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Socio-anthropological and environmental study of water resources in the North and North-West of the Central African Republic, Lake Chad basin, in a context of climate change

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ABSTRACT: The fragility of Lake Chad's existence due to climate change and anthropogenic activities has been demonstrated by several scientific articles in physics-chemistry, water chemistry and climatology, as well as studies in the human and social sciences, notably anthropology and sociology. The aim of this study is to investigate the population of the North and North-West of the Central African Republic, the Lake Chad basin, in order to understand all the existing uncertainties which will contribute to the definition of new preventive solutions for the sustainability of water resource management. In human societies, water potential reveals modes of social organization, local socio-political dynamics, power relations and the legitimization of status and social roles. Around water resources, actors with opposing interests confront and clash, making this natural and cultural heritage an «arena» at the heart of social organization. This implies that water potential is one of the «resources most closely interwoven with social and cultural relations», and appears to be a vector of social transformation. This work has highlighted the advent of inter-community conflicts caused by cross-border transhumance, the abandonment of local knowledge on water use, water pollution from mining and the destruction of the ecosystem that protects water resources in the southern slopes of the basin.

KEYWORDS: Socio-environmental, transhumance, Lake Chad, water, ecosystem.

1 INTRODUCTION

The potential of water in human societies is surrounded by social representations which stipulate that water is the foundation of existence. In other words, "water is life" for all living beings on earth. "People's lifestyles were subject to the natural availability of water", and scarcity also led to a reshaping of behaviours [13]. In this order, as a vital strategic resource, water is at the center of several issues, both positive and negative, including anthropogenic phenomena, public planning and management policies, as well as environmental and climatic hazards. These factors need to be considered and rethought to ensure sustainable management and the well-being of populations. Lake Chad is a case in point. With this in mind, understanding the physico-chemical and socio-environmental situation of water resources in the Lake Chad basin, in the context of climate change, is today at the heart of a multidisciplinary approach, aimed at identifying structural and conjunctural dynamics, i.e., the strengths and weaknesses linked to the existence of this water potential. This perspective strengthens the overall analysis of the lake's drying situation [8]. A number of natural and environmental factors need to be analyzed in order to gain an integrated understanding of the seasonal dynamics of surface and groundwater flow. The exercise finds its raison d'être in the global vision relating to the implementation of strategies aimed at the integrated preservation of this natural resource. It is in this context that socio-environmental studies are essential for the integrated analysis of water resource management in the Lake Chad basin.

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2 STUDY AREA

The missions took place in the North and North-West regions, mainly in the towns of Bossangoa, Bozoum, Bocaranga and Paoua (figure 1). For this zone, which constitutes the head of the Lake Chad basin in CAR, two field campaign missions were organized from September 20 to 29, 2022 and from January 19 to 26, 2023 within the framework of the GEF-UNDP-CBLT/LHL project:

