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ASIAN JOURNAL OF SCIENCE AND TECHNOLOGY

ISSN: 0976-3376

Asian Journal of Science and Technology
Vol. 13, Issue, 11, pp.12286-12292, November, 2022

RESEARCH ARTICLE

ROLE OF THE GEOLOGICAL STRUCTURE IN THE LAYOUT AND ORGANIZATION OF RIVER SYSTEM IN THE CHADIAN BASIN OF MAYO – KEBBI (SOUTH – WEST CHAD)

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ARTICLE INFO

Article History:
Received 09th August, 2022
Received in revised form
10th September, 2022
Accepted 15th October, 2022
Published online 30th November, 2022

Keywords:
Watershed, Hydrography, Léré lakes, geology, Mayo – kebbi, Chad.

ABSTRACT

This study involves geological material, topographic phenomena and the river system in a cause-and-effect relationship in the Mayo-Kebbi watershed. This river connects South - West Chad to Northern Cameroon via the Benoué River, which connects with the Niger river basin. The main objective of this work is to understand the influence of geological material and topographic factors on the Mayo-Kebbi hydrographic system. For this purpose, the description of the rocks in place and their structure was made on the basis of a state of the art of the acquired knowledge. Characterization of the river system was done by mapping watersheds. In addition, to understand the organization of the hydrographic network, we described rocks and tectonics and determined the hypsometric variables. The analysis of the data shows, on the one hand, the tectonic-assisted geological right-of-way on the main watercourse route because their profiles follow the axes of break and are marked by right-angle elbows and their sinuosity index close to 1 (0.90, 0.84, 0.97). On the other hand, the secondary drainage beam is linked to the influence of the topography characterized by low slopes (0.67, 0.073, ...). This study made it possible to characterize the water network of the Chadian basin of Mayo - Kebbi and to understand its surface organization. The results obtained show a dualism of factors between tectonics and topographic parameters.

Citation: ***PASSINRING Kedeu and DOUMNANG MBAIGANEJean Claude*, 2022.** "Role of the geological structure in the layout and organization of river system in the chadian basin of mayo – kebbi (south – west chad)", *Asian Journal of Science and Technology*, 13, (11), 12286-*12292*.

INTRODUCTION

Mayo - Kebbi is a river that flows on horseback across the south - west of Chad and the north of Cameroon. The source is the Logone spill waters on its left bank at the thresholds of Eré and Bongor (Billon, 1996), precisely at the level of the Cameroonian village of Dana, in the Mayo Danaye Department. In his journey, he feeds and empties the lakes of Léré held in a half-graben of Cretaceous age (Imrich, 1993), before jumping into the Bénoué, upstream from Garoua. It is fed by a river system consisting of three sub-basins - the Mayo Binder, El Ouaya and El Dallah (Fig. 1). These secondary streams have a significant impact on the Benoué diet and lake dynamics. The Mayo-Kebbi watershed covers an area of 26 000 km2 (Hervie, 1968). The organization of its hydrographic network is subject to tectonic accidents which have affected the geological material (Vidal *et al*., 2015; Doumnang Mbaigané, 2011). This is how the major valleys are oriented following the main axes of the fractures. With the climatic influence characterized by the disorder that affects the flow of the rainfall and its distribution over time (Passiring, 2016b), this drainage network is constantly evolving and shapes to the sandstone of the surface states, the hydrogeomorphological landscapes as diverse as they are varied (Passiring, 2006). In addition, the Mayo-Kebbi valley is a hydrographic link between southwestern Chad and northeastern Cameroon. The main Chadian tributary of the Benoué, the organization of its hydrographic network raises questions that we propose to sketch answers in view of the similarity of a hydrogeomorphological history of these two parts of territory. It flows on very diverse geological formations and its valley has a varied morphology where sections in gorge, widened and sanded, calibrated and rocky, cubits, regularly follow each other up to its point of junction with the Benoué upstream of Garoua in Cameroon. This diversity of hydrographic profile can also be seen in its own tributaries. This finding leads us to several research questions:

- Why this succession of varied hydrographic profiles?
- What explanation can be given to sections swollen and declined in lacustrine depression?
- What was the influence of tectonics and the intervention of erosion phenomena?

- Finally, what are the hydrogenic challenges and challenges of linking the south-west of Chad to the Niger basin through the Benoué cordon?

The main objective of this study is to understand, on the one hand, the influence of geological material on the Mayo-Kebbi route and the organization of its hydrographic system and, on the other hand, the hydrogeomorphological links between its basin and that of Niger, which makes Chad, a continental country, communicate with the Atlantic Ocean.

