HONG KONG JOURNAL OF SOCIAL SCIENCES

香港社會科學學報

第一的第63期 (2024春/夏) Vol. 63 Spring/Summer 2024

Available online at
http://hkjoss.com/index.php/journal

Open Access Article https://doi.org/10.55463/hkjss.issn.1021-3619.63.37

Adaptive Sustainable Livelihood Strategies for Climate Change Adaptation in the Lake Chad Region

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Received: July 28, 2024 ▪ Reviewed: August 25, 2024

▪ Accepted: September 1, 2024 ▪ Published: September 15, 2024

Abstract:
In the last five decades, Lake Chad has shrunk drastically because of climate-induced factors. The lake's recession has impacted the livelihood of the people, and the region has witnessed an increase in violent conflict between extremist groups that culminated in migration and displacement. This study explored livelihood strategies in the wake of climate variability and environmental degradation. The main climatic risks to communities in these countries, which share a border with Lake Chad, are increasing minimum and maximum temperatures, high rainfall variability, and extreme droughts and floods. The study objectives are to examine sustainable livelihood in the Lake Chad region, understand sustainable livelihood approaches, vulnerabilities, and climate change, and identify an adaptive sustainable livelihood strategy in the Lake Chad region. This study adopted a qualitative method, specifically secondary data such as journals, textbooks, archival materials, and online sources, to examine livelihood strategies in the Lake Chad region. This study identified innovative adaptation practices by the communities in the region that promote sustainable livelihoods. The paper is anchored on its analysis using the sustainable livelihoods approach and DFID framework to establish the relationship between vulnerability and adaptation to sustain livelihoods in the Lake Chad region. This paper argued that despite the implementation of local adaptation

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strategies, medium- and long-term livelihood sustainability and Agenda 2030 are unrealistic in the wake of the continuing threat of climate change. The results of this study contribute to a more nuanced understanding of survival strategies in Lake Chad.

Keywords: Climate change, Livelihood, Sustainability, Lake Chad.

乍得湖地区适应气候变化的可持续生计战略

摘要:
在过去的五十年中，由于气候因素，乍得湖面积急剧萎缩。湖水萎缩影响了人们的生计，该地区极端团体之间的暴力冲突不断增加，最终导致移民和流离失所。本研究探讨了气候变化和环境恶化后的生计策略。这些与乍得湖接壤的国家面临的主要气候风险是最低和最高气温升高、降雨变化大以及极端干旱和洪水。研究目标是研究乍得湖地区的可持续生计，了解可持续生计方法、脆弱性和气候变化，并确定乍得湖地区的适应性可持续生计策略。本研究采用定性方法，特别是期刊、教科书、档案材料和在线资源等二手数据，以研究乍得湖地区的生计策略。本研究确定了该地区社区促进可持续生计的创新适应实践。本文以可持续生计方法和DFID框架为基础，分析了脆弱性和适应性之间的关系，以维持乍得湖地区的生计。本文认为，尽管实施了当地适应战略，但在气候变化持续威胁的背景下，中长期生计可持续性和2030年议程是不现实的。这项研究的结果有助于更细致地了解乍得湖的生存策略。

关键词：气候变化、生计、可持续性、乍得湖。

1. Introduction

There has been a growing debate at national and international levels on climate change and its impacts on livelihoods, security, migration, displacement, agriculture, and conflict. An increase in global warming and greenhouse emissions due to human activities culminate in climate change and environmental degradation (Adedeji et al., 2014). The Intergovernmental Panel on Climate Change (IPCC) (2007; Boko et al., 2007) asserted that the global climate has been influenced by human activities in the last century. However, some of the impacts of climate change include drought, variations in the precipitation pattern, rises in sea level, land degradation, and water shortage, which are currently being felt but are expected to worsen in the future (Skah & Lyammouri, 2020). Climate is defined as a long-term weather pattern that describes a region. However, climate change connotes a change in global temperature resulting from "natural climate like the large eruption of the volcano, sun's energy, persistent greenhouse gases and emission of black carbon to the atmosphere" (Adedeji et al., 2014, p. 2). Meanwhile, variability in climate across the world occurs due to natural internal processing and/or human driving forces (anthropogenic), like the burning of fossil fuels within the climate system (Adedeji et al., 2014). Therefore, climate variability could persist for many years.

Climate variability accounts for the extent of the impact of climate change on livelihoods as it determines how often a region experiences an increase in sea level, floods, droughts, and heatwaves, and it varies across the world (Behrens et al., 2010). This variation in the global average surface temperature is referred to as global warming and cooling. The earth has been witnessing changes in the intense heat of the sun, causing a cycle of warming and cooling. Although climate change occurs naturally, the increase in human-induced greenhouse gases increases the heat of the natural greenhouse effect, potentially increasing the rate of global warming that has never been experienced by humans, particularly in sub-Saharan Africa (Pounds & Puschendorf, 2004; Adedeji et al., 2014). Nevertheless, the concept of climate change and global warming is often used interchangeably; the word "climate change" is more appropriate as it encompasses human and natural phenomena (Frimpong, 2020).

The consequences of climate variability vary from one region to another across the globe. Furthermore, it reflects the individual region's access to adaptation mechanisms, finance, technology, and climate information and services (Skah & Lyammouri, 2020). Climate change is the leading human and environmental problem in recent times, particularly in Africa. Of course, scholars, politicians, and diplomats have established that climate change poses substantial threats to the continent, including security threats (Tadesse, 2010). This assertion could be attributed to weak awareness, finance, technology, and structural factors (Behrens et al., 2010). Sub-Saharan Africa has suffered disproportionately in the pursuit of food, water, sustainable development, and socio-economic sustainability due to climate change despite producing the least number of global pollutants (Tadesse, 2010). However, adaptation and mitigation options are a matter

of sustainability as the impact of climate variability already occurs. Deforestation, desertification, high temperatures, soil drying, floods, and erosion in sub-Saharan areas are some of the impacts of climate change on livelihoods (Tadesse, 2010).

