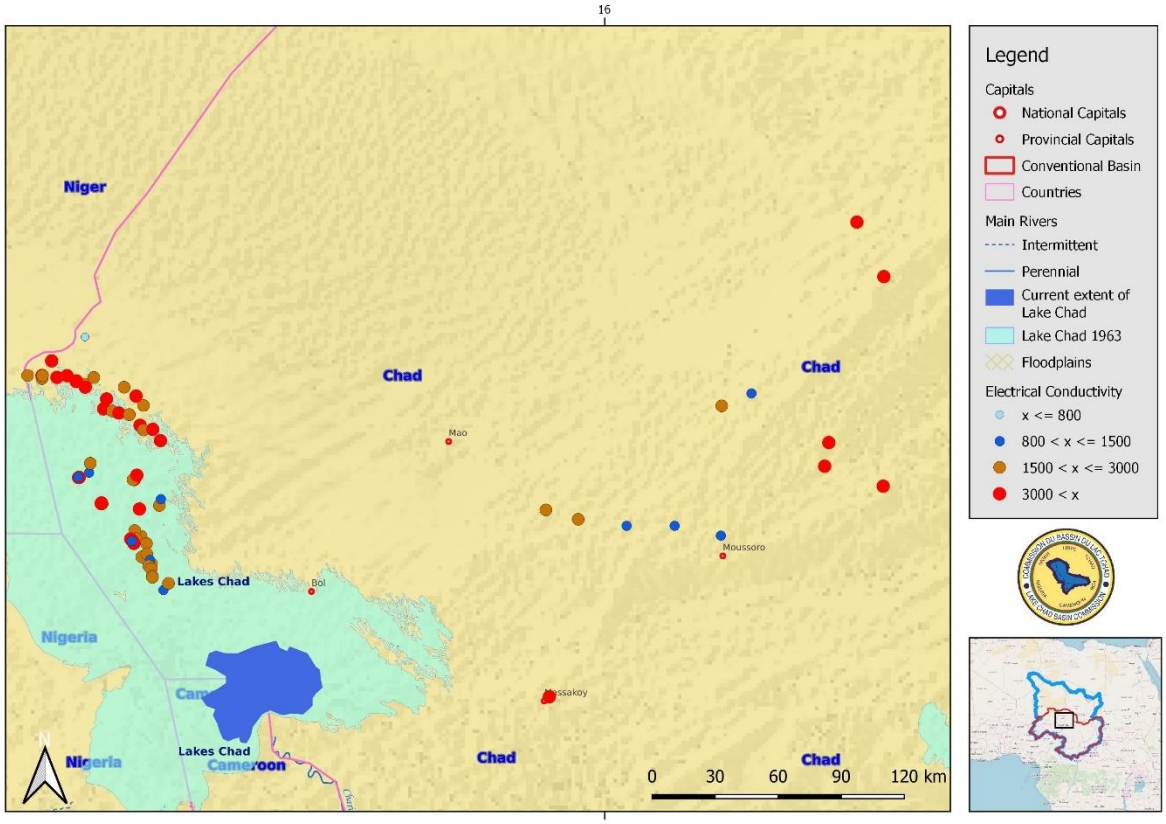


Figure 34: Thematic map of electrical conductivity (µS/cm) in 2017 in the Lake and Kanem region

Electrical conductivity ranges from 462 µS/cm to 6990µS/cm with an average of 3137µS/cm. The high concentration (>3000µS/cm) is mainly concentrated in the direction of Bahr El Ghazal and on the northern basin edge of Lake Chad.

Thematic map of fluoride concentration

The distribution of fluoride in the Lake and Kanem area is shown in Figure 35.

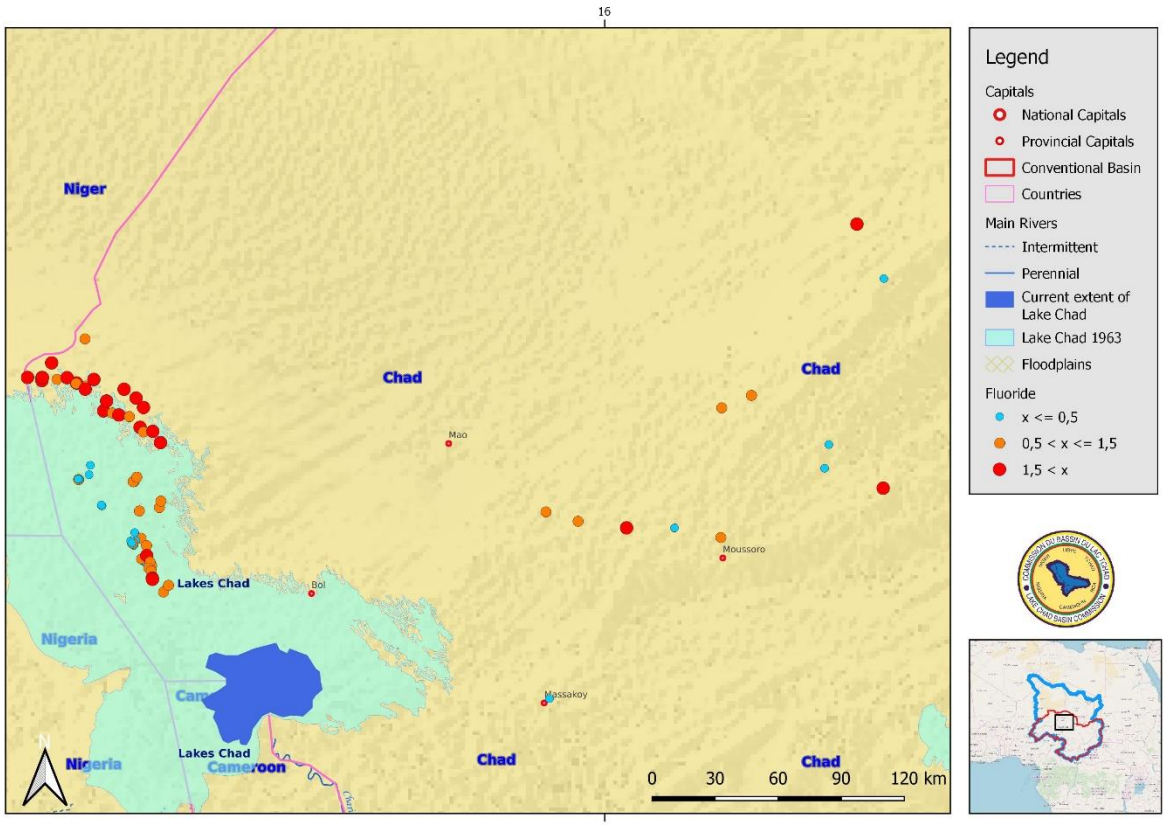


Figure 35: Thematic map of fluoride concentration (mg/l) in the Lake and Kanem area in 2017 (Source BGR-LCBC project).

Fluoride concentrations range from 0.11 mg/l to 6.6 mg/l with an average of 1.4 mg/l. Concentrations above 1.5 mg/l are found in almost all samples from the region around the northern basin of Lake Chad and in the Bahr el Ghazal Valley.

Thematic map of arsenic concentration

The distribution of arsenic in the Lake and Kanem area is shown in Figure 36.

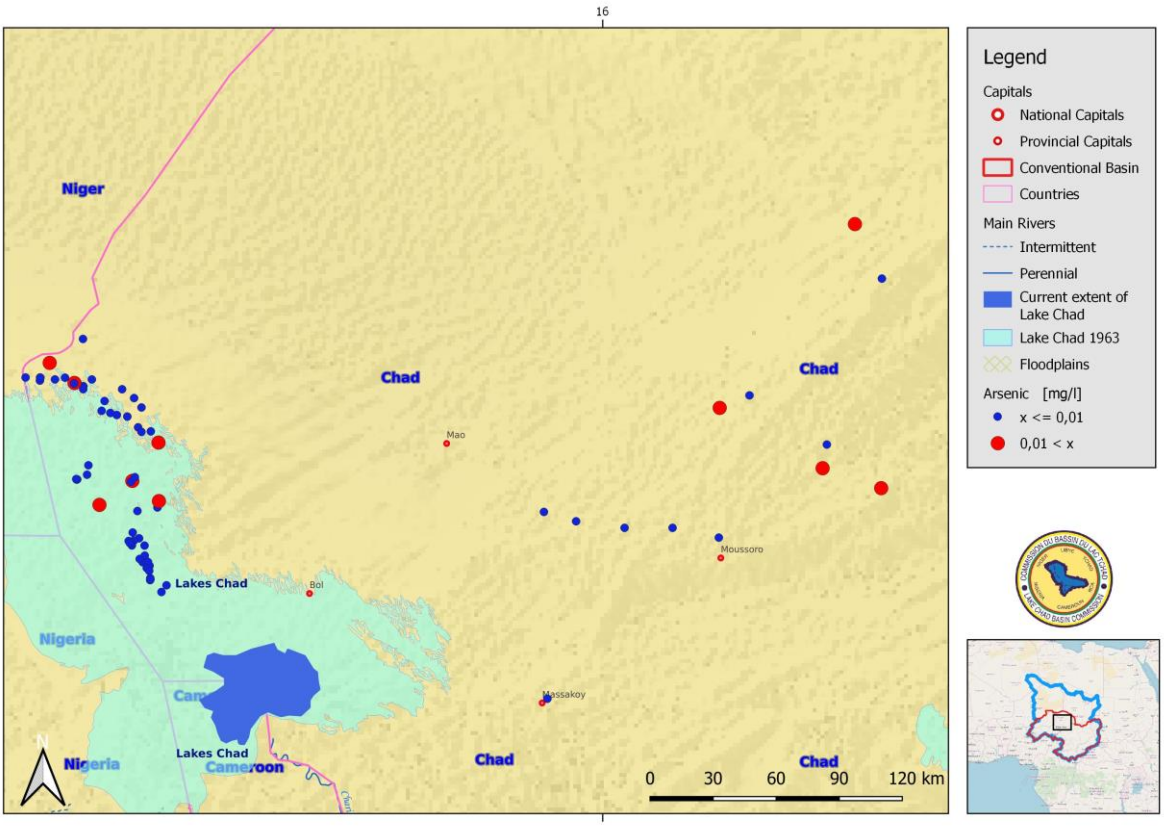


Figure 36: Thematic map of arsenic concentration in the Lake and Kanem area in 2017 (Source BGR-LCBC project)

In the Kanem Region and the northern basin of Lake Chad, arsenic concentrations vary from below the detection limit of 0.0005 mg/l to 0.19 mg/l. The maximum arsenic concentration of 0.19 mg/l was measured at Etri and Soua 1.

Arsenic concentrations measured above the WHO limit of 0.01 mg/l are found in 10 samples, all located in the flanks of the Bahr El Ghazal fossil valley and in the northern basin of Lake Chad. Due to the hazardous health effects of high levels of arsenic in drinking water, it is strongly recommended that raw water be treated before consumption or that alternative water supply sources are made available.

Thematic map of nitrate concentration

The distribution of nitrate concentration in the Lake and Kanem area is shown in Figure 37

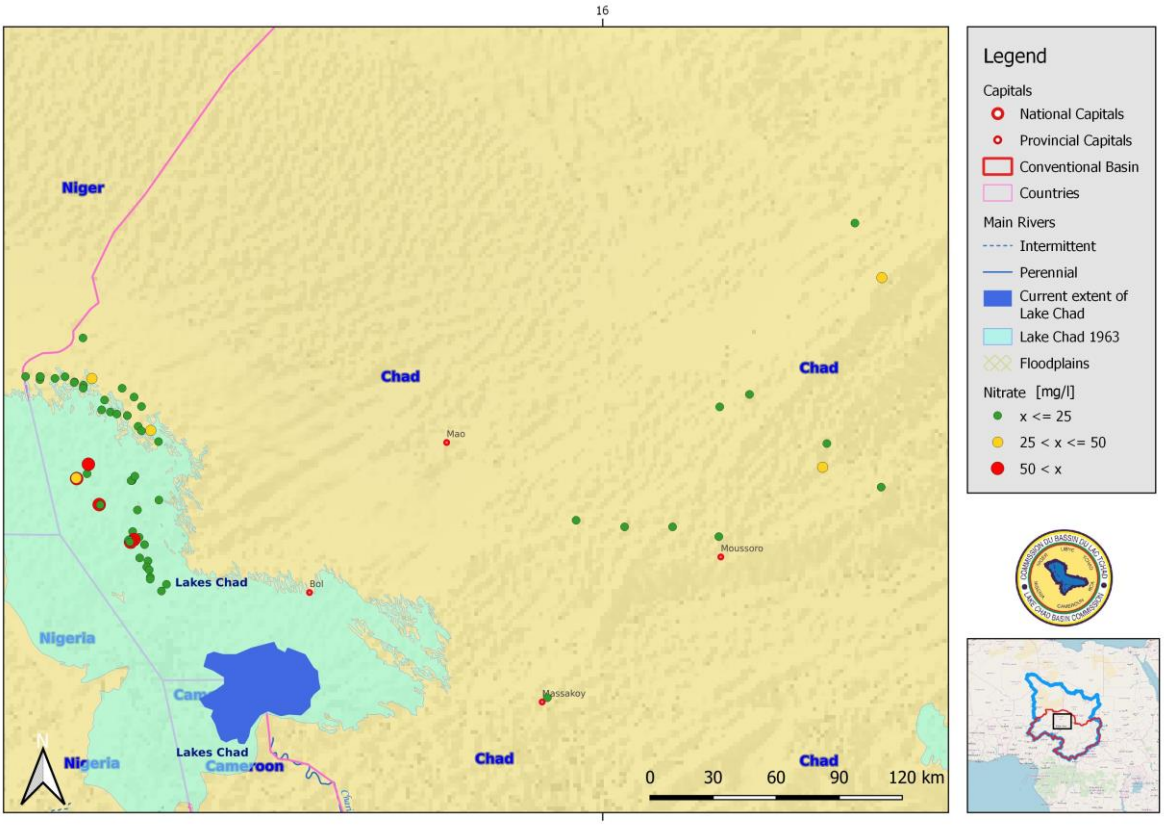


Figure 37: Thematic map of nitrate concentration in the Lake and Kanem area

Nitrate concentrations in the Kanem Region and the northern basin of Lake Chad range from 0.01 mg/l to 568 mg/l with an average of 30 mg/l. High values, which are sometimes 10 times higher than the limit value specified by WHO, are particularly found in the northern basin of Lake Chad. It is assumed that agricultural activity and fertilizer use in the polders are the source of these high concentrations.

Hydrochemical Analyses of Groundwater in the Salamat Region in 2016-2017

In 2016, about 50 wells and boreholes located in the Salamat plain were examined for the main anions and cations as well as for heavy metals. The results of the hydrochemical analyses are presented below.

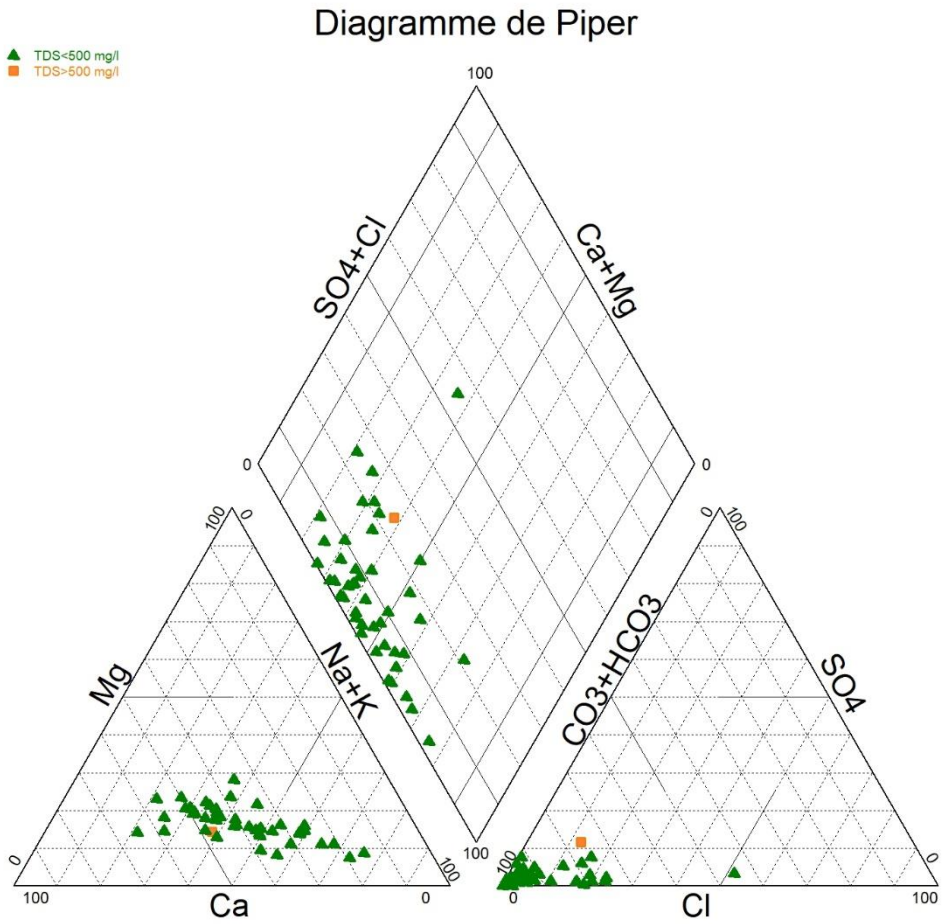


Figure 38: Chemical facies of groundwater in the wetland of the Salamat Region in 2016 and 2017 (Sources of data BGR-LCBC project)

The Piper diagram is based on samples in two types of infrastructures (wells and boreholes). Groundwater in the Salamat floodplain is mainly characterized by a calcium magnesium bicarbonate and potassium sodium bicarbonate facies with low mineralization. Only one sample shows a magnesium sulphate pole.

Thematic map of electrical conductivity

The distribution of electrical conductivity in Salamat is shown in the following Figure 39.

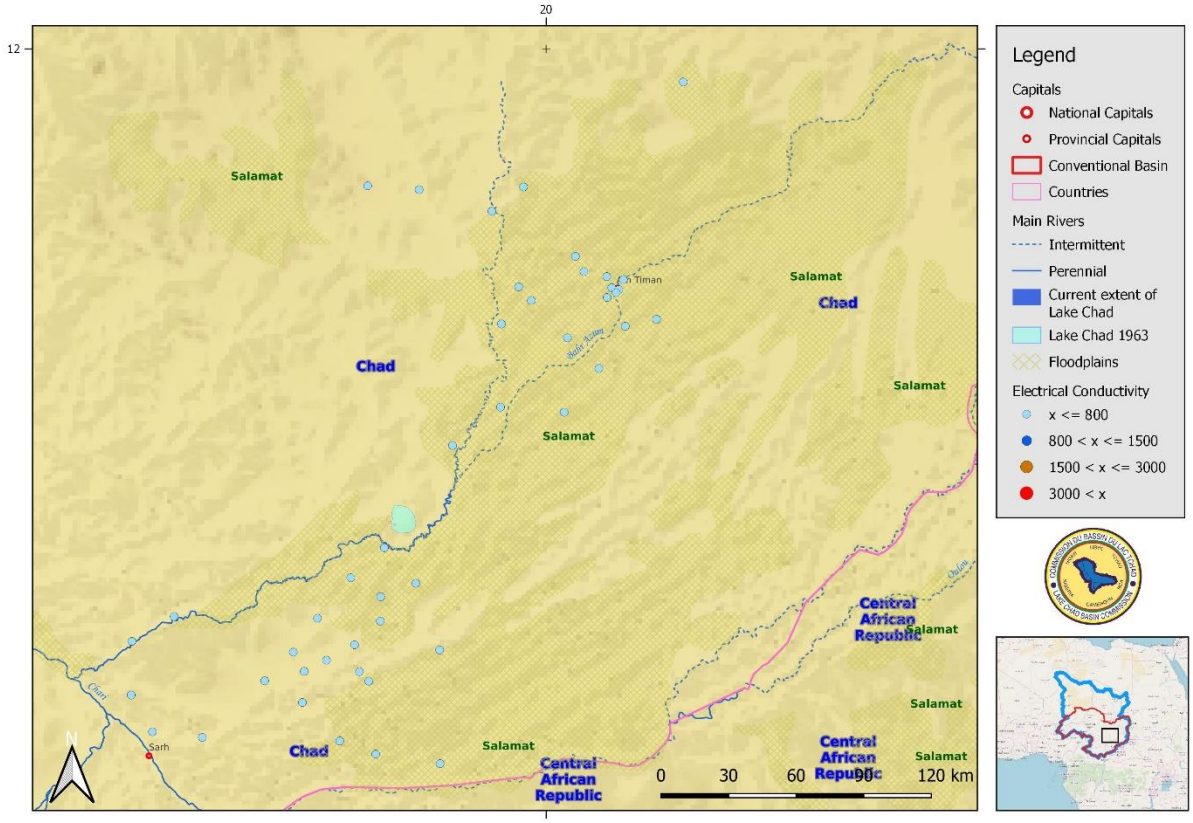


Figure 39: Thematic map of electrical conductivity in the Salamat Region (Source of data BGR-LCBC project)

As shown in the figure, conductivity is very low throughout the study area, i.e. below < 800µS/cm.

Thematic map of fluoride concentration

The distribution of fluoride concentration in Salamat is shown in Figure 40.

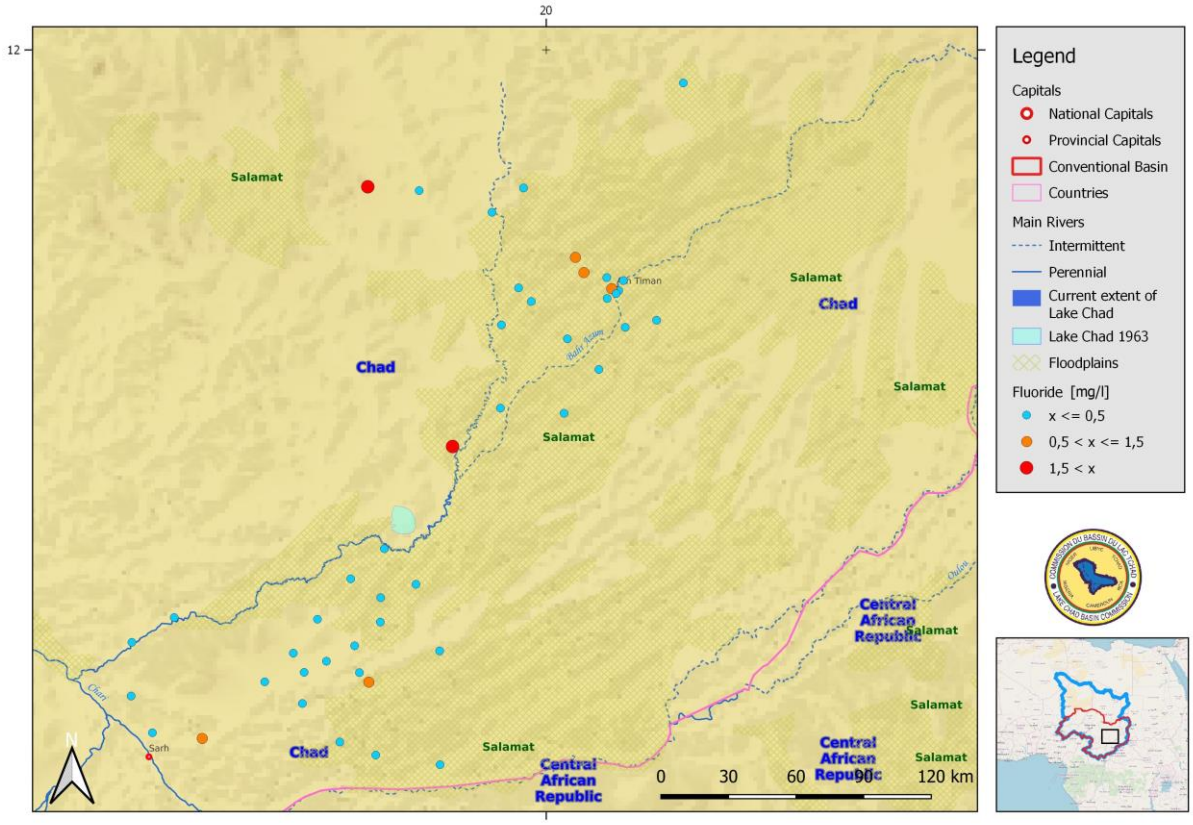


Figure 40: Thematic map of fluoride concentration (mg/l) in the Salamat Region (Source of data BGR-LCBC project)

The fluoride concentrations found in Salamat range from 0.023mg/l to 4.7mg/l with an average of 0.46mg/l. Concentrations above the WHO limit of 1.5mg/l for drinking water are in Thiole and Aboudeia.

Thematic map of the nitrate concentration

The distribution of nitrate concentration in the Salamat Region is shown in Figure 41.

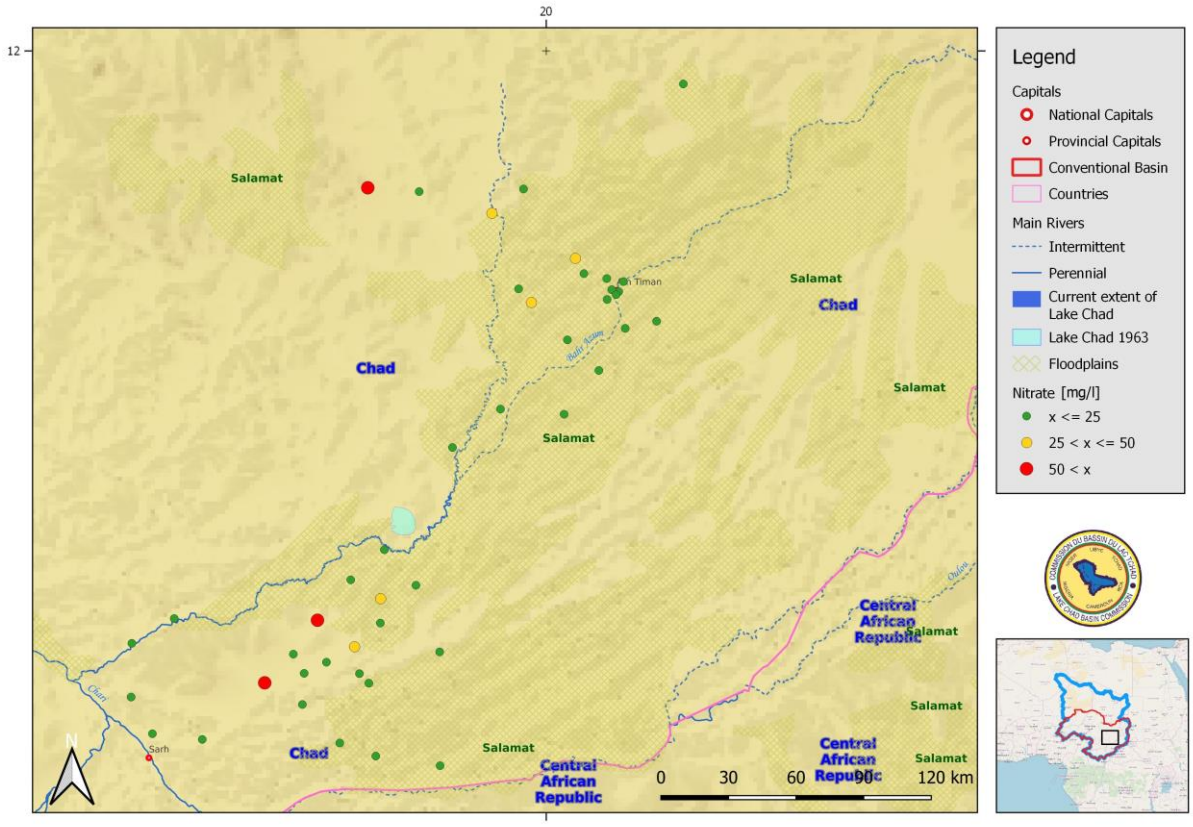


Figure 41: Thematic map of nitrate concentration in the Salamat Region (Source of data: BGR-LCBC project)

Nitrate concentrations in the Salamat Region range from 0.003 mg/l to 84 mg/l with an average of 11 mg/l. The values, which exceed the WHO specified limit value of 50 mg/l, are located in Aboudeia, Roro and Koumakoke. It is assumed that agricultural activity and fertilizer use are the source of these high concentrations.

Hydrochemical Analyses of Groundwater in the Yaéré Floodplain in 2017

In 2017, about 76 groundwater samples of the Yaéré plain were examined for the main anions and cations as well as for heavy metals. The results of the hydrochemical analyses are presented below.

Chemical analyses show that groundwater in the floodplain is generally of good quality.

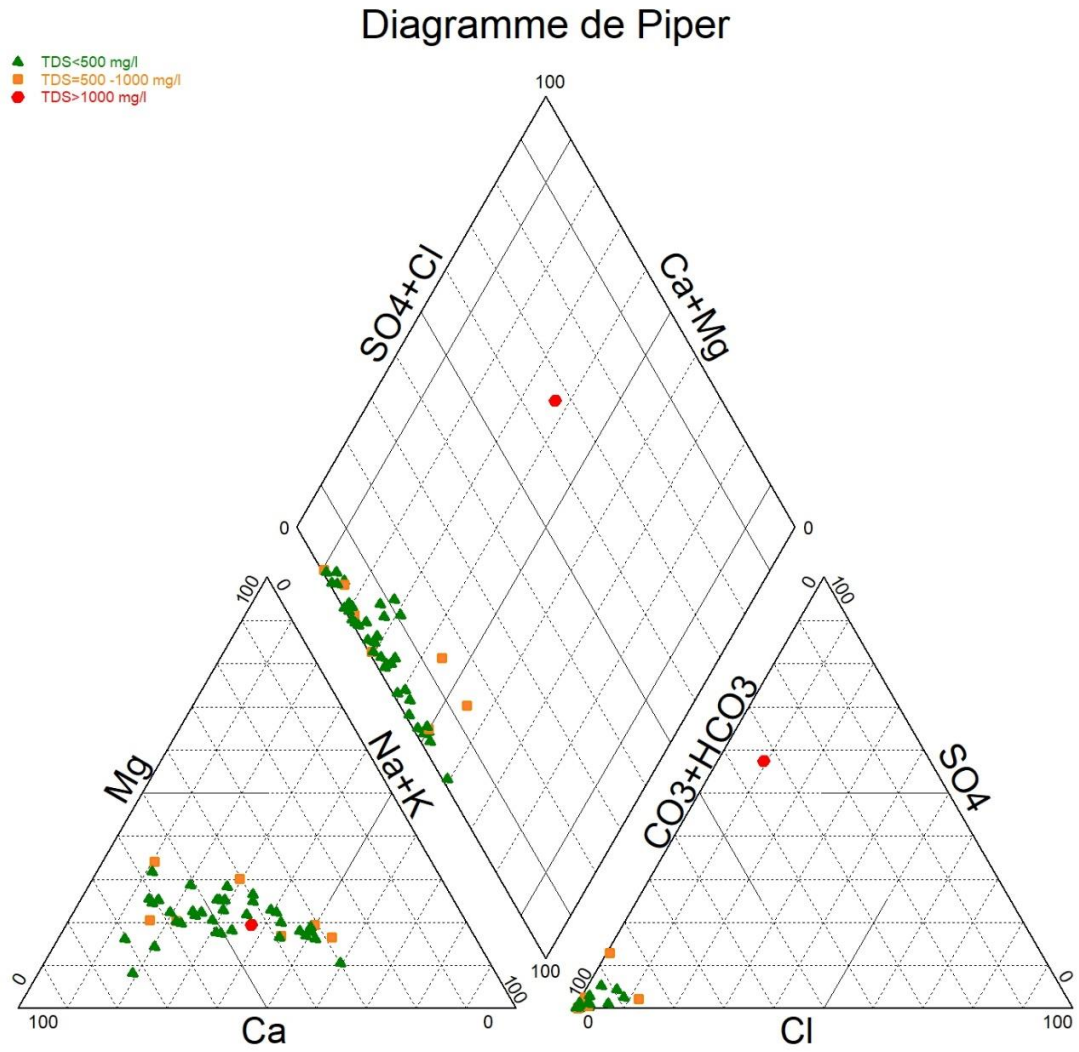


Figure 42 : Chemical facies of groundwater sampled in the Yaéré area in 2017 (Source of data: BGR-LCBC project)

The resulting Piper Diagram for the 76 groundwater samples shows that most water samples have calcium magnesium bicarbonate facies. Approximately 6 samples are located between the magnesium calcium bicarbonate and potassium sodium bicarbonate poles. Only two samples show a sodium bicarbonate facies. However, only one sample with mineralization greater than 1000 mg/l is of the potassium sodium sulphate type.

Thematic map of electrical conductivity

The distribution of electrical conductivity in the Yaéré floodplain in 2017 is shown in Figure 43.

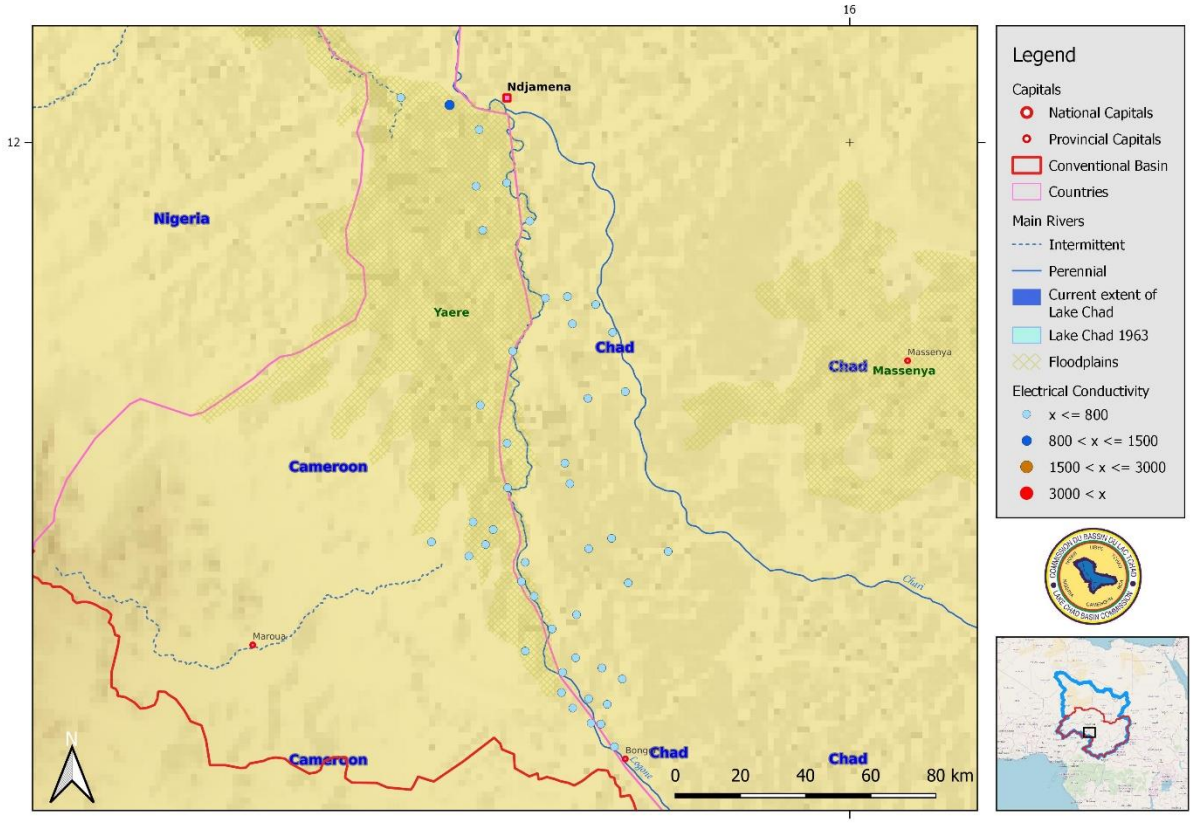


Figure 43: Thematic map of the distribution of electrical conductivity in the Yaéré floodplain in 2017 (Source of data: BGR-LCBC project)

The map shows that the electrical conductivity values are all below 1500 µS/cm and therefore show low mineralized water, which is true for groundwater obtained near the recharge area.

Thematic map of fluoride concentration

The distribution of fluoride concentration in mg/l in the Yaéré floodplain is shown in Figure 44.

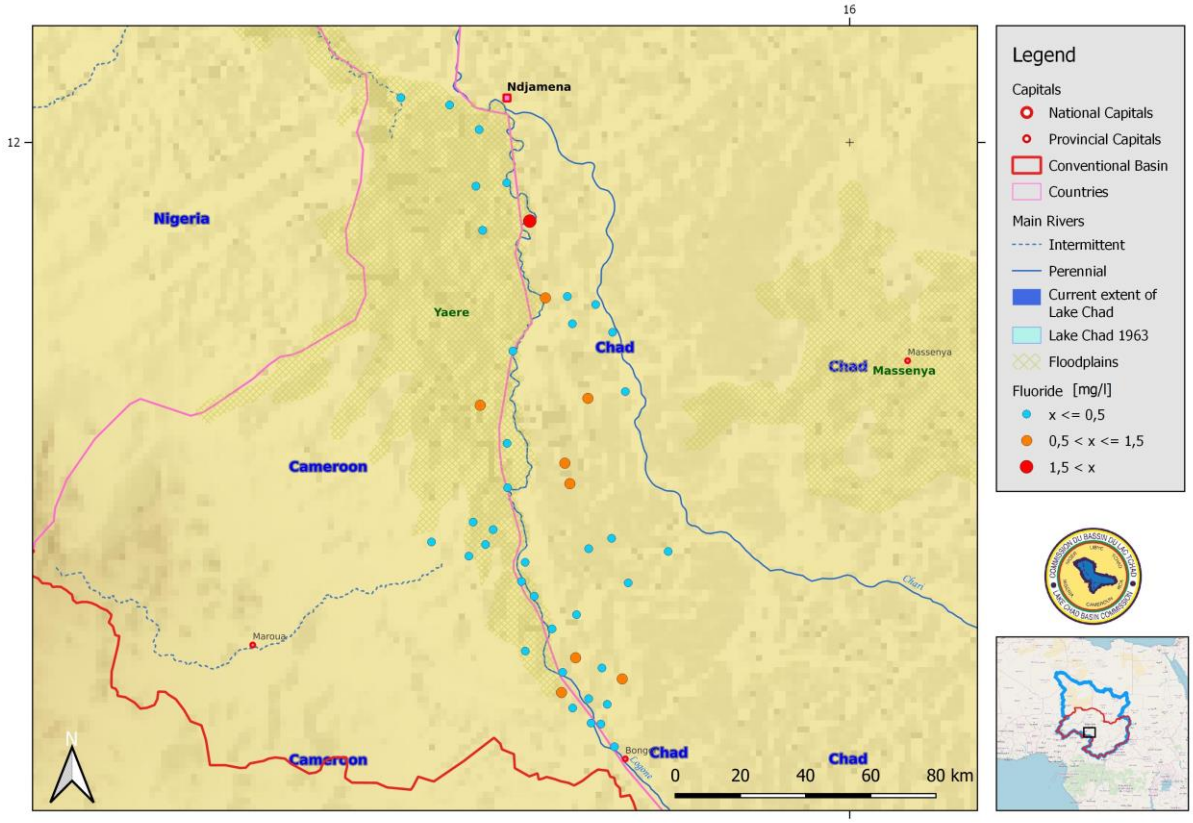


Figure 44: Thematic map of fluoride concentration in mg/l in the Yaéré floodplain in 2017 (Source of data: BGR-LCBC project)

High concentrations between 0.5 mg/l and 1.5 mg/l of fluoride in the Yaéré floodplain were observed at eight points along the Logone River (north of Bongor), in the Yaéré and Logone Gana plain. A concentration of 1.75 mg/l was detected at Logone Birni in Cameroon (YC15B).

Thematic map of nitrate concentration

The distribution of nitrate concentration in mg/l in the Yaéré floodplain in 2017 is shown in Figure 45.

