Characterising the relationship between climate shocks, lake drying and conflict in the Lake Chad Basin

Uche Thaddeus Okpara

Submitted in accordance with the requirements for the degree of Doctor of Philosophy

The University of Leeds
School of Earth and Environment

August 2016

The candidate confirms that the work submitted is his own, except where work which has formed part of jointly-authored publications has been included. The contribution of the candidate and the other authors to this work has been explicitly indicated below. The candidate confirms that appropriate credit has been given where reference has been made to the work of others.

PhD Publications

Several aspects of this PhD thesis have been published in the following peer-reviewed international journals:

Okpara, U., Stringer, L. & Dougill, A. 2016. Perspectives on contextual vulnerability in discourses of climate conflict. *Earth System Dynamics*, 6: 2543-2576. DOI: 10.5194/esdd-6-2543-2015 (**Impact Factor: 4.589**).

Okpara, U., Stringer, L. & Dougill, A. 2016. Using a novel climate-water conflict vulnerability index to capture double exposures in Lake Chad. *Regional Environmental Change*. DOI: 10.1007/s10113-016-1003-6 **(Impact Factor: 2.664)**.

Okpara, U., Stringer, L. & Dougill, A. 2016. Lake drying and livelihood dynamics in Lake Chad: Unravelling the mechanisms, contexts and responses. *Ambio - A Journal of the Human Environment*. DOI: 10.1007/s13280-016-0805-6 **(Impact Factor: 2.555)**.

Okpara, U., Stringer, L., Dougill, A. & Bila, M. 2015. Conflicts about water in Lake Chad: Are environmental, vulnerability and security issues linked? *Progress in Development Studies*, 15(4): 308 – 325. DOI: 10.1177/1464993415592738 **(Impact Factor: 0.795)**.

The candidate designed the research that led to the journal articles, including the methodologies and data analyses, and led the writing of the articles, with co-authors providing editorial input around the structure and writing style.

Other aspects of the thesis currently in preparation for publication include:

Okpara, *et al*. (in prep.) Does lake drying condition the effect of climate shocks on conflict in lake riparian zones? Targeted for *Global Environmental Change* (to be submitted for publication in September 2016).

Okpara, *et al*. (in prep.) Climate violence in the worst of times: Unpacking lessons for integrating climate adaptation, water governance and conflict management. Targeted for *Environmental Science and Policy* (to be submitted for publication in September 2016).

Acknowledgments

I owe a special thanks to God Almighty, the true source of all wisdom, strength and grace.

This thesis has benefitted immensely from funding support from several sources. I would especially like to thank the following: the Nigerian Tertiary Education Trust Fund who provided funds for my tuition fees and living expenses, the US Social Science Research Council who granted me a pre-doctoral fellowship that facilitated my fieldwork activities in Lake Chad, the University of Leeds Climate and Geo-hazards Hub who provided funding for the stakeholder workshop I organised at the Headquarters office of the Lake Chad Basin Commission in N'Djamena, the University of Leeds Sustainable Agriculture Bursary Fund which enabled me to successfully complete a scoping study in Lake Chad, and the University of Leeds Centre for Climate Change Economics and Policy for additional funding support that led to the publication of my research papers. I am grateful to all the agencies that provided me with conference travel grants, especially the Carnegie Fund for Conference Attendance, USA.

I am deeply indebted to my supervisors, Professors Lindsay Stringer and Andrew Dougill, for their invaluable guidance and support. Their hard work and proactive attitudes to research remain a daily inspiration to me.

I owe my sincere thanks to the Executive Director of the Lake Chad Basin Commission (LCBC), Engineer Sanusi Imran Abdullahi, for providing all the institutional support that facilitated my fieldwork at the Lake Chad villages in Chad Republic at a time it was practically impossible to visit the Lake Chad territories. I am also deeply grateful to Mr. Bila Mohammed who coordinated my fieldwork and Ms Hindou Oumarou Ibrahim whose NGO facilitated my first entry into the islands and lakeside communities around the Lake Chad Basin.

I am very grateful to my interpreters. Their knowledge, socio-cultural understanding and inspiring company made fieldwork a valuable learning adventure. My friends and colleagues at the Faculty of Environment have been invaluable in providing pleasant intellectual engagements, as well as good laughs that made the PhD journey a pleasant one.

Family members have encouraged me and prayed for me. I owe a lot of thanks to my parents and siblings, including my in-laws.

Most importantly, I deeply thank my wife, Onyinyechi Blessing, and my two lovely daughters – Kayla and Katriel. They have always provided me a home full of happiness and peace.

This thesis is dedicated to all the victims of violence and environmental degradation in the Lake Chad Basin, especially the 276 Chibok girls kidnapped in 2014 from their secondary schools in the Lake Chad area of Borno State, Nigeria.

Abstract

This thesis provides a basin-level analysis of climate shocks and conflict links, utilising livelihoods and vulnerability toolboxes, including a newly assembled conflict dataset that captures communal, rebel and water conflicts in four Lake Chad Basin (LCB) zones. The thesis draws on multi-method approaches to assess: (i) the manner in which lake drying shapes livelihood drawbacks and opportunities, (ii) the directionality of occupation-based vulnerability to double exposures, (iii) climate conflict interactions in the context of contextual vulnerability and lake drying, and (iv) adaptation-water-conflict integration need for the LCB. Key findings reveal that:

- Asset holdings from unstable water-based activities are a medium through which drying influences livelihoods;

- Pastoralists are more vulnerable to double exposures because they have limited social networks and income strategies;

- Rainfall anomalies have dampening effects on conflict and lake drying does not represent a sufficient mediator for climate conflict links. Effects of rainfall anomalies on conflict are more pronounced in the presence of political exclusion in the Chad and Nigeria zones which occupy large areas of the LCB;

- Policy initiatives increasingly acknowledge the need to preserve the Lake waters, yet initiatives that explicitly integrate adaptation, water and conflict concerns are only beginning to emerge. Two new documents indicating integration have been developed between 2015 and 2016.

This thesis is the first to develop a new set of integrated vulnerability tools for use in framing climate conflict vulnerabilities in water scarce environments. It provides a piece of empirically-rich understanding that suggests that climate conflict studies that fail to account for vulnerability forces risk a critical misrepresentation and misunderstanding. The results offer an empirical case to buttress the theoretical critiques already available in the literature. The thesis concludes by

outlining recommendations and ways forward that better integrate LCB-related adaptation, water governance and conflict management goals.

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Acronyms and abbreviations

ACCLC	Adaptation to Climate Change in the Lake Chad Basin
ACLED	Armed Conflict Locations and Events Dataset
AfDB	African Development Bank
API	Agricultural Price Index
AU	African Union
CIESIN	Centre for International Earth Science Information Network
CNA	Centre for Naval Analysis
CONOPS	Strategic Concept of Operations to fight against Boko Haram
CWCVI	Climate-Water Conflict Vulnerability Index
DEI	Double Exposure Index
DREM	Water Resources and Meteorological Directory of the Hydrological Ministry of Chad
EPR	Ethnic Power Relations
FAO	Food and Agriculture Organisation
FEWS	Famine and Early Warning System
GeoEPR	Geo-referencing Ethnic Power Relations
GHCN	Global Historical Climatology Network
GIWA	Global International Water Assessment
GMACCC	Global Military Advisory Council on Climate Change
GPCC	Global Precipitation Climatological Centre
GPW	Gridded Population of the World
GWP	Global Water Partnership
ICBP	International Crisis Behaviour Project
ILEC	International Lake Environment Committee Foundation
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IWRM	Integrated Water Resources Management
LCB	Lake Chad Basin

LCBC	Lake Chad Basin Commission
LCDAP	Lake Chad Development and Climate Resilience Action Plan
MNJTF	Multinational Joint Task Force
NBR	Negative Binomial Regression
NGOs	Non-Governmental Organisations
NNC	Norwegian Nobel Committee
NOAA	National Oceanic and Atmospheric Administration
NRA	Negative Rainfall Anomalies
OECD	Organisation for Economic Cooperation and Development
	Oslo Armed Conflict
PRESIBALT	Programme to Rehabilitate and Strengthen the Resilience of Socio-ecological Systems in the Lake Chad Basin
PRODEBALT	Lake Chad Basin Sustainable Development Programme
PWT	Penn World Table
SAP	Strategic Action Programme for the Lake Chad Basin
SCAD	Social Conflict Analysis Database
SLA	Sustainable Livelihood Approach
SLC	Small Lake Chad
SPAM	Spatial Production Allocation Model
SPSS	Statistical Package for the Social Science
SSA	Sub-Saharan Africa
UCDP/PRIO	Uppsala Conflict Data Programme/Peace Research Institute
UCDP-GEP	Uppsala Conflict Data Programme Georeferenced Events
UDCRC	University of Delaware Climate Research Centre
UNEP	United Nations Environment Programme
UNHD	United Nations Human Development
UNSC	United Nations Security Council
WARICC	Water-Related Interstate Conflict and Cooperation
WB	World Bank
WHO	World Health Organisation

Chapter 1

Introduction

Outline

Despite the unprecedented rate of hydrological changes in the Lake Chad Basin (LCB), the opportunity to explore innovative ways of understanding the livelihoods and vulnerabilities prevalent in the basin and to objectively contextualise the linkages between climate shocks and conflict (hereinafter termed climate conflict) provides a huge space to chart a future to a more hospitable, peaceful LCB environment. This thesis offers a novel assessment of climate conflict relations in the context of lake drying and contextual vulnerability. This introductory chapter provides an overview of debates that exist in the climate conflict research domain and presents the research context in which the thesis is grounded. It also justifies the decision to focus on the LCB as a dynamic test bed of broad relevance for investigating mainstream climate conflict thinking. The aim and objectives of the thesis are identified, as well as the key contributions of the thesis.

1.1 Overview of the climate conflict discourse lines

The relentless warming of the Earth's climate in recent decades presents a real concern for security and peace in several fragile environments. This concern is shared by a variety of actors, such as think tanks (CNA Corporation, 2007; Campbell *et al.*, 2007), Non-Governmental Organisations (NGOs) (e.g. Christian Aid, 2007) and governmental advisory bodies (Schwartz and Randall, 2003; WBGU, 2007; GMACCC, 2014). It has been advanced by many scientists (Scheffran and Battaglini, 2011; Hsiang *et al.*, 2013; Yong, 2013) and is present in UN Security Council Debates (UNSC, 2007; 2011). Indeed, the seriousness of this concern led the Intergovernmental Panel on Climate Change (IPCC) to devote a chapter to the subject in its Fifth Assessment Report (AR5) (Adger *et al.*, 2014), and spurred several national governments to include climate concerns on their list of threats to national and human security (Morales Jr., 2015).

Several accounts linking abnormal climatic conditions to conflict are organised around three sets of ideas: “trends in climatic events” (Burke *et al*., 2009; Hsiang *et al*., 2013) , “presence of conflict triggers” (O'Loughlin *et al*., 2012; Raleigh and Kniveton, 2012) and “dynamics of intervening variables” (Fjelde and von Uexkull, 2012; von Uexkull, 2014). Although the increasing vulnerability of politically fragile countries to the security consequences of climate shocks is widely acknowledged, particularly within the “dynamics of intervening variables” perspective, the literature is replete with controversies. Three distinct discourses underlie these controversies.

A ‘*climate-centric*’ viewpoint (i.e. climatic determinism) suggests that climatic conditions and events directly and dominantly influence conflict and violence (Burke *et al*., 2009; Anderson and DeLisi, 2011). Another viewpoint based on a ‘*context-centric*’ narrative affirms indirect linkages through a confluence of factors which evidently differ across different scales (human, national and global), particularly in terms of what may constitute ‘the state of nature’ and the ‘nature of the state’ across varying contexts (Raleigh *et al*., 2014; Zografos *et al*., 2014). Next come ‘*denial claims*’ which hold that conflict under climatic trends is a social construct, and that climatic changes need not be characterised as a security issue (Gartzke, 2012; Koubi *et al*., 2012). Although the literature on climate conflict has progressed markedly, the evidence so far points to a research enquiry that has failed to embed the notions of livelihoods and vulnerability as part of the analytical and discursive formation of climate conflict issues (Deligiannis, 2012; Gemenne *et al*., 2014; Seter, 2016).

Based on the notion of vulnerability, for example, a large portion of the empirical climate conflict studies has focused on sub-Saharan Africa (SSA) (Couttenier and Soubeyran, 2014; Buhaug *et al*., 2015; Fjelde, 2015) or a sub-sample within the region (Raleigh and Kniveton, 2012; Papaioannou, 2016). While climate conflict analysis in fragile regions reflects a continuum of conditional forces that coalesce around the notion of vulnerability (von Uexkull, 2014), vulnerability is mentioned much less frequently in case study analyses (Okpara *et al*., 2016a).

The few cases that do emphasise vulnerability (e.g. Fjelde and von Uexkull, 2012; Ludwig *et al*., 2011; Zografos *et al*., 2014) often fail to highlight the distinct manner in which notions of livelihoods and vulnerability can offer explanatory power to support distinct causal climate conflict pathways and dynamics.

Indeed, research on livelihood and vulnerability elements of climate conflict studies is still preliminary, with scant empirical, location-specific findings from which to extract practical lessons (Deligiannis, 2012). The consequence has been a lack of understanding of the nuances of climate conflict relations, particularly in several fragile locations in the Sahel that are increasingly a global focus of resource conflict concerns (Okpara *et al*., 2016a).

1.2 Framing the study

This thesis is grounded in the African Lake Chad Basin (LCB). The LCB covered an area larger than the size of the state of Israel (i.e. 25, 000 km^2) in the 1960s, but currently approximately 10 % of it remains (Gao *et al*., 2011). With increasing crop failures, dying animals and depleted fisheries, a dry lake means that over 30 million people will have no means of livelihood, a situation that can lead to major security challenges. During the twenty-first Global Change Conference of the Parties to the United Nations Framework Convention on Climate Change (COP 21) held in Paris in December 2015, concerns about the drying of Lake Chad featured on the agenda three times. First, during an Africa meeting that involved twelve African Heads of State (including those of the Lake Chad countries) and the French President, Lake Chad was presented as a conflict hotspot where persistent water shortages represent a threat to rural livelihoods, socioeconomic development and human security (Ghozali, 2015). Second, a side event entitled *Act for Lake Chad* was organised by the French Research Institute for Development (IRD), alongside NGOs and civil society organisations from the Lake region, where a call was made for an urgent emergency international response to save the Lake (Ngalame, 2015). Third, during a presentation organised by major international donors and development partners of the Lake Chad Basin Commission (LCBC), notably the World Bank and the African Development Bank, an ambitious development initiative – *The Lake Chad*

Development and Climate Resilience Action Plan – was launched (Mekonnen, 2016). The initiative seeks to strengthen human and natural potential, including resilience to hydro-climatic variability of local populations and the Lake itself, by funding public infrastructure (roads) and services (health and education), and supporting rural agricultural activities.

The presentations in Paris illustrate how various levels of authorities are involved in the LCB cause, not only in terms of offering solutions, but also as actors attempting to facilitate public understanding of the ways in which Lake Chad reflects a classical example of climate impacts. Although this window of visibility has enabled the Lake to acquire “the status of a global environmental icon” (Magrin, 2016, p. 218), detailed empirical case study analyses accounting for the various ramifications of livelihoods, vulnerability and climate conflict challenges in the LCB are sorely lacking (Asah, 2015). In particular, little is known about the diverse range of mechanisms through which lake drying shapes livelihood drawbacks and opportunities (Nindi, 2007), including the directionality of occupation-based vulnerability in the context of double exposures. Unpacking the livelihood, lake drying and vulnerability elements of climate conflict interactions requires in-depth multi-method case studies in a local riparian arena (White, 2013).

This research proposes a different approach to the study of climate conflict, one that begins with a comprehensive account of local livelihoods and vulnerabilities based on empirical case studies in seven Lake Chad villages. Directing attention towards vulnerability and lake drying in climate conflict relations, the research aims to go beyond asking if climate shocks lead to conflict. By not appearing *climate-centric* or focusing on environmental determinism, the research reveals that what appear to be straightforward conflicts in water-scarce settings are often embedded within feelings of deprivation linked to livelihoods underperformance and political exclusion.

This is therefore an investigation into the moderating and mediating roles of vulnerability and lake drying respectively in climate conflict interactions in the context of extreme climatic conditions in the LCB. The thesis unravels whether climate shocks can deliver the ‘knockout punch’ that may breed violent escalations where political exclusion exists, where people living on climate-sensitive resources are poor, and where there is underlying competition. As such, the thesis is theoretically and empirically grounded, and seeks to contribute to a rapidly growing strand of climate-vulnerability-conflict literature focusing on water scarce, conflict prone environments.

The thesis adopts the following overarching aim:

- To explore the relationship between climate shocks[1] and conflict in the Lake Chad Basin in the context of contextual vulnerability and lake drying.

This aim is met through four objectives, which are outlined in Table 1.1, together with the operational questions used to achieve them.

1.3 Arguments and research contributions

In addressing the research questions (Table 1.1), this thesis presents a range of propositions and arguments, which combine to define the key contributions the research seeks to make. First, by portraying climate conflict as a continuum of socially determined factors that coalesce around extremely vulnerable systems, the thesis emphasises that climate conflict cannot simply be conceived as conflicts triggered solely by extreme climatic events. Climate conflict has to be analysed based on an understanding of the contexts prevalent in locations where it has occurred or is projected to occur. As such, this thesis argues that a natural entry point for pinning down the relevant population of cases where conflict is a possible outcome of climate impacts is through assessments of contextual factors (Seter, 2016). Scholars seeking to unpack the mechanisms between climate shocks/anomalies and conflict without first understanding how local forces interact risk critical misinterpretation and misunderstanding (Linke *et al*., 2015).

[1] In this research, climate shocks/anomalies and rainfall anomalies are used interchangeably. In particular, the climate conflict empirical analysis presented in Chapter 6 used data depicting rainfall anomalies as proxy for climate shocks (Papaioannou, 2016). Note also that the terms ‘Lake Chad Basin’ and ‘Lake Chad/Lake Chad region’ are used interchangeably in the research/thesis.

Table 1.1: Outline of the thesis objectives, their specific research questions and the chapter in which each is covered.

Objective 1. Identify the ways in which lake drying influences livelihood drawbacks and opportunities, and the range of mechanisms that shape the connections between these issues.	**Chapter 4**
Research questions i) What are the diverse range of mechanisms through which lake drying shapes livelihood drawbacks and opportunities? ii) Where does lake drying fit in the suite of stressors affecting livelihood groups in Lake Chad? iii) Are locally-evolved adaptive responses enhancing livelihoods?	
Objective 2. Identify and compare the vulnerabilities of farmers, fishers and pastoralists to double exposures.	**Chapter 5**
Research questions iv) What underlying factors shape differential occupation-based vulnerabilities and exposures to climate variability and water conflict in Lake Chad? v) How relevant are vulnerability determinants in understanding climate conflict interactions?	
Objective 3. Empirically explore the linkages between climate shocks and conflict in a regional sample of Lake Chad riparian zones.	**Chapter 6**
Research questions vi) Does the likelihood of conflict increase as anomalous climatic conditions increase? vii) Is the effect of climate shocks on conflict most pronounced in the presence of contextual vulnerability factors? viii) Does lake drying represent a significant mediator in the interactions between climate shocks and conflict?	
Objective 4. Identify and evaluate policy interventions related to the LCB, and propose recommendations and ways forward that better integrate adaptation, water governance and conflict management goals.	**Chapter 7**
Research questions ix) What range of initiatives have been developed to address environmental and conflict related concerns in the LCB? x) What considerations are needed to integrate goals related to adaptation, water governance and conflict management in the broader Lake Chad regional context?	

Second, the contribution of lake systems to rural livelihoods is often postulated to be important (Rast, 2015), but clear empirical evidence about what happens to different livelihood groups, including their vulnerability status, when such systems collapse or experience fluctuations, is rarely offered. Livelihoods and vulnerability studies in the context of lake drying can: (i) reveal how the uniqueness of individual locations matter in explaining lake drying impacts and climate conflict relations, (ii) deepen understanding about conflict determinants, and (iii) suggest why conflict behaviours prevail in environments where resource users are, for example, marginalised (Gemenne *et al.*, 2014). The thesis argues that assessing livelihoods and vulnerability based on micro-scale, participatory approaches can provide guidance for a regional scale approach for climate conflict analysis. By developing a novel climate conflict vulnerability index, as well as a double exposure index, this thesis advances the rigour and utility of indirect climate conflict analysis.

Third, almost all climate conflict studies use quantitative approaches in which findings are rarely contextualised using qualitative, case study evidence. This thesis advances existing work by applying a mixed qualitative and quantitative approach. There are good reasons why climate shocks or lake drying may have dampening effects on conflict (e.g. when people are well adapted or when survival is the aim of the locals - (Seter, 2016)). The thesis shows that knowledge of contextual vulnerability matters in both explaining dampening and amplifying effects in climate conflict relations.

Fourth, previous research has focused on a single type of conflict event occurring in fragile environments - a practice that masks the range of violent expressions that can manifest from tensions, scarcity/abundance or limited access to water resources (Buhaug, 2015). This thesis argues that a broad spectrum of conflict types often emerge in locations where livelihoods are closely linked to climate-sensitive resources (Raleigh and Kniveton, 2012). Climate shocks may indirectly feed cross-border violence, particularly in regions where cross-border rivers and lakes provide cover for local (violent) actors and rebel groups (UNEP, 2014; Asah, 2015). If persistent droughts shrink transboundary waters, relationships amongst riparian states may worsen (Hensel *et al.*, 2006). Since villages along transboundary territories are often the first victims of scarcity, interpersonal or communal tensions that start locally may trigger intra- or cross-border violence

(Kreamer, 2012). Thus, where climate shocks fuel such local tensions, this may breed widespread grievances that motivate groups and communities to mobilise to take up arms against the state. Indeed, it is often difficult to establish a clear boundary with which to differentiate the range of conflicts types that might occur in a transboundary context. A more rational approach would be to aggregate conflict types[2] into a single variable for analysis in climate conflict research (Raleigh *et al*., 2015).

This thesis aggregates common conflicts types (i.e. communal, rebel and water conflicts) held by many scholars to be the more probable outcomes of climate shocks in natural resource-dependent location (Hendrix and Salehyan, 2012; Raleigh and Kniveton, 2012). Climate is often assumed as one of the many drivers of different conflict types occurring in the same environment (Seter, 2016). In the context of the LCB, conflict types often have a similar range of determinants, and as such, would exhibit commonalities in their association with environmental changes (Onuoha, 2009). By building on LCB specific understandings of how local populations experience climate impacts, the study reveals the grievances local conflict actors leverage upon to drive conflict.

Finally, this thesis provides a piece of empirically-rich climate conflict evidence by adopting a spatially disaggregated approach. This approach avoids the aggregated research approach of global, regional and country level enquiries that often mask sub-national variations in climate conflict outcomes (Papaioannou, 2016). Thus, the research contributes to the growing strands of studies utilising spatiotemporal disaggregated data to assess climate conflict relations. In particular, by assessing over three decades of spatiotemporally disaggregated, basin-level data on climate, lake levels and conflict, the thesis offers the first true transboundary, locally-comprehensive and theoretically consistent (quantitative) analysis to date of a yet to be tested indirect climate conflict relationship. The thesis advances climate conflict research by cross-fertilising theoretical and empirical insights from several strands of the scholarly literature covering multiple thematic areas, including political ecology and civil war.

[2] Water conflict was captured as an exposure element in the vulnerability assessment linked to objective 2 based on narratives provided by local people through participatory field research (see Chapter 5).

Many lake riparian zones face a number of vulnerability and security challenges that often combine with climate shocks to weaken states' capacity to meet basic human-welfare needs, including adaptation planning (White, 2013). To address these challenges, scientific enquiries and policy interventions would require an understanding of the mechanisms linking climate variables to conflict outcomes (Burke *et al*., 2015). Understanding mechanisms is a relevant track for developing adaptation, water governance and conflict management interventions (Gustafsson, 2016). Indeed, pinning down key transmission channels is a research objective that holds great promise as the policy initiatives necessary to address conflict can only be designed if the reasons conflicts occur in a particular context are understood (Buhaug, 2015).

In sum, the systematic, multi-method approaches applied in this thesis provide a methodological contribution in line with the demand to combine a diversity of approaches and methods to investigate the full complexity of climate conflict links in human-environment systems (Gemenne *et al*., 2014). The research is locally and regionally comprehensive, and sufficiently spatiotemporally-resolved to advance insights for designing interventions for social stability under unfavourable climatic conditions.

1.4 Structure

This thesis is structured around eight chapters. Immediately after this introduction, Chapter 2 explores key debates and narratives within the livelihoods, vulnerability, climate conflict and adaptation-water-conflict integration literature. The pertinent theoretical and analytical perspectives guiding the research are presented, as well as the gaps in previous studies. The thesis used mixed-methods case study research approaches, as well as an indicator-based vulnerability approach, negative binomial regressions, and a qualitative document analysis approach. The specifics pertaining to these approaches are highlighted in Chapter 3. The study area is identified and justified, while considerations on research ethics and positionality related to the field visits carried out in Chad Republic are outlined. Chapters 4 to 7 present results and discussion addressing the research objectives outlined in Table 1.1. After synthesising the key research findings and the main contributions of the thesis, Chapter 8 concludes by highlighting relevant recommendations for the Lake Chad region and beyond.

Chapter 2

Literature review and theoretical grounding

Outline

This chapter unpacks the key conceptual, theoretical and analytical literature that pertains to livelihoods, vulnerability, adaptation-water-conflict integration and climate conflict analysis, in order to better understand the key debates and advances in knowledge, as well as the remaining gaps. The synthesis places transboundary waters at the centre of wider debates across the thematic literatures reviewed based on an understanding that water presents a vital channel for climate conflict links. The Sustainable Livelihoods Approach (SLA), the indicator-based vulnerability approach and the *context-centric* hypothesis are presented as appropriate theoretical foundations upon which to situate the research. The analytical concerns related to empirical quantification of climate and conflict are synthesised to guide the estimation procedures and frameworks developed for use in this thesis. Review of previous studies emphasising 'conflict-sensitive adaptation' and 'climate-proof peacebuilding' provides the policy context underpinning pathways towards collaborative engagements in conflict management under water and climate stresses. Taken together, the review offers relevant theoretical and analytical direction required to advance understandings of climate conflict relations in water-scarce, conflict prone environments.

2.1 Conceptual framework

Well defined concepts and contexts are necessary for meaningful operationalisation of important empirical variables and validation of empirical findings (Seter, 2016). The concepts - climate, climate change, climate variability, climate shocks/anomalies, and conflict and violence, are used to describe a broad range of events or outcomes in livelihood, vulnerability and climate conflict studies. The manner in which each one is framed is often influenced by context, data choice/availability, scope of research and the theoretical hypotheses within which a particular study is grounded (O'Loughlin *et al*., 2014a). These concepts/terms are clarified up front in this section to better communicate how they have been portrayed in this thesis.

2.1.1 Climate change and variability

The distinction between climate variability and climate change is contentious in the climate impact research literature. In quantitative studies, climate (whether change or variability) refers to observations of climatic variables, such as rainfall, temperature and/or water supplies, including other climate indices used as proxies for these variables (e.g. Palmer Drought Severity Index or the El Niño Southern Oscillation Index) (Buhaug, 2015). Averaging these variables over shorter or longer observational periods is a common practice in the literature. Many scholars adopt the Intergovernmental Panel on Climate Change's (IPCC, 2007) distinctive framing in which climate change is presented as changes in average climate at a location over long periods (usually a 30-year period or more), and climate variability as short-term (i.e. year-to-year) changes around a long-term average climate value. On this basis, some have argued that variables averaged over shorter periods (e.g. monthly, yearly) portray only climate variability, and do not fully reflect climate change impacts (Burke *et al*., 2015). However, resource-dependent societies experience anomalous climatic events in continuous time periods and respond to short-lived and long-lived changes as they emerge, making the occurrence of short-lived changes a relevant component of the climate. To illustrate, if rainfall shortages increase the probability of communal protests in a village setting – even if extreme shortages are experienced only for a few months – this is relevant for understanding climate change impacts because the frequency of these 'momentary shortages' may change if the distribution of monthly rainfall changes. Although climate variability is qualitatively distinguishable from climate change, findings pertaining to climate variability are useful in informing debates on climate change issues (Auffhammer *et al*., 2013), in particular, because global warming is assumed to heighten the frequency and severity of anomalous climatic events (captured as climate variability) in many regions of the world (Wischnath and Buhaug, 2014).

Climate shock or anomaly is conceptualised as unfavourable deviations from long-term normal climatic patterns encompassing, for example, droughts (extreme rainfall shortages) and floods (excessive rainfall) (Papaioannou, 2016). This thesis uses the term climate variability in discussions related to livelihoods and vulnerability (Chapters 4 and 5) and operationalises climate shocks as rainfall anomalies (i.e. exogenous variables) in quantifying climate conflict relations (Chapter 6). Climate anomalies and climate shocks can be used interchangeably (e.g. in terms of their various extreme manifestations) (Salehyan and Hendrix, 2014). The thesis measures climate shocks through long-term deviations from normal rainfall patterns in a non-linear perspective capturing both droughts (negative rainfall anomalies) and floods (positive rainfall anomalies) (Raleigh *et al*., 2015).

2.1.2 Conflict and violence

Conflict and violence are often used interchangeably in research on climate conflict (Seter, 2016). The conflict literature offers abundant accounts of the multi-faceted nature of conflict and violence (Themnér and Wallensteen, 2014). Conflict may suggest outcomes for which normal patterns of resolving disagreements fail (Burke *et al*., 2015) or situations in which the incompatible expectations of individuals and groups meet (Scheffran *et al*., 2014). Conflict outcomes in this sense may be violent (armed conflict) or non-violent (non-armed). Similarly, they may involve groups or individuals, actor organised or non-organised, and may be resource-driven, or politically, socioeconomically or personally motivated. The nature of conflict suggests that it can be bad and destructive, but also good and constructive, such as when it creates spaces for (progressive) institutional changes (Kallis and Zografos, 2014). Conflict can encourage cooperation (i.e. a constructive force for societal change/stability), but also cooperation can mask conflict. Similarly, conflict can be hidden, occurring in subtle patterns within the fabric of a society, or visible. It can be multi-scalar in scope – from the global down to the village or household level, and can spill over from one territory to another (Scheffran *et al*., 2014).

Ongoing conflicts can aggregate across lower scales, become aggravated over time and breed a spiral of violent conflict actions or violent cascading effects at much larger scales that can dissolve social ties and structures (Seter, 2016).

Violence generally has a broad range of meanings across several fields. One useful definition is put forward by the World Report on Violence and Health - a report from the World Health Organisation (WHO, 2002, p. 4). Here, violence is: “the intentional use of physical force or power, threatened or actual, against oneself, another person, or against a group or community, which either results in or has a high likelihood of resulting in injury, death, psychological harm, mal-development or deprivation”. Although violence can be a function of human judgement, it often occurs when conflicts cannot be immediately resolved or overcome - when actors in conflict are pushed towards extreme actions. The large majority of climate conflict studies focus on intra-state conflicts or violent conflicts. This is not unexpected since environmental factors are less likely to influence inter-state violent conflicts compared to conflicts occurring within states (Weidmann, 2014).

Given that conflict and violence are inevitable components of social interactions (Gehrig and Rogers, 2009) and because of the unresolved disagreements regarding the boundaries that differentiate both concepts (Seter, 2016), the thesis uses both concepts interchangeably in order to streamline the empirical position specified in the research questions associated with climate conflict relations (see Section 2.6.5 for discussions on conflict quantification). In particular, the thesis conceptualises conflict in its broadest sense to capture a wide range of events (conflict, violent and non-violent incidents). It defines conflict as a form of disagreement leading to clashes between individuals or groups, or groups against the state, and in which at least one party employs physical force or violence.

Conflicts in rural sub-Saharan Africa (SSA) often (although not always) depict issues concerning unequal access to, use of or control over livelihoods or economic resources, which may be shaped by ethnic or political power struggles (Verhoeven, 2014). In this region, three distinct categories of conflicts are distinguishable: (i) communal conflicts across social/ethnic groups and villages, involving actions that are either violent or non-violent - events that fall into this category include all sorts of social unrest (e.g. assaults, demonstrations, riots, thefts, large scale village raids and other destructive activities) (Fjelde and von Uexkull, 2012); (ii) water resources and other resource-based conflicts, such as livestock raiding/rustling, interpersonal land/water disputes, eviction of individuals or groups over land and/or water issues (Freitas, 2013; Almer *et al*., 2015); and (iii) rebel violence, including those by militia groups and the Boko Haram terrorist organisation across the Sahel (Raleigh and Kniveton, 2012). Several quantitative studies examine only a single type of conflict at a time. This thesis adopts the approach in Raleigh *et al*. (2015) by aggregating these three conflict types[3] because in the LCB context they: (i) occur within the same environment; (ii) have a similar range of determinants, and as such (iii) are assumed to exhibit some commonalities in terms of their association with climatic conditions (see Chapter 3, Section 3.8). The assumption made is that aggregating and jointly assessing these conflict types can deepen understanding of climate conflict relations generally for the LCB.

2.1.3 Human security

That climate change poses threats to human welfare is well established in the climate impact literature (Scheffran and Battaglini, 2011). Security encompasses human, national, regional and international aspects (McDonald, 2013). In the context of climate conflict research in SSA, human security appears to be of greater interest to scholars (Adger, 2010). It is conceived in terms of climate-induced conflicts where human welfare and livelihoods are impacted and rendered less secure (Barnett and Adger, 2007). Specifically, human security is concerned with development, justice, human life and dignity - how freely people live and are able to exercise their many choices/rights, e.g. in terms of whether they can access social opportunities and live in peace (Adger *et al*., 2014). Further, in discussing climate impacts, a human security perspective can also imply community stability – where climate impacts are perceived to transit from being a problem of adaptation to being a matter of survival (Barnett, 2003).

This thesis conceptualises security beyond the traditional notions of protection from the consequences of external military threats or internal manipulation of governance or political

[3] Note: war and intrapersonal conflict, e.g. suicide, are not included.

disorder. In this context, security is perceived as a non-traditional threat requiring non-military responses (e.g. evidence-based policies) to mitigate actions (e.g. conflicts) caused by climate shocks (Okpara *et al*., 2015). Human security is often embedded in regional security. A concern with regional security relates security to the well-being of individuals, communities and states based on a regional perspective. In the LCB context, regional security is conceptualised as a condition whereby the Lake region has the option to respond to natural resource scarcity-based threats to its environmental and socio-economic well-being. The thesis adopts the notion of regional security (in which human security is embedded) in the context of threats to human capabilities and well-being (Norwegian Nobel Committee (NNC), 2007).

2.2 Conceptualising lake water resources

Lakes are important features of the global landscape. Whether natural or artificial, fresh or saline, they hold more than 90 % of the Earth's freshwater resources (Rast, 2014) and provide one or more of the supporting, provisioning, regulating and cultural services expounded within the ecosystem services framework (Millennium Ecosystem Assessment, 2005). Specifically, these include serving as hydrological buffers against droughts and floods, habitats for plants and animals, spaces for recreation and tourism, and providing freshwater fisheries and safe drinking water (Kafumbata *et al*., 2014). Much of the freshwater from lakes feeds into and replenishes ground waters and sub-soil aquifers, and supports basic ecological processes (Rast, 2015). These benefits create opportunities for households' well-being (Singh *et al*., 2006; White, 2013). The environment in which lakes are located, including the surrounding riparian zones, attract a variety of interests and activities, and for several reasons (e.g. the benefits from lakes) constitute an important feature of economic development.

Despite the multi-functionality of lakes (Table 2.1), they remain as endangered as any other types of freshwater ecosystems (Schuyt, 2005), mostly through damming, dumping, draining and other water diversion activities, including natural causes (Singh and Moirangleima, 2012). Temporal lake hydrological fluctuations undermine opportunities for agricultural livelihoods and exert significant effects on the well-being of human populations within and outside their physical basins (Nindi, 2007). This suggests that when lakes are mismanaged and their resources used in an unsustainable way, they can represent a source of concern to societies. Lakes generally have defined borders. As such they are influenced by, and also influence, the hydrological and climatic regimes that characterise where they are located, including water inflows from nearby water bodies. Although the role of lakes has continued to assume greater importance in environmental research, awareness of the progressive scope of degradation of several world lakes is less emphasised (Rast, 2014).

Table 2.1: Unpacking the multi-functionality of lakes[4] (extracted from the Millennium Ecosystem Assessment, 2005).

Lake function	Description
1. Regulatory function	Lakes regulate ecological processes that enhance a healthy environment, including climate stabilisation and recycling of human wastes to increase water quality.
2. Carrier function	They provide spaces for various activities, such as human settlement, fertile soils for agriculture including fisheries, and for energy conversion.
3. Production function	They provide resources for societies, such as food, water, raw materials for fuel, clothing and building.
4. Information/recreation function	They contribute to mental health by providing a space for tourism, recreation, and scientific, aesthetic and spiritual fulfilment, including serving as a cultural heritage.

Lakes are central to human insecurity. First, the shrinking nature of lakes often influences shifts in rural or urban settlement processes, such as expansion or relocation. Human settlements can be spatially bounded to lakes' unique seasonal ebb and flows, including their temporal shrinking regimes (Odada *et al*., 2006). Situations where people 'move with lakes' can intensify pressure

[4] Lakes are of significant value to human societies mostly through the hydrological functions they perform and the ecological services they provide. This thesis is mainly concerned about the provisioning services of freshwater resources from the LCB.

over access to land and water across lakeshore communities. Second, lake riparian zones are areas where biophysical, socio-economic and institutional forces interact intensely to influence how water-based, life-supporting ecosystem services are exploited (Asah, 2015). Where such services anchor livelihood activities, such as crop cultivation, livestock herding and fishing, struggles and conflicts over who receives what can become a major challenge (Nunan, 2010). Third, economic activities such as irrigation facilities, hydro-power plants, fish-landing ports, and desalination sites are usually lake basin-dependent, and often combine to endanger the water security needs of riparian dwellers (ILEC, 2007).

The shrinking of lakes remains high among the critical issues facing lakeside communities and households in the Earth's dryland regions where livelihoods thrive on subsistence agriculture that uses lake resources (Sigh *et al*., 2006). In the Sahel and most parts of SSA, where lakes serve as an important lifeline for local people, societies and cultures, temporal hydrological fluctuations or absolute lake degradation can determine important social and ecological patterns (Hope *et al*., 2004). For communities facing serious lake degradation crises, economic hardship and struggles for survival can lead individuals and groups to perceive access to resources as a matter of livelihood security, and lack of access as a salient element for conflicts and violence (Musoke and Boon, 2012).

2.3 Livelihoods and vulnerability in climate impact research

Livelihoods and vulnerability are key themes in this thesis. This section provides a detailed overview of the important ways they have been conceptualised and evaluated in the literature.

2.3.1 Understanding livelihoods

A livelihood has been described as a means of gaining a living (Ellis, 2000). Although a variety of meanings are offered in the literature, a common thread is the emphasis on how different people and households in different places combine and utilise different resources/assets and strategies to generate a means of survival (Scoones, 2009). The concept is based on the notion that even the poorest households hold wealth in at least some of the assets at their disposal (de Sherbinin *et al*., 2008). In most agriculturally marginal environments such as in the Sahel, the household is the basic unit of cash and non-cash production activities, where critical livelihood decisions can be made and in which socio-economic interdependencies occur (Fisher *et al*., 2010). In order to generate a means of survival and secure beneficial livelihoods during what can often be difficult circumstances, households often claim, control, or mobilise assets, which may comprise human, natural, physical, social and financial capitals (Small, 2007). They combine assets (an important ‘engine’ for household activities and ‘buffer’ that cushions the effects of external disturbances) to pursue a livelihood strategy which may comprise agricultural activities such as farming, fishing and herding, and non-agricultural activities such as off-farm wage labour.

The sustainable livelihoods approach (SLA) (Chambers and Conway, 1992) is widely used to assess rural livelihoods. The approach is concerned about the assets people own or can have access to, and how they use those assets. It seeks to identify the mediating structures and processes that shape endowment/entitlement to assets, livelihood strategies and outcomes (Twyman and Slater, 2005; Sallu *et al*., 2010), as well as define ways to remove access constraints to assets in order to strengthen capabilities to cope with stressors or shocks, or to enhance peoples’ inventive capacities (Bebbington, 1999; Ifejika-Speranza *et al*., 2014). It also serves as useful tool for informing and monitoring adaptation programmes, including allocation of intervention funds (Scoones, 2009).

The SLA is underpinned conceptually on a pentagon of five types of livelihood assets and invokes the interdependency of the diverse assets within a specific human-environment context. It situates the livelihood assets within two contexts - the vulnerability context (comprising trends, shocks and seasonality – i.e. seasonal fluctuations that are outside the control of the household) and the policy/institutional context (comprising social relations, institutions and organisations – which are conceived as transforming structures). The ‘contexts’ enable or hinder access to household livelihood assets. Access to assets enables livelihood strategies (and activities) to be generated/constructed. What the approach does in the end is to indicate livelihood outcomes in relation to e.g. livelihood opportunities (e.g. more income and better welfare) and drawbacks (e.g. less capacity to diversify and less access to assets) (Small, 2007). The approach suggests that an important livelihood strategy is to acquire enough assets in order to develop resilience against external disturbances (Reed *et al*., 2013). The approach has a tradition of village-based studies or local-level fieldwork, with understandings focused on complex or dynamic local livelihood realities (Scoones, 2009). Many analyses along this line focus on the input (i.e. assets), output (i.e. strategies) and outcome (e.g. human well-being) components of the livelihoods approach. It presupposes that at the scale of small rural regions and villages for example, key contextual factors and livelihoods outcomes are often easy to identify and interpret by engaging local people (Motsholapheko *et al*., 2011).

In the notion of the SLA, a sustainable livelihood implies a livelihood that is stable and resilient to shocks or stresses, that can enhance its capacities and assets, without inhibiting the livelihood options of others or undermining (on a long-term basis) the productivity of the natural resource base on which it depends (Scoones, 2009). Human or household well-being is explicit in sustainable livelihood thinking and constitutes a positive livelihood outcome. Well-being in this sense relates to the five dimensions of human well-being made popular through the Millennium Ecosystem Assessment: basic materials for a good life, health, security, better social relations and the freedom to choose and act responsibly (Millennium Ecosystem Assessment, 2005).

Although the SLA provides a useful conceptualisation of livelihoods, it has been criticised for its insufficient attention to the dynamics of various re-organisations that may occur at household level (e.g. in terms of strategies) and structural level (i.e. vulnerability context and transforming structures/processes) over long time periods (Scoones, 2009). Its inability to capture complex environmental consequences of livelihood strategies and adaptations (Small, 2007) and the focus on stock of natural assets, rather than the flow of services that natural assets provide (Reed *et al*., 2013) have equally been identified. The SLA further comes from a parentage that focuses on the local dynamics and may not be well suited to deal with big shifts in politics or global markets (Scoones, 2009).

A micro-scale and single time-frame approach offers scope to deepen understanding about livelihoods dynamics when the SLA is used repeatedly over time in the same location (e.g. to compare village livelihoods across seasons and years). Although using the SLA repeatedly in the same location does not represent an ideal approach (e.g. in this thesis), thinking about livelihoods as dynamic and focusing on lakes as a natural asset within the SLA provides a basis to understand what lakes represent in the lives of local people (Millennium Ecosystem Assessment, 2005). Several studies have shown that lake water resources often add to the multitude of assets that shape rural livelihoods and economies, particularly in developing countries (Njaya *et al*., 2011; Goulden *et al*., 2013). In these studies, the presence of lakes in human-environment systems are conceived broadly to represent both a natural and a physical asset in terms of the water they supply for agricultural inputs and irrigation infrastructure respectively. This thesis draws insight from these broad perspectives as a basis to assess the effects of lake drying on livelihoods through its influence on livelihood assets.

2.3.2 Logic of vulnerability interpretations

Vulnerability is commonly understood as the susceptibility of people to the harmful consequences of (climatic) shocks or stressors, yet various underlying interpretations are ascribed to it in the climate impact literature. The interpretations come under a variety of labels, e.g. “end point”, “starting point” and “focal point” interpretations (Kelly and Adger, 2000), as well as “outcome” and “contextual” interpretations (O’Brien *et al*., 2007). In O’Brien *et al*.’s (2007) writing, end point and starting point interpretations convey the same meanings as outcome and contextual vulnerability interpretations respectively. A review of what these different terms mean shows that there are generally two main interpretations (Table 2.2); although there could be another interpretation that falls between the end point and starting point of a vulnerability assessment. Füssel and Klein (2006, p. 305) refer to this as “an intermediate element” of vulnerability portrayal.

Vulnerability according to the end point or outcome interpretation is focused on estimates of potential (net) climate impacts, taking into account possible (future) adaptive responses. It represents a linear result or outcome of a sequence of analyses that involves projections of future emission trends, development of climate scenarios, biophysical impact evaluations and identification of adaptation options (Kelly and Adger, 2000). This interpretation orients towards a static quantification of biophysical vulnerability, and relates to the level of susceptibility that is observed after adaptation has taken place (Hopkins, 2014).

Table 2.2: Interpretations of vulnerability in climate impact studies (based on Füssel and Klein, 2006; Füssel, 2007; Kelly and Adger, 2000; O'Brien *et al*., 2007).

	Outcome interpretation	Contextual interpretation
Prioritised meaning of vulnerability	Extent to which expected net climate impacts may harm a particular system	Current susceptibility to climate impacts as influenced by multiple factors and processes
Temporal reference	Future vulnerability to climate impacts; adaptation to future climatic events	Present vulnerability and adaptation to current climate impacts
Framing	Scientific framing of the climate problem based on physical flows (the state of nature) view	Human security framing based on actor-system view (nature and society are inseparable aspects of the same context)
Entry point of analysis	Projections of future emission trends and scenarios of future climate hazards	Current climatic, biophysical and contextual conditions drive vulnerability
Vulnerability approach	Integrated, risk hazard	Political economy, social or intrinsic vulnerability
Vulnerability and adaptive capacity links	Adaptive capacity determines vulnerability	Vulnerability determines adaptive capacity
Policy context	Climate mitigation, compensation, technological and sectoral adaptations	Social and economic adaptations, reduce inequalities, promote sustainable development

Vulnerability assessment based on this interpretation provides a convenient means of differentiating between net and gross climate impacts through estimates of feasible adaptations. Füssel (2007) reveals this interpretation is grounded in the integrated or risk-hazard vulnerability framework and is relevant for mitigation and compensation policies (i.e. the assistance high CO_2 emitting nations offer countries who disproportionally suffer from climate impacts), and for advancing technical adaptations (e.g. irrigation schemes or supply of drought-tolerant seed varieties).

The starting point or contextual interpretation, in contrast, depicts vulnerability as a "present" lack of capacity to cope or adapt to changing climate conditions. It considers vulnerability as a condition generated by multiple factors and processes, and focuses on social and ecological systems (O'Brien *et al*., 2007). This interpretation suggests that the starting point to understanding climate-related problems in societies should be based on the locations/context in which climate impacts occur. The context entails a multidimensional view of climate and society interactions, which may draw upon climatic, biophysical and other contextual conditions (i.e. social, economic, political and institutional structures and dynamics), consistent with the political ecology framework of vulnerability, and the entitlements, local livelihoods and social capital literature (Leach *et al*., 1999). This interpretation is relevant for explaining how intrinsic (dynamic) vulnerability determines adaptive capacities and adaptations, and for addressing broader social development issues.

Vulnerability according to the "focal point" idea represents an overarching concept or goal that a particular vulnerability study seeks to address. It reflects the course of a particular vulnerability analysis. It is more like an indicator for identifying other interpretations of vulnerability. Relating "focal point" to the food security and natural hazards literature, Kelly and Adger (2000) make reference to the space of vulnerability in terms of exposure, risk and capacity to cope with shock, including the consequences of shocks and the associated risks of slow recovery. The focal point indicates whether a study is concerned about current, future or dynamic vulnerability of climate impacts (Füssel, 2007); sectoral sensitivities, political economy or multiple stressors (O' Brien *et al*., 2007); or concerned about "intermediate elements" that lie between outcome and contextual interpretations (Füssel and Klein, 2006). Because of its indicative nature, the "focal point" notion is often not considered as a type of vulnerability interpretation.

Outcome and contextual interpretations of vulnerability differ in their descriptions of vulnerability, temporal reference and framing, starting point of analysis, vulnerability approach, adaptation-vulnerability links and policy contexts (Table 2.2). Although none of the interpretations is considered more or less appropriate than another in the context of climate impacts and conflict research (Kelly and Adger, 2000), contextual vulnerability can be more apt for studying current vulnerability to the social impacts of climate events, such as conflict and violence. Differences in interpretations are often emphasised to guide climate impact assessment studies and to demonstrate the need for studies to be explicit and transparent in the interpretation of vulnerability. This thesis adopts the contextual vulnerability logic in assessing vulnerability and climate conflict relations in the LCB.

2.4 Revisiting the climate conflict discourses

A rapidly growing body of academic literature has attempted to establish empirical relationships between climatic events and conflict. This includes those exploring direct (Burke *et al*., 2009; Hsiang *et al*., 2013) and indirect (O'Loughlin *et al*., 2012; Raleigh and Kniveton, 2012) links, as well as those examining potential intervening factors and/or transmission mechanisms linking climate-induced hardship with a single or multiple conflict outcomes (Fjelde and von Uexkull, 2012; O'Loughlin *et al*., 2014b). Although few studies deny the role of climatic events in conflict (e.g. Gartzke, 2012; Koubi *et al*., 2012), studies concerned about more subtle indirect climate conflict relations are increasingly becoming the core of the broad quantitative literature. The range of indirect pathways proposed include: weather-driven water scarcities (Böhmelt *et al*., 2014), rainfall abundance (Salehyan and Hendrix, 2014), agricultural/food production shocks (Buhaug *et al*., 2015; Raleigh *et al*., 2015), low agricultural incomes (Fjelde, 2015), human health challenges (Levy and Sidel, 2014), and increased residential/human mobility (Bohra-Mishra *et al*., 2014). Nine general stances and three broad typologies of climate conflict discourses exist within the climate conflict literature (Table 2.3).

Table 2.3: Typology of climate conflict discourses and associated stances across the peer-reviewed sources.

Discourse lines	Stances
For 'climate conflict'	Climate change is a 'threat multiplier', an 'accelerant of instability'.
Climatic determinism	Climatic conditions and events directly influence the propensity for violent conflict (Burke *et al*., 2009; Hsiang *et al*., 2011).
Context centrism	Indirect linkages demonstrate that the 'state of nature' and 'nature of the state' are inseparable aspects of the same context across different scales (Raleigh *et al*., 2014).
▪ *National security threat*	Threats from the manifestations of climate change will challenge the sovereignty, territorial integrity and institutional capacity of the nation-state, undermining the national 'way of life' (Busby, 2008; Morales Jr., 2015).
▪ *Human security threat*	The poor are powerless victims; climate change will drive human insecurity and violent confrontations by shrinking the resource base anchoring livelihoods and by undermining political and economic stability (Zografos *et al*., 2014).
▪ *International security threat*	Climate change is likely to cause planetary upheavals (Brown and McLeman, 2009).
▪ *Ecological security threat*	Climate change will accelerate (negative) systematic structural change in people-biosphere relationships, and undermine moral obligations humans have to preserve plants, animal species and other living beings (McDonald, 2013).
Against 'climate conflict'	Branding conflict as an outcome of climate change is misleading and fails to address the ideological variables driving conflict.
Denial claims/detached	Conflict is a social issue/construct, its drivers have no link with climate change (Selby, 2014).

The stances differ in their arguments "for" and "against" considerations of climate change as a security issue (or as a threat multiplier). The stances arguing for climate conflict (seven stances in all) affirm a security threat position across different scales. One specific stance with a *climate-*

centric viewpoint suggests that climatic conditions and events directly and dominantly influence conflict and violence. Another stance based on a *context-centric* narrative affirms indirect linkages through a confluence of factors which evidently differ across different scales (national, human, global and ecological), particularly in terms of what may constitute “the state of nature” and the “nature of the state” across varying contexts.

Next comes the opposing stances (two stances in all) – which hold that conflict under climatic trends is a social construct, and that climatic changes need not be characterised as a security issue. A detailed discussion of the various discourses are presented in Sections 2.4.1 to 2.4.3.

2.4.1 Climatic determinism

Climate determinism argues that warming climates influence irritability, aggression and violent intergroup conflicts (Hsiang *et al*., 2013). Central to this discourse is a thermal stress hypothesis grounded in research mainly in psychology of social conflict and aggression (Anderson and DeLisi, 2011). In particular, extant studies that use quantitative methods to link conflict to climate in global or regional datasets affirm that heat and aggression are closely linked by illustrating that physically uncomfortably hot conditions (e.g. during El Niño events) can increase the likelihood of physical aggression and violence (Hsiang *et al*., 2011). This discourse prescribes an almost instant ‘conflict’ response to thermal extremes and represents a worldview in which climate change is conceived as a dominant factor in, and a key entry point to the climate conflict storyline. By promoting a direct effect of uncomfortably warm temperatures on conflict and violence, and therefore placing climate trends as the central focus, the discourse evidently suggests a modern form of “biophysical or environmental determinism” (Raleigh *et al*., 2014). Indeed, the discourse draws upon enlightenment ideals of positivist science to suggest that more knowledge about the dynamic climate/biophysical systems will enable humankind to better mitigate climate impacts, and cope with social conditions such as conflict escalations.

2.4.2 Context centrism

The *context centrism* discourse in which the notions of human, national, global and ecological security are a part, is often cast from a deterministic storyline that encourages viewing climate change/shock as a threat to the extent that it precipitates threats across diverse scales (Detraz, 2011; McDonald, 2013). In the frame of political ecology and neo-Malthusian perspectives, it embeds the subjects whose security is threatened, including specific causal mechanisms, as a central premise to offer support for connections between climate and conflict. Specifically, it is concerned about tracing multi-level linkages, including decision-making, governance and hierarchies of power (Kallis and Zografos, 2014). Statements pointing to climatic events as fueling more droughts and famine, more forced migration/mass displacement, hikes in food prices, scarcities of resources anchoring human livelihoods, and negative changes in economic growth are often invoked to explain how climate disturbances drive conflicts and violence (Gemenne *et al*., 2014; IPCC, 2014). Generally, studies articulating a *context-centric* view emphasise that: (i) climate conflict links are multi-directional, i.e. there is not a simple one-way connection, (ii) several themes and variables are involved, pointing to climate change as one of a range of factors in conflict outcomes, (iii) SSA and southern/central Asia present potential locations where evidence is most stark, and (iv) climate change is associated with low level conflicts. The discourse concentrates on what must be done to address some known drivers of conflict under climate disturbances to create resilient societies (Dumaine and Mintzer, 2015).

2.4.3 Denial claims

Denial claims discourse does not deny climate change, nor imply that its influence will not be problematic. Rather, it questions the existence or severity of climate change impacts on conflict outcomes, insisting that claims about climate conflict are insufficiently supported by scientific evidence (Slow, 2013). Most studies here either establish “no link” (Gartzke, 2012; Koubi *et al*., 2012), demonstrate “little evidence” (Wischnath and Buhaug, 2014) or view climate conflict predictions with scepticism (Mason and Zeitoun, 2013). This discourse draws mostly upon a philosophical/traditional security type of thinking that presents conflict as a social construct, a somewhat “militarised framing” or “heterodox idea” that is critical to claims about relations between environment/climate and conflict (Deudney, 1990). By constructing realities based on a combination of historical antecedence and current economic, political and cultural contexts, the discourse argues for a need to explore conflict in more complex ways than simply pointing to climate factors, and suggests tackling more pressing challenges such as terrorism, HIV and poverty that plague developing countries (Selby, 2014; Floyd, 2015).

Although the discourses evaluated in this section differ considerably in their conceptualisation of the roles of climatic events in conflict events, studies within particular discourses – in particular the quantitative *climate-centric* and *context-centric* studies – also differ in the conclusions and policy suggestions they provide. This is explained by the: (i) varied climate and conflict datasets used, (ii) different quantitative and qualitative definitions and scope of conflict employed, (iii) different climate parameters, (iv) benchmark model specifications (i.e. modelling problems), including varied evaluation and statistical procedures, and (v) choice of spatial scales and theories. Because many of the climate conflict studies in the frame of *context centrism* reveal a compelling priority for human security in Africa, this thesis draws insight from this discourse frame to contextualise climate conflict relations for the LCB on the basis of contextual vulnerability and lake drying.

2.5 Climate adaptation, water governance and conflict management in transboundary settings

Climate conflict is a useful concept for raising awareness on the variety of impacts unfavourable climatic conditions have on different vulnerable population groups, particularly in relation to climate adaptation, water and conflict management (Burke *et al*., 2015). In transboundary settings, water is one of the medium through which societies will experience climate impacts and conflict challenges (Dinar *et al*., 2015). It also represents the means through which climate adaptation will encourage conflict management and livelihood well-being. Water is not a sector per se in a transboundary context (Subramanian *et al*., 2014), but a resource for livelihood development, climate adaptation and peace building. Any effective water governance and human security planning will need to take adaptation into account, and conversely, climate adaptation initiatives require water and security interventions to succeed, especially in transboundary settings that are exposed to climate shocks (Babcicky, 2013). Indeed, water action, peace action and climate action are the three ‘legs’ that need to move together to engender social stability (Gustafsson, 2016). This explains why the need to integrate climate adaptation, water governance and conflict management goals in vulnerable, conflict-prone transboundary settings is now incorporated within the high level policy agenda in the *context-centric* climate conflict discourse (Ludwig *et al*., 2011). Yet, integration has hardly been taken on board by national decision-making organs of many developing countries (Gerstetter *et al*., 2011). Perhaps, the reason for this may be connected to a lack of understanding regarding the tools that inform the process of cross-thematic integration.

This section reviews literature on climate adaptation, water governance and conflict management, and explores the ways in which the narratives on integration have been framed in previous studies.

