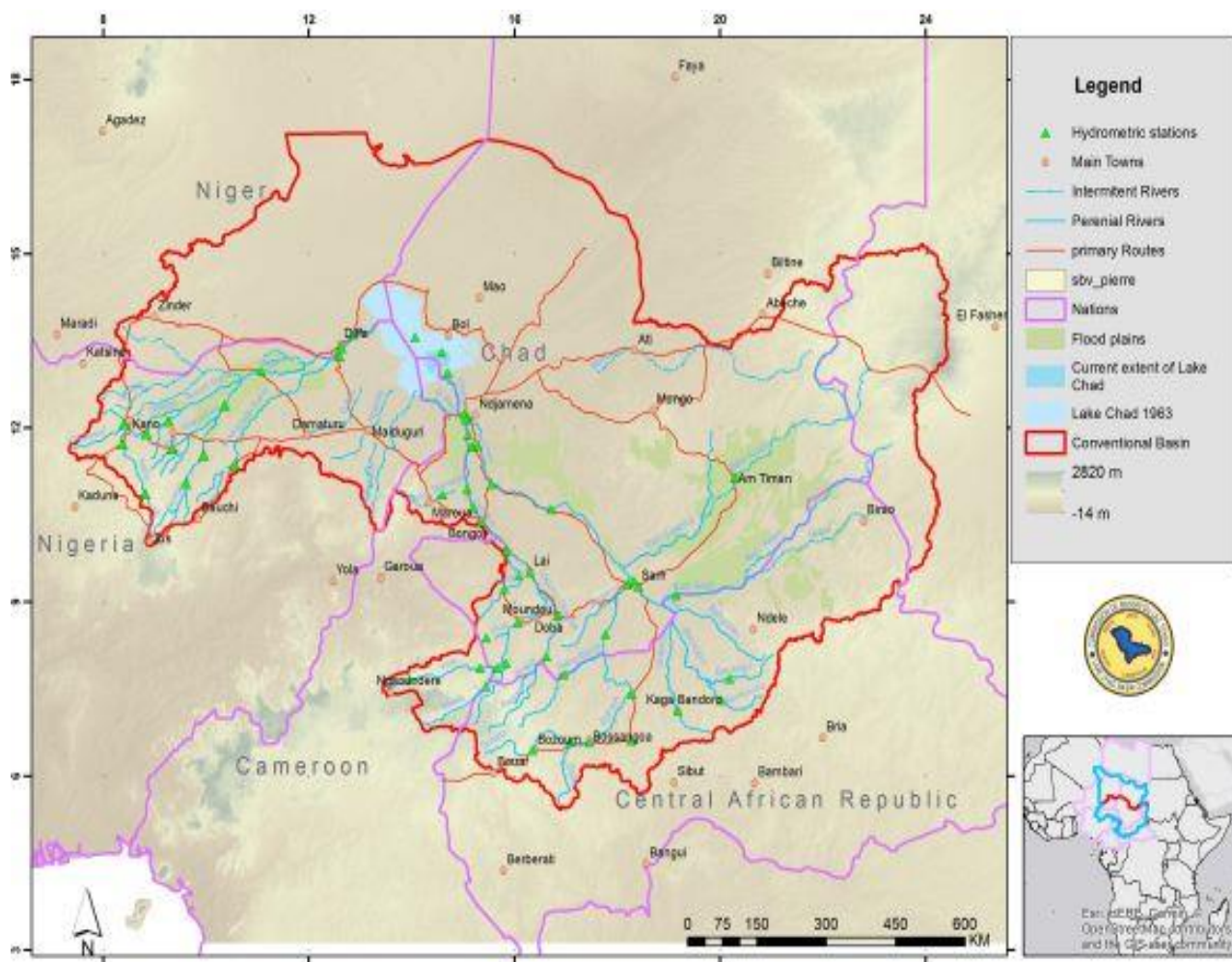




**BRIEF ON THE HYDROLOGICAL SITUATION
IN THE LAKE CHAD BASIN**



Network of Hydrometric Stations in the Lake Chad Basin

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Introduction

The 2022 hydrometeorological situation in the Lake Chad Basin is characterised by the start of the wet season in the southern part of the Basin during the 2nd quarter and in the central and northern parts of the Basin in the 3rd quarter. This situation marked the effective commencement of the rainy season and, by extension resumption of flows into the main rivers that supply Lake Chad.

