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Shrinking pasture, burgeoning herds: Divergent adaptation to climate change in Tahoua, Niger

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“The power of a theory is exactly proportional to the diversity of situations it can explain.”
- Elinor Ostrom

“Il faut creuser les puits aujourd’hui pour éteindre les soifs de demain.”
- Proverbe Tuareg

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A note about the author

This self-illustration stems from the premise that the approach to any problem is shaped by the researcher's own perspective. This research, a treatise on sustainable development and adaptation to climate change in Niger, stems from my experience living with and learning from the KelGress Eghawilen (Tuareg from southern Niger) agro-pastoralist people of Tahoua, Niger first as a Peace Corps volunteer from 2005 to 2006 and thereafter as a frequent visitor, guest, and 'surrogate' family member. The way of being of this group in Niger is one of the lenses through which I have experienced West Africa. These perspectives helped to form my own view of development as a process based that is not void of conflict, due to the shifts in values, ecology, and morality as a society 'develops'. Through these observations, I found that this type of development retracts power from the hands of the ones who are acted upon, the rural majority, and puts it in the hands of the state (governmental and non-governmental actors). The model of modernity rejects the incongruous, intangible, adaptable, and uncertain management of its own vast common pool territories, many of which were the most ecologically rich areas of the country. Rather, the Nigerien State prefers to replace these with a system more easily controlled through top-down governance, put in place under the guise of sustainable development. The sustainability in development is thus a paradox, as it sustains only one perspective and way of being, while pushing out minority perspectives. The challenge that remained was - how to examine and uphold the indigenous perspective with neither the bias against it nor the favoritism for the 'loser' in development? This question led me to this scientific work.

What has maintained and continues to maintain my interest in this region are the vast changes I have observed over a 12-year career in Niger, a country that is now considered to be a terrorism hotspot and also hosts a drone base for the US government. When I first arrived into the dusty enclave/capital Niamey in January 2005, the country was already experiencing the beginnings of Islamic extremism, yet it remained latent and hidden until the fall of the Libyan regime and the resulting influx of arms into the Sahel in 2011 and 2012. By this time, Tahoua, a key transportation artery for international migration from West Africa to Europe through Libya, had also been labeled as a red (off limits) zone for Westerners. Yet, after close deliberation with the American embassy and United Nations staff, our team decided to carry out the research program as planned, and I spent nearly 11 months in Tahoua safely moving between my trusted contacts' houses.

The depth of my dedication to Niger and the Sahel region continues to motivate me to return, and my hope is that this thesis will contribute to a process of readdressing adaptation and human security in Niger in both policy and development programs.

Abstract (English)

Climate change adaptation is a complex and dynamic process that has been found to produce unequal adaptive capacities for multiple users across a social ecological system (SES). Stemming from SES theories on adaptation, this thesis asks the question: *How does divergent adaptation link to conflict and cooperation in a rural 'farmer-herder' SES?* To examine social, ecological, institutional and climatic dynamics, the thesis introduces the concept 'divergent' adaptation. Adaptation is divergent when one user or group's adaptation causes a subsequent reduction in another user or group's adaptive capacity in the same ecosystem, which may be linked to cooperation and conflict dynamics.

To understand divergent adaptation, I performed a case study land and water use conflicts within and between agro-pastoral and pastoral groups in Niger, a country with low levels of adaptive capacity that is located in the heart of the Sahel-Sahara region of West Africa. Sites were selected within three ecological zones in the region of Tahoua: Tillia (a primarily pastoral area in the Sahelo-Saharan rainfall zone), Keita (an agro-pastoral area in the Sahel zone), and Madaoua (a primarily agricultural area on the edge of the Sudano-Sahel zone). The research aimed to: 1) understand perceptions of historical, present, and future changes to ecosystem services and related livelihoods; 2) identify the adaptive capacities of multiple users; 3) explain the pace and volume of the development of enclosures around ephemeral and permanent lakes; and 4) analyze multi-scalar institutions supporting the organization of the rural space and resolution of land and water access conflicts therein.

The divergent adaptations described in this study include: expanding cultivation into pastoral areas, introducing payments for water access, and developing irrigated gardening on seasonal lakes. Divergent adaptation can be a process that builds more cooperation and equity in society or enhances entrenched patterns of injustice and inequality, a process determined by the patterns of degradation of ecosystem services, the shifting land tenure regimes relevant to adaptations, and the type and influence of institutions on the adaptation process. Based on a rigorous examination of divergent adaptations, findings show that across the three ecological zones, expanding cultivation continues to supersede mobile pastoral systems, sometimes resulting in conflict. In this context, the cultivating livelihoods dependent upon certain ecosystem services for agricultural production are more destructive to multiple ecosystem services than the livelihoods of pastoralists and the users themselves. In Tillia, the exhortation of water payments contributes to the ongoing shifts of land management regimes from commonly-shared to privately owned resources. In one location in the official pastoral zone, fencing-in of common watering holes has grown at a rate of 124% over a period of nine years as a result of irrigated gardening. While the Rural and Pastoral Codes are in place to protect pastoral space, they are rarely enforced, a problem exacerbated by conflicting governance, low accountability, and corruption. Stakeholders at climate change scenario focus group, unanimously agree that pasture will continue to be enclosed and cultivated, especially as pastoralists settle in villages, thus constraining resources.

Divergent adaptation is a state-of-the-art concept relevant for the study of how the differential adaptive capacities of multiple users contributes to conflict and cooperation in the context of climate change. Given the empirical findings, this thesis demonstrates the need for more equitable and inclusive decision-making processes at multiple scales of adaptation in the SES.

