

CLIMATE CHANGE, LIVELIHOOD, AND HOUSEHOLD VULNERABILITY  
IN EASTERN NIGER

By

SARAH LINDLEY MCKUNE

A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL  
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT  
OF THE REQUIREMENTS FOR THE DEGREE OF  
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

2012

© 2012 Sarah Lindley McKune

To my colleagues, team, and friends in Tanout

## ACKNOWLEDGMENTS

I offer my sincere thanks to my doctoral committee co-chairs, Drs. Brian Mayer and Sandra Russo, and members, Drs. Leonardo Villalon and Alyson Young. Without you, this research would not have happened in this form.

I am additionally grateful to Dr. Sandra Russo who roped me into this PhD while I was floundering in an attempt to live happily in Gainesville and work in US public health happily. Her support, guidance and friendship have served me immeasurably. With Dr. Mark Brown and the Adaptive Management of Water, Wetlands, and Watershed (AMW3) IGERT team, she helped me find a home, both professionally and personally. I thank the National Science Foundation and the entire AMW3 IGERT team for that opportunity and for their financial support of my doctoral program.

The Center for African Studies and the Foreign Language Area Studies (FLAS) Fellowship program, funded through the US Department of Education, provided financial support of my doctoral program and allowed me to study Arabic for two years, a lifelong goal fulfilled.

I would like to thank the Livestock and Climate Change Collaborative Research Support Program (LCC CRSP) for providing funding for my fieldwork in Niger, and for the encouragement and guidance of Drs. Julie Silva and Leo Villalon concerning how to conduct research in a volatile pocket of the African Sahel while raising two small children.

My heartfelt thanks must be expressed to my friends and research assistants, Drs. Sambo Bodé and Malam Souley Bassirou, who enabled data collection when and where it might not otherwise have been possible. I learned immensely from them both, and I hope this document is a reflection of that.

I will be ever grateful to my husband, J., and my kids, Matilda (2.5 years) and James (10 months). J.'s support throughout my doctoral program and encouragement at the end were instrumental to its completion. And though only concepts in my mind at the time, Matilda and James were the reason I embarked on this journey; and they are certainly my motivation to complete it.

## TABLE OF CONTENTS

	<u>page</u>
ACKNOWLEDGMENTS.....	4
LIST OF TABLES.....	9
LIST OF FIGURES.....	11
LIST OF ABBREVIATIONS.....	12
ABSTRACT.....	14
<b>CHAPTER</b>	
<b>1 OPENING REMARKS.....</b>	<b>16</b>
National Context.....	16
Introduction to Niger.....	16
Economics.....	17
Environment.....	20
Population and Health.....	23
People.....	24
Ethnicity, Livelihood, and Water.....	27
Research Questions.....	29
Research Design.....	31
Research Area and Sample.....	31
Data Collection.....	33
Data Analysis.....	36
<b>2 PASTORALISTS UNDER PRESSURE - DOUBLE EXPOSURE TO ECONOMIC AND ENVIRONMENTAL CHANGE IN NIGER.....</b>	<b>37</b>
Introduction.....	37
Background: Pastoralists in the Contemporary Economy.....	39
Methodology.....	43
The Case of Niger.....	45
Feedback Double Exposure: Uranium Markets.....	48
Context Double Exposure: Land Use Change, Markets, and Household Demographics.....	52
Concluding Remarks.....	59
<b>3 PERCEIVED RISK OF CLIMATE CHANGE, ADAPTATION AND LIVELIHOOD VULNERABILITY IN EASTERN NIGER.....</b>	<b>62</b>
Introduction.....	62
Background.....	65

Climate Change in Niger .....	65
Pastoralism as a Sustainable Livelihood .....	66
Pastoralism and Vulnerability/Resilience .....	67
Research Methods.....	69
Key Variables.....	71
Livelihood .....	72
Perceived Risk of Climate Change .....	73
Vulnerability/Resilience .....	74
Food Security .....	74
Adaptations/Coping Mechanisms .....	75
Wealth .....	76
Ethnicity .....	77
Findings .....	77
Perceptions of Climate Change and Livelihood.....	77
Perceptions of Climate Change, Coping Strategies, and Adaptations.....	79
Coping Strategies, Adaptations, and Household Vulnerability/Resilience .....	84
Discussion .....	89
4 UNDERNUTRITION AND FOOD SECURITY IN NIGER – A STUDY OF AGROPASTORAL COMMUNITIES FOLLOWING THE 2005 AND 2010 FOOD CRISES .....	95
Introduction .....	95
Background.....	96
Niger and Nutrition .....	96
Causes of Malnutrition.....	97
2005 Crisis .....	102
2010 Crisis .....	104
Methods.....	105
Findings .....	110
Distribution of Undernutrition 2005 and 2010 .....	110
Case study: Dareram .....	116
Case study: Kékeni .....	119
Food Security and Undernutrition.....	122
Wealth.....	127
Food security, HHH age, and ethnicity.....	127
Food security and livelihood.....	128
Ethnicity .....	129
Discussion .....	130
5 MOVING FORWARD: IMPLICATIONS OF RESEARCH FINDINGS.....	136
Paper Review .....	136
Livelihood Index Development .....	137
Factors Effecting Pastoral Vulnerability .....	139
The Need for Interdisciplinary Collaboration.....	141

## APPENDIX

A	KEY INFORMANT INTERVIEW INSTRUMENT .....	143
B	FOCUS GROUP INSTRUMENT .....	145
C	HOUSEHOLD QUESTIONNAIRE INSTRUMENT .....	153
D	ANTHROPOMETRIC DATA COLLECTION INSTRUMENT .....	166
E	METHODOLOGY FOR CREATION OF LIVELIHOOD INDEX .....	171
	LIST OF REFERENCES .....	175
	BIOGRAPHICAL SKETCH.....	190

## LIST OF TABLES

<u>Table</u>	<u>page</u>
2-1 Livestock Loss and Coping Strategies Employed during 2005 and 2010 Food Crises by Community .....	56
3-1 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Livelihood, Wealth and Coping Strategies on Perceived Risk of Climate Change.....	81
3-2 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Perceived Risk of Climate Change Among Pastoral Households.....	83
3-3 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Perceived Risk of Climate Change Among Agricultural Households.....	85
3-4 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Coping Strategies and Livelihood on Self-reported Resilience, All Households.....	86
3-5 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Self-reported Resilience Among Pastoral Households.....	88
3-6 Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics and Coping Strategies on Self-reported Resilience, among Agricultural Households .....	89
3-7 Percent of household heads with any education and mean household size by ethnicity. ....	92
3-8 Comparison of coping strategies correlated with PRCC and vulnerability/resilience by livelihood.....	93
4-1 Sample Size for 2005 and 2010 Household Survey and Anthropometric Data	110
4-2 Descriptive statistics of sampled children, 2005 (N=200) and 2010 (N=290) ...	111
4-3 Percent of total* and severe** stunting (HAZ), wasting (WAZ), and underweight (WHZ) by community, 2005 .....	112
4-4 Weight for height z-scores by community, 2005.....	112
4-5 Percent of total and severe stunting (HAZ), wasting (WAZ), and underweight (WHZ) by community, 2010.....	114

4-6	Weight for height z-scores by community, 2010 .....	114
4-7	Comparison of undernutrition (mean WHZ) between 2005 and 2010 by community .....	115
4-8	Change in mean community undernutrition and self-reported resilience .....	116
4-9	Mean WHZ between food security groups.....	123
4-10	One-way ANOVA tests to compare mean WHZ by food security and other predictor variables .....	124
4-11	Nested Multivariate Regression Models Examining the Effects of Demographic and Food Security Characteristics on Undernutrition in Children 6-60 months. ....	125
4-12	Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics and Food Aid on Undernutrition in Children 6-60 months.....	126
4-13	Linear regression model of undernutrition on wealth and demographic characteristics.....	127
4-14	Linear regression model of undernutrition on food security, head of household age, and interaction term .....	128
4-15	Linear regression model of undernutrition on food security, head of household age, and interaction term .....	128
4-16	Mean WHZ by ethnicity, 2010 data.....	129
4-17	Linear Regression model of WHZ on ethnicity.....	129

## LIST OF FIGURES

<u>Figure</u>	<u>page</u>
1-1 Livelihood/food zones of Niger .....	17
1-2 Five-year moving averages of August rainfall at selected locations in Niger .....	22
1-3 Evolution of number of days with annual mean minimum temperature greater than 30 °C between 1950 and 1998 for Maradi, Niger .....	23
2-1 Research Sites in Tanout District Niger .....	44
3-1 Map of Niger .....	65
3-2 Map of Research Area in Eastern Niger .....	71
3-3 Agricultural-pastoral Livelihood Continuum .....	72
3-4 Univariate Distribution of Key Variables .....	76
3-5 Distribution of Research Communities Along the Agricultural-pastoral Livelihood Continuum by Average Household Livelihood .....	79
5-1 Outbreaks of Locust, drought, political uprising, and famine against the backdrop of changing rainfall and population growth.....	140

## LIST OF ABBREVIATIONS

AE	Adult equivalent
AQIM	Al Qaeda in the Maghreb
BARA	Bureau for Applied Research in Anthropology
BRC	British Red Cross
CA	Chronbach's alpha
CDC	Centers for Disease Control and Prevention
DE	Double Exposure
FAO	Food and Agriculture Organization
FCFA	Franc Communauté Financière Africaine (currency used in Niger and throughout much of West Africa)
FEWSNET	Famine Early Warning System Network
GDP	Gross domestic product
HAZ	Height for age z-scores
HH	Household
HHH	Head of household
IPCC	Intergovernmental Panel on Climate Change
IRIN	Integrated Regional Information Networks (humanitarian news agency covering sub-Saharan Africa)
MS	Microsoft
MT	Metric ton (1000 kg or 2204 pounds)
MUAC	Middle upper arm circumference
PCA	Principal component analysis
PRCC	Perceived risk of climate change
RA	Resident adult
SPSS	Statistical Package for the Social Sciences

TLU	Tropical livestock unit
UA	University of Arizona
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
WAZ	Weight for age z-scores
WHO	World Health Organization
WHZ	Weight for height z-scores

Abstract of Dissertation Presented to the Graduate School  
of the University of Florida in Partial Fulfillment of the  
Requirements for the Degree of Doctor of Philosophy

CLIMATE CHANGE, LIVELIHOOD, AND HOUSEHOLD VULNERABILITY IN  
EASTERN NIGER

By

Sarah Lindley McKune

August 2012

Chair: Sandra Russo  
Cochair: Brian Mayer  
Major: Interdisciplinary Ecology

Climate change is projected to disproportionately affect arid and semi-arid regions of the world, including the African Sahel. Niger, a Sahelian country and one of the poorest countries in the world, is home to an estimated 1.5 million pastoralists, those whose livelihood is based on livestock herding. Niger is chronically food insecure, and increasing frequency and severity of environmental shocks are testing household and community resilience. Utilizing household data collected following the 2005 and 2010 food crises, this research examines the relationship between climate change, livelihood (pastoralism/agropastoralism), and vulnerability in a collection of three papers. The first investigates the role of livelihoods, coping mechanisms, and adaptations on perceived risk of climate change (PRCC). The second explores if and how coping mechanisms - including migration, sedentarization, and acceptance of food aid - are affecting food security, and the predictive power of food security on undernutrition. The final paper utilizes a Double Exposure (DE) framework to analyze the impact of economic globalization and global climate change on the vulnerability of Tuareg pastoralists in Niger. As a collection, the three papers aim to enrich the current understanding of

household vulnerability in Niger, and allow for improved design and targeting of development programs that work to improve livelihood and food security in the region.

## CHAPTER 1 OPENING REMARKS

### **National Context**

#### **Introduction to Niger**

The Republic of Niger is among the least developed countries in the world (United Nations Development Program (UNDP), 2011). The dire health situation throughout the country, exacerbated by widespread, absolute poverty is driving Niger's very poor development status: 81.8% of Nigeriens live in severe poverty and life expectancy is 44 years (UNDP, 2011). Malnutrition rates in the country indicate high prevalence of both acute and chronic malnutrition as 39.9% of children under-five are under weight for age and 54.8% of children under-five are under height for age (UNDP, 2011). More than 50% of the population lack access to appropriate water sources and health services, and food security is an ongoing threat to the country (UNDP, 2007). National rates such as these – dire as they may be – minimize the more severe situation that exists among the poorest, most remote communities of the country.

A former French colony, Niger is located in the heart of the West African Sahel, a semi-arid stretch of land that runs along the southern border of the Sahara Desert. Niger shares borders with Mali, Algeria, Libya, Chad, Nigeria, Benin and Burkina Faso. Niger is mostly flat, rarely rising 200 meters above sea level except in the Air Mountains in the north and the Djado Plateau in the northeast. Natural resources include uranium, coal, iron ore, tin, phosphates, gold, and petroleum. The country can be divided latitudinally into three zones: agricultural, pastoral, and desert. In Figure 1-1 below, these zones are broken down further into food zones of Niger, where the agricultural zone includes an irrigated rice zone, distinct cash crop zones, a rainfed agricultural

zone, and the agropastoral zone; the pastoral zone and desert are labeled individually. These zones follow rainfall levels, which decrease progressively as one moves north.

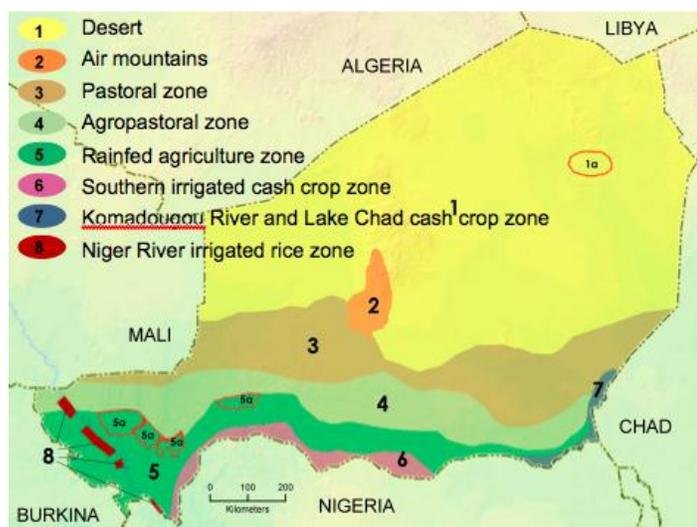


Figure 1-1. Livelihood/food zones of Niger (Source: Famine Early Warning System Network [FEWSNET], 2012).

## Economics

As previously stated, Niger is one of the least developed and poorest countries in the world. Its economy is largely based on subsistence crops and livestock, though natural resource reserves – namely uranium – have played an important part of its economic history at various stages. In the 1970 and 1980s, Niger’s exportation of uranium was of the most significant globally and substantially contributed to the GDP. A decline in demand and thus revenue in the late 1980s led to a decline in uranium earnings from 22% of the GDP in 1987 to less than 16% by 1998. Recent resurgences in foreign interest in uranium bode well for the Nigerien economy; after a 20-year period of relative stability, renewed interest in alternative energy sent the global price of uranium skyrocketing in 2007, with prices jumping from \$10 per pound in 2003 to a record \$136 per pound by June 2007. Although prices have not remained that high,

uranium prices have remained above \$50 per pound throughout 2011, and new exploration for uranium in Niger continues (IndexMundi, 2012). Uranium represents the highest percent of foreign exchange earnings within Niger (55.4%). Earnings from livestock sales are a distant second, at 13.6%, with agricultural earnings trailing at 9.9% (U.S. Department of State, 2008). The latter two numbers are very difficult to measure, however, as much transport and trade occur on an informal basis, particularly of livestock, thus official numbers are expected to substantially underestimate the real value of trade in livestock and agriculture.

Debt relief in Niger was initiated by the IMF's fund for Highly Indebted Poor Countries in December 2000. In January 2006 this debt forgiveness was increased to cover 100% of Niger's \$77.5 million debt. By alleviating the burden of massive international debt incurred largely during the 1970s and 1980s, Niger was free to reallocate funds that would have previously serviced that debt to basic health services, education, infrastructure, and other programs that aim to alleviate the widespread poverty plaguing the country. Despite improved investments since this time, however, the situation remains dire.

Niger shares a common currency (CFA franc) with six other members of the West African Monetary Union (ECOWAS). The French government supplements the international reserves of the Central Bank of West African States (BCEAO), and, thus, the rate of exchange has historically been tied to the French franc (100 CFA to the French franc). This fixed rate of exchange was transferred to the Euro on January 1, 2002 (U.S. Department of State, 2008). These economic ties to France play a significant role in Niger's economy. In 1994, France devalued the CFA, and its value in

Niger was cut in half overnight. This devaluation proved devastating in many ways, however it also significantly improved Niger's trade relationship with Nigeria, its Anglophone neighbor to the south. Subsequent to the devaluation and a newly established level of price competition internationally, revenue from trade in livestock, millet, cowpeas, cotton and onions to Nigeria all increased (US Department of State's Bureau of African Affairs, 2008).

Since the early 1990's, regional trade markets, including livestock trade with Nigeria, have been an important driver of Niger's economic and food security. With the support of ECOWAS, Sahelian countries – including Niger – made development of regional markets a priority and set out to limit government interventions in the market and, in general, to liberalize trade within the region. Research indicates, however, that outcomes of these efforts have been mixed – with some areas (geographic, market, and temporal) experiencing increased liberalization and decreased barriers, and others experiencing both informal and formal obstacles to entry into a free market (Beekhuis, 2007). Research has also shown that neoliberal policy reform on food production and livelihood security, which aimed to improve food security, actually increased reliance on imported foods and dramatically increased the vulnerability of urban populations in three West African countries including Niger (Moseley *et al.*, 2010). As will be discussed in the case of the 2004/5 food crisis in the next chapter, this mixed outcome of trade liberalization and restriction has the potential for catastrophic effects on household economics and, importantly, food security.

In recent years, Niger has made strides to increase its appeal to foreign investors. In conjunction with UNDP, Niger has worked to revise codes affecting private sector

investment, including its investment code (1997 and 2000), petroleum code (1992 and 2000), and mining code (1993) (US Department of State's Bureau of African Affairs, 2008). With such changes, Niger hoped to better market itself to an audience of the global investors. The positive benefits of economic globalization, however, have arguably not reached most parts of Niger. To date nearly half of the Nigerien Government's annual budget comes from foreign donor resources, and, inevitably, a substantial portion of this is in food aid. For a subsistence-based economy like Niger's the role of foreign donor resources and involvement is widely debated, and, as evidenced by the case of the 2005/6 food crisis (see Chapter 2), is sometimes seen as harmful to overall economic growth.

## **Environment**

Covering a vast 1,267,000 km<sup>2</sup> of land, two-thirds of Niger is desert and sub-desert, and drought is a persistent problem. Less than 4% of Niger's land is arable, 9% is permanent pastures, and 2% is forests and woodlands; an additional 70 percent of it is desert (Geesing, 2008). Ninety-four percent of Nigeriens live on 35% of the land, and at least 85% of the population is rural and relies on rain-fed subsistence farming (IRIN, 2008). Chronic food insecurity affects 80% of the population, and yearly 10-30% of the population suffers more than a 50% deficit in their cereal needs (BARA, 2006b). The climate across Niger's limited agricultural zone is typically Sahelian; average annual rainfall varies from 350 mm in the northern part of the zone to 600 mm in the south (Sivakumar, 1992). The average temperature in the rainy season (June-September) ranges from 27 to 30 C° and in the dry season from 20 to 45 C°. Relative humidity is very low, rarely exceeding a monthly average of 40%, even during the rainy season.

Winds are generally mild (8-20 kilometers per hour), however, high winds do occur at the beginning of the rainy season and when cooler Harmattan winds sweep off the desert from December to March. During this period dust storms are not uncommon.

Rainfall is the principal determinant of agricultural production in Niger, as the amount of rainfall and its distribution are unpredictable, and variance occurs between important production thresholds. The minimum amount of rain needed to grow millet, Niger's majority staple food, is 350 millimeters (mm) per year. Although water has never been abundantly available in this semi-arid stretch of land (Bradley, 1971), changing rainfall patterns, due at least in part to global climate change, have led to greater water scarcity in many communities scattered throughout the stark landscape (Mohamed *et al.*, 2002). Although there was a progressive southward shift of the 350-mm isohyet rainfall line – a movement of 50 to 100 kilometers from roughly 1970 through the 1990s (Daouda, 1996a; Sivakumar, 1992), there is recent documentation of a re-greening of the country in some regions (Sendzimir *et al.*, 2011). However, the declining rainfall levels in some areas have turned previously productive areas of the agriculture zone into food deficit zones (e.g., Filingué and Tanout). With water scarcity a defining characteristic of its semi-arid zones, changing rainfall patterns and increasing temperatures - both included in current climate change projections - are threatening water supplies in the already fragile landscape

Although there has been a significant reversal of the trend toward desertification that appeared inevitable in Niger through the 1980s, and researchers are hopeful that this may reduce the vulnerability of the 4.5 million people in the improved area, the impact of rapid population growth and global climate change create uncertainties for the

extremely vulnerable population of the area (Reij, 2006; Sendzimir *et al.*, 2011). Global climate change is predicted to have significant effects in arid and semi-arid regions of the world, including increased frequency and severity of extreme events, such as droughts and floods, and continued overall drying in the Sahel (Held *et al.*, 2005; Huntingford *et al.*, 2005; IPCC, 2007). Years of food crises in Niger appear to be increasing and periodicity of such events decreasing, as the country has experienced exceedingly high rates of childhood mortality and undernutrition in 1973, 1984, 2005, 2010, and again this year, 2012. These crises have been catalyzed by environmental shocks such as drought, pocketed rainfall shortages, and locust infestations, though the situations often become emergencies due to the compounding effects of structural determinants including unsustainable farming practices, high rates of population growth, widespread poverty, poor infrastructure, and political instability. Overall trends of decreasing rainfall and increasing heat exacerbate the problem (see Figure 1-2 and Figure 1-3). Since the 1980s, Niger has become progressively less able to feed itself; even in good years, most rural families do not produce enough food to feed themselves for more than five or six months (Baro & Deubel, 2006).

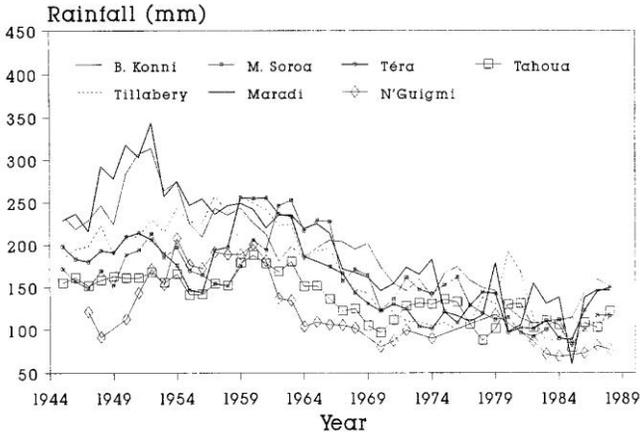


Figure 1-2. Five-year moving averages of August rainfall at selected locations in Niger (Source: Sivakumar, 1992).

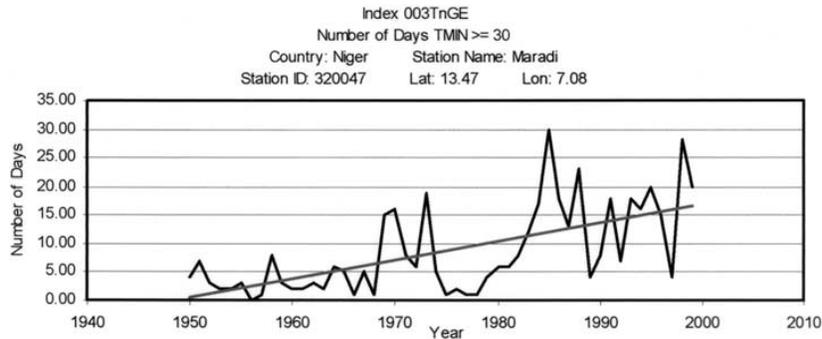


Figure 1-3. Evolution of number of days with annual mean minimum temperature greater than 30 °C between 1950 and 1998 for Maradi, Niger (Source: Ben Mohamed et al., 2002).

### Population and Health

Niger's population was 4.8 million in 1975, 16.1 million in 2011, and it is projected to reach 30 million by 2030. Current population growth is high: 3.6 percent annually. At this rate, Niger's population doubles every 25 years. Extremely high fertility rates are coupled with extremely high mortality rates, which act as a mitigating factor against even greater population growth. It is notable that 56% of the population is under 18 years of age, and 19.8 percent are children under five (UNICEF, 2011). Life expectancy is approximately 44 years, and nearly one of every six newborns does not live to see its 5<sup>th</sup> birthday (UNICEF, 2011).

The crowding of such a large population onto diminished arable and pastoral lands results in lower per capita food production and subsequent lower per capita food availability. Furthermore, the population of Niger's urban areas is growing at a rapid pace (6% per year), and the question arises about how all the non-producing urban dwellers will be fed. In 2008, 22% of Niger's total population was urban and was projected to increase to as much as 50% by 2030 (UN Population Division, 2008). In 1975, Niamey had a population of 80,000; today, its population is well over one million.

Rapid urbanization has produced a growing group of urban poor, with associated malnutrition and food security issues.

Since the 1980s, Niger has become progressively less able to feed itself and today it is one of the most food insecure countries in the world. Even in a good rainfall year, rural families who can produce enough food to feed themselves year round are rare. As noted earlier, most families produce only enough food to cover their needs for five or six months. Diets are generally deficient in protein, calories, and essential vitamins and minerals. Chronic malnutrition levels of 40 percent are recorded in many areas of Niger, and it is estimated that 40 percent of the rural population cannot satisfy its minimal caloric intake requirements (Baro & Deubel, 2006).

Niger's high child mortality is mainly due to malnutrition, Vitamin A deficiency, diarrhea, improper breastfeeding practices, and poor food variety and utilization. Exacerbating this situation, only 46 percent of the population has access to potable water (UNDP, 2007). Access to potable water drops to 35.9% among households designated as multidimensionally poor (UNDP, 2011). As food production and arable land per capita are declining, Niger is becoming increasingly dependent on food aid and imports. Over 75% of Niger's cultivated area is planted in either millet or sorghum, and such heavy reliance on monocropping by region has heavy dietary, overall health, and economic implications in such a fragile environment.

## **People**

Two-thirds of Niger's population is concentrated in a 100-kilometer wide band that runs along Niger's 2,000-kilometer long southern border with Nigeria (IRIN, 2008). A majority of the population lives along the 300 miles of the Niger River, which runs through the southwestern corner of the country and is one of the country's few natural

water sources. Niger's population is made up of four major ethnic groups, classified by language and livelihood; in order of magnitude, these groups include the Hausa (53%), Zarma (21%), Tuareg (11%), and Fulani (7%) (US Department of State's Bureau of African Affairs, 2008). Although ethnicity in Niger is fluid and intermarriage between ethnic groups is not uncommon, opportunities and discrimination, as well as cultural norms and household practices, are a shared experience by most within an ethnic group. As this research will show, ethnicity – used as a control variable to capture a variety of differences related to the political ecology of the household – is a significant predictor of self-reported vulnerability and child undernutrition. Thus, a brief description of each of the four major ethnic groups in Niger is included here.

Although French is the official language of Niger, Hausa is the most widely spoken. The Hausa people are predominately located in south-central Niger, as the Hausaland stronghold is located just south of the Niger/Nigeria border and is home to some 20 million Hausa. The Hausa maintain a very strong network that crosses not just the border with Nigeria, but national borders throughout Sub-Saharan Africa. They are found most often working as farmers, traders, or merchants throughout the country. Because they control much of the trade with Nigeria, the Hausa in Niger are known for their economic influence and entrepreneurial spirit (Neef, 2000).

The Zarma live predominately in southwestern Niger, largely along the Niger River and its left bank, and are descendants of the Songhai Empire, whose base was in neighboring Mali (US Department of State's Bureau of African Affairs, 2008). Although historically warriors and hunters, the Zarma lived predominately as farmers and fishermen until colonialism. Under French rule, the Zarma were among the first to

benefit from the colonial education system and have maintained a dominant presence in central government and in civil service since independence (Neef, 2000). Zarma are also the dominant ethnic group in the capital city of Niamey and continue to hold dominance in national politics. A majority of both Hausa and Zarma live as sedentary farmers, largely in the southern portion of the country.

In contrast to the agricultural tradition of Hausa and Zarma households, the Tuareg and the Fulani population maintain ties to their pastoralist heritage, practicing either nomadic or semi-nomadic livelihoods that rely heavily upon animal husbandry. The Tuareg are of Berber (North African) descent, and are notoriously known as warriors and raiders of the historic trade routes that crisscrossed the Sahara. During colonialism, the French made clear distinction between the productive black African land-holders and the nomadic Arab-Berber herders who they portrayed as unproductive and landless (Marty, 1996). Though traditionally nomadic, since the 1970's periods of devastating drought and widespread animal losses have forced many of the Tuareg of Niger to sedentarized (University of Saskatchewan). Because of their historically nomadic livelihood, formal education has been limited among the Tuareg, despite literacy in their own script (Tifinar), thus limiting economic opportunities for those who have ventured into urban areas (Hammel, 2001). However, renowned Tuareg silver and leatherwork can be found throughout Niger, as well as most of sub-Saharan Africa. Throughout recent history and again in 2012, the Tuareg have rebelled against the national governments of Mali and Niger in an attempt to create an independent Tuareg state. The Tuareg are disenfranchised from Nigerien society, and the current return of

Tuareg immigrants to Mali and Niger from Libya with arms has fueled a new surge in violence.

The Fulani are located throughout West Africa and have very diverse cultural and social norms. The Fulani of Niger have a pastoral history and were dominant to the Hausa and Zarma populations of Western Niger during pre-colonial periods. This power dynamic shifted under French colonial rule, as the Zarma and Hausa gained political and economic clout, while the Fulani and the Tuareg were ostracized and marginalized based on misconceptions of their landless livelihood (Neef, 2000). Nonetheless, the Fulani have deep connections to the Zarma and Hausa, more so than the Tuareg likely because of geographic proximity. Fulani who are agro-pastoral have tended to settle near to Zarma or Hausa communities where complementary production systems have fostered important trade and cooperation, for example, milk and meat in exchange for millet (Neef, 2000).

### **Ethnicity, Livelihood, and Water**

The historical distinction and relationship between sedentary agricultural populations and nomadic pastoral populations have important implications for understanding access to resources, as livelihoods have historically been nearly analogous to ethnic lines in Niger. As outlined in CARE USA and CARE Denmark's report on Human Right to Water, pastoralists struggle to access water in Niger:

“The multiple actors working in the water sector tend to focus on water supply for the villages of the south, as water points in the pastoral north have often been the source of conflict . . . The history of conflict in Niger has long discouraged donors from investing in water for marginal populations; the example here highlights the effect on one of the most sidelined groups – the pastoralists, among whom water consumption averages only 7 liters a day,” (CARE USA and CARE Denmark, 2007).

Thus, beyond climate change and its impact on surface water availability, cultural and social processes appear to have hindered pastoral access to water when compared to their sedentary counterparts.

Poor regulation and legislative inconsistencies also appear to encumber pastoralist access to water. In 1993, Niger developed a Rural Code that defined access to all resources and economic activity in rural areas, including water points. Although the attempt of the Rural Code was to clarify pastoral rights and put into law that which previously was only customary law, the reality has not been entirely advantageous for pastoralists, particularly with regard to water (Lavigne Delville, 1999). The Rural Code states that pastoralists have a right to graze animals in all commonly held rangeland as well as in their home grazing territory. Home grazing territory is commonly defined as an area to which the herder returns for months at a time during the rainy season (Hammel, 2001). Within home grazing territory, a clan has priority access to water and grass, while all others are required to negotiate access to these resources; thus common access to wells exists only on commonly held lands, where wells are less likely to exist. In addition, creation of modern wells must be associated with priority rights, which exist only in home grazing territory. This is inherently problematic given the mobile nature of pastoralists, particularly because they move in search of water, thus are more likely to be out of their home grazing territory when water is in short supply. Further complicating the situation, Niger has a Water Code, which presents national guidelines that govern the installation of water points throughout the country, which is not in alignment with guidelines set out by the Rural Code. The Water Code indicates that access to water is open to all, including outsiders and nomadic groups, at all times.

Thus, where modern wells and boreholes are being drilled, whether on home grazing territories of herders or in communities of sedentary populations, outsiders are citing the Water Code and demanding their right to water without negotiation (CARE USA and CARE Denmark, 2007). Despite historical tension between nomads and sedentary populations over land and access to water, unclear regulation and legislative inconsistencies manifest new tension and violent conflict around water access at wells.

