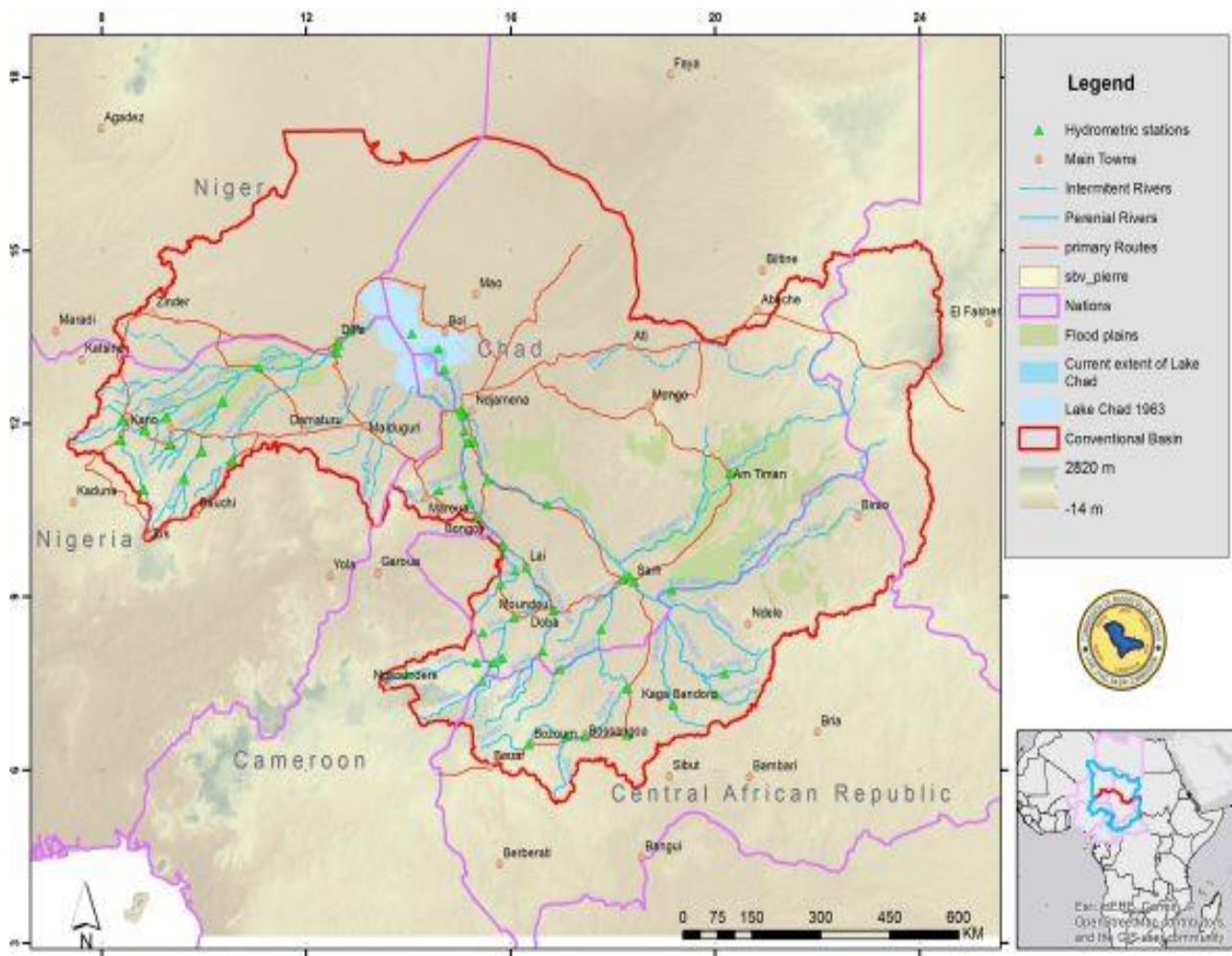




2023/ 2024 BRIEF ON THE HYDROLOGICAL SITUATION IN THE LAKE CHAD BASIN



Map indicating the locations of hydrometric network stations in the Lake Chad Basin

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Introduction

This brief presents the hydrological situation observed in the Lake Chad basin from 1 May 2023 to 1 April 2024 (hydrological year). It also provides information on the filling level of Lake Chad and its surface area in 2023/2024.

