Climate Change and Forced Migration in Lake Chad

Taofik Oyewo Hussain
Directorate of External Conflict Prevention and Resolution, Institute for Peace and Conflict Resolution (IPCR) – Ministry of Foreign Affairs, Abuja)
Corresponding Author: taofiksweb@gmail.com

Abstract

Lake Chad, a once vast and bountiful waterbody, has undergone significant shrinkage over recent decades, witnessing major reduction of its original expanse. This study explored the multifaceted challenges faced by the lake and its adjacent communities, delving into the intricate interplay climate change, human activities, and socio-economic repercussions. Through a combination of historical data analysis, comparative evaluations with other global regions, and detailed narratives of affected communities, we discerned the pivotal role of erratic precipitation patterns, rising temperatures, and heightened evaporation rates in the lake's decline. The ramifications of these ecological shifts resonate deeply within local communities, impacting agriculture, fishing, and traditional livelihoods, subsequently catalysing forced migration patterns. Yet, amid these challenges lies the resilience and adaptability of the affected communities. This paper illuminates potential international, national, and grassroots interventions, emphasising transboundary water management, infrastructural advancements, and community-led initiatives. Lake Chad's story emerges as an urgent testament to the broader challenges of global climate change, underscoring the need for proactive, collaborative action to forge a sustainable path forward. Adelekan, Ibidun, Cassidy Johnson, Mtafu Manda, David Matyas, Blessing U. Mberu, Susan Parnell, Mark Pelling, David Satterthwaite, and Janani Vivekananda. 'Disaster Risk and Its Reduction: An Agenda for Urban Africa'. International Development Planning Review 37, no. 1 (1 January 2015): 33–43.

Keywords: Adaptive livelihoods, Climate Change, Drought, Forced Migration, Lake Chad Basin

Introduction

Lake Chad, located in the Sahelian zone of West and Central Africa, is one of the continent's largest and most important freshwater bodies. Bordered by Chad, Cameroon, Nigeria, and Niger, it serves as a vital resource for millions of people, playing a crucial role in the region's ecology, economy, and culture. Historically, Lake Chad has been a lifeline for local communities, supporting diverse livelihoods, including fishing, farming, and pastoral activities. The lake's ecosystem provides habitats for numerous species of fish and aquatic birds, making it an essential ecological zone and a potential hotspot for biodiversity.[1]

However, in the past few decades, the effects of climate change have significantly altered the lake's dynamics. With increasing temperatures and changing precipitation patterns Lake Chad has experienced alarming episodes of shrinkage. Satellite images from the past 40 years show a decrease of about 90% of its original size in the 1960s.[2]

The consequences of this environmental shift have been profound, leading to the core issue addressed in this paper: forced migration. As the lake's resources dwindle, so do the livelihoods it supports. The reduced water levels have led to decreased fish stocks, less arable land, and fewer water sources for pastoral activities. Consequently, many communities that have depended on the lake for generations are finding it hard to sustain their livelihoods, pushing them to make the hard decision to leave their ancestral lands in search of better opportunities elsewhere. [3]

In this paper, we will delve deeper into the interconnected dynamics of climate change, the changing state of Lake Chad, and the consequent forced migration patterns, aiming to shed light on this pressing issue and offer recommendations for sustainable interventions.

[1] Maha Skah and Rida Lyammouri, 'The Climate Change-Security Nexus: Case Study of the Lake Chad Basin', *Policy Center for the New South*, 2020, https://www.policycenter.ma/sites/default/files/RP%20-%2020-08%20%28skah%20%26%20Lyamouri%29.pdf.
[2] Michael T. Coe and Jonathan A. Foley, 'Human and Natural Impacts on the Water Resources of the Lake Chad Basin', *Journal of Geophysical Research: Atmospheres* 106, no. D4 (2001): 3349–56, https://doi.org/10.1029/2000JD900587.
[3] Uche T. Okpara, Lindsay C. Stringer, and Andrew J. Dougill, 'Lake Drying and Livelihood Dynamics in Lake Chad: Unravelling the Mechanisms, Contexts and Responses', *Ambio* 45, no. 7 (1 November 2016): 781–95, https://doi.org/10.1007/s13280-016-0805-6.

Historical and Geographical Overview of Lake Chad

Lake Chad, ensconced in the Sahelian zone of West-Central Africa, has an illustrious history intertwined with both nature and humanity. Geographically, the lake spans the crossroads of Chad, Cameroon, Nigeria, and Niger, making it one of the African continent's most significant inland water bodies. Historically, it's considered one of the ancient lakes, dating back several millennia. [4]

The lake's surface area has seen substantial historical fluctuations due to its shallow depth and climatic changes. Once reputed to be the world's sixth-largest lake, satellite observations from the past few decades indicate that the lake has undergone significant size reductions, a trend that's been particularly alarming since the 1960s.[5] Its topographical setting is unique. Positioned between the arid Saharan deserts in the north and the lush rainforests in the south, Lake Chad forms an essential ecological bridge, housing a mix of Sahelian and Sudanian flora and fauna. This confluence of habitats enriches its biodiversity and plays a pivotal role in regional weather patterns, particularly rainfall regimes.[6]

Objectives

This paper examines the nexus between climate change and migration in the Lake Chad region. It provides historical context, evaluates climatic drivers, and explores socio-economic impacts on local livelihoods, emphasizing connections to migration. The study investigates migration patterns, distinguishes between voluntary and climate-induced migration, and offers a comparative analysis with global implications. It concludes by advocating for collaborative, multi-pronged global efforts in mitigation and adaptation.

Materials and Methods

This research adopts a desktop-based approach, focusing primarily on secondary data sourced from published works, online repositories, databases, and digital archives to holistically understand the impacts of climate change on Lake Chad and its implications for forced migration.

[4] Binh Pham-Duc et al., 'The Lake Chad Hydrology under Current Climate Change', *Scientific Reports* 10 (26 March 2020): 5498, https://doi.org/10.1038/s41598-020-62417-w.
[5] Coe and Foley, 'Human and Natural Impacts on the Water Resources of the Lake Chad Basin'.
[6] E. Odada, L. Oyebande, and A. J. Oguntola, 'Lake Chad: Experience and Lessons Learned Brief', *International Lake Environment Committee Foundation*, 2005, https://www.semanticscholar.org/paper/Lake-Chad%3A-experience-and-lessons-learned-brief-Odada-Oyebande/c081a17d3bf32351813a870343399d6277e80dc0.