Key Words: divergent adaptation, adaptive capacity, adaptive management, ecosystem services, pastoralist, agro-pastoralist, climate change, Niger

Résumé (français)

L'adaptation au changement climatique est un processus dynamique et compliqué pour les multiples acteurs d'un système socio-écologique (SES), possédant des capacités d'adaptation inégales. Provenant des théories des SES incluant l'adaptation, cette thèse pose la question suivante : Dans quelle mesure l'adaptation divergente est-elle liée aux conflits et à la coopération du SES ruraux, également partagé par des acteurs pastoral et agro-pastoral ? Pour examiner les dynamiques sociales, écologiques, institutionnelles, et climatiques, cette thèse introduit le terme de 'l'adaptation divergente.' L'adaptation est divergente quand l'adaptation d'un acteur ou d'un groupe provoque la réduction de la capacité d'adaptation d'un autre acteur ou groupe du même écosystème, possiblement lié à des dynamiques coopératives et conflictuelles.

Pour mieux comprendre l'adaptation divergente, un cas d'étude a été effectué au Niger, un pays dont le niveau de capacité d'adaptation est très bas et qui se trouve au cœur de la région sahélo-saharienne, en Afrique de l'ouest. Les sites ont été sélectionnés suivant trois zones écologiques de la région de Tahoua : Tillia (une région pastorale située au niveau de la zone de pluie sahélo-Saharienne), Keita (une région agro-pastorale du Sahel) et Madaoua (une région principalement agricole au bord de la zone soudano-sahélienne). Cette recherche a divers objectifs. Premièrement, de comprendre les perceptions des changements écosystémiques passés, présents et futurs ainsi que les liens entre ces changements et les différents moyens de subsistance des acteurs ; Deuxièmement, d'identifier les capacités d'adaptation des acteurs multiples ; Puis, de clarifier la vitesse et le volume de l'accaparement des terres en zones humides ; Et enfin, d'analyser comment les institutions à multi-échelles soutiennent l'organisation des espaces ruraux et la résolution des conflits au sein de ces derniers.

Les adaptations divergentes décrites dans cette étude sont composées de l'extension de la cultivation en zone pastorale, l'introduction des paiements pour accéder à l'eau ainsi que de l'installation du jardinage irrigué en zones humides. L'adaptation divergente peut être un processus qui construit davantage de coopération et d'équité au sein de la société, mais elle peut également approfondir certains modèles d'injustice et d'inégalité. Ce processus s'établit à travers les modèles de la dégradation des services écosystémiques, les changements fonciers relatifs aux adaptations ainsi qu'à travers la caractérisation et l'influence des institutions pour le processus d'adaptation. Basée sur une étude rigoureuse des adaptations divergentes, les résultats montrent qu'à travers les trois zones écologiques, la cultivation continue à remplacer les éléments des systèmes pastoraux d'adaptation, provoquant parfois des conflits. Dans ce contexte, les moyens de subsistance des cultivateurs dépendants de la production agricole et des services écosystémiques sont plus destructeurs pour les services écosystémiques multiples que sont les moyens de subsistance pastoraux et les utilisateurs eux-mêmes. Dans la région de Tillia, l'exhortation au paiement de l'eau contribue à la disparition continue des espaces communs, alors remplacés par des terres privées. Dans un des sites en zone officielle pastorale, la clôture des terres humides a augmenté au taux de 124% sur ces neuf dernières années à cause du jardinage irrigué. Tandis qu'il existe des lois (Code Rural et Pastoral) convenables pour protéger les espaces pastoraux, celles-ci sont rarement appliquées. Un problème aggravé par une gouvernance contradictoire, un manque de responsabilité et la corruption. Les intervenants du groupe de réflexion sur les scénarios au changement climatique conviennent à l'unanimité que le pâturage va continuer à être clôturé et cultivé, notamment parce que les éleveurs s'installent dans les villages.

L'adaptation divergente est un concept de pointe qui permet d'étudier la manière dont l'adaptation et les capacités d'adaptation des différents utilisateurs peuvent contribuer à des conflits ainsi qu'à la coopération dans le contexte du changement climatique. Cette thèse démontre de manière empirique, la diversité des phénomènes socio-écologiques expliqués par le concept d'adaptation divergente et souhaite contribuer aux multiples domaines scientifique et politique relatifs aux capacités d'adaptation des systèmes socio-écologiques.

Mots clés : adaptation divergente, capacité d'adaptation, gestion adaptative, services écosystémiques, pasteurs, agro-pasteurs, changement climatiques, Niger

Resum (català)

L'adaptació al canvi climàtic és un procés complex i dinàmic que s'ha observat que provoca capacitats adaptatives desiguals entre els múltiples actors d'un sistema socioecològic (SSE). Partint de les teories dels SSE sobre adaptació, aquesta tesi formula la pregunta: Com es relaciona l'adaptació divergent amb el conflicte i la cooperació en un SSE rural compartit entre actors pastorals i agro-pastorals? Per tal d'examinar les dinàmiques socials, ecològiques, institucionals i climàtiques, la tesi introdueix el concepte d'adaptació "divergent". L'adaptació és divergent quan l'adaptació d'un grup d'actors provoca la subseqüent reducció de la capacitat adaptativa d'un altre grup d'actors en el mateix ecosistema, la qual cosa pot estar lligada a dinàmiques de cooperació i de conflicte.