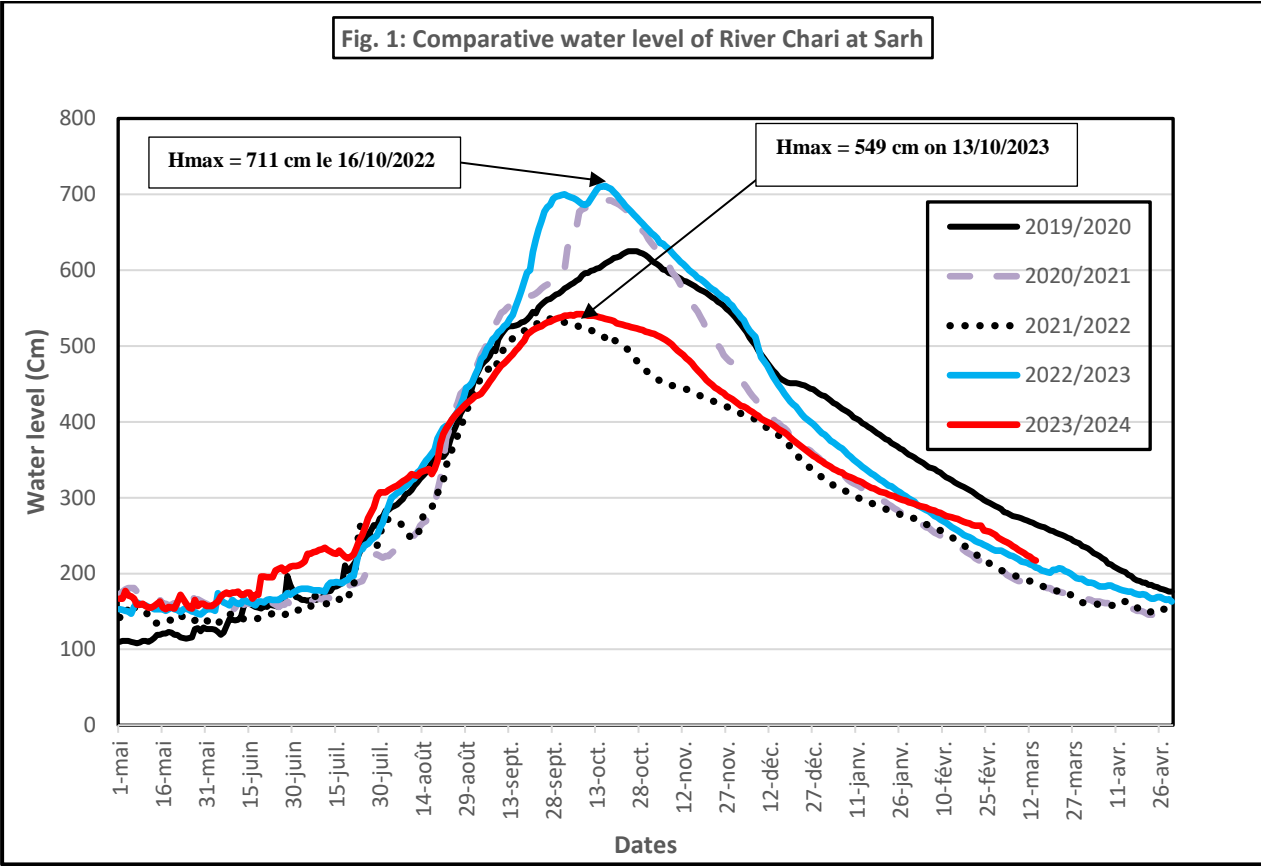
The 2023/2024 hydrometeorological situation in the Lake Chad basin was characterised by a slow start to the rainy season in the southern part of the basin during the second quarter and in the centre and north of the basin during the third quarter. This situation marked the effective beginning of the rainy season with the resumption of run-off in the main rivers supplying Lake Chad.

1. Hydrological situation: 2023/2024

The rainfall recorded in the basin in July, August, and September 2023 generated run-off in the main tributaries of the lake, carrying reasonably large volumes of water. This rainfall situation was significantly lower than that observed in 2022, which caused severe flooding in the Lake Chad Basin. It is also consistent with the seasonal forecast of Agro-Hydro-Climatic characteristics for the Sudan-Sahelian zone (PRESA-SS) organised in April 2023, where average to surplus run-off was observed over the Sahel, covering Niger, southern Chad, and the northern parts of Togo, Benin, Nigeria, and Cameroon.