### **Research Questions**

Although famine was traditionally understood as a discrete consequence of external causes, it has recently begun to be reframed as a long-term process with social and cultural drivers whose consequences are not equally distributed and exacerbate the worsening situation of the most vulnerable (Sen, 1981; Walker, 1989). An estimated 10% of the 15.6 million people living in Niger are pastoralists and live predominantly in the southwestern corner, near the Malian border, and in the northern stretches of the country (see the Pastoral Zone in Figure 1-1). The Tuareg and the Fulani, the largest ethnic groups among Nigerien pastoral populations, claim discrimination by the Hausa and the Zarma, ethnic groups who comprise a majority of the population and control much of government and commerce throughout the country (Levinson, 1998). As pastoralists, the Tuareg and the Fulani are inextricably linked to the land and subject to variable weather patterns as they steer their herds towards water and grazing lands. This research aims to investigate if and how global climate change is differentially affecting the vulnerability of agropastoral and pastoral populations in Niger.

This research examines how households in Tanout District, Niger experience climate change and the relationship between livelihood, coping mechanisms, adaptation, and vulnerability on this experience. I had the opportunity to work in this

area of Niger from 2005-2007. I arrived on the heels of the 2005 food crisis as part of a monitoring and evaluation team and visited 19 communities repeatedly over the course of 14 months. During this time I was privilege to conversations – particularly among women and community leaders – that repeatedly referenced the changes in the natural environment. Though my background and interest at the time focused on health, these conversations piqued my curiosity and drive to understand the experience of these communities and their natural environment. The research presented here builds on baseline data collected as part of that project in 2005, the utilizing the 2005 and 2010 food crises as shocks around which perceptions of climate change, livelihood decisions, and nutritional consequences are examined. The research seeks to qualitatively and quantitatively describe the relationship between climate change, livelihood vulnerability/resilience, and adaptation, as experienced by communities along an agricultural-pastoral continuum. The hypotheses of this research were:

- Hypothesis 1: There is a positive association between perceived risk of climate change and an increased rate of sedentarization as a livelihood adaptation;
- Hypothesis 2: There is a positive association between pastoralism and livelihood resilience, as measured by land degradation, vegetation cover, soil and/or crop productivity, water supply, wealth, access to food, and mobility; and
- Hypothesis 3: Perceived risk of climate change disproportionately increases the vulnerability of pastoral populations, as measured by land degradation, vegetation cover, soil and/or crop productivity, water supply, wealth, access to food, and mobility, compared to agricultural populations, thus weakening the relationship described in Hypothesis 2.

The research findings are presented in the form of three distinct papers, each written to be submitted independently for publication in a different peer reviewed journal article.

The hypotheses identified above are all addressed within the second paper (Chapter 3).

The specific aims of each paper are as follows:

- Paper 1 (Chapter 2): Examine the vulnerability of pastoralists in Niger by explaining the interactions of economic globalization and global climate change in eastern Niger, and examine the consequences of those stressors and their interactions on food security among pastoral populations;
- Paper 2 (Chapter 3): Investigate how households perceive and respond to climate change, determine variation by livelihood, and identify if and how certain coping mechanisms and adaptations affect their livelihood vulnerability/resilience; and
- Paper 3 (Chapter 4): Examine food insecurity and humanitarian food aid as risk factors associated with undernutrition in children 6-60 months, and identify determinants of undernutrition for the 2005 and 2010 food crises.

Because I have written each of the three papers to stand alone, some information contained within each may be redundant to information contained in this introductory chapter or to the other papers. Each paper contains its own methods section, however the following section is included to provide an introduction to the overall research design.

## **Research Design**

### **Research Area and Sample**

This research was conducted in eastern Niger in the agropastoral and pastoral livelihood zones within the administrative department of Tanout. The area was targeted for intervention by the British Red Cross (BRC) during the 2005 food crisis, based on vulnerabilities identified by two rapid assessments conducted by University of Arizona (Bureau for Applied Research in Anthropology, 2005). I oversaw four phases of data collection in 19 communities in 2005/2006 as part of a 12-month evaluation of this project. Baseline data research presented here comes from 359 households that were part of the evaluation. The 2010 food crisis created an opportunity to understand if and how perceived climate change and perceptions of risk around climate change (as manifested during two food crises) are affecting livelihood vulnerability/resilience. Thus,

five of the six research sites selected for the 2010 research were among the larger sample of communities targeted by the UA/BRC evaluation in 2005/2006. This research includes participants from seven communities along an agricultural-pastoral continuum that ranges from fully sedentarized agricultural to fully nomadic pastoral. These sites are: Takoukout, Kékeni, Guinia-Alhazaye, Dareram, Farak, and Eliki/Djijtoji.

The six sample sites along this agricultural-pastoral continuum were identified through meetings with local experts and researchers to identify communities among the 19 UA/BRC communities that had various livelihood compositions that would thus represent various positions along the continuum. Although an ideal sample would have come entirely from those communities who participated in 2005, pastoral communities who practice minimal to no agricultural cultivation were not included at that time. Thus, one additional site (Eliki/Djijtoji), identified by local pastoral researchers as meeting point (*point d'attache*) where two communities of Tuareg and Wodaabe pastoralists could be located, was included with the five UA/BRC sites so as to get representation along the continuum. Collectively, the six sites (seven communities) include communities whose range of household livelihoods include fully and historically agricultural households, newly sedentarized agricultural households, semi-nomadic pastoral households, fully and historically pastoral households, as well as some that occupy the space between.

The sample for household data collection (individual household interviews and measurements of children between six months and five years of age) is made up of the 19 households at each of five sites previously researched in 2005 and 38 new households at a pastoral *point d'attache*, for a total of 133 households. Nineteen

households were used in each community in the 2005 study, and those 19 households were targeted again for this research. Where loss to follow-up occurred (n=5), a new household was selected so that a total of 19 households are included from each community. At Elik/Djiptoji, 19 households were included from both the Wodaabe (Fulani) and Tuareg communities, constituting the 38 new households added to the sample. For measures of child health and growth, where participant households included less than 40 total children, additional children were selected from household census lists (all children in randomly selected households were measured) until data for at least 40 children were collected.

Researchers conducted interviews at each site with key informants, identified as leaders (*chef du village* or *chef du tribu*) and/or elders within the community. A minimum of three interviews was conducted at each site. Focus groups were conducted among men and women (separately) in each community. Participants were selected to maximize appropriate diversity of age, ethnicity, socio-economic status, and livelihood, where possible. The researcher team worked with community leaders and census lists to identify appropriate participants.

### **Data Collection**

This research employs a comprehensive mixed-method approach including document review, analysis of secondary data, and primary data collection via key-informant interviews, focus groups, household interviews, anthropometric measurements and, to a lesser extent, participant observation (Bernard, 1995). I worked with two research assistants, both doctoral candidates researching pastoralists of the region who were affiliated with LASDEL in Niamey. We met in July of 2010 to review my research design and finalize a grant proposal. I traveled to Niger again in October of

2010 to train the research assistants, translators, and interviewers. We pilot tested the research instruments in a community of Fulani pastoralists who had fled into Tanout during the crisis. Once instruments were finalized, the two research assistants coordinated fieldwork for the duration of data collection. All of the data collection was conducted in the primary household language of either Hausa or Tamachek. Research team members were able to conduct interviews and focus groups in other languages, but the sample population did not require this.

Research included semi-structured interviews with male and female (where available) key informants at each site (see Appendix D for key informant interview instrument). Key informants were asked to describe the history of the community, including the ethnic composition, livelihood composition, and history of migration/sedentarism. Researchers used key informants to learn each community's experience of the 1973, 1984, 2005 and 2010 droughts/food crises, and some of the coping strategies and adaptations employed during each. Prompting was used to investigate the role of sedentarization within the community. These interviews were used to investigate local manifestations of climate change, and to refine generic indicators of livelihood resilience to locally appropriate indicators of resilience for use in focus groups and household interviews.

Research also included focus groups, conducted with men and women, separately, at each site (see Appendix C for focus group instrument). At the advice of key informants, where sites included distinct livelihood groups or ethnic groups between which tensions were present, separate focus groups were held for each ethnic group, as was the case in Eliki/Djijtoji. The research includes focus groups to compare and

contrast the communities' experience of the 1973, 1984, 2005 and 2010 shocks, and to understand each community's experience of climate change and how it has changed over time.

Additional research included structured interviews, conducted with heads of household (see Appendix B for full survey instrument). Among pastoral populations, the definition of a household can be complex, as traditional methods, such as the use of a shared cooking pot or sleeping domicile, counts multiple households under one polygamous male. Thus, the definition of household used in this study is based on relation of male head of household to females, herd association, and food stores. All co-wives are associated with the same household. Individual household interviews provide data on water, sanitation, hygiene, health, livelihood, coping strategies, food intake, migration, livestock and harvest stocks, and household demographic data. The instrument replicates similar data collected in November 2005 so to allow for comparison between the two points in time (Bryman, 2008). Additional questions were added, including inquiry into the household's history of migration or sedentarization and perceptions of change in indicators of vulnerability/resilience between 2005 and 2010.

Data collection also included anthropometric measurements of all children between six months and five years of age for each household in the sample. Anthropometric scores were then calculated using data about: 1) the age of each child, (using a local event calendar following Cobey & Cunningham, 1968; Tukei, 1963); 2) mid-upper arm circumference (MUAC), measured using a color-coded MUAC tape; 3) length/height of children, using recumbent measuring boards; 4) weight, using hanging scales with nylon pants; 5) presence of diarrhea and/or fever; and 6) enrollment in a

feeding program, as reported by mothers. Growth performance was measured using CDC's EPI-INFO software (CDC, 2008), which employs globally standardized z-scores for weight-for-age (WAZ), height-for-age (HAZ), and weight-for-height (WHZ). The anthropometric data collection instrument is included in Appendix E.

### **Data Analysis**

All independent and dependent variables have been analyzed using univariate statistics to determine variation based on age, sex, ethnicity, and livelihood, as well as to determine central tendencies and dispersion. Goodness of fit has been verified for all models (R square method) in order to test the total variance explained by each model. Correlation coefficients have been analyzed to identify spurious correlations in the research analyses that follow. Principal components analysis has been used to develop all indices, allowing for analysis of perceived risk of climate change, livelihood, and vulnerability/resilience along a continuous scale.

## CHAPTER 2 PASTORALISTS UNDER PRESSURE - DOUBLE EXPOSURE TO ECONOMIC AND ENVIRONMENTAL CHANGE IN NIGER

### **Introduction**

In order to better understand the complex systems driving human vulnerability, academics and policy makers are increasingly turning to collaborative research, where scholars from different disciplinary backgrounds join forces to investigate the various dimensions of human well-being, human actions, and global change. The goal of integrated science necessitates the development of frameworks that can bring together varied approaches, theories, and methods in order to address related questions. Within interdisciplinary environments, frameworks take on analytical significance, in that they help bridge the gap between theory and applied research. In addition, they help build synergies among researchers from different disciplinary backgrounds and open windows of opportunity for collaboration. For example, the double exposure (DE) framework (Leichenko & O'Brien, 2008), allows multiple processes of global change to be analyzed concurrently and sequentially in order to better understand human vulnerability and possible points of intervention in the cycle.

The DE framework illustrates how different global processes, such as environmental change and economic globalization, constantly alter the context in which individuals and communities are responding to change – change stimulated, often, by one or the other processes that are occurring simultaneously or sequentially (Leichenko & O'Brien, 2008; Leichenko *et al.*, 2010; O'Brien & Leichenko, 2000; Silva *et al.*, 2010). This framework has been used in various contexts to reveal insights otherwise not apparent in the analysis of globalization, poverty, and vulnerability. In Mozambique's Limpopo River Basin, the DE framework demonstrates how economic stressors are

causing small scale agriculture to be less well adapted and more vulnerable to future climatic events (Silva *et al.*, 2010). In India, application of the framework reveals how institutional support or barriers are key determinants of farmers' ability to adapt to climate change and increased globalization (O'Brien *et al.*, 2004). Adger *et al.* have used the framework to show how the vulnerability of coffee farmers in Mexico and Vietnam, while not geographically bounded, is intimately connected to large-scale processes of global change (Adger *et al.*, 2009).

Increased understanding of how exposure to multiple global change processes – global climate change and economic globalization – affects a particular geographic region or human population may improve the prospects of appropriate humanitarian aid or development intervention. This may occur through identification of synergies in the two processes that lead to improvements in overall human well being, through a better understanding of the local variability of winners and losers, or through the identification of intervention points that maximize impact and efficiency. By applying the DE framework to examine the vulnerability of pastoralists in Niger, this article aims to 1) explain the complex interactions between economic and environmental stressors in eastern Niger, 2) examine the consequences of those stressors and their interactions on food security among pastoral populations, and 3) offer reflections on the framework to improve its analytic use.

This article examines how economic and environmental processes are interacting to affect food security of pastoral populations. Secondary data from the literature on Niger and primary data collected in 2005 and 2010 for three pastoral communities in eastern Niger are analyzed within the DE framework to broaden our understanding of

how some pastoralists are dealing with the interactive processes of globalization and environmental change at a local level, and their consequent direct and indirect effects on food security. The remainder is organized as follows: the literature on pastoralists and vulnerability is reviewed, including how the contemporary economic and climate change has affected their livelihood. Then the methodology used to conduct the analysis is outlined. Next the economic and environmental situation of Niger is introduced. Findings from the analysis of feedback and context double exposures are then presented. The paper concludes with discussion and directions for future research.

### **Background: Pastoralists in the Contemporary Economy**

Global climate change is predicted to have significant effects in arid and semi-arid regions of the world, especially in the African Sahel (Held *et al.*, 2005; Huntingford *et al.*, 2005), a region that is also described as having very limited adaptive capacity (IPCC, 2007; Reid & Vogel, 2006; Tschakert, 2007). In addition, pastoralists face increasing risks associated with economic restructuring as they are precariously linked to the global market. Though they may seem isolated, pastoralists are significant contributors to international livestock markets (Davies & Hatfield, 2007) and are directly affected by international markets for natural resources, including uranium and oil (Keenan, 2008).

Pastoralists, those whose livelihood depends upon the raising of livestock for consumption (meat and/or milk), social exchange, sale and trade, have historically been socially and politically marginalized (Hogg, 1997; Sen, 1981). In the Sahel, French colonial policies favored the farming communities of the agricultural south over pastoral populations of the north (Dayak, 1992; Decalo, 1997; Fugelstad, 1983). By the late 1970s, pastoralists were blamed for environmental degradation, desertification, and

mismanagement of resources, as the rich, complex land use system they employ was not well understood (Fratkin, 1997; Hesse & Thebaud, 2006; Warren, 1995). Policies which promoted sedentarization, limited mobility, and privatization of lands and livestock markets were justified by ecological research based on Garret Hardin's "Tragedy of the Commons" (Hardin, 1968), which asserted that common property resources such as pastoral lands led to overgrazing and degradation of the environment (Lamprey, 1983; Lamprey, 1976; United Nations Conference on Desertification (UNCOD), 1977). Despite subsequent extensive research to indicate otherwise, many national policies throughout Africa have promoted abandonment of pastoralism as a livelihood, encouraging the settlement of pastoral people, defended by the promise of increased socioeconomic opportunities (Campbell, 1984; Smith, 1998).

Historically, distinct social adaptations (including exchanges of livestock, restocking alliances, dowries, traditional loan mechanisms, and support of the poor through livestock loans) have fostered high levels of resilience among pastoral populations, enabling human existence in unpredictable and otherwise uninhabited environments (Adger, 2000; Davies & Bennett, 2007; Fratkin, 2004; Friedel, 1991; Kratli, 2001; McCabe, 2007; Niamir-Fuller, 2000; Thebaud & Batterbury, 2001; Westoby *et al.*, 1989). Because of the erratic nature of rains and water supply in dryland ecosystems, pastoral systems operate in a disequilibrium state (Behnke *et al.*, 1993). It is this characteristic of the livelihood that necessitates mobility, an essential strategy that allows pastoralists to take advantage of natural resources (e.g., water, grazing areas) that are scattered throughout an otherwise stark landscape (Behnke, 1994; Birch & Grahn, 2007; Galvin *et al.*, 2008). Despite this resilience, however, their

environmentally embedded livelihood operates within fragile ecosystems, and pastoralists are increasingly vulnerable to the effects of climate change (Adger, 2003; Bohle *et al.*, 1994; Hesse & Cotula, 2006; IPCC, 2007; Morton, 2007; White, 1991). Current climate change projections indicate that most drylands, including the Sahel, will experience rising temperature, decreasing rainfall, and increasing number and severity of extreme weather events, including flooding and drought (Hesse & Cotula, 2006; IPCC, 2007). Pastoralists are highly vulnerable to extreme environmental fluctuations such as drought and rainfall shortages, which leave animals hungry, without water, and ill from cycles of undernutrition and disease. Severe or consecutive droughts lead to herd decimation, as seen in Niger during the 1970s (Bohle *et al.*, 1994; White, 1991). As their natural resource base becomes increasingly threatened, so too does the pastoral livelihood.

Pastoralists are also vulnerable to market fluctuations. Pastoral communities have historically relied on consumption of milk and other animal products, but most do not have sufficient numbers of animals to be independent of agricultural communities; instead, they increasingly depend upon the sale of animals or animal products for the purchase of grain (Hogg, 1997). Fluctuating terms of trade mean that the cost of grain is very high at the end of the dry season, the time when pastoralists are most in need of grain and when livestock are thinnest and fetch the lowest price (White, 1991). As livestock flood into market for sale, prices drop precipitously and grain prices soar, further reducing the purchasing power of pastoralists. These terms of trade work against pastoral people and increase their overall vulnerability (White, 1991). During drought

these terms are worsened, as the price of scarcely available grain goes up and livestock prices plummet, meaning greater loss of animals in exchange for less grain.

Research indicates that the global economic system places pastoralists at a distinct disadvantage with regards to accessing markets and acquiring essential goods (Sen, 1981). First, the very mobility that allows them to cope with unstable environmental factors is largely incompatible with capitalist labor markets. Second, pastoralist populations tend to live in areas poorly served by transportation and other infrastructure, which increases their isolation and inability to use markets effectively (Smith *et al.*, 2000). In addition, internationally and domestically promoted export-based growth strategies have been adopted across the Sahel, and these often lead to the state appropriation of land for economic purposes, such as mineral exploration. This hinders pastoralists from maintaining traditional livelihoods and increases their reliance on markets. In many ways, neoliberal development policies have increased the need for cash income in order to access basic needs, such as food, education, and healthcare. This growing need for goods and services not produced by the household or community pushes pastoralists into deeper poverty.

The complexity of the rapidly changing environmental and economic conditions facing pastoralists necessitates a multidisciplinary approach to understand how the resilience of the pastoral livelihood system has come under sustained pressure in contemporary economies. Moreover, integrative frameworks may help identify effective coping mechanisms and adaptations for pastoralists in altered environments. Identification and facilitation of appropriate, effective adaptations for vulnerable

populations, such as pastoralists, are essential skills for development practitioners working within the context of global climate change and economic globalization.

### **Methodology**

This article applies the DE framework to examine how economic and environmental stressors may interact to affect food security in pastoral economies. As described in Leichenko and O'Brien (2008), *feedback double exposure* emphasizes the ways that actions prompted by globalization or global environmental change drive additional global change. *Context double exposure* emphasizes how global change processes alter the environment in such a way as to increase its vulnerability to future internal and/or external shocks. These two pathways serve as focal points in the application of the DE framework to the pastoral experience in Niger. Secondary data from literature on Niger and pastoralism demonstrate feedback double exposure, as epitomized in the case of uranium markets and pastoral food security. Primary data collected just following the food crises of 2005 and 2010 are then used to illustrate context double exposure. Collectively, data from both sources populate the framework, the analytical platform for our improved understanding of vulnerability and food security among pastoral populations.

Primary data were collected during field research in 2005 and 2010 in the pastoral and agropastoral zones of the administrative department of Tanout in eastern Niger. Three Tuareg communities make up the research sites included in this paper: Farak, Dareram, and Abdounezé (see Figure 4-1). The area was originally targeted for intervention by the British Red Cross (BRC) during the 2005 food crisis, based on vulnerabilities identified by two rapid assessments conducted by University of Arizona (Bureau for Applied Research in Anthropology, 2005). Communities with the highest

vulnerability were selected for inclusion in the BRC intervention and were monitored for 12 months after the intervention. Farak was a beneficiary community and Dareram was a control community. Control communities were identified as those with similar but slightly less vulnerability than beneficiary communities and were thus not targeted for intervention but included in monitoring to establish impact of the intervention. During the 2010 food crisis, seven communities, including Farak and Dareram, were targeted for inclusion in the research on pastoral vulnerability to climate change. Insecurity in the region limited mobility and willingness of locals to travel into some areas, leading to the replacement of Farak with the community of Abdounezé. Thus, 2010 data include information on the communities of Dareram and Abdounezé.

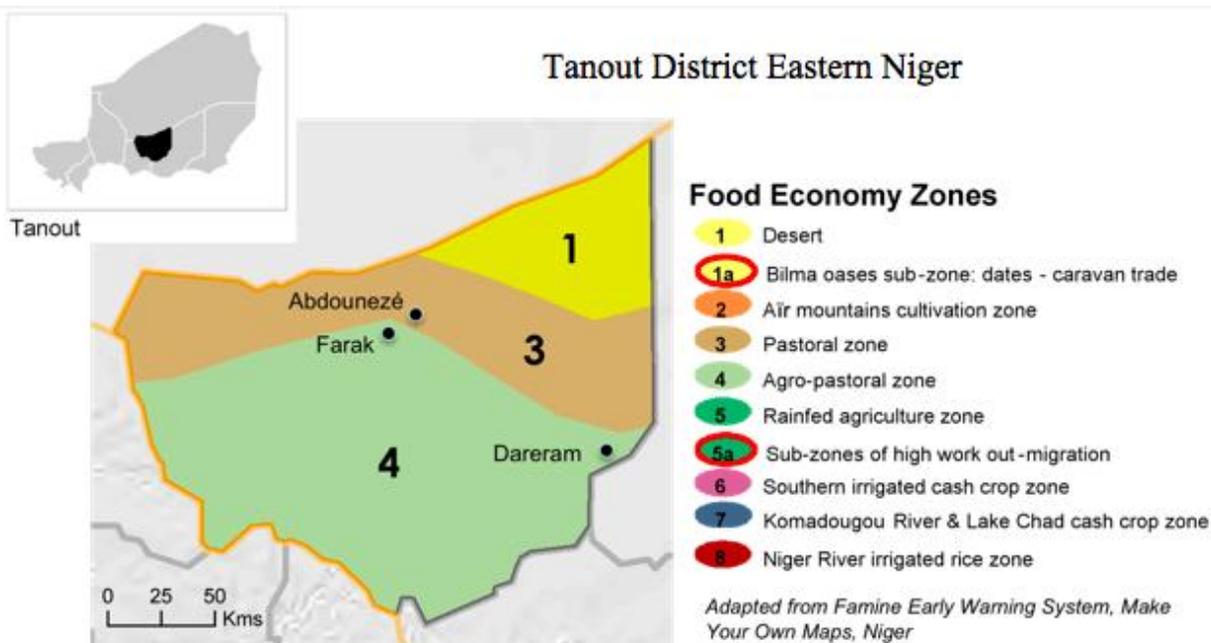


Figure 2-1. Research Sites in Tanout District Niger (Source: FEWSNET, 2012).

This study draws on data collected during key informant interviews (at least three in each community), community focus groups (male and female in each community), randomly selected household surveys (19 households per community per year,

conducted with the HHH and, in cases of male HHH, the senior wife), anthropometric measurements of children under-five (40 children per community per year, including children of targeted households), and on field observations of the research teams from both periods. All data were collected in household preferred languages of either Tamachek or Hausa and were translated into French by research assistants, Nigerien doctoral students, and field assistants. Field assistants were originally recruited and trained by the BRC in 2005 before conducting focus groups and household surveys throughout 2005-2007, the duration of the BRC project; the same individuals were available and able to assist by conducting household surveys in 2010. Data were collected by hand, using survey instruments and written notes, and were later analyzed using SPSS and through content analysis for identification of common themes relating to food insecurity.

### **The Case of Niger**

Niger provides an illustrative case to examine interactive processes of environmental and economic change. Landlocked in the West African Sahel, Niger is divided into three zones: agricultural, pastoral, and desert. Rainfall is the principal determinant of agricultural production in Niger, as its quantity and distribution are unpredictable and variance occurs between important thresholds for crop production. Although water has never been abundantly available in this semi-arid stretch of land (Bradley, 1971), changing rainfall patterns, arguably due to global climate change, have lead to greater water scarcity in communities scattered throughout the stark landscape (Ben Mohamed *et al.*, 2002). Historically, there was a progressive southward shift of the 350 mm isohyet rainfall line – a movement of 50 to 100 kilometers from roughly 1970 through the 1990s – which triggered the conversion of previously productive areas of

the agriculture zone, including Filingué and Tanout, into food deficit zones (Daouda, 1996b; Sivakumar, 1992). Changing rainfall patterns and increasing temperatures - both included in current climate change projections - are threatening water supplies in the already fragile landscape. According to the Nigerien government, chronic food insecurity affects 80% of the population, and yearly 10-30% of the population suffers more than a 50% deficit in their cereal needs (Government of Niger, 2005).

Niger is one of the most food insecure countries of the world, and severe events including drought, floods, and increasing desertification threaten its fragile natural resource base (Held *et al.*, 2005; Hesse & Cotula, 2006). In a country that is economically dependent upon crop production and livestock (nearly 80% of the population relies on subsistence agriculture), the outcome of global climate change has large implications. The negative consequences of increased temperatures and decreasing rainfall are tangible at household levels, as crop production falls and herd numbers decline precipitously in years of excessive heat or poor rains. Over the past 30 years, Niger has become increasingly less able to feed itself, and most agricultural families produce only enough food to cover their needs for five or six months (Baro & Deubel, 2006). Diets are generally deficient in protein, calories, and essential vitamins and minerals, contributing to chronic undernutrition (Wuehler & Biga Hassoumi, 2011); it is estimated that 40% of the rural population cannot satisfy its minimal caloric intake requirements (Baro & Deubel, 2006). As food production and arable land per capita decline, Niger becomes increasingly dependent on food aid and imports. Over 75% of Niger's cultivated area is planted in millet and sorghum, and such heavy reliance on monocropping has serious dietary, overall health, and economic implications.

In terms of economic change and approaches to development, Niger has taken a number of steps within the last two decades to increase its appeal to direct foreign investors. In conjunction with UNDP, Niger has worked to revise codes affecting private sector investment, including its investment code (1997 and 2000), petroleum code (1992 and 2000), and mining code (1993). With such changes, Niger hopes to increase export revenue by selling minerals to multiple countries. The positive benefits of economic globalization, however, have arguably not reached most parts of Niger. To date nearly half of the Nigerien Government's annual budget comes from foreign donor resources, a substantial portion of which is almost always in food aid.

Described as living on "the distant fringe of the globalized world," rural Nigeriens are not significantly engaged in the global economy (Kelley, 2002, p. 635). However, very few remain entirely unaffected by its progress or decline. For example, cell phone coverage and subsequent cell phone use in Niger has increased dramatically since 2005. While conducting research in Niger in the spring of 2005, the long awaited cell phone tower in Tanout, our research base, was completed and coverage turned on. This single act connected an otherwise isolated town in the Sahel to the globe. Our Nigerien research team members were reunited with family by phone calls to France and Libya, using numbers that had been sent overland years, sometimes decades prior to this moment. Improved communication meant, for many families, an increased possibility of receiving remittances. Immediately, ad hoc systems for monitoring regional market prices of livestock - mainly camel - were created. And information on security issues including car-jackings and other acts of violence began traveling quickly, often restricting movement within certain areas of eastern Niger. Beyond ubiquitous cell

phone use and the now common sight of a road side solar charging station for cell phones, evidence of engagement in the global market is seen other places in pastoral Niger, including the regular use of large plastic sheets, made and sold by Chinese merchants, to collect large quantities of water from deep wells in a single draw.

The Tuareg are Muslim, historically nomadic people that speak a Berber language, Tamachek, and practice small scale agriculture, caravan trading, and livestock herding throughout the Sahel. Marginalization of Tuareg pastoralists in Niger was ignited under French colonial rule. The French favored the agricultural Hausa and Zarma communities of the south over the pastoral populations of the north; policy decisions and legal codes that favored the agricultural sector extremely limited Tuareg rights and access to land, and upon independence, the Tuareg were essentially unrepresented within the new government (Abdalla, 2009; Hammel, 2001; Simanowitz, 2009). This disenfranchisement has been documented in both policy and practice and has overlapping consequences to processes of global change (Emerson, 2011). During the 1970s, the region experienced severe drought and accompanying food insecurity. In that time period, the Tuareg lost an estimated 75% of their herds and thus thousands fled their homeland for cities or neighboring states (Libya or Algeria). When some 20,000 of them returned in the mid 1980s under the promise of a new political regime, they were greeted by a national economic crisis and promises of humanitarian aid that never materialized - leaving them feeling, again, marginalized and discriminated against (Bednik, 2008).

### **Feedback Double Exposure: Uranium Markets**

Nigeriens, particularly Tuareg, can be viewed as “losers” in the processes of globalization and global climate change (Leichenko & O'Brien, 2002); projections

indicate that they will endure the greatest negative impact associated with these processes, and yet they are among the least responsible for the changes. However, their responses to these processes, as well as those of others within the region, are in some cases driving additional change, further exacerbating their own vulnerability. The examples of uranium markets and land use change are explored here as both consequences and drivers of global change processes in Niger, both of which have important implications on Tuareg vulnerability and food security.

The process of economic globalization is currently engaging individuals, communities, and nations from around the world in a highly connected, interactive marketplace. Niger, too, is engaged in globalization. Niger is one of the leading exporters of uranium in the world. And though uranium mining may deliver economic benefit to an elite few within Niger, the negative impact of the uranium industry on the Tuareg pastoralists of the region is gaining attention (Abdalla, 2009; Action Against Hunger, 2006; Bednik, 2008; Keenan, 2008, 2009; Meyer, 2010).

Today, despite being the world's third largest uranium producer, exporting an estimated 3,300 tons annually, Niger remains extremely poor, perhaps *the* poorest country in the world (Bednik, 2008; Keenan, 2008; United Nations Development Program (UNDP), 2011). When the French granted Niger its independence, they maintained control over the uranium mines in and around Arlit, and, until recently, continued to pull a majority of the profit from Niger's uranium industry (Bednik, 2008; Niger Uranium Limited, 2008). Arevo, the largest uranium mining company in the world, maintained the only two uranium mines that endured since the end of colonialism (Staff, 2008). But, since the early 1990s, the Nigerien government has actively engaged

investors from China, Canada, India, Australia, South Africa, and numerous other countries in the exploration for and mining of uranium. In 2006, the French lost their monopoly on Niger's uranium. The Chinese were awarded licenses to explore for uranium, followed shortly thereafter by numerous other countries; that year Niger sold roughly 300 tons directly on the market (Bednik, 2008; Keenan, 2008). After a 20-year period of relative stability, renewed interest in alternative energy sent the global price of uranium skyrocketing in 2007, with prices jumping from \$10 per pound in 2003 to a record \$136 per pound by June 2007. Although prices have not remained that high, uranium prices have remained above \$50 per pound throughout 2011, and new exploration for uranium in Niger continues (IndexMundi, 2012).

By October 2007, the Government of Niger had issued around 90 exploration permits, with 90 more under consideration (Keenan, 2008). To date, nearly two dozen countries have been granted exploration permits throughout the northern reaches of Niger, yet the Tuareg have not been consulted. The Tuareg, in whose ancestral lands the uranium deposits exist, claim continued marginalization, a lack of benefit from the presence of the mining companies, increased burden of disease due to the mines, and dire ecological consequences to their fragile ecosystem (Abdalla, 2009; Emerson, 2011; Keenan, 2008; Meyer, 2010). Grazing has been disrupted by exploration and mining, and the increased demand for water (required in the uranium exploitation process) is threatening traditional alternative livelihood activities of Tuareg, essential coping mechanisms during times of stress (Bednik, 2008; Emerson, 2011). Mining in the area is also compromising human health: dust and water show high levels of radioactivity (Keenan, 2008; Meyer, 2010). Greenpeace visited Arlit in March 2010 and documented

contamination of air, soils, and water, as well as the sale of radioactive scrap-metal at markets throughout the pastoral region (France 24, 2010).

Profit from uranium accounted for 64 percent of Niger's export income in 2009, and depending upon global trends in energy, projections indicate steady to significant increases in the near future (Mira, 2011; US Department of State, 2012). The Tuareg believe they have a right to benefit from the uranium mining, which until now they have not received. They are adamant that reckless mining efforts are disrupting the essential, yet delicate balance with the environment on which their livelihood depends (Emerson, 2011). These grievances among others, including marginalization, discrimination, and a failure to meet the terms of the 1995 Peace Accord, have led to increased violence in the region since 2007. The Mouvement des Nigériens pour la Justice (MNJ), a Tuareg rebel group organized in and around the region, has claimed a series of violent attacks, kidnappings, and other crimes, many of which have targeted the uranium industry and other westerners in the area. The group claims racist neglect and seeks increased representation in the military, government, and mining industry (McConnel, 2007).

