

Climate Risk Vulnerabilities and the Effects on Livelihoods in the Lake Chad Basin

Insight on Africa
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DOI: 10.1177/09750878261433476

journals.sagepub.com/home/iaoa

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Abstract

The article contributes to how climate affects people's livelihoods in the Lake Chad Basin (LCB) of Sub-Saharan Africa. Also, contributes to discourse on the global climate-security nexus, specifically focusing on the LCB. Theoretically, it utilises environmental resource scarcity theory to analyse climate risk vulnerabilities and adaptation measures. A qualitative design with data from individual interviews, group interviews and direct observations across countries—Nigeria, Niger, Chad and Cameroon. The study found climate change affected the livelihoods of people in diverse ways, including food shortages, low yields from farming and fishing. It recommends institutional reformation and realignment towards effective coordination of climate actions.

Keywords

Climate change, climate risk vulnerabilities, Lake Chad, Sub-Saharan Africa

Introduction

The main purpose of the study is to examine how climate risk vulnerabilities affect the livelihood of people in the Lake Chad Basin (LCB) in four countries, namely Nigeria, Niger, Chad and Cameroon. The main question this study addresses is: *What are the climate risk vulnerabilities that affect livelihoods in the Lake Chad Basin?*

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Climate change affects everyone; it needs all hands on deck approaches in dealing with climate change, and as such, the push for the effective implementation and coordination of climate action. Climate change has become one of the most critical policy dilemmas within the international political system and is a common global problem that transcends the traditional boundaries and jurisdictions of states (Intergovernmental Panel on Climate Change (IPCC) 2021; Thomas 2024). There is widespread consensus within the scientific community that there are rapid changes in the global climate system with about 95% scientific certainty that these changes are a result of anthropogenic human activities, and their danger holds no precedence in the history of human civilisation (IPCC 2007). Thus, climate change has become a multiplier and macro-driver of diverse environmental and ecological changes, such as a rise in temperatures, sea levels, erratic rainfall patterns, coastal erosion, the intensity of storms, migration of species, drought and floods (Luhunga and Songoro 2020; Sarker, Alam, and Gow 2017).

Luhunga and Songoro (2020) contend that these changes negatively impact social-ecological systems, and experience far-reaching effects on climate-dependent sectors like agriculture, fishery and tourism, which consequently lead to large-scale social disruptions, human insecurities and loss of livelihoods, especially in areas where there is high volatility and vulnerability. The negative impacts of climate change are pronounced in most parts of the world, especially in the developing world, where adaptive capacity is already low (Adger, Lorenzoni, and O'Brien 2009; Benjamin, Alcamo, and Schaldach 2020; UNEP 2005). While suggestions to the contrary may not be ignored in certain cases, the situation is already alarming in Africa, a particularly vulnerable region to climate change.

According to the Sixth Assessment Report (AR6) of the IPCC, Africa will be one of the most affected regions in the world by climate impacts due to its reliance on climate-sensitive sectors like agropastoralism and fisheries, as the primary means of economic activities for most of its population (IPCC 2021). In this regard, climate change not only undermines the biophysical environment but also poses a threat to the well-being, livelihood and security of people. Following its high vulnerability, most areas in Sub-Saharan Africa have already witnessed the vivid negative effects of climate change. Despite its socioeconomic importance as the major natural resource basket in the world, Sub-Saharan Africa has come under extreme vulnerability to climatic hazards with a significant increase in the number of floods and droughts over the past decades, affecting the livelihood of people (Benjamin, Alcamo, and Schaldach 2020; Butler et al. 2024; Mubaya, Jalloh, and Mogaka 2014).

Other effects of climate change on the livelihood of people across the globe, especially in Africa, are enormous. The United Nations Environment Programme (UNEP 2021) indicated that a greater portion of the effects of variations in the mean conditions of the earth's climate system, thus, affecting areas in Africa like the LCB and the surrounding communities, one of the most vulnerable agrarian areas in the world, with enormous human security implications arising from the situation and affecting human habitation (Adger et al. 2014; UNDP

2013). Most countries in the region suffer floods, droughts, water scarcity, reduced rains, desertification, and scarce arable wetlands (Benjamin, Alcamo, and Schaldach 2020). Moreover, the consequences have even been extremely severe concerning migration, the prevalence of infectious diseases, loss of jobs, worsening poverty rates, mortality, malnutrition, displacement of people and property, famine and food insecurity. These conditions have adversely affected livelihoods and undermined human security (Borhara et al. 2020; Sarker, Alam, and Gow 2017; Shanzie 2014; Wainwright et al. 2019).

Moreover, the exponential increase in human population in the region has further exacerbated the situation (UNDP 2013). As the negative effects of climate change are already manifest in Sub-Saharan Africa, there is evidence of a surge in the vulnerabilities of people and systems (IPCC 2021; Kundzewick 2016). The intensity of these vulnerabilities is predicated on the extent to which they are dependent on climate-sensitive natural resources and services from ecosystems, as well as their capacity to adapt to changes emanating from these resources and services (Luhunga and Songoro 2020). Also, climate migrants are on the increase in Africa, and studies suggest that such migration leads to conflicts in destination areas over habitation and resource usage, especially among farmers and pastoralists (Ibrahim and Mensah 2022; Kaba 2024; UNDP 2013). Among other challenges, climate-induced insecurities are of critical relevance to global peace, international stability, and sustainable development, created by climate change (Benjamin, Alcamo, and Schaldach 2020; Luhunga and Songoro 2020).