2.5.1 Climate adaptation

Adaptation to climatic events has continued to rise on the agendas of states, development actors and researchers, spurred by the growing evidence that changes in climatic conditions are real, increasingly observed, and already undermining security in several places (Mcgray *et al*., 2007). According to the IPCC (IPCC, 2014, p. 5), adaptation is 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities". The IPCC identifies two type of adaptation:

- Autonomous adaptation - ''adaptation that does not constitute a conscious response to climatic stimuli but is triggered by ecological changes in natural systems and by market or welfare changes in human systems'';

- Planned adaptation - ''adaptation that is the result of a deliberate policy decision, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain or achieve a desired state".

Rural people often depend on a combination of assets and income generating activities, support from social networks and states' safety net policies in order to develop adaptive capacities. Adaptive capacity is the ability of a livelihood system to withstand major disturbances such as stress or shocks (Ifejika-Speranza *et al*., 2014). Coping capacity is short-term adaptive capacity, and is often part of climate conflict vulnerability assessments (Busby *et al*., 2014a). Coping and adaptive capacities better equip actors to confront climatic events and adapt to current and future climate impacts (Adger, 2006). Adaptation thinking within the livelihood perspective encompasses reactive capacity (capacity to cope with and adjust to shocks or stresses/adverse conditions based on autonomous adaptation) and proactive capacity (capacity to search for and create livelihood options and strategies in order to increase competence with which to confront a threat – based on planned adaptation) (Ifejika-Speranza *et al*., 2014). Reactive livelihoods (based on reactive strategies) and proactive livelihoods will display different responses to lake water depletion and other contextual forces since they will use assets and construct livelihood strategies in different strategic manners (Paavola, 2008).

A wide range of environmental, technical and institutional measures may qualify as adaptation actions, ranging from local dams and urban water desalination infrastructure to water markets and pricing strategies, to reforms in entitlement planning and land-use processes (Stringer *et al*., 2009). Not all are necessarily promising. Some approaches with adaptation tags can spur more harm than good in vulnerable communities, or they can enhance carbon emissions. Adaptations that increase risks of these kind have been called "mal-adaptations' (Barnett and O'Neill 2010; Juhola *et al*., 2016). Broadly, adaptations can lead to conflict in several ways, for example, when they are: (i) incoherent with important socio-political processes (e.g. poverty reduction and water management); (ii) designed to capture national level concerns at the expense of subnational challenges facing local people (e.g. in the water sector); (iii) not participatory enough to engage affected individuals and stakeholder groups; (iv) designed to reinforce inequities or 'set up' distinct groups or communities as competitors; (v) perceived as illegitimate, especially if they ignore property rights (e.g. where natural disaster risks are used to justify why populations should be forcefully relocated/resettled). Benjaminsen *et al*. (2012, p. 105) reported a case in Mopti region in Mali where official policies on land use spurred settled farmers to expand their cereal (rice) farmlands into 'vacant' riverbeds where they constructed irrigation systems across fields that previously were used by herdsmen for dry-season pastures. This 'shift' led to local grievances and conflicts between farmers and herdsmen.

Mal-daptation has become a vital topic in the debate regarding the security implications of climatic disturbances (Kallis and Zografos, 2014). To prevent mal-adaptation, several scholars have advocated that adaptation planning needs to be conflict-sensitive (Barnett and O'Neill, 2010; Babcicky, 2013; Rüttinger *et al*., 2015; Juhola *et al*., 2016). To achieve this, security policy discussions need to align with those on adaptation design (i.e. to reconceptualise adaptation in the language of security) by applying, for example, the 'do-no-harm' principle (Tänzler *et al*., 2013). This principle aims to engender socio-political transformation and foster opportunities to build sustainable societies. It suggests that effective adaptations should not erode established social cohesion - they should not generate friction or resistance. Similarly, Babcicky (2013) suggests that there is need to: understand the context in which people live and work, including how institutions operate; understand the interactions that are prevalent in different areas, including between sectors, activities and contexts; and act upon this understanding to prevent potential negative effects in order to optimise positive ones. Indeed, the task for conflict-sensitive adaptation action requires multiple tiers of actions across different scales (from the household to the global level), as well as effective coordination (reconciliation) of approaches between vital policy areas (Vivekananda *et al*., 2014). It also demands high levels of negotiation (in terms of reaching a compromise) amongst stakeholders who have diverse agendas and preferences (Gustafsson, 2016).

2.5.2 Water governance

Water governance has different conceptual meanings, but broadly it connotes 'the exercise of authority' in water-related actions, which can encompass decision-making in water management from policy-setting to service delivery (Kuzdas and Wiek, 2014). In clear terms, "water governance is the manner in which authority is acquired and exercised on behalf of the public in developing, utilising and protecting a nation's water resources" (De Stefano *et al*. 2014, p. 1123). This definition is applicable across a range of scales, from regional, national to village levels, including both formal (high-level state decisions) and informal (local authority actions) governance arrangements. Water governance is relevant for decision-making about sustainable water supplies. It can indeed mean conflict management (Gehrig and Rogers, 2009). This implies that governance can be a force for peace or for conflict depending on the governance approach adopted. Water cannot be governed for one purpose or in the case of shared water, for a single country. Although water governance has several aspects, it is inherently a political issue requiring multi-level participation and engagement. Indeed, scholars have suggested that the growing water crisis in several places around the world is a problem of governance rather than one of scarcity, indicating the critical place of governance in addressing water-related stresses (Perreault, 2014; Dinar *et al*., 2015).

The approach to water governance is often framed on the basis of its varied components: institutional structures covering policies, laws and organisations; interlinked decision-making processes that are participatory and decentralised; and inherent sets of standard water functions encompassing water distribution planning, monitoring quality, enforcing quality and maintaining facilities (De Stefano *et al*., 2014). In structuring water governance, policies often map out the overall direction, whereas laws create the official or informal 'rules of service delivery' and authorise the institutional or organisational structure to drive policy implementation. Policies as purposive courses of action are often made explicit in documents by a capable authority/state. Laws encompass written, unwritten or customary rules and practices. Together, policies and laws create the 'governance template' that constitutes the action plan for institutions and management practices.

Organisations are actors and/or stakeholders in water governance. Ideally they execute and are governed by established policies and laws. Examples include formal (ministries of the environment and water resources), customary (local water users association) or NGO-based water management institutions. These entities (though operational details vary depending on the country) develop, manage, allocate, use and protect water resources. If policies, laws and organisations set the institutional structures, decision-making processes enhance the manner in which actors, stakeholders and the general public are carried along the water governance ladder. Processes that are participatory and decentralised matter a great deal to individuals and groups in societies, and can place new ideas before key decision-makers, facilitating awareness of the opinions held by society (Matthews and Schmidt, 2014). Good water governance thrives on robust decision-making processes (Tortajada, 2010).

What constitutes good/effective water governance has been the subject of enormous debate in the water governance literature, particularly within the context of the so-called integrated water resources management (IWRM) (Gain *et al*., 2013). The Global Water Partnership (GWP, 2000) conceptualises IWRM as a collection of coordinated development and management activities on water, land and related resources, planned to maximise the economic and social benefits of water in an equitable manner while ensuring the sustainability of important ecosystems. The IWRM buzzword is no longer popular in today's water governance literature as several scholars argue over its practical applicability in a developing world setting (Cook and Bakker, 2012; Schnegg and Bollig, 2016). Although integration is a critical aspect of good water governance, certain basic features appear more pronounced, for example: accountability/integrity, transparency, participation, equity and decentralisation. These features are elements of desirable decision-making processes and constitute the heart of water governance (De Stefano *et al*., 2014).

Another component of the water governance structure pertains to a set of basic water governance functions carried out by the water sector/institutions and organisations (Bring and Destouni, 2011; Norman and Bakker, 2015). Usually a country's water sector is required to undertake functions such as: building capacity for water sector development (e.g. through establishment of links with neighbouring riparian countries, coordinating the implementation of national water policy, building political/public awareness of water sector issues etc.); planning strategically (e.g. by using relevant water data to match water supply and demand, and to deal with shortfalls); allocating water (e.g. by coordinating issuance of water rights and adjudicating conflicts); managing water resources (e.g. by overseeing the construction of public infrastructure); and regulating quantity/quality of water resources and enforcing water service standards.

Water governance is essential for peaceful co-existence in lake environments (Grafton *et al*., 2013). It is relevant both to reduce drying as a result of declining inflows caused by climatic disturbances, as well as to manage water stresses (Subramanian *et al*., 2014). Several water governance approaches exist for transboundary locations, for example, by employing treaties and joint river governance (Dinar *et al*., 2015). Designing treaties requires paying attention to the web of bilateral and multilateral interactions that influence interests, regulations, and responsibilities within riparian zones and lakeside communities (Turner *et al.*, 2012). Other approaches, according to Grafton *et al*. (2013), include: (i) imposing water-use reductions by the central government/institution based on prevailing political economies; (ii) centralisation of basin water management using basin institutions and water acts; (iii) empowering multiple jurisdictions, including informal customary institutions to govern water use in less centralised ways; (iv) water reforms that enable equity in water sharing and rights; and (v) matching legislative goals with on-the-ground water governance (Grey and Sadoff, 2002).

Despite these approaches, the governance of transboundary waters is complicated by the political borderlines and boundaries that transect lakes or river basins, including varied perceptions about how best to share the variety of ‘public goods and services’ river basins supply (Gleditsch *et al*., 2006). Institutions, perceptions and values differ across transboundary settings, and these can lead to inter-state tensions or conflicts. Climate disturbances present an additional challenge given their influence on river inflows, and in shaping how treaties and negotiations are framed (Dinar *et al*., 2015). With heightened uncertainty regarding future climate and water conditions, water governance represents an essential feature of water preservation and adaptation processes in transboundary basins.

2.5.3 Conflict management

Conflict management encompasses peacebuilding concepts such as conflict prevention, conflict resolution and conflict transformation (Babcicky, 2013)**.** These terms are often used interchangeably, with the overall aim of either tackling root causes of conflicts or containing them (Turner *et al*., 2012). Conflict management is a vital part of transboundary water governance (Hensel *et al*., 2006). The transformative potential of conflict is realised through effective management, and this can drive innovation in water governance, leading to beneficial adaptive governance for riparian states and communities (Brochmann and Gleditsch, 2012). Indeed, conflict management can be vital for a process-driven governance approach, i.e. an approach that incorporates conflict as an integral component of just and equitable governance (Nursey-Bray, 2016).

There are multiple ways conflicts can be managed in transboundary environments. Specifically, the nature of a particular conflict can determine the most appropriate management strategy to employ (Kuzdas *et al*., 2015). For example, unvoiced but recognised divergent interests as well as openly-voiced contentions can be managed through informal mediation by neighbours and kinsmen (a typical example is the water court or village square court where locally-elected judges mediate issues of contention and conflict locally) (Turner *et al*., 2012). In contrast, the more serious verbal or violent conflicts can be redressed/managed through formal mediation involving official administrative and judicial entities.

In his work on indigenous approaches to water and conflict management conducted in two dryland regions (i.e. the Berbers of the North Africa High Atlas Mountain in Morocco and the Bedouin of the Negev Desert in southern Israel), Wolf (2000) provides lessons for indigenous conflict management that can be applied to modern water governance problems under climate change. These include the need to prioritise different demand sectors following a defined hierarchy of importance (highest priority is provision of drinking water for humans, followed by drinking water for animals and then for fishing and irrigation); protecting downstream and minority rights (this enables justice and economic equity); embracing alternative conflict resolution (e.g. through a recognised water authority); and practicing communal ceremonies of forgiveness that encompass private negotiations or public declarations of forgiveness.

While water may be central to conflicts in water scarce locations, conflict management will need to link up well with water governance and climate adaptation to enable improved human well-being. It requires adaptation that facilitates common positions and mutually win-win actions that e.g. stabilise existing tensions (Scheffran *et al*., 2014). Whether conflict management succeeds depends on a range of factors, including the (resource) governance capacity of institutions to transform conflicts into cooperative engagements. Conflict management can be sustained through, for example, a signed peace agreement between leaders of contending parties, under a social setting that supports and encourages political leaders' continued commitments (Gehrig and Rogers, 2009).

2.5.4 Cross-thematic integration

A key overriding basis for policy integration targeting adaptation, water and conflict, hinges on the recognition that adaptation and conflict management conflate to some extent, as suggested by the terms “conflict-sensitive adaptation” (Tänzler *et al*., 2013) and “climate proof peacebuilding” (Gustafsson, 2016). It also hinges on the premise that climate change does not fit well into ‘sectoral boxes’, since it is an issue with cross-cutting implications. The range of institutional policies advocating climate adaptation is increasing for several water-scarce regions, and the majority are planned to account for conflict management needs through better water governance in light of extreme climatic conditions (Mcgray *et al*., 2007). Indeed, water governance is a central component for integration goals and hence collaboration on water issues is vital for reaching better development outcomes across the three interlinked themes (Hensel *et al*., 2006).

Scholars have suggested that ‘integration’ will require proper conceptualisation of what the problem to address truly is, including understanding how the compatibility of an integrated adaptation-water-conflict policy can co-exist with national/transboundary action plans and agendas, and the level of institutional support that can be facilitated through funding, scientific knowledge and other practical support (Gehrig and Rogers, 2009; Goulden and Few, 2011). Some key integration strategies and calls have been about: data sharing (e.g. using satellite earth observatory systems to monitor changing environmental condition, sharing such information as widely as possible); condemning acts of violence and terrorism in fragile, climate conflict prone regions; funding climate adaptation plans; and using frameworks and mechanisms based on best science and satellite technology to predict impacts, disseminate identifiable challenges and consequences in understandable formats (Tänzler *et al*., 2013). Others include: using elements of good water governance, a combination of planned and autonomous adaptation in a manner that enhances equity/justice, and conflict management approaches that are representative and fair, and applying the new sustainable development model framework to push for better integration of adaptation, water and conflict (Mugagga and Nabaasa, 2016).

Although climate adaptation, water and conflict span various policy sectors that can in many cases be strongly separated, if these areas are within the mandate of one department or institution, integration can become significantly easier (Gustafsson, 2016). Also, integration can be easier when adaptation, water governance and conflict management efforts are addressed using a single analytical or assessment tool (e.g. vulnerability assessments using indicators can incorporate all these elements and at the end develop approaches that address all elements). Since it is no longer suitable to use a standalone adaptation measure to address the multiplicity of instability drivers in developing countries (Stringer *et al*., 2014), integration across key policy areas appears more promising (Babcicky, 2013). Integration serves to harmonise the so called "scattered approaches", aligning them to reduce vulnerabilities (Cox *et al*., 2016). Integration helps to avoid setbacks in transboundary plans that target community and livelihood security by ensuring that policy-making, budgeting and implementation are carried out in a manner that delivers multiple solutions to local resource users.

If integration succeeds, the benefits can be multifaceted, including: helping to reduce mal-adaptation (Snorek *et al*., 2014); preventing project failures (i.e. where water projects fail because of violence and climate shocks); and reducing standalone adaptation projects that take a significant share of national/institutional budgets and which may not enhance resilience in conflict-prone, water-scarce settings. Further, integrating adaptation, water governance and conflict management can be well suited to local development processes (Cox *et al*., 2016), and may constitute the 'peace conduit' needed for amicable communal and livelihood group relationships (Tänzler *et al*., 2013). This thesis addresses the call for cross-thematic integration and provides the much needed lessons for harmonisation of policy interventions in the LCB.

2.6 Theoretical and analytical issues

While the theoretical basis around livelihood assessments has been presented through the SLA (Section 2.3), this section explores the theoretical and analytical issues pertaining to vulnerability assessment and climate conflict analysis, highlighting how they are used in this thesis.

2.6.1 Using indicator-based vulnerability assessments

Vulnerability assessments focus on identifying determinants of vulnerability by investigating reasons behind unequal exposure, impacts or responses. The priority areas are usually to identify vulnerable places, people and sectors, raise awareness on where adaptation funds should be directed, and to monitor adaptation policies (Luers *et al*., 2003). These are recognised as necessary for enhancing the utility of vulnerability reduction strategies in development planning (Oppio *et al*., 2015).

Vulnerabilities of individuals and communities are initiated by different interacting biophysical and socio-economic stressors. The extent to which populations are able to protect themselves is contingent upon how they are able to adjust (Reid and Vogel, 2006; Tschakert, 2007). Yet, as O'Brien *et al*. (2004; 2009) point out, assessments are often undertaken in isolation from ongoing global negative interacting outcomes. This is often the case for social stressors driven by human conflict *(*Mason *et al*., 2011). However, vulnerability indicators are now widely applied to account for interacting shocks and stressors, and in particular to enhance the communicative power of vulnerability assessment findings (Tonmoy *et al*., 2014). Indeed, growing interest in understanding the forces that shape the state-of-affairs in vulnerable countries has made the use of vulnerability indicators relevant in vulnerability hotspot mapping (Hinkel, 2011; Abson *et al*., 2012).

Several criticisms have been raised regarding the scientific novelty and policy relevance of vulnerability indicators. Many suggest that indicators are "a typical example of failed science-policy communication" (Hinkel, 2011: p. 199) particularly in relation to the opaque manner in which methodologies for developing indicators are presented (Eriksen and Kelly, 2006; Barnett *et al*., 2008). Scientific definitions and frameworks guiding vulnerability assessments are generally imprecise about methodologies. For example, Working Group II of the IPCC (IPCC, 2007), identifies exposure, sensitivity and adaptive capacity as the defining components of vulnerability. Yet the largely subjective connotation of these components makes it unclear how they can combine to capture vulnerability, as well as the relationships between them (Wolf *et al*., 2013). Many vulnerability indicators capture these components separately, paying limited or no attention to how to integrate them. The lack of communality in definitions has often meant that indicators must come from the specific research or policy questions considered (Wolf *et al*., 2013). Due to the place-based and context-specific nature of vulnerability, normative value judgement has tended to guide many vulnerability assessment methodologies (Hahn *et al*., 2009; Shah *et al*., 2013).

Despite criticisms concerning the use of indicators, their local relevance is widely supported (Barnett *et al*., 2008; Orencio and Fujii, 2013). In this thesis, vulnerability is conceptualised as a theoretical, non-observable phenomenon that relates to the propensity of a system, subsystem or system component to experience harm due to exposure to a perturbation or stressor (Turner *et al*., 2003). The thesis applies observable variables or indicators to operationalise vulnerability, focusing on agricultural livelihoods in a lake-dependent environment.

2.6.2 Neo-Malthusian pessimism versus cornucopian triumphalism

Environmental resources have historically been portrayed as drivers of conflict in the environmental security (ES)[5] literature (Homer-Dixon, 1999). The core premise of this literature is that resources, both renewable and non-renewable, anchor human livelihoods and national economies, and their depletion or degradation is at the root of instability and violence, particularly in regions where large populations depend on environmental resources. Almost a decade of climate conflict research has revealed that the putative effects of anomalous climatic conditions on conflict are the staple of a revised version of the neo-Malthusian narrative of demand, supply, and structurally driven resource scarcities that characterise the ES literature. This literature offers several theoretical ideas that point to the manner in which climate and conflict can be discussed, modelled or analysed and understood. The ideas are conceived in two different ways.

[5] Environmental security refers to a variety of security concerns triggered by environmental forces (e.g. resource shortages/abundance, climatic changes, and non-sustainable resource use practices) (Halden, 2011).

The first is strictly resource-centric and conveys a pessimistic neo-Malthusian view. This view suggests that pressure on essential resources, such as water, can alter the socio-economic and political structure of underdeveloped countries, heighten tensions and disputes, and make violent conflicts more frequent (Baechler, 1999; Homer-Dixon, 1994; Homer-Dixon, 1999). Freshwater is a particularly problematic resource here because it represents an invaluable resource worth fighting over. It has no suitable substitutes and the supply is finite and inequitably spatiotemporally distributed.

The second theoretical idea is innovation-centric and offers a rather cornucopian optimistic perspective (Simon, 1996; Lomborg, 2001a, b). Cornucopians point to the significance of: (i) human ingenuity/creativity (i.e. humans can engage social capitals, livelihood diversification and migratory behaviours to survive conditions of extreme scarcities); (ii) technological advancement (e.g. using water transfer technologies to address water shortages); (iii) the right employment of market processes (e.g. using the logic of virtual water and enhanced commodity supply chain mechanisms to ensure continuous supply of resources); and (iv) creative engagement of socio-cultural and political institutions (e.g. based on social collaboration and community governance for water cooperation in the face of increasing degradation). This resource-optimistic view often comes under the general rubric of ‘eco-modernisation’ (Gleditsch *et al*., 2006). Elsewhere this is labelled as ‘Prometheans’ (Dryzek, 1996). Proponents of this view argue that by counteracting resource scarcities using purposeful technological innovations, substitution and flexible market mechanisms, including better pricing of resources, that cooperation is a likely outcome of scarcity or environmental hardships (Urdal, 2005).

Climate conflict research has its root within these varied narratives and as such, has apparently reflected what can be termed the new generation of ES thinking, carrying most of the labels and arguments that characterise the ES thesis. While the argument that innovation and human ingenuity drive environmental improvement and climate-related cooperation is less prominent in the climate conflict thesis, less prominent still is the analogy with environmental Kuznets curves (Figure 2.1; Gray and Moseley, 2005). Here, environmental degradation (droughts) or surplus (floods) at the outset can lead to societal instability and conflict through e.g. income shocks in resource dependent regions. Further degradation/surplus over time and beyond certain thresholds might lead to fewer fatalities/conflicts as people shift livelihoods, find alternative resources and become better adapted to existing conditions (Huang, 2014). This line of argument suggests an inverted U-shaped relationship between degradation/surplus and societal stability (Gizelis and Wooden, 2010). Clearly, the literature has tended to underestimate the capacities of local communities to negotiate adaptive or innovative means of tackling climate conflict resulting from environmental hardship (Seter, 2016).

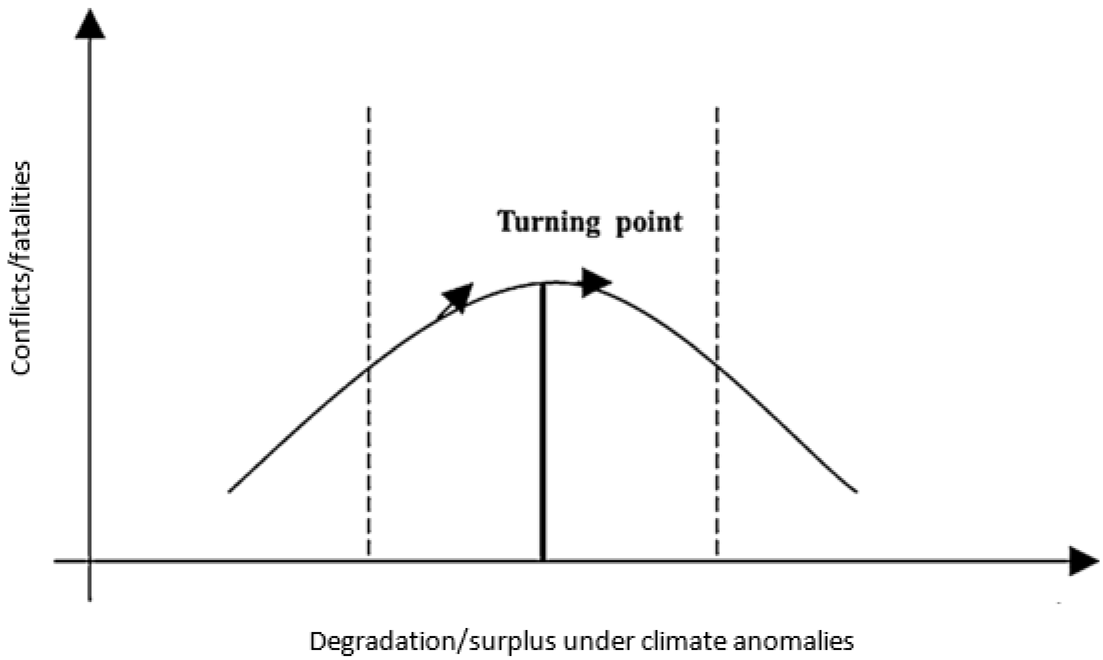

Figure 2.1: Environmental Kuznets curve (*Source*: Gray and Moseley, 2005)

The disagreement that runs through the climate conflict literature has its root, to a certain degree, in both the neo-Malthusian fears - that violence will increase as global warming progresses (Burke *et al*., 2009; Hsiang *et al*., 2013); and the cornucopian narrative - that human ingenuity and technological progress/innovation will increase human adaptations in a way to match any negative implications of a warming planet (Urdal, 2005). Gleditsch *et al*. (2006) have argued along this line, insisting that many environmental and climate conflict debates are structured between the neo-Malthusian unrelieved pessimism about natural resource limits and cornucopian optimistic views and triumphalism. Indeed, within the plethora of climate conflict discourses, it is only the human ingenuity-focused optimism found in eco-modernisation that directly challenges the resource limits narrative driving the eco-scarcity/abundance thesis.

2.6.3 Theoretical debates advancing a context-centric hypothesis

As highlighted in Section 2.4, the prominence of violent conflict as a label applied to the threats posed by climate disturbances has been widely and inclusively debated. Yet, studies concerned with more subtle indirect climate conflict relations are increasingly becoming the core of the broad quantitative literature (Gemenne *et al*., 2014; Buhaug, 2015). The literature proposes several theoretical directions for understanding violent conflicts under environmental hardships and abundance. Among the several theoretical lenses are narratives under the following umbrellas: zero-sum, relative deprivation, opportunity cost of fighting, self-sufficiency and no-gain narratives (Table 2.4). All of these coalesce around the understanding that climatic events can shape conflict outcomes (positively and negatively) by their ability to “change the operating environment and, with it, the opportunities and grievances that influence conflict” (Moran *et al*. 2014, p. 1). The ‘operating environment’ in this context can encompass anomalously wet or dry conditions, including certain non-climatic conditions (e.g. political exclusion), that collectively increase or decrease opportunities for violence (Burke *et al*., 2015). Several non-climatic factors that influence the ‘operating environment’ for conflict events often come under the rubric of vulnerability determinants.

The vulnerability literature suggests that exposure to unfavourable climatic events in highly sensitive, agriculturally-dependent environments undermines human coping capacities (De Souza *et al*., 2015) and may predispose groups and individuals to conflict behaviours when alternative livelihood opportunities are not available (Busby *et al*., 2014b). The ES literature adds to this pessimistic view, suggesting that the unsustainable use of natural resources may generate conflict under conditions of high natural resource demands and/or declining resource supplies (Homer-Dixon, 1999). Within the ES literature therefore, rainfall shortages (and abundance) are purported to create incentives for violence along several lines. This position is further advanced in the political ecology literature (Le Billon, 2001). Concerned with the larger contexts and historical components of tensions and conflicts (Adger *et al*., 2001), this literature posits that conflict escalates and becomes violent when power struggles characterise local resource use or management, particularly in developing countries where the main livelihood support system is based on renewable natural resources (Turner, 2004). Here, the emphasis is on recognising both the presence of scarce or abundant resources in conflicts and grasping the underlying causal mechanisms at work (Seter, 2016).

Table 2.4: Theoretical arguments within a context-centric hypothesis.

Narratives	Arguments
Opportunity structures	On the basis of economic considerations, individuals would join violent actions when the benefits of doing so trump the costs (Collier and Hoeffler, 2004). Opportunity costs to fight decrease during harsh climatic conditions[6].
Relative deprivation	Economic hardship caused by climate shocks/anomalies influence income/wage level differentials across populations, and with increased inequalities between individual and groups violent reactions can become a regular occurrence (Jakobsen *et al*., 2013). This is a likely outcome when different groups perceive a gap between what they get in terms of economic opportunities and what they perceive they should have (Fjelde and von Uexkull, 2012). Where livelihood deprivation is blamed on state failure or an incompetent government following climate disturbances, this may motivate group violence against the state (Seter, 2016).
Zero-sum	Cooperation pertaining to sharing a scarce resource is difficult to attain or is considered impossible - violent conflict is viewed as the only option to secure the use of resources (Raleigh and Kniveton, 2012).
No-gain	Relative benefits from violence during rainfall shortages are too low to justify the effort or labour of violence – there is little to fight for during scarcity, instead local people's focus is on survival (Eaton, 2008; Owuor *et al*., 2011).
Self-sufficiency	Rainfall abundance and plenty of natural resources/supplies are unlikely to motivate individuals and groups to participate in violent actions – they are self-sufficient (Raleigh and Kniveton, 2012).

[6] Opportunity cost in this sense refers to the gap between the returns from participating in the legal economy (e.g. paid employment or private food cultivation) and from enlisting in militant groups/violent actions. Opportunity costs to fight decrease if this gap declines (Salehyan and Hendrix, 2014).

The economics literature (Dell *et al*., 2014; Prediger *et al*., 2014) indicates that scarcities can undermine economic activities, shrink government resources (i.e. gross domestic product) and capacity to support local populations. Variations in climate patterns can act to facilitate violence through income losses, rising unemployment and reduction in national tax (e.g. government revenues through land taxes) (Burke *et al*., 2015). This indicates that economic variables are important mechanisms, especially in low-income settings where extreme climatic events influence economic conditions through agriculture (Miguel and Satyanath, 2011; Koubi *et al*., 2012).

Climate-induced scarcity/abundance is widely discussed within the civil-war literature as an economic driver of conflict, particularly in arguments related to opportunity structures (i.e. opportunity costs of fighting) (Collier and Hoeffler, 2004). The argument suggests that on the basis of economic considerations, individuals would join violent actions when the benefits of doing so trump the costs. For example, supporting or joining insurgent groups offer several (material) benefits as rebels typically employ several economic incentives, besides political/religious indoctrination, forceful coercion and ethnic vocabularies (Maystadt and Ecker, 2014; von Uexkull, 2014; Jacob *et al*., 2016).

Economic hardship is crucial in relation to the relative deprivation narrative (Jakobsen *et al*., 2013), particularly if climate shocks influence income/wage level differentials across populations. In this view, conflicts between groups are much more likely, and may be much more prevalent under increased inequalities between individuals and groups (Seter, 2016). According to Fjelde and von Uexkull (2012), deprivation can be absolute or relative: it is absolute where a discrepancy exists between what people get and what they need; it is relative when there is a discrepancy between what they obtain and what they feel they should have. Political powers/coalitions play a role in deciding who gets what (i.e. they influence the spread or dynamics of relative deprivation). Therefore, individuals and groups inhabiting peripheral areas, and who lack political relevance, are often deprived of basic public services and effective state-governed institutional supports. Collective actions for economic resources in such settings usually follow ethnic or religious lines, and often can be violent. Further, conflicts linked to climate shocks can be portrayed in the zero-sum narrative, which presupposes that cooperation pertaining to sharing of a scarce/abundant resource is difficult to attain or is considered to be impossible when violent conflict is viewed as the only option to secure the use of resources (Raleigh and Kniveton, 2012).

Insights from the vulnerability literature suggests that mechanisms or pathways may differ between contexts, particularly in terms of differences in geographical locations and political economies across time and space (Singh and Moirangleima, 2012; Fjelde and von Uexkull, 2012). For example, the Sahel is often held to be particularly vulnerable to violent conflicts resulting from climatic events (Raleigh, 2010; Benjaminsen *et al.*, 2012), as dependence on climate-sensitive agricultural livelihoods, widespread deprivations and weak institutional support limit the region's coping and adaptive capacities (Tschakert, 2007). Like vulnerability studies, the livelihoods literature focuses on people's reliance on local income and food supplies from rain-fed agriculture (Ellis and Freeman, 2004; Nunan, 2010). One of the most frequently posed arguments is that the loss of agricultural livelihoods increases the likelihood of conflict (Deligiannis, 2012; Meierding, 2013). Anomalous climatic events undermine livelihood stability and over time can spur grievances amongst locals, which in turn may lead to antisocial behaviours, including conflict (Fjelde, 2015).

Although the influence of climatic events on livelihood performance and vulnerability is frequently brought forward, it is still a subject of controversy among scholars, and the theoretical and empirical understanding of livelihood losses and vulnerability as climate conflict transmission channels remains limited (Seter, 2016). For example, people in marginal areas facing livelihood hardship may be more concerned about preserving their livelihoods, and as such, focus their energy and time on survival or building adaptive capacities (Owuor *et al.*, 2011). They can take advantage of scarcity/abundance to build social ties and cooperation, rather than take up arms (Eaton, 2008). Indeed, depending on the context, scarcity can dampen people's motivation to fight as the potential gain may not be worth the risk during times of livelihood struggles (the no-gain narrative). Similarly, abundance can breed a sense of self-sufficiency, dampening the motivation to fight (the self-sufficiency narrative). Fighting is costly and can be suicidal during extreme droughts; so also is sustaining a militant group or a communal protest (Eaton, 2008).

A livelihoods or vulnerability lens for climate conflict research does not seek to universalise climate conflict issues. Livelihoods and vulnerability studies can combine to capture aspects of socio-political and economic desperations that create incentives for conflict (Deligiannis, 2012). Hence, it can be argued that violent responses to climate-induced livelihood hardships can be shaped by increased vulnerability, particularly in a context where socio-economic marginalisation/political exclusion and institutional weaknesses combine to weaken local adaptive capacities (Fjelde and von Uexkull, 2012; Tir and Stinnett, 2012). Such context can breed different types of conflicts (the common ones in SSA being rebellion against the state, communal violence, ethnic conflicts, including individual and group level conflicts). Although connecting mechanisms are becoming the norm, they should not be conceived as standard, law-like statements – rather, they should be understood in terms of contexts. Mechanisms play out differently depending on the context, and also condition how response (conflict) and predictor (climate) variables interact (Falleti and Lynch, 2009). This thesis draws on these various insights to empirically investigate climate conflict relations, particularly by focusing on the *context centrism* hypothesis in the context of vulnerability and lake drying.

2.6.4 Analytical considerations

The modal analytical issues surrounding climate conflict studies suggest that analysis around causal arguments should connect theories to empirical testing of climate conflict links (Seter, 2016). The logic is that since there is no automatic stimulus–response relationship, findings might be more convincing when research enquiries are based on identifying relevant causal mechanisms, selecting the range of cases where the outcome of interest is possible, and afterward adjusting empirical analyses to capture the hypotheses of interest (Burke *et al*., 2015). Broadly, the tight linkages between climatic and non-climatic factors that drive conflict make analysis of ‘pure’ climate-induced conflict somewhat difficult. The range of ways various causal factors interplay has been recognised in a bulk of recent studies (Salehyan and Hendrix, 2014; Wischnath and Buhaug, 2014; Papaioannou, 2016). For example, Bulke *et al*. (2015) elaborate how driving factors of conflict in general can be influenced by climatic changes, emphasising the need to place climate conflict links in a broader socioeconomic and political context.

Previous research has focused on various measures of conflict (mostly conflict onset, incidence and intensity – see Section 2.6.5) and different aspects of climate parameters (mostly rainfall, temperature, droughts and floods). The absence of standard measures for these variables represent one of the reasons for heterogeneity in results (Scheffran *et al*., 2014). Similarly, perspectives regarding the limited spatial impacts of climate and conflict within small areas in a country or region have encouraged the use of disaggregated approaches and sub-national data to better explain local variations in climate conflict interactions (Burke *et al*., 2015). Like the aggregated approaches at national and global scales, the results remain inconclusive. For example, results from East Africa, a common test bed captured in several subnational climate conflict studies, reflect this inconclusiveness: O'Loughlin *et al*. (2012) show that conflict is likely to occur under higher temperatures; Raleigh and Kniveton (2012) reveal that rebel violence can result from both rainfall shortages and abundance; Maystadt and Ecker (2014) suggest that drought drives local violence through variations in livestock prices; Linke *et al*. (2015) point to the need to focus on social and political contexts in efforts to understand climate conflict interactions. Studies in this location largely find no direct connections, rather they point to a variety of conditional forces based on contextual conditions.

Popular empirical analyses in this field utilise regression analyses (e.g. via time-series data) in which different shades of estimation techniques are employed based on the ways the response variable (i.e. conflict) is operationalised (e.g. logit for binary dependent variables and Poisson or Negative Binomial for count variables (Salehyan and Hendrix, 2014)). Nevertheless, regression approaches are faced with several drawbacks, implying that several checks must be undertaken to obtain robust results (e.g. drawing on ground-truthed knowledge of the study location). Although empirical, quantitative analysis can provide useful insights into cause-and-effect linkages between climate and conflict (unavailable for descriptive or qualitative approaches alone), inferences drawn often depend on the analytical judgement of the scholar. Also, quantitative analyses are usually conducted using pre-defined spatiotemporal units or scales. If units are not properly accounted for, the spatial or temporal variations in the climatic factor may not adequately match the response data, and the quantitative associations can be underestimated. The logic is to aggregate data to the same level of analysis spatially and temporally. Ideally, research into the conflict effects of climate shocks is inspired by data availability and methods that stem from conflict studies and climate impact/environmental change studies (Papaioannou, 2016).

Despite the analytical progress in the climate conflict literature, there remain obvious gaps regarding how the conflict-increasing effects of climate shocks may be theorised and modelled as a vulnerability-based question given that many of the facilitating forces in the literature often coalesce around the notion of vulnerability (Okpara *et al*., 2016a). There is a need to sufficiently reflect on the ways in which vulnerability may represent a valuable entry-point into empirical analysis and understanding of climate conflict links. This is one gap this thesis seeks to fill.

2.6.5 Approaches for quantifying conflicts

Most quantitative conflict studies that have assessed the risk of conflict onset or event have considered the occurrence of conflict/violence as the main variable to analyse. Employing logistic regression models, conflict, being a dependent variable, is often regressed against factors known to cause conflicts (Hsiang and Meng, 2014). In this case, the dependent variable is binary and often assign 0 for a country-year with no conflict, and 1 for the year conflict started, and missing for the periods of ongoing conflict (Hendrix and Salehyan, 2012; Klomp and Bulte, 2013). Other studies that assessed the incidence of conflict coded 1 for periods of ongoing conflict (Hauge and Ellingsen, 1998; Basedau and Pierskalla, 2014). The most often used proxy defines conflict as events causing the death of at least 25 persons and war as events causing the death of 1000 or more persons throughout the duration of the event (Themnér and Wallensteen, 2014). This simple way of quantifying conflict events has been widely criticised as it can become a ‘blind’ method of assessing conflict. For example, Stetter *et al*. (2011) faulted the use of the conventional threshold of 25+ annual battle deaths as common yardstick. They stated that the conflict spectrum stretches from non-violent expression of differences in opinion and value to outbreaks of violence. A number of authors (e.g. Buhaug, 2015; Seter, 2016) adduce to this submission, stressing the need to understand and incorporate the dynamics of conflicts in empirical assessments.

Conflict within a society exists not as a nominal level variable, i.e. something that is present or absent. Rather, it encompasses a wide range of conditions from latent or no significant conflict (distrust and frustrations that are underlying but not expressed) to manifest or cold conflict (where groups are aware of conflicting interests and voice their divergent positions e.g. through nonviolent demonstrations or strike actions) and violent conflict (where major hostilities are imminent or realized or as seen in extensive war acts causing deaths, dislocations or high strategic costs) (Gemenne *et al*., 2014). Few quantitative studies (Zeitoun and Warner, 2006; Bernauer *et al*., 2012) have attempted to code the intensity of conflict on an ordinal multilevel scale accounting for a taxonomy of conflict indicators. In this case, levels of conflict are categorised and coded according to intensity. Conceptually, a measure along an ordinal multilevel scale makes sense. It seems to capture the complexity of the dynamic process of conflict, and appears to reduce the methodological challenge in conflict studies. However, in practice it is difficult to objectively assess (the 'quantity' of) conflict this way. It is challenging to identify a fully inclusive set of mutually exclusive categories, hence the reliance on the 'conflict presence and absence' approach.

Throughout the literature, conflict types, intensity and dimensions have often been defined and described within the specific context in which a given study is grounded. There are no conflict studies that provide a compelling reason to suggest that any one approach (binary, categorical or continuous) to quantifying conflict is or will be superior. Each of the operationalisation methods has strengths and weaknesses. Following Raleigh and Kniveton (2012) and Raleigh *et al*. (2015), this thesis operationalises conflict events/incidence as a count variable (see Chapter 3, Section 3.8).

2.7 Summary of chapter two

Addressing climate adaptation and water challenges in ways that promote cooperation is vital in advancing livelihood opportunities that enhance the well-being of lake dwellers. Cross-thematic integration, through the water channel, represents one route towards this goal. Understanding climate conflict relations, particularly in transboundary settings, can offer the needed insights to drive this goal. Climate conflict analysis, nevertheless, remains controversial, with several conflicting discourses framed around different disciplinary perspectives and geographical contexts. This chapter has synthesised the key debates and gaps in the literature, and outlined how this thesis seeks to contribute towards addressing them, particularly in relation to the need for climate conflict research to be grounded in insights from livelihoods and vulnerability assessments. The theoretical and analytical insights guiding this research have been flagged up, particularly the *context-centric* discourse hypothesis, the ‘relative deprivation’, ‘no-gain’ and ‘self-sufficient’ narratives, and the notion of contextual vulnerability. The SLA and indicator-based vulnerability assessment approaches have been presented as the analytical bases for the livelihoods and vulnerability assessments carried out in this research. The next chapter presents the research design and methodology, drawing on key analytical insights from the literature review and synthesis carried out in this chapter.

Chapter 3

Study area, research design and methodology

Outline

This chapter describes Lake Chad (and its basin), highlighting its geographical significance in west-central Africa, as well as its different shrinking phases. The research design and approaches presented are discussed around three main phases of the research. The research phases guided the multi-method data collection and analysis applied to realise the research objectives outlined in Chapter one (Table 1.1). Phase one (Section 3.4) involved field-based participatory research conducted in the south-eastern shores and islands of the LCB in the Chadian Hadjer-Lamis region. Phase two (Section 3.8) used secondary data covering four distinct Lake Chad riparian zones from 1980 to 2015 to investigate climate conflict relations. The third phase (Section 3.9) involved the collection and qualitative analysis of policy intervention documents developed or promoted by the Lake Chad Basin Commission (LCBC) (a regional organisation mandated to govern the use and allocation of the resources in the LCB). Each phase presents a wide range of methodologies applied in the research. While phases two and three covered the broader Lake Chad region, phase one focused on a village-level case study in order to unpack the livelihoods and vulnerability concerns in the Lake region. Research ethics and positionality considerations associated with the field-based participatory research undertaken in Chad Republic are outlined, together with the spatiotemporal specifications of the secondary data used.

3.1 Background information on Lake Chad and its environment

Lake Chad's location, within the borders separating Cameroon, Chad, Niger and Nigeria (Figure 3.1), is geographically significant in west-central Africa because of its cultural and socio-economic prominence as the region's agricultural heart-land. It is situated between latitudes 11°N and 15°N and longitudes 12°E and 16°E, and sits within a basin regarded as the largest endorheic basin in the world (Ovie and Emma, 2012) - a closed, freshwater basin with no surface outflow.

The Lake sits at a transition zone which divides the Sahara Desert to the north and the more humid savannah to the south. It is the fourth largest lake in Africa (Magrin, 2016). Water enters the Lake through two of its main drainage systems (Figure 3.1; Odada *et al*., 2006): the Chari-Logone River (which flows south-to-north of the Lake along the boundaries of Cameroon and Chad) and the Komadugu-Yobe River (on the Nigerian side). Lake Chad also receives water through direct rainfall during the wet season (May to October). The Chari-Logone River supplies most of the waters in the Lake (approximately 90 %) (Gao *et al*., 2011).

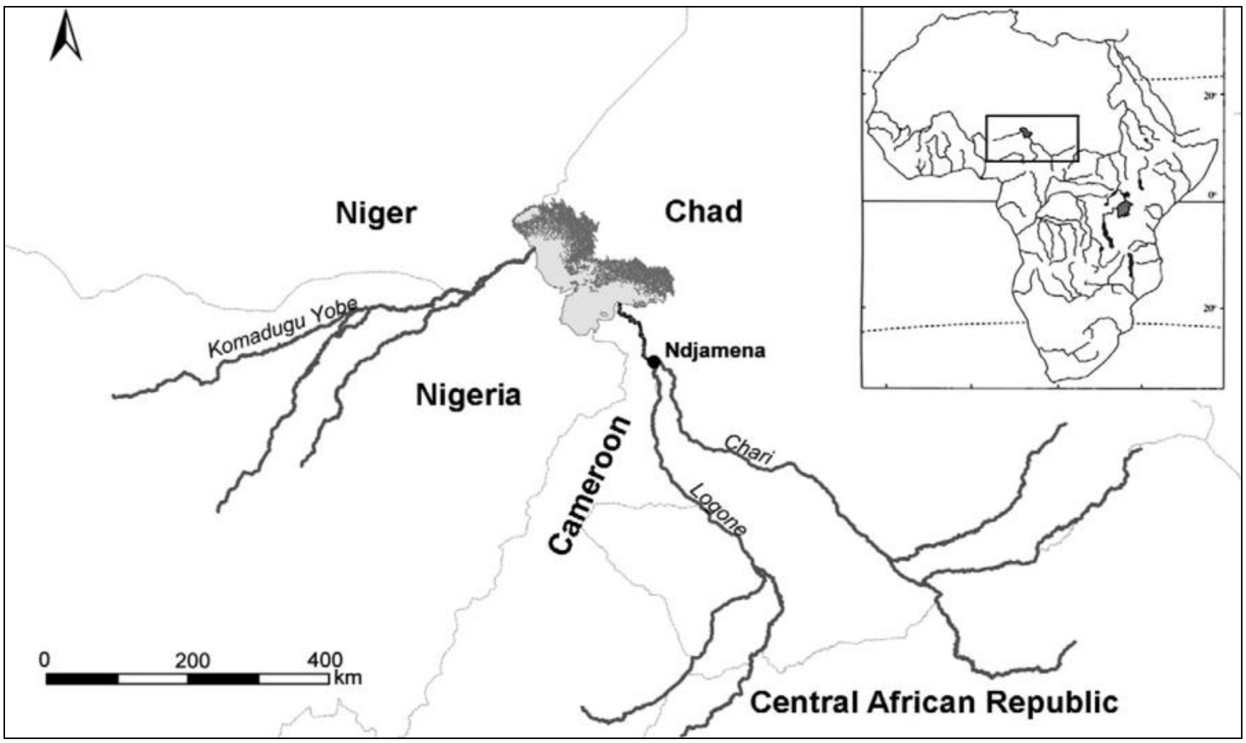

Figure 3.1: Location of Lake Chad in Africa showing its four main riparian countries and major tributaries (Chari-Logone and Komadugu-Yobe Rivers) (*Source*: Modified from Magrin, 2016)

At 25 000 km^2 open water area in the 1960s, Lake Chad was the world's sixth largest inland water body (Odada *et al*., 2006). The Lake today is a shrivelled, fragmented collection of two distinct water bodies, the northern and southern pools, dotting a drought-prone, desiccated landscape within the arid and semi-arid Sahel corridor. Satellite images and aerial photographs have been used to monitor the Lake's fluctuations since the 20th century and evidence indicates the Lake has shrunk by over 95 % between 1960 and 2010 (Leblanc *et al*., 2011). Five major recession phases of the Lake occurred during the 19th and 20th centuries, during which the Lake was alternatively described as a Mega, Large or Normal, Average, Small and Dry Small Lake Chad according to its water levels, depth and areal dimensions (Table 3.1, Figure 3.2).

Table 3.1: The different phases/states of Lake Chad over time based on Lake Chad Development Expert Group Review, 2014 (cited in Mekonnen, 2016)

	Lake Chad Phases				
Attributes	Dry Small	Small	Average/Medium	Large/Normal	Mega
Inflows from the Chari-Logone (km^3/year)	< 15	15 – 34	35 – 43	> 43	>50
Water level (m asl)	Dry northern basin	Different levels (<275)	280 – 282	>282.3	>285
Number of water bodies	Several	Several	One	One	One
Flooded area of the northern basin (km^2)	0	0 – 8 000	9 000	10 000	>10 000
Dominant landscape	Swamps and savannas	Swamps/marshes	Dune archipelago	Open water	Wide open water
Aquatic vegetation	++	+++	++	+	+
Time period	Few years in the 1970s and mostly in the 1980s	1973 to present, except for "Dry Small" periods	1954 – 1972	1953 – 1954	Before the 1950s
Estimated size (km^2)	500 – 1 410	3 000 – 14 000	18 000 – 22 000	22 000 – 25 000	340 000 – 400 000

Causes of the shrinkage are reported by many (Gao *et a*l., 2011; Lemoalle *et al*., 2012; Magrin, 2016). They include increased irrigation withdrawals (i.e. agricultural and urban withdrawals along the Chari-Logone River and abstractions via the dams along the Komadugu-Yobe), decadal rainfall shortages spurred by the droughts of the 1980s, increased surface water evaporation, and infiltration into the ground[7]. Another reason is related to the characteristic shallowness of the Lake, which often does not exceed 11 m - implying that small variations in the water volume have large impacts on its size (Steely, 2014). The Lake is known to have fluctuated markedly in geological history, even completely drying up in the 1400s (Odada *et al*., 2006), yet the extent to which the recent drying is caused by each of these factors remains unclear. What is clear is that all of the factors have some kind of an impact (Gao *et al*., 2011).

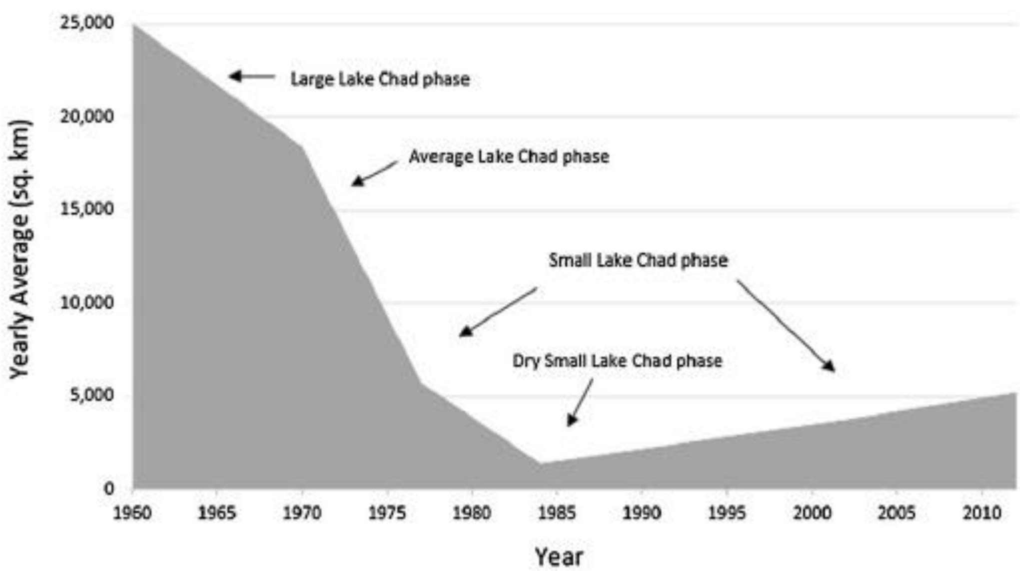

Figure 3.2: Open surface area of Lake Chad (stacked area graph with arrows pointing at lake levels for each specific phase – highlighting the various shrinking phases from 1960 to 2010). Data received from the LCBC in N'Djamena

The climate of Lake Chad is characterised by high temperatures, strong winds, high evapotranspiration (estimated at 2 200 mm/annum) and fluctuating rainfall patterns (Odada *et al*., 2009). Annual rainfall varies spatially from nearly 1,400 mm along the southern pools to less than 150 mm near the northern end (Okonkwo *et al*., 2013). The history of drought in the Lake area is defined by its changing rainfall patterns. From the middle of the 1960s, rainfall started to drop intermittently until the droughts of 1972 - 1975 which coincided with the shrinking of the

[7] The nature of the Lake's bathymetry makes it vulnerable to water losses.

Lake to about 10 700 km^2 from its initial area of 25 000 km^2 in 1963. Another drought of 1982 - 1985 resulted in a drop in Lake area to 1 410 km^2 and then 500 km^2, the lowest basin surface level recorded over the past 100 years (GIWA, 2004). The Lake is surrounded by a variety of ecological zones, including deserts, forests, wetlands, savannas and mountains, and large marshland. By serving as a home to almost 372 species of birds, 120 species of fish and larger game such as hippopotamus and crocodiles, the Lake represents an important African biodiversity hotspot (Ovie and Emma, 2012). Fertile vegetation thrives at the Lake's northern portion where the water has disappeared, and where overgrazing and desertification are a major challenge.

The Lake supports an integrated small-scale economy made up of agricultural livelihoods, and provides a lifeline to over 30 million people in four countries. The population distribution is highest in the Nigeria area and lowest in the more arid northern areas in Niger Republic. The population is predominantly rural and characterised by youthfulness in terms of age structure. In Niger, for example, nearly 50% of the population is under 15 and only 2% are aged over 65 (LCBC, 2014). Further, the Lake region represents a multi-directional corridor of human migrations. Historically, populations in Lake Chad constantly migrated in a pattern in synchrony with shrinking shorelines and lake levels (Odada *et al*., 2006). Two populations movements are notable – one from the East of the Lake represented by the Arabs and the other from the West, represented by the Fulanis (Cerezo *et al*., 2011). Its yearly cycles of wet and dry seasons enable the co-existence of three populations with different lifestyles: sedentary crop farmers, fishermen and nomadic pastoralists. Together they represent the producers and consumers of primary commodities in the region. The Lake's dramatic shrinkage has resulted in water shortages for several lakeside communities engaged in agriculture, a condition that has put a strain on local resource users who require water to irrigate their farmlands, raise animals and increase their fish stocks.

The 2015 Human Development Report (UN Human Development, 2015) reveals that the Lake Chad countries are among the least human developed countries, with Niger being the least developed (poorest) country globally. The human development indices for the Lake Chad zones are far lower than national averages, which themselves are lower compared to global standards

(Mekonnan, 2016). Table 3.2 presents a summary of the human development outlook for the Lake Chad countries.

Table 3.2: Human development report for four Lake Chad countries (UN Human Development, 2015)

Country	HDI*	MDI**	Rank	Remark (summary of the 2005 – 2014 surveys)
Nigeria	0.514	0.279	152/188	30% households are in severe poverty, with majority in the North east region
Cameroon	0.512	0.260	153/188	35.9% in severe poverty
Chad	0.392	0.545	185/188	87% of the population live in severe poverty
Niger	0.348	0.584	188/188	73.5% population is in severe poverty

* HDI: Human development index is a summary of long and healthy life, access to knowledge/decent standard of living – which are the key dimensions of human development. Maximum HDI is 100% (1.0).

** MDI: Multidimensional poverty index indicates the percentage population that is multi-dimensionally poor; it identifies multiple deprivation at the household level in education, health and standard of living using micro-data from surveys (maximum deprivation score is 100%; i.e. 1.0).

Recognising the Lake Chad's dynamic nature and the importance of collectively preserving the resources of Lake Chad and its basin, the four riparian countries (Cameroon, Chad, Niger and Nigeria) signed the ground-breaking Fort Lamy Convention in 1964, which led to the establishment of the Lake Chad Basin Commission (LCBC), reputed as Africa's oldest basin institution (Odada *et al*., 2006; Steely, 2014). The goal of the Convention was to enable cooperation in managing the Lake's resources (Sand, 1974). During the mid-1990s, the Convention was amended to admit Algeria, Central African Republic (CAR), Libya and Sudan, as riparian partners of the wider basin area.

The current state of the Lake is one of acute water shortage. In 2000 water supply was less than 500 m^3 per person per year (Henninger *et al*., 2000); this has not changed to date though the population has continued to increase. A change from cultivation of low water intensity food crops (such as wheat) to high water intensity food crops (such as rice) has added to the water demand and scarcity (Odada *et al*., 2006). Water scarcity is increasingly perceived to be associated with the myriad of socioeconomic and livelihood shifts around the Lake, for which climate disturbances act as an amplifier. In light of the varied theoretical narratives that characterise the climate conflict literature identified in Chapter 2, the LCB is considered an appropriate case study location for this research because it exhibits the conditions suitable for understanding the *climate centric* narratives, particularly in the contexts of contextual vulnerability and lake drying.

3.2 Research design

The research design developed for this thesis encompasses six stages (Figure 3.3) which make up the three research phases [8] presented in this chapter. While the research phases point to the different objectives, the stages identify the steps taken across the various phases in order to realise the research objectives set for the thesis. The first stage involved: (i) searching for and reviewing the relevant literature on livelihoods, vulnerability, climate adaptation, the LCB, water governance and conflict management, and climate conflict relations, (ii) selection of the study location in the LCB, (iii) identifying data requirements and drafting the preliminary/pilot questionnaires based on key selected research questions, and (iv) identifying and making contacts with relevant informants in preparation for the first field visit. This stage touched on all the three research phases (see Figure 3.3). The first field visit to Lake Chad in Chad Republic (an exploratory scoping study) was carried out during stage two. The purpose and outcomes of this are outlined in Section 3.4.2. The third stage involved an assessment of the findings and observations from the scoping study. The knowledge gained from this exercise was used to: (i) contextualise the climate conflict research need for the LCB and draw insight for the final research questions and objectives, (ii) select specific study villages and zones, (iii) define the need for language support and research collaborators, and (iv) prepare for the main fieldwork.

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[8] The phases are distinguished by data and methodologies used. Phase one targets objectives one and two (which are based on participatory field research). Phase two focuses on objective three (which is based on statistical regression analysis of secondary data – see Section 3.8). Phase three addresses objective four (which is mainly a qualitative analysis of policy intervention documents – see Section 3.9). The six stages presented in Figure 3.3 cover the steps taken across the various phases of the research.