The battle over uranium in the pastoral regions of Niger illustrates a double exposure of globalization and environmental global change with important feedback mechanisms: globalization, through colonialism and foreign direct investment, has sidelined the pastoral Tuareg from economic benefit while simultaneously creating increased global demand for energy. To date, that energy has required either oil, which has negative climatic impacts on the region through global warming, or uranium, which further exacerbates the presence of the mining companies and the marginalization of the Tuareg. The violence now gripping the region is arguably a consequence of the

aforementioned processes. This insecurity then acts as a barrier to regional and local economic development by restricting pastoralists from utilizing locally adapted strategies, such as migration, and encouraging strategies that take them southward, outside the area of conflict. In addition, violence and insecurity deter international investors, humanitarian aid, and development organizations that might otherwise bring economic or livelihood relief to the region.

### **Context Double Exposure: Land Use Change, Markets, and Household Demographics**

This section utilizes data from three Tuareg communities located within the agropastoral and pastoral zones of Niger to examine how context double exposure is affecting food security. These historically pastoral communities are located geographically south of the areas most affected by uranium mining and, today, have varying degrees of mobility. Their experiences are used to illustrate the Tuareg experience of context double exposure.

Throughout Niger, changes in the contextual environment are resulting from the local response of agricultural and pastoral communities to the ongoing drying of the region. As previously established, decreased rainfall has led to a southward shift of the 350 mm isohyet line, the amount required for cultivation of millet. This means that households that choose to stay in their historical homelands suffer from decreasing yields over time, due to reduced rainfall. Similarly, the drying pattern has threatened the viability of historic livelihood systems in some pastoral communities. Herds must travel farther and farther afield in search of grazing lands, and, yet, increased violence is limiting migration options. In addition, traditional coping strategies for maintenance of herds are no longer as effective as they once were. For example, in 2005 and in 2010

both communities reported that they were no longer using the traditional restocking system of *haba nai*, where female livestock are loaned for a period of time long enough to produce offspring for the borrower, then returned to the original owner. Due to malnourishment of animals and the consequent length of time required for maturation and reproduction, in addition to the widespread loss of livestock among pastoral families due to illness, starvation, and sale, this strategy has been abandoned.

Pastoralists are moving further afield in search of grazing lands and water, which often means traveling farther south, where average rainfall is slightly higher, earlier in the dry season and for longer stays. In doing so, pastoral communities encroach upon agricultural land and thus must negotiate access to grazing land and water with agricultural communities (CARE USA & CARE Denmark, 2007). At the same time, decreasing yields have resulted in farmers claiming and trying to cultivate land in areas that have historically been used for pastoral grazing (Hammel, 2001). Land use changes among pastoralists and agricultural communities in response to climate change and globalization are pushing the geographic boundaries of historic livelihood territories (Bassett & Zuéli, 2000; Mortimore, 1998), increasing land degradation and conflict between agricultural and pastoral communities (Baro & Deubel, 2006; Thebaud & Batterbury, 2001). In addition, some pastoralists are choosing to sedentarize. Though some research argues its merits, sedentarization, the loss or decrease in pastoral mobility, has been linked to increased fertility, infectious disease, and other indicators of vulnerability, thus this adaptation is not without additional risk (Blench, 2001; Hogg, 1986; Keenan, 2000a; Little, 1985; Niamir-Fuller, 2000; Talle, 1999). Each of the Tuareg communities included in this research is more settled than their ancestors were, having

employed a range of coping strategies, including sedentarization, to adapt to changes in the natural and political environment. A brief introduction to each community and its current composition is presented below.

Farak is a predominately Tuareg community of roughly 800 people, situated 38 km north of Tanout. A majority of the population grows no crops, though some produce small scale gardens for their own consumption, as water is available from an open well. They continue to live in traditional, temporary shelters that are easily moved, though at least a portion of the population moves only very short distances around the open well. Others continue transhumant migration. There is a health center, a veterinary input center, and a primary school within the environs of the camp and the well, which provides water year round. Focus groups reported that staff and supplies at the health center and veterinary input center are inconsistent; no one was available to speak with during data collection.

Dareram is a predominately Tuareg community of roughly 200 people located 38 kilometers southeast of Tanout. Made up of three small settlements, most community members have sedentarized, while others are semi-nomadic and use the community as a base. In years of poor agricultural production, families reported they return to transhumance as a coping mechanism. In addition to livestock herding and agricultural cultivation, households engage in small scale commerce, including jewelry making. There is no school, medical or nutritional service offered in town. The nearest school and health center is 10 km away (Adjiri) and the nearest nutritional center is 45 km away (Kokoram). There is no community well, but a seasonal lake provides water in the wet season.

Abdounezé is a pastoral community of mostly Tuareg located 45 km north of Tanout, situated near a seasonal lake. The area was a traditional destination for herders to water animals as they came south during the dryer months. However, due to widespread loss of livestock during the 1984 crisis, a group of Tuareg began adopting agricultural practices and settled in the area in 1990. There is a livestock market that occurs every Friday in Abdounezé. There is also a primary school, a health center, and a cereal bank within the community. The community of Abdounezé reports rapid increase in the number of family members to feed since settlement, but also cites the advantage that they are now reached by aid that flows in during food crises. They report new health problems associated with settlement, and though there are some that prefer being settled, most agree that the lack of milk in their diet is causing a new host of health problems.

Food security of pastoral households is undermined by the longer-term consequences of herd loss as compared to crop loss. When agricultural communities suffer from drought and have a loss of crops, they are able to start over with minimal to moderate impact on the next year's planting and crops; by contrast, pastoral communities who lose livestock have to rebuild herds - sometimes entire herds - which takes an average of five to seven years. When herds in Dareram and Abdounezé were decimated during the 1984 crisis, the communities dispersed and families fled to Nigeria. Upon returning, neither community was able to rebuild herds to a sufficient size, and by 1990, the community of Abdounezé decided to settle and begin growing crops in addition to herding. Having employed this coping mechanism of sedentarization, the context in these two Tuareg communities was quite different for the recent crises. Due

in part to their agricultural ventures, neither community dispersed during the 2005 or 2010 crisis (as some other pastoral communities did), and in 2010, both reported reduced mobility and sedentarization among common coping mechanisms (see Table 1). Additional coping mechanisms employed in research sites during the 2005 and 2010 crises included migration of young people to Nigeria and Libya, consumption of famine foods (namely *Boscia*), collection and sale of wood (as reported in focus groups), days of fasting, and reduction in number of meals – all of which negatively affect nutrition and health, increasing overall vulnerability (see Table I).

Table 2-1. Livestock Loss and Coping Strategies Employed during 2005 and 2010 Food Crises by Community

	Dareram 2005	Farak 2005	Dareram 2010	Abdounezé 2010
Average HH livestock loss	46.0%	26.0%	50.3%	39.4%
Collect/eat famine foods	63.2%	57.9%	44%	15.8%
Migration <i>en exode</i>	94.7%	84.2%	38.9%	10.5%
Day without food	26.3%	52.6%	5.6%	52.6%
Decreased number of meals	47.4%	68.4%	84.2%	100%
Sedentarization	Not asked	Not asked	55.6%	63.2%
Reduced Mobility	Not asked	Not asked	55.6%	52.6%

Note: Household sample size = 19 per community, except where missing data decreased sample size to 18.

In addition to land use changes, including sedentarization, global changes are affecting these communities through markets and changes in household demographics. Tuareg pastoralists in Niger have varying access to regional markets for the exchange of goods; those who have decreased their mobility are generally situated further south than their nomadic counterparts and generally have increased access to markets, due to their proximity to crop producing communities. Their household food security can be greatly affected by their geographic access to markets, as well as their purchasing

power. In November 2005, pastoral communities of Dareram and Farak reported livestock losses (based on average decrease in total livestock units per household) during the crisis year of 46% and 26% respectively, and in November 2010, Dareram and Abdounezé reported losses of 50% and 39% (Jahnke, 1982). While some of these livestock died due to starvation and disease, others were sold at market at significantly reduced prices in exchange for grain. A 2005 focus group in Dareram indicated that grain prices at local markets reached nearly four times (1200 FCFA/tia) their normal price (300-350 FCFA/tia) by July 2004, the peak of the hungry season during the crisis year. During the 2010 crisis, grain prices rose but, according to 2010 focus groups, not as dramatically as they did during the 2005 crisis - never surpassing 500 FCFA/tia.

As a final example of context double exposure, globalization is affecting household composition, an important determinant of household vulnerability. Nigerien households regularly rely on the seasonal or short-term migration of a family member, often an adult male, either to another region of the country or abroad. Sending someone *en exode*, as it is called, is an important coping mechanism for families in both agricultural and pastoral communities, and globalization is changing this pattern. In 2005, 89% of households reported having a family member who migrated in search of work as a coping strategy for the crisis. Two of the most common destinations for this out migration of the labor force were Libya and Nigeria. In 2010, household data indicated a drop in out migration of adult men to 24% of households. Focus groups in Dareram and Abdounezé indicate that this change is due to increased humanitarian aid (neither group received any aid in 2005, while both received aid from at least one NGO in 2010), history of past migration (some have lost family members to out migration after past

crises and no longer see it as an effective coping mechanism or have no additional members to send), and increased agricultural production within the communities.

Globalization has also changed the demographics of households by limiting in-country migration through increased violence and political upheaval, and increasing migration overseas through the increased economic disparity between Nigeria and Niger, largely driven by the oil economy of southern Nigeria. The activity of Al Qaeda in the Maghreb (AQIM), a radical Islamic militia who have been active in Niger since 2007, and increasing violence among the Tuareg in the region around and north of Tanout are discouraging movement of both local people and NGOs throughout the agropastoral and pastoral zones (Keenan, 2009). During data collection in 2010, field assistants blatantly refused to go into certain Tuareg held areas, and local entrepreneurs owning the only 4x4 vehicles available for rent in the region forbade travel into certain pastoral areas around Tanout (the reason Farak was not visited in 2010). As households have fewer economic options that rely on short term migration of family members to nearer destination they must rely more heavily upon long distance migration, *if* they are to engage in this historic coping mechanism of out migration. But this type of migration is contentious, as family members are gone for long periods of time, and the remaining family may or may not receive remittances in this time. Research findings suggests that families whose members migrate abroad experience increased vulnerability, despite the coping mechanism's intention, based on loss of human resources within the household while awaiting remittances. Conversely, they may opt out of migration and risk increasing household vulnerability through a loss of potential income. The changing demographics of households as a result of globalization and the ways it stimulates or

stymies migration has important implications on household vulnerability when food crises are stimulated.

### **Concluding Remarks**

As the case of the Tuareg in Niger shows, issues of food security result from dynamic, interacting processes that operate at different scales. Using an interdisciplinary framework allows us to identify two multiscale dynamics, and the causal mechanisms behind them, which alter the food security of pastoral populations. Perhaps the most important finding of this study is the effects that climate change and globalization have on political stability in the region. First, climate change at the global scale has decreased the mobility of pastoralists. With their herds decimated by excessive heat and droughts, people increasingly settle near water sources and attempt to position themselves in areas serviced by international aid organizations. Their inability to re-grow herds after severe and/or consecutive droughts increases incentives for crop farming, a choice that increases local level conflicts over land with agricultural communities already living in the area. At the same time, growing demand for uranium at the global scale has also contributed to increasing violence and insecurity at the regional level, as the pastoral population is angered over the government's inequitable distribution of benefits from uranium sales and the negative ecological and human health consequences of mining in the region. Resistance to state appropriation of land for mineral exploration, conducted by foreign multinational firms, has knock-off effects that serve to further marginalize an already oppressed group. Conflict prevents international food aid from reaching those in need, and limits the use of migration to nearby areas as a coping strategy for pastoralists. These political issues compound the negative effects of climate change and reduce the coping strategies available to

pastoral households. All the processes examined in this analysis interact in a way that works to decrease food security among the Tuareg, which suggests that their situation will worsen over time.

While food insecurity is an obvious manifestation of poverty, global economic processes appear to be a thin driver of change to livelihoods. Although better access to cash income would most likely improve their health and wellbeing, the processes that reduce their capabilities to earn income appear more directly related to weather and conflict. As interconnected as processes may be, some exert more force than others when looking at how change affects food security at the local level. And in this case, economic globalization plays a smaller role relative to other processes of change. While global economic processes may contribute to climate change or to higher demand for uranium, it is the conflict and weather that, in this case, have the most direct influence in altering local livelihoods. Moreover, our findings suggest limited potential for economic globalization to bring benefits to the Tuareg. For example, the feedback double exposure created by the movement of both pastoralists and farmers into each other's traditional lands decreases the ability of globalization to bring economic opportunity to the area and increases the potential for climate change to do harm.

In terms of policy, our analysis underscores dynamics between structural and circumstantial determinants of vulnerability. There is no simple intervention to improve food security; it must be addressed structurally (e.g., development implications) as well as circumstantially (e.g., humanitarian/relief implications). Feedback pathways in this case illustrate how interconnected global change processes cannot be separated from context. The Tuareg have been structurally and institutionally marginalized:

development programs - with the best of intentions - further their vulnerability by providing incentives for settlements; climate change threatens their relationship to natural resources; and they are being disproportionately (negatively) impacted by the main export opportunity (uranium) existing in country.

Ultimately the use of the DE framework in this case provides a cautionary tale. The framework is designed to examine multiple processes of global change; however, the processes selected for examination by researchers may not necessarily be the most significant drivers of change. With an interdisciplinary framework, there remains the need for open-mindedness when analyzing multiple processes of change. In this case, an additional driver, conflict, had more influence on food security dynamics than the original processes that the framework introduces. When approached in this spirit of discovery, interdisciplinary frameworks may identify overlooked or underemphasized drivers of change – essential information for effective aid and development intervention. However, no matter how interdisciplinary, a theoretical framework cannot substitute for theories themselves. In order to truly understand the complex drivers of vulnerability, the advancement of interdisciplinary theories is a critical next step for scholars and policy makers.

## CHAPTER 3 PERCEIVED RISK OF CLIMATE CHANGE, ADAPTATION AND LIVELIHOOD VULNERABILITY IN EASTERN NIGER

### **Introduction**

Pastoralism, a livelihood that depends upon the raising of domestic animals for consumption (meat and/or milk), social exchange, sale and trade, is practiced throughout the African Sahel. Among pastoralists, reliance on milk and animal products for subsistence and distinct social adaptations allow for a high level of resilience, essential for communities whose natural environment is unpredictable and requires constant coping and adaptation. Pastoral populations have been described as “dynamic managers of risk,” dealing routinely with consequences of climate variability, including drought-induced livestock loss and increased competition for grazing land (pp. 492, Davies & Bennett, 2007). However, arid and semi-arid regions of the world are projected to be among those most affected by global climate change, which poses new challenges - increasingly erratic weather patterns (timing, duration, and amount of rainfall), rising temperatures, and the deterioration of social resources - to the historic adaptability and resilience of populations that inhabit these lands (Niamir-Fuller, 2000). In an attempt to understand how communities have coped and adapted thus far, indigenous knowledge, perceptions of risk, and adaptive capacity of farmers have become critical areas of research (Ben Mohamed *et al.*, 2002; Mortimore & Adams, 2001; Nyong *et al.*, 2007; Roncoli, 2006; Roncoli *et al.*, 2002). Though some of this research has included pastoral experiences of climate change (Hesse & Cotula, 2006; Le Houerou, 1996; Morton, 2007), much of the research has focused on farming communities.

The term livelihood has been defined as the “capabilities, assets (stores, resources, claims and access) and activities required for a means of living” (Chambers & Conway, 1992, pp. 7-8), which prioritizes access over availability as a determinant of poverty and vulnerability (Sen, 1981). Pastoral and agricultural livelihoods are neither permanent nor distinct in Niger; instead they are better conceived as theoretical opposite poles on a spectrum of possible livelihoods. Significant assumptions are made when pastoralists are subsumed into larger agricultural livelihood groups, but dichotomizing livelihoods into pastoral or agricultural groups based on ethnicity, community, or primary income source is an oversimplification of a complex set of experiences. Household livelihood is not static, particularly within the pastoral livelihood system. Households constantly shift strategies, coping and adapting to economic, environmental and personal shocks in an attempt to endure the ever-changing environment in which they live – a classic demonstration of what has come to be referred to as livelihood sustainability (Chambers, 1992; Davies, 1996; Scoones, 1998). This dynamism of livelihood, typical of pastoralists, has long been a seminal and defining characteristic of pastoral resilience. For example, a settled household may abandon farming practice and return to nomadic pastoralism in times of drought (Galvin, 2009; Le Houerou, 1996) or a nomadic household may respond to consecutive droughts by reducing mobility, settling, and initiating crop production (McKune & Silva, 2012). The same household may look like farmers one year and pastoralists another, and coping strategies and adaptations may vary in their effectiveness due to the historical livelihood of the household and accompanying knowledge and skill sets. Thus, it is essential that global efforts to improve livelihoods determine if/how climate change is differentially

affecting pastoral, agropastoral, and agricultural communities, rather than assuming that communities with different means of subsistence will experience, interpret, and be affected equally by climate change and the strategies and adaptations used to manage climate related risk. Furthermore, any discussion of climate change that aims to improve the livelihood security of pastoralists needs to use a well-defined, robust indicator of livelihood that allows for appropriate interpretation of the findings, given the dynamic nature of pastoral existence.

This research investigates the development and use of a livelihood index to examine how agropastoral populations in eastern Niger perceive and respond to climate change, the role of livelihood in perceptions of climate-related risk, and if/how coping mechanisms and adaptations affect their livelihood vulnerability/resilience. Data for this study was collected among seven communities in eastern Niger from November 2010 to February 2011. The study aims to augment existing literature by 1) describing the relationship between perceived risk of climate change and livelihood within communities across an agricultural-pastoral spectrum, 2) investigating whether perceived risk of climate change is correlated with the use of certain coping mechanisms and adaptations, and 3) examining the consequences of certain livelihood-associated coping mechanisms on pastoral or agricultural vulnerability. The remainder of this article is divided into four sections. The first reviews the literature on climate change in Niger, the sustainability of pastoralism as a livelihood, and pastoralism and vulnerability/resilience. The second section describes research methods and defines key variables used in analysis. In the third section, findings from the research are presented, organized by specific aim, as outlined above. The fourth and final section discusses implications and

constraints of using a livelihood spectrum to assess vulnerability among pastoral populations.

## Background

### Climate Change in Niger

Niger is an extremely poor, landlocked country in the West African Sahel, two-thirds of which is desert or sub-desert (see Figure 1). Tanout, the research base for this study, is located in eastern Niger within the Sahel-Sahara zone, a water scarce region characterized by 200-350 mm annual rainfall (Ben Mohamed *et al.*, 2002). Global climate change is predicted to have significant effects in arid and semi-arid regions of the world, including substantial drying in the Sahel (Held *et al.*, 2005; IPCC, 2000 (IPCC); IPCC 2007). Rainfall and temperature data suggest that rainfall has decreased in recent years by as much as 42% in Tanout (pre-1968 compared to 1968-1990) and that the average number of days with temperatures exceeding 30° C have increased from 0 to over 15 days in the second half of the 20<sup>th</sup> century in nearby Maradi (Barbé & Lebel, 1997; Battisti & Naylor, 2009; Ben Mohamed *et al.*, 2002).

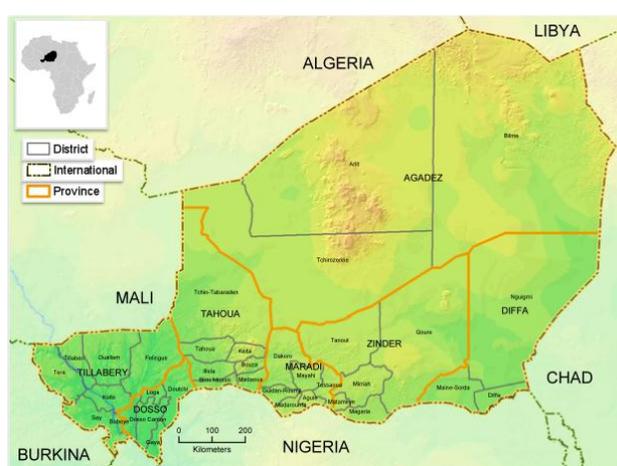


Figure 3-1. Map of Niger (Source: FEWSNET, 2012).

Semi-arid regions of the world such as the Sahel typically experience a high level of variability in rainfall and temperature. However, despite *regular* high variability, climate data from Zinder, the largest town within reasonable distance from Tanout, for three periods (1951-1968, 1969-1984, 1985-1998) show clear trends of climate change: a decrease in average annual rainfall (542 to 367 mm), a reduction in average length of rainy season (92 to 74 days), and later onset of rains (from late June to mid-July) (Lebel *et al.*, 1992; van Duivenbooden *et al.*, 2002). Although climate variation and extreme events such as droughts and floods are typical for the Sahel, climate change models predict increased variability, including increases in the number of very dry and very wet years in the next 90 years, and extreme events such as droughts and floods (Huntingford *et al.*, 2005). These changes are predicted to have a number of dire consequences, and vulnerability to these consequences is not equally distributed; vulnerability is expressed along social, power, poverty, and gender lines, leaving marginal groups – women, ethnic minorities, and the poorest – among the most vulnerable (Denton, 2000, 2002; London, 2001; Nelson *et al.*, 2002).

### **Pastoralism as a Sustainable Livelihood**

The people who inhabit the Sahel are accustomed to both weather and climate variability, and the flexibility of the pastoral livelihood there reflects this. Pastoralists' ability to survive in geographic regions where weather patterns and rainfall are unpredictable is a defining characteristic of their livelihood. As elsewhere, pastoralists in Niger rely on a range of economic activities, not solely the production of livestock through herding (Davies & Bennett, 2007; Hogg, 1997; McPeak & Barrett, 2001). These activities include livestock herding, jewelry making, salt trade, and petty commerce. This range of economic activities in which pastoral households and communities engage

often renders distinction between pastoral and non-pastoral populations quite difficult (Davies & Hatfield, 2007; Hogg, 1997). Livelihood diversification, where households spread their risk by investing across multiple economic sectors, has been widely researched as an instrumental means of decreasing the vulnerability of the household to external shocks and unpredictable income and production (Ellis, 1998; Little *et al.*, 2001; Scoones, 1998). Increasingly, pastoral populations are sedentarizing and employing crop cultivation and small-scale gardening for the sake of livelihood diversification. Unfortunately, research has shown that, for nomadic pastoralists of the Sahel, sedentarization for the sake of agricultural production is not improving livelihood security, due to the large costs associated with maintenance of different livelihoods (Pedersen & Benjaminsen, 2008). Several researchers have concluded that sedentarization of pastoral populations leads to increased rates of impoverishment and destitution (Blench, 2001; Hogg, 1986; Little, 1985; Niamir-Fuller, 2000; Talle, 1999); others adhere to the benefits of pastoral sedentarization, particularly surrounding the benefit of increased access to markets (Campbell, 1984; Ensminger, 1992; Sato, 1997; Smith, 1998). Households within the study area have a range of economic activities that may be more or less significant from one year to the next and, increasingly, may involve some agricultural production.

### **Pastoralism and Vulnerability/Resilience**

Vulnerability is a function of the sensitivity and exposure of a system to an external shock and the adaptive capacity of that system to absorb or recover from consequences of that shock (Adger, 2006; Kelly & Adger, 2000; Turner *et al.*, 2003). Within the climate change literature, adaptive capacity - the ability of a system to adjust to a shock, minimize negative impact, and cope with consequences - has gained important traction

in understanding, assessing, and intervening to reduce vulnerability (Adger, 2006; Gallopin, 2006; Smit & Wandel, 2006). Because global climate change models predict increased climate variability and extreme events in the Sahel, the adaptive capacity of populations to current climate variability serves as a good indicator of their future vulnerability to global climate change (Elasha *et al.*, 2005). Resilience is a concept borrowed from ecology, which refers to an ecosystem's ability to absorb a perturbation and return to a stable state (Holling, 1995). In human systems, the word is used to describe populations that are able to cope and adapt in the face of external shocks, including climate extremes (Davies, 1996). Pastoralists are inherently resilient, as the livelihood is responsive to significant climatic variations (Adger, 2000; Ellis & Swift, 1988; Friedel, 1991; Niamir-Fuller, 2000; Westoby *et al.*, 1989).

Among the most useful contributions to understanding vulnerability/resilience of pastoralists came in the 1990s in what was then referred to as the “new” ecological thinking, which challenged the previously-held assumption that rangelands are equilibrium-based ecosystems (McCabe, 2007; Scoones, 1999). The theory proposes that arid and semi-arid lands are persistent, non-equilibrium systems characterized by ecological variability, unpredictability, and high resilience; it posits that ecological areas of great unpredictability and variability lend themselves to communal management (Niamir-Fuller, 2000). As Grell states, “The evidence shows that there is no sustainable alternative, economically or ecologically, to the pastoral herders’ opportunistic strategies for managing natural resources in arid and semi-arid zones” (pp. 65, Grell & Kirk, 1999). Nomadic pastoralism is seen as an efficient, effective adaptation to instability inherent within the ecosystem (Ellis & Swift, 1988; Friedel, 1991; Westoby *et al.*, 1989).

A key aspect of this resilience is mobility. Pastoral populations employ varying degrees of mobility, and they move in response to ecological, political, and social changes in the environment. A number of researchers have investigated the importance of mobility in pastoral populations and the consequences of decreased mobility (Ellis & Swift, 1988; Fratkin, 1992; Nathan *et al.*, 2005; Roth, 1996; Schwartz, 1995), as more and more pastoral communities have initiated semi-nomadic and even sedentary livelihoods (Keenan, 2000b). In semi-nomadic communities women, children, and the elderly will often stay in a camp around a well for long periods of time, while men travel with herds shorter distances around the well or well system. When grazing land is exhausted, the community may or may not move with the men to another well system, depending upon the time of year (Clarke, 1959). This change in livelihoods allows communities to practice small-scale agriculture and gardening, as well as trade in non-animal goods, such as jewelry.

Other important determinants of pastoral vulnerability include social bonds and social capital, created through exchanges of livestock, re-stocking alliances, dowries, traditional loan mechanisms, and support of the poor through gifts or loans of livestock (Davies & Bennett, 2007; Fratkin, 2004; McCabe, 2007; Niamir-Fuller, 2000; Thebaud & Batterbury, 2001). Just as the functional diversity of an arid ecosystem contributes to its health and resilience, the range of options, adaptations and coping mechanisms available to a pastoral community contributes significantly to its health and resilience.

### **Research Methods**

This study includes analysis of information from document review, secondary data (data previously collected by others and available either publicly or used with permission), and new, primary data collected via key-informant interviews, focus

groups, household interviews, and anthropometric measurements from 2010-2011. Fieldwork was based out of Tanout, Niger and was initiated during the period just post-harvest (late October) in 2010. Seven communities representing livelihoods along an agricultural-pastoral continuum were identified for inclusion in the study (see Figure 3-2). Originally, seven communities were selected from a pool of 19, previously identified for research through a vulnerability assessment during a 2005 British Red Cross food security intervention (Bureau for Applied Research in Anthropology, 2005). However, nomadic pastoralists were not well represented in the 2005 pool of communities, thus, two new pastoral communities with high levels of mobility and ethnic composition that contributed to sample diversity were added to the sample (Eliki and Djijtoji). A third new community (Abdounézé), comparable in ethnic make up, livelihood, and location, replaced one of the 2005 communities (Farak) when political insecurity obviated the possibility of researchers accessing it in November 2010. In repeat communities, the same households that were interviewed in 2005 were targeted in 2010 (BARA 2006a). In new communities, 19 households were randomly selected from a census list for inclusion in the household survey sample, replicating household targeting techniques employed in 2005. In each community, researchers conducted male and female focus groups with randomly selected individuals, and a minimum of three key-informant interviews (elders, teachers, health workers, and spiritual leaders). Research and field assistants collected all data in the primary household languages of Tamachek and Hausa. Research assistants translated responses into French, and I analyzed all data in French.

Hand written data from surveys were entered into spreadsheets in Niger. Data were sorted, cleaned, and rechecked for accuracy in order to reduce data entry error. Descriptive statistics were run for all independent and dependent variables. Data were transferred to SPSS software and quantitative analysis was conducted, applying

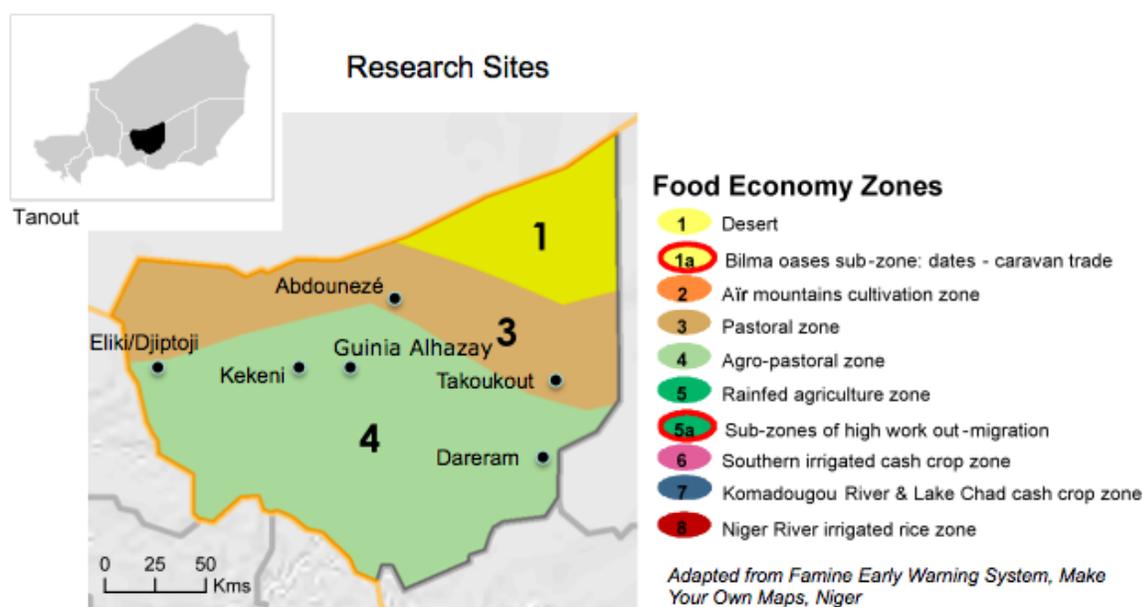


Figure 3-2. Map of Research Area in Eastern Niger (Source: FEWSNET, 2012).

tests of bivariate association (Spearman’s Rho and Pearson’s r) and estimating multiple linear regression models to examine the effects of independent variables on PRCC and vulnerability, while holding demographic, economic, and livelihood data constant (SPSS, 2011). Qualitative data from focus groups and key informant interviews was analyzed using thematic coding, without the use of qualitative analysis software. Findings from the study are organized by research aim and presented here.

### Key Variables

Key variables for this research include livelihood, perceived risk of climate change (PRCC), vulnerability/resilience, food security, health, wealth and various adaptations

and coping mechanisms. Brief definitions, methodologies, and univariate descriptions are given below for each.

### Livelihood

A livelihood index was created using information from 14 questions on the household survey and from more general information collected during focus groups interviews. This data included revenue sources, history of agriculture, history of pastoralism, self-identification as pastoral, and use of migration as herding strategy. Ultimately, I established a seven-item index to represent the agricultural-pastoral continuum on which research households continually move (see Figure 3-3 for index and see Appendix E for full explanation of index creation). Since most households fall somewhere between exclusive reliance on either agriculture or pastoral production, each household is assigned a position (1-7) along the continuum representing their livelihood portfolio at that moment in time, rather than being identified as either agricultural or pastoral (n=128). For each position on the continuum in Figure 1, typical households are described in the text-circle above. Univariate distribution of the livelihood of households in the sample is presented in Figure 3-4.

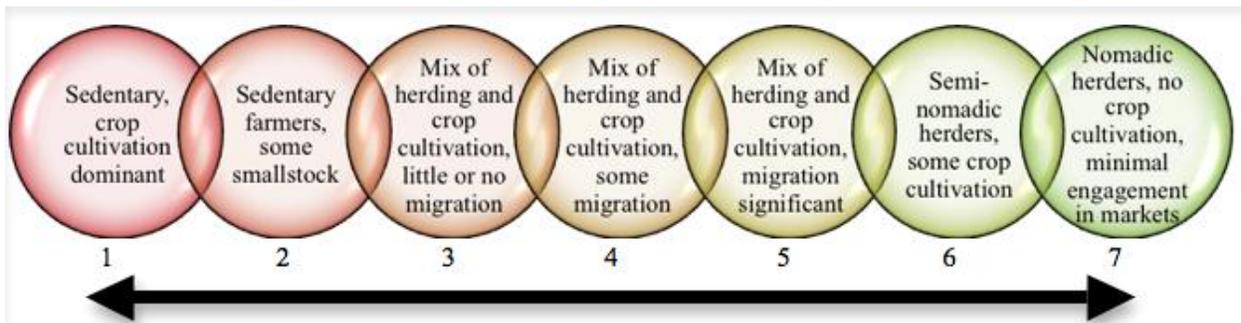


Figure 3-3. Agricultural-pastoral Livelihood Continuum.