To remedy the situation, governments of the riparian States of the LCB, in partnership with the UNCFCC and other international actors, and in compliance with the Kyoto Protocol and Paris Accord, presented in 2015 (COP21) a Plan for Development and Adaptation to Climate Change in Lake Chad as a comprehensive roadmap to improve the adaptive capacity of communities in the basin against these climatic impacts and towards advancing human security, livelihood and wellbeing. Significant gains have been achieved in areas such as agroforestry, infrastructure to protect the agroecological ecosystem, organic fertilisation, and support for farmers in new practices such as the use of drought-resistant improved seeds. Thus, the vested interests of governments of the riparian States of the LCB on climate change and effective adaptation measures.

Also, there is evidence that these vulnerabilities, coupled with the growing scarcity of natural resources, promote violent conflict (Mbih 2020; Ogudairo and Ijimakinwa 2021) in communities within the basin that are competing over access to natural resources (Jeremiah and Falaju 2018; McCarthy 2020). According to the AR6 (IPCC 2021; Okoro 2018), these conflicts are becoming common in the basin, and it is feared that they will increase the potential to degenerate into large-scale violent conflicts. A report by UNEP (2005) suggests that, in the last two decades, at least 40% of intrastate conflicts in the basin are linked to natural resources. Evidence points to the fact that these conflicts are widespread in the broader Sahel, with a high propensity of this link doubling the risk of relapse, and the likelihood of new conflicts in future if climate change

exacerbates existing vulnerabilities. As corroborated by Ehiane and Moyo (2021), the Lake Chad region is already suffering the effects of dwindling resources, and this could especially intensify the already existing conflict in parts of the basin.

The Concept of Vulnerability

Vulnerability is an evolving concept concerning climate change and is gaining the attention of researchers, experts and policymakers (Birkmann et al. 2022). The reason is that most parts of the world continue to experience the adverse effects of climate change. According to IPCC (2007), vulnerability 'is an integrative measure of the threat to a system'. Also, vulnerability has been defined as 'a state of being threatened, a feeling or fear of harm' (Black and Weiner 1992, 48). Furthermore, vulnerability has been defined as 'an adaptive function of the load capacity of stations and extreme weather conditions, and an analysis of the impact of extreme weather conditions on public transport network' (Ma et al. 2019, 2). Vulnerability has also been described as 'the introduction of individuals or collective groups to livelihood stress resulting from the influences of changes in the environment'. In addition, vulnerability has been defined as 'a reduced capacity to anticipate, cope with, resist and recover from the impact of natural hazard' (Cipolla 2018, 112). The various conceptions or definitions contain terminologies such as a threat to a system, state of being threatened, extreme weather conditions, livelihood stress, changes in the environment, natural hazards, individuals or groups, etc. It can be argued that, based on the definitions of different scholars, vulnerability involves the level of exposure to climatic risk of either individual human beings or groups who reside in a particular environment. Also, it can be noticed from the definitions that these individuals may become vulnerable due to climate change or extreme weather conditions, which bring changes which are unbearable for the people and their daily survival.

Environmental Resource Scarcity Theory

On these grounds, Homer-Dixon argues that such scarcities, together with the inability to develop alternative consumption routes and livelihood for people, culminate into a situation where communities and states in the developing parts of the world become adversely affected and vulnerable owing to the heavy reliance on their populations on such resources (Feng et al. 2023; Homer-Dixon 1994).

Kaplan (1994) assert that natural factors like increased climate change, population growth, and rise in sea levels, coupled with certain human activities such as deforestation, and heavy dependence on the use of fossil fuels and mining, constitute a huge metropolis of factors that may cause a depletion or reduction in the quality and quantity of renewable environmental resources, hence giving momentum to increased scarcity and unhealthy competition over natural resources.

Consequently, three (3) distinct sources of scarcity of renewable environmental resources emerge, in the words of Kaplan (1994), and manifest within the consumption cycle in the three forms. One is *supply-induced scarcity*, which arises from the degradation or decline in the quality and quantity of environmental resources, especially at a rate higher than their recovery by natural processes. Second, *demand-induced scarcity* is caused by population growth within a given place, with a reduction in the per capita availability of resources relative to the number of people. The third is *structural scarcity*, which results from the unequal distribution and utilisation of available resources. This raises the danger of the political economy of distribution of key resources, where such resources are kept under the control of a few elites with the monopoly of power at their disposal, who either benefit entirely from the resources or take an unfairly bigger proportion to the detriment of the rest of society. These situations then result in less availability of essential renewable environmental resources for vulnerable groups and other less powerful social categories whose entitlement to these resources is challenged by those within influential power groups or brackets (Benjamin, Alcamo, and Schaldach 2020; Brown and Crawford 2009; Kaplan 1994).

Primarily arising from the transformation of the ecosystem in ways that radically affect their functional integrity, ecological marginalisation often becomes a subject of resource exploitation on the balance of asymmetrical power dynamics (Ehiane and Moyo 2021; Luhunga and Songoro 2020). This subsequently attracts the collective resistance of despondent marginalised social groups who resort to rebellion, violent unrest, civil disobedience or war as retaliation against opportunistic economic and power actors (Brown and Crawford 2009). In the context of the present study, irrespective of the cause of despondency, whether arising from Resource Capture or Ecological Marginalisation, the implication of such despondency is its high possibility of yielding an uncontrollable level of grievance, which is subsequently translated into action. Here, a major intervening variable between despondency and actual action is concerned with identity issues such as ethnicity, tribal lineage, or even religious factors that translate the grievances into full-scale conflict and corresponding reprisal attacks based on the above identity factors (Homer-Dixon 1994).