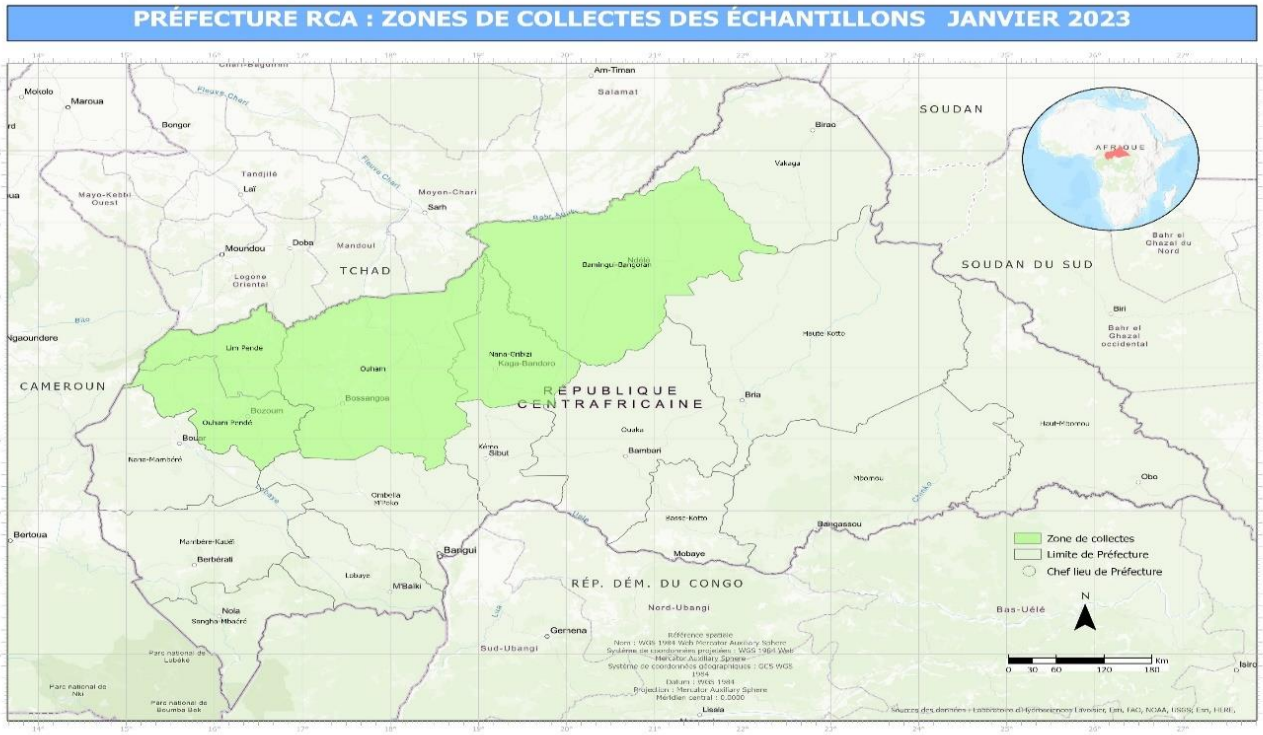

Fig. 1. Study area

3 METHODOLOGY

Information and data collection for the socio-environmental study was based on individual interviews with stakeholders considered strategic in the management and use of water resources. The profile of these stakeholders is not exclusively homogeneous, and includes village and district chiefs, commune mayors, heads of household, presidents of water point management committees, fishermen, farmers, herders, leaders of women's and youth associations, leaders of religious denominations, mining craftsmen and housewives. The interviews focused on the following themes:

a) Anthropogenic factors influencing the sustainability of water resources
b) Local socio-political dynamics
c) Socio-spatial issues relating to water resources.
d) Local knowledge of water resources Water uses

The present study was carried out from September 20 to 28, 2022 in the North-West localities, notably in the Ouham and Lim-Pendé prefectures, and from January 19 to 26, 2023 in the North-East localities, in the Nana-Gribizi and Bamingui-Bangoran prefectures. In the absence of an exhaustive sampling frame characterizing all the stakeholders involved in the management of the water potential of the Lake Chad Basin, sampling was random (semi-probabilistic). Survey populations were identified in situ, according to the "reasoned choice" method, taking into account the importance of the study's themes and objectives. Information was collected through individual interviews and focus groups with the above-mentioned potential stakeholders.

A total of thirty (60) individual interviews were conducted with the above-mentioned stakeholders in the various villages where the water samples were collected. In addition, a total of six (06) focus group discussions, one in each sub-prefecture, were held in the north-west zone, in Bozoum, Paoua and Bossangoa respectively. In the north-east, these group interviews were carried out in Kaga-Bandoro, Bamingui and Ndélé.

Table 1. Summary of the number of interviews carried out.

N°	Localities	Number of interviews	Number focus group
1	Bozoum	10	1
2	Paoua	10	1
3	Bossangoa	10	1
4	Kaga-Bandoro	10	1
5	Bamingui	10	1
6	Ndélé	10	1
	Total	60	6

Semi-probabilistic random sampling, based on the "reasoned choice" method, was used for the focus groups only. This made it possible to compare and cross-check the opinions of the target actors on the discussion themes. All opinions in the different localities (north-west and north-east) converged and highlighted the anthropic and environmental factors and local socio-political dynamics that we have developed in the following lines.

This empirical approach was complemented by a literature review, the synthesis of which revealed that the threat to the water potential of the Lake Chad basin, in terms of possible drying-up as a result of climate change and dangerous human activities, is still very much with us today. The literature review also presents the overall situation of the basin's hydrological and chemical behavior in wet and dry periods, and states that "the lake's recharge by rainfall from the downstream plains is low" [2, 11, 13]. in the dry season. This situation is complicated by the intensity of human activity on the waters in the southern part of the lake. However, solutions aimed at avoiding this probable catastrophe are possible, even if some of these solutions are extremely costly. The non-application of direct observation as an empirical survey technique can be seen as a limitation of this study. Indeed, the aim of this technique was to analyze the behavior of water resource users and to identify local knowledge likely to support scientific strategies that could be put in place with a view to preserving, in an integrated, participatory perspective, the factors that could contribute to the drying up of these water resources [1, 4, 8].