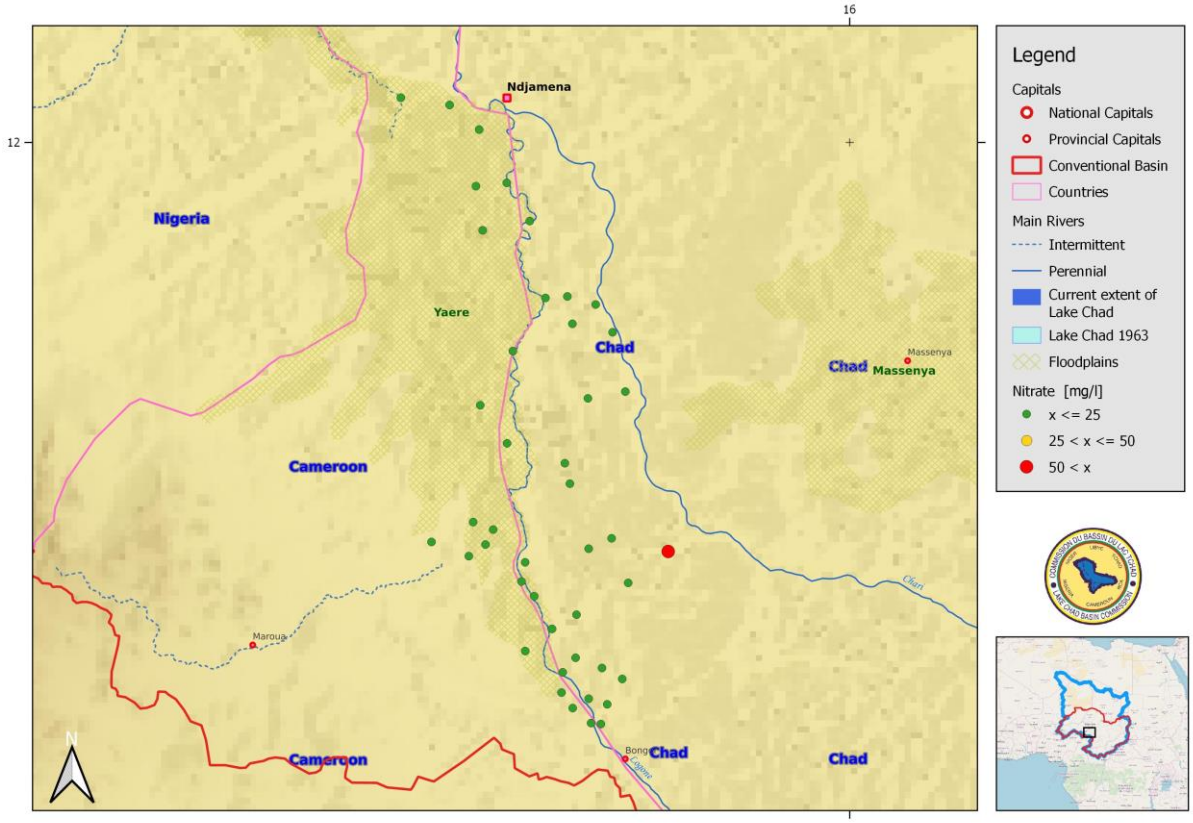


Figure 45: Thematic map of nitrate concentration (in mg/l) in the Yaéré floodplain (Source of data: BGR-LCBC project)

As agriculture is the main activity in the floodplain of Yaéré, particularly rice cultivation, high pollution could be an effect of excessive use of nitrogen fertilizer. In the Yaéré area, only one sample from the 2017 season shows a nitrate concentration above the WHO limit. It was found in Chad in Dabla Foulbé (YT61B).

Hydrochemical Analyses of Groundwater in the N'Djamena in 2018

The Figure below shows the Piper diagram for the 60 points sampled in the city of N'Djamena in 2018.

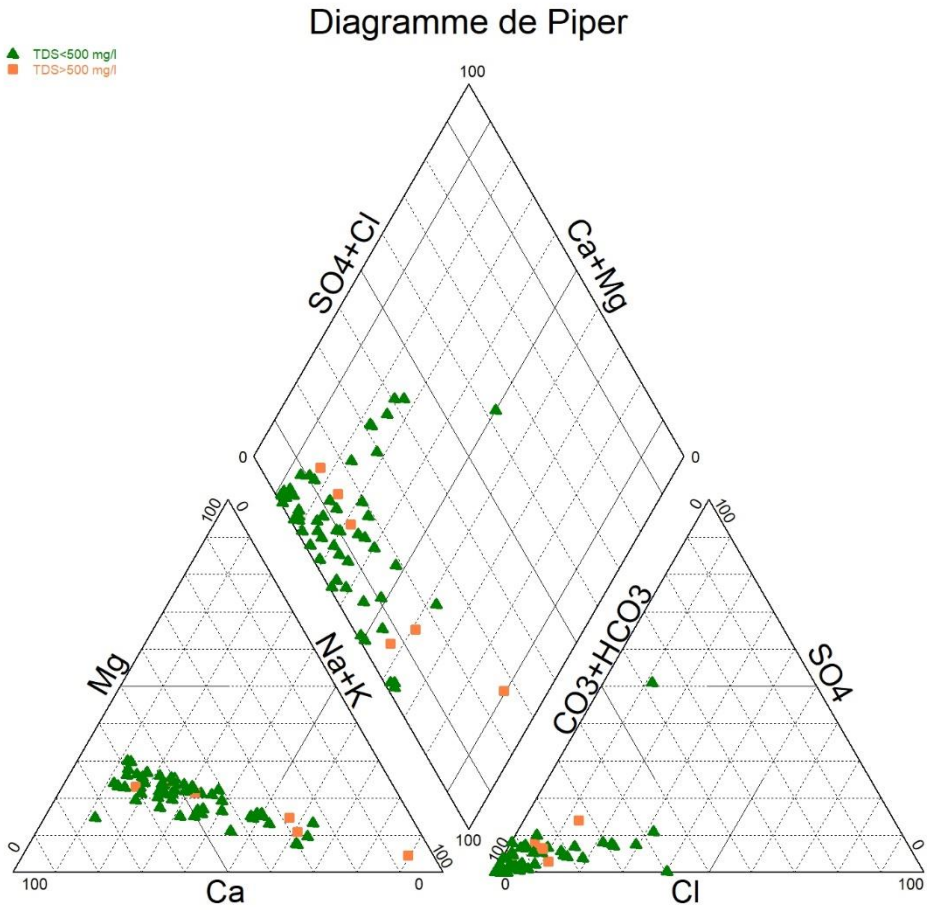


Figure 46: Chemical facies of groundwater in N'Djamena in 2018 (Source: BGR-LCBC project)

Most of the groundwater in N'Djamena belongs to the calcium magnesium bicarbonate type with mineralization below 500 mg/l.

Thematic map of electrical conductivity

The distribution of electrical conductivity in N'Djamena in 2018 is shown in Figure 47

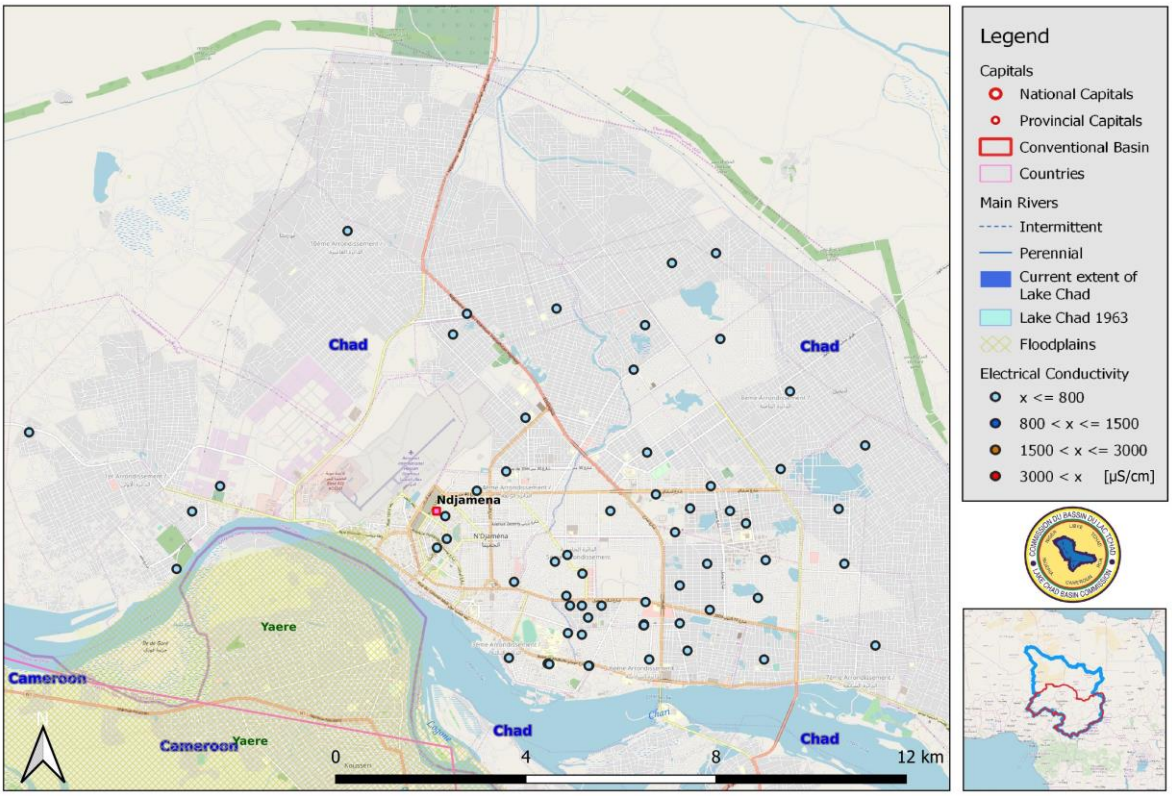


Figure 47: Thematic map of groundwater electrical conductivity (µS/cm) in N'Djamena in 2018 (Data source BGR-LCBC project)

The map shows that the electrical conductivity values are all below 800 µS/cm and therefore show low mineralized water, which is true for groundwater obtained near the recharge area.

Thematic map of fluoride concentration

The fluoride distribution in the intervention area in N'Djamena in 2018 is presented in Figure 48.

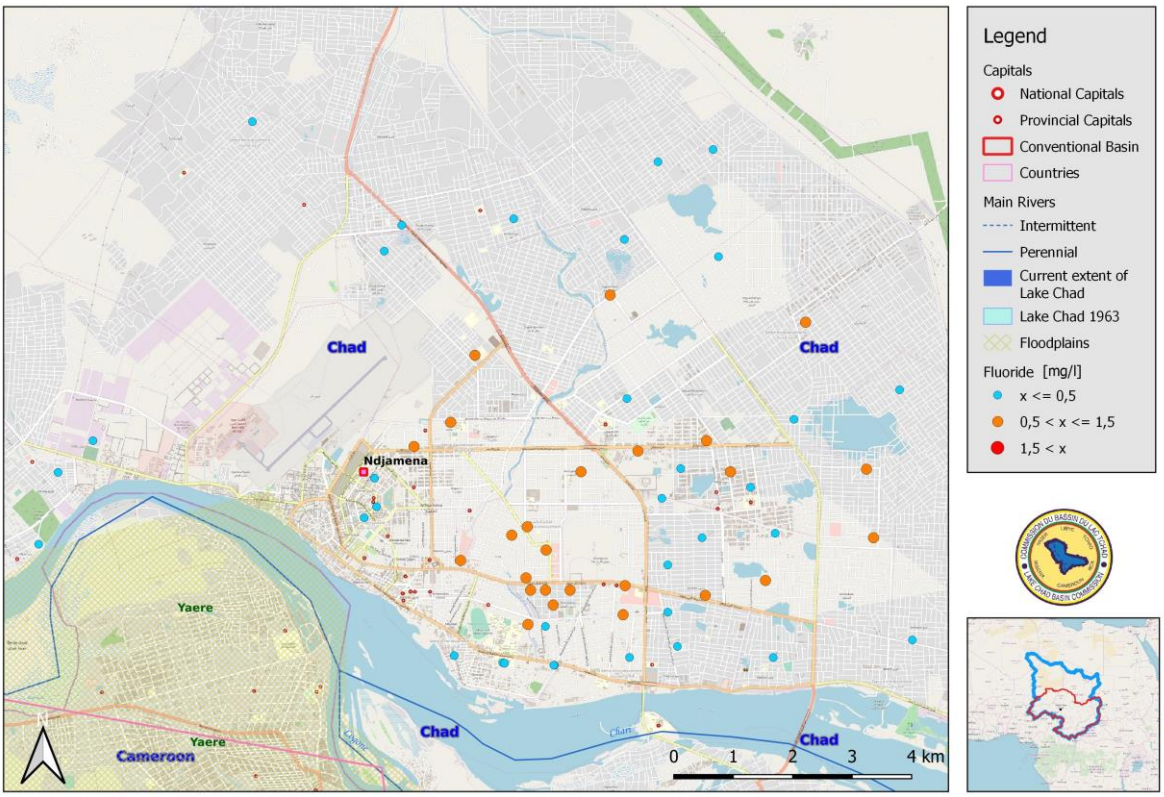


Figure 48: Thematic map of groundwater fluoride concentration in N'Djamena in 2018 (Data source BGR)

The fluoride concentration limit of 1.5 mg/l which is recommended by the WHO for drinking water was not exceeded, but 28 samples (43%) show high concentrations of fluoride above 0.5 mg/l which can cause dental fluorosis in case of long-term exposure.

Thematic map of nitrate concentration

The distribution of nitrate concentration in N'Djamena in 2018 is shown in Figure 49.

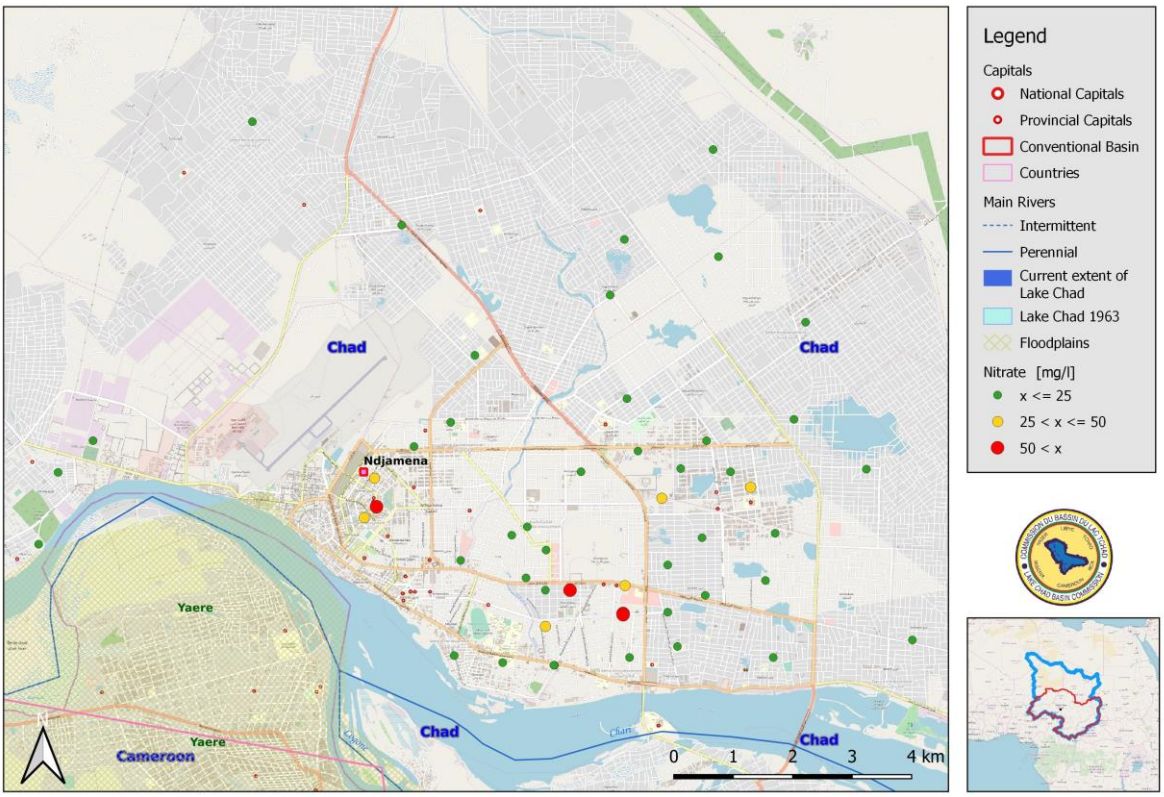


Figure 49: Thematic map of groundwater nitrate concentration in N'Djamena in 2018 (Data source BGR-LCBC project)

The nitrate concentration in 2018 in the city of N'Djamena ranges from the detection limit to 144 mg/l, with an average of 11 mg/l.
Most water samples show nitrate concentrations below the WHO limit, but in three cases (4.6%), concentrations above 50 mg/l were measured. These are two boreholes of the water supplier STE: GD8 and GD1, located in the 2nd arrondissement in N'Djamena center, and two public boreholes: one located in a high school in Amriguebe (NDJ15) and a second well in Ndjari (NDJ36).

Thematic map on the discovery of faecal bacteria in the urban area of N'Djamena in 2018

Figure 50 below shows the spatial distribution of contamination by E. coli and therefore faecal bacteria in N'Djamena in 2018.

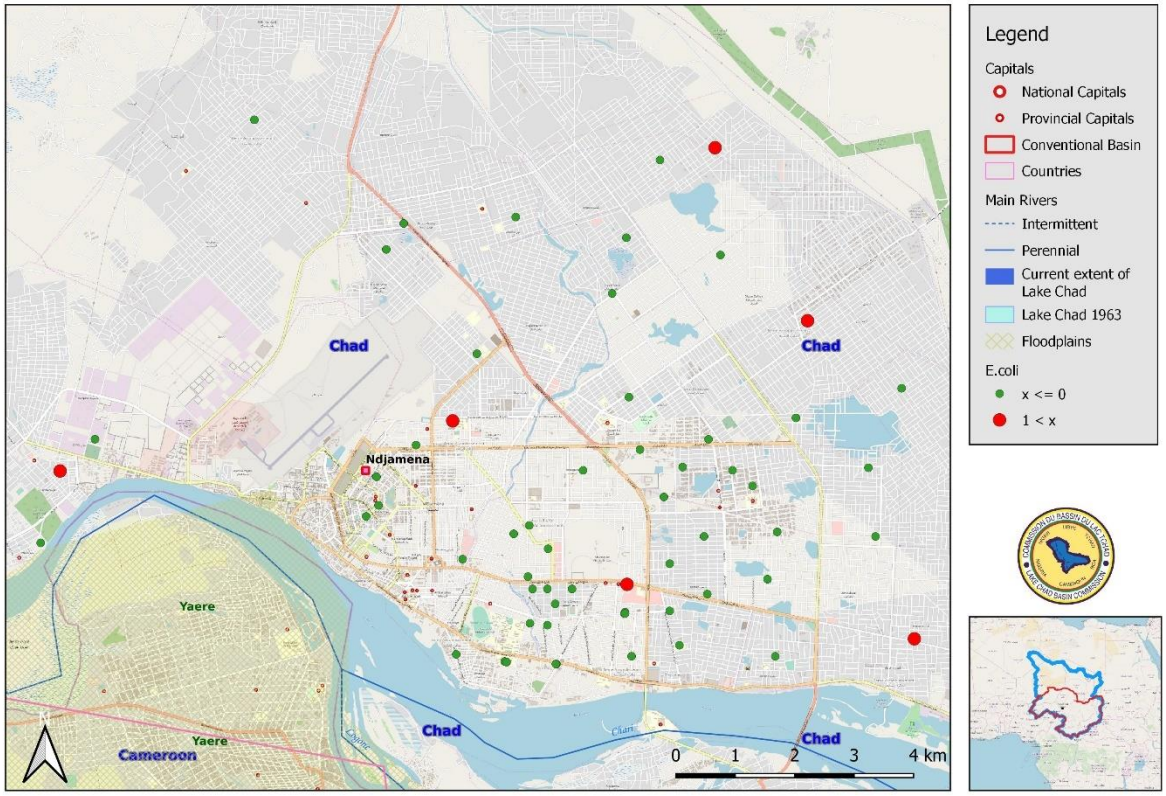


Figure 50: Thematic map of the presence of faecal bacteria in groundwater in N'Djamena in 2018 (Data source BGR-LCBC project)

Seven out of 62 boreholes tested in 2018 were contaminated with *E. coli*, indicating contamination by human and animal faeces.
In addition, a total of 21 out of 62 boreholes (33.87%) revealed the presence of enterococci, which is a clear indicator for water contamination by human and animal faeces.

Hydrochemical Analyses of Groundwater in the Komadugu-Yobe Floodplain in 2018

A sampling and monitoring campaign in the Komadugu-Yobe sub-basin in Nigeria was carried out by the LCBC in collaboration with the BGR project in March 2018. A total of 191 groundwater points were analyzed.

The results of the analysis show that most samples have concentrations below the WHO acceptable limits for safe drinking water, although there are isolated cases where concentrations (nitrate, chloride, iron, fluoride, etc.) are very high, much higher than the standards accepted by WHO. These sites are located in Jimbam, Gashua, Maiduguri, etc. The cause of these high concentrations remains uncertain, but pollution from human activities could be a likely factor, as the nitrate concentration is very high at these sites.
For heavy metals, concentrations are generally below the detection limits for almost all samples. Nevertheless, there are few isolated sites in the Komadugu-Yobe area with high concentrations of some heavy metals.

In agricultural terms, most samples based on the percentage of sodium (Na) are of good and acceptable classes. Ultimately, groundwater quality in the Komadugu-Yobe region is generally very good for domestic consumption and agricultural activities. However, the threat of pollution by anthropogenic factors remains likely. Proactive measures, such as raising awareness of good hygiene practices and water point management, are recommended.

The Figure below shows the Piper diagram for the 191 points sampled in the Komadugu-Yobe sub-basin.

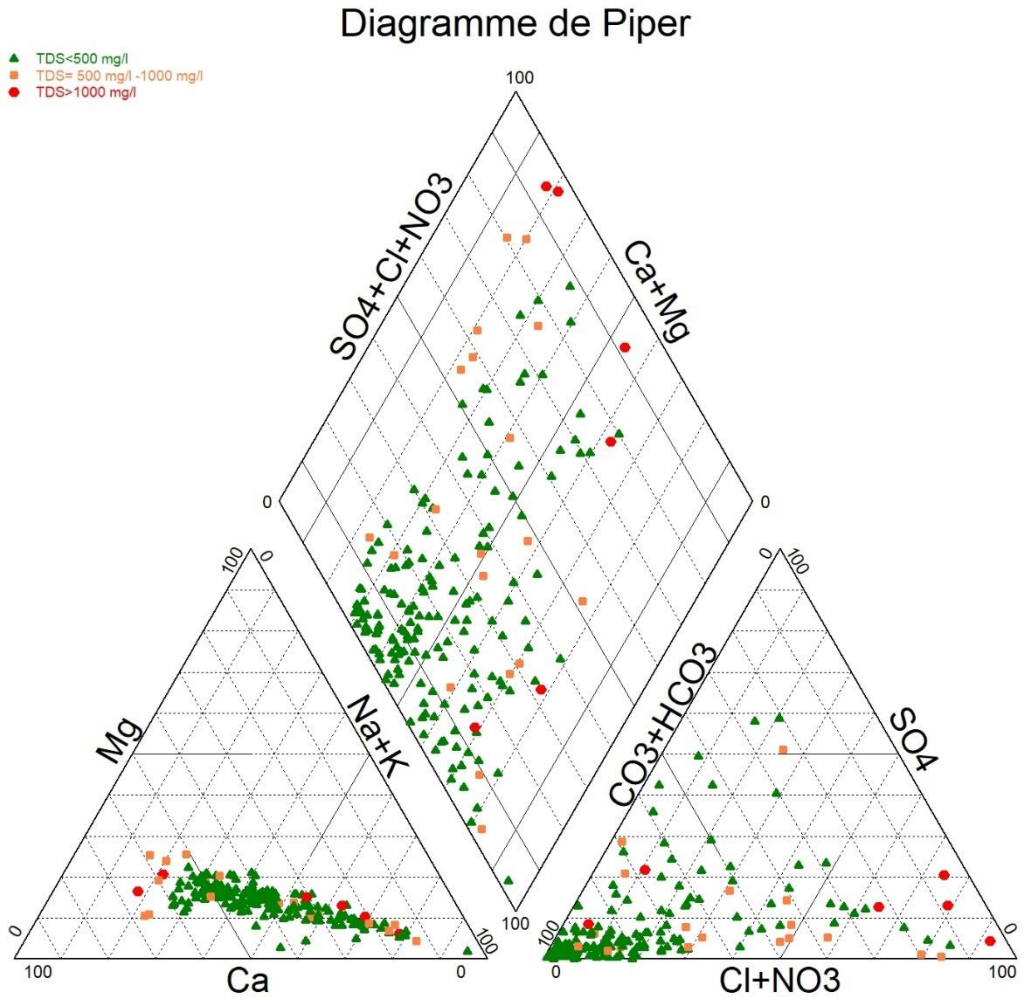


Figure 51: Chemical facies of groundwater in the floodplain of Komadugu-Yobe in 2018 (Source: BGR-LCBC project)

Most of the groundwater in the study area is dominated by calcium. However, there is an ion exchange phenomenon between calcium and sodium for cations and between bicarbonate and chloride for anions. The order of dominance of cation and anion in the study area is presented as follows:

Cation Ca2+>Na+>Mg2+>K+ et Anion HCO3->Cl->SO42-

Thematic map of electrical conductivity

The distribution of electrical conductivity in the Komadugu Yobe plain in 2018 is shown in Figure 52.

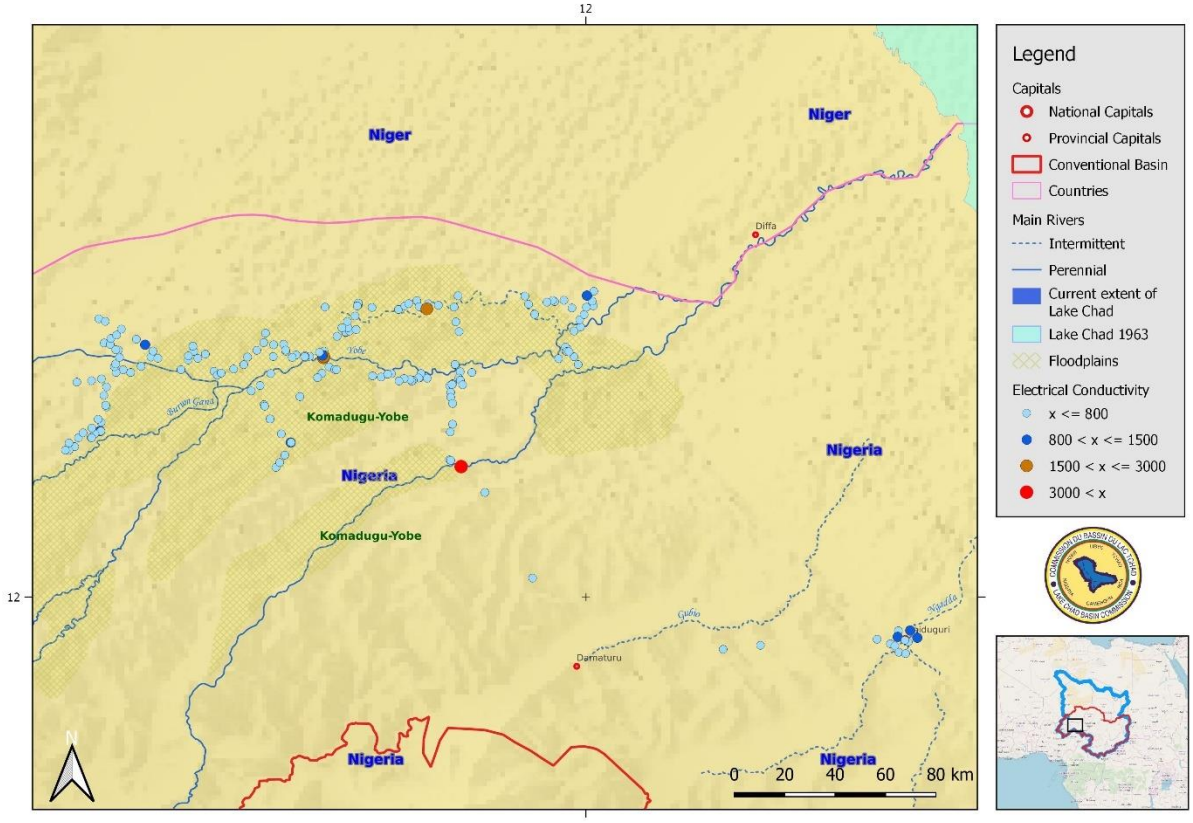


Figure 52: Thematic map of electrical conductivity (µS/cm) in groundwater of the Komadugu-Yobe floodplain in 2018 (Source of data: BGR-LCBC project)

At a single site in Jimbam, the electrical conductivity exceeds 3000 µS/cm and therefore reveals the presence of brackish water. Most of the groundwater points sampled have values below 800 µS/cm and are therefore fresh water.

Thematic map of fluoride concentration

The distribution of fluoride concentration in the Komadugu Yobe plain in 2018 is shown in Figure 53.

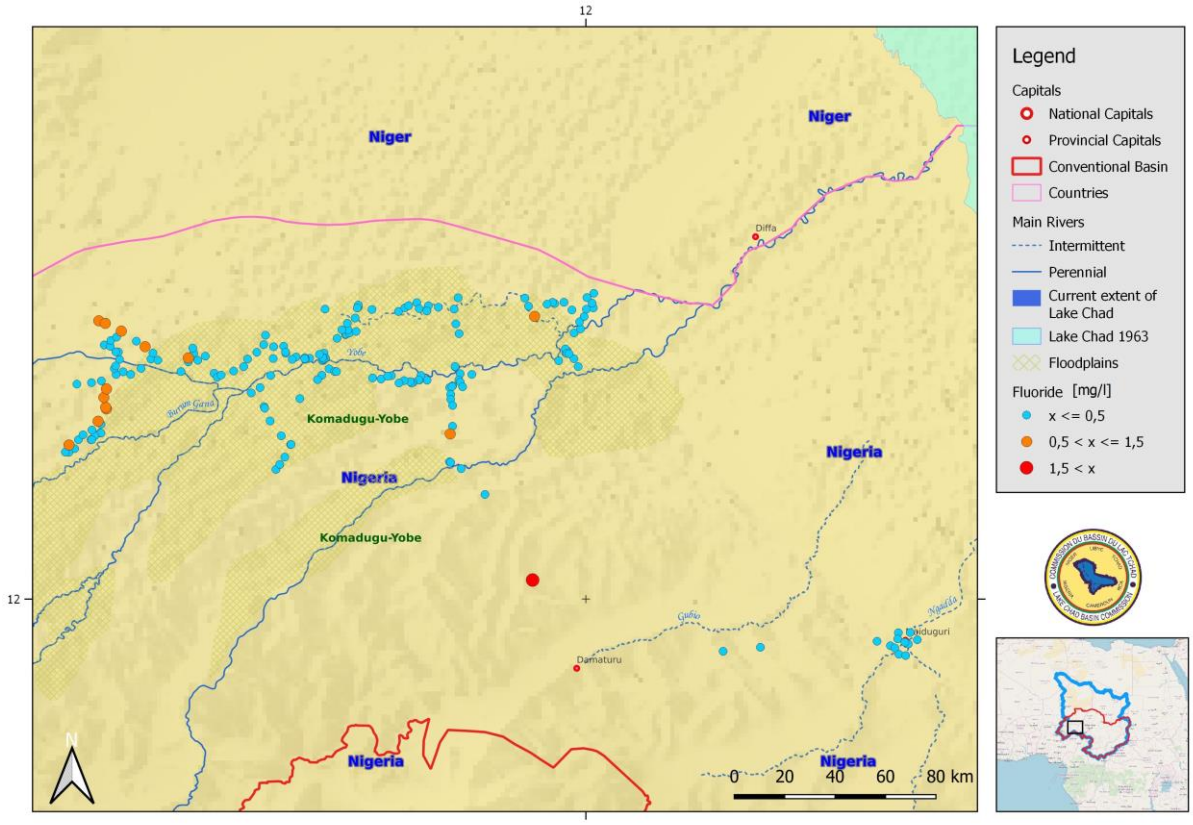


Figure 53: Thematic map of fluoride concentration in groundwater of the Komadugu-Yobe floodplain in 2018 (Source of data: BGR-LCBC project)

At a single site in Dogon Kuka, fluoride exceeds WHO standards. This is therefore of no consequence for the Komadugu-Yobe sub-basin region.

Thematic map of nitrate concentration

The distribution of nitrate concentration in the Komadugu Yobe plain in 2018 is shown in Figure 54.

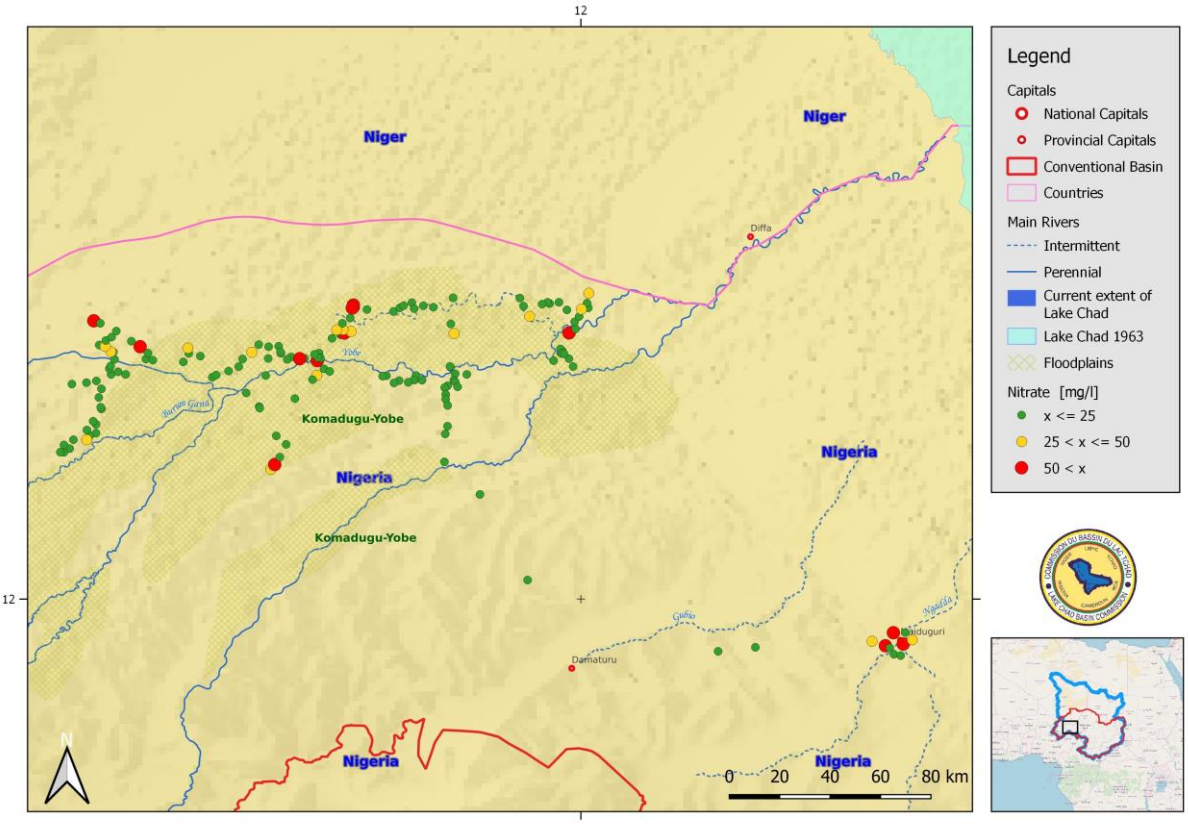


Figure 54: Thematic map of nitrate concentration in groundwater of the Komadugu-Yobe floodplain in 2018 (Source of data: BGR-LCBC project)

At 24 points, nitrate values significantly exceed the WHO recommended limit of 50 mg/l. The points are located in the Komadugu-Yobe plain, but also in Maiduguri. Boreholes in Jimbam and Guyamari have values of 1249 mg/l and 1002 mg/l respectively.
It is assumed that agricultural activity and fertilizer use in the Komadugu-Yobe plain are the source of these high concentrations. On the other hand, in Maiduguri, human activities are certainly the cause of the high concentrations.

3.2.2.3 Conclusion of Groundwater Quality 2017-2018

The results of chemical analyses show that groundwater is generally of good quality. However, the levels of certain elements (fluoride, arsenic, faecal bacteria, nitrate) in some regions have an impact on the quality of these waters and corrective measures, treatments or awareness campaigns on the management of the surroundings of water points would be necessary to improve water quality.

4. Environment

4.1 Environmental Flow

One of the specific objectives of the Water Charter is to establish environmental flows to be maintained in the tributaries of Lake Chad during periods of low flow in order to protect and preserve aquatic ecosystems and the services provided by such ecosystems. Therefore, the States Parties to the Charter undertake to maintain environmental flows at the following key stations in the basin (as defined in Annex 3 of the Water Charter). Key stations should be located on existing gauging stations to facilitate flow control.

The environmental flows recorded during periods of low water are as follows:

Table 16: Minimum flows to be respected at key hydrometric stations during low water periods (Water Charter Article 3.3)

Station	River	Country	Environmental flow in low water periods
Moundou	Logone	Chad	13m³/s
Doba	Pendé	Chad	1 m³/s
Bongor	Logone	Chad-Cameroon	25 m³/s
Logone-Gana	Logone	Chad-Cameroon	12 m³/s
Manda	Bahr Sara	Chad	12 m³/s
Sarh	Chari	Chad	3 m³/s
Tarangara	Salamat	Chad	0 m³/s
Chagoua	Chari	Chad	12 m³/s
N'Djamena	Chari	Chad	22 m³/s
Diffa	Yobe	Niger-Nigeria	0 m3/s
Gashua	Burum Gana	Nigeria	12 m3/s
Gapchi	Komadugu- Gana	Nigeria	1 m3/s

Many of the permanent and temporary wetlands in the basin are created by natural flooding during floods when tributaries of Lake Chad overflow their beds. Overflow occurs when a minimum flow level is reached; below this level, there is no flooding.

In order to maintain good conditions in the wetlands without reducing their size, the States Parties have agreed to maintain flows at key stations in the basin to ensure that the wetlands are flooded during floods. The maintenance of environmental flows depends on the existence of a higher natural flow in the watercourse than the set flow, which can be difficult in the case of some climatic events.
Key stations should be located at existing gauging stations to facilitate flow control.
The environmental flows for flood periods are as follows:

Table 17: Minimum flows to be respected at key stations during high water periods (Water Charter Article 3.5)

Station	River	Country	Environmental flow for high water periods
Lai	Logone	Chad	1900 m³/s
Eré	Logone	Chad	1750 m³/s
Bongor	Logone	Chad-Cameroon	1500 m³/s
Gashua	Burum Gana	Nigeria	80 m³/s
Gapchi	Komadugu-Gana	Nigeria	20 m³/s

4.2 Sources of Pollution

The quality of surface and groundwater in the basin is impacted by human and natural factors. Intensive agriculture and the use of chemical fertilizers, pesticides and insecticides, high population density combined with the lack of adequate sanitation systems and the non-treatment of industrial effluents can have an impact on the physico-chemical and bacteriological quality of water.
In addition to the surface and groundwater sampling campaigns carried out as part of the LCBC projects (see Chapter 4.2), there are no appropriate field observation networks in the basin countries that could identify and locate pollution sources.

4.3 Vegetation and Degradation

4.3.1 The Normalized Difference Vegetation Index (NDVI)

The Normalized Difference Vegetation Index (NDVI) is a measure of plant health and vitality.

In general, healthy vegetation absorbs the red part of the electromagnetic spectrum and reflects the NIR (Near Infrared) part. The production of chlorophyll requires a lot of energy, which the plants use from the red band of the light spectrum. The energy absorption in the latter explains the low amount of energy that is reflected. On the other hand, plant biomass has the effect of reflecting NIR waves. The large difference between the reading of the red band and that of the NIR band will therefore be an indicator of vigorous vegetation.

The NDVI, which is the difference between the two bands, varies from 0 represented in brown in the images (bare soil) to 1 represented in green (vigorous vegetation in full growth). The yellow colour represents early season vegetation (young plants).

The images below are NDVIs produced from the red and near infrared bands of the sensor mounted on board of the European Space Agency's Sentinel 2 Satellite.