Despite its stratification of scarcities and the predictive value of conflicts, the environmental resource scarcity theory is criticised for its lack of a coherent pathway to environmental resilience in times of ecological adversity and has also left a void due to its non-conflict comparison nature (Martin et al. 2006). This theory provides an understanding of the intricacies of ecological insecurities and a sense of analysis of salient issues, such as the recognition of actors in climate action in the LCB of Sub-Saharan Africa.

Resilience Theory

The second theory used is resilience theory. The theory puts out the argument that adversity is inevitable, and so how it is dealt with is what matters rather than the nature of its manifestations. Resilience in climate studies relates to the ability of

ecological, environmental and human systems to recover from climatic hazards. According to Korda, Gray, and Stead (2021), resilience theory outlines three modes in which strategies for dealing with adversities (climate insecurities) are categorised, namely, passive or absorptive, adaptive, and transformative modes of resilience. Passive resilience relates to a situation whereby people accept their adversity as a matter of destiny, regardless of its dangers, without any regard for the risk of an unsustainable future. On the other hand, the adaptive (reactive) mode of resilience relates to a situation in which people, confronted with adversity, attempt to react in ways to devise alternatives to enable them to adapt to their adverse circumstances. Both passive and adaptive modes of resilience hold the view that any attempt to change the nature of adversity will amount to a futile adventure (Chandler and Reid 2016). However, their contrasting difference is the fact that, unlike in passive resilience, people who resort to adaptive resilience mode hold the belief that, through behavioural change, they can adjust to external circumstances to adapt to their situation at any given time.

The transformative mode of resilience relates to a radical approach by people confronted with adversity to resist adapting to perpetual vulnerability but strive to change external situations through proactive means (Okeke-Ogbuafor et al. 2023). Chandler and Reid (2016) assert that ‘for transformers, the problems are in the world, not in the mind: there is a need therefore to remake the world, not to remake the human being’. This creates agency for transformative resilience to create new pathways towards ending their vulnerabilities and to transform their social and economic ecosystems. The transformative mode of resilience constitutes a political response, unlike adaptive resilience, which reflects a psychological response to adversity (Okeke-Ogbuafor et al. 2023). The transformative mode of resilience rejects any notion that adapting to a problematic system will amount to solutions to the problems created by it. Therefore, for transformers, taking steps to replace a system saddled with adversity to end the problems is a better alternative. Such a replacement allows the ecosystem to bounce back, with the benefit of restoring its functional integrity. The theory has been applied in many fields of study, ranging from psychology, sociology, social work, and even management sciences (Breda 2018; Linnenluecke 2017; Zimmerman 2013).

For climate research, the theory helps in elucidating the extent to which people are coping, adapting, and transformatively responding to insecurities associated with environmental and ecological hazards caused by climate change and its effects. Resilience theory has been applied in several climate change studies to test the extent to which remedies, coping and adaptive measures are contributing towards climate resilience (Okeke-Ogbuafor et al. 2023). Okeke-Ogbuafor et al. (2023) describe resilience as ‘the ability to persist, adapt to change, and transform after a disturbance’. Corroborating this, Béné et al. (2003) note that ‘these three dimensions (absorptive capacity, adaptive capacity and transformative capacity) are seen as the three critical features of resilience’. In this study (article), therefore, the resilience theory is applied to examine existing cooperative adaptation alliances of climate change and

coping strategies to ascertain the resilience of inhabitants in the LCB and to proffer solutions for transformative resilience against climatic impacts. This theoretical perspective enhances human security and livelihoods while achieving peace and sustainable development in the LCB and Africa.

In summary, the overall summation of the two theories provides a broader understanding of the intricacies of ecological insecurities and a sense of analysis of salient issues such as recognition of actors in climate action in the LCB; Climate vulnerabilities and corresponding insecurities; predictive value of conflicts; the existing cooperative adaptation alliances, and coping strategies in the LCB. The aggregate of these theories also offers useful insights that are relevant in providing a scientific model to achieve ultimate transformation and restoration in ecological terms; a pathway towards transformative resilience and a *glocal* approach to climate governance in the African context, which is the main thrust of this study (article).

Methods and Materials

The study adopted a case study research design or approach. The case study design allows for the generation of an in-depth, multifaceted understanding of complex issues in their real-life context (Creswell 2017; Yin 2009). Accordingly, the climate change-security nexus is so complex, and the convolution of factors within it requires in-depth investigations to create an understanding of the issues within the LCB. The choice of the LCB for the study is because it is one of the highly agrarian places in Sub-Saharan Africa that is very vulnerable to the impact of climate change. Thus, a need to investigate the issues of climate vulnerabilities and their effect on the livelihood of the people or inhabitants of the geographic area of Sub-Saharan Africa. The choice of qualitative design or approach was to provide the means of investigating the key research question, and this design involves the collection and subsequent analysis of non-numeric data in the form of audio, text or video to generate in-depth insights to aid in the understanding of concepts, experiences, opinions, as well as problems of people in their natural setting (LCB). Its advantages are that it gives room for naturalistic means of gathering data and exploring meaningful insights into the problem with the view to generating new ideas that will form the basis for designing or improving systems within the given context (climate vulnerability and the effect on the livelihood of the people or inhabitants of LCB with participants across the various countries. The qualitative design helped the researchers to utilise in-depth interviews as a means of eliciting information from experts and key players who hold deeper insights into the effects of climate change on the livelihood of the people in the LCB.