This brief presents the hydrological situation of the Lake Chad Basin from 1st May to 20th October 2022. It also makes projections on the water level and surface area of Lake Chad in 2022.

1. Hydrological Situation for 2022

The heavy rains of July, August and September 2022 in the Basin resulted in massive flows into the main tributaries of the Lake, hence a very significant increase in water volumes. This situation confirms the predictions of the seasonal forecasts on agro-hydro-climatic characteristics for the Sudano-Sahelian zone (PRESA-SS) carried out in April 2022, which predicted excess and above-normal flows compared to the climatological reference period (1981-2010) for all river basins in Sahelo-Sudanese countries.

Thus, above-normal flows were expected in the Chari, Logone and Komadugu Yobe basins.

As such, the following situation has been observed in the different sub-basins of the Lake Chad Basin.

1.1 The Upper Basin of the Chari Catchment

The 2022-2023 hydrological situation in the upper basin of the Chari-Logone is characterised by a steady rise in water levels recorded at various stations in this area, particularly the Sarh Hydrometric Station in the Chari. The water-rise dynamic, which started in the upper basin in May, got worse in August and September 2022 following heavy rains recorded in this upper basin, particularly in the Central African Republic. The water evolution curve at the Sarh station in the Chari (Chad) clearly shows this (Fig.1).

This station also shows the rise in water level from May, which reached a first peak of **700cm on 2 October 2022** and a second peak of **711 cm on 15 October 2022**. This is the highest level recorded and corresponds to a flow of **1150 m³/s**. As at now, the water continues to rise slowly in Sarh. This means we are inching towards a flood peak for 2022.

It is worth noting that this 711 cm water level recorded in Sarh is largely above the peak reference for wet years of this last decade: **2012/2013 (609 cm recorded on 29 September 2012)**, **2019/2020 (625 cm recorded on 24 October 2019)**, **2020/2021 (693 cm recorded on 16 October 2020)**, **2021/2022 (537 cm recorded on 26 September 2021)**. This is an increase of 3% compared to 2020, which is the wettest of the reference series (Fig. 1).