The impacts on livelihoods have huge consequences on the economies of sub-Saharan African people (Adedeji et al., 2014) because of the over-reliance on agriculture. The economic impact of climate change, besides the fact that it is substantial, is that its multiple effects cannot be overemphasized, particularly on industries that rely solely on primary produce as raw materials (Stern, 2006). Scholars have been unable to quantify the economic cost of climate change in individual countries and continents. The economic cost of living, according to scholars, has been predicted to "increase from 5 per cent to 20 per cent of the world income" (Adedeji et al., 2014, p. 5). However, if nothing is done to ameliorate the emission of greenhouse gases, achieving the 2030 Agenda for sustainable development goals (SDGs) adopted by the United Nations (UN) member states in 2015 will be impossible. These goals, according to Morton et al. (2017, p. 4), include the following:

- No Poverty
- Zero Hunger
- Good Health and Well-being
- Quality Education
- Gender Equality
- Clean Water and Sanitation
- Affordable and Clean Energy
- Decent Work and Economic Growth,
- Industry, Innovation, and Infrastructure
- Reducing Inequality
- Sustainable Cities and Communities
- Responsible Consumption and Production
- Climate Action
- Life below Water
- Life on Land
- Peace, Justice, and Strong Institutions
- Partnerships for the Goals

Climate change mitigation and SDGs must be addressed simultaneously in sub-Saharan Africa, where climate-related impacts exacerbate poverty, hunger, inadequate sanitation, and water scarcity, and subsequently eliminate other forms of deprivation (Serdeczny et al., 2017). The vulnerability of the sub-region arises from the mixture of extreme poverty and population increase. The occurrence of a natural disaster like a flood or drought affects agriculture, which depends profoundly on rainfall (Tadesse, 2010). For instance, eradicating poverty in such circumstances must concurrently accompany strategies for improving education, reducing inequality, and increasing gender equality. Considering the various impacts of climate change on the continent, where overdependence on agriculture exists, means less environmental sustainability. Hence, achieving SDGs by 2030 depends on addressing the causes of climate change across the continent.

The continent's high vulnerability to climate change impacts, coupled with its limited adaptive capacity, contributes to the competition for scarce natural resources, which results in conflict. The scarcity of resources has raised competition among communities in Somalia, Cameroon, Niger, Nigeria, Chad, and Sudan. Besides, limited adaptation capacity and the challenge of accessing information and resources pertaining to climate change science are significant issues, particularly as some nations are signatories to the UN Framework Convention on Climate Change (UNFCCC), which was established in 1994 in collaboration with the World Meteorological Organization (WMO) of the IPCC (1988). The IPCC was meant to constantly provide governments with a clear view of the current state of knowledge regarding the science of climate change, potential impacts, and options for adaptation and mitigation through regular assessments of the most recent information published in scientific, technical, and socio-economic literature worldwide (United Nations Framework Convention on Climate Change, 2007).

The Lake Chad drainage basin covers approximately 2,434.000 km and is situated at the edge of the Saharan desert, which is bordered by four countries: Nigeria, Cameroon, Chad, and Niger (Odada et al., 2005). The four countries formed the Lake Chad Basin Commission (LCBC), established in 1964 under the Fort Lamy convention (Odada et al., 2005). The conventional basin lake has been a vital source of water for humans, livestock, and wildlife for the inhabitants (Onuoha, 2008). However, in the last 50 years, surface water has rapidly declined due to the combined impact of climate change and resource overuse (Adedeji et al., 2014; Onuoha, 2008). The impacts of climate change on the lake feared environmental degradation and demographic pressure, displaced millions of people, and created social upheaval (Onuoha, 2008). The region is characterized by civil conflict and the massive displacement of people among the Lake Chad basin states (Nigeria, Cameroon, Chad, and Niger). These countries border one of the largest lakes and one of the poorest and most drought-prone regions in the world (Adedeji et al., 2014). Again, the activities of Boko Haram have disrupted the protected lives of individuals and the communities in the region, thereby posing challenges to livelihoods (Odada et al., 2005).

Nevertheless, the lake has remained a significant source of fresh water and other resources for sustainable development. In light of the foregoing, this paper addresses the vulnerability of sub-Saharan Africa to the impacts of climate change, with particular focus on the Lake Chad region. Considering the present and future impacts of climate change in the region, the need for livelihood sustainability becomes paramount to the inhabitants, while solutions to climate change are yet to be embraced. Therefore, this paper conceptualized sustainable livelihood within the context of climate change. This study underpins the sustainable livelihood

approach (SLA) and the Department for International Development (DFID) framework. This study further expands on the trajectory of climate change by zooming into the Lake Chad region to explicate the various measures taken by local communities to mitigate the impacts of climate variability and live sustainably in the region. We argue that local adaptation strategies cannot address the medium- and long-term effects of climate change, thereby jeopardizing the holistic idea of sustainable livelihood in the region. However, a high level of collaboration among local communities, national governments and the international organization is immediately required to achieve Agenda 2030.

2. Sustainable Livelihood in the Lake Chad Region

The lake and basin have played an extremely significant role in the livelihood of individuals and communities within the area, considering the rich resources such as lake freshwater, fisheries, irrigation, exploration of resources like gold, and rich agricultural lands (Bene et al., 2003). These resources provide livelihoods for over 47 million people in the region, most notably, livestock breeders and fishermen (Amali et al., 2016); hence, the region is less industrialized for sustainable livelihoods. Sustainable livelihoods originated from the World Commission on Environment and Development (WCED) to achieve sustainable rural development through sustainable livelihood security (Hammill et al., 2005; Shankland, 2000). Livelihood is a "set of capacities, assets and activities that are needed by people to generate and maintain their means of living, enhance their well-being, and that of future generation" (Rahman & Hickey, 2020, p. 2). It comprises assets that are not only "natural (land, water, and resources), but also social (family, community, empowerment, and participation), human (knowledge), and physical (road, clinic, school) required for a living" (Rahman & Hickey, 2020, p. 3). It became sustainable when the "community can adapt, cope and recover from stress, shock and enhances its capabilities and assets to present and future pursue of livelihood and not undermining the natural resources base" (Lamichhane, 2010, p. 17).

Over the years, the Lake Chad region has impacted significantly, besides climate variability, deforestation, overgrazing, and bush burning, desertification in the LCB (Amali et al., 2016). The region has "over sixty per cent of poverty households, poor standard of health and women represent fifty-two per cent of the population with little or no education" (Onuoha, 2008, p. 23). The increasing population in the region has also resulted in heightened competition for limited resources. The diminished lake has furthermore led to the loss of livelihoods, including livestock mortality, crop failure, and the collapse of fisheries. This culminates in high unemployment, conflict over limited resources, extreme poverty, migration, and the like, which have become the order of the day (Yusuf, 2015). It can be argued that sustainable livelihood emphasizes the subsistence of impoverished populations, who maintain their livelihoods under adverse socioeconomic, political, and environmental conditions, as exemplified in the Lake Chad region. The communities in the region have been adapting to climate change impacts to manage climate risk and variability.