In terms of the sampling methods used in the study, the researchers chose a purposive sampling method with selected participants who possess the requisite expertise to provide deeper insights and detailed descriptions on the subject under investigation. The other justification for the use of purposive sampling

methods was to reach out to persons with good knowledge of climate change and other persons with lived experience of climate change on their livelihood within the LCB. Miles and Huberman (1994), 'such a process will lead to producing believable descriptions as well as generate rich information that will enhance rigour and the credibility of the research findings'. Purposive sampling has the advantage of allowing researchers to draw on or tap from the knowledge of experts. Thus, the organisations and subjects were selected or picked because they possessed the required information on the question or the main aim of the study, which is phenomenal in environmental and climate change vulnerabilities on the people's livelihood in Sub-Saharan Africa and LCB, particularly. Hence, by this design, the researchers were able to elicit rich data from targeted individuals who were active participants with relevant facts and scientific details of the climate vulnerabilities, livelihood situations or dilemmas. Also, the researchers utilised the snowball sampling method, which enabled them to reach out to unknown targets with vital information. By the snowball sampling method, as Handcock and Gile (2011) define as a process of 'Link-Tracing' whereby the researchers are directed under the recommendation and links of earlier participants, to trace other participants or persons not earlier targeted, for participation in the study.

The choice of the LCB as a case study (study area) is purposive and predicated on two pertinent considerations. First, the LCB, though the largest endorheic basin in Africa and one of the most densely populated agrarian areas in the world, remains one of the most vulnerable and hard-hit places to the impacts of climate change in Sub-Saharan. Over 80% of the estimated 35 million inhabitants within the basin depend on climate-sensitive resources such as agriculture and pastoralism as their primary means of economic engagement. Hence, the harsh impacts of climate change within the basin have created one of the worst humanitarian and human security crises in Africa. For this reason, the governments of the riparian states of LCB are hugely investing in climate adaptation strategies to organise some of the harsh conditions on the people. The second consideration for the choice of LCB is data accessibility. Despite the fragile security situation in some parts of the basin, some other places have been suitable for this study and have enjoyed relative stability over the period and therefore guarantee a sufficiently safer environment for data collection. Four countries were covered in the study out of the eight countries in the LCB. These are the details of the four countries which were selected for data collection: (a) Nigeria; Borno, Adamawa, and Yobe States; (b) Niger; Diffa Region; (c) Chad; Provinces of Lac and Hadjer-Lamis and (d) Cameroon; Far North and North Regions. There are reasons for the selection of the four countries and the areas or regions. First, the eight territories above are confirmed to be the worst-affected areas of climate-induced security and vulnerabilities within the LCB (UNDP 2013). Second, the four selected countries constitute the only countries that are in direct contact with the Lake. Finally, the four countries with the eight territories have become the focal areas within the basin where the LCBC, in collaboration with the AU and the UNDP, are implementing the Regional

Strategy for Stabilisation, Recovery and Resilience (RS–SRR) programme, which intends to help these climate-induced worse-affected areas to recover and develop resilience (UNDP 2013).

Some secondary data was obtained from internet sources, books, and journal articles, among others, using some key words like ‘climate change’, ‘climate vulnerabilities’, ‘Lake Chad Basin’, among others, from reputable datasets or databases such as Web of Science, Google Scholar, Google, Science direct among others. In terms of primary sources of data, two main data sources were used, namely key informant interviews (KIIs) as well as focus group discussions (FGDs) of community members across selected communities in the LCB. The study data collected directly from key informants (experts) using a semi-structured interview guide, which offers guidance and focus towards addressing the study’s main research question. This helped in elucidating an in-depth investigation and scrutiny of the subject matter. In total, 42 KIIs were conducted, and their details are in Table 1.

Some group interviews were also conducted in the field, and the details of the FGDs are in Table 2. The number of participants who responded to the main research question: *What are the Climate Risk Vulnerabilities that affect livelihoods in the Lake Chad Basin?* is presented in Table 2. Five FGDs were involved in the analysis of this main research question. It is important to note that this study forms part of a major research project that was undertaken by the Lead Author (First Author) while the Second Author assisted in the conceptualisation/analysis of the data gathered in the field.

Table 1. Breakdown of Key Informants’ Interviews in Nigeria, Chad, Niger and Cameroon.

ID	Institution	Actual Participants
1	Lake Chad Basin Commission, LCBC	14
2	AU Commission	9
3	Institute of Security Studies, ISS	5
4	Scholars, Others	14
	Total	42

Table 2. Details of the Focus Group Discussions (FGDs) in Nigeria, Chad, Niger and Cameroon.

No.	Community	Territory	Country	Composition
1	Baga	Borno State	Nigeria	12
2	Wuro Dai	Adamawa State	Nigeria	12
3	Liwa	Lac Province	Chad	10
4	Maine-Sorno Community	Diffa Region	Niger	10
5	Naga-Hile Alifa	Far North Region	Cameroon	12
	Total Participants			56

Both in-depth interviews (key informants) and focus group interviews (FGDs) involved people with diversity ranging from men and women, young and older persons, both educated and those without formal education in English and French. These were the efforts of the researchers to achieve some kind of representation of groups, occupations, professionals, as well as diverse perspectives and data from multiple countries (four) around LCB towards data triangulation from two forms of interviews (in-depth and FGDs).