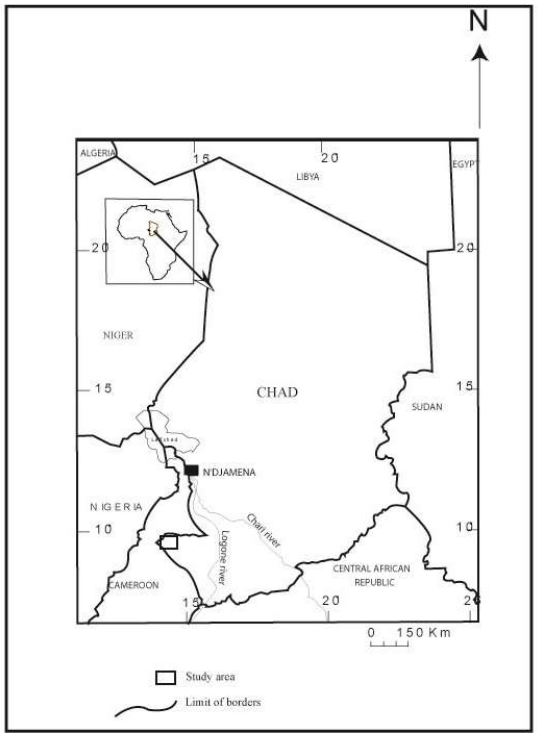

Figure 1. Location Map of Area under Study

METHODOLOGY

This study involves the knowledge of the geological material and the organization of the hydrographic network around the main artery that is the Mayo - Kebbi. For this purpose, the description of the rocks in place and their structure was made on the basis of a state of the art of the acquired knowledge as well as the examination of the existing photographic documents. The hydrographic system has been approached with a particular emphasis on watershed mapping. This descriptive step is followed by an analytical phase in which the examination of morphogenic data (rock type and nature, tectonic) is linked to hydrogenic data (nature and type of plots, characterization of the hydrographic web, hydrodynamics, ...). In addition, computer-aided mapping is used for watershed identification and characterization.

RESULTS

GEOLOGICAL STRUCTURE AND OLD FASHIONING MATERIALS AND THEIR STRUCTURE

The field of study centred on the Chadian basin of Mayo - Kebbi is characterized by a geological formation consisting of granite and volcano-sedimentary rocks metamorphized during pan-African orogenesis, sandstones and secondary-age conglomerates in discordance on the base, and then tertiary sandstones and sand of Continental Terminal (Passiring, 2006). All granitoids composed of Léré granite, Zabili granite, Guegou granodiorite, Boloro gabbroic diorite, and Gauthiot Falls oriented granite constitute Léré batholite (Fig. 2). The volcano-sedimentary series of Zalbi, of Proterozoic age, consists of volcanites shale, argilite, green shale, and spilite deformed and metamorphized in the amphibolite facies (Vidal, 2003; Doumnang, 2011; Doumnang Mbaigané, 2006) This series is found west of Léré in the form of small hills with rocky outcrops. The secondary school classes identify with the Léré series. It is the lower Cretaceous, of Anteaptian-Albian age, resting in discordance on the Precambrian (Guiraud, 1991). This series consists of conglomerates topped by coarse sandstones above which are fine sandstones that alternate with green marnes. The series of Lamé covers that of Léré. It corresponds to the Upper Cretaceous of the Cénomanian - Turonian age and has coarse conglomerates that overlook the lumachelle limestone, witness of a marine transgression. The large geological formations of the Léré region are affected by many steering faults from N0° to N10°. They are observed in contact areas: Zabili granite, Zalbi metasedimentary series, Zalbi metavolcanic series, Mourbamé granite. The Mourbamé family crosses Lake Léré from north to south. Flaws are also observed in the granite of Gauthiot Falls with a preferential orientation N90° to N110°. Cretaceous age faults line the half-grabens of the Cretaceous basins. These E-W-oriented faults are said to be part of the Guinean-Nubian lineaments that have replayed the Lower Cretaceous several times and in different ways