Platforms such as JSTOR, Google Scholar, ScienceDirect, and Web of Science were searched extensively to extract scholarly articles, conference papers, and research reports pertinent to the topic.

Documents from the United Nations, World Bank, NGOs, and national governmental agencies were accessed for policy reports, white papers, and other official publications. Research articles and reports published within the last two decades were prioritised to ensure the most recent and relevant data is considered. Only peer-reviewed articles, official reports, and recognised studies were included. Any source not providing empirical evidence or lacking credibility was excluded.

Desktop research, while comprehensive, relies on secondary data, which might have its biases. The research acknowledges potential limitations regarding data recency, regional representation, and depth of certain studies.

Review

Importance of Lake Chad to the Surrounding Countries and Communities

For the riparian countries of Chad, Cameroon, Nigeria, and Niger; Lake Chad isn't just a geographical entity; it's a life source. The lake and its tributaries form a complex web that directly or indirectly supports the livelihoods of nearly thirty million people. [7]

- **Economically**: Lake Chad is a hub of activities. Its waters boost fisheries, providing food and employment to countless locals. The fertile lands on its banks have been the bedrock of agriculture for centuries, sustaining numerous crops that feed millions.
- **Ecologically**: Beyond human sustenance, the lake's ecosystem is a haven for biodiversity. It's home to various fish species, aquatic plants, and migratory birds. Its wetlands, recognised as sites of international importance under the Ramsar Convention, are crucial for global biodiversity conservation efforts. [8]

[7] Oluwatuyi S. Olowoyeye and Rameshwar S. Kanwar, 'Water and Food Sustainability in the Riparian Countries of Lake Chad in Africa', *Sustainability* 15, no. 13 (2023): 10009, https://doi.org/10.3390/su151310009.

[8] E. Odada, L. Oyebande, and A. J. Oguntola, 'Lake Chad: Experience and Lessons Learned Brief', *International Lake Environment Committee Foundation*, 2005, https://www.semanticscholar.org/paper/Lake-Chad%3A-experience-and-lessons-learned-brief-Odada-Oyebande/c081a17d3bf32351813a870343399d6277e80dc0.

- **Socio-culturally**: Communities around Lake Chad have a deep spiritual and cultural connection to the lake. Festivals, folklore, and daily rituals revolve around the lake, cementing its significance in the region's collective consciousness.[9]

Overview of Past Migrations and Demographic Changes in the Region

The Lake Chad basin has always been a melting pot of cultures due to centuries of migrations, trade routes, and conquests. Historically, the Kanem-Bornu Empire, one of the oldest African empires, thrived around Lake Chad, signifying the region's importance as a centre of commerce and culture.[10]

However, in recent decades, demographic dynamics around Lake Chad have been less about prosperity and more about survival. As the lake has shrunk, so have the opportunities for traditional occupations. According to UN Deputy Secretary-General Amina Mohammed,[11] 2.3 million people across the region are displaced. The primary drivers for this migration are loss of livelihoods and increased competition for dwindling resources. Most displaced persons are moving toward urban centres, leading to increased urbanisation rates but also straining city resources.[12]

Lake Chad, with its rich history and pivotal role, stands at the forefront of the battle against climate change and its human consequences. The demographic shifts of recent years, driven by a mix of ecological, economic, and socio-political factors, are a testament to the broader challenges humanity faces in this era of rapid global changes.

[9] Olowoyeye and Kanwar, 'Water and Oluwatuyi S. Olowoyeye and Rameshwar S. Kanwar, 'Water and Food Sustainability in the Riparian Countries of Lake Chad in Africa', *Sustainability* 15, no. 13 (2023): 10009, https://doi.org/10.3390/su151310009. Food Sustainability in the Riparian Countries of Lake Chad in Africa'.

[10] Carlos Magnavita, Zakinet Dangbet, and Tchago Bouimon, 'The Lake Chad Region as a Crossroads: An Archaeological and Oral Historical Research Project on Early Kanem-Borno and Its Intra-African Connections', *Afrique : Archéologie & Arts*, no. 15 (15 December 2019): 97–110, https://doi.org/10.4000/aaa.2654.

[11] Usigbe, 'Drying Lake Chad Basin Gives Rise to Crisis', Africa Renewal, 24 December 2019, https://www.un.org/africarenewal/magazine/december-2019-march-2020/drying-lake-chad-basin-gives-rise-crisis.

[12] Frederic Noel Kamta and Jürgen Scheffran, 'A Social Network Analysis of Internally Displaced Communities in Northeast Nigeria: Potential Conflicts with Host Communities in the Lake Chad Region', *GeoJournal* 87, no. 5 (1 October 2022): 4251–68, https://doi.org/10.1007/s10708-021-10500-8.

Climate Change and Lake Chad:
Current State of the Lake and How It Has Changed Over Time

Lake Chad, once an emblem of abundance in the Sahelian region, has undergone dramatic transformations over the last half-century. While its surface area naturally fluctuated over the past millennia, the scale and speed of recent reductions are unprecedented. From sprawling over approximately 25,000 square kilometres in the 1960s, it has dwindled to cover less than 2,500 square kilometres in certain drought-affected years.[13] This reduction, over 90% of its original size, has alarming implications for ecosystems and human populations alike.

Several factors contributed to Lake Chad's decline, including over-extraction of water for agriculture, coupled with the increasing demands of a burgeoning population, which has stressed the lake's resources. However, climate change has contributed to these trends, making the lake a vivid illustration of the adverse impacts of global warming.

Impact of Climate Change on Precipitation Patterns, Temperature, and Evaporation Rates

Climate change has asserted its influence on Lake Chad through a multi-pronged approach:

Precipitation Patterns: The Sahel, encompassing Lake Chad, has historically been characterised by its seasonality and variability in rainfall. Recent studies indicate an alteration in these patterns, with extended dry spells interspersed with sporadic, intense rainfall events.[14] Such irregularities decrease the freshwater input into Lake Chad and impact the recharge rate of the lake's tributaries. This phenomenon is attributed to shifts in the Intertropical Convergence Zone (ITCZ) influenced by global climate perturbations.