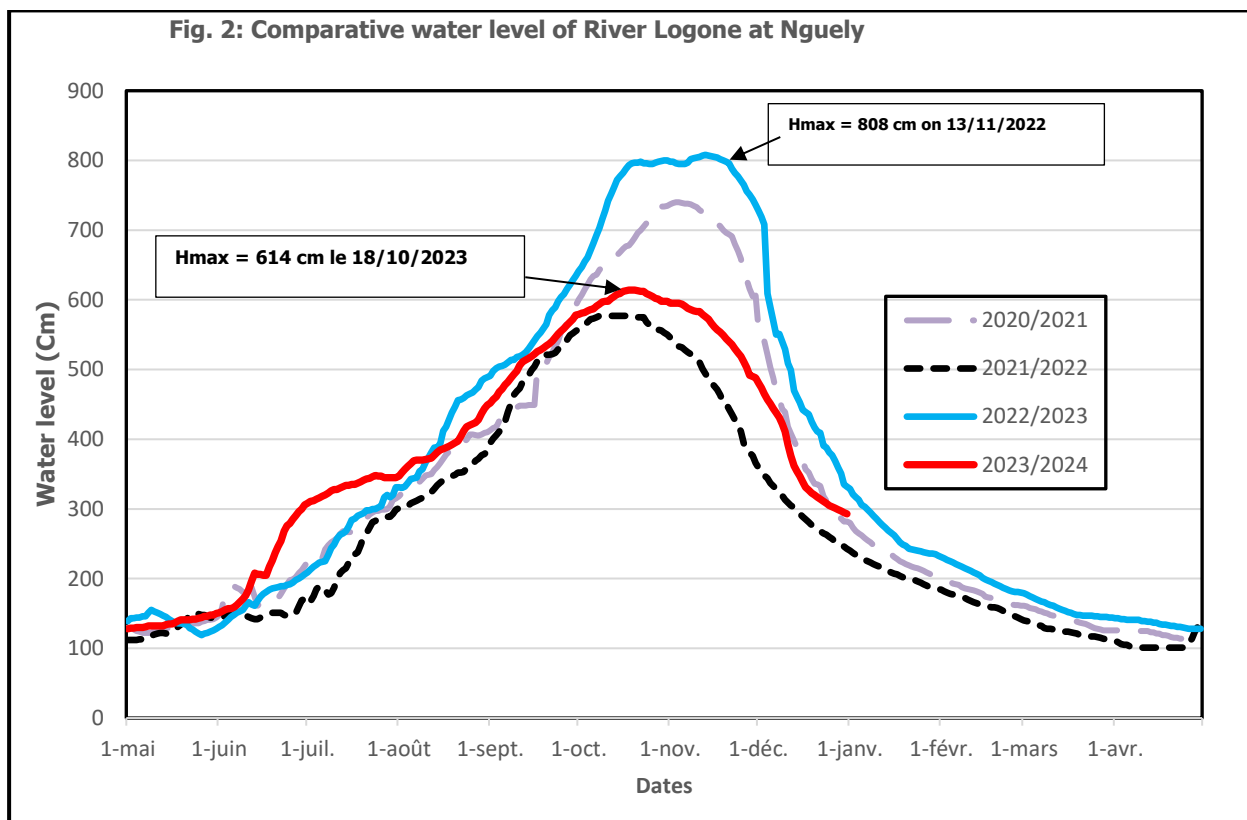
1.1 Upper Chari Basin

The 2023-2024 hydrological situation in the upper Chari sub-basin was characterised by an irregular rise in water levels at various stations, particularly at the Sarh hydrometric station in Chad. This dynamic rise in water levels, which began in May, reflects the slow onset of the rainy season. It was only at the end of July/beginning of August 2023 that the rise in water level accelerated, reaching a maximum of **542 cm on 6 October 2023**. It is clearly shown by the water level curve for the Chari at the Sarh station (Chad) (Fig.1). This maximum of 542 cm corresponds to a discharge of ***585 m³/s on the rating curve***. It should be noted that this peak flood of 542 cm recorded at Sarh is significantly lower than that of the wet year **2022 (711 cm for 1130 m³/s)**, which is a reference year in recent decades. This corresponds to a reduction of **76.23% compared with 2022** in terms of the volume of water flowing at the Sarh station (**Fig. 1**).