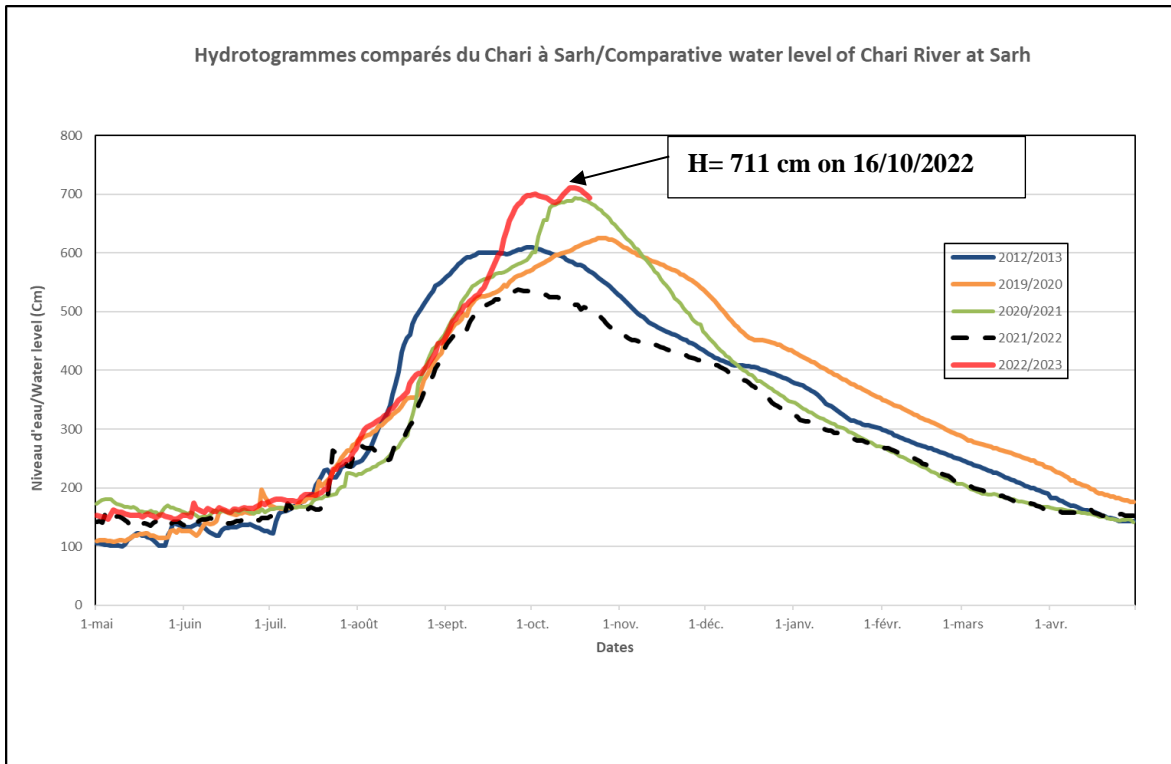


Fig. 1 Comparative Water Level at Sarh, Chari

1.2 The Logone Lower Basin

The rapid rise in water level in the lower Logone at the Ngueli station is a response to the significant rainfall recorded in the Logone sub-basin in the Central African Republic and Cameroon. Thus, the hydrological situation in this area is characterised by outflows from the upper Logone and, in this case, from the Adamawa Plateau. The rise in the water level recorded from Logone to Ngueli in 2022 is significantly higher than the reference years from the beginning of the season. (Fig. 2).

The **800797 cm water level recorded on 30th October 2022 at the Ngueli Hydrometric Station** is the maximum ever observed since 1961. This is significantly higher than the recorded level in 2020 (**740 cm recorded on 3 November 2020**), which is also a wet year. This is an approximately **8%** increase;