Per tal d'entendre l'adaptació divergent, he realitzat un estudi al Níger, un país amb nivells baixos de capacitat adaptativa que està situat al cor de la regió del Sahel-Sàhara, a l'Àfrica occidental. Diferents àrees d'estudi van ser seleccionades d'entre tres zones ecològiques a la regió de Tahoua: Tillia (una àrea principalment de pastura a la zona plujosa del Sahel-Sàhara), Keita (una àrea agro-pastoral a la zona del Sahel), i Madaoua (una zona principalment agrícola en el límit de la zona sudanesa-saheliana). La recerca ha tingut com a objectius: 1) entendre les percepcions dels canvis històrics, presents i futurs en els serveis dels ecosistemes i els mitjans de vida relacionats; 2) identificar les capacitats adaptatives dels múltiples actors; 3) explicar el ritme i el volum de la creació de "enclosures" al voltant de llacs efímers i permanents; i 4) analitzar les institucions multiescalars que donen suport a l'organització de l'espai rural i a la resolució dels seus conflictes.

Les adaptacions divergents descrites en aquest estudi inclouen: l'expansió de cultius en zones de pastura, la introducció de pagaments per l'accés a l'aigua, i el desenvolupament d'horts de regadiu en llacs estacionals. L'adaptació divergent pot ser un procés que aporta més cooperació i equitat a la societat o pot augmentar els patrons ja arrelats d'injustícia i desigualtat. És un procés determinat pels patrons de degradació dels serveis dels ecosistemes, els règims canviants de propietat de la terra rellevants per les adaptacions, i el tipus i influència de les institucions en el procés d'adaptació.

Basat en un exàmen exhaustiu de les adaptacions divergents, els resultats mostren que en les tres zones ecològiques l'expansió de cultius continua reemplaçant els sistemes mòbils de pasturatge, provocant conflictes en algunes ocasions. En aquest context, els mitjans de vida que depenen dels serveis dels ecosistemes d'aprovisionament i suport de l'agricultura són més destructius pels serveis múltiples que no pas els mitjans de vida i actors que es basen en el pasturatge. A Tillia, el foment dels pagaments per l'aigua contribueix als canvis en curs dels règims de gestió de la terra, on els recursos passen de ser comuns i compartits a ser propietat privada. En una de les àrees de la zona oficial de pastures, la construcció de tancats al voltant de basses de reg comunes ha crescut a un ritme del 124% en un període de nou anys. Malgrat l'existència de lleis adequades per protegir els espais de pastures, aquestes rarament són aplicades, un problema agreujat pels conflictes en la governança, per una baixa responsabilitat i per la corrupció. Els participants en un grup de discussió sobre escenaris futurs de canvi climàtic van estar d'acord de manera unànime en què a les zones de pastures s'hi seguiran construint tancats i seran cultivades, atès especialment a què els pastors s'estan instal·lant en els poblats.

L'adaptació divergent és un concepte de gran actualitat que pot ser de suma importància per a l'estudi de com l'adaptació i les capacitats adaptatives dels múltiples actors poden contribuir al conflicte i a la cooperació en el context de canvi climàtic. Aquesta tesi demostra empíricament la diversitat de fenòmens socials i ecològics que poden explicar el concepte d'adaptació divergent i contribueix en diversos àmbits científics i polítics pertinents per a la capacitat d'adaptació en SSE.

Paraules clau: adaptació divergent, capacitat adaptativa, gestió adaptativa, institucions policèntriques, canvi climàtic, serveis dels ecosistemes, pastorals, agro-pastorals, Níger

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Chapter 1: Introduction and key concepts

1.1 Climate change and human insecurity in the Sahel

In 2009 and 2010, a drought-based disaster struck Niger. According to an FAO report, low levels of grain production in 2009 caused a 12% increase in rural market prices during the five months prior to the next harvest in September (FAO 2011). The United Nations Emergency Humanitarian Action Plan (UN 2010) reported that nearly 8.3 percent of the rural population (1 million people) was at risk of displacement due to the crisis, corroborated by reports of rural school closings due to low attendance. Livestock prices plummeted during this time and one fifth of pastoralists lost 80 to 100% of their herds due to the insufficient and erratic rainfall (FAO 2011). With low grain production and purchasing power, many farmers had gone through their stock of grain seven months before the onset of the next rainy season (ibid.). The country had not seen a crisis of this magnitude since 1984, and several experts stated that the 2010 crisis surpassed the great droughts of the 70s and 80s (FAO 2010). When they finally came, the rains fell in such abundance that heavy floods tore across the country, leaving 226,000 people without homes (FAO 2011).

Increasing frequency of high rainfall variability resembles the predictions of what would occur as a result of climate change in the Sahel (IPCC 2007; Bruggeman 2010; IPCC 2012; IPCC 2014). Yet, the shifting rainfall patterns reverberate with social and economic forces to create greater vulnerability, especially where there is little adaptive capacity (Adger 2006). Such reverberations have been shown to produce high market price fluctuations, shift the terms of trade for small holders (Breusers et al. 1998; Mortimore and Adams 2001), and create conflict over poorly distributed humanitarian aid (Guichaoua 2008), all of which are related to but not directly influenced by drought. Food crises produced by elevated staple grain prices (millet and sorghum) and deflated livestock prices and punctuated by rainfall variability were recurrent throughout the past decade in Niger (2005, 2008, 2010, 2012, and 2015) (FAOSTAT 2016).