## Perceived Risk of Climate Change

An index of perceived risk of climate change was developed based on a) climate change hazards relevant to the community, b) potential harm of each hazard, and c) an assessment of the current situation (Slovic *et al.*, 1982). Perceptions rather than measures of climate change are examined in this study, as perceptions may not mirror ground-truth measures, such as land-use or land-cover change, and household and community decision-making is not always based on fact. Seven areas of potential climate change (hazards) were identified through literature review and focus group discussions at the research site (Elasha *et al.*, 2005; IPCC 2000; IPCC 2007). The hazards identified were: land degradation, condition of vegetation cover, soil and crop productivity, rainfall, desertification, heat/temperature, and loss of indigenous species (plant or animal). Heads of household then assessed each hazard for 1) their capacity to do harm or damage and 2) the change that each household has observed locally. A perceived risk of climate change associated with each hazard was then calculated as the product of capacity to do harm and locally observed situation. The sum of the seven individual products was then used as a summary statistic or index for overall perceived risk of climate change. PCA factor analysis indicated three components within the index. Due to poor inter-item correlation and internal reliability (Chronbach's  $\alpha = .425$ ), an alternate index was created to include only condition of vegetation cover, crop and soil productivity, and heat/temperature (Chronbach's  $\alpha = .557$ ). Both indices were binned into tertiles, representing high, medium, and low perceived risk of climate change, and both were used in initial analysis (n=126, see Figure II).

## **Vulnerability/Resilience**

Since vulnerability/resilience in this context are seen as representing opposite ends of the same spectrum, they were measured using a vulnerability index adapted from Elasha et al. (Elasha *et al.*, 2005). Generic indicators of vulnerability, taken from the previous study and appropriate for the Sahel, were presented to key informants at the research site who helped establish locally appropriate indicators. These indicators were then validated and specified through focus group discussions, and additional indicators were suggested. Ultimately eight items were used in the final survey. Locally specific indicators of vulnerability identified through this process and utilized in construction of the index were: land degradation, condition of vegetation cover, soil and crop productivity, health and sanitation, wealth, access to food, *exode*, and mobility<sup>1</sup>. Heads of household were asked to compare their current situation for each indicator to the situation immediately following the 2005 food crisis (the same time period after two different crises). Respondents indicated whether their situation was worse, about the same, or better than in 2005. PCA factor analysis indicated three components and a Chronbach's  $\alpha$  of .428. Thus, the index was edited to include only five items (removing land degradation, *exode* and mobility), resulting in an index with a slightly higher internal reliability (CA = .547). This index was then binned into tertiles, representing low, stable, and high resilience (n=126, see Figure 3-4).

## **Food Security**

Food security was defined at the World Food Summit of 1996 as the state in which “all people at all times have access to sufficient, safe, nutritious food to meet their

---

<sup>1</sup> *Exode* is the local term used to describe the outmigration, predominately of young men, to other regions of Niger, neighboring countries (Nigeria and Libya), and Europe in search of paid work.

dietary needs and food preferences for an active and healthy life” (Food and Agriculture Organization, 1996). Accordingly, three dimensions of food security have been identified, which are important for both measurement and protection; these dimensions are food availability, food access, and food utilization (Webb *et al.*, 2006). The food security indicator for this study is calculated using a method that assesses the frequency of use and severity of coping mechanisms employed by households, and thus is a measure of food access (Maxwell *et al.*, 1999; Maxwell, 1996). The measure uses a household’s perception of vulnerability as an indicator for household access to food. Changed eating habits, decreased portions at meals, decreased nutritional quality at meals, acceptance of gifts/loans from family and friends, decreased number of meals, collection of wild famine foods, day without eating, and sale of personal belongings are the self-reported coping strategies included in the food security variable. Calculated based on reported use of the strategy and local severity rankings (which mirrored Maxwell’s), the food security variable is a scale from 1-15. For this study, households were assigned a status of mild, moderate or severe food insecurity, based on this scale (n=133, see Figure 3-4).

### **Adaptations/Coping Mechanisms**

During household interviews, data were collected on various coping mechanisms and adaptations, referred to here as strategies. Households were asked to identify all strategies employed during the past year (year of crisis) from a list of possible responses generated during the 2005 crisis and verified in 2010 pilot tests. Households were then asked to identify how often each strategy is employed (commonly, only during exceptional years, or not at all). These strategies included those coping mechanisms utilized to measure food security, as well as others including

sedentarization, reduced mobility, migration, removal of children from school, consumption of own harvest, consumption of own milk/meat, and acceptance of commercial credit or loans. The frequency distribution of certain adaptations and coping strategies is presented in Figure 3-4 (n=130-133, varying by strategy).

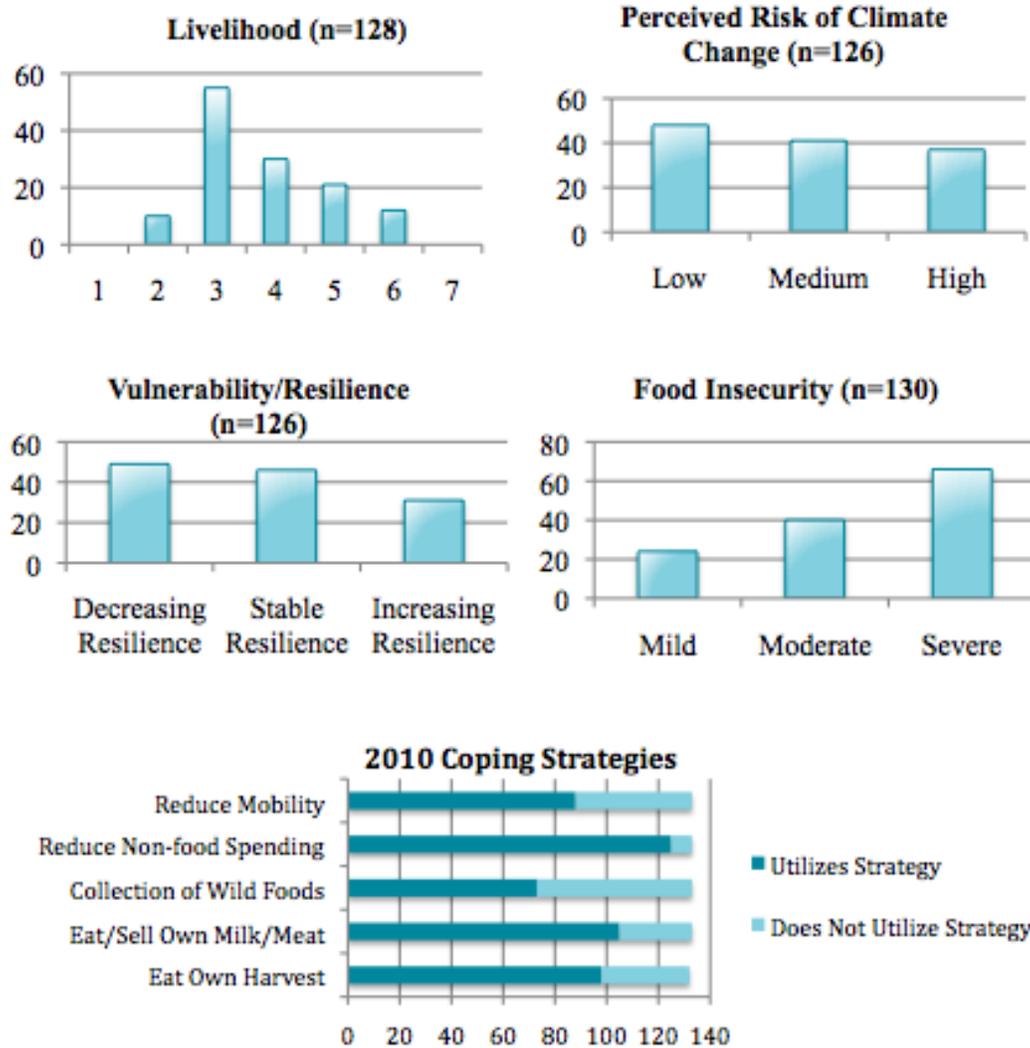


Figure 3-4. Univariate Distribution of Key Variables.

### Wealth

The measure of wealth of households in this study is estimated by assigning average regional market value (in FCFA) to grain and livestock holdings at the time of

the survey for each household and dividing the sum of those values by the number of adult equivalents (AE) per household. Households were then categorized into groups representing poor, average, and wealthy tertiles of the sample population.

### **Ethnicity**

Each of the regression models estimated in this research includes key demographic characteristics as control variables, including ethnicity. Despite that ethnicity is fluid and intermarriage between ethnic groups is not uncommon in Niger, ethnic groups maintain a shared set of opportunities and disadvantages, as well as cultural norms and household practices, that are more similar within than across groups. The differences that exist across groups may have significant effects on the outcome of the model, thus ethnicity is included as a control variable.

## **Findings**

### **Perceptions of Climate Change and Livelihood**

A correlation test was run to assess bivariate association, generating a Spearman's Correlation Coefficient of .045. Although this indicates a positive association between perceived risk of climate change (seven-item index) and livelihood (the greater the perceived risk of climate change, the more pastoral the livelihood), the correlation is not statistically significant ( $p=.625$ ), indicating significant chance that the observed association has occurred due to sampling error. The test was rerun using the modified version of the PRCC variable, and it was still not significant ( $p=.427$ ).

Linear regression was used to estimate a model that regresses perceived risk of climate change on livelihood. The results are not significant ( $p=.528$ ); however they are presented here in the interest of statistics: the slope of the line is .033, indicating that for every unit increase in the independent variable, livelihood (moving toward pastoralism),

there is an increase of .033 in the dependent variable, perceived risk of climate change. The y-intercept, the value of PRCC when livelihood is equal to 0, is 1.765 (where 1 equals low perceived risk and 3 equals high perceived risk of climate change). Thus, the regression equation is:  $PRCC = 1.765 + .033(\text{Livelihood})$ .

None of the findings indicate a relationship between perceived risk of climate change and livelihood. Interestingly, no significant correlation was found between the perceived risk of any individual hazard within the PRCC index (land degradation, land cover, soil productivity, rainfall, desertification, heat, and loss of species) and livelihood. Also of interest, there was no significant correlation between PRCC and wealth ( $p=.129$ ), ethnicity ( $p=.163$ ), or dichotomized livelihood ( $p=.875$ ); and a marginally significant positive correlation between PRCC and food insecurity ( $p=.075$ ).

In focus groups, all seven communities identified rainfall as the most significant and most critical environmental change. Specifically, the quantity and distribution of rainfall is identified as the environmental change with the greatest impact on overall community wellbeing. All communities cite the loss of plant and/or animal species as problematic; two highly agricultural communities (Takoukout and Kékeni, average livelihood index of 2.76 and 2.47, respectively; see Figure 4-5) identified the invasion of non-traditional plant species, those typical of desert landscape, as an indicator of climatic problems within the community. All communities discussed a loss of land cover (particularly trees) within the context of either rainfall deficit or harvesting of wood. Perceptions of climate change, based on focus group data, did not vary by livelihood, i.e., across the livelihood continuum.

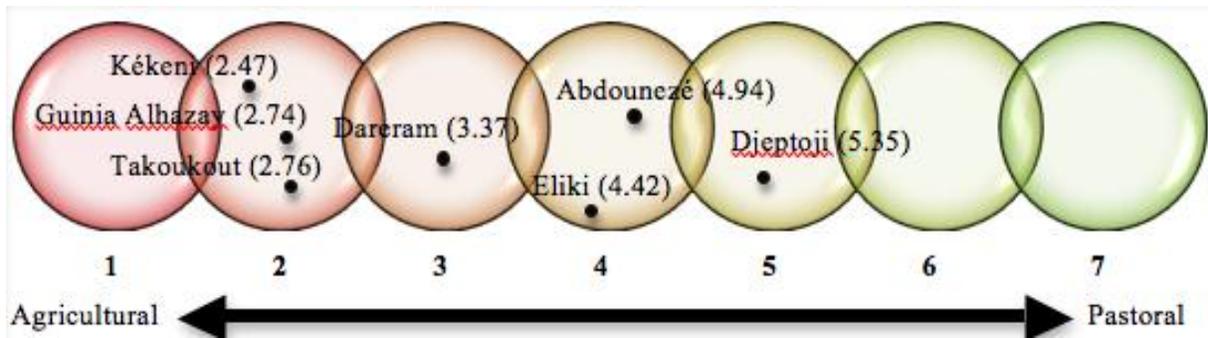


Figure 3-5. Distribution of Research Communities Along the Agricultural-pastoral Livelihood Continuum by Average Household Livelihood.

### Perceptions of Climate Change, Coping Strategies, and Adaptations

In order to better understand climate related risk, households were asked about a number of strategies and whether they employed these strategies during the crisis year. Correlation tests indicate that PRCC (seven-item index) is positively correlated with reducing amount of food ( $p=.095$ ,  $n=125$ ), reducing quality of food ( $p=.095$ ,  $n=125$ ), eating own meat or milk ( $p=.087$ ,  $n=126$ ), collecting famine foods to eat ( $p=.003$ ,  $n=126$ ) and bartering ( $p=.043$ ,  $n=126$ ) as coping mechanisms.

A nested multivariate regression model was estimated to further investigate the relationship between coping strategies and PRCC, taking into consideration other potential confounders. The model includes the following demographic characteristics: household size; sex, age and education of the head of household (HHH); and ethnicity. In addition, wealth and livelihood are included in the model. The results indicate that, among coping strategies identified as significantly correlated with PRCC through bivariate analysis, only the collection of famine foods maintains significance when confounders are included in the model. Results also show that the sale of personal belongings and regular migration are coping strategies associated with a lower perceived risk of climate change (see Table 3-1). Interestingly, education is marginally

positively correlated with risk of climate change in the final version of the model. Also being Fulani, one of the major pastoral ethnic groups in Niger, is highly positively correlated with perceived risk of climate change, indicating a significantly higher reported risk of climate change compared to Hausa (the reference population). Finally, living in a pastoral geographic livelihood zone is marginally positively correlated with risk of climate change as well.

Interaction terms were created to investigate a possible interaction between ethnicity and education. The interaction term was tested in a regression model containing demographic and wealth variables, and no significant effect on PRCC was generated ( $p=.204$ ,  $n=121$ ). Similarly, interaction terms for PRCC and individual coping mechanism (collection of wild foods and regular migration) were created and tested; no significance found ( $p=.128$ ,  $n=121$ ; and  $p=.472$ ,  $n=121$ , respectively).

Though certain coping strategies may be associated with agricultural communities and others with pastoralists, the previous findings stand independent of variations that may exist by livelihood, as the livelihood index is included in the model. However, in order to better understand how climate change might differentially affect the use of coping strategies, the livelihood index was dichotomized into 1) agricultural and 2) pastoral groups: agricultural households consisting of those whose livelihood index was less than four, and pastoral households consisting of those whose livelihood index was greater than or equal to four. While not perfect, this methodology allows for a comparison of strategies employed by those who are more agricultural and those who are more pastoral. Bivariate tests for correlation indicate that households with a livelihood score of four or more (hereafter, pastoral) have a PRCC that negatively

correlates with the strategy of eating one's own harvest ( $p=.020$ ,  $n=50$ ) and positively correlates with collecting famine foods to eat ( $p=.014$ ,  $n=51$ ) and reducing mobility ( $p=.083$ ,  $n=51$ ). In other words, pastoral populations who consume their own harvest

Table 3-1. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Livelihood, Wealth and Coping Strategies on Perceived Risk of Climate Change.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Household Size	.003	.003	.004	.014
Sex of HHH	-.058	-.007	-.018	.051
Age of HHH	-.001	.000	.001	.004
Education of HHH	.044	.046	.047	.101 <sup>^</sup>
Ethnicity				
Hausa	---	---	---	---
Tuareg	-.188	-.064	-.034	-.093
Fulani	.495 <sup>^</sup>	.734 <sup>*</sup>	.763 <sup>*</sup>	.713 <sup>*</sup>
Beri-Beri	-.071	-.065	-.050	-.231
Geographic Zone				
Agricultural	---	---	---	---
Agropastoral	.504	.547 <sup>^</sup>	.518	.440
Pastoral	.416 <sup>^</sup>	.466 <sup>^</sup>	.445 <sup>^</sup>	.321
Livelihood index		-.093	-.086	-.096
Wealth			-.040	.001
Reduce amount of food				.684
Reduce quality of food at meals				-.069
Eat own milk or meat				.099
Collection of famine foods to eat				.604 <sup>**</sup>
Barter				.094
Reduce number of meals				.342
Accept gifts				1.174
Sell personal belongings				-.314 <sup>*</sup>
Regular migration				-.333 <sup>*</sup>
Constant	1.514	1.605	1.683	-.745
Model Fit				
Subset F	3.133 <sup>**</sup>	2.980 <sup>**</sup>	2.744 <sup>**</sup>	3.121 <sup>**</sup>
Adjusted R-square	.137	.141	.137	.260
N	122	122	122	122

Notes: <sup>\*\*</sup> $p<.01$ ; <sup>\*</sup> $p<.05$ ; <sup>^</sup> $.05<p<.10$

Values shown in each cell are unstandardized coefficients

have a lower perceived risk of climate change than pastoralists who do not; and pastoral populations who collect famine foods and those who have reduced their mobility both have a higher perceived risk of climate change than those who have not. Among households whose livelihood index is less than four (agricultural), there is a significant positive correlation between PRCC and eating one's own harvest ( $p=.041$ ,  $n=72$ ), reducing the amount of food consumed ( $p=.042$ ,  $n=72$ ), eating one's own milk or meat ( $p=.065$ ,  $n=72$ ), eating famine foods ( $p=.038$ ,  $n=72$ ), and taking a commercial loan ( $p=.084$ ,  $n=72$ ).

A regression model was estimated to better understand the effect of coping mechanisms on perceptions of climate change (seven-item index) among pastoral populations (livelihood index greater than or equal to four). Household size is significantly negatively associated with PRCC, and education of the HHH is significantly positively correlated with PRCC. When wealth is included in the second model, the effect of household size on PRCC goes away. However the effect of education remains throughout the second and third model<sup>2</sup>. In addition, as previously noted, ethnicity has a significant effect on PRCC. Tuareg households have significantly lower PRCC than Fulani households, and this effect remains throughout all models. As presented in Table 3-2, once demographic and wealth characteristics are included in the model, the coping strategies that are significantly positively correlated with PRCC among pastoralists include accepting gifts, collecting famine foods, *exode*, and reduced mobility. The use of these strategies is associated with a higher perceived risk of climate change. Strategies that are significantly negatively associated with PRCC include regular migration,

---

<sup>2</sup> (Among pastoralists only two of 56 sample households reported members with any education: one had some primary school, and one had completed primary school).

reducing quality of foods, sending family members elsewhere to eat, reduced food spending, and removing a child from school. Again, these represent coping strategies whose use is associated with a lower perceived risk of climate change, net of demographic and wealth characteristics.

Table 3-2. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Perceived Risk of Climate Change Among Pastoral Households.

Independent Variables	Model 1	Model 2	Model 3
Household Size	-.044*	-.038	-.040
Sex of HH	-.297	-.295	-.539*
Age of HH	.007	.007	.001
Any Education HH	1.348*	1.362*	1.368*
Ethnicity			
Fulani	---	---	---
Tuareg	-.943*	-.938*	-1.166*
Geographic Zone			
Agricultural	---	---	---
Pastoral	.523	.504	.303
Wealth		-.050	-.004
Reduce amount of food			1.223
Accept gifts			1.490**
Collection of wild foods to eat			.737**
Regular Migration			-.958**
Reduce quality of foods			-1.951**
Eat own milk or meat			.197
Barter			-.080
Send family elsewhere			-.561**
Reduce food spending			-2.273**
Exode			.640**
Remove child from school			-1.664**
Reduce mobility			.385*
Constant	1.585	2.045	7.365
Model Fit			
Subset F	5.920**	5.084**	4.228**
Adjusted R-square	.371**	.364	.716
N	51	51	49

Notes: \*\*p<.00; \*p < .05; .05 < ^p < .10

Values shown in each cell are unstandardized coefficients

Comparable analysis was conducted for the agricultural population (where livelihood index < 4). Bivariate analysis generated significant correlations between perceived risk of climate change and reduced quality of food ( $p=.06$ ,  $n=72$ ), collecting wild foods for consumption ( $p=.030$ ,  $n=72$ ), regular migration ( $p=.09$ ,  $n=72$ ), and sending a child to work ( $p=.05$ ,  $n=71$ ) among agricultural households. Regression models were then estimated to analyze the relationship between these coping mechanisms and agricultural households' PRCC. Regression analysis, as presented below in Table 3-3, indicates that collection of wild foods and accepting commercial loans are significantly positively correlated with perceived risk of climate change, while the sale of personal belongings is negatively correlated with PRCC among agricultural households. This model explains 19% of the variance in PRCC among agricultural households, compared to 72% explained by comparable pastoral models.

### **Coping Strategies, Adaptations, and Household Vulnerability/Resilience**

The final aim of this research is to understand how certain strategies employed during crisis affect the vulnerability and resilience of households, and whether there is variation in the effect of certain coping strategies by livelihood. While strategies are employed to reduce vulnerability, some meet short-term needs and may render households more vulnerable in the long-run, while others may reduce the vulnerability of agricultural communities, but increase the vulnerability of pastoralists, or vice versa.

Based on self-reported measures of vulnerability across all livelihoods, bivariate tests of correlation show that the following strategies positively correlate with high self-reported household vulnerability: reducing number of meals, reducing amount of food at meals, fasting on certain days, and consuming one's own milk/meat.

Table 3-3. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Perceived Risk of Climate Change Among Agricultural Households.

Independent Variables	Model 1	Model 2	Model 3
Household Size	.038	.039	.033
Age of HH	.000	-.001	.004
Sex of HH	.153	.153	.238
Education of HH	.514	.518	.685*
Ethnicity			
Hausa	---	---	---
Tuareg	.596	.585	.618
Fulani	1.313*	1.330**	1.456^
Beri-Beri	-.039	-.045	-.323
Geographic Zone			
Agricultural	---	---	---
Agropastoral	1.145*	1.154*	1.114*
Pastoral	.892*	.901*	.812*
Wealth		.013	-.008
Reduce quality of food			.809
Collection of wild foods to eat			.651**
Regular migration			-.172
Send child to work			.171
Reduced mobility			.311
Accept commercial loan			.506*
Sell personal belongings			-.485*
Constant	.497	.480	-.722
Model Fit			
Subset F	1.799^	1.595	1.945*
Adjusted R-square	.094^	.079	.191*
N	70	70	69

Notes: \*\*p<.01; \*p < .05; .05 < ^p < .10

Values shown in each cell are unstandardized coefficients

Conversely, accessing grain banks and sending children to work are both correlated with low self-reported household vulnerability. In other words, bivariate analysis indicates that when food supplies are protected through a grain bank and child labor opportunities exist, people report being less vulnerable. People report feeling more vulnerable when consumption patterns have had to change – including reductions

Table 3-4. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Coping Strategies and Livelihood on Self-reported Resilience, All Households.

Independent Variables	Model 1	Model 2	Model 3	Model 4
Household Size	-.019	.019	-.021	-.032
Age of HH	.001	.001	-.206	-.282
Sex of HH	-.238	-.227	.001	-.003
Education of HH	-.019	-.018	-.021	-.038
Ethnicity				
Hausa	---	---	---	---
Tuareg	.114	.148	.076	.247
Fulani	-.501*	-.437	-.513	-.317
Beri-Beri	.107	.108	.086	.050
Geographic Zone				
Agricultural	---	---	---	---
Agropastoral	-.046	-.032	.005	.170
Pastoral	-.090	-.074	-.056	.130
Livelihood index		-.023	-.031	-.053
Wealth tertiles			.071	.057
Reduce number of meals				-.362
Reduce amount of food				-.370
Fasting day				.093
Eat own milk or meat				-.167
Cereal bank				.332 <sup>^</sup>
Send child to work				.255 <sup>^</sup>
Constant	2.451	2.472	2.321	3.034
Model Fit				
Subset F	2.142*	1.920*	1.917*	2.267**
Adjusted R-square	.070	.071	.078	.152
N	121	121	121	121

Notes: \*\*p<.01; \*p < .05; .05 < <sup>^</sup>p < .10

Values shown in each cell are unstandardized coefficients

in the number of meals or amount of food at meals, use of fasting days or having had to eat into their own stock.

These findings were used to estimate a regression model examining the effects of coping strategies on self-reported vulnerability, within the context of potential

confounders. When demographic, livelihood, and wealth variables are included in the model, none of the strategies previously associated with high vulnerability are statistically significant; only those associated with low vulnerability (accessing grain banks and sending children to work) are marginally significant see (Table 3-4).

Despite having included livelihood in the previous model, livelihood was again dichotomized to investigate the use of coping strategies and consequent vulnerability in pastoral communities. Bivariate analysis showed that, among all coping strategies, only accepting commercial loans was significantly correlated with vulnerability (decreased vulnerability, in this case). A regression model was estimated to see how coping strategies affect self-reported resilience when demographic and economic characteristics of the household were included in the model. Results are presented in Table 3-5, showing a significant negative correlation between reducing the amount of food consumed and household resilience (indicating an increase in vulnerability with use of the strategy) and a significant positive correlation between household resilience and accepting a commercial loan (decrease in vulnerability with use of the strategy), net of household demographic characteristics and wealth. Additionally, the model shows that household size has a positive significant correlation with resilience (the larger the household, the less vulnerable the household) and age of HHH has a negative significant correlation with resilience (the older the HHH the more vulnerable the household). Once again, ethnicity has a significant predictive power on self-reported resilience among pastoralists, with Tuareg households reporting much higher resilience than their Fulani counterparts.

Table 3-5. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics, Wealth and Coping Strategies on Self-reported Resilience Among Pastoral Households.

Independent Variables	Model 1	Model 2	Model 3
Household Size	.066 <sup>^</sup>	.075*	.102*
Age of HHH	-.016 <sup>^</sup>	-.016*	-.022*
Sex of HHH	-.204	-.202	-.035
Education of HHH	.096	.116	-.109
Ethnicity			
Fulani	---	---	---
Tuareg	.994**	1.003**	.887**
Geographic Zone			
Agricultural	---	---	---
Pastoral	.069	.039	-.224
Wealth		-.078	-.116
Reduce amount of food			-1.845 <sup>^</sup>
Reduce quality of food			1.318
Accept commercial loan			.456 <sup>^</sup>
Constant	1.443	1.697	2.549
Model Fit			
Subset F	2.865*	2.642*	2.631*
Adjusted R-square	.183*	.301	.409 <sup>^</sup>
N	51	51	49

Notes: \*\*p<.01; \*p < .05; .05 < <sup>^</sup>p < .10

Values shown in each cell are unstandardized coefficients

Comparable data was then analyzed for agricultural communities (where livelihood index < 4) in order to compare the impact of coping mechanisms of self-reported vulnerability by livelihood. Bivariate analysis indicates significant correlation between household resilience and the coping mechanisms of eating one's own harvest (p=.04, n=72), reducing amount of food (p=.04, n=71), eat one's own milk/meat (p=.06, n=72), and the collection of wild foods to eat (p=-.38, n=72). However, none of these was significantly significant when included in regression models that control for demographic and wealth characteristics of the household. As seen in Table 3-6, among agricultural

households, having access to a cereal bank and regular migration were the only coping mechanisms significantly positively correlated with self-reported resilience.

Table 3-6. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics and Coping Strategies on Self-reported Resilience, among Agricultural Households

Independent Variables	Model 1	Model 2	Model 3
Household Size	-.059*	-.055*	-.063*
Sex of HHH	-.018	.011	.007
Age of HHH	.016*	-.024	.122
Any Education HHH	-.369	-.325	-.279
Ethnicity			
Hausa	---	---	---
Tuareg	-.578	-.718^	-.517
Fulani	-1.462**	-1.255*	-.511
Beri-Beri	.132	.058	-.149
Geographic Zone			
Agricultural	---	---	---
Agropastoral	-.849^	-.737^	-.386
Pastoral	-.797*	-.686^	-.258
Wealth		.165*	.184*
Eat own harvest			.314
Reduce amount of food			-.249
Collection of wild foods to eat			-.070
Cereal bank			.489*
Regular migration			.462*
Constant	2.612	2.403	1.994
Model Fit			
Subset F	2.346*	2.727*	2.545*
Adjusted R-square	.149*	.200*	.267^
N	70	70	69

Notes: \*\*p<.00; \*p < .05; .05 < ^p < .10

Values shown in each cell are unstandardized coefficients

## Discussion

Analysis of data from seven communities in eastern Niger shows no significant difference in the perception of risk from climate change across the agricultural-pastoral livelihood continuum. This finding is important, as future researchers and policy-makers

will work with various groups to appropriately adapt to and cope with the negative consequences of climate change and will be required to identify subgroups within which the experience of climate change differs (e.g., sex, wealth, ethnicity, nearness to road, access to grain bank, etc.). It is important to note that the lack of significant findings may be in part due to the narrow range of livelihoods included in the sample population. Otherwise stated, a sample population that included households with a broader range of agricultural and pastoral livelihood practices might find different results when measuring the perceived risk of climate change. Though this finding must therefore be validated in other locations and with other research tools, it suggests that livelihood is not a determining factor in the perception of household risk to climate change.

However, perception of climate change is correlated with specific coping strategies and the nature of this relationship varies significantly by livelihood. Only the collection of famine foods is significantly positively correlated with perceived risk of climate change for all livelihoods. More often, different coping strategies are associated with PRCC for different livelihoods, and some are in direct contrast. For example, eating one's own harvest significantly positively correlates with PRCC among agricultural households and significantly negatively correlates with PRCC among pastoral households. Though temporal sequence cannot be determined through this cross sectional survey, this finding points to a distinction between the pastoral and agricultural communities' experience of climate change and eating one's own harvest. Similarly, coping strategies concerning mobility differentially affect the pastoral populations of this study; bivariate analysis indicates that reduced mobility is positively associated with the perceived risk of climate change, and linear regression illustrates that regular migration is negatively

associated with the perceived risk of climate change. These findings reinforce the significance of mobility in pastoral resilience, as those who are more mobile are those reporting lower risk of climate change.

This research also indicates that certain strategies are associated with vulnerability. For pastoralists, reducing the quality of food and accepting commercial loans are both strategies associated with decreased vulnerability. However, this association varies between livelihood groups. Thus, because perception of climate change is associated with the use of certain coping strategies - which themselves are associated with vulnerability, but vary based on livelihood - it is too early to relinquish the idea that the perception of climate change might be acting as a driver for certain coping mechanisms that have consequences on household vulnerability. In the example outlined above, if mobile pastoralists are more likely to report lower risk of climate change, one possible explanation is that these populations reduce mobility as risk increases; equally possible, however, is that risk related to climate change increases as pastoralists decrease their mobility. Further research is needed to clarify this association.

In analyzing the relationship between climate change, coping strategies, and household vulnerability, a number of confounding factors, included in the regression models, surfaced as significant determinants of PRCC. Not surprisingly education, household size, ethnicity, and geographic livelihood zone all had a significant effect on PRCC within the regression models. Education and northern (pastoral) proximity of livelihood zone were positively correlated with PRCC, as was being Fulani (as compared to Tuareg, Hausa or Beri-Beri). Among pastoral populations, Fulani have

significantly higher self-reported vulnerability than Tuareg populations and have a significantly higher reported PRCC. These findings support qualitative information indicating that Fulani populations were severely affected by the 2010 crisis due to the widespread loss of cattle and donkey populations (the primary large livestock of the Fulani); camel populations (historically herded by Tuareg) were less affected. Variation in household size and education are presented in Table 3-7 below. This data is important when interpreting results.

Table 3-7. Percent of household heads with any education and mean household size by ethnicity.