1.2 Lower Logone Basin

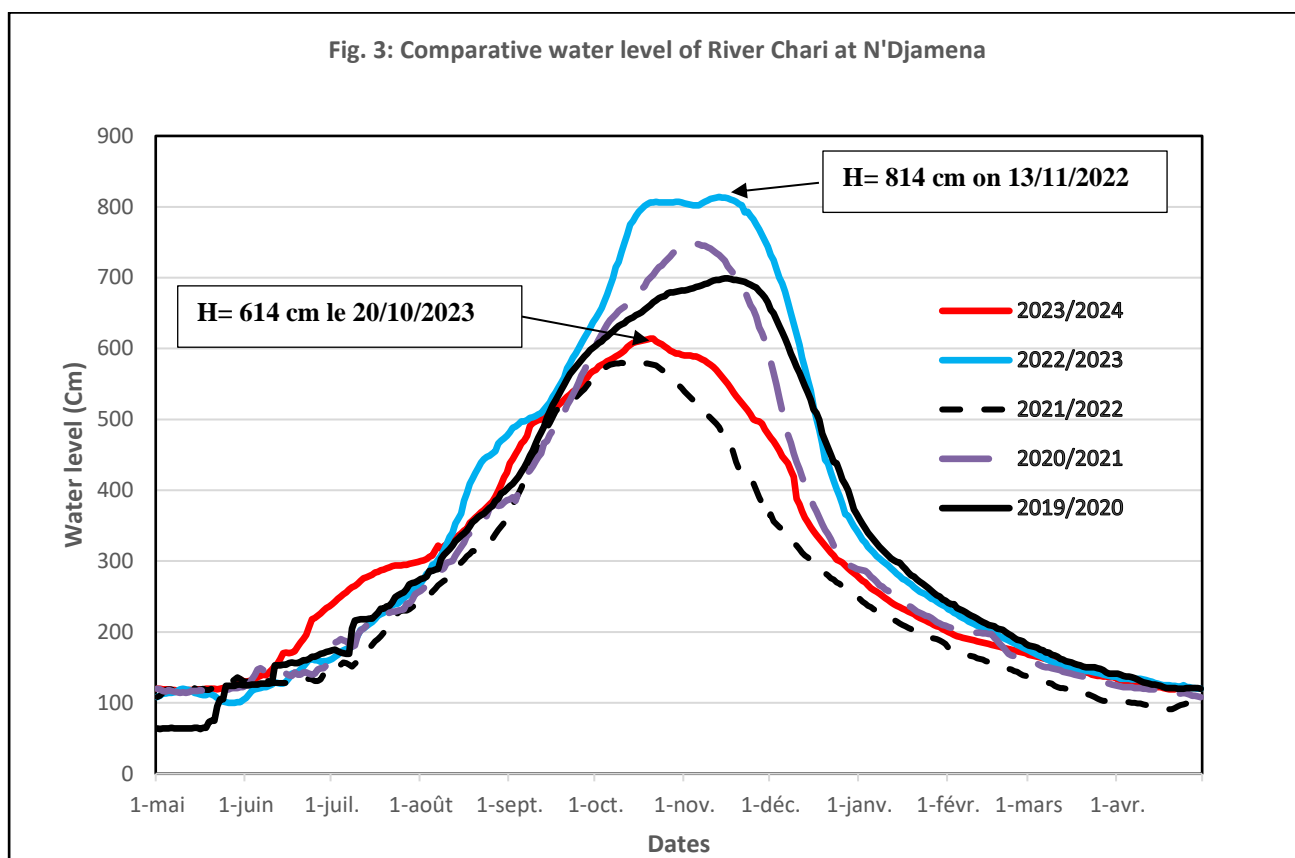
The rapid rise in the water level in the lower Logone at the Ngueli station is a response to the rainfall recorded in the Logone sub-basin in the Central African Republic and Cameroon. The hydrological situation was characterised by the emptying of water from the upper Logone, particularly from the Adamaoua plateau. The rise in the water level of the Logone at Ngueli observed in **2023** was much lower than that observed in **2022 (Fig. 2)**. The peak of **614 cm recorded on 18 October 2023 at the Ngueli hydrometric station** was significantly lower than in 2022, but slightly higher than in 2021 (577 cm). This situation shows a reduction in run-off of around 76% in 2023 compared with 2022.