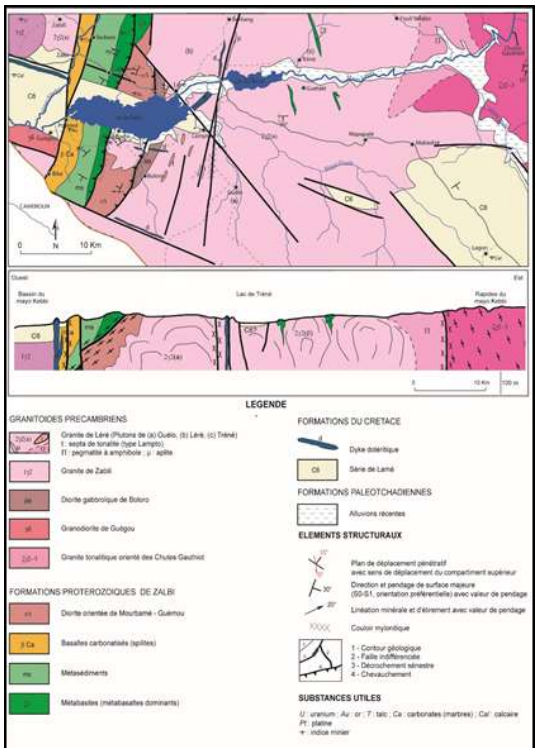

Figure 2. Geological structure of the Léré bowl (4)

IMPACT OF GEOLOGICAL STRUCTURE ON HYDROGRAPHIC PATTERNS

The geological structure of the Léré region has led to the establishment of the major hydrographic arteries of the Mayo-Kebbi basin.

According to M. NONTANOVANH (14), the geological history of the region has resulted in the shaping of the collapse basins filled by the Cretaceous Lamé series (Figure 3). This series of Wealdian facies, composed of conglomerates at the base, successively surmounted by sandstones that alternate with greenish marnes have undergone tectonic manifestations. These movements are post-Cenomanian and correspond to the end of the Cretaceous transgression (Chevery, 1970), during which the terminal episodes of the opening of the Atlantic and the Benoué basin (Guiraud, 1991) occurred, (Nontanovanh, 2002). The main consequence of these tectonic movements is the establishment of a network of faults that have guided the route of the major rivers (Fig. 3), notably the Mayo Kebbi and the retention of the lakes of Léré in the position of a fault angle (Collet) In addition, the highly silicified and indurated Léré granite massif, which occupies the central part of the Mayo-Kebbi basin, forms a natural barrier on a sub-regional scale by separating the country of Léré, the margin of the Benoué basin in the west, from the Lake Chad basin fed by the Logone and the Chari in the east (Vidal, 2003). In view of this hydrogeological analysis, the current configuration of the watershed-wide water network of the Mayo Kebbi suggests a likely influence of the geological structure on its path.

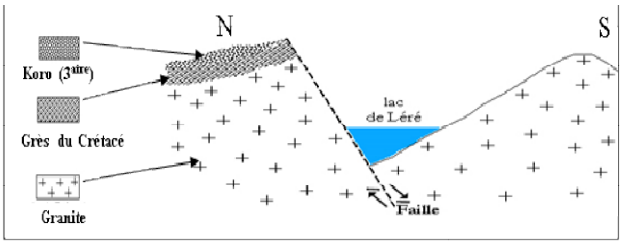

Figure 3. Structural position of Lake Léré (18)

CURRENT HYDROGRAPHY OF MAYO - KEBBI SYSTEM LERE LAKES

ANDO – EXOREICSYSTEM CENTRED ON THE LAKES OF LERE

The hydrographic system, animated by the Mayo - Kebbi, is a dualist type centred on Lake Léré. Indeed, the Mayo Kebbi, crosses its basin - slope in the East from the altitude coast 324 m at the threshold of the Mayo Dana to the coast 225 m in the West, at the confluence of the Mayo-Louti in the district of Figuil / Cameroon (Figure 4). Taking the status of tributary, it feeds the lakes of Léré upstream of which its waters are swollen by two large tributaries on its left bank, namely el Dallah and el Ouaya. It is in this capacity that, together with the Léré structural lakes, it forms a sleepy-type hydrographic system. Downstream of the lakes, the Mayo-Kebbi becomes an emissary, drains solid deposits accumulated by settling and alluviation, then receives a large water flow from the Mayo Binder, its main tributary on the right bank, before joining the Bénoué (Fig. 4). It is by continuing its course downstream from the lake that it forms with it an exoreic system because its contact with the Bénoué that feeds the Niger River, establishes a hydrographic communication between the Atlantic Ocean and the Léré basin (Vigneau, 1996). The watershed thus contains three main sub-watersheds: Mayo-Binder, el Dallah and el Ouaya.

It is a rain-type network where the main rivers have a pure tropical regime and are only active during the rainy season (Cabot, 1967).

Figure 4. The Dendritic Hydrographic System of the Chadian Basin of Mayo Kebbi

The secondary drainage network is denser upstream of the lakes, operating in a dormant state as their waters add to the lakes. In general, the hydrographic diagram of the Chadian part of the Nigerian basin of the Mayo Kebbi presents a simple dendritic tree structure with a network of dense secondary channels that develop in all directions (Fig. 5).