The qualitative data that was gathered in the four countries of the LCB was analysed thematically. The thematic analysis method was employed to analyse data, where key themes of the study were identified alongside major subjects and associations between them, which have all been discussed. A Case study of the LCB helped to examine the mutual interrelation of climate vulnerabilities and their effect on the livelihood of the people in the LCB. Also, the primary data that was collected from both KIIs and FGDs were deduced, analysed, and then incorporated into the identified organising themes with the support of ATLAS.ti Data Analysis Software, V7.5.16.

The researchers obtained ethical approval from the Ethics Committee of the College of Humanities, University of Ghana, with ethical approval (Ref: ECH 148/22-23) to visit the sampled organisations and individuals (participants). Participants' informed consent was obtained at any point while ensuring the ethical issues of confidentiality, strict privacy, anonymity and voluntary participation were adhered to and not compromised in any way. This regime of confidentiality is adopted in this study to ensure that the investigation is carried out devoid of any breach of ethical regulations that must be observed in the proper context of social science research.

Findings

The findings are based on the main question the study seeks to address: *What are the Climate Risk Vulnerabilities that affect livelihoods in the Lake Chad Basin?*

The main theme that emerged is the contextual Perception of Climate Change in the LCB and several other sub-themes, which were analysed as part of the findings. The findings are based on the data obtained from in-depth interviews and FGDs among others.

Contextual Perception of Climate Change in the LCB

Some interaction with community members who participated in FGDs sought to elucidate from their perspective what they perceive as climate change. From their responses emerged their notion of climate change, which may be paraphrased as: 'changes in weather conditions and the recession of the Lake Chad'. In their view, climate change concerns the recession of the lake and other issues relating to uncertain rain patterns, as well as increasing desertification in parts of the basin. Two FGD participants from Nigeria and Cameroon noted that:

My perception of climate change is just the observable changes in weather parameters like temperature, rainfall pattern, and other things that are causing our river to dry up, denying us water, and affecting our work as fishers, farmers and herders. [FGD, Baga Community–Borno State, Nigeria]

[W]hen discussing climate change in the LCB, the argument is anchored on the lake’s recession. For us, climate change is a matter of life and death. [FGD, Naga Community–Far North Region, Cameroon]

Other FGD participants on the issue of water insecurity expressed other views. Water insecurity was mentioned as one of the ways by which climate change undermines the livelihoods of inhabitants of the basin. Participants indicated that water, which constitutes a necessity upon which agriculture and domestic activities thrive, has become scarce and presents enormous challenges to their survival. Participants in two FGDs noted that:

Let me talk about water again. Water scarcity can cause us, the women, to fight, and our husbands and sons will take it over and end up injuring themselves in a pool of blood. We need help with water. Even drinking or cooking has become a big problem because of water ... we always have cholera and typhoid because of unclean water. [FGD, Naga Community–Far North Region, Cameroon]

The researchers used various codes that constitute the organising themes, as shown in Figure 1. These organising themes, as in Figure 1, constituted the factor that constituted climate vulnerabilities from the perspectives of the key informants (KIIs). These factors are found to have greatly affected the livelihood of the people in the LCB.

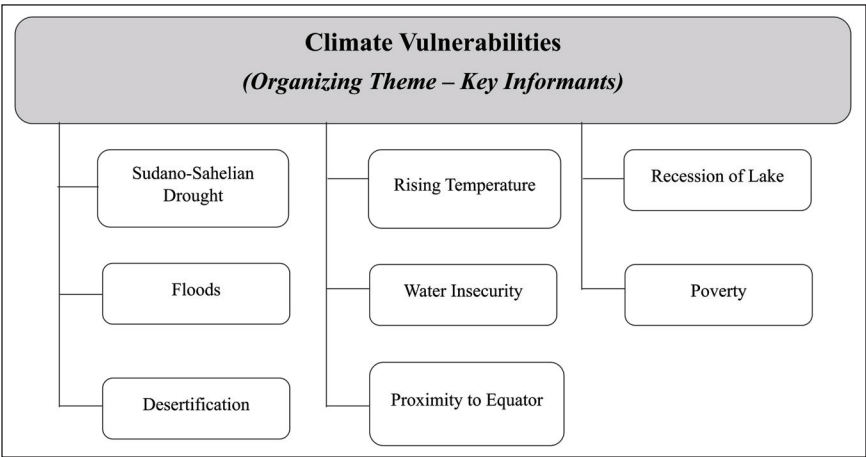


Figure 1. Organising Theme and Codes on Climate Vulnerabilities (KIIs).