Though the farming and herding populations of the region have been adapting to climate variability for centuries (Thébaud and Batterbury 2001; Mortimore and Adams 2001; Hammel 2001; Turner 2004), modern social and economic challenges have reoriented the rural sphere such that individuals and communities engage in more extreme adaptations and overall are disillusioned with increasingly difficult rural livelihoods (Bryceson 2002). Migration, while not explored fully in

this thesis emerges as one of the more precarious adaptation decisions (Warner 2009; Barnett et al. 2009), especially in the current context of the Sahel. Despite war and threats to personal safety, migrants traverse the Sahara or Northern Nigeria in search of seasonal or more permanent economic opportunities (Rossi 2009; Snorek 2016). For those who stay behind, remittances supplement rural livelihoods and, increasingly, humanitarian aid distributions such as cash transfers have become endemic to the livelihoods of rural peoples, creating an ‘rentier culture’ in which assistance-seeking makes up a part of one’s livelihood mechanisms (Olivier de Sardan 2013; Langendorf 2014).

In recent discussions at the United Nations Security Council, livelihood vulnerability has been linked to reverberations of insecurity, manifested as violence, banditry, large-scale rebel movements, and terrorist activities in the Sahel (Chambas 2016). The roots of poverty including land degradation, low levels of education, unemployment, alienation, and poor natural resource governance have prompted a growing belief that the Sahel region is a ripe breeding ground for terrorism, radicalization, and cycles of war and instability (Chambas 2016). To respond, the government is building up its military power with the help of French and American forces, including an American-managed drone base in Agadez and more than 3,000 French and American military personnel have been added as part of Operation *Barkhane*, which serves as a unified force to control the terrorist groups in the Sahel, namely Boko Haram and Al Qaeda of the Islamic Maghreb. This strengthening of American and French military presence shifts the country towards what many fear is an era of continued militarization (Kfir 2016).

At the same time, multiple frameworks of crisis response have been established in Sahelian countries centered around both humanitarian and resilience-based efforts. Resilience, in this context is a form of development that reduces the need for continuous assistance, and is based upon examining multiple factors in the social ecological framework for development including how individuals and communities build adaptive capacities. Yet the ways in which government activities will enhance the region’s adaptive capacity in the face of climate hazards, soil degradation, and deforestation and desertification has not been highly successful. Humanitarian aid, development, and adaptation programs have, since the onset of the Sahel droughts of the 1970s and 1980s prompted a dramatic push to build food security through the expansion of cultivation (Snorek et al. 2014a). In more recent years, Nigerien government established the program “Nigeriens Nourish

Nigeriens” or 3N (Ford 2012), funded by nearly 25% of Niger’s annual budget and supported by international partners. These efforts, aiming to increase cultivated agricultural production have in turn steer the population on a trajectory of shifting land tenure regimes, resulting in an increase in cultivated plots, managed under private tenure rules and a decrease of open access or commonly managed spaces. As a result, pastoralists are also settling to secure tenure while, dichotomously, farming populations slowly have been building up livestock holdings, which are primarily dependent upon the grasslands of the pastoral system. These conflicting modes of existence frame the context of this thesis.

In the aftermath of the two Great Sahel droughts, scholars have perceived that small scale conflicts between farming and herding populations have incrementally been increasing in frequency and magnitude (Diarra 1975; Benoit 1982; de Haan et al. 1990). This assertion, based on Sahel social and ecological equilibrium theories (Raynaut 2001), contributes to a conceptualization of enhanced conflict for two alternating livelihoods that at one time shared greater symbiosis (Diarra 1975) due to the complementarity of their activities. Land scarcity has since enhanced competition, as natural resources in the Sahel are increasingly occupied and exploited by a swiftly growing population (3 to 4% per annum), burgeoning herds (Breusers et al. 1998; Afane and Gagnol 2014), and expanding of cultivation into formerly pastoral areas (Mortimore and Adams 2001; Snorek et al. 2014a). While conflict may or may not be increasing, the need for policy measures to manage farmer and herder conflicts is clear (Benjaminsen 2012; Snorek et al. 2014a), especially in the context of increasing climate variability.

While conflict is neither perceived to be an inevitable nor a direct outcome of climate variability, adaptations, prompted at times by national development policies, can produce an uneven playing field. In this light, this thesis presents a new and novel concept and theoretical framework called ‘divergent adaptation.’ The concept explains, through three empirical case studies the linkages between conflict and cooperation, adaptation to climate change, changes or degradation to ecosystems, adaptive capacities, and institutions (Snorek et al, 2014a). It is worth noting that this thesis contains a compendium of articles, most of which are or will be peer-reviewed and published in international journals and publications. Thus, the structure that follows for this introduction only briefly lays the derivation of divergent adaptation, whereas a more detailed explanation can be found in Chapter 4. The following sections explain the main concepts to which this dissertation

most contributes and the gaps that this dissertation aims to fill. Thereafter is a brief methodology, a context chapter, and the theoretical and empirical chapters (4 – 7).

1.2 Linking human security, adaptation, and conflict in a social ecological system

1.2.1 Environmental and climate security debates

Anthropogenic and climate hazards such as drought and floods have begun to pose grave challenges to the earth's systems (IPCC 2007; IPCC 2014; Nevins 2014), which in turn produce multiple human insecurities, such as those described in the section above. The release of the Bruntland Commission's Report "Our Common Future" in 1987 propagated the belief that "the environmental problems of the poor will affect the rich as well in the not too distant future, transmitted through political instability and turmoil" (UN 1987). In the late 1990s, along with similar statements from numerous heads of state across the political spectrum, Colin Powell was quoted as stating, "Sustainable development is a compelling moral and humanitarian issue, but it is also a security imperative. Poverty, environmental degradation and despair are destroyers of people, of societies, of nations. This unholy trinity can destabilise countries, even entire regions" (In Myers 2002: 2). Moreover, the Bruntland Commission drew a line between the elements of justice and equity and environmental integrity, which is echoed in both the Millenium Ecosystem Assessment (MA 2005) and the recently established Sustainable Development Goals (SDGs) (Griggs et al. 2013).