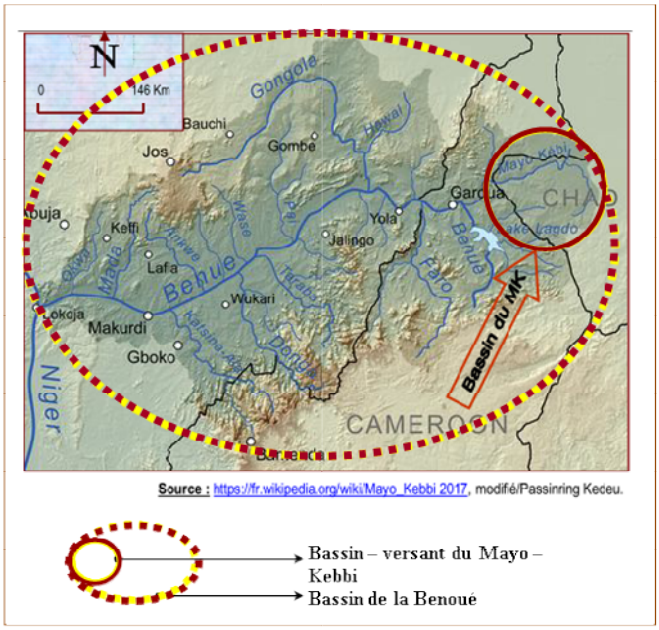

Figure 5. The Chadian Basin of Mayo - Kebbi, a portion of the Benoué Basin

THE MAIN VALLEYS AND THEIR CATCHMENT AREAS

The major river arteries in the Nigerian basin of the Mayo Kebbi are made up of the Mayo - Kebbi itself, the Mayo Binder, el Ouaya and el Dallah. Knowledge of their watersheds and their associated physiographic characteristics

makes it possible to recognize the extent of their hydrogeomorphological influence.

THE MAYO – KEBBI AND ITS CATCHMENT AREA

From its source located on the ridges of the left bank of the Logone at the thresholds of Eré and Dana to the lake plain at Léré, the Mayo-Kebbi valley has two main hydrogeomorphological units. Upstream of the Chutes Gauthiot, which are themselves the result of a resumption of the regressive erosion of the Bénoué basin (Cabot, 1967), it presents a more or less regular profile elaborated on a relatively flat marshy terrain, interspersed by the string of Toupouri lakes (Fig. 6).

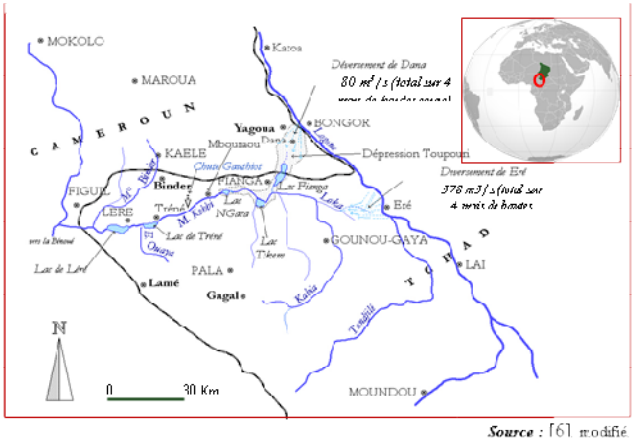

Figure 6. Simplified hydrographic layout of the Mayo - Kebbi system / Léré lakes

Downstream of the Toupouri Depression, the Mayo Kebbi valley widened and then narrowed to the height of Mbourao, where it was encased in the cracks of the crystalline base (Cabot, 1965), crossed volcanic-series terrain (Cabot, 1967) on which the regressive erosion that favoured a steep break in slope, Gauthiot Falls, had stopped. From these, it forms an elbow and then cascades into a narrow gorge dug into leucocrate granite, the alteration of which produces benches of sand, gravel and pebble detritic material downstream of the break of the slope. The Mayo-Kebbi, which is 140 mi long, was born after the Toupourri depression as the emissary of Lake Ngara. This depression consists of three small retention basins occupied by Fianga, Tikem and Ngara lakes, respectively, from upstream to downstream. This basin is drained on the one hand by the waters of the Kabia River, which originates in the Gagal region, and on the other hand by the spill waters of the Logone at the threshold of Dana, which enlarge the Kabia after filling the upstream depression, forming the lake of Fianga (Billon, 1966) (Figure 6).