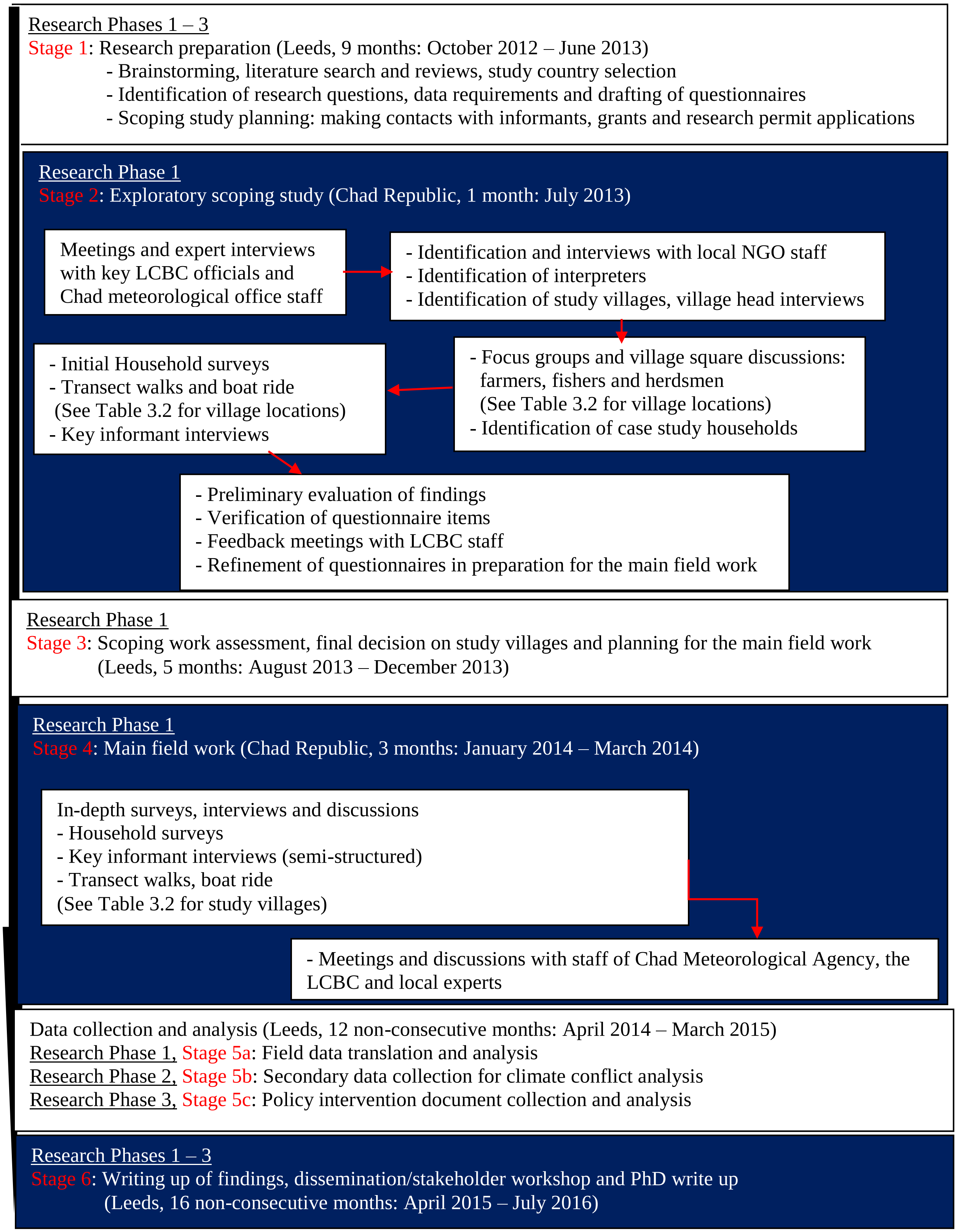

Figure 3.3: Integrated research design and the various research phases

Stage four involved several months of fieldwork in Chad during which detailed surveys, interviews and group discussions were undertaken. Section 3.4 outlines the various components of the main fieldwork. During stage five, field (primary) data were transcribed and analysed (Stage 5a). Secondary data for climate conflict analysis (Stage 5b) and policy intervention documents (Stage 5c) were also collected and analysed (see Sections 3.8 and 3.9 – these captured the second and third phases of the research).

Stage six involved further analysis and writing up the research findings, as well as disseminating them through journal articles, conference engagements and a stakeholder workshop. Writing up the PhD thesis was also undertaken during this stage.

The data and methodologies utilised in the research are presented in detail in Sections 3.4, 3.8 and 3.9.

3.3 Research approaches

Varied approaches were used to achieve the research objectives. These include field-based participatory livelihood assessments based on perspectives from the SLA (Chapter 4), indicator-based vulnerability assessments (Chapter 5), negative binomial regression evaluations of climate conflict hypotheses (Chapter 6), and qualitative document analysis (Chapter 7). This integrated set of approaches was vital as this research spans security dimensions of climate shocks and context-specific livelihoods and vulnerability assessments in relation to lake drying. Research encompassing these various themes inherently requires the use of multi-method approaches that provide the necessary empirical grounding for data collection and hypotheses testing, as well as offering opportunities to conduct research that satisfies the information need of policy makers and development actors (Thaler, 2012; Buhaug, 2015).

The approaches employed were informed by the research objectives, and they cover qualitative-quantitative case studies and theory testing approaches. Objective one focused on identifying the ways in which lake drying (i.e. the Small Lake Chad) influences livelihood drawbacks and opportunities, and the range of mechanisms that shape the connections between these issues. To achieve this objective, responses from household surveys, key informant interviews and focus group discussions (involving different farmer, fishermen and pastoralist groups) were analysed following a livelihood analytical approach (Ellis, 2000; Jagger *et al*., 2012). Achievement of objective two followed similar patterns of data gathering adopted in objective one, except that indicator-based vulnerability and double exposure approaches (see Chapter 5; Okpara *et al*., 2016c) were used to analyse the data - in order to identify and compare the vulnerabilities of farmers, fishers and pastoralists to double exposures.

The steps taken to address objectives one and two are highlighted in stages 1 – 6 in Figure 3.3. The scoping study enabled an initial visit to seven case study villages where focus group discussions and interviews with local leaders were conducted. The scoping approach involved using local gate-keepers and a lake-based NGO to track lakeside villages, including research participants with varied experiences related to the research themes (see Section 3.4.2). This was followed by a second visit which involved more detailed rural livelihood and vulnerability assessments (Small, 2007; Shah *et al*., 2013). The field-based participatory approach used for data collection enabled respondents to provide answers to a set of questions pertaining to their livelihoods and vulnerabilities in the context of lake drying (Jagger *et al*., 2012). Approaches in which respondents are viewed as providers of data (e.g. by using questionnaires and discussion/interview schedules), provide a means of integrating knowledge gained from livelihoods and vulnerability studies into climate conflict research (Linke *et al*., 2015; Seter, 2016).

The third and fourth objectives focused on the broader Lake Chad riparian zones, which are mostly areas where village-level data could not be collected because of fierce fighting and kidnapping activities (Cold-Ravnkilde and Plambeck, 2016). Secondary data were collated from a variety of sources (see Sections 3.8 and 3.9), including from the LCBC. In the achievement of objective three, three interrelated approaches were adopted: (i) creating an event dataset to document past and current conflicts in four Lake Chad riparian zones covering Far North Cameroon, Far West of Chad Republic, South East Niger and North East Nigeria; (ii) creating indicator variables encompassing biophysical (i.e. rainfall anomalies and lake drying variables), socioeconomic (e.g. population and income variables) and vulnerability factors (political exclusion, democracy and agricultural production variables); and (iii), formulating and testing theoretical hypotheses on climate conflict relationship (Burke *et al*., 2015) (see Section 3.8).

Addressing objective four involved using qualitative document analysis (QDA) to identify and evaluate policy intervention documents, and to advance the need to integrate adaptation, water governance and conflict management goals (Section 3.9; Chapter 7). The QDA approach followed two steps. First, document screening/reading (Gerstetter *et al*., 2011) was undertaken to identify whether subjects pertaining to adaptation, water governance/management and conflict management/peacebuilding featured in the LCBC's policy actions and initiatives. This represented an important first step in pinning down both the contents of policy goals/initiatives and the drive towards integration (Altheide *et al*., 2008). Second, a subjective scoring approach was developed to identify whether and how integration is happening, including lessons for future planning (see Section 3.9).

Using these different approaches provided a comprehensive range of data which enabled this research to link the multi-level results from both village-level participatory approaches of livelihood and vulnerability assessments to the broader Lake Chad regional assessments of climate conflict interactions and policy intervention efforts. Also, the approaches enabled the identification of issues that offer insights into the ways local people might be assisted by governments and development actors. Figure 3.4 summarises the research approaches, as well as indicating the linkages between the various research objectives and methods.

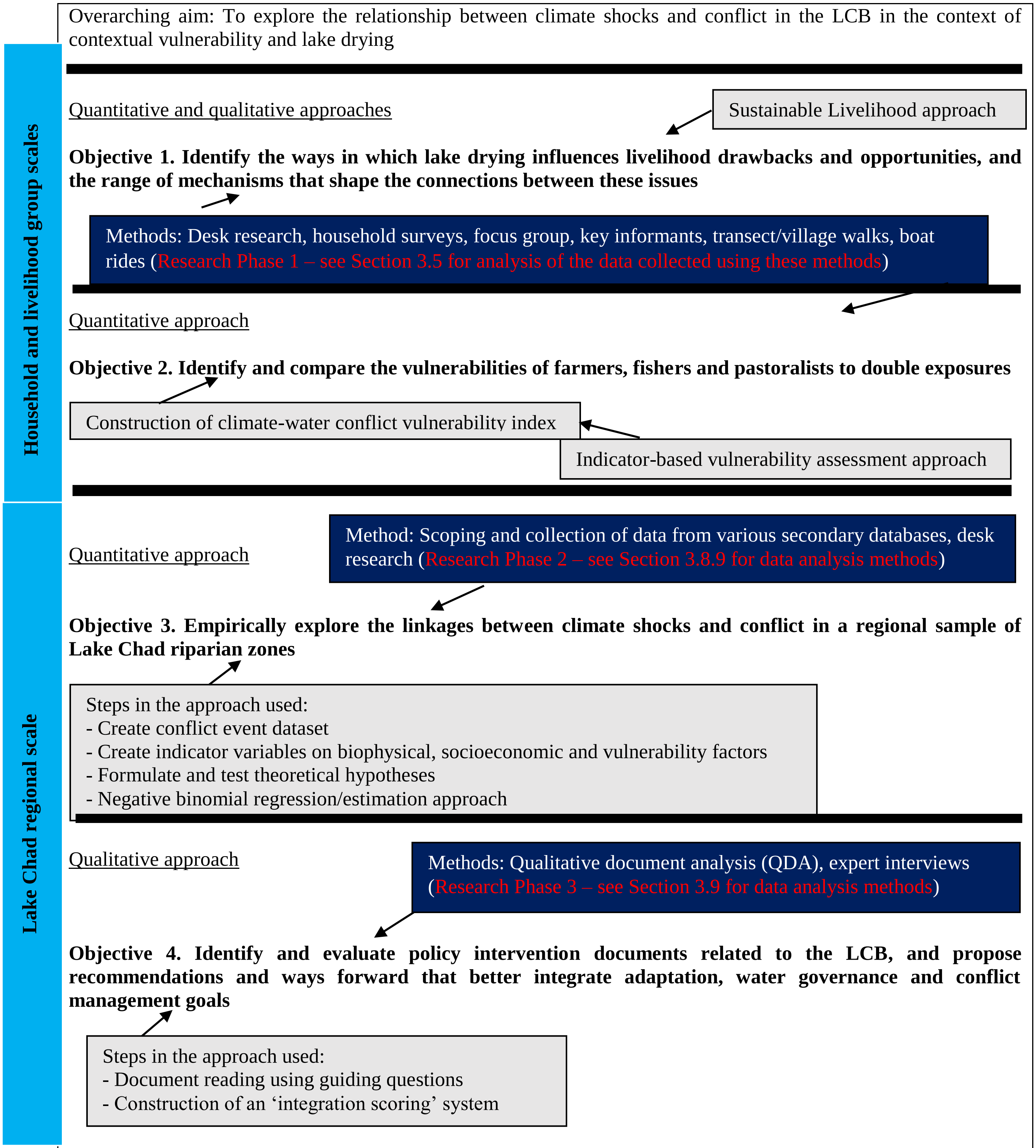

Figure 3.4: Synthesis of the research approaches and links between research objectives and methods

3.4 Data and research methodology 1: Livelihoods and vulnerability assessments

A detailed explanation covering the case study villages, sampling and data collection techniques, as well as the merits and limitations of each method applied during research phase one is presented in this section. The research methodology focused on capturing and understanding local contexts: the prevailing socioeconomic and environmental factors influencing people's lives; experiences and views about the environment in which they live and work; and interactions (i.e. how various livelihood groups interact and co-habit). The principle guiding the methodological approaches used is based on a constructivist logic that: (i) people differ in their views, experiences and understanding of socioeconomic and environmental realities; (ii) social issues related to livelihoods and vulnerability cannot be fully understood outside the local contexts in which people live and work; (iii) interactions with respondents through use of participatory methods embedded in a case study research design can be a useful means of generating data to describe specific events or phenomenon.

The discussion on the study location pertains to the villages where the livelihoods and vulnerability research phase of this thesis (i.e. phase one) were conducted.

3.4.1. Case study location, village selection and characteristics

The case study location is the south-eastern shore and islands of the Small Lake Chad (SLC) (Figure 3.5) in the administrative department of Haraze Al Biar in the Chadian Hadjer-Lamis region (12° 53″ N; 14° 37″ E). Lake Chad's water resources support agricultural livelihoods spanning several rural villages in south-eastern Chad (Odada *et al*., 2006). Although the Lake lost more than 90% of its waters between 1963 and 2012 (Lemoalle *et al*., 2012), the Chadian shore continued to hold a large portion of the Lake's waters. It was observed during the scoping study (see Section 3.4.2) that the severe droughts of the 1980s (Leblanc *et al*., 2011) pushed several of the Lake's populations towards the Chadian shores and islands where the remaining open waters allowed for crop cultivation, fishing and cattle herding – these livelihood activities have created spaces for frequent trading and interactions amongst migrants of diverse ethnic groups at this portion of the Lake.

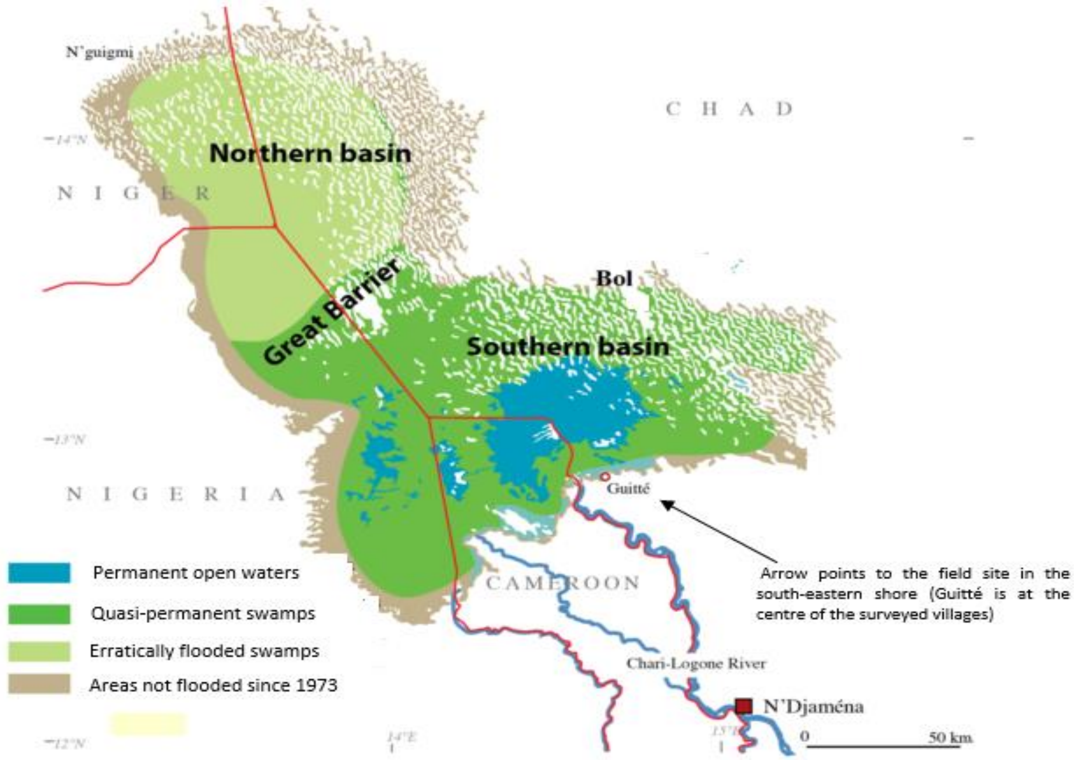

Figure 3.5: Study area showing the average situation of Lake Chad in its 'small state' (2010-2015). The Great Barrier demarcates the southern pool of the Lake from the northern portion. (*Source*: Modified from Mekonnen, 2016)

Lake Chad is recognised as a location where human security is and will be progressively threatened under unfavourable environmental conditions (Kafumbata *et al.*, 2014). Security, in terms of absence of threats or safety from violence, is a vital consideration for research success in fragile locations (Vivekananda *et al.*, 2014). The precarious security situation around the Lake, as evident in the manner the Lake environment acts as a cover for criminal and terrorist activities (Ifabiyi, 2013), limited the choice of case study location to the Hadjer-Lamis region and to the seven villages selected for this research (Table 3.3). The presence of open waters in this location also informed this choice. Following these considerations, the villages were jointly decided upon for data collection in 2013/2014 by the researcher, the LCBC and a local NGO, the Chadian Indigenous Peule Mbororo Association.

Table 3.3: Characteristics of study villages and household surveys undertaken.

Villages surveyed	Mean [a] household size	Location [b]	Estimated [c] households	Number of household heads sampled
Farming villages:	8.68 (4.79)			
Miterine		Middle-distant	93	40
Guitté [b]		Near-to-road	186	80[d]
Fishing villages:	8.71 (3.41)			
Kaesai		Remote island	70	30
Basara		Remote island	69	30
Kouri (Topio)		Remote island	47	20
Pastoral villages:	8.80 (3.37)			
Dandi		Near-to-road/forests	70	30
Ngurutu		Remote camp	23	10
			(558)	(240)

[a] Values in parentheses are standard deviations.

[b] Near-to-road village is within vehicle access (120 – 130 km) from N'Djamena and have a central market and bus/fuel stations; the middle-distant village is a long way off the paved roads (about 150 km from N'Djamena), accessible through unmarked tracks by motor bikes; remote islands where the fishermen live are accessible by boat or canoe; vehicle or motor bike access to remote locations is difficult without a guide who is familiar with the rough terrain. Access is usually not possible during rainy seasons.

[c] Estimates are based on personal communications with local chiefs.

[d] Guitté is a 'mixed' village where majority of households engage in either farming and herding activities or both; income-source ranking enabled the selection of 40 farmers and 40 herders from the village.

Other specific reasons that informed the selection of the villages include the following:

- The villages are in close proximity to the Lake: previous studies conducted in the vicinity of Lake Chad suggest that the closer villages are to wetlands and lakes, the more they depend on resources from such water bodies (Bene *et al.*, 2003; Onuoha, 2009);

- It was considered that people living in villages close to the Lake would be more impacted by water-level fluctuations in the Lake because they depend on the provisioning services of water from the Lake for various farming, fishing and pastoral activities;
- Specific climate markers (e.g. droughts and water scarcity) represent a characteristic environmental feature of the villages;
- The existence of local governance structures (e.g. the presence of local chiefs or *Bulama*), including the willingness of the local leaders and the people to participate in the research;
- The accessibility of the villages by road, canoe or bush/forest paths.

The villages were categorised as outlined in Table 3.3, according to farming, fishing and pastoral livelihood activities. The majority of fishermen were resident in Kaesai, Basara and Kouri villages on the Lake's islands while pastoralists were found in village locations in Dandi and Ngurutu. Miterine is a farming village close to Guitté where livelihood activities are mixed. Prominent livelihood activities, in terms of contribution to income, differ considerably among the villages. The livelihoods of fishermen on the island villages largely revolve around fishing (contributing almost 70% to their annual income). In Guitté where livelihood activities are relatively mixed and households are either farmers or livestock herders or both, the researcher conducted an 'income source' ranking exercise to identify and categorise households according to the two main livelihood activities (see Section 3.4.7). This way, the researcher was able to properly group and compare households according to their livelihood activities, and tease out the influence(s) of the SLC on each group. The selected villages are geographically remote (and sparsely populated), being over 80 km from N'Djamena. They were considered representative of the majority of villages in the south-eastern shores of the Lake that are generally and historically exposed to disruptive climate extremes and conflicts. As such, they reflect a range of environmental and socioeconomic characteristics that are well suited for in-depth livelihood and vulnerability assessments.

Existing SLC water-bodies around the villages, including the permanent and seasonal ponds and the Lake's open waters, provide important livelihood options in farming, fishing and livestock herding for the sedentary and nomadic population. Average annual rainfall is approximately 200 - 500 mm with maximum rainfall observed during July – September. Average temperature is approximately 27 ^{0}C, ranging from 21 - 36 ^{0}C throughout the year (Amaral *et al*., 2013). Common crop types are maize (*Zea mays*), potatoes, soybeans, millet, wheat, sugarcane and vegetables (FEWS, 2005). Soils close to the Lake are largely drought-prone, and can easily be flooded during extreme flood years (Luxereau *et al*., 2012). Property rights encompass *ndouba* (village owned) and private (landlord) arrangements, except for land within the lake floor, floodplain and wetland areas, which is held and allocated by the local authorities (the imams and *bulamas*) (USAID, 2010). Fishing takes place both in the open water at the centre of the lake basin and along pools and water channels around villages and islands. Access to fishing, especially in open waters, is determined by the Chadian government and regulated by local authorities and the Joint Patrol Team (a team of regional security personnel guarding the open waters). Livestock herding is largely transhumant. The dominant ethnic group is the Arab Shuwa. Other groups present include the Kotoko, Guran and Wadai. The common languages spoken are Shuwa/Chadian Arabic, French and Hausa.

Although there are studies that explain water and livelihood conditions in the northern pool of Lake Chad, particularly those focusing on either the fishers or farmers or both (e.g. Sarch, 2000; Luxereau *et al*., 2011), there is limited research on current conditions in the relatively more socially stable south-eastern shores of the Lake. This research extends the livelihood and vulnerability research lens to this portion of the Lake in order to better understand farming, fishing and pastoral livelihoods and the directionality of vulnerabilities, including understanding how local people perceive the drying of the Lake and the benefits they have lost or gained.

3.4.2 Scoping fieldwork

Scoping fieldwork was undertaken between 8 and 24 July 2013 with the following goals:

- Identifying and gaining preliminary understanding of the livelihoods, vulnerability, climate and conflict research need for the LCB;
- Establishing research links for collaborative engagements with relevant actors (i.e. the LCBC, government ministries, local NGOs) and stakeholders (village heads and opinion leaders);

- Identifying research locations/villages and data collection approaches suitable for the area;
- Establishing language support requirements/need for interpreters;
- Re-interpreting the existing literature as it applies to the LCB context and evaluating the breadth and comprehensiveness of the preliminary interview and survey instruments to facilitate the main fieldwork.

Upon arrival in N'Djamena where the LCBC office is located, initial meetings were held with key members of staff of the commission, including the executive director and the legal adviser. During these meetings, the purpose and scope of the PhD research were presented and discussed. Through the assistance of the commission's legal advisers, ten semi-structured interviews were undertaken with relevant experts working for the commission (the experts have specialist knowledge on the Lake region, including climatic and local livelihoods conditions, and they include the LCBC hydrologists, wetland experts, transhumance experts and chief language translators). The LCBC later connected the researcher to a local NGO, the Chadian Indigenous Peule Mbororo Association, whose humanitarian activities cover a large part of the villages in the Chadian Hadjer-Lamis region. An initial interview was held with the leader of the NGO to better understand the broader socioeconomic and livelihood contexts of the region, and obtain information about language support and the need to recruit research assistants.

The scoping study involved travelling from N'Djamena to the hinterland/lakeside villages and islands of Lake Chad in western Chad where a part of the Chadian shores of Lake Chad is located. Entry into the lakeside villages and islands was facilitated by the NGO during one of its missions to the Lake areas. The NGO works with several key village gate-keepers in the villages surveyed in this research - these are individuals residing in the various villages who have strong local contacts with village heads/opinion leaders, and who provided easy access for village meetings. Seven meetings were arranged (i.e. one in each of Ngurutu and Dandi transhumance villages, the Miterine farming village, Guitté mixed village, and Kaesai, Basara and Kouri fishing villages)[9] which led to seven semi-structured interviews with village heads covering the objectives and key themes of the research. Impressed by the environmental and socioeconomic scope of the research, particularly because the research encompassed issues of interest to the Lake populations, each of the village heads initiated village square (group) discussions (in the form of an open village gathering). As such, seven village square discussions were held. The interactions, grounded in locally-appropriate practices, focused on getting the local leaders and their subjects to communicate openly on the research themes and to identify their main livelihood challenges, including the various ways they have been coping with/adapting to prevailing conditions (Figure 3.6). The open village square meetings further led to eight livelihood group (focus groups) discussions with different farmer, fishermen and pastoral groups (see Section 3.4.5).

Figure 3.6: The researcher introducing the research to the Kouri fishing village, an island in the Lake Chad area with the NGO leader helping with local language communications

[9] See Table 3.3 for village categorisation – the villages are about 12 - 50 km apart. Mixed village refers to a village where livelihood activities are diverse and range from farming, fishing, herding to trading and transportation.

Exploratory questionnaire surveys with fourteen households (two in each village selected using a snowball approach) were undertaken to gain preliminary insights into resource users' perceptions regarding the lake conditions, and its influence on their livelihoods, including the various vulnerability forces influencing them. Using a snowball sampling method (see Section 3.4.3) enabled the establishment of various collaborative links, as well as broad information required to pre-test the survey instruments in order to address any ambiguous questions or language that might lead to different answers depending on participants' interpretation. Internal quality control measures were established to ensure that the survey questions convey a common definition and interpretation (to enable this, the researcher administered all the questions himself).

Security personnel guarding the lake waters were also interviewed (three semi-structured interviews in all with notes taken) to gain insight on the security dynamics of the Lake area. Further, two key staff of the Chadian Directorate of Water Resources and Meteorology were interviewed on the weather and climatic conditions of the Lake area. The scoping study provided opportunities for transect walks and boat rides with local gate-keepers between the lakeside villages and villages on the islands in order to have an open overview of the livelihood activities and lake water conditions, and to reconcile information gathered through meetings, discussions and interviews with realities on the ground. Details on the transect walks and boat rides are provided within Section 3.4.6.

The scoping study provided valuable information for decisions regarding which village location and livelihood groups to include as part of this research. The scoping study did not suggest a research assistant was needed, rather it revealed there was need for competent interpreters to provide language support (in French, Arabic, Hausa and other local dialects) for the main fieldwork. Language is a door-opener, as such, working with experienced translators who understand local languages and traditions can enable effective and swift data gathering. Based on the LCBC's recommendations, two interpreters were contacted during the scoping study and recruited during the main field work.

After completion of the scoping study, the researcher visited the LCBC commission's library to access previous research work on Lake Chad, including climate-related information. Also, a feedback meeting was held with the LCBC contact person [10] to clarify and validate the preliminary information obtained from the scoping exercise. The information generated through the scoping exercise was assessed by reviewing all field notes (as well as data in the questionnaires) taken during meetings/discussions and interviews, to identify key trends and emerging thematic issues, in terms of similarities and differences. Categorising the information and integrating insights from written materials obtained from the LCBC enabled the researcher to better reflect on the ways in which the main fieldwork should be conducted. The information obtained also enabled the refinement of the research focus (including the research instruments – survey questionnaires, question and interview guides) in readiness for the main fieldwork (for example, it was realised that the recall ability of locals in terms of quantitative conflict events was limited, thus questions related to conflict counts were deleted from the final survey instruments).

3.4.3 Sampling methods [11]

Major choices about livelihood activities are taken at the household and livelihood group levels (UN, 2008). As such, it was considered desirable to conduct field research at these levels. The study location (see Section 3.4.1) was stratified into villages that are internally homogenous and externally heterogeneous based on a criterion which emphasised lake dwellers' major livelihood activities in terms of contribution to income and labour investments. Fieldwork[12] was conducted in the selected villages in mid-2013 (scoping study) and early 2014 (main fieldwork) using household surveys and semi-structured interviews stratified by farming (n = 80), fishing (n = 80) and pastoral (n = 80) livelihood groups; eight focus group discussions (FGDs) with different livelihood associations (Section 3.4.5); and twenty key informant interviews (KIIs) with individuals with specialist knowledge on the study themes (Section 3.4.8). Three types of non-

[10] This was the individual the LCBC executive secretary assigned to provide an institutional link to the PhD field research activities around the LCB.

[11] The sampling methods outlined relate to both the scoping and main fieldwork exercises.

[12] After the scoping study, it was considered necessary to revisit the seven villages again for the main fieldwork. FGDs were only held during the scoping study (see Section 3.4.5), whereas twenty KIIs (see Section 3.4.8) were conducted during both the scoping and main fieldwork exercises (i.e. ten interviews during each exercise/period).

probabilistic sampling techniques were used (purposive/random walk, quota and snowball) (cf. McCubbin *et al*., 2015) because of the transient lifestyle of many households, the different sizes of the villages (in terms of populations), as well as the non-availability of a sampling frame for each village.

Purposive sampling selected a cross-section of households in each of the villages (based on income contributions from their predominant livelihood activities). This was achieved through random walks [13] across the villages (UN, 2008). The sampling process (for households) began at the homes of the village leaders, where consultations and permissions were obtained. To specify the paths of travel, some geographical starting points for each village were identified and selected (i.e. farmlands, pasture areas, homesteads/settlements, water-ways and desert-grazing sites) with assistance from a local guide/gate keeper. Qualifying households from each sub-group (i.e. those deriving over 70% of their income from either farming, fishing or pastoral activities) were selected until a predetermined quota (determined based on population and village sizes) was reached for each village and for each sub-group. Selected households represent approximately 43% of households in each village (refer back to Table 3.3). To enable comparison across groups, an equal number of households within each livelihood group was recruited. Household respondents were surveyed at different locations – some in their farmlands, others while grazing animals or sorting fish from nets, and yet others in their homes.

Snowball sampling (Noy, 2008) involved requesting the *bulamas*, the village gate-keepers and the LCBC to recommend participants for the FGDs (see Section 3.4.5) and KIIs (see Section 3.4.8), as well as households where necessary. Using snowball sampling [14] ensured a low missing response frequency, and enabled the researcher to achieve a specific quota per village. Experts and stakeholders [15] were identified using both purposive and snowball sampling (UN,

[13] Random walks focused on sampling and selection of respondents, while transect walks focused on data collection – they both involve walking, but the purposes differ.

[14] Snowball or chain sampling implies using one contact to recruit other contacts and so on.

[15] These are individuals who are positively or negatively affected by the thematic issues addressed in this research or can influence development decisions.

2008). The small sizes of the seven villages constituted manageable units that enabled in-depth investigation of the contextual issues surrounding livelihoods and vulnerability.

3.4.4 Participatory field data collection approach

Empirical (field) data used in this research were collected using different research methods, and were based on three rounds of field visits – an exploratory scoping study (July 2013), main fieldwork (January to March 2014) and a stakeholder workshop (aimed at clarifying and validating the initial research results (July 2015) – see Section 3.4.10). A detailed explanation of the various research methods used to achieve the livelihoods and vulnerability objectives, as well as their strength and limitations, is presented here.

The need for a case study approach informed the use of in-depth, participatory methods of data collection. Participatory methods allow sharing of experiences and knowledge, particularly between local people and scientists/researchers, in order to gain perspectives about certain issues or find solutions to issues (Chambers, 1994). The method requires that the researcher act as the facilitator of the investigation process, in ways that actively engage local actors/respondents - so that the actors can claim ownership of the information or knowledge generated (Rossignol *et al.*, 2014). Participatory methods (such as FGDs and village square gatherings) enabled marginalised individuals and groups to communicate the threats that they face, e.g. in the context of livelihoods and vulnerability challenges under climatic changes (Chandra and Gaganis, 2015). This was achieved by allowing open participation where participants communicated freely. There was no occasion where any participant showed signs of intimidation (felt reticent) or a sense of powerlessness in the presence of certain individuals during focus group discussions.

Participatory methods are not without limitations. In the context of this research, purposively identifying and contacting households and organising surveys/interviews proved to be a costly activity (for the researcher) and time consuming (to the respondents). As such, the researcher ensured that gate-keepers were used to contact respondents to schedule meetings at a time respondents were willing and able to respond to questions. Similarly, during surveys and discussions, only relevant issues related to the research were flagged up in a manner that minimised digressions. Although concerns about the broader applicability of findings from the use of participatory methods exist (Chambers, 1994), this research combined qualitative data with quantitative data available beyond the village level as a way to enhance scope for generalisation, particularly across the Lake region.

The use of participatory methods in this research at a time in which the themes of the research were high on the agenda in the study location facilitated the local insights gained and the successes achieved. Taken together, the methods (i) fostered the researcher's learning about the current situations in the LCB, and (ii) encouraged deeper assessment of the problems faced.

3.4.5 Focus groups

Focus group discussions (FGDs) were held with different local resource users (i.e. farmer groups, fishing groups and group of pastoralists) across the seven selected villages. The discussions explored the conditions of current livelihoods as well as changes in Lake Chad levels, vulnerability, conflict and response behaviours/strategies. Each group discussion was made up of 4 to 8 participants who are engaged in similar livelihood activities (Hopkins, 2007). Participant selection was based on a snowball sampling approach (Noy, 2008) in which the *bulamas* and village gate-keepers were asked to identify and recommend resource user groups. Invitations were extended to participants through the gate-keepers (i.e. a contact person was identified in each village to serve as a gate-keeper)[16]. Participants were full-time members of farming, fishing or pastoralist associations, and they held considerable knowledge about local environmental conditions and livelihood changes. Discussions were held outdoors and under conditions that allowed openness, collaborative engagements and transparency (Gill *et al*., 2008). One focus group was carried out in each village visited during the scoping fieldwork, except in Guitté (a mixed village) where two FDGs were conducted with each of farmer and pastoralist groups. Having organised FGDs in all the villages during the scoping study, it was not considered necessary to engage the same groups again during the main fieldwork. As such, the research focused on using other data collection methods during the main fieldwork.

[16] Gate-keepers represent local contact points, as well as key informants. The researcher used gate-keepers that have previously worked with the local NGO associated with this research.

The FGDs enabled questions to be raised, which facilitated open interactions (Figure 3.7). A constant effort was made to ensure that all participants contributed by asking for responses/contributions from every participant. The key questions (see Appendix 1) that guided the discussions include: (i) What are the major influences of climatic events that members of your village, (including your resource group members) have faced during the past 10 years? (ii) What are the immediate and underlying causes of contention/aggression, who are the actors in conflict, and how is their behaviour during moments of disagreements? (iii) Describe how vulnerable your group members are to unfavourable climatic events and conflict – what local conditions promote livelihood underperformance? (iv) What kind of livelihood support do you offer each other? (v) What new measure are you taking now to address the challenges you face – considering lake drying and water shortages?

Figure 3.7: Focus group discussion with fishermen, Kaesai, July 2013

The researcher moderated the discussions in a way that enabled questions/answers to be communicated in simple local dialects through the local NGO team that accompanied the researcher to the villages. The discussions were not structured; guiding questions were used to initiate discussions on several related issues and enabled in-depth insights to be gained as new views emerged. Given the cultural setting (and local arrangements) in the villages where only men are allowed to grant interviews or participate in public discussions, it was difficult to include females in the FGDs[17]. This may appear to suggest that the livelihoods and vulnerability-related data under-represented female-headed homes or female resource users. Yet non-inclusion of females in data collection does not suggest that women's views are unappreciated. Similarly, an 'all male' sample or view does not imply gender bias. Bene *et al*.'s (2003, p. 22) Lake Chad study also used responses from males only, classifying them as 'ordinary' villagers. The nature of this research and the context of the study villages suggest that it is impossible to obtain different 'vulnerability-and-livelihood-focused' views from a single household composed of males and females. Pastoralists and fishermen in the villages are largely males - and often males speak for their female counterparts. The researcher was required to strictly adhere to the strong patriarchal cultural norms in which only males have freedom to grant interviews, especially where the researcher responsible for data collection is male. While the researcher cannot pin down the magnitude of any bias in the absence of a female control group/female views, a low risk of bias in both the local data generated and the interpretation of the findings is assumed.

FGDs enabled generation of information based on collective perceptions on the research themes, especially the meanings those perceptions communicated. A deepened understanding of resource users' experiences was gained (particularly because the issues raised were topics the participants wanted to and can discuss). FGDs proved useful because the discussions provided background details that facilitated the data generated through other methods. All FGDs were conducted in Arabic, French and Hausa, and translated at the time of collection. Each FGD lasted approximately between one hour thirty minutes and two hours.

[17] Females were (generally) not included in all the data collection methods used at the village level because of cultural barriers.

3.4.6 Transect walks and boat rides

Transect walks and boat rides are often used to gain additional on-the-ground information (Banks *et al*., 2013). Both activities were undertaken with NGO representatives and local gate-keepers across the lakeside and island villages. These facilitated understanding of the local context in which local people live and work, including knowledge of farmland areas, lake waters, fishing activities, movements of livestock and the physical infrastructure in the villages. A one hour boat ride from Guitté to Kaesai (Figure 3.8) enabled the researcher to properly contextualise the many narratives pertaining to the drying of the Lake.

Figure 3.8: Boat ride across the Lake Chad waters between Guitté and Kaesai, July 2013

Two boat rides (one each during the scoping and the main fieldwork) were undertaken throughout the field research process. One transect walk was undertaken in each village after each FGDs during the scoping fieldwork. Notes and photographs were taken during these outdoor exercises to capture the conditions prevalent in the Lake Chad fragile environment and compare the information accessed through other methods (e.g. from FGDs).

3.4.7 Household questionnaire surveys

Given that decisions about livelihood activities, and local-level vulnerabilities are better captured at the household and group levels, it was considered necessary to conduct livelihood and vulnerability assessments at the livelihood group scale by aggregating responses from households classified as farmers, fishers or pastoralists. Household surveys were conducted in the selected villages during the main fieldwork stage of this research. Fourteen surveys undertaken during scoping were not included here as they were insufficiently comprehensive. Households, in the Lake Chad region, are defined as a group of individuals who live together (under the same roof), feed from the same pot and collectively own the same productive assets (e.g. land, houses and water wells) (Bene *et al*., 2003). Households here comprised spousal couples (and their children), who rely mainly on a subsistence-based economy characterised by farming, fishing and herding.

A combination of closed and open-ended questions (Gill *et al*. 2008) was used to solicit information from household heads during the main fieldwork (n = 240 in total: farming (n = 80), fishing (n = 80) and pastoral (n = 80)) from the seven selected villages. Household heads, in the context of this study, are those individuals (generally males) contributing the largest amount to household assets and income (Fisher *et al*., 2010). Because of the socio-cultural and religious beliefs of the villages in which only males have the freedom to grant interviews, only responses from male household heads were recorded (refer back to Section 3.4.5). Where the household head was unavailable, another male adult household member participated in the survey. Surveys considered livelihood groups as the principal unit of analysis. Thus responses were aggregated across livelihood groups to compare livelihood and vulnerability conditions along occupational lines. Social differentiation within villages was not emphasised.

Preliminary surveys of households during the scoping study (covering fourteen households - two from each village) revealed that households living in the same village face similar environmental stresses (e.g. water scarcity) and that they engage in similar livelihoods activities (e.g. the households in Ngurutu are mostly pastoralists while those in Basara are fishers). However, this was observed not to be the case in Guitté, which is larger in terms of population size and land areas than the other selected villages. Here, livelihood activities were observed to be diverse, covering trading, transportation and construction activities, alongside farming and pastoralism. Thus, an 'income-source' assessment was undertaken in which the village head and the gate-keeper in Guitté were asked to identify full-time farmers, fishers and pastoralists, to enable the grouping of households based on livelihood activities. Households who spent more time on and derive 60 - 70 % of their income from livestock herding or farming (i.e. crop cultivation) were categorised as pastoralists or farmers (Bene *et al*., 2003). Fishing households were observed to be very few in Guitté and therefore were not included in the household surveys. Household surveys carried out during the main fieldwork (not those undertaken during the scoping visit) were included in the final analysis of data.

Household surveys (Figure 3.9) included questions categorised into themes based on the livelihoods framework (Ellis, 2000) and the IPCC's tripartite typology of exposure, sensitivity and adaptive capacity (IPCC, 2007 – see Chapter 5).

Figure 3.9: Researcher with a male household head (fisherman) in Basara, February 2014, during one of the household surveys

Data were collected on household characteristics, assets owned (or accessed), livelihood activities, conditions affecting the household, livelihood drawbacks and opportunities experienced due to the changing state of the Lake and other contextual factors (e.g. climate-related losses, feelings of insecurity and dependency on Lake waters), and the diverse portfolio of response strategies.

Although the questionnaires (see Appendix 1) helped to define thematic issues to explore, a mixture of open and closed questions allowed the researcher and the respondents to diverge when possible in order to better capture an idea or elaborate on a new response in more detail. The flexibility of this approach enabled the identification of important issues that previously were considered not to be pertinent. For example, it was observed that farmers were often excited each time the Lake shrank, as the receding of the Lake often opened new farmland areas which served to enable farmers to expand their crop cultivation. The data generated were used to address objective one (see Chapter 4) and to construct vulnerability and double exposure indices that addressed objective two. To do this, data were matched with specific indicators focusing on current vulnerability concerns (see details in Chapter 5). Surveys were conducted in Arabic, French and Hausa, and translated at the time of administration through the assistance of the interpreters. On average, each survey lasted between forty minutes and one hour twenty minutes. Data generated from other data collection methods were used to compare and enrich the responses obtained from the household surveys.

3.4.8 Key informant interviews

Key informant interviews (KIIs) were conducted during scoping fieldwork (n = 10) and the main fieldwork (n = 10) (with different informants each time). Key informants (Figure 3.10) demonstrated rich understanding of local environmental and socioeconomic conditions around the Lake region. Individuals interviewed included village heads, local opinion leaders (e.g. religious leaders such as village chief Imams), security personnel guarding activities on the Lake shores, village gate-keepers who served as key points of access to the different villages, key staff of a local NGO, and boat owners engaged in transporting people from one point of the lake to another. Individuals in these categories (also regarded as stakeholders) were selected using purposive and snowball sampling (see Section 3.4.3). A one-to-one interview with the informants enabled the researcher to clarify or confirm the issues that emerged from FGDs and household surveys (McKenna and Main, 2013). Informant interviews were conducted either at the lakeside villages or on the islands; the exception here are the interviews conducted with the NGO staff recommended by the LCBC (held in the capital city of Chad). The KIIs enabled the researcher to gain in-depth insight on the drawbacks and opportunities local people face under unfavourable environmental changes. The interviews generally involved note-taking following responses to a set of open-ended questions (Appendix 1). Notes were summarised after each interview to facilitate further probing and questioning during subsequent interviews. Responses were summarised in meeting reports and key themes/issues were coded, and analysed in line with data from other sources based on meanings communicated (see Section 3.5).

Figure 3.10: Key informant with the researcher in a village farm in Miterine, February 2014

3.4.9 Expert interviews

In this research, experts with relevant knowledge on the research themes and who are well positioned to highlight and address issues of broad relevance, especially pertaining to the LCB, were approached through contacts from the LCBC. Contacts were obtained after the purpose and scope of the research were communicated to the executive director and legal adviser of the LCBC (refer back to Section 3.4.2). Ten open interviews were conducted with key experts linked to the LCBC during the first week of the exploratory scoping fieldwork in July 2013. This was considered necessary to enable the researcher gain first-hand knowledge on how to approach the research. Interviews were also held with two key staff members of the Chadian meteorological agency to obtain information on climate-related data and water conditions of the Lake. These exercises were conducted in N'Djamena before visits to the lake villages were undertaken.

3.4.10 Stakeholder workshop

A stakeholder workshop was convened in July 2015 at the LCBC headquarters in N'Djamena (Figure 3.11). The workshop involved thirty participants. Participants were invited by the LCBC (they were mainly individuals/groups who had previously engaged in a variety of collaborative Lake Chad-related work with the Commission). These included NGOs working with communities in the LCB, military personnel who were part of the Multinational Joint Military Task Force to combat Boko Haram, and scholars in different fields such as water, climate change, human security and livelihoods. The goal of the workshop was to communicate the findings from the analysis of the field-based data (see Section 3.5), with a view to validating the responses collated from research participants during the scoping and main fieldwork exercises. Although many participants already had ideas of the challenges around the Lake area, the findings enabled them to grasp the true extent of the current livelihoods and vulnerability issues locals face. There was consensus that the responses collated during field activities reflected the conditions in the LCB. Overall, the workshop provided a forum for the researcher to negotiate how the research results can be used more widely to facilitate development actions.

Figure 3.11: Stakeholder interactive workshop held in N'Djamena, July 2015

3.5 Data capture and analysis

This section highlights the ways in which the data generated during the field based research activities on livelihoods and vulnerability objectives (phase one) were captured and analysed.

3.5.1 Data capture

Field notebooks, questionnaires, interview question guides and a digital camera[18] were used to capture field data. The researcher administered the surveys and interviews personally during the scoping fieldwork and main fieldwork, working with interpreters where necessary. The question guides and questionnaires had spaces for comments and remarks that emerged from field research, particularly those provided by key informants and households. Field notes enabled the capture of open conversations and interviews, including observations during transect walks and boat rides. A digital camera was used to capture important photos of the biophysical settings at lakesides and island villages during the whole process of field data gathering. All electronic data for the research were stored on a password-locked computer system.

[18] Photographs captured using the digital camera served as visual aids to support the written information.

3.5.2 Analysis of qualitative data

Qualitative research often generates rich data. Decisions regarding how such data should be analysed are vital in the quest to obtain reliable research results. For this research, analysis of qualitative data focused on drawing out patterns and meanings based on the experiences and views provided by different respondents. A mixture of different data collection methods were used to gather qualitative data. Response data collected in different languages (mostly Arabic, Hausa and French) were translated at the point of collection. The research instruments used in the field research had questions organised into themes based on the research objectives (themes represented categories of ideas/views that emerged from grouping of data points using the research objectives). The data were checked to ensure that they were properly categorised into relevant themes. They were later coded, and where possible, the themes were modified to facilitate entry into MS Excel spread sheets (Version 2010). Coding involved attaching labels/symbols to lines of text so that related pieces of information could be grouped and compared. Each column in the spreadsheets focused on specific variables/themes (e.g. the purpose of coming to live at a Lakeside village, changes observed in villages in terms of conflict/cooperation and climate effects on income/settlement patterns). Content analysis was applied to analyse the coded data. Content analysis enabled the categorisation of responses (views and experiences) and facilitated data classification, summarising and tabulating.

Content analysis was applied in two ways: (i) a descriptive screening to understand what the data was about; (ii) an interpretative approach to understand what the data meant. Using a deductive approach enabled a successful search for patterns and explanations in the coded data. Major issues and patterns that emerged from each theme during content analysis were carefully noted, enabling the extraction of meanings based on the research objectives/questions. Where contradictions in meanings or views existed, further clarifications were sought through the key informants (e.g. the village gate-keepers) and the LCBC staff. Applying a deductive approach enabled the research questions/objectives to guide understanding of the meanings the coded data communicated. Using spread sheets to structure qualitative data into themes enabled the identification of similarities and differences in people’s experiences and views. Where necessary, appropriate quotes from respondents were utilised to illustrate and enrich presentation of results and discussions. Data analysis was conducted at the household level and later aggregated to obtain information on the different sub-groups (farmers, fishers and pastoralists).

3.5.3 Analysis of quantitative data

Quantitative data from questionnaires were coded and entered into SPSS (Scientific Package for Social Science) analytical software (Version 21) for statistical analysis. Simple descriptive statistics (such as averages and percentages) were used. Results emanating from the analysis were presented mostly in tables and charts. To establish the livelihood context of local people in the case study villages, different assets held by the locals were quantitatively assessed using SPSS and disaggregated based on livelihood groups to compare and substantiate the influences of the Lake on livelihoods. Analysis was guided by the SLA in terms of asset aggregation and livelihood comparison (see Chapter 4). A quantitative index computation analytical technique was employed to understand differential vulnerabilities. This was based on an indicator-based vulnerability assessment approach. A set of novel vulnerability and double exposure indices were developed using this approach, and later applied to quantify the vulnerabilities of farmers, fishermen and pastoralists. Details on this are presented in Chapter 5.

3.6 Limitations of methodology

This section presents the limitations associated with the methodology applied in research phase one, as well as how they were addressed during the course of the research. A summary of the strengths and limitations of the research methods is presented in Table 3.4.

Research participants and the instruments used were central to the quality of data generated in this study. Participants' understanding and willingness to provide unbiased, truthful information can influence data quality. Earlier in the research process, the researcher adopted an awareness creation strategy that involved village level gatherings and focus groups (Gill *et al*., 2008). This provided the participants with an insight into the purpose, target and expected outcome/impacts of the research, and allowed relationships to be built between the researcher and the villagers. Efforts in this direction raised the interests of the locals, and spurred their willingness to provide information considered as truthful.

Table 3.4: Summary of the strengths and limitations inherent in the field methods used (the summary is based on fieldwork experience with background insights from Warrick (2008) and Iaquinto (2016)).

Method	Strength and limitation	Strategy adopted to overcome limitation
HHQS	Strength: Enabled flexibility in data generation Limitation: Time consuming, views based on questionnaires.	Digression was allowed where necessary to capture relevant views; adherence to time.
KIIs	Strength: Rich in-depth discussions on thematic issues Limitation: Several key informants declined invites.	Used local chiefs, gatekeepers, and contacts following FGDs to access appropriate informants.
FGDs	Strength: Enabled identification of vital livelihood concerns Limitation: Certain people felt reticent/indifferent.	Every participant was encouraged to contribute.
Expert interviews	Strength: Expert views on research themes gained Limitation: Difficulty tracking experts.	Used the LCBC contacts to reach appropriate experts.
Transect walks	Strength: Informative, visual grasp of people's resources. Limitation: Harsh weather conditions limited coverage	Evening walk schedules under favourable weather conditions
Boat rides	Strength: Helped to reconstruct narratives about lake drying Limitation: Insecurity on lake waters limited coverage	Scheduled boat rides when the patrol team was on the waters

The ways in which the research instruments were constructed/designed also helped to elicit truthful data (Harris and Brown, 2010). Wide consultations with the LCBC, including reading several documents on local conditions in the Sahel helped the researcher to design instruments that contained specific, easy to understand questions. During surveys and interviews/focus groups, responses to questions were checked regularly to ensure that answers reflected a clear understanding about what was being asked, and the scoping study aided greatly in making sure questions targeted the kinds of responses required to meet the research objectives. Because the instruments were administered personally by the researcher, efforts were made (through the village gate-keepers) to schedule meetings when the respondents were willing and able to respond to questions. Although respondents sometimes struggled to recall numerical information (e.g. on quantifiable crop harvests, fish catch and livestock losses over the past ten years), the flexible approach used enabled a short term recall period (i.e. three to five years) where possible. Combining different data collection methods (transect walks, boat rides, focus groups, interviews and questionnaire surveys) enriched the data gathered, especially by enabling triangulation and helping to overcome the weaknesses and biases associated with the use of mono-methods (Morgan, 2007).

The methodology did not rely overly on research instruments in a way that disconnected the researcher from people's lived experiences. Living with the local people during the main fieldwork periods provided a lot of opportunities to observe, work and collaborate with the people. The results presented in Chapters 4 and 5 are grounded in the data provided by male respondents and involved the information collected first in July 2013, and then between January and March of 2014. This minimal time gap between the data collected using varied methods does not suggest that the methodology captured inherent dynamics in data points, rather it indicates a 'snap-short' understanding of livelihoods and vulnerability conditions within a specified time period.

3.7 Ethical considerations and positionality

This research was conducted according to the University of Leeds research ethics guidelines, specifying the need for research to be guided by the principles of confidentiality, anonymity, data protection, obtaining of informed consent, and avoidance of harm (Banks *et al.*, 2013). Approval was granted by the University Ethics Committee (approval reference code: AREA 12-115 – see Appendix 2).

Before fieldwork commenced, the researcher sought and obtained formal institutional support from the LCBC in order to facilitate receipt of expert advice and official documents for entry into the Lakeside territories in Chad Republic. Once in the Lakeside villages, participants were provided with information on the research themes and goals of the PhD research, including details concerning the research funding body and what will happen to the research results. Participants were later requested to indicate their willingness to participate in the research by signing a written informed consent document. The informed consent form (see Appendix 3) provided a two-way agreement between the researcher and the participants. The agreement specified that participation in the research was voluntary. It also indicated a personal commitment by the researcher to keep all data collected during the course of the research strictly confidential by not identifying or mentioning participants' names in any reports or publications (the exception here was that villages and institutions can be mentioned in reports/publications). Details about the consent document were orally discussed in several villages where the participants expressed discomfort in reading/signing documents, and verbal consents were obtained and recorded in the consent document. Based on ethics of research conduct that are considered appropriate (Banks *et al*., 2013), the researcher ensured that anonymity, confidentiality, data protection and avoidance of harm were guaranteed throughout the research process. In terms of avoidance of harm, fieldwork-related risk assessments were conducted and adhered to during the course of the research. All electronic data were kept safe and stored on a password-protected computer.

The field based research was heavily dependent on personal and group interactions. Interactions are of critical significance when surveying or interviewing respondents as they can be influenced by respondents' perceptions/expectations, social values held by locals, and power differences between the researcher and the researched. To ensure adequate field based interactions, the researcher recognised his positionality (being a young, male researcher registered at a UK University) *vis a vis* the perceptions that may be held by the respondents (i.e. where the researcher is perceived as an outsider, someone that lacks knowledge of local dialects and cultural norms). Since positionality can influence successful interactions and access to information, the researcher considered it appropriate to integrate into the everyday lives of the research participants in order to properly take on more of an insider position (Dwyer and Buckle, 2009). Social values in rural Chad are diverse, and characterised by religious beliefs, cultural norms and traditional rituals. Knowledge of local values and habits enabled local integration, and spurred good rapport and collaborative links with the respondents (Collins, 1999). Living in

Guitté (located at a centre of the selected villages - refer back to Figure 3.5) enabled the researcher to build local relationships faster throughout the field research process.

Engaging the assistance of a local NGO staff (a female grass-root humanitarian expert with strong links across the Lake Chad villages), village gate-keepers (all males) and local interpreters (all males) positively influenced the researcher's interactions with the locals, and created suitable conditions for acceptance. For example, the fact that the NGO staff was a female and a humanitarian personnel facilitated easy access to the village heads during the scoping visits (as they are often receptive of female humanitarian actors). Similarly, engaging male gate-keepers and interpreters enabled cordial interactions in the villages, where important discussions concerning households and occupational issues are normally held among the male folk. The continued guidance of these individuals during the scoping and main fieldwork exercises ensured that the behaviour and actions of the researcher were in accordance with locally-appropriate conducts. In every village and on meeting the heads of villages, gifts of sugar and salt were presented after initial greetings and presentation of the research objectives. The local culture demands that visits to respected local authorities should be accompanied with gifts. The village gate-keeper, as well as the NGO staff the researcher worked with recommended these gifts. All visits to the village heads led to the issuance of permissions to conduct surveys, interviews and discussions with the local respondents and were in line with local cultural norms.

To ensure transparency during local interactions (Muhammad *et al.*, 2015), each household (and other participants) interviewed were informed that: (i) the researcher was not a government agent or a development actor, (ii) the interviewees would not be remunerated, (iii) the research was not initiated to provide humanitarian aid to the villages either presently or in the future, (iv) the researcher was an independently motivated student seeking to understand local conditions around the Lake beyond the narratives in books and newspapers, (v) the potential contribution of the research may not be immediate, but that by disseminating the results widely the responsible authorities may assist them (it was made clear that this may or may not happen due to e.g. national or regional constraints). With this clarification, it was assumed that the participants who accepted to be interviewed were genuinely eager to voluntarily participate (without any form of coercion). When possible, small presents such as matches, soap and sugar were given to respondents, particularly those who stayed long hours away from their activities in order to be interviewed. When necessary, feedback on insights from previous visits were provided to respondents. As the positionality of the researcher evolved (through building local relationships), it became easier to visit their markets, eat local foods and assist local people in their activities (e.g. helping out with clearing of farmlands and sorting out fish from nets (Figure 3.12)).

Outside the villages, interviews with experts linked to the LCBC were conducted in a manner that positioned the researcher as an ‘indigenous insider’ (Banks, 1998). For example, many of the experts interviewed were Nigerians who had come to N’Djamena to work, and with the LCBC executive director being a Nigerian also, it became easy to influence the manner in which the experts perceived the research and the researcher, and thus enabled rapport to be built.

Figure 3.12: Field interactive moments in Lake Chad during the scoping fieldwork

3.8 Data and research methodology 2: Climate shocks and conflict

The approach adopted in research phase two links conflict to climate shocks in the context of increased vulnerabilities and lake drying by drawing relational and causal inferences from disaggregated, spatiotemporal data. The analysis covered the Lake Chad riparian zones. The approach ensured that each spatial unit employed in the analysis served as both the treatment (i.e.

after the effect) and control (i.e. before the effect) unit in a time-series context. Thus, observations and inferences were based on how each fixed spatial unit (each riparian zone) responded to varying climatic conditions over time. With this approach, and by drawing on key recent studies that use temporal variations in climate parameters to study conflict outcomes (e.g. Salehyan and Hendrix 2014; Papaioannou 2016), the hypotheses proposed (see below) were empirically explored.

The analytical procedure is guided by the 'relative deprivation' theoretical narratives, which presupposes that feelings of deprivation due to, for example, contextual vulnerability forces, such as political exclusion (marginalisation), spur grievances which over time escalate into violent confrontations. The analysis is also guided by the 'no-gain' and 'self-sufficient' narratives (see Chapter 2, Section 2.6.3). The assumption, overall, is that the deciding factor for conflict actions is the vulnerability status of each riparian zone. As such, vulnerability is presented as an important determinant of conflict following anomalous climatic events. Specifically, the empirical analysis undertaken in addressing objective three was guided by three theoretically-defined *climate-centric* and *context-centric* hypotheses (see details in Chapter 6). The hypotheses state that:

H_1: The probability of conflict increases as anomalous climatic conditions increase;

H_2: The effect of anomalous climatic conditions on conflict is most pronounced in the presence of contextual vulnerability factors (political exclusion, poor governance and agricultural production changes);

H_3: Anomalous climatic events will increase lake drying, which then increases the likelihood of conflict.