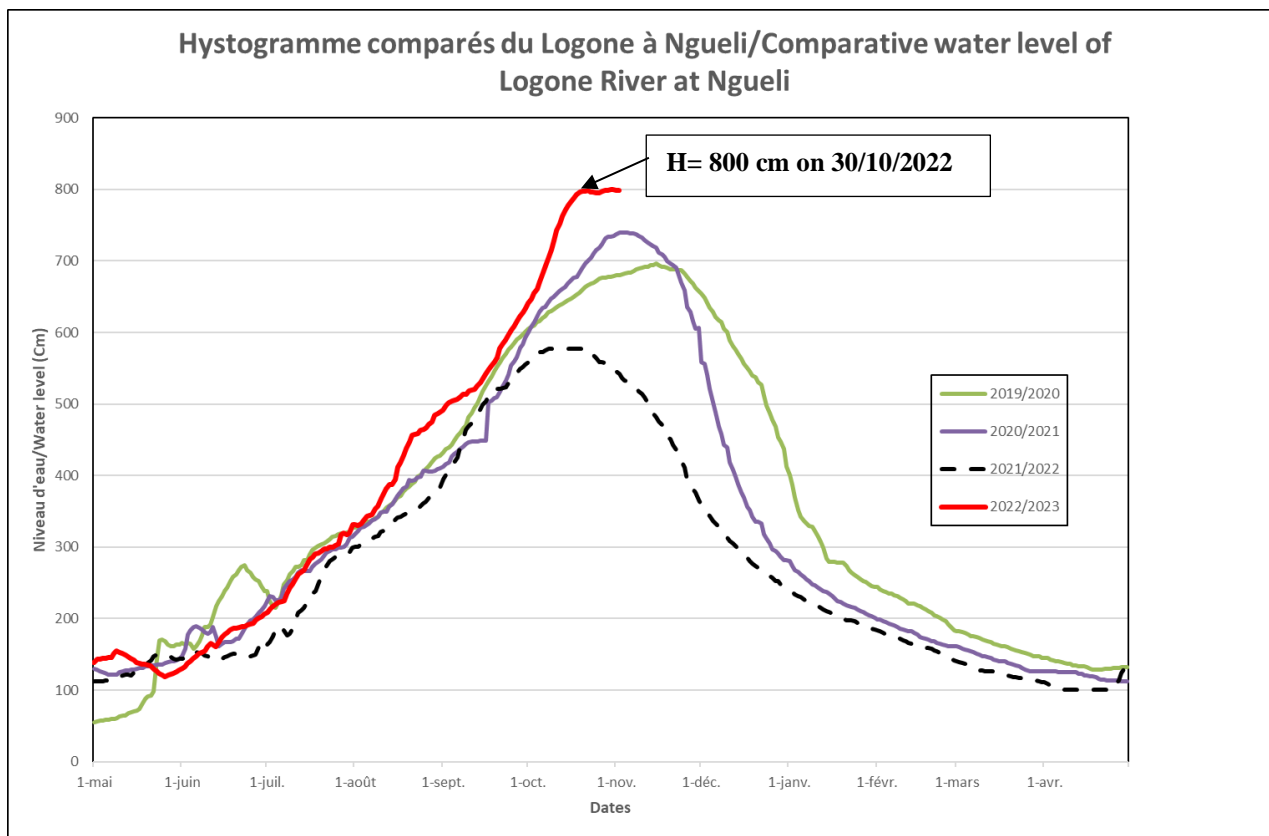


Fig. 2 Comparative Water Level at Ngueli, Logone

1.3 The Lower Basin of the Chari-Logone Catchment

The situation recorded in the lower basin of the Chari-Logone catchment is a response to hydrological and rainfall situations in the upper basin of the catchment. Data recorded at the N'Djamena TP station show the immediate response by the Chari as early as June 2022 and gradually up to October. This rise was even more remarkable at the confluence of the Chari and Logone rivers, with the arrival of water from the upper Chari basin and the peak recorded at Ngueli, Logone.

As at 20 October 2022, the water level on the Chari in N'Djamena continues to rise, with a first **peak of 806 cm**, never recorded in recent decades. This represents a flow of **3860 m³/s**. This peak is much higher than the reference wet years, especially **2012/2013, with a maximum observed on 18 October 2012 of 766 cm**. The water level on Chari, as recorded at the N'Djamena TP station, continues to rise. As such, the maximum level is expected to be reached by the end of October, which could attain the **815 cm level (See Fig. 3)**.

This exceptional rise of the Chari has caused extensive damage in the city of N'Djamena, with thousands of persons rendered homeless and houses destroyed. Due to this situation and the extent of the damage recorded, the Government of the Republic of Chad signed a decree on **19 October 2022** declaring a **state of natural disaster in the Republic of Chad**.