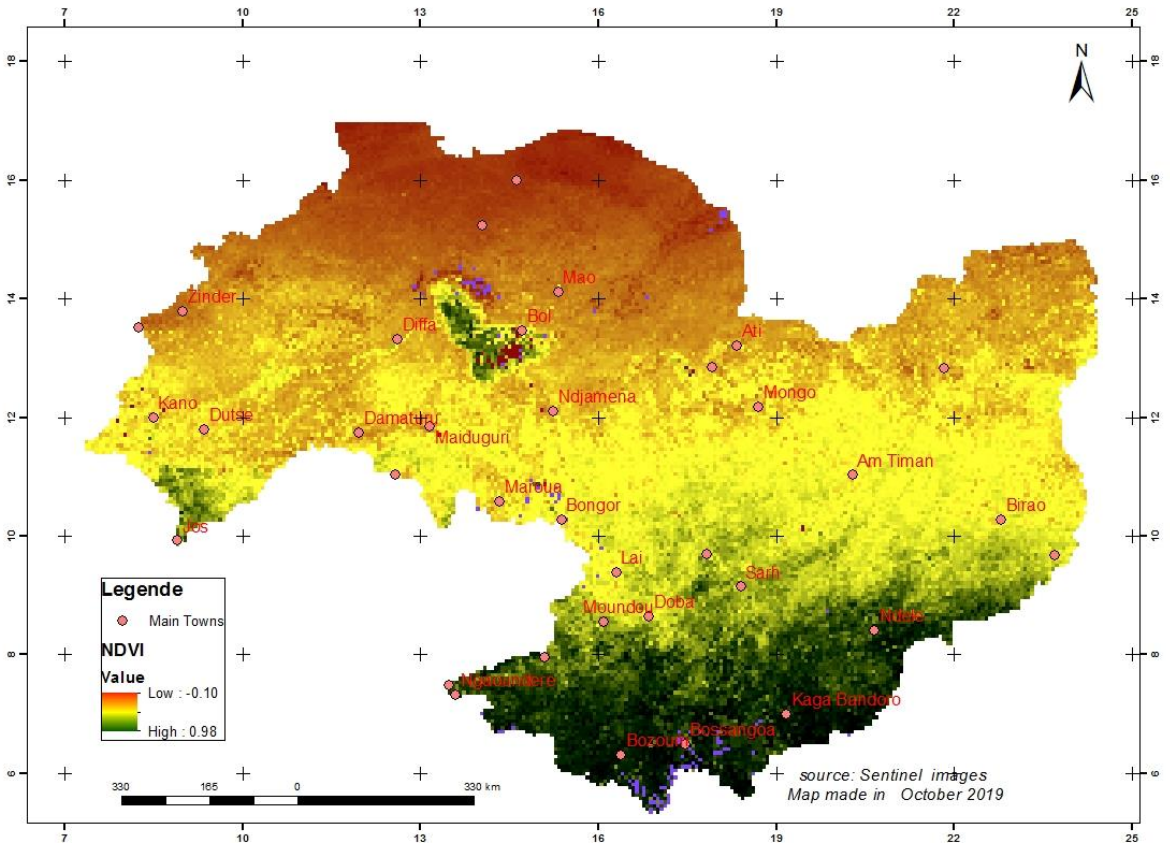


Figure 55: Vegetation cover of the Lake Chad Basin in May 2017

The analysis of Figure 55 shows that the vegetation cover in May 2017 was characterized by dense and healthy vegetation in the southern part of the Basin, in the Jos Plateau in Nigeria and in the swampy areas of Lake Chad. This is due to the start of the rainy season in these areas.

On the other hand, in the north of the Basin the soil is almost bare.

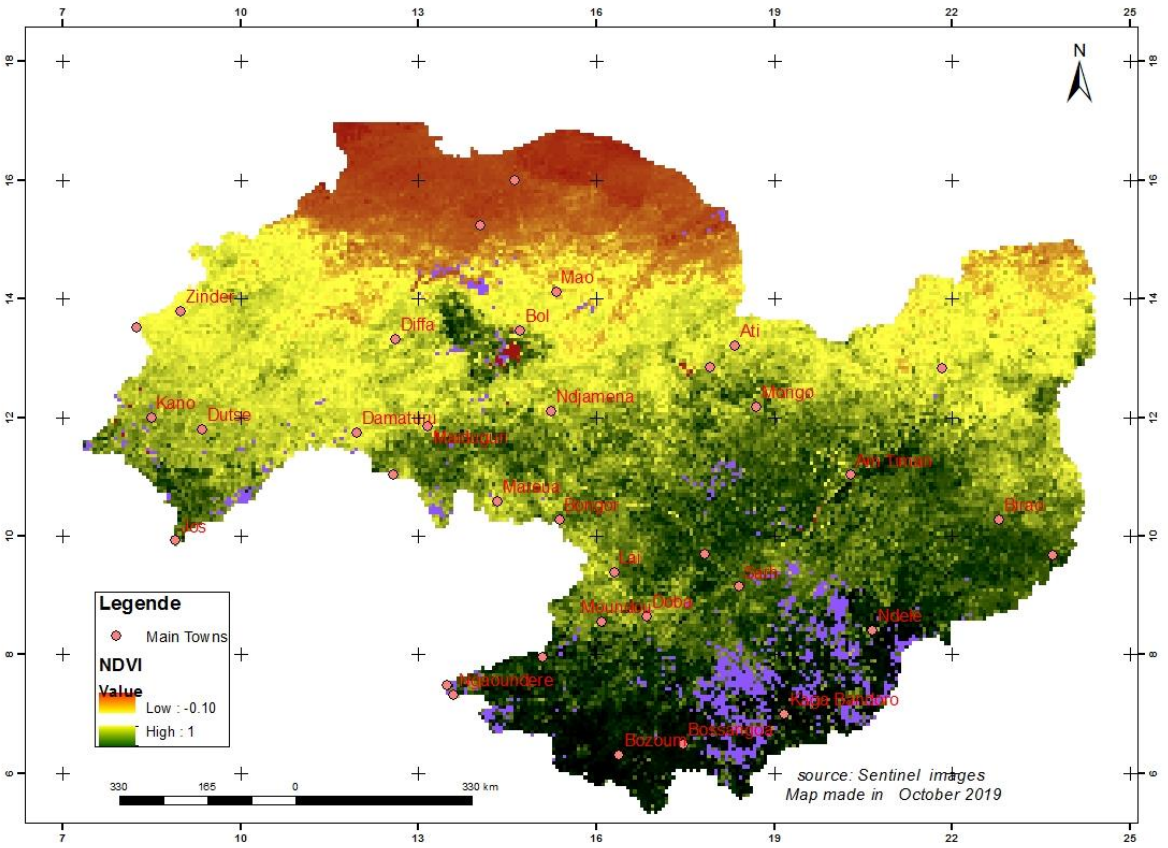


Figure 56: Vegetation cover of the Lake Chad Basin in July 2017

In July 2017 (Figure 56), a large part of the Lake Chad conventional basin has dense vegetation whose density varies from south to north depending on the rainfall received.
Only the northern zone of Mao in Chad and N'Nguigmi in Niger have very bare soil. This is due to the low rainfall in these areas.

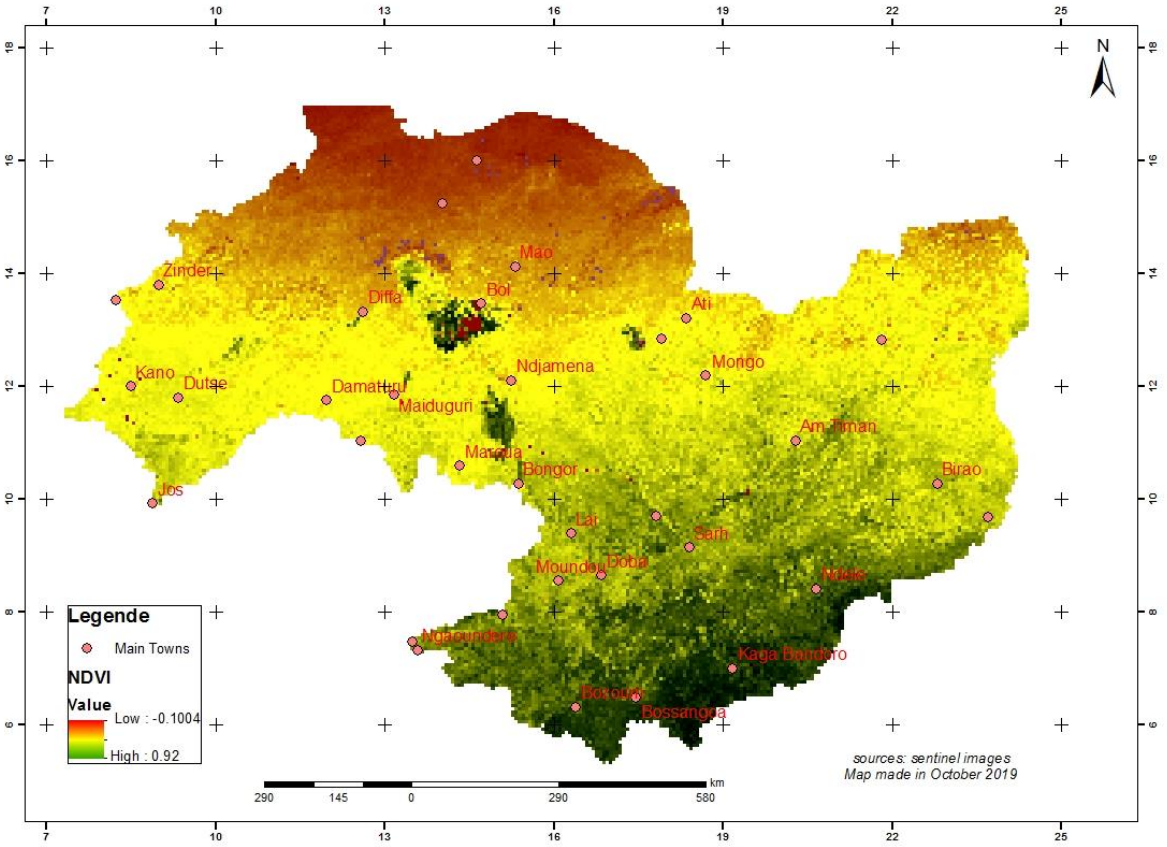


Figure 57: Vegetation cover of the Lake Chad Basin in November 2017

In November 2017, the vegetation cover of the Lake Chad conventional basin is marked by vegetation ranging from dense to nothing as one moves from south to north (Figure 57).
It is worth mentioning here that the Yaéré plain located between Cameroon and Chad has dense vegetation in very good health. This is mainly due to the flooding of the plain by the Logone River at this time of year.

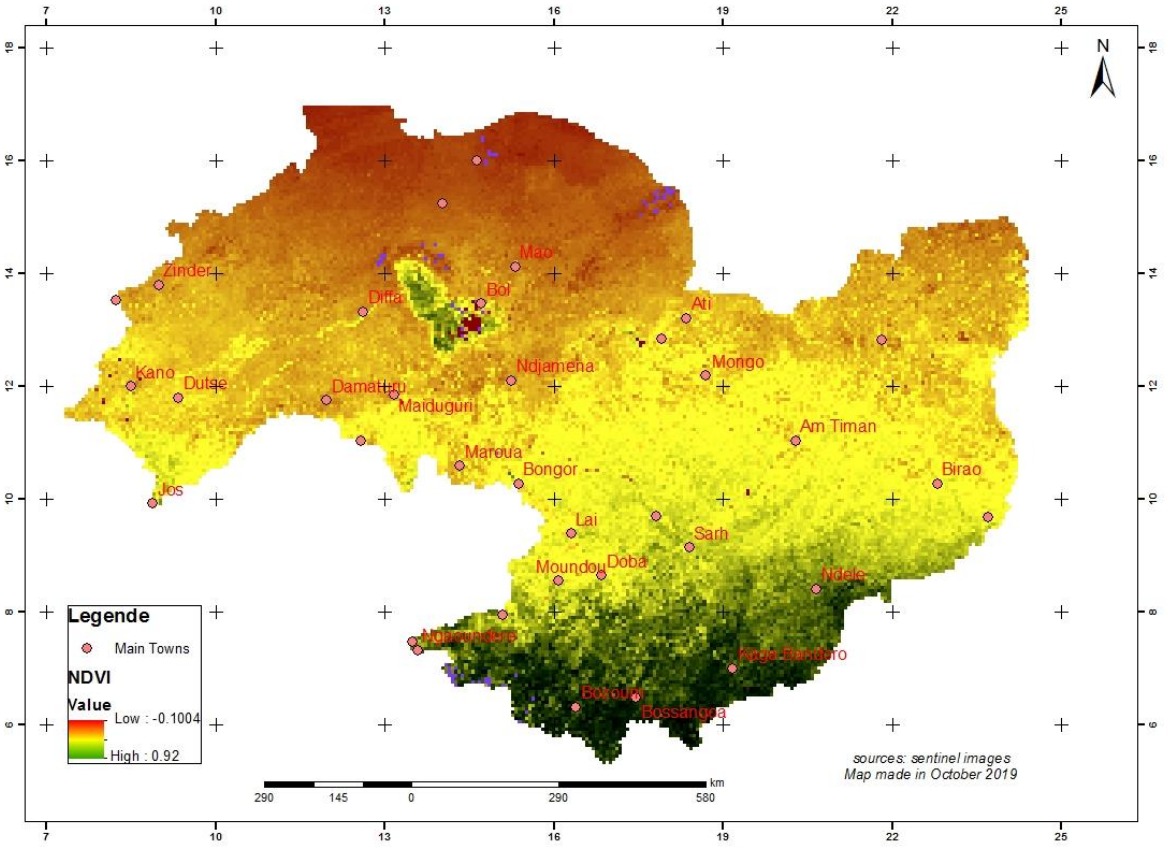


Figure 58: Vegetation cover of the Lake Chad Basin in April 2018

April is a very dry and hot month in the Sahelo-Saharan zone. During this period, vegetation is often characterized by water stress.

In April 2018, the south of the Basin, i. e. Adamaoua (Cameroon), the north of the Central African Republic and the south of Chad (cities like Sarh and Moundou) has a dense vegetation in good health represented in green color on the figure. This is due to the beginning of the rainy season but also due to existing forests in these regions.

However, in the northern part of the Basin, with the exception of the bed of Lake Chad, the soil is almost bare.

4.3.2 Vegetation Extent in 2005 compared to 2015

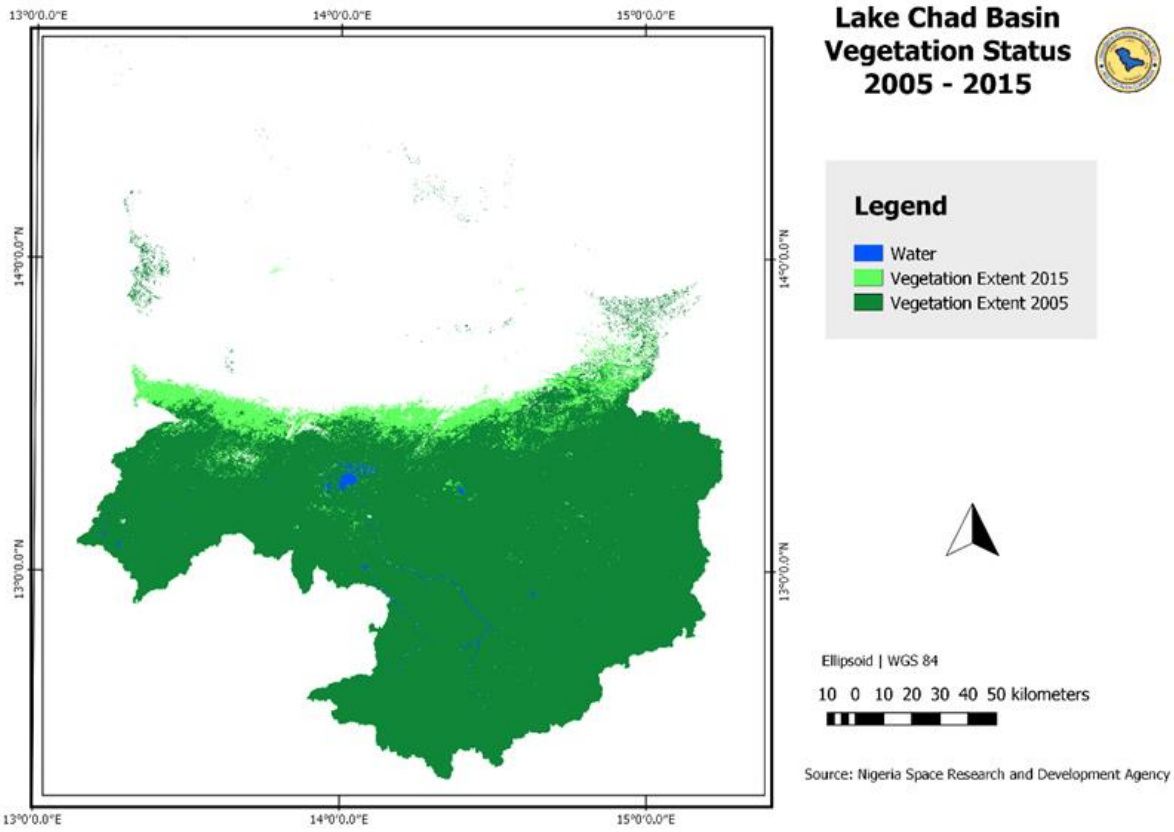


Figure 59: Vegetation extent increase in 2015 compared with 2005 in the Lake Chad Basin.

The Lake Chad Basin in 2015 experienced an increase in vegetation in a belt north of Lake Chad compared with the year 2005. The increase in vegetation in the Sahel generally is attributed to more rainfall compared with the previous decade.

4.3.3 Degradation and Increase of Vegetation

However, anthropogenic declined in vegetation is experienced in 2015 due to movement of refugees from Borno State, Nigeria to new settlements in the north west of Lake Chad between the towns of Diffa and Nguigmi. In the area south to south east of Baga, the observed degradation is as result of the increase of the surface area of the Lake Chad because of rainfalls above average between 2010 and 2012 (Figure 60).

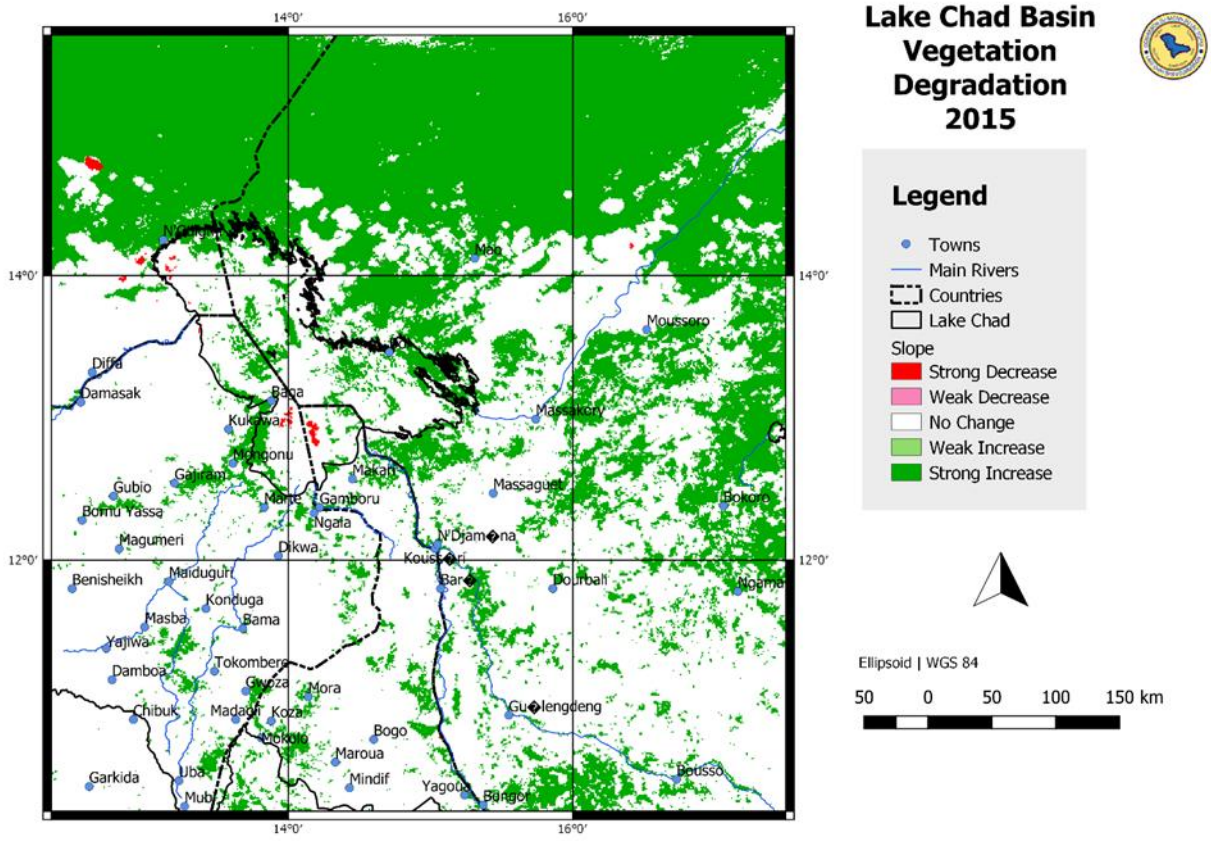


Figure 60: Areas of degradation of vegetation due to new refugee camps between Diffa and Nguigmi and inundation of vegetation in the south basin of Lake Chad.

4.4 Protected Areas / Conservation areas

The protected areas of the Lake Chad Basin play a very important role in protecting biodiversity and economic development in the region. The main roles of the basin's protected areas are to protect biodiversity, maintain ecological integrity and balance, and prevent environmental degradation.
The basin is a biodiversity center in the Sahel and is home to many Ramsar sites, Important Bird Areas (IBAs), classified forests, national parks, national nature reserves, wildlife reserves and biosphere reserves.

According to the availability of information, the purpose of this chapter is to provide, on the one hand, an overview of the basin's biodiversity in terms of species and numbers of individuals and, on the other hand, the conservation status of the main protected areas and other conservation sites in the basin grouped by country and IUCN status.

Table 18: Summary of the main biodiversity areas in the Lake Chad Basin

	Strict Natural Park (IUCN category Ia)		**National Park (IUCN category II)**		**Nature and Wildlife Reserve (IUCN category IV)**		**Ramsar sites**		**IBAs**	
Country	No	Area (km²)	No	Area (km²)	No	Area (km²)	No	Area(km²)	No	Area (km²)
Cameroon	-	-	2	2 145	-	-	2	6125	4	NA
Niger	1	12 800	-	-	2	161 560	4	31489	3	NA
Nigeria	-	-	1	2 300	3	3 274	5	7687	4	NA
CAR	1	843	3	31 050	6	23 853	-	-	1	NA
Chad	-	-	2	3 140	6	109 450	5	122700	5	146490
Total	2	13 643	8	38 635	17	298 137	16	168002	17	-

Source: https://www.ramsar.org ,SOB (www.protectedplanet.net) et http://datazone.birdlife.org

The following figure presents the location of the main biodiversity areas in the basin.

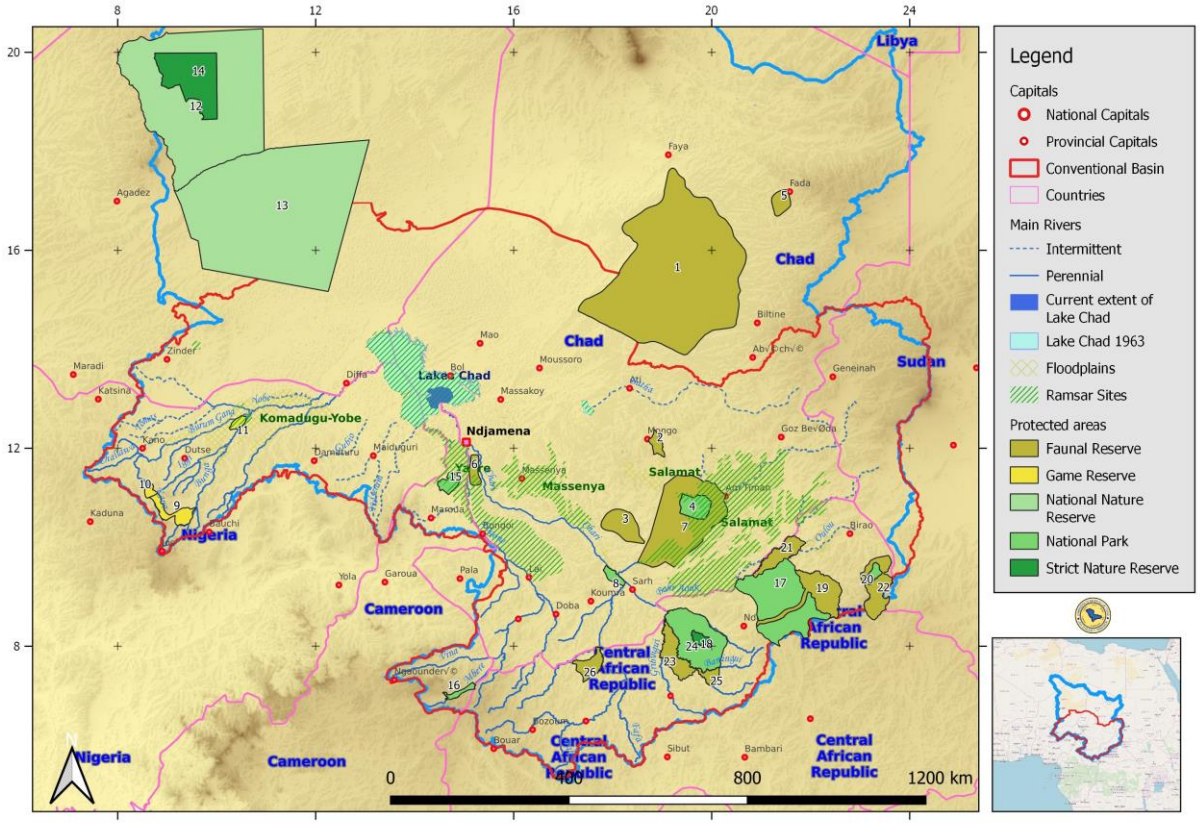


Figure 61: Map of Ramsar sites in the Conventional Lake Chad Basin

The names of the protected areas corresponding to the numbers indicated on the map are given in the following tables.

4.4.1 Strict Nature Reserves

Category Ia: Strict nature reserves
Protected areas that are strictly reserved for the protection of biodiversity and possibly geological/geomorphological features, where human visitation, use and impacts are strictly controlled and limited to ensure the protection of conservation values. These protected areas can serve as essential reference areas for scientific research and monitoring.

Table 19: List of strict nature reserves in the Lake Chad Basin

Country	Site	N° Legend	Status IUCN Ia	Area (km²)	Importance/Threats
Niger	Addax Sanctuary	14	designated	12800	Protection of addax (Addax nasomaculatus), also known as white antelope and screwhorn antelope.
CAR	Vassako-Bolo	18	designated	843	ND

4.4.2 National Parks

Catégorie II : Parc national

De vastes zones naturelles ou à proximité de zones naturelles mises de côté pour protéger les processus écologiques à grande échelle, ainsi que les espèces et les écosystèmes caractéristiques de la région, qui constituent également le fondement de possibilités spirituelles, scientifiques, éducatives, récréatives et touristiques compatibles sur le plan environnemental et culturel.

Table 20: List of nature parks in the Lake Chad Basin

Country	Site	N° Legend	Status IUCN II	Area (km^2)	Importance / Threats
Cameroon	1. Waza	15	Designated	1405	It is a biosphere reserve recognized by UNESCO since 1979. The area is home to an exceptional natural fauna. Originally it was a hunting reserve created in 1934 under the name of Zina-Waza, the park was designated a national park in 1968.
	2. Vallé du Mbéré	16	Designated	740	The park was created in February 2004 with the following objectives: • Protection of water reserves in southern Cameroon and preservation of the picturesque landscapes of the Mbéré Valley. • Ensure the continuity and flow of the Mbéré River. • Promote the development of ecotourism • Protect the habitat of species such as the hippopotamus, African bison and mountain reedbuck. In addition to the highly endangered mountain reedbuck species *(Redunca fulvorufula adamauae)*, there are the olive baboon (Papio anubis), the sitatunga, the defassa waterbuck *(Kobus ellipsiprymnus defassa)* and the harnessed bushbuck (Tragelaphus scriptus). From time to time, kobs *(Kobus kobus)* and roan antelopes *(Hippotragus equinus)* cross the park.
Nigeria	1. Chad Basin	NA	Designated	2300	Chad Basin National Park is a national park located in Borno and Yobe States in Nigeria. The Chad Basin National Park was created in 1991. It consists of three non-adjacent protected areas: Chingurmi-Duguma, Bade-Nguru and Bulatura.

CAR	1. Bamingui-Bangoran	24	Designated	11191	Bamingui-Bangoran National Park is a national park of the island and has been recognized by UNESCO as a biosphere reserve since 1979. It was created in 1993. The Vassako Bolo Strict Nature Reserve is located in the middle of the park. Mammals considered threatened include the Chadian wild dog, the Sudanese cheetah, the Central African lion and the African manatee. According to Spinage, the park's antelope populations have declined considerably since 1960. Amphibians in the park reserve include the Mascarene frog, the pointed-nosed frog, the Schilluk ridged frog, the Galam white-lipped frog, the cryptic sand frog, the ornate frog, the crowned bullfrog, the flat-backed toad, the Senegal running frog, and the swimming frog. The red-headed lovebird is found here and in Gashaka Gumti National Park in Nigeria.
	2. Manovo-Gounda-Saint Floris	17	Designated	18908	Manovo-Gounda St. Floris National Park is a UNESCO World Heritage Site. The most notable species are black rhinoceros, elephants, Sudan cheetahs, leopards, redheaded gazelles, buffaloes, giraffes and lions; a wide range of waterfowl species are also found in the northern floodplains. The site is threatened due to the death of its rare fauna and the disappearance of animal species. The western black rhinoceros that was indigenous to the Central African Republic disappeared in 2011.
	3. André Felix	20	Designated	951	The park shelters a savannah of jungle forests with Bambousa, Isoberlinia and Terminalia. The main species of fauna found are ostriches, buffaloes, crocodiles, elephants, giraffes, hippopotamuses, lions, panthers, wild boars, etc.

Chad	1. Manda	8	Designated	1140	The national park was created to protect populations of giant elands *(Taurotragus derbianus)*. The park population has become extinct, but the species has been preserved in the western region of Goundi. Large mammal populations are at a low level. The presence of the African wild dog *(Lycaon pictus)* is presumed to be safe. During the dry season, the national park is frequented by many livestock, although the vegetation is considered relatively intact. In 1997, surveys of avian fauna were carried out and populations of red-faced pytilia *(Pytilia hypogrammica),* Sahel bush sparrow *(Petronia dentata)*, Gambaga flycatcher (Muscicapa gambagae), white-collared starling (Grafisia torquata), purple starling (*Lamprotornis purpureus*), blackcap babbler (*Turdoides reinwardii*), Senegal eremomela *(Eremomela pusilla)*, rufous cisticola *(Cisticola rufus)*, yellow penduline tit *(Anthoscopus parvulus)*, black-breasted barbet *(Lybius rolleti)* and red-throated bee-eater *(Merops bulocki)* were found.
	2. Zakouma	4	Designated	3000	Since 2006, the national park has been part of the Ramsar Area of the Bahr Aouk and Salamat Floodplains, which is one of the largest protected areas of its kind in the world. 226 bird species have been recorded in the park. The most important are the black crowned crane (in winter), the Niam-Niam parrot, the green-fronted bee-eater, the “sillon à poitrine noire”, the “alouette sole”, the redheaded cisticola, the shining starling, the Gambaga flycatcher (in breeding season), the Heuglin's masked weaver and the grey waxbill. Zakouma National Park will also be home to larger populations of pelicans. In August 2006, environmentalists discovered 100 elephants poached in a small plane. From 2006 to 2008, the number of elephants declined from 3000 to about 1000, and some park rangers were also killed by poachers. Since the takeover of the park by the non-profit organization African Parks, poaching has decreased considerably, and elephant populations are recovering.

Source www.protectedplanet.net and Wikipédia

4.4.3 Nature and Wildlife Reserve

Category IV : Habitat and Species Management Area
Protected areas aimed at protecting particular species or habitats and management reflect this priority. Many Category IV protected areas will require regular and active interventions to meet the needs of particular species or to maintain habitats, but this is not a requirement of the category.

Table 21: List of nature and fauna reserves in the Lake Chad Basin

Country	Site	Nr Legend	Type	Status IUCN IV	Area (km²)	Importance/Threats
Niger	1. Aire et Ténéré	12	Nature reserve	Designated	64560	The Aïr and Ténéré National Nature Reserve was created on 1 January 1988. It includes several overlapping reserve designations and was designated a UNESCO World Heritage Site in 1991 and a Site in Danger in 1992. It has been identified by Bird Life International as an important area for birds.
	2. Termit-Tintoumma	13	Nature and Culture Reserve	Designated	97000	The habitat of the reserve is isolated, these are conditions that have contributed to the creation of the rich congregation of desert wildlife. Many endangered species on the IUCN Red List, such as addax, dama and dorcas gazelles, Sudan cheetah, Barbary sheep and striped hyena, survive in large numbers. Bustards, of Nubian and Sudanese species, as well as turtles (for example African spurred tortoise in the desert) are also present in large numbers; vultures, small carnivores, including canids (such as fennec, pale fox, Rüppell's fox and African golden wolf) and small species (Sahara sand cat and African wildcat), are also reported in this reserve. Several hundred dama gazelles are noted here. Although the slender-horned gazelle has already been reported here, it was not known in 1999 whether it was still present in the region. The Saharan cheetah is said to be very few in number, about ten. They have adapted to the scorching heat of the Saharan desert and can survive without a sustainable water source. Barbary sheep are also found there.

Nigeria	1. Falgore	10	Game Reserve	Designated	920	The Falgore Wildlife Reserve preserves floral savannah wildlife species in their natural habitat. However, one of the main objectives of the reserve is to serve as a regulator of siltation and sedimentation that threatens the Tiga Dam, which is the backbone of the Kano River project. The villages around the Falgore reserve believe that it offers them a good microclimate and protects them from destructive windstorms.
	2. Lame Burra	9	Game Reserve	Designated	2057	ND
	3. Baturiya Wetlands	11	Game Reserve	Designated	297	On 30 April 2008, it was included in the Ramsar Convention's list of wetlands of international importance. The Baturiya wetlands are particularly important for native birds, particularly waterfowl, and for migratory birds in the northern hemisphere, which use these wetlands as resting and wintering areas. Native breeding birds include the pink-backed pelican *(Pelecanus rufescens)*, great white pelican *(Pelecanus onocrotalus)*, yellow-billed stork *(Mycteria ibis)*, knob-billed duck *(Sarkidiornis melanotos)* and African grey hornbill *(Tockus nasutus).* In 2001, 197,535 waterbirds were counted in the Baturiya wetland area. Many African mammals live in wetlands, including the endangered African wild dog *(Lycaon pictus)*. Other major predators are lions *(Panthera leo)*, striped hyenas *(Hyaena hyaena)*, spotted hyenas *(Crocuta crocuta*), leopards *(Panthera pardus)*, African golden wolves *(Canis anthus)* and side-striped jackal *(Canis adustus)*. They hunt red-fronted gazelles *(Eudorcas rufifrons)*, waterbucks (Kobus ellipsiprymnus), African buffalo *(Syncerus caffer)* and bohor reedbuck *(Redunca redunca)*. Primates in this region include the hamadryas baboon (*Papio hamadryas*), the patas monkey *(Erythrocebus patas)* and the African green monkey *(Chlorocebus aethiops)*.

RCA	1. Yata - Ngaya	22	Fauna reserve	Designated	5404	ND
	2. Ouandjia -Vakaga	19	Fauna reserve	Designated	7233	ND
	3. Gribingui-Bamingui	23	Fauna reserve	Designated	4321	ND
	4. Nana-Barya	26	Fauna reserve	Designated	2313	The reserve is a protected area located in the north of the country near the Chadian border. It was created on 11 December 1953 with the aim of protecting large fauna
	5. Koukourou -Bamingui	25	Fauna reserve	Designated	1131	ND
	6. Aouk-Aoukale	21	Fauna reserve	Designated	3451	ND

Tchad	1. Abou Telfane	2	Fauna reserve	Designated	1100	It was created in 1955.
	2. Fada Archei	5	Fauna reserve	Designated	2110	It was created in 1967. Its primary purpose was to protect the Barbary sheep *(Ammotragus lervia)*, and considered as a poor ecosystem with vegetation mainly composed of acacias and balanites on the banks of the wadis. The bird species recorded consist of 13 species of the Sahara-Sindian biome and 10 species of the Sahelian biome. The mammalian species observed in the threatened category are *Panthera leo senegalensis* (CR), *Acinonyx jubatus soemmeringii* (VU), *Addax nasomaculatus* (CR), *Ammotragus lervia* (VU) and *Gazella dorcas* (VU). The aquatic fauna recorded in the water bodies of the reserve is composed of 16 endemic fish species. Some of these species are the blackstripe barb, the redbelly tilapia *(Coptodon zillii)* and the *Labeo tibestii*.
	3. Siniaka Minia	3	Fauna reserve	Designated	4260	The Siniaka-Minia Wildlife Reserve was established in 1965 as an IUCN Category IV area because of its importance for the preservation of the black rhinoceros.
	4. Mandelia	6	Fauna reserve	Designated	1380	The Mandelia Wildlife Reserve in Chad was declared a reserve in 1969. The fauna is composed of mammals, including the elephant (there were 660 at the beginning when the reserve was classified by the Canada Gazette). Larger mammals such as elephants and kobs that had migrated to Cameroon would return to Chad due to hunting pressure in that country.

	5. Ouadi Rimé – Ouadi Achim	1	Fauna reserve	Designated	80000	It was created in 1969, with 80,000 km², it is one of the largest reserves in the world. The wildlife species observed are dama gazelle (*Gazella dama*, EN), dorcas gazelle (*Gazella dorcas*, VU), red-fronted gazelle (*Gazella rufifrons*, VU), Northeast African cheetah (*Acinonyx jubatus soemmeringii*, VU) and addax (*Addax nasomaculatus*, VU) but the presence of the latter two species is currently at risk. The scimitar oryx had its last stronghold in this reserve before dying out in the wild. Subsequently, a reintroduction programme selected Ouadi Rimé-Ouadi Achim to reintroduce the species; as a result, since 2016, a small herd has been living in the reserve. The reported avian fauna includes 267 bird species and three species from the Sudano-Guinean savannah biome. During the rainy season, migratory Palearctic waterbirds arrive into rivers in large numbers.
	6. Bahr Salamat	7	Fauna reserve	Designated	20600	The reserve takes its name from the Bahr Salamat River, which flows through the reserve and is an important source of water for the animal species that live there. Bahr Salamat Wildlife Area was designated in January 1964. The Bahr Salamat Wildlife Reserve offers an important wetland area favorable to integrated rural development and conservation. The most common animal species in this reserve are antelopes, giraffes, Nile crocodiles and birds such as ostriches.

4.4.4 Ramsar Sites

These sites have acquired a new national and international status. They are recognized as being very important not only for the country or countries in which they are located, but also for all humanity. The table below summarizes the Ramsar sites in the basin, their extent, importance and threats.