	Percent of household head's with any education	Mean household size
Hausa (32)	9.4%	8.91
Tuareg (44)	2.3%	6.38
Fulani (31)	3.2%	9.97
Beri-Beri (23)	17.4%	8.21

Because of the dynamic nature of pastoral livelihoods in Niger, this research developed and utilized a livelihood index, in lieu of ethnicity or primary income source, in its attempt to identify and understand how pastoral households are experiencing and responding to climate change. Though the seven point livelihood index did not have a significant effect on either the PRCC or vulnerability models in this research, creating a dichotomous variable from the index allowed for a more robust definition of pastoralism than is typically used. By creating the index before dichotomizing the population, the complexity of pastoral livelihoods is better captured, which is meaningful in an environment like Niger, where identification as an agriculturalist or a pastoralist is nuanced and complex. Table 8 provides a comparison of findings among agricultural and pastoral communities – identifying coping strategies that are correlated with

Table 3-8. Comparison of coping strategies correlated with PRCC and vulnerability/resilience by livelihood

	Agricultural (1-3 <sup>3</sup> )	Pastoral (4-7)
Descriptive characteristics of livelihood (livelihood index 1-7):	Highly sedentarized; more permanent dwelling structure; largely reliant on crop cultivation for household economy; some small stock; minimal if any migration with livestock; some history of migration with livestock, but moving toward agricultural production	Historically nomadic herders; some practice transhumance; highly mobile population; focus on management of livestock herds (camel and cattle); non-permanent dwelling structures; reliance on livestock, milk and meat for household economy
Coping strategies associated with increased risk of climate change	<ul style="list-style-type: none"> <li>• Wild foods</li> <li>• Accepting commercial loans</li> </ul>	<ul style="list-style-type: none"> <li>• Accepting gifts</li> <li>• Collecting famine foods</li> <li>• <i>Exode</i></li> <li>• Reduced mobility</li> </ul>
Coping strategies associated with decreased risk of climate change	<ul style="list-style-type: none"> <li>• Sale of personal belongings</li> </ul>	<ul style="list-style-type: none"> <li>• Regular migration</li> <li>• Reducing quality of foods</li> <li>• Sending family members elsewhere to eat</li> <li>• Reduced food spending</li> <li>• Removing a child from school</li> </ul>
Coping strategies associated with increasing vulnerability	<ul style="list-style-type: none"> <li>• None</li> </ul>	<ul style="list-style-type: none"> <li>• Reducing the amount of food consumed</li> </ul>
Coping strategies associated with increasing resilience	<ul style="list-style-type: none"> <li>• Grain bank</li> <li>• Regular migration</li> </ul>	<ul style="list-style-type: none"> <li>• Accepting a commercial loan</li> </ul>

<sup>3</sup> These numbers represent positions along the livelihood index.

climate-related risk and coping strategies that are correlated with vulnerability/resilience for each group. Use of the livelihood index in this way may be meaningful in the development of appropriate livelihood interventions.

Although more research is required to determine the full utility of a livelihood index, it is reasonable to assume that use of a continuum, as a tool for generating rich distinction between livelihood groups, will allow for more appropriate interventions to improve pastoral livelihoods. As pastoral populations face the imminent threat of climate change in the Sahel, researchers and policy makers must be mindful to define exactly who the population is that they are targeting, and what it is about that population that renders them vulnerable – mobility, geographic location, herd health, or otherwise. As evidenced by this research, the coping strategies employed by households during food crisis and their effects on household vulnerability vary by livelihood, thus the definition of what makes someone a pastoralist must be carefully examined and articulated.

## CHAPTER 4 UNDERNUTRITION AND FOOD SECURITY IN NIGER – A STUDY OF AGROPASTORAL COMMUNITIES FOLLOWING THE 2005 AND 2010 FOOD CRISES

### **Introduction**

Food insecurity is a chronic problem in Niger. The country is characterized by widespread poverty, a lack of infrastructure, low education, and erratic low rainfall. In addition, extreme climatic events associated with climate change, including floods, droughts, and extreme heat, are further disrupting the fragile systems of rainfed agriculture and livestock production that the population depends upon for food. Consequently, rates of malnutrition – specifically, undernutrition – remain high, even in years of average or above average crop and livestock fodder production. Although malnutrition includes micronutrient deficiencies as well as overnutrition (obesity), the ongoing nutritional crisis in Niger is driven by undernutrition, or a lack of protein and/or calories. In years of crisis, such as the recent events of 2005, 2010, and the unfolding situation of 2012, undernutrition rates soar. The Nigerien government, along with national and international non-governmental organizations, monitors rates of undernutrition, and early, heightened undernutrition rates, generated by ongoing surveillance of child growth, serve as an indicator of impending crisis. Nationally, the multiplicity of causes of undernutrition is complex and likely varies across crisis years, as does the national/international response triggered by crisis. In 2005, the national government refused to acknowledge and appropriately respond to the severity of the food crisis, and international response was late and uncoordinated. Research indicates that the lessons learned by humanitarian aid groups in 2005 and changes implemented in policy and government response since then facilitated improved response during the 2010 crisis (Baker & Ngendakuriyo, 2011; Tsai, 2010), when once again, crop and

fodder production were low, and rates of undernutrition and child mortality were extraordinarily high. In 2010, response was timely, widespread and coordinated, compared to 2005 (Baker & Ngendakuriyo, 2011; Georgieva, 2011).

This study examines risk factors associated with undernutrition in children 6-60 months in communities in eastern Niger. Utilizing data collected in the post-harvest period just after the food crises in 2005 and 2010, this study seeks to investigate the role of food security and humanitarian food aid as determinants of nutrition.

The remainder of this article is arranged as follows. First, a review of the literature describes the nutritional situation of Niger, including a discussion of food insecurity as one of multiple causes of malnutrition, and provides information on the 2005 and 2010 crises. Next, the article outlines research methods that were utilized during data collection and data analysis. A presentation of research findings follows this chapter and includes 1) an analysis of undernutrition in the 2005 and 2010 crises, including qualitative explanations of the contrasting experiences of two communities during the 2005 and 2010 crises, and 2) a quantitative investigation of the role of food security and humanitarian food aid in the 2010 crisis. Finally, the article closes with a discussion of key findings and their implications on future research and humanitarian relief and development activities.

## **Background**

### **Niger and Nutrition**

Niger, a land-locked country in the African Sahel, is consistently ranked among the least developed countries in the world, based on the United Nations Human Development Index (United Nations Development Program (UNDP), 2011). Its population is among the most rapidly growing in the world and relies almost entirely on

subsistence, rain-fed agriculture for its food supply. Much of the government's budget comes from foreign assistance, and livestock and uranium are among the few exported goods. The population 16.1 million is projected to reach 30.8 million by 2010, due to the alarmingly high 3.6% growth rate. The child mortality rate is 167 per 1000 live births, one of the highest rates in the world (United Nations Development Program (UNDP), 2011).

In this context, nutrition is in, arguably, a chronic state of emergency in Niger (Blackwell *et al.*, 2010). The prevalence of total undernutrition (defined as weight-for-height Z scores [WHZ] of <-2 and/or edema) in 2009, a non-crisis year, was 12.3 percent in children under-five, and prevalence of severe undernutrition (defined as WHZ of <-3) was 2.1 percent (UNICEF, 2009). In Zinder region, the research area for this study, the prevalence of total undernutrition was 15.4% in 2009 – slightly above the 15 percent threshold used by the UN and other aid organizations as an indicator of emergency situation (UNICEF, 2009). Thus, even in normal years, nutrition is an urgent problem.

### **Causes of Malnutrition**

It is widely understood that inadequate food intake particularly in the first two years of life leads to stunting and wasting in children. However, research has made clear that food availability, which is often restricted during food crisis, is not the only determinant of food intake or malnutrition (Smith & Haddad, 2001). Breast-feeding practices, food quality, and disease state within the household are among the many other factors that affect nutritional status in the household. In 1990, UNICEF produced a conceptual framework illustrating the causes of malnutrition at the household level that has been modified only slightly over the past 20 years (UNICEF, 1990). The framework identifies

the immediate causes of malnutrition as inadequate food intake and poor health or disease. Importantly, the conceptual framework also identifies three underlying causes: poor health services and unhealthy environment (insufficient clean water), inadequate care of women and children, and inadequate household food security. This section reviews each of these underlying causes of malnutrition and examines the contribution of each cause to the overall nutritional situation in Niger.

A poor health system and poor environmental conditions contribute to malnutrition by fostering disease, one of the immediate causes of malnutrition. In the context of a food crisis, poor health infrastructure is problematic because the population will be more vulnerable to malnutrition and other negative health outcomes because of the reduced state of health prior to the crisis. Poor health infrastructure and systems may exacerbate the problem of malnutrition in a crisis if the system lacks the ability to effectively accommodate increased numbers of malnourished or otherwise ill children caused by the crisis (Grobler-Tanner, 2006). Although overall funding for health appears to be improving, as is evidenced by the near doubling of the percent of GDP spent on health from 3.6% in 2003 to 6.1% by 2009, Niger is still below the average for sub-Saharan Africa (6.9% in 2009), and historic patterns of underfunding have led to an extremely weak health system (UNDP, 2011). Recent research has shown that while private financial contributions in aid to Niger increased between the 1999-2002 and 2003-2006 time periods, government funding of healthcare decreased dramatically, a trend that is replicated throughout much of Sub-Saharan Africa (Lu *et al.*, 2010). In 2004, there were 377 physicians in Niger, or 3 per 100,000 people (World Health Organization, 2006). A skilled birth attendant is present at only 33% of births and the total fertility rate is 6.9

(UNDP, 2011). In general, health services are either missing entirely or largely dysfunctional. Basic health indicators demonstrate this point; under-five mortality is 160 per 1,000 live births and life expectancy at birth is 54.7. Basic hygiene and sanitation is a problem, as 64% of the population lacks access to clean water and 89.3% lacks access to improved sanitation (UNDP, 2011).

Care of children, particularly infants and young children, plays a significant role in determining their dietary intake and can be detrimental to nutrition, even in a context of food security (Brown *et al.*, 1988; Dettwyler, 1989; Shankar *et al.*, 1998). Practices essential for infant and young child health include early exclusive breastfeeding, which has been shown to reduce mortality in developing countries (Edmond *et al.*, 2006; Mullany *et al.*, 2008); appropriate complementary feeding (Brown *et al.*, 1988; Engle, 2002); and birth spacing (birth to birth) of at least three and no more than five years (Rutstein, 2005; Wuehler & Biga Hassoumi, 2011). A 2007 national nutritional survey in Niger indicated that only 9% of children are exclusively breastfed for six months, as recommended by WHO, and less than 25% of children are fed within the recommended first hour of birth (République du Niger, 2007). Analysis of 2006 demographic and health data indicates that 50-75 percent of Nigerien children are not consuming age-appropriate quantity or quality of complementary foods (Wuehler & Biga Hassoumi, 2011). Food allocation within the household is also a key determinant in dietary intake in Niger, affecting both the quality and quantity of food consumed, particularly among women and young girls who are often the last to eat.

The low status of women in Niger problematizes nutrition, as the marginalized status of women has been linked to poor nutrition in children (Smith *et al.*, 2003; Smith

& Haddad, 2001). Niger has one of the lowest female literacy rates in Africa (11.6% of women age 15-24 are literate), one of the highest fertility rates (6.9) and one of the highest maternal mortality ratios (820 deaths per 100,000 live births; UNDP, 2011). All of these factors serve as an indicator of the low overall status of women (Shen & Williamson, 1999). The Gender Inequality Index is a tool developed and utilized by UNDP to illustrate the disadvantage of women through reproductive health, empowerment, and labor market statistics. In 2011, Niger's index value was 0.724, ranking it 144 out of 146 countries (UNDP, 2011). The 2006 Demographic and Health Survey indicates that the average age at first marriage – another important indicator of women's status – is 15 in Niger, one of the lowest in the world (Macro International Inc., 2007). The poor status of women negatively impacts the health of the household, particularly children. Where women have better access to and control over food resources, both women and children have better health outcomes, including lower rates of undernutrition. Where women lack this control, due in part to their status and the care society takes of women, children are much more likely to suffer from undernutrition.

Food security is defined as a state where “all people at all times have access to sufficient, safe, nutritious food to meet their dietary needs and food preferences for an active and healthy life,” inferring both physical and economic access to foods (Food and Agriculture Organization, 1996). There are three dimensions of food security: food availability, food access, and food intake (Webb *et al.*, 2006). These dimensions are hierarchical – each one a requirement for those dimensions which follow. The relationship between household food access (which requires food availability) and

household nutrition (a metric for food intake) is complex. Securing access to food does not necessarily eliminate malnutrition; it is a necessary but not sufficient condition (Pinstrup-Andersen, 2009). Even when families are able to bring adequate amounts of nutritious food into the household, this does not ensure that everyone in the house will be well nourished – feeding practices of infants and preferential feeding of boys illustrate how age and sex of a child may create increased risk for undernutrition. Household food insecurity is a chronic problem in Niger, as both availability and access are insecure. There are multiple ways that food security is routinely threatened: 82% of Nigeriens live in severe poverty, so financial access to enough quality food is a regular obstacle for many households (UNDP, 2011); seasonal variations in food availability for humans and livestock (in good years) mean fluctuations in household income and expenditure on food and, thus, regular annual periods of limited food supply or hungry seasons (Grobler-Tanner, 2006); and political instability restricts movement, which may limit physical access for buyers and sellers to markets, and/or hamper humanitarian aid activities that aim to strengthen livelihood and food security through various interventions (Tsai, 2010). Additionally, those who have money or other assets control the food that is available.

Climatic events are also a major threat to food security in Niger, as climate change is predicted to have a number of dire consequences on the agricultural sector, largely due to changing rain patterns, with increased incidences of both flooding and drought (Nelson *et al.*, 2002). Increased frequency and severity of extreme climatic events, characteristic of climate change projections for the Sahel, have manifested recently in years of poor agricultural production and livestock fodder growth, limiting both

availability of grains and access through market exchange (Battisti & Naylor, 2009; Ben Mohamed *et al.*, 2002; Held *et al.*, 2005; IPCC, 2007). This situation, overlaid on a web of political and economic realities distinct to each year and underlain with continued inequities (e.g., gender, ethnicity), lead to situations of food crisis in 2005 and 2010. The existing high burden of disease, low rates of early exclusive breastfeeding, weak health infrastructure, and poor health and sanitation render Nigeriens nutritionally depleted – independent of crisis years – and extremely vulnerable to malnutrition in the face of environmental shocks.

### **2005 Crisis**

The 2005 food crisis was the result of both structural determinants as well as distinct events that occurred that year. As previously outlined, a number of structural causes of food insecurity and undernutrition persist in Niger; these include widespread poverty, rapid population growth, climate change, and unsustainable agricultural practices. In addition to these factors, the Nigerien government had been drawing down its National Food Reserve Stock for a number of years, so that by 2005 it was well below the 50,000 metric tons (MT) of reserved grains and the financial reserves to purchase an additional 60,000 MT that were supposed to be in place, based on historic food security policies (Wilding *et al.*, 2005). This was the situation in 2004, when a regional cricket infestation decimated pastures and early cessation of rains caused scattered crop failure and deficits throughout the country. While the cricket infestation and poor rains certainly affected crop production, harvest deficit was 223,500 MT, only 11% below the 1999–2003 average (Government of Niger *et al.*, 2004; USAID, 2005). There was, however, a 4.6 million MT fodder deficit, and the impact of livestock famine on food security and human suffering was not appropriately included in the assessment

and response of the 2005 situation (Wilding *et al.*, 2005). Overall, there was very poor analysis of the regional situation as well. The cricket infestation was foreseeable, as the damage was reported months before in neighboring countries of Mauritania and Senegal. Effective regional analysis of grain markets could have predicted a shortfall of grain availability, but instead Nigerien officials designed a plan that relied heavily on importation of grains from Nigeria and other neighboring states. Regional markets hampered this plan when borders were closed, prohibiting the importation of grains into Niger, and countries within the region reduced exportation to Niger, both to meet their own national cereal needs and to respond to coastal countries' demands, where purchasing power is greater (Mousseau & Mittal, 2006; Wilding *et al.*, 2005). Nigerien President Mamadou Tandja downplayed the severity of the situation, delaying subsidization of foods and refusing distribution of free food until it was much too late to achieve positive impact (Tectonidis, 2006). Consequently, grain prices soared to 2-3 times their normal prices during the lean season of 2005; undernutrition rates rose above 20 percent; 3.3 million people were affected by food shortage; and thousands of children died (McKune & Silva, 2012; Mousseau & Mittal, 2006; Tsai, 2010). The humanitarian response was delayed and unorganized, culminating in the bulk of aid arriving too late (Cornia & Deotti, 2008; Mousseau & Mittal, 2006; Wilding *et al.*, 2005). Nearly all of the aid that came into Niger during the 2005 crisis went through international relief organizations, rather than through the Nigerien government, where it might have had the added benefit of reinforcing existing systems and improving capacity of the state to respond (Wilding *et al.*, 2005).

## 2010 Crisis

Due to a shorter than normal rainy season, like 2004, the 2009 growing season resulted in reduced crop and livestock fodder production. After harvest, there was a national cereal deficit of 410,000 MT; an estimated 40% of agricultural villages lost half or more of their crop production and total grain yields were on average 30% below the previous season's harvest (Tsai, 2010). As well, pasture production of fodder was estimated to meet only 67% of livestock requirements, which led to massive and premature transhumance to the southern part of the country (FEWS NET, 2010). A national survey conducted in April 2010 indicated that 7.1 (47.7%) million people, nearly half of the population, were at risk of food insecurity, and that 22.2% were extremely food insecure and 25.5% were moderately food insecure (Baker & Ngendakuriyo, 2011). A nutritional survey from late May/early June 2010 showed the rate of total undernutrition among children 6-60 months to be 16.7% and of children 6-24 months to be 26.1% (National Institute of Statistics & Ministry of Public Health, 2010). As in 2005, President Tandja downplayed the situation; however this position was quickly reversed in February 2010 after a military coup overthrew Tandja's government. The interim militia government quickly put together an emergency appeal for international assistance. Recognition of the looming crisis and timely appeal to international donors by the Government of Niger was followed by an improved response by the international community. Where previously there was a lack of coordination, NGOs clustered into four areas active during the response to ensure effectiveness, efficiency and impact (Wilding *et al.*, 2005). Aid arrived during the *sourdure*, the hungry season, rather than weeks before the next harvest, and it went through an existing public system designed and structured to deal with this type of crisis: the National Framework for the Prevention

and Response to Food Crises (*Dispositif National de Prévention et de Gestion des Crises Alimentaires*). Rather than aid going almost entirely through international aid organizations, as it did in 2005, it served to reinforce capacity of existing infrastructure within the Nigerien government. In addition to an improved response by a government that no longer approached food crises as taboo and by an engaged and orchestrated international community, the regional markets were better functioning in 2010, which allowed for improved food security in Niger through international safety-nets (Tsai, 2010).

Despite these improvements, the 2010 crisis saw some setbacks compared to the 2005 crisis, due in large part to political security. In 2007, after a 20-year peace, unrest in the northern pastoral zones of Niger was reignited, catalyzing sporadic outbreaks of violence. The situation remained tenuous through the 2010 crisis. Political insecurity in the region restricted the movement of humanitarian and development assistance personnel into a priority zone, as well as the movement of Nigeriens who might otherwise have been mobile in these areas as part of a coping mechanism during the crisis. In addition, the insecurity in this area leading up to 2010 led to the withdrawal of a number of development and economic programs that were investing in the area. The presence and activity of an al Qaeda cell, al Qaeda in the Islamic Maghreb (AQIM), in Niger further complicated aid efforts throughout the country; as the safety and security of expatriate staff working with international NGOs was jeopardized and aid workers were increasingly targeted, more and more NGOs pulled out of the region.

### **Methods**

Research assistants collected data from November 2005 through February 2006 and from October 2010 through January 2011. Tanout, Niger served as the research

base and the University of Arizona and British Red Cross (BRC) Cash Distribution Monitoring and Evaluation project identified the original sample (Bureau for Applied Research in Anthropology, 2005, 2006a). In the BRC project, a research team visited 361 households from 19 communities four times over the course of a year, and collected household and community level data through surveys, key informant interviews, focus groups, and anthropometric measurements. Data utilized in this research comes from one of four phases of this project. I served as a project manager on the BRC project and was involved in data collection and analysis from November 2005 through the end of the project in February 2007. I designed the 2010 research to utilize and build upon the 2005 data. Thus, the 2010 research targets four of the 2005 communities, along with three new ones, for participation during the same post-harvest time period following the crisis, and collects comparable nutritional data, as well as new data on mobility and climate change.

The seven communities included in the sample represent livelihoods along an agricultural-pastoral continuum. Some of these livelihoods are more reliant on livestock herds and high mobility, while others are more sedentarized and reliant on agriculture. Originally, the seven communities were selected from the 19 BRC communities, based on livelihood composition. However, because nomadic pastoralists were not well represented in the 2005 pool of communities, and because representation across the livelihood spectrum was important to the study, two nomadic pastoral communities with high levels of mobility and an ethnic composition that contributed to sample diversity (Eliki and Djiptoji) replaced two of the communities originally targeted. A third new community (Abdounézé), comparable in livelihood, ethnic make up, and location,

replaced one of the 2005 communities (Farak) when insecurity obviated the possibility of researchers accessing it in November 2010.

In repeat communities, researchers targeted the same households interviewed in 2005 for inclusion in the 2010 sample (BARA 2006a). Where original households were not available (this occurred less than twice per site), research assistants randomly selected new households for inclusion. In new communities, research assistants randomly selected 19 households from a census list for inclusion in the household survey sample, replicating household targeting techniques employed in 2005 in order to maximize consistency. In each community, researcher assistants conducted male and female focus groups with randomly selected individuals; conducted a minimum of three key-informant interviews (elders, teachers, cereal bank managers, health workers, and spiritual leaders); and collected anthropometric measurements of children 6-60 months.

Focus groups of six to eight individuals were conducted within the community, usually on mats in open-air or in tent dwellings. Although the research team attempted to secure privacy, inevitably community members gathered to listen and sometimes contributed to the focus group discussion. Researchers discouraged participation by non-members, but community norms of inclusion often trumped researcher efforts and groups became as large as 12-15 people.

Field assistants collected anthropometric measurements, including height, weight, age, and middle upper arm circumference (MUAC), on all children 6-60 months of age from targeted households. Where this number was less than 40, the sample included additional children from the community until 40 individuals were measured. In some communities, sample households contributed more than 40 children, thus there is some

variation in the number of children per community. As well, in some communities the number of children coming from targeted households was quite low, thus the sample size of children for whom household level data is available was reduced (see Table 4-1 below).

The food security variable for this research uses the perception of vulnerability and use of coping mechanisms as an indicator of household food access. I developed this variable using a method that assesses the frequency of use and severity of coping mechanisms employed by households during the crisis (Maxwell *et al.*, 1999; Maxwell, 1996). Though researchers have recently developed a universally accepted and standardized measurement tool for food security (Household Food Insecurity Access Scale), this study uses a predecessor to that tool to ensure that data from 2005 and 2010 are comparable (Swindale & Bilinsky, 2006). The self-reported coping strategies included in the food security variable include: changed eating habits, decreased portions at meals, decreased nutritional quality at meals, acceptance of gifts/loans from family and friends, decreased number of meals, collection of wild famine foods, day without eating, and sale of personal belongings. Calculated based on reported use of the strategy and local severity rankings (which mirrored Maxwell's), the food security variable is a scale from 1-15. For this study, I dichotomized the variable and assigned households a status of either food insecure or secure.

Each of the regression models estimated in this research includes key demographic characteristics as control variables, including ethnicity. Despite that ethnicity is fluid and intermarriage between ethnic groups is not uncommon in Niger, ethnic groups maintain a shared set of opportunities and disadvantages, as well as

cultural norms and household practices, that are more similar within than across groups. The differences that exist across groups may have significant effects on the outcome of the model, thus ethnicity is included as a control variable.

Two Nigerien doctoral students (both male) studying pastoralism in Niger served as research assistants. Four former Red Cross team leaders (one female, two male) served as field assistants. For two years they worked and received extensive training when we worked together on the monitoring and evaluation project that generated the 2005 data. Those who conducted anthropometric data were trained and certified by Médecins Sans Frontières and have substantial experience in collecting child growth measures. Research and field assistants collected all data in the primary household languages of Tamachek and Hausa. Research assistants translated responses into French, and I analyzed all data in French.

Research and field assistants originally entered all data on site (in Niger) into Microsoft Excel then imported into either SPSS (SPSS, 2011) or CDC's EpiInfo (CDC, 2008). I used EpiInfo to generate nutritional z-scores (weight-for-age [WAZ], height-for-age [HAZ], and WHZ) based on CDC 2000 growth curves. I then imported these data into SPSS where all other analyses were completed. 2005 and 2010 data sets included hierarchical data made up of household level data (n = 95 and 133, respectively) and child growth data (n = 200 and 290). I merged these data into a single data set allowing for a comparison of 2005 and 2010 data. I then cleaned the data and screened key variables for distribution and normality. The dependent variable, undernutrition, defined here as WHZ of less than -2, is normally distributed in both the 2005 and 2010 data set.

Table 4-1. Sample Size for 2005 and 2010 Household Survey and Anthropometric Data

	Household data	Child anthropometric data	Linked child anthropometric and household data
2005	95	200	144
2010	133	290	169

One-way ANOVA tests were used to compare mean undernutrition (WHZ) between groups. Bivariate tests were run to determine correlation between variables prior to their inclusion in regression models. These included Pearson’s R and Spearman’s Rho, where non-parametric tests were necessary due to non-normal distribution of data or use of categorical variables. Other analysis included chi-square tests to establish correlations between categorical and dichotomous variables, except where sample size was too small, and Fisher’s Exact test was calculated. I employed linear regression to estimate multiple models that regressed undernutrition on food security and humanitarian food aid, as well as undernutrition on other potential determinants of undernutrition, including various coping strategies, consumption patterns, health, and environmental determinants. I initially controlled for age and sex of the child in all models.

## Findings

### Distribution of Undernutrition 2005 and 2010

The 2005 sample population was comprised of 200 children from five communities. The average child in this sample was almost 32 months of age and mildly malnourished (z-score between -2 and -1, see Table 4-2). At the time of data collection, approximately 14% of children presented with fever, 15% with diarrhea, and over a quarter (25.5%) were enrolled in a feeding program. The 2010 sample population consists of 290 children from seven communities. Household data are available for 155

of these children. In certain cases, multiple children were sampled from the same household. The average child in the sample was approximately 30 months old, mildly malnourished, and from a household with moderate to high food insecurity (see Table 2). Nearly one third (31.7%) of all children presented with fever, nearly one quarter (24.8%) presented with diarrhea, and nearly one fifth (19.0%) of all children were actively enrolled in a feeding program at the time of data collection.

Table 4-2. Descriptive statistics of sampled children, 2005 (N=200) and 2010 (N=290)

	Mean ± SD	
	2005	2010
Age (months)	31.7 ± 15.9	29.5 ± 15.2
Weight (kg)	10.8 ± 3.1	11.3 ± 5.8
Height (cm)	84.4 ± 12.6	84.1 ± 16.1
MUAC (mm)	139 ± 13	137 ± 12
Underweight z-score	-1.2 ± 1.2	-1.1 ± 1.2
Food security (1-15, secure to insecure)	NA	10.3 ± 3.9*
	Percent	
	2005	2010
Male	46.5	46.2
Presenting with fever	13.6	31.7
Presenting with diarrhea	14.6	24.8
Currently enrolled in a feeding program	25.5	19.0
Received food aid	NA	84.6*

Note: Frequencies may vary due to missing values

\*N=155, relies on household data

The rates of stunting, wasting, and underweight varied across communities in both 2005 and 2010. In 2005, total stunting rates (HAZ less than -2) ranged from a low 21.1 in Farak to a high 51.4% in Dareram (see Table 4-3 for nutritional rates by community in 2005). Total wasting rates (WAZ less than -2) ranged from 16.2% in Farak to 51.5% in Dareram. Total underweight rates (WHZ less than -2), ranged from 13.3% in Guinea Alhazaye 29.4% in Takoukout. All of the 2005 communities (Guinea Alhazaye, Kékeni, Takoukout, and Farak) had total underweight rates above the emergency threshold of

15%, except Dareram, where total underweight rate was 13.3%. Also of note, rates of severe underweight ranged from alarmingly high in communities of Takoukout (11.8%) and Guinea Alhazaye (11.4%) to zero in Kékeni. Kékeni was the only community to have severe rates of underweight below the emergency threshold of 2%.

Although rates of stunting and wasting are important measure of chronic and acute undernutrition, the difficulty in obtaining reliable age data on children renders these measures less reliable than weight-for-height measures. Because WHZ are widely accepted as the most reliable summary measure of malnutrition, hereafter, malnutrition will refer to total malnutrition, defined as the population with a WHZ of less than -2, unless otherwise noted. A comparison of means using one-way ANOVA indicated no significant difference in undernutrition by community, though means ranged from -0.82 in Kékeni to -1.57 in Guinea Alhazaye ( $p=0.16$ ,  $n = 172$ , see Table 4-4).

Table 4-3. Percent of total\* and severe\*\* stunting (HAZ), wasting (WAZ), and underweight (WHZ) by community, 2005

Community	Stunting		Wasting		Underweight	
	Total	Severe	Total	Severe	Total	Severe
Dareram	51.4	29.7	51.5	18.2	13.3	3.3
Guinea Alhazaye	41.0	23.1	47.1	20.6	28.6	11.4
Kékeni	32.3	16.1	48.6	28.6	15.2	0.0
Takoukout	28.1	6.2	40.6	12.5	29.4	11.8
Farak	21.1	2.6	16.2	2.7	21.6	2.7
Total (N=172)	35.0	15.8	40.4	16.4	21.9	5.9

Note: Frequencies may vary due to missing values

Table 4-4. Weight for height z-scores by community, 2005

Community	Mean	N	Std. Deviation
Dareram	-1.11	31	1.33
Guinea Alhazaye	-1.57	36	1.15
Kékeni	-0.82	33	1.19
Takoukout	-1.29	34	1.38
Farak	-1.18	38	1.18
Total	-1.20	172	1.26

Note: One-way ANOVA comparing mean WHZ by community:  $F = 1.66$ ,  $p=.16$

Similar to 2005, the prevalence of stunting, wasting and underweight in 2010 varied across sample communities (see Table 4-5). Total stunting rates ranged from a low 14.3% in Abdounezé to a high 44.2% in Djiptoji. Total wasting rates ranged from 17.1% in Abdounezé to 56.1% in Kékeni. Total underweight rates ranged from 2.6% in Abdounezé to a high 34.2% in Eliké. Abdounezé and Dareram had rates of total underweight below emergency threshold, while all other total underweight rates (Djiptoji, Eliké, Guinea Alhazaye, Kékeni, and Takoukout) were above the 15% emergency threshold. For severe underweight, only Abdounezé had rates below the 2% emergency threshold. Though this variation appears similar to 2005, variation by community is greater in 2010; one-way ANOVA comparison of means indicated a significant difference in undernutrition by community in 2010, ranging from -.33 in Abdounezé to -1.61 in Eliké ( $p=.000$ ,  $n = 263$ , see Table 4-6).

The communities of Eliké and Djiptoji, both predominately Fulani communities, have the lowest mean WHZ, while Dareram and Abdounezé, both predominately Tuareg communities, have the highest mean WHZ. Though Dareram is an agropastoral community today, all four communities have pastoral roots, and all households within Eliké, Djiptoji and Abdounezé practice nomadic pastoralism today. The contrasting experiences of these pastoral communities may be attributed to a number of practices that vary by ethnicity, many of which are beyond the scope of this research. However, of significance to this research may be the historical reliance of Fulani pastoral populations on donkeys. In multiple focus groups and household interviews, participants shared stories of starving animals and repeatedly told researchers that they had no memory of a crisis where donkeys died.

Table 4-5. Percent of total and severe stunting (HAZ), wasting (WAZ), and underweight (WHZ) by community, 2010

Community	Stunting		Wasting		Underweight	
	Total	Severe	Total	Severe	Total	Severe
Abdounezé	14.3	4.8	17.1	2.4	2.6	0
Dareram	32.5	10.0	32.5	10	8.6	2.9
Djiptojo	44.2	11.6	58.1	25.6	29.3	4.9
Eliki	26.8	2.4	51.2	24.4	34.2	10.5
Guinea Alhazaye	26.8	12.2	36.6	14.6	32.5	5.0
Kékeni	39.0	22.0	56.1	26.8	27.8	5.6
Takoukout	21.1	10.5	34.1	14.6	26.5	14.7
Total (n=263)	29.4	10.5	41.0	17.0	23.2	6.1

Note: Frequencies may vary due to missing values

Table 4-6. Weight for height z-scores by community, 2010

Community	Mean	N	Std. Deviation
Abdounezé	-.33	39	.98
Dareram	-.84	35	.99
Djiptojo	-1.37	41	1.4
Eliki	-1.61	38	.99
Guinea Alhazaye	-1.34	40	1.06
Kékeni	-1.12	36	1.13
Takoukout	-1.31	34	1.38
Total	-1.13	263	1.20

Note: One-way ANOVA comparing mean WHZ by community:  $F = 5.312, p = .000$

Asked why they believed donkeys had died at such high rates in this crisis, community members indicated that rains were better further north than in the southern pastoral zone, so communities had traveled farther away than normal and arrived to find crowded pastures. Many of the donkeys did not survive either the trip home or travel to the next area for grazing, whereas more camels survived these moves. The question of ethnicity will be further addressed in the discussion section.

Communities were targeted to allow for repeat measures of undernutrition, thus mean undernutrition was compared for 2005 and 2010 in repeat communities. The community of Farak, initially included in the 2010 target sample, was not accessible during data collection in 2010 due to civil insecurity in the area. Research assistants

identified a replacement community, Abdounezé, based on similarities in livelihood (pastoral), ethnic composition (largely Tuareg), geographic location of meeting point (within 15 kilometers of Farak’s meeting point), and historical migration patterns.

Findings from a comparison of means indicate that, although some communities’ mean WHZ increased and others’ decreased, none was statistically significant, except Farak/Abdounezé (see Table 4-7). Given that these are two distinct communities, the dyad was not considered a repeat measure from this point forward.