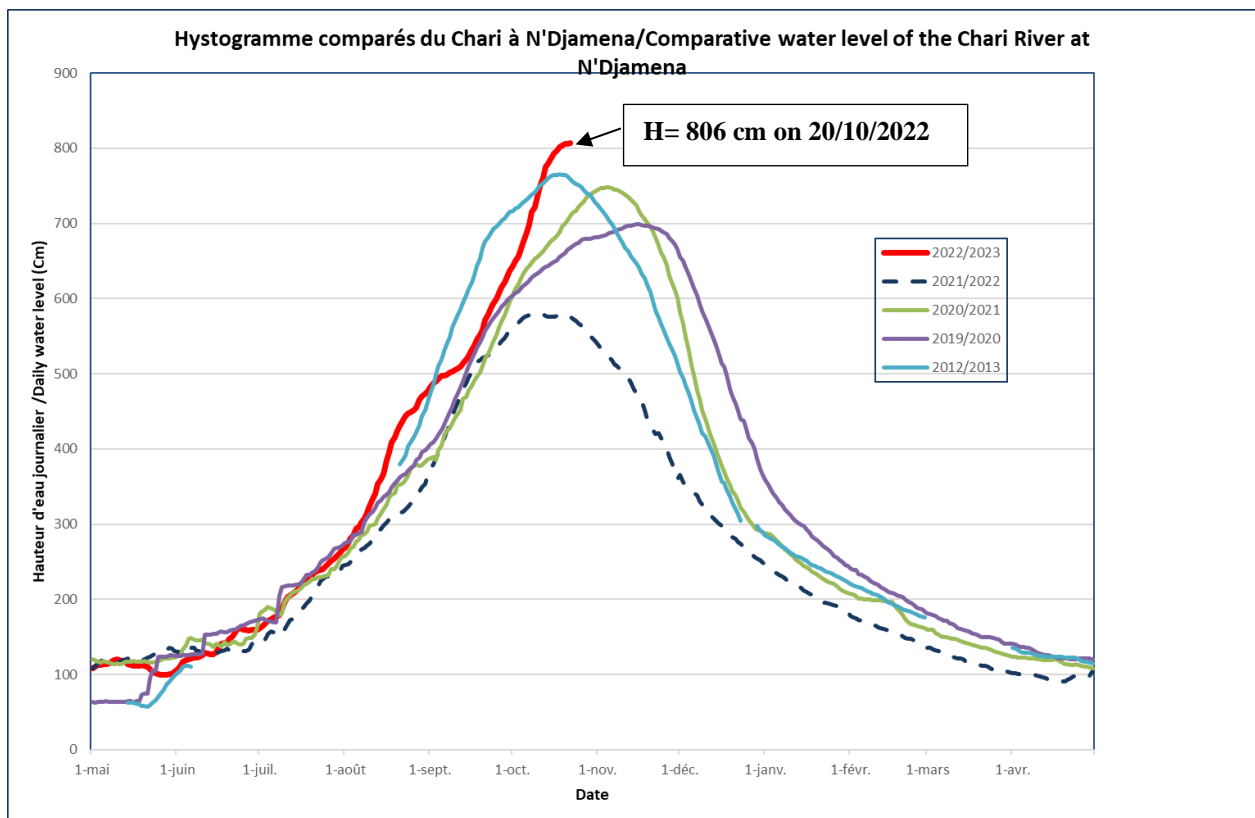


Figure 3: Comparative Histogramme of the N'Djamena station

1.4 Komadugu Yobe Sub-Basin

The readings of the Bagara Diffa station in the Komadugu Yobe basin result from the excess hydrological and rainfall situations recorded in the Nigerian portion of the Basin. The Komadugu Yobe experienced an early and rapid rise in water levels from July 2022, and this continued gradually, clearly exceeding the following reference years: 2012/2013, 2019/2020, 2020/2021 and 2021/2022. (**See Figure 4**).

This situation is exceptional, in fact, the **alert threshold (449 cm)** has been exceeded since September 22, 2022 to reach a maximum of **558 cm on October 4, 2022**, which is an excess **height of 109 cm (plus 1 m)**.

After a slight drop, the water level of the Komadugu Yobe in Diffa continued to rise, reaching a maximum of **578 cm on October 21, 2022**, the highest ever recorded since the station was created in 1957.

It should be noted that this height of **578 cm** has never been recorded at this station (Bagara, Diffa). Hence, this is proof of the recurrent phenomenon of flooding in this portion of the Basin, resulting from a change in surface conditions, upstream silting up of structures and climate variability and change. This has led to major flooding and extensive destruction of material and farmland in the town of Diffa and its environs.