Table 22: List of Ramsar sites of the Lake Chad Basin

Country	Sites	Significance	Threats
CHAD	1. Chadian portion of the Lake Chad	Supports internationally important numbers of waterbirds and is essential for some 150 fish species and is the only place in the country that supports the endemic Kouri Ox, which is threatened by extinction through interbreeding.	Desiccation and sanding over are seen as the main threats.
	2. Lake Fitri	It supports a productive fishery and extensive seasonal grazing. Habitat is of international importance for wintering Palearctic waterbirds and as drought refuge for Afrotropical species and elephants	Deforestation, over exploitation of natural resources are considered the main threats to the site.
	3. Bahr Aouk and Salamat Floodplains	The site One of Africa's largest wetlands and plays a very important role for the surrounding wildlife, providing breeding grounds for several migratory waterbirds and supporting hippos, leopards, elephants and different antelope species. It also is a spawning and nursery ground for several fish families, and plays a role in flood control, groundwater recharge, sediment trapping and chemical regulation of the waters.	The main threats to the site arise from poaching, oil exploration, overgrazing, illegal fires and contamination by pesticides.
	4. Logone Floodplains and Toupouri Depressions	One of Africa's largest wetlands, characterized by a succession of rivers, lakes, floodplains and permanent and temporary ponds. The different ecosystems support typical faunal and floral associations, among which are some locally threatened plant species such as the African Palmyra palm and the Néré (Parkia biglobosa). The site also hosts important Occidental Palearctic and Ethiopian migratory species such as the Black Crowned-Crane, the Spur-winged Goose and Dendrocygna species. The floodplains also	Deforestation, poaching, water extraction, pesticide pollution and oil extraction are some of the threats arising from within the site, while irrigation, oil mining and cement production threaten the site's integrity from outside.

		play an essential role in providing spawning and nursery sites for numerous fish families	
	5. Massenya Plain	It plays several roles such as flood control, sediment capture, groundwater renewal, etc. Various endangered species that also attract tourists are present, e.g., the African elephant, leopards, the Nile crocodile, and others. There are 386 species of birds noted in the area, as well as numerous fish species.	The main threats are deforestation, high concentrations of livestock, bush fires, over-fishing practices, poaching and lack of personnel with technical capabilities to ensure proper management practices.
CAMEROON	6. Camerooni an part of Lake Chad	Support over 200, 000 birds and various other fauna and flora of the region such as the endangered species like the African Clawless Otter, Red Fronted Gazelle and the African Bush Elephant among others. Of note is the use of the site as a refuge by hippopotamuses and the Nile crocodile during the dry season.	The site is recognized, however, as one of the most affected areas as a result of the challenges posed by climate change and localized threats of overgrazing, water pollution, invasive species, excessive use of pesticides, etc.
	7. Waza Logone Floodplain	Said to represent 10% of the surface area of major inland wetlands in West African Sahel, is home to more than 100,000 people who depend upon wetland products for fishing, seasonal grazing, and agriculture. A 2001 census counted more than 320,000 waterbirds from 104 species, and there is a huge concentration of wildlife, particularly in the parks, including large mammals such as elephants, ostriches, giraffes, lions, and many others.	Two decades of poor rainfall and the construction of the Maga Dam in 1981 for rice irrigation caused severe disruption to the ecological character of the floodplain, but an important rehabilitation project, begun in 1988 and a collaboration among IUCN, the governments of Cameroon and the Netherlands, and the CML of Leiden University with contributions from other institutions such as WWF and the EC, has shown good results in demonstrating the feasibility of the partial rehabilitation of the floodplain.
NIGER	8. Lassouri Pond	A semi-permanent wetland, part of Lake Chad's catchment, which during the dry season separates into a string of shallow ponds with good water quality. The area has dense woody vegetation which is rarely found in the Sahel, characterized by *Acacia nilotica*, *Acacia albida* and *Mitragyna inermis*. It is an important refuge for waterbirds and regularly hosts an average of 23,000 birds, with especially significant proportions	The area is threatened by overgrazing, illegal logging and sand deposition caused by water and wind erosion

		of white-faced whistling duck *Dendrocygna viduata* and comb duck *Sarkidiornis melanotos* in addition to egrets, terns, ducks, herons, sandpipers and harriers.	
	9. Nigerien portion of Lake Chad	The Nigerien portion is extremely rich in biodiversity, with many migratory birds but also 120 species of fish. The rich bird life includes the Northern pintail (*Anas acuta*), garganey(*Anas querquedula*), gull-billed tern (*Gelochelidon nilotica*), reed cormorant (*Microcarbo africanus*), ruff (*Philomachus pugnax*) and marabou stork *(Leptoptilos crumenifer).*	In this arid or semi-arid environment, the supply of water depends upon the rainfall across the wider catchment, which fluctuates and has generally not been favorable in recent years. Fish catches have declined significantly in recent decades despite very recent positive trends. Traditional nomadic livestock practices could contribute to desertification and require improved management.
	10. Gueltas and Oasis de l'Air (not visible in the map, since it is located outside the conventional basin)	Hosts a number of endangered species such as the vulnerable cheetah, Barbary sheep and Dorcas gazelle, as well as the critically endangered addax (*Addax nasomaculatus*). 290 species of flowering plants and 150 bird species have been counted at the Site, including permanent residents and Palearctic migrants. They include grey heron (*Ardea cinerea*), dark chanting goshawk (*Melierax metabates*), Egyptian vulture (*Neophron percnopterus*), spotted eagle-owl (*Bubo africanus*) and white stork (*Ciconia ciconia*).	Desertification, combined with anthropogenic pressures, is changing the area's ecology and consequently its ability to support both animal and human populations.
	11. Oasis of Kawar (not visible in the map, since it is located outside the conventional basin)	It is one of the last remaining areas in Niger where different varieties of productive and prized date palms (*Phoenix dactylifera*) can be found. It is a refuge for a range of mammals including the Cape hare *Lepus Capensis*, the golden jackal *Canis aureus*, the vulnerable Dorcas gazelle *Gazella dorcas* and the Barbary sheep *Ammotragus lervia*.	This biological diversity is potentially threatened by oil exploration and the phenomenon of climate change.
NIGERIA	12. Lake Chad Wetlands in Nigeria	The major vegetation types include grasses, sedges, floating macrophytes, and shrubs, which form important habitats for a great variety of Palearctic migrating waterbirds, including the vulnerable Marbled Teal.	Threats to the site include recession of lake waters due to climatic influence and upstream dam construction, and the consequent continuing desiccation of the wetlands.

	13. Nguru Lake (and Marma Channel) Complex	A Sahelian floodplain and lake which qualifies under the representative Criterion (embodying all of the diverse flora and fauna of both the Sahel and Sudan), the 20,000 waterfowl Criterion for at least three species (Philomachus pugnax, Anas querquedula, and Dendrocygna viduata), and the fish Criteria (with some 20% of the fish variety of the Lake Chad Basin and about 1% of all fish caught in inland freshwater bodies in Nigeria	Grazing, cultivation, and fishing are increasingly causing pressure. The spread of invasive Typha grass, taking over flood rice and cassava fields, blocking river channels, and undermining fisheries, is seen as a major problem.
	14. Dagona Sanctuary Lake	The site supports over 25 bird species and is one of the most important sites in the Hadejia-Nguru wetlands for wintering Palaearctic and inter-African migrant waterbirds. It also provides a breeding site for the Grey heron and Little Egret.	Grazing and collection of wild resources are practiced by the local population
	15. Baturiya Wetland	A good example of a natural wetland of the Sudano-Sahelian biogeographical region, It supports a great diversity of flora and fauna and is particularly important for its waterbirds. A wide range of resident and migratory waterbirds depend on this wetland - the Yellow billed stork, Knob-billed goose, African Grey Hornbill, etc.	A large population of over 10,000 inhabitants living in the surrounding villages depends on the wetland's resources for their livelihood. They practice agriculture, fishing and general harvesting of resources.
	16. Maladumba Lake	The wetland has a unique assemblage of plant and animal species that are important for the maintenance of biological diversity. It supports a large number of migrant bird species such as the Grey Heron, white-necked stork, Green Fruit Pigeon, etc.	Rapid siltation is a growing threat.
Sources: https://www.ramsar.org/wetland/s			

4.4.5 Zones importantes pour la conservation des oiseaux (ZICO)

Key Biodiversity Areas (KBAs) are sites that contribute to the maintenance of a global biodiversity and vital habitats for threatened plant and animal species in terrestrial, marine and freshwater ecosystems. Important Bird Areas (IBAs) are specific KBAs identified for birds based on internationally agreed criteria applied locally by the NGO Birdlife.

4.4.5.1 Chad

There are 8 IBAs in Chad out of which 5 are in the Lake Chad Basin as follows;

- ✓ Lake Chad
- ✓ Lake Fitri
- ✓ Manda National Park
- ✓ Ouadi Riné-Ouadi Achim
- ✓ Zakouma National Park

There are 16 globally threaten species (IUCN Red List) including

- ✓ Black crowned-Crane
- ✓ Sociable Lapwig
- ✓ White-headed vulture
- ✓ Marbled Teal

In total, Chad IBAs is host to 524 bird's species

4.4.5.2 Cameroon

There is a total of 33 IBAs in Cameroon out of which 4 sites are in the Lake Chad Basin:

- ✓ Kalamaloué National Park
- ✓ Lake Maga
- ✓ Waza National Park
- ✓ Logone floodplain

There are 30 globally threaten species on the IUCN Red List, including:

- ✓ Marbled Teal
- ✓ Yellow-casqued Hornbill
- ✓ Black Crown-crane

Of importance, Cameroon IBAs host 885 bird species and is home to 7 endemic species and 2 endemic bird areas.

4.4.5.3 Niger

There are a total of 16 IBAs in Niger out of which 3 sites are in the Lake Chad Basin:

- ✓ Lassouri-Karandi Wetland
- ✓ NNR Air Ténéré
- ✓ Tarmit Mountains

There are 14 globally threaten species on the IUCN Red List. Niger IBAs host 436 bird species

4.4.5.4 Nigeria

There is a total of 27 IBAs in Nigeria out of which 4 sites are in the Lake Chad Basin:

- ✓ Chad Basin National Park

- ✓ Falgore and Lame Burra Game Reserve
- ✓ Hadejia Nguru Wetland
- ✓ Sambissa Game Reserve

There are 24 globally threaten species on the IUCN Red List, including

- ✓ Marbled Teal
- ✓ Yellow-casqued Hornbill
- ✓ Black Crown-crane
- ✓ White-faced vulture
- ✓ Northern Ground-hornbill

Of importance, Nigeria IBAs host 864 bird species and is home to 4 endemic species

4.4.5.5 Central African Republic

There are a total of 8 IBAs in CAR out of which 1 is in the Lake Chad Basin;

- ✓ Bozoum

Based on the IUCN Red List, there are 30 globally threaten species including

- ✓ Sociable Lapwing
- ✓ Egyptian vulture
- ✓ White-faced vulture

Table 23: List of globally threaten and endemic species detected in the IBAs located in the Lake Chad Basin

Country	**Number of IBAs**	**Number of IBAs in the basin**	**Number of bird species**	**Number of globally threatened species**	**Endemic species**
CHAD	8	5	524	16	-
CAMEROON	33	4	885	30	7
NIGER	16	3	436	14	-
NIGERIA	27	4	864	24	4
CAR	8	1	-	6	-

4.4.6 Species inventory and survey (Number of individuals per species)

4.4.6.1 Cameroon

Wildlife in Mozogo-Gokoro National Park

The wildlife observed in the Park very recently consists of mammals from the following groups:

- **Artiodactyla :**
  - Common duiker;
  - Harnessed bushbuck;
  - Thomson's gazelle;
  - Warthogs…
- **Primates:**
  - Baboon;
  - Green monkey;
  - Patas monkey…
- **Carnivorans:**
  - Genet;
  - Gamète;
  - Malabar large-spotted civet;
  - White-tailed mongoose
  - Spotted hyena…
- **Rodents:**
  - Porcupine;
  - Squirrels
  - Brown hare…
- **Many reptiles:**
  - Tortoises;
  - Savannah monitor;
  - Python canin
- **Insectivores:**
  - Aardvark …

Several amphibians and invertebrates are also present. An ornithological report indicates the presence of a varied birdlife, with 114 species, some of which could be inferred to the site (MINEF 2000, Anonymous 2011).

4.4.6.2 Chad

Table 24: Waterbird census in Zakuma and Lake Fitri (DCFAP 2018)

	Name of species																																					
Name of site	Grande aigrette	Héron cendré	Héron mélanocephale	Héron garde boeuf	Héron garzette	Héron crabier	Grue couronnée	Oie de gambie	Oie d'égypte	Jacana	Dendrocygne veuf	Dendrocygne fauve	Sarcelle d'été	Sarcelle d'hiver	Canard souchet	Canard pilet	Canard casqué	Ibis sacré	Ibis falcinelle	Ibis hagedash	Spatule d'Afrique	Héron pourpré	Vanneau du sénégal	Vanneau éperonné	Marabout d'Afrique	Tantale ibis	Pelican gris	Chevalier sylvain	Chevalier guignette	Chavalier aboyeur	Chevalier combattant	Chevalier stagnatile	Chevalier arlequin	Becasseau minute	Bec ouvert	Jabiru du sénégal	Ombrette d'Afrique	Glareole à collier	Becassine des marais	**Total**
Machtour	3	4	2	18	1	1	138	278	138		27		35				2	6	1		17		13	4		2		8	9	7	4	20	211	23	18					**990**
Koubouch		2		2		10			2									1		2			2					3	1		5	5		2						**37**
Antigua		1		2		5			5	1	1							1		4								7	3			12					3		1	**46**
Dalaa	1	2				8							3							1											3	3	1							**22**
Fatagoki		1	6	14					3									1		3								2			6		4	5						**45**
Bahr Djourf		2		1			2											1		1						1		1							5					**14**
Adeleye		1	21	50		36	6											2										2			6									**104**
Nome		4	19	66		4	10	213									49	32	24	9			6									1			8					**445**
Dikéré	12		24	104	30	13	181	9	67	4	340		15				91	44	18		31		12	3		12		30	6	5	10	12	12	9		12	2			**1108**
Tourdo Assala	2		52								54				17		18			23			16					14												**196**
Amdouma	12	52	278	752	13	130	4052	3420	2814	85	4562	53	75	14	152	9	841	253	105	56	50	23	47	34	6	64		96	5		574	40	63	12	10	12	7	320		**19091**
Al Ham	48	3	13	56		13		385		7								63				2		1				3				2					2			**598**
Kouba		1	2	30		2	3																2					3							4					**394**
Rigueik	220	155	418	3826	11	63	1161	663	691	14	2625		3934	700	375	935	511	618	224	10	149	162	22	14		184	2500	106		13	215	81	151	234		52		1873	5	**22915**
Tororo	16		2	12	1	18					325						17		2									20			34									**447**
Ardeba	7		9	20		12	10											21										12			230									**321**
Machtoura	1		3	10			4	14		2								44				2						2			66						1			**148**
Kolol	12	2		14	56		5		7		4	50	10					41			9								32	4			1	2	8					**257**
Am Kalam			10	86	11	41	120	320	54			13	5				24		5	4					2		45				58				1					**754**
Biherat	4	5	15	312	3		64	123	4		1835		246	52			67		13		78							25			62		4	6						**2857**
Am kreko			81	4	1		952	1925	18												20				83										53					**4089**
TOTAL	**338**	**235**	**955**	**5379**	**127**	**356**	**6708**	**7350**	**3803**	**110**	**9773**	**116**	**4323**	**766**	**544**	**944**	**1620**	**1089**	**392**	**113**	**354**	**189**	**120**	**56**	**91**	**327**	**2545**	**330**	**56**	**29**	**1273**	**176**	**447**	**293**	**103**	**80**	**15**	**2193**	**6**	**53186**

4.4.6.3 Niger

Table 25: Species and number of individuals recorded in Niger (RNNTT 2017)

Observed species	**Number of individuals**
Addax (*Addax nasomaculatus*)	23
Dama gazelle (*Nanger dama*)	53
Barbary sheep (*Ammotragus lervia*)	11
Dorcas gazelle (*Gazelle dorcas*)	1530
Sahara Cheetah (*Acinonyx jubatus*)	0
Lappet-faced vulture	64
Rüppell's vulture	8
Egyptian vulture	4
Nubian bustard	199
Arabian bustard	8
Golden jackal	6
Fennec	23
Cape hare	25
African spurred tortoise	3
Squirrel	1
African wildcat	1
Caracal	1

4.4.7 Ongoing Conservation Initiatives and Achievements

4.4.7.1 Black Rhinos Reintroduction in Chad

An unprecedented collaboration between the South African and Chadian Governments, SANParks and African Parks, has enabled the translocation of critically endangered black rhinos from South Africa to a secure park in Chad in May 2018, reintroducing the species to the country after almost fifty years of local extinction. The relocation of the rhinos from South Africa was intended to safeguard the species by expanding its geographic distribution, restore Zakouma's ecosystem and boost tourism to the 3,049 square-kilometer park (African Parks 2018).

4.4.7.2 Reintroducing Scimitar-Horned Oryx to Chad

Chad's Ouadi Rimé-Ouadi Achim Game Reserve was the last major stronghold of scimitar-horned oryx, which was classified Extinct in the Wild by the IUCN in 2000.
In March 2016, the first group of captive-bred oryx was flown from Abu Dhabi to Chad. The oryx were initially released into a large fenced area containing natural vegetation to allow them to acclimatize to their new habitat in a secure area. In August 2016, after the rainy season had begun and the grasslands were at their most abundant, 21 oryx were released into the wild. During the six months following the release, the first group, which is composed mostly of young animals, ranged over 55km from the release site, remaining close together.
In late January 2017, the second phase of the reintroduction programme was initiated, with a further group of 14 oryx being released into the reserve. In the first few days following their introduction, the oryx were recorded as grazing calmly close to the release site and are expected to follow their predecessors into the further reaches of the reserve (Sources: Zoological Society of London 2019).

4.4.7.3 Addax Conservation

Formerly found in great numbers over immense arid areas, addax populations have crashed to less than one hundred individuals in isolated pockets since the advent of modern weapons and transport, and more recently oil exploration and civil unrest. Today, the addax is the most threatened ungulate in the Sahara and quite possibly the world and is listed as Critically Endangered on the IUCN Red List.
Over the past decade, the Sahara Conservation Fund (SCF) and its partners have been monitoring this tiny meta-population and helping Chad and Niger's wildlife service's ensure its protection.
The first priority is to prevent the loss of more animals from the wild by ensuring effective protection from poaching at key sites and also extending protection to habitat, notably by identifying areas of habitat known to be important to the addax and establishing disturbance-free zones there that limit or exclude human activities (Sahara Conservation Fund 2019).

5. Socio-economy and Food and Nutrition Security

5.1 Number of Population and Human Development Index

The population growth rate varies between 2.5 and 5.5% per year depending on the country. For Nigeria, the population is estimated 196 million in 2018 (FAO STAT). The birth rate is very high (5.5%) and demographic projections anticipate significant population growth in the future. This rate is explained by the rapid urbanization of regions such as Kano or Maiduguri. Chad follows Nigeria's lead with a birth rate of 3.3% and 11 million inhabitants according to the latest general population and housing census of 2009. Niger has the highest population average growth after Nigeria, 3.9% per year (estimated between the general population census of 2001 and the census of 2012). It has even increased over the past decade.
In Cameroon, the annual growth rate is 2.8% with an estimated population of more than 20 million in 2018 (BUCREP 2010b). The population of the Central African Republic is estimated at more than 5 million inhabitants with a growth rate of 2.5% (RGPH 2003).

The Human Development Index (HDI) was created to emphasize that people and their capacities should be the ultimate criteria for assessing a country's development, not just economic growth.

The HDI is a synthetic measure that assesses a country's long-term progress in three fundamental dimensions of human development: a long and healthy life, access to knowledge and a decent standard of living. A long and healthy life is measured by life expectancy. The level of knowledge is measured by the average number of years of education among the adult population, i.e., the average number of years of education received over a lifetime by people aged 25 and over. Finally, access to learning and knowledge is measured by expected years of schooling for school-age children, which is the total number of years of schooling to which a school-age child can expect to have access to if current trends in the age-specific enrollment rate remain the same throughout their lives. The standard of living is measured by gross national income (GNI) per capita expressed in 2011 international constant dollars converted using purchasing power parity (PPP) conversion rates.

In 2017, the LCBC member country with the highest HDI is Cameroon with 0.556 (which places the country in the category of medium human development countries). Cameroon ranks 151st out of 189 countries and territories. It is followed by Nigeria with an HDI of 0.532, 157th in the ranking and placed in the category of low human development countries. In Chad, the HDI is 0.404, which also places the country in the category of low human development countries and 186th in the ranking. The Central African Republic and Niger occupy respectively the penultimate and last position in the ranking with an HDI of 0.367 and 0.354 (UNDP 2019).

5.1.1 Cameroon

The demographic situation in the three provinces of the Cameroon's Far North Region is still growing steadily. According to the latest census in 2005, the growth rate is 2.8% (between 1987 and 2005), which would double the population every 27 years (BUCREP 2010b).
Although demographics vary by ethnic group, the growth rate is expected to remain relatively higher in the Far North than in Cameroon's Far South. However, while fertility rates are higher in the North, infant mortality rates are also higher. In the Far North more than elsewhere, the number of children is considered a source of economic income and corresponds to the expressed demand of women (Directorate of Statistics and National Accounts of Cameroon, 1999). Even if, according to demographers, the birth rate was to gradually decline with the

increasing urbanization of societies, this growth will remain rapid over the next two decades (according to the Central Bureau of Censuses and Population Studies (BUCREP 2010a)).

Adamaoua

Table 26: Distribution of the population by sex and age for Adamaoua in 2015 (published projection (BUCREP n.a.)) and for the current year 2018 (estimated by LCBC)

Cameroon	Year 2015				Year 2018 (growth rate 3.2 %[1])			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Adamaoua	0-4	107718	107084	214802	0-4	118393	117697	236090
	5-9	95262	93203	188465	5-9	104703	102440	207143
	10-14	79476	76154	155630	10-14	87352	83701	171054
	15-19	67240	72426	139666	15-19	73904	79604	153508
	20-24	51736	59755	111491	20-24	56863	65677	122540
	25-29	40662	47414	88076	25-29	44692	52113	96805
	30-34	31922	35604	67526	30-34	35086	39133	74218
	35-39	25508	27900	53408	35-39	28036	30665	58701
	40-44	22440	22595	45035	40-44	24664	24834	49498
	45-49	17829	16690	34519	45-49	19596	18344	37940
	50-54	14039	12342	26381	50-54	15430	13565	28995
	55-59	11113	8890	20003	55-59	12214	9771	21985
	60-64	8954	7599	16553	60-64	9841	8352	18193
	65-69	7439	5821	13260	65-69	8176	6398	14574
	70-74	5870	4745	10615	70-74	6452	5215	11667
	75-79	3543	2876	6419	75-79	3894	3161	7055
	80+	4323	4798	9121	80+	4751	5274	10025
	Total	595074	605896	**1200970**	Total	654049	665943	**1319992**

[1](BUCREP 2010a)

Far North

Table 27: Distribution of the population by sex and age for the Far North Region in 2015 (published projection (BUCREP n.a.)) and for the current year 2018 (estimated by LCBC)

Cameroon	Year 2015				Year 2018 (growth rate 2.8 %[1])			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Far North	0-4	398519	386793	785312	0-4	432941	420202	853143
	5-9	344341	330181	674522	5-9	374083	358700	732783
	10-14	269692	247279	516971	10-14	292986	268637	561624
	15-19	209166	214075	423241	15-19	227232	232566	459798
	20-24	140870	172492	313362	20-24	153037	187391	340428
	25-29	113946	151924	265870	25-29	123788	165046	288834
	30-34	90489	115183	205672	30-34	98305	125132	223437
	35-39	72893	92978	165871	35-39	79189	101009	180198
	40-44	64326	75687	140013	40-44	69882	82224	152106
	45-49	55151	58455	113606	45-49	59915	63504	123419
	50-54	47725	47714	95439	50-54	51847	51835	103682
	55-59	40488	33180	73668	55-59	43985	36046	80031
	60-64	35243	30703	65946	60-64	38287	33355	71642
	65-69	28927	21799	50726	65-69	31426	23682	55107
	70-74	22907	19738	42645	70-74	24886	21443	46328
	75-79	12881	10494	23375	75-79	13994	11400	25394
	80+	19065	19640	38705	80+	20712	21336	42048
	Total	1966629	2026378	**3993007**	Total	2136495	2201404	**4337899**

[1](BUCREP 2010a)

North

Table 28: Distribution of the population by sex and age for the North Region in 2015 (published projection (BUCREP n.a.)) and for the current year 2018 (estimated by LCBC)

Cameroon	Year 2015				Year 2018 (growth rate 3.9 %[1])			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Nord	0-4	242895	239359	482254	0-4	272436	268470	540907
	5-9	200668	196978	397646	5-9	225074	220935	446009
	10-14	152710	140574	293284	10-14	171283	157671	328954
	15-19	124656	139320	263976	15-19	139817	156264	296081
	20-24	96002	121218	217220	20-24	107678	135961	243639
	25-29	82096	104698	186794	25-29	92081	117432	209512
	30-34	67363	76051	143414	30-34	75556	85300	160856
	35-39	51805	57834	109639	35-39	58106	64868	122974
	40-44	45512	44063	89575	40-44	51047	49422	100469
	45-49	38239	31369	69608	45-49	42890	35184	78074
	50-54	29373	23365	52738	50-54	32945	26207	59152
	55-59	23191	15526	38717	55-59	26012	17414	43426
	60-64	17884	13683	31567	60-64	20059	15347	35406
	65-69	13967	9650	23617	65-69	15666	10824	26489
	70-74	9816	8462	18278	70-74	11010	9491	20501
	75-79	5408	4250	9658	75-79	6066	4767	10833

	80+	7422	7171	14593	80+	8325	8043	16368
	Total	1209007	1233571	**2442578**	Total	1356049	1383601	**2739650**

[1] (BUCREP 2010a)

The population of the North, Far North and Adamawa remains characterized by its extreme youth. The median age of the population is 17.7 years and the average age is 22.1 years. The population under 15 years represents 43.6% of the total population while people under 25 years of age represents 64.2%. It should be noted that the proportion of elderly people (60 years and over) is not negligible.

In addition, population growth is still quite high in the three regions located in the Lake Chad Basin (2.8% in the Far North and 3.2% in Adamaoua and 3.9% in the Northern Region of Cameroon).

This demographic situation is an asset for the country but also involves development problems: it is an asset in terms of expanding the national market for the consumption of goods and services and involves development problems in terms of social demand to be fulfilled (health, education, employment, social protection, etc.).

5.1.2 Niger

Niger is a Sahelian country marked by strong climatic instability and very high economic and food vulnerability. It is one of the largest countries in West Africa with an area of 1,267,000 km².

Niger has 17,129,076 inhabitants, including 8,461,444 men (49.4%) and 8,667,632 women (50.6%) (according to the latest census on 17 December 2012) (INS-Niger 2015). Its population is mainly composed of Houassa, Djemma-Sonrai, Touarege, Pheuls, Kanouri, Toubou, Arabes, Boudouma et Goumantier.

Population growth is quite high and has been estimated at an average of 3.9% per year between the 2001 and 2012 general population censuses. This demographic growth is creating new needs for basic services.

The diagnosis established showed that the phenomenon of poverty is general, multidimensional and manifests itself at all levels.

Diffa

The population of the Diffa region in 2012 is 593,821 inhabitants (according to the last census in 2012). It is one of the least populated regions in Niger (3.5% of the country's population). It has 85% of sedentary people and 15% of nomads who only practice livestock farming. After analysis, the demographic structure shows the following constants: 37% of the population is under twenty years old and 6% is over sixty years old.

The population growth rate is quite high and has been estimated at 4.8% per year between the 2001 and 2012 (INS-Niger 2015).

In 2018, the population increased to 786,726 according to the projection formula.

Table 29: Distribution of the population by sex and age for Diffa during the last census in 2012 and for the current year 2018 (estimated by LCBC)

Niger	Year 2012 (last census)				Year 2018 (growth rate 4.8 %)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Diffa	0-4	66402	59999	126401	0-4	87973	79490	167463
	5-9	59359	55536	114895	5-9	78642	73577	152219
	10-14	37745	35484	73229	10-14	50007	47011	97018
	15-19	28284	29801	58085	15-19	37472	39482	76954
	20-24	20380	23106	43486	20-24	27001	30612	57613
	25-29	18174	19013	37187	25-29	24078	25189	49267
	30-34	15066	15093	30159	30-34	19960	19996	39956
	35-39	11526	11818	23344	35-39	15270	15657	30927
	40-44	11134	10326	21460	40-44	14751	13680	28431
	45-49	9303	7948	17251	45-49	12325	10530	22855
	50-54	7454	6040	13494	50-54	9875	8002	17878
	55-59	5837	4346	10183	55-59	7733	5758	13491
	60-64	4280	3452	7732	60-64	5670	4573	10244
	65-69	3749	2737	6486	65-69	4967	3626	8593
	70-74	2436	1923	4359	70-74	3227	2548	5775
	75-79	1714	1450	3164	75-79	2271	1921	4192
	80+	1403	1503	2906	80+	1859	1991	3850
	Total	304246	289575	**593821**	Total	403081	383644	**786726**

Zinder

Located in the south-east of the country, the Zinder region is bordered to the east by the Diffa region, to the west by the Maradi region, to the south by the Federal Republic of Nigeria and to the north by the Agadez region. The population of Zinder is characterized by a pastoral production system based on mobility: transhumance routes, their amplitudes and variants; practical mechanisms for implementing mobility (pathfinders, alliances with sedentary people, alternative or extreme solutions).
The city of Zinder, the capital of the Zinder region, is the second largest city in the country by its population estimated at 322 935 inhabitants in the last census in 2012 (General Population and Housing Census of 17 December 2012). For the entire Zinder region, the population estimated at the last census in 2012 was 3 534 547 inhabitants, the most populated region. It is estimated at 4 682 755 inhabitants in 2018 according to the projection, with a population growth rate per year of 4.8% (INS-Niger 2015).

Table 30: Distribution of the population by sex and age for Zinder during the last census in 2012 and for the current year 2018 (estimated)

Niger	Year 2012 (last census)				Year 2018 (growth rate 4.8 %)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Zinder	0-4	411256	392353	803609	0-4	544854	519810	1064664
	5-9	318196	312144	630340	5-9	421563	413545	835108
	10-14	233724	229906	463630	10-14	309650	304592	614242
	15-19	181443	185298	366741	15-19	240385	245493	485878
	20-24	136640	134879	271519	20-24	181028	178695	359723
	25-29	113850	104553	218403	25-29	150835	138517	289352
	30-34	87015	89135	176150	30-34	115282	118091	233373
	35-39	71301	72179	143480	35-39	94463	95627	190090
	40-44	52066	61248	113314	40-44	68980	81145	150124
	45-49	41239	57466	98705	45-49	54636	76134	130770
	50-54	35194	38789	73983	50-54	46627	51390	98017
	55-59	25181	28288	53469	55-59	33361	37477	70839
	60-64	19678	20061	39739	60-64	26070	26578	52648
	65-69	14416	17855	32271	65-69	19099	23655	42754
	70-74	9175	12462	21637	70-74	12156	16510	28666
	75-79	7951	9280	17231	75-79	10534	12295	22829
	80+	4723	5603	10326	80+	6257	7423	13680
	Total	1763048	1771499	**3534547**	Total	2335779	2346976	**4682755**

In the current context of scarce economic and budgetary resources, significant unmet needs in many areas, such as education and health, Niger's exceptional demographic growth continues to be a major additional constraint to its development. It is also likely to jeopardize the success of the country's recent fight to reduce poverty. This excessively rapid population growth (4.8% in Diffa and Zinder) can be controlled, in a non-binding way, freely consented to by the population, if the authorities decide to make a clear and resolute commitment to this path.
To do this, Niger must conduct awareness and information campaigns on fertility control. Local FM radios and those with agreements with the LCBC through PRESIBALT should be involved in this work.

5.1.3 Nigeria

Nigeria is the most populous country in Africa (7th in the world). The population is estimated at about 196 million inhabitants in 2018 (FAO Stat). The birth rate is very high (5.8% in 2016 according to NBS-Nigeria (2018)) and demographic projections anticipate significant population growth in the future. Due to its high birth rate, Nigeria's population is expected to increase considerably until at least 2050. By that date, the population is expected to reach 440 million inhabitants according to the United Nations (median variant).

Bauchi

The population of Bauchi has grown at a rapid rate in recent decades and will continue to do so. With a current growth rate of about 3.39% per year, the population of Bauchi will double in about 19 years (NPC 2010). Demographic projections estimate that the state's population will increase by almost four times by 2050, reaching more than 26 million people.

Table 31: Distribution of the population by sex and age for Bauchi during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 3.39 %)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Bauchi	0-4	479983	451789	931772	0-4	716091	674028	1390119
	5-9	396050	358295	754345	5-9	590871	534544	1125414
	10-14	293068	251050	544118	10-14	437231	374544	811775
	15-19	239021	237348	476369	15-19	356598	354102	710699
	20-24	173564	227559	401123	20-24	258942	339497	598439
	25-29	157528	207575	365103	25-29	235017	309683	544701
	30-34	136446	152859	289305	30-34	203565	228052	431617
	35-39	107431	102404	209835	35-39	160277	152777	313055
	40-44	100876	88646	189522	40-44	150498	132252	282750
	45-49	69138	50894	120032	45-49	103148	75929	179077
	50-54	70040	53918	123958	50-54	104493	80441	184934
	55-59	29726	19011	48737	55-59	44348	28363	72711
	60-64	39413	29843	69256	60-64	58801	44523	103324
	65-69	15107	11038	26145	65-69	22538	16468	39006
	70-74	24881	15860	40741	70-74	37120	23662	60782
	75-79	9583	6208	15791	75-79	14297	9262	23559
	80+	27411	19503	46914	80+	40895	29097	69991
	Total	2369266	2283800	**4653066**	Total	3534730	3407222	**6941952**

Borno

The State is bordered to the south by Adamawa State, to the southwest by Gombe State, to the west by Yobe State, to the north by Niger, to the northeast by Lake Chad and to the east by Cameroon.

Table 32: Distribution of the population by sex and age for Borno during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 3.47 %)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Borno	0-4	411571	383864	795435	0-4	619752	578031	1197783
	5-9	355861	315674	671535	5-9	535863	475349	1011212
	10-14	253662	210728	464390	10-14	381970	317319	699288
	15-19	208160	200155	408315	15-19	313452	301398	614849
	20-24	164976	207041	372017	20-24	248424	311767	560191
	25-29	152237	183944	336181	25-29	229242	276987	506228
	30-34	134379	139974	274353	30-34	202351	210776	413127
	35-39	102104	88480	190584	35-39	153750	133235	286985
	40-44	102048	84501	186549	40-44	153666	127243	280909
	45-49	66254	43693	109947	45-49	99767	65794	165561
	50-54	69828	51843	121671	50-54	105148	78066	183215
	55-59	28966	16959	45925	55-59	43618	25537	69155
	60-64	42672	30635	73307	60-64	64256	46131	110387
	65-69	14128	10022	24150	65-69	21274	15091	36366
	70-74	24048	16470	40518	70-74	36212	24801	61013
	75-79	7852	5413	13265	75-79	11824	8151	19975
	80+	24612	18350	42962	80+	37061	27632	64693
	Total	2163358	2007746	**4171104**	Total	3257630	3023306	**6280937**

Adamawa

Table 33: Distribution of the population by sex and age for Adamawa during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 2.89 %)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Adamawa	0-4	286910	273660	560570	0-4	403853	385203	789056
	5-9	251048	236263	487311	5-9	353374	332563	685937
	10-14	192418	178550	370968	10-14	270847	251326	522173
	15-19	164142	164293	328435	15-19	231046	231258	462304
	20-24	132652	158418	291070	20-24	186720	222989	409709
	25-29	118466	142764	261230	25-29	166752	200954	367706
	30-34	97535	105705	203240	30-34	137290	148790	286080
	35-39	79891	73580	153471	35-39	112454	103571	216025
	40-44	70256	65142	135398	40-44	98892	91694	190586
	45-49	53160	39799	92959	45-49	74828	56021	130849
	50-54	46520	41060	87580	50-54	65481	57796	123277
	55-	26646	17559	44205	55-	37507	24716	62223

	59				59			
	60-64	27191	24767	51958	60-64	38274	34862	73136
	65-69	14742	11546	26288	65-69	20751	16252	37003
	70-74	18004	15623	33627	70-74	25342	21991	47333
	75-79	8612	6243	14855	75-79	12122	8788	20910
	80+	19077	16708	35785	80+	26853	23518	50371
	Total	1607270	1571680	**3178950**	Total	2262387	2212290	**4474677**

Jigawa

Table 34: Distribution of the population by sex and age for Jigawa during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 2,91%))			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Jigawa	0-4	458193	420388	878581	0-4	646457	593118	1239575
	5-9	369700	341532	711232	5-9	521603	481862	1003465
	10-14	249086	222304	471390	10-14	351431	313645	665076
	15-19	201054	213005	414059	15-19	283664	300525	584189
	20-24	144224	218232	362456	20-24	203483	307900	511383
	25-29	136193	198696	334889	25-29	192152	280337	472489
	30-34	136266	157618	293884	30-34	192255	222381	414636
	35-39	101061	95637	196698	35-39	142585	134933	277518
	40-44	106550	92539	199089	40-44	150330	130562	280891
	45-49	62025	44680	106705	45-49	87510	63038	150548
	50-54	78140	56183	134323	50-54	110246	79268	189514
	55-59	23913	16163	40076	55-59	33738	22804	56543
	60-64	46516	31910	78426	60-64	65629	45021	110650
	65-69	11996	8992	20988	65-69	16925	12687	29612
	70-74	31489	18249	49738	70-74	44427	25747	70174
	75-79	7511	4964	12475	75-79	10597	7004	17601
	80+	34159	21834	55993	80+	48194	30805	79000
	Total	2198076	2162926	**4361002**	Total	3101228	3051635	**6152863**

Kano

Table 35: Distribution of the population by sex and age for Kano during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 3.36%)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Kano	0-4	939779	878819	1818598	0-4	1397191	1306560	2703751
	5-9	799199	704692	1503891	5-9	1188187	1047682	2235869
	10-14	627032	472931	1099963	10-14	932223	703117	1635340
	15-19	535345	444284	979629	15-19	795910	660527	1456437
	20-24	379355	445211	824566	20-24	563996	661905	1225901
	25-29	336017	409612	745629	25-29	499564	608980	1108544
	30-34	290300	306901	597201	30-34	431596	456277	887872
	35-39	222660	196041	418701	35-39	331034	291459	622492
	40-44	217205	182147	399352	40-44	322924	270802	593726
	45-49	137368	93011	230379	45-49	204228	138282	342510
	50-54	151242	109979	261221	50-54	224855	163508	388363
	55-59	60559	34804	95363	55-59	90034	51744	141778
	60-64	87367	59718	147085	60-64	129891	88784	218675
	65-69	28502	18993	47495	65-69	42375	28237	70612
	70-74	55569	37223	92792	70-74	82616	55340	137956
	75-79	16669	10851	27520	75-79	24782	16132	40915
	80+	63784	48119	111903	80+	94829	71540	166369
	Total	4947952	4453336	**9401288**	Total	7356233	6620876	**13977109**

Plateau

Table 36: Distribution of the population by sex and age for Plateau during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 2,94%)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Plateau	0-4	276464	273266	549730	0-4	391425	386897	778322
	5-9	242632	238031	480663	5-9	343525	337011	680535
	10-14	193965	186673	380638	10-14	274621	264297	538917
	15-19	169792	174109	343901	15-19	240396	246508	486904
	20-24	134869	164773	299642	20-24	190951	233290	424241
	25-29	125454	150581	276035	25-29	177621	213197	390818
	30-34	100316	106736	207052	30-34	142030	151120	293150
	35-39	83782	77296	161078	35-39	118621	109438	228058
	40-44	68695	63028	131723	40-44	97260	89237	186497
	45-49	54077	42322	96399	45-49	76564	59921	136484
	50-54	42711	38554	81265	50-54	60471	54586	115057
	55-59	25555	18837	44392	55-59	36181	26670	62851
	60-64	23319	22575	45894	60-64	33016	31962	64978
	65-69	14132	12322	26454	65-69	20008	17446	37454
	70-74	15127	14117	29244	70-74	21417	19987	41404
	75-79	8605	6714	15319	75-79	12183	9506	21689
	80+	19503	17599	37102	80+	27613	24917	52530
	Total	1598998	1607533	**3206531**	Total	2263903	2275987	**4539891**

Yobe

Table 37: Distribution of the population by sex and age for Yobe during the last census in 2006 (NPC 2009) and for the current year 2018 (estimated)

Nigeria	Year 2006 (last census)				Year 2018 (growth rate 3,53%)			
Region	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
Yobe	0-4	228750	210103	438853	0-4	346861	318586	665447
	5-9	198708	177505	376213	5-9	301307	269157	570464
	10-14	145207	123035	268242	10-14	220182	186562	406744
	15-19	120549	118771	239320	15-19	182792	180096	362889
	20-24	89719	116327	206046	20-24	136044	176390	312434
	25-29	83296	101838	185134	25-29	126304	154420	280725
	30-34	76627	77195	153822	30-34	116192	117053	233245
	35-39	54912	45709	100621	35-39	83265	69310	152575
	40-44	56409	45415	101824	40-44	85535	68864	154399
	45-49	33091	21676	54767	45-49	50177	32868	83045
	50-54	39673	28173	67846	50-54	60157	42720	102877
	55-59	14268	8287	22555	55-59	21635	12566	34201
	60-64	24414	16049	40463	60-64	37020	24336	61355
	65-69	7091	4769	11860	65-69	10752	7231	17984
	70-74	14701	9292	23993	70-74	22292	14090	36381
	75-79	4127	2526	6653	75-79	6258	3830	10088
	80+	13492	9635	23127	80+	20458	14610	35068
	Total	1205034	1116305	**2321339**	Total	1827233	1692690	**3519923**

According to population analyses and census results, the number of men exceeds the number of women by 51.2 per cent; women by 48.8 per cent, i.e. a sex ratio of 105 men to 100 women. This predominance of men over women contrasts with the general trend in the basin countries, where the number of women is higher than that of men (FAO/UNDP 2017-2018).
However, we note that the Nigeria has the highest growth rate (3.53%) with a galloping population dynamic and is undoubtedly one of the basin states with the largest population. An effort to control the growth rate should be encouraged in the concerned regions.