Table 4-7. Comparison of undernutrition (mean WHZ) between 2005 and 2010 by community

Community	Year	Mean WHZ	N	SD	F	P
Dareram	2005	-1.11	31	1.33	0.918	0.342
	2010	-0.84	35	0.99		
Guinea Alhazaye	2005	-1.57	36	1.15	0.834	0.364
	2010	-1.34	40	1.06		
Kékeni	2005	-0.81	33	1.19	1.168	0.284
	2010	-1.12	36	1.13		
Takoukout	2005	-1.29	34	1.38	0.005	0.946
	2010	-1.31	34	1.38		
Farak/Abdounezé	2005	-1.18	38	0.98	0.933	0.001
	2010	-0.33	39	1.18		
Total	2005	-1.20	172	1.26	0.332	0.565
	2010	-1.13	263	1.20		

In 2010, households were asked a series of questions to determine their overall self-reported resilience (see Appendix B for full Household Questionnaire). For each of seven items (land degradation, vegetation cover, soil productivity, health and sanitation, wealth, food security, and mobility), they indicated whether they thought their current situation was declining, about the same, or improving, compared to 2005. Based on this data, significant difference existed when comparing mean community self-reported resilience (scale of 1-3, where 1 is more vulnerable and 3 is more resilient;  $p=.000$ ,  $n=165$ ). This measure of self-reported resilience was compared to the average change

in community WHZ for the four repeat communities (see Table 4-8). Chi-square test indicates a highly significant correlation between self-reported resilience and change in mean community undernutrition ( $p=.000$ ,  $n = 121$ )

Table 4-8. Change in mean community undernutrition and self-reported resilience

Community	Mean WHZ	Mean self-reported resilience
Dareram	.27	2.75
Guinea Alhazaye	.23	1.62
Kékeni	-.31	1.85
Takoukout	-.02	1.56

Although analysis shows no significant difference in rates of undernutrition between crisis years of 2005 and 2010, Dareram and Kékeni represent the greatest improvement and decline in nutritional status between 2005 and 2010; thus, an analysis of the two communities, their coping strategies, aid activities in the community and other determinants of food and livelihood security are presented here. These data come from key informant interviews and focus groups at each location. Interviews and focus groups included discussion of the 2005 and 2010 crises, as well as historical years of crisis. Most often the events of 1973 and 1984 were referenced without prompting, but where past years of hardship were not volunteered, researchers asked specifically about these years, as both were events associated with a significant loss of human and livestock life in the region. Quantitative data from child growth surveys and household surveys are included, where relevant.

### **Case study: Dareram**

Dareram is a community of about 200 people situated in three small settlements. Predominantly Tuareg, community members are agropastoralists of the Icherifan clan – those that claim decent from the prophet Mohammed. Slaves of the noble Tuareg, their

ancestors escaped and formed the community of Dareram. Initially families continued to practice transhumance, and at least some part of the family would travel with small ruminants, camel and cattle toward Agadez. But this practice has diminished over time because of the declining herd numbers. As one participant stated, “Our grandparents were pastoralists, but we, we have come to know agropastoralism” (Dareram, male focus group, 2010). With unreliable rainfall and years of crisis repeating, mobility has declined and reliance on crop production has increased. Not everyone cultivated crops before, but now community members feel it is clear that animals will be lost with each crisis, so everyone has started cultivating crops.

This community has historically relied on natural resource base of the area (such as famine food) during crisis years. Women would collect fodder to sell at market; household heads and families would collect wild foods to survive on through the crisis. Heads of household and young men would also travel *en exode* in search of work or food. In good years, youth travel *en exode* to earn money with which they buy their own animals to raise, but the strategy is employed by heads of household as well during times of crisis. In 1973, heads of household traveled south with camel and effectively secured food supply for those at home. When these efforts fail, however, entire families flee the area, as happened in 1984 – the worst crisis in living memory for this community. The entire community fled to Nigeria, Tanout, Zinder and Agadez. Most went to Nigeria where they stayed 2-3 years, and some have never returned. Many social ties within the community were broken at this time, and community members see this as a turning point in their vulnerability to crisis.

The 2010 crisis was not as bad as 2005 for this community. In 2005 there was a rain deficit, and some of the households did not produce any grain. Regionally, the price of millet passed 1100 FCFA and was scarcely available at market. Those who were able to cultivate a harvest shared what they had with those whose harvest failed entirely; however, generalized production deficit led to crisis within the community, and no outside aid was received. During the 2005 crisis, households reportedly collected *Boscia* (wild food) more than 50 km north of Dareram to bring home to their families to eat. In 2010, there was always grain at market and the price of millet did not surpass 500 FCFA. The entire community stayed in place, with the exception of young men who left *en exode*, largely to Nigeria. The financial contributions of those *exodants* are cited as instrumental to the communities' survival of the 2010 crisis. Other coping strategies included small-scale commerce (sale of tea and jewelry) and quick sale of livestock early in the crisis. By June, however, reserves were empty and the community was in crisis. NGOs including Catholic Relief Services began distribution of substantial food aid to the community. This is in distinct contrast to 2005, when Dareram received no aid. 2010 aid came in four phases: 1) distribution of corn and sorghum (50 kg per 7 people), 2) distribution of corn and beans (12.5 kg per person), 3) blanket distribution of 50 kg corn to all families with a child under five, and ½ liter of oil per child under five, and 4) blanket distribution of 50 kg of corn per child under five. The community cites the loss of men *en exode* and declining livestock holdings, due to death and sale, as the consequences of the 2010 crisis, and they attribute financial contributions of *exodants* and humanitarian aid as the most important determinants of their ability to endure the 2010 crisis.

Participants identified repeated years of poor rainfall as the greatest threat to food security and nutritional status within the community. Youth and household heads leave to find work, but they are not always successful. Those that are left at home are no longer able to rely on natural resources (wild food) while they are gone. One must travel farther and farther north to find those wild foods that remain. The community relied heavily on humanitarian aid during the last crisis and recognizes that there is no guarantee that there will be aid during the next crisis.

### **Case study: Kékeni**

Kékeni is an agricultural community that is heavily reliant upon rainfed crop cultivation. Some households keep a small number of livestock (average TLU/RA = .19), and some practice off-season gardening, cultivating tomatoes, lettuce, cabbage, potatoes and or squash, depending upon the year and water availability, but millet cultivation is the primary livelihood of most houses. Keeping livestock (particularly cattle) and off-season gardening are largely the responsibility of women. Historically, the community also hunted. Around 1970, the number of wild animals, particularly guinea hen and dear, began declining, which largely eliminated hunting by this community. The community is made up of over 100 households, and access to water is a major constraint. There are two open cement wells that function during the wet season. Only one well functions during the dry season; it used for both animal and human consumption at that time, which leads to a lot of tension within the community concerning water use and distribution. The community is over 40 km from a health center, requiring six hours by cart or walking, and women have died in labor while traveling to the health center.

Coping strategies during crisis years in this community historically included gathering of wild plants for human and animal consumption, hunting, and migration – particularly among the poorest families. A majority of the population fled to either Matameye or Zinder in 1973 and to Tessaoua in 1984. There was no aid at that time unless families relocated to refugee camps in cities or towns nearby, so once hunting and collection of wild foods failed, families fled. In 2005 and 2010, some aid reached the community of Kékeni, so many people stayed. In hope of receiving aid within the community, many households (24%, n=33) sent young men *en exode*, to Nigeria, Libya, Agadez, or even Europe, in search of work. Both male and female community members fear that this strategy is undermining the strength of the community because it is breaking families apart.

In terms of rainfall deficit and crop production, residents indicate that the 2010 crisis was worse than 2005 in Kékeni, but not as bad as 1973 or 1984. However, the impact, they argue, was worse in 2010 than 2005, 1984, or 1973, because there is now only one species of wild food to collect and no animals to hunt. Other factors worsening the 2010 crisis include the short time between 2005 and 2010 crises, and the difference in amount of aid. In 2005 households received 120,000 FCFA from the Red Cross and a food for work project was active in the area. In 2010 families have received an average of 2 sacs (50 kg) of grain, in large part through blanket feeding programs for children under five, and protective rations for children enrolled in feeding programs (36% of children in feeding program, n=41). However, before aid arrived, an estimated half to two-thirds of the household heads sold livestock, purchased what grain stock they could, and then traveled *en exode*, to seek work in either Agadez or nearby

communities that had sufficient crop production. Those who remained received aid. The community identifies consecutive crises, population growth, lack of health infrastructure, shifting temporal and geographic distribution of rainfall, decreasing quantity of rainfall, lack of aid, and the loss of natural resources as key determinants of difficulty in managing the 2010 crisis.

Based on this analysis of Dareram and Kékeni, the loss of indigenous species of animals to hunt and plants to collect as food during crisis years is an important, recently developed constraint on livelihood and food security in years of poor rainfall. And, while variation in rainfall and years of rain deficit are normal for the region, the short amount of time between crisis years is making resilience to subsequent shocks evermore difficult. Coping strategies identified by both communities as seminal to successful management of crisis are the financial support of family members *en exode* and food aid from humanitarian aid organizations. While the percent of families reporting the use of *exode* during the 2010 crisis is comparable between communities (25% in Dareram and 24.2% in Kékeni), the reported receipt of humanitarian aid – largely food aid – was very different. Focus group and key informant interviews show that Dareram was the beneficiary of at least four phases of food aid in 2010 and reportedly received no aid in 2005; conversely, Kékeni was beneficiary to the Red Cross's cash distribution in 2005 and received minimal aid in 2010. This information is validated by household surveys, which indicate that 94% of households in Dareram and 63% of household in Kékeni received some form of food aid during the 2010 crisis. There is a statistical significance in the difference in aid across all villages in 2010, and aid is statistically significantly lower in Kékeni than in Dareram (Fishers exact test,  $p=.021$ ,  $n= 38$ ). In addition,

explanations of the type of aid received by households in Kékeni are largely linked to children under-five rather than the general population. Receipt of aid is not significantly correlated with food security ( $p=.38$ ), nor is it significantly correlated with undernutrition ( $p=.60$ ). Temporal sequence of when aid arrived would be interesting to measure, but is not captured in these data. As indicated in Dareram, coping strategies may have already been employed by the time food aid arrives, thus complicating interpretation of the findings.

### **Food Security and Undernutrition**

As previously described, food security is a necessary condition for good nutrition, though a number of other underlying factors interact to determine if a child is malnourished or not. This section of the study examines the effect of food security on malnutrition in Niger, net of demographic and underlying health differences, and the role of food aid as a buffer against food insecurity and malnutrition. For the purpose of this research, food security is calculated using a method that assesses the frequency and severity of coping mechanisms employed by households during the crisis (Maxwell *et al.*, 1999; Maxwell, 1996). Changed eating habits, decreased portions at meals, decreased nutritional quality at meals, acceptance of gifts/loans from family and friends, decreased number of meals, collection of wild foods, day without eating, and sale of personal belongings are the coping strategies included in the food security variable. Respondents were asked if they had utilized the strategy during the crisis year and with what regularity they employ that strategy (rarely, if ever; sometimes, often; almost every year). Calculated based on reported use of the strategy and local severity rankings, the food security variable is a scale from 1-15. For this study, households were assigned a status of food secure or insecure, by dichotomizing this scale into lower and upper 50

percentile. The sample is made up of 146 children for whom anthropometric data and household food security were available.

It is important to note that this food security indicator identifies household food insecurity relative to the sample population. This is extremely important to remember, as the prevalence of food security in Niger is among the lowest in the world. Thus, even those who are “food secure” are likely very insecure compared to other populations, external to the study. Due to the pervasive nature of food insecurity in Niger, the variable was dichotomized to allow for only one distinction in a group that is largely food insecure.

In order to assess the relationship between food security, food aid, and undernutrition in the 2010 sample population, a number of statistical tests were computed. First a one-way ANOVA to compare mean WHZ by group was calculated for food security (see Table 4-9), as well as a number of other predictor and control variables. Results from the individual one-way ANOVA calculations are included in Table 4-10 below.

Table 4-9. Mean WHZ between food security groups

	Mean	N	Std. Deviation
Food secure	-1.11	107	1.16
Food insecure	-1.48	39	1.33
Total	-1.21	146	1.21

These results show significant differences in mean undernutrition when data are grouped by ethnicity; level of mobility; self-reported resilience; consumption of beans, oil or bread in the 24 hours prior to survey; household water source; household reported presence of community vaccine campaign; child presentation with diarrhea, and child presentation with fever.

Table 4-10. One-way ANOVA tests to compare mean WHZ by food security and other predictor variables

	N	F	Sig.
Food security	146	2.643	.106
Received humanitarian aid	155	.276	.600
Wealth (1-5, grain and livestock values)	155	0.294	.882
TLU/RA	153	1.180	.235
Household size	155	1.706	.066**
Sex of household head (male reference)	155	1.961	.163
Age of household head	155	1.023	.446
Education of household head (none reference)	153	.509	.477
Ethnicity (Hausa reference)	155	5.377	.022*
Livelihood	151	.606	.659
Mobility (migration this year)	155	8.832	.003*
Self-reported resilience (7 item vulnerability index)	151	3.618	.029*
Perceived risk of climate change	152	.019	.981
Child consumption of beans (last 24 hours)	153	4.488	.036*
Child consumption of oil (last 24 hours)	154	6.304	.039*
Child consumption of bread (last 24 hours)	152	14.785	.001*
Child consumption of fish (last 24 hours)	153	1.557	.214
Child consumption of meat (last 24 hours)	153	.570	.451
Child consumption of milk (last 24 hours)	153	.797	.373
Household water source	154	3.598	.030*
Community vaccine campaign	149	4.274	.040*
Child presentation with diarrhea	263	5.616	.019*
Child presentation with fever	263	3.000	.084*

Calculations indicate a marginally significant difference in average undernutrition by household size. Negative findings of interest include no significant difference in undernutrition by wealth, calculated as either the value of grain and livestock holdings or by tropical livestock unit per adult resident (cite); no significant difference in undernutrition by age, sex, or education of the HHH; and no significant difference in mean undernutrition by aid.

Table 4-11. Nested Multivariate Regression Models Examining the Effects of Demographic and Food Security Characteristics on Undernutrition in Children 6-60 months.

Independent Variables	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Child age	-.011*	-.013*	-.010**	-.009	-.008	-.008
Child Sex						
Male	---	---	---	---	---	---
Female	.081	.112	.128	.168	-.207	-.206
Head of Household Sex						
Male		---	---	---	---	---
Female		.467	.404	.277	.193	.190
Age of HHH		-.003	-.005	-.008	-.008	-.012
Education of HHH		.192	.350	.283	.269	.274
Ethnicity						
Hausa			---	--	---	---
Tuareg			.351	.189	.176	.175
Fulani			-.225	-.129	-.010	-.011
Beri-Beri			-.434**	-.457**	-.574**	-.575**
Food security				-.327	-.372	-.373
Child presentation with diarrhea					-.115	-.114
Child presentation with fever					-.501**	-.501**
Community vaccine campaign					.415	.409
Household water source					.080	.078
Received food aid						-.016
Constant	-.841	-.800	-.748	-.551	-.647	-.623
Model Fit						
Subset F	2.98*	1.50	1.88**	1.32	1.38	1.27
Adjusted R-square	.022*	.016	.044**	.020	.032	.026
N	263	153	153	144	141	141

Notes: \*p<.05; \*\*p<.10

Values shown in each cell are unstandardized coefficients

Four multivariate regression models were estimated to examine if and to what extent food security affected undernutrition, net of child and household demographic characteristics, in the 2010 food crisis in Niger. A fifth model was estimated to examine how health and disease affect the predictive power of food security and aid on undernutrition. Results are presented in Table 4-11.

Because bivariate tests for correlation indicate no significance between undernutrition and child sex, HHH age, or HHH sex, these variables were removed and the models were estimated again. These findings are presented below in Table 4-12.

Table 4-12. Nested Multivariate Regression Models Examining the Effects of Demographic Characteristics and Food Aid on Undernutrition in Children 6-60 months

Independent Variables	Model 1	Model 2	Model 3	Model 4
Child age	-.008	-.007	-.007	-.007
Education of HHH	.206	.111	.192	.210
Food security		-.271	-.270	-.273
Child presentation with diarrhea			-.192	-.190
Child presentation with fever			-.361	-.362
Community vaccine campaign			.599**	.578**
Household water source			-.312	-.317
Received food aid				-.028
Constant	-1.040	-.955	-1.224	-1.550
Model Fit				
Subset F	.1.278	1.254	1.733°	1.509
Adjusted R-square	.004	.005	.035*	.028
N	141	141	141	141

Notes: \*p<.05; \*\*p<.10; °p=.106

Values shown in each cell are unstandardized coefficients

Each of the predictor and control variables, identified in one-way ANOVA tests as having significant differences in mean WHZ, were included in linear regression models

to estimate their independent effect on undernutrition. Subsequently these models were repeated with other control variables, in order to better understand the relationship.

Some key findings from these tests are included here.

### Wealth

There is a marginally significant decrease in undernutrition with increasing wealth, when wealth is defined as TLU/RA ( $p=.072$ ); this relationship is not significant once sex and age of child are included in the model (see Table 4-13).

Table 4-13. Linear regression model of undernutrition on wealth and demographic characteristics

	Model 1	Model 2
TLU/RA	.391**	.334
Child age		-.010
Child Sex		
Male		---
Female		.082
Constant	-1.295	-1.022
Model Fit		
Subset F	3.287**	1.969
Adjusted R-square	.015**	.019
N	198	198

### Food security, HHH age, and ethnicity

There is an increase in effect of food security on undernutrition when the age of the HHH is included as a control variable in the linear regression mode; when HHH age is included, the previous insignificant relationship between food security and undernutrition ( $p=.106$ ) becomes highly significant ( $p=.05$ ). An interaction term (food security x HHH age) was created and tested, but was not significant ( $p=.219$ , see Table 14).

Table 4-14. Linear regression model of undernutrition on food security, head of household age, and interaction term

	Model 1	Model 2	Model 3
Food security	-.366	-.476*	-.694*
HHH age		-.010	-.005
HHH age X food security			-.030
Constant	-1.110	-.599	-.844
Model Fit			
Subset F	2.643	1.994	1.843
Adjusted R-square	.011	.014	.017
N	146	146	146

Notes: \*p<.05; \*\*p<.10

Values shown in each cell are unstandardized coefficients

### Food security and livelihood

Regression analysis shows that although livelihood is not a significant predictor of undernutrition ( $F=.887$ ,  $p=.348$ ), inclusion of livelihood in a model estimating the effect of food security on undernutrition increases the negative effect of food insecurity on undernutrition ( $p=.089$ ).

Table 4-15. Linear regression model of undernutrition on food security, head of household age, and interaction term

	Model 1	Model 2	Model 3
Food security	-.366		-.415**
Livelihood (index)		.086	.070
Constant	-1.110	-1.458	-1.331
Model Fit			
Subset F	2.643	.887	1.479
Adjusted R-square	.011	.001	.007
N	146	151	142

Notes: \*p<.05; \*\*p<.10

Values shown in each cell are unstandardized coefficients

## Ethnicity

Findings from both qualitative and quantitative analyses underscore the role that ethnicity plays as a potential determinant of undernutrition. Thus, a few additional analyses were run on ethnicity. ANOVA test to compare means shows a significant difference between mean WHZ by ethnicity (see Table 4-15).

Table 4-16. Mean WHZ by ethnicity, 2010 data

Ethnicity	Mean	N	Std. Deviation
Hausa	-1.06	50	1.22
Tuareg	-1.68	27	1.20
Fulani	-1.46	29	1.27
Beri-Beri	-1.38	49	1.14
Total	-1.17	155	1.22

A linear regression model estimating the effect of ethnicity on undernutrition indicates that ethnicity as a block (Hausa is the reference group) is significantly correlated with undernutrition, though directionality varies by ethnicity (see Table 4-16).

Table 4-17. Linear Regression model of WHZ on ethnicity

Ethnicity	
Hausa	---
Tuareg	.376
Fulani	-.399
Beri-Beri	-.322
Constant	
Model Fit	
F	2.694
Adjusted R-square	.032*
N	155

Notes: \*p<.05; \*\*p<.10

Values shown in each cell are unstandardized coefficients

Other key indicators of undernutrition, including food security (p=.00), water source (p=.01), and vaccine coverage (p=.00), also vary significantly across ethnic groups.

## Discussion

This research describes the nutritional situation in Niger just following the 2005 and 2010 food crises. Undernutrition rates are extremely high, well above emergency thresholds in most areas, despite widespread receipt of humanitarian food aid. This is particularly alarming given the knowledge that undernutrition rates will often drop by as much as 10% after the harvest – the period during which these data were collected, implying even higher rates at other points during the year (Loutan & Lamotte, 1984). There is variability across communities in both years, though nutritional status varied significantly only in 2010.

This research aimed to describe the relationship of food security and food aid on undernutrition in these communities. Based on this analysis, neither food aid nor food security is a significant predictor of undernutrition in children in this sample, and the effect of food aid on household food security is not significant. None of the estimated models generated an r-square of greater than .04, indicating that less than 4% of the nutritional variance observed in the sample is explained by the models. Because health and food security were included in the model, this finding indicates a need to better understand the context of care and feeding practices of children in these communities, as this may be the underlying determinant of undernutrition that is most important. Another important consideration is the possibility that the extremely high rates of undernutrition make it difficult to tease out specific drivers of undernutrition. For example, food insecurity may be linked to undernutrition, but given the limited variation in food security among these, the most isolated of communities in the least developed country in the world, the relationship may not be measurable.

Despite these negative findings, some interesting observations may be made from the analysis. First, the role of ethnicity has significant predictive power for undernutrition in the study population. This finding underscores the earlier hypothesis that the context of child feeding practices – largely linked to cultural, community and household norms and embedded in any ethnic discrimination that exists – may be an important area for further understanding of undernutrition in this area. Also, the role of disease and health is a statistically significant driver of undernutrition (fever and vaccine coverage were statistically significant in various models). This finding reinforces the need to improve the very poor health status and environmental conditions in which Nigeriens live if nutritional crisis during years of poor rainfall are to be averted. Wenhold had documented the important role of nutritional education in strengthening the link between agriculture and nutrition (Wenhold *et al.*, 2007). In the Nigerien scenario, efforts to increase nutritional and health education may doubly serve to protect communities from undernutrition.

Another objective of the research was to examine other predictors of undernutrition. Practice and use of *exode*, long distance migration of individual family members, is a leading coping mechanism in communities in this region of Niger. It is preferred by communities over full family migration because it allows families to stay in place, and it has gained traction in communities where there is a belief that they may receive aid in their communities, not just in refugee camps in larger towns and cities. And while community members see the practice as seminal to coping during crisis because of the external financial resources it provides, the use of *exode* as a coping strategy is not without repercussions. The practice is blamed for a loss of solidarity with

the community and increased rates of divorce. Women are particularly critical of the practice, citing the impact on family and community structure when highly productive men leave the community. The uncertainty of financial remittances from family members *en exode* and the certainty of the loss of their productivity within the household makes the decision to send members away additionally difficult.

The experience of Dareram in 2005 illustrates the need to tailor the targeting of humanitarian food aid appropriate to the specific crisis. Dareram, a Tuareg community that has pastoral roots but has increasingly practiced agropastoralism, relies to a greater extent than most agropastoral communities on livestock. However, in 2005, Dareram received no aid, even though the shortfall of fodder was significantly worse than the shortfall of grain. If food aid is going to be effective, the nature of the crisis and critical analysis of who is rendered most vulnerable must be part of the rapid assessment conducted for appropriate targeting of beneficiaries. Hindsight has illustrated the vulnerability of pastoral populations to the 2005 fodder deficit, and not simply because of the increased mortality and sale of livestock. Pastoral populations are also affected by poor rainfall because it means that families are split earlier in the season to allow animals to travel south toward better grazing areas, extending the length of time that women and children are separated from milk producing livestock.

One of the findings of this research is the potential of humanitarian aid to act as a catalyst for mobility or immobility, a phenomenon well documented by other researchers (Abebe *et al.*, 2008; Fratkin & Roth, 2005; McPeak & Barrett, 2001). Historically, communities fled their home location for town and cities during crisis, to ensure that aid organizations found them. As aid becomes more and more common, it is reaching many

of these stationary communities in situ. However, others, including nomadic pastoralists, are taking a lesson from agropastoralists of the past and are coming into towns or choosing to partially sedentarize in order to avail themselves of emergency services, including food aid, that arrive in towns during crises such as 2005 and 2010. This situation was observed in 2010 during pilot testing of the research instruments. In October 2010, the research team convened in Tanout town and aimed to target agropastoral households in and around Tanout as participants in the pilot phase of data collection. After arriving in Tanout, however, the team quickly became aware of a refugee camp of nomadic pastoral Fulani, situated 500 meters from the team's accommodations. All instruments were pilot tested in this community, and the experience of the nomadic Fulani is illustrative of others in the area. They were very hard hit by the 2010 crisis – losing over 90% of their livestock, including donkeys. The 2005 crisis had been difficult for them, and they did not receive any aid. Having heard that aid was distributed in Tanout, once the severity of the 2010 crisis was clear, families fled into Tanout and set up camp on the outskirts of town. Indeed, by the time researchers met with the community in October 2010, they had been beneficiaries of food aid distributions.

Similarly, food aid can be seen as the driver of migration in the case of *exode*, as previously discussed. In Kékeni, individuals – not families – migrated, with the hope that those who stayed in place would benefit from aid distribution, which is exactly what happened; food aid was distributed to households with young children. Unfortunately, the very poor are often the first forced to leave the community in search of help. Thus there is a risk that the most vulnerable populations will lose most by having to migrate

away from home in search of help and receiving less, because they are not in place if and when their home community is targeted for aid.

Vulnerability to livelihood and food insecurity in Niger is closely tied to the natural resource base. Although Niger and much of the Sahel have experienced repeated drought and famine since the 1960s, a dramatic reversal of vegetation cover has occurred in the Maradi and southern Zinder regions; in the past 20 years, over 200 million trees have been planted and are supporting the livelihood of some 4.5 million people (Reij, 2006; World Resources Institute, 2008). This success has been attributed to institutional changes in governance, livelihood and the biophysical environment, and researchers argue that people there are consequently less vulnerable to economic and environmental shocks (Sendzimir *et al.*, 2011). This re-greening of the Sahel does not overlap with the study area of this research, but is located to its immediate south. Nationally, Niger lost an average of 37,050 hectares (1.90% per year) of its forest cover between 1990 and 2000, for a total loss of 38.1% (741,000 hectares) (Food and Agriculture Organization, 2010). Land-cover and land-use change were intended to be included in this research, but the author was not able to secure the appropriate satellite imagery in a timely manner. This information may hold important implications on findings of this research and overall understanding of vulnerability in the area, thus is an area in which the author intends to follow-up. Qualitative data indicate that the availability of wild foods and wild animals for consumption during times of crisis has decreased significantly in the past 20-30 years, eliminating historically important coping mechanisms among agropastoral and pastoral populations of the area. Information on land-cover and land-use change in Niger may also help explain some of the

observations of this research, including the significant loss of certain animals in specific years, such as donkeys during the 2010 crisis.

Food insecurity is going to be a long-term issue for Niger. Climate change and continued high population growth are likely to worsen an already difficult situation. Current political instability in Mali and in Libya is sending hundreds of thousands of additional mouths into rural Niger, increasing the demand for food in areas that consistently operate at a food deficit. This year, the inflow of 250,000 Nigeriens who have returned from Libya and the 65,000 Malians who have fled violence in their own country will certainly add to livelihood insecurity, as households struggle to meet their nutritional requirements. The need for improved food aid and livelihood development efforts in this area of Niger is more important than ever. Researchers have documented the long-term impact of short-term, early childhood nutritional shocks (Alderman, 2010; Martorell, 1999). Niger is experiencing its third shock in seven years; without improved response and distribution of food aid and improvement of basic conditions in “good” years, the nutritional situation of children in Niger is likely to continue a downward spiral.

## CHAPTER 5 MOVING FORWARD: IMPLICATIONS OF RESEARCH FINDINGS

The overall aim of this research was to investigate if and how climate change is differentially affecting the vulnerability of communities with different livelihoods in Niger. This study has sought to qualitatively and quantitatively describe the relationship between climate change, livelihood vulnerability/resilience, and adaptation, as experienced by communities along an agricultural-pastoral continuum. Although each paper is a distinct, stand-alone unit, whose specific findings have previously been discussed, collectively this research 1) augments existing literature by introducing and applying a livelihood index to the assessment of vulnerability of pastoral populations, 2) contributes to the growing body of literature describing the interactive effects of climate change, globalization, and political instability on pastoral vulnerability, and 3) underscores the need for improved interdisciplinary collaboration to understand pastoral vulnerability and resilience. This final chapter will briefly review the findings of each distinct paper before discussing these major implications of the collective research.

### **Paper Review**

To review, in the first paper, the Double Exposure framework is used to understand how multiple global processes – climate change and economic globalization – are interacting to affect the vulnerability of Tuareg pastoralists in Niger. Examination of the uranium markets, land-use change, markets, and household demographics is used to illustrate how feedback and content double exposure to these processes are affecting pastoral Tuareg. The analysis of feedback and content double exposure pathways indicate that conflict – which is both a consequence and driver of these global changes – is important determinant of pastoral vulnerability and food security.

The second paper focuses on understanding how people are experiencing climate change. Perceived risk of climate change is measure and compared across a livelihood index in order to understand if and how the differential experience of climate change might be driving livelihood adaptations and consequent health indicators. Findings indicate no significant difference in the experience of climate change by livelihood when using the livelihood index. Discussion regarding the revision and future development of the livelihood index is discussed in more detail below. Findings from this research also show that perceived risk of climate change is significantly correlated with certain coping strategies, and that strategies vary by livelihood. As well, this research shows a significant correlation between certain coping strategies and vulnerability, which varied by livelihood.

Last, the third paper investigates undernutrition by examining the experience of sample communities during the 2005 and 2010 crises. Findings indicate that neither food aid nor food security is a significant predictor of undernutrition in children under five years of age, and that the effect of food aid on household food security also is not significant. The research illustrates alarmingly high rates of undernutrition – well above the internationally recognized emergency thresholds – thus findings must be interpreted within this context. The research indicates that ethnicity is significantly correlated with undernutrition and that the use of *exode* is an important coping mechanism in modern day Niger.

### **Livelihood Index Development**

Having reviewed the findings of each paper, I now turn to those broader implications of the research. Households with a greater reliance on livestock have fundamentally different needs than communities with greater reliance on agriculture. For

example, programs that aim to improve livelihood security may focus on crop productivity for agricultural communities and livestock health for pastoral communities. However, important livelihood differences exist *among* pastoral households as well; some differences may include mobility, economic activity, education, environment, or access to health. The use of a livelihood index affords the researcher the following options: to analyze the effect of livelihood as a continuous variable (1-7, agricultural to pastoral); to analyze the effect of livelihood as a dichotomous variable (pastoral and agricultural subgroups); to investigate the effect of being more or less agricultural or pastoral within just one subgroup (e.g., to assess the impact of decreased mobility among pastoral populations); and/or to analyze, through repeat measures, the effect of changing household livelihoods over time. As well, the livelihood index may be applied at various scales: the same household at different time periods, different households within a community, or communities across a wider area. Use of the livelihood index also helped identify other variables, such as ethnicity, which hold meaning for peoples' perception and response to stressors. In each instance, the index fosters improved, nuanced understanding of the role of livelihood over traditional research that dichotomizes the livelihood variable.

As shown in the second paper (Chapter 3), livelihood (defined by the livelihood index) is not significantly correlated with perceived risk of climate change. However, this is likely explained by the very different experiences of the Tuareg and Fulani pastoral populations during the 2010 food crisis, and is useful in illustrating both constraints and potential of the livelihood index. Despite no significant difference in wealth ( $p=.229$ ,  $N=61$ ) or TLU/RA ( $p=.249$ ,  $N=61$ ), Tuareg and Fulani populations represented the

ethnic groups with the lowest and highest rates, respectively, of undernutrition ( $p=.048$ ,  $N=155$ ); self-reported vulnerability ( $p=.00$ ,  $N=166$ ); food insecurity ( $p=.002$ ,  $N=159$ ); and PRCC ( $p=.00$ ,  $N=166$ ). Because these two ethnic groups made up the pastoral population of the study, their disparate experiences during the 2010 food crisis masked any pattern that might otherwise have existed by livelihood; in other words, differences in ethnicity trumped the potential impact of livelihood, in this scenario. This will not always be the case. Communities commented during pilot testing for this research that the experience of Fulani and Tuareg communities was not normally so different; communities were acutely aware of the abnormal contrast in the experience of Fulani and Tuareg communities in 2005. Thus, use of the livelihood index will clearly be more meaningful when assessing dependent variables that vary between agricultural and pastoral groups, and communities' comments indicate that on the heels of a different food crisis, this might also be the case with perceived risk of climate change. In such a context, use of the index would allow for identification of important thresholds or points of intervention that would be missed with use of a dichotomized livelihood variable.