4 RESULTS AND DISCUSSION

The study showed that water is at the heart of the development industry (just as it was the entry point to the colonial relationship), and its scarcity and competition are major issues in various contexts. Analysis of the study's findings highlights two main complementary human and physico-natural factors in understanding the water resources situation in the southern Lake Chad basin.

4.1 ANTHROPOGENIC FACTORS INFLUENCING WATER RESOURCES

In this first phase of the study, the surveys carried out with the above-mentioned stakeholders were aimed at identifying the anthropogenic uses and activities, as well as the environmental and social factors, in particular the impacts of climate change, which could weaken the basin's existence, i.e. contribute to its drying up. Two main anthropogenic activities have been identified as real factors influencing water resources in the Lake Chad basin. These are industrial and artisanal mining in the Ouham riverbed and its tributaries, and transhumant herding along the river.Gold mining by Chinese companies was noted by the local communities of Bozoum and Bossangoa as a potential danger to the drying up of the river. According to interviewees, "around 17 mining permits have been awarded to mining companies, creating an intensification of gold mining activity". This information is justified by the results of the physico-chemical analysis published in 2019 by the Lavoisier laboratory. These mining companies divert water from its natural bed in order to extract gold ore. The water is then forced to create new paths, leading to a systematic reduction in its quantity and quality. The parameters measured at the sites show the following significant values: Suspended solids (SS) concentrations ranged from 276 mg/l to 504 mg/l, above the current standard of 25 mg/l; Turbidity levels ranged from 375 to 630 NTU, well above the admissible value of 50 NTU; With regard to heavy metals, iron and mercury are present in the water in abnormally high concentrations; total iron concentrations range from 4.21 to 8.97 mg/l (standard = 1mg/l); mercury concentrations range from 4.2 to 26 µg/l (standard = 1µg/l). It should be noted that mercury was not detected upstream of the mining site. Thus, this highly toxic heavy metal pollution is thought to originate from the mining sites [10]. In this practice, aquatic animals, which communities believe contribute to maintaining the natural balance of the water, are killed or taken away and sold by the foreign staff of these mining companies. In addition to mining, there is the illegal sale of aquatic animals. The chief of Bossangoa's Bôro district explains: *"The waters of the Ouham are important to our*

lives. It is thanks to this river that we have fish for our diet through fishing, and our daughters and wives also do their laundry and other domestic activities there. But with the drought of recent years, and especially the gold mining by the Chinese, we can see that our lives are in danger. The n'kono (hippos) and ngoundé (crocodiles) now refuse to stay underwater, and even many other animals that live underwater have died. If this continues, we won't have any fish left and we'll all die. The river's waters will dry up".This observation sums up the dangers associated with water resources in the Lake Chad basin. The gradual drying-up of the river due to dangerous anthropogenic activities and climate change are highlighted by the local populations as the main factors of degradation. In addition, the intensification of transhumant livestock farming is also a dominant factor, contributing to the reduction in water levels according to the communities interviewed. Every year, transhumant herders graze their cattle all along the Ouham River and its tributaries. As they pass, the herders cut down the trees that are supposed to contribute to the environmental protection of the water. For the communities, the crossing of the rivers by the herds of cattle contributes to the silting-up of the water beds, leading to a systematic reduction in the water level. The waters of the lake basin are thus disrupted. Boreholes are used extensively by the local population, as they are the main source of water for drinking and for domestic activities such as washing clothes, washing up, cooking, etc. The intense use of these boreholes is a source of great concern to the local population. Intense use of these boreholes in the dry season sometimes results in some drying up.

4.2 LOCAL SOCIO-POLITICAL DYNAMICS FOR PRESERVING WATER POTENTIAL

In addressing the question of local socio-political dynamics, the study showed that water is central to many domestic tasks carried out by riverside populations, who use it for washing, laundry, making bricks for building houses, market gardening and even irrigation for rice growing. As such, water resources become a central object in power relations, part of a perspective of consensual or binding cooperation between users. They evoke specific socio-cultural norms in time and space, as well as relations of dependence between those who consider water resources as a natural heritage and those who solicit their use [3, 9,14]. Water supply or use is negotiated with a view to reaching agreements between social groups and socio-professional categories, notably farmers, stockbreeders, fishermen and miners.