Sudano-Sahelian Drought

The first factor is the Sudano-Sahelian Drought; 18 key informants confirmed the incidence of protracted droughts as one major vulnerability of climate change in LCB. These key informants explained that the incidence of drought, notably the Sudan-Sahelian drought, presents fundamental challenges to agriculture and fishing, which constitute the primary economic activity of the population within the LCB. This situation has led to underproductivity in the agricultural sector, with enormous implications for food, the economy and even the health security of inhabitants. One of the key informants had this to say:

Principally and historically, looking at the data, the most pronounced vulnerability in the basin is that of the Sudano-Sahelian climate drought basically due to natural factors, ... and all these factors compound the situation of the Lake Chad Region. [KII, Senior Research Fellow–WASCAL, April 2023]

Another key informant noted that:

There's this issue of intense drought in the Niger area here because of the shrinking patterns of water bodies around the Chad basin. I think that this issue of drought is one key vulnerability. [KII, Snr Official–ISS, April 2023]

Floods

The second factor identified includes floods. On floods, 14 key informants indicated that some parts of the LCB experience floods during the peak of the rainy seasons, especially around the lowlands in the southern belt, where much arable land abounds for agronomic activities. One of the key informants noted that:

One of the main issues of vulnerability in this whole Chad Basin is flooding; especially in the lowlands, flooding is causing havoc and serious crises aside from Boko Haram Walahi! [KII, Senior Technical Officer–ISS, June 2023]

Desertification

As indicated in Figure 1, desertification is one of the key risk vulnerability factors as identified by some of the key informants. In this regard, eight key informants noted that desertification prevails as a key vulnerability factor. The key informant asserted that the areas of the LCB around Niger and Cameroon are fast becoming desert and sandy because of increasing droughts, hence affecting livelihoods. This is what one key informant said:

Not only the Lake Chad Area, but the broader Sahel is also more vulnerable to climate in terms of rapid desertification of the area due to droughts and dust accumulation; this creates a lot of our problems even in farming and livestock. [KII, Professor of Sustainability–Abdoo Moumouni University, Niger, May 2023]

Water Insecurity

On the issue of water insecurity, six key informants noted that there is generally an issue of water scarcity in the LCB. This, they (the key informants) say, is a compelling vulnerability, as water is a primary need for households and industries. The scarcity is seen as phenomenal. This is what a key informant indicated:

Water, they say is life, but we don't have water again in the basin This alone makes us very vulnerable. [KII, Climate Activist–Nigeria, July 2023]

Rising Temperature

The issue of fast-rising temperatures also came up as a fundamental climate vulnerability in the area. On this issue, 11 key informants mentioned that the temperature is fast on the rise, causing excessive heat, particularly around the highlands or during the dry seasons. Some key informants went ahead to attribute desertification partly to the rising temperature. A senior meteorologist in Cameroon had this to say:

Also, we can have temperature extremes; the Nino and the Lunar, but most of the time, we experience the Lunar; very high temperatures of over 40 degrees Celsius, causing lots of livelihood challenges. [KII, Senior Official–ISS, April 2023]

Another key informant added his voice to the issue of rising temperatures in the LCB. The academic said that the patterns of recent temperature rise were very dangerous. These were his words:

These patterns, for me, in terms of vulnerabilities such as what I consider temperature rises and level of precipitation, as well as other aspects of the climate system, remain dangerous. [KII, Professor of Geography–University of Maiduguri, May 2023]

Recession of Lake Chad

One other vulnerability mentioned by key informants was the issue of the recession of Lake Chad. They (key informants) indicated that, though the quantity of water fluctuates lately, it remains a scientific fact that the lake has lost up to about 90% of its original size; from 25,000 km in the 1960s to about 2,500 km presently. This has affected fishing and dry-season farming in the LCB.

The biggest vulnerability that caused us to surrender to this battle of climate change here in the Baga area is the disappearance of the lake. It was our strength in everything. [KII, Senior Official–LCBC, May 2023]

Some probing was done regarding the factors of the recession of Lake Chad. This led to a discussion not limited to the key informants, but this time round the focus shifted to the perspectives or the views, opinions and experiences of the FGD participants with the communities of the catchment area (LCB).

The specific issues of questions are about some of the Causes of the Recession of Lake Chad. Interrogating the issue of the recession of Lake Chad, FGDs with community members elucidated several factors that are responsible for

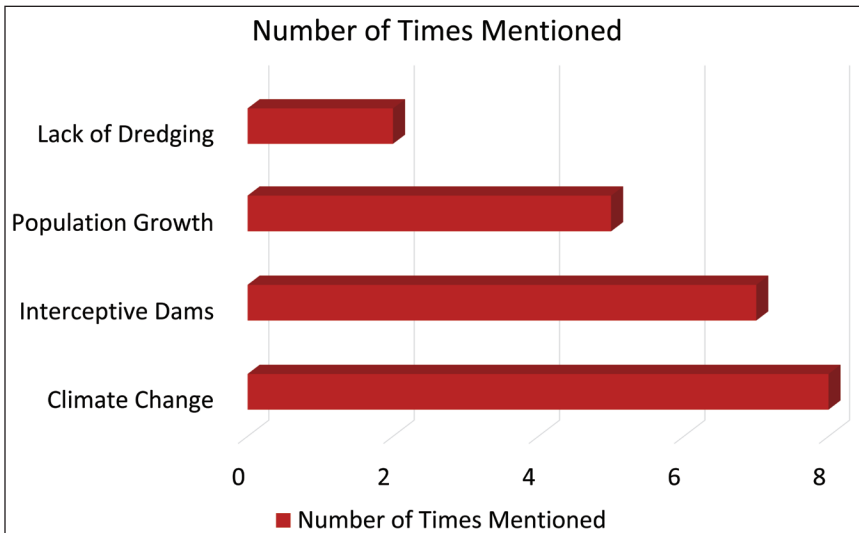


Figure 2. Causes of the Recession of Lake Chad (Organising Theme and Codes-FGDs).

the recession of the lake. These causes of the recession of Lake Chad are presented in Figure 2 (depicting perspectives of FGD participants in communities).