### **Factors Effecting Pastoral Vulnerability**

The vulnerability of pastoral populations is seemingly in contradiction to their historic adaptability and documented resilience. This research has underscored that a synergistic set of factors is to blame, including rapid population growth, global climate change (reduction of rainfall and increase in temperature), economic globalization, and political instability. Collectively, these factors have altered recent pastoral experiences and are threatening to undermine the livelihood system of pastoralists in Niger (see Figure 5-1). Their past resilience may not prove sufficient given the onslaught of external shocks and stresses. The past year, 2011, was another year of poor rainfall

and subsequent production shortage in Niger, indicating a reduction in the periodicity of climate related shocks. In addition, recent conflicts in Libya and Mali have sent hundreds of thousands of people fleeing into Niger, increasing the food demand on individual households and eliminating remittances from family members *en exode* for many households. Uprising of the Tuareg in Niger may soon follow: Tuareg who are demanding an independent state are driving the conflict in Mali, and many of those returning to Niger from Libya are returning to pastoral homelands. Al Qaeda in the Maghreb continues to operate throughout the Sahel, threatening both existing and future development efforts. And as demonstrated in the examination of the global uranium market and the Tuareg experience, globalization is affecting Niger, despite its appearance as existing at the fringe of economic globalization. Thus, it appears likely that agropastoral and pastoral populations in Niger will face mounting obstacles to livelihood security in the months and years ahead.

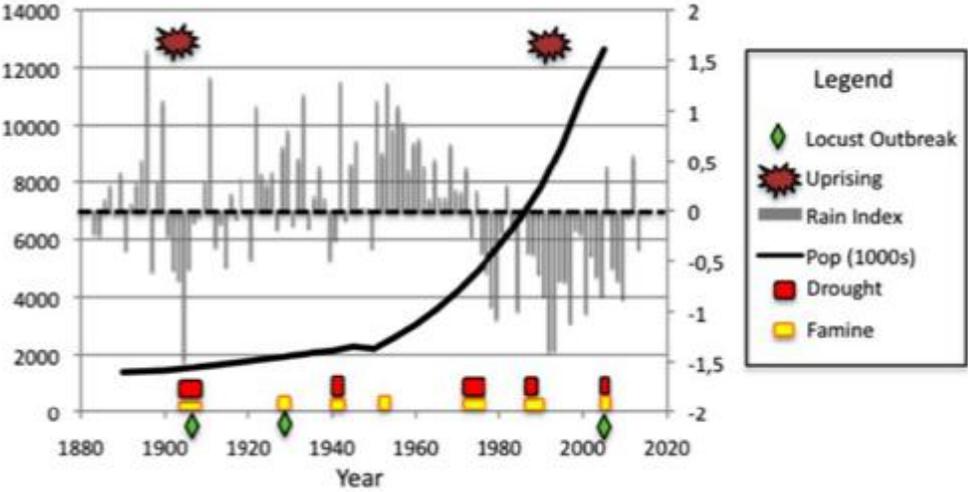


Figure 5-1. Outbreaks of Locust, drought, political uprising, and famine against the backdrop of changing rainfall and population growth (Source: Sendzimir, 2011).

## **The Need for Interdisciplinary Collaboration**

Interdisciplinary collaboration is necessary to ensure full understanding of the socio-ecological system within which pastoralists operate. There has recently been substantial discussion of adaptive capacity, resilience, vulnerability, and the various contributions and language use of different disciplines (Engle, 2011; Gallopin, 2006; Smit & Wandel, 2006). Historically, measures of vulnerability have focused on social components and measures of resilience have focused on ecological components. I developed the research presented here within the constraints of data collected in 2005 and created a measure of vulnerability based on a metric established to measure community resilience to climate change (Elasha *et al.*, 2005). Reframing this research in the context of adaptive capacity within the socio-ecological system, per Engle, might more effectively combine the insights from both resilience and vulnerability frameworks.

Collaboration between various disciplines investigating pastoral vulnerability is not only necessary to ensure effective cross-disciplinary learning, but also to ensure the integration of social science research that investigates household vulnerability with ecological and geospatial modeling that predicts vulnerability at a broader scale. Land-cover and land-use change data – information that is important to understanding the vulnerability of pastoral populations – are missing from this research and would contribute to an understanding of household level vulnerability of pastoralists. Likewise, much of the research that uses such modeling techniques for assessing pastoral vulnerability to climate change does not sufficiently include social science indicators of vulnerability, such as food insecurity, malnutrition, or gender inequity. If future research is going to inform effective development policy to improve livelihood and food security of pastoral populations, then efforts must be made to ensure research collaboration

between social, ecological, and geographic scientists to maximize understanding of vulnerability within pastoral populations.

APPENDIX A  
KEY INFORMANT INTERVIEW INSTRUMENT

Village/tribus .....  
Date.....  
Enquêteur.....

**Enquête des Informants Clés**

Nom du chef du village.....

Responsabilité de participant au village .....

Homme ou Femme

## **Composition de la communauté**

- Merci beaucoup d'avoir accepté de parler avec nous aujourd'hui. S'il vous plaît, décrivez-nous votre communauté ; combien êtes-vous et quelle est votre histoire ici?

## **Moyens de subsistance**

- Je vois que votre communauté est (agricole, pastoral, etc.) ; dites-moi un peu de votre vie. Avez-vous cultivé?

*Invites possibles: Avez-vous toujours cultivé? Quelles sont les cultures? Quelle est la part de la communauté cultive les cultures?*

- Parlez-moi de la migration dans cette communauté.

Possible invites: Jusqu'où déplacez-vous? Qui voyage lors de la migration /transhumance se produit? Qu'est-ce qui peut catalyser la migration pour votre communauté?

## **Histoire**

- A ce qui concerne la productions (agricole/pastoral), a t-il toujours été ainsi pour votre communauté? Avez-vous toujours survivre sur la base de votre (bétail, des terres, une combinaison des deux)?

## **La crise alimentaire**

- Votre communauté a été confrontée aux crises alimentaires passées comme en 1973, 1984 et 2005. Comment jugez-vous la crise alimentaire actuelle par rapport à ceux d'autres? Comment s'est passée pour votre communauté et comment a-t-elle fait face au cours de chacun de ces événements?

- Quelle a été la réaction de la communauté toujours le même? Comment et pourquoi a t-elle changé?

- Quelle a été la crise alimentaire provoquée par des événements semblables? Ce qui a changé pour chaque événement?

## **Les changements climatiques**

- Quels sont les changements dans l'environnement qui se sont passé dans votre vie?

*Invites possibles: la productivité des produits (récolte), la qualité des sols, le rythme des pluies, la quantité des précipitations*

- Est-ce que ces changements ont joué un rôle dans toutes les crises alimentaire que vous avez connu?

- Est-ce que les réponses de votre communauté à des moments difficiles ont changés? Pourquoi et de quelle manière?

APPENDIX B  
FOCUS GROUP INSTRUMENT

## Group Focal

Nom du Village/tribu: ..... Canton: ..... Commune: .....

Département: ..... Zone Agro-écologique .....

Group: Hommes Femmes (choisit un)

Quelle est la mode principale de production dans votre village ? Avant et maintenant?

<p>Vous venez de survivre une crise alimentaire nationale.</p> <p>Lequel a été l'impact de la crise de l'année passé ?</p> <p>Comment avez-vous répondu ?</p> <p>Quelles étaient les stratégies de survivre, des adaptations, ou des changements qu'on a fait ici ?</p> <p>Est-ce qu'on a reçu de l'aide ici ? Expliquez.</p> <p>Quelles étaient les conséquences pour les femmes contre les hommes ?</p>	
---	--

Comment compare la crise actuelle aux crises historiques de 1973, 1984, et 2005 ?

Est-ce que la réponse communautaire était pareille ou différent aux crises historiques ?

Décrivez-le, si' il vous plait.

Comment est-ce  
que l'environnement  
a changé pendant  
les années  
passées ?

(Qualité de sol,  
productivité du sol,  
pâturage, rythme,  
quantité, et durée de  
la pluie, etc.)

<p>Parmi les changements de l'environnement que vous avez observé, lesquels ce dont concerne la communauté le plus ? Comment et pourquoi ?</p>	
--	--

Est-ce que la capacité de votre famille a répondre aux crises, comme celle de cette année, a changé depuis 1973 ? Vous êtes plus ou moins capable de faire face à de telles crises ?  
Comment ?

Aimeriez vous  
rajouter quelque  
chose particulier à  
notre discussion ?

APPENDIX C  
HOUSEHOLD QUESTIONNAIRE INSTRUMENT

Questionnaire Number: |\_|\_|\_|\_|\_|\_|\_|\_|\_|\_|

### *Household Interviews*

**NOTE: This instrument was originally created by the University of Arizona's research team, under supervision of Mamadou Baro, received IRB approval and was used to collect data during 2005. Ms. McKune has UA's full permission to utilize it October 2010 to replicate the survey.**

<b>A. GENERAL INFORMATION</b>			
<b>A.1</b>	2005 Head of Household		
<b>A.2</b>	Longitude :  _ _ ,  _ _ _ _	Latitude :  _ _ ,  _ _ _ _	
<b>A.3.</b>	2005 household located?	1 = Yes 2 = No	/___/
<b>A.4</b>	Name of current head of HH		
<b>A.5</b>	Name of interviewer		
<b>A.6</b>	Date of interview:	/___/___/___/___/ 2010	
<b>A.7</b>	Village/Tribe:	_____	
<b>A.8</b>	Commune:	_____	
<b>A.9</b>	Canton/Subgroup	_____	
<b>A.10</b>	Department	_____	
<b>A.11</b>	Language of interview	1 = Hausa 2 = Djerma 3 = Tamashek 4 = Fulani 5 = Other _____	/___/
<b>A.12</b>	Ethnic group	1 = Hausa 2 = Djerma 3 = Touareg 4 = Fulani	/___/

		5 = Beri-Beri 6 = Other _____	
--	--	----------------------------------	--

<b>B. WATER AND HEALTH</b>			
<b>B.0</b>	What is your principal source of water?  <b>(Choose the best response)</b>	1 = Open well 2 = Protected well 3 = Water channeled from the well 4 = Running water 5 = Lake, seasonal lake, or river 6 = Other (specify): / _____ /	/ ___ /
<b>B.1</b>	How many months of the year is this water source available??	1 = 0-2 months 2 = 3-8 months 3 = 9-11 months 4 = Entire year	/ ___ /
<b>B.2.</b>	What is the distance to the water source that you regularly use?	1 = Source is in the homestead 2 = Less than one kilometer 3 = 1-3 km 4 = 3-5 km 5 = More than 5 km	/ ___ /
<b>B.3</b>	What is the distance to the water sources that you regularly use for your animals' needs?	1 = Source is in the homestead 2 = Less than one kilometer 3 = 1-3 km 4 = 3-5 km 5 = More than 5 km	/ ___ /
<b>B.4</b>	How do you collect water?	1 = Manually collected 2 = With the use of animals 3 = With the use of motorized vehicles 4 = Other (specify) _____	/ ___ /
<b>B.5</b>	How do you transport water (from the principal source)?  <b>Choose all that apply</b>	1 = Human (manual) transport 2 = Use of animals 3 = Transport by motorized vehicles 4 = Other (specify): / _____ /	/ ___ / / ___ / / ___ /
<b>B.6</b>	Does your household have access to a latrine?	1 = Yes 2 = No → <b>End of Section</b>	/ ___ /
<b>B.7</b>	<b>If C.4.0 = 1 (yes):</b> How far is the latrine from your house?	1 = Within the homestead (household concession) 2 = Less than 100 meters 3 = Between 100-200 meters 4 = Plus de 200 meters	/ ___ /
<b>B.8</b>	Has there been a vaccination campaign in this community during the past 12 months?	1 = Yes 2 = No	/ ___ /
<b>B.9</b>	If yes,: how many of your children were immunized and against what illnesses?	Fill in the number of children who are vaccinated	/ ___ /
<b>B.10</b>	If yes: Against what diseases?  <b>Choose all that apply</b>	1 = Polio 2 = Meningitis 3 = Measles 4 = Tetanus 5 = Other (specify) _____	/ ___ / / ___ / / ___ / / ___ /

<b>B.10.1</b>	<b><i>If the children were vaccinated against measles, respond to B.10.1, B.10.2, B.10.3. If No, skip to B.11 :</i></b>  When were the children immunized?	When were the children immunized (the most recent)?  _____	
<b>B.10.2</b>	Where did the children receive their vaccines?	(Location of vaccination campaign) _____	
<b>B.10.3</b>	Who administered the vaccination campaign?	Name of the organization that administered the vaccination campaign _____	
<b>B.11</b>	How many household children 0-5 years old have died in the past 12 months?	Number of deceased children	/___/
<b>B.12</b>	By what cause?	Cause 1 _____ Cause 2 _____ Cause 3 _____	
<b>B.13</b>	Has the woman of the house (any) accessed prenatal services during the past 12 months?	1 = Yes 2 = No 3 = She (none) has had the need	/___/
<b>B.14</b>	How many pregnancies has the senior wife in this household had (including a current pregnancy) If the response is = 0 → <b>section C</b>		___  pregnancies
<b>B.15</b>	How many living children does she (senior wife) have?		___  children

### **C. HOUSEHOLD INCOME**

<b>C.1</b>	What is the principal source of income for the household?	1 = Sale of animals 2 = Sale of animal products 3 = Salaried herder (shepherd) 4 = Caravan 5 = Seasonal work outside the village 6 = Established salaried work 7 = Small/petty commerce 8 = Temporary hire (for a salary) 9 = Cultivation and sale of crops 10= Others (specify) _____	/___/
<b>C.2</b>	What is the secondary source of income for the household?	1 = Sale of animals 2 = Sale of animal products 3 = Salaried herder (shepherd) 4 = Caravan 5 = Seasonal work outside the village 6 = Established salaried work 7 = Small/petty commerce 8 = Temporary hire (for a salary) 9 = Cultivation and sale of crops 10= Others (specify) _____	/___/

### D. AGRICULTURAL GOODS AND ACTIVITIES

<b>D.1</b>	What is the statue of your property?	1 = Owner 2 = Renter/tenant 3 = Sharecropper 4 = Owner of rented land 5 = Other _____ 6666 = Do not cultivate	/ ___ /
<b>D.2</b>	How much land do you own?	1 = 0-0.5 hectare 2 = 0.5-1 hectare 3 = 1-1.5 hectares 4 = 1.5-2 hectares 5 = More than 2 hectares	/ ___ /
<b>D.3</b>	What are the principal crops that you cultivate?  <b>Choose all that apply</b>	1 = Millet 2 = Sorghum 3 = Corn 4 = Beans 5 = Legumes 6 = Watermelon 7 = Other fruits 8 = Peanuts 9 = Others _____ 6666 = Do not cultivate	/ ___ / / ___ / / ___ / / ___ / / ___ /

#### D.4 Input of Grain

Products	a. Previous stock	b. 2009 Harvest	Other inputs			
			c. Tithe	d. Gifts	e. Purchase	f. Reimbursement
4.1. Millet						
4.2 Sorghum						
4.3 Corn						
4.4 Beans						
4.5 Other						

#### D.5 Output of Grain

Products	a. Consumed	b. Reimbursement	Other outputs			f. Current Stock	g. Seeds kept
			c. Tithe	d. Gifts	e. Sale		
5.1 Millet							
5.2 Sorghum							
5.3 Corn							
5.4 Beans							
5.5 Other							

UNITS OF MEASUER MUST BE IN TIA !!

(SPACE FOR CALCULATIONS)

---



---



---

<b>D.6</b>	Your current stock (including 2010 harvest) will last how many months?	Fill in the number of months	/___/
<b>D.7</b>	Have you already harvested this fall?	1 = Yes 2 = No 6666 = Do not harvest	/___/
<b>D.8</b>	What portion of your household income comes from agricultural production?  <i>Use small rocks, peas, etc. to demonstrate for participants.</i>	1 = None 2 = Very small portion, less than 5% 3 = Half 4 = Most 5 = All	/___/
<b>D.9</b>	Has your family always planted crops for an income?	1 = Yes 2 = No	/___/
<b>D.10</b>	Is your family more, less, or equally reliant on agriculture as in the past?	1 = More 2 = Less 3 = About the same	/___/

### E. LIVESTOCK

What is livestock count?

Code	Type of animal	a : How many did you have six months ago?  (Number)	b : How many have you destocked in the past 6 months?			c : Reason sold  1 = Buy good 2 = Health 3 = Travel 4 = Education 5 = Ceremony 6 = Animal food 7 = Clothes 8 = Taxes 9 = Other	d : Current stock  (Number)
			Sold  (Number)	Consumed  (Number)	Lost/Died  (Number)		
<b>E.1</b>	Chicken	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.2</b>	Goat	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.3</b>	Sheep	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.4</b>	Cow	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.5</b>	Donkey	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.6</b>	Camel	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _
<b>E.7</b>	Horse	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _	_ _ _

<b>E.8</b>	Were pastures this year sufficient for feeding your animals?	1 = Yes → <b>Go to E.10</b> 2 = No	/___/
------------	--	---------------------------------------	-------

<b>E.9</b>	If pastures were NOT sufficient, what did you do to feed your animals?	1 = Migration of animals 2 = Purchase of livestock feed 3 = Liquidation of some livestock for income 4 = Nothing 5 = Other  <b>Choose all that apply</b>	/ ___ / / ___ / / ___ /
<b>E.10</b>	What portion of household income comes from livestock production?  <b>Use small rocks, peas, etc. to demonstrate for participants.</b>	1 = None 2 = Very small portion, less than 5% 3 = Half 4 = Most 5 = All	/ ___ /
<b>E.11</b>	Has your family always practiced livestock herding for an income?	1 = Yes 2 = No	/ ___ /
<b>E.12</b>	Is your family more, less, or equally reliant on livestock herding as in the past?	1 = More 2 = Less 3 = About the same	/ ___ /
<b>E.13</b>	On a scale of 1-7, where 1 represents agricultural communities and 7 represents transhumant pastoral populations, where would you place your family?  <b>Use small stones, peas, etc. to create a scale in the sand and demonstrate positioning.</b>	Complete with a number, 1-7	/ ___ /

**F. I AM GONG TO READ A LIST OF STRATEGIES. AFTER EACH ONE, PLEASE INDICATE IF THIS IS A STRATEGY THAT IS USED BY YOUR HOUSEHOLD, AND WITH WHAT FREQUENCY IT IS USED.**

	Strategy	Have you used this strategy in the past year?	Do you use this strategy every year, in exception years, or never?
Code	Strategy	1 = Yes 2 = No	1 = Every year 2 = Exceptional years 3 = Never
<b>F. 1</b>	Eat/sell own harvested grain	/ ___ /	/ ___ /
<b>F. 2</b>	Change in eating habits	/ ___ /	/ ___ /
<b>F. 3</b>	Reduce number of meals	/ ___ /	/ ___ /
<b>F. 4</b>	Reduce amount of food at meals	/ ___ /	/ ___ /
<b>F. 5</b>	Reduce food quality at meals	/ ___ /	/ ___ /
<b>F. 6</b>	Day without eating	/ ___ /	/ ___ /
<b>F. 7</b>	Send family members to other households	/ ___ /	/ ___ /
<b>F. 8</b>	Reduce food expenditures	/ ___ /	/ ___ /



	months? <b>(loans/credit = money)</b>	
<b>G.6</b>	What were the terms of the loan/credit?	Interest rate (%) <input type="text"/>

### **H. INTERVENTIONS/AID**

<b>H.1</b>	Has your household received food aid of any sort from any organization in the past six months?	1 = Yes 2 = No	<input type="text"/>
<b>H.2</b>	What aid did you receive?	Name the types of intervention/aid _____ _____ _____	

### **I. FOOD**

<b>In the past 24 hours, please indicate when different members of your household have eaten?</b>								
	Household member		Before breakfast	Breakfast	Between breakfast and lunch	Lunch	Between lunch and dinner	Dinner
<b>I.1</b>	Household children	1 = Yes 2 = No						
<b>I.2</b>	Household women							
<b>I.3</b>	Household men							

#### **In the past 24 hours, which members of your household have eaten the following:**

	Food product	Household member		
		Children of the household	Women of the household	Men of the household
		1 = Yes      2 = No		
<b>I.5</b>	Millet	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.6</b>	Sorghum	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.7</b>	Rice	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.8</b>	Other grains	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.9</b>	Bread, crackers, pasta	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.10</b>	Fist	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.11</b>	Poultry	<input type="text"/>	<input type="text"/>	<input type="text"/>
<b>I.12</b>	Meat	<input type="text"/>	<input type="text"/>	<input type="text"/>

<b>I.13</b>	Eggs	__	__	__
<b>I.14</b>	Beans	__	__	__
<b>I.15</b>	Legumes	__	__	__
<b>I.16</b>	Greens	__	__	__
<b>I.17</b>	Oil or fats	__	__	__
<b>I.18</b>	Fruit	__	__	__
<b>I.19</b>	Sugar	__	__	__
<b>I.20</b>	Salt	__	__	__
<b>I.21</b>	Milk or dairy product (yogurt)	__	__	__

### **J. VULNERABILITY/RESILIENCE**

How would you compare the situation in 2005 to the current situation for each of the following aspects, based on your household's experience?

	Possible change		
<b>J. 1</b>	Land degradation	1 = Increasing 2 = Stable 3 = Decreasing	__
<b>J. 2</b>	Condition of vegetation cover	1 = Worsening 2 = Stable 3 = Improving	__
<b>J. 3</b>	Soil and crop productivity	1 = Decreasing 2 = Stable 3 = Increasing	__
<b>J. 4</b>	Health and sanitation	1 = Decreasing 2 = Stable 3 = Increasing	__
<b>J. 5</b>	Wealth	1 = Decreasing 2 = Stable 3 = Increasing	__
<b>J. 6</b>	Access to food	1 = Decreasing 2 = Stable 3 = Increasing	__
<b>J. 7</b>	Transhumance	1 = Increasing 2 = Stable 3 = Decreasing	__
<b>J. 8</b>	Mobility/Migration	1 = Decreasing 2 = Stable 3 = Increasing	__

### **K. CLIMATE CHANGE**

I am going to list a few aspects of climate change that may be occurring here. Please tell me what you see as the potential for these aspects to affect your household is (little, somewhat, or a lot), as well as how you perceive the current situation (worsening, getting better, etc.).

	Possible change	Potential to do harm	Current situation
<b>K.1</b>	Land degradation	1 = Little 2 = Somewhat  __  3 = A lot	<i>Déjà fait en haut</i>

<b>K.2</b>	Condition of vegetation cover	1 = Little 2 = Somewhat  __  3 = A lot	<i>Déjà fait en haut</i>
<b>K.3</b>	Soil and crop productivity	1 = Little 2 = Somewhat  __  3 = A lot	<i>Déjà fait en haut</i>
<b>K.4</b>	Rainfall	1 = Little 2 = Somewhat  __  3 = A lot	1 = Decreasing 2 = Stable  __  3 = Increasing
<b>K.5</b>	Desertification	1 = Little 2 = Somewhat  __  3 = A lot	1 = Decreasing 2 = Stable  __  3 = Increasing
<b>K.6</b>	Heat	1 = Little 2 = Somewhat  __  3 = A lot	1 = Decreasing 2 = Stable  __  3 = Increasing
<b>K.7</b>	Loss of indigenous species	1 = Little 2 = Somewhat  __  3 = A lot	1 = Decreasing 2 = Stable  __  3 = Increasing

## **L. OBSERVATIONS**

**L.1.** Based on the information you have received and your own visual observations, how would you categorize the vulnerability of this household?

- Very vulnerable ..1  
Somewhat vulnerable ..2  
Not vulnerable ..3

**L.2.** Please explain the situation of this household with regards to mobility, with particular attention to the years since 2005.

---



---



---



---

**Any other observations:** (please include household dwelling type, visibility of livestock, farming equipment, etc. – any indicators of livelihood should be captured here).

---

---

---

---

## L. MEMBERS OF HOUSHOLD

First and Family names	Sex	Age	Marital status	Literate	Education	Present	Seasonal Migration	Principal Occupation	Secondary Occupation
<b>Please begin with head of household</b>	1 =M 2 =F	(in years or partial years)	1 = married; 2 = widowed; 3 = single; 4 = young (<13 years)	1 = Yes 2 = No	0= none 1= primary incomplete; 2= primary complete; 3= secondary; 4= Koranic school only	1 = Yes 2 = No	1 = Yes 2 = No	0= none; 1= agriculture; 2= herding/livestock care; 3= commercial; 4= artisanal; 5= civil servant; 6= housekeeping; 7= small trade (carpentry, blacksmith, etc.) ; 8= other	
1. (head of household)	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
2.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
3.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
4.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
5.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
6.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
7.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
8.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
9.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
10.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
11.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
12.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
13.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
14.	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>



APPENDIX D  
ANTHROPOMETRIC DATA COLLECTION INSTRUMENT

## *Anthropometric Questionnaire*

<b>A. General Information</b>
1.1. Name of interviewer:
1.2. Date:
1.3. Village/Tribe:

Name of Head of Household	Name of Child	Child Age (months)	Sex 1 = M 2 = F	Anthropometrics			Vaccine card present 1 = yes 2 = no	Participating in a nutritional feeding program? 1 = yes 2 = no	Currently :		
				Weight (kg)	Height (cm)	MUAC (cm)			Diarrhea 1 = yes 2 = no	Fever 1 = yes 2 = no	Nursing 1 = yes 2 = no
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
12											
13											

14												
15												
16												
17												
18												
19												
20												
21												
22												
23												
24												
25												
26												
27												
28												

29												
30												
31												
32												
33												
34												
35												
36												
37												
38												
39												
40												

## APPENDIX E METHODOLOGY FOR CREATION OF LIVELIHOOD INDEX

This research sought to develop a livelihood index rather than using a dichotomous variable for livelihood (agricultural versus pastoral). The final seven-item index was created using several items, collected during household interviews. Initially, information gathered and analyzed in the construction of the variable included the following sub-items (parentheses indicate reference survey number):

- Principal revenue source (C1)
- Property ownership (D1)
- Principal crop production (D3)
- Timing of harvest (D7)
- Revenue portion from crops (D8)
- Family history of crop production (D9)
- Comparison of present and past crop production (D10)
- Revenue portion from livestock (E10)
- Family history of pastoralism (E11)
- Comparison of present and past pastoralism (E12)
- Self-identification of livelihood (E13)
- Migration (F17B)
- Geographic livelihood zone (Focus Groups)
- Qualitative history of migration (Focus Groups)

Through factor analysis and tests for multi-collinearity, these sub-items were then organized into 9 items to create a preliminary nine-item index. They were arranged into the following items:

- Principal revenue source (C1)
- Lack of land, crops, and harvest (D1, D3, and D7)
- Revenue portion from crops (D8)
- Agricultural heritage (D8, D9, and D10)
- Revenue portion from livestock (E10)
- Pastoral heritage (E10, E11, and E12)
- Self-identification of livelihood (E13)
- Livelihood zone (FG)
- History of migration (FG)

Detailed descriptions of how each item was coded and generated, referencing household survey question numbers, is included here:

Item1: Principal revenue source:

- If C1=1 (sale of animals) or 2 (sale of animal products) then Item1 = 7
- If C1=3 then Item1= 6
- If C1= 9 then Item1 = 1
- Else Item1 = 4

Item2: Lack of land, crops, and harvest

- If SubItem2.1 or SubItem2.2 or SubItem2.3 = 6666 then Item2 = 7
- Else Item2 = 1

*SubItem2.1: Property ownership*

- If D1 = 6666 then SubItem2.1 = 7
- If D1 = 1 or 2 then SubItem2.1 = 1
- Else SubItem2.1 = 4

*SubItem2.2: Principal crop production*

- If D3 = 6666 then SubItem2.2 = 7
- Else SubItem2.2 = 1

*SubItem2.3: Harvest*

- If D7 = 6666 then SubItem2.3 = 7
- Else SubItem2.3 = 1

Item3: Revenue portion from crops

- If D8 = 1 then Item3 = 5
- If D8 = 2 then Item3 = 4
- If D8 = 3 then Item3 = 3
- If D8 = 4 then Item3 = 2
- If D8 = 5 then Item3 = 1

Item4: Agricultural heritage

Item4 = SubItem4.1 \* SubItem4.2 \* SubItem4.3

*SubItem4.1: Revenue portion from crops*

- See above (Item3)

*SubItem4.2: Family history of crop production*

- If D9 = 1 then SubItem4.2 = 1
- If D9 = 2 then SubItem4.2 = 2

*SubItem4.3: Comparison of present and past crop production*

- *If D10 = 1 then SubItem4.3 = 0.5*
- *If D10 = 2 then SubItem4.3 = 2*
- *If D10 = 3 then SubItem4.3 = 1*

Item5: Revenue portion from livestock

- If E10 = 5 then Item5 = 5
- If E10 = 4 then Item5 = 4
- If E10 = 3 then Item5 = 3
- If E10 = 2 then Item5 = 2
- If E10 = 1 then Item5 = 1

Item6: Pastoral heritage

Item6 = SubItem6.1 \* SubItem6.2 \* SubItem6.3

*SubItem6.1: Revenue portion from livestock*

- *See above (Item5)*

*SubItem6.2: Family history of pastoralism*

- *If E11 = 1 then SubItem6.2 = 1*
- *If E11 = 2 then SubItem6.2 = 2*

*SubItem6.3: Comparison of present and past pastoralism*

- *If E12 = 1 then SubItem6.3 = 0.5*
- *If E12 = 2 then SubItem6.3 = 2*
- *If E12 = 3 then SubItem6.3 = 1*

Item7: Self-identification of livelihood

- Item7 = E13

Item8: Livelihood zone

- Pastoral zone = 7
- Agropastoral zone = 4
- Agricultural zone = 1
- Borderline pastoral zone = 6

Item9: Qualitative history of migration (Focus Groups)

- Communities were placed along the agricultural/pastoral continuum based on focus group discussions about livelihood, historical livelihood, transhumance and migration patterns (1-7)

After running tests for reliability and assessing inter-item correlation, the final seven-item index was constructed using the following items:

- Principal revenue source (C1)
- Lack of land, crops, and harvest (D1, D3, and D7)
- Revenue portion from crops (D8)
- Agricultural heritage (D8, D9, and D10)

- Pastoral heritage (E10, E11, and E12)
- Self-identification of livelihood (E13)
- Migration (F17B)

## LIST OF REFERENCES

- Abdalla, M. A. (2009). Understanding of the Natural Resource Conflict Dynamics: The Case of the Tuareg in North Africa and the Sahel, *Institute for Security Studies* (Vol. Paper 194). Pretoria, South Africa: ISS.
- Abebe, D., Cullis, A., Catley, A., Aklilu, Y., Mekonnen, G., & Ghebrechirstos, Y. (2008). Impact of a commercial destocking relief intervention in Moyale district, southern Ethiopia. *Disasters*, 32(2), 167-189.
- Action Against Hunger. (2006). Humanitarian Context in Niger. Retrieved 11/10/11, from [www.actionagainsthunger.org](http://www.actionagainsthunger.org)
- Adger, W. N. (2000). Social and ecological resilience: are they related? *Progress in Human Geography*, 24(3), 347-364.
- Adger, W. N. (2003). Social Capital, Collective Action, and Adaptation to Climate Change. *Economic Geography*, 79(4), 387-404.
- Adger, W. N. (2006). Vulnerability. *Global Environmental Change*, 16(3), 268-281.
- Adger, W. N., Eakin, H., & Winkels, A. (2009). Nested and teleconnected vulnerabilities to environmental change. *Frontiers in Ecology and the Environment*, 7(3), 150-157.
- Alderman, H. (2010). Safety Nets Can Help Address the Risks to Nutrition from Increasing Climate Variability. *The Journal of Nutrition*, 140(1), 148S-152S.
- Baker, J., & Ngendakuriyo, A. (2011). *5-Year Evaluation of the Central Emergency Response Fund, Case Study: Niger*. Ohain, Belgium: Channel Research and OCHA.
- Barbé, L. L., & Lebel, T. (1997). Rainfall climatology of the HAPEX-Sahel region during the years 1950-1990. *Journal of Hydrology*, 188-189, 43-73.
- Baro, M., & Deubel, T. (2006). Persistent Hunger: Perspectives on Vulnerability, Famine, and Food Security in Sub-Saharan Africa. *Annual Review of Anthropology*, 35(1), 521-538.
- Bassett, T. J., & Zuéli, K. B. (2000). Environmental discourses and the Ivorian savanna. *Annals of the Association of American Geographers*, 90(1), 67-95.
- Battisti, D. S., & Naylor, R. L. (2009). Historical Warnings of Future Food Insecurity with Unprecedented Seasonal Heat. *Science*, 323(5911), 240-244.
- Bednik, A. (2008). Niger's mine war - Radioactive land is real price of uranium. *Le Monde diplomatique (France)*.