These stirring political arguments have their source in a long-standing scientific debate over climate and environmental securitization. Many strong postulates with neo-Malthusian undertones emerged that climate-based insecurities will lead to greater and more violent conflicts and human displacement due threatened water and food security, more challenging resource allocation, and the loss or degradation of land and water resources (Homer-Dixon 1991; Myers 2002; Brown et al. 2007). In one more recent and heavily-criticized study, Burke et al. (2009) model the relationship between civil wars and rising temperatures in Africa, finding strong corellations between the two. Buhaug (2010) debunks this explanation through an analysis of the model's data sources and finds that "African civil wars can be [better] explained by generic structural and contextual conditions: prevalent ethno-political exclusion, poor national economy, and the collapse of the Cold War system" (2010:1). While not negating the premise that climate change is the greatest security threat to face our world, Adger (2010) reframes this discourse and propels the discussion towards human

security, adaptation, vulnerability, and justice. It is this latter argument that forms the basis also of divergent adaptation.

1.2.2 Human security: a framing concept

Human security, a concept that emanated from the post-Cold War discourses on development, is defined as the protection of individuals or communities from threats and disruption as well as protection of their rights and basic needs (Goulden and Porter 2010). The Millennium Development Goals (2000) Under the leadership of Sadako Ogata and Amartya Sen, the Commission on Human Security (formed in 2001) aimed to operationalize the concept in the public sphere for both policy makers and development practitioners as well as develop a program of action to address critical and pervasive threats to 'human security' (Owen 2010). Stemming from Sen's (1989) work, Leaning and Arie (2000) purport that human security is dependent not just on material means, but also on the social and psychological needs, including self-fulfillment and enlarged capacities. They argue that individuals and communities have greater resilience to hazards when their core attachments to home, community, and hope for the future remain intact (2000). Human security can also be defined as the safeguarding of communities from pervasive threats, including climate threats in a way that is consistent with long-term fulfillment (Alkire 2003).

The empirical study of human security has not gained much ground. While recognizing the usefulness of this concept for descriptive purposes and policy making, human security lacks analytical value (Paris 2001; Owen 2003). A strong debate has criticized the term's validity and usefulness (Florini and Simmons 1998), as well as an overall confusion about how to use analytically and define human security (Owen 2003). Paris (2001) criticized the concept's great breadth, arguing that it lacks the analytical and descriptive power of a robust theoretical construct to identify causal relationship and define appropriate responses. Owen (2010) finds several persistent problems contributing to the fallibility of the human security concept. Firstly, it is difficult to distinguish without great ambiguity the differences between human security and development practices. Also, there is a lack of differentiation of the term from human rights concepts and definitions. Terpstra et al. (2014) argue that the experiences with the human security approach have well demonstrated that as a rhetorical concept it has only in a limited manner been translated into practice. To bring human security into a more practical sphere begins with the development of a way to understand and address human insecurities analytically.

Social ecological systems (SES) theories provide clearer insights into the development of human insecurities. Complex interactions within an SES, expressed as humans being shaped by (Geertz 1963) and shaping or constructing their environment (Blaikie 1985; Escobar 1996) has become the basis for numerous frameworks analyzing human-environment interactions (Holling 2001; Turner et al. 2003; Anderies et al. 2004; Abel et al. 2006; Ostrom 2007; Bodin and Tangö 2012;) in light of climate change (IPCC 2012; 2014; Snorek et al. 2014; Kloos 2013) and large-scale ecosystem change (MA 2003; 2005). While natural systems consider biological and biophysical processes, SES also consist of the rules, norms, strategies, and behaviors that influence these processes (Berkes and Folke 1998; Adger et al. 2006). SESs are partially decomposable (Ostrom 2007), meaning that they are arranged within multiple levels, each level being a subdivision of the one above (Simon 2000), and they are stochastic and complex in their patterns of change and adaptation (Holling et al. 2001). Thus, there exists no simple and predictive model for understanding SESes that can provide a universal solution to problems such as the overuse and destruction of natural resources (Ostrom 2007) or the conflicts that relate to this destructions and other changes in the SES, both of which are relevant elements of human security.

1.3 Adaptation and inequality: a cause for concern

1.3.1 Origins

Since especially the 1940s and 1950s, adaptation of societies has been a key concept in anthropology and several subfields (White 1949, Steward 1955) and has grown significantly within global environmental change literature. In the early discussions of climate change during the late 1980s, policy analysts at the global scale dealt with it as an environmental issue (Schiffer 2007). In a short time period of only 20 years, the discussion and discourse evolved such that climate change became not only a common debate, but developed into an overriding issue that has permeated discourses well beyond environmental problems to all aspects of human wellbeing, security, and future development and adaptation (Brauch 2009; Adger et al. 2007; Adger 2010; IPCC 2014). Beginning dialogues focused on mitigation efforts, with the great hope of preventing the need for adaptation (Gore 1992, cited in Ayers and Dodman 2010). While climate mitigation is mandatory to prevent disastrous global environmental change, the discourse surrounding adaptation has risen to extreme urgency to establish a sounder design of climate change adaptation initiatives (IPCC 2014; Noble et al. 2014). The release of the Fourth Assessment Report (IPCC 2007) of the Inter-