5.1.4 Central African Republic

The population of the Central African Republic is estimated at over 5 million with a growth rate of 2.5% (Central Bureau of Census, RGPH 2003).
Long in the grip of armed conflict, this country is experiencing serious problems for its economic take-off. The civil war that is still ravaging some regions as well as the permanent insecurity in others are pushing rural populations to seek refuge and work in the capital Bangui, the only large city in the whole country, and the real economic lung of the whole Central African Republic.
The population figures from the last census in 2003 and the estimates made in 2018 by the administrative units located in the LCB are presented in the following table.

Table 38: Distribution of the population by sex for prefectures and subprefectures located in the Lake Chad Basin during the last census in 2003 and for the current year 2018 (estimated with a growth rate of 2.5%)

Prefecture/ Subprefecture	**Census 2003**			**2018 (growth rate 2.5 %)**		
	Masculine	**Feminine**	**Total**	**Masculine**	**Feminine**	**Total**
OUHAM - PENDE	**159155**	**166412**	**325567**	**230504**	**241014**	**471518**
Bozoum	20095	20836	40931	29104	30177	59280
Bocaranga	30223	30967	61190	43772	44849	88621
Koui	10858	11089	21947	15726	16060	31786
Paoua	58670	61920	120590	84972	89679	174650
Ngaoundaye	32467	34836	67303	47022	50453	97475
Bossemptélé	6842	6764	13606	9909	9796	19706
OUHAM	**138603**	**142169**	**280772**	**200738**	**205903**	**406642**
Bossangoa	47069	48291	95360	68170	69940	138110
Nana-Bakassa	16821	17387	34208	24362	25182	49543
Markounda	6635	6853	13488	9609	9925	19535
Nanga-Boguila	8060	8685	16745	11673	12578	24252
Bouca	21174	21388	42562	30666	30976	61642
Batangafo	23844	24353	48197	34533	35270	69804
Kabo	15000	15212	30212	21724	22032	43756
NANA - GRÉBIZI	**43459**	**43882**	**87341**	**62942**	**63554**	**126496**
Kaga-Bandoro	35946	35942	71888	52061	52055	104115
Mbrés	7513	7940	15453	10881	11499	22381
BAMINGUI - BANGORAN	**19012**	**19425**	**38437**	**27535**	**28133**	**55668**
Ndélé	15905	16302	32207	23035	23610	46645
Bamingui	3107	3123	6230	4500	4523	9023
VAKAGA	**17897**	**19698**	**37595**	**25920**	**28529**	**54449**
Birao	16477	18279	34756	23864	26473	50337
Ouadda-Djallé	1420	1419	2839	2057	2055	4112
Nana-Mambere	92129	92465	184594	133429	133916	267345
Bouar	48317	48278	96595	69977	69920	139897
BANGUI	**268973**	**262790**	**531763**	**389553**	**380598**	**770151**

The continued economic recovery in 2017, with a real GDP growth rate of 4.3%, slightly lower than in 2016 (4.5%) but higher than forecast at the beginning of the second half of 2017 (3.8%), led CAR to improve the situation of its population. Private consumption was the main driver, accompanied by modest public consumption. Exports declined to 5.2% in 2017 after a record 8.2% increase in GDP in 2016, driven by the main export products (wood, gold, coffee and cotton). Imports, including of food products, have increased as security conditions along the Bangui-Garoua Boulai corridor have improved. Despite the ongoing turf war, the country can soon be reintegrated into the community of nations in terms of controlling population dynamics (FAO and UNDP Report on CAR 2018).

5.1.5 Chad

In 2009, Chad had 12,768,961 inhabitants, according to the latest general population and housing census (INSEED/RGPH 2009). The country now has more than 15 million inhabitants with an intercensal annual growth rate of 3.6%. Its population has quadrupled since Independence. Given its high fertility (more than 6 children per woman on average) and the extreme youthfulness of the population (more than two out of three Chadians are under 25 years old), it is estimated that, in the next 20 years, the current total population will double, the urban population will almost triple and the number of young people seeking employment will increase considerably.

Table 39: Population of Chad classified by sex and age at the last census in 2009 and for the current year 2018 (estimated)

Chad	Year 2009				Year 2018 (growth rate 3.6 %)			
	Age	Sex		Total	Age	Sex		Total
		Masculine	Feminine			Masculine	Feminine	
	0-4	304126	200415	504541	0-4	418111	275529	693640
	5-9	915330	890958	1806288	5-9	1258391	1224884	2483275
	10-14	1003296	978677	1981973	10-14	1379326	1345480	2724806
	15-19	693672	644952	1338624	15-19	953656	886676	1840333
	20-24	498333	552627	2785970	20-24	685105	759749	1444854
	25-29	378651	478553	857204	25-29	520567	657912	1178479
	30-34	317163	429836	746999	30-34	436034	590936	1026970
	35-39	274809	332474	607283	35-39	377806	457083	834889
	40-44	239778	258240	498018	40-44	329645	355027	684672
	45-49	213931	212311	426242	45-49	294111	291884	585995
	50-54	162461	138140	300601	50-54	223350	189914	413265
	55-59	146383	131858	278241	55-59	201247	181278	382524
	60-64	84165	62269	146434	60-64	115710	85607	201317
	65-69	91856	84282	176138	65-69	126283	115870	242154
	70-74	55551	48859	104410	70-74	76371	67171	143542
	75-79	23929	17219	41148	75-79	32897	23673	56570
	80+	46893	37264	84157	80+	64468	51230	115699
	Total	5497946	5536005	**12768961**	Total	7493080	7559904	**15052984**

Source : RGPH 2009

Table 40: Chad's population by region at the last census in 2009 and for the current year 2018 (estimated)

Chad	Year 2009 (last census)			Year 2018 (growth rate 3.6 %)		
Region	Masculine	Feminine	Total	Masculine	Feminine	Total
Batha	235412	253046	488458	323643	347886	671529
Borkou	49985	43599	93584	68719	59940	128659
Chari-Baguirmi	287003	291422	578425	394570	400645	795216
Guéra	261191	277168	538359	359084	381049	740133
Hadjer-Lamis	283378	283480	566858	389587	389727	779313
Kanem	162840	170547	333387	223872	234467	458339
Lac	219032	214758	433790	301124	295248	596372
Western Logone	334357	354687	689044	459672	487622	947294
Eastern Logone	379105	400234	779339	521191	550240	1071431
Mandoul	305598	322467	628065	420134	443326	863460
Eastern Mayo-Kebbi	371245	403537	774782	510386	554780	1065166
Western Mayo-Kebbi	273333	291137	564470	375777	400254	776030
Moyen-Chari	291794	296214	588008	401157	407233	808390
Ouaddaï	348634	372532	721166	479300	512155	991455
Salamat	146906	155395	302301	201966	213636	415602
Tandjilé	315482	346424	661906	433723	476262	909985
Wadi Fira	245193	263190	508383	337090	361832	698922
N'Djamena City	506218	445200	951418	695946	612059	1308004
Barh el Ghazel	137592	119675	257267	189161	164529	353689
Ennedi	92381	75538	167919	127005	103849	230854
Sila	192132	195329	387461	264142	268537	532679
Tibesti	13672	11811	25483	18796	16238	35034

Source : RGPH 2009

Normally Borku, Ennedi and Tibesti (BET) are not part of the Lake Chad Basin. Borku is one of the 23 provinces of Chad whose capital is Faya-Largeau. It was created on 19 February 2008 by the break-up of the former Borku-Ennedi-Tibesti region. Between 2002 and February 2008, Borku was one of the 4 departments making up the Borku-Ennedi-Tibesti region. According to the last census in 2009, its population is 93,584. Given its current

status, it would be appropriate to consider it as part of the population of the basin. Also, due to the general situation in Lake Chad, a large part of the refugee population of the Lake is hosted by the indigenous people of the former BET.

Since the country's independence in 1960, the population has increased fourfold. It increased from 2.95 million inhabitants at independence to around 15 million in 2018 (RGPH 2009). This corresponds to nearly 600,000 births and 170,000 deaths, an exceptional natural increase of 400,000. This evolution is essentially the result of high fertility, with an average of about 7 children per woman. This makes Chad, after Niger, the second most fertile country in the world. At this high fertility rate, Chad is also characterized by high mortality. However, this high mortality does not slow the rapid population growth. Other social phenomena such as migration in Chad, which concerned returns from Libya, the Central African Republic and refugee movements, have a strong impact on population dynamics. That is why it is necessary to take a very special look at this situation, especially the Lake Chad Basin.

5.1.6 Conventional Lake Chad Basin

Table 41: Distribution of the estimated total population living in the Lake Chad Conventional Basin in 2018

Member States	Population living in the Conventional Basin in 2018
Cameroon (for the Adamaoua, Far North and North regions)	8.397.541
Niger (for the Zinder and Diffa regions)	5.469.481
Nigeria (for the Bauchi, Yobe, Adamawa, Borno, Kano, Plateau, Jigawa regions)	45.887.352
CAR (for the Ouam, Ouam Pende, Nana Gribizi, Bimingui-Bangoran, Vakaga, Nana-Mambéré regions)	1.254.670
Chad (all regions)	15.052.984
Total	**76.062.028**

NB. *The total number of populations is obtained from the latest censuses and estimates for 2018 (using growth rates) of the population of the respective countries.

The total population living in the conventional Lake Chad Basin in 2018 is estimated 76 million people.

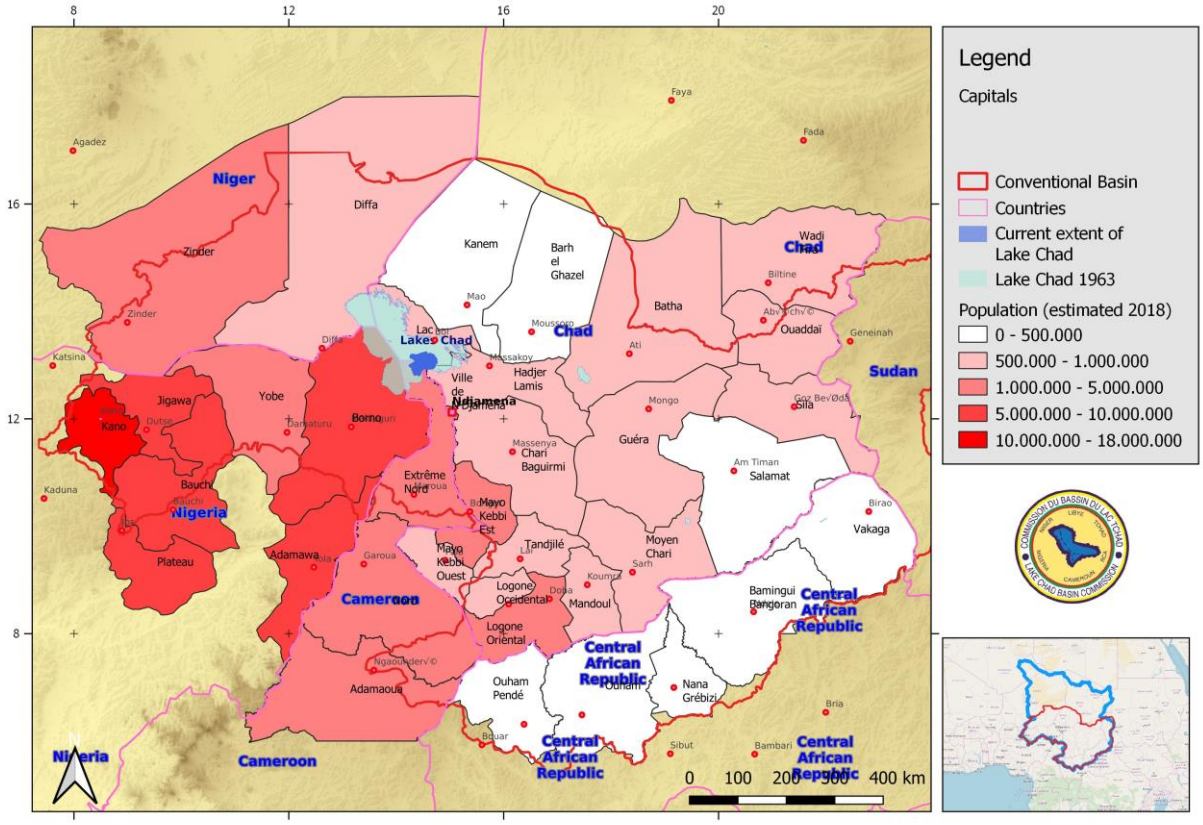


Figure 62: Thematic map of population distribution in the Lake Chad Basin in 2018 by region

5.2 Refugee Population

5.2.1 Conventional Lake Chad Basin

In the Lake Chad region, climatic hazards, poverty, underdevelopment and violence linked to attacks by armed groups have forced more than 2.4 million people to move, causing one of the largest population movements ever recorded on the African continent. Most of these displaced persons have lost their livelihoods and are now in the poorest areas of the 4 countries (northeastern Nigeria and parts of Niger, Chad and Cameroon) concerned. This crisis began in northeastern Nigeria in 2009 and spread to neighboring countries in 2014. In January 2019, Cameroon, Chad, Niger and Nigeria hosted approximately 4.5 million affected people, including internally displaced persons (IDPs), refugees (inside and outside the camp), returnees (former IDPs and returnees) and third-country nationals (TCN). 80% of the affected population was in Nigeria, 10% in Cameroon, 5% in Niger and 4% in Chad (IOM (2018)).

The presence of all these particularly vulnerable populations increases the frequency of gender-based violence, pressure on health and education systems and threats to social cohesion. The persistence of abuses and threats by Boko Haram suggests the need for increasing care for new displaced persons and refugees in the Lake region.

In addition, the region faces structural development challenges, particularly in terms of youth employment, social cohesion and strengthening links between institutions.

The recurrence of attacks in the Lake area has led to internal displacement. At present, due to the security situation in the areas of origin, the prospects for return are not yet conceivable. It is therefore necessary to facilitate the socio-economic inclusion of refugees and to work for a perfect peaceful coexistence between refugees, returnees, IDPs and the population.

Table 42: Number of internally displaced populations by country in the basin (IOM 2018)

Country of origin	Source	Date	IDP Population
Cameroon (Far North)	IOM	21 January 2019	**245,725**
Nigeria (Borno, Yobe, Bauchi, Gombe, Adamawa, Taraba)	IOM	21 January 2019	**2,026,602**
Tchad (Lake Region)	IOM	21 January 2019	**122,312**
Niger (Diffa)	IOM	21 January 2019	**104,288**
CAR	IOM	20 March 2019	**464,000**

Table 43: Number of refugees by country in the basin (IOM 2019 and UNHCR 2018b)

Country	Country of origin	Source	Date	Number of refugees
Cameroon	**Nigeria + CAR**	IOM	21 January 2019	**100,371+286,052**
Nigeria	**Cameroon**	UNHCR Operational Portal	September 2019	N/A[2]
Chad	**Nigeria + CAR + Sudan**	IOM/UNHCR	21 January 2019	**11,310+103,396+ 331,918**

[2] It should be noted that this number only takes into account the Lake Chad region. There are refugees from Cameroon in Nigeria outside the Lake Chad basin (about 44,000 refugees in September 2019)

Country	Country of origin	Source	Date	Number of refugees
Niger	**Nigeria**	IOM	21 January 2019	**118,868**

Table 44: Number of populations returned per country to the basin (IOM 2018)

Country of origin	Source	Date	Number of returned people
Cameroon	IOM	21 January 2019	**105,906**
Nigeria	IOM	21 January 2019	**1,642,696**
Chad	IOM	21 January 2019	**41,240**
Niger	IOM	21 January 2019	**25,731**

The following figure gives an overview of the number of IDPs and refugees and of the number of IDPs and refugee camps in the Lake Chad Basin.

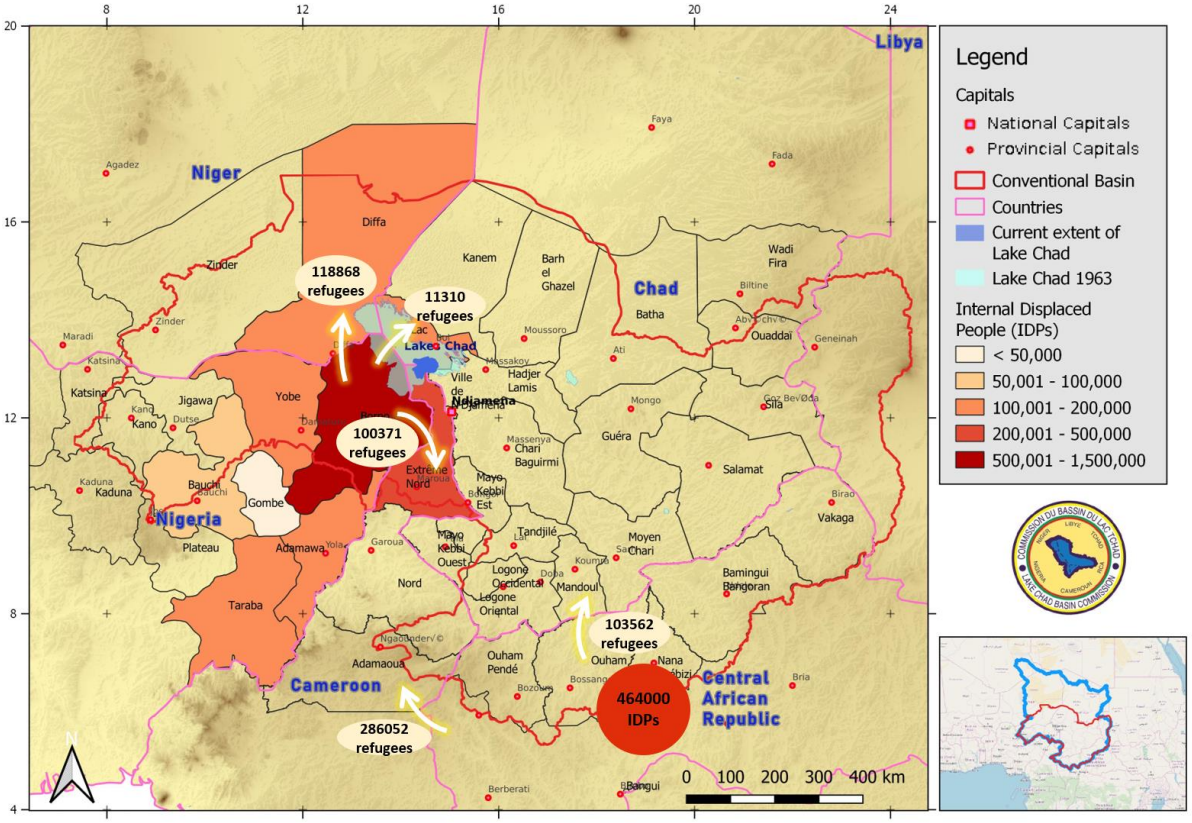


Figure 63: Map of the number of IDPs and refugees (Data Status January 2019, IOM DTM)

5.2.2 Cameroon

Since 2014, Cameroon has been under attack by armed groups. Recurrent attacks and threats continue to cause the displacement of people living in the Far North region.

In this part of Cameroon, it was reported that in July 2018, about 2000 people moved to Nguétchewé and Mozogo (Mayo-Tsanaga Department in the Far North region of Cameroon) following repeated incursions by Boko Haram forces. In addition, insecurity continues to restrict people's access to their fields, the main means of subsistence. (UNHCRb 2019).

In terms of impacts on civilian populations, the department of Mayo-Tsanaga is experiencing a greater dynamic of displacement, caused by Boko Haram's incursions into remote villages in the Mayo-Moskota district.

On the Cameroon-Nigeria border, the number of Cameroonian refugees who fled the violence and found refuge in Nigeria and the number of internally displaced persons crossed a very high threshold. Refugees fleeing the south-west, north and north-west regions of Cameroon are flowing into the Cameroon/Nigeria borders. Nearly 2,026,602 people arrived at the refugee facilities. Four out of five registered refugees are women and children. Refugees are housed in Yobe, Bornou, Bauchi, Adamawa, Nigeria and Adamaoua States in Cameroon (Portal UNHCR, November 2018).

5.2.3 Niger

Following the abuses committed by Boko Haram, several Nigeriens were forced to leave their usual localities to seek refuge in Chad, and more specifically in the Lake region.
The displacement situation in the Diffa region remains complex. The region is currently hosting internally displaced persons (IDPs), refugees and returnees. This situation was aggravated by the socio-economic crisis and the state of emergency declared following the attacks of 6 February 2015 and prohibiting activities essential to the local economy (cultivation of peppers, fishing and circulation of motorized two-wheeled vehicles) and imposing restrictions on movements in the region.
The population has been almost entirely displaced by the insurgency. One percent of the current population was displaced before 2014; 38% in 2014; 46% in 2015; 14% in 2016 and 1% in 2017. The majority (90%) of displaced households live in spontaneous sites, while 10% live in rented houses, host families and collective centers (IOM-Niger).

According to government figures of 28 February 2019, 104,288 internally displaced persons (26,378 households) have been identified and registered. (UNHCR Portal 2019 and IOM 2018).

5.2.4 Nigeria

Nigeria hosts the vast majority of the identified affected population (82%). This can be explained by the fact that non-state armed groups (NSAGs) have been active in the north-east of the country since 2009 and therefore for much longer than in neighboring countries (Cameroon, Chad and Niger) and by the large number of people living in this region. Nigeria is also the most affected country in terms of attacks and violence. From June 2011 to June 2018, ACLED (Armed Conflict and Location Event Data) identified 3346 incidents in which 43261 people were killed ((IOM 2019)).
In addition, NSAGs controlled large areas of territory in Nigeria, which was not the case in neighboring countries.

In addition to deadly attacks, local populations live in unstable and unsafe conditions, fleeing their usual localities to find safer places, either in their neighboring regions, capitals and other regions of the country and also in neighboring countries, specifically in the Lake region.

As a result, of the four affected countries, Nigeria is the most displaced, with more than two

million people displaced in the northeast of the country in six states. The largest number of displaced households are in Borno, Adamawa and Yobe States, and the majority of them live in host communities. Displaced people often have few or no basic services and live in conditions that do not meet the most basic standards.

Statistics on Nigerian refugees are based on refugee populations in the three main countries of asylum: Cameroon (≈~100,371 refugees), Niger (≈~118,868 refugees) and Chad (≈11 310 refugees).

5.2.5 Central African Republic

The Central African Republic has experienced a violent conflict that began in 2013. This conflict has caused the internal and cross-border displacement of an increasing number of people, particularly between 2017 and 2018. At the beginning of 2018, there are about 464,000 IDPs in CAR and 546,000 Central Africans are refugees in neighboring countries (IOM 2018 and UNHCR 2018).

The outbreak of violence in December 2017 forced some 78,000 people to flee the town of Paoua, in the prefecture of Ouham-Pendé. By 2018, at least 2.5 million people, more than half of the population, will need humanitarian assistance.

5.2.6 Chad

Today, emigration and immigration movements between Chad and its border countries (Libya, Sudan, CAR, Cameroon, Niger and Nigeria) form the basis of Chad's migration dynamics. These very important cross-border exchanges are explained by the fact that there are shared communities on both sides of the border. Very often, this notion of border is not materialized or considered by communities that share the same ethnicity and dialect.

The massive influx of refugees and the presence of internally displaced persons and Chadian returnees from Chad's neighboring countries constitute a heavy burden on the availability and delivery of basic social services.

There are nearly 570,000 refugees and internally displaced persons currently living in Chad (IOM 2018 and UNHCR 2018).

All these displaced persons are mainly located along the borders and in the Lake Chad region and this is due to the various conflicts in neighboring countries.
Refugees and asylum seekers live in 19 camps, in host villages and in urban areas, including N'Djamena and Bongor.

Chad/CAR border
Since the 26th of December 2017, following clashes between the *Mouvement Patriotique pour la Centrafrique* (MPC), a former member of the Seléka rebellion, and the *Revolution and Justice Group* (RJ), which were followed by abuses committed against the civilian population, an influx of Central African refugees has been recorded in the southern Chadian part.

It should be noted that since April 2018, 622 new refugees from 176 families have been received in the department of Barh Koh (subprefecture of Moussafoyo) and relocated to the

Bolom camp in Maro. The relocation of refugees living along the border is complete. Registration at level 2 continues and has significantly reduced the number of refugees. This decrease is explained by the spontaneous return of some refugees, the refusal of others to leave the border areas (UNHCR 2018a).

As of June 2018, 22,211 refugees are registered and settled in camps and villages. 7,943 refugees live in the camps while 14,268 residents live in the host villages. This number is in addition to the 76,000 refugees who have arrived from CAR since 2003 (UNHCR 2018b).

Chad/Sudan border: the Sila, Ouaddai, Wadi Fira and Ennedi East regions in the east of the country are home to thousands (~334,377 people) of Sudanese refugees who fled the violence in Darfur between 2003 and 2004. After 14 years in exile, most of them live in camps supervised by UNHCR in difficult conditions. At the end of May 2017, a tripartite agreement was signed in Khartoum between UNHCR and the Sudanese and Chadian governments for the voluntary repatriation of Sudanese refugees living in Chad and vice versa. Some 100 Sudanese refugees have decided to return to neighboring Darfur since April 2018 (RFI 2019).

5.3 Food and Nutrition Security

Agriculture, livestock and fishing are the main activities that predominate in the Lake Chad region. Therefore, trade is important and ensures cross-border exchanges. Agriculture and livestock are essentially family-based and diversified in terms of production, forms of livestock (large and small), species and varieties, but also in terms of space and time. The mobility of people and herds plays an essential role in the resilience of systems. Four types of spaces/territories can be distinguished:

1) Dense and old population areas, agricultural exporters, places where seasonal workers are welcomed and inhabitants leave (e.g. Komadugu-Yobe valley, Firki and Diamaré plains);
2) Reception areas, exporters of agro-(halio)-pastoral products, with a younger population and having sometimes aspects of pioneer areas (e.g. Lake Chad region and Benue Valley);
3) Threatened agropastoral areas, sources of migration (e.g. Mandara mountains, Sahelian and Sahelo-Sudanese areas)
4) Saharan-Sahelian areas exclusively pastoral (northern Kanem and Diffa regions).

The interdependence of agriculture and livestock (seasonality of activities, valorization of plant residues by livestock farming) is challenged locally by the pressure on resources due to the growth of human and animal populations and the monopolization of resources.

This spatial differentiation depends on bioclimatic gradients, population history and access to natural resources. Livestock farming is widespread in the Lake Chad Basin and highly mobile throughout the year and more concentrated in wetlands during the dry season.

Around 2010, the Lake Chad region was plunged into a serious crisis linked to the violent uprising of the jihadist group Boko Haram. Its effects are manifested in the form of an economic crisis, coupled with the fall in oil prices in autumn 2014, which affected Nigeria and Chad in particular, but also Cameroon and Niger.

The direct consequences of the Boko Haram crisis are considerable. Violent conflict and military repression and measures taken during the state of emergency have led to significant population movements: an estimated 2.4 million people have sought refuge in cities or rural areas that are not equipped to accommodate a large population totally dependent on food aid. The epicenter of the conflict is in Borno State, Nigeria, but all of the northeastern Nigeria is depopulated, the islands and shores of Lake Chad are empty, as is Komadugu-Yobe. The most productive areas are the most affected.

To economically stifle Boko Haram, cross-border markets were closed, as were Nigeria's borders, blocking all the labor, trade and transhumance flows that were the foundation of the regional system. Shepherds have been forced to station their herds outside the conflict zone: they now focus on the western part of the Diffa in Niger, southwest of the affected area in Nigeria and the Yaéré area in Cameroon.

Wherever refugees are settled, pressure on natural resources has increased, particularly in the extraction of timber, firewood and straw for grazing. Fishing in Lake Chad and Komadugu-Yobe is continuing temporarily. Agriculture is still officially banned, and security conditions are too dangerous to allow a massive return of farmers.

Gross domestic product (GDP) is the most commonly used indicator to measure a country's total production of goods and services over a year. It indicates the extent of economic activity. For countries like Niger, GDP per capita is very low (USD 1048 in 2018), and a significant part of the population (56.1% in 2011) lives in extreme poverty. One of the causes of this chronic poverty is the low level of education. Just over one in four people are literate (28.4% in 2017). For Nigeria, GDP per capita was USD 5980 in 2018, well above the other countries of the Basin, while that of Chad was USD 1965 in 2018. Cameroon's GDP was USD 3771 in 2018 according to the latest World Bank publication (Global Outlook 2018).

5.3.1 Livestock Farming

5.3.1.1 Cameroon

Far-North Region

Livestock population

Table 45: Livestock population in the Cameroonian portion of the Lake Chad Basin in 2017 (in the Far North region) (Source: Data provided by the Ministry of Livestock, Fisheries and Animal Industries, Far North Regional Delegation in Maroua 2018)

	Cattle	Sheeps	Goats	Pigs	Camels	Donkeys	Horses	Dogs	Rabbits	Cats
Diamaré	100 112	307235	515848	11950	ND	14463	11184	4791	4791	4810
Logone-Chari	187939	307241	802434	1225	90	6 347	1 212	5504	ND	1225
Mayo-Danay	78737	307237	630483	25087	70	3685	3073	6042	241	1 284
Mayo-Kani	93 263	292606	401219	43640	05	6 154	2 393	8 445	847	3 843
Mayo-Sava	29600	87702	401218	1982	ND	1500	167	1699	ND	ND
Mayo-Tsanaga	63806	160934	114634	8672	ND	9793	734	3495	ND	702
Total	553 457	1462955	2865836	92556	165	41942	18763	29976	5879	11864

Table 46: Poultry population situation in the Cameroonian part of 2017 (Far North Region) of the Lake Chad Basin (Source: Data provided by the Ministry of Livestock, Fisheries and Animal Industries, Far North Regional Delegation in Maroua 2018)

Department / Category	**Mayo-Danay**	**Mayo-Tsanaga**	**Diamaré**	**Mayo-Kani**	**Mayo-Sava**	**Logone et Chari**	**Total**
Table type chicks	0	0	0	0	0	0	**0**
Laying chicks	0	0	0	0	0	150	**150**
Broiler chickens	0	1000	650	0	0	0	**1650**
Laying chickens	1400	1200	2745	0	0	1800	**7145**
Young roosters	0	1100	0	0	0	0	**1100**
Village chickens	389026	124499	126964	256781	37752	208189	**1143211**
Ducks	142261	10260	15588	35026	7545	22831	**233511**
Pigeons	25440	2138	3867	11123	962	4345	**47875**
Guinea fowls	36598	2244	3570	26352	16	2096	**70876**
Geese	449	80	211	215	72	2050	**3077**
Turkey hens	147	43	121	210	48	376	**945**
Peacocks	58	0	139	237	30	602	**1066**
Ostrichs	6	0	0	0	0	0	**6**

Milk production

Table 47: Annual milk production in the Cameroonian portion of the Lake Chad Basin in 2017 (Source: Data provided by the Ministry of Livestock, Fisheries and Animal Industries, Far North Regional Delegation in Maroua 2018)

Departments of the Far North region	**Type of livestock**	**Quantity (liter)**	
		2016	**2017**
Diamaré	Traditional	476 452	474 657
Logone and Chari	Traditional	408 033	310 500
Mayo-Danay	Traditional	74 794	84 316
Mayo-Kani	Traditional	11 947	84 480
Mayo-Sava	Traditional	10 690	2090
Mayo-Tsanaga	Traditional	15 066	43 060
Total		**996 982**	**999 103**

Northern Region

Only the Mayo-Rey Department of the Northern Region is located in the Lake Chad Basin.

Cattle farming

The cattle farming system in the northern region is sedentary and transhumant during the hungry gap season.

However, alongside this most widespread type of livestock farming, there are semi-intensive fattening and milk production units that are developing around cities. The most common breeds are the Fulani Zebu and to some extent the Namchi bulls found in Faro, which are trypanotolerant. This minority race needs to be preserved.

Number of cattle population

Table 48: Number of cattle population in the Cameroonian portion of the Lake Chad Basin in 2017 (in the northern region) (MINEPAT 2018b)

Categories/Departments	Bullock	Heifer	Castrated	Bull	Cow	Calf	Total
Mayo-Rey	28514	29416	9859	23905	44523	18850	**155067**
TOTAL	**64571**	**64053**	**19261**	**59719**	**135515**	**54870**	**397989**

The number of cattle registered in the region during 2017 is estimated at 397,989 head compared to 345,555 at the end of 2016. We note an increase of 52,434 head, which can be explained by better health monitoring and improved statistical data collection. It should also be noted that the rainy season of 2017 was good and this made it possible to obtain good pastures.

In addition, we note that the cattle population remains high in the Benue (about 40%) and Mayo-Rey (about 39%).

Sheep farming

The majority of sheep are raised in divagation or confinement by some urban producers. There is an increasing presence of small fattening units in urban and peri-urban areas, especially as the sheep sacrifice festival approaches. This livestock constitutes a savings that can be mobilized at any time for several households. The Fulani races predominate in the region.

Number of sheep population

The region's sheep population at the end of 2017 was 179,624 head, an increase of 15,377 head compared to 2016.

Table 49: Number of sheep by department (in heads) (MINEPAT 2018b).

Departements	Rams	Ewes	Castrated	Lambs	TOTAL
Mayo-Rey	14810	22962	5506	11797	**55075**
TOTAL	**41 361**	**84 974**	**6 356**	**46 933**	**179 624**

Goat farming

The Northern region is part of the agro-ecological zone suitable for goat farming. The most common farming method is extensive farming with some variations depending on the departments, seasons and farming locations. As fattening is the only form of intensive livestock farming, it is almost exclusively in urban areas. The Sahelian race is the most widespread.

Number of goat population

The number of goats in the region has increased by 21,560 head compared to 2016. They are summarized by department in the following table:

Table 50: Number of goats by department (in heads) (MINEPAT 2018b).

Departments	Billy goat	Nanny goat	Castrated	Kids	TOTAL 2017	TOTAL 2016
Mayo-Rey	21543	19598	6862	15901	**63 904**	**42 805**
TOTAL	**52 153**	**93 341**	**21 131**	**66 876**	**233 501**	**211 941**

Pig farming

Pig farming is widespread throughout the region. It is mostly a divagation farming. Housing is generally built of local materials and is precarious. Feeding is based on waste, brewery dregs and sometimes on complete feed.

Pig farming faces other challenges such as access to finance, high input costs, low productivity of local breeds of pigs, straying animals, lack of operating infrastructure, poor organization of stakeholders.

Number of pig population

The region's pig population is evolving compared to 2016. This proves that the sector is in the recovery phase on the one hand and, on the other hand, it testifies the difficulties of destocking production due to the ban on sales to the southern part because of the PPP, which was only lifted at the end of December 2017.

Table 51: Number of pigs by department (in heads) (MINEPAT 2018b)

Departments	Boars	Sows	Castrated	Piglets	TOTAL 2017	TOTAL 2016
Mayo-Rey	2878	4025	1465	4333	**12701**	**10 763**
TOTAL	**10 286**	**18 206**	**5 271**	**26 715**	**60 478**	**55 578**

Poultry farming

Poultry farming in the North remains essentially village-based, non-intensive and largely unsupervised; it is decimated each year by Newcastle disease and housed in an inadequate and precarious habitat. However, there are some modern structures in large cities that operate clandestinely outside of a few listed and approved structures.

During this year, the poultry sector was particularly affected by avian influenza surveillance in order to prevent the Northern Region from being contaminated by this epizootic from Nigeria or from other regions that have been infected with this disease.

Number of poultry population

The following table summarizes a situation of the bands that is far below reality due to the lack of basic data in the different categories of this sector. The number of poultries in the region is estimated at 356,057 birds. Compared to last year's headcount, there was an increase of 35,634.

Table 52: Number of poultry population by department (in heads). (MINEPAT 2018b)

	Mayo-Rey	Total
Table type chicks	0	**633**
Laying chicks	0	**1 897**
Cockerel chicks	0	**0**
Broiler chickens	0	**708**
Laying chickens	0	**1 078**
Unfit	0	**0**
Young roosters	0	**4 666**
Village chickens	92678	**274 598**
Breeding animals	0	**0**
Ducks	12560	**48065**
Pigeons	2406	**10 464**
Guinea fowls	1798	**12 568**
Peacocks	0	**121**
Turkeys	6	**890**
Quails	0	**12**
Geese	0	**274**
Capons	0	**83**
TOTAL	**109 448**	**356 057**

Milk production

The following table is a summary of the information available in the milk and milk products sector.

Table 53: Summary of milk production in the northern region of Cameroon, 2017 (MINEPAT 2018b).

Departements	Fresh milk			Curdled milk			Yogurt							Butter			Chesse			TOTAL OF GENERATED RESOURCES
							Traditional			Modern										
	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Total de Generated resources (in millions FCFA)	Quantity (in kg)	Average price of one kg	Generated resources (in millions FCFA)	Quantity (in kg)	Avrage price of one kg	Generated resources (in millions FCFA)	
Mayo-Rey	78548	275	**21.6**	83779	210	**17.59**	46363	350	**16.22**	0	1000	**0**	**16.22**	10301	2500	**25.75**	0	0	0	**81.17**
TOTAL	**385854**	**305.25**	**118.57**	**317246**	**265**	**90.11**	**314794**	**484.5**	**173.14**	**22322**	**768.75**	**22.99**	**196.14**	**19923.5**	**2725.5**	**54.77**	**0**		**0**	**459.61**

Milk production has increased slightly compared to last year. The quantity of fresh milk produced in 2017 was 385,854 liters compared to 330,528 in 2016. This can be explained by the good rainfall recorded this year, which guarantees good pastures.

As for derived products, the quantities recorded are 317,246 liters for curdled milk; 19923.5 kg for butter; 314,794 liters for traditional yoghurt and 22,322 liters for modern yoghurt.

Adamaoua Region

The departments of Mbéré and Vina are part of the Lake Chad Basin.

Sheep farming

Number of sheep population

Table 54: Number of sheep by department (in heads) (MINEPAT 2018a)

Departments	Rams	Ewes	Castrated	Lambs	TOTAL
Mbere					**27 350**
Vina					**20 841**
TOTAL					114 381

Number of goat population

Table 55: Number of goats by department (in heads) (MINEPAT 2018a)

Departments	Billy goat	Nanny goat	Castrated	Kids	TOTAL ongoing year
Mbere					**30 000**
Vina	7898	7255	799	6940	**23179**
TOTAL					113 595

Number of poultry population

Table 56: Number of poultries by department (in heads) (MINEPAT 2018a)

	Mbere	**Vina**	**Total**
Table type chicks	00	7000	7000
Laying chicks	00	5000	5000
Cockerel chicks	00	2000	2000
Broiler chickens	31325	51550	93533
Laying chickens	8754	10906	37893
Unfit	00	0	5319
Young roosters	00	456	456
Village chickens	67404	72820	356396
Breeding animals	00	1000	1000
Ducks	2318	1387	15298
Pigeons	2850	669	6715
Guinea fowls	80	139	818
Peacocks	06	2	20
Turkeys	135	40	206
Quails	00	0	0
Geese	185	41	330
Capons	00	0	0
TOTAL	**113057**	**153010**	**531984**

Milk production

Table 57: Summary of milk production in the Adamaoua region of Cameroon, year 2017 (Source: RAPPORT SUR LE DEVELOPPEMENT ECONOMIQUE DE LA REGION DU NORD (RADEC) 2017)

Departments	Fresh milk			Curdled milk			Yogurt							Butter			Cheese			TOTAL OF GENERATED RESOURCES
							Traditional			Modern										
	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Quantity (in liter)	Average price of one liter	Generated resources (in millions FCFA)	Total de ressources générées (en millions de FCFA)	Quantity (in kg)	Average price of one kg	Generated resources (in millions FCFA)	Quantity (in kg)	Average price of one kg	Generated resources (in millions FCFA)	
Mbere	1025207	400	410,08	25133	300	7,54	0	0	0	22669	500	11,33		13903	3500	48,6	273	8000	2,18	482107450
Vina	2050414	400	820,17	53298	500	26,65						36,35				1,68			5,59	451316500

5.3.1.2 Niger

Niger's geographical position makes it a livestock area that is the preferred domain of nomads. Livestock farming occupies an important place, it is the second most important economic sector in the country. This sector represents 13% of the national GDP and 35% of the agricultural GDP. In this respect, Niger remains the largest supplier of livestock to countries such as Nigeria.