3.8.1 Brief description of the case study riparian zones

This phase of the research covered areas in Cameroon, Chad, Niger and Nigeria, bordering the LCB - referred to here as the Lake riparian zones. The case study zones are largely subsistence agricultural areas where state-extended political structures are either non-existent or less centralised (see Section 3.1). Specifically, the zones are areas bordering the Lake within 300 km distance from the Lake shores, covering the islands, lakeside villages and hinterlands[19]. The decision to focus on the zones is informed by the assumption that the LCB cannot be treated as a homogenous unit given its varied geography (Table 3.5).

Table 3.5: Geographical coordinates of selected Lake Chad zones (Source: Centre for International Earth Science Information Network – CIESIN, 2015)[20]

Name of zone	Area of Lake in country (km ^{2})	Geographical coordinate of the Lake zone selected*
Cameroon riparian zone	15 184.85	Latitude 11.06 - 11.99^0 N and Longitude 14.15 - 14.66^0 E
Chad riparian zone	112 551.70	Latitude 11.73 - 14.13^0 N and Longitude 15.03 - 15.53^0 E
Niger riparian zone	24 509.48	Latitude 13.61 - 14.21^0 N and Longitude 12 - 13.28^0 E
Nigeria riparian zone	59 720.63	Latitude 11.12 - 13.42^0 N and longitude 12.54 - 14.52^0 E

*The selected zones (as indicated by the coordinates) do not cover the entire areal extent of the LCB in each country. These are locations that are approximately 300 km away from the Lake. The coordinates were used to match secondary data to the zones.

Chad Republic has the greatest share of the Lake size located within its territory. The Lake zone in Niger Republic has experienced the worst shrinkage and it is not clear whether the drying of the northern lake axis makes the area around Diffa and N'guigma in Niger (see Figure 3.13) worse off in terms of livelihood hardship. Climatologically, Niger and parts of Chad are located

[19] The distance - 300 km - was chosen because the areas of the Lake that are severely threatened by climate and conflict are within this circle (see Mekonnen, 2016).

[20] Several gazetteers, such as www.eonames.org, www.itouchmap.com/latlong, www.gadm.org, www.fallingrain.com, and the World Geodesic System - WGS84, provide information on distinct geographical locations.

within arid and semi-arid Lake Chad climatic areas. Nigeria and Cameroon, including parts of Chad are within semi-arid and humid climatic areas (Bastola and François, 2012). The prevalence of conflict and climate shocks varies from one zone to another. As such, assuming a unit of homogeneity can be problematic in terms of needs-based policy interventions/recommendations.

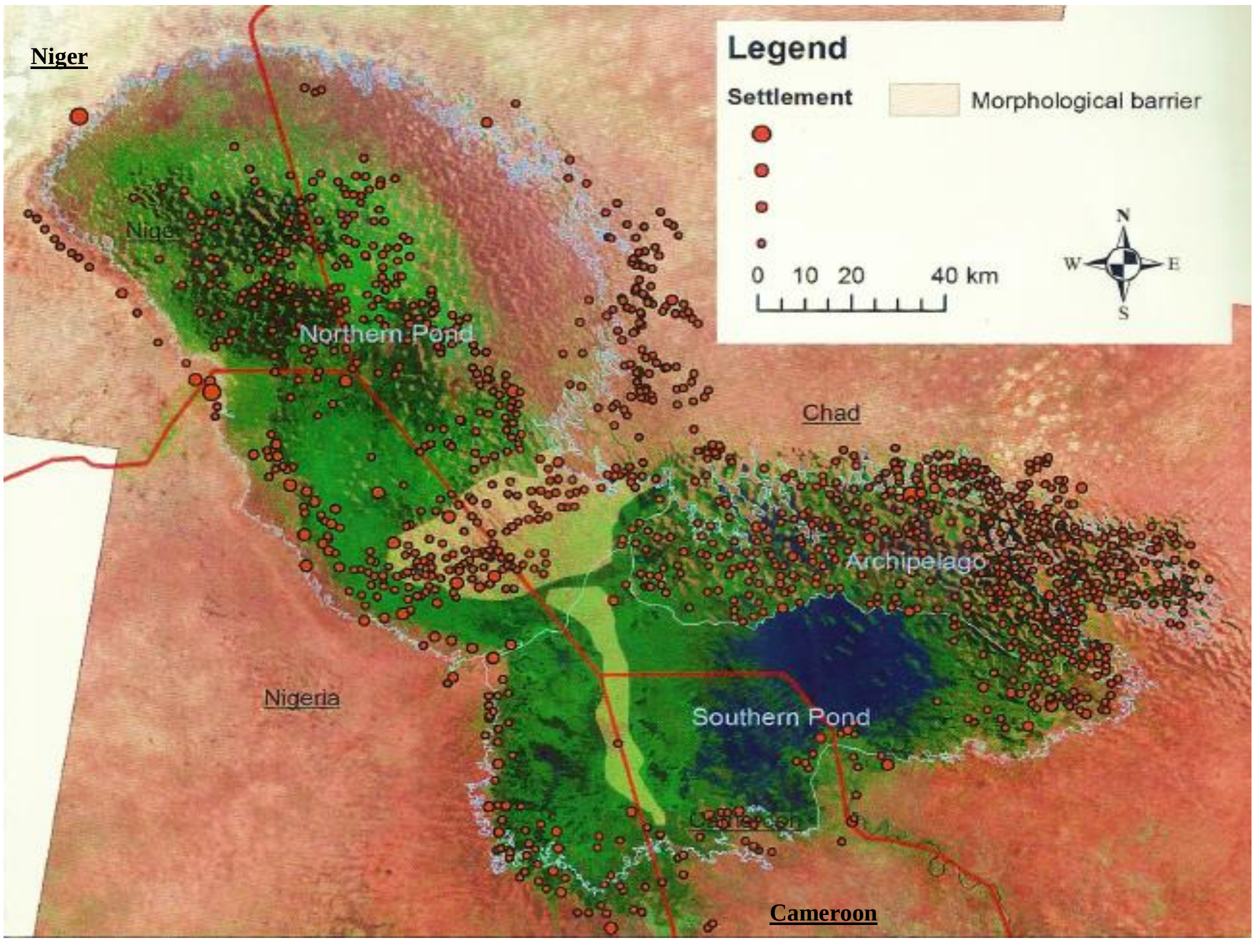

Figure 3.13: Locations of human settlement in and around the Lake Chad riparian zones. Background is a mosaic of Landsat images from 2003, with vegetation displayed in green colours and water in dark blue to black. Brownish colours are sparsely or non-vegetated areas. Spill-overs into the northern pond occur east of the east-west oriented barrier and through passages in the barrier itself. Interpretation of settlements is based on very high resolution satellite data (Source: GIZ, 2015b)

Spatially, the Lake zones covered in this study have six distinct, first-level administrative areas: (i) the Far North Province in Cameroon, (ii) the Lac, Kanem and Hajer-Lamis regions in Chad, (iii) the Diffa region in Niger, and (v) the Borno area in Nigeria. Data from Lac, Kanem and Hajer-Lamis were aggregated to represent data for the Chad zone of the Lake (see Section 3.8.2 for details on the data used and how they were collected). The LCB is an insecure region in terms of lake-wide primary data collection. As such, using administrative riparian zones provided the benefits of gathering secondary data based on a first-level administrative scale to provide evidence for lake-related climate conflict outcomes. It also prevents the constraints associated with data generation at the village level for such a data-poor region.

Because rivers and wetlands run across several boundaries and also constitute parts of the borders across the four zones, local resource conflicts are a regular occurrence. Gleditsch *et al*. (2006, p. 361) stress that where rivers form the boundaries between riparian states, "conflict may arise because river boundaries are fluid and fuzzy; i.e. they shift over time". The conflicts that arise in this context usually pertain to interstate disputes and violence. Although Lake Chad is both boundary crossing and boundary demarcating, boundaries and borderlines are clearly marked by riparian governments and as such there are minimal interstate confrontations. Based on this, and also because interstate conflicts are often less influenced by extreme climatic conditions (Salehyan and Hendrix 2014), the study did not fully capture this type of conflict (see Section 3.8.3).

3.8.2 Spatiotemporal specification of the data

To fit the research approach to theoretical mechanisms, specification of the spatial and temporal scales is necessary (Salehyan and Hendrix, 2014; Buhaug, 2015). This involves reconciling the resolution of the data with the spatial and temporal units (Seter, 2016). For example, when investigating conflict events in the context of opportunity cost to fight or relative deprivation narratives (see Chapter 2, Section 2.6.3), the geographical areas should be disaggregated to capture subnational units since such narratives are well suited to subnational conditions (Fjelde and von Uexkull, 2012). Furthermore, Raleigh and Kniveton (2012), Adano *et al*. (2012) and Tafere Reda (2015) show how this applies to different types of conflicts that co-occur, and that exhibit limited spatial overlap over time within countries. They indicate that several conflict types predominantly occur in locations where political exclusion and discriminatory state policies are prevalent, and where socio-economic supports or infrastructure are absent. Based on these, the units of analysis used are the annual observations of zone-level areas, which are the units for which the theoretical hypotheses are assumed to be relevant. Data collected from first and second-level administrative provincial units were aggregated to the Lake zone level. Sub-national administrative units are relevant across the Lake's riparian countries because they play significant roles in national political processes. They are the sites of electoral contests, as well as forming the structure on which local government authorities are constructed (e.g. for the provision of public goods and revenue collections through taxation). Using subnational zone-level administrative entities portrays the geographically distinct nature of the Lake Chad area, and as such, enables local variations across the Lake to be better captured.

Temporal issues are also relevant in climate conflict analysis, especially in decisions regarding the use of annual, seasonal or monthly data. Analysts who argue in favour of using temporally disaggregated data indicate that the seasonal aspects of climate are often masked by aggregated annual data analyses (O'Loughlin *et al*., 2012; Raleigh and Kniveton, 2012). Instances of high and low seasonal rainfall changes, which can influence water supplies, may not be adequately captured in annual rainfall data. There are possibilities that seasons could influence aggressors' violent behaviour, as is the case with the 'fighting seasons' prevalent in South Sudan (The Guardian, 2014). If conflict unfolds rapidly across seasons, it is likely that annual observations will mask the underlying dynamics, whereas if it unfolds slowly in a context where climatic events work through long-term annual processes, the temporal disaggregation may not be well suited (Salehyan, 2008; Selby, 2014). However, data limitations, e.g. socioeconomic variables for remote areas, often confine researchers to the use of aggregated annual data. The contexts under investigation often factor into decisions about temporal data scale (Seter, 2016).

The analysis undertaken here adopts a longitudinal (annual) data assessment approach in order to obtain disaggregated results depicting climate conflict evidence for each riparian zone. A cross-sectional data assessment approach often does not account for the range of ways in which societies and individuals differ from one another, in terms of variables that are time-variant across spatial units (Burke *et al*., 2015). Since the full suite of conflict drivers is unknown, and many that are known cannot be fully measured quantitatively, it is implausible that a cross-sectional assessment can credibly capture all relevant temporal differences (Auffhammer *et al*., 2013). Based on this reason, the approach adopted did not draw inferences (on climate conflict links) from cross-sectional assessments. Instead, it relies on longitudinal (annual) data assessment approach as a way to unmask key differences in climate conflict and vulnerability parameters over time for a single transboundary setting made up of four riparian zones with relatively similar cultural histories and developmental orientations. Using longitudinal data for this study meant that four different regression analyses were required, each supplying specific results for specific zones of the LCB.

The analysis carried out in this phase matched data within zones that are both theoretically and empirically justifiable (Raleigh and Kniveton, 2012). This means, data used for each riparian zone were aligned to the same spatial and temporal (1980 – 2015) resolution. A range of factors informed the 1980 to 2015 timeframe:

- The year 1980 marked the beginning of extreme droughts and water shortages in the region during which each riparian country unilaterally took decisions to construct dams and divert water away from the Lake without recourse to existing water agreements and consultations with the LCBC (Onuoha, 2008);

- The year 1980 marked the beginning of the Small and the Dry Small Lake Chad phases (refer back to Table 3.2 and Figure 3.2);

- Considerations based on data availability, manageability of research, and the research timing.

3.8.3 Data: operationalisation and estimation

Variables (Table 3.6) were selected based on generally accepted practices and precedents in previous studies (Salehyan and Hendrix, 2014; Wischnath and Buhaug, 2014; Raleigh *et al*., 2015; Papaioannou, 2016), and modified by the theoretical literature (see Chapter 2, Section 2.6) and the three hypotheses guiding this phase of the research.

Table 3.6: Variables used in phase two of the research.

Variable	Description/measure
Conflict	Annual counts of conflict events in each riparian zone
Climate shocks	- Negative and positive rainfall anomalies - deviations from the long-term mean (1980 – 2015) divided by standard deviation of rainfall rates - Wet and dry season variations - absolute values of total annual rainfall by calendar month over a 6-month period using data from May to October for the wet season and November to April for the dry season
Political exclusion	Riparian zone's relevance in central governance. Dummy variable - coded as 1 if dominant or majority of local ethnic groups resident in a particular riparian zone were excluded, and 0 if they held a political position in central government in a particular year
Changes in agricultural production	Level of agricultural performance in each zones - proxied by a local agricultural price change index
Effectiveness of governance (democracy)	The polity2 score (squared) from the Polity IV project dataset used to capture governance effectiveness or democracy
Lake size anomalies	Continuous measure of lake size deviations from normal patterns
Population density	Riparian zone population density (total population divided by area size)
Gross domestic product	Locational gross domestic product – measure of riparian state poverty level

Conflict is treated as endogenous to three key instabilities - climate shocks, vulnerability and lake drying[21]. The study matches conflict data with data on rainfall anomalies (used as proxy for climate shocks) to assess whether prolonged periods of climate shocks in regions with rain-fed agriculture will have impacts on conflict when the lake waters upon which locals depend shrink markedly and when vulnerability forces are prevalent. It is assumed that the interactive relationships from climate to conflict will be moderated by vulnerability or mediated by lake drying (see Chapter 6). Several explanatory and control variables were used to explore the research hypotheses[22].

3.8.4 Dependent variable

To evaluate the research hypotheses, recently compiled event data on conflict for each zone of the Lake were used. Conflict was coded as the annual total counts of conflict events for each riparian zone. Recent reports on conflict events for the LCB have focused on a broad range of conflict types, particularly communal, rebel and resource/water conflicts (Lanne, 2004; Onuoha, 2009; Okpara *et al*., 2015; Mekonnen, 2016). As such, following Raleigh *et al*. (2015), the analysis aggregated the common conflict types (communal, rebel and water conflicts) experienced across the zones and operationalised such events as a total annual count dependent variable (*conflict_total*), instead of the common dichotomous variables of the form (1, 0), which assume an arbitrary measure of 25-battle related deaths. Dichotomous measures often fail to capture both conflict frequencies and non-violent incidents where there are no losses of lives. Nonetheless, this way of capturing conflict suggests a particularly promising avenue for further research. The decision to capture three conflict types and aggregate them as total conflicts emerged from the broad view in the literature that there is no standard conflict reaction to climatic events – all conflicts in local resource-dependent environments tend to show commonalities in their response to climatic events (Burke *et al*., 2015). This means that by

[21] In hypothesis three, lake drying is endogenous to rainfall anomalies but exogenous to conflict.

[22] For data provided in grid cells, geographical coordinates were used to capture and aggregate the data that fall within the scope/spatial resolution of each riparian zone. In other words, for each georeferenced data point used, e.g. conflict events, the coordinates were used to match the events to the locations in the Lake Chad zones in which they occurred.

exhibiting similar responses to climatic events, interdependencies exist between different types of conflict (Fjelde and Uexkull, 2012) (see Chapter 2, Section 2.6.2 on analytical issues related to conflict quantification; also see Chapter 1 for reasons the conflict types were aggregated).

'Conflict event' as used in the context of this research is an incident or a contested incompatibility within a territory where armed force or non-armed confrontation is used by an organised or non-organised actor against another organised or non-organised actor, or against civilians, resulting in injuries, killings (at least one direct death) and other social disturbances on a specific date. This definition captured a broad spectrum of conflict events in a way that enabled the research to account for the range of localised conflicts that occurred in and around the LCB. The definition did not include events where the government of a state[23] was the initiator of conflicts, rather it included events where governments could be the target of conflict.

To enable the use of a broad array of conflict databases (since most of the databases consulted differ in their definitions of an event) and to ensure that events were coded correctly, events were conceptualised based on the actors involved, issues of disputes, specific locations and targets of the events. In this sense, events can be fatal, non-fatal, violent and non-violent (the study used conflict and violence interchangeably – see Chapter 2, Section 2.1.2). Although the conflict literature is yet to establish a standard set of criteria for classifying violent and non-violent conflicts, it reveals that information on conflict events may be more reliable than information indicating conflict intensity or deaths (Weidmann, 2014). As such, the research did not capture conflicts in terms of fatality rates (number of deaths).

To ensure that as many conflict events as possible were captured – especially the common conflict types in the LCB, the research explored as many conflict databases as are available, particularly several of the common geo-referenced[24] databases used in climate conflict research

[23] Scheffran *et al*. (2014) stress that conflicts in which the state is the main actor are rarely influenced by climatic events.

[24] 'Geo-referenced' means that each event was connected to a specific location defined by a pair of latitude and longitude coordinates.

(and those that focused on water conflicts only). Some scholars have used geo-referenced specifications to link conflict outcomes to exact geographical locations where conflicts are experienced (Raleigh *et al*., 2010; Salehyan *et al*., 2012; Sundberg and Melanda, 2013). The main conflict event data used came from the following sources (see Appendix 4 for full description of these sources):

- Armed Conflict Locations and Events Dataset (ACLED) version 6.0 (Raleigh *et al*., 2010);
- Social Conflict Analysis Database (SCAD) version 3.1 (Salehyan *et al*., 2012);
- Uppsala Conflict Data Programme Georeferenced Event Dataset (UCDP-GED) version 3.0 (Sundberg *et al*., 2013);
- Basin at Risk Project - Transboundary Freshwater Dispute Database (Wolf *et al*., 2003);
- Water-Related Interstate Conflict and Cooperation (WARICC) (Bernauer *et al*., 2012);
- International Crisis Behaviour Project (Brecher *et al*., 2016);
- Uppsala Conflict Data Programme/Peace Research Institute Oslo Armed Conflict Dataset (UCDP/PRIO) version 4 (Pettersson and Wallensteen, 2015);
- Uppsala Conflict Data Programme Non-State Conflict Dataset version 2.5 (1989 – 2014) (Sundberg *et al*., 2012).

To achieve the level of detail necessary for developing a LCB conflict dataset, the various conflict databases were systematically assessed, and the conflict data relevant to each of the Lake zones were selected (i.e. those that fall within each zone’s geographical coordinates). This was done in three steps: (i) the countries of the Lake were filtered and separated from each database, (ii) for each country, the geographical coordinates were used to filter the data related to each zone of the Lake, and then (iii) the data falling within each zone were aggregated across the first, second and third administrative levels where available. The dates (day, months and years) of interest were also used to delineate the required data, including information on actors in conflict, issues associated with each event, and types of conflicts. These steps were carried out in Microsoft Excel as most of the databases were downloaded in this format. The steps outlined here were applied in retrieving other data (i.e. the data related to the independent, control and vulnerability variables) used in testing the hypotheses.

Filtering, checking and coding prevented double entries/counting as several of the data sources had similar data that matched specific years for each of the zones (for example, several of the events recorded in ACLED from 1997 to 2014 were also found in SCAD - so careful checking reduced the likelihood of double counting of events). Similarly, several of the databases complemented one another in terms of the temporal scale and missing data points (e.g. the UCDP/PRIO, covering 1946 to 2015, appeared more comprehensive in terms of the temporal scale, and the data helped to make up for years in which data expected from other databases were unavailable). Anywhere there was a conflicting record amongst data sources in terms of days and numbers of conflict, records from ACLED were selected because ACLED is broadly recognised to have good accuracy and reliability and has been widely used in climate conflict research (Seter, 2016).

Every report on social disorder, whether violent or non-violent, relating to communal, rebel or resource/water disturbances, was coded as a conflict event for each riparian zone. There is no standard benchmark/threshold for quantifying conflict, except to view them as social disturbances (Burke *et al.*, 2015). Events that are within the broad spectrum of conflict and violence, and that are not in any sense cooperative (ranging from non-violent social disturbances to violent occurrences, excluding civil war and intrapersonal (e.g. suicide actions)) were captured, cross-checked, coded and used in the analysis. The LCB conflict data used in this study are well suited to aid conflict assessment in a way that can foster understanding of conflict trends (from 1980 to 2015). Instead of conceptualising conflict as an event happening in a homogenous basin-level unit, the dataset recognises the need to spatially disaggregate conflict events based on how they occur across four distinct spatial scales that make up the Lake zones. Based on the researcher’s familiarity with the Lake region, and following a series of field visits (Section 3.4) and consultations with people of the region, it is envisaged that the data used in the analysis reflect the relative magnitude of conflict events in each Lake Chad riparian zone. As such, they indicate a realistic picture of the social disturbances in the LCB.

3.8.5 Explanatory variables

Climate shock is operationalised as rainfall anomalies (Papaioannou, 2016). In the LCB (as with the entire Sahel region), rainfall signals resource availability, e.g. water supplies for agricultural activities (Odada *et al*., 2006; Tschakert, 2007). Similarly, wet and dry conditions provide a basis for debating the ‘scarcity’ and ‘abundance’ thesis (Seter, 2016). In contrast to temperature which varies much less spatially and temporally, rainfall in the tropics generally displays significant spatio-temporal variability, often over scales of tens of metres (Raleigh *et al*., 2015). For a region such as the LCB that is characterised by fluctuating rainfall patterns, spatiotemporal variations often influence river runoff, a condition that can severely affect outcomes for rain-fed agriculture and water supplies in lakes and wetlands.

Three operationalisations of rainfall measures were explored: (i) negative inter-annual rainfall anomalies (*Rain (-)*); (ii) positive inter-annual rainfall anomalies (*Rain (+)*); and (iii) rainy season (*RainySeason*) and dry season (*DrySeason*) anomalies - accounting for intra-annual, seasonal deviations of rainfall totals from long-term (1980 – 2015) patterns. The negative and positive rainfall anomalies for each zone were generated by calculating rainfall deviations from the long-term mean (1980 – 2015) and dividing the score by the standard deviation (SD) of rainfall rates (i.e. $\text{Rain}_{\text{current}} - \text{Rain}_{\text{long-term mean}} / \text{Rain}_{\text{SD}}$) (Raleigh and Kniveton, 2012). Following the approach in Fjelde and von Uexkull (2012), the positive deviation variable (i.e. *Rain (+)*) was assigned the absolute value of positive deviations while setting all non-positive (or negative) numbers to zero. Similarly, the negative deviation variable (*Rain (-)*) took the absolute value of negative deviations, while setting all non-negative deviations to zero. Negative rainfall anomalies can suggest water shortages or drought, while positive anomalies can indicate disruptive rainfall abundance leading to flooding, mudslides and increased crop damage. The ‘anomalies calculation’ approach employed here is akin to Hendrix and Salehyan's (2012) suggestion that deviations from long-term mean rainfall reflect an optimal operationalisation of the ‘climate anomalies or shocks’ mechanism. Societies often develop expectations regarding normal rainfall conditions and plan agricultural activities and coping strategies based on these expectations (Tschakert, 2007). Deviations from normal patterns disrupt these expectations in a way that can negatively impact human well-being. This justifies the rationale for a focus on extreme events – i.e. shocks/anomalies - in empirical climate conflict analysis (Hendrix and Salehyan, 2012).

For the wet and dry season variables, absolute values of total rainfall for each year were computed by calendar month over a 6-month period using data from May to October for the wet season and November to April for the dry season. Although the climatological patterns of the region differ across the arid, semi-arid and humid zones, the Lake Chad areas generally receive most of their rains between June and September. May and October usually mark the beginning and ending of the rainy seasons respectively (Bastola and François, 2012). Seasonal anomalies were calculated using a similar approach applied for the rainfall anomalies measures. Seasonal measures are useful for understanding whether, for example, total dry season or wet season rainfall in a given year is below or above the long-term normal patterns/averages for the season. Matching the measures with patterns of conflict enabled the study to assess whether seasonal conditions influence conflict (i.e. to understand whether dry season or wet season months are more prone to conflict). It is expected that interactions between conflict and rainfall anomalies will likely vary by whether or not it is a rainy season. *Rain (-)* and *Rain (+)* measures were tested with various time lags (Raleigh *et al*., 2015). By not imposing any conventional parametric form (i.e. a quadratic function depicting curvilinear relationships) on the rainfall measures, it is expected that the variables would more accurately estimate the different conflict effects of rainfall anomalies. Constructing rainfall anomalies in this manner acknowledges that climate is different from weather, pointing to long-term periods rather than month-to-month changes (Landis, 2014). Moreover, as the measures used are standardised, they allow for meaningful comparisons of deviational differences across the riparian zones.

Using annual rainfall anomalies to capture climate shocks enabled the study to account for deviations from long-term normal rainfall patterns, including standard deviations from mean values (Salehyan and Hendrix, 2014). The measure captured shocks/anomalies more closely than a mere measure of rainfall amount or annual averages (Auffhammer *et al*., 2013). Similarly, the measures used accounted for the effects of current extreme rainfall shortages and abundance (on conflict), including their effects in prior periods, up to two years (Raleigh *et al*., 2015). Climate estimates constructed with multiple variables and lags, as undertaken here, are generally unbiased and can point towards robust empirical results (Burke *et al*., 2015).

Station rainfall data spanning 1980 to 2015 (Table 3.7), were collected from the Water Resources and Meteorological Directory of the Hydrological Ministry of Chad (DREM, 2013), the National Oceanic and Atmospheric Administration's (NOAA) Global Historical Climatology Network (NOAA-GHCN – Monthly Version 3) (Lawrimore *et al*., 2011), including a recent version of rainfall data from the University of Delaware Climate Research Centre (UDCRC Version 4.01) (NOAA, 2015) and the Global Precipitation Climatological Centre (GPCC - Version 7) (Schneider *et al*., 2014). Rainfall data were matched to each zone based on the geographical coordinates[25] specified in Table 3.5. Data were collected to ensure that one data source complemented any missing data in another source where possible. This enabled the creation of composite month-to-annual geo-referenced zone-record data series. When there were two or more monthly (mean or total) observations from different data sources for a given zone per month, the observations were blended to create a single, zone time series, i.e. the median of these values was taken for that month (Lawrimore *et al*., 2011). This approach ensured that all available data were utilised to create reliable rainfall data series for the riparian zones.

[25] Rainfall data covered Chad, Cameroon, Niger and Nigeria zones. Each zone falls within one or more administrative provinces. Overall, the study employed rainfall data from six administrative provinces where meteorological stations exist. Data from N'Djamena, Bol and Mao stations were merged to obtain a composite mean rainfall dataset for the Chad zone; a similar step was taken for the Niger zone where data from Diffa and N'Guigmi were merged. Where necessary, rainfall data were merged to enable analysis at the riparian zone/yearly units. Where rainfall data were available up to 2014, an extrapolation approach using values for the two previous years was applied.

Table 3.7: Sources of rainfall data.

Name of station and associated riparian zone	Associated province/region	Estimated distance to the Lakeshores/waters (in km)	Rainfall data source and temporal coverage
Mao, Chad	Kanem	147.2	DREM (1980 – 94); GPCC Version 7 (1995-2015)
N'Djamena, Chad	Hadjer-Lamis	118.9	DREM (1980 – 2008); NOAA-GHCN Version 3 (2009 – 2015)
Bol-Berim, Chad	Lac	52.8	DREM (1980- 90); GPCC Version 7 (1991-2015)
Maroua-Salak, Cameroon	Far North	293	UDCRC Version 4.01 (1980 – 2014)
Diffa, Niger	Differ	213.1	GPCC Version 7 (1980-2015)
N'Guigmi, Niger	Differ	207.7	GPCC Version 7 (1980-2015)
Maiduguri, Nigeria	Borno	208.8	UDCRC Version 4.01 (1980 – 2014)

3.8.6 Contextual vulnerability variables

To evaluate the second hypothesis, measures of *political exclusion*, *local agricultural production changes* and effectiveness of governance (captured as *democracy*) were constructed and applied in the empirical analysis. *Political exclusion* is conceived as a form of discrimination directly targeted at a particular ethnic community or group, and is often operationalised in the literature on the basis of whether or not an ethnic group or a region is politically relevant in central governments (Uexkull, 2014; Wischnath and Buhaug, 2014; Fjelde, 2015). Political relevance in this context implies a condition where at least one significant political or ethnic actor represents the interest of a particular group in the domain of public politics (Cederman *et al*., 2010). In contrast, exclusion prevails if members of an ethnic group are systematically and intentionally excluded or discriminated against in the politics of central government.

Conflict seems to occur more frequently in locations made up of different ethnic groups (ethnic diversity), especially where groups are excluded from governance activities (Hegre and Sambanis, 2006). Recent studies (e.g. Dabalen *et al*., 2012; Basedau and Pierskalla, 2014) suggest that ethnicity (in the context of ethnic exclusion rather than ethnic diversity) plays a strong role in SSA politics as a source of conflict and division. Ethnicity can also be influential in determining future vulnerabilities to the effects of climatic events (Busby *et al*., 2014a). Where ethnic groups are at odds with the central government, they may become the target of discrimination and as such may be deprived of essential relief services or other assistance during extreme climatic events (Raleigh, 2010). This can spur ethno-political grievances, which can represent a powerful predictor of instability and violence (Wimmer *et al*., 2009), especially if the marginalised groups have high mobilisation capacities and have experienced violence in the past (Cederman *et al*., 2010).

In this research, the variable *political exclusion* is captured as a dummy variable, and coded as 1 if the dominant or majority of local ethnic groups resident in a particular riparian zone were excluded, and 0 if they held a political position in central government in a particular year (Uexkull, 2014). Central government, rather than the provincial or local government, is considered in the literature because national wealth and opportunities in poor countries are concentrated at the national government level. The variable is based on data on the political status of ethno-political groups from both the Ethnic Power Relations (EPR version 3.01) (Wimmer *et al*., 2009), and the Geo-referencing Ethnic Power Relations (GeoEPR) (Wucherpfennig *et al*., 2011; Vogt *et a*l., 2015) databases. The former provides year-to-year information on politically relevant ethnic groups and their access to state/central executive power but does not indicate where excluded groups are located geographically. The latter (often referred to as a geocoded version of the EPR) provides geo-referenced information on locational base and settlement patterns of different ethnic groups[26]. Combining both datasets can help to identify vulnerable areas inhabited by groups that have experienced historic discrimination and that are politically irrelevant or powerless (Busby *et al*., 2013). A substantial population and

[26] The accuracy of both databases were verified using telephone communications with key informants.

ethnic groups in the LCB reside in far-away hinterlands, islands and the state peripheries, and as such, lack political representation in the central governments. Discriminatory political systems have meant that the majority have limited access to central power, depicting a condition that may likely correlate with patterns of local conflicts (Asah, 2015).

The analysis also included values of *local agricultural production changes*, proxied by a local agricultural price change index, as another contextual vulnerability variable. Following Fjelde (2015), location-specific time-invariant data on sub-national output of agricultural crops (mentioned below) were combined with time-varying international price data on these crops to identify exogenous variation in local agricultural production revenue (i.e. revenue influenced by output and price) at the local riparian zone level. The time-varying price data are from International Monetary Fund (2015) price statistics, whereas the data on sub-national crop production patterns are from the Spatial Production Allocation Model (SPAM) (You *et al*., 2014). Because local crop prices could be endogenous to local conflicts (local price data are unavailable for the zones), it was assumed that reliance on international commodity prices can allow for the identification of exogenous variations in local agricultural outputs and revenues for locations facing climate-related instability (Raleigh *et al*., 2015).

SPAM provides sub-national level crop production outputs for several crop types across the world using information from numerous sources that provide agricultural output statistics at the local level, including the Food and Agricultural Organisation of the United Nations (FAO), the World Food Programme, National Bureaus of Statistics, Agricultural Performance Surveys and regional/local NGOs. One drawback associated with the SPAM data is that they are only available for the year 2005 (i.e. the updated 2005 model version 2, release 0). Although the data capture overall spatial agricultural production patterns, their failure to reflect temporal changes represents an obvious bias. The lack of better-quality, i.e. local-level time-varying data on crop output, is a limitation here. To be able to construct a ‘proxy’ measure of agricultural production values that are both exogenous and location specific, a bundle of crops whose prices are captured in the IMF price statistics were filtered from the SPAM data. The selected bundle encompasses outputs (in metric tons) of groundnut, maize, rice and soybean – crops considered as relevant to the livelihoods of individuals and the economies of the Lake riparian zones (Odada *et al*., 2006).

Based on Fjelde's (2015) approach, the IMF prices data were aggregated from monthly to annual price series for each crop, and multiplied with a 2005 constant production value for each of the selected crops to obtain a time varying local agricultural price index (API) for each zone using the equation:

$$\text{API}_{ct} = \sum_{i=1}^{n} \omega_{ci} P_{it}$$

where P_{it} is the time-variant (*t*) price series for each selected crop *i* and w_{ci} is the time-invariant share of crop *i* output in riparian zone *c*. The index is assumed to capture variations in local agricultural production and the value ranges from: – 0.001 to 0.45. To ensure the right temporal ordering, the index was entered in the empirical analysis at t – 1 (i.e. one year prior time lag of changes in agricultural production level) (Fjelde, 2015).

The polity2 score from the Polity IV project database is widely used to capture governance effectiveness or *democracy* (Hendrix and Haggard, 2015). Values in the dataset range from – 10 for the most institutionalised autocratic system to + 10 for the most institutionalised democratic regime (Marshall *et al*., 2013). Previous studies suggest that the most and least democratic regimes may be less prone to violence conflict (Hegre *et al*., 2001; Gizelis and Wooden, 2010). Following Salehyan and Hendrix (2014), the squared term of the Polity2 score was computed and included in the empirical analysis as a proxy measure of democracy, and as a way to account for the potential for a curvilinear relation of democratic regime with conflict (i.e. based on the assumption that the most and least democratic systems are the least prone to conflict) (Hendrix and Haggard, 2015). The rationale here is that -10 and +10 values representing the least and the most policy2 scores may suggest less conflict outcomes, which points to a likely curvilinear relationship with conflict. The polity2 data covering the Lake Chad zones range from 1960 to 2014. The value assigned to the year 2014 was replicated for 2015 because the regime statuses in both years are the same for the Lake Chad countries. The data used captured governance at the national level and assume that national governance often influences local patterns of village and community leadership. Local democracies and power dynamics were not considered. Further ways of understanding governance effectiveness or better governance at the local level than degree of national democracy can also matter, but data limitations means that this can be better addressed using qualitative narratives (Linke *et al*., 2015). Such narratives for the LCB, as captured in Odada *et al*. (2006), Onuoha (2009) and Asah (2015), suggest a less stable, more centralised governance structure that is skewed towards autocracy.

3.8.7 Lake size anomaly

Fluctuations in lake size or water levels can be influenced by certain demand side (e.g. population, agricultural and irrigation pressures) and supply side (e.g. rainfall variations) factors (Böhmelt *et al*., 2014). The analysis here is concerned about the supply side - in the context of climate shocks. The natural conditions of the LCB are often dictated by oscillating wet and dry periods, which alternates not only at an inter-annual temporal scale, but also over much longer time periods (Cerezo *et al*., 2011). The Lake's shrinking pattern acts as an amplifier of climate effects on the rural populations who depend on its waters for survival (Ovie and Emma, 2012). Several studies on lake and river basins argue that the size of a lake or the basin in which it is located, particularly in the context of extreme water shortages, can spur conflicts or act as a precursor to conflict (Gleditsch *et al*., 2006; Brochmann and Gleditsch, 2012). In contrast, the geographical importance of transboundary lakes can also make seemingly conflict-prone river basins or lakes arenas for cooperation, enabling co-governance by riparians countries (Yoffe *et al*., 2003).

The LCB has two portions in terms of its shrinking area extent – the north and the south. These portions have never had similar water levels since the beginning of the Small Lake Chad phase in the late 1970s (Gao *et al*., 2011), and there are possibilities that areal extent in terms of size fluctuations would not be the same in the different zones bordering the Lake (water level is often a reflection of lake size). Data on distinct patterns of lake drying are not available for different zones. Given this limitation, the analysis used the same lake size value as proxy for all zones by incorporating an annual lake drying variable, operationalised as a continuous measure of lake size anomalies (*LakeSize_Anomalies*). The rationale is to capture abnormal conditions of lake size fluctuations based on the 1980 – 2015 temporal scale covering periods of abnormal drying trends across the Small and Dry Small Lake Chad phases. Lake drying often constitutes an abnormal water condition for locations where lake waters are a major source of water supplies for livelihood activities (and could be indicative of water scarcity conditions) (Ovie and Emma, 2012). Anomalies were captured to reflect annual and long-term oscillations, computed as lake size deviations from the long-term average (1980 – 2015) and dividing the score by the standard deviation (SD) of lake size rates (i.e. $\text{LakeSize}_{\text{current}} - \text{LakeSize}_{\text{long-term mean}} / \text{LakeSize}_{\text{SD}}$). Data on annual estimates of lake size (i.e. area extent in km^2) were collected from the LCBC and are available from 1980 to 2012. Following Buhaug and Urdal's (2013) an extrapolation method was applied (the method is as used in the extrapolation of population data – see Section 3.8.8) to complete the missing data points from 2012 to 2015, based on fluctuation rates between the last two observations.

3.8.8 Control variables

A battery of control variables typical of the climate conflict literature was included in the empirical analysis. Although the exclusion or inclusion of control variables is debated amongst those quantitatively studying the climate conflict nexus (O'Loughlin *et al*., 2014a), the approached used here followed Buhaug (2010) and Theisen (2012). Their arguments advance the inclusion of a full suite of control variables (based on data availability) as a way of placing the relative causal weight of spatiotemporal climatic events in context and to tackle the confounding influences of factors (such as population density and per capita gross domestic product) that may exhibit significant time trends (Salehyan and Hendrix, 2014). The analysis included measures of population (i.e. lagged population density) and economic development (lagged gross domestic product per capita), as well as lagged conflict in a specific zone and lagged conflict in neighbouring zones as controls.

Conflict is likely to be more frequent in more populous locations (i.e. locations with high population density), especially populated areas remote from the capital (Raleigh and Hegre, 2009; Buhaug and Urdal, 2013). The LCB is increasingly perceived as having one of the highest population growth rates in the Sahel region (Mekonnen, 2016), suggesting the possibility for increased conflict. Similarly, low levels of economic development can also predict the likelihoods of conflict (Jakobsen *et al*., 2013). Population data are from the Gridded Population of the World database (GPW versions 3 and 4) from the Centre for International Earth Science

Information Network (CIESIN) of the Columbia University (CIESIN, 2015). As a widely used geo-referenced, UN-adjusted estimate of human population distribution database (Doxsey-Whitfield *et al.*, 2015), CIESIN attributes population to the lowest sub-country level administrative units. The primary sources of population data contained in the GPW database are from national censuses and surveys. The combined third and fourth versions of the database are available for every five years beginning from 1990 (i.e. version 3 covers 1990, 1995 and 2000; while version 4 includes data for the years 2000, 2005, 2010 and 2015). Because population censuses are not synchronised and census taking has been irregular in the LCB countries since the 1980s, figures needed to be estimated for missing years. As such, annual rural population estimates were created by linearly interpolating between existing data values and extrapolating across existing observations to the right and left to estimate new data values. Both the interpolation and extrapolation approaches are based on Buhaug and Urdal (2013) and the GPW methodology for estimating population values for target years (CIESIN, 2015).

Specifically, based on the CIESIN (2015) codebook, annual population growth rate (interpolated estimates) were computed using the equation:

$$r = \mathit{In}\ (P_2/P_1)/t.$$

Thereafter, the resulting annual population estimates were adjusted to the year of interest using:

$$P_x = P_2\, e^{\,r * t}$$

where r is the average (annual) growth rate, P_1 and P_2 are the census population counts – i.e. the population totals observed for two different periods, t is the number of years between population counts and P_x is the population estimate for the target year (*e* and *In* stand for exponential and natural log signs respectively).

As there were no population data available for most of the years before 1990, simple mathematical trend predictions were made using the two closest observations (1990 and 1991) in the trend function in Excel to extrapolate the data to the year 1980 (Buhaug and Urdal, 2013).

With the data for 1980, the two equations above were applied as a way to estimate new observations that lie between 1980 and 1990.

The analysis used *population density* as a proxy variable for population. This was computed by dividing the estimated population values by the estimated average zone-specific land area per annum (estimated land area in km^2 is provided for each riparian zone in the CIESIN population database). The variable was used in the analysis as a lagged value to account for the effect of inertia in population changes (Uexkull, 2014). Based on Buhaug and Urdal (2013), the population estimates used here are assumed to be fairly accurate despite not adjusting for underlying conditions that may influence changes in population, such as natural disasters, civil war, migration, disease outbreaks, death and birth rates.

Lower levels of sub-national economic development often increase conflict risk by increasing the relative (and absolute) deprivation of rural dwellers (Koubi *et al*., 2012; Shortland *et al*., 2013). In the analysis, economic development was captured using *gross domestic product per capita (GDP pc)* based on data from the Penn World Table (PWT) version 8.1 (Feenstra *et al*., 2015). Although a country-level indicator of per capita income, the PWT data were considered relevant because they have a wide temporal range (1950 – 2011). All missing data points were extrapolated to 2015. Broadly, national GDP per capita data are often less precise as they do not reflect exclusively the high poverty or low income levels at the local scale. However, they represent a useful proxy as they are readily available over a wide range of time periods. In using the data (since reliable (alternative) data on sub-national GDP could not be accessed), the research assumes that GDP per capita is uniformly distributed within each riparian country (Jakobsen *et al*., 2013). The G-Econ database (Nordhaus *et al*., 2016), a widely used local equivalent of GDP, has several missing data points for locations around the Lake, and several data points presented were found to be unreliable, particularly in capturing sub-national patterns of poverty in the context of the Lake Chad zones. In the analysis, GDP pc was entered at $t - 1$ in order to ensure the right temporal ordering (Salehyan and Hendrix, 2014).

Several studies (Theisen, 2008; Fjelde, 2015; Maystadt *et al*., 2015) suggest the inclusion of variables that account for the occurrence of conflicts at nearby locations and in the recent past when assessing the influence of a focal predictor (e.g. climate shocks) on the risk of conflict, particularly within conflict-affected regions. Riparian zones are often interconnected in time and space (Norman and Bakker, 2015). As such, a rebel attack in one riparian zone can provide opportunities for rebel groups to attack a nearby area (Wischnath and Buhaug, 2014). This study accounts for the likelihood that conflicts can spread from one location to nearby locations (a spill-over effect) and also from one period to another period within the same location. The assumption regarding spatiotemporal dependency of conflict outcomes is well established in conflict and peace studies (Hegre *et al*., 2001) and is often employed in quantitative climate conflict research (Fjelde and von Uexkull, 2012).

To operationalise the occurrence of conflicts at nearby locations (i.e. spatial lag within the 300 km riparian zone radius), a variable *lagged conflict in neighbouring zone* was included - which takes the value 1 if there was conflict in any neighbouring zone in the year before the year of observation (Hegre *et al*., 2001). Also, to account for temporal dependency (i.e. assuming a one year temporal lag), the main dependent variable (total conflict) was included as a *lagged count of conflict events* (Raleigh *et al*., 2015). Only conflict incidence/event, not intensity, was captured (because information on intensity is often less reliable (Weidmann, 2014)). Conflicts that may spread into each riparian zone from areas beyond 300 km from the Lake shores were not considered. Unobserved temporal dependency beyond the previous year was also not captured. The spatial and temporal dependencies are assumed to be linked to the conflict types captured in this study (civil war influences are not included). Despite these sources of bias, it is believed that the spatial and temporal considerations accounted for are adequate, and given the qualitative narratives supporting the findings presented in Chapter 6, the approaches adopted are considered reliable.

3.8.9 Statistical analysis

The three theoretical hypotheses (H_1 to H_3) outlined in Section 3.8 were used to address objective three. Each hypothesis was evaluated using a specific type of estimation model and analytical technique. A complete discussion on the estimation procedures and analytical frameworks is presented in Chapter 6. Estimation techniques did not assume a reciprocal association between rainfall anomalies and conflict. Negative binomial regression (Hilbe, 2007) was used to evaluate H_1 because of the over-dispersed patterns observed in the conflict variable (see details in Chapter 6). A multiplicative interaction model (Brambor *et al*., 2006; Buis, 2010) was used to evaluate H_2. To evaluate H_3, a mediation analysis based on PROCESS for SPSS version 2.15 (Hayes, 2013) was utilised. Each hypothesis was evaluated individually for each of the four riparian zones in separate models. These are presented and discussed fully in Chapter 6.

3.9 Data and research methodology 3: Qualitative document analysis

The approach adopted to address objective four, which forms the third phase of the research, is presented in this section. To systematically evaluate a sample of LCB-related policy intervention documents covering issues pertaining to adaptation, water and conflict, qualitative document analysis (QDA) was carried out. Evaluation in this sense sought to ascertain: (i) whether themes related to water, security/conflict and adaptation were considered in the policy documents developed or promoted by the Lake Chad Basin Commission (LCBC); and (ii) whether statements pertaining to these three themes are integrated, including the contexts in which integration has been approached or treated. For this research, integration is considered to occur when climate adaptation actions include options for water governance and conflict management, when water governance activities accommodate adaptation and conflict prevention approaches, and when conflict management efforts account for adaptation and water governance needs. Policy as used in this research refers to any initiative, action plan or decision by the LCBC oriented towards either a short or long-term goal or to a particular problem in and around the LCB.

The QDA approach (Altheide *et al*., 2008; Gerstetter *et al*., 2011) is often used in qualitative assessments of written documents, such as policy actions and initiatives, in order to unpack meanings, contexts and implications of text and/or narratives. The approach requires the use of subjective criteria, e.g. scores, including a range of linked steps to facilitate rigour and consistency in document analysis (Le Gouais and Wach, 2013). Such steps often include: setting criteria for screening and selection of documents, sourcing for documents, setting criteria for document analysis, and conducting qualitative analysis and validation (De Stefano *et al*., 2014).

In setting the boundaries for document selection, official documents on key intervention projects and strategies from the LCBC, including those developed in collaboration with its partners[27] covering the LCB geographical area were selected and sampled. Documents that did not meet the geographical area specification were screened out. Specifically, on the basis of a set of 20 potentially relevant policy intervention documents, 12 were selected. Documents selected were those targeting key intervention needs in the Lake Chad area – particularly on development, climate change, security, water management and resilience building, and included published and unpublished publicly available draft versions of action plans, initiatives and strategies. Chapter 7 (Table 7.1) presents the publicly available LCB-related documents that most closely relate to adaptation, water and security/conflict themes. The LCBC website and other online sources were searched to collate the documents. Also, informal discussions with the LCBC legal adviser (during scoping) and the human resource manager (during stakeholder workshop) informed decisions on which documents were appropriate to investigate. Whilst the assessment here cannot claim to include all related policy documents (documents evaluated were those accessible in English), the analysis showed gaps in vital areas across water, adaptation and security/conflict which reflect the state of integration for many of the LCBC-coordinated interventions.

Document analysis began by reading each document in detail, marking keywords, phrases and sections, and identifying the meanings they communicate in relation to ‘adaptation’, ‘security’, ‘climate impact’, ‘conflict’ and ‘water’, including identifying the range of initiatives proposed or implemented in the document. Next, the specific aims and approaches/strategies proposed were identified including the wider discursive context shaping such approaches (i.e. the contexts in which the approaches are situated). Further reading led to identification of more keywords, such as water management (e.g. water transfer and conservation), conflict resolution (e.g.

[27]The LCBC partners include the World Bank Group, French Development Agency, German Cooperation, Global Environment Facility, different UN agencies, the African Development Bank, African Union Peace and Security Council, Summits of Heads of State and Governments of the LCBC member countries and Benin, and NGOs.

peacebuilding, cooperation and prevention). These further guided the in-depth analysis. Specifically, reading and assessments of documents were guided by the following questions:

- Did the policy initiative address the risk of human insecurity in the context of water shortages/floods?
- Were adaptation, water governance and conflict management concerns mentioned fleetingly or strongly emphasised?
- Did the initiative emphasis climate adaptation (whether planned or autonomous or both)?
- Was the document explicit about approaches to address one or more of conflict risks, water challenges and climate adaptation?
- Was the agenda for integration or coherence mentioned explicitly or fleetingly? Did it suggest a need for integration?
- Was the document a replication of previous initiatives (duplication of efforts)?
- What is the time frame of the action plan/policy proposed?

To understand how adaptation, water and conflict have evolved over time, the dates associated with each document or policy were noted. The chronology of the initiatives was evaluated to understand trends in the LCBC intervention priorities for the area. To evaluate whether integration of approaches across adaptation, water and security needs was happening, a subjective scoring approach was developed (Table 3.8) following Le Gouais and Wach (2013).

Table 3.8: Scoring criteria used to assess integration and document integration score (modified from Le Gouais and Wach, 2013).

Type of integration	Description of integration	Score
No integration	There is a complete lack of evidence in the policy/strategy to suggest that thematic issues or statements are harmonised and/or integrated.	0
Unclear integration	The three key themes/issues were mentioned briefly/fleetingly, but details were lacking as to whether the policy pointed to integration.	1
Mild or limited integration	The policy supports integration of two of the three thematic issues (i.e. adaptation and water governance, or conflict resolution and water management). Lack of details to guide activities and plans for integration.	2
Moderate or partial integration	Policy initiatives support all three themes (adaptation, water and security) and suggest a need for alignment/integration, especially in the form of general statements. Yet such initiatives are less clear and distinct regarding how integration could be achieved. Relatively fewer details and guidelines are included within the policy document.	3
High or full integration	Policy actions are coordinated and aligned strongly across adaptation, water and security statements. Policy integration devotes specific attention to conflict management and water governance in relation to climate adaptation/resilience needs. It includes numerous and detailed complementary strategies and actions for achieving integration (triple-objectives).	4

The scoring criteria incorporated the meanings of text and narratives, including the keywords identified during document assessment as building blocks in which to guide the scoring. Initial results from the analysis were validated for correctness through phone contacts with key staff members of the LCBC. This helped to avoid bias or faulty assumptions. Also, by ensuring that the analysis and conclusions were based on what was written in the sampled documents, the approach adopted facilitated credibility, reliability, dependability and impartiality.[28]

[28] The analysis carried out did not capture implementation effectiveness, in terms of the capacity of the LCBC to implement action plans. Also, an assessment of outcomes of policy actions on each of water, adaptation and conflict intervention activities was not carried out. These are potential areas for further research.

3.10 Summary of chapter three

This chapter focused on the research design, approaches and methodology developed in the research. The variety of sampling procedures, data collection methods and links to field research approach has been described. Background information on Lake Chad and its basin, and the specific case study villages and zones has been presented. The multi-method approaches used in the research, including negative binomial regression and qualitative document analysis, were also presented. Justifications around choice of the study area, riparian zones, the sample design and the data used have been highlighted. The strengths and limitations associated with the research method used for each phases of the research have been discussed. The chapter also highlighted the research ethics and positionality concerns related to the scoping and main fieldwork exercises carried out in Chad Republic. The academic novelty of the multi-method case study approach adopted indicates the leading role that a combination of methods can play in research spanning security dimensions of climate shocks and context-specific livelihoods and vulnerability assessments in the context of environmental degradation. Such an approach offers opportunities to conduct research that satisfies the information need of development actors, and as such, will be replicable to other water scarce, conflict-prone regions in SSA where abnormal climatic conditions are a subject of concern.

Chapter 4

Lake drying and livelihood dynamics in Lake Chad: Unravelling the mechanisms, contexts and responses[29]

Outline

This chapter examines lake drying and livelihood dynamics in the context of multiple stressors through a case study of the “Small Lake Chad” in the Republic of Chad (Objective 1). Livelihoods research in regions experiencing persistent lake water fluctuations has largely focused on the well-being of lakeshore dwellers. Little is known about the mechanisms through which lake drying shapes livelihood drawbacks and opportunities, and whether locally-evolved responses are enhancing livelihoods. The chapter addresses these gaps using empirical, mixed-methods field research. The analysis demonstrates that limited opportunities outside agriculture, the influx of mixed ethnic migrants and the increasing spate of violence all enhance livelihood challenges. Livelihood opportunities centre on the renewal effects of seasonal flood pulses on lake waters and the learning opportunities triggered by past droughts. Although drying has spurred new adaptive behaviours predicated on seasonality and the availability of assets, responses have remained largely reactive. The chapter points to where lake drying fits amongst changes in the wider socio-economic landscape in which people live, and suggests that awareness of the particularities of the mechanisms that connect lake drying to livelihoods can offer insights into the ways local people might be assisted by governments and development actors.

[29] This chapter is developed from the published journal article of Okpara, U. T., Stringer, L. C. and Dougill A. J. 2016. Lake drying and livelihood dynamics in Lake Chad: Unravelling the mechanisms, contexts and responses. *Ambio* – Journal of the Human Environment. DOI:10.1007/s13280-016-0805-6.

4.1 Introduction [30]

Lakes represent a key store of accessible freshwater for pursuing a wide array of social, economic and environmental goals. As such, they often mirror the general livelihood conditions of lakeside communities when they experience changes in their water levels (Rast, 2014). At the heart of most discussions about the challenges posed by the diminution of lakes is the well-being and security of lakeshore dwellers, who are often postulated to lack the capacity to cope with and adapt to change (Bene *et al*., 2003; Nindi, 2007; Goulden *et al*., 2013; Kafumbata, 2014). With some exceptions, empirical studies rarely examine the diverse range of mechanisms through which lake fluctuations influence livelihoods. Even less is known about the range of opportunities lakeshore dwellers can access under lake level fluctuations – including where lake drying fits in the suite of stressors affecting household livelihoods in water-limited environments that are increasingly a global focus of resource conflict concerns. As policy makers, managers and scientists work to address the changing climatic and socio-political landscape within which lake dwellers operate, there is a need for knowledge regarding the livelihood benefits that resource-users lose or gain under conditions of water resource depletion, and in particular, how lake drying interacts with local contextual issues (White, 2013).

This chapter engages varied perspectives from individuals with livelihood patterns that combine subsistence agriculture with utilisation of lake water resources to better understand the underlying processes that set the context for livelihoods-environment links in regions facing lake water fluctuations. The chapter unpacks how lake drying influences livelihood drawbacks and opportunities, as well as the range of mechanisms that shape the connections between these issues. To address these, the chapter applies empirical, mixed-methods field research (see Chapter 3.4) based on the sustainable livelihoods perspective (see Chapter 2, Section 2.3) to identify the dynamics of change in the livelihoods of lake dwellers, composed of farming, fishing and pastoral livelihoods, and the range of stressors confronting them. It equally assesses where lake shrinkage fits amongst contextual stressors people experience and whether their portfolio of

[30] The terms Lake Chad, Lake Chad basin and Lake basin are used interchangeably to mean the Lake area bordering Cameroon, Chad, Niger and Nigeria. The Small Lake Chad refers to the current state of the Lake, with a large portion of its waters located in Chad Republic.

responses reflect locally-adapted solutions. By studying the conditions and experiences of lake dwellers, the chapter contributes to discussions on functional linkages between livelihoods and the environment in relation to the socio-economic needs of lakeshore societies and the ability of the changing environment to satisfy them. It equally points to a range of livelihood and lake-related concerns, and offers insights into the ways local people might be assisted by governments and development actors.

The chapter is situated within the current “Small Lake Chad” (SLC) in the administrative department of Haraze Al Biar in the Chadian Hadjer-Lamis region (12° 53″ N; 14° 37″ E) (Chapter 3, Section 3.1). The Lake Chad region is often presented as one of the most water impoverished areas in the world (Singh *et al*., 2006) and has recently witnessed several sporadic outbreaks of violence (Figure 4.1), including terror attacks (Asah, 2015). The data used are from 240 households (farming (n = 80); fishing (n = 80); and pastoral (n = 80)), eight focus groups and twenty key informant interviews. The chapter also utilises data from experts outside the Lakeside villages and islands to further contextualise understandings about livelihood conditions around the Lake (see Chapter 3, Section 3.4). The fieldwork focused on the provisioning services of water supplies from the SLC and drew insights from the reasons given for changes in livelihood conditions and strategies. It situated the role(s) of the SLC in the context of other conditions, including conflicts (Figure 4.1) and climate variability (Figure 4.2) in order to tease out the mechanisms by which lake water depletion can influence different livelihood groups and livelihood dynamics. The emphasis on livelihood dynamics considers that if state or community-led water governance is predicated on a more complete understanding of how locals generate a means of survival, it can result in more effective lake resource conservation, promotion of livelihood security and reduced risk of local clashes.