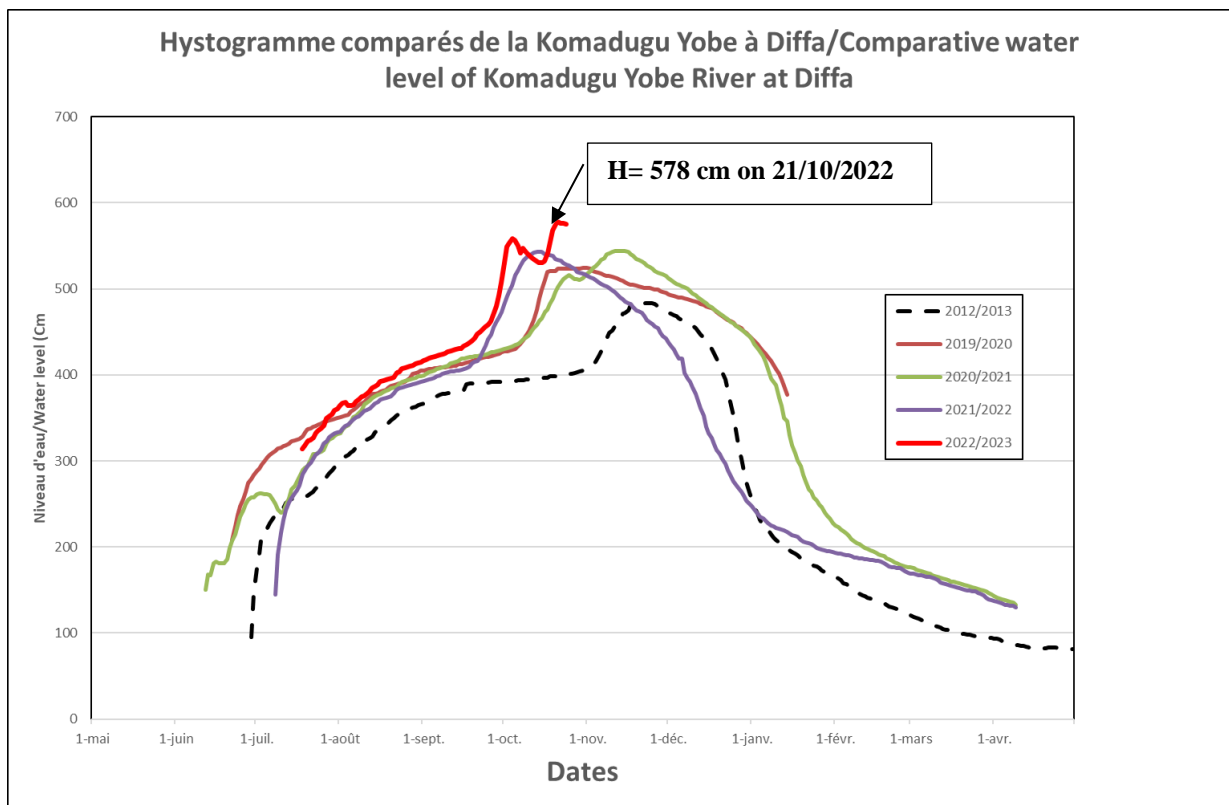


Figure 4: Comparative Water Level of the Komadugu Yobe River recorded the Bagara Diffa Station

2.4 State of Flooding in the Lake Chad Basin

Several cities In the Lake Chad Basin have been built along watercourses, with some extending into flood retention areas. This is the case with N'Djamena in Chad, Kousseri in Cameroon on the Chari-Logone catchment and Diffa on the Komadugu Yobe river course.

As such, they are directly exposed to flooding, with overflows from the Chari-Logone catchment and the Komadugu Yobe river.

N'Djamena and Kousseri are located at the confluence of the Chari and Logone rivers on clay soil with depressions.

In most cases, flooding is caused by the effects of confluences, the degradation of riverbanks (anthropic pressures) and exceptional rainfall flowing from the upstream basin.

It is evident that when the N'Djamena station attains the 4.40 m level, the Chari becomes a barrier for the Logone, thus causing a rise in the water level upstream.