3. SLAs, Vulnerabilities, and Climate Change

The SLA, as proposed in this study, is the operationalization of the sustainable livelihood concept, coined by Robert Chambers and Gordon Conway in 1991 (Wright et al., 2012). The concept of sustainable livelihood was introduced concurrently with other concepts such as governance and rights-based approaches, serving as methodologies and frameworks for formulating development interventions aimed at reducing extreme poverty by half and enhancing global well-being (Wright et al., 2012). This approach was developed as an agenda for poverty reduction, and by 1990, the sustainable livelihood had been consolidated as an approach and implemented by development agencies, academics, and national governments.

Development agencies, academics, and national governments that have, at various times, adopted this approach include the United Kingdom DFID (Wright et al., 2012; Hammill et al., 2005), UN Food and Agricultural Organization (UNFAO), UN World Food Programme (UNWFP), UN Development Programme (UNDP), and academic scholars like Boko et al. (2007). These scholars and international organizations have applied the concept of the SLA in different ways to propose varied developmental programs on poverty reduction, vulnerability and building resilience. This approach aims to provide a more comprehensive strategy for poverty reduction, addressing not only rural areas but also the intersection of rural-urban poverty and livelihoods (Hammill et al., 2005). The tendency of a community to be adversely affected by climate change indicates the level of community vulnerability. Vulnerability in the context of climate change is "the degree to which a community is susceptible to or unable to cope with, adverse effects of climate change including climate variability and extremes" (Intergovernmental Panel on Climate Change, 2007, p. 12).

However, vulnerability is a function of the rate and magnitude of a community's exposure to climate variability (Intergovernmental Panel on Climate Change, 2007).

Therefore, the extent to which people are susceptible to the impacts of climate variations is a function of their vulnerability level. Again, the exposure of people to external risks, shocks, stresses and their coping mechanisms to recover from these impacts determine

their vulnerability, which differs in every individual and community, owing to their livelihood status. To understand the coping mechanisms in Lake Chad, it is necessary to consider the socio-economic and political differences between countries that share their borders with the lake. The approach is justified in this study as it examines the relationship between the impacts of climate change and adaptive capacity as livelihoods are threatened by climate change. The concepts of livelihood and vulnerability were, for the first time, integrated into the sustainable livelihoods framework by the United Kingdom DFID (Hammill et al., 2005). Livelihood encompasses the requisite resources and activities essential for sustaining human existence (Kengoum & Tiani, 2013). Figure 1 presents the DFID's sustainable livelihoods framework, which itemizes the factors that hinder livelihoods and the relationships between them. The analysis was drawn from the DFID conceptual framework provided by the SLA. The impacts of climate change, particularly in Africa, have been predicted by scholars and international communities to worsen in the near future if not addressed (APO Group, 2019). Figure 1 denotes a sustainable livelihood framework (SLF), in which the vulnerability context is significant in determining the sustainability of livelihood assets (human, natural, financial, social, and physical).

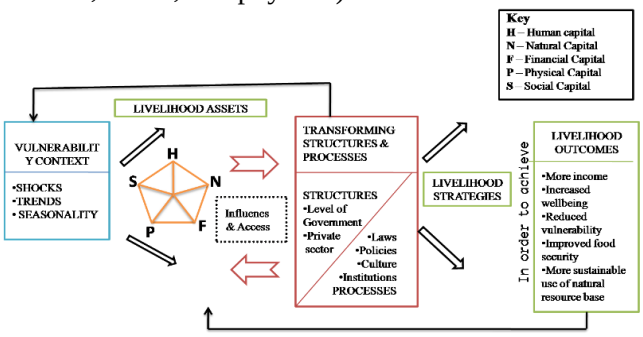

Figure 1. UK Department for International Development (1999).

The adverse impacts of climate change, such as floods, desertification, land degradation, and drought, fall under the vulnerability context of Figure 1. Therefore, the extent to which a community is vulnerable is determined by the impacts of adverse climate change on the community's livelihood assets, strategies, and outcomes. However, the communities in Lake Chad are greatly susceptible to the impacts of climate change, and its related shocks are determined by communities' and individuals' vulnerability. Shocks connote sudden changes in people's livelihoods due to drought, conflict, and disasters, which automatically compelled people to evacuate their land and homes (Hammill et al., 2005).

The SLF is predicated on the concept that a household's livelihood is founded upon five principal assets or capitals: social (S), human (H), natural (N), financial (F), and physical (P) (Figure 1). The SLF demonstrates how climate change generates environmental stressors and perturbations that compromise the livelihood assets (human, natural, financial, social, and physical) of communities predominantly comprised of agriculturalists, fisherfolk, and pastoralists, such as those in the Lake Chad region. In addition, it damages and destroys their living conditions, income, food security, and ability to sustain natural resources. Livelihoods are sustainable if people and communities can cope with and recover from stress and shock, maintain and enhance households, and provide lasting livelihood opportunities for the next generation (Rahman & Hickey, 2020).

Of course, the livelihood of the communities in the region has remained unsustainable and incapacitates their functions to such an extent that they are no longer able to be self-dependent. The socioeconomic conditions of the region have been exacerbated by various deleterious effects of violent conflict outbreaks, including fatalities, forced migration and displacement, abductions, sexual violence, and the recruitment of youth into extremist organizations. This situation makes it difficult or even impossible for farmers, herders, and youths to earn an income and live sustainably. Hence, the level of vulnerability in the region is high due to floods, land degradation, desertification, poor adaptive mechanism, weak nature of LCBC, lack of technology, and climate information and services, which to a higher extent results in the impacts of adverse climatic conditions on the community's livelihood assets, strategies, and outcomes not being sustainable. In this context, the SLF is useful for analyzing the effects and coping mechanisms available to victims of climate change, such as individuals and communities, which can be used to transform their livelihood asset bases and improve their living conditions.

4. Adaptive Sustainable Livelihood Strategy for the Lake Chad Region

Sustainable livelihoods approaches focus on impoverished and marginalized populations and their capacity to adapt and maintain their means of subsistence under severe climate change conditions. African nations have been identified as the most susceptible to climate change variability due to the interaction of multiple stressors at various levels, exacerbated by limited adaptive capacity (Intergovernmental Panel on Climate Change, 2007). The Lake Chad region has a poor socio-economic background, and access to basic services is limited or inexistent, exemplifying the socio-economic status of the LCBC states (Onuoha, 2008). The LCBC comprises four countries: Nigeria, Chad, Cameroon, and Niger. These countries are on different "levels of development in terms of demographics of the region, geographical positioning, sociocultural factors, political dynamics, regional economics, productivities, and endemic poverty" (United Nations Development Programme, n.d.).