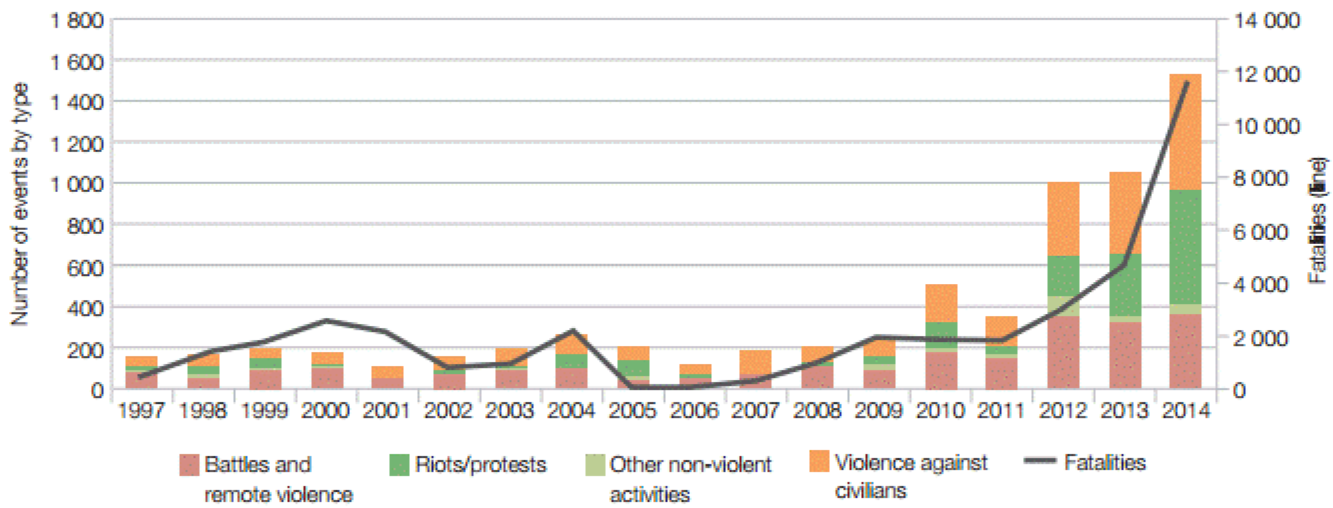

Figure 4.1: Trends of violence and fatalities in the Lake Chad region (1997 – 2014). (*Source*: Armed Conflict Location and Event Database (ACLED) Version 5; http://www.acleddata.com/data/version-5-data-1997-2014/)

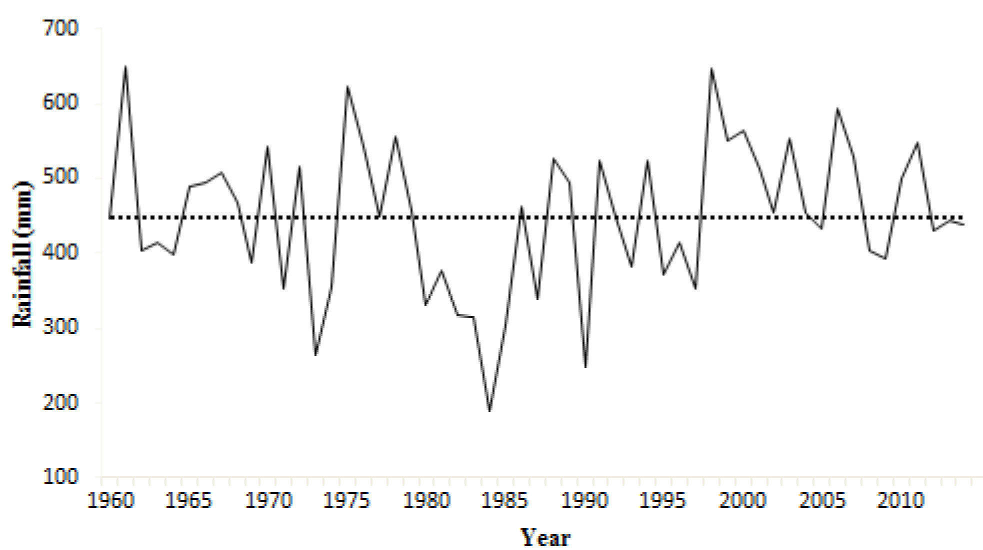

Figure 4.2: Rainfall trends for Lake Chad south-eastern shore. The figure illustrates total annual rainfall for the study area with *dotted lines* representing the average values (449 mm) for the 1960 – 2014 period. It reveals substantial inter-annual rainfall variability typical of the Sahel belt (*Source*: Statistics derived from climatological data obtained from the Directorate of Water Resources and Meteorology in N'Djamena)

Reflections on the data collected were undertaken jointly with key informants (particularly the village heads and gatekeepers) and the LCBC through continual dialogue/follow-up interviews. Data analysis was conducted at the household level and later aggregated at the livelihood group level. The influences of the SLC were assumed to be homogenous within households, but heterogeneous across groups. Results addressing objective one are presented in Section 4.2. The discussions addressing research questions one, two and three are presented in Section 4.3, each informed by findings from analysis of data collected using mixed-methods.

4.2 Unpacking the influences of the Small Lake Chad on rural livelihoods

This section provides results covering the rural livelihood contexts in the study area, the influences of the SLC on livelihoods, the place-based stressors affecting livelihoods and the range of local response strategies employed by livelihood groups. Results are disaggregated across three main livelihood groups.

4.2.1 The rural livelihoods contexts

Several households in the study villages are migrants (Table 4.1) [31] from around the Lake basin. Their tendency to co-habit within small villages around one primary livelihood activity informed their placement into three livelihood groups. Table 4.2 sets out the assets held by different groups. More than half of all households, focus group discussants and key informants noted the relative weakness of household assets in terms of contribution to local livelihoods. The livelihood context is largely conditioned by high dependency on seasonal variations in natural assets. The SLC is a more accessible water source to farmers and fishermen than pastoralists, who on several occasions need to travel more than 50 km to the Lake's water. While fishermen who fish the open waters are required to pay certain charges, the wetlands and floodplains near several villages offer free fishing spaces for anyone during the rising flood seasons. The

[31] See Table 4.1 - Several are either internal or cross-border migrants settling temporary or permanently, who move due to economic and environmental constraints, including conflict threats. They are spurred by the need for survival; and because the attractiveness of the lake resources heightens during dry periods, migrants travel from far away islands and hinterlands, as far as several hundreds of kilometres to the lake water areas (see Okpara et al., 2015).

cultivation grounds of the Lake's wetlands and recession beds provided fertile soils for food and cash crop cultivation in the past. Farming currently requires huge investments in fertilisers, pesticides and gasoline for motorised irrigation pumps to enable higher yields.[32] Several farmers reported unimpeded access to arable land under the freehold and short-term use arrangements, except for the 'new' land spaces following the Lake's contraction and in the forest areas. Landholding is based on smallholder arrangements over dispersed areas of 0.5-5 ha per household. Some fishermen and pastoralists who own or can access land sometimes engaged in crop cultivation as an additional activity.

Table 4.1: Migrants in the sample: mean length of residency/mobility based on the 2014 survey exercise.

Livelihood group	Migrants in sample	Mean length stay (years) [a]	Ethnic affiliation (dominant groups) [b]
Farmers	55 (69%)	18.29	*Arab* (29%), *Wadai* (20%), *Guran* (13%)
Fishermen	62 (78%)	16.42	*Kotoko* (30%), *Guran* (20%), *Masai* (16%)
Pastoralists [c]	64 (80%)	22.75	*Arab* (48%), *Guran* (34%), *Fulani* (19%)

[a] Length of stay/residency implies the number of years migrant resource users have lived in or traversed the Lake Chad area where the survey was undertaken.

[b] Mixed ethnic groups characterise the southern Lake Chad area – the dominant groups are shown in the table. The human population dynamics around Lake Chad are often driven by a southward migration trend (spurred by the need for survival) since the collapse of the lake's northern pool in the 1970s and 1980s (Okpara *et al*., 2015).

[c] Pastoralists are very mobile groups; for them the lake represents a shelter during exceptional drought periods and thus serves as the heart of a mobile radius/system across seasons.

[32] This emerged from interview conversations with local experts and agrees with evidence in previous studies (e.g. Luxereau *et al*., 2012; Ovie and Emma, 2012).

Table 4.2: Descriptive statistics of assets held by different livelihood groups derived from the survey data.

Asset variable	Livelihood group [a]		
	Farmers (n = 80)	Fishers (n = 80)	Pastoralists (n = 80)
Natural asset			
Water (for livelihood activities): households reporting SLC as the nearest water source for livelihood activity [b]	58 (72.5)	78 (97.5)	13 (16.3)
Land: household reporting unimpeded access to land	75 (93.8)	25 (31.3)	14 (17.5)
Financial asset			
Remittance: from members/relatives working elsewhere	18 (22.5)	36 (45.0)	30 (37.5)
Credit: households reporting access	24 (30.0)	8 (10.0)	15 (18.8)
Income: enough to cover important household expenses	29 (36.3)	19 (23.8)	6 (7.5)
Social asset			
Membership of social group	36 (45.0)	13 (16.3)	27 (33.8)
Access to institutions (e.g. LCBC) for external support	3 (3.8)	2 (2.5)	4 (5.0)
Group cooperation during challenges	44 (55.0)	53 (66.3)	23 (28.7)
Human asset			
Education: head started and/or completed primary school	13 (16.3)	20 (25.0)	21 (26.3)
Experience in livelihood activity (mean in years)	16.8±12.7	14.2±5.6	27±8.1
Access to health care when sick	27 (33.8)	7 (8.8)	3 (3.8)
Household head (active age: 20 - 50 years)	61 (76.3)	65 (81.3)	66 (82.5)
Household depending majorly on one agro-based activity	64 (80.0)	49 (61.3)	64 (80.0)
Physical asset			
Housing: traditional (non-flood resistant) house	80 (100.0)	80 (100.0)	80(100.0)
Tools/equipment for livelihood activity [c]	78 (97.5)	75 (93.8)	12 (15.0)
Access to well, borehole, piped drinking water	72 (90.0)	8 (10.0)	23 (28.7)
Telecommunication: mobile phone	72 (90.0)	71 (88.8)	79 (98.8)
Average livelihoods diversification index [d]	0.46	0.42	0.47

[a] Values in parentheses are percentages. Survey takes livelihood groups as the principal unit of analysis in line with the nature of the enquiry, therefore social differentiation within villages is not emphasised.

[b] Local people at the southeast shore exploit various SLC (Small Lake Chad) water-bodies, which include permanent and seasonal ponds, receding channels, Lake's open water and water flows coming in from the Chari River.

[c] Tools and equipment for livelihood activities are manual farming, fishing and herding tools.

[d] Average livelihoods diversification index was computed across groups following Hahn *et al*. (2009) as the inverse of the number of livelihood activities + 1, reported by a household and aggregated across each group (higher values were assigned to groups with a lower number of livelihood activities).

Almost all participants expressed concern over not receiving enough income to cover important household expenditure, such as food, water, housing and clothing. Access to remittances and credit is limited; a few households who have access reported that their incomes and livelihoods had not improved. Although membership of social groups that have productive livelihood benefits is low, several households attend mosques regularly, relate with religious doctrines that influence local cultural values and interact more readily during challenges (e.g. periods of low harvests, food and income) and festivals. These forms of social cohesion are common amongst farmers and fishermen who live a sedentary lifestyle. Although tendencies to specialise in one activity are high, a few households referred to having access to a range of different livelihood options that are not directly based on water and land, such as small trading in local markets, brick making, repairing of fishing nets and boats, and seasonal wage labour in nearby towns. Basic physical assets around villages and islands are dilapidated. Except for boreholes and mobile phone facilities that are accessible, schools, markets and hospitals are either non-existent or widely dispersed and poorly equipped. Poor rural roads affect the distribution of harvested produce. People live in weak, traditionally built houses, constructed with materials such as wood, sand, clay and papyrus.

4.2.2 Influences of the Small Lake Chad

Interviewees, particularly village elders, recalled the ‘good’ times of the Normal and Average Lake Chad when rains were regular, and crop and fish yields were plentiful. During these phases, livelihoods benefited from a rich Lake ecosystem characterised by abundant flora and fauna. The Lake’s hydrological cycle enabled steady water supplies, and the region’s fishery productivity and food crop output flourished, while pastoralists had several pastures and succulent grasses (Odada *et al*., 2006). In contrast, the SLC phase is notable for the population pressure it triggered at the southern portion of the basin as the northern pool desiccated (Mekonnen, 2016). This has caused new villages and temporary camps to emerge, while competition over limited resources intensified. The SLC phase first appeared in the mid-1970s during severe droughts in the Sahel region. It later re-appeared in the late 1980s and has since fluctuated between 3 – 14 000 km^2. Although limited narratives prevent a complete understanding of livelihood conditions during the mid-1970s, pertinent to respondents’ current livelihoods is concern over local aggression towards the Lake's changing state and declining income levels. Although aggressive attitudes towards land and water claims resulted in several conflict outcomes during the 1980s' Dry Small Lake (Okpara *et al.*, 2015), most respondents who reported aggression as a limiting factor stated it is often expressed through village-based urges to grab and scramble for scarce public resources, regular confrontations at water points, and limited sharing and cooperation.

Respondents could not accurately quantify their crop harvests, fish catches and milk/livestock sales over the past 5 years, but could identify trends in income status.[33] Several farmers reported overall declines in crop outputs, although yields in some years (e.g. 2013) were better than others. One farmer in Guitté reported variations in the extent and timing of floods associated with the contraction of the SLC. These make it difficult for farmers to predict when in the year the floods would reach the farmland around their villages. This is particularly a concern to farmers who cultivate the Lake beds as they regularly lose crops to floods. FGDs with farmers revealed a link between the current Lake state, water scarcity and low food production. Repeatedly, they referred to high costs of digging wells and pumping water (approximate costs range from USD110 – 180),[34] and the labour involved in creating water channels into their farms. These limited their income from annual crop harvests.

While a few fishermen stressed that fishing activities have not decreased, there was general agreement that the size and quantity of fish catches have declined. In one week, several artisanal fishermen would capture approximately 120 – 180 small fish using hooks, a quantity that most fishermen of the full Lake era would catch in a single night. Fishermen generally complained about long distance fishing, high costs of renting or acquiring boats, strict fishing rules regarding the types of gear to use, high water access charges imposed by local authorities and the intrusion of unlicensed migrants from neighbouring countries, whose better fishing expertise often deny local fishermen access to the large fish. Similarly, pastoralists complained that their livestock

[33] In Chad generally, Multidimensional Poverty Index is estimated to be 0.545; intensity of deprivation is put at 63% with approximately 87% of households living in poverty (the 2005 – 2015 survey results on poverty for this region are available in the UN Human Development Report of 2015).

[34] Locally, this is approximately CFA Franc 106,070; a cost that is very high for majority of the local resource users.

were often sick and many had died with the decline in the richness and quality of the SLC pasture. Over half of the herders reported losing livestock in the last 5 years. Ten herders reported that milk output had declined from 2 - 5 l to 1 - 2 l per day. Key informants reported a series of other livelihood drawbacks linked to the SLC. Many agreed that the Lake's shrinking limited local incomes and livelihood opportunities. Most referred to the Lake as creating a pool of unemployed people and providing convenient hideouts for insurgent activities, which had further increased the level of deprivation experienced by locals. Increased outmigration, disease outbreak and low food quality were also noted (see Mekonnen, 2016).

Current livelihood opportunities for lake dwellers centre on the renewal effects of the aquatic and soil environment associated with the seasonal floods, and the learning opportunities triggered by past droughts. Some farmers reported benefiting from flood recession cultivation while several pastoralists utilised the Lake's water for dry season herding. Inter- and intra-annual flood pulses enabled recycling of the aquatic environment, providing multiple options for fishermen. Nearly 38% of fishermen fished during previous floods and farmed on small land parcels after the floods. Key informants revealed that the flexibility of the Lake shore allowed for diversification and sustained regular interactions amongst migrants, but these often created inter-group competition. One key informant stated:

"Two kinds of people exist around the SLC: those who take advantage of the dried Lake by seeking permission to cultivate the 'new' land areas and those who follow the Lake to new territories as it contracts. No matter the annual or seasonal condition of the Lake, people have always sought opportunities to better their lots" (Key informant, July 2013).

Another said:

"The drying of the Lake has attracted several NGOs and institutions who often visit the areas for field surveys. What is happening now coupled with increased insurgency in the area has made the Lake a policy concern for riparian governments" (Key informant, January 2014).

FGDs revealed that the ability of the lake dwellers to take advantage of existing opportunities depended on how long they had lived around the Lake and exploited the Lake's resources, the range of social networks they can access and how proactive they can be during seasonal fluctuations. Many agreed that the lessons from the SLC period could spur new adaptive behaviours and learning, preparing the lake dwellers for possible future challenges, should sufficient external support become available.

4.2.3 Place-based stressors affecting livelihoods

Respondents noted social conflict, climatic changes and political/institutional instability as major livelihood stressors (Table 4.3). Regular conflicts in the Lake Chad region have been reported resulting from environmental degradation, clashes amongst different ethnic groups and between locals and security officials at the Chadian shore. The Lake's geo-political location is characterised by instability which several key informants linked to past incidents of civil unrest in Chad, the arming of different ethnic militias and to recent terrorist threats. Periodic raiding of villages and the proliferation of military patrol checkpoints undermine livelihoods. Exertion of authority by the Joint Military Patrol at checkpoints often causes delays and adds unpredictable financial burdens to households moving their agricultural produce to markets. Challenges related to state regulations and local administration of rights to farmlands, pasturelands and open waters were reported during FGDs.

Table 4.3: Identified stressors affecting livelihoods.

Stressor (% of respondents: 'aggregated')	Description of stress condition based on FGDs, KIIs and previous studies	Illustrative quote (s)
Conflict Conflict in the SLC (89%) Losses/injury from conflict (44%) Feeling insecure (45%)) Participation in conflict (54%)	....the succession of civil wars in Chad, the arming of militias from different ethnic groups, and recent terrorist threats create insecurity, thus villages are continuously raided and livelihood resources destroyed [a, b, d]	"People are now used to not having the Lake around, so everyone just goes about as if the Lake doesn't exist, thereby creating space for regular contacts and conflicts between locals and foreigners" (Fisherman respondent in Basara, March 2014). "Before people were selfless, less suspicious and liberal with their possessions. That has changed now. Deprivation is increasing and struggles for survival keeps driving people into conflict behaviours, making this area very insecure for humankind" (Farmer respondent in Miterine, July 2013). "Psychologically, people's mind-sets are changing as the environment is changing; people are more careful now with their relationships with others, lack of understanding causes in-fighting here…on the surface people move about as if nothing is happening, but there are underlying issues of discord that are unaddressed" (Pastoralist respondent in Ngurutu, July 2013).
Climate Long-term climate shifts (>10 years) – (100%)	....increasing droughts (reduced rainfall) and uncertainties regarding the timing and extend of inter- and intra-annual floods	"There's a lot of complaint about bad harvest here; what you put in the soil often turns out bad in the end due to hot temperatures, and this makes commercial farming difficult" (Farmer respondents in Guitté, February 2014).

Climate impact-related losses (96%)	pose a threat to livelihoods [a, b, c]	"I have noticed we no longer receive our seasonal rainfall in its time. Our dry season has extended, shortening our rainy season. Dry seasons make 'big catches' difficult…we are further impoverished as a result" (Fisherman respondent in Kaesai, February 2014).
Political/institutional instability (85%)	....organisations charged with regulation of resources are not well funded….officials extort money from locals indiscriminately [a] ...regional instability negatively influences government willingness to invest scarce resources in infrastructural development at village locations whose future is described as uncertain [a, d]	"Life is hard, people and communities lack so many basic amenities and our government does not seem to care" (Pastoralist respondent in Dandi, March 2014). "Four national governments hold the lake waters. Their agents come here regularly to ask us questions. We supply them relevant information and expect their assistance. Yet illegal fishing has continued and the security men often interrupt our fishing activities" (Fisherman respondent in Kouri, July 2013).

[a] Responses from key informant interviews (March 2014); [b] Response from FGDs (March 2014). Other studies that identified similar stressors around the wider Lake Chad area: [c] Onuoha (2009); [d] Sarch (2001).

High taxes and inconsistent demands from local authorities constrain the asset profiles of lake dwellers, limiting their net income. Regarding climate influences, especially rainfall shortages, one key informant at the office of the LCBC revealed that:

"Current climate variability in the area is hard on the people and it is driving them into poverty; some commit crimes because it is increasingly becoming difficult for them to secure their livelihoods merely by farming or fishing or herding" (July 2013).

Several livelihood groups that identified institutional instability (Table 4.3) related this to unjust governance over water and land whereby *bulamas* favour close associates and relatives when allocating resources. Although ethnic migrant influx (Table 4.1) has been increasing in the area, respondents complained that village elders/leaders are not often consulted before permits are granted to migrant fishers. This contributed to several conflicts experienced by locals on the Lake's islands.

4.2.4 Local response strategies

Livelihood groups employ a broad range of strategies to cope with and adapt to the conditions affecting their livelihoods. Table 4.4 summarises groups' adaptive strategies and Figure 4.3 shows the seasonal water conditions (in response to monthly rainfall patterns – Figure 4.4), including the cycle of local activities. Farmers' response strategies are largely agronomic and technological. More than half of the farmers followed seasonal patterns in their practice of mixed cropping, crop rotation, timing of land preparation, and planting and harvesting of crops. As indigenous water and soil 'engineers', they dug tiny canals through which water encircled their plots and remained as water reserves within the soil to curtail the effects of drought. This allowed crops to grow into maturity. They exploited water in wells or harvested ground water along different flooded water channels during dry months (November to March). Better-off respondents constructed farm-based dams or ponds to store water. Less than half have used improved crop varieties as they are not available locally.

Table 4.4: Contextual adaptive responses employed to deal with conditions affecting livelihoods compiled from household survey in the southeast shore of the Small Lake Chad.

	Livelihood group		
Adaptive responses [a]	Farmers	Fishermen	Pastoralists
Agronomic-related	Changes in timing of land preparation, including planting and harvest dates Use of improved crop varieties when available (~ 45 % had access) Expansion of cultivated areas, including mixed cropping and rotation cropping (intensification and extensification as more land became accessible)		
Economic-related	~13 % trade in crops after peak farming activities are over	Migratory fishing in groups ~ 20 % practice recession cultivation and act in similar manner as farmers in terms of agronomic-related seasonal patterns of farming ~ 10 % trade in processed fish during low fishing periods	Collective livestock grazing and seasonal migration ~ 13 % cultivate crops when land is accessible
Environment-related	Afforestation: ~ 21 % plant trees usually around the homestead [b] Exploitation of seasonal floods near the Lake is common	~ 12 % identified seasonal floods as suitable for increasing fish yield	~ 16 % often culled disease-infected animals ~ 8 % deliberately decrease herd size based on water and pasture availability

Technology-related	Ground water harvesting and storage of water in wells is common ~ 8 % construct small dams/ponds in farmland ~ 38 % can access weather information	~ 10 % cited using water from wells occasionally for drinking Aspire better fish traps ~ 64 % use weather forecasts	Well water is a backup against severe droughts; ~ 20 % harvest water along ground water channels ~ 33 % can access weather information

[a] The adaptive responses identified by respondents have been categorised into four here as agronomic (related largely to land and crop cultivations), economic (adjustments in behaviours to tackle the effects of low productivity), environmental (modifications in order to exploit the benefits of environmental changes either by tree planting, herd size reduction or exploiting seasonal floods), and technological (use of elements of local techniques in anticipation of future changes). A mix of strategies is common around the SLC.

[b] Tree crops planted are mostly mangoes, banana, apple, cashew and orange trees – those planted on farmlands have their lower branches pruned regularly to enable minimal penetration of sun rays in order to help soils retain water and to prevent crops from drying out.

When land and labour were available and accessible, most farmers practiced intensification and/or extensification. They referred to cultivating three or more crops in the same or new units of land within the year, although cultivation was largely not mechanised. Farmers that traded or practiced short-term migration did so for economic reasons (e.g. to access land, credit, markets or new wage labour); and those engaged in tree crop cultivation and the exploitation of seasonal floods did so to take advantage of environmental opportunities for better livelihood outcomes. When farmers go fishing, particularly along small water channels during floods, it is usually for subsistence consumption. They often do not engage in pastoral activities, but keep small animals such as fowl, sheep and goats, which are sold to supplement household income.

Most fishermen fish in groups of two or more while exploiting the seasonal floods, a form of environmental advantage that allows for increases in fish yield. As various species (*Clarias gariepinus* - catfish, *Tilapiine cichclids* - tilapia, and *Alestes baremoze* – freshwater sardine) are caught (when the fish are tiny), fishers either created or accessed markets for tiny fish. As they live on islands and remote temporary camps close to the Lake, they fish within a short distance of their homes during the rising flood seasons, travelling far away when the floods recede. Most camps are evacuated during flood recession periods, and fishers sometimes farm the 'new' lands within the camps. Almost all surveyed fishing households sold smoked, dried, fried or fresh fish. Fishermen often desire better fishing tools, including safe and fast moving boats, but few can afford these. They can access weather information more easily than the two other livelihood groups largely because they are more concerned about water temperatures and wave/wind movements. Around the SLC, annual and long-term fish catch is difficult to estimate due to the large number of artisanal fishermen who do not keep records and the limited capacity of institutions and government agencies to collect and store fish catch data.

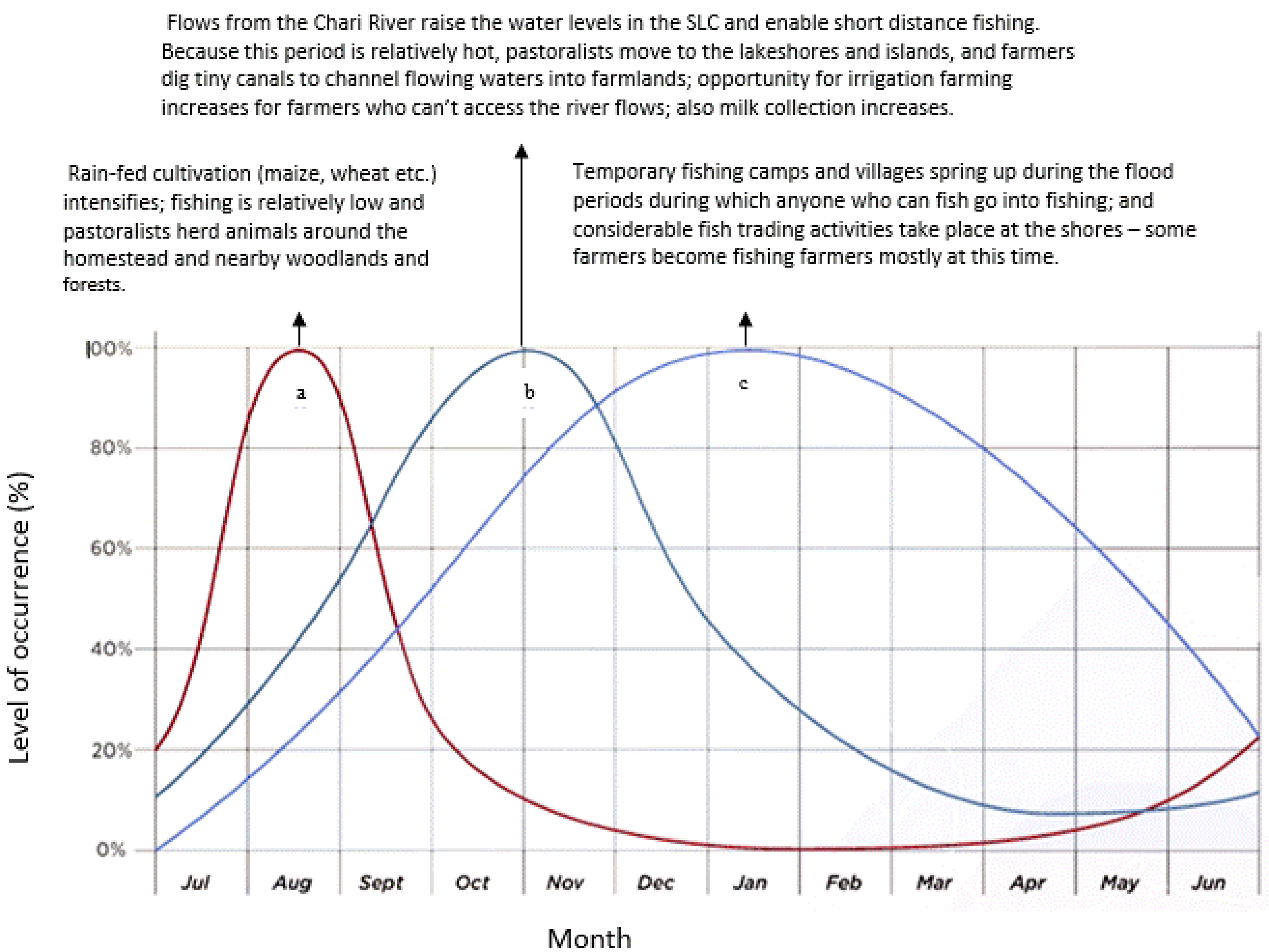

Figure 4.3: Annual flux of seasonal activities (based on Seasonal rainfall [a], River flow [b], Water level/flood [c]) observed during fieldwork at the south-eastern shore of Lake Chad, 2013 – 2014

FGDs with pastoralists revealed that herders' adaptive strategies address several challenges, including issues of sick animals and conflicts with farmers when animals stray into farmlands. Pastoralists maintain a specific herd size based on what they can manage or afford per annum, and also considering the availability of water and pasture around the SLC. Average cattle herd sizes are 53.65±17.66 (ranging from 20 to 81 cattle). Camels, donkeys, horses, sheep and goats are herded too, but cattle remain an important social identity and represent economic status amongst the nomads. As pastoralists' income is largely from livestock-related activities, they utilise their social ties to identify favourable grasslands as they migrate seasonally in the surrounding SLC. Water storage in wells among several homesteads serves their water needs in dry seasons when the SLC is not nearby. They camp around villages and forest woodlands, returning to the Lake areas during the dry season when they can ascertain that grasslands and pastures are productive. Some respondents stated that when cows have enough grasses and water, they are able to produce 2 - 5 litres of milk per day which can add to household income (through its sale).

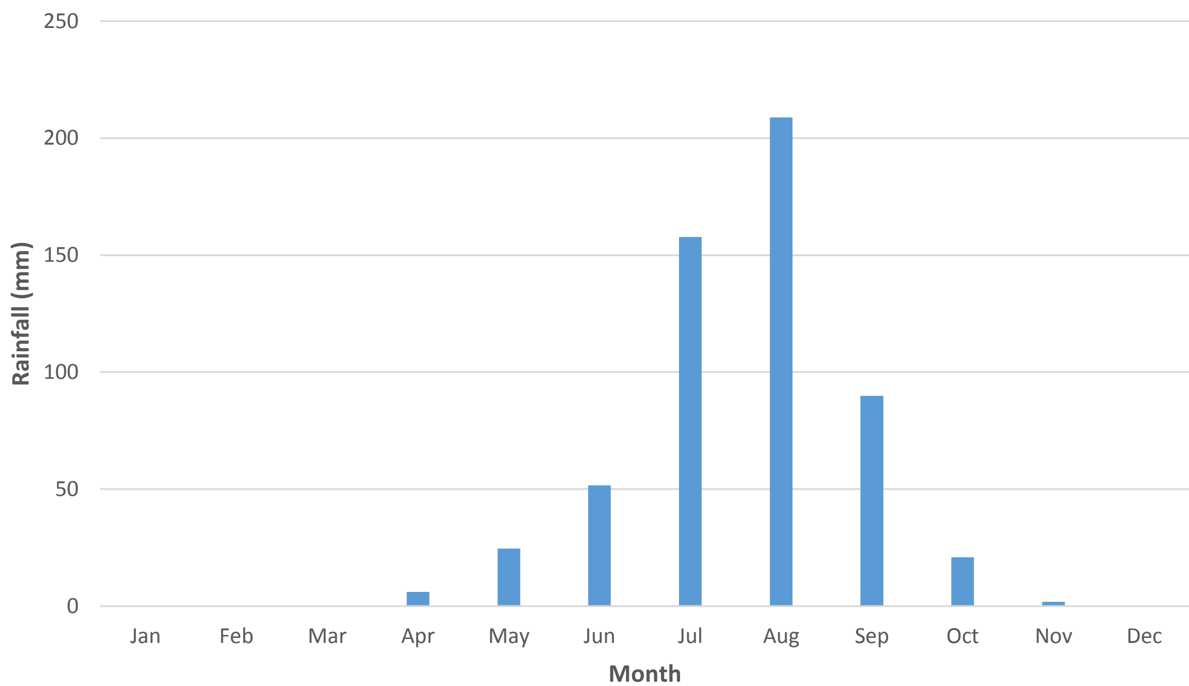

Figure 4.4: Mean monthly rainfall of the Lake's southern shore near N'Djamena (1990 – 2014) (*Source*: Data from the Water Resources and Meteorological Directory of the Hydrological Ministry of Chad – N'Djamena Weather Station, Chad)

4.3 Discussion

This section integrates the findings presented in section 4.2 to answer the following research questions:

- What are the diverse range of mechanisms through which lake drying shape livelihood drawbacks and opportunities? (Research question one)

- Where does lake drying fit in the suite of stressors affecting livelihood groups in Lake Chad? (Research question two)

- Are locally-evolved adaptive responses enhancing livelihoods? (Research question three)

4.3.1 Mechanisms shaping the Lake's influences on rural livelihoods

The Chadian shore holds a relatively large portion of the basin's remaining open waters, and consequently has continued to create spaces for frequent trading and interactions amongst migrants of diverse ethnic groups (LCBC, 2014). However, findings show this advantage is yet to translate into better livelihoods for local people in the Hadjer-Lamis Lake Chad area. Farmers are burdened by low harvests despite that the SLC allows a combination of irrigation, flood-recession and rain-fed cultivation. Opportunities for seasonal mobility exploited by pastoralists have often pitched them against other resource users as aggression over limited supplies of water and grasslands intensifies. Fishermen exploit various water-bodies seasonally, yet increased fishing activities have not led to increased catches. FAO (2012) reported a decrease from 220,000 tonnes of fish in the 1960s to about 100,000 tonnes in 2000. Recent annual yields are placed at 50,000 to 60,000 tonnes (Murray, 2007). Similarly, low outputs have been reported for crops (e.g. sorghum declined from 328,000 tonnes to about 180,000 tonnes between the late

1960s and the years following 2010) and livestock - declining at nearly 2% per year since the 1960s (Ovie and Emma, 2012; Mekonnen, 2016)[35].

There is strong evidence that when households lack important livelihood assets, especially human, financial and social capitals, changes in environmental variables (affecting natural capital) shape the processes of household decision-making, constraining livelihood options (de Sherbinin *et al*., 2008; Musoke *et al*., 2012). Locals have diverse socioeconomics needs which existing asset portfolios, including the changing Lake water system, cannot satisfy. Several livelihood groups were unable to secure enough income to cover basic materials for a good life. Although the findings indicate that the provisioning services of the SLC waters created a range of livelihoods drawbacks and opportunities, the major mechanisms that shaped these stem from the: (i) way different livelihood groups are inflexibly tied to water-dependent activities, (ii) tendency to focus on one primary livelihood activity due to limited opportunities outside agriculture (restricting diversification and asset accumulation), (iii) influx of the mixed ethnic migrants, (iv) manner in which the Lake provides spaces for different terrorist activities and violent conflicts, and (v) limited village infrastructure.

The shrinking of the SLC rarely affects livelihood groups directly. Asset holdings derived from unstable water-based activities are a medium through which water depletion influences livelihoods. The tendency to specialise in one primary activity for survival made such activity the delivery agent of many of the impacts of SLC water level fluctuations for the different livelihood groups. This resonates with observations by Kafumbata (2014) for Lakes Chilwa and Naivasha in Malawi and Kenya respectively. Aggression and contestation amongst the mix of migrant ethnic groups, including the role seasonality plays in shaping social interactions and the scramble for scarce resources, offer explanatory power in understanding the influences of the SLC on livelihood groups. The evidence presented demonstrates how sources of livelihood drawbacks can become more obvious in a setting where lake depletion opens up remote spaces for inter-group clashes and other activities that undermine human security (see Taguem Fah,

[35] The crop, fish and livestock outputs reported here are for the wider Lake Chad region (not only the SLC area in Chad Republic).

2007; Ifabiyi, 2013). Scarce local infrastructure (e.g. local markets), weaken trade networks and prevent people from earning sufficient income from the sale of agricultural produce. Lack of amenities, as reported by several participants and evident in much of the Hadjer-lamis region, presents another medium through which the influence of the Lake's depletion is experienced. Sarch (2001) has argued that governments often display unwillingness to invest in infrastructural development at lakeshore locations whose future is uncertain or whose jurisdiction is unclear. This is particularly the case on islands where local people use the Nigerian currency, yet they are located within the Chadian shores where the Central African CFA Franc is the medium of exchange.

4.3.2 Where does the Small Lake Chad fit among other stressors?

Resource poor locations are constrained by multiple stressors (Tschakert, 2007). Climate, conflict and governance issues, identified by the participants as key interacting stressors affecting people's livelihoods, were long a concern in the Lake region (personal communication with a security guard, Guitté, July 2013). To demonstrate where the SLC fits among these stressors, a disaggregative approach was used (cf. Leauthaud *et al*., 2013). This showed the SLC has become interwoven and deeply rooted in the fabric of local livelihood contexts that influence the assets of resource-dependent households. Analysis of the Lake's influence points to its contributory role in driving vulnerability to climate and non-climatic conditions through the water channel (Ovie and Emma, 2012). In particular, it has been argued that the underlying conditions fuelling social and political instability, including climate variability are shaped by the SLC (Onuoha, 2009; Lemoalle *et al*., 2012). For example, the Lake's depletion constrains its ability to serve as a hydrological buffer against drought events in much of the dryland area. Weakened social ties due to struggles over limited water supplies, including limited income opportunities caused by unfavourable tax regimes on the open water fishing activities, point to some of the ways the SLC fits among the stressors influencing the development trajectories of lakeshore villages and islands.

Observations that water depletion represents a major channel through which much of the SLC roles fit into the context of other stresses are consistent with: Kreamer's (2012) description of water shortages as a facilitator of tribal violence and cross-border terrorism; Ludwig *et al*.'s (2011) illustration of water scarcity in climate conflict interactions in settings where socio-cultural and political structures are weak; and Tir and Stinnett's (2012) argument for water governance challenges in situations where a water resource traverses national boundaries.

4.3.3 Are locally-evolved responses suggestive of locally-adapted solutions?

A range of local responses to survive the challenges posed by the changing Lake waters were identified. Locally-evolved responses indicate how decisions based on seasonality and traditional predictive factors are predicated on the availability of capital assets. For example, better-off farmers who constructed small dams and ponds to store water were able to cultivate more crops on bigger land areas and remained productive across the seasons. This type of proactive response keeps livelihoods functioning, and enhances resilience against adverse water conditions (Ifejika Speranza *et al*., 2014). Because many adaptive options to environmental changes depend on using, combining or substituting assets in different ways (Reed *et al*., 2013), the low asset profiles of several households limited them to responses that were largely reactive and as a result, constrained capacities to create locally-adapted solutions that both reduce poverty and enhance well-being. Basic materials were in short supply due to the decrease in water available to support soil fertility and plant growth, including fishery and livestock productivity. This led to a sense of deprivation within local populations, especially as access to external support remains limited. With the added burden of fear of militant Islamists (Taguem Fah, 2007) and the loosening of social cohesion, opportunities through which groups and households could enhance response strategies were blocked.

How seasonal patterns and water conditions might change in the future for locations in the Sahel region is unclear (Cook, 2008). If local people experience difficulty in predicting the timing and cycle of hydrological changes, deciding when and how to adjust livelihood activities might become challenging. This could further undermine local livelihoods, reducing adaptive options. Negative changes in the wider social (e.g. conflict), economic (e.g. income levels) and political/institutional contexts will create additional burdens in ways that could broaden the mechanisms through which lake water depletion influences agricultural livelihoods.

4.4 Conclusions

This chapter used primary information to study the conditions and experiences of lake dwellers in order to pin down the mechanisms shaping how lake drying influences livelihoods. It addressed the range of stressors confronting people that are tied to water-based activities, and identified how seasonality spurs reactive behaviours. Findings underline how a relatively homogenous livelihood structure, low asset profiles, limited village infrastructure and a conflict-prone environment influence livelihood drawbacks and opportunities. The findings have resonance for the lake dwellers. For these locals, the condition of the SLC represents much more than a drying, fragmented collection of water bodies. Lake drying has meant the destruction of the basic materials needed for a good life, as well as an unwelcome assault on livelihoods. The findings point to several livelihood concerns requiring development assistance. Of particular importance is assistance that targets the low infrastructure profile of the lake region, including agricultural production practices anchoring rural livelihoods. Such assistance would need to target the socioeconomic, political and human insecurity factors shaping influxes of migrants in ways that can enhance and enable scope for asset accumulation, co-habitation of mixed migrants and easy access to opportunities outside lake-based activities.

Chapter 5

Using a novel climate-water conflict vulnerability index to capture double exposures in Lake Chad [36]

Outline

Many works on climate and (water) conflict relations pay insufficient attention to vulnerability determinants, in particular the fundamental issues that shape directionality of vulnerability. While the contested nature of the vulnerability concept is widely recognised, it cannot be assumed that there is broad consensus regarding what constitutes scientifically-sound explanatory variables for climate and conflict relations. In response to recent calls to uncover local dynamics of climate and environmental conflict interactions, this chapter develops a novel climate-water conflict vulnerability index (CWCVI), as well as a Double Exposure Index (DEI), as tools for exploring ordinary people's differentiated vulnerability and capacities to adapt to change. The tools resonate with livelihood perspectives and use a normative framing consistent with the context, place and time specific nature of indicator-based vulnerability analysis. The chapter applies the CWCVI and DEI in selected Lake Chad villages composed of farming, fishing and pastoral livelihoods (see Chapter 3, Table 3.3) to address objective two (identify and compare the vulnerabilities of farmers, fishers and pastoralists to double exposures), as well as to provide answers to research questions four (what underlying factors shape differential occupation-based vulnerabilities and exposures to climate variability and water conflict in Lake Chad?) and five (how relevant are vulnerability determinants in understanding climate conflict interactions?). Results indicate that in contrast to farmers and fishermen, pastoralists were more vulnerable to climate variability and water conflict stresses. They were prone to climate-structured aggressive behaviour, have limited social networks and livelihood income strategies,

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[36] This chapter is developed from the published journal article of Okpara, U. T., Stringer, L. C. and Dougill A. J. 2016. Using a novel climate–water conflict vulnerability index to capture double exposures in Lake Chad. Regional Environmental Change (2016). DOI:10.1007/s10113-016-1003-6.

and their migratory lifestyle often pitched them against other resource users. Using ‘views from the vulnerable’ and accounting for the DEI as an embedded component of the CWCVI, the chapter illustrates that water conflict and climate variability are important exposure elements amongst groups, and that farmers may be more exposed to the double (combined) effects of climate variability and water conflict. Further, the chapter employs the CWCVI to understand how drivers of vulnerability may be useful in explaining climate and water conflict interactions and notes that besides informing climate conflict thinking, the CWCVI can provide the basis for causality analysis. It privileges the directionality of vulnerability by focusing on the usefulness of the vulnerability lens over resource scarcity in operationalising climate-water conflict relations for lake dependent environments.

5.1 Introduction

Climate variability is among an array of threats facing agricultural livelihoods, with its effects unevenly distributed. With resource conflict being increasingly recognised as one significant outcome of climate variability and change, understanding the underlying drivers that shape differential vulnerabilities in areas that are double-exposed to climate and conflict has great significance. The concept of double exposure was popularised by O’Brien and Leichenko (2000) in their accounts of climate change and economic globalisation interactions. The concept invokes the notion of multiple and overlapping processes of change (biophysical and socioeconomic) that take place within particular localities. It emphasises how contextual conditions influence the exposure and capacities of populations to create new contexts for experiencing and responding to change (Silva *et al*., 2010). This perspective has been applied to understand vulnerability through the lens of conflict-generating social dynamics across national and sub-national scales (Mason *et al*., 2011; Busby *et al*., 2013; Ide *et al*., 2014).

The climate security research community now recognises that exposure to climate and conflict stresses present a critical challenge for locations where natural resources are declining and livelihood losses are driving people into conflict-structured practices (Gemenne *et al*., 2014; Scheffran *et al*., 2014). Discourses in this domain are useful for stressing human security and climate vulnerability concerns (Detraz, 2011). Nonetheless, research into what makes a place vulnerable to the conflict consequences of climate change has tended to create more confusion than answers (Buhaug, 2015). This may be related to a limited strategic understanding of ‘the nature of the state’ as against ‘the state of nature’ (see Raleigh *et al*., 2014), leaving a major gap in the literature where ‘views from the vulnerable’ (Tschakert, 2007) provide useful insight. Except for Busby *et al*.'s (2014a,b) work on climate security vulnerability which maps ‘double exposed’ locations in Africa using sub-national level data, vulnerability frameworks are rarely applied in climate conflict studies at household and community levels – which is the scale at which processes generating vulnerability can be narrowly defined and validated (Barnett *et al*., 2008). A bottom-up, systematic approach to operationalise climate-water conflict vulnerability holds promise in terms of teasing out the repertoire of interacting variables that influence climate and conflict relationships.

This chapter develops and applies a composite climate-water conflict vulnerability index (CWCVI) to identify and compare the vulnerabilities of farming, fishing and pastoral livelihoods in Lake Chad to climate variability and water conflict (Objective 2). In doing this, the chapter answers the following research questions linked to objective two:

(i) What underlying factors shape differential occupation-based vulnerabilities and exposures to climate variability and water conflict in Lake Chad? (Research question 4)

(ii) How relevant are vulnerability determinants in understanding climate conflict interactions? (Research question 5)

Further, the chapter introduces a Double Exposure Index (DEI) as an embedded component of the CWCVI to capture differential ‘climate - water conflict’ exposures amongst different livelihood groups. The chapter serves the ‘ground truthing’ requirements for studies on climate change and conflict hotspot mapping (e.g. Busby *et al*., 2014a; de Sherbinin, 2014) where field-based data validation is essential. The systematic, multi-method approach used provides a methodological contribution in line with the demand to combine a diversity of approaches and methods to investigate the full complexity of climate conflict links in human-environmental systems (Gemenne *et al*., 2014). The focus on a village-level assessment in Lake Chad contributes to a growing strand of vulnerability literature which seeks to enhance the rigour and utility of indicator-based vulnerability assessments.

In this chapter, vulnerability is conceptualised as a theoretical, non-observable phenomenon that relates to the propensity of a system, subsystem or system component to experience harm due to exposure to a perturbation or stressor (Turner *et al*., 2003). The chapter applies observable variables or indicators to operationalise vulnerability (see Chapter 2, Sections 2.3.2 and 2.6.1), focusing on agricultural livelihoods in a lake-dependent environment. The chapter begins by outlining the manner in which climate-water conflict vulnerability has been framed (Section 5.2). It then proceeds by presenting the CWCVI approach (Section 5.3), covering the methodology used for index computation (Section 5.3.1) and the ways in which the limitations linked to the methodology were addressed (Section 5.3.2). The results (Section 5.4) and discussion (Section 5.5) address objective two and provide answers to research questions four and five.

5.2 Framing climate conflict vulnerability in water-limited environments

Climate and conflict are rarely examined together in vulnerability science or within a single vulnerability framework (Eriksen *et al*., 2005). Similarly, little work has advanced vulnerability models to capture climate and conflict stressors at household and community levels in locations facing severe water scarcity. The absence of a common narrative that explains vulnerability evidently influences how vulnerability to the water conflict consequences of climate change is understood and interpreted. Existing theoretical state-of-the-art literature seeking explanations for climate conflict highlights many methodological postulations which have produced more divisions than agreements (Buhaug, 2015). The diversity of ways in which conflict is conceived is accompanied by a similar diversity of proxies used to quantify climate change across systems, and within specific temporal and spatial scales. Conversations in this field typically draw upon the environmental security thesis (Homer-Dixon, 1999; Le Billon, 2001) as the basis for a theoretical understanding of the role of environmental resources in conflict events (see Chapter 2, Section 2.6.2). Water has remained a key element in the literature given its characteristic feature as a resource worth fighting for (Cook and Bakker, 2012), particularly where rivers flow across state boundaries (Ludwig *et al*., 2011).

Although there is a rich literature on whether the impact of climate change on water supplies is a factor in domestic conflicts, little is known about where the livelihood vulnerability literature fits in the environmental security discourse. The concept of vulnerability is less evident in water conflict studies compared with poverty, food security and disaster risk management studies. Mainstream writings (e.g., Böhmelt *et al*., 2014; Selby and Hoffmann, 2014) explore indicators that suggest a pathway linking climate change and water conflict. Yet the literature remains vague regarding how vulnerability analysis may enable identification of interacting variables that shape both the demand for and supply of water, including efforts to restrain water conflict in lakeside villages where climate extremes are a major threat. This chapter fills these gaps. It is based on the premise that to anticipate appropriate solutions for resource-dependent societies marred by conflict requires knowledge from the broad fields of climate conflict (Chapter 2, Sections 2.4 and 2.6.3), livelihoods (Chapter 2, Section 2.3.1) and contextual vulnerability (Chapter 2, Section 2.3.2) to investigate the structures and processes that shape the propensity for livelihoods and groups to be weakened by exposure to climate stressors and violence. Important aspects include, for example, knowing how people's adaptability is shaped by socio-demographic profiles, livelihood strategies and social/political networks. Giving climate vulnerability a security focus (Scheffran *et al*., 2012) and knowing the vulnerability condition in which households and groups are 'powerless' or 'wounded' has huge practical significance (Füssel and Klein, 2006).

5.3 The CWCVI framework approach

Climate-water conflict vulnerability[37] was assessed based on the broader discourse on livelihoods, vulnerability and the security consequences of climate change on human well-being. The composite index is couched within the double stressor/exposure framework (Leichenko and

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[37] Water conflict is conceptualized in the words of OECD (2005) as "any conflict arising between two or more parties holding competing claims over a water resource, its allocation or its use." In this sense, the chapter emphasises the spectrum of water conflict that stretches from non-violent expression of differences in opinion and value, through verbal assaults/heated arguments to deliberate contamination/pollution of water and to outbreak of violence (open competition, riots and aggression) within a village scale (Stetter *et a*l., 2011). Water conflict is emphasised because: (i) amongst all environmental resources within the LCB, it is water which is most often linked to conflict; (ii) amongst all conflict events in the region, it is water conflict that the people are best able to report.

Brien 2008) which emphasises the importance of dissecting the underlying contexts (using a contextual vulnerability interpretation (cf. O'Brien *et al.*, 2007)) in which vulnerability is experienced, including how adaptation outcomes may reduce or amplify vulnerability (Silva *et al.*, 2010).

The index accounts for the security aspect of the double exposure framework by applying aspects of Busby *et al.*'s (2014a) framing of climate security vulnerability, where vulnerability is conceived as a condition where people could be susceptible to death as a result of exposure to climate-related hazards. However, this past study lacks a bottom-up livelihoods approach. Instead, climate-water conflict vulnerability is framed as the propensity to be constrained by conflict-structured water threats as a result of climate stress. This encompasses situations where human populations are at risk of losing their livelihoods, including loss of life. Assessment of vulnerability in this context opens up considerations for a human security perspective in which attention is given to understanding biophysical exposures and socioeconomic strategies to assist vulnerable populations from threats that limit their livelihoods and freedom (Adger, 2010; Mason *et al.*, 2011).

5.3.1 Index computation

This chapter adopts a five-step interrelated process to compute the CWCVI (Figure 5.1). Based on Füssel's (2007) suggestion for describing a vulnerable situation, the 'human-environment system' was identified as the system of interest. By conceiving climate variability and water conflict as human well-being and livelihood security challenges, the chapter identifies the system's valued attributes as 'livelihoods and human well-being', and the stresses of interest as 'climate variability and water conflict'. For the 'time period of interest', the chapter focuses on a static snapshot of 'current' differential vulnerabilities occurring during 2009 to 2014, as vulnerability at the household level tends to be more dynamic than at national level (Eakin and Bojórquez-Tapia, 2008). Resource user groups in the study villages constitute the unit of analysis. The IPCC's tripartite typology of exposure, sensitivity and adaptive capacity (IPCC, 2007) was utilised as a simple entry point for expressing vulnerability. This typology was incorporated in the categorisation scheme (Figure 5.2) to identify seven indicating baskets that were considered relevant for operationalising vulnerability: exposure to (i) climate variability and (ii) water conflict; sensitivity to (iii) lake water variability and (iv) physical/natural assets; and adaptive capacity captured by (v) socio-demographic profile, (vi) livelihood income strategies and (vii) social/political networks.

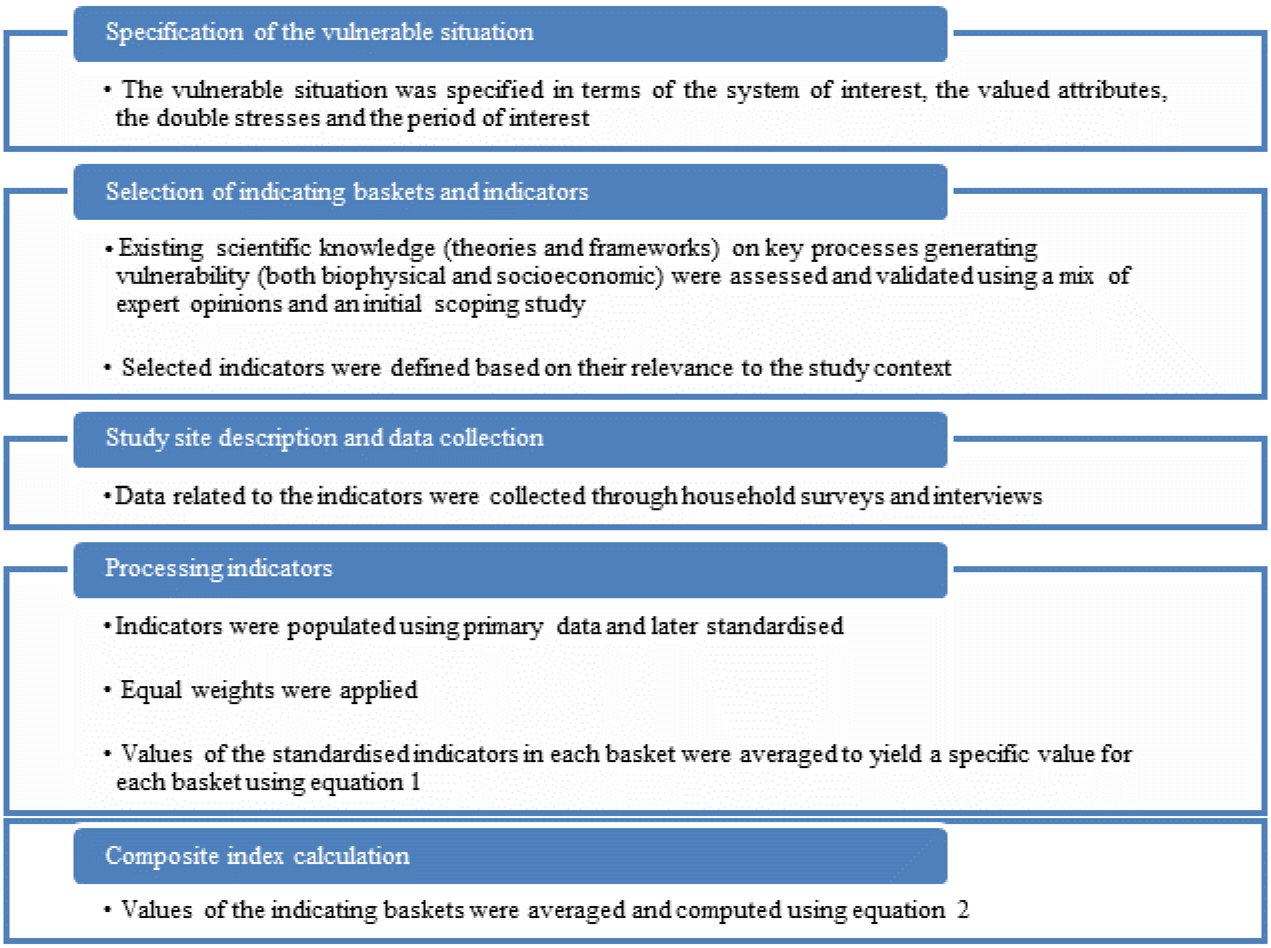

Figure 5.1: Methodological approach

Indicators were selected deductively based on a review of the literature considering a broad spectrum of social and environmental challenges facing Lake Chad (e.g. GIWA, 2004; Luxereau *et al*., 2012; Ovie and Emma, 2012). Indicators were validated through consultations with Lake Chad Basin Commission staff and other professionals (experts) with specialist knowledge on the study themes (see Chapter 3, Section 3.4). The selected indicators were incorporated into the questionnaires and the practicality of collecting the needed data through an initial field visit (see Chapter 3, Section 3.4.2) in July 2013 was confirmed. The supplementary material (see Okpara *et al*., 2016c) outlines how each indicator was quantified, the rationale for selecting each, as well as the survey questions used to collect the data associated with each indicator.

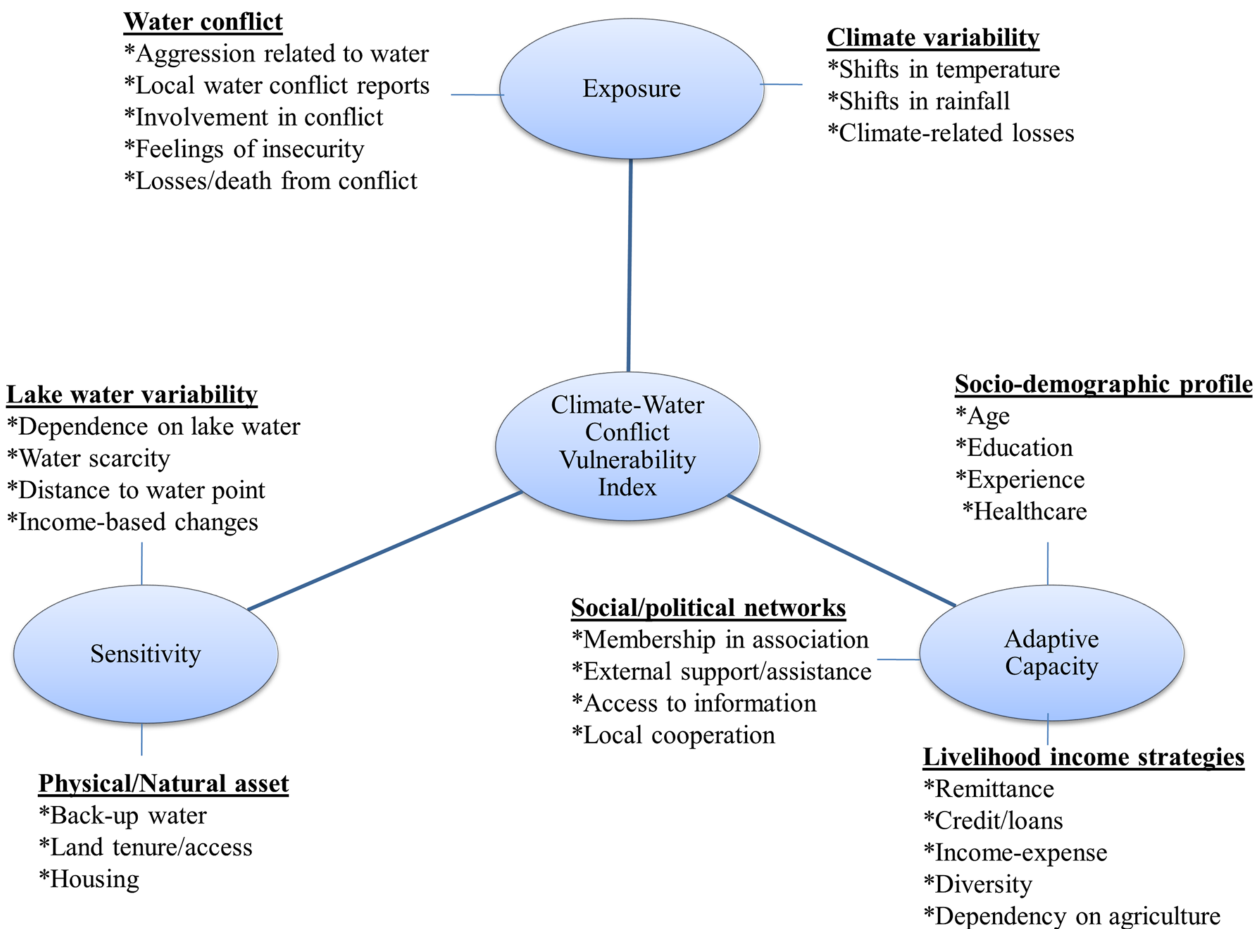

Figure 5.2: Indicative composite framework used to assess climate-water conflict vulnerability

* Indicators are captured in each basket

Raw household survey data were transformed into appropriate measurement units (percentages and indices) and used to quantify the indicators. The CWCVI uses indicators measured on different scales. To bring the indicators to a uniform, comparable scale and allow for aggregation into a single index, standardisation was necessary (OECD, 2008). A maximum-minimum (percentage ranked) transformation approach (Hahn *et al*., 2009) was used to capture the actual score of an indicator relative to the maximum and minimum spread of the entire range of values for that indicator. This was computed by obtaining the quotient of the difference between each actual indicator score and the minimum value of that indicator, and the difference between the maximum and minimum values obtained from the total sample.