Due to the diversity of the geological terrain it crosses, its bed is transformed into a series of rapids and waterfalls, one of the most important of which is the Gauthiot Falls downstream of Mbourao. Despite this variability in the geological terrain it crosses, its longitudinal profile is more or less regular. Its sinuosity index is 0.97, indicating a quasi-straight stream, indicating that its route follows a fault line. The overall slope of the main talweg is in the order of 0.63%. The Chadian basin of Mayo Kebbi is the geomorphological unit of order 1 of the study area with an area of 19540 km2, i.e. 75 % of the entire geographical basin which is 26 000 km2 (Hervie, 1968). It stretches from East to West from the Toupouri depression to Foul-Mbaré, then from the plateau of Zigazan (Cameroon) in the North-West to the region of Gagal in the South-East. It is a relatively unrugged basin, drained by a relatively simple river system (Figure 4).

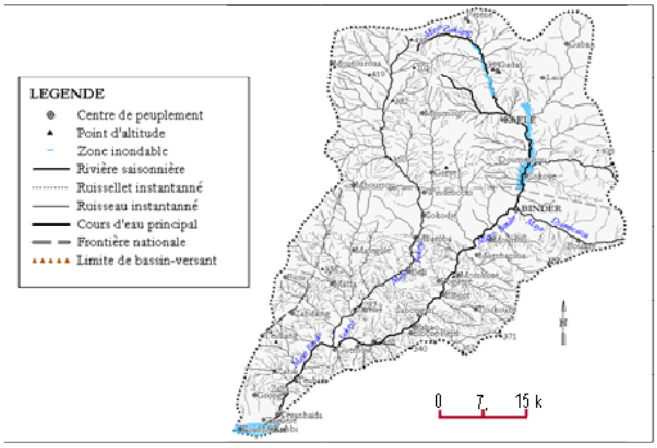

Figure 7. The Mayo Binder Watershed

From a morphological point of view, it should be noted that the main talweg occupies an unsymmetrical position making the south side a long slope with a steep slope and the north side a loose slope with a gentle slope. The Gravelius compactness index is 1.07, which gives it a substantially square shape that is not favourable for rapid concentration of water and flood. The height of the basin, obtained by the difference between the two extreme dimensions, is 145 m and its average altitude is 277.5 m for a mass coefficient of the order of 0.0074 (Passiring, 2018).

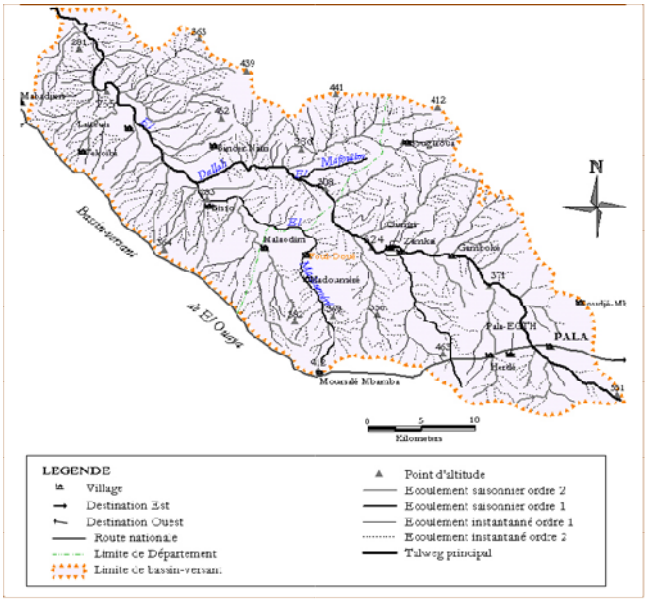

Figure 8. El Dallah Watershed

THE MAYO – BINDER AND ITS WATERSHED: The Mayo Binder is located on the north side of the Lake Léré bowl (Fig. 7). It originates at an altitude of 440 m at the foot of the inselberg of Biwara in Cameroon under the name of Mayo Zaklang, who is taken in turn by the Mayo Sokoye and the Mayo Djambutou. The Mayo Binder bed is carved into both the cradle and the Cretaceous and has a varied longitudinal morphology that can be easily divided into three sections. First in its upper course which includes its source, the mayo flows

in a narrow valley, dug in undifferentiated deposits of a stony to sandy-clay nature which have covered the granite base. From Binder to Zagueré, its bed is increasingly steep and wider, dug into the micaschist base on which the arkotic sandstones with their bed of dolls of the Continental Terminal, at the level of Zalbi, rest in discord. The middle course presents a valley crowded with blocks and stones where successive rapids with polished rocks on precambrian quartzites From Zagueré to the mouth, the mayo bed is dug in its own alluvions where there are countless secondary channels encased in the metric order in the sandy-clay alluvions. At this base level, where the flow rate is significantly reduced, large alluvial deposits are deposited, resulting in a large ejection cone that amputates the lake to its 231 m west coast. The Mayo-Binder is 118 km long and has a very irregular longitudinal profile (Fig. 7). Its sinuosity index is 0.67. Oriented NE-SW, it drains the water collected from the Kaélé massif and is endowed with seasonal dynamics. With a slope of 2.68% and a general altitude of 332 m, favourable to the rapid concentration of the waters, the Mayo Binder has generally spectacular floods.