Hitherto, the complex and multi-faceted impacts of climate change in the LCBC states are similar but differ in magnitude. Differentiation necessitates the

examination of sustainable livelihood strategies, focusing on the adaptive capacity of an individual country that borders the Lake Chad basin. Adaptive capacity is the ability of individuals and communities to maintain their livelihoods despite climate stress (Amali et al., 2016, Onuoha, 2008). These adaptive measures include diversifying livelihoods or responding to changing environmental conditions to mitigate the impact of climate change (Amali et al., 2016). The essence of these people-centered approaches is strengthening resilience, reducing vulnerability, and enhancing coping mechanisms. The local economy in the region is intricately interconnected with the livelihoods of herders, farmers, and fishermen; however, it exhibits disparities in terms of developing resilience against adverse climate change impacts in the area (Onuoha, 2008).

In the case of Nigeria, the country borders Lake Chad in the North-Eastern Region, and the effects of climate change on the lake are felt by local communities who depend on the lake for their livelihoods. The communities and individuals in the region, irrespective of their diverse occupational skills, engaged in fisheries, agriculture, or nomadic pursuits, either alternately or concurrently, in accordance with the seasonal cycle (Bene et al., 2003). With respect to fisheries, the floodplain and shallow components of the lake basin are conducive to the activity, and some permanent ponds are also established within the communities to facilitate fishing (Onuoha, 2008). As one of the adaptive measures, fishing was found to have aligned with the robust and flexible seasonal patterns, thereby enabling farmers and herders to become potential fishermen in grazing fields and cultivated lands (Kimmage & Adams, 1992). Hitherto, especially for communities in the South-West of Borno in Nigeria, have taken advantage of the numerous "temporary ponds, swamp and marshland left behind when the flooding Lake receding" for fishing (Bene et al., 2003, p. 5).

In addition, year-round open grazing is no longer viable, considering the adverse impact of climate change. Animal husbandry is now predominantly limited to stabling practices, particularly for bovine species, throughout the year (Neiland et al., 2000). Free grazing is only restricted to animals "from October to December at the end of the crop harvest and at the beginning of planting in January to February" (Bene et al., 2003, p. 12). Of course, farming is part of the community's practices but only with selected crops, such as beans, millet, and corn, seasonally and not throughout the year (Sarch & Birkett, 2000). In addition to agricultural and pastoral activities, individuals engaged in the trade and illicit transportation of goods and armaments across the four LCBC countries (Nigeria, Niger, Chad, and Cameroon), facilitated by the permeable nature of national borders (Neiland et al., 2000). Besides the porous border, the conflict in the northeast, where the lake is located, has exacerbated the impacts of climate change, which could have created fertile ground for the jobless youth to consider instead of being recruited as fighters as an alternative livelihood. To be more precise, climate change does not breed terrorists and influence innocent citizens to become criminals; however, the impact of climate change on jobless youth necessitates alternative means of livelihoods, such as being vulnerable to terrorist recruitment for economic gain.

Cameroon has a population of over seven million, and over 40% of the population live below $2 per day (Chia et al., 2019). The impact of climate variability in Cameroon accounts for over 45% of the vulnerability of cattle grazers and farmers because of dryness and weak adaptability, further worsening the poverty situation (Ufon, 2004). As a component of the adaptation mechanism to mitigate climate variability, animal graziers and farmers establish collaborative farming arrangements, wherein herd farmers negotiate mutually beneficial agreements regarding the utilization of resources such as water and land, particularly in locations including Binshua in Nkambe, Ngyenmbo in Mbengwi, and Ashong and Baijong in Batibo (Nchinda Valentine et al., 2014). Nchinda Valentine et al. (2014) observed that both animal grazers and farmers benefit from this mutual arrangement in the sense that animal dung fertilizes the piece of land for crop production and animals graze plant residues after harvest.

In addition, the expansion of agricultural land into virgin forests is a practice to cushion the impacts of climate change, although this practice is at the expense of biodiversity (Chia et al., 2019). In some parts of Cameroon, particularly in the Southwest, farmers change planting and harvesting seasons and sometimes substitute crops for the short growing season to adapt to climate change (Epule & Bryant, 2016). Local communities in the southern part of the country have also turned to crop diversification as an adaptation strategy to mitigate climate risk and uncertainty in agricultural outputs for sustainable livelihoods (Chia et al., 2013; Yengoh et al., 2010). Nevertheless, farmers have also embarked on traditional adaptation as a coping mechanism based on observation and interpretation of phenomena (Tingem & Rivington, 2009). For instance, the color of amphibians or the height of arboreal ant nests is utilized to predict precipitation quantity, onset, and cessation. Agricultural practices are also predicated on such forecasting methods (Molua, 2006, p. 258). The use of indigenous knowledge as an adaptative technique has mitigated the vulnerability (Molua, 2006).

In recent times, climate change in Chad has impacted socio-economic activities in the country. The resurgence of extreme weather culminates in floods, droughts, bush fires, and degradation, and local communities are badly hit. The tremendous effects are because over 90% of farmers relied on rainfall for irrigation and it explains the extent of Chad vulnerability to climate change (Sanoussi et al., 2015).

The vulnerability may worsen due to the constant decline in precipitation coupled with the limited capacity of local communities to adapt to climate risks (United Nations Development Programme, n.d.). To mitigate climate variability, farmers manage to adapt agriculture to climate change by shifting planting time and planting heat-tolerant crops, which are most readily available to farmers (Barbier et al., 2009). In Chad, crop diversification and cultivars, staggering planting dates, and management of soil fertility are the major adaptation mechanisms to stabilize food security during rainfall variability (Sanoussi et al., 2015; Traore et al., 2014). Traore et al. (2014) observed that rapidly maturing crops are planted, supported by supplemental irrigation, and soil fertility management is an adaptation strategy during the rainy season (Barbier et al., 2009). This system of soil fertility has been productive in the recent past due to the huge geographical area in Chad.