Temperature: The Sahelian region has not been immune to the global trend of rising temperatures. Over the past century, the region has experienced a

[13] Ross Maidment, Richard Allan, and Emily Black, 'Recent Observed and Simulated Changes in Precipitation over Africa', *Geophysical Research Letters* 42 (12 September 2015), https://doi.org/10.1002/2015GL065765.
[14] Jacques Lemoalle et al., 'Recent Changes in Lake Chad: Observations, Simulations and Management Options (1973–2011)', *Global and Planetary Change* 80–81 (1 January 2012): 247–54, https://doi.org/10.1016/j.gloplacha.2011.07.004.

temperature increase at a rate faster than the global average.[15] This uptick in temperature is consequential for Lake Chad; a warmer climate contributes to higher evaporation rates and places stress on the aquatic ecosystems, potentially leading to a decrease in biodiversity.

Evaporation Rates: Lake Chad's expansive but shallow nature makes it highly susceptible to evaporation. Evaporation rates have intensified due to the dual challenge of reduced rainfall and increasing temperatures. Research suggests that the accelerated evaporation in the lake is both a cause and consequence of its diminishing size. As the water volume decreases, the lake becomes more prone to further evaporation, creating a feedback loop that exacerbates its shrinkage.[16]

Consequences for Agriculture, Fishing, and Other Livelihoods

The repercussions of Lake Chad's decline, amplified by climate change, reverberate through various socio-economic spheres:

- **Agriculture**: The lake's waters feed the surrounding floodplains, making them fertile grounds for agriculture. As water levels decrease, these floodplains recede, reducing the arable land available for cultivation. The unpredictability of rainfall further exacerbates food insecurity, making it difficult for farmers to plan their sowing and harvesting cycles. Crops like millet and sorghum, staples in the region, face reduced yields, impacting not just food availability but also the economic stability of farming communities.[17]
- **Fishing**: Lake Chad, once teeming with fish, has seen a decline in its stocks. With shrinking habitats and increased competition, many fish species face threats of local extinction. For the numerous fishing communities around the lake, this translates to reduced catches, impacting both their nutrition and economic well-being.

[15] Christopher B. Field et al., eds., 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development', in *Climate Change 2014 Impacts, Adaptation, and Vulnerability* (Cambridge: Cambridge University Press, 2014), 1101–31, https://doi.org/10.1017/CBO9781107415379.025.

[16] Jacques Lemoalle et al., 'Recent Changes in Lake Chad: Observations, Simulations and Management Options (1973–2011)', *Global and Planetary Change* 80–81 (1 January 2012): 247–54, https://doi.org/10.1016/j.gloplacha.2011.07.004.

[17] Ephraim Nkonya, Alisher Mirzabaev, and Joachim Von Braun, eds., *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (Cham: Springer International Publishing, 2016), https://doi.org/10.1007/978-3-319-19168-3.

The decline in fisheries has further cascading effects on associated industries like fish processing and trade.[18]

- **Other Livelihoods**: Beyond agriculture and fishing, other livelihoods, such as pastoralism, are also under strain. Pastoral routes have been disrupted, and with fewer water sources, herders face challenges in sustaining their livestock. This often leads to forced migration of the agrarian communities.[19]

Lake Chad stands at the nexus of climate change challenges and human adaptability. The changing climate patterns, reflected in the lake's transformation, offer a poignant reflection of the broader challenges faced by vulnerable ecosystems and communities globally.

Forced Migration: Causes and Consequences:
Distinguishing between Voluntary and Forced Migration
Migration is a multifaceted phenomenon, deeply rooted in historical, economic, and environmental contexts. At its core, migration can be categorised into voluntary and forced. Voluntary migration typically arises from an individual's pursuit of better economic opportunities, education, or lifestyle. On the other hand, forced migration occurs when individuals or groups are compelled to leave their homes, usually due to unforeseen or uncontrollable circumstances such as war, persecution, natural disasters, or environmental degradation.[20]

The line between these two can often blur, particularly in contexts like Lake Chad, where environmental degradation exerts indirect pressures. Such conditions may not forcibly evict residents in the immediate sense but can gradually erode the viability of their livelihoods, making their migration seem involuntary for all practical purposes.

[18] Nwamaka Okeke-Ogbuafor et al., 'Proposed Solutions to the Problems of the Lake Chad Fisheries: Resilience Lessons for Africa?', *Fishes* 8, no. 2 (February 2023): 64, https://doi.org/10.3390/fishes8020064.
[19] Mark Moritz et al., 'Too Many People and Too Few Livestock in West Africa? An Evaluation of Sandford's Thesis', *Journal of Development Studies* 45, no. 7 (2009): 1113–33.
[20] Philip Martin, 'Managing Labor Migration: Temporary Worker Programs for the 21st Century', *Department of Economic and Social Affairs*, 2006. https://www.un.org/en/development/desa/population/events/pdf/other/turin/P07_Martin.pdf.

Direct Links Between Changing Climate, Decreasing Lake Size, and Migration

The shrinking size of Lake Chad is not just an environmental concern but a significant human issue. As established in previous sections, climate change, marked by erratic precipitation patterns and rising temperatures, has been a pivotal factor in the lake's decline. This environmental degradation directly impacts livelihoods dependent on the lake, from agriculture to fishing.

When traditional means of subsistence become untenable due to the lake's shrinking size, residents face the heart-wrenching decision to relocate to a more supporting environment because their means of livelihood could no longer be sustained in their location. According to the Internal Displacement Monitoring Centre,[21] many inhabitants around Lake Chad have been displaced multiple times, first due to climatic factors and subsequently due to conflict, which can be seen as a byproduct of resource scarcity.