Weights are an important aspect of indexing approaches (see Barnett *et al*., 2008; Hinkel, 2011; Wolf *et al*., 2013). Although what constitutes an appropriate weighting system can vary significantly based on context (Chen and Lopez-Carr, 2015), the balanced/equal weights framework used in Hahn *et al*. (2009) was applied assuming that each indicating basket contributes equally to a group's overall vulnerability despite that the number of indicators under each basket differs. Although this approach is adjustable, e.g. to reflect the judgement of experts and values of groups in a participatory method (Eakin and Bojórquez-Tapia, 2008), or by using the principal component analysis method (Abson *et al*., 2012), the scheme used was considered appropriate for conflict-prone settings where data are relatively difficult to gather and comparison is focused on groups perceived to be similarly exposed.

Finally, the value for the baskets was calculated by taking the average scores of the standardised indicators in each basket using equation 1:

$$\text{Indicating basket value} = \left[\frac{\text{Indicator}_1 + \text{Indicator}_2 + \cdots + \text{Indicator}_n}{n}\right] \qquad (1)$$

where n represents the number of indicators for a particular basket.

The values of the indicating baskets were calculated to obtain the CWCVI score for each livelihood group (equation 2).

$$\text{CWCVI}_l = \left[\frac{w_1 B_1 + w_2 B_2 + \cdots + w_n B_n}{W_1 + W_2 + \cdots + W_n}\right] \qquad (2)$$

where CWCVI is the computed index for livelihood group *l*, $B_1 \ldots B_n$ are the indicating baskets, and $w_1 \ldots w_n$ represent the number of indicators in each basket. The value for each basket and overall vulnerability score were computed for each livelihood group (farmers, fishermen and pastoralists). The CWCVI [38] is scaled from 0 (least vulnerable) to 1 (most vulnerable).

5.3.2 Limitations of the CWCVI approach

The non-random sampling approach applied in the research (see Chapter 3, Section 3.4) accounts for the transient lifestyle of many respondents. This limits the ability of this chapter to comment on whether or not differences in vulnerabilities for farmers, fishermen and pastoralists are statistically significant (United Nations, 2008). Nonetheless, the assignment of directionality from least to most vulnerable provides a straightforward alternative to compare and understand differential vulnerabilities (Hahn *et al*., 2009). While local arrangements that limit females from granting interviews are recognised (see details in Chapter 3, Section 3.4.5), the data used may appear to have under-represented vulnerable female-headed homes. In this case, this study cannot comment on the magnitude of any potential selection bias. Further, because indicators were aggregated at the ‘livelihood group’ scale and averaged into one major indicating basket score, indexing did not emphasise differences within groups (e.g. between farmers or between fishermen). The study did not ‘statistically’ account for the directionality of the relationship between indicators and vulnerability, although previous studies assume both exposure and sensitivity indicators to be positively correlated to vulnerability (Ide *et al*., 2014; Krishnamurthy *et al*., 2014). The weighting method applied constitutes less burden and time constraint on respondents, and enabled the researcher to avoid any complications that may result from experts’ inability to reach agreements over roles of indicators/baskets in vulnerability outcomes. Yet it is possible that other types of weights (or a combination of weighting schemes) could add confidence to the CWCVI. While many processes for operationalising vulnerability (particularly

[38] The CWCVI analysis captures double exposures in the form of climate variability and water conflict from which the DEI was derived. See details in Section 5.4.2.

the schemes for selecting, validating, standardising and weighting indicators) involve normative judgement, the underlying approach employed to obtain different vulnerability scores here is consistent with the indexing approaches from larger vulnerability studies that utilise indicators (Brooks *et al*., 2005; Eakin and Bojórquez-Tapia, 2008; Chen and Lopez-Carr, 2015).

5.4 Results

The results presented in this section focus on identifying and comparing the vulnerabilities of farmers, fishermen and pastoralists to double exposures (i.e. climate variability and water conflict). This is achieved by unpacking the underlying factors behind differential occupation-based (livelihood) vulnerabilities using the CWCVI and the DEI. As such, it provides answers to research question four and guides the discussion section where both questions four and five are fully addressed.

5.4.1 CWCVI: farmers, fishermen and pastoralists

Values for each indicator basket and the composite CWCVI for farmers, fishermen and pastoralists are presented in Table 5.1. Shifts in temperature and rainfall indices were generally similar for all livelihood groups. However, fishermen showed greatest vulnerability on the climate variability basket than farmers and pastoralists because of the reported higher climate-related losses due to the 'low-fish-catch' consequences from the direct impacts of climate parameters on the Lake Chad waters ($CV_{\text{fishermen}}$ 0.993, CV_{farmers} 0.987, $CV_{\text{pastoralists}}$ 0.963). The climate variability index serves to complement existing data on climate and therefore should be interpreted with caution since locations around the shores of Lake Chad are equally exposed to climate variability.

The aggression index was higher for pastoralists (0.98) than the other groups (Farmers 0.81, Fishermen 0.55). Pastoralists are often more aggressive during periods of extreme water and pasture shortages. Their involvement in water conflict often has a link with their inability to prevent straying animals from water points around farmlands or areas where fishermen's nets or hook traps are positioned. Farmers (95%) and pastoralists (96%) reported more conflicts in their villages than fishermen (78%). The feeling of insecurity index showed a greater vulnerability score for farmers (0.84) and a lower score for fishermen (0.09) compared to pastoralists (0.43). Farmers on average suffered greater losses in terms of crop destruction, post-harvest damages, money expended settling conflict cases in police stations, market closures and deaths due to water-related conflicts. This is reflected in the index for losses/death from conflict: farmers 0.65, pastoralists 0.52, fishermen 0.16. Overall, farmers were more vulnerable than pastoralists and fishermen on the water conflict basket (0.768 versus 0.750 versus 0.352, respectively).

Table 5.1: Indexed indicating baskets and overall CWCVI scores for farmers, fishermen and pastoralists in the south-eastern portion of Lake Chad in Chad Republic.

Indicating baskets	Number of indicators	Values for indicating baskets		
		Farmers	Fishermen	Pastoralists
Climate variability (CV)	3	0.987	0.993	0.963
Water conflict (WC)	5	0.768	0.352	0.750
Lake water variability (LWV)	4	0.495	0.495	0.573
Natural/physical assets (NPA)	3	0.387	0.863	0.847
Socio-demographic (SD)	4	0.450	0.475	0.470
Livelihood strategies (LS)	5	0.648	0.620	0.70
Social/political networks (SPN)	4	0.623	0.533	0.74
CWCVI		0.62	0.59	0.71

The influence of the variability in Lake Chad waters on livelihoods has been systematically investigated in Chapter 4. However, pastoralists showed greater vulnerability on the lake water variability index (0.573) than farmers and fishermen who had identical scores of 0.495. A higher percentage of fishermen reported relying solely on Lake Chad waters for domestic and livelihood activities (lake water dependency index: fishermen 0.98, farmers 0.73, pastoralists 0.16). Consequently, many fishermen had experienced income-related changes resulting from the falling water levels of the Lake (index on income-based changes: fishermen 0.73, farmers 0.59, pastoralists 0.39). The high vulnerability score for pastoralists for this basket is reflected in the indicators that report water scarcity (0.94) and distance (over 50 km) to the Lake Chad water point (0.80).

The vulnerability scores for the physical/natural asset basket were similar for fishermen and pastoralists (0.863 versus 0.847). Both had a higher score than farmers (0.387). While most farmer respondents (90%) have relatively consistent water supplies or a back-up water source through village water pumps and private wells, fishermen and pastoralists reported a declining trend in the volume and quality of the water sources they can access (mostly rivers and streams around villages). Private land ownership is more common amongst farmers than the other groups with higher vulnerability scores for the land access indicator. Weak, less climate-resistant houses are common in all villages. Households live in either mud-walled thatched houses, brick houses with iron sheets or make-shift houses. The latter is common amongst pastoralists. Basic government-owned physical assets (schools, hospitals, boreholes, markets and telecommunication) are either non-existent or widely dispersed and poorly equipped.

Approximately 93% of pastoralists, 86% of farmers and 80% of fishermen do not have access to social/political support during difficult times. Although fishermen are more isolated in terms of their village settings on islands, they often received more visits from NGOs, researchers and institutions. This contact enabled access to weather and livelihood-related information (without access to information index: pastoralists 0.68, farmers 0.63, fishermen 0.36). However, where promises regarding aid/support are made, they are often never fulfilled (personal communication with the leader of fishermen, Kaesai, February 2014). Except for a few farmers, the majority of respondents are not members of any formal local association. Cooperation was common amongst fishermen during periods of harsh weather conditions and aggression. Overall, pastoralists were more vulnerable than farmers and fishermen on the social/political network basket ($SPN_{pastoralists}$ 0.74, $SPN_{farmers}$ 0.623, $SPN_{fishermen}$ 0.533).

Pastoralists showed greater vulnerability on the livelihood strategies basket (0.70) than farmers (0.648) and fishermen (0.620). Most farmers reported not receiving remittances in the form of cash and in-kind help from family members who travel outside the village to work, or from friends/colleagues living mainly in urban areas (remittance index: farmers 0.78, pastoralists 0.63, fishermen 0.55). Further, the majority of fishermen reported that they have no access to credit/loans to support their activities while more pastoralists reported having less income to cover important household expenses. A large proportion of farmers and pastoralists rely solely on one agriculture-based activity for income (agriculture dependency index: farmers 0.80, pastoralists 0.80, fishermen 0.61). Fishermen are more diversified in their livelihood activities; they fish, grow crops, trade fish, use boats for transportation and engage in menial jobs as ways to cope with livelihood challenges. The livelihood diversification scores reflect the vulnerability of the three groups (farmers 0.33, pastoralists 0.33, fishermen 0.28). When the five indicators were averaged, the vulnerability score for the livelihood strategies basket was highest for pastoralists.

The age index was highest for farmers (0.27) then fishermen (0.24) and pastoralists (0.18). Overall however, fishermen showed greater vulnerability on the socio-demographic basket than the other groups ($SD_{fishermen}$ 0.475, $SD_{pastoralists}$ 0.470, $SD_{farmers}$ 0.450). A large proportion of household heads across all villages never attended school, although they reported having various years of experience in agricultural activities (farmers 16.8±12.7; fishermen 14.2±5.6; pastoralists 27±8.1). Approximately 3% of farmers reported having 0 – 2 years of experience. Over 90% of fishermen and pastoralists have no access to medical services/facilities. During illness, they travel 2 - 12 km to Guitté or Dandi to local clinics.

Values for the indicating baskets are shown in a radar chart (Figure 5.3). The diagram, with scales in 0.1 increments ranging from 0 (least vulnerable) at the centre of the web to 1 (most vulnerable) at the outside edge, shows which baskets contribute most to climate variability-water conflict vulnerability across the surveyed livelihood groups.

Pastoralists are ‘most vulnerable’ in terms of Lake water variability, livelihood strategies and social/political networks, while farmers are ‘most vulnerable’ in terms of water conflict and fishermen in terms of climate variability, physical/natural assets and socio-demographic profile. In sum, pastoralists had the highest CWCVI (0.71), then farmers (0.62) and fishermen (0.59), indicating relatively greater vulnerability to climate variability and water conflict.

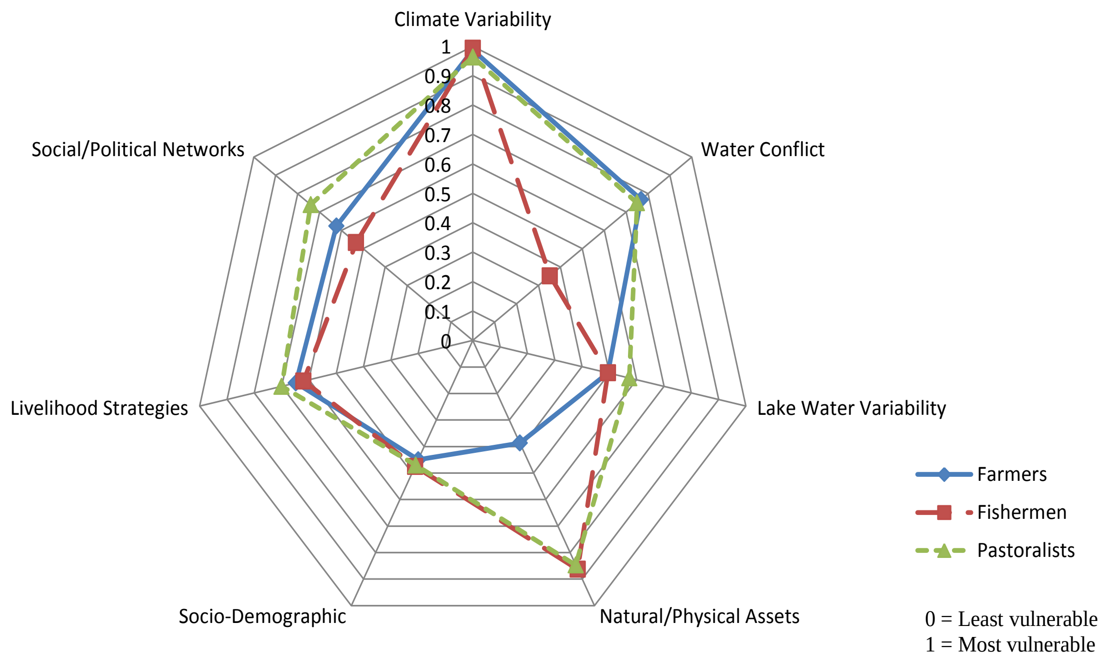

Figure 5.3: Vulnerability radar chart of the indicating baskets of the CWCVI for different livelihood groups at the south-eastern Lake Chad shores

5.4.2 The CWCVI and double exposure

Based on the IPCC vulnerability typology, eight indicators fall within the exposure categorisation (see Figure 5.2). The CWCVI analysis captures double exposure in the form of climate variability and water conflict. The values of these two baskets, drawn from their contributing indicator scores, are incorporated into the double exposure index (DEI) computation to specifically draw out double exposure for all resource user groups. Table 5.2 shows the DEI for the different groups as DEI $_{\text{farmers}}$ 0.85, DEI $_{\text{pastoralists}}$ 0.83, DEI $_{\text{fishermen}}$ 0.60. Figure 5.4 illustrates an integrated vulnerability and 'double exposure' triangle which plots the scores for DEI and CWCVI for the three livelihood groups. Accounting for the DEI as an embedded component of the composite CWCVI, Table 5.2 indicates that farmers may be more exposed to the double (combined) effects of climate variability and water conflict than other livelihood groups in a context where the CWCVI was highest for pastoralists, and the CWCVI and DEI for fishermen yielded similar values.

Table 5.2: Summary of computed double exposure indices for farmers, fishermen and pastoralists

Based on the summarising method [a]: $V_{DE} = DEI = \left[\frac{(W*B)_{cv} + (W*B)_{wc}}{W_{cv} + W_{wc}}\right]$	$DEI_{farmers}$	$\frac{3(0.987) + 5(0.768)}{3+5}$	= **0.85**
	$DEI_{fishermen}$	$\frac{3(0.993) + 5(0.352)}{3+5}$	= **0.60**
	$DEI_{pastoralists}$	$\frac{3(0.963) + 5(0.750)}{3+5}$	= **0.83**

Note: V_{DE} is a recast version of equation 2 (adopted from Hahn *et al*. (2009)) accounting for vulnerability under double exposure. DEI is double exposure index. W (number of indicators in each basket) and B (indicating basket) are based on climate variability (CV) and water conflict (WC) contributing indicators.

[a] Index values are interpreted as relative values for livelihood groups within the study context only and are based on views from the local resource users in the sample. The DEI is on a scale from 0 (least 'double exposed') to 1 (most 'double exposed').

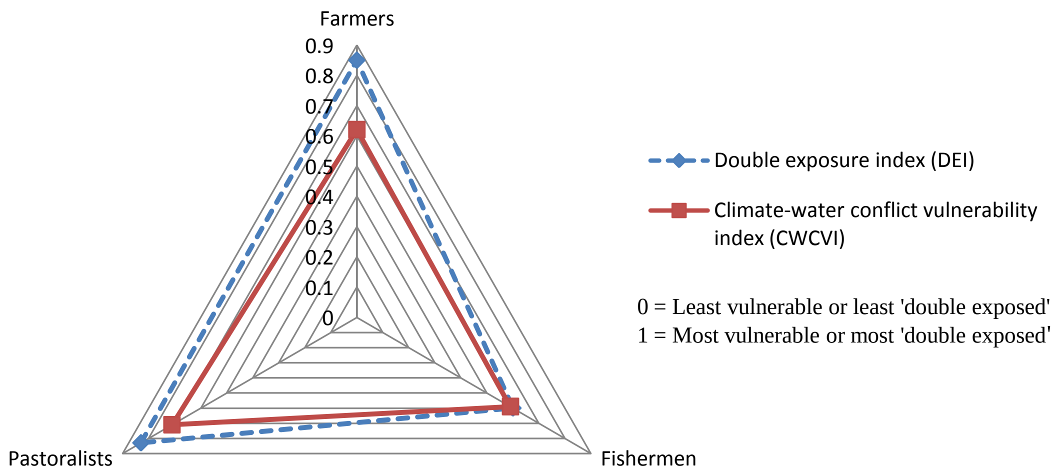

Figure 5.4: Integrated vulnerability and double exposure triangle diagram illustrating the CWCVI and DEI for farming, fishing and pastoral livelihood groups

5.5 Discussion

This section reflects on the results by unpacking the wider implications of the CWCVI-DEI analysis in light of the relevance of vulnerability determinants in Lake Chad and more broadly for understanding climate conflict interactions in fragile environments.

5.5.1 Unpacking the implications of the CWCVI – DEI assessment

Recurrent shifts in temperatures and rainfall, including water-related conflicts, are well-known livelihood stresses in the Sahel, often acting in combination to alter agricultural production, food supplies and livelihood dynamics (Benjaminsen, 2008; Couttenier and Soubeyran, 2014; Uexkull, 2014). Losses from climate and water conflict impacts represent an important vulnerability concern in the Lake Chad case study context. In contrast to existing data on temperature and rainfall which suggest similar climatic patterns for locations within the Lake Chad Basin, local people's perceptions about climate variability indicated that differences exist in local exposures, vulnerability and responses. The findings presented show that fishermen are more vulnerable to climate-related losses, but were better off in terms of response capacities through social/political networks and livelihood income strategies than farmers and pastoralists. Most local water conflict reports were received from pastoralists, including reports on aggression related to water. Yet it was the farmers who suffered the most from the consequences of water conflict. The high percentage of farmers who felt insecure in their villages and who reported crop, cash and human losses in the past five years underline the reasons many entry routes into farm villages were manned by local security personnel. The majority of farmers reported having the mobile telecommunication contacts of security officials to enable receipt of immediate help in the event of conflict.

Although the analysis yielded a high water conflict vulnerability score for farmers, low vulnerability on the natural/physical asset basket for farmers, particularly in terms of access to back-up water sources and land, was noted. This demonstrates why pastoralists (mostly) often encroached into farmlands and/or migrated towards farm villages. Resource scarcity and the relatively regular contacts farmers have with pastoralists and fishermen underlie the reasons for approximately 75% of the conflicts reported in farm villages. This finding has crucial implications for conversations regarding Lake Chad variability. Although the Lake waters play a central role in livelihoods (see Chapter 4), the relatively high dependence of villages on the Lake contributed to the income-based changes they experienced during low water levels. While fishermen suffered from limited water quality, pastoralists reported that they struggle to find water (in terms of volume and quality) during annual dry periods. Although pastoralists did not report the same level of dependence on lake waters and income-related changes resulting from lake water fluctuations as other groups, they had a higher vulnerability to lake water variability. Development programmes for village assistance regarding water supplies might constitute an appropriate intervention for locals, especially pastoralists needing secure watering points. When such an intervention is locally defined and centrally enforced, the frequent aggression amongst resource users during periods of water shortages can be reduced (Turner, 2004).

Despite receiving more remittances than farmers and having greater access to credit/loans than fishermen, the pastoralists showed more vulnerability than the other groups on the livelihoods income strategies index. Depending solely on livestock for meat, milk and cash meant that pastoralists are prone to income fluctuations resulting from cattle devaluation, diseases, scarcity of quality feed and conflict (Majekodunmi *et al*., 2014). Opportunities for alternative and supplementary livelihoods were limited in all the surveyed villages. The low socio-demographic profiles, as reflected mostly through limited education amongst a large proportion of the respondents, suggest why efforts by a few to diversify agricultural livelihoods were unable to fill immediate cash needs. To better capture livelihood income, future research might approach this by including quantitative estimates of annual income and expenditure across various groups.

While there are many measures of social/political networks at the local level (Eakin and Bojórquez-Tapia, 2008; Hahn *et al*., 2009), documenting membership in associations, receipt of external support/assistance, access to climate and livelihood-related information and local cooperation provide an indirect way of teasing out the contribution of social/political networks to differential vulnerability across different livelihood groups (Shah *et al*., 2013). Membership in group- or village-level associations influences the way local people bond with one another, including their access to informal insurance and logistic supports, and capacity for collective actions (Baird and Gray, 2014). This form of social capital is crucial for decreasing vulnerability to climate and conflict impacts (Uexkull, 2014). In contrast to fishermen who were better off in terms of cooperation and access to information, and a few farmers who belonged to farming associations, pastoralists were more limited in their social/political networks. Pastoralists' migratory lifestyle influences their perception of the cost of and benefits from social/political participation or engagement with authorities at the village and district levels (Thébaud and Batterbury, 2001). Despite occasional visits by agencies providing social and economic assistance, respondents reported that such visits were yet to translate into any solid relationship between villages and agencies/institutions. Further investigation (e.g. through focus groups) into how location-specific characteristics disrupt village linkages with the state and aid donors would help uncover reasons why social support and livelihood assistance remain largely non-existent in the surveyed villages (despite the range of existing policy interventions found in the LCBC documents – see Chapter 7).

The researcher's interactions with local experts and observations during field visits suggest that water conflict may have contributed more to local exposure challenges than climate variability. While this may not be detected from the DEI scores, the DEI nonetheless reflected an important conclusion regarding climate variability (CV) and water conflict (WC) exposures amongst different groups in the area. Despite the high climate-related losses reported by fishermen, including their high vulnerability to natural/physical assets and socio-demographic profile, they showed lower CWCVI and DEI scores than the rest of the groups. Indicators that constitute the sensitivity and adaptive capacity elements did not create any difference between 'double exposure' and vulnerability in the computation of fishermen's vulnerability. This might require further investigation to understand why this is the case. Fishermen's low vulnerability to water conflict and better social networks may have accounted for the low CWCVI score. Although farmers and pastoralists did not show similar low vulnerability, in the absence of development supports that address poor infrastructure, lack of representation, and ineffective systems of conflict management, including social protection and livelihoods planning (Luxereau *et al*., 2012; Ovie and Emma, 2012), the local populations in Lake Chad would face challenges in adapting to future changes in livelihood conditions.

5.5.2 Prioritising vulnerability assessment in climate and conflict research

There is a livelihood security imperative to frame climate conflict research around vulnerability (Gemenne *et al*., 2014). Yet applying a vulnerability lens to explain the climate and conflict link raises complex challenges. The link is not exclusively a collection of environmental (supply), institutional (restraint) and social (demand) drivers that can be understood purely in scientific or technical one-size-fits-all ways (Böhmelt *et al*., 2014). It reflects a conundrum of underlying realities that are context, place and time specific, and contingent on an array of theoretical postulations regarding what indicators or metrics that researchers deem important (Buhaug, 2015). This is why attempts to link climate and conflict stresses in vulnerability assessments is arguably the least advanced aspect of vulnerability science (Busby *et al*., 2014a). Nevertheless, the contextual nature of the CWCVI provides a vulnerability lens depicting a range of indicating variables that inform climate conflict thinking for lake-dependent environments. It points to a repertoire of potential explanatory factors (e.g. feelings of insecurity/deprivation, dependency on

Lake water and agriculture, climate-related losses, and livelihood diversity) linking climate and (water) conflict (Scheffran *et al*., 2012). Chapter 6 builds on this understanding using a wide range of secondary data from a regional sample of Lake Chad riparian zones to empirically explore the linkages between rainfall anomalies and conflict.

The results presented in section 5.4 underline how background conditions of vulnerability are an important entry point in identifying ways people are likely to face threats of death or livelihood emergencies resulting from climate-related events. Theoretical conversations on peace-building suggest that conditions where human needs are grossly denied can be critical drivers of vulnerability (Le Billon, 2003; Yardley, 2013; Matthew, 2014). Territories with problematic societal conditions such as insurgencies, high levels of militarisation and increased displacement of human populations convey a broad spectrum of leading conditions that shape the climate conflict dimensions of vulnerability (Verhoeven, 2014). Although the arrival of water conflict is often signalled years in advance by deteriorating climatic, socio-demographic, economics and governance conditions, the CWCVI variables provide a basis for a fine-grained causality analysis that can lead to socially-focused solutions – such as agricultural cooperatives, conservation of common property resources and conflict resolution, and strengthening of collective adaptations. These solutions are consistent with what many consider as suitable interventions in a climate conflict context where vulnerability is experienced (Scheffran *et al*., 2012; Sterzel *et al*., 2014).

The results establish that biophysical and socioeconomic factors trump several determinants of vulnerability. Comparison with climate and conflict case studies (e.g. Ludwig *et al*., 2011; Tir and Stinnett, 2012; Böhmelt *et al*., 2014; Kuzdas and Wiek, 2014; Selby and Hoffmann, 2014; Ide, 2015) indicates both good agreement in terms of the utility of the indicators in understanding climate variability and (water) conflict links, and a prospect to expand the indicators as data for other conflict-torn portions of the Lake become available.

It is important to stress that research efforts to prioritise vulnerability frameworks or indicators applicable to climate and (water) conflict analysis should be undertaken with caution. Choice of vulnerability indicators is largely based on subjectivity and use of several kinds of proxies (Hinkel, 2011) that may influence how climate conflict relations are interpreted. By using a mix of expert views (Chapter 3) and theories (Chapter 2), this chapter has demonstrated the need to control the way normative judgements translate into indicating variables used in characterising vulnerability to double stresses. Further, the directions of causality, in terms of pathways and feedbacks, may not be easily teased out from quantitative, empirical vulnerability studies. Additional steps in econometric modelling (e.g. Opiyo *et al*., 2014) underpinned by fundamental variables that are known to influence the directionality of vulnerability may complement indicator-based approaches. In doing this, the research design can move beyond mainstream views that privilege climate-induced resource scarcities in conflict outcomes by considering the balance between vulnerability and adaptability as a key contextual entry point to understanding climate conflict relations.

5.6 Conclusions

The CWCVI and DEI approaches developed in this chapter have several strengths. First, the multi-step methods of index computation provide detailed quantitative information about livelihood vulnerabilities, as well as local perceptions of shifting climatic conditions and conflict outcomes. Many indicator-based vulnerability studies focus on quantitative comparison of vulnerabilities across districts and regions, emphasising a single environmental or social stressor/hazard. Few studies use household survey data (including those from other participatory data collection approaches) to develop vulnerability indices that capture double exposures across different resource user groups in the manner presented here. Second, the DEI approach uses the views of ‘vulnerable locals’ to gain insight into current climatic and conflict situations, and therefore can comment on differences in double exposure among farmers, fishermen and pastoralists despite popular belief (based on existing secondary data) that areas within Lake Chad are similarly exposed to climate and (water) conflict. Third, the chapter presented a model that aggregates indicators to better understand the strength of livelihoods/households to resist pressures resulting from double exposures. Although it is unclear how the CWCVI and DEI scores might change if different weighting methods are employed, comparison with other studies across the region confirms that fishing and fish trading allow for more stability (see Luxereau *et al*., 2012); and that the “capacity of fishing activities to generate instantaneous gains represent an enormous advantage over farming” (Bene *et al*., 2003, p. 43) and over pastoral activities as well.

The deep-rooted issues identified through the CWCVI raise concerns about the ability of resource users to confront current and future challenges associated with climate change and growing insecurity. The CWCVI communicates locally-appropriate insights about what may contribute to apparently new forms of interventions for rural livelihoods. Replication of the CWCVI-DEI approach in the same location over time might communicate useful information about changes in vulnerability as adaptation and other livelihood interventions are initiated provided that any potential biases in sampling techniques and indicator selections are given consideration. However, as with any index approach there is need for caution in interpreting any empirical findings, as indicators and indices by their nature can mask underlying multidimensional realities shaping vulnerability.

Further refinement of the indicator-framework might focus on regional contexts to more accurately quantify how the factors operating beyond the household shape the roles of climate and conflict in driving local vulnerabilities. Similarly, future research can account for duration and severity of double exposure elements to uncover the extent indicators and indices oversimplify complex climate and water conflict realities. In doing this, scenarios of climate and conflict changes can be introduced into the indexing process to capture hidden and also future vulnerabilities. It is hoped that the CWCVI tool will help guide discussions on the need to prioritise vulnerability assessments in climate conflict research, particularly in order to better explain the interactions between climate shocks and conflict in a way that is easy to understand without glossing over the complexity.

Chapter 6

Climate shocks and conflict in lake riparian zones: evidence from the Lake Chad Basin [39]

Outline

The assertion that acute rainfall shortages or abundance breed violent conflict dominates climate conflict discourses. This chapter presents a contrary argument by showing that there are good reasons why both scarcity and abundance might have a dampening influence on conflict, including why conflict may be more prevalent in locations where vulnerability forces heighten livelihood hardship. The chapter employed secondary data obtained from a variety of sources to explore the relationship between climate shocks (measured as rainfall anomalies) and conflict in a regional sample of Lake Chad riparian zones, 1980 – 2015. The study finds little evidence to support the claim that climate shocks are directly linked to conflict outcomes in the simple and general manner proposed by previous studies. While a significant parameter coefficient can be observed under certain model specifications, the mediating role of lake drying is less significant. Empirical results reveal that the direction and magnitude of the rainfall variables are generally inconsistent and may be sensitive to research design. Indeed, the Lake Chad riparian zones appear to share common features with conflict events elsewhere, suggesting the underlying correlates of contemporary conflict to be contextual vulnerability forces rather than climatological. The chapter provides unique empirically-rich findings that suggest that climate conflict studies that fail to account for vulnerability forces risk a critical misrepresentation and misunderstanding.

[39] This chapter draws theoretical perspectives from the peer-reviewed published article of Okpara, U. T., Stringer, L. C., Dougill, A., J. 2016. Perspectives on contextual vulnerability in discourses of climate conflict. *Earth System Dynamics* 7, 89 – 102. DOI:10.5194/esd-7-89-2016.

6.1 Introduction

Academic research generally disagrees over whether and how climatic events cause violent conflict. The modal suggestion across recent studies, particularly those from Africa, is that extreme environmental conditions can influence people's inclination towards violent actions under certain conditions (Raleigh *et al*., 2015; Papaioannou, 2016). This chapter focuses on the most likely climate conflict transmission mechanisms in a lake drying context by assessing interactions between climate shocks and conflict in the presence of vulnerability factors. Livelihoods and vulnerability assessments are often useful entry points into climate conflict analysis (Deligiannis, 2012). As such, this chapter builds on the knowledge gained from previous result chapters by asking:

(i) Does the likelihood of conflict increase as anomalous climatic conditions increase? (Research question 6)

(ii) Is the effect of climate anomalies on conflict most pronounced in the presence of contextual vulnerability factors? (Research question 7)

(iii) Does lake drying represent a significant mediator in the interactions between climate shocks and conflict? (Research question 8)

The chapter scrutinises possible moderating (vulnerability factors) and mediating (lake drying) factors that influence climate conflict interactions. It pins down the ways in which climate shocks and conflict are contextually-bound and interrelated in LCB riparian zones in Cameroon, Chad, Niger and Nigeria.

The chapter uses conflict types beyond civil war and intrapersonal violence (see Chapter 3, Section 3.8). It switches attention from a single communal or civil conflict type of study employed in much of the existing large-N climate conflict literature, towards broad, aggregated conflict types held by many scholars to be the more probable outcomes of climatic events in natural resource-dependent settings (Hendrix and Salehyan, 2012; Raleigh and Kniveton, 2012).

The rationale for examining aggregated conflict types (i.e. communal, rebel and water conflicts) arises because climate is often assumed to be one of the many drivers of conflicts occurring in the same environment (Raleigh and Kniveton, 2012). In the context of the LCB, different conflict types have a similar range of determinants, and as such, often exhibit commonalities in their associations with climatic conditions (Onuoha, 2009). By building on Lake Chad understandings of how local populations experience climate shocks and conflict, the chapter reveals the grievances local conflict actors leverage upon to drive conflict.

The chapter uses variables depicting rainfall anomalies as proxies for climate shocks. It presupposes that rainfall shortages can delay river flows, diminish water levels in lakes and wetlands, and in turn influence the productivity of arable land and grazing areas (Singh and Moirangleima, 2012). Rainfall is a useful climate variable in terms of its influence on agricultural societies. This influence is particularly pronounced in the LCB where the majority of the rural population relies on rain-fed agricultural livelihoods.

Three hypotheses are proposed to guide the empirical analyses undertaken in this chapter. The next section (Section 6.2) presents the hypotheses based on the modal theoretical conventions in the broad environmental security literature discussed in Chapter 2 (see Sections 2.4 and 2.6). Data used to evaluate the hypotheses were presented in Chapter 3 (Section 3.8).

6.2 Research hypotheses

Following the theoretical literature explored in chapter two (see Section 2.6), this chapter proposes the following hypotheses. First, anomalous climatic conditions often connote a sense rainfall shortages or abundance that may spur conflicts in natural resource dependent locations (Uexkull, 2014; Maystadt *et al.*, 2015). If resource scarcity or abundance increases conflicts under unfavourable climatic conditions, then increases in anomalous climatic events will increase the likelihood of conflicts experienced by local resource users in lake riparian zones. This informs the first hypothesis to be empirically tested in this chapter.

H_1: The probability of conflict increases as anomalous climatic conditions increase.

Second, the chapter advances two distinct effects: a moderation (interaction) effect of contextual vulnerability in climate conflict relations and a mediation (indirect) effect through lake drying (see Section 6.3 below for details justifying the use of moderation and mediation variables). A large segment of the theoretical account of the climate sources of violent conflict does not suggest a direct linkage, but emphasises the relevance of non-climatic factors (Seter, 2016). Whether climate shocks lead to conflict will depend on the vulnerability status of communities and the coping capacity of individuals/groups affected (Fjelde and von Uexkull, 2012). Therefore, if climate shocks thrive within the context of increased vulnerability (i.e. low capacity to adapt), then both climate impacts and low capacity to adapt can mutually reinforce the risk of conflict. Based on this argument, the chapter proposes a second hypothesis:

H_2: The effect of anomalous climatic conditions on conflict is most pronounced in the presence of contextual vulnerability factors (i.e. political exclusion, poor governance/democracy and changes in agricultural production).

Third, the mediation effect presupposes that if lake drying provides an operating environment or a channel for climate conflict links, then it can be considered as a mediating variable (Onuoha, 2009; Luxereau *et al*., 2012). Shrinking lakes under anomalous climatic conditions can spur threats of violence because by virtue of their existence, they anchor local agricultural livelihoods and rural economies (Rast, 2014). In contrast, they can also serve as a rallying point for cooperation, a sort of motivational factor that encourages peacebuilding, particularly in settings where lakes traverse several cross-country borders and boundaries (Wolf *et al*., 2003). While the interest of the empirical analysis here is not about climate cooperation, the chapter notes that the terrains where most African lakes are located can provide 'unhealthy' hideouts for insurgent groups (Taguem Fah, 2007). Similarly, when a lake is located within a region characterised by diverse ethnic and occupational groups, it is likely that scarcity or abundance-related grievances will form along ethnic or livelihood/occupational lines. Perceived deprivation during periods of lake drying may spur aggrieved individuals and groups to seek violent means of voicing their grievances or demand state support, or deprivation may motivate groups to form alliances (based on a ‘no-gain’ narrative) for positive social actions (White, 2013). On this basis, a third hypothesis is proposed:

H_3: Anomalous climatic events will increase lake drying, which then increases the likelihood of conflict.

6.3 Empirical estimation procedures and framework of analysis

The outcome or dependent variable (conflict) is a count [40] variable based on counts of conflict events. Count outcome data are non-normally distributed, and can be analysed within the generalised linear models (GLMs) framework (Dobson, 2002). Many statistical packages, including SPSS, implement the GLMs for e.g. Poisson Regression and Negative Binomial Regression (NBR) (Coxe *et al*., 2009). To evaluate hypothesis one, NBR for count outcome variables (Hilbe, 2007) was used. Negative Binomial Regression (NBR) was preferred to a Poisson Regression due to: (i) the over-dispersion of the conflict count data (i.e. the value of mean conflict count for each zone was less than the variance (see Table 6.1); (ii) the skewed distribution of conflict events towards recent years for which there are several conflict observations (see Figure 6.1), and (iii) because the count data do not have an excess number of zeros. Indeed, NBR has a useful advantage when modelling count variables whose distributions are highly skewed (not normally distributed) and over-dispersed (i.e. variance greater than mean) (Cameron and Trivedi, 1998; Hilbe, 2014). The NBR approach has been widely used across the quantitative environmental and social sciences to model count variables (Alario *et al*., 2015; Pasgaard *et al*., 2015; Gray and Wise, 2016), including conflict events and fatalities (Hendrix and Salehyan, 2012; Raleigh and Kniveton, 2012; Salehyan and Hendrix, 2014; Caruso *et al*., 2016). As such, the choice of NBR is appropriate and consistent with existing literature.

[40] “A count variable is a variable that takes on discrete values (0, 1, 2, . . .) reflecting the number of occurrences of an event in a fixed period of time. A count variable can only take on positive integer values or zero because an event cannot occur in a negative number of times” (Coxe *et al*., 2009, p. 121).

Table 6.1: Conflict count descriptive statistics.

Zone	Observation	Mean	Standard deviation	Min	Max
Cameroon	36	8.08	24.23	0	111
Chad	36	5.44	7.95	0	35
Niger	36	4.08	10.54	0	55
Nigeria	36	33.14	73.26	0	297

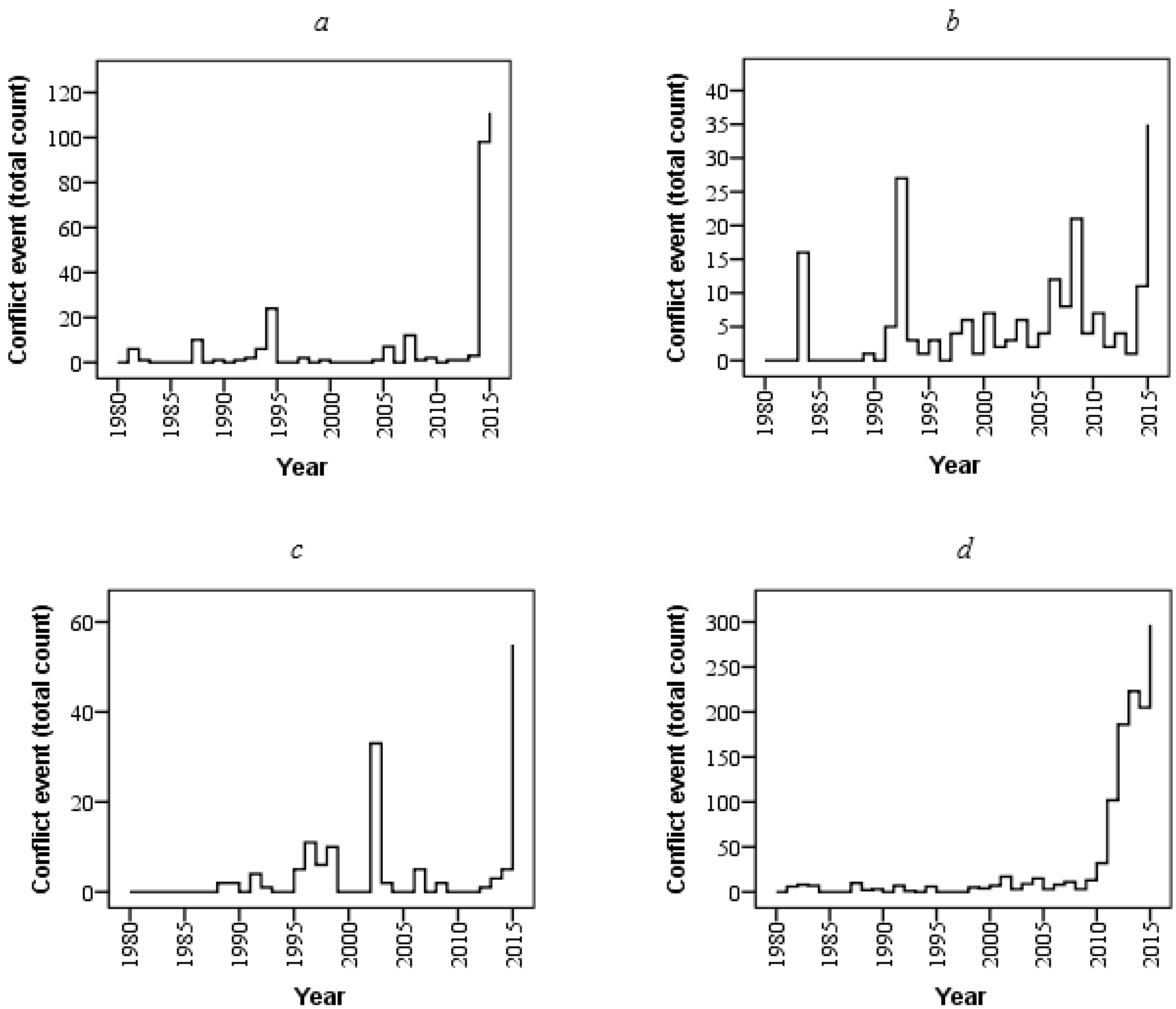

Figure 6.1: Estimated zone-specific conflict events, 1980 – 2015 for Cameroon (a), Chad (b), Niger (c) and Nigeria (d)

Hypothesis two states that “the influence of anomalous climatic conditions on conflict is most pronounced in the presence of contextual vulnerability forces”. Because of the conditional nature of the relationship to be established, a multiplicative interaction model, based on a NBR analysis, was applied to address this hypothesis (Brambor *et al*., 2006; Buis, 2010). The analysis here specifically focused on the moderation effects of contextual vulnerability factors in climate conflict relationships – i.e. whether vulnerability factors amplify or dampen the effect of rainfall anomalies on conflict. In this instance, the interest is not to establish a ‘mechanism’ or an ‘indirect pathway’ effect. Because the Lake Chad region is a relatively dry land area characterised by significant rainfall shortages, the study assumes anomalous climatic conditions to reflect abnormal rainfall events (i.e. rainfall anomalies). This implies that the moderating effects to be unpacked would be associated with interactions involving a measure of long-term rainfall shortages (i.e. inter-annual negative rainfall anomaly) and relevant contextual vulnerability factors.

To evaluate hypothesis three, the analysis examined the proposition that “anomalous climatic events will increase lake drying, which then increases the likelihood of conflict”. The focus is on the likelihood of a mediating effect of lake drying on climate conflict relations, i.e. the indirect pathway from climate shocks to conflict through lake drying. A mediation analysis based on PROCESS for Statistical Package for the Social Science (SPSS) version 2.15 (Hayes, 2013) was utilised to evaluate this hypothesis. According to Hayes (2013), a mediation analytical model links a putative predictor/independent variable (e.g. rainfall anomalies in this case) to a presumed outcome or response variable (e.g. conflict) at least through an intermediary variable (e.g. lake drying). The mediating variable usually can be any conceivable channel through which the predictor exerts an effect on the response/outcome variable (Preacher and Hayes, 2004). The mediation model is a causal model that carries with it the criteria for making causal claims (Zhao *et al*., 2010).

In the analysis undertaken here, lake drying was theoretically conceived to be related to and ‘causally’ located between climatic conditions (rainfall anomalies) and conflict, and therefore could possibly act as a mediator in climate conflict relations. This does not in any way suggest or claim that lake drying cannot also act as a moderator or that the vulnerability factors captured in hypothesis two cannot act as mediators. The justification for a good mediator is that it should be influenced directly by the main independent variable (Hayes, 2013). In this sense, rainfall anomalies do not influence political exclusion and democracy directly the way they influence lake drying (agricultural production is an exception – it can act as a mediator like lake drying).

The PROCESS macro for SPSS is a computational tool that can be used in an ordinary least square (OLS) regression environment to simplify the analysis of a mediation-based path model. It can also be used for moderation and other conditional process analysis (Hayes and Preacher, 2014). Because OLS regressions often require normally distributed, continuous outcome variables (Moberg and Brattstrom, 2011), the count data variable used to evaluate hypothesis three was log-transformed (i.e. by taking *In* (1 + number of conflict events)) to satisfy assumptions of statistical approaches based on normal distributions (Seavy *et al*., 2005), and to enable a quantitative PROCESS mediation analysis to be undertaken. Previous studies have used log-transformed conflict count data, particularly in a context where such data are considered to have much larger mean values and where zero is not the most common value (Coxe *et al*., 2009; Raleigh *et al*., 2015). The approach adopted here was to enable comparison and interpretation of parameter coefficients (Fankhauser and McDermott, 2014). Based on suggestions from Ding (2014), the analysis here did not use the PROCESS tool to explore the moderation effect (in hypothesis two) because a log-transformed dependent variable can deflate the effect of moderation variables in PROCESS moderation analysis. In contrast, mediation analysis through PROCESS appears less problematic with a log-transformed dependent variable.

Hypothesis testing from PROCESS outputs involved comparing the strength of a direct climate conflict effect with an indirect lake drying path effect. The significance of a mediation effect was tested using the bootstrap confidence interval (BCI) (Capstick and Pidgeon, 2014). Although there are other ways of testing for significance, such as the Sobel test (Sobel, 1987) and the Test of Joint Significance based on coefficient and standard error values (Hayes and Scharkow, 2013), the BCI has become the preferred inferential method for testing indirect effects - because it is considered more rigorous [41] (Zhao *et al*., 2010).

6.4 Empirical results and discussion

Empirical analyses and hypotheses testing focused on each zone of the Lake. As such, four cross-sectional time-series analyses [42] were carried out, each for a riparian zone. The results presented are disaggregated to reflect the universe of cases for climate conflict relations in the LCB.

A preliminary inspection of zone-specific conflict trends, rainfall anomalies and lake fluctuation reveals the well-known drying across the Sahel over the past 36 years. Figure 6.1 (see Section 6.3) visualises temporal patterns of conflict events in the four Lake Chad zones. The figure shows a notable peak in conflict events over the past 10 years, in part because of substantial attacks by the Boko Haram insurgent group (Cold-Ravnkilde and Plambeck, 2016). Although, the general upward trend in conflict may be due to improvements in conflict reporting in recent years (particularly for Nigeria), overall the frequency of conflict in the LCB indicates considerable similarities in spatial variations across the various zones over the past 36 years. After the extreme rainfall shortages depicting the Sahelian drought of the early- to mid-1980s (Figure 6.2), rainfall increased moderately, although with marked inter-annual and intra-zonal variations.

Figure 6.3 shows contemporaneous mean lake size fluctuations, 1980 to 2015. The two phenomena (i.e. rainfall anomalies and lake shrinkage) appear to exhibit similar trends, but the decline in Lake size is stronger than that of rainfall, in part because of substantial human water demand for domestic and agricultural uses in the period covered (Odada, *et al*., 2006).

[41] The Sobel test is conceived as outdated, though it is integrated in the PROCESS path analysis for the sake of comparing different results. Bootstrapping is a computer intensive analytical tool often used for significance testing in mediation analysis (Hayes, 2013).

[42] Disaggregating the analysis this way did not require the inclusion of location and time fixed effects (O'Loughlin *et al*., 2014a).

Line graphs are of limited value in displaying causal inferences, but can be effective in revealing patterns of temporal covariance. The increased frequency of conflicts observed since 2010 reveals little evidence to suggest that higher incidences of conflict are directly associated with more abnormal rainfall conditions. Fewer conflicts occurred during periods of significant rainfall shortages that characterised the 1980s and early 1990s. In contrast, conflicts have increased since 2010 despite the observed abnormalities in rainfall conditions (Figure 6.4).

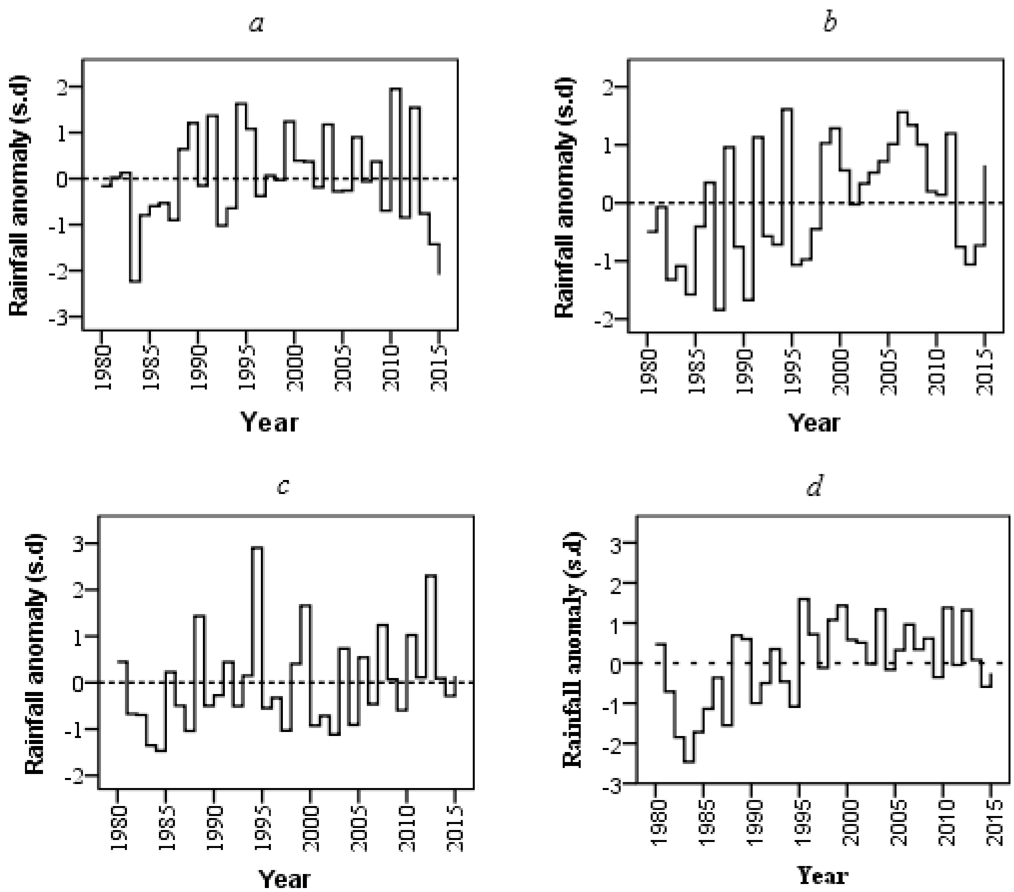

Figure 6.2: Trends in rainfall anomalies across the riparian zones with straight line marking the point of separation between negative and positive anomalies (a = Cameroon zone, b = Chad zone, c= Niger zone, and d = Nigeria zone)

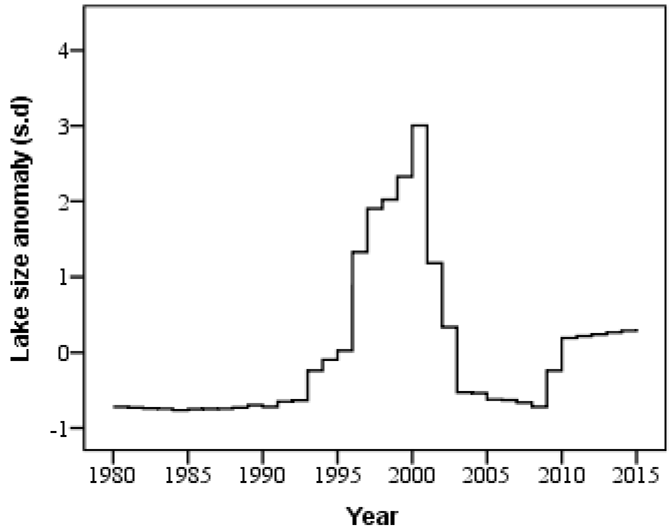

Figure 6.3: Trends in Lake size anomaly in the Lake Chad Basin, 1980 – 2015

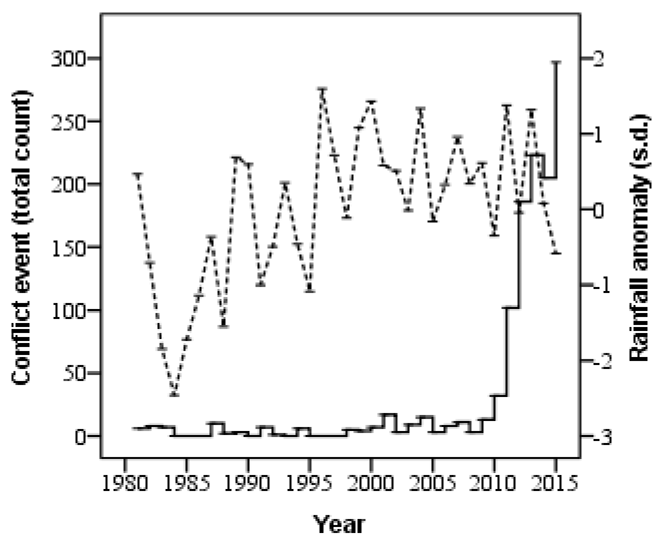

Figure 6.4: Reported counts of conflict events (solid-step line) and rainfall anomaly (dashed line) in the Nigerian zone (where conflict is more pronounced). The figure overlays statistics on estimated conflict events with data on rainfall anomaly (one-year lagged) 1980 – 2015. There is little in the historical data presented to suggest that rainfall anomalies are necessarily the cause of increased conflict events here.

6.4.1 Model predictions on hypothesis one

The empirical evaluation of hypothesis one, based on a NBR, was conducted using three sets of regression models across the riparian zones (Models 1 – 3 in Table 6.2). The main explanatory variables are various measures of rainfall conditions. The models were run with a lagged dependent variable to account for temporal dependence between conflict observations. Similarly, all control variables were introduced to reflect one-year prior conditions in order to capture a time lag in the causal effects on conflict events, as well as to reduce problems associated with reverse causality (Hendrix and Salehyan, 2012; Böhmelt *et al*., 2014). All models failed to lend support to hypothesis one, except for the Lake Chad area in Chad where the 'current' negative rainfall anomaly indicates a statistically significant positive relationship with the frequency of conflict events at the 0.1 significance level (Model 1). Although relevant in terms of support for a positive climate conflict relation, the finding associated with the Chad zone in model 1 is largely inconsistent and therefore unsatisfactory: coefficients for the negative rainfall anomaly show evidence of a switch (flip) in signs and levels of significance at different time lags. Although there is evidence suggesting a decline in conflict due to both negative and positive rainfall anomalies, a few measures of rainfall anomalies in Model 1 (i.e. $Rain\ (-)_{t}$ for the Cameroon and Nigeria, and $Rain\ (-)_{t-2}$ for the Chad zone) generally produce statistically significant negative relationships with conflict.

The majority of the exogenous control variables do not behave as expected, except in a few cases[43]. For example, the coefficients on the estimated measure of GDP per capita (lagged one year) for the Cameroon, Niger and Nigeria zones reveal contrasting evidence. In both Cameroon and Niger zones, the coefficients are negative and reach statistical significance across models 1 – 3, suggesting that improvement in GDP levels (one year prior) reduces the frequency of current conflict events. In the latter (Nigeria zone) the coefficient is positive and consistent across the models, indicating a positive association between GDP per capita and conflict (GDP pc for Chad is not distinguishable from zero). Further, models 1 and 3 reveal a statistically significant

[43] This comes as a surprise when compared with previous findings that show measurable, significant effects of control variables, such as population density and lagged conflict, on conflict in sub-Saharan Africa (Fjelde and Uexkull, 2012).

positive association between population density (one year prior) and conflict in the Niger zone. Finally, Table 6.2 indicates that prior year conflicts in neighbouring zones of Chad and Nigeria significantly reduce current conflict events in Far North Cameroon. This result is consistent with Wischnath and Buhaug (2014), who suggest that conflicts in neighbouring zones have little to do with conflicts in another state under certain conditions (e.g. effective border controls or good relationships with neighbours). There is no evidence that previous (prior year) conflict events in any particular zone influence current conflicts within the zone.