From Figure 2, climate change was mentioned in 8 FGDs as a major contributing factor to the recession of Lake Chad. They (FGD participants) intimated that climate change and its associated perils like global warming, reduced rainfall, and drought could not be exonerated from the blame for the recession. A participant in one of the FGDs maintained that:

The contributory factors for the recession of the lake over time, even before the 1960s is due to natural climate change; ... from the mega Chad to the present lake Chad that we have, we need to bear in mind that the major cause for the shrinkage is due to natural climatic changes. [FGD, Baga Community–Borno State, Nigeria]

The second most mentioned cause of the recession of the Lake was the impervious dams. In this case, the community members who participated in seven of the FGDs blamed the recession on the activities of private individuals who have constructed dams along the sloping regions of the tributaries that flow to feed Lake Chad. Such privately constructed dams intercept these rivers and collect most of the water, hence reducing the volumes that feed the lake (Lake Chad). This was seen as the second biggest worry for the FGD participants (community members) as far as the causes of the recession of the Lake are concerned. This is how the FGD participants commented:

One participant noted that:

It has to do with anthropogenic factors ... what humans have done is construct dams across different locations of the waters that flow into the Lake, hence cutting it off. [FGD, Liwa Community–Lac Province, Chad]

Another FGD participant also indicated that:

The tributaries that contribute to the inflow of the lake are used by some countries to provide water, electricity and so on. These have led to the unsustainable construction of dams along these major rivers; Chari-Lagunu, Lomogana and so on which largely contribute to around 90% of the inflow of water into this region. [FGD, Dikumari Community–Yobe State, Nigeria]

Population growth was another cause of the recession of the lake that emerged from 5 FGDs. These participants associated the case of the recession of the Lake with population growth. Participants noted that the basin records a high influx of people from other countries and urban centres who relocate to the area because of its rich biodiversity. This makes the basin's population inexorably high, hence creating overdependence and overuse of Lake Chad. One participant said that:

In this region, Niger has one of the highest and fastest growing populations, and that has also brought fishing stress to this natural endowment, which is the lake; and not only the size, it also has a significant impact on its biodiversity. [FGD, Maine-Soroa Community, Diffa Region, Niger]

The fourth and the least cause of the recession of Lake Chad was linked to the lack of dredging. The lack of dredging was also mentioned in 2 FGDs, where some participants indicated that the lake has not seen any dredging, though it is a shallow lake which can recede faster if left without any action to desilt portions of it. A participant noted that:

Also, the filling up of the places with sand needs to be dredged to allow the lake to survive. However, the lack of dredging also contributes significantly to the shrinkage of the Chad River. [FGD, Wuro Dai Community–Adamawa State, Nigeria]

Proximity to the Equator

One of the factors identified by the key informants in Figure 1 as risk vulnerability factors that have affected the livelihood of people/inhabitants in LCB is the basin's proximity to the equator.

One of the key informants, who is a Professor of Geography, suggested that the default position of the broader Sahelian region, including portions of the LCB which form the core of the Sahel, is its being extremely close to the equator, hence making the area very vulnerable in terms of rapid changes of climatic conditions. These were her words:

Populations, humans and other creations are vulnerable globally, but the peculiarities in the Lake Chad Basin are because of its location and proximity to the equator. From a lot of studies, locations closer to the equator are much more vulnerable. [KII, Snr Official–AU, April 2023]

Poverty

Finally, the climate change risk vulnerability that has affected the inhabitants of the LCB is poverty. Again, a commonly mentioned vulnerability that emerged was the issue of abject poverty. 22 of the key informants indicated that poverty among the settlers in the LCB makes it difficult for them to adjust in a manner to reduce climatic impacts. One key informant noted that:

My brother, everyone here within the basin now is suffering from poverty, because the drying of the lake dried with our toils, and so we are poor. How will we, in poverty, take steps to adapt to prevent climate change effects. [KII, Snr Official–ISS, April 2023]

Hence, the study has found eight major climate risk vulnerabilities (factors) that have affected the livelihoods of people/inhabitants in the LCB, as shown in Figure 1.

Discussion

The findings highlight the vulnerabilities of climate change and its impact on the livelihoods of people in the territories around the LCB. These findings reveal the forms of climate vulnerabilities of the LCB and proceed to underscore the various means by which such dimensions affected food security, water security, and economic activities including the two major occupations farming and fishing. The study found that economic security and general livelihoods of the people in the LCB are negatively affected by climate variability and the most affected groups are farmers-herders and fishermen and these empirical observations or findings concur with previous studies (Benjamin, Alcamo, and Schaldach 2020; Butler et al. 2024; Ehiane and Moyo 2021; Mubaya, Jalloh, and Mogaka 2014).

Also, despite the international recognition of the glaring climatic insecurities and humanitarian crisis in the LCB, there abounds a varied ecological significance of the area, which is critical to national and regional development. This is because the potential of the LCB has been historic in terms of food production, livestock rearing, and its export capacity in agriculture and fisheries, as the LCB was once a major food basket within the sub-region. These potentials of the regions are opposite due to some climatic conditions like floods, droughts, water scarcity, reduced rains, desertification, and scarce arable wetlands (Benjamin, Alcamo, and Schaldach 2020; Curtis 2019). What an irony of LCB, instead of the region maintaining its position as the food basket of Sub-Saharan Africa and the world, the region is faced with food shortages and unstable fishing, among others.