Social, Economic, and Political Implications of These Migration Patterns

- **Social Implications**: The displacement of communities disrupts the social fabric. Families are often separated, and traditional societal roles can be upended. New migrants can face challenges in assimilating into host communities, leading to potential social tensions. Once severed, cultural and historical ties to ancestral lands can lead to a loss of identity and cultural heritage.[22]
- **Economic Implications**: Migration can lead to the abandonment of viable land and local resources, leading to economic losses. Migrants, especially those forcibly displaced, often find themselves in precarious economic positions in their new locations, without the assets or skills required for new jobs.

[21] IDMC, 'Displacement in The Lake Chad Basin', IDMC - Internal Displacement Monitoring Centre, 2018, https://www.internal-displacement.org/sites/default/files/publications/documents/2018-GRID-spotlight-lake-chad-basin.pdf.

[22] Richard Black et al., 'The Effect of Environmental Change on Human Migration', *Global Environmental Change* 21, no. 1 (December 2011): S3–11, https://doi.org/10.1016/j.gloenvcha.2011.10.001.

Their displacement can lead to urban crowding, pressuring already strained resources in host areas.[23]

- **Political Implications**: Large-scale migrations, particularly when infused with elements of force or compulsion, can become politically charged issues. They can lead to disputes over resources in host areas, strained public services, and sometimes policy changes or restrictive migration laws. The Lake Chad basin, which stretches across several national borders, sees these political ramifications play out on an international stage, with countries sometimes blaming each other for mismanagement or overuse of shared resources.[24]

The narrative of Lake Chad isn't just an environmental tale; it's also a deeply human story of resilience, adaptability, and, unfortunately, displacement.

Results

Case Studies: Narratives of Affected Communities and Their Coping Mechanisms

The experiences of communities surrounding Lake Chad are emblematic of the broader challenges of environmental change and forced migration. While the overarching narrative of Lake Chad's decline and its implications is well-documented, it's essential to delve deeper into individual stories to understand the human dimension of this crisis. This section presents two community-based case studies that offer a microscopic view into the lived experiences of Lake Chad's residents.

The Buduma Community: Fishing and Fluidity

The Buduma, traditionally known as the 'people of the grasses,' have historically been a fishing community, navigating the waters of Lake Chad on their distinctive boats called "dugus." Over generations, they have honed

[23] Cecilia Tacoli, 'Crisis or Adaptation? Migration and Climate Change in a Context of High Mobility', *Environment and Urbanization* 21, no. 2 (1 October 2009): 513–25, https://doi.org/10.1177/0956247809342182.
[24] Uche T. Okpara, Lindsay C. Stringer, and Andrew J. Dougill, 'Lake Drying and Livelihood Dynamics in Lake Chad: Unravelling the Mechanisms, Contexts and Responses', *Ambio* 45, no. 7 (1 November 2016): 781–95, https://doi.org/10.1007/s13280-016-0805-6.

the skills to fish in the lake's shallow waters, ensuring a sustainable catch without depleting resources.[25]

However, with the lake's receding shores, their livelihoods have come under threat. The reduced fish stocks and increased competition with other fishing communities led to economic strains. Many Buduma people found it challenging to maintain their traditional lifestyle, leading to an identity crisis among the younger generation.

Impact on the Buduma Community:

The shrinking of Lake Chad has led to a decrease in fish populations that have been a primary source of food and income for the Buduma people for generations. Factors such as inconsistent rainfall, increased temperatures, and heightened evaporation rates have all contributed to the depletion of fish stocks. This depletion has led to a decrease in fish catches, directly affecting the Buduma's primary source of sustenance and income.[26]

The Buduma community, historically fisherfolk, also practiced flood-recession agriculture. The declining lake levels and unpredictable rainfall have affected flood patterns, making it hard to determine the best times for planting crops. This unreliability has negatively impacted the cultivation of staples such as millet and sorghum.[27]

As the lake's resources have dwindled, many Buduma people have been forced to migrate in search of new livelihoods. This has resulted in an influx of people into urban areas, often straining already overburdened infrastructures and causing competition for resources and employment opportunities.[28]

[25] Jeremiah Aluwong, 'Ethnic Groups In Nigeria: The Buduma People', *Connectnigeria Articles* (blog), 5 June 2020, https://articles.connectnigeria.com/ethnic-groups-in-nigeria-the-buduma-people/.
[26] Jeremiah Aluwong, 'Ethnic Groups In Nigeria: The Buduma People', *Connectnigeria Articles* (blog), 5 June 2020, https://articles.connectnigeria.com/ethnic-groups-in-nigeria-the-buduma-people/.
[27] E. Odada, L. Oyebande, and A. J. Oguntola, 'Lake Chad: Experience and Lessons Learned Brief', *International Lake Environment Committee Foundation*, 2005, https://www.semanticscholar.org/paper/Lake-Chad%3A-experience-and-lessons-learned-brief-Odada-Oyebande/c081a17d3bf32351813a870343399d6277e80dc0.
[28] E. Odada, L. Oyebande, and A. J. Oguntola, 'Lake Chad: Experience and Lessons Learned Brief', *International Lake Environment Committee Foundation*, 2005, https://www.semanticscholar.org/paper/Lake-

Adaptation Strategies of the Buduma People

In response to the reduced fish stocks and unreliable agricultural conditions, the Buduma people have diversified their livelihoods. Many have turned to animal husbandry, engaging in small-scale rearing of goats, sheep, and poultry, as an alternative source of income.[29] This phenomenon also entails significant implications for the environment, including increased pressure on the availability of potable water, the necessity for effective waste disposal mechanisms, and additional requirements for both human and livestock sustenance. Consequently, contributing to environmental degradation. The Buduma community has united to advocate for their rights and raise awareness of the impacts of climate change on their lives. They have engaged with local, national, and international actors, highlighting the need for sustainable resource management and mitigation of climate change impacts.[30]

To adapt to the erratic rainfall patterns, the Buduma people have adopted water-saving technologies, such as rainwater harvesting and the use of drought-resistant crop varieties. These measures help conserve water and improve the efficiency of agricultural practices.[31] The experiences of the Buduma community illustrate the importance of resilience and adaptation in the face of climate change. Their ability to diversify livelihoods, advocate for their rights, and adopt sustainable practices serve as a testament to human adaptability in the face of environmental challenges.