Species

Livestock farming occupies a prominent place in the Nigerien economy. Its restructuring and development are a priority for the Nigerien government. Several actions have been undertaken to increase animal production. These actions include the protection of grazing areas and the improvement of the health of the livestock, which is composed of cattle, sheep, goats, camels, horses and donkeys.

Livestock Population

Table 58: Livestock census in the Nigerien part of the Lake Chad Basin in 2018 (Source of data: Diffa and Zinder Regional Livestock Directorate)

Region	Cattle	Sheep	Goats	Camels	Horses	Donkeys	TLU
Diffa	1 368 967	929 473	1 459 068	421 198	50 519	172 984	2 011 664
Zinder	3 003 656	3 231 791	4 816 109	253 358	147 109	335 673	4 178 413
Total	4 372 623	4 161 264	6 275 177	674 556	197 628	508 657	6 190 077

5.3.1.3 Nigeria

Table 59 provides information on the number of holdings by size of livestock and place of residence among households who own or raise animals. About 84 percent of households do not own a calf. At least 8.5 percent own between 1 and 4 head of cattle. Only 0.8 percent own more than 50 head of cattle. At least 53.8 percent of households own 1 to 9 head of sheep, goats or pigs, and 21 percent own between 10 and 49 head of the same, while only 0.8 percent own more than 50 head. Ownership of horses, oxen, bulls and donkeys, however, is not as common in the country, with a maximum of 8 percent ownership of any number of livestock in this category. Moreover, about 40 percent of households own 1 to 9 head of poultry while 26.8 percent own 10–49 head (NBS; Ministry of Agriculture and Rural Development; WB 2016).

Table 59: Holding by Size of Livestock and Place of Residence (% of livestock owning Households)

Region	North Central	North East	North West	South East	South South	South West	Urban	Rural	NGA
Calf/Cow/Heifer									
None	82.6	75.5	77.8	98.9	99.8	97.5	93.5	82.8	84.3
1-2 head	2.1	6.9	10.8	0.3	0.0	0.0	1.3	6.2	5.6
3-4 head	2.2	5.0	4.2	0.0	0.0	1.0	4.2	2.6	2.9
5-9 head	2.1	4.5	2.5	0.3	0.0	0.0	0.4	2.4	2.1
10-19 head	3.3	3.8	1.7	0.0	0.2	0.0	0.3	2.1	1.9
20-49 head	5.1	3.5	2.4	0.4	0.0	1.5	0.3	2.9	2.5
50+ head	2.5	0.8	0.6	0.0	0.0	0.0	0.0	0.9	0.8

Sheep, Goats and Pigs									
None	31.5	18.2	9.5	38.9	53.0	42.4	28.5	23.8	24.5
1-4 head	30.1	17.4	29.3	40.5	29.8	31.7	34.0	28.5	29.3
5-9 head	20.9	24.9	34.8	12.0	11.8	17.2	27.1	24.1	24.5
10-49 head	16.1	38.9	25.5	8.4	5.4	7.9	10.0	22.8	21.0
50+ head	1.4	0.7	0.9	0.2	0.0	0.8	0.4	0.8	0.8
Horse, Ox, Bull and Donkeys									
None	91.6	65.0	74.7	99.6	100.0	100.0	98.2	80.7	83.2
1-2 head	1.3	8.5	17.1	0.0	0.0	0.0	1.8	9.0	8.0
3-4 head	1.3	19.2	5.8	0.4	0.0	0.0	0.0	6.6	5.7
5-9 head	1.6	5.8	1.6	0.0	0.0	0.0	0.0	2.2	1.9
10+ head	4.1	1.5	0.8	0.0	0.0	0.0	0.0	1.5	1.3
Poultry									
None	24.6	31.3	41.7	21.9	24.3	23.1	36.5	30.7	31.5
1-9 head	46.0	36.1	35.2	47.2	41.3	43.6	38.5	40.3	40.0
10-49 head	28.3	32.1	22.4	29.8	25.1	28.1	20.5	27.8	26.8
50+ head	1.0	0.5	0.6	1.2	9.3	5.2	4.5	1.2	1.7

An overview of the actual number of livestock by type of animal and geographical region of households is presented in Table 60. Goats (67.3%) and chickens (64.8%) are the most commonly owned animals, followed by sheep (33.1%), and cows (15.1%). Male-headed households, on average, own more animals than female-headed households, with a maximum of 64.4 percent of male-headed households and 67.5 percent of female-headed households owning chickens. Regionally, the most common animals owned by households across all regions are goats and chickens (NBS; Ministry of Agriculture and Rural Development; WB 2016).

Table 60: Livestock Ownership by Type of Animal and Region of Residence (% of Livestock Owning Households)

Region	**Calf Female**	**Calf Male**	**Cow**	**Bull**	**Ox**	**Goat**	**Sheep**	**Chicken Local**	**Duck**	**Guinea Fowl**
North Central	2.3	2.1	17.2	7.6	2.5	61.1	18.5	73.9	4.4	1.3
North East	5.8	5.3	23.5	15.6	19.4	72.1	42.1	66.2	8.8	4.0
North West	2.5	3.5	21.0	15.4	3.8	79.1	57.8	55.9	1.3	9.6
South East	0.0	0.0	1.1	0.0	0.0	56.0	6.9	74.2	0.0	0.0
South South	0.0	0.0	0.2	0.0	0.0	45.8	0.7	60.9	2.3	0.0
South West	0.0	0.0	2.5	0.0	0.0	53.7	4.9	68.9	2.7	0.0
Urban	0.0	0.0	6.5	1.4	0.4	58.8	24.9	55.4	1.6	1.2
Rural	2.7	3.0	16.5	11.0	5.9	68.7	34.4	66.3	3.4	4.9
NGA	2.3	2.6	15.1	9.6	5.2	67.3	33.1	64.8	3.1	4.4
Male-headed households	2.6	3.0	17.1	10.7	5.8	68.5	36.6	64.4	3.3	5.0
Female-headed households	0.2	0.0	1.7	3.1	1.1	59.2	10.3	67.5	1.8	0.5

5.3.1.4 Central African Republic

The data collected do not allow us to highlight the part of the basin from Lake Chad in CAR.

5.3.1.5 Chad

Livestock farming in Chad is carried out in three very different ways: sedentary, nomadic and transhumant. These three modes are found through the following pastoral systems:

In the Saharan zone

Two pastoral systems have been recognized in the Saharan region. These are the Piedmont type pastoral system linked to water resources, which is concentrated in the vicinity of the hills, generally in the immediate vicinity of the foothills, and the Western Kanem pastoral system, where herders have very short journeys, limited to the wadis they exploit and where they grow rainfed cereals and sometimes cultivate gardens.

In the Sahel Zone

These are pastoral systems that are growing as we approach the border with Sudan. The movements range from a few kilometers covered annually by the herds of the large wadis in South Kanem, to several hundred kilometers in eastern Chad. Six pastoral systems coexist in the Sahel and differ according to the regional characteristics of the flows and the annual distribution of pastoral resources. These are:

1. The pastoral system of the lake sector: in Lake Chad, herders use herds of bulls to farm the hundreds of receding pastures of the islands, archipelagos that show up as the level of Lake Chad drops.
2. The pastoral system of Eastern Kanem, where the movements of pastoralists can be assimilated to annual oscillations made in relation to the Bahr El Ghazal axis. At the end of the dry months, they head south, to the level of the road from Massakory to Ati, to wait for the rainy front to pass them. As soon as they believe that the Saharan grasslands have enough ponds, they "go up" to them, passing through the surface waters concentrated in the Bahr-El-Ghazal valley.
3. The pastoral system of the Western Batha: herders spend at least nine months of the year at Fitri Lake, where their herds graze the burghers in accordance with customary rules passed with the sedentary people.
4. The pastoral system of the East Batha: depending on the year, pastoralists spend nine to ten months outside their administrative capital, Oum-Hadjer, going south so as not to have to draw from the very deep wells of their sub-prefecture, because they have very large herds. Depending on their starting positions, they reach the lakes and large ponds of Salamat by bypassing the Guéra massif to the east or west. They rise quickly at the beginning of the winter, so as not to be cut off from the northern rainy season parking lots by the wadis in flood.
5. The pastoral system in eastern Chad has as wide a range of nomadization as that of previous pastoralists. When herders begin their descent southward, they often abandon barely exploited pastures, because the wells in these dark regions in hard, heavily faulted terrain quickly dry up.
6. Finally, the pastoral system is changing and transhumant: in all sedentary villages there are herders who often own large herds of zebus and small ruminants. In the dry season, they move more or less away from villages in search of pastures. In the

wintering season, the owners entrust their livestock to transhumant herders during the summer migrations to devote themselves to their agrarian activities.

In the Soudanese Zone

This part of the country is mainly devoted to cotton cultivation in all the regions west of the Chari River. However, there are four pastoral systems:

1. A generalized system of village livestock and harnessed crop livestock (stirring and transhumance) which, as we move closer to the major provincial centres, crystallizes more and more small speculative herds. These agro-pastoral situations are limited by the locally available water resources.
2. The river pastoral system developed along major rivers and constituted by large herds of zebus, since animals have the possibility of drinking all year round at the level of permanent rivers. Very often during the rains, they carry out short transhumances rather intended to keep the herds away from the crops than to carry out a real wintering transhumance.
3. A Fulani pastoral system, specific to Chari-Baguirmi, which, by embracing regional mobility during the dry months, begins a transhumance before the rains, all the earlier as the dry season stretches in length, towards the villages of Lake Chad.
4. Foreign pastoral systems, originating from Cameroon and CAR, including Fulani sheep and cattle breeders, which pass through the southern sub-prefectures. They enter Chad with the first rains and go as far as the Sahel zone, and even to the margins of the Saharan zone during rainy years. This "foreign" transhumance, evaluated in 1988 at one third of the animals in Western Chad, does not use hydraulic infrastructures since it bases its progress on wintering ponds.

Number of livestock

As shown in Table 61 below, the number of Chadian livestock stands at 93,803,192 livestock units and 34,638,609 poultry heads, according to the results of the general livestock census. These numbers, although significant, are however unevenly distributed among the species raised, between the geographical areas of the country and between the farming methods used.

Table 61: Number and proportion of different species of animals raised
(FAO/MEPA/INSEED; 2016)

Species of animals raised	Number of main species	Proportion of livestock
BEEF	24 892 098	26.5
SHEEPS	26 436 170	28.2
GOATS	30 519 349	32.5
CAMELINS	6 413 521	6.8
SHORTS	1 073 498	1.1
HORSE	2 804 210	3.0
PIGS	1 664 346	1.8
TOTAL LIVESTOCK	93 803 192	100.0
POULTRY FARMING		
CHICKS	26 554 643	76.6
TOTAL POULTRY	3 463 869	100.0

The "livestock group", mainly composed of ruminants, is dominated by goats (32.5% of the population), sheep (28.2%), cattle (26.5%) and camels (6.8%). Other livestock species, such as donkeys, horses and pigs, are poorly represented. For the poultry livestock, the number of individuals is estimated at 34.6 million, including 26.6 million chickens (76.7% of the workforce). Other poultry include ducks, geese, guinea fowls and pigeons. This distribution by species, however, hides a great disparity in the spatial distribution of the different categories of animals.

The number of livestock is estimated at 93,803,192. The study of the geographical location of the different species that make up this group shows that the regions of Batha with 12.6% of the population, Wadi Fira and Ouaddaï (9%) and Kanem and Lac (7%) have the highest numbers (see Table 62). The same distribution is observed for the bovine species and the "small ruminants" group, with respectively 17.1% and 11% of the numbers recorded for the Batha region, 8.5% and 9.4% for the Ouaddaï, 5.1% and 10.2% for the Wadi Fira, 8.4% and 7.1% for the Kanem and, finally, 7% and 7.2% for the Lake.

Table 62: Distribution of livestock numbers by region and raised species (FAO/MEPA/INSEED; 2016)

REGION	BOVINS	SHEEPS	GOATS	CAMELINS	SHORTS	HORSES	PIGS	POULTRY
Batha	4269086	3273951	3000143	912951	113549	227842	**-**	2072316
Borkou	338073	1670439	1506359	1243247	101712	209616	-	539435
Chari-Baguirmi	1645654	1131051	1091804	31924	65660	107486	59923	2221386
Guéra	1308618	766481	1390785	66333	57865	147668	449	1238830
Hadjer-Lamis	1841028	1177558	1543302	56834	72891	133445	2719	1271511
Kanem	1745311	1987703	2107955	467663	100228	245239	-	696781
Lac	2080248	980306	3039149	102100	60247	242777	-	1031998
Logone Occidental	332165	322336	364022	3717	2532	2325	98234	1573383
Logone Oriental	1194985	1248839	1722018	6138	12606	30120	789309	5755978
Mandoul	665156	413889	597397	3636	9789	20543	138775	1668937
Mayà-Kebbi Est	1248136	1197749	1841877	20907	29202	55882	135296	5121074
Mayo-Kebbi Ouest	783534	530985	689950	7321	2582	28090	158246	2174030
Moyen-Chari	465538	148552	346404	8137	4152	9679	46126	734853
Ouaddaï	2119020	2569953	2791917	100067	131247	413589	-	1885932
Salamat	1503291	925103	877852	90927	70397	133173	-	1296731

Tandjilé	398470	323069	631178	1304	17915	17017	224740	2198864
Wadi Fira	1258654	3537754	2255374	898478	83277	221109	-	854662
N'Djaména	99386	120056	120591	650	1607	1637	10529	418463
Barh-El-Gazal	746865	720033	814986	290296	46980	126084	-	351250
Ennedi East	46979	1088869	1069943	496346	15399	82638	-	31095
Ennedi West	82214	1104297	804736	1299612	21777	66431	-	346618
Sila	719689	1033371	1439026	117759	48944	216930	-	1033363
Tibesti	-	163826	472583	187175	2942	64891	-	121118
Total	24892098	26436170	30519349	6413521	1073498	2804210	1664346	34638609

5.3.1.6 Conclusion Livestock Farming

The Lake Chad Basin area is an ideal livestock area. This makes this sector the second largest contributor to GDP in this part of the world.

For the future, it will be necessary to have a framework that provides the information needed to feed the AMR. However, it will also be necessary to work with countries to enable them to collect the types of data that the AMR needs and the results of the analysis will enable politicians to make significant decisions to promote this sector.
Given the importance of transhumance for livestock farming in this area, an effort must be made to ensure that animal movements are properly managed in order to minimize conflicts between herders and farmers.

5.3.2 Fishery (Aquaculture)

In terms of fish species, the lake basin has a high diversity of fish species, with about 120 to 140 species distributed between Lake Chad and the main rivers that supply it with water, with disparities according to ecological characteristics. However, the basin does not have an endemic species.

Fishing and aquaculture contribute to food and nutritional security and gross domestic product. A study was carried out in 2014 as part of the development of the Lake Chad fisheries management plan using the ecosystem approach to fisheries. The result is presented in the following table.

Table 63: Value of fishing in Lake Chad and its contribution to GDP (Source of data: National AEP Reference Reports from 2014)

Country	Year	Quantity (t/years)	Selling price (local currency /kg)	Value in local currency (millions)	Value in dollars (millions)	Added value ratio	Added value (in millions of dollars)	GDP (in millions of dollars)	% GDP
Niger	2013	20,160	600	12,096	25	0.77	19	6,381	0.30%
Cameroon	2013	2,100	2,000	4,200	9	0.77	7	26,410	0.02%
Chad	2012	36,000	1,100	39,600	81	0.77	62	10,450	0.60%
Nigeria	2012	45,000	400	18,000	106	0.77	82	245,229	0.03%
All countries		103,260			220	0.77	169	288,470	0.06%

Table 64**:** Annual catches by fishermen, as estimated by the total reported catch and the number of fishermen per country (Source of data: National AEP Reference Reports from 2014)

Country	Year	Quantity (t/year)	Number of fishermen	Annual catch per fisherman (kg/year)
Niger	2013	20,160	40,000	504
Cameroon	2013	2,100	6,870	306
Chad	2013	36,000	6,941	-[3]
Nigeria	2013	45,000	150,000	300

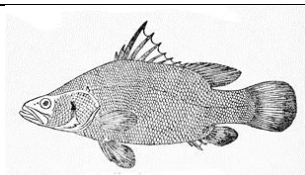
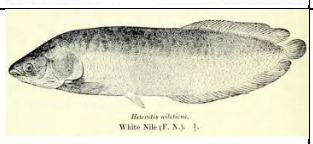
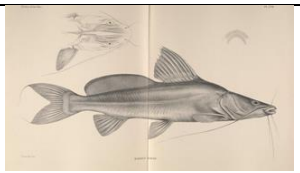
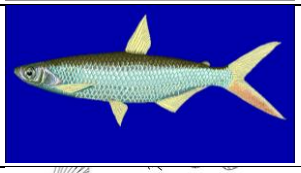
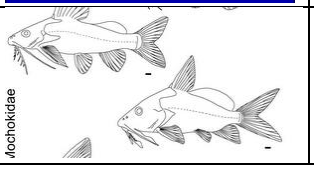
Since 2015, the insecurity problem linked to Boko Haram has led to the cessation of almost all fishing activities on Lake Chad and in the Komadugu-Yobe River, in the part where it flows into Lake Chad.

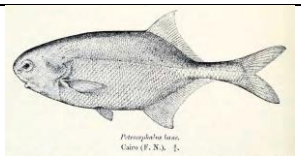
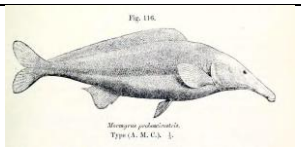
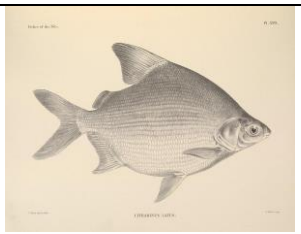
[3]Ne peuvent être calculés

5.3.2.1 Cameroon

The fish species found in Cameroon are presented in the following table.

Table 65: Fish species encountered in Cameroon (Data provided by MINEPIA, Far North Regional Delegation in Maroua in 2018)

Name	Local name	Photo (wikipedia)	Department	Water body
Oreochromis niloticus (family Cichlidae)	Carpe (parawé)		Logone and Chari; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Clarias gariepinus (family Clariidae)	Silure		Logone and Chari; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Lates niloticus (family Latidae)	Capitaine		Logone and Chari; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Heterotis niloticus (family Arapaimidae)	Kafka or Kanga		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Protopterus annectens (family : Protopteridae)	Boinadji		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Bagrus sp (family Bagridae)	Machoiron	 	Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Alestes baremoze (family Alestidae)	Sardine		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Synodontis sp (family Mochokidae)	Kouroungou		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré

Petrocephalus sp (family Mormyridae)	Soud da moukka		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Mormyrus rume (family Mormyridae)	Soudda moukka		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Citharinus sp (family Citharinidae)	Disque		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Tetraodon linaetus (family Tetraodontidae)	Poisson ballon		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Malapterurus electricus (family Malapteruridae)	Poisson électrique		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Gymnarchus niloticus (family Gymnarchidae)	Dangsarki		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré
Hydrocynus sp (family Alestidae)	Gnihédji		Logone and Chari ; Mayo-Danay	Logone river and its tributaries, Waza floodplain; Maga reservoir and lake of Guéré

The fishing production in the Cameroonian part of Lake Chad is presented in the following table:

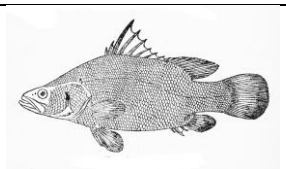
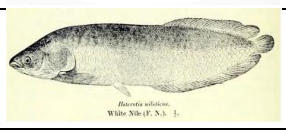
Table 66: Fishing production from 2013 to 2017 in the Cameroonian part of the Lake Chad Basin

Department	Year	Quantity of fish caught in tons
Logone and Chari	2013	2,280.41
	2014	929.12
	2015	807.18
	2016	3,960
	2017	941.681
Mayo-Danay	2013	5,067.90
	2014	723.181
	2015	671.45
	2016	1,237.77
	2017	879.557
Part of the lake Chad	2013	2,100

5.3.2.2 Niger

The fish species found in Niger are presented in the following table.

Table 67: Fish species encountered in Niger

Name	Photo (wikipedia)
Oreochromis niloticus (family Cichlidae)	
Tilapia zillii (family Cichlidae)	
Sarothrodon galilea (family Cichlidae)	
Clarias spp.(family Clariidae)	
Lates niloticus (family Latidae)	
Heterotis niloticus (family Arapaimidae)	

Protopterus annectens (family Protopteridae)	
Bagrus bayad (family Bagridae)	
Auchenoglanis occidentalis (family Claroteidae)	

Fishing production in the Nigerien part of Lake Chad is presented in the following table:

Table 68: Fishing production in the Nigerien part of the Lake Chad Basin between 2013 and 2017 (Source of data: Regional Directorate of Environment of Zinder (2017))

Année	**Production (in tons)**	**Observation**
2013	20,447	
2014	20,469	
2015	248	This production trend is affected by insecurity due to the Boko Haram group from 2015 onwards
2016	151	
2017	251	

Aquaculture production in the Nigerien part of the Lake Chad Basin is insignificant.

5.3.2.3 Nigeria

Fishing production by species and sector in Nigeria in 2015 is presented in the following tables. The LCBC does not have data by region and for the year 2017/2018.

Table 69: Nigeria's fish production per species in 2015 (National Bureau of Statistics (NBS) 2017)

FAO ENGLISH NAME	**SCIENTIFIC NAME**	**2015**
TILAPIAS	HEMICHROMIS /OREOCHROMIS	95319
MOONFISH CARPS	CITHARINUS SPP.	15257
AFRICAN CARPS	CYPRINIDAE	45562
AFRICAN LUNGFISHES	PROTOPTERUS SPP.	6595
BONYTONGUEFISHES	HETEROTIS SPP.	22059
UPSIDEDOWN CATFISHES	SYNODONTIS SPP.	16589
TIGERFISH	CHARACIDAE	18356
BAGRID CATFISHES	CHRYSICHTHYS, CLAROTES	15871
BAGRID CATFISHES	AUCHENOGLANIS OCCIDENTIALS	3041

TORPEDO-SHAPED CATFISHES	HETERBRANCHUS,	80186
TORPEDO-SHAPED CATFISHES	CLARIAS SPP.	112330
TORPEDO-SHAPED CATFISHES	CLARIAS LAZERA	22324
SNAKEHEADS	CHANNA (OPHICEPHALUS) SPP	21507
NILE/NIGER PERCH	LATES NILOTICUS	27092
SEACATFISHES	ARIIDAE	17444
SOLES	SOLEIDAE	4285
TONGUEFISHES	CYNOGLOSSIDAE	12888
SNAPPERS	LUTJANUS SPP	9742
BIGEYE GRUNTS	BRACHYDEUTERUS AURITUS	2992
GRUNTERS	HAEMULIDAE (POMADASYIDAE)	8362
WEST AFRICAN CROAKERS	PSEUDOTOLITHUS SPP	14499
CROAKERS DRUMS	SCIAENIDAE	12351
SPADEFIHES	EPHIPPIDAE	1688
ELECTRIC/SCORPION/CATFISHES	MALAPTERURUS SPP	8745
NEEDLEFISHES	BELONIDAE	537
FLYINGFISHES	EXOCOETIDAE	614
BARRACUDAS	SPHYRAENA SPP	18681
MULLETS	MUGILIDAE	11967
SHINYNOSE	POLYDACTYLUS QUADRIFILIS	20675
THREADFIN	GALEOIDES DECADACTYLUS	7134
JACKS, CREVALLES	CARANX SPP	460
JACKFISH	CARANGIDAE	562
MADEIRAN SARDINELLA	SARDINELLA MADERENSIS	15115
SHAWA	SARDINELLA SPP	7473
BONGA SHAD	ETHMALOSA FIMBRIATA	26505
LADYFISH	CLUPEOIDEI	1227
TUNA-LIKE FISHES	SCOMBROIDEI	344
GRASSEATERS	DISTICHODUS SPP	13328
MACKEREL LIKE-FISHES	SCOMBROIDEI	3912
SHARKS, SKATES	ELASMOBRANCHII	14038
RAYS, STINGRAYS, MANTAS NEI	RAJIFORMES	6867
MARINE CRABS	BRACHYRA (CALLINECTES)	4679
PALINURID SPINY LOBSTERS	PALINURUS SPP	5216
SOUTHERNPINK SHRIMPS	PENAEUS NOTIALIS	9889

PRAWN	PANDALIDAE	4737
FAO ENGLISH NAME	SCINTIFIC NAME	2015
CRAYFISH (EDE)	NATANTIA	15889
TRUNKFISH	GYMNARCHUS SPP	19075
ELEPHANTSNOUT	MORMYRIDAE, GNATHONEMS SPP	28813
MARINES FISHES	OSTEICHTHYES	41578
FRESH WATER FISHES	OSTEICHTHYES	13926
SMOKED FISHES		79857
NAKED CATFISHES	BAGRUS SPP	9052
GLASSCATFISHES	PHYSAILIA SPP	1803
AFRICAN(RIVER)PIKE	HEPSETUS ODOE	5728
SAILFINS/BIRCHIR	POLYPTERUS SPP	687
AFRICAN KNIFEFISHES	NOTOPTERUS NIGRID	491
BUTTER FISH	EUTROPIUS, SCHILBE SPP	7082
EGERIA (BENGUELA HAKE)	MERLUCCIUS POLLI	2685
PERIWINKLES (GASTROPODS NEI)	LITTORINA SPP.(GASTROPODA)	5637
RIBBON FISH (LARGEHEAD HAIRTAIL)	TRACHIPTERIDAE	2992
CUTLASS/SILVERFISH	TRICHIURIDAE	2252
GOLDEN FISH	CARASSUS AURATUS	378
GROUPERS	EPINEPHELUS SPP	4833
ARROWFISH/SWORDFISH	XIPHIAS GLADIUS	153
FEATHER-BACK (RETICULATE KNIFEFISH)	PAPYROCRANUS SPP	14422
EELFISH		145
CUTTLEFISH, BOBTAIL SQUIDS	SEPIIDAE, SEPIOLIDAE	536
TOTAL		1027058

Table 70: Nigeria's fish production by sector (National Bureau of Statistics (NBS) 2017)

	Secteur	**2014**	**2015**
Artisanal	Coastal & Brackish Water	435 384	382 964
	Inland : Rivers & Lakes	324 444	311 903
	Sub-Total	759 828	694 867
Aquaculture	Sub-Total	313 231	316 727
Industrial	Fish (Inshore)	29 237	10 727
	Shrimp (Inshore)	20 715	4 737
	EEZ	-	-
	Sub-Total	49 952	15 464
Grand Total		1 123 011	1 027 058

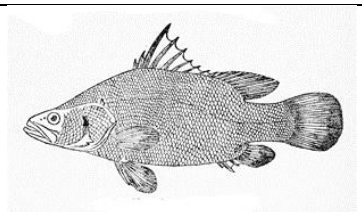
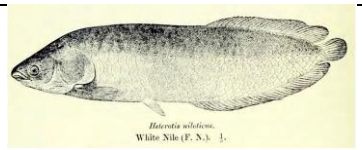
5.3.2.4 Chad

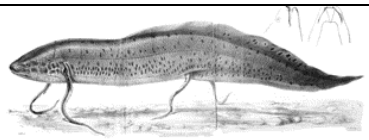
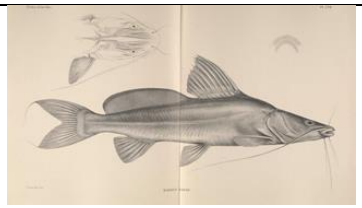
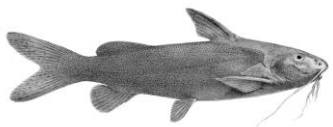
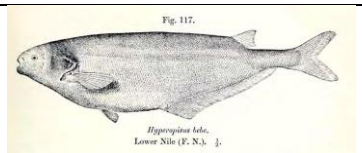
With a production of several hundred million tons each year, fishing is practiced in the Lake Chad Basin by several thousand small craftsmen and many households. They use traditional boats and devices on the lake, rivers, floodplains.

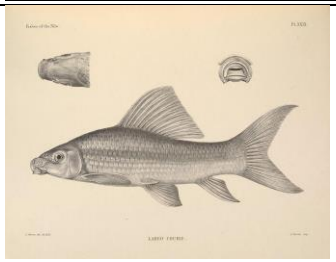
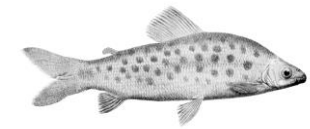
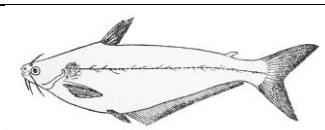
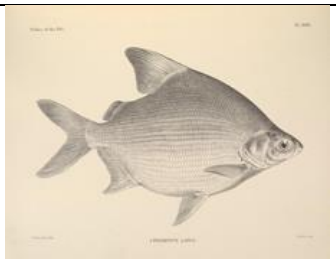
Fishermen catch a wide variety of fish species estimated at 176 according to an ORSTOM study in the 1960s. A significant portion of the catch is either smoked or dried. These products then enter a well-organized commercial circuit that extends to urban markets in southern Nigeria such as Lagos, Ibadan, Onitsha, Enugu, where smoked and dried fish are highly prized.

The fish species found in Chad are presented in the following table.

Table 71: Fish species encountered in Chad (Source: FAO, Photos Wikipedia)

Name	**Local name**	**Photo (Wikipedia)**	**Commercial importance**
Tilapia spp	Carpe		+++
Clarias spp.(family Clariidae)			+++
Lates niloticus (family Latidae)	Capitaine		+
Heterotis niloticus (family Arapaimidae)	Kafka ou Kanga		+

Name	**Local name**	**Photo (Wikipedia)**	**Commercial importance**
Protopterus annectens (family : Protopteridae)	Boinadji		+
Bagrus sp (family Bagridae)	Machoiron	 	++
Auchenoglanis occidentalis (family Claroteidae)			++
Gymnarchus sp (family **Gymnarchidae)**			+
Alestes sp (family Alestidae)			+++
Mormyrus sp (family Mormyridae)			+++
Mormyrus nurs (family Mormyridae)			+++
Synodontis shall (family Mochokidae)			+++
Hyperopisus (family Mormyridae)			?

Name	**Local name**	**Photo (Wikipedia)**	**Commercial importance**
Polypterus (family Polypteridae)			?
Labeo coubea (family Cyprinidae)			++
Distichodus sp (family Distichodontidae)			+
Schilbe mystus (family Schilbeidae)			+
Citharinus (famille Citharinidae)	Disque		+

+ + + very high proportion of the quantities caught
+ + medium proportion of the quantities caught
+ very small proportion of the quantities caught

Fish is very important for food security in Chad. Of the total fish production, it is estimated that about 44 percent is for export and the remaining 56 percent is consumed domestically (CIMA/SOGEC International, 2002).

In the absence of infrastructure such as wharves, hangars and concrete areas, fish are generally landed on a beach or easily accessible area. The landing stages are disparate and all along the rivers, around the ponds and lakes, the landing of fish is done near the camps and villages of the fishermen, i.e. where the pirogues of the latter can land.

However, there are a few main landing sites, including

- Yao for Lake Fitri where the fish is dried to supply the markets of N'Djaména, Moundou...;
- Kinasserom, Fitiné and Koulfoua from the islands of Lake Chad where the fish is smoked in "banda nigeria" and then transported to the Nigerian markets;

- Guité, Mittériné and Mahada, villages located south of Lake Chad where fresh fish

from Lake Chad is transported to the Dembé market in N'Djaména;

- Mallam and Roro, two villages where the fish from Lake Iro is processed for markets in Sarh, Moundou and the Central African Republic;

- Léré (Fouli district) where the fish from Lac Léré is processed and destined for the surrounding markets of Léré, Kélo, Pala...;
- Fianga and Tikem where the fish from Lake Tikem is processed and sold;

- Logone Gana, a village located along the Logone River about 100 km south of N'Djaména where collective fishing is practiced. The fish caught is either sold fresh or processed and is generally destined for the markets of N'Djaména;
- Kouno, a village located along the Chari River about 400 km southeast of N'Djaména where fish mainly processed into "banda bangui" is destined for the markets of Sarh, Moundou and the Central African Republic.

Due to lack of available data, we cannot present the production of some species for the year 2017/2018.

5.3.2.5 Conclusion Fishery

The data collection technique is very disparate from one country to another. This does not allow a good analysis of the data collected.

In addition to these difficulties, there was also the problem of insecurity linked to the Boko Haram sect. This has almost halted fishing activities on Lake Chad and the Komadugu Yobe River in the part where it flows into the Lake Chad.

The static data collection situation has already been studied for the establishment of a permanent system for the collection, processing and analysis of data on fisheries and aquaculture. Unfortunately, the security situation on Lake Chad has not made it possible to implement this technique, which is postponed to a later date.

With regard to the aquaculture situation, outside the Nigerian part of the Lake Chad Basin, this activity is still in an initial phase.

In terms of fish species, the Lake Basin has a high diversity of about 120 to 140 species distributed between Lake Chad and the main rivers that supply it with water, with disparities according to ecological characteristics. However, the basin does not have endemic species.

Despite all these constraints, fishing and aquaculture contribute to food and nutritional security and gross domestic product. A study carried out in 2014, as part of the development of the Lake Chad Fisheries Management Plan using the ecosystem approach, estimated fishing production on Lake Chad (Cameroon, Niger, Nigeria and Chad) at around 100,000 tons of fresh fish in 2013. That is the equivalent of US$220 million.

If reliable data on fisheries and aquaculture production were available, analyses could be carried out to see the sector's contribution to food and nutritional security in accordance with FAO recommendations that require a per capita consumption of 21 kg/capita per year for a good balanced diet.

The result of this type of analysis will enable policies to take significant action so that fisheries and aquaculture contribute to the fight against food and nutritional insecurity, economic growth and poverty reduction.

5.3.3 Agriculture

The collection of data on agricultural production is not carried out in the same way in the different countries, i.e., the methodologies used are different, which makes it difficult to interpret the results. However, the way Chad collects data is interesting because it provides a situation with respect to the measures to be taken for food and nutritional security.

5.3.3.1 Cameroon

Agricultural systems

The following principal crops are grown:

- maize
- sorghum
- rice
- cowpea

Yield by crop

Table 72: Situation of the areas planted, yields and production in 2017 by speculation (cultivation) and by department of the Far North region (Source: Agricultural season 2017, Ministère de l'Agriculture et du Développement rural (MINADER), 2018)

Crop	Departments	Department level			Region level (Far North)		
		Areas (Ha)	Productions (T)	Yields (T/Ha)	Areas (Ha)	Productions (T)	Yields (T/Ha)
Sorghum	Diamaré	89330	85209.19	1.85	442430.77	508278.48	13.94
	Logone et Chari	34397.2	31912.61	1.81			
	Mayo Danay	84529.6	91549.16	3.34			
	Mayo Kani	87423	124956.61	2.83			
	Mayo Sava	65179.73	63129.17	1.71			
	Mayo Tsanaga	81571.25	111521.75	2.40			
Maize	Diamaré	9999	11458.85	1.15	113667.06	196381.07	11.29
	Logone et Chari	26033	38915.98	3.65			
	Mayo Danay	6707.50	9242.94	1.38			
	Mayo Kani	15772.25	30553.55	1.94			
	Mayo Sava	4953.31	5805.76	1.17			
	Mayo Tsanaga	50202	100404.00	2			
Millet	Diamaré	1418	1411	0.99	27121.14	25788.57	5.43
	Logone et Chari	159.60	93.28	0.58			
	Mayo Danay	7780	6355.65	0.82			
	Mayo Kani	4822.3	5492.80	1.14			
	Mayo Sava	7435.24	7480.44	1.00			
	Mayo Tsanaga	5506	4955.40	0.90			
Rice	Diamaré	881	1439.00	1.63	46446.96	126881.97	22.59
	Logone et Chari	12212	20484.5	5.66			
	Mayo Danay	28510.9	97962.39	10.77			
	Mayo Kani	1479.1	3538.13	2.39			
	Mayo Sava	656.36	750.35	1.14			
	Mayo Tsanaga	2707.6	2707.60	1			

Cowpea	Diamaré	11409	10537	0.92	99501.85	80668.11	5.29
	Logone et Chari	11792.5	13790.1	1.30			
	Mayo Danay	12634.4	10107.52	0.80			
	Mayo Kani	15613.25	15784.98	1.01			
	Mayo Sava	23747.7	15136.36	0.63			
	Mayo Tsanaga	24305	15312.15	0.63			
Groundnut	Diamaré	2763	2143.00	0.78	604060.63	102428.12	5.02
	Logone et Chari	25	5	0.20			
	Mayo Danay	18039	10823.40	0.60			
	Mayo Kani	5206.38	4841.50	0.93			
	Mayo Sava	7496.63	8578.61	1.14			
	Mayo Tsanaga	55099	76036.62	1.37			
Soja	Diamaré	207	251	1.21	16661	22611.01	5.17
	Logone et Chari	0	-	-			
	Mayo Danay	178	124.60	0.70			
	Mayo Kani	129	121	0.94			
	Mayo Sava	15	14.25	0.95			
	Mayo Tsanaga	16132	22100.16	1.37			
Sesame	Diamaré	142	131	0.92	3963.21	2429.81	3.53
	Logone et Chari						
	Mayo Danay	1447.9	434.37	0.30			
	Mayo Kani	976.75	995.40	1.02			
	Mayo Sava	228.56	156.86	0.68			
	Mayo Tsanaga	1168	712.18	0.61			
Bambara nut (*Voandzou*)	Diamaré	251	201	0.80	19219.2	20699.34	4.52
	Logone et Chari	9	0.05	0.01			
	Mayo Danay	2397	719.10	0.30			
	Mayo Kani	1111	1229.50	1.11			
	Mayo Sava	3988.2	4221.56	1.05			
	Mayo Tsanaga	11463	14328.13	1.25			
Cassava	Diamaré	Diamaré	48	479	1257.1	24591.87	106.37
	Logone et Chari	LogoneetC	454	15774			
	Mayo Danay	MayoDana	117.8	25			
	Mayo Kani	MayoKani	100.3	2391.0			
	Mayo Sava	MayoSava	36	1008			
	Mayo Tsanaga	MayoTsan	501	4914.8			
Sweet potato	Diamaré	398	3971.71	9.98	4031.8	80019.04	102.11
	Logone et Chari	920	35425	38.51			
	Mayo Danay	17	10				
	Mayo Kani	63.8	875.64	13.72			
	Mayo Sava	50	1250	25			
	Mayo Tsanaga	2583	38486.70	14.90			
Potato	Diamaré				3819	25090.83	6.57
	Logone et Chari	0	0	0			
	Mayo Danay						
	Mayo Kani						
	Mayo Sava						
	Mayo Tsanaga	3819	25090.83	6.57			
Taro (old cocoyam)	Diamaré				826.3	6536.03	7.91
	Logone et Chari	0	0	0			
	Mayo Danay						
	Mayo Kani						
	Mayo Sava						
	Mayo Tsanaga	826.3	6536.03	7.91			
Macabo (new cocoyam)	Diamaré				136	788	5.80
	Logone et Chari						
	Mayo Danay						
	Mayo Kani						
	Mayo Sava						
	Mayo Tsanaga	136	788	5.80			

The context in which the 2017/2018 crop year took place has boosted the development of 629,673 ha of cereal area compared to 674,257 ha in 2016. The production, taking into account the areas planted and the evolution of rainfall, is estimated at 618,183 tons of cereals excluding off-season crops, whose expected production is estimated at 201,219 tons. A total of 819,401 tons of cereals were produced in the 2017/2018 season.