- Beekhuis, G. (2007). Cross-border trade and food markets in Niger: why market analysis is important for humanitarian action. *Humanitarian Exchange Magazine*.
- Behnke, R. H. (1994). Natural Resource Management in Pastoral Africa. *Development Policy Review*, 12, 5-27.
- Behnke, R. H., Kerven, C., & Scoones, I. (Eds.). (1993). *Range ecology at disequilibrium : new models of natural variability and pastoral adaptation in African savannas* London: Overseas Development Institute.
- Ben Mohamed, A., van Duivenbooden, N., & Abdoussallam, S. (2002). Impact of Climate Change on Agricultural Production in the Sahel – Part 1. Methodological Approach and Case Study for Millet in Niger. *Climatic Change*, 54(3), 327-348.
- Bernard, H. R. (1995). *Research Methods in Anthropology: Qualitative and Quantitative Approaches* (Second Edition ed.). Walnut Creek: AltaMira Press.
- Birch, I., & Grahn, R. (2007). Pastoralism - Managing Multiple Stressors and the Threat of Climate Variability and Change, *Human Development Occasional Papers*. New York: Human Development Report Office, UNDP.
- Blackwell, N., Augier, A., & Sayadi, S. (2010). Food crisis in Niger: a chronic emergency. *The Lancet*, 376(9739), 416-417.
- Blench, R. (2001). *'You Can't Go Home Again!': Pastoralism in the New Millennium*. London: Overseas Development Institute.
- Bohle, H. G., Downing, T. E., & Watts, M. J. (1994). Climate change and social vulnerability: Toward a sociology and geography of food insecurity. *Global Environmental Change*, 4(1), 37-48.
- Bradley, P. (1971). The Ecological Survey of Sub-Desert and Sahel Zone. *The Geographical Journal*, 137(4), 462-466.
- Brown, K., Dickin, K., Bentley, M., Oni, G., Obassanju, V., Esrey, S., et al. (1988). *Complementary Feeding of Young Children in Developing Countries: a Review of Current Scientific Evidence* WHO/NUT/98.1. Geneva: WHO.
- Bryman, A. (2008). Structured interviewing In *Social Research Methods*: Oxford University Press.
- Bureau for Applied Research in Anthropology. (2005). Cash Distribution - Initial Assessment UA, *Cash Distribution Project in Tanout, Niger*. Tucson: University of Arizona.

- Bureau for Applied Research in Anthropology. (2006a). *Final Monitoring Report of the First Direct Cash Transfer Project in the Sahel: An Innovative Response by the British Red Cross to the 2005 Food Crisis in Tanout* University of Arizona and the British Red Cross.
- Bureau for Applied Research in Anthropology. (2006b). Review of Available Secondary Data: Niger 2005-2006. University Of Arizona and the British Red Cross.
- Campbell, D. J. (1984). Response to drought among farmers and herders in southern Kajiado District, Kenya. *Human Ecology*, 12(1), 35-64.
- CARE USA, & CARE Denmark. (2007). *The Human Right to Water - Beyond Access*. Atlanta: CARE USA.
- CARE USA and CARE Denmark. (2007). *The Human Right to Water - Beyond Access: CARE USA and CARE Denmark*.
- CDC. (2008). *EpiInfo (Version 3.5.1)*. Atlanta: CDC.
- Chambers, R. (1992). *Rural appraisal: rapid, relaxed and participatory*. Brighton: Institute of Development Studies at the University of Sussex, Discussion paper 311.
- Chambers, R. (2007). *Who Counts? The Quiet Revolution of Participation and Numbers*. Brighton: IDS Working Paper 296.
- Chambers, R., & Conway, G. (1992). Sustainable rural livelihoods: practical concepts for the twenty-first century In *IDS Discussion Paper 296*. Brighton: Institute of Development Studeis.
- Clarke, J. I. (1959). Studies of Semi-Nomadism in North Africa. *Economic Geography*, 35(2), 95-108.
- Cobey, J. C., & Cunningham, N. (1968). Anthropometry in action: an evaluation of a local calendar used in determining ages of children in a Nigerian village. *The Journal of Tropical Pediatrics*, 14 132-138.
- Cornia, G. A., & Deotti, L. (2008). *Niger's 2005 Food Crisis: Extent, Causes and Nutritional Impact*. European Development Research Network WP 2008-15.
- Daouda, M., Ozer, P., and Erpicum, M. . (1996a). *Conséquences de la sécheresse sur la longueur et l'amplitude de la saison des pluies au Niger*. Proceeding from the International Conference on Tropical Climatology, Meteorology and Hydrology, Brussels, 22–24 May 1996, Brussels, Belgium Royal Meteorological Institute of Belgium and Royal Academy of Overseas Sciences.

- Daouda, M., Ozer, P., and Erpicum, M. . (1996b). *Conséquences de la sécheresse sur la longueur et l'amplitude de la saison des pluies au Niger*. Proceeding from the International Conference on Tropical Climatology, Meteorology and Hydrology, Brussels, 22–24 May, Brussels, Belgium Royal Meteorological Institute of Belgium and Royal Academy of Overseas Sciences.
- Davies, J., & Bennett, R. (2007). Livelihood adaptation to risk: Constraints and opportunities for pastoral development in Ethiopia's Afar region. *Journal of Development Studies*, 43(3), 490 - 511.
- Davies, J., & Hatfield, R. (2007). The economics of mobile pastoralism: A global summary. *Nomadic Peoples*, 11(1), 91-116.
- Davies, S. (1996). *Adaptable Livelihoods: Coping with Food Insecurity in the Malian Sahel*. London: MacMillan.
- Dayak, M. (1992). *Touareg, la tragédie*. Paris: Jean-Claude Lattès.
- Decalo, S. (1997). *Historical Dictionary of Niger*. Lanham, MD and London: Scarecrow Press.
- Denton, F. (2000). Gender impact of climate change: a human security dimension. *Energia News*, 3(3).
- Denton, F. (2002). Climate change vulnerability, impacts, and adaptation: Why does gender matter? *Gender and Development*, 10(2), 10-20.
- Dettwyler, K. A. (1989). Styles of Infant Feeding: Parental/Caretaker Control of Food Consumption in Young Children. *American Anthropologist*, 91(3), 696-703.
- Edmond, K. M., Zandoh, C., Quigley, M. A., Amenga-Etego, S., Owusu-Agyei, S., & Kirkwood, B. R. (2006). Delayed Breastfeeding Initiation Increases Risk of Neonatal Mortality. *Pediatrics*, 117(3), e380-e386.
- Elasha, B. O., Elhassan, N. G., Ahmed, H., & Zakieldin, S. (2005). *Sustainable livelihood approach for assessing community resilience to climate change: case studies from Sudan* AIACC Working Papers Number 17.
- Ellis, F. (1998). Household strategies and rural livelihood diversification. *Journal of Development Studies*, 35(1), 1 - 38.
- Ellis, J. E., & Swift, D. M. (1988). Stability of African pastoral ecosystems: alternate paradigms and implications for development. *Journal of Range Management*, 41, 450-459.
- Emerson, S. A. (2011). Desert insurgency: lessons from the third Tuareg rebellion. *Small Wars & Insurgencies*, 22(4), 669-687.

- Engle, N. L. (2011). Adaptive capacity and its assessment. *Global Environmental Change*, 21(2), 647-656.
- Engle, P. L. (2002). Infant Feeding Styles: Barriers and Opportunities for Good Nutrition in India. *Nutrition Reviews*, 60, S109-S114.
- Ensminger, J. (1992). *Making a Market: The Institutional Transformation fo an African Society*. New York: Cambridge University Press.
- FEWS NET. (2010). *Markets and Food Security in the Eastern Basin (Benin, Niger, Nigeria, Chad)*. Washington, D.C.: USAID FEWSNET, CILSS, FAO, and WFP.
- FEWS NET. (2012). Make Your Own Maps Niger: An interactive Microsoft PowerPoint Presentation for Building Maps. Retrieved February 10, 2012
- Food and Agriculture Organization. (1996). *Declaration on world food security*. Proceeding from the World Food Summit, Rome Food and Agriculture Organization.
- Food and Agriculture Organization. (2010). *Global Forrest Resource Assessment Report - Country Report Niger*. Rome: Food and Agriculture Organization of the United Nations.
- France 24. (2010, March 29). GreenPeace slams Areva over radioactive contamination. Retrieved 12/11/11, from <http://www.france24.com/en/20100329-greenpeace-slams-areva-over-radioactive-contamination>
- Fratkin, E. (1992). Drought and Development in Marsabit District, Kenya. *Disasters*, 16, 119-130.
- Fratkin, E. (1997). Pastoralism: Governance and Development Issues. *Annual Review of Anthropology*, 26, 235-261.
- Fratkin, E. (2004). *Ariaal Pastoralists of Kenya: Studying pastoralism, drought, and development in Africa's arid lands*. (Second Edition ed.). Boston: Pearson.
- Fratkin, E., & Roth, E. A. (Eds.). (2005). *As pastoralists settle: social, health, and economic consequences of the pastoral sedentarization in Marsabit District, Kenya*. New York: Kluwer Academim Publishers.
- Friedel, M. H. (1991). Range condition assessment and the concept of thresholds: A viewpoint. *Journal of Range Management*, 44(5), 422-426.
- Fugelstad, F. (1983). *A history of Niger, 1850–1960*. Cambridge and New York: Cambridge University Press.
- Gallopin, G. C. (2006). Linkages between vulnerability, resilience, and adaptive capacity. *Global Environmental Change*, 16(3), 293-303.

- Galvin, K. A. (2009). Transitions: Pastoralists Living with Change. *Annual Review of Anthropology*, 38(1), 185-198.
- Galvin, K. A., Reid, R. S., Behnke, R. H., & Hobbs, N. T. (Eds.). (2008). *Fragmentation in semi-arid and arid landscapes: Consequences for human and natural systems*. Dordrecht, the Netherlands: Springer.
- Geesing, D. a. D., H. (2008). Food and Agriculture Organization. *Country Pasture/Forage Resource Profile*. Retrieved December 10, 2008, from [www.fao.org](http://www.fao.org)
- Georgieva, K. (2011). International response to Niger's hunger crisis. *The Lancet*, 377(9759), 28.
- Government of Niger. (2005). *Rapport Général de la 1er Réunion Annuelle du Système de Prévention et de Gestion des Crises Alimentaires*. République du Niger: CNPGCA, SAP et Cabinet Premier Ministre.
- Government of Niger, World Food Programme, & FEWSNET. (2004). *Joint Harvest Assessment: Government of Niger, WFP, and USAID FEWSNET*.
- Grell, H., & Kirk, M. (1999). The Role of the Donors in Influencing Property Rights over Pastoral Resources in Sub-Saharan Africa In N. McCarthy, B. Swallow, M. Kirk & P. Hazel (Eds.), *Property Rights, Risk, and Livestock Development in Africa*. Washington, D.C.: International Food Policy Research Institute.
- Grobler-Tanner, C. (2006). *Understanding nutrition data and the causes of malnutrition in Niger*. Washington, D.C.: USAID FEWSNET.
- Hammel, R. (2001). Securing land for herders in Niger. Niamey, Niger: AREN, Drylands Programme.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.
- Held, I. M., Delworth, T. L., Lu, J., Findell, K. L., & Knutson, T. R. (2005). Simulation of Sahel Drought in the 20th and 21st Centuries. *Proceedings of the National Academy of Sciences of the United States of America*, 102(50), 17891-17896.
- Hesse, C., & Cotula, L. (2006). Climate Change and Pastoralists: Investing in people to respond to adversity. In I. I. f. E. a. Development (Ed.), *Sustainable Development Opinion*. London: International Institute for Environment and Development.
- Hesse, C., & Thebaud, B. (2006). Will Pastoral Legislation Disempower Pastoralists in the Sahel? *Indigenous Affairs*, 1/06, 14-23.
- Hogg, R. (1986). The New Pastoralism: Poverty and Dependency in Northern Kenya. *Africa*, 56(3), 319-333.

- Hogg, R. (1997). *Pastoralists, ethnicity and the state in Ethiopia*. London: Haan in association with the Institute for African Alternatives.
- Holling, C. S. (1995). What barriers? What bridges? In L. Gunderson, C. S. Holling & S. S. Light (Eds.), *Barriers and bridges to the renewal of ecosystems and institutions*. New York: Columbia University Press.
- Huntingford, C., Lambert, F. H., Gash, J. H. C., Taylor, C. M., & Challinor, A. J. (2005). Aspects of climate change prediction relevant to crop productivity. *Philosophical Transactions of the Royal Society* 360(1463), 1999-2009.
- IndexMundi. (2012). Uranium Monthly Price - US Dollars Per Pound. Retrieved 1/17/12, from <http://www.indexmundi.com/commodities/?commodity=uranium&months=60>
- IPCC. (2000). IPCC Special Report on The Regional Impacts of Climate Change: An Assessment of Vulnerability. Geneva: UNEP/WMO.
- IPCC. (2007). Climate Change 2007: Impacts, Adaptation, and Vulnerability. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden & C. E. Hanson (Eds.), *Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 1000). Cambridge: Cambridge University Press.
- IRIN. (2008). Population explosion threatens development gains. *UN Office for the Coordination of Humanitarian Affairs*.
- Jahnke, H. E. (1982). *Livestock Production Systems in Livestock Development in Tropical Africa*. Kiel, FRG: Kieler Wissenschaftsverlag Vauk.
- Keenan, J. (2000a). The father's friend: Returning to the Tuareg as an 'elder'. *Anthropology Today*, 16(4), 7-11.
- Keenan, J. (2000b). [Untitled]. *The Journal of the Royal Anthropological Institute*, 6(2), 369-370.
- Keenan, J. (2008). Uranium goes critical in Niger: Tuareg rebellions threaten Sahelian conflagration. *Review of African Political Economy*, 35(117), 449-466.
- Keenan, J. (2009). Al-Qaeda terrorism in the Sahara? Edwin Dyer's murder and the role of intelligence agencies. *Anthropology Today*, 25(4), 14-18.
- Kelley, T. A. (2002). Squeezing Parakeets into Pigeon Holes: The Effects of Globalization and State Legal Reform in Niger on Indigenous Zarma Law. *NYU Journal of International Law & Politics*, 34 (3), 635-711.
- Kelly, P. M., & Adger, W. N. (2000). Theory and Practice in Assessing Vulnerability to Climate Change and Facilitating Adaptation. *Climatic Change*, 47(4), 325-352.

- Kratli, S. (2001). *Educating nomadic herders out of poverty? Culture, education and pastoral livelihood in Turkana and Karamoja*. Sussex for the World Bank: Institute of Development Studies.
- Lamprey, H. (1983). Pastoralism yesterday and today: The overgrazing problem In F. Bourliere (Ed.), *Ecosystems of the World* (Vol. 3). Amsterdam: Elsevier Scientific.
- Lamprey, H. F. (1976). The UNEP-MAB Integrated Project in Arid Lands: Phase III, *Regional Project Document FP/1101-77*. Nairobi: UNEP.
- Lavigne Delville, P. (1999). *Harmonising formal law and customary land rights in French-speaking West Africa*. London: IIED: Issue Paper 86.
- Le Houerou, H. N. (1996). Climate change, drought and desertification. *Journal of Arid Environments*, 34(2), 133-185.
- Lebel, T., Sauvageot, H., Hoepffner, M., Desbois, M., Guillot, B., & Hubert, P. (1992). Rainfall estimation in the Sahel: the EPSAT- NIGER experiment. *Hydrological Sciences* 37(3), 201-217.
- Leichenko, R., & O'Brien, K. (2002). The dynamics of rural vulnerability to global change. *Mitigation and Adaptation Strategies for Global Change*, 7(1), 1-18.
- Leichenko, R., & O'Brien, K. (2008). *Environmental Change and Globalization*. New York: Oxford University Press.
- Leichenko, R. M., O'Brien, K. L., & Solecki, W. D. (2010). Climate change and the global financial crisis: A case of double exposure. *Annals of the Association of American Geographers*, 100(4), 963-972.
- Levinson, D. (1998). *Ethnic Groups Worldwide - A Ready Reference Handbook*. Phoenix: Oryx Press.
- Little, P. D. (1985). Social differentiation and pastoral sedentarization in northern Kenya. *Africa*, 55(3), 243-261.
- Little, P. D., Smith, K., Cellarius, B. A., Coppock, D. L., & Barrett, C. (2001). Avoiding Disaster: Diversification and Risk Management among East African Herders. *Development and Change*, 32(3), 401-433.
- London, L. (2001). Pesticides and Women Workers in South Africa: A Question of Social Justice. *Women and Environments*, Fall 2001.
- Loutan, L., & Lamotte, J.-M. (1984). Seasonal variations in nutrition among a group of nomadic pastoralists in Niger. *The Lancet*, 323(8383), 945-947.

- Lu, C., Schneider, M. T., Gubbins, P., Leach-Kemon, K., Jamison, D., & Murray, C. J. L. (2010). Public financing of health in developing countries: a cross-national systematic analysis. *The Lancet*, 375(9723), 1375-1387.
- Macro International Inc. (2007). Enquête Démographique et de Santé et à Indicateurs Multiples au Niger 2006. Calverton, Maryland, USA: Institut National de la Statistique, Ministère de l'Économie et des Finances, and Macro International Inc.
- Martorell, R. (1999). The nature of child malnutrition and its long-term implications. *Food and Nutrition Bulletin*, 20(3), 288-292.
- Marty, A. (1996). La division sédentaires-nomades. Le cas de boucle du Niger au début de la période coloniale: IRAM.
- Maxwell, D., Ahiadeke, C., Levin, C., Armar-Klemesu, M., Zakariah, S., & Lamptey, G. M. (1999). Alternative food-security indicators: revisiting the frequency and severity of 'coping strategies'. *Food Policy*, 24(4), 411-429.
- Maxwell, D. G. (1996). Measuring food insecurity: The frequency and severity of "coping strategies". *Food Policy*, 21(3), 291-303.
- McCabe, J. T. (2007). *Cattle Bring Us to Our Enemies: Turkana Ecology, Politics, and Raiding in a Disequilibrium System*. Ann Arbor: University of Michigan Press.
- McConnel, T. (2007, October 30). Niger: the uranium curse. *Open Democracy*.
- McKune, S., & Silva, J. (2012). Pastoralists Under Pressure: Double Exposure to Economic and Environmental Change in Niger. Unpublished Manuscript. Unpublished manuscript.
- McPeak, J. G., & Barrett, C. B. (2001). Differential Risk Exposure and Stochastic Poverty Traps among East African Pastoralists. *American Journal of Agricultural Economics*, 83(3), 674-679.
- Meyer, C. (2010, April 2). Uranium Mining in Niger: Tuareg Activist Takes on French Nuclear Company. *Spiegel Online International*.
- Mira, C. (2011). Oil, Uranium Projects Brighten Medium-term Prospects in Niger, *IMF Survey Magazine, Countries & Regions*. Washington, D.C.: Africa Department of the International Monetary Fund.
- Mohamed, A. B., Duivenbooden, N. V., & Abdoussallam, S. (2002). Impact of Climate Change on Agricultural Production in the Sahel - Part 1. Methodological Approach and Case Study for Millet in Niger. *Climatic Change*, 54, 327-348.
- Mortimore, M. J. (1998). *Roots in the African dust*. Cambridge: Cambridge University Press.

- Mortimore, M. J., & Adams, W. M. (2001). Farmer adaptation, change and 'crisis' in the Sahel. *Global Environmental Change*, 11, 49-57.
- Morton, J. F. (2007). The impact of climate change on smallholder and subsistence agriculture. *Proceedings of the National Academy of Sciences*, 104(50), 19680-19685.
- Moseley, W. G., Carney, J., & Becker, L. (2010). Neoliberal policy, rural livelihoods, and urban food security in West Africa: A comparative study of The Gambia, Côte d'Ivoire, and Mali. *Proceedings of the National Academy of Sciences*, 107(13), 5774-5779.
- Mousseau, F., & Mittal, A. (2006). *Sahel: A Prisoner of Starvation? A Case Study of the 2005 Food Crisis in Niger*. Oakland, CA: The Oakland Institute.
- Mullany, L. C., Katz, J., Li, Y. M., Khatry, S. K., LeClerq, S. C., Darmstadt, G. L., et al. (2008). Breast-Feeding Patterns, Time to Initiation, and Mortality Risk among Newborns in Southern Nepal. *The Journal of Nutrition*, 138(3), 599-603.
- Nathan, M. A., Roth, E. A., Fratkin, E., Wiseman, D., & Harris, J. (2005). Health and Morbidity among Rendille Pastoralist Children: Effects of Sedentarization In E. Fratkin & E. A. Roth (Eds.), *As Pastoralists Settle*. New York: Kluwer Academic Publishers.
- National Institute of Statistics, & Ministry of Public Health. (2010). *National Nutrition Survey*. Niamey, Niger: Institute Nationale des Statistiques.
- Neef, A. (2000). Ethnic Groups in Niger In P. L. F. Graef, and M. von Oppen (Ed.), *Adapted Farming in West Africa: Issues, Potentials, and Perspectives*. Stuttgart, Germany: Verlag Ulrich E. Grauer.
- Nelson, V., Meadows, K., Cannon, T., Morton, J., & Martin, A. (2002). Uncertain predictions, invisible impacts, and the need to mainstream gender in climate change adaptations. *Gender and Development*, 10(2).
- Niamir-Fuller, M. (2000). The resilience of pastoral herding in Sahelian Africa In F. Berkes & C. Folke (Eds.), *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*. Cambridge: Cambridge University Press.
- Niger Uranium Limited. (2008). Uranium in Niger. Retrieved 12/16/2009, from <http://www.niger-uranium.com/>
- Nyong, A., Adesina, F., & Osman Elasha, B. (2007). The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. *Mitigation and Adaptation Strategies for Global Change*, 12(5), 787-797.

- O'Brien, K. L., & Leichenko, R. M. (2000). Double exposure: assessing the impacts of climate change within the context of economic globalization. *Global Environmental Change*, 10(3), 221-232.
- O'Brien, K., Leichenko, R., Kelkar, U., Venema, H., Aandahl, G., Tompkins, H., et al. (2004). Mapping vulnerability to multiple stressors: climate change and globalization in India. *Global Environmental Change*, 14, 303-313.
- Pedersen, J., & Benjaminsen, T. A. (2008). One Leg or Two? Food Security and Pastoralism in the Northern Sahel. *Human Ecology*, 36, 43-57.
- Pinstrup-Andersen, P. (2009). Food security: definition and measurement. *Food Security*, 1(1), 5-7.
- Reid, P., & Vogel, C. (2006). Living and responding to multiple stressors in South Africa, Glimpses from KwaZulu-Natal. *Global Environmental Change*, 16(2), 195-206.
- Reij, C. P. (2006). *More success stories in Africa's drylands than often assumed*. Proceeding from the Forum sur la Souveraineté Alimentaire, Niamey 7-10 Novembre, 2006. Réseau des Organisations paysannes et de Producteurs Agricoles de l'Afrique de l'Ouest, Ouagadougou, Burkina Faso.
- République du Niger. (2007). *Plan stratégique pour la protection, la promotion et le soutien de l'allaitement maternel au Niger (2008–2012)*: Ministère de Santé Publique –Niger.
- Roncoli, C. (2006). Ethnographic and participatory approaches to research on farmers' responses to climate predictions. *Climate Research*, 33, 81-99.
- Roncoli, C., Ingram, K., & Kirshen, P. (2002). Reading the Rains: Local Knowledge and Rainfall Forecasting in Burkina Faso. *Society and Natural Resources*, 15, 409-427.
- Roth, E. A. (1996). Traditional pastoral strategies in a modern world: An example from Northern Kenya. *Human Organization*, 55(2), 219.
- Rutstein, S. O. (2005). Effects of preceding birth interval on neonatal, infant and under-five years mortality and nutritional status in developing countries: evidence from the demographic and health surveys. *International Journal of Gynecology and Obstetrics* 89, S7-S24.
- Sato, S. (1997). How the East African Pastoral Nomads, Especially the Rendille, Respond to the Encroaching Market Economy. *African Studies Monographs*, 18(3-4), 121-135.
- Schwartz, H. J. (1995). Ecological and Economic Consequences of Reduced Mobility in Pastoral Livestock Production Systems In E. Fratkin & E. A. Roth (Eds.), *As Pastoralists Settle*. New York: Kluwer Academic Publishers.

- Scoones, I. (1998). *Sustainable rural livelihoods: a framework for analysis*. IDS Working Paper, No. 72. Sussex, UK: Institute of Development Studies.
- Scoones, I. (1999). New Ecology and the Social Sciences: What Prospects for a Fruitful Engagement? *Annual Review of Anthropology*, 28, 479-507.
- Sen, A. (1981). *Poverty and Famines: An Essay on Entitlements and Deprivation*. Oxford: Clarendon Press.
- Sendzimir, J., Reij, C. P., & Magnuszewski, P. (2011). Rebuilding Resilience in the Sahel: Regreening in the Maradi and Zinder Regions of Niger. *Ecology and Society*, 16(3).
- Shankar, A. V., Gittelsohn, J., West, K. Ä., Stallings, R., Gnywali, T., & Faruque, F. (1998). Eating from a Shared Plate Affects Food Consumption in Vitamin A Deficient Nepali Children. *The Journal of Nutrition*, 128(7), 1127-1133.
- Shen, C., & Williamson, J. B. (1999). Maternal mortality, women's status, and economic dependency in less developed countries: a cross-national analysis. *Social Science & Medicine*, 49(2), 197-214.
- Silva, J. A., Eriksen, S., & Ombe, Z. A. (2010). Double exposure in Mozambique's Limpopo River Basin. *Geographical Journal*, 176(1), 6-24.
- Simanowitz, S. (2009). Blue men and yellowcake: the struggle of the Tuaregs in Mali and Niger. *Contemporary Review*(291), 70-74.
- Sivakumar, M. V. K. (1992). Climate change and implications for agriculture in Niger. *Climatic Change*, 20(4), 297-312.
- Slovic, P., Fischhoff, B., & Lichtenstein, S. (1982). Why Study Risk Perception. *Risk Analysis*, 2, 83-94.
- Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, 16(3), 282-292.
- Smith, K. (1998). Sedentarization and market integration: New opportunities for Rendille and Ariaal women of northern Kenya. *Human Organization*, 57(7), 459-468.
- Smith, K., Barrett, C. B., & Box, P. W. (2000). Participatory Risk Mapping for Targeting Research and Assistance: With an Example from East African Pastoralists. *World Development*, 28(11), 1945-1959.
- Smith, L., Ramakrishnan, U., Ndiaye, A., Haddad, L., & Martorell, R. (2003). *The Importance of Women's Status for Child Nutrition in Developing Countries* Research Report 131. Washington, D.C.: International Food Policy Research Institute.

- Smith, L. C., & Haddad, L. (2001). How important is improving food availability for reducing child malnutrition in developing countries? *Agricultural Economics*, 26(3), 191-204.
- SPSS. (2011). IBM SPSS Statistics, Version 20.
- Staff. (2008). French Niger Uranium Mines under Direct Threat from Tuareg Nomads. *Space Daily*, from [http://www.energy-daily.com/reports/French\\_Niger\\_Uranium\\_Mines\\_Under\\_Direct\\_Threat\\_From\\_Tuareg\\_Nomads\\_999.html](http://www.energy-daily.com/reports/French_Niger_Uranium_Mines_Under_Direct_Threat_From_Tuareg_Nomads_999.html)
- Swindale, A., & Bilinsky, P. (2006). Development of a Universally Applicable Household Food Insecurity Measurement Tool: Process, Current Status, and Outstanding Issues. *The Journal of Nutrition*, 136(5), 1449S-1452S.
- Talle, A. (1999). Pastoralists at the border: Maasai poverty and the development discourse in Tanzania In D. M. Anderson & V. Broch-Due (Eds.), *The Poor are Not Us: Poverty and Pastoralism in Eastern Africa* (pp. 106-124). Oxford: James Currey.
- Tectonidis, M. (2006). Crisis in Niger -- Outpatient Care for Severe Acute Malnutrition. *N Engl J Med*, 354(3), 224-227.
- Thebaud, B., & Batterbury, S. (2001). Sahel pastoralists: opportunism, struggle, conflict, and negotiation: A case study from eastern Niger. *Global Environmental Change*, 11, 69-78.
- Tsai, T. C. (2010). Food crisis no longer taboo in Niger. *The Lancet*, 375(9721), 1151-1152.
- Tschakert, P. (2007). Views from the vulnerable: Understanding climatic and other stressors in the Sahel. *Global Environmental Change*, 17(3), 381-396.
- Tukei, P. M. (1963). A calendar for the assessment of the ages of young Baganda children. *Journal of Tropical Medicine and Hygiene*, 66, 42-44.
- Turner, B. L., Kasperson, R. E., Matson, P. A., McCarthy, J. J., Corell, R. W., Christensen, L., et al. (2003). A framework for vulnerability analysis in sustainability science. *Proceedings of the National Academy of Sciences*, 100(14), 8074-8079.
- U.S. Department of State. (2008). Background Note: Niger. Retrieved December 11, 2008
- UN Population Division. (2008). Niger. Retrieved December 11, 2008, from [www.globalis.gvu.unu.edu](http://www.globalis.gvu.unu.edu)

- UNDP. (2007). Human Development Report 2007/2008. New York, New York: United Nations Development Programme.
- UNDP. (2011). *Sustainability and Equity: A Better Future for All* Human Development Report 2011. New York, New York: United Nations Development Programme.
- UNICEF. (1990). *Conceptual Framework for the Causes of Malnutrition* Strategy for improved Nutrition of Children and Women in developing countries. New York: UNICEF.
- UNICEF. (2009). *June 2009 Child Survival and Nutrition Survey*: UNICEF, WFP, and HKI.
- UNICEF. (2011). *Niger Humanitarian Action for Children - West and Central Africa*. Geneva: UNICEF.
- United Nations Conference on Desertification (UNCOD). (1977). *Proceedings from the United Nations Conference on Desertification: Its Causes and Consequences*. Proceeding, Nairobi UNEP.
- United Nations Development Program (UNDP). (2011). *Human Development Report 2011*. New York: UNDP.
- United Nations Development Programme (UNDP). (2007). Human Development Report 2007/2008. New York, New York: United Nations Development Programme.
- University of Saskatchewan. People of Niger. Retrieved October 26, 2008, from [www.usask.ca/nursing/international/niger/people.htm](http://www.usask.ca/nursing/international/niger/people.htm)
- US Department of State. (2012). Background Note: Niger. Retrieved 2/24/12, from <http://www.state.gov/r/pa/ei/bgn/5474.htm>
- US Department of State's Bureau of African Affairs. (2008). Background Note: Niger. Retrieved October, 2008
- USAID. (2005). *Niger - Drought and Locusts* Situation Report #1, Fiscal Year 2005. Washington, D.C.: USAID.
- van Duivenbooden, N., Abdoussalam, S., & Ben Mohamed, A. (2002). Impact of Climate Change on Agricultural Production in the Sahel – Part 2. Case Study for Groundnut and Cowpea in Niger. *Climatic Change*, 54(3), 349-368.
- Walker, P. (1989). *Famine Early Warning Systems: Victims and Destitution*. London: Earthscan.
- Warren, A. (1995). Changing Understandings of African Pastoralism and the Nature of Environmental Paradigms. *Transactions of the Institute of British Geographers, New Series*, 20(2), 193-203.

- Webb, P., Coates, J., Frongillo, E. A., Rogers, B. L., Swindale, A., & Bilinsky, P. (2006). Measuring Household Food Insecurity: Why It's So Important and Yet So Difficult to Do. *The Journal of Nutrition*, 136(5), 1404S-1408S.
- Wenhold, F., Faber, M., Van Averbek, W., Oelofse, A., Van Jaarsveld, P., Van Rensburg WS, et al. (2007). Linking smallholder agriculture and water to household food security and nutrition. *Water South Africa*, 33(3), 327-336.
- Westoby, M., Walker, B., & Noy-Meir, I. (1989). Opportunistic Management for Rangelands Not at Equilibrium. *Journal of Range Management*, 42(4), 266-274.
- White, C. (1991). Increased vulnerability to food shortages among Fulani nomads in Niger In R. E. Downs, D. O. Kerner & S. P. Reyna (Eds.), *The Political economy of African famine* (Vol. 9). Philadelphia: Gordon and Breach Science Publishers.
- Wilding, J., Mossi, I. I., Edwards, D. L., Weisbaum, A., Aw, B., & Mander, T. (2005). *Joint Independent Evaluation of the Humanitarian Response of CARE, CRS, Save the Children and World Vision to the 2005 Food Crisis in the Republic of Niger*. CARE, CRS, Save the Children, and World Vision.
- World Health Organization. (2006). *Country Health System Fact Sheet 2006: Niger*. Geneva: World Health Organization.
- World Resources Institute. (2008). *World Resources 2009 - roots of resilience: growing the wealth of the poor - ownership, capacity, connection*. World Resources Institute. Washington, D.C.: World Resources Institute, in collaboration with United Nations Development Programme and the World Bank.
- Wuehler, S. E., & Biga Hassoumi, A. (2011). Situational analysis of infant and young child nutrition policies and programmatic activities in Niger. *Maternal & Child Nutrition*, 7, 133-156.

## BIOGRAPHICAL SKETCH

Sarah McKune received a Bachelor of Arts degree in French and sociology from Wofford College in 1999 and a Master of Public Health from Rollins School of Public Health at Emory University in 2002. She spent 6 years working in domestic and global public health before pursuing her doctoral degree at the University of Florida in the School of Natural Resources and the Environment.