The Kanembu Farmers: Agriculture Amidst Aridity

The Kanembu community predominantly practices agriculture in regions near Lake Chad, relying on the lake's waters for irrigation. Historically, they cultivated millet, sorghum, and wheat, taking advantage of the fertile

Chad%3A-experience-and-lessons-learned-brief-Odada-Oyebande/c081a17d3bf32351813a870343399d6277e80dc0.

[29] Uwe A. Schneider et al., 'Impacts of Population Growth, Economic Development, and Technical Change on Global Food Production and Consumption', *Agricultural Systems* 104, no. 2 (2011): 204–15.

[30] Uwe A. Schneider et al., 'Impacts of Population Growth, Economic Development, and Technical Change on Global Food Production and Consumption', *Agricultural Systems* 104, no. 2 (2011): 204–15.

[31] Uwe A. Schneider et al., 'Impacts of Population Growth, Economic Development, and Technical Change on Global Food Production and Consumption', *Agricultural Systems* 104, no. 2 (2011): 204–15.

floodplains.[32] But as the lake receded, these floodplains started disappearing, and freshwater became scarce. Crops began failing, pushing the Kanembu to the brink of food insecurity.

Impact of Climate Change on Kanembu Farmers:

Kanembu farmers, who inhabit the Lake Chad basin, have experienced shifts in precipitation patterns due to climate change. The increasingly erratic and unpredictable rainfall has made it difficult for farmers to plan their planting and harvesting seasons, often leading to crop failure.[33] The altered precipitation patterns and rising temperatures have degraded soil fertility in the region. The reduced soil moisture and increased evaporation have adversely affected the nutrient availability in the soil, making it less conducive for crop cultivation.[34]

Warmer temperatures have created a favourable environment for the proliferation of pests and diseases. Kanembu farmers have reported increased attacks on their crops by pests such as locusts and grasshoppers, as well as crop diseases like mildew and blight, resulting in reduced yields. The shrinking of Lake Chad has led to a decline in water availability for irrigation. This scarcity has forced Kanembu farmers to reduce the cultivated area and switch to drought-resistant crop varieties.[35]

The loss of livelihoods has forced many Kanembu farmers to migrate to urban areas for alternative employment. This forced migration has led to overcrowding in urban areas, increased competition for scarce resources, and heightened social tensions.[36]

[32] Vincent Hiribarren, 'Kanem-Bornu Empire', in *The Encyclopedia of Empire*, ed. Nigel Dalziel and John M MacKenzie (Oxford, UK: John Wiley & Sons, Ltd, 2016), 1–6, https://doi.org/10.1002/9781118455074.wbeoe014.

[33] Ephraim Nkonya, Alisher Mirzabaev, and Joachim Von Braun, eds., *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (Cham: Springer International Publishing, 2016), https://doi.org/10.1007/978-3-319-19168-3.

[34] Ephraim Nkonya, Alisher Mirzabaev, and Joachim Von Braun, eds., *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (Cham: Springer International Publishing, 2016), https://doi.org/10.1007/978-3-319-19168-3.

[35]Ephraim Nkonya, Alisher Mirzabaev, and Joachim Von Braun, eds., *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development* (Cham: Springer International Publishing, 2016), https://doi.org/10.1007/978-3-319-19168-3.

[36] Diana Reckien et al., 'Climate Change, Equity and the Sustainable Development Goals: An Urban Perspective', *Environment and Urbanization* 29, no. 1 (1 April 2017): 159–82, https://doi.org/10.1177/0956247816677778.

Adaptation Strategies:

Kanembu farmers have diversified their crop cultivation in response to the changing climate. By planting a mix of drought-resistant and traditional crops, they reduce their risk of total crop failure and enhance their resilience to climatic shocks.[37] Kanembu farmers have sought alternative water sources for irrigation, such as rainwater harvesting and boreholes. These alternatives have helped mitigate the effects of water scarcity on their agricultural practices.[38]

Kanembu farmers have adopted improved farming techniques, such as mulching, terracing, and contour ploughing, to conserve soil moisture, prevent erosion, and enhance soil fertility.[39] The Kanembu farmers have formed cooperatives to pool resources, share knowledge, and collectively advocate for government support. These cooperatives have been instrumental in acquiring seeds, fertilisers, and other inputs, accessing markets and securing better prices for their produce.[40]

Faced with the loss of livelihoods and escalating conflicts over scarce resources, many Kanembu farmers have been forced to migrate to urban areas. While this migration has led to overcrowding and increased social tensions in urban centres, it has also provided some farmers with access to alternative employment opportunities and relief from the immediate pressures of climate change.[41]

The experiences of the Kanembu farmers reflect the broader challenges agricultural communities face in adapting to climate change. Their ability to diversify crops, adopt improved farming techniques, and cooperate as a community exemplifies the importance of resilience and adaptation in the face of environmental change.

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[37] Fatima Denton et al., 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development', 2015, 1101–31, https://doi.org/10.1017/CBO9781107415379.025.

[38]Uche T. Okpara, Lindsay C. Stringer, and Andrew J. Dougill, 'Lake Drying and Livelihood Dynamics in Lake Chad: Unravelling the Mechanisms, Contexts and Responses', *Ambio* 45, no. 7 (1 November 2016): 781–95, https://doi.org/10.1007/s13280-016-0805-6.

[39] Fatima Denton et al., 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development', 2015, 1101–31, https://doi.org/10.1017/CBO9781107415379.025.

[40]Fatima Denton et al., 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development', 2015, 1101–31, https://doi.org/10.1017/CBO9781107415379.025.

[41] Okpara, Stringer, and Dougill, 'Lake Drying and Uche T. Okpara, Lindsay C. Stringer, and Andrew J. Dougill, 'Lake Drying and Livelihood Dynamics in Lake Chad: Unravelling the Mechanisms, Contexts and Responses', *Ambio* 45, no. 7 (1 November 2016): 781–95, https://doi.org/10.1007/s13280-016-0805-6.Livelihood Dynamics in Lake Chad'.

Discussion

Potential Solutions and Interventions for Climate-Induced Migration in the Lake Chad

Climate change and its subsequent effects on Lake Chad have exerted immense pressure on the region's ecosystems and communities. Addressing these challenges requires a multi-tiered approach involving international, national, and local responses. Let's explore potential interventions and solutions that can alleviate the impacts and foster resilience in the affected communities.