In the Niger Republic, as in other Sahel countries, the main climatic risks are extreme floods and droughts, increasing minimum and maximum temperatures, and increasing rainfall variability. To manage climate variability, local farmers adapt by planting based on climate variability, including the micro water harvesting method (Barbier et al., 2009). To further mitigate climate variability, local farmers adjust planting dates and focus on heat-tolerant crops, as practiced in Chad (Sanoussi et al., 2015). The practice of agroforestry systems with windbreaks to reduce the effect of temperature is predominant among indigenous farmers as a pattern of adaptation. However, faster-maturing crops are planted, and soil fertility management practices have remained an adaptation mechanism during the rainy season (Traore et al., 2014). Besides adaptation mechanisms, the communities also engage in the sale of wood, utensils, domestic appliances, handcrafts, and livestock (United Nations Development Programme, 2006). In the Niger Republic, vulnerable communities include cattle breeders, women, children, farmers, craftsmen, and elders (United Nations Development Programme, 2006).

In all the four countries that border the Lake Chad basin, increasing the resilience of communities' livelihoods in the wake of climate variability impacts is very pronounced. However, the adaptation strategies implemented to mitigate climate variability appear to be ineffective in medium- and long-term mitigation efforts. The practice of various adaptation strategies by local communities in the region aims to mitigate climate change variability and ultimately sustain livelihoods. However, a livelihood is considered sustainable when communities in all the four countries bordering Lake Chad demonstrate the ability to adapt to challenges, manage difficulties, and enhance their capacity and resources (including financial, social, human, physical, and natural capitals) both in the present and future (Kengoum & Tiani, 2013).

5. Conclusion and Recommendations

This study has revealed climate change and its impacts on the Lake Chad region. The region, like another component of the continent, has witnessed the build-up of greenhouse gases and global warming, such that various external factors influence the internal dynamics of the climate system, leading to the human and environmental crisis of the 21st century. Such crises include severe droughts, floods, environmental degradation, rising sea levels, displacement, migration, and conflict; in essence, climate change is a socio-economic upheaval. However, strengthening livelihoods in the wake of climate change impacts in the Lake Chad region of the continent necessitates the need for this study. In addition to the shrinking Lake Chad water, due to climate change, conflicts in the region have exacerbated, thereby challenging livelihood sustainability. This study explored sustainable livelihood and vulnerability in the region using the SLA and DFID framework. It also examined the various adaptation mechanisms implemented by communities in the countries that share borders with the lake water to ensure sustainable livelihoods. The study concludes that a local community's adaptation strategies cannot provide medium- and long-term livelihood sustenance. Our recommendations focus primarily on what can be done to achieve livelihood adaptation in the wake of climate change and in achieving long-term SDGs. These include diversifying livelihoods and responding to changing environmental conditions to mitigate the impact of climate change. Second, the communities and individuals in the region, irrespective of their diverse occupational skills, engaged in fishery, agriculture, or nomadic pursuits, either alternately or concurrently, contingent upon the seasonal cycle. Third, farming should also be encouraged as part of the community's practices, but only with selected crops, such as beans, millet, and corn, seasonally and not throughout the year. Lastly, collaboration and monitoring should be established among local communities, national, and international organizations to facilitate rural development through the adoption or enhancement of comprehensive plans and activities. These efforts should include improving living conditions, infrastructure, employment opportunities, and incomes of rural communities in the Lake Chad region.

6. Limitations and Further Study

The study would benefit from the use of empirical data. Therefore, future studies will focus on primary data.

Acknowledgments

We acknowledge the mentorship of the National Institute for the Humanities and Social Sciences (NIHSS), Johannesburg, South Africa.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/or falsification, double publication and/or submission, and redundancies have been completely observed by the authors.

Author Contributions

PM contributed to the design and implementation of the research, SOE to the analysis of the results and to the writing of the manuscript. SOE conceived the original and supervised the project.

References

[1] ADEDEJI, O., REUBEN, O., & OLATOYE, O. (2014). Global Climate Change. *Journal of Geoscience and Environment Protection,* 2(2), 114–122. https://doi.org/10.4236/gep.2014.22016

[2] AMALI, A.A., BALA, M.S., & ADENIJI, F.A. (2016). Dying Lake Chad: adaptive strategies to climate change and water scarcity of the Lake Chad basin. Proceedings of the Water Management in a Changing World: Role of Irrigation for Sustainable Food Production, 6-8 November 2016, Chiang Mai, pp. 1-11. Retrieved from https://www.icid.org/wif2_full_papers/wif2_w.2.2.13.pdf

[3] APO GROUP (2019). *Drying Lake Chad Basin gives rise to crisis.* Retrieved from https://www.africa-newsroom.com/press/drying-lake-chad-basin-gives-rise-to-crisis?lang=en

[4] BARBIER, B., YACOUBA, H., KARAMBIRI, H., ZOROMÉ, M., & SOMÉ, B. (2009). Human Vulnerability to Climate Variability in the Sahel: Farmers' Adaptation Strategies in Northern Burkina Faso. *Environmental Management,* 43(5), 790–803. https://doi.org/10.1007/s00267-008-9237-9

[5] BEHRENS, A., GEORGIEV, A., & CARRARO, M. (2010). *Future impacts of climate change across Europe.* Centre for European Policy Studies. Retrieved from http://aei.pitt.edu/14586/1/WD_324_Behrens,_Georgiev_&_Carraro_final_updated_(1).pdf

[6] BÉNÉ, C., NEILAND, A., JOLLEY, T., OVIE, S., SULE, O., LADU, B., MINDJIMBA, K., BELAL, E., TIOTSOP, F., BABA, M., DARA, L., ZAKARA, A., & QUENSIERE, J. (2003). Inland Fisheries, Poverty, and Rural Livelihoods in the Lake Chad Basin. *Journal of Asian and African Studies,* 38(1), 17–51. https://doi.org/10.1177/002190960303800102

[7] BOKO, M., NIANG, I., NYONG, A., VOGEL, C., GITHEKO, A., MEDANY, M., OSMAN-ELASHA, B., TABO, R., & YANDA, P. (2007). Africa. Climate Change 2007: Impacts, Adaptation and Vulnerability. In: PARRY, M.L., CANZIANI, O.F., PALUTIKOF, J.P., LINDEN, P.J., & HANSON, C.E. (eds.) *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge: Cambridge University Press, pp. 433–467. Retrieved from https://archive.ipcc.ch/publications_and_data/ar4/wg2/en/ch9.html

[8] CHIA, E.L., KANKEU, S.R., & HUBERT, D. (2019). Climate change commitments and agriculture sectoral strategies in Cameroon: Interplay and perspectives. *Cogent Environmental Science,* 5(1), 1625740. https://doi.org/10.1080/23311843.2019.1625740

[9] CHIA, E.L., SOMORIN, O.A., SONWA, D.J., & TIANI, A.M. (2013). Local Vulnerability, Forest Communities and Forest-Carbon Conservation: Case of Southern Cameroon. *International Journal of Biodiversity and Conservation,* 5(8), 498-507.