1.3 Lower Chari-Logone Basin

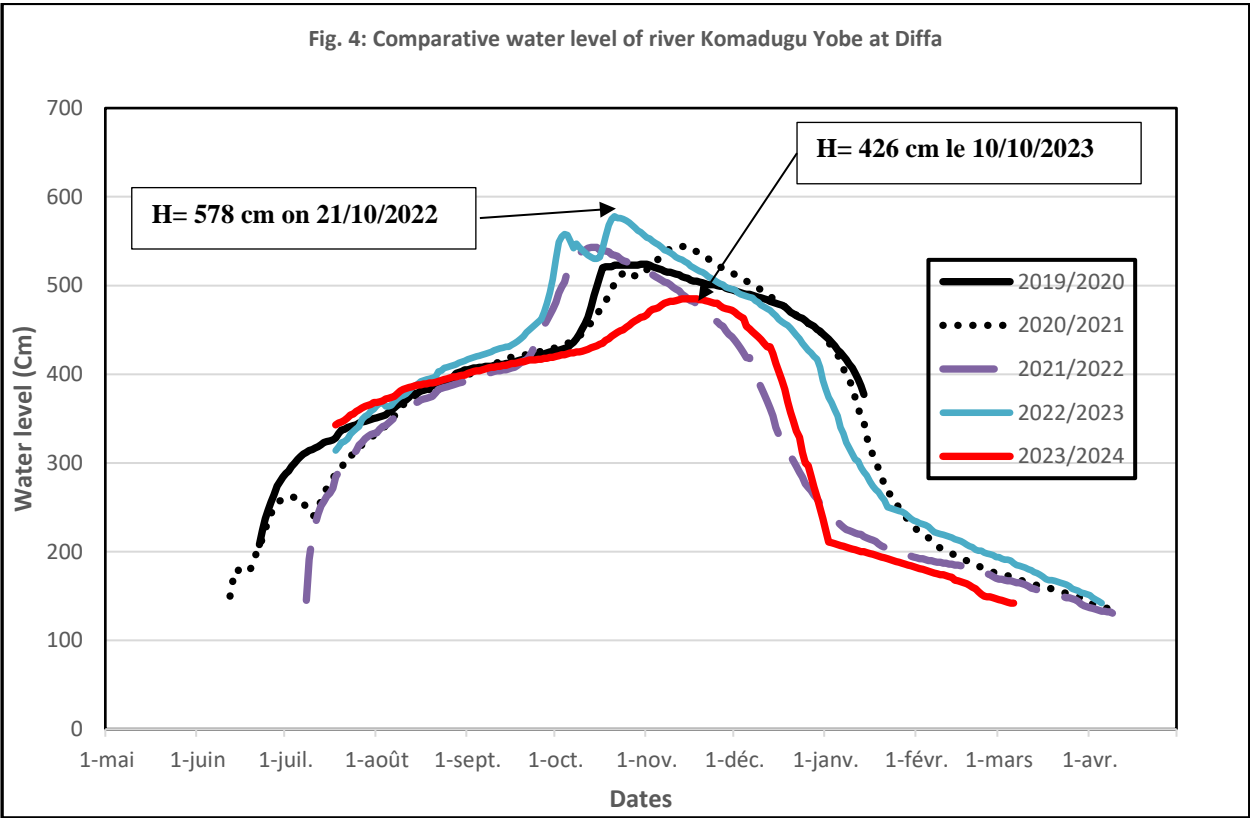
The rainfall and hydrological conditions influence the response of the lower basin of the Chari-Logone system in the upper sub-basins of the system. Data recorded at the N'Djamena TP station indicate that the Chari's response was immediate from June and July 2023, with a higher volume compared to the same period in 2022. However, this rise was moderated by reduced rainfall in the lower sub-basin of the Chari-Logone system. The **maximum water level recorded in 2023** at the N'Djamena TP station was **614 cm, which represents 2,498 m³/s on 20 October**. This maximum water level was **significantly lower** than the **814 cm** recorded on 13 November 2022, corresponding to **3,937 m³/s, representing a decrease of 75.42%** in terms of the volume of water passing through the N'Djamena TP station (**Fig. 3**). Compared to the 1991-2020 normal, the hydrological situation in 2023 was slightly better, with a **maximum water level of 614 cm compared to 599 cm**, respectively.