governmental Panel on Climate Change (IPCC) triggered the process of writing National Adaptation Programs of Action (NAPAs), especially for countries that were perceived to be the most vulnerable to climate change impacts (Yohe and Tol 2002; Adger et al. 2007). The Fifth Assessment Report (IPCC 2014) demonstrated unprecedented climate change impacts that have not been observed in over decades to millennia (Ayers and Dodman 2010; IPCC 2014), catalyzing the need for urgent policy action. Great progress in the conceptualization of adaptation and adaptive capacity has been made since the writing of the NAPAs, including a developing understanding of the positive and negative aspects of adaptation (Tucker et al. 2010; Nielsen and Reenberg 2010; Adger 2010), and the possibility that adaptation can become maladaptive or translate to hegemonic impositions on societies (Whatmore 2008; D'Alisa and Kallis 2016; Klein et al. 2014), giving rise to an awareness of the relevance of equity and justice issues to the study of adaptation (IPCC 2014) and unfolding a discussion within the United Nations Framework Convention for Climate Change (UNFCCC) on loss and damage (Warner and van der Geest 2013).

1.3.2 Defining adaptive capacity

Adaptation is based on one's capacity to adapt and make adjustments in response to actual or expected climatic stimuli or to social and economic stimuli (IPCC 2007; Eriksen et al. 2011; Noble et al. 2014). According to Adger, "[t]he capacity to adapt is dynamic and influenced by economic and natural resources, social networks, entitlements, institutions and governance, human resources, and technology" (2007: 17.3.3). While the components of adaptive capacity are similar to those of human security, the analysis of climate hazards is unique to adaptation. One's adaptive capacity influences the ultimate potential for implementing sustainable adaptation actions that maintain or transform a situation (Engle 2011; Eriksen et al. 2011).

Measuring adaptive capacity is difficult due to the constantly changing factors influencing processes of change within and across societies (IPCC 2007; IPCC 2014). A behavior that may enhance one's capacity to adapt today may not be relevant tomorrow in a stochastic SES (Galvin 2009). Adaptations prescribed to reduce environmental vulnerability for one may result in greater vulnerability for another (Snorek et al. 2014) or produce adverse consequences in the long-term (O'Brien and Leichenko 2007). Indicators that measure the adaptive capacity of alternate actors may include, but are not limited to (IPCC 2007; Snorek et al. 2014a): 1) the amount of economic and natural resources (access to capital, land, and water resources); 2) viable links in their social network

(transactions and trust shared with neighboring groups); 3) access to entitlements (the extent to which communities or individuals are permitted to make use of resources, Adger et al 1999); 4) multiple levels of institutional support; 5) human resources (eg. children to engage in economic migration); and 6) technology (communication, transportation ease and availability). A broader list of possible indicators can be found in Table 1.1.

Capacities	Source(s)
Natural and economic resources (assets, capital, infrastructure)	IPCC 2007; Vincent 2007; Yohe and Tol 2002; Tol et al. 2004; Smit et al. 2001
Access to entitlements	Adger et al. 1999; Yohe and Tol 2002
Multiple scales of institutional support	Gupta et al. 2010; Adger et al. 1999
Technology	Tol 2004
Long term vision	Bermann & Paavola 2012
Flexibility (infrastructure and processes)	Adger et al. 2006; Pahl-Wostl
Creativity and empowerment to take advantage of opportunities	Engle and Lemos 2010; Tol 2004; MA 2006; Gupta et al. 2010
Equity of distribution	Tol 2004; Smit et al. 2001;
Human, political, social capital	Tol 2004;
Multiple forms of knowledge, information	Smit et al. 2001; Folke et al. 2003
Comfort with uncertainty	Folke et al. 2003
Social-ecological memory (biodiversity, institutions building social connectedness)	Folke et al. 2003;
Self-organization	Folke et al. 2003;

Table 1.1 Definitions of adaptive capacity mentioned in the literature.

The adaptive capacity of multiple users of natural resources is socially-derived (Adger 1999; 2009) and supported through institutions (Ostrom 2007). Pressures on the SES including environmental degradation, population growth, economic recession, political uprisings, and climate change-related hazards have pushed societies to demonstrate their resilience to shocks and stresses. What has resulted in some cases are conflict and cooperation dynamics, especially over contested landscapes where the access to and regulation of natural resources is unclear (Snorek et al. *in review*). Strong and effective learning institutions (Korten 1980; Ostrom 2007) can provide the rules that maintain peace and cooperation in areas of contested resources; however, climate change hazards enhance the stresses facing individuals and communities and the institutions that govern them. Institutions need to fit the particular individual and community adaptation needs and sets of social and environmental interactions to effectively prevent conflict.

1.3.3 Adaptation: A stochastic process

Humans have been shown to be inherently adaptive when faced with an adversarial environment (Mortimore and Adams 2001; Engle 2011). The IPCC (SREX) report (2012) considers both reactive (Tompkins and Adger, 2005) and proactive (Fankhauser et al., 1999) adaptation in human systems as well as the possible human interventions that could adjust the impacts on the environmental system. Motives for adaptations to environmental stresses range from the desire to maintain the status quo (maintaining) to a shift or transformation to a different state (transforming) (Smithers and Smit 1997; Adger 1999; Pelling et al. 2015). Maintaining and transforming adaptation occur at different time scales, before, during, or post the hazard event. For example, in the agricultural sector an individual may proactively replace high-water-consuming sorghum with more drought resistant sorghum in response to long-standing desiccation and drought, maintaining his or her production patterns. Yet, shifting from rain-fed crop production to livestock commerce essentially transforms the livelihood of the farmer, and the local system's functionality shifts (IPCC 2014; Pelling et al. 2015). To incorporate these multiple dynamics and concepts, the definition of adaptation used for this thesis is: an ever-shifting process of response to human or environmental stimuli that can be structural or behavioral, occur before or after the event or stimuli, and may buffer, sustain activities, or transform a situation (Snorek et al., 2014a).