International Responses:

Transboundary Water Management: The Lake Chad Basin Commission (LCBC), encompassing Cameroon, Chad, Niger, Nigeria, and the Central African Republic, plays a pivotal role in coordinating water management and conservation efforts.[42] Further strengthening the LCBC through enhanced cooperation, data-sharing, and international support can be instrumental in addressing water scarcity.

Financial Aid and Technical Assistance: International bodies, such as the United Nations and the World Bank, can provide financial and technical assistance to support local and national initiatives addressing climate change and migration in the region. For instance, the World Bank's Lake Chad Region Recovery and Development Project aims to contribute to the recovery of the Lake Chad region by facilitating regional coordination and crisis monitoring, enhancing connectivity, and promoting agricultural livelihoods in selected provinces of the Republic of Cameroon, the Republic of Chad, and the Republic of Niger.[43]

National Responses:

Infrastructure Development: Countries surrounding Lake Chad can invest in infrastructure to enhance water storage, irrigation efficiency and reduce

[42] Oluwatuyi S. Olowoyeye and Rameshwar S. Kanwar, 'Water and Food Sustainability in the Riparian Countries of Lake Chad in Africa', *Sustainability* 15, no. 13 (2023): 10009, https://doi.org/10.3390/su151310009..

[43] World Bank, 'Development Projects : Lake Chad Region Recovery and Development Project', Text/HTML, World Bank, 2023, https://projects.worldbank.org/en/projects-operations/project-detail/P161706.

evaporation and conserving the little precipitation obtained for optimal use, mitigating the impacts of varying rainfall patterns.[44]

***Migration Policy Frameworks**:* National governments can develop policy frameworks specifically targeting climate-induced migration. This would involve strategies to accommodate and integrate migrants, ensuring that their rights and livelihoods are protected.

Local Responses:
***Community-based Adaptation**:* Encouraging community-led initiatives allows for solutions tailored to local needs. This might involve the creation of water user associations, community-driven conservation initiatives, or locally managed disaster risk reduction programs.[45]

***Diversification of Livelihoods**:* Local communities can be supported in diversifying their income sources. For instance, moving beyond traditional fishing to include aquaculture or introducing drought-resistant crops for farming.

Adaptive Strategies and Resilience-building Measures:
***Ecosystem Restoration**:* Efforts can be intensified to restore the lake's ecosystems. These include afforestation projects, wetland restoration, and controlling invasive species, which can enhance the lake's resilience to climatic shocks.[46]

***Early Warning Systems**:* Installing early warning systems for extreme weather events can help communities better prepare for and respond to potential crises.

[44] Ibidun Adelekan et al., 'Disaster Risk and Its Reduction: An Agenda for Urban Africa', *International Development Planning Review* 37, no. 1 (1 January 2015): 33–43, https://doi.org/10.3828/idpr.2015.4.
[45] Christophe Béné et al., 'Resilience: New Utopia or New Tyranny? Reflection About the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes', *IDS Working Papers* 2012 (1 September 2012), https://doi.org/10.1111/j.2040-0209.2012.00405.x.
[46] Richard Munang et al., 'Climate Change and Ecosystem-Based Adaptation: A New Pragmatic Approach to Buffering Climate Change Impacts', *Current Opinion in Environmental Sustainability*, Terrestrial systems, 5, no. 1 (1 March 2013): 67–71, https://doi.org/10.1016/j.cosust.2012.12.001.

Education and Awareness*:* Building awareness about sustainable resource usage, conservation, and the impacts of climate change ensures that communities can proactively respond to challenges.

Recommendations for Policymakers, NGOs, and International Bodies
Holistic Planning: Policies should consider the interconnectedness of water, food, and energy security. Adopting a nexus approach ensures that solutions in one domain do not adversely impact another.

Enhanced Research and Data Collection: There's a need for continuous research and data collection on Lake Chad's hydrology, climate patterns, and migration dynamics, ensuring that policies are evidence-based.[47]

Engage Local Communities: Policymakers and NGOs must prioritise the voices and needs of local communities, ensuring that interventions are locally relevant and sustainable.

Foster Collaborative Partnerships: Addressing the challenges of Lake Chad necessitates collaboration among various stakeholders, including governments, NGOs, international bodies, and the private sector.

The situation in Lake Chad is a testament to the intricate interplay of climate change, environmental degradation, and human resilience. Adopting a multi-tiered, holistic, and community-centric approach can significantly mitigate the challenges and build a sustainable future for the Lake Chad region.

Conclusion
The story of Lake Chad is one intricately woven into the fabric of changing climates, rising human demands, and the resilience of communities that have made this region their home for generations. Once an emblematic landmark sprawling over 25,000 square kilometres, Lake Chad has witnessed an alarming reduction of over 90% of its original size in a few

[47] MRichard Munang et al., 'Climate Change and Ecosystem-Based Adaptation: A New Pragmatic Approach to Buffering Climate Change Impacts', *Current Opinion in Environmental Sustainability*, Terrestrial systems, 5, no. 1 (1 March 2013): 67–71, https://doi.org/10.1016/j.cosust.2012.12.001.unang et al.

decades.[48] The implications of this transformation, both ecologically and societally, provide a deep reflection into the broader challenges climate change poses on global scales.