In terms of run-off, 2023 falls within the average range compared to reference years such as 2022/2023, 2021/2022, 2020/2021, and 2019/2020.



1.4 Komadougou Yobe Sub-Basin

The Bagara Diffa station monitors the rainfall and hydrological conditions in the Nigerian portion of the Komadougou Yobe sub-basin. Flow in the Komadougou Yobe began on 18 July 2023 in Diffa. The rise in water level was slower compared to the reference years 2019/2020, 2020/2021, 2021/2022, and 2022/2023 (**Fig. 4**). The **maximum water level recorded in 2023** at the Bagara Diffa station was **426 cm i.e. 68.65 m³/s on 10 October**. This maximum water level was **significantly lower** than the **578 cm** recorded on **21 October 2022**, which represented **93.15 m³/s, representing a decrease of 73.70%** in terms of the volume of water passing through the Bagara Diffa station. It is noteworthy that in 2023, people living along the Komadougou Yobe in the Diffa area were spared the flooding that had occurred recurrently in recent years. This situation indicates the normalcy of the 2023/2024 hydrological year compared to the reference years 2019/2020, 2020/2021, 2021/2022, and 2022/2023.



1.5 Flooding in the Lake Chad Basin

In the Lake Chad basin, several towns are located along the banks of watercourses, with some extending into the floodplains of rivers. They include N’Djamena in Chad, Kousseri in Cameroon on the Chari-Logone, Gashua in Nigeria, and Diffa in Niger on the Komadougou Yobe.

The rainfall recorded in 2023, and consequently the run-off in the tributaries of Lake Chad, did not result in any significant flooding. This situation can be explained by the phenomenon of climatic variability that characterises the agro-hydro-climatic conditions of the Lake Chad Basin.

1.6 Volume and Surface Area of Lake Chad Observed in 2023/2024

The filling situation of Lake Chad has continued to improve in line with the rainy season and run-off from its tributaries. The **maximum level of the lake recorded was 280.628 m on 24 November 2023**, compared with **281.3 m observed on 16 December 2022**, indicating a slight drop **of 0.24%**. This maximum level is slightly above the level of the great barrier (**279.3 m**), which separates the southern basin from the northern basin. At this elevation, the southern basin and the Komadougou Yobe essentially supply the northern basin (**Fig. 5 and Fig. 6**).