The area devoted to legumes is estimated at 227,974 ha for a total production of 192,718 tons. Many other achievements, particularly for tubers and many other crops, are recorded in the Far North region of Cameroon and contribute significantly to the population's food security but are not taken into account in the estimates of food needs coverage rates.

Table 73: Area sown and production Adamaoua, crop season 2017 (Data provided by MINADER (2018))

Crop	**Departments**	**Department level**		**Region level (Adamaoua)**		
		Areas (Ha)	**Productions (T)**	**Areas (Ha)**	**Production (T)**	**Yields (T/Ha)**
Maize grains	Vina	29276	76254,3	73754,50	169 470,60	2,30
	Faro et Déo	19350	40870,3			
	Mbéré	5400	13500			
	Djérem	4978,5	12446			
	Mayo Banyo	14 750	26 400			
Cassava tubers	Vina	16786,5	109019	34033,10	291 300,70	8,56
	Faro et Déo	1415,6	3873,7			
	Mbéré	8000	120000			
	Djérem	5041	40328			
	Mayo Banyo	2 790	18 080			
Groundnut grains	Vina	1349,5	1847,25	11408,00	11 418,45	1,00
	Faro et Déo	3398,5	3001,2			
	Mbéré	138	138			
	Djérem	3702	3702			
	Mayo Banyo	2 820	2 730			
Yam	Vina	1013,375	5941,37	2076,38	28 518,87	13,73
	Faro et Déo	116,25	622,5			
	Mbéré	175	17500			
	Djérem	613,75	3385			
	Mayo Banyo	158	1 070			
Sweet potato	Vina	1274	12873	2289,75	21 296,95	9,30
	Faro et Déo	254,75	1913,95			
	Mbéré	160	1300			
	Djérem	421	4120			
	Mayo Banyo	180	1 090			
Potato	Vina	1106	13835,8	1314,70	15 463,30	11,76
	Faro et Déo	48	574			
	Mbéré	19	111			
	Djérem	56,7	567,5			
	Mayo Banyo	85	375			
Plantain	Vina	284	2021	2617,50	16 474,00	6,29
	Faro et Déo	56	328			
	Mbéré	125	955			
	Djérem	202,5				
	Mayo Banyo	1 950	13 170			
Soja	Vina	909,75	1625,15	921,75	1 625,15	1,76
	Faro et Déo					
	Mbéré					
	Djérem	12				
	Mayo Banyo					
Rice	Vina	43,5	119,4	535,20	1 397,70	2,61
	Faro et Déo	183	308,3			

Crop	Departments	Department level		Region level (Adamaoua)		
		Areas (Ha)	Productions (T)	Areas (Ha)	Production (T)	Yields (T/Ha)
	Mbéré					
	Djérem	8,7				
	Mayo Banyo	300	970			
Sugar cane	Vina	70	1081,75	128,70	1 845,85	14,34
	Faro et Déo	41,7	457,1			
	Mbéré	17	307			
	Djérem					
	Mayo Banyo					
Red beans, small grains	Vina	5005	7234	6238,00	8 424,50	1,35
	Faro et Déo	550	589,5			
	Mbéré	95	146			
	Djérem	73				
	Mayo Banyo	515	455			
Old/new cocoyam	Vina	360	2966,6	2106,50	14 532,35	6,90
	Faro et Déo	136,5	1160,75			
	Mbéré	135	655			
	Djérem	560	4200			
	Mayo Banyo	915	5 550			
Millet/Sorghum	Vina	1189	8907	7829,60	15 481,90	1,98
	Faro et Déo	6610,6	6514,9			
	Mbéré	30	60			
	Djérem					
	Mayo Banyo					
Cowpea	Vina	209,75	271,53	262,75	301,93	1,15
	Faro et Déo	51	30,4			
	Mbéré					
	Djérem	2				
	Mayo Banyo					
Chili	Vina	20	20	841	1828,5	2,2
	Faro et Déo	37	37,5			
	Mbéré	525	260			
	Djérem	214	1412			
	Mayo Banyo	45	99			
Cucumber	Vina	4150	5810	7336,00	14 206,50	1,94
	Faro et Déo	4	6			
	Mbéré	2550	7600			
	Djérem	247	370,5			
	Mayo Banyo	385	420			
Tomato	Vina	230,75	2626,71	363,75	4 035,21	11,09
	Faro et Déo	4	67,5			
	Mbéré	30	450			
	Djérem	99	891			
	Mayo Banyo					
Cotton	Vina	77	173,25	77,00	173,25	2,25
	Faro et Déo					
	Mbéré					
	Djérem					
	Mayo Banyo					
Gumbo	Vina	22,5	102	216,20	1 100,50	5,09
	Faro et Déo	38,5	297,5			
	Mbéré	35	220			
	Djérem	120,2	481			
	Mayo Banyo					
Watermelon	Vina	3	73	16,50	123,00	7,45
	Faro et Déo					
	Mbéré	2	50			
	Djérem	11,5				
	Mayo Banyo					

Compared to 2016 there has been a loss of area for some crops (e. g. cassava, sweet potato, yam and groundnuts) in the Adamaoua region but production is increasing. This loss of land is explained by the fact that some farms located in insecure areas have been abandoned.
Thanks to the clement climate, the agricultural framework and the multiple support provided by the Government and its partners, agricultural production in Adamaoua has increased.

5.3.3.2 Niger

Agriculture is the main activity of the population, despite the lack of cropland in the country. Nearly 85% of the working population lives in rural areas with agriculture or livestock as their main activity. Agriculture in Niger is essentially traditional and represents about 34.8% of GDP.

Agricultural systems

Rain-fed Agriculture

In Niger in general and in the Zinder region in particular, the production system is extensive. It is essentially dominated by rain-fed agriculture supplemented by irrigated crops where this is possible.
This agriculture is characterized by extreme poverty of land and producer populations as well as great genetic heterogeneity within the plant population due to the use of seeds of various local cultivars that hardly adapt to the local ecological conditions to which they are subjected due to climate change.
The dominant cultivation system is the practice of mil-niébé, sorghum-niébé, mil-arachide and sorghum-arachide associations.

The West and South-East zones of the region are mainly specialized in the practice of mil-niébé association compared to the South and South-West zones where producers practice mil-arachide association more (the communes of Droum, Dogo, ...). In these areas, we also know the mil-sorghum associations.

Monocultures of millet and sorghum are also practiced mainly in the northern and eastern agricultural areas of the region (Tanout, Belbédji, Gouré and the northern DTK).

Irrigated Agriculture

This system of farming is also characterized by crop associations. It is mainly justified by the availability of surface water, crop diversification and self-consumption. We can also note sites specialized in certain speculations: sugar cane (Doungou, Bandé), tomato (Gafati, ...), cabbage (Kantché, Ichirnawa), onion (Guididmouni, ...), etc.
This activity is very timid in the northern part of the region due to difficulties in water mobilization.

The main varieties grown in general are as follows: Millet, Maize, Rice, Sorghum, Cowpea, Groundnut, Sesame, Gumbo, Onion, Cassava, Sorrel, Voandzou (Bambara nut)

Cultivated area per variety, yield per variety and production per variety

Table 74: Final results of the 2017 agricultural season (Data transmitted by the Direction Régionale de l'Agriculture, 2018)

Diffa	Variables	Millet	Sorghum	Rice	Cowpea	Groundnut	Sesame	Voandzou	Sorrel	Gombo	Onion	Cassava
Total Region	Area (ha)	92,843	25,280	993	64,499	3,583	200	94	404	116	660	671
Total Region	Yield (kg/ha)	386	412	1,039	276	492	994	605	489	795	18,807	14,404
Total Region	Production (kg)	41,647	9,193	1,032	17,804	1,764	955	57	91	92	12,114	11,212

Table 75: Results of the 2016 winter growing season (Data transmitted by the Direction Régionale de l'Agriculture, 2018)

Diffa	Variables	Millet	Sorghum	Cowpea	Groundnut	Voandzou	Sorrel	Gombo	Onion	Cassava
Total Region	Area (ha)	107,625	17,844	31,355	3,489	83		162	378	83
Total Region	Yield (kg/ha)	512	493	354	513	630	510	538	16,624	696
Total Region	Production (kg)	55,113	8,802	11,095	1,789	53	193	87	6,283	58

Table 76: Results of the wintering agricultural season (rainfed crops) 2017 (Data provided by the Regional Directorate of Agriculture (2018)).

	Variables	Millet	Sorghum	Maize	Rice	Cowpea	Groundnut	Sesame	Voandzou	Sorrel	Gombo
Zinder Region	Area (ha)	1447889	1212705	350	411	1272502	360573	45821	3766	15157	90647
	Yield (kg/ha)	493	466	860	981	368	493	399	441	231	673
	Production (kg)	713436	564630	301	403	468164	177648	18268	1662	3506	61040

Table 77: Results of the 2017-2018 irrigated crop season (Data provided by the Regional Directorate of Agriculture (2018)).

Crop	Variables	TOTAL
Laitue	Superficie (ha)	1,237.95
	Rendement (T/ha)	24.11
	Production (T)	29,843.84
Chou	Superficie (ha)	1,768.01
	Rendement (T/ha)	27.88
	Production (T)	49,290.76
Tomate	Superficie (ha)	1,011.60
	Rendement (T/ha)	20.24
	Production (T)	20,476.70
Oignon	Superficie (ha)	1,226.93
	Rendement (T/ha)	26.84
	Production (T)	32,935.08
Carotte	Superficie (ha)	164.25
	Rendement (T/ha)	25.32
	Production (T)	4,159.09
Poivron	Superficie (ha)	1,968.20
	Rendement (T/ha)	18.20
	Production (T)	35,816.29
Blé	Superficie (ha)	108.46
	Rendement (T/ha)	0.66
	Production (T)	72.10
Maïs	Superficie (ha)	2,611.74
	Rendement (T/ha)	1.27
	Production (T)	3,304.59
Niébé	Superficie (ha)	269.56
	Rendement (T/ha)	0.60
	Production (T)	162.08
P de Terre	Superficie (ha)	231.61
	Rendement (T/ha)	22.96
	Production (T)	5,318.62
Pat. Douce	Superficie (ha)	336.81
	Rendement (T/ha)	20.94
	Production (T)	7,052.84
Manioc	Superficie (ha)	2,660.09
	Rendement (T/ha)	24.89
	Production (T)	66,197.69
Piment	Superficie (ha)	200.22
	Rendement (T/ha)	9.53
	Production (T)	1,908.43
Aubergine	Superficie (ha)	32.07
	Rendement (T/ha)	12.79
	Production (T)	410.27

Crop	Variables	TOTAL
Courge	Superficie (ha)	925.87
	Rendement (T/ha)	26.86
	Production (T)	24,864.26
Courgette	Superficie (ha)	65.53
	Rendement (T/ha)	19.76
	Production (T)	1,294.56
Riz	Superficie (ha)	67.41
	Rendement (T/ha)	5.75
	Production (T)	387.39
Gombo	Superficie (ha)	43.18
	Rendement (T/ha)	6.58
	Production (T)	284.33
Jaxatu	Superficie (ha)	88.73
	Rendement (T/ha)	16.51
	Production (T)	1,464.73
Moringa	Superficie (ha)	435.35
	Rendement (T/ha)	17.59
	Production (T)	7,656.22
Melon	Superficie (ha)	82.61
	Rendement (T/ha)	16.59
	Production (T)	1,370.87
Ail	Superficie (ha)	16.35
	Rendement (T/ha)	4.03
	Production (T)	65.82
Pastèque	Superficie (ha)	281.27
	Rendement (T/ha)	18.77
	Production (T)	5,280.17
CA Sucre	Superficie (ha)	3,099.62
	Rendement (T/ha)	47.91
	Superficie (ha)	148,494.80
Tabac	Rendement (T/ha)	14.97
	Production (T)	13.01
	Superficie (ha)	194.71
Sorgho	Rendement (T/ha)	43.67
	Production (T)	0.57
	Superficie (ha)	24.89
Oseille	Rendement (T/ha)	16.20
	Production (T)	1.21
	Superficie (ha)	19.67
TOTAL REGION	Superficie	19,008.26
	Production	448,350.80

5.3.3.3 Nigeria

Agricultural systems

The varieties grown are as follows:

- Rice
- Maize
- Sorghum
- Wheat
- Millet
- Cassava
- Groundnut
- Cowpea
- Cotton
- Bennisé/Sesame
- Tomato
- Onion
- Gumbo
- Acacia gum

Table 78: Estimation of land area and forecast of rice production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	178.13	181.44	1.86	111.62	113.03	1.26	1.60	1.61
Yobe	156.63	160.03	2.17	102.09	102.58	0.48	1.53	1.56
Bauchi	202.77	216.16	6.61	118.94	122.08	2.63	1.70	1.77
Adamawa	265.50	278.58	4.92	155.81	156.83	0.65	1.70	1.78
Jigawa	186.88	212.08	13.49	97.29	99.66	2.43	1.92	2.13
Kano	365.58	418.48	14.47	171.09	186.84	9.20	2.14	2.24
Plateau	212.74	245.23	15.28	119.62	129.39	8.16	1.78	1.90

Table 79: Estimation of land area and forecast of maize production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	550.13	613.55	11.53	358.78	367.75	2.50	1.53	1.67
Yobe	330.95	375.81	13.56	198.57	202.54	2.00	1.67	1.86
Bauchi	453.32	515.26	13.66	271.99	278.79	2.50	1.67	1.85
Adamawa	464.81	506.00	8.86	249.01	260.21	4.50	1.87	1.94
Jigawa	288.04	324.64	12.70	166.18	177.92	7.07	1.73	1.82
Kano	286.91	325.01	13.28	120.71	134.51	11.43	2.38	2.42
Plateau	562.94	641.67	13.98	227.46	258.32	13.56	2.47	2.48

Table 80: Estimation of land area and forecast of sorghum production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	319.24	327.22	2.50	323.37	334.54	3.45	0.99	0.98
Yobe	262.03	266.61	1.75	250.89	251.60	0.28	1.04	1.06
Bauchi	376.27	383.88	2.02	332.28	366.77	10.38	1.13	1.05
Adamawa	287.92	296.17	2.87	225.88	247.33	9.50	1.27	1.20
Jigawa	347.28	353.92	1.91	289.40	291.72	0.80	1.20	1.21
Kano	744.12	784.93	5.48	560.08	576.51	2.93	1.33	1.36
Plateau	290.92	294.56	1.25	197.51	196.04	-0.74	1.47	1.50

Table 81: Estimation of land area and forecast of millet production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	73.18	75.01	2.50	92.74	95.66	3.15	0.79	0.78
Yobe	146.02	149.16	2.15	173.12	179.66	3.77	0.84	0.83
Bauchi	70.05	71.92	2.67	78.90	82.39	4.43	0.89	0.87
Adamawa	111.20	113.31	1.90	128.79	133.87	3.95	0.86	0.85
Jigawa	69.42	71.15	2.50	89.73	91.74	2.24	0.77	0.78
Kano	56.57	58.13	2.77	66.00	68.20	3.33	0.86	0.85
Plateau	65.19	67.42	3.42	73.83	76.96	4.23	0.88	0.88

Table 82: Estimation of land area and forecast of cassava production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	na	na	na	na	na	na	na	na
Yobe	479.20	487.70	1.77	116.60	121.56	4.25	4.11	4.01
Bauchi	481.56	484.77	0.67	120.07	126.08	5.00	4.01	3.84
Adamawa	450.84	465.04	3.15	129.18	139.07	7.65	3.49	3.34
Jigawa	375.04	385.44	2.77	124.41	130.39	4.81	3.01	2.96
Kano	426.63	445.63	4.45	115.10	125.35	8.91	3.71	3.55
Plateau	980.76	1052.68	7.33	353.64	381.20	7.79	2.77	2.76

Table 83: Estimation of land area and forecast of groundnut production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	184.59	187.36	1.50	153.23	160.13	4.50	1.20	1.17
Yobe	72.26	72.62	0.50	65.14	66.90	2.70	1.11	1.09
Bauchi	494.48	511.78	3.50	394.08	394.34	0.07	1.25	1.30

Adamawa	125.24	128.73	2.79	102.24	107.05	4.70	1.22	1.20
Jigawa	120.00	122.00	1.67	120.52	127.10	5.46	1. 00	0.96
Kano	301.06	314.61	4.50	207.72	215.51	3.75	1.45	1.46
Plateau	197.37	203.09	2.90	138.38	143.84	3.95	1.43	1.41

Table 84: Estimation of land area and forecast of cowpea production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production (‘000MT)			Area (‘000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	117.20	118.77	1.34	139.77	143.75	2.84	0.84	0.83
Yobe	162.41	164.73	1.43	192.62	197.69	2.63	0.84	0.83
Bauchi	167.70	169.58	1.12	180.16	183.48	1.84	0.93	0.92
Adamawa	181.62	188.10	3.57	191.18	199.30	4.25	0.95	0.94
Jigawa	103.16	109.61	6.25	128.16	138.96	8.43	0.80	0.79
Kano	156.13	163.08	4.45	191.85	198.30	3.36	0.81	0.82
Plateau	89.81	90.88	1.19	170.47	173.02	1.50	0.53	0.53

Table 85: Estimation of land area and forecast of bennisé production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production (‘000MT)			Area (‘000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	5.94	6.91	16.32	14.74	15.21	3.17	0.40	0.45
Yobe	3.01	3.15	4.42	20.93	26.38	26.07	0.14	0.12
Bauchi	8.90	9.38	5.41	18.29	19.78	8.10	0.49	0.47
Adamawa	10.60	12.47	17.70	17.99	17.33	-3.67	0.59	0.72
Jigawa	7.80	8.73	11.93	18.83	17.28	-8.26	0.41	0.51
Kano	27.14	28.61	5.40	46.38	47.18	1.72	0.59	0.61
Plateau	51.01	55.01	7.84	58.67	68.37	16.54	0.87	0.80

Table 86: Estimation of land area and forecast of cotton production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production (‘000MT)			Area (‘000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	13.74	13.44	-2.20	42.23	45.26	7.17	0.33	0.30
Yobe	11.11	11.66	4.95	31.34	32.56	3.89	0.35	0.36
Bauchi	26.50	28.73	8.43	96.90	96.57	-0.34	0.27	0.30
Adamawa	9.33	10.04	7.62	22.44	22.08	-1.62	0.42	0.45
Jigawa	11.53	11.82	2.49	35.69	35.00	-1.91	0.32	0.34
Kano	25.24	26.18	3.70	43.72	44.32	1.37	0.58	0.59
Plateau	5.75	6.15	7.01	9.62	9.50	-1.22	0.60	0.65

Table 87: Estimation of land area and forecast of tomato production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	199.87	215.86	8.00	29.62	32.58	10.00	6.75	6.63
Yobe	98.52	104.73	6.30	17.88	19.25	7.70	5.51	5.44
Bauchi	171.59	177.59	3.49	32.22	33.85	5.06	5.33	5.25
Adamawa	91.35	98.16	7.45	30.91	32.53	5.22	2.95	3.02
Jigawa	68.78	73.34	6.63	27.54	28.61	3.87	2.50	2.56
Kano	136.87	145.84	6.55	40.74	48.76	19.71	3.36	2.99
Plateau	50.26	54.94	9.30	12.68	13.87	9.42	3.96	3.96

Table 88: Estimation of land area and forecast of onion production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	68.7	70.3	2.3	16.0	17.9	11.9	4.3	3.9
Yobe	83.0	93.9	13.2	48.3	49.3	2.1	1.7	1.9
Bauchi	85.0	91.4	7.5	43.0	42.3	-1.6	2.0	2.2
Adamawa	122.7	139.8	14.0	46.1	57.7	25.4	2.7	2.4
Jigawa	67.8	79.2	16.8	31.1	34.7	11.6	2.2	2.3
Kano	90.4	99.7	10.3	48.9	50.8	3.8	1.8	2.0
Plateau	45.2	47.8	5.8	30.0	37.6	25.4	1.5	1.3

Table 89: Estimation of land area and forecast of gumbo production and yield in the Nigerien part of the Lake Chad Basin (NAERLS, FDAE and P&PCD (2017))

Department	Production ('000MT)			Area ('000ha)			Yield	
	2016	2017	% Change	2016	2017	% Change	2016	2017
Borno	25.2	28.4	12.8	27.2	33.2	22.1	0.9	0.9
Yobe	19.1	22.6	18.3	24.4	30.1	23.6	0.8	0.7
Bauchi	20.4	23.6	15.9	14.2	17.7	24.8	1.4	1.3
Adamawa	14.1	17.3	22.7	24.3	31.3	28.6	0.6	0.6
Jigawa	16.6	20.1	20.7	14.5	17.5	20.4	1.1	1.1
Kano	18.5	19.7	6.2	46.1	48.5	5.1	0.4	0.4
Plateau	50.3	52.3	4.0	25.4	30.8	21.2	2.0	1.7

5.3.3.4 Central African Republic

In general, agriculture in the Central African Republic remains rainfed. Climate factors have a major influence on agricultural production, hence the need to collect a large amount of information on these climate parameters in order to understand the variability of crop yields in each agro-ecological zone. The part of the Lake Chad Basin of the Central African Republic includes the areas:

- Sudano-Sahelian, known as the hunting and tourist area, is located in the north of the country
- Sudano-Guinean, known as the cotton-food-livestock zone, extends from West to East to North

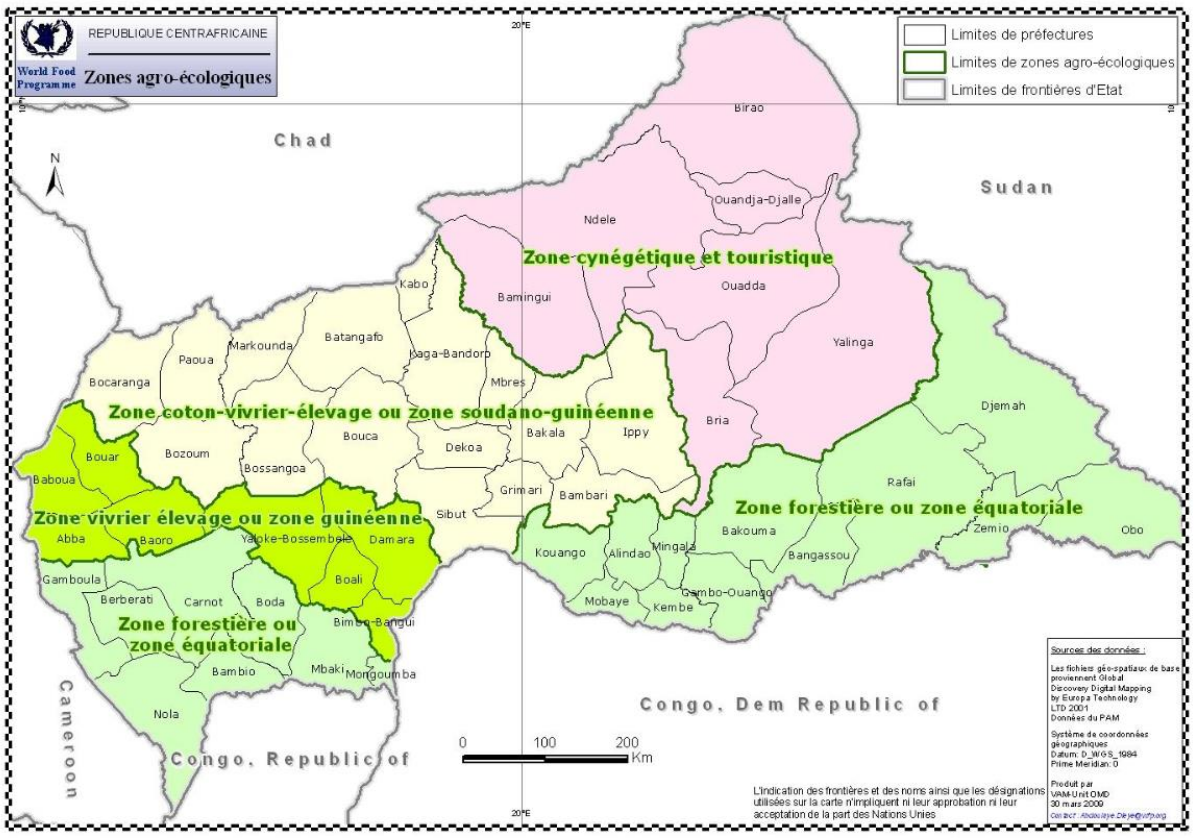


Figure 64: Large agro-ecological zones in CAR (Source: WFP)

Agricultural systems

The annual rainfall in the Sudano-Guinean zone is between 1200 mm and 1500 mm with a plant growth period ranging from 240 days to 180 days. It is characterized by 3 months of dry season, 3 months of off-season and 6 months of rainy season. The soils are ferruginous, relatively rich in chemical elements, but sensitive to the phenomenon of erosion. Their depth is shallow and, and in combination with their lateritic cuirasses their exploitation is limited. The average temperature is 28°C. The Sudano-Guinean zone is also a savannah zone where **cotton, maize, rice, sorghum, millet**, grain and protein legumes such as **groundnuts, cowpeas, sesame and squash** are grown.

The Sudano-Sahelian zone in the north of the country is characterized by a long dry season of 7 to 8 months and a short rainy season of 4 to 5 months. The annual rainfall varies between 800 mm and 1200 mm with a plant growth period of 120 to 180 days. The average temperature

is 30°C. The soils are of the sandy type, associated with indurations, at shallow depths. The main crops are **millet, sorghum, dates and acacia gum**.

Cultivated area by crop and production by crop

The LCBC does not have an official report of a crop year from the Ministry of Agriculture with data on area, production and yield per crop in the two agro-ecological zones located in the Lake Chad Basin. Nevertheless, the LCBC has a scientific report from a 2017-2018 agricultural season on seed production carried out by the Central African Institute for Agricultural Research (ICRA) in these Regional Multipurpose Research Centres (CRPR) and the various agricultural stations (Table 90).

Table 90: CRPR and referenced agricultural stations (Ernest KONGUERE 2018)

Subprefecture	Center/Agricultural station	GPS Coordinates		
		Latitude (North)	Longitude (East)	Altitude (m)
Mbaïki	Boukoko	03°54.416'	17°56.231'	580
Bossembélé	Bakéré	05°08.813'	17°46.444'	700
Bouar	Bolée	06°00.779'	15°38.883'	1000
Bossangoa	Soumbé	06°26.341'	17°14.403'	514
Paoua	Poumbaïndi	07°06.021'	16°27.032'	597

The agricultural station from Bolée to Bouar is located in the Guinean food and livestock zone and therefore in the Lake Chad Basin.
The Soumbé agricultural station is located in the sub-prefecture of Bossangoa and belongs to the Sudano-Guinean area, also known as the cotton-food-livestock area.
The Poumbaïndi agricultural station located about 24 km from Paoua belongs to the Sudano-Guinean zone.

This agricultural season gives an overview of the yield of the different crops in the Central African part of the Lake Chad Basin.

Table 91: Maize seed production in Bolée, 2017-2018 (Ernest KONGUERE 2018)

Crops	Varieties	Areas (in ha)	Sowing date	Production (in kg)	Real yield (kg/ha)	Potential yield (kg/ha)
Maize WHH	CMS 8704	02	15-17/06/2017	4000	2000	500-1200
	CMS 2019	02	19-24/06/2017	3000	1500	
	Subtotal	**04**		**7000**		
Maize PREVES	CMS 8501	0,5	05/05/2017	1600	3200	
	CMS 2019	3,5	28-29/06/2017	4000	1143	
	CMS 8704	1	17-26/07/2017	600	600	
	Subtotal	**05**		**6000**		
	Total	**09**		**13200**		

Table 92: Maize seed production in Poumbaïndi, 2017 (Ernest KONGUERE 2018)

Crops	Varieties	Areas (in ha)	Sowing date	Production (in kg)	Real yield (kg/ha)	Potential yield (kg/ha)
Maize	CMS 8704	3,5	29/06/2017	9 524	2 721	500-1 200
	CMS 8806	4	06/07/2017	6 160	1 540	
	CMS 8501	4	29/07/2017	4 653	1 163	
Total		**11,5**		**20 337**		

Table 93: Cowpea seed production in Bolée, 2017-2018 (Ernest KONGUERE 2018)

Crops	Varieties	Areas (in ha)	Sowing date	Production (in kg)	Real yield (kg/ha)	Potential yield (kg/ha)
Cowpea WHH	LORI	0,875	05/08/2017	450	514	100-400 without inputs
	BR1	0,875	04/08/2017	550	628	
	Subtotal	**1,75**		**1000**		
Cowpea PREVES	LORI	0,850	07-08/08/2017	500	588	
	BR1	0,850	07-08/08/2017	550	647	
	FEKEM	0,25	08/08/2017	50	200	
	Subtotal	**1,95**		**1100**		
	Total	**3,7**		**2100**		

Table 94: Bean seed production in Bolée, 2017-2018 (Ernest KONGUERE 2018)

Crops	Varieties	Areas (in ha)	Sowing date	Production (in kg)	Real yield (kg/ha)	Potential yield (kg/ha)
Bean WHH	GLP 190	1	15/08/2017	450	450	100-400 without inputs
	ECAPAN 025	1,25	14/08/2017	350	280	
	NITU (ECAPAN 021)	0,75	24-25/08/2017	150	200	
	Subtotal	**3**		**950**		
Bean PREVES	GLP 190	0,4	09/08/2017	50	125	
	ECAPAN 025	0,3	09/08/2017	7	23	
	NITU (ECAPAN 021)	0,3	09/08/2017	50	166	
	Subtotal	**1**		**1 07**		
	Total	**4**		**1057**		

Table 95: Groundnut seed production in Soumbé, 2017-2018 (Ernest KONGUERE 2018)

Crops	Varieties	Areas (in ha)	Sowing date	Production (in kg)	Real yield (kg/ha)	Potential yield (kg/ha)
Groundnut	57-313	15,25	20/05/ au 11/07/2017	9 720	637	500-800 up to 2 000 according to variety.
	ICGV	2,75	09-19/06/2017	458	166	
	Fleur 11	3	21/06/2017	360	120	
	Grimari	2	27/06/ et 19/07/2017	455	227,5	

	Locale Soumbé	0,5	08/06/2017	328	656	
	Flower	2	10/07/2017	640	320	
	55-437	2	18/0/2017	400	200	
Total Arachide		**27,5**		**12 361**		

Table 96: Groundnut production in Poumbaïndi, 2017 (Ernest KONGUERE 2018)

Crops	**Varieties**	**Areas (in ha)**	**Sowing date**	**Production (in kg)**	**Real yield (kg/ha)**	**Potential yield (kg/ha)**
Groundhut	57-313	4,50	29/05/2017	5 080	1 128	500-800 up to 2 000 according to variety.
	Grimari	8	31/05/2017	720	90	
	ICGV	5,50	02/06/2017	680	123	
	ICGS 11	0,25	03/07/2017	00	0	
Total Arachide		**18,25**		**6 4 80**		

Cultivated area by crop and production by crop

Table 97: Evolution of the main food crops in CAR (DSDI (2018))

CAR		1989	1990	1996	2010	2011	2012	2013	2014	2015	2016	2017	2018
Cassava (cossettes)	Area (ha)	166,858	192,492	198,017	250,978	241,122	247,581	137,158	143,735	156,532	156,176	161,765	167,647
	Production (tons)	516,118	545,956	588,054	751,105	692,083	708,771	455,494	488,700	516,556	531,000	550,000	570,000
Maize	Area (ha)	67,804	69,769	75,157	92,891	93,213	94,947	85,180	99,494	105,165	107,500	120,163	122,875
	Production (tons)	62,088	57,216	65,871	83,308	84,373	84,365	67,514	79,595	84131,915	86,000	96130	98300
Groundnut	Area (ha)	88,286	86,567	96,332	121,611	124,078	127,048	95,852	101,794	107,596	113,000	117000	119,700
	Production (tons)	103,294	80,520	101,465	128,535	129,737	131,520	91,727	101,794	107596,258	113000	117,000	119700
Rice (paddy)	Area (ha)	9,523	4,675	7,696	9,172	9,132	9,251	7,460	9,159	9,681	11,071	13934	15734
	Production (tons)	14,746	7,821	12,073	14,102	14,171	14,249	10,147	12,822	13552,854	15500	16100	17300
Sesame	Area (ha)	31,444	21,557	28,970	35,504	35,008	35,439	33,314	39,304	48,469	54,286	61,429	73,000
	Production (tons)	17,180	21,034	21,157	27,085	29,306	28,923	17,374	27,513	29081,241	38000	43000	43800
Millet/ Sorghum	Area (ha)	39,486	36,019	43,305	53,495	54,234	55,065	31,011	34,137	36,082	38,667	39,556	42,444
	Production (tons)	47,135	30,221	44,687	55,254	54,337	54,681	27,279	30,723	32474,211	34800	35600	38200
Gourd	Area (ha)	37,459	35,520	40,855	51,721	52,602	54,049	43,601	45,688	48,292	57,750	60,500	62,375
	Production (tons)	16,266	12,822	16,093	20,307	19,227	19,305	14,673	18,275	19,317	23,100	24,200	24,950
TOTAL	Area (ha)	440,860	446,599	490,332	615,372	609,388	623,379	403,994	465,388	511,817	538,450	574,347	603,775
	Production (tons)	776,827	755,590	849,400	1,079,696	1,023,234	1,041,813	684,208	759,422	802,709	841,400	882,030	912,250
Average growth of cultivated areas			**1,3%**	**1,6%**	**1,6%**	**-1,0%**	**2,3%**	**-28%**	**11,90%**	**8,7%**	**8,60%**	**9,30%**	**7,20%**
Average growth of crops			**-2,7%**	**2,0%**	**6,2%**	**-5,2%**	**1,8%**	**-32,7% DSDI)**	**22,60%**	**5,7%**	**11,70%**	**6,10%**	**4,00%**

There has been an increase in the area cultivated, which is certainly due to the increase in needs linked to population growth.

5.3.3.5 Chad

Agricultural systems

Following varieties are cultivated:

- sorghum
- rice
- maize
- cowpea
- watermelon
- melon
- cassava
- cotton

Production by crop

Table 98: Summary of production by province (ONDR 2015)

Administrative region	Total production (t)	Seed needs and losses (20%) in t	Availability (t)	Total population (inh)	Food needs (159 kg/inh/year)	Surplus/Deficit (t)
Moyen Chari	73,753	14,751	59,002	744,057	118,305	-59,303
Mandoul	111,430	22,286	89,144	815,078	129,597	-40,453
Eastern Logone	135,010	27,002	108,008	1,013,313	161,117	-53,109
Western Logone	103,078	20,616	82,462	869,342	138,225	-55,763
Tandjilé	212,926	42,585	170,341	868,734	138,129	32,212
Western Mayo Kebbi	116,055	23,211	92,844	723,799	115,084	-22,240
Eastern Mayo Kebbi	193,756	38,751	155,005	993,473	157,962	-2,957
Chari-Baguirmi	237,753	47,551	190,202	735,918	117,011	73,191
Hadjer Lamis	127,414	25,483	101,931	721,202	114,671	-12,740
Kanem	3,934	787	3,147.2	424,161	67,442	-64,294
Barh El Gazal	11,235	2,247	8,988	327,315	52,043	-43,055
Guéra	102,654	20,531	82,123	666,621	105,993	-23,870
Batha	79,363	15,873	63,490	604,831	96,168	-32,678
Salamat	327,663	65,533	262,130	374,323	59,517	202,613
Ouaddai	66,996	13,399	53,597	887,354	141,089	-87,492
Sila	76,824	15,365	61,459	361,072	57,410	-4,049
Wadi Fira	32,525	6,505	26,020	625,537	99,460	-73,440
Borkou	-	-	-	120,831	19,212	-19,212
Tibesti	-	-	-	32,962	5,241	-5,241
Ennedi	-	-	-	216,415	34,410	-34,410
N'Djamena	-	-	-	1,328,576	211,244	-211,244
Total	**2,012,369**	**402,474**	**1,609,895**	**13,454,914**	**2,139,331**	**-529,436**

NB : Agricultural production is estimated at:

- Cereals: 2,012,369 tons against 2,663,769 tons, a decrease of 24.45%;
- Oilseeds: 599,268 tons against 973,092 tons, a sharp drop of 38%;
- Cassava: 140,959 tons against 180,024 in 2014, a decrease of 21.6%;
- Cotton: 196,056 tons against 151,980 tons, a strong increase of 29% compared to the previous season.

Organizational Advice Project at the Lake Chad Basin Commission, Component C "Adaptation to Climate Change"

Within the framework of the project "Organizational Consulting to the Lake Chad Basin Commission, Component C "Adaptation to Climate Change" carried out by the GIZ and financed by the BMZ, an inventory of agricultural production in 2013 and pilot measures for agricultural adaptation to climate change between 2016 and 2018 have been established in the most widespread agricultural systems (rainfed, recession, irrigated and livestock farming) and tested in a participatory manner in a pilot area. This cross-border pilot area extends over approximately 40,000 km² between N'Djamena, Bongor (Chad) and the Far North of Cameroon (Maroua).

For most of the inhabitants of the pilot area, rainfed agriculture is an important source of livelihood (93.5% of the villages studied), followed by recession agriculture (55.4%), livestock production and pastoralism (31.6%), irrigated agriculture and market gardening (14.9%), and fishing (7.6%).

However, there are wide variations within the pilot area. While rainfed agriculture is a means of livelihood for people throughout the pilot area, other production systems are not as evenly distributed. For example, recession agriculture is mainly practiced near rivers and streams on soils with high clay content, as these provide enough soil moisture for crops after the end of the rainy season. Irrigated agriculture and market gardening, on the other hand, are mainly practiced along rivers, where there are enough water resources, and around urban centers, where there are markets for high-value crops (see figure).