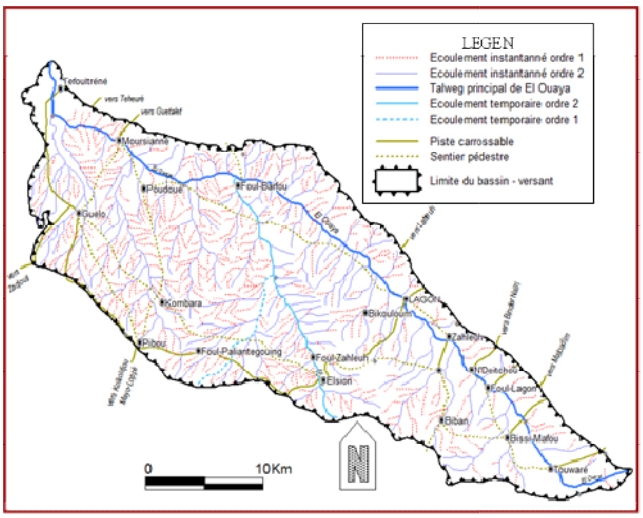

Figure 9. The El Ouaya Watershed

Its catchment area is located on the north side of the Léré basin. It covers an area of 2,931 km2, or 15% of the area of the Mayo Kebbi basin. It is oriented NE-SW direction and stretches from upstream on the Moutouroua-Péténé-Gaban axis (Cameroon) to its outlet in Foulmbaré in Chad. Its hypsometric characteristics are defined by two extreme elevation ratings, 440 and 225 at the outfall. It has a compactness coefficient of 1.28, which indicates a very elongated basin. Its height is 215 m and the average altitude is 281 m for a relief mass coefficient of 0.073. The pool has an average slope of 7.33% while the main thalweg slope is 2.7%. The low slope of the valley is explained by the fact that the mayo partially exploits a tectonic ditch, so it does not necessarily follow the steep slope. Moreover, its valley occupies an unsymmetrical position with a shorter south slope. The values of the altitudes, slope, coefficient of massivity,... show that the Mayo Binder basin has a more massive and more accentuated relief than the entire Nigerian basin of the Mayo Kebbi; as such, it has potential for erosion.

EL DALLAH AND ITS WATERSHED: El Dallah is born at an altitude of 480 m in the south-east of Pala (Dagou, 1986). It results from the fusion of several streams of water from the sandstone trays of the Continental Terminal and then crosses secondary-age land with materials made up of the pleated series of Léré with conglomerates, sandstones and marnes and the series of Lamé notably conglomerates, sandstone, arkoses, marnes and clays (Fig. 8). The stream then flows on the Precambrian eruptive-rock base such as hyper-alkaline, calco-alkaline, and granodiorite granites before reaching the Mayo-Kebbi approximately 10 km downstream of Gauthiot Falls on the quaternary alluvium. Its waters are swollen during the wintering by several tributaries including El Oumri which takes its source at 400 m on the plateau of Ngara Djévo and El Madouméré which takes its source at 400 m on the plateau of Moursalé Mbamba, on its left bank. On its right bank, the main tributary is El Mafoulim. It originates 400 m southwest of Bougaroua. Upstream of Oumri, El Dallah flows in a narrow, little-encased bed, then gradually widens and reaches up to 1000 m wide (Figure 8). After the village of Oumri, it sinks into the geological material with steep banks.