Climate change is rarely the sole or primary motivator for adaptive actions, which vary when moving across spatial scales (Berrang-Ford et al 2011). The primary motivation for adaptation is to reduce vulnerability in the short- or long-term, and temporality of the adaptation inevitably is based in the social learning that occurs over variable temporal scales and within various types of shocks and stresses in the SES (Adger 1999). Individual or place-based community adaptations are more reactive to localized climate stimuli and tend to be less proactive (Berrang-Ford et al 2011). This tendency is related to the values held by individuals in the local sphere, which shape adaptive actions (Adger 2009). Thus the motivation or intent (Smithers and Smit 1997) for the adaptation is also linked to the expression of one's values and norms. This more nuanced definition illustrated how adaptation is an iterative learning process shaped by the norms, values, and expected behaviors that make up societies as well as the magnitude, duration, frequency, and suddenness of climate events (Smithers and Smit 1997; Adger 2008).

The dynamic nature of adaptation is due not only to the multiple stresses facing individuals and communities (such as HIV/AIDS, land degradation, trends of globalization, politics, and violent conflict, for instance), but also the ways in which institutions are influencing adaptive capacity. Institutions, or the formal and informal rules governing complex systems across multiple scales, frame behavioral tendencies within adaptation actions. Some institutions can enhance adaptive capacity, such as systems of early warning for drought risk, women's savings groups, and strong socio-cultural ties within a community that promote individuals to look out for those managing poverty, sickness, or other challenges (Table 1). Institutions must deal with high levels of uncertainty (Ostrom 2005) and adapt to changing situations (Pahl-Wostl 2007). Developing effective institutions for adaptation is a process of learning from the feedback from social and environmental patterns of interactions such as overuse, collapse, stability, and increasing returns that can produce conflict or cooperation (Ostrom 2007). Individual actors are embedded within institutions possessing diverging objectives (Moser and Ekstrom 2010). Institutions that determine for whom adaptation resources will be supplied may or may not meet the adaptation needs equitably (Engle 2011).

1.3.4 Actor-based approach

While the majority of vulnerability and resilience literature takes a system-oriented approach to adaptation, it is valuable to examine adaptation from a local or actor-oriented approach (Denevan 1983; Adger 1999; Moser and Ekstrom 2010; Eisenack and Stecker 2011). Adaptive action is spontaneous (Smithers and Smit 1997) and grounded in the social psychology of risk (Adger 2008), making it a useful framework from which to analyze its linkages to social conflict and ecological change phenomena. Moreover, actions are more relevant to a study of behavior, values, and the social conflicts that may arise in the process. This research adopts the theory of adaptations as localized actions (Eisenack and Stecker 2011) due to its relevance for an analysis of small-scale conflicts and the potential to enhance an understanding of adaptation as a social process (Adger 2006). Adaptation requires not only the change of circumstances that would make one vulnerable, but also behavioral changes, which demand more long-term, iterative processes inducing change, thus stressing the need to examine adaptation as process, learning, and behavior change. This process can best be understood in its social context (Lavigne-Delville 2000; Adger 2010).

1.3.5 Unequal adaptive capacities and conflict

An unequal distribution of vulnerability and adaptive capacity within and across societies represents the major challenge for adaptation strategies and management (Yohe and Tol 2002; O'Brien and Leichenko 2003; Tol et al. 2004; Adger et al. 2007; Kpadonou et al. 2012; Nevins 2014), and has pointed some to consider climate change as a security issue (Barnett and Adger 2007; Burke et al. 2009; Brown and Crawford 2009; Dalby 2009; Hsiang et al. 2011; Scheffran et al. 2012; Hsiang et al. 2013). In 2007, United Nations Secretary-General Ban Ki-moon (cited in Evans, 2010:5) stated that "changes in our environment and the resulting upheavals – from droughts to inundated coastal areas to loss of arable lands – are likely to become a major driver of war and conflict." The AR5 has demonstrated that the choice of adaptation actions also has ethical implications (IPCC 2014).

Adaptation, similarly to development does not have a tendency to eliminate social inequities (Kates 2000; Adger 2001; Dreze and Sen 1989) and sometimes tends to reinforce them (Adger 1999). Limits or barriers to adaptation stem from the inability to avoid or prevent risk related to one's livelihood or the ecological system upon which one depends (Klein et al. 2014). Adaptive actions are limited by power relations, values, and societal processes, which are based upon the society's ethics, knowledge, perceptions of risk, and culture (Smither and Smit 1997; Adger 2009). Some limits or adaptations could inadvertently stimulate conflict (Buhaug et al. 2008; Engle and Lemos 2010), such as large scale adaptation measures that do not meet the needs of all individuals. Yet, the individual or community's perceptions of risk to climate hazards are socially derived and mutable (Adger 2009). Limits to adaptation, thus, are not insurmountable, but can be reshaped and molded based on the social and institutional conditions (Adger 2009) as well as perceptions, culture, and material realities.