However, it should be noted that when

- ✓ the maximum water level of the Logone at Ngueli (H_{max}) is greater than or equal to 6 m, this river overflows its banks, causing floods;
- ✓ When the maximum water level is between 6 and 7 m, there is a risk of flooding with minor damage;
- ✓ Lastly, when the maximum level recorded at the Ngueli station is greater than or equal to 7 m ($H_{max} \geq 7$ m), which is equal to the red alert zone, the risk of flooding with extensive destruction is very high.

This is what has been observed this year at the Ngueli station on the Logone, where a maximum of 796 cm was recorded on 20 October 2022.

This rising of river waters caused by heavy rains upstream has resulted in significant material damage in several districts in N'Djamena, Chad and, Kousseri, Logone Birni in Cameroon, hence a natural disaster. A similar situation was observed in Diffa, Niger, on the Komadugu Yobe. Again, this has displaced so many people.

Topographically, the water level in the Chari has risen above the drainage system of these areas. Hence the reverse effect.

2.5 Estimate of the Lake's volume (2022/2023)

The direct consequence of the overflow of tributaries of Lake Chad is its rising volume. As at **20 October 2022**, the Lake level was **280.59 m**. This is already beyond the Great Barrier, which separates the south sub-basin from the north. The south sub-basin and the Komadugu Yobe are supplying the northern sub-basin (**Fig. 5**) and (**Fig. 6**).

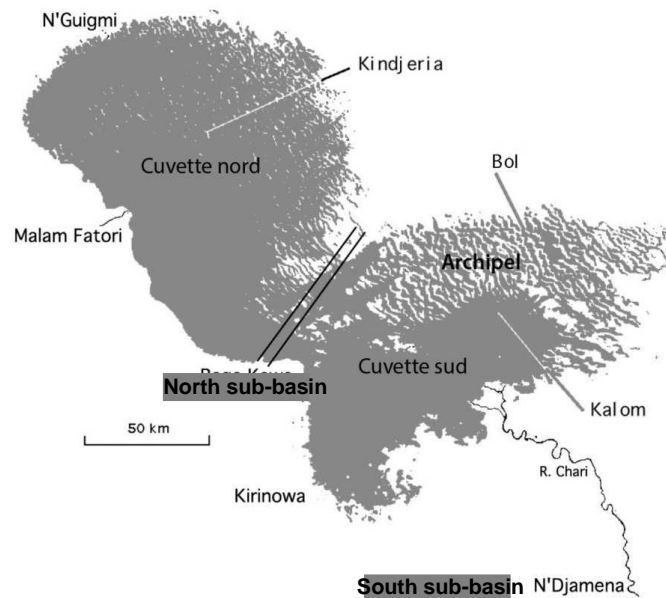


Fig. 5: Lake Chad, with its different sub-basins and the Great Barrier, illustrated by the double lines between the north and south sub-basins.

Based on findings by the Institute of Research for Development (IRD), the zero level of the south sub-basin is 278.2 m, while the upper level of the barrier is 279.3 m (**See Fig. 6 below**)

The average level of the water body in the south sub-basin stands at **280.57m**, which is largely above the barrier. This was taken on **20 October 2022**.