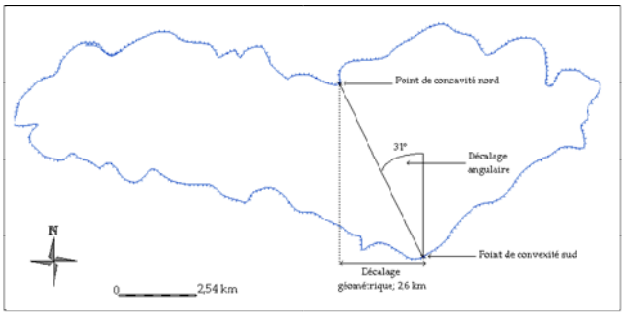

Figure 9. The El Ouaya Watershed

Its lower course extends to about 5 miles from its mouth. It has a very large bed, encased and crowded with rocks, transforming the flow of water into a succession of rapids. Overall, the longitudinal profile is fairly consistent. Its sinuosity index is 0.84 and its slope is 4.83% and a ratio-relief of 0.005. This ratio shows that El Dallah has generally sudden and dramatic floods. In addition, the valley's main feature promotes a massive and rapid concentration of water. This valley is marked by significant inputs of slopes and active lateral erosion. El Dallah is a very important watercourse for Mayo Kebbi in that it brings considerably both water flows and detritic materials. Its watershed has an elongated shape (Kc de Gravelius = 1.20) that stretches from the southeast of Pala at an altitude of 551 m upstream to 240 m, its meeting point with the Mayo Kebbi, downstream of the Gauthiot Falls. It is oriented SE-NW with a slope of 25.16%. It covers an area of 1236 km2. The El Dallah watershed is 311 m high and has an average altitude of 395.5 m. Its relief mass coefficient (H/S) is 0.25 and the orographic coefficient (H2/S) is 78.25. These hypothesized indices show a high and steep watershed.

EL OUAYA AND ITS CATCHEMENT AREA: El Ouaya is one of the main hydrographic arteries that plays a decisive role in the hydrological regime of the Mayo - Kebbi and the lakes of Léré (Fig. 9). It originates 400 m west of Moursalé Bamba thanks to the fusion of 3 water nets from the Tou-Waya plateau where the water table emerges. 66 km long and oriented towards SSE-WNW, El Ouaya occupies an unsymmetrical position on the scale of its catchment, which becomes almost monoclinal characterized by the principle of the south slope.

Table 1. Synoptic table of hydrographic network and hypsometric variables

COURS D'EAU	LTP (KM)	NBA	BAF	ORIGINE BRANCHES	DAN	SBV KM²	ORIENTATION		ALTITUDE	
							O1	O2	A1	A2
Mayo-Kebbi	238	11	Moujubuana	Djondong	V.I.	19540	E-W	NE-SW	324	273
			Kabia	Am-Kayo						
			M° Dégné	Bélé						
			M° Lésé	-						
			M°Madonga	Gamba						
			El madjoui	Mabachackré						
			El Dallah	Pala						
			El Ouaya	M/Bamba						
			M° Binder	Zigazan						
			M° Ganré	Matéta						
			M° Biou	DanouCam						
			M° Laddé	M° LADE						
Mayo-Binder	118	2	M° Sokoye	Plateau de Zigazan	I	2931	NE-SW	NE-SW	440	332
			M° Djamboutou							
El Dallah	76	3	El Madouméré	$M/Bamb_a$	S	1236	SE-NW	SE-NW	551	394
			El Mafoulim	Bougarwa						
			El Oumri	Ngarajévo						
El Ouaya	66	3	Gang-seuh	Guelo	S	785	ESE-WNW	ESE-WNW	360	300
			Elsion	Elsion/village						
			El Guelibi	Biban						

LTP: length of the main talweg; BAF: tributary arms; DAN: annual dynamics; SBV: watershed area; NBA: number of tributary arms; A1: elevation at source; A2: mean watershed elevation; V.I.: variable intermittent; I: intermittent; S: seasonal; O1: watershed orientation; O2: orientation primary talwegSource: (6)

The river has no tributary on its right bank, while on its left bank, El Gueulibi is successively noted, coming from the heights of Goïloum in the sub-prefecture of Lamé, El Sion, which takes its source at 360 m of altitude east of the village of Elsion and Gang-Seuh, born from the fusion of a multitude of streams coming from 36 330 ft above sea level south of Guelo. All along its route, El Ouaya crosses Precambrian terrain with eruptive rocks. It flows in a quiet and not very wide valley to Foul-Barfou and then widens considerably to the mouth because of the sedimentary nature of the land. Its valley is dotted with basement shreds that appear in/form rocks with leucocrate granites with altered structure. These rocks are half drowned in benches of coarse seabed sand.