[10] EPULE, T., & BRYANT, C. (2016). Small Scale Farmers' Indigenous Agricultural Adaptation Options in the Face of Declining or Stagnant Crop Yields in the Fako and Meme Divisions of Cameroon. *Agriculture,* 6(2), 22. https://doi.org/10.3390/agriculture6020022

[11] FRIMPONG, O.B. (2020). *Climate change and fragility in the Lake Chad Basin.* Retrieved from https://africaupclose.wilsoncenter.org/climate-change-and-fragility-in-the-lake-chad-basin/

[12] HAMMILL, A., LECLERC, L., MYATT-HIRVONEN, O., & SALINAS, Z. (2005). Using the sustainable livelihoods approach to reduce vulnerability to climate change. In: *Tropical forests and adaptation to climate change: In search of synergies,* pp. 71-96. Retrieved from https://www.jstor.org/stable/resrep02052.10

[13] INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE (2007). *AR4 Climate Change 2007: The Physical Science Basis.* Retrieved from https://www.ipcc.ch/report/ar4/wg1/

[14] KENGOUM, F., & TIANI, A.M. (2013). *Adaptation and mitigation policies in Cameroon: Pathways of synergy.* Center for International Forestry Research. https://doi.org/10.17528/cifor/004647

[15] KIMMAGE, K., & ADAMS, W.M. (1992). Wetland Agricultural Production and River Basin Development in the Hadejia-Jama'are Valley, Nigeria. *The Geographical Journal,* 158(1), 1-12. https://doi.org/10.2307/3060012

[16] LAMICHHANE, K. (2010). *Sustainable livelihoods approach in assessment of vulnerability to the impacts of climate change: A study of Chhekampar VDC.* Gurkha District: Kathmandu University. Retrieved from https://www.academia.edu/3726215/Sustainable_Livelihood_Approach_in_Climate_Change_Vulnerability_Assessment

[17] MOLUA, E. (2006). Climatic trends in Cameroon: Implications for agricultural

management. *Climate Research,* 30, 255–262. https://doi.org/10.3354/cr030255

[18] MORTON, S., PENCHEON, D., & SQUIRES, N. (2017). Sustainable Development Goals (SDGs) and their implementation. *British Medical Bulletin,* 124, 81–90. https://doi.org/10.1093/bmb/ldx031

[19] NCHINDA VALENTINE, P., MARCELLUS, C., IJANG, T.P., ABUBAKAR, S., & NAPOLEON, C. (2014). *"In Search of Common Ground" for Farmer-Grazer Conflicts in the North West Region of Cameroon.* https://doi.org/10.13140/2.1.1912.4163

[20] NEILAND, A.E., JAFFRY, S., LADU, B.M.B., SARCH, M.T., & MADAKAN, S.P. (2000). Inland Fisheries of North East Nigeria Including the Upper River Benue, Lake Chad and the Nguru–Gashua Wetlands. *Fisheries Research,* 48(3), 229–243. https://doi.org/10.1016/S0165-7836(00)00180-6

[21] ODADA, E.O., OYEBANDE, L., & OGUNTOLA, A.J. (2005). *Lake Chad: experience and lessons learned brief.* Kusatsu: International Lake Environment Committee Foundation.

[22] ONUOHA, F.C. (2008). Environmental Degradation, Livelihood and Conflicts: A Focus on the Implications of the Diminishing Water Resources of Lake Chad for North-Eastern Nigeria. *African journal on conflict resolution,* 8(2), 35-61. https://doi.org/10.4314/ajcr.v8i2.39425

[23] POUNDS, J.A., & PUSCHENDORF, R. (2004). Clouded futures. *Nature,* 427(6970), 107–109. https://doi.org/10.1038/427107a

[24] RAHMAN, H.M.T., & HICKEY, G.M. (2020). An Analytical Framework for Assessing Context-Specific Rural Livelihood Vulnerability. *Sustainability,* 12(14), 5654. https://doi.org/10.3390/su12145654

[25] SANOUSSI, A., MOHAMED, L., SEYNI, S., & DAVID, A.G. (2015). Adapting to climate variability and change in smallholder farming communities: A case study from Burkina Faso, Chad and Niger. *Journal of Agricultural Extension and Rural Development,* 7(1), 16–27. https://doi.org/10.5897/JAERD14.0595

[26] SARCH, M., & BIRKETT, C. (2000). Fishing and Farming at Lake Chad: Responses to Lake-level Fluctuations. *The Geographical Journal,* 166(2), 156–172. https://doi.org/10.1111/j.1475-4959.2000.tb00015.x

[27] SERDECZNY, O., ADAMS, S., BAARSCH, F., COUMOU, D., ROBINSON, A., HARE, W., SCHAEFFER, M., PERRETTE, M., & REINHARDT, J. (2017). Climate Change Impacts in Sub-Saharan Africa: From Physical Changes to Their Social Repercussions. *Regional Environmental Change,* 17(6), 1585–1600. https://doi.org/10.1007/s10113-015-0910-2

[28] SHANKLAND, A. (2000). *Analysing policy for sustainable livelihoods.* Institute of Development Studies. Retrieved from https://www.ids.ac.uk/publications/analysing-policy-for-sustainable-livelihoods/

[29] SKAH, M., & LYAMMOURI, R. (2020). *The climate change-security nexus: case study of the Lake Chad Basin.* Rabat: Policy Center for the New South. Retrieved from https://www.policycenter.ma/sites/default/files/RP%20-%2020-08%20(skah%20&%20Lyamouri).pdf

[30] STERN, N. (2006). *The Economics of Climate Change — The Stern Review.* Cambridge: Cambridge University Press.

[31] TADESSE, D. (2010). *The impact of climate change in Africa.* Retrieved from https://www.files.ethz.ch/isn/136704/PAPER220.pdf

[32] TINGEM, M., & RIVINGTON, M. (2009). Adaptation for crop agriculture to climate change in Cameroon: Turning on the heat. *Mitigation and Adaptation Strategies for Global Change,* 14(2), 153–168. https://doi.org/10.1007/s11027-008-9156-3

[33] TRAORE, B., VAN WIJK, M.T., DESCHEEMAEKER, K., CORBEELS, M., RUFINO, M.C., & GILLER, K.E. (2014). Evaluation of climate adaptation options for Sudano-Sahelian cropping systems. *Field Crops Research,* 156, 63–75. https://doi.org/10.1016/j.fcr.2013.10.014

[34] UFON, B. (2004). *Farmer-grazier conflict and women's agricultural productivity in Cameroon grasslands: Case of Wum, Menchum Division, Northwest Region.* Postgraduate Diploma dissertation, University of Buea.