Taken together, the probability of conflict increasing under increased positive or negative inter-annual and seasonal abnormal rainfall (climatic) conditions is not fully supported across all the models. Despite the lack of evidence in support of hypothesis one, the empirical results suggest (albeit partially) that rainfall shortages and abundance dampen the frequency at which conflicts occur in different Lake Chad zones and at lags of one to two years [44]. Based on the model results, Table 6.2 implicitly contrasts claims (in recent works with a geographical focus on sub-Saharan Africa) that conflict is more prevalent when rainfall is relatively scarce (Fjelde and Uexkull, 2012) and/or abundant (Theisen, 2012; Salehyan and Hendrix, 2014). For example, dry conditions are often conceived to indicate periods of limited water supplies for beneficial agricultural livelihood activities and as such, one should have *a priori* reason to expect increased conflict under rainfall shortages. Further, one might argue that the weakening (in terms of negative signals) of many of the climate-predictive variables could be due to poor data, parameter selection bias or wrongly specified models. However, it is believed that this is not likely to be the case here. The absence of clear, direct and significant positive effects comes as no surprise. The findings presented are consistent with the cornucopian thesis about the ability of humans in marginal areas to cope with extreme conditions (see Chapter two, Section 2.6.2). Human ingenuity (i.e. capacity to cope with or get used to unfavourable conditions) under harsh environments often enables communities to transit from coping to adapting, particularly where a single drought event is known to translate into repeated drought extremes over time (Gray and Moseley, 2005).

[44] The sign of the coefficient for rainfall anomalies is negative in twenty three of the thirty two specifications (Table 6.2).

Table 6.2: Base model: rainfall anomalies and conflict.

DV: Conflict_total	Model 1				Model 2				Model 3			
	Cameroon	Chad	Niger	Nigeria	Cameroon	Chad	Niger	Nigeria	Cameroon	Chad	Niger	Nigeria
Rain (-) $_{t}$	- 0.945*	1.298*	- 0.392	- 0.822**								
	(0.490)	(0.773)	(0.809)	(0.410)								
Rain (-) $_{t-1}$	- 0.600	- 0.782	- 0.654	0.526								
	(0.658)	(0.634)	(0.818)	(0.456)								
Rain (-) $_{t-2}$	- 1.014	- 0.654*	- 0.466	0.520								
	(0.873)	(0.382)	(0.940)	(0.402)								
Rain (+) $_{t}$					- 0.913**	0.215	-1.028**	- 0.030				
					(0.467)	(0.455)	(0.382)	(0.387)				
Rain (+) $_{t-1}$					- 1.615**	0.687	-0.454*	0.203				
					(0.621)	(0.497)	(0.239)	(0.382)				
Rain (+) $_{t-2}$					-1.128*	-0.832*	-0.316	0.343				
					(0.609)	(0.450)	(0.232)	(0.371)				
Rainy_season anom.									-0.442	0.305	-0.156	- 0.200
									(0.282)	(0.250)	(0.516)	(0.233)
Dry_season anom.									0.221	-0.606	-0.893**	- 0.259
									(0.436)	(0.371)	(0.345)	(0.223)
GDP pc $_{t-1}$	- 0.003**	0.002	- 0.02**	0.001*	-0.004**	0.000	-0.018**	0.002**	-0.004**	0.001	-0.029**	0.002**
	(0.0012)	(0.0012)	(0.007)	(0.0007)	(0.001)	(0.001)	(0.006)	(0.0007)	(0.001)	(0.001)	(0.010)	(0.007)
Pop_density $_{t-1}$	0.038	- 0.073	0.131**	0.048	0.053**	0.072	0.072	0.015	0.005	0.003	0.121**	0.058*
	(0.029)	(0.116)	(0.056)	(0.032)	(0.022)	(0.101)	(0.046)	(0.028)	(0.030)	(0.907)	(0.058)	(0.030)
Spatial lag, conflict in	- 2.023*	3.010**	- 0.386	0.099	-2.385**	1.389	0.374	0.124	-2.932**	1.292	-1.089	0.101
neighbour zone $_{t-1}$	(1.209)	(1.438)	(0.975)	(0.690)	(1.046)	(1.018)	(0.923)	(0.583)	(1.075)	(0.925)	(1.099)	(0.575)
Conflict $_{t-1}$	- 0.025	- 0.015	- 0.004	0.007	-0.026*	0.019	0.013	0.006	-0.010	-0.010	-0.002	0.004
	(0.016)	(0.024)	(0.059)	(0.004)	(0.015)	(0.031)	(0.027)	(0.005)	(0.011)	(0.019)	(0.036)	(0.005)
Constant	6.891*	-2.44**	13.49**	- 2.247**	11.248**	-1.031	13.322**	-2.146**	6.451	-1.563	20.966**	- 3.278**
	(3.956)	(1.031)	(5.031)	(1.119)	(3.255)	(0.872)	(4.140)	(0.892)	(1.853)	(1.011)	(7.399)	(1.199)
Observations	36	36	36	36	36	36	36	36	36	36	36	36
Log-likelihood	- 70.265	- 88.716	- 65.841	- 110.064	-69.793	-90.377	-64.737	-113.193	-74.451	-89.338	-63.423	-112.522

Note: Negative binomial regression coefficients with standard errors are in parentheses; *p < 0.1; **p < 0.05; ***p < 0.001. Models differ in terms of choice of time-varying rainfall parameters. All control variables represent one-year prior conditions to account for the likelihood of a time lag in causal effects on conflict events, as well as to reduce problems associated with reverse causality.

During severe rainfall shortages, people are likely to focus more on immediate survival and on preserving their livelihoods rather than fighting, as a way to enable them return to a normal way of life after extreme conditions (Eaton, 2008). The findings are also consistent with the 'no-gain' narrative, where local people's perceptions about the relatively low benefits of fighting (under rainfall shortages) compels them to seek solutions through collaboration and cooperation (Owuor *et al*., 2011). There is little to fight for during scarcity. Indeed, rainfall shortages can both reduce incentives for conflict and the fighting capacities of actors, especially by making conflict a costly endeavour.

Under favourable climatic conditions characterised by abundant rains, livelihood resources (water, pasture) could become readily available, enabling people to devote time and energy to productive labour to meet basic needs. Rainfall abundance can breed a feeling of self-sufficiency (i.e. the self-sufficiency narrative), thus dampening the likelihood of conflict (Raleigh and Kniveton, 2012). Increased motivation to cooperate can occur, especially where locals are willing to take advantage of favourable conditions to build social ties rather than engage in costly fighting (Seter, 2016).

Based on these arguments, it is believed that the results presented in Table 6.2 reflect the realistic nature of a 'direct' climate conflict relationship in the different Lake Chad zones where economic hardship is prevalent and livelihood opportunities are linked to the availability of natural resources. Although the results do not claim that there can be no relationship whatsoever, they suggest that rainfall anomalies and conflict events are at best causally unrelated in a positively significant manner outside the moderating or mediating influences of certain factors (Okpara *et al*., 2016a; Seter, 2016). Placing climatic factors under the spotlight without consideration for other traditional conflict-inducing factors can yield a misleading signal of the cause-effect process under investigation, thus biasing understandings of how climate conflict relations should be approached and interpreted (Burke *et al*., 2015). The results point towards the need to look away from a direct climate conflict linkage by shifting focus to how climate shocks may lead to conflict in the presence of important contextual vulnerability issues that are location-specific. While the underpinnings of the effects of climate shocks or anomalies may differ across contexts, notions of marginalisation, governance instability and low agricultural production can be more relevant in explaining positive climate shock effects on conflict outcomes (Fjelde and von Uexkull, 2012). In this sense, there is a need for further assessments in the context of potentially important location-specific factors, which are explored in view of contextual vulnerability variables in hypothesis two.

6.4.2 Model predictions on hypothesis two

Given that increased anomalous climatic conditions neither significantly increase nor decrease the likelihood of conflict 'directly', dismissing hypothesis one (i.e. the role of climate anomalies) altogether would be premature as the effect of rainfall anomalies on conflict might be most noticeable and pronounced in the contexts of certain potentially important vulnerability drivers, as expressed below in hypothesis two. In the next set of empirical analysis, three potential moderating (i.e. conditional) effects are assessed, in which the inter-annual negative rainfall anomaly variable (indicating rainfall shortages and dry conditions) is interacted with political exclusion, low agricultural production and governance instability/democracy in a multiplicative interaction model. Negative rainfall anomaly is considered as a suitable variable in the empirical evaluation of hypothesis two because it accounts for the prevailing harsh environmental conditions in Lake Chad better than other climate-related variables. This choice is consistent with theoretical arguments that suggest dry years (extreme rainfall shortages) are associated with increased likelihood of conflict events in SSA under certain conditions (e.g. Fjelde and Uexkull, 2012). The results showing the 'interaction terms' between negative rainfall anomaly and contextual vulnerability variables are presented in Table 6.3.

Hypothesis two proposes that the influence of anomalous climatic conditions on conflict is most pronounced in the presence of contextual vulnerability forces (i.e. political exclusion, levels of agriculture production and democracy). The hypothesis is based on the notion that climatic events often require a set of conditions with which to transmit their negative effects in human-environment systems and on human conflicts (Seter, 2016). The hypothesis emphasises 'context conditionality' and presupposes that climate shocks should be estimated in a multiplicative interaction term with vulnerability factors. The hypothesis is tested using multiplicative interaction models (MIMs) (Brambor *et al*., 2006). The MIMs account for the intuition behind 'a conditional hypothesis' as they make the influence of the independent variable (rainfall anomaly) on the dependent variable (conflict) depend on some third variables (i.e. the contextual vulnerability factors). Each of the 'moderating variables' is interacted with the negative interannual rainfall anomaly variable. While '*exclusion*' and '*democracy*' were included as modifying dichotomous variables, changes in agricultural production was included as a continous modifying variable. The approach adopted here is based on Brambor *et al*. (2006) and includes the following steps. First, the analysis included the interaction terms that account for the conditional effects of rainfall shortages on conflict. Interaction terms are presented in Table 6.3 in a multiplicative interaction format - i.e. Rain (-) $_t$ * exclusion (Model 4); Rain (-) $_t$ * agricultural production (Model 5); and Rain (-) $_t$ * democracy (Model 6) [45]. Second, the constituent terms are specified (i.e. the constitutive elements of the interraction terms). This refers to each of the variables that constitute the interaction terms (i.e. negative rainfall anomaly, political exclusion, democracy and agricultural production).

Mirroring the coefficients on the interaction terms in models 4 – 6 as the conditional marginal influences of negative rainfall anomaly (NRA) on conflict in the presence of contextual vulnerability variables, Model 4 reports that the influence of NRA is amplified in the presence of political exclusion in the Chad and Nigeria zones (despite yielding large coefficients and standard errors)[46]. The interaction result for the Niger zone failed to reach statistical significance despite showing a positive sign; whereas the coefficient for the Cameroon zone has the opposite sign (i.e. negative) which is not distinguishable from zero (insignificant). Model 4 suggests that political exclusion is relevant in modifying the effect of NRA on conflict in the Chad and Nigeria areas of Lake Chad than in the Cameroon and Niger zones. The insignificant nature of the results on the interaction terms for the Cameroon and Niger zones make such results an unexpected finding. One reason for this might be because the reductive/dampening effect of NRA on conflict (as observed from the magnitude of the coefficient on Rain (-) $_t$) is larger than the combined effect of NRA and political exclusion on conflict (e.g. for the Cameroon zone).

[45] Rain (-) $_t$ reflects dry conditions/dry years in the context of this study, and is captured as negative rainfall anomaly.

[46] Large standard errors and coefficients in a sense may point to the presence of multicollinearity. This, however, is not the case with the analysis carried out here, but a likely case of the data not having enough information to estimate the model parameters accurately (Brambor *et al*., 2006).

Table 6.3: Multiplicative interaction model reporting interaction effects

DV: Conflict_total	Model 4				Model 5				Model 6			
	Cameroon	Chad	Niger	Nigeria	Cameroon	Chad	Niger	Nigeria	Cameroon	Chad	Niger	Nigeria
Rain (-) $_t$	-0.536	-0.489	-0.156	-0.773**	-1.234**	0.556	-0.432	-0.567	-1.310	0.384	0.192	1.920
	(1.103)	(0.855)	(0.892)	(0.359)	(0.553)	(0.494)	(0.596)	(0.398)	(1.178)	(0.677)	(2.592)	(1.576)
Excluded	0.356	0.202	1.510	0.792*								
	(0.971)	(0.763)	(0.918)	(0.416)								
Rain (-) $_t$ * excluded	-0.220	2.775**	0.098	2.807**								
	(1.272)	(1.232)	(1.224)	(1.217)								
Ag. Prod. Δ $_{t-1}$					4.134	1.337	-1.360	0.574				
					(2.402)	(1.116)	(2.009)	(1.126)				
Rain (-) $_t$ * Ag. Prod.Δ$_{t-1}$					0.473	6.079**	7.137	0.268				
					(3.335)	(2.065)	(4.458)	(1.300)				
Democracy									-0.007	-0.360	-0.022	-0.046*
									(0.030)	(0.040)	(0.046)	(0.024)
Rain (-) $_t$ * Democracy									0.015	0.028	-0.021	-0.060*
									(0.025)	(0.039)	(0.074)	(0.033)
GDP pc $_{t-1}$	-0.004**	0.002	-0.030**	0.001*	-0.004**	0.002	-0.019**	0.001**	-0.003*	0.002*	-0.018**	0.001**
	(0.028)	(0.002)	(0.010)	(0.0006)	(0.001)	(0.001)	(0.006)	(0.0007)	(0.002)	(0.001)	(0.006)	(0.0006)
Pop_density $_{t-1}$	0.014	-0.066	0.040	0.047	0.006	-0.006	0.118**	0.061*	0.013	-0.153	0.100	0.031
	(0.028)	(0.168)	(0.056)	(0.029)	(0.030)	(0.146)	(0.055)	(0.030)	(0.036)	(0.132)	(0.063)	(0.032)
Spatial lag, conflict in	-2.785*	1.158	-1.00	0.025	-2.689**	1.630	-0.690	0.062	-2.933**	1.218	0.388	-0.162
neighbour zone $_{t-1}$	(1.100)	(1.355)	(1.008)	(0.533)	(1.299)	(1.018)	(1.085)	(0.599)	(0.964)	(1.190)	(1.739)	(0.585)
Conflict $_{t-1}$	-0.015	0.032	0.042	0.008**	-0.009	-0.040	0.009	0.005	-0.012	-0.002	-0.002	0.008**
	(0.012)	(0.027)	(0.058)	(0.004)	(0.184)	(0.025)	(0.049)	(0.004)	(0.013)	(0.024)	(0.049)	(0.004)
Constant	11.366**	-1.233	21.668**	-2.897**	10.130**	-1.736*	13.538**	-2.983**	9.988**	-0.133	12.688*	-0.727
	(3.501)	(1.630)	(7.458)	(0.984)	(3.374)	(0.932)	(4.525)	(1.113)	(3.966)	(1.403)	(4.352)	(1.598)
Observations	36	36	36	36	36	36	36	36	36	36	36	36
Log-likelihood	-74.541	-87.195	-65.304	-109.611	-72.811	-87.769	-64.918	-112.335	-74.566	-88.486	-66.098	-109.927

Note: Negative binomial regression - standard errors are in parentheses; *p < 0.1; **p < 0.05; ***p < 0.001 (two tailed). Models differ on the basis of varied interaction terms. Vulnerability factors are presented as political exclusion, agricultural production and democracy (the selection was informed by the participatory research that led to Chapters 4 and 5 – see Okpara *et al*., 2015, Okpara *et al*., 2016b,c). Further research can consider several other socioeconomic and political factors beside the factors captured here, since it is likely that several determinants of vulnerability can modify the influence of rainfall anomaly (climate) on conflict (see Seter, 2016). The analysis carried out here was not designed to capture all relevant factors. Rather, it uses three relevant factors to demonstrate why the notion of vulnerability should be included in efforts to understand climate conflict relations.

Model 5 shows that in the four zones, the effect of NRA on conflict is positive (as expected) and is amplified in the presence of prior year changes in levels of agricultural production (or agricultural price changes), but only the interaction terms for the Chad zone yield a statistically significant (positive) effect. Model 6 suggests that higher levels of democracy significantly dampen the effect of NRA on conflict in the Nigeria zone: the coefficient on the interaction terms is negative and significant, suggesting that conflict is less likely to occur under rainfall shortages when the zone has higher levels of democracy/governance stability. The analysis is unsuccessful in establishing similar evidence for the rest of the riparian zones.

Overall, hypothesis two is partially supported. Contrasting results are observed as one moves from one zone to another, implying the peculiarities of locational contexts. In the Chad zone, political exclusion and changes in agricultural production seem to matter more as conditional factors in amplifying the links between NRA and conflict. When the interaction is compared with the individual effect of NRA, the coefficients switch signs from a dampening rainfall effect (-0.489) to a more powerful interaction effect (2.775) in the case of political exclusion in Model 4, and then to positive gains (i.e. from 0.556 and 6.079) in significant levels (Model 5). This suggests the relevant (positive) influence of political exclusion and agricultural production for climate conflict relationships in the Lake zone in Chad. The interaction between NRA and political exclusion (Model 4) in the Nigeria zone suggests that the likelihood of conflict incidence goes up under rainfall shortages when political exclusion is present but goes down with a favourable governance regime (an indication that a free, stable political/governance system can dampen the risk of conflict), as predicted by hypothesis two.

Mirroring the results for Chad and Nigeria, Table 6.3 suggests a possible indirect effect of NRA working through specific vulnerability factors. The result on political exclusion on climate conflict relations is strong and convincing and therefore comes as no surprise since political marginalisation is historically a characteristic feature of the Chad and Nigeria zones: exclusion leads to economic marginalisation, infrastructural decay and highly skewed wealth distribution systems, which together enhance deprivation amongst the excluded groups and communities (Jacob *et al*., 2016; Cold-Ravnkilde and Plambeck, 2016). These are the realities in the current-day Lake Chad territories in both zones (Okpara *et al*., 2015). The results for these two zones are generally more supportive of hypothesis two in the contexts of the interaction terms that appear significant in each case. Indeed, the evidence that exclusion and democracy, including agricultural production changes, increase the risk of conflicts following negative rainfall anomalies is consistent with previous studies (e.g. Fjelde and Uexkull, 2012).

Given that the results from the Cameroon and Niger zones lend no support to hypothesis two, it is believed that the strength and significance of the conditioning effect of political exclusion, changes in agricultural production and democracy on climate conflict relations would depend on which riparian zone one is considering. The results from the Cameroon and Niger zones are somewhat ‘puzzling’, and that they come as a surprise suggests the need for further investigation (e.g. through field visits) to understand the reasons for the divergent results and to ensure that it is not entirely due to a data issue. Nevertheless, as the population and land areas in the Chad and Nigeria zones of the entire basin trump those of Niger and Cameroon, the statistical findings regarding the roles of vulnerability factors (reported in Table 6.3) might indeed reflect a more general pattern (Mekonnen, 2016). This is consistent with the evidence presented in Chapters 4 and 5 – livelihoods in lakeside villages and islands are vulnerable to climate and (water) conflict, and confirmation from studies across the region (e.g. Bene *et al*., 2003; Luxereau *et al*., 2012; Ovie and Emma, 2012) further indicates that the general pattern behind conflicts might likely be associated with vulnerability factors (see also Busby *et al*., 2014a,b). Taken together, Models 4 - 6 reinforce the impression (albeit less evident in some zones) that anomalous climatic events could be relevant for conflict outcomes, conditional upon interactions between NRA and vulnerability factors.

The remaining covariates (i.e. control variables) yield results that contrast with those shown in Table 6.2. The sole exception is GDP per capita which maintains the parameter estimate similar to previous models in Table 6.2 (an increased GDP suggests that improvements in income level can safeguard against the frequency of local conflicts). Previous studies suggest that all forms of conflicts are likely to increase following increases in population density (Buhaug and Urdal, 2013), previous conflict events (Buhaug *et al*., 2015) or if violence is prevalent in neighbouring locations in the previous year (Bollfrass and Shaver, 2015). While this might be the case for several areas in SSA (Fjelde and Uexkull, 2012), the results presented here indicate an unexpected divergent view, as one moves from the north to the south of the LCB. While the concern here may not relate to the need to reconcile results, the fundamental issue may be the case pertaining to differential (underlying) contextual forces – different contexts reflect different evidence.

6.4.3 Model predictions on hypothesis three

Hypothesis three holds that anomalous climatic conditions will increase lake drying, which then increases the likelihood of conflict. Introducing lake drying (captured as lake size anomaly) as a mediating variable in the climate conflict relations does not suggest that the values associated with both the lake size variable and NRA are measuring the same thing twice, despite that both variables correlate (correlation reaches the 0.05 significance level for Chad and Nigeria). Previous research on Lake Chad shows that changing climatic patterns only partially explain lake drying, indicating that other forces, such as population pressures, economic demand for water and land use changes might also be responsible for observed fluctuating trends in lake conditions (Gao *et al*., 2011). Because drying is often associated with rainfall shortages (Okpara *et al*., 2016b), the variable $Rain\ (-)_t$ was used in the analysis presented here.

The results from the four zones do not support the contention in hypothesis three. As shown in Figure 6.5, negative rainfall anomaly (NRA) yields statistically significant positive relationship with lake drying for Chad and Nigeria zones, whereas insignificant positive and negative associations are observed for the Cameroon and Niger zones respectively. Again, the findings for the Cameroon and Niger zones are puzzling and contrast with previous studies where rainfall shortages are implicated as an important supply-side causal factor in lake size shrinkage (Gao *et al*., 2011), including causing reductions in river flows compared to the demand-side factors (Böhmelt *et al*., 2014). Further, the association between lake drying and conflict is positive for three of the zones as expected (except in Cameroon), albeit not statistically significant. Similar to the results presented in Model 1 (Table 6.2), the direct NRA to conflict relationship presented in Figure 6.5 is generally not significant. The sole exception is the result for the Chad zone where the coefficient on the $Rain\ (-)_t$ variable is positive and significant at the 0.05 level.

The outputs from the PROCESS macro for SPSS yield three types of effects (total, direct and indirect effects) for the mediation path analysis based on a default bootstrapping setting (Hayes, 2013). The logic behind bootstrapping is to enable the analyst to empirically compute the sampling distribution of any indirect effect, and thus generate a set of upper and lower level confidence intervals (i.e. ULCI and LLCI) for hypothesis testing (Hayes and Scharkow, 2013). The convention is that if there is no zero in-between the ULCI and LLCI values, then one can claim that the indirect effect is statistically significant with 95% confidence (Hayes and Preacher, 2014). Following this logic, particularly as applied in Capstick and Pidgeon (2014), the results from the mediation analyses for the Lake Chad zones suggest an absence of a significant indirect effect of NRA on conflict through lake drying (for both the analyses in which covariates/controls are either included or excluded). All the statistical tests – i.e. the test of Joint Significance[47], the Sobel test and the Bootstrapped Confidence Intervals Test - confirm that the indirect effect is insignificant. The results fail to lend support to hypothesis three. The evidence implies that lake drying does not represent a sufficient mediator for climate conflict relations, indicating the need to look beyond environmental issues in explaining conflict outcomes under harsh environmental conditions. As such, the results further solidify (albeit implicitly) the relevance of moderating vulnerability factors, particularly those that are exogenous to climate shocks (e.g. political exclusion and democracy/governance effectiveness).

Although the analyses did not consider the effects that lake rising might have on conflict, the results presented here, nonetheless, are consistent with previous qualitative studies (e.g. Onuoha, 2009; Asah, 2015) that suggest a broad range of contextual issues underlying conflict events in the LCB beyond lake drying. It is possible that anomalous climatic conditions could spur conflicts indirectly through lake drying if contextual vulnerability factors are present. Because quantitative analyses do not often tell the full story, and in particularly considering the regression results presented, there is a need to back up the results with qualitative evidence.

[47] Test of Joint Significance is a liberal test that is often used to supplement other tests – it supposes that if for example, the paths from rainfall anomaly to lake drying and then from lake drying to conflict are significant, then the mediating effect is significant.

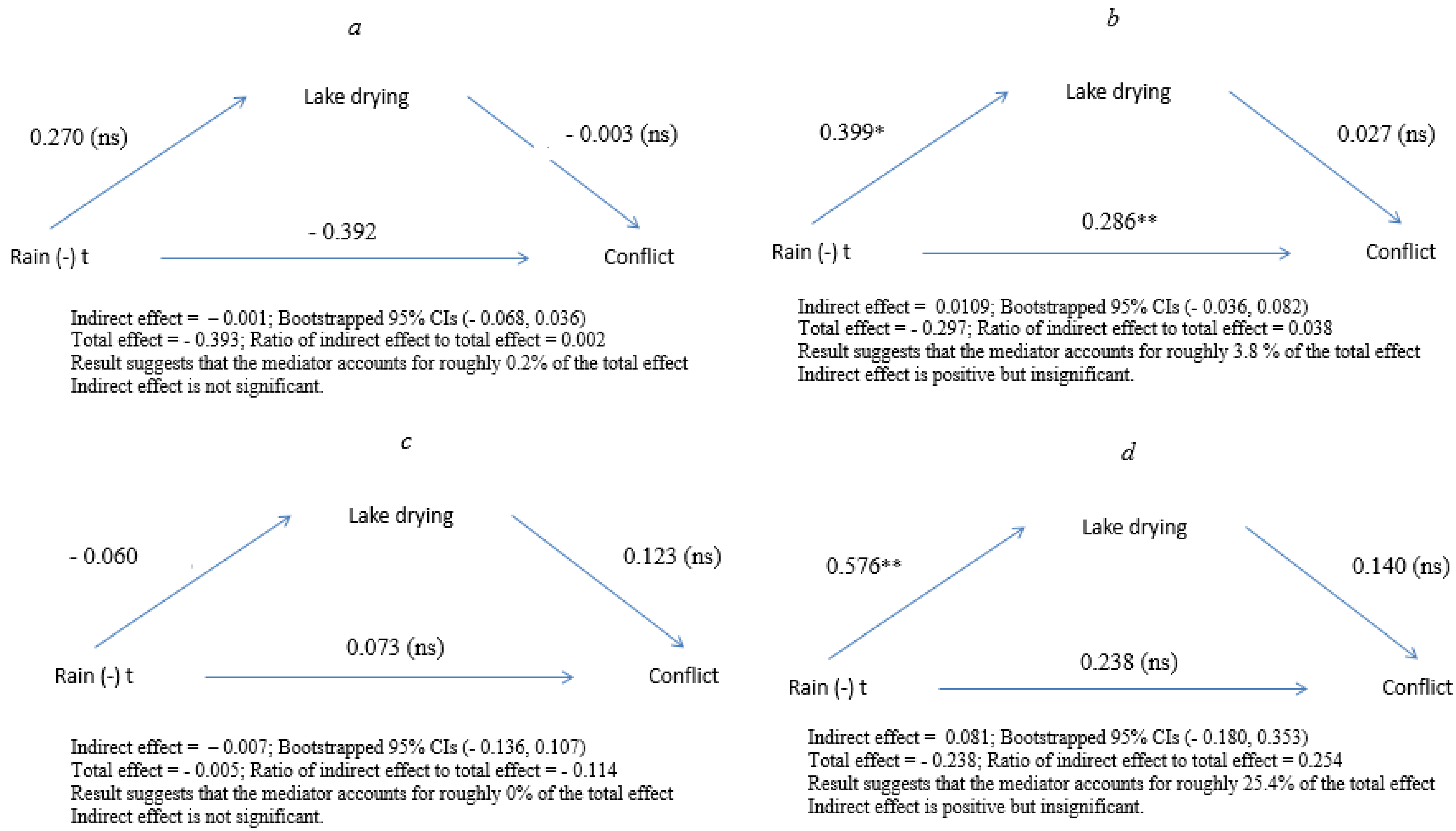

Figure 6.5: Path diagram showing indirect pathways from climate to conflict through lake drying. Results show the mediation effects of lake drying in Cameroon (a), Chad (b), Niger (c) and Nigeria (d) zones of the LCB (without the control variables). Values indicated are the coefficients (ns = not significant). The directions of the coefficients from the analysis in which controls are excluded appear more intuitive. (Note: lake drying does not suggest water scarcity in this analysis; also because lake dying is endogenous to NRA, the study did not consider that lakes can act as a buffer against climate variability (no reverse causality was inferred))

6.4.4 Qualitative evidence

To provide a comprehensive back-up to the regression results presented in this chapter, there is need to understand what was/were responsible for several of the conflicts reported to have occurred during the drought years across the LCB – particularly between 1980 and 2005. This concern was spurred by the evidence presented in Table 6.2 showing that rainfall anomalies have a dampening effect on conflict in most parts of Lake Chad, including the results on contextual vulnerability and lake drying presented in Table 6.3 and Figure 6.5.

To address this concern, qualitative historical analysis was undertaken (with information aggregated for the entire Lake basin). Lake Chad-related literature, encompassing official documents from the LCBC, Food and Agriculture Organisation and the United Nations Environment Programme, as well as peer-reviewed/grey literature and newspaper articles, was used to explore climate, lake drying, vulnerability and conflict challenges in the LCB. Findings from key informant interviews (during the field visits to Chad Republic between 2013 and 2014) were used to provide additional insights about the role of the shrinking Lake in conflict. Information from these various sources was combined to address the underlying mechanisms behind several of the conflicts reported to have occurred in previous drought/climate shock years across the LCB.

Aggregation and triangulation of information were carried out in two stages. First, the rainfall patterns indicated four specific periods during which the region witnessed severe negative rainfall anomalies (droughts) – these are: 1972 – 1975, 1982 – 1985, 1989 – 1992 and 2002 – 2005. Second, Lake Chad regional conflicts were observed to coincide more with these specific drought events (and less with non-drought events) for the periods 1970 to 2010 (see Okpara *et al.*, 2015). Information on rainfall anomalies and conflict were matched to assess whether periods of drought events (excluding non-drought periods) led to conflicts and how vulnerability may have aided such conflicts. Because the Lake region is historically prone to droughts and conflict, the assessment sought to capture conflicts using evidence within drought years over the course of the shrinking Lake Chad. Thus, the four drought periods were selected and situated within the Lake Chad socio-economic and political context of vulnerability and regional insecurity.

A synthesis of various documented reports on LCB shows that there were increased conflicts in the region during the droughts of the 1980s and 1990s (Figure 6.6). This period witnessed several conflicts over competing river claims, especially as resource users migrated in response to the shrinking Lake. For example, between 1980 and 1994, almost 60,000 Nigerians followed the receding Lake waters - fishing, cultivating crops and rearing animals within Cameroon's border of the Lake Basin (Hall, 2009). As communities and individuals in the receiving cities and states could not engage diplomatic options to resolve conflicts, several people lost their lives. By triggering hostilities with neighbours or damaging relationships between and among nations sharing the Lake's common pool resources, the shrinking Lake threatened regional security. As Figure 6.6 indicates, between 1982 and 1985, interstate water and boundary conflicts increased among the riparian nations (Eriksson *et al*., 2003; Odada *et al*., 2006). In 1982 local people from Cameroon and Nigeria clashed over access to the water resources around the south end border of the Lake Basin (Odada *et al*., 2006). In 1983, Chad engaged in an interstate violent conflict with Nigeria over the status of the islands in the Lake to which both countries have borders (UCDP, 2008). This violence resulted in over 100 casualties (Wallensteen and Margareta, 1999). In the late 1980s, Nigeria and Niger Republic clashed over water diversion and access to the Komadugu-Yobe River flow within the Lake Basin. In 1992 there were clashes between upstream (Nigeria) and downstream (Niger) communities over access to the waters from the Tiga and Challawa Gorge dams at the south-west end of Lake Chad (Odada *et al*., 2006).

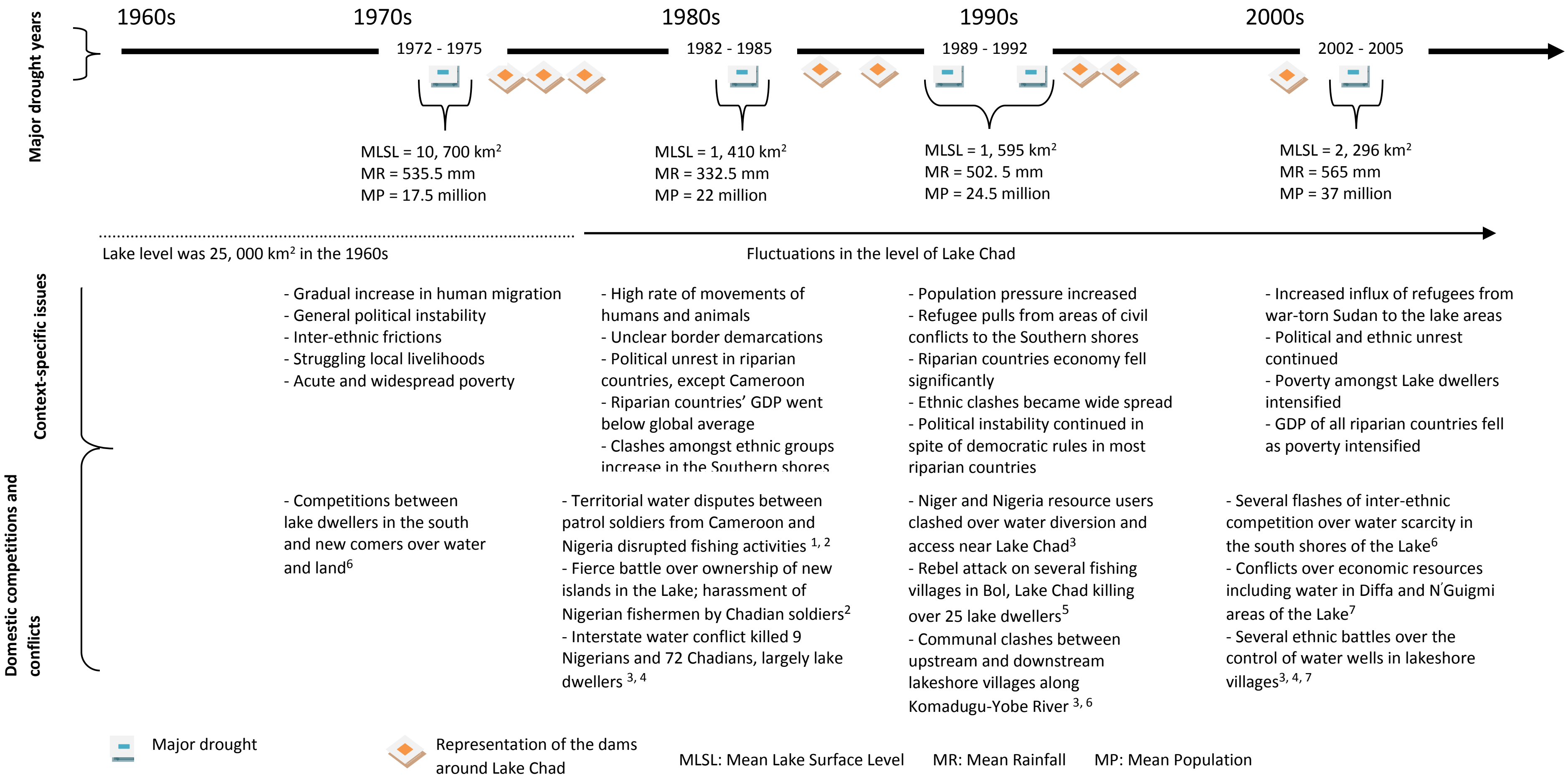

Figure 6.6: Synthesis of major droughts and conflict events ([1]UCDP, 2008; [2]International Crisis Behaviour Project Database, 2004; [3]Odada *et al*., 2006; [4]Hall, 2009; [5]Lane, 2004; [6]GIWA, 2004; [7]Social Conflict in Africa Database). Here vulnerability is captured in the notion of the context-specific nature of the Lake area as mirrored by livelihood losses, migration, political unrest, poverty, social instability, ethnic differences and historical conflict events.

Since 2005, competition and conflict over the use of resources within the Lake have continued to create security concerns at the Lake's southern pool where the largest population of resource users live (GIWA, 2004). Water shortages and loss of livelihood opportunities have driven vulnerable people into risky behaviours such as drug trafficking and trading of arms. Ohlsson (2000) argued that large cohorts of young people deprived of their sources of livelihoods constitute the major share of terrorist groups/rebels in third world militias. The rise of violent jihadist militants, who have killed over 20,000 people in the southern portion of the Lake, has been linked to loss of livelihoods and joblessness created by harsh socioeconomic conditions around the Lake (Ifabiyi, 2013; Signe Cold-Ravnkilde and Sine Plambeck, 2016).

From Figure 6.6, vulnerability can be mirrored broadly in the notion of the context-specific characteristics of the Lake areas as seen in loss of livelihoods, migration, political unrest, poverty, social instability, ethnic differences and historical conflict events. As water scarcity and poverty became more amplified and intense during the period covered, the economic and political value that communities and nations placed on the lake resources increased (Odada *et al*., 2006). Growth in unilateral consumption and unregulated allocation and use of water (e.g. through damming, diverting, dumping and draining activities) by one nation decreased the amount available to another (GIWA, 2004). Changes in the Lake's environment coupled with the vulnerability of the people and villages have always played a role in security issues (Asah, 2015). While climatic issues did not constitute a sufficient cause of conflict, lake fluctuations acting alongside Lake Chad context-specific factors (climate, population, socio-economic and political factors) provided the necessary condition for conflict to evolve and thrive (Figure 6.6). A shift in Lake water conditions, either due to climatic events or human activities, created a lot of challenges for household and livelihood systems (Luxereau *et al*., 2012).

6.5 Conclusions

The LCB territory is highly vulnerable to a number of external stressors (Ovie and Emma, 2012). This chapter posits that environmental and security concerns may be secondary to vulnerability concerns in a developing world context such as the LCB, because it is on the basis of vulnerability dynamics that we can better understand why locations facing the same environmental conditions are impacted differently (Gemenne *et al*., 2014). Much as the factors driving vulnerability in the LCB have been identified (Chapter 5), they combine to shape the link between environmental change(s), vulnerability and insecurity. Insight from this region supports conclusions from previous studies (Hauge and Ellingsen, 1998; Homer-Dixon, 1999; UNEP, 2005; Ludwig *et al*., 2011; Selby and Hoffmann, 2014) that the environment is connected to human well-being; that livelihood opportunities are linked to a stable environment; and that all of these are connected in one way or another to conflict. It is the presence of political exclusion (breeding weak justice and absence of livelihood support systems) and ineffective governance that differentiate locations facing similar environmental challenges in terms of whether conflict happens or not (Tir and Stinnett, 2012). These factors are within the purview of vulnerability issues and support the notion that efforts to unpack regional vulnerability issues can be a critical first step towards addressing climate shocks and conflict challenges.

Chapter 7

Towards the integration of climate adaptation, water governance and conflict management goals: what considerations are needed?

Outline

Tackling current instabilities around the LCB requires policy integration, where the achievement of development agendas in one area of concern (e.g. climate adaptation) does not undermine the achievement of the agendas of another (e.g. water governance and conflict management). Cross-cutting issues such as adaptation, water and conflict which cross multiple themes and sectors need to be integrated in a manner that advances human well-being and security. This chapter analyses Lake Chad transboundary policies on water, adaptation and security/conflict. These include policy documents on Lake Chad related interventions/plans for water governance and agriculture, climate adaptation and vulnerability reduction, together with human/regional security action plans. The chapter assesses whether initiatives/policies are integrated in terms of their treatment of adaptation, water and conflict management needs using a Qualitative Document Analysis (QDA) approach. Findings indicate that policy initiatives developed and/or promoted by the LCBC increasingly acknowledge the need to preserve the Lake waters, build resilience of individuals and communities and address human and transboundary insecurity. However, few policy initiatives exist that explicitly integrate climate adaptation, water and conflict concerns, particularly in the context of sustainable development for the LCB. Documents that are indicating these have been developed or written between 2015 and 2016. The chapter outlines the considerations needed to integrate cross-thematic goals across adaptation, water and security.

7.1 Introduction

Issues pertaining to prolonged rainfall shortages, lake drying and conflict create a challenging context for the Lake Chad Basin Commission (LCBC) in terms of the drive to achieve its various mandates. The LCBC is the lead institution on transboundary resource management (a regional water cooperative agent). It serves as a regional agency for communications between governments, NGOs and communities, and also for cross-ministerial/sectoral communications on climate change, security and water governance issues (Odada *et al*., 2006). The Commission was established in 1964 to facilitate a benefit-sharing scheme between the riparian countries and to prevent any unilateral actions that may harm local livelihoods and riparian economies by fostering political and economic cooperation, conflict settlement, and regional resilience against environmental disturbances (LCBC, 2015).

Economic development in the LCB territory has been sluggish since the 1980s. This makes the integration of cross-cutting strategies and plans for human well-being imperative, particularly as climate shocks are predicted to exacerbate water scarcity and livelihood insecurity in the islands, hinterlands and boundary communities around the Lake. In the context of this chapter, the term 'policy or strategic integration' is conceived as the systematic advancement of mutually reinforcing initiatives and actions across issues of thematic relevance to peoples and societies in order to create synergies towards achieving desirable goals. Policies are conceived to include regulations, as well as steering mechanisms such as action plans, strategies, advisory councils, initiatives and resolutions (Gerstetter *et al*., 2011).

Analyses of cross-thematic interventions and their integration are relevant to pin down where initiatives on key thematic areas support or conflict one another. The chapter is developed on the premise that a lack of effective cross-thematic action plans in water-scarce transboundary settings may impede adaptation, spur water competition and aggravate conflicts (Babcicky, 2013). Providing infrastructure and other public goods and services is a primary duty of responsible institutions which becomes especially relevant for reducing vulnerability. In a region such as the LCB, it is the LCBC's responsibility to effectively govern water use and allocation, and manage conflict risks on behalf of livelihood groups and societies. Thus, institutionallydriven policy initiatives can be an essential part of integrating adaptation, water governance and conflict management efforts. Effective policy integration[48] can spur better financial and budgetary management, including enabling situations where achievement of development agendas in one area of societal concern does not undermine the achievement of the agendas of another (Stringer *et al*., 2014).

Dialogues on regional cooperation within the LCB have identified the importance of strengthening partnerships and collaboration to manage the resources of the basin and to address the impacts of environmental changes, as well as to develop an appropriate institutional context to support needs-based policy actions (Asah, 2015). The need to harmonise and drive such policy actions on resource management was recognised in the mid-1960s following the Forty Lamy Convention (Sand, 1974). Despite the central role the LCBC plays in initiating joined-up developmental agendas, the Lake area has remained a vulnerability hotspot. Several action plans have been initiated, yet analyses are lacking regarding whether actions/initiatives on the key areas of water, adaptation and security are being integrated in a manner that encourages mutual co-habitation and resilience building at the basin level.

This chapter presents findings emerging from QDA of action plans, initiatives, strategies and advisory engagements regarding climate adaptation, water resources governance and conflict management within the confines of the LCBC mandates and activities. The chapter addresses objective four (i.e. to identify and evaluate policy intervention documents related to the LCB, and propose recommendations and ways forward that better integrate adaptation, water governance and conflict management goals). To achieve this objective, the chapter asks the following:

- What is the range of initiatives developed/implemented to reverse lake drying and promote better livelihoods? (Research question nine)

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[48] The focus of the chapter is not on cross-sectoral agencies, rather the concern is about the LCBC and its mandates on the LCB. It is also not about the national policies of Niger, Cameroon, Chad and Nigeria.

- What considerations are needed to integrate goals related to adaptation, water governance and conflict management in the broader Lake Chad regional context? (Research question ten)

The focus on adaptation, water and conflict is informed by the important role these issues can play in promoting stability in the region. The approach taken involved two steps: First, document screening/reading was undertaken to identify whether subjects pertaining to adaptation, water governance/management and conflict management/peacebuilding featured in the Commission's policy actions and initiatives. This represents an important first step in pinning down both the content of policy goals/initiatives and the drive towards integration. Second, document analysis focused on identifying whether and how integration is happening, including the lessons for future planning. The approach presupposes that the LCBC's action plans and policies on these subjects would reflect some sort of integration at least in the past decade (the period conflicts increased markedly across the region). This is because the Commission, by its mandates, is aware of the various manifestations of environmental hardship and contentions across the basin's riparian zones and has sufficient back-up from the riparian states and various development/donor agencies to both integrate cross-thematic issues and pursue developmental objectives.

The rest of the chapter focuses on identifying the range of interventions developed/promoted by the LCBC to address the challenges in the LCB (Section 7.2), the approaches used (Section 7.3), and identifying whether (and how) integration across adaptation, water and conflict goals is happening (Section 7.4). The discussion (Section 7.5) focuses on the considerations needed to integrate goals related to adaptation, water governance and conflict management in the broader Lake Chad regional context.

7.2 What is the range of policy interventions/initiatives developed to address the challenges in the Lake Chad Basin?

Table 7.1 shows the documents sampled for qualitative analysis. Lake degradation has been a prominent subject in many of the policy documents from the LCBC since the 1980s. Before then, particularly between 1964 and 1984, much policy attention focused on addressing droughts and desertification (LCBC, 2016). This focus was later broadened following a transboundary diagnostic study on the status of the Lake commissioned by the LCBC and the United Nations Environmental Programme in the late 1980s. The diagnostic study formed the basis for four key policy initiatives undertaken by the LCBC since the early 1990s: the Vision 2025 (developed in 2000) for the sustainable development of the LCB, the Strategic Action Plan (SAP) for the reversal of land and water degradation trends in the LCB ecosystem (developed in 2008), the LCB Water Charter (drafted in 2011) and the initiative on Water Transfer from the Congo basin via the Ubangi River to the LCB (the idea for this was raised in the late 1980s, but is yet to be implemented to date). The desire to drive the implementation of these key policy initiatives gave rise to several other initiatives (Table 7.1). Each of the initiatives has a variety of overarching theme(s). Because adaptation, water governance and conflict management (the three themes) needs are central to the developmental objectives of the LCBC for the Lake region, the existing initiatives were screened and categorised under the three themes.

Adaptation was not specifically mentioned in the LCBC operational mandates when it was established 1964. It became a subject of interest following the massive degradation of the LCB's environment in the 1980s and 1990s. The document on the 'adaptation to climate change in the LCB (ACCLC)' initiative launched in 2013 by the German Federal Ministry for Economic Cooperation and Development (in collaboration with the LCBC) notes that climate change has an acute impact on livelihood activities and as such, the LCB populations need to develop adaptive capacities (GIZ, 2015a). The initiative seeks to provide expertise on climate and agricultural adaptations to enable the water and environment department of the LCBC to provide comprehensive advice to local resource users and member states on adaption matters. This initiative (ongoing until 2018) fills an important knowledge gap in the LCBC climate change adaptation strategic development (LCBC, 2016). Beside a few cross-thematic initiatives such as the PRODEBALT (Table 7.1) addressing adaptation and other societal challenges, there is no record of any initiative that has focused solely on adaptation needs before 2013. Yet, there has been interest in adapting local and modern agricultural practices to climate change (through, for example, establishment of demonstration plots for knowledge transfer, provision of irrigation facilities and different seed varieties, and improved storage practices) which are largely within the context of autonomous adaptation practices aimed at increasing rural agricultural production.

While the regional emphasis on adaptation has grown markedly since 2013, inclusion of adaptation in several of the recent cross-thematic initiatives suggests that climate adaptation is becoming integrated with other thematic issues. Indeed, inclusion represents an important first step in the drive for cross-thematic integration (Milman and Arsano, 2014).

Table 7.1: Documents sampled for qualitative analysis.

Theme of the initiative contained in sampled document	Overarching goal and the associated thematic area(s)	Source
Inter-basin water transfer (**idea raised in the late 1980s – yet to be implemented**)	Plan and implement inter-basin water transfer from the Congo basin via the Ubangi River to the LCB (a distance of about 1350 km) in order to halt the degradation of the LCB (**water and security/conflict**)	Steely (2014); LCBC (2016)
Strategic Action Programme (SAP) for the Lake Chad Basin: reversal of land and water degradation trends in the Lake Chad Basin ecosystem (**launched in 2008**)	Reverse land and water degradation trends in the LCB ecosystem, improve water quantity and quality, and enhance regional environmental cooperation to improve environmental stewardship (**water**)	SAP (2008)
The Master plan for the development and environmentally sound management of the natural resources of the Lake Chad Basin (**launched in 1992**)	Develop and ensure environmentally sound management of the LCB freshwater resources (**water**)	LCBC (1992)
Lake Chad Vision 2025 (**developed in 2000**)	The vision is broadly in three components: "The Lake Chad Region would like to see by the year 2025 the Lake Chad - common heritage - and other wetlands maintained at sustainable levels to ensure the economic security of the freshwater ecosystem resources, sustained biodiversity and aquatic resources of the basin, the use of which should be equitable to serve the needs of the population of the basin thereby reducing the poverty level" - "A Lake Chad region where the regional and national authorities accept responsibilities for freshwater, ecosystem and biodiversity conservation and judicious integrated river basin management to achieve sustainable development" - "A Lake Chad Region where every Member State has equitable access to safe and adequate water resources to meet its needs and rights and maintain its freshwater, ecosystem and biodiversity resources" (**water and security/conflict**)	LCBC (2002, p.3)
The Lake Chad Water Charter (**drafted in 2011**)	This constitutes a binding framework whose goal is to promote sustainable development in the LCB through integrated, equitable and coordinated management of natural resources, in particular the Lake's water resources, in order to achieve higher standards of living, poverty alleviation, good governance and stronger sub-regional solidarity and integration (**water and security/conflict**)	African Water Facility (2011)

Programme to Rehabilitate and Strengthen the Resilience of Socio-ecological Systems in the Lake Chad Basin (PRESIBALT) (**launched in 2015/2016**)	Build the resilience of socioecological systems for sustainable and inclusive development in the LCB by preserving and developing water resources, develop ecological services and value chains, and build institutional capacity and programme management (**adaptation and water and security/conflict**)	AfDB (2015)
The LCBC strategy against Boko Haram (the Multinational Joint Task Force (MNJTF) Strategic Concept of Operations (CONOPS) to fight against Boko Haram) (**launched first in the mid-2000; later repackaged in 2014/2015**)	A multinational military formation involving five nations (Niger, Nigeria, Cameroon, Chad and Benin) aimed to checkmate banditry activities, deal with common border security issues and completely eradicate the Boko Haram terrorist group operating in the LCB territory (**security/conflict**)	African Union (2015); African Union Peace and Security Council (2015)
The Lake Chad Development and Climate Resilience Action Plan (LCDAP) (**a new intervention, launched at the COP21 meeting in Paris in 2015**)	A multi-sectoral development and climate resilience action plan aimed at turning the LCB into a rural hub for regional development by facilitating employment generation, enhancing food security, promoting social inclusion of young people and women, building resilience, restoring peace and security, and improving living conditions (**adaptation, water, security/conflict**)	Mekonnen (2016)
The Lake Chad Basin Sustainable Development Programme (PRODEBALT) **(launched in 2008; project ended)**	Focused on three components: - natural resources management and adaptation to climate change; integrated management and sharing of water resources; and regional co-operation and integration (**adaptation and water**)	AfDB (2008)
Adapting to climate change in the LCB **(launched in 2013; ongoing)**	Implement effective measures for adapting agricultural practices in the LCB to climate change by: raising awareness on climate change among local producer groups and associations; adapting local and modern agricultural practices to climate change; and providing input for LCBC climate adaptation strategy development (**adaptation**)	GIZ (2015a)
Sustainable water resources management of the LCB **(launched in 2011)**	Strengthen the planning, cooperation and communication capacities of the LCBC for the better performance of its tasks and to achieve sustainable results in terms of fulfilling its water mandates (**water**)	LCBC (2016)
Strengthening Climate Information and Early Warning Systems (EWS) for Climate Resilient Development and Adaptation to Climate Change in the LCB area (**new intervention – launched in January 2016)**	Enhance the LCBC adaptation planning process in order to promote water security and climate resilience in the basin; improve safety, increase awareness in disaster-prone and climate affected zones in the basin; provide and enhance observing and monitoring technologies, build capacity through technical training on how to maintain weather/climate and water flow/quality stations, and use of recorded data; and deliver early warnings in timely and effective manner (**adaptation and water**)	Global Water Partnership (2016)

Water is central to the majority of the initiatives assessed in the analysis. This does not come as a surprise as water is a critical issue in the quest for the sustainable development of the Lake Chad region (Odada *et al*., 2006). Three initiatives in particular focused solely on water issues. These are the: (i) LCB strategic action plan, (ii) the Master plan for the development and environmentally sound management of the LCB resources, and (iii) sustainable water resource management of the LCB. Together, these initiatives target the realisation of the water component of vision 2025 (Table 7.1).

Although security and conflict resolution are relevant to the mandates of the LCBC, several LCBC initiatives tended to address security concerns through improvements in people's lives and livelihoods based on the belief that poverty is at the root of insecurity (Jakobsen *et al*., 2013). However, the increased frequency of antisocial vices such as cross-border thefts and banditry activities, common-border kidnapping and killings, and Boko Haram violence since the 2000s, spurred the creation of a Multinational Joint Task Force (MNJTF) in the mid-2000s (African Union, 2015). The task force initiative later metamorphosed into the LCBC strategy against Boko Haram in 2015. The primary goal of this multi-partnership, counter-terrorism initiative is to eradicate insurgency (and in particular Boko Haram violence) completely from the region, and secure the livelihoods of innocent people in and around the Lake. Being the only bold, widely-accepted regional conflict and security initiative, its implementation is regulated by the African Union Peace and Security Council (AUPSC) within the context of a 'strategic concept of operations for the MNJTF'. All operations are structured within well-defined operational areas in the basin and in strict compliance with international humanitarian law (African Union Peace and Security Council, 2015).

Several policy interventions are cross-thematic in nature. For example, adaptation, water and security goals are included in several places in the Programme for the Rehabilitation and Strengthening of the Resilience of Socio-ecological Systems in the LCB (PRESIBALT) (AfDB, 2015) and the Lake Chad Development and Climate Resilience Action Plan (LCDAP) (Mekonnen, 2016). These initiatives were launched recently (between 2015 and 2016) and embraced the nexus issues required to address climate change adaptation, water shortages and conflict challenges around the basin territory. While the Vision 2025, inter-basin water transfer initiative and the Water Charter included requirements to address water and security/conflict issues, the Programme on the Sustainable Development of the LCB (PRODEBALT) focuses more on adaptation and water issues within the context of sustainable poverty reduction. These cross-thematic initiatives indicate that the timings of societal challenges linked to lake drying appear to play a key role in shaping the range of policy strategies and action plans the LCBC initiates, the manner in which adaptation, water or security are treated, and by extension, the level of integration attained.

7.3 What approaches exist?

A range of approaches for climate adaptation, water management/governance and conflict/security management were identified in the documents for each of the three thematic categories (Table 7.2). Several approaches mentioned in each of the adaptation-focused (e.g. the initiative on adaptation to climate change in the LCBC), water-based (e.g. the initiative on sustainable water resources management of the LCB) and the conflict-oriented documents (e.g. the MNJTF initiative) were repeated in the cross-thematic documents (e.g. the LCDAP and PRESIBALT). Although the documents containing cross-thematic initiatives generally addressed two (e.g. water and conflict in the inter-basin water transfer initiative) or three (e.g. adaptation, water and conflict in the LCDAP initiative) of the themes less well than initiatives focusing on one theme, in most cases they considered the challenges pertaining to the various themes to a similar degree as single-themed initiatives. While the approaches identified appear to coalesce around the subject of sustainable development for the LCB, they reflect the dynamic nature of adaptation, water availability and human conflict behaviours. They also point towards the need to attain a desired ‘stable’ state for the LCB environment and the populations in the region.

Adaptation initiatives reflect an awareness of the effects of climate disturbances on agriculture and water resources, and the implication for resource degradation, poverty and other underlying drivers of vulnerability. Indeed, how the Lake Chad populations adapt to extreme climatic events is a pressing security and development concern for the LCBC (GIZ, 2015a).