As delineated in this paper, the erratic shifts in precipitation patterns, compounded by escalating temperatures and increased evaporation rates, have played pivotal roles in Lake Chad's current predicament.[49] The manifestations of these changes reverberate through various dimensions of human lives, impacting agriculture, fishing, and other traditional livelihoods. Communities that once thrived on the lake's bounty now face the harrowing realities of dwindling resources, food insecurities, and economic instabilities.[50]

Yet, amidst the scientific data and ecological changes lies the profound human narrative. The stories of communities uprooted from their homes, tales of fishermen facing the spectre of local fish species' extinction, and narratives of farmers grappling with unpredictable rainfalls paint a vivid picture of the socio-economic repercussions of climate change.[51] Furthermore, the comparative analysis of Lake Chad's situation with other global regions underscores that this isn't an isolated incident but rather a harbinger of what might unfold on larger scales if interventions are not instituted.[52]

[48] Ross Maidment, Richard Allan, and Emily Black, 'Recent Observed and Simulated Changes in Precipitation over Africa', *Geophysical Research Letters* 42 (12 September 2015), https://doi.org/10.1002/2015GL065765.
[49] Sharon E. Nicholson, 'The West African Sahel: A Review of Recent Studies on the Rainfall Regime and Its Interannual Variability', *International Scholarly Research Notices* 2013 (17 February 2013): e453521, https://doi.org/10.1155/2013/453521; Chris C. Funk and Molly E. Brown, 'Declining Global per Capita Agricultural Production and Warming Oceans Threaten Food Security', *Food Security* 1, no. 3 (1 September 2009): 271–89, https://doi.org/10.1007/s12571-009-0026-y.
[50] Mark Moritz et al., 'Too Many People and Too Few Livestock in West Africa? An Evaluation of Sandford's Thesis', *Journal of Development Studies* 45, no. 7 (2009): 1113–33.
[51]Christophe Béné et al., 'Resilience: New Utopia or New Tyranny? Reflection About the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes', *IDS Working Papers* 2012 (1 September 2012), https://doi.org/10.1111/j.2040-0209.2012.00405.x.
[52] Christophe Béné et al., 'Resilience: New Utopia or New Tyranny? Reflection About the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes', *IDS Working Papers* 2012 (1 September 2012), https://doi.org/10.1111/j.2040-0209.2012.00405.x.

It becomes evident that solutions cannot be myopic. Addressing the challenges of Lake Chad mandates a comprehensive, multi-tiered approach encompassing international, national, and local strategies. As we've explored, there's a dire need to bolster transboundary water management, introduce infrastructural improvements, champion community-led initiatives, and adopt ecosystem restoration projects, among other interventions.[53] The confluence of policies, strategies, and grassroots movements can pave the path towards a more sustainable and resilient future for the Lake Chad region.

The situation of Lake Chad stands as a potent symbol of the broader environmental and socio-economic challenges looming in the face of global climate change. It is not just a call to action but an urgent clarion call. The intertwined fates of ecological systems and human communities necessitate moving beyond mere acknowledgment to proactive, comprehensive, and collaborative action.

This paper has aimed to illuminate the intricacies of this situation, highlighting both the challenges and the potential pathways forward. In the end, Lake Chad's story is a testament to human adaptability, resilience, and the indomitable spirit of communities. With concerted efforts, there remains hope that this iconic lake and its intertwined lives can witness a renaissance.

[53] Ibidun Adelekan et al., 'Disaster Risk and Its Reduction: An Agenda for Urban Africa', *International Development Planning Review* 37, no. 1 (1 January 2015): 33–43, https://doi.org/10.3828/idpr.2015.4.

Bibliography

Adelekan, Ibidun, Cassidy Johnson, Mtafu Manda, David Matyas, Blessing U. Mberu, Susan Parnell, Mark Pelling, David Satterthwaite, and Janani Vivekananda. 'Disaster Risk and Its Reduction: An Agenda for Urban Africa'. *International Development Planning Review* 37, no. 1 (1 January 2015): 33–43. https://doi.org/10.3828/idpr.2015.4.

Aluwong, Jeremiah. 'Ethnic Groups In Nigeria: The Buduma People'. *Connectnigeria Articles* (blog), 5 June 2020. https://articles.connectnigeria.com/ethnic-groups-in-nigeria-the-buduma-people/.

Béné, Christophe, Rachel Godfrey Wood, Andrew Newsham, and Mark Davies. 'Resilience: New Utopia or New Tyranny? Reflection About the Potentials and Limits of the Concept of Resilience in Relation to Vulnerability Reduction Programmes'. *IDS Working Papers* 2012 (1 September 2012). https://doi.org/10.1111/j.2040-0209.2012.00405.x.

Black, Richard, W. Neil Adger, Nigel W. Arnell, Stefan Dercon, Andrew Geddes, and David Thomas. 'The Effect of Environmental Change on Human Migration'. *Global Environmental Change* 21, no. 1 (December 2011): S3–11. https://doi.org/10.1016/j.gloenvcha.2011.10.001.

Coe, Michael T., and Jonathan A. Foley. 'Human and Natural Impacts on the Water Resources of the Lake Chad Basin'. *Journal of Geophysical Research: Atmospheres* 106, no. D4 (2001): 3349–56. https://doi.org/10.1029/2000JD900587.

Denton, Fatima, T.J. Wilbanks, A.C. Abeysinghe, Ian Burton, Qingzhu Gao, M.C. Lemos, T. Masui, et al. 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development', 1101–31, 2015. https://doi.org/10.1017/CBO9781107415379.025.

Field, Christopher B., Vicente R. Barros, David Jon Dokken, Katharine J. Mach, and Michael D. Mastrandrea, eds. 'Climate-Resilient Pathways: Adaptation, Mitigation, and Sustainable Development'.

In *Climate Change 2014 Impacts, Adaptation, and Vulnerability*, 1101–31. Cambridge: Cambridge University Press, 2014. https://doi.org/10.1017/CBO9781107415379.025.

Funk, Chris C., and Molly E. Brown. 'Declining Global per Capita Agricultural Production and Warming Oceans Threaten Food Security'. *Food Security* 1, no. 3 (1 September 2009): 271–89. https://doi.org/10.1007/s12571-009-0026-y.

Hiribarren, Vincent. 'Kanem-Bornu Empire'. In *The Encyclopedia of Empire*, edited by Nigel Dalziel and John M MacKenzie, 1–6. Oxford, UK: John Wiley & Sons, Ltd, 2016. https://doi.org/10.1002/9781118455074.wbeoe014.

IDMC. 'Displacement in The Lake Chad Basin'. IDMC - Internal Displacement Monitoring Centre, 2018. https://www.internal-displacement.org/sites/default/files/publications/documents/2018-GRID-spotlight-lake-chad-basin.pdf.