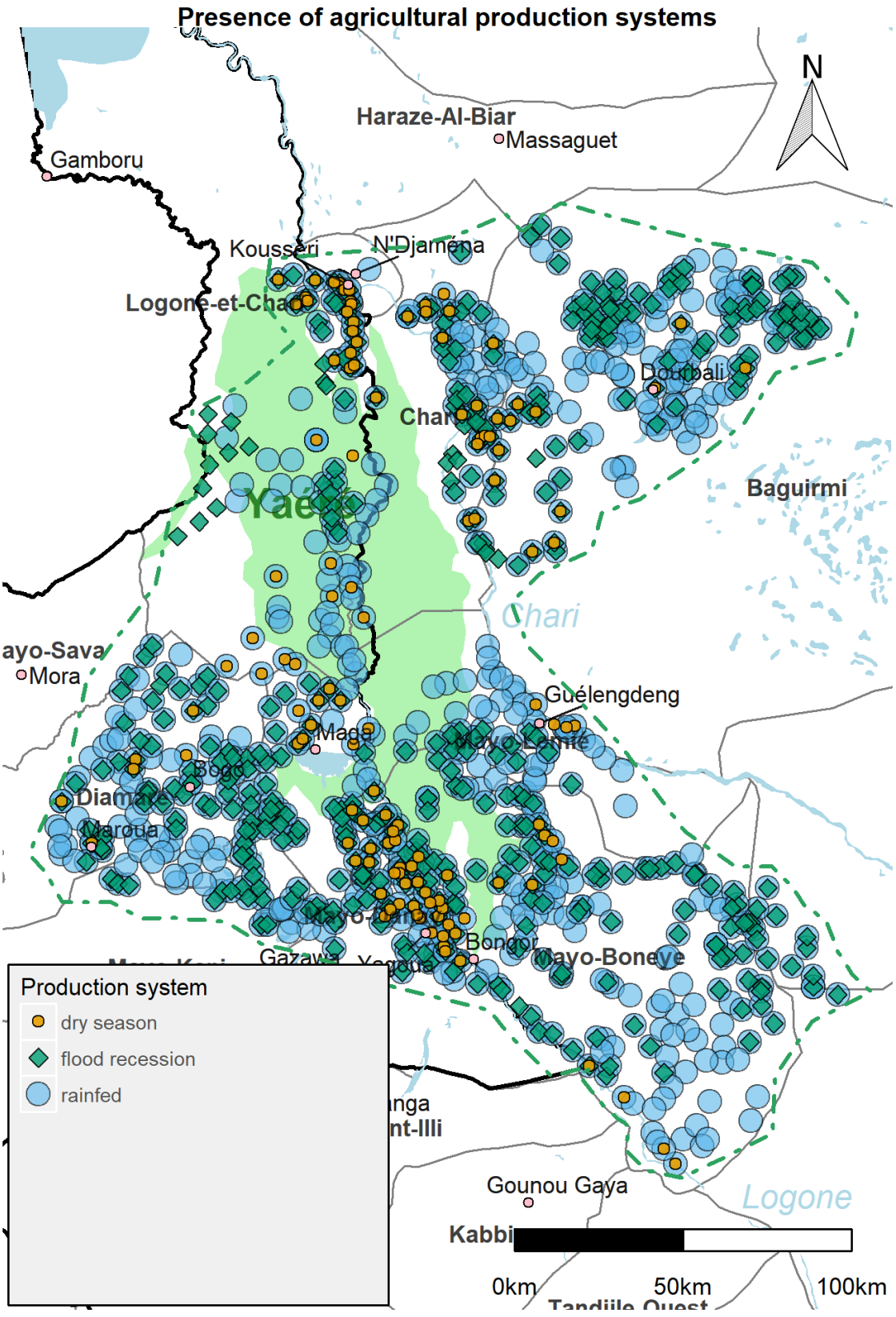


Figure 65: Map of the presence of agricultural production systems in the pilot area between N'Djamena, Bongor (Chad) and the Far North of Cameroon (Maroua). (AHT 2017)

Production levels of all major cereals, except rice, remain low, with some regional variations. Yields are higher in the southern half and on the Cameroonian side of the pilot area. As a result, yields of all crops are the highest in the Cameroonian departments of Diamaré and Mayo-Kani in the south and the lowest in the Chadian departments of Chari and Baguirmi in the north. Crop yields in the pilot area are presented in the following table and maps:

Table 99: Rainfed agriculture: average yields of certain crops in the departments of the study area (AHT 2017)

Country	**Department**	**Crop**													
		Sorghum		Maize		Rice		Millet		Cowpea		Groundnut		Cotton	
		N*	kg/ha	N*	kg/ha	N*	kg/ha	N*	kg/ha	N*	kg/ha	N*	kg/ha	N*	kg/ha
Cameroon	Diamaré	95	1,137	45	936	1	400	0	-	0	-	0	-	63	1,003
	Logone-et-Chari	68	958	25	812	47	1,223	2	425	4	369	1	25	0	-
	Mayo-Danay	95	987	25	1,024	42	3,571	30	1,007	10	1,087	3	700	29	1,293
	Mayo-Kani	36	1,055	9	1,162	0	-	14	924	19	948	4	1,650	24	1,300
	Total	294	1,033	104	948	90	2,448	46	955	33	915	8	1,091	116	1,118
Chad	Baguirmi	270	708	74	568	0	-	142	540	0	-	32	622	0	-
	Chari	72	638	6	658	0	-	17	520	0	-	1	700	0	-
	Mayo-Boneye	178	761	6	657	73	1,511	25	632	22	408	63	701	0	-
	Mayo-Lémié	57	927	0	-	0	-	0	-	0	-	0	-	0	-
	Total	577	736	86	581	73	1,511	184	550	22	408	96	680	0	-
	Total	871	833	190	777	163	1,992	230	630	55	714	104	716	116	1,118

* Total number of observations, i.e., the number of individual yield measures

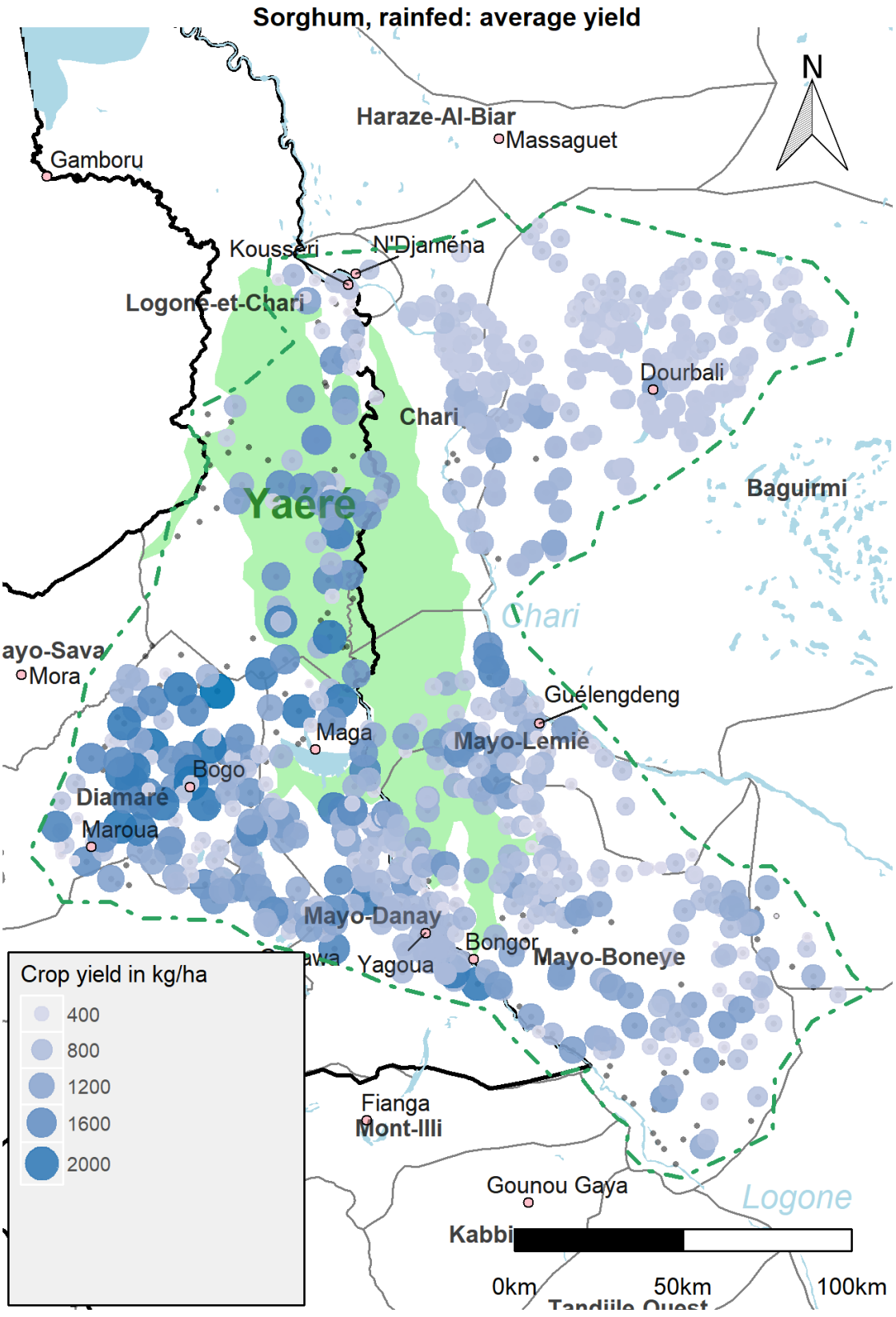


Figure 66: Rainfed sorghum: map of average yields in the pilot area (AHT 2017)

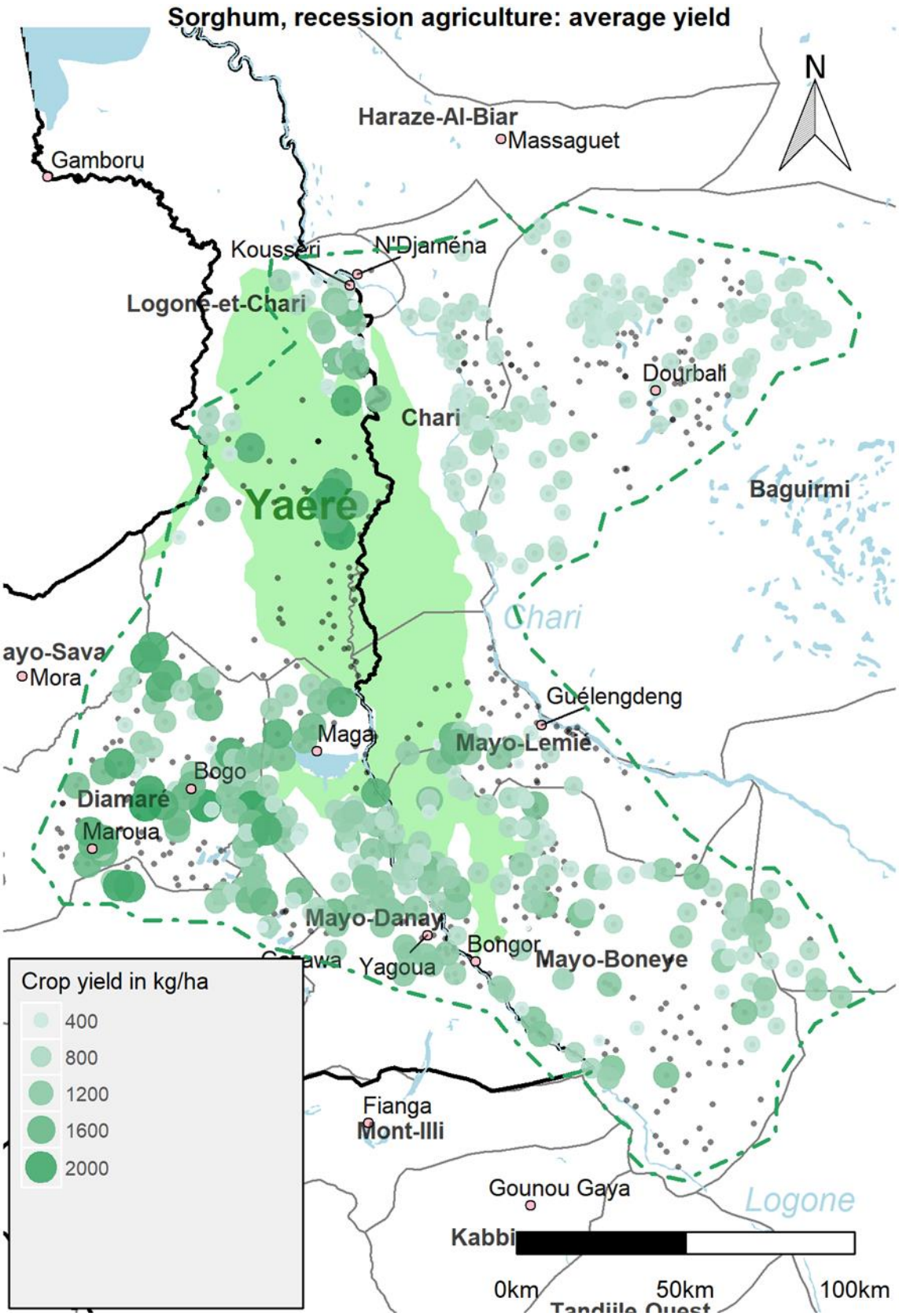


Figure 67: Sorghum, flood recession agriculture: map of average yields in the pilot area (AHT 2017)

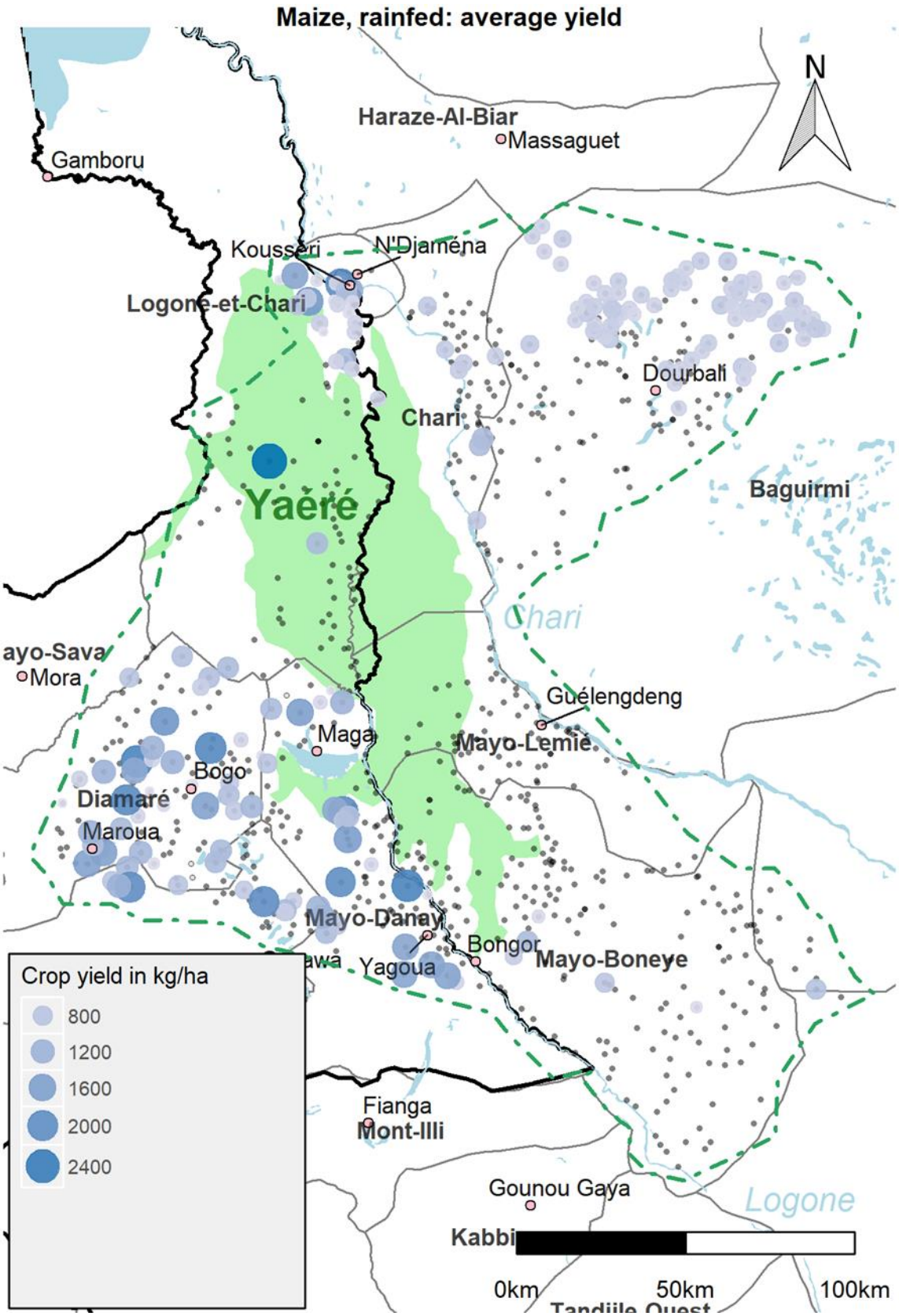


Figure 68: Rainfed maize: map of average yields in the pilot area (AHT 2017)

5.3.3.6 Conclusion of the agricultural campaign 2017-2018

The collection of data on agricultural production in different countries is not done in the same way, i.e. by using the same methodology. This makes it difficult to interpret the results. However, the way Chad collects data is interesting because it provides a situation in relation to the measures to be taken for food and nutritional security. So we can see how other countries can provide such a food situation at the end of each agricultural season.
Therefore, good monitoring of agricultural production will make it possible to take significant measures to address the food and nutritional situation.

6. Water Charter

Adopted by the LCBC Summit of Heads of State and Government in 2012 and ratified by two thirds of the Member States, the Water Charter has since become a supranational law. It is a conventional framework whose overall objective is the sustainable development of the Lake Chad Basin through integrated, equitable and concerted management of shared water resources and the environment of the Basin.
This framework promotes good governance, sub-regional cooperation and solidarity based on the community of interest that binds Member States for this management.
The Water Charter applies to all measures and activities, public or private, underway or planned in the Basin, undertaken to (i) improve knowledge of groundwater and surface water resources and ecosystems (ii) mobilize or use them to meet socio-economic and environmental needs and which are likely to have an impact on water resources or the environment, and (iii) protect and preserve water resources and the environment and combat harmful situations.

The Water Charter applies to the national portions of the Lake Chad watershed and hydrogeological basin.

The Water Charter is part of the Convention establishing the Lake Chad Basin Commission and the Statutes of the Commission signed on 22 May 1964 in Fort-Lamy and supplements this Convention.
It contributes to the implementation of Vision 2025 and the Strategic Action Programme.

To date, four (4) out of six (6) countries have ratified the Charter, including:

- The Republic of Cameroon
- The Republic of Niger
- The Republic of Nigeria
- The Republic of Chad

Only the Republic of Nigeria has officially transmitted the instruments of ratification.

To date, the Lake Chad Basin Water Charter has entered into force.

Works carried on by the LCBC in 2017/2018

To ensure the effectiveness of the Charter, annexes are provided (Water Charter, art. 97). Five of these annexes were drafted and adopted at the same time as the Water Charter.

Other annexes to the Water Charter were developed and validated between 2017 and 2019:

(i) Annex 6 on environmental protection,
(ii) Annex 7 on the organs of the Charter,
(iii) Annex 8 on notification,
(iv) Annex 9 on coordinated management of the works.

As part of the implementation of the Lake Chad Basin Water Charter, a roadmap has been prepared by the LCBC in relation to the provisions of the Charter, the main lines of which are as follows:

1. Collect decrees and laws ratifying the Charter in Member States;

2. Deposit all the instruments of ratification collected in the countries in Chad, so that Chad can notify the other Member States of the entry into force of the Water Charter;

3. Initiate registration with the African Union (AU) and the United Nations (UN);

4. Collect all prepared and validated appendices

5. Make an inventory of the planned implementing bodies in the Charter;

6. Seek the acts of decision establishing the existing bodies, especially:

   - The technical committee,
   - The Parliamentary Regional Committee,
   - The committee of water resources experts,
   - The committee of experts on environment, science and planning.

7. Initiate the process of setting up the remaining bodies, especially:

   - The forum of partners for the sustainable development of the basin and
   - The national agencies of the Lake Chad Basin Commission, by the Member States.

7. Interventions in the Lake Chad Basin

7.1 Ongoing Projects in 2017 and 2018 at LCBC

Table 100: Characteristics of projects in progress between 2017 and 2018 at the LCBC

N/R	Name of project	General objective	Amount	Financing sources	Implementation period	Observations
1	**PRODEBALT**	Improving productivity and ecosystem management in the Lake Chad Basin in a context of adaptation to climate change	30 000 000 UC	ADF	03/2010 to 12/ 2017	
2	**Programme for the Rehabilitation and Strengthening of the Resilience of Socio-ecologic Systems of the Lake Chad Basin (PRESIBALT)**	Improve the resilience of populations living on the resources of the Lake Chad Basin	71,230,000 UC (53,25 billion FCFA)	ADF, GEF, UNESCO, LCBC	2015-2020	This programme has already undergone its midterm evaluation. At the request of the countries, its implementation period has been extended by one year. Since its inception, 25.202 billion FCFA have been mobilized, corresponding to 3 ADF grants and 1 loan. GEF funding has not yet been mobilized and the 2nd loan has not been signed.

N/R	Name of project	General objective	Amount	Financing sources	Implementation period	Observations
3	**Emergency Program for youth and vulnerable groups in the region of Lake Chad (PURDEP)**	Reduce poverty through the implementation of development actions in the region in order to combat the causes and conditions that foster the development of insecurity	37,500,000,000 FCFA	Member States of the LCBC and the Regional Stabilization Strategy	18 months	This programme has so far been financed partly from the Member States' own funds
4	**Organizational advice to the LCBC (GIZ)**	The project includes three components: • A – Cooperation with the Member States • B – Strategic planning; • C – Adaptation to climate chance The component C has the following objective: "Relevant strategic information and practical experience to improve climate change adaptation capacity in the Lake Chad Basin is available".	6 000 000 EUR	BMZ (Federal Ministry for Economic Cooperation and Development)	2014-2019	
5	**Sustainable management of groundwater resources in the Lake Chad Basin (BGR)**	Support the LCBC and its Member States in the implementation of technical measures/solutions for sustainable groundwater management	3,000,000 EUR	BMZ (Federal Ministry for Economic Cooperation and Development)	2014-2019	

N/R	Name of project	General objective	Amount	Financing sources	Implementation period	Observations
6	**Regional strategy for the stabilization, recovery and resilience of the areas of the Lake Chad Basin affected by Boko Haram**	The general objectives of this strategy are: 1. To generate policies and programs applicable to the stabilization and development in the short, medium and long term of the Lake Chad Basin region 2. The Strategy will focus on commonalities while taking into account the particularities of each of the States involved in the Lake Chad Basin region 3. The Strategy will aim to address the root causes of the crisis in the Lake Chad Basin region in order to strengthen resistance	About USD 12,000,000,000	To be researched, approximately EUR 2 000 000 000 was announced at the Berlin-Oslo II Conference	2018-2023	The Coordinator takes office and the team is gradually set up. In addition, a campaign to raise awareness and provide information to the high authorities is now being conducted by the LCBC across all the involved countries to ensure that the Strategy is adopted.
7	**Project for Improving Lake Chad Management by Implementing the SAP for the Lake Chad Basin through Climate Change Resilience and Ecosystem Pressure Reduction (GEF-UNDP)**	Achieve ecosystem-based, integrated and resilient management of the Lake Chad Basin through the implementation of agreed policy, legal and institutional reforms and investments to improve water quality and quantity, protect biodiversity and sustain livelihoods.	242,112,304 USD	GEF-UNDP-GIZ-IUCN-GOUVERNMENTS-LCBC	2018-2023	Establishment of a steering committee and a technical committee of the Project; Recruitment of the Project Management Unit (PMU); Development of the Annual Work Programme (AWP)

N/R	Name of project	General objective	Amount	Financing sources	Implement ation period	Observations
8	**Socioeconomic Reintegration Support Project for Vulnerable Groups in the Lake Chad Basin (PARSEBALT)**	Contribute, through social and economic reintegration, to improving the living conditions of the populations most affected by insecurity and climatic hazards in the Lake Chad Basin	13,000,000 UC	AfDB/ADF	2018-2021	Memoranda of Understanding between the States concerned and the African Development Fund signed; Memoranda of Understanding (retrocession) between the States concerned and the LCBC in the process of being signed
9	**Project for the Relaunch and Development of the Lake Chad Region (PROLAC)**	Contribute to the recovery of the Lake Chad region by supporting the coordination and monitoring of crises, connectivity and agricultural livelihoods in selected provinces of Cameroon, Niger and Chad	170,000,000 USD	World Bank	2018-2023	Procurement plans validated for Cameroon, Niger and Chad; Ongoing collaborative discussions with the LCBC, particularly on *Subcomponent 1.1: Regional Platform for Knowledge and Monitoring of Lake Chad and the Secretariat for the Development of the Lake Chad Region*

7.2 Achievements of Projects in Progress in 2017 and 2018

Table 101: Implementation of projects in progress in 2017 and 2018 in LCBC member countries

Achievements of the PRODEBALT project in LCBC member countries				
Cameroon: - Completion of paving and tiling work in the ice factory rooms of the Maga and Kai-Kai landing stages; - Construction of fishing infrastructures; - Realization of 10 pastoral boreholes in solar energy - Rehabilitation of the National Coordination Office; - Acquisition of piezometric and hydrometric equipment; - Cleaning of the Vrick canal allowing the evacuation of water and thus contributing to an increase in the water supply from the Lake; - Completion of 3150 ha of landscaped works in the Departments of Mayo-Kani, Mayo Tsanaga and Mayo-Sava.	**Niger:** - Uprooting of 130 ha of invasive aquatic plant species; - Acquisition of equipment for the Sayam Centre; - Acquisition of 150 "Kouri" cows for the benefit of the Sayam Centre; - Fixation of 1800 ha of sand dunes; - Development of DRS/CES on 1200 ha; - Restoration of degraded ecosystems over 1300 ha; - Realization of small village irrigated perimeters on 441 ha; - Marking of 100 Km of transhumance corridors; - Construction of 4 pastoral wells; - Community reforestation on 280 ha; - Construction of 90 ha of forage perimeter; - Realization of 1340 ha of agroforestry; - Rehabilitation of the National Coordination Office; - Acquisition of piezometric and hydrometric equipment; - Realization of 1400 ha of landscaped land works in the Departments of N'guigmi and Diffa.	**Nigeria:** - Uprooting of 42 ha of aquatic invasive plant species; - Materialization of 100 km of transhumance corridors; - Construction of 7 pastoral wells; - Acquisition and distribution of 240 Chorkor ovens; - Acquisition and distribution of 170 dryer units; - Acquisition and distribution of 100 isothermal boxes; - Development of 370 ha of small irrigated village perimeters; - Construction of a modern fish market; - Rehabilitation of the national coordination office; - Acquisition of piezometric and hydrometric equipment.	**Chad** - Installation and equipment of 8 nurseries; - Realization of 6 boreholes; - Development of 450 ha of /CES (Water and Soil Conservation); - Awareness raising on the fight against pollution of the waters of the Lake; - Fixation of 400 ha of sand dunes; - Construction of 3 landing stages and 4 fishing surveillance antennas; - Acquisition of equipment for fishing surveillance antennas; - Acquisition and distribution of 4,000 impregnated mosquito nets; - Acquisition and distribution of 300 ml drying racks, 75 isothermal boxes and 35 Chorkor ovens; - Development of 80 ha of small irrigated village perimeters; - Marking of 278 km of transhumance corridors; - Development of 23 pastoral wells; - Construction of 48 ha of community forests and 140 ha of agroforestry; - Rehabilitation of the National Coordination Office; - Acquisition of piezometric and hydrometric equipment; - Implementation of work to develop degraded land - Development of 450 ha of land in the Guéra and Hadjer-Lamis Regions.	**CAR:** - 8 Chorkor ovens acquired and distributed - 1,000 impregnated mosquito nets acquired and distributed to the population in the covered area; - 6 mills acquired and installed for the beneficiaries of the programme - 6 shelling machines acquired and installed for the beneficiaries of the program - Contract for audits of the accounts for the years 2016, 2017 and 2018; -2 contracts with the Bureau for studies and work controls; -2 contracts with community radio stations for information, education, communication for behaviour change; -Contract with the design office to carry out the basic studies of the Programme.

Achievements of the PRESIBALT project in the LCBC members countries			
Cameroon - Audit contract for the years 2016, 2017 and 2018; - 2 contracts with the office for studies and work controls; - 2 contracts with community radio stations for information, education and communication for behaviour change; - Contract with the design office for the carrying out of the basic studies of the Programme;	**Niger:** - 150 ha of small village irrigated perimeters (PPIV) under development; - 5 rural markets, 2 already built and 3 in the process of being finalized; - 4 health centres under construction with levels ranging from 30% to 45%. The reception of these centres will be done at the end of 2019; -25 autonomous water stations (PEA) under construction in the field with 12 castles made up, including 4 installed on site, 6 boreholes and 3 fountains built. - Ongoing acquisition process for the work of: - 45 classrooms; - 60 km of rehabilitation of rural roads, including feasibility studies and tender documents are finalized. - 1 multifunctional platforms planned. - 4,000 ha of anti-erosion facilities in the programme area; - 1000 ha of restoration of fragile, degraded and/or highly threatened ecosystems; - 12 dairies in the project area but reviewed at mid-term; - 1 electrification kiosk - 2 threading workshops in the project area -52 Chorkor ovens acquired and distributed in the 4 countries - 2,000 Impregnated mosquito nets acquired and distributed to the population in the coverage area in Niger; - 37 mills acquired and installed for the beneficiaries of the programme - 37 shelling machines acquired and installed for the beneficiaries of the program.	**Chad:** - 60 ha of small village irrigated perimeters (PPIV) of which 26 ha have been received and 34 ha under development; - 5 rural markets, 2 already built and 3 in the process of being finalized; - 1 health centre, 95% of which is currently being built. The reception of these centres will be done at the end of 2019; - Equipment of the health centre - 36 boreholes have been constructed and accepted. - 17 Chorkor ovens acquired and distributed - 2,000 impregnated mosquito nets acquired and distributed to the population in the area covered; - 15 mills acquired and installed for the beneficiaries of the programme; - 15 shelling machines acquired and installed for the beneficiaries of the program.	**CAR:** - 8 Chorkor ovens acquired and distributed - 1,000 impregnated mosquito nets acquired and distributed to the population in the coverage area; - 6 Mills acquired and installed for the beneficiaries of the programme - 6 shelling machines acquired and installed for the beneficiaries of the program - Contract for audits of the accounts for the years 2016, 2017 and 2018; - 2 contracts with the Bureau for studies and work controls; - 2 contracts with community radio stations for information, education, communication for behaviour change - Contract with the design office to carry out the basic studies of the Programme.

<table>
<tr><th colspan="5">Achievements of the BIOPALT project in LCBC member countries (component of PRESIBALT)</th></tr>
<tr><td>Cameroon:
- Contract with an NGO for the support of beneficiaries in the field of management and maintenance of signed goods and works</td><td>Chad:
- Contract with SOS Elephant for the implementation of the project</td><td colspan="3">LCBC:
- The contract with UNESCO for the implementation of the Lake Chad Biosphere and Heritage Project (BIOPALT) contains the following content:
- The inscription of Lake Chad on the World Heritage List;
- The creation of protected areas
- The establishment of the MAB, IHP and PM Committees;
- The identification of transboundary areas of the Lake between Cameroon, Nigeria and Chad and CAR;
- Studies on the improvement of knowledge on hydro-climatic variability within the Lake Chad Basin

As part of the implementation of the BIOBALT project, the LCBC initiated studies to improve knowledge of the biological, cultural and hydrological resources of Lake Chad, which led to the preparation of a provisional nomination dossier for the inscription of Lake Chad on the World Heritage List. The project is also developing a management plan for the Lake as future world heritage.</td></tr>
<tr><th colspan="5">Achievements of the PURDEP project in LCBC member countries</th></tr>
<tr><td>Cameroon:
- Rehabilitation of an integrated health centre in Kousseri in 2017
-Rehabilitation of the Maga breeding station in the Far North region in 2017.
- Completion of 3 manual boreholes in the villages of Dafra, Hounangare and Kassire (Far North Cameroon region) in 2017</td><td>Niger:
- Construction of three (3) mini-poaching poultry farms in three sites in the Zinder region for the benefit of youth groups in 2017</td><td>Nigeria:
- Development of 75 ha of small irrigated village perimeters in Jigawa, Kano, Bauchi and Yobe States, particularly in Kiyawa, Guri, Kirkasamma, Birniwain, Darazo, Gajuwa, Dambam, Sumaila, Takai, Albasu, Baden, Fune, Nguru, Jakusko and Geidam in Komadugu Yobe subbasin in Nigeria in 2017 and 2018
- Construction of three solar water supply systems in Nigeria in Adamawa states (Hildi village and Lakuwa village) and Unguwan Madaki village in Gombe in 2017 and 2018</td><td>Chad:
- Construction of 3 manual boreholes in Chad in the villages of Sidi Koura, Koulou Kourou, Alati and Djaramaye, Lake region in 2017 and 2018
-Construction of three (3) solar pastoral boreholes in Deyla, Doumdoum and Baderi in the Lake region, in 2017 and 2018</td><td>CAR:
- Support for shea butter and honey production groups in villages in the Bossangoa departments in 2017-2018</td></tr>
</table>

Achievements for the GIZ project at the LCBC

1. Improve information exchange with member countries

-The internal exchange of hydrological and socio-economic data is improved through the establishment of the regional database (RDB) and a Lake Chad Basin Information System (LIS).
- Elaboration of the biennial State of the Lake Chad Basin Ecosystem report (published 01/2017).
- Preparation of a roadmap for the AMR; Designation of AMR Experts (Memorandum available);
- Collection of existing data in member countries, analysis and preparation of chapters of the Annual Monitoring Report (AMR) of the Lake Chad Basin 2017-2018

2. Support strategic planning of the LCBC

- LCBC planning is more effective through the implementation of a planning, monitoring & evaluation system

3. Improve LCBC intern and extern communication

- Improvement of the IT infrastructure through the installation of a high-performance server
- Internal: Establishment of an internal communication platform
- External: Development of a website for the LCBC
- Link with the PAS: AXIS V "Development of the institutional and operational framework of the LCBC"
- Study tours (Mekong River Commission, Danube Commission).

4. Training of LCBC staff in the following areas:

- Planning, Monitoring and Evaluation
- Communication
- Leadership
- IT-Administrator
- Use of the LCBC communication platform
- Use of LCBC LIS
- Data analysis for the drafting of the AMR chapters

5. Adaptation measure to climate change in agriculture

- Development of a climate study analysing past, present, and future climate variability and change in the Lake Chad Basin (1900-2013 and 2000-2099, respectively) and an inventory of agricultural production systems in a transboundary pilot zone between Chad and Cameroon.
-Planning, implementation and dissemination of agricultural adaptation measures in four production systems in the pilot zone directly supporting more than 200 households in adapting their agricultural practices, reducing vulnerability to rainfall variability, and in increasing yields and incomes.
-Analysis, documentation, and dissemination of project results and best practices through radio broadcasts, the LCBC website, reports, fact sheets, a video, and conference presentations.
-Elaboration of a Regional Adaptation Strategy to Climate Change including the diagnosis of vulnerability

Achievements of the BGR project at the LCBC
1. Collection and analysis of groundwater resource data; - 16 data collection campaigns in 3 intervention areas (Komadugu Yobe, Waza Logone and Salamat) with the participation of the LCBC and Member States were implemented; - During the data collection campaigns, 517 samples were analyzed; - 12 thematic maps of each intervention area (Komadugu Yobe, Waza Logone and Salamat) are available; - 16 reports containing the results of the measurement campaigns are available; - 12 practical recommendations for groundwater management are available; - Advice to the LCBC on groundwater resources issues (Support to the Water Coordination Group for knowledge management); **2. Installation of a groundwater resources monitoring network at the regional level;** - Regional inventory of piezometers; - 8 dataloggers installed in Chad; - 6 dataloggers installed in Cameroon; - 7 dataloggers installed in Niger; - The network is installed, two dataloggers are missing in CAR; - Regional technical training for the use of dataloggers; **3. Training and exchange with Member States** - Regional training on the QGIS software; - Regional training on "Integration of groundwater management"; - Regional technical workshops for presentations/discussions of results; - Regional workshops for planning/monitoring/evaluation of activities; - Study tours; Financing of training at IHE Delft and participation in international conferences

8. Conclusion

The Annual Monitoring Report (AMR) for the period 2017-2018 presents an overview of the status of the monitoring system for natural and socio-economic resources in the Lake Chad Basin. This Report is a technical document that presents and analyses the data collected in the Member States during the period in order to monitor the key indicators of the basin. These data covered meteorological aspects, water resources, agriculture, biodiversity and basic socio-economic indicators (population figures, HDI and refugee population) in the basin.

In terms of meteorological, hydrological and hydrogeological data, the collection of available data of all monitoring stations by sub-basin shows that they are only a few data available and that monitoring stations are in a dilapidated state. The absence of monitoring and maintenance missions for the monitoring system cause significant gaps in the observed data series.

In terms of weather, the hydrological year 2017-2018 was marked by heavy rainfall in the Sahel region of the basin. Excess cumulative rainfall with a normal tendency is recorded in the N'Djamena area. Thus, the cumulative recorded rainfall at the N'Djamena Airport station is 28.16% higher than the 1980-2017 normal.
However, the situation is particularly different in the Upper Chari Basin represented by the Sarh weather station in Chad, where a deficit of 47.58% was recorded compared to the 1980-2017 normal (ANAM 2018).

This deficient rainfall situation observed in the upper Lake Chad Basin had a significant impact both on the water conditions of the rivers supplying the Lake and on the recharge of groundwater aquifers. Thus, the total volume of water recorded in the Lake in 2018 is 31.59 km3, which corresponds to the small Lake in terms of water surface area (about 2,500 km²).

Regarding the water quality, the results of chemical analyses of surface water taken from the Logone and Chari rivers show that these water courses are in the process of being impacted by pollution. As such, monitoring of these resources during high and low water periods is necessary for better surface water management.

The results of chemical analyses of groundwater show that the overall quality of groundwater is good. However, the levels of some elements (nitrate, arsenic, fluoride and/or faecal bacteria) are higher than the limits recommended by WHO for save drinking water and deteriorate the quality of the groundwater. These sites are located in Jimbam, Gashua, Maiduguri (in the Komadugu Yobe basin), N'Djamena, Bahr El Ghazal, Salamat and Yaéré.
Corrective measures would be required to improve water quality through awareness campaigns on management around water points.

In view of this situation, it is strongly recommended that the competent authorities raise awareness of the risk and then receive a good health education or prohibit its use through government regulations.

From an environmental point of view, the 2017-2018 period is characterized in the Lake Chad Conventional Basin by vegetation varying from dense to none as one move from south to north. Depending on the season the extent of vegetation differs strongly. In the dry season, only the southern part of the basin shows dense vegetation except regions in the north located along water courses e.g. around Lake Chad and the Yaéré floodplain (located between Chad and Cameroon).

This annual report of the Lake Chad Basin has also provided an overview of the basin's biodiversity in terms of species and numbers of individuals and the conservation status of the main protected areas and other conservation sites in the basin grouped by country.

In terms of socio-economic development, the period 2017-2018 was marked by exceptional population growth in some countries of the basin, such as Niger and Chad. This constitutes a strong additional constraint to development in these countries.
The total population living in the conventional Lake Chad Basin in 2018 is estimated 76 million people.
The population profile in the basin highlights important demographic issues. The characteristics of the population are marked by wide geographical disparity, rapid urbanization and the extreme youth of the population. This demographic situation of the Basin constitutes an asset for the countries but also includes development problems: it is an asset in terms of expanding the national market for the consumption of goods and services but it involves development problems in terms of social demand to be met (health, education, employment, social protection, etc.). In view of these findings, it is important that targeted study topics are developed to address governments' development and social protection concerns.

The development of this first AMR has not been completed without difficulties. Among the difficulties, we can mention the current insecurity in the basin which makes it difficult, if not impossible, to collect some data that are crucial for the annual monitoring report and the integrated management of the basin’s resources. This is the case for hydrological and meteorological data from the Nigerian and Central African portions of the basin. Other difficulties are related to the inaccessibility of some data that are subject to a charge, the very short time for data collection made by LCBC experts, and the limited exchange between the LCBC and the competent authorities of the Member States.

Finally, this report will be used not only by the Executive Secretariat of the LCBC for more in-depth analyses, in particular for the preparation of the next State of the Basin Ecosystem (SOB) Report, but also as a basis for all Member States to carry out more detailed and analyses and, for example, future planning of hydraulic infrastructures, irrigation areas and decision-making to meet future challenges.

9. Recommendations and Perspectives

At the end of the preparation of this first Annual Monitoring Report (AMR), the following recommendations were made:

For the LCBC:

- Data collection in the Member States for the preparation of the next AMR should be done by expert and each according to its field of competence;

- LCBC AMR experts should strongly involve the technical services of States in the data collection and the drafting of the AMR, so that they can provide the types of data that the AMR needs

- Adapt the data collection protocol to take into account some missing aspects such as the biodiversity data protocol; or food security (fisheries, livestock and agriculture).

- Set up a committee to monitor the data exchange protocol between the Member States and the LCBC.

- Make available to the technical institutions of the Member States an identical field monitoring protocol for collecting socio-economic data and food security (livestock, agriculture, fisheries).

- Provide LCBC experts with appropriate software for trend analysis in order that they can support Member States' institutions in field surveys using modern technologies such as the World Bank's Survey Solution;

- Involve universities, research centers and partners in the basin in the preparation of the next annual monitoring report,

- Organize a workshop to validate the data collected in each Member State for the preparation of the next annual monitoring report.

For the Member States:

- Compliance with the Data exchange Protocol between Member States and the LCBC signed at the 54th Ordinary Session of the Council of Ministers held on 25-26 March 2008 in Abuja, Nigeria

- Compliance with the Water Charter, Chapter 10 and Articles 64 and 65 respectively, that States Parties have the obligation to regularly collect data and information on their respective territories,"..." and also States Parties have the obligation to regularly exchange their available data and information on the Basin, through the Commission in the context of sustainable management of the Basin, in order to improve their knowledge from the hydrological, environmental and socio-economic points of view.

- Involve the Member States in the data collection for the preparation of the next annual monitoring report.

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