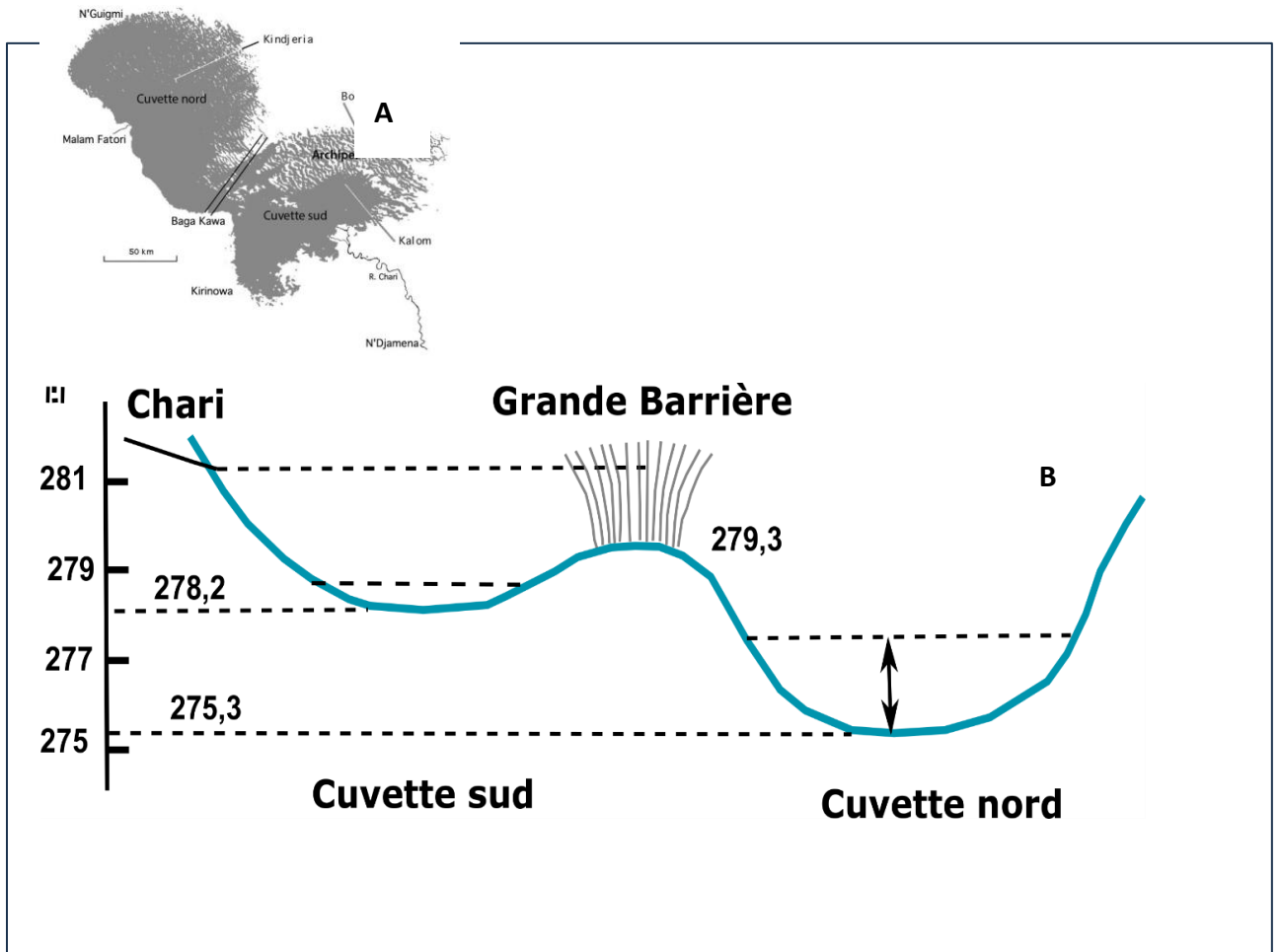


Fig. 5: Lake Chad (A), with its two basins, North and South, is separated by the Great Barrier symbolised by the double line, and (B) their altitudinal position (m) (Olivry et al., 1996).

According to research by the IRD, the altitude of the southern basin is **278.2 m**, and the top of the barrier is **279.3 m (Fig. 5)**. The maximum water level in the southern basin reached in 2023 was **280.628 m**, slightly above the level of the Great Barrier. At this altitude, the **lake's water surface area can be estimated at around 15,000 km²**. In 2022, it had reached **16,000 km²**. For a surface area of 15,000 km², the total estimated volume would be **30.38 billion cubic metres of water**, which corresponds to an average lake situation (Magrin & Lemoalle, 2014).

Lake Chad	Small	Medium	Large
Inflow from the Chari (km ³ /year)	10 - 34	40	45
Water level (m)	Variation Levels	280 - 282	> 282.3
Number of water bodies	Several	One only	One only
Total lake surface area (km ²)	2000 -15,000,	15000 - 20,000	20000 - 25,000
Flooded area of the northern basin (km ²)	0 - 8000	9000	10,000
Dominant landscape	Wetlands	Archipelago Dunes	Open water

Table 1: Main Characteristics of the Different States of Lake Chad (Magrin and Lemoalle, 2014)

2. Satellite Observation of Lake Chad 2023/2024

Satellite images show an estimated 4,500 km² of open water. It should be noted that the area covered by swamps is vast, covering around 9,000 km². The total area of the lake occupied by open water and marshes would thus cover around 13,500 to 14,000 km², which is consistent with the estimates made by ground observations.