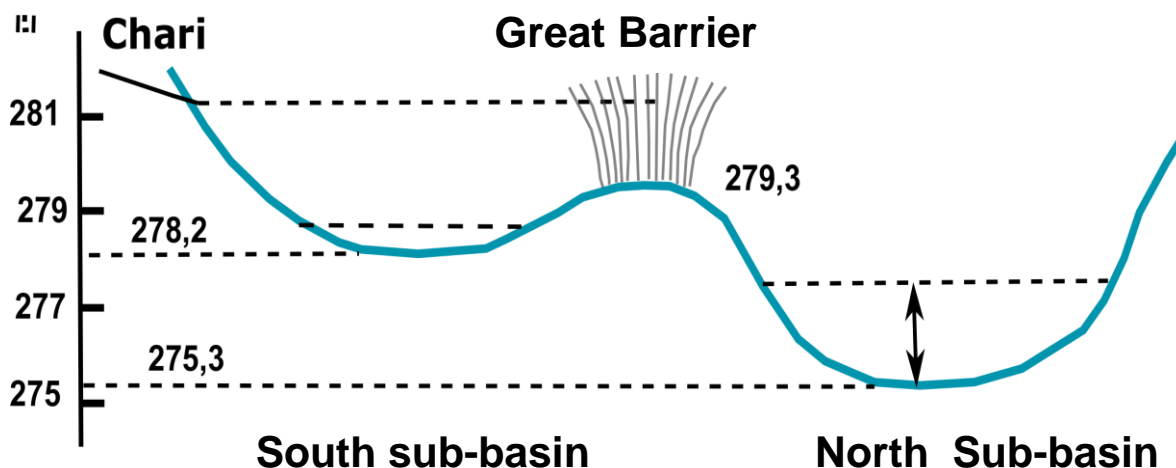


Figure 6: Comparative evolution of the bed of the basins

Based on available data at the N'Djamena TP and Bagara Diffa stations, it is possible to estimate the volume of water flowing from the Chari-Logone catchment and Komadugu Yobe river into Lake Chad.

Statistical studies carried out by ORSTOM (IRD) show a relationship between the modulus and the maximum flow of the Chari at the N'Djamena TP station.

The maximum flow observed at the N'Djamena station **on 20 October 2022 stood at 3860 m³/s. That is a height of 806 cm.**

Thus, based on the ORSTOM formula, the modulus of the Chari at tin N'Djamena = **0.310*Qmax +144** where 0.310 represents the slope of the adjustment line (Modulus-Qmax) and 144, the adjustment constant, **that is, a modulus of 1340.6 m³/s in 2022.** The modulus of the Komadugu Yobe will be about **420 m³/s.** Thus, a cumulative volume of **1760.6 m³/s** is expected in Lake Chad in 2022. In other words, an estimated total annual volume of **55.52 billion cubic meters of water is expected in the Lake.** This volume corresponds to a **surface area of approximately 24,000 km²,** which is equal to the **average lake,** or even a **large lake,** based on the **IRD classification in the "Collegial Expertise" study of 2014. (See Table 1 below)**

Lake Chad	Small	Medium	Large
Flow from the Chari (km ³ /year)	10 - 34	40	45
Water level (m)	Different Levels	280 - 282	> 282.3
Number of water bodies	Several	One	One
Totals surface area of the Lake) (km ²)	2000 -15000	15000 - 20000	20000 -25000
Flooded areas of the Northern sub-basin	0 - 8000	9000	10000
Dominant Landscape	Marshland	Archipelago dune	Open Water

Table 1: Main characteristics of the different states of Lake Chad (Source: Collegial Expertise)

Conclusion

To sum up, the 2022 wet season is considered normal to excessive, based on rainfall and hydrology within the Lake Chad Basin. This has helped farming in several localities to go through their cycles.

However, cases of flooding have also been reported in several areas in the Chari-Logone and Komadugu Yobe sub-basins (N'Djamena and Diffa), the results of which are huge material losses and internally displaced persons.

This situation confirms the April 2022 seasonal forecasts of overall rainfalls that are higher than equivalent to the 1981-2010 seasonal average, and so, throughout the Central and Eastern zones of the Sahel strip.

In terms of hydrology, higher than normal run-off and higher than the reference years **2012/2013, 2019/2020, 2020/2021, 2021/2022** were recorded in the main rivers of the Lake Chad region. This has caused overflows in several places within the Chari-Logone catchment and the Komadugu Yobe, hence, flooding and significant material damage.

The Lake is filling up rapidly, following higher than the average rainfalls of 1981-2010 recorded in the Lake Chad Basin in 2022. Consequently, its volume is comparable to that of an average lake with a **surface area of about 24,000 km²**.