In a paper prepared for the Berkeley Environmental Politics Workshop entitled: Climate Change and Social Resilience: 'Adaptive' Conflict in the Sahel, Matthew Turner stated that "[i]f one considers community 'adaptation' or resilience not as internal organizational adjustment but as social change involving divergent interests and hard choices, it becomes clear that social responses to climatic variability are political and are not without conflict" (Turner 2010:6). When the fulfillment of one's livelihood impacts another's livelihood, conflict and cooperation dynamics are not absent, especially when resources are scarce due to ecological and wider political economies of a system

or community (Lake and Rothchild 1996; Robbins 2012; Turner 2010). Conflict dynamics include interactions occurring at varying levels of severity and geographic scales within or between individuals, communities, and institutions, varying over time and frequently coexisting (Goulden et al 2010; Keohand 2005; Yoffe et al 2003; Zeitoun 2007; Zeitoun and Mirumachi 2008). It cannot be assumed that conflict is always negative, despite that this claim is made by the predominant actors in environmental security (Peluso and Watts 2001; Obi 2000; Homer-Dixon 1999; Barnett and Adger 2007). Conflict in many contexts originates from political economic practice and is not of necessity socially undesirable (Bierschenk and Olivier de Sardan 1997; Goulden et al 2010; Turner 2010). Cooperation can also induce or suppress conflict, which is not positive (Keohane 2005). The study of conflict in this research reflects these views and presupposes that conflict is made up of a myriad of social and political positions defined by the varied tones of human interactions. "Conflict <...> is best seen not as erupting from in-the-moment scramble over resources but part of a range of political expressions over time" (Turner 2010: 6).

1.3.6 Winners and losers in adaptation

Social and ecological vulnerability to multiple climate hazards disrupts the core components that comprise human security, creating the potential for social upheaval. Yet, climate change in and of itself does not cause conflict (Buhaug 2010; Benjaminsen 2012; Kloos et al. 2013; Hsiang and Meng 2014; Buhaug 2014). Rather, conflict occurs with the evolution of socio-political processes and is exacerbated by limited access to resources, environmental degradation, and other social ecological processes of change (Robbins 2012; Benjaminsen 2012). Unequal risk is created by the dynamics related to class, gender, and ethnicity and demarcate an unequal playing field for vulnerable groups managing climate change hazards (Cannon 1994). Thus, vulnerability can be perceived as not only a material reality, but also as a social outcome (Bankhoff et al. 2004). The literature discussing climate change adaptation (Noble et al. 2014; Anderson and Monimart 2008; Eisenack and Steckner 2011), has begun to relate the social constructs of inequality and marginalization to the process and content of adaptation programs (Turner 2003; Adger and Kelly 1999; Kates 2000; Adger 2001; Smit et al 2001; Gallopin 2006; Folke 2006). These social inequities are directly related to some of the more prevalent roots of conflict and social strife such as horizontal and vertical inequities, a lack of representation, social marginalization, political exclusion, and a record of human right violations (Tadjbakhsh and Chenoy 2007). Relating the process of marginalization to the process of adaptation must become integrated into the practice of adaptation management and

planning to support the development of peaceful, sustainable societies facing slow and fast onset change in social-ecological systems (Eriksen et al. 2011).

Some literature has discussed winners and losers in climate change (O'Brien and Leichenko 2003; O'Brien and Leichenko 2010; Turhan 2014), most often highlighting those nations with the least capacities to adapt as losers. Yet, understanding who benefits or fails as a result of climate change adaptation involves the study of more local-scale dynamics in a complex SES. 'Winners' in climate change could be a northern community that is able to establish new opportunities for agriculture production due to melting permafrost. 'Losers,' contrariwise would be those who experience losses of any kind due to climate change hazards (O'Brien and Leichenko 2010). The discussion of winners and losers in climate change adaptation has highlighted maladaptations, barriers to adaptation, and the related costs and benefits of an adaptation decision. As defined by Barnett and O'Neil, maladaptation refers to an action taken with the intent to reduce one's vulnerability to climate change hazards, yet which in turn 'impacts adversely on, or increases the vulnerability of other systems, sectors or social groups' (2010: 211). Adaptations that are both equitable and have the potential to avoid conflict are those that avoid the production of winners and losers (Goulden and Few 2011). Barriers to adaptation, unlike maladaptations are sometimes self-generated through cultural norms, religious beliefs, or isolation from information and society (Nielsen and Reenberg 2010). When cultural groups are unable to adapt due to cultural norms, such as the loss of dignity that would result from accepting food aid or working certain laborious jobs (ibid.), these actors also become 'losers' in the process. This leads one to inquire what processes within adaptation can contribute to more equitable and fair outcomes, avoid unfairness in the distribution of costs and benefits, and produce situations where multiple and diverse vulnerable groups are better equipped to adapt?

1.4 The thesis contribution

As the literature review has shown, there is no direct link between climate change and conflict, but human security can be threatened by high levels of vulnerability and low or unequal adaptive capacities. It has further been demonstrated that unequal distribution of adaptive capacity is a major challenge and needs to be studied in more detail and within extended timeframes (IPCC 2014) and that adaptation measures themselves can be create more problems in the short and

long term (Li and Chang 2013). Furthermore, due to the stochastic nature of adaptation processes in complex SESs, there is no single approach or solution (Ostrom 2007).

Research stemming from the European Commission funded CLICO project (which supported initial research for this thesis) has begun to shed light on the way adaptation processes function to produce unequal vulnerability, conflict, and state-dependencies (Milman and Arsano 2014; Turhan 2015; D'Alisa and Kallis 2016). Contributing to this scholarship, this thesis provides a theoretical framework and several empirical case studies that examine the linkages between local-scale adaptations, multiple actor groups sharing similar ecosystems, and multiple institutions and their role in either building or breaking down the adaptive capacities of diverse societies. The discussion of the process by which climate change adaptation contributes to or creates inequalities has begun (Kloos et al. 2014; Goulden and Few 2011; D'Alisa and Kallis 2016); this thesis' approach and empirical findings provide insight, awareness, and depth to this discussion.