[35] UNITED NATIONS DEVELOPMENT PROGRAMME (2006). *National adaptation programme of action.* Retrieved from https://unfccc.int/resource/docs/napa/ner01e.pdf

[36] UNITED NATIONS DEVELOPMENT PROGRAMME (n.d.). *Community based climate risks management in Chad.* Retrieved from https://www.adaptation-undp.org/projects/community-based-climate-risks-management-chad

[37] UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE (2007). *Climate Change: Impacts, Vulnerabilities and Adaptation in Developing Countries.* Retrieved from https://unfccc.int/resource/docs/publications/impacts.pdf

[38] WRIGHT, H., KRISTJANSON, P.M., & BHATTA, G.D. (2012). *Understanding adaptive capacity: Sustainable livelihoods and food security in coastal Bangladesh.* Copenhagen: CGIAR Research Program on Climate Change, Agriculture and Food Security. Retrieved from https://cgspace.cgiar.org/items/3f03ba4b-f3a1-42bf-bc5b-de8f4aff8232

[39] YENGOH, G.T., TCHUINTE, A., ARMAH, F.A., & ODOI, J.O. (2010). Impact of prolonged rainy seasons on food crop production in Cameroon. *Mitigation and Adaptation Strategies for Global Change,* 15(8), 825–841.

https://doi.org/10.1007/s11027-010-9241-2

[40] YUSUF, A.K. (2015). Groundwater resource management strategy in the Nigerian sector of the Chad Basin. *Journal of Natural Sciences Research*, 5(14), 56-63. Retrieved from https://www.iiste.org/Journals/index.php/JNSR/article/view/24354

参考文:

[1] ADEDEJI, O.、REUBEN, O. **和** OLATOYE, O. (2014)。**全球气候**变化。地球科学与环境保护杂志，2(2)，114–122。https://doi.org/10.4236/gep.2014.22016

[2] AMALI, A.A.、BALA, M.S. **和** ADENIJI, F.A. (2016)。**垂死的乍得湖**：应对气候变化和乍得湖盆地水资源短缺的适应性策略。《变化世界中的水资源管理：灌溉在可持续粮食生产中的作用》会议论文集，2016**年**11**月**6-8**日**，**清**迈，第1-11页。摘自https://www.icid.org/wif2_full_papers/wif2_w.2.2.13.pdf

[3] **阿波羅集團** (2019)。**乍得湖盆地干涸引**发危机。摘自https://www.africa-newsroom.com/press/drying-lake-chad-basin-gives-rise-to-crisis?lang=en

[4] BARBIER, B.、YACOUBA, H.、KARAMBIRI, H.、ZOROMÉ, M. **和** SOMÉ, B. (2009)。萨赫勒地区人类对气候变化的脆弱性：布基纳法索北部农民的适应策略。环境管理，43(5)，790–803。https://doi.org/10.1007/s00267-008-9237-9

[5] BEHRENS, A.、GEORGIEV, A. **和** CARRARO, M. (2010)。**气候**变化对欧洲未来的影响。欧洲政策研究中心。摘自http://aei.pitt.edu/14586/1/WD_324_Behrens,_Georgiev_&_Carraro_final_updated_(1).pdf

[6] BÉNÉ, C.、NEILAND, A.、JOLLEY, T.、OVIE, S.、SULE, O.、LADU, B.、MINDJIMBA, K.、BELAL, E.、TIOTSOP, F.、BABA, M.、DARA, L.、ZAKARA, A. **和** QUENSIERE, J. (2003)。**乍得湖流域的内**陆渔业、贫困和农村生计。《亚洲和非洲研究杂志》，38(1)，17-51。https://doi.org/10.1177/002190960303800102

[7] BOKO, M.、NIANG, I.、NYONG, A.、VOGEL, C.、GITHEKO, A.、MEDANY, M.、OSMAN-ELASHA, B.、TABO, R. **和** YANDA, P. (2007)。**非洲**。**气候**变化2007：**影响**、**适**应和脆弱**性**。**引自**：PARRY, M.L.、CANZIANI, O.F.、PALUTIKOF, J.P.、LINDEN, P.J. **和** HANSON, C.E. (编辑) **政府**间气候变化专门委员会第四次评估报告第二工作组的贡献。剑桥：剑桥大学出版社，第433-467页。检索自https://archive.ipcc.ch/publications_and_data/ar4/wg2/en/ch9.html

[8] CHIA, E.L.、KANKEU, S.R. **和** HUBERT, D. (2019)。**喀麦隆的气候**变化承诺和农业部门战略：相互作用和观点。**康杰特**环境科学，5(1)，1625740。https://doi.org/10.1080/23311843.2019.1625740

[9] CHIA, E.L.、SOMORIN, O.A.、SONWA, D.J. **和** TIANI, A.M. (2013)。**当地脆弱性**、**森林群落和森林碳保**护：以喀麦隆南部为例。国际生物多样性与保护杂志，5(8)，498-507。

[10] EPULE, T. **和** BRYANT, C. (2016)。**喀麦隆法科和模因地区小**规模农民在作物产量下降或停滞的情况下的本土农业适应选择。农业，6(2)，22。https://doi.org/10.3390/agriculture6020022

[11] FRIMPONG, O.B. (2020)。**乍得湖盆地的气候**变化和脆弱性。取自https://africaupclose.wilsoncenter.org/climate-change-and-fragility-in-the-lake-chad-basin/

[12] HAMMILL, A.、LECLERC, L.、MYATT-HIRVONEN, O. **和** SALINAS, Z. (2005)。**利用可持**续生计方法减少气候变化的脆弱性。在：热带森林和适应气候变化：寻求协同作用，第71-96页。摘自https://www.jstor.org/stable/resrep02052.10

[13] **政府**间气候变化专门委员会 (2007)。AR4**气候**变化2007：**物理科学基**础。摘自https://www.ipcc.ch/report/ar4/wg1/

[14] KENGOUM, F., & TIANI, A.M. (2013)。**喀麦隆的适**应和缓解政策：协同途径。国际林业研究中心。https://doi.org/10.17528/cifor/004647