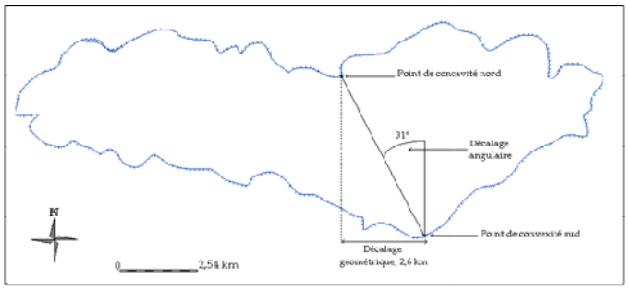

Figure 10. Geometry of Lake Léré

The bed morphology has a regular longitudinal profile marked by the right-angled elbows of Barfou and the one located downstream of Moursianné (Fig. 9). This longitudinal hydrographic profile is typical of a faulted structure, hence the low sinuosity index (0.90) of its valley for a general slope of 0.95 per thousand. The ratio-relief is 0.001, which means that the secondary drainage network plays a rather important geomorphological role. The El Ouaya watershed is the smallest of all the sub/basins. It has a surface area of 785 km2 and a perimeter of 142 km. Its coefficient of proportionality (S/S1) is 0.040, which means that it occupies only 4% of the total surface of the Chadian basin of Mayo Kebbi and extends over 60 km from its source to its junction with Mayo - Kebbi downstream of the bridge at Léré where the altitude drops to 240 m. Its compactness index is 1.42.

THE LAKE BOWL: Léré's lake-holding bowl is a post-Mesozoic tectonic bowl that originates from a fault escarpment. This escarpment consists of a normal fault with a south-north sloping plane. The resulting bowl has a flat, unsymmetrical bottom with a steep south slope and a gentle north slope. It consists of a small, concave, north-facing basin stretching from east to west for 55 km and from north to south for 7 km (2). This bowl holds the lakes of Léré in the position of fault angle with upstream the lake of Tréné (7 km2) and downstream, the lake of Léré (40 km2). The two lake complexes are separated at Lao level by an important waste cone built by El Ouaya. The presence of this cone leads us to consider that the two lakes were only one. Lake Léré, larger, attracts attention from the point of view of natural processes and socio-economic use. It is centred on 14°10' east longitude and 9°37' north latitude and is approximately 15 km long with an average width of 5 km. Like the bowl that holds it, Lake Léré takes an elongated, slightly concave form to the north. The concavity point on the north bank was located about 2 km east of the village of Dissing, while on the south bank the convexity point is about 2 km east of Kabogai. The angular offset between the two inflection points is 31°; and from the geometric point, this offset corresponds to a 2.6 km gap between the two inflection points (Fig. 10).

DISCUSSION

The water network of the Chadian basin of Mayo - Kebbi, centred on the lakes of Léré, is dominated by the Principality of Mayo - Kebbi. This river acts as both a tributary and an emissary to both lakes. Its emissary regime has made it possible to establish a hydrogenic link between the south - west of Chad and the Niger basin. An examination of the organization of the whole network and the analysis of the profiles along the main thalwegs shows a sustained influence of two phenomena: the impact of the geological structure and the role of the topography. Affected by recurrent tectonic movements, the geological material, dominated by the Precambrian, appears to be at the origin of the orientation and profile along the main drainage axes.

Thus, the lakes of Léré are housed in a half - graben and its main tributaries are oriented according to the major axes of breakage. Hence some long profiles marked by right angle elbows (cases of el Ouaya in Barfou and Moursianné, mayo Binder in Guemou, el Dallah downstream of Zamkaye and Bisso and the break of the slope of Mayo - Kebbi downstream of Mbourao). This geological influence is also marked by sinuosity indices that are close to 1:0.9 for the Ouaya, 0.84 for the Dallah, 0.97 for the Mayo - Kebbi. However, the secondary network examination does not test the tectonic influence hypothesis. The high density of the secondary drainage network is explained by the hypsometric variables such as the elevation of the catchment, the slope, the coefficient of the massiveness of the relief, favourable to surface runoff. This is the case for the Mayo Binder, which has an average altitude of 281 m, a coefficient of relief mass of 0.073, with an average slope of 2.7%. These variables explain that this stream is partially tapping a tectonic gap and that the rest of its network is closely dependent on the influence of topography.

CONCLUSION

The Mayo-Kebbi hydrogeological pattern and layout are linked to hydrogeological factors such as the nature of the material, tectonics and topography. This river is a link between south-west Chad and northern Cameroon. The main tributary of the Benoué, it connects Chad to the Niger basin, which communicates with the Atlantic Ocean. In fact, tectonic movements that affected the secondary formations favoured the formation of the bowl that currently holds the lakes of Léré. The main rivers that make up the current hydrographic scheme have a layout that obeys this geological history. They are oriented almost according to the fault lines while the secondary beam has an orientation dictated in most cases by the steep lines. The hydrographic structure is, on the whole, simple dendritic, and all the waterways connect to the Mayo Kebbi, which turns into an emissary to join the Benoué. This hydrographic structure gives the Mayo - Kebbi a competence to drain the detritic material from the tributaries that clog the lakes.

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