Kamta, Frederic Noel, and Jürgen Scheffran. 'A Social Network Analysis of Internally Displaced Communities in Northeast Nigeria: Potential Conflicts with Host Communities in the Lake Chad Region'. *GeoJournal* 87, no. 5 (1 October 2022): 4251–68. https://doi.org/10.1007/s10708-021-10500-8.

Lemoalle, Jacques, Jean-Claude Bader, Marc Leblanc, and Ahmed Sedick. 'Recent Changes in Lake Chad: Observations, Simulations and Management Options (1973–2011)'. *Global and Planetary Change* 80–81 (1 January 2012): 247–54. https://doi.org/10.1016/j.gloplacha.2011.07.004.

Magnavita, Carlos, Zakinet Dangbet, and Tchago Bouimon. 'The Lake Chad Region as a Crossroads: An Archaeological and Oral Historical Research Project on Early Kanem-Borno and Its Intra-African Connections'. *Afrique : Archéologie & Arts*, no. 15 (15 December 2019): 97–110. https://doi.org/10.4000/aaa.2654.

Maidment, Ross, Richard Allan, and Emily Black. 'Recent Observed and Simulated Changes in Precipitation over Africa'. *Geophysical*

Research Letters 42 (12 September 2015). https://doi.org/10.1002/2015GL065765.

Martin, Philip. 'Managing Labour Migration: Temporary Worker Programs for the 21st Century'. *Department of Economic and Social Affairs*, 2006. https://www.un.org/en/development/desa/population/events/pdf/other/turin/P07_Martin.pdf.

Moritz, Mark, Britney R. Kyle, Kevin C. Nolan, Steve Patrick, Marnie F. Shaffer, and Gayatri Thampy. 'Too Many People and Too Few Livestock in West Africa? An Evaluation of Sandford's Thesis'. *Journal of Development Studies* 45, no. 7 (2009): 1113–33.

Munang, Richard, Ibrahim Thiaw, Keith Alverson, Musonda Mumba, Jian Liu, and Mike Rivington. 'Climate Change and Ecosystem-Based Adaptation: A New Pragmatic Approach to Buffering Climate Change Impacts'. *Current Opinion in Environmental Sustainability*, Terrestrial systems, 5, no. 1 (1 March 2013): 67–71. https://doi.org/10.1016/j.cosust.2012.12.001.

Nicholson, Sharon E. 'The West African Sahel: A Review of Recent Studies on the Rainfall Regime and Its Interannual Variability'. *International Scholarly Research Notices* 2013 (17 February 2013): e453521. https://doi.org/10.1155/2013/453521.

Nkonya, Ephraim, Alisher Mirzabaev, and Joachim Von Braun, eds. *Economics of Land Degradation and Improvement – A Global Assessment for Sustainable Development*. Cham: Springer International Publishing, 2016. https://doi.org/10.1007/978-3-319-19168-3.

Odada, E., L. Oyebande, and A. J. Oguntola. 'Lake Chad: Experience and Lessons Learned Brief'. *International Lake Environment Committee Foundation*, 2005. https://www.semanticscholar.org/paper/Lake-Chad%3A-experience-and-lessons-learned-brief-Odada-Oyebande/c081a17d3bf32351813a870343399d6277e80dc0.

Okeke-Ogbuafor, Nwamaka, Tim Gray, Kelechi Ani, and Selina Stead. 'Proposed Solutions to the Problems of the Lake Chad Fisheries: Resilience Lessons for Africa?' *Fishes* 8, no. 2 (February 2023): 64. https://doi.org/10.3390/fishes8020064.

Okpara, Uche T., Lindsay C. Stringer, and Andrew J. Dougill. 'Lake Drying and Livelihood Dynamics in Lake Chad: Unravelling the Mechanisms, Contexts and Responses'. *Ambio* 45, no. 7 (1 November 2016): 781–95. https://doi.org/10.1007/s13280-016-0805-6.

Olowoyeye, Oluwatuyi S., and Rameshwar S. Kanwar. 'Water and Food Sustainability in the Riparian Countries of Lake Chad in Africa'. *Sustainability* 15, no. 13 (2023): 10009. https://doi.org/10.3390/su151310009.

Pham-Duc, Binh, Florence Sylvestre, Fabrice Papa, Frédéric Frappart, Camille Bouchez, and Jean-Francois Crétaux. 'The Lake Chad Hydrology under Current Climate Change'. *Scientific Reports* 10 (26 March 2020): 5498. https://doi.org/10.1038/s41598-020-62417-w.

Reckien, Diana, Felix Creutzig, Blanca Fernandez, Shuaib Lwasa, Marcela Tovar-Restrepo, Darryn Mcevoy, and David Satterthwaite. 'Climate Change, Equity and the Sustainable Development Goals: An Urban Perspective'. *Environment and Urbanization* 29, no. 1 (1 April 2017): 159–82. https://doi.org/10.1177/0956247816677778.

Schneider, Uwe A., Petr Havlík, Erwin Schmid, Hugo Valin, Aline Mosnier, Michael Obersteiner, Hannes Böttcher, et al. 'Impacts of Population Growth, Economic Development, and Technical Change on Global Food Production and Consumption'. *Agricultural Systems* 104, no. 2 (2011): 204–15.

Skah, Maha, and Rida Lyammouri. 'The Climate Change-Security Nexus: Case Study of the Lake Chad Basin'. *Policy Centre for the New South*, 2020. https://www.policycentre.ma/sites/default/files/RP%20-%2020-08%20%28skah%20%26%20Lyamouri%29.pdf.

Tacoli, Cecilia. 'Crisis or Adaptation? Migration and Climate Change in a Context of High Mobility'. *Environment and Urbanization* 21, no. 2 (1 October 2009): 513–25. https://doi.org/10.1177/0956247809342182.

Usigbe. 'Drying Lake Chad Basin Gives Rise to Crisis'. Africa Renewal, 24 December 2019. https://www.un.org/africarenewal/magazine/december-2019-march-2020/drying-lake-chad-basin-gives-rise-crisis.

World Bank. 'Development Projects : Lake Chad Region Recovery and Development Project'. Text/HTML. World Bank, 2023. https://projects.worldbank.org/en/projects-operations/project-detail/P161706.