In this logic, the local socio-political dynamics we dealt with refer to the conflicts and forms of governance of water resources we had identified as underlying factors likely to be assets or obstacles to the proper preservation of the Lake Chad Basin's water potential against natural hazards. The study identified two forms of emerging conflict surrounding wells, boreholes, natural water sources, marigots and rivers. On the one hand, the information gathered points to conflicts between farmers and herders, which have become more acute in recent years as a result of declining water supplies and the scarcity of rainfall due to climate change. On the other hand, there are interpersonal and inter-community social conflicts resulting from the way boreholes and village wells are managed. One of the group leaders interviewed in Ndélé stressed: "Water in our locality is a resource that often creates conflicts. In the dry season, there are always disputes over boreholes and, above all, conflicts along the rivers between villagers and transhumant herders from neighboring countries. There are always difficult problems to resolve after the passage of their herds of oxen. The herders come with large numbers of oxen, which they bring into the river to fill it up. The farmers, the fishermen, all the villagers are unhappy. See *"Water in our locality is a resource that often creates conflicts. In the dry season, there are always disputes around boreholes and, above all, conflicts along the rivers between villagers and transhumant herders from neighboring countries. There are always difficult problems to resolve after the passage of their herds of oxen. The herders come with large numbers of oxen, which they bring into the river to fill it up. The farmers, the fishermen, all the villagers are unhappy. That's what often happens.*

Based on this observation, which explains the overall situation of water resources in the Lake Chad basin, two types of conflict emerge. The first type of conflict is of a violent nature, and can be observed around the main rivers such as Nana, Ban, Bakassa, Nana-Barya, which form the tributaries of the Ouham, as well as the Lim and Pendé rivers in the north-western part. In addition, in the northeastern areas, this conflict occurs around the main rivers, notably the Gribizi, Bamingui and Bangoran, which feed the Chari. According to the people interviewed at all the information-gathering sites, transhumant herders graze their flocks in the villagers' fields and then drive them to the water to drink. The amicable settlement of this often difficult conflict ends in clashes and killings. This phenomenon, already widely discussed in previous studies, often takes place during the dry season [11, 12, 15]. The absence of a peaceful environment in this context is a major challenge for the preservation of this water potential.

The second socio-political dynamic at local level relates to the exclusive management of boreholes by a certain group of people known as the "waterpoint management committee". This management creates misunderstandings between women seeking water for drinking and domestic use and the fountain vendor. This management, as an initiative of international and national NGOs facilitating the construction or rehabilitation of boreholes with the mechanical participation of villagers, leads

to fights, embezzlement of collected money and rivalries between families. Intensified use of these boreholes in the dry season in non-riparian villages leads to some drying up, creating a shortage of drinking water for the population.

5 CONCLUSION

The results of the socio-environmental study present some of the dynamic factors influencing the water potential of the Lake Chad basin in the north of the Central African Republic. Gold mining is strongly criticized by all populations living along the Ouham and its tributaries. For these populations, this activity, if it continues to be carried out, will inevitably cause the water to dry up completely from its bed, as the gold extraction techniques practiced by the mining companies are not respectful of the environment. Aquatic animals such as hippos, crocodiles, snakes, fish and other species, whose important role is to open up the underground waterways to maintain normal flow, are dying, being swept away or killed. In view of these difficulties, a vast campaign to raise awareness and mobilize local populations is essential, to facilitate individual and collective awareness and to ensure participative and integrated management by creating optimum conditions for risk prevention. Transhumant livestock farming in the prefectures of Nana-Gribizi, Ouham, Bamingui-Bangoran and Ouham-Pendé has been identified as a factor facilitating the silting-up and drying-out of river beds. It is a sector of activity that creates conflicts during the dry seasons in relation to its operation. As a result, local populations would like transboundary transhumance to be properly supervised to avoid destroying the ecosystem that protects water resources on the southern slopes of the basin. These results do not appear to be exhaustive, and deserve to be studied in greater depth in subsequent studies, in order to gain a better understanding of how people perceive the project to transfer water from the southern slopes of the basin to Lake Chad.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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