Table 7.2: Typology of approaches in Lake Chad-related intervention documents

Approaches are categorised based on the thematic focus related to adaptation, water and conflict	Total count in the twelve documents
Adaptation approaches: mostly related to adapting water, agriculture and the lake environment to climate	
- Re-establish agricultural irrigation and fisheries development	3
- Awareness creation among local producer groups	1
- Reduce poverty by enhancing agro-production through drought mitigation (control desertification, maintain	8
vegetation cover)	9
- Use early warning systems/flood emergency preparedness/develop effective climate predictability systems	2
- Preserve environmental capita (plant cover, soil, reforestation, clean energy to mitigate climate impacts)	1
- Rehabilitate agro-hydro meteorological stations/networks to promote climate information in rural activities	2
- Improve access to basic social amenities and support post-harvest operations	3
- Support local producers and promote value chain at the local level	1
- Create multipurpose centres for women	3
- Secure access to livelihood resources in disaster prone areas (farmland, pasture, fisheries)	1
- Boost regional markets and expand trade	1
- Enhance LCBC capacity to coordinate adaptation actions	1
- Improved seed variety, enhance storage capacity	
Approaches to water governance/management	
- Inter-basin transfer to recharge the Lake (to buffer local weather, bring more rainfall and reverse desertification)	3
- Facilitate inter-state agreements and inter-basin collaboration using legal frameworks	5
- Use water charter	3
- Initiate market-based compensation mechanisms for disadvantaged downstream states	1
- Facilitate data collection and information sharing	6
- LCBC institutional development to govern water allocation and arbitrate over interstate complex disputes	7
- Improve water quantity and quality through a regionally coordinated water monitoring action	5
- Promote education/training on environmental stewardship	3
- Adopt principles of water management and cooperation	2
- Adopt water pricing to ensure water quality standard	1

- Harmonise/synchronise national laws/data with LCBC initiatives	3
- Promote equitable and reasonable use of aquatic resources	2
- Enforce abstraction/discharge rules/reduce water withdrawals	2
- Enforce water rights	1
- Finance water users' fora and improve stakeholder skills	2
- Manage trade-offs	1
- Address pollution risks	2
- Draft inter-governmental protocol for the exchange of hydrological data	1
- Promote website for interactive visualisation of hydro-meteorological information	1
- Promoted early warning in timely and effective manner	9
Approaches for peace/security/conflict management	
- Promote food security preparedness	3
- Improve greater regional economic integration and conflict prevention/resolution	2
- Facilitate inter-state agreements and inter-basin collaboration using legal frameworks	2
- Initiate market-based compensation mechanisms for disadvantaged downstream states	1
- Information sharing	5
- LCBC institutional development to govern water allocation and arbitrate over interstate complex disputes	7
- Promote inter-sectoral projects to reduce conflicts	1
- Create legal consensus on access and use rights	1
- Promote conflict/emergency preparedness responses	2
- Promote friendly dispute settlement/judicial dispute settlement	1
- Improve living standards and social security to sustain peace and cooperation	3
- Regular conflict assessment	1
- Checkmate banditry and deal with common-border insecurity	1
- Stakeholder coordination to eradicate insurgency	2
- Adopt humanitarian law in fight against insurgency	1
- Improve coexistence of livelihood activities in the same area to prevent conflict	1

Although adaptation approaches are designed to reach the poorest villages, they are simply development-oriented and concerned about: (i) addressing drivers of vulnerability amongst vulnerable populations (e.g. to reduce spread of malaria and HIV, provision of seeds, pesticides, irrigation and storage facilities); and (ii) building response capacities of the LCBC (e.g. through improved weather/climate monitoring, building early warning/response systems, effective communication systems, and natural resource management practices). There are limited wider efforts to buffer households and communities against climate shocks (e.g. through developing climate-proof infrastructure/housing, robust systems for decision-making, including disaster response and resettlement planning). Similarly, because the majority of adaptation approaches are autonomous, conflict-sensitive adaptation initiatives remain limited. For example, there is a limited focus on comprehensive pastoral 'laid-out' routes to reduce 'conflict contacts' between pastoralists and other occupational groups. The majority of adaptation approaches related to water and agriculture do not seem to explicitly link the twin challenges of climate and conflict in a way that suggests that addressing climate disturbances will directly help to reduce human insecurity and conflict. For example, it is unclear how efforts to control desertification and maintain vegetation cover will prevent conflicts between pastoralists (who are already used to grazing their livestock around the desert and forest areas of the Lake) and individual actors charged with the implementation of this adaptation objective. In other words, the 'do-no-harm' (Babcicky, 2013) approach to adaptation planning is explicitly missing.

Water governance and conflict management approaches that embrace adaptation efforts cover development actions on integrated management of Lake Chad resources for poverty reduction (e.g. through improved cooperative irrigation development and desertification control, including partnership engagements for water conservation (LCBC, 2016)). Because the specific climate impacts (e.g. flood, drought or wind-related hazards) being addressed are often not explicitly defined, adaptation approaches tend to be more vulnerability-oriented (e.g. helping locals to cope with immediate resource challenges) than impact-focused (e.g. building climate-proof water and community (settlement) infrastructure for long-term adaptation needs).

While adaptation practices were found to be less conflict-sensitive[49], water governance approaches often accounted for conflict challenges. Crucially, water conservation is at the heart of the majority of the water-focused initiatives. To drive conservation, water governance approaches were observed to have shifted towards a more decentralised and democratic principle (Table 7.2). This seems appropriate given the diversity of ethnic groups and nationalities depending upon the Lake waters. Regulations on water abstraction exist through the LCBC and are well documented in the Lake Chad Water Charter (e.g. the Water Charter specified 6 km^3 as the maximum annual volume of water that can be abstracted from the Lake, including its tributaries and the surrounding aquifers). This volume represents an increase of 4 km^3 over and above withdrawals in 2011 when the charter was ratified (African Water Facility, 2011). Water guards are stationed across several axes of the Lake to ensure compliance and to maintain security of access and use. Both water and conflict management approaches embraced several aspects of human and regional security needs, including needs that pertain to social, economic, food, health, and water and livelihood security (Mekannon, 2016). Adaptation seemed to be pursued by focusing on these needs despite that the approaches did not seem to be 'conflict-proof' in a way that suggests long-term livelihood transformation. Few initiatives, such as the Vision 2025, inter-basin water transfer and the Water Charter initiatives, have longer-term approaches (e.g. the promotion of environmental stewardship, use of sustainable inter-basin legal frameworks and agro-hydrological surveillance systems for water monitoring). The rest appear more event-driven and largely short-term.

The most frequently mentioned approaches associated with both water governance and conflict management across the documents include: greater regional collaboration and networking based on legal consensus on water use and access rights, use of inter-governmental protocol for the exchange of hydrological data, and use of the agency of the LCBC to govern water sharing and arbitrate over complex disputes that are beyond the capacity of Member States. While timely and effective early warning systems for flood emergency planning (and for the management of other risks associated with water and agriculture) constitute the most frequently mentioned approaches

[49] Conflict-sensitive adaptation is "adaptation that recognises and addresses the dynamics that may trigger new or escalate existing conflict in the course of planning, implementation and management of adaptation projects. Conflict-sensitive adaptation understands the context it acts upon and strives to minimise negative and maximise positive impacts on human security" (Babcicky, 2013, p. 486).

for both adaptation and water governance themes, clear evidence for conflict management at the community scale (where the majority of the conflict events occur) was largely absent. The LCBC strategy against Boko Haram represents a vital conflict-focused initiative (African Union Peace and Security Council, 2015), yet the focus on eradicating cross-border banditry, kidnapping and violence in Lake Chad leaves a major gap regarding how the LCBC approaches conflict management/prevention in communities. Several conflicts happening at the local level go unnoticed and over time these aggregate to trigger violent conflicts. There were no documents showing how to approach these local conflict dynamics, rather the majority pointed towards poverty reduction and sustainable development as the means to address local conflict dynamics.

7.4 Is integration happening?

Seven of the twelve documents analysed made explicit inter-thematic linkages. These include: three documents focusing on water and security/conflict issues (i.e. inter-basin water transfer, Lake Chad Vision 2025 and the Lake Chad Water Charter initiatives), two documents addressing adaptation and water issues (i.e. PRODEBALT and the initiative on strengthening climate information and early warning systems (EWS) for climate resilient development) and two documents focusing on adaptation, water and security/conflict issues (i.e. PRESIBALT and the LCDAP). Using a scoring system based on Le Gouais and Wach (2013), the results of the analysis on thematic-integration of initiatives/policies are presented in Table 7.3.

In terms of integration scores, the LCDAP initiative (timeframe 2016 – 2025) sponsored by the World Bank Group (Mekonnen, 2016) appeared to be the most integrated across adaptation, water and security/conflict concerns. This is followed by PRESIBALT (timeframe 2016 – 2021), an African Development Bank-sponsored initiative (AfDB, 2015). Both initiatives were launched between late 2015 and early 2016, and as such they explicitly highlight the current urgency to address the triple challenges of adaptation deficits, poor water resources management and violent conflict in the region - despite that they are framed around the Lake Chad sustainable development agendas highlighted in the Lake Chad Master plan, Vision 2025 and the Strategic Action Plan.

Table 7.3: Scoring criteria used to assess integration and document integration score (modified from Le Gouais and Wach, 2013).

Type of integration	Description of integration	Score	Document sampled (list of LCB-related interventions)
No integration	There is a complete lack of evidence in the policy/strategy to suggest that thematic issues or statements are harmonised and/or integrated.	0	Adapting to climate change in the LCB; Strategic Action Programme (SAP) for the LCB: reversal of land and water degradation trends in the Lake Chad basin ecosystem; Sustainable water resources management of the LCB; the LCBC strategy against Boko Haram (the Multinational Joint Task Force (MNJTF) Strategic Concept of Operations (CONOPS) to fight against Boko Haram
Unclear integration	The three key themes/issues were mentioned fleetingly, but details were lacking as to whether the policy pointed to integration.	1	The Master plan for the development and environmentally sound management of the natural resources of the Lake Chad conventional basin
Mild or limited integration	The policy supports integration of two of the three thematic issues. Lack of details to guide activities and plans for integration.	2	Lake Chad Vision 2025; Inter-basin water transfer; The Lake Chad Water Charter; The Lake Chad Basin Sustainable Development Programme (PRODEBALT); and Strengthening Climate Information and Early Warning Systems (EWS) for Climate Resilient Development
Moderate or partial integration	Policy initiatives support all three themes and suggest a need for alignment/integration, especially in the form of general statements. Yet such initiatives are less clear and distinct regarding how integration could be achieved. Relatively fewer details and guidelines are included within the policy document.	3	Programme to Rehabilitate and Strengthen the Resilience of Socio-ecological Systems in the LCB (PRESIBALT)
High or full integration	Policy actions are coordinated and aligned strongly across adaptation, water and security statements. Policy integration devotes specific attention to conflict management and water governance in relation to climate adaptation needs. It includes numerous and detailed complementary strategies and actions for achieving integration (triple-objectives).	4	The Lake Chad Development and Climate Resilience Action Plan (LCDAP)

The findings reveal that despite some progress (in addressing lake drying and societal challenges), adaptation, water governance and conflict management are not well integrated into Lake Chad-focus initiatives, at least for several of the initiatives launched before 2015. Indeed, a chronological view indicates that present-day realities may have informed why the PRESIBALT and LCDAP initiatives are more integrated. Crucially, the merging of adaptation, water governance and conflict management has a down side. Donor agencies and development partners often influence the initiatives that are launched and by extension, funding and resource availability have implications in decisions pertaining to whether the adaptation-water-security thematic issues are integrated or not (personal communication with a LCBC staff member).

7.5 Discussion: What considerations are needed to integrate goals related to adaptation, water governance and conflict management in the broader Lake Chad regional context?

Integration is relevant if vulnerable people, occupational groups and communities targeted by policy initiatives and action plans are to receive developmental assistance, and for climate adaptation, water governance and conflict management goals to be synchronised (Gerstetter *et al*., 2011). Although the analysis did not suggest any significant conflicting signals between the different LCB-focused initiatives (as is sometimes the case when triple-win conflicting signals need to be managed between e.g. sectoral policies on adaptation, mitigation and development (Stringer *et al*., 2014)), considerable scope exists (given present-day realities around the Lake and the enhanced capacity of the LCBC [50]) to promote a more coherent portfolio of strategies across vital themes if a mutually beneficial condition for adaptation and security is to prevail.

There are several ways climate adaptation and water management approaches, including conflict management actions, coincide, which may serve as a starting point from where policy integration may be achieved: (i) policy initiatives focusing on adaptation goals incidentally embraced freshwater resources needs in the context of livelihood empowerment, indicating that such goals may end up meeting both adaptation and water development/supply needs; (ii) water supply initiatives, such as the proposed water transfer project, are planned in consideration of new

[50] In January 2016, the LCBC went through a restructuring process to strengthen its capacity to deliver on its mandates, particularly in the context of the current challenges facing the LCB.

security realities under a changing climate – as such the overall development goal of the project indirectly serves as a means to raise awareness about adaptation, water shortages and insecurity; (iii) approaches focusing specifically on achieving security goals encourage dialogue and cooperative engagements, and because adaptation and water governance thrive on cooperative negotiations, (such as in the case of 'climate proofing') collective adaptation and water development approaches serve as means to achieve desired security goals.

A range of factors might explain the lack of cross-thematic integration in the initiatives launched before 2015 despite that climate-induced devastations, water shortages and conflicts were increasingly observed during the period 1980 - 2015. The LCBC, being a regional institution, is governed and funded by the Summit of Heads of State and Government of member nations, as well as the resolutions of the Council of Water/Environmental Ministers (LCBC, 2016). It relies on external expertise, donor agencies and development partners to develop and fund its various initiatives. Governance and funding arrangements from external sources can reduce opportunities for wider local-level consultations and as such limit opportunities where requirements for integration are needed. For example, local authorities had complained during interviews that initiatives for which they can claim ownership are lacking – they are often 'side-lined' and their views are not always considered in action plans that target the Lake territory (see Chapter 4, Section 4.2.3). This indicates that action plan preparedness based on local level scoping assessments and consultations remain lacking. Constraints - including time and project costs, availability of skilled personnel, people's demands, the rigour associated with monitoring and evaluation, lack of information, internal organisational structures and preferences/priorities (Gustafsson, 2016) - can encourage cross-thematic incoherence. Time pressure for action plan preparation and completion can limit scope for comprehensive consultation and integration (Kloos *et al*., 2013). Limited funding can influence the range of targeted policy issues.

Integrating initiatives requires greater monitoring and rigorous evaluation approaches (Le Gouais and Wach, 2013). Although the Lake Chad-focused initiatives appear to be largely event-driven, integration can be spurred when various livelihood interests are accommodated, and social relations/identity and status of formal and informal institutions are reconciled, as well as when community project ownership is encouraged (Turner *et al*., 2012). The two initiatives with high scores on the integration scale suggest that holistic multi-stakeholder and multi-sectoral co-ordination are relevant to enable integration and also to ensure that gaps are avoided as integration agendas progress. Some of the factors that might have influenced current integration drives, particularly as observed from the PRESIBALT and the LCDAP initiatives, include:

- Poor or incomplete implementation of previous initiatives leading to a repackaging of old initiatives as new ones;
- The dynamic nature of adaptation, water availability and human security requiring greater policy attention and funding;
- The new sustainable development goals serving as motivations to the World Bank Group and the African Development Bank, as well as to other donor agencies, in terms of funding commitments to address the present-day poverty and humanitarian crises in the LCB territory;
- The Boko Haram crises that have shaped better inter-governmental collaborations and collective interests to better understand and tackle context-specific environmental and security issues in the LCB.

While this analysis is based on the proposition that integration is inherently desirable, limiting future initiatives to dominant approaches present in previous policy actions may not necessarily be helpful, especially considering that challenges beyond the themes explored here (such as ethnic differences and marginalisation) also exist as part of the dynamics influencing societal instability in the LCB. The analysis shows that approaches for water governance and conflict management in the LCB often coalesce around inter-governmental Lake water restoration planning linked to sustainable development and poverty reduction. Water and conflict management approaches suggest a vital entry point for adaptation actions. Adaptation practices for water and agriculture are largely reactive and autonomous (see Table 4.4, Chapter 4). Given the uncertainties associated with water supplies and security dynamics in the region, there is a need for proactive, government-led adaptation planning with a long-term outlook. Anchoring adaptation planning in sound decision-making processes that enable principles of good governance (e.g. actions that engender inclusiveness, equity, transparency and accountability), can create room for adaptation priorities that align with water development and human security goals, and thus enhance capacities to build resilience and cooperation (Babcicky, 2013).

Integrated initiatives (such as the PRESIBALT and the LCDAP) require a secure environment to be fully implemented. This will involve initiating regular conflict assessments, as well as developing more joint coordination mechanisms through relevant local powers and ministries (i.e. promoting vertical synergies) in a manner that demonstrates humanity, neutrality, impartiality and interdependence (Mcgray *et al.*, 2007). Crucially, the integrated initiatives reveal that funding mechanisms, including the capacity of donor agencies to drive policy coherence, are vital if integration must happen.

All the initiatives and strategies reviewed here explicitly suggest that significant investment is needed to reverse the current antisocial and unfavourable environmental trends in the LCB. However, environmental stewardship that promotes long-term adaptation, effective water governance (based on the principles of governance/management emphasised in the Water Charter and the SAP documents) and conflict management (based on friendly dispute settlement and/or judicial conflict resolution that guarantees efficient and lasting inter-state/inter-group conflict prevention) is required in order to make any investment in the region meaningful in the long-run. The themes (adaptation, water and conflict) emphasised in this analysis represent both a challenge and also an opportunity for development, including opening scope for the inclusion of social and cultural issues that are inherent in the vast wealth of knowledge held by indigenous people.

7.6 Conclusions

The results presented in this chapter give valuable insight about the range of key LCB focused initiatives targeting different developmental goals (adaptation, water and conflict management), particularly in relation to how cross-thematic goals are integrated in such initiatives. However, the results do not necessarily point to the overall perceptions of the LCBC towards these thematic subjects and the need to integrate them, rather they reflect what is contained or omitted in their published strategy and action plan documents evaluated as part of the exercise in qualitative document analysis. In addition, care must be taken regarding assumptions about LCBC's priorities for the LCB and the extent to which it is developing and ratifying initiatives and approaches for the development of the Lake Chad region more broadly.

Although two initiatives were found to integrate adaptation, water and conflict, written documents constitute one facet of policy planning, and policies in general do not always directly indicate implementation – actions taken may differ considerably from what is written, either for better or worse for those the policies are intended to serve. Similarly, just because something is omitted in written policy initiatives does not suggest that is not being implemented or practiced. Cases abound where stakeholders are 'appeased' by policy 'talks and documentations', and in the long-run a lack of corresponding actions (maybe due to limited buy-in across a range of decentralised agencies), constrain implementation efforts. In the case of the LCB, personal communications with key LCBC staff revealed that there are few disconnects between policy and practice, whereas local people reported otherwise. Three visits to Chad Republic reveal that 'promises' within policy initiatives and on-the-ground conditions of locals are far apart. This presents an opportunity for further research, particularly to triangulate the findings presented here with public (existing) LCBC 'practice documents' on different initiatives e.g. proposals, terms of references, project assessments and progress/completion reports, to better understand the linkages between 'talk', 'decisions' and 'implementation'.

Chapter 8

Synthesis and conclusions

Outline

Climate shocks are upon the Lake Chad region. The region is warming, the dry seasons are becoming longer and water is flowing at different times and at reduced amounts. The LCB exhibits the conditions one would expect to produce a heightened risk of violent conflict under anomalous climatic conditions. This chapter synthesises the key findings emerging from this research, as well as the main scholarly contributions to the wider debates on climate conflict. It highlights some brief recommendations for tackling the LCB challenges and outlines some research issues that appear particularly promising for the wider climate conflict research scholarship.

8.1 Synthesis of key results and recommendations

This thesis aimed to explore the relationship between climate shocks and conflict in the context of vulnerability and lake drying. Chapter 4 provided insight on the wider livelihood context in seven Lake Chad villages, which was built upon by the vulnerability assessment in chapter 5. Both chapters suggest that understanding livelihoods and vulnerability conditions can enhance the manner in which the climate conflict relationship is understood and interpreted. Chapter 6 built on this understanding to test three hypotheses centring on rainfall anomalies, vulnerability, lake drying and conflict. The chapter revealed different findings for the four different zones surrounding the Lake, flagging up some provocative/unexpected insights. Key evidence has been provided that challenges the *climate centric* and *denial claims* discourses. Given that the LCB is largely a fragile environment where several contextual forces interact to induce insecurity, the research further sought to pin down the range of existing policy interventions developed or promoted by the LCBC to address the biophysical, social economic and human insecurity challenges around the Lake. While several interventions and action plans exist, they are largely not integrated to capture climate adaptation, water governance and conflict management.

Bringing these chapters together, the thesis provides a unique piece of empirically-rich research that suggests that climate conflict studies that fail to account for vulnerability forces risk a critical misrepresentation and misunderstanding.

Presenting the LCB as a dynamic test bed of broad relevance in the context of double exposures, the following key results and recommendations are reported.

8.2 Research phase 1: Livelihoods and vulnerability assessments (Objectives 1 and 2)

Objective one (a component of research phase one) focused on the mechanisms through which lake drying shapes livelihood drawback and opportunities (based on insight from the SLA). The key findings are:

- The livelihood context in Lake Chad is largely conditioned by high dependency on seasonal variations in natural assets, especially the Lake Chad waters;

- Drying triggered population pressure to the south (the Chad zone in particular), and local aggressions towards lake drying exist, particularly in relation to low income from lake-based livelihood activities;

- Lake drying created a pool of unemployed people in villages characterised by large populations of young people and this is providing a hideout for insurgent activities which have further increased local deprivation;

- Inter and intra-annual flood pulses enable regular recycling of the aquatic environment, providing multiple options for fishermen; pulses allow a combination of irrigation, flood-recession and rain-fed cultivation and create opportunities for seasonal mobility;

- Asset holdings derived from unstable water-based activities are a medium through which lake drying influences livelihoods. A tendency to specialise in one primary activity for survival made such activity the delivery agent of many of the impacts of lake drying;

- Seasonality influences social interactions and the scramble for scarce resources; it offers explanatory power in understanding the influences of lake drying on livelihood groups;

- Drying drives vulnerability to climate and non-climatic stressors through the water channel;

- Drying constrains the Lake’s ability to serve as a hydrological buffer against drought;

- Decisions based on seasonality are predicated on the availability of capital assets;

- Low asset profiles of several households limited them to responses that are largely reactive, and as a result, constrained capacities to create locally-adapted solutions that both reduce poverty and enhance livelihood opportunities.

To address objective two, the thesis developed and applied a novel climate-water conflict vulnerability index (CWCVI), as well as a new Double Exposure Index (DEI). The approaches adopted to develop these tools were drawn from advances in livelihoods research and indicator-based vulnerability assessments. The CWCVI is place-based, bottom-up and puts different groups directly at the centre of analysis. The DEI was presented as an embedded component of the CWCVI to capture differential ‘climate-water conflict’ exposures amongst different livelihood/occupation groups. Results presented in chapter 5 are grounded in the premise that: (i) the climate variable is among an array of threats facing agricultural livelihoods, with its effects unevenly distributed; and that (ii) with resource conflict being increasingly recognised as one significant outcome of climate variability and change, understanding the underlying drivers that shape differential vulnerabilities in areas that are double-exposed to climate and conflict has great significance.

Analyses of field data (categorised into exposure, sensitivity and adaptive capacity variables) collected from the south-eastern shores of Lake Chad in the Republic of Chad suggest that pastoralists are more vulnerable in terms of climate-structured aggressive behaviour within a lake-based livelihoods context where all resource user groups show similar levels of exposure to climate variability. In particular, the key results presented here are:

- CWCVI shows that pastoralists are the most vulnerable – they have limited social networks and livelihood income strategies;

- DEI shows conflict and climate are key exposure variables and that farmers may be more exposed to both forces because of their sedentary lifestyle;

- CWCVI and DEI inform climate conflict thinking and provide a basis for identifying underlying factors in climate conflict relations, facilitating causality analysis, and privileging the directionality of vulnerability as a more useful lens than resource scarcity.

The thesis suggests that the CWCVI and DEI tools can offer locally-appropriate guidance for understanding the determinants of vulnerability, as well as for developing options to reduce the vulnerability of populations in high-risk, conflict-prone environments. Climate vulnerability frameworks are rarely applied in (water) conflict research. Indeed little work has been done to capture climate and conflict stressors at household and livelihood group levels using a single vulnerability model. The CWCVI and DEI represent the required (vital) tools with which to fill this gap.

8.3 Research phase 2: Climate shocks and conflict (Objective 3)

Research phase two set out to understand whether rainfall anomalies (a proxy for climate shocks) are associated with an increased risk of conflict using newly assembled conflict data for the LCB as a less-studied location in Africa. The data captured instances of rebel, communal and water conflicts in four Lake Chad riparian zones for the period 1980 – 2015. Specifically, this research phase explored evidence for direct, moderating and mediating effects on climate conflict relations. In doing this, it departed from mainstream environmental security literature by using a much broader definition of conflict (that is short of full-blown war, state failures or coup). The empirical analysis matched subnational (zone level-delineated) and time varying data on climate (focal predictor variable) and conflict (main response variable) events. The spatiotemporal nature of the data applied reflects their dynamism. Analysing these data in combination with key exogenous variables revealed interactions between climate shocks and conflict exist, indicating that the interactions vary across the north and south portions of the LCB. The results point to a wider set of contextual issues through which climate impacts on conflict can be addressed. Among the key findings are that:

- Rainfall anomalies have dampening effects on conflict in several locations across the Lake zones – increased anomalous climatic conditions are not associated with an increased likelihood of conflict, rather anomalies may heighten the need for survival, cooperation, humanitarian aid and other assistance;

- Explanations for climate conflict relations should be sought through vulnerability moderating lenses since the effects of rainfall anomalies on conflict are more pronounced in the presence of political exclusion at least for the Chad and Nigeria zones occupying large areas of the LCB.

Evidence for Chad and Nigeria indicate that political exclusion reaches statistical significance at the 0.05 level. Whereas agricultural production level is relevant for conflict reactions in Chad under rainfall anomalies, democracy is more relevant in Nigeria. Results from Cameroon and Niger zones do not lend support to the moderating roles of contextual vulnerability factors, indicating the need for further investigation. Further findings indicate that:

- Negative rainfall anomalies may influence lake drying, but drying does not represent a sufficient mediator for a climate conflict relationship;

- If fighting has ever occurred in dry years, it may have occurred when people felt highly excluded from national wealth or profits (i.e. feelings of relative deprivation).

Results from qualitative (climate conflict) analysis underscore how conflict in any guise is not a standard response to rainfall anomalies. Location-specific challenges driving local vulnerabilities clearly trump any direct causal impacts of rainfall anomalies on conflict. Water security is a key development priority for LCB zones given that over 90% of communities within the riparian zones are episodically water insecure, and another large chunk of the population are chronically livelihood insecure (Mekonnen, 2016). The interactive relationships reported in this second phase tap into different important mechanisms of climate conflict causal processes, illustrating that failure to consider vulnerability forces (in particular) can create needless confusion and arguments amongst governments and development actors. This resonates with several recent conclusions in the climate conflict research domain (e.g. Buhaug, 2015; Papaioannou, 2016; Seter, 2016).

The findings presented here, including the methods applied, can be generalised/applied beyond the Lake Chad riparian zones to other lake-dependent environments experiencing destructive conflicts and instabilities, where the influence of climate change is a subject of controversy (e.g. the Congo, Nile and Niger River Basins). The findings speak to the topography of responses concerning how environmental and climate conflicts can be approached and addressed by local, national or international development agencies/organisations. Integrating water governance and climate adaptation in a way that secures people's lives and livelihoods can enhance security and well-being in lake-dependent environments. Communities in riparian zones who do not face socioeconomic challenges associated with political exclusion and poor governance may be less vulnerable to climate shocks in a manner that dampens or discourages conflictive behaviours. The case of lake drying suggests the need to support local actions for alternative water supplies or sustainable water resources management.

In the context of current climate conflict debates, analysts and government planners can: (i) anticipate significant reductions in conflicts during periods of climate shocks, but should look out for conditional forces and processes that may switch the influences of anomalies, e.g. from a dampening effect to an amplifying threat; (ii) focus on issues that can enhance coping and adaptive capacities under abnormal climatic conditions, such as cooperation, peacebuilding, adaptation, livelihood diversification and local resources management, and intensify efforts to address political exclusion/marginalisation and governance instabilities. Indeed, developing nations can avert the expected trajectory into localised conflict if vulnerability considerations are central to development planning. The significance of the findings in the longer run hinges on future interactions between vulnerability forces and climatic trends. If the link between rainfall anomalies and conflict is mediated by increased vulnerability in the context of limited water supplies, as suggested in this study, strengthening efforts to address vulnerability, including better management of lake waters (in order to sustain water supplies for agricultural and other related livelihood activities) should constitute a vital policy goal. Current losses (e.g. in agricultural yields and human life) linked to violence in the region have led to a crumbled economy across the zones (Jacob *et al*., 2016). As such, reducing violence, through better conflict management strategies and livelihood support programmes, can constitute a 'do-no-harm' approach that might have wide-ranging benefits for rural development.

By specifying the contexts in which climate shocks are more likely to lead to increased conflicts in lake-dependent environments, this thesis advances several important 'next steps' within the climate conflict research portfolio that appear to be particularly promising. These include to: (i) understand what happens in rural villages and communities during periods of relatively 'normal' climatic conditions in terms of security and conflict, (ii) provide scenarios of future climate and conflict patterns for water scarce locations that are increasingly a global focus of security concerns. If we understand what future climates will look like, we can, to a certain degree, predict variations in future climate-related conflict. Little has been done regarding this specific line of climate conflict research; (iii) focus more on the dynamics of vulnerability and resilience directionality, in particular issues related to power, governance and institutions.

This thesis is the first lake basin-focused study to integrate quantitative and qualitative evidence for potential moderating and mediating elements associated with climate conflict relations in an interlinked riparian region. The results on Lake Chad riparian zones are an important addition to the broader environmental security literature because they offer an empirical case to buttress the theoretical and methodological critiques already available, particularly by advancing the notion of vulnerability in a way that suggests that increased vulnerability can reinforce a climate of insecurity by creating new conflicts and aggravating old ones. Similarly, the need to place livelihoods and vulnerability concerns at the centre of efforts to understand and interpret climate conflict links suggests an important check on the theoretical hypotheses of the predominant voices in the literature and in policy circles on environmental scarcity and conflict. The thesis, overall, contributes to a wider climate conflict research portfolio by emphasising the roles of moderators in linking climate shocks to societal instability and conflict. It also bridges the ongoing divide between proponents of '*climatic determinism*', '*context centrism*', and '*denial claims*' within the spectrum of climate conflict discourses by indicating that a contextual vulnerability perspective can reveal contextual differences in disaggregated analyses.

8.4 Research phase 3: Integrating adaptation, water governance and conflict management goals (Objective 4)

The analysis presented in Chapter 7 addresses integration needs for adaptation, water and security in the policy actions of the LCBC. Water governance and advancement of human and regional security were specifically mentioned in the LCBC mandates. Though adaptation was not mentioned, it appears as a component of several previous and ongoing policy initiatives. The majority of initiatives reviewed are somewhat cross-thematic with core interests centred on water preservation and regional development, yet integration is largely missing - except for two recently launched initiatives accounting for climate adaptation, livelihood resilience, water governance and conflict management.

If inclusion (and effective coordination) suggest integration, then it is evident that current livelihoods and security concerns around the Lake region may be shifting policy interventions towards a needs-based, cross-thematic integrative mode of development planning. In particular, the current World Bank-sponsored initiative on Lake Chad Development and Climate Resilience Action Plan (LCDAP) reveals some vital integration principles that are worth noting: (i) it structures cross-thematic, multi-objective integration by embracing the development landscape logic (i.e. pursuit of well-being in all its dimensions – social equity, individual security, ecological integrity and economic sufficiency); (ii) an integrated context assessment was adopted as the foundation for planning the initiative; (iii) it balances short-term and long-term priorities; (iv) it addresses key contextual issues behind climate conflict linkages by coordinating varied local and regional preferences; (v) it is forward-looking in scope; and overall, (vi) vulnerability reduction is the overarching goal. These indicate the considerations needed to integrate cross-thematic goals across water, adaptation and security.

Institutionally-governed initiatives in this context have some way to go before a win-win integration approach can be realised. There are suggestions (Mugagga and Nabaasa, 2016) that the Paris agreement and the new Sustainable Development Goals should provide vital entry points to spearhead opportunities for cross-thematic integration of vital issues confronting less developed nations, such as the Lake Chad countries. At a minimum, the template provided by these international processes can facilitate the ways in which institutional, financial, technical and political dimensions of policy integration can be understood, reconciled and/or negotiated. The processes advocate vertical coordination, as a way to account for local project ownership and power negotiations that integrate the vast wealth of indigenous knowledge (Griggs *et al*., 2013; Hák *et al*., 2016).

More importantly, while more attention has been paid to develop approaches to realise cross-thematic goals at the regional level, building processes to realise the same goals at household and community levels is also needed. Institutions, such as the LCBC, that themselves are able to adapt to changing conditions and that can treat policy interventions as experimental or learning processes, can provide a critical supporting environment to realise cross-thematic objectives at all scales. Indeed, some forms of effective transboundary water agreements exist which guarantee water dispute resolution, however the scope of such agreements should be revisited in light of current climate shocks, lake drying and conflict realities. Climate sensitive political leadership is vital here, so also is a cooperative transboundary conflict management framework. The following are proposed as ways forward:

- Promote decentralisation as a way to engage participation in action plan design. Decentralisation as a form of governance architecture can promote ownership of the integration process by local actors and thus enhance development of household and community-based solutions;

- Promote knowledge sharing. The ‘vulnerable locals’ need to understand the laws and regulations that govern their livelihood activities and resource use. Investment in research, education, conflict and water monitoring, and awareness creation is key;

- Embed and vigorously pursue early warning, relief and recovery (to facilitate drought and conflict management);

- Ensure that intervention approaches are collaborative. For example, there is need to ensure stronger inter-departmental cooperation where possible to prevent fragmentation and duplication of actions within the LCBC. Responsive, people-centred, context-specific, comprehensive, and prevention-oriented interventions should be pursued in a way that agrees with a ‘do-no-harm’ principle. This means that interventions should enable win-win situations (not aggravating conflict) through enhancing clear, negotiated and consensual agreement amongst key players at the local level.

Integration when fully in place can serve as a means to an end, where the end is to improve rural livelihoods and communities through, e.g. provision of water, food, and income opportunities (within the context of sustainable development). This outcome-oriented perspective may foster the necessary political will for accelerated sustainable development. Externalities that breed environmental harms, including drying threats, can then be addressed cooperatively and accounted for within the riparian cooperative actions. Also, conflict monitoring can help build climate adaptive systems (in water and agriculture) that are conflict sensitive.

8.5 Concluding remarks

While the Lake Chad region has a long history of instability, the ongoing political-will to tackle climate impacts and insecurity represents an opportunity to catalyse lasting peace and development in the region. Prior to 2012, security and environmental issues across different Lake Chad zones were addressed by various national ministries and sectors (e.g. the environment and defence ministries). With increased conflict, the region has witnessed more coordinated alliances between ministries of defence (concerned about security) and foreign affairs (concerned about international diplomacy and cooperation) and the LCBC (concerned about environmental issues and conflict resolution around the LCB). The ongoing dialogue, information sharing and cooperation should be sustained. While the current alliances seek to root violence out of the region, one can clearly observe a model of cooperation emerging, reflecting how unfavourable environmental and security challenges can create space for collective actions in peacebuilding. If the Lake Chad countries succeed in joining forces against the urgent challenges of climate and insecurity, the region would provide a useful model for other regions of the world.

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Appendix 1

Appendix 1 presents the household survey questionnaire and the question guides for the focus group discussions and key informant interviews used during field visits to the south-eastern shores of LCB in Chad Republic.

Household survey questionnaire

Section 1: Socio-economic, demographic and livelihood characteristics

1.1 Name (optional)	
1.2 Age 1.3 Highest level of education	______________________ 1. None ( ) 2. Primary –std 1-4 ( ) 3. Primary –std 5-8 ( ) 4. Secondary ( ) 5. Higher education ( ) –specify
1.4 Marital status	1. Single ( ) 2. Married ( ) 3. Divorced/Separated ( ) 4. Widowed ( )
1.5 Household size 1.6 Indicate the household type you belong to	_______________ 1. Male headed ( ) 2. Female headed ( )
1.7 Tribe/Ethnic group affiliation 1.8 Religious practice(s)	_________________ 1. Non-religious ( ) 2. Christianity ( ) 3. Islam ( ) 4. Traditional religion ( ) 5. Others (specify) ______________________
1.9 Years of farming experience	
1.10 Do you work on other activities beside crop production?	1. Fishing ( ) 2. Trading/self-employed ( ) 3. Civil/Public servant on salary ( ) 4. Animal rearing ( ) 4. Others (specify) _______________________ Note: Identified alternative livelihood _________________ Identified supplementary livelihood ___________________
1.11 Type(s) of crops grown	1. Maize ( ) 2. Millet ( ) 3. Cassava ( ) 4. Pepper ( ) 5. Others (specify) _________________________________

<table>
<tr><td rowspan="5">1.12 List the most important crops grown and their yields (in kg) in the past 5 years

1.13 Please indicate (by ticking) the changes in the following over the years</td><td colspan="5">2009 Yield | 2010 Yield | 2011 Yield | 2012 Yield | 2013 Yield
1.
2.
3.
4.</td></tr>
<tr><td>1.14.1 Land size
1: Increased
2:Decreased
3: No change
4: Others (specify)</td><td>2009</td><td>2010</td><td>2011</td><td>2012 | 2013</td></tr>
<tr><td>1.14.2 Location of land
1: Uplands
2: Lowlands
3: Plain
4: Wetlands
5: Others (specify)</td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.14.3 Crop sale income
1: Improved
2: Worsened
3: No changes
4: Others (specify)</td><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>1.14 Land and crop ownership (current)</td><td colspan="5">1. Private ownership (No:_____)
2. Communal ownership (No:_____)
3. Ownership by rent (No:_____)
4. Government ownership (No:_____)

5. Others (specify) _________________________</td></tr>
<tr><td>1.15 Last year's income from major occupation (crop production)</td><td colspan="5"></td></tr>
<tr><td>1.16 Last year's income from other activities (minor occupation)</td><td colspan="5"></td></tr>
<tr><td>1.17 Compared with other families how would you rate the economic status/income of your household?

1.18 Have you received remittances (money or goods outside your location) from family members, friends or colleagues in the last 24 months?</td><td colspan="5">1. Below average ( )
2. Average ( )
3. Above average ( )

1: Yes ( ) 0: No ( )</td></tr>
</table>

1.19 Do you have access to credit for your livelihood activity? 1.20 Do you belong to any social group (e.g. farmers association)? 1.21 If yes, how many groups?	1: Yes ( ) 0: No ( ) 1: Yes ( ) 0: No ( ) 1. Membership of one group ( ) 2. Two groups ( ) 3. More than two groups ( )
1.22 How would you rate your household income based on your expenses?	1. Usually not enough to cover important household expenses ( ) 2. Just enough to cover important household expenses ( ) 3. Usually have some left after important household expenses ( )
1.23 How long have you lived around the Lake Chad area? 1.24 What made you come to live in this community?	__________years _________________Months ____
1.25 Indicate the type of housing you have or live in	1. Mud walled grass thatched ( ) 4. Make-shift house ( ) 2. Semi-permanent with iron sheet ( ) 3. Stone walled (permanent) ( ) 5. Others (specify) ( )

1.26 Do you or your household have any of the following?

Lifelines/assets/implements	Yes or No	If relevant, please identify them
1. Back-up for electricity		
2. Back-up for drinking water (well)		
3. Farming tools		Types:
4. Motor vehicle		
5. Radio		
6. Telephone/mobile phone		
7. Internet access		
8. Access to shelter		
9. Access to health care		
10. Farm land		Size:
11. Wheelbarrow		
12. Bicycle		
13. Shop/kiosk		
14. Others (specify)		

Section 2: Climate and its effects

2.0 Have you heard of climate change/variability before now?	1: Yes ( ) 0: No ( )
2.1 From your understanding how would you describe it to a friend?	

2.2a Have you noticed any long term (10-20 years) shifts in temperature in your area? 2.2b Have you noticed any long term shifts in rainfall in your area?	1: Yes ( ) 0: No ( )
2.3 Has it gotten warmer or cooler?	1. Warmer ( ) 2. Cooler ( )
2.4 Does it rain more or less?	1. More ( ) 2. Less ( )

2.5 Which of the following do you think have changed in your community over the past 10 years? What are the reasons for your answers? To what extent do you think climate is contributing to these changes (to a very great extent=5; to a great extent=4; to some extent=3; to a little extent=2; and to no extent=1)?

Phenomena you think has been getting worst over the past 10 years	Increasing (IC=1) Decreasing (DC=2) No change (NC=3)	Reasons for your answer	Extent to which you think climate is contributing to the changes 1 | 2 | 3 | 4 | 5
Extreme events 1. Heavy rainfall 2. Heavy wind 3. Prolonged floods 4. Prolonged droughts 5. Heat waves 6. High temperature			

2.6 What have been the major effects of these changes to your community (please tick the options that apply)?

1. Crop failure	
2. Outbreak of animal diseases	
3. Dying animals	
4. Water scarcity	
4. Soil erosion	
5. Lake shrinkage	
6. Famine	
7. Disruption in settlement	
8. Depleted fisheries	
9. Others (specify)	

2.7 To what extent do you agree that climate affect your crops and land?

1. Strongly agree ( ) 2. Agree ( ) 3. Don't know ( ) 4. Do not agree ( ) 5. Strongly disagree ( )

2.8 Please explain the changes climate has had on:
1. Crop production____
2. Your income ____

3. Settlement patterns/where people live ____

4. Lake Chad basin ____

5. Conflict and cooperation in your community ____

Section 3: Water resources and receding Lake Chad basin

3.1 How long have you been using the Lake Chad waters? ________________

3.2 Is the lake the nearest water source to you? 1: Yes ( ) 0: No ( )

3.3 If no, how far is the nearest water source? 1. <10mins walk ( )
2. 10-20mins walk ( )
3. 21-30mins walk ( )
4. >30mins walk ( )
5. Don't know ( )

3.4 What different benefits did you derive from Lake Chad several years back? ____

3.5 Have there been any **major** changes in the benefits you derive from the lake in recent years?
1: Yes ( ) 0: No ( )

3.6 If yes, what are some of the changes? ____

3.7 Identify your access to the lake waters 1. Free access ( ) 2. Community regulated access ( )
3. Government/Institute regulated access ( ) 4. No access ( )
5. Others (specify) ________________

3.8 What problem do you experience generally in accessing water?
1. Long distance ( ) 2. Dirty water ( ) 3. Scarcity of water ( )
4. Conflict with neighbouring communities/resource users ( )
5. Others (specify) ____

3.9 How do you ensure you have enough water to support the crops you grow? ____________________

3.10 Please indicate (by ticking) the extent to which the shrinking lake is responsible for the following:

Impacts	5= to a very great extent	4= to a great extent	3= to some extent	2= to a little extent	1= to no extent
1. Water scarcity 2. Dying animals 3. Reduced income 4. Decreased herd size 5. Migration (people & animals) 6. Loss of pastures/vegetation 7. Reduced gracing space 8. Resource use conflicts 9. Others (specify)					

Section 4: Security situation and conflict (water) events

4.1 What changes have you observed in the community where you live in terms of conflict and cooperation?

4.2 Are resource users around the lake aggressive about the drying lake? 1: Yes (   )   0: No (   )

4.3 If yes, please indicate behaviours/actions that indicate this_______________________

4.4 Have you had any problem (i.e. conflict) with other farmers (Yes: ___; No:___), fishermen (Yes:____; No:_____) and herders (Yes:____; No:______) in using land and water around the lake?

4.5 If yes, please state the cause(s) ____
and 4.6 state the period _____________

4.6 Are you aware of any water-related conflict? 1: Yes (   ) 0: No (   )

4.7 If yes, please list the common causes of water-related conflict around Lake Chad basin
1.____________________________________ 2. ___________________________
3. __________________________________ 4. ___________________________

4.8 What form does it take?	1. Killing of persons ( ) 2. Verbal assaults/heated arguments ( ) 3. Maiming/stabbing ( ) 4. Vandalisation ( ) 5. Killing of animals ( ) 6. Destruction of fishing nets ( ) 7. Destruction of crops and farm land ( ) 8. Deliberate contamination/pollution of water ( ) 9. Riot and damage of infrastructure ( ) 10. Others (please specify) _____________________________

4.9 Who are those (individuals or groups) usually engaged in water-related conflicts?

4.10 Please indicate by ticking the changes you have observed generally in water-related conflicts over the past 20 years

Changes in water-related conflicts	5years ago	10years ago	15years ago	20years ago
1. Increased (conflicts were more frequent) 2. Decreased (conflicts were less frequent) 3. No changes (no conflicts) 4. Others (specify)				

4.11 Please mention the specific years you observed water-related conflicts in your community? ____

4.12 Do you feel secure in your community now? 1: Yes ( ) 0: No ( )

4.13 Are there areas/places around the lake basin where people feel insecure? 1: Yes ( ) 0: No ( )

4.14 If yes, where are these areas/places? ____

4.15 Please describe how water-related conflicts affect your livelihood activity (farming)

4.16 Do groups/communities cooperate more during water scarcity? 1: Yes ( ) 0: No ( )

4.17 If yes, could you please give examples on how they cooperate _____________

4.18 How sensitive is your farming activities/operations to climate and conflict?
1. Very sensitive ( ) 2. Sensitive ( ) 3. Slightly sensitive ( ) 4. Not sensitive ( )

4.19 How exposed are your crops and land to temperature and rainfall variations, and conflict?
1. Very exposed ( ) 2. Exposed ( ) 3. Slightly exposed ( ) 4. Not exposed ( )

4.20 The answers to 4.18 and 4.19 are based on what?
1. Personal experience ( ) 2. Observation of crops/land ( ) 3. Information from colleagues ( )
4. Others____

Section 5: Adaptation Strategies/Practices

5.1 Are you aware of any institution or organisation your community has worked with to address the effects of climate/water scarcity and conflict?	1: Yes ( ) 0: No ( )
5.2 If yes, please indicate what type of institutions or organisations they were	1. NGO ( ) 2. Government ministry ( ) 3. Private sector ( ) 4. Lake Chad Basin Commission ( ) 5. Others (please specify)

5.3 Please indicate by ticking the measures/practices you employed in the past or currently against climate and water scarcity to sustain your livelihood/well-being and why.

Adaptation measures/practices	Used Past| Current	Not Used	Reason for use/change
1 Water storage in ponds or wells (T)			
2 Groundwater harvesting (T)			
3 Construction of dam within household/farms (T)			
4 Changes in timing of land preparation (A)			
5 Changes in planting and harvesting dates (A)			
6 Use of weather forecasts (T)			
7 Migration (E)			
8 Use of improved crop varieties (A)			
9 Change from farming to marketing of agric products (E)			
10 Expansion of cultivated land area (A)			
11 Mixed cropping (specify...) (A)			
12 Afforestation – planting of trees (EV)			
13 Others (please specify) Note: **A=agronomic, E=economic, EV=environmental, T=technological**			

Section 6: Water management/governance and conflict resolution/prevention

6.1 Which formal and/or informal water management institution(s) control water access/availability in your community?	1. Ministry of water/environment ( ) 2. Local council/district authority ( ) 3. Water board ( ) 4. Lake Chad Basin Commission ( ) 5. Others (please specify) ___________________________
6.2 How do you think the problems of water scarcity can be resolved?	1. Construct wells ( ) 2. Protect water sources ( ) 3. Encourage roof catchment ( ) 4. Promote water storage during rainy season ( ) 5. Promote community awareness on water resources ( ) 6. Others (please specify) ____________________________
6.3 In your opinion, what would help reduce/prevent water-related conflicts?	____ ____
6.4 What would help to improve relationship among individuals, groups and communities who are involved in conflict?	____ ____
6.5 Do you know of any peace meetings or conflict-resolution	1. Yes ( ) 0. No ( )

mechanism in your community?	Are they useful? ________________________ Please explain ____ ____

On a scale of agreement from 1 to 5 (1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree), please rate the following:

6.6 Our community has plans in place to deal with climate-related changes (such as droughts and water scarcity response plan)	
6.7 Our community is able to coordinate activities to respond quickly to water conflict events	
6.8 Our community has institutions that support us when we need to reorganise to cope with new situations or problem (such as those related to climate, conflict and water use/access)	
6.9 Our community members work well with each other	
6.10 Our community is able to access outside support when needed	

Section 7: National Government and the Lake Chad Basin Commission

7.1 Are you aware of any action your national or local government is taking to address the receding Lake Chad basin and water-related conflict?	1. Yes ( ) 0. No ( )
7.2 If yes, please explain	
7.3 Are you aware of the activities of the Lake Chad Basin Commission?	1. Yes ( ) 0. No ( )
7.4 If yes, state what you expect from the commission	
7.5 In your opinion, what should your national government do or stop doing to tackle the impacts of climate change and conflicts?	Do: ____________________________________ Stop doing: _______________________________

Remarks: ____

Question guide for focus group discussions

1. What are the five major climatic events that members of the community have faced during the past 5-10 years?

2. In your view, what are the immediate and underlying causes of conflicts over the past 10 to 20 years (beside climate disturbances)?

3. Please identify year (water) conflict occurred, actors/parties involved, behaviours actors demonstrated and what is commonly done to resolve such conflicts?

4. What are the **specific** impacts of climatic events and conflict (water) on members of your group (i.e. on individual members and the group as a whole)?

5. Are your group members vulnerable to climate shocks and conflicts? If yes identify the local conditions that promote livelihood vulnerability to climate and conflict.

6. What kind of livelihood support do you give individual members of your group in terms of the following:

1. Access to water and other resources	
2. Access to credit/loans	
3. Climate change information	
4. Security during conflicts, tensions etc.	
5. Justice and equity in the pursuit of livelihood activities	
Others:	

7. What measures are taken now compared with previously to:

1. Adapt to climatic disturbances (what are you doing differently as a result of changing climate?)	
2. Tackle conflict	
3. Address water scarcity and management challenges	

Key informant interview guide

1. Who are the main users of the lake water and for what purpose?

2. What activities are you involved in within LCB and how long have you been involved in these activities?

3. How would you describe the income sources of the majority of the population in the area surrounding the LCB? How directly is this dependent on LCB waters?

4a. Have you seen a lot of changes during the last 10 to 20 years of people coming or going?

4b What changes have you seen in relation to water/land use activities?

4c If there have been changes, what has caused them?

5. Following widespread reports that Lake Chad is drying, would you say there is a change in people's use of and influence on the LCB resources today?

6. a) What have been the major climatic changes/events within the last 10 years? b) How have these affected the lives of resource users?

Farmers: Coping/adaptation strategies they adopt:
Herders: Coping/adaptation strategies they adopt:
Fishermen: Coping/adaptation strategies they adopt:

7. a) How often (specify year/month) is (water) conflict around LCB and what form does it take?

b) In your opinion, how has conflict impacted on lives and development of the people and local communities?

c) With climatic events being linked to human insecurity/conflict in several places, would you say there is
evidence in the Lake Chad area to support this link?

d) What are some of these evidences (if there are)?

e) Please state the conditions (socio-economic, political etc.) that make this possible:

f) What are some of the intervention measures that have been adopted in dealing with water scarcity and conflict?

8. Are institutions/governments doing anything to make water accessible to local resource/agricultural users and/or to promote cooperation in local communities? If yes, please give explanation as to how these have been done.

9. Are there any policies in place that deal with climate change?

If yes, do you view that they have been implemented? How well have these been implemented?

10. In your opinion, how can climate adaptation be integrated into conflict management and water governance strategies/goals?

Additional comments:…………………………………………………

Appendix 2

Ethics approval document

UNIVERSITY OF LEEDS

Performance, Governance and Operations
Research & Innovation Service
Charles Thackrah Building
101 Clarendon Road
Leeds LS2 9LJ Tel: 0113 343 4873
Email: ResearchEthics@leeds.ac.uk

Uche Thaddeus Okpara
Room 9.125b, Environment Building
Sustainability Research Institute
University of Leeds
Leeds, LS2 9JT

AREA Faculty Research Ethics Committee
University of Leeds

26 October 2016

Dear Uche

Title of study: **Drying Lake Chad: Climate Change, Hydro-conflict and Sustainable Solutions**
Ethics reference: **AREA 12-115**

I am pleased to inform you that the above research application has been reviewed by the ESSL, Environment and LUBS (AREA) Faculty Research Ethics Committee and I can confirm a favourable ethical opinion as of the date of this letter. The following documentation was considered:

Document	*Version*	*Date*
AREA 12-115 Consent Form.doc	1	29/05/13
AREA 12-115 Ethics doc new....Uche Okpara.doc	1	29/05/13
AREA 12-115 Focus Group Discussion (General).doc	1	29/05/13
AREA 12-115 HH1 Questionnaire Herders (Repaired)New.doc	1	29/05/13
AREA 12-115 HH2 Questionnaire for crop farmers and food growers.doc	1	29/05/13
AREA 12-115 HH3 Questionnaire for fishermen.doc	1	29/05/13
AREA 12-115 Information Sheet ....corrected.doc	1	29/05/13
AREA 12-115 Key informant interview guide.doc	1	29/05/13
AREA 12-115 research permit letter from LCBC.pdf	1	29/05/13
AREA 12-115 Risk Assessment Uche Okpara.doc	1	29/05/13
AREA 12-115 yahoo email message from LCBC.doc	1	29/05/13

Committee members made the following comments and suggestions:

- This seems like a well thought out proposal in many respects. The nature of the resource conflict in this area is the key issue that makes this ethically complex. The reviewers were not familiar with the cultural or political context of the region, so could not provide specific suggestions. However, it was suggested that you do as much as possible to understand this context, and to adapt accordingly, to minimise any ethical problems.

- Reviewers also suggested you consider the issues of positionality involved in recruiting interpreters (participants will relate to your work not just through you and your identity/ position, but also that of your interpreter), and in having an official affiliation with a state body, which is particularly important given that you are looking at conflict.

- It would be useful if you could reflect more directly on whether even the act of being seen to speak with researchers potentially carries risks to respondents, even if their responses remain confidential. Would the act of participating lead to harm to anyone?

- There is a risk that participants, who may be at conflict with the state, particularly Lake Chad authorities, may see you as a state actor, which poses various problems. The Committee suggests that you make it as clear as possible to village level participants that you are not a state actor, and consider how you approach these participants to make this clear (if you want a reference, read Ben Orlove's book "lines on the water", which is about the management of Lake Titicaca, and which also shows what happens when local people who are in conflict over water rights see researchers as state actors, not as independent academics).

Yours sincerely

Jennifer Blaikie
Senior Research Ethics Administrator, Research & Innovation Service
On behalf of Dr Emma Cave, Chair, AREA Faculty Research Ethics Committee

CC: Student's supervisor(s)

Appendix 3

Informed consent document July 2013	Add your initials next to the statements you agree with
I confirm that I have read and understood the information sheet dated July 2013 explaining the above research project and I have had the opportunity to ask questions about the project.	
I understand that my participation is voluntary and that I am free to withdraw at any time without giving any reason and without there being any negative consequences. In addition, should I not wish to answer any particular question or questions, I am free to decline.	
I give permission for members of the research team to have access to my anonymised responses. I understand that my name will not be linked with the research materials, and I will not be identified or identifiable in the report or reports that result from the research. I understand that my responses will be kept strictly confidential.	
I agree for the data collected from me to be used in relevant future research.	
I agree to take part in the above research project and will inform the researcher should my contact details change.	

Name of participant	
Participant’s signature	
Date	
Name of lead researcher [or person taking consent]	
Signature	
Date*	

*To be signed and dated in the presence of the participant.

Appendix 4

Conflict data sources

This thesis examined evidence for transboundary conflict events for Lake Chad zones using conflict data from several sources. While interstate conflicts are very minimal, intrastate conflicts are common in the Lake zones, and range from violent armed conflict to non-violent disputes/clashes. Events that influence the Lake Zone as a whole, such as the Boko Haram violence, received wider media attention than events with a smaller frequency and intensity (the ACLED and SCAD reported the different conflict event types – whether inter or intra-state; and also gave number of deaths/fatality rates depicting the intensity dimension of each conflict). Fatality counts were not used in this research because number of deaths are often not reliably reported.

Table A1 presents the conflict data sources used in the study.

Table A1: Sources of conflict data used to achieve research objective three

Main conflict database used	Description	Source
Armed Conflict Locations and Events Dataset (ACLED) version 6.0	ACLED covers all African violent and non-violent events from 1997 to 2015, tracking the actions of opposition groups, governments and militias across Africa, and specifying the frequency, intensity, location and date of conflict events. Data from this source were disaggregated by types of conflicts, including conflicts between armed actors, violence against civilians, and rioting, and a wide variety of actors, such as rebel groups, militias and civilians.	Raleigh *et al*. (2010)
Social Conflict Analysis Database (SCAD) version 3.1	SCAD covers social disturbances, broadly defined to include violent protests, riots, strikes, demonstrations, inter-communal conflicts, government violence against civilians, and other forms of social disturbances (from 1990 to 2014) in villages and communities for which actors are mainly political, ethnic and religious militias and indigenous	Salehyan *et al*. (2010)

	resource users such as farmers, herders and fishermen (excluding military and rebel actors).	
Uppsala Conflict Data Programme Georeferenced Event Dataset (UCDP-GED) version 3.0	UCDP-GED covers three types of violence: state-based, non-state based and one-sided violence, from 1989 to 2014. Similar to ACLED and SCAD, data in the UCDP-GED are geo-referenced, meaning that each event is connected to a specific location defined by a pair of latitude and longitude coordinates.	Sundberg *et al*. (2013)
Basin at Risk Project - Transboundary Freshwater Dispute Database	Provides historical data on water conflict and cooperation across several international river basins (spanning the years 1948 to 1999). Incidents are ranked by intensity – the scale ranges from -7 (formal declaration of war) to +7 (cooperative event – voluntary unification). The project addresses a series of overarching gaps in research on freshwater resources and international conflict by providing a quantitative, global scale exploration of the relationship between freshwater resources and conflict. The project identifies indicators that predispose basin locations at risk of conflict/violence (Only few data available for the LCB were collated)	Wolf *et al*. (2003)
Water-Related Interstate Conflict and Cooperation (WARICC)	WARICC dataset contains data on cooperative and conflictive water-related events for all countries in the Sahel as well as the riparian countries of the Mediterranean Sea for the time-period 1997–2009. It is georeferenced, uses an 11 point water-event scale that range from +5 (most cooperative events) to -5 (most conflictive event). Data pertaining to water conflict for the LCB were filtered out from the dataset. Only the Nigerian and Chadian zones of the Lake had data entries which were identified and collated.	Bernauer *et al*. (2012)

International Crisis Behaviour Project	The dataset contains information for all crises/conflict events occurring during the 1918-2013 period. Data captured for the LCB involved water, communal and interstate disputes over the water and border resources at the axis of the Lake's hinterlands occurring in the 1980s.	Brecher *et al*. (2016)
Uppsala Conflict Data Programme/Peace Research Institute Oslo Armed Conflict Dataset (UCDP/PRIO) version 4	UCDP/PRIO covers conflict types based on actors and territories from 1946 to 2015. Each conflict is listed in all years where fighting in one or more dyad(s) caused at least 25 battle-related deaths.	Pettersson *et al*. (2015)
Uppsala Conflict Data Programme Non-State Conflict Dataset version 2.5 (1989 – 2014)	This is a conflict-year dataset with information on communal and organized armed conflict where none of the parties is the government of a state. The dataset has a temporal scope covering 1989-2014, and includes information on start and end dates, fatality estimates, and locations.	Sundberg *et al*. (2012