[15] KIMMAGE, K., & ADAMS, W.M. (1992)。**尼日利**亚**哈德加**-贾马阿雷**谷的湿地**农业生产和河流流域发展。地理学杂志，158(1)，1-12。https://doi.org/10.2307/3060012

[16]LAMICHHANE，K。（2010**年**）。**可持**续生计方法在评估气**候**变化影响脆弱性中的应用：对**切坎帕**VDC**的研究**。**廊**尔喀**区**：**加德**满都大学。摘自https://www.academia.edu/3726215/Sustainable_Livelihood_Approach_in_Climate_Change_Vulnerability_Assessment

[17]MOLUA，E。（2006**年**）。**喀麦隆的气候**趋势：对农业管理的影响。气候研究，30，255-262。https://doi.org/10.3354/cr030255

[18] MORTON, S.、PENCHEON, D. **和** SQUIRES, N. (2017)。**可持**续发展目标(SDG)**及其**实施。英国医学公报，124，81-90。https://doi.org/10.1093/bmb/ldx031

[19] NCHINDA VALENTINE, P.、MARCELLUS,

C.、IJANG, T.P.、ABUBAKAR, S. 和 NAPOLEON, C. (2014)。“寻找喀麦隆西北地区农民与放牧者冲突的共同点”。https://doi.org/10.13140/2.1.1912.4163

[20] NEILAND, A.E.、JAFFRY, S.、LADU, B.M.B.、SARCH, M.T. 和 MADAKAN, S.P. (2000)。**尼日利**亚东北部内陆渔业，包括贝努埃河上游、乍得湖和恩古鲁-**加舒**亚湿地。渔业研究，48(3)，229–243。https://doi.org/10.1016/S0165-7836(00)00180-6

[21] ODADA, E.O.、OYEBANDE, L. 和 OGUNTOLA, A.J. (2005)。**乍得湖**：经验教训简报。草津：国际湖泊环境委员会基金会。

[22] ONUOHA, F.C. (2008)。环境退化、生计和冲突：重点关注乍得湖水资源减少对尼日利亚东北部的影响。非洲冲突解决杂志，8(2)，35-61。https://doi.org/10.4314/ajcr.v8i2.39425

[23] POUNDS, J.A.，& PUSCHENDORF, R. (2004)。**阴云密布的未来。自然**，427(6970)，107–109。https://doi.org/10.1038/427107a

[24] RAHMAN, H.M.T.，& HICKEY, G.M. (2020)。评估特定背景下农村生计脆弱性的分析框架。可持续性，12(14)，5654。https://doi.org/10.3390/su12145654

[25] SANOUSSI, A.、MOHAMED, L.、SEYNI, S. 和 DAVID, A.G. (2015)。**适**应气候变化和小农农业社区的变化：布基纳法索、乍得和尼日尔的案例研究。农业推广与农村发展杂志，7(1)，16-27。https://doi.org/10.5897/JAERD14.0595

[26] SARCH, M. 和 BIRKETT, C. (2000)。**乍得湖的**渔业和农业：对湖面波动的反应。地理杂志，166(2)，156-172。https://doi.org/10.1111/j.1475-4959.2000.tb00015.x

[27] SERDECZNY，O.、ADAMS，S.、BAARSCH，F.、COUMOU，D.、ROBINSON，A.、HARE，W.、SCHAEFFER，M.、PERRETTE，M. 和 REINHARDT，J. (2017)。**气候**变化对撒哈拉以南非洲的影响：从物理变化到其社会影响。区域环境变化，17(6)，1585-1600。https://doi.org/10.1007/s10113-015-0910-2

[28] SHANKLAND, A. (2000)。**分析可持**续生计政策。发展研究所。摘自https://www.ids.ac.uk/publications/analysing-policy-for-sustainable-livelihoods/

[29] SKAH, M.，& LYAMMOURI, R. (2020)。**气候**变化与安全关系：乍得湖盆地案例研究。拉巴特：新南方政策中心。摘自https://www.policycenter.ma/sites/default/files/RP%20-%2020-08%20(skah%20&%20Lyamouri).pdf

[30] STERN, N. (2006)。**气候**变化经济学——**斯特恩**评论。剑桥：剑桥大学出版社。

[31] TADESSE, D. (2010)。**气候**变化对非洲的影响。摘自https://www.files.ethz.ch/isn/136704/PAPER220.pdf

[32] TINGEM, M.，& RIVINGTON, M. (2009)。**喀麦隆作物**农业适应气候变化：加热。全球变化的缓解和适应战略，14(2)，153–168。https://doi.org/10.1007/s11027-008-9156-3

[33] TRAORE, B.、VAN WIJK, M.T.、DESCHEEMAEKER, K.、CORBEELS, M.、RUFINO, M.C. 和 GILLER, K.E. (2014)。评估苏丹-萨赫勒种植系统的气候适应方案。大田作物研究，156，63–75。https://doi.org/10.1016/j.fcr.2013.10.014

[34] UFON, B. (2004)。**喀麦隆草原的**农牧民冲突和妇女的农业生产力：西北地区门楚姆区乌姆案例。布埃亚大学研究生学位论文。

[35] 联合国开发计划署 (2006)。**国家适**应行动计划。摘自https://unfccc.int/resource/docs/napa/ner01e.pdf

[36] 联合国开发计划署 (**无日期**)。**乍得的社区气候**风险管理。摘自https://www.adaptation-undp.org/projects/community-based-climate-risks-management-chad

[37] 联合国气候变化框架公约 (2007)。**气候**变化：发展中国家的影响、脆弱性和适应性。摘自https://unfccc.int/resource/docs/publications/impacts.pdf

[38] WRIGHT, H.、KRISTJANSON, P.M. 和 BHATTA, G.D. (2012)。**了解适**应能力：孟加拉国沿海地区的可持续生计和粮食安全。哥本哈根：CGIAR**气候**变化、农业和粮食安全研究计划。摘自https://cgspace.cgiar.org/items/3f03ba4b-f3a1-42bf-bc5b-de8f4aff8232

[39] YENGOH, G.T.、TCHUINTE, A.、ARMAH, F.A. 和 ODOI, J.O. (2010)。**雨季延**长对喀麦隆粮食作物生产的影响。全球变化的缓解和适应战略，15(8)，825–841。https://doi.org/10.1007/s11027-010-9241-2

[40] YUSUF, A.K. (2015)。**乍得盆地尼日利**亚地区的地下水资源管理战略。自然科学研究杂志，5(14)，56-63。**摘自**https://www.iiste.org/Journals/index.php/JNSR/article/view/24354