This description was due to the legacy of the LCB, and how the riparian states and communities around it were able to guarantee human security, live decent livelihoods and without fear of terror, following its endowment of water and environmental resources. The LCB conveys the potential to supply the food needs of not only its population but also up to about 50% of regional food demands while serving several other socioeconomic imperatives (FAO 2017a, 2017b). Notwithstanding the above, increasing climate vulnerabilities, recession of the Lake Chad, and insecurity are fast eroding the ecological relevance of the LCB, and worsening human insecurity rapidly. The indication by key informants that the LCB is saddled with low agricultural production using drought-induced low yields, crop failures and reduced soil nutrients, corroborates the notion that in recent times, food insecurity has been creating humanitarian concerns/needs along the riparian communities (Abaje et al. 2015; Fujimori et al. 2019). This makes the LCB a more vulnerable place now in terms of human security.

Also, the LCB is tremendously affected by water insecurity due to the recession of the lake and erratic rains. A significant proportion of the basin's population relies on the lake's resources and agriculture. Key informants established that the scarcity of water has further undermined agriculture, food production and dry-season irrigation of vegetables and critical nutritional commodities. This critical vulnerability and impact of climate change on food security in the LCB, as indicated by key informants, is corroborated by Beltran-Peña and D'Odorico (2022) in their assertion that about 70% of agricultural and agronomic activities are dependent on the lake and rainfall directly or indirectly. It is estimated that many areas of the LCB, such as Niger, Chad and portions of Cameroon, will be more affected by severe food insecurity and malnutrition because of this development (Ehiane and Moyo 2022).

Additionally, the LCB serves as a major source of fish stock and meat production due to the fishing prospects of the lake, and the production of livestock to meet nutritional aims (Caridade, Vidal, and Dinis 2022). However, as noted by key informants, this legacy is undermined by reduced fishing and even extinction in some notable fish and aquatic species, due to the recession of the lake, and further worsened by the scarcity of fodder and water needs, which have made it significantly cumbersome for livestock production. These observations of this study are corroborated by the assertion by Momberg et al. (2021) that lack of water and wetlands for grazing livestock in the LCB has affected meat supply, nutritional dynamics and protein targets in the sub-region. Theoretically, environmental resource scarcity theory has high relevance to the study findings. Homer-Dixon argues that resource scarcity, together with the people's inability to develop alternative consumption routes and livelihoods, becomes adversely affected and vulnerable due to their heavy reliance on natural resources (Chandler and Reid 2016; Feng et al. 2023; Homer-Dixon 1994; Okeke-Ogbuafor et al. 2023).

Conclusions

Conclusively, the LCB is undoubtedly endowed with high environmental and ecological significance and offers critical opportunities for the development of its riparian states and the sub-region. However, to maximise these opportunities, LCB member countries would be confronted with the compelling need to create the enabling environment necessary for enhancing human security and peace, by dealing with vulnerabilities and climate insecurities, especially in food supply and economy, which form key threats to livelihoods and socioeconomic development in the LCB. Socioeconomic and insecurities that persist in the LCB to be adequately dealt with, the nature of these insecurities and threats must be understood, not only from the point of view of climate change and environmental disruption but also from striving to comprehend the underlying socioeconomic dynamics that continuously engender these threats and exacerbate environmental hardships from the perspective of riparian communities in the basin as established in this study.

Recommendations

One recommendation is that there is a need to adopt a bottom-up approach to climate action in the face of the inability and incapacity of a Eurocentric approach to climate action, which is embedded in top-down adaptation interventions to address climate vulnerabilities and insecurities; a bottom-up approach (the direct involvement of farmers-herders and fishermen on the ground-LCB) must be adopted to improve resilience. Also, there is a need for broader stakeholder engagement and involvement of local community members in climate action and interventions- using local workshops, village-town hall meetings as platforms or forums. There is a need to consider migrant seasonal workers, women, and critical social groups to benefit from an appreciation and adoption of indigenous knowledge, cultural values and traditional practices, especially in agriculture and fishing for inhabitants of the LCB. Such a local-level initiative may help address issues of rural-urban migration patterns in the LCB or other closely related areas.

In addition, the study recommends the establishment of a joint meteorological infrastructure with an early warning system that is robust enough to predict and forecast possible climatic and environmental hazards with a reliable degree of scientific accuracy to help ease the suffering of people from natural disasters like floods, which often affect people's livelihood in the LCB. There is a need to establish high-capacity solar-powered irrigation schemes to help communities bounce back to an all-year farming in the LCB. This is a practical way to keep farmers actively involved in farming during the dry season.

Acknowledgement

Special thanks to the Legon Centre for International Affairs and Diplomacy of the University of Ghana for the administrative support. Also, thanks to the external links and support of Ghana's Ministry of Foreign Affairs, Ghana's Foreign Missions abroad and the participating organisations, bodies/actors, translators, and research assistants, among others, who helped during and after fieldwork.

Availability of Data and Materials

The data sources are not available in any repository, but the transcribed data could be made available upon request to the corresponding author.

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

Ethical Approval

The study received ethical approval from the Ethics Committee of the College of Humanities (Ref: ECH 148/22-23) and obtained institutional permissions/approval before the conduct of interviews.

Funding

The authors received no financial support for the research, authorship and/or publication of this article.

Informed Consent

The informed consent of the study participants was obtained before the interviews.

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