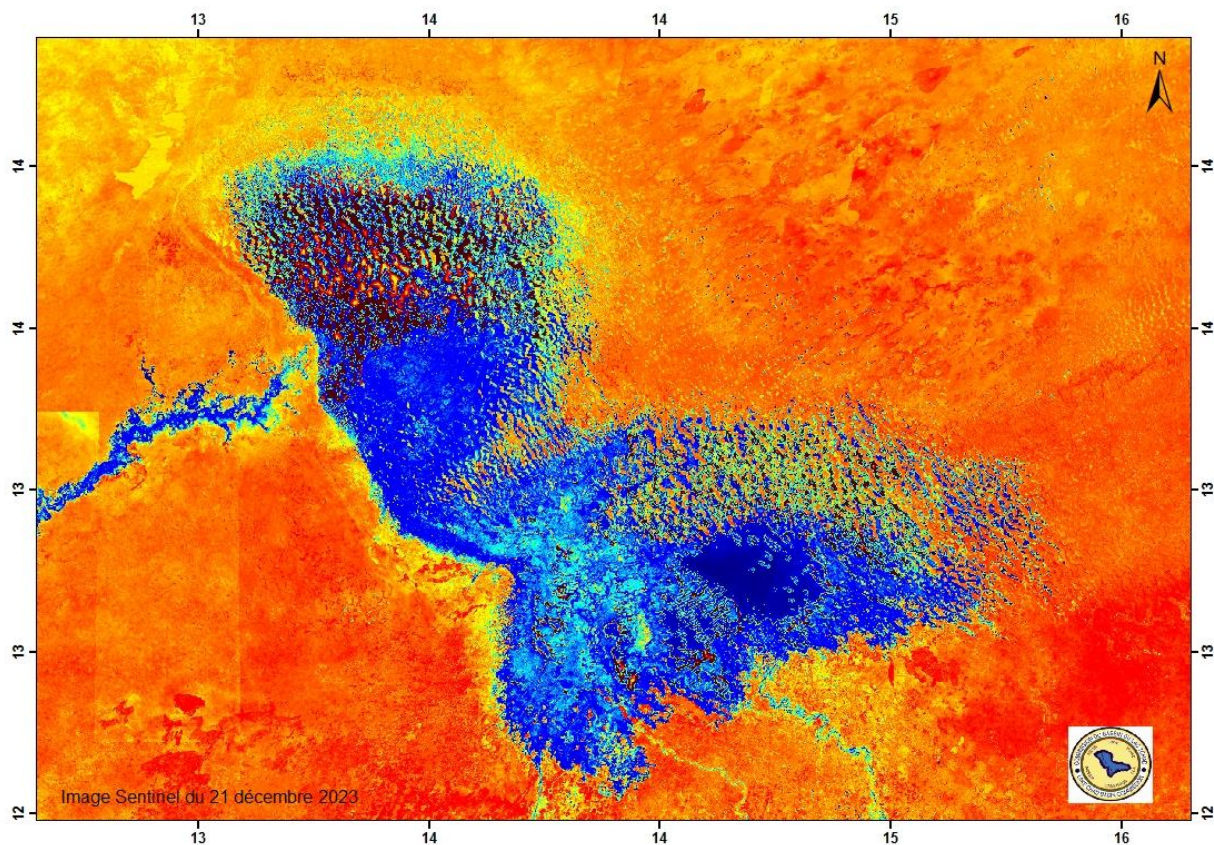


Figure 7: Lake Chad in 2023 (Sentinel image/21/12/2023)

Conclusion

In summary, 2023 was considered an average year from a rainfall and hydrological perspective throughout the Lake Chad basin.

The rise in water levels in Lake Chad and its main tributaries was slow, aligning with the seasonal forecasts that predicted average rainfall throughout the Sahel.

Hydrologically, the main rivers in the Lake Chad region recorded expected flows, but these were below the levels observed in the reference years of **2019/2020, 2020/2021, 2021/2022, and 2022/2023**. Consequently, no floods were recorded in the Chari-Logone and Komadougou Yobe systems in 2023.

Regarding the lake's filling level, the average rainfall recorded in the Lake Chad basin in **2023** increased the lake's **surface area, reaching approximately 15,000 km²**, which is consistent with the characteristics of an average lake.

This analysis was also compared with satellite observations. They show a substantial amount of open water in Lake Chad, but less than in 2022. The open water covered an area of around **4,500 km²** in 2023, compared with **6,000 km²** in 2022. The wet zone of the lake, covered by marshes, occupies an area of around **9,000 km²**. Consequently, the

total area of the lake occupied by open water and marshes was around **13,500 to 14,000 km²** in **2023**, compared with **16,000 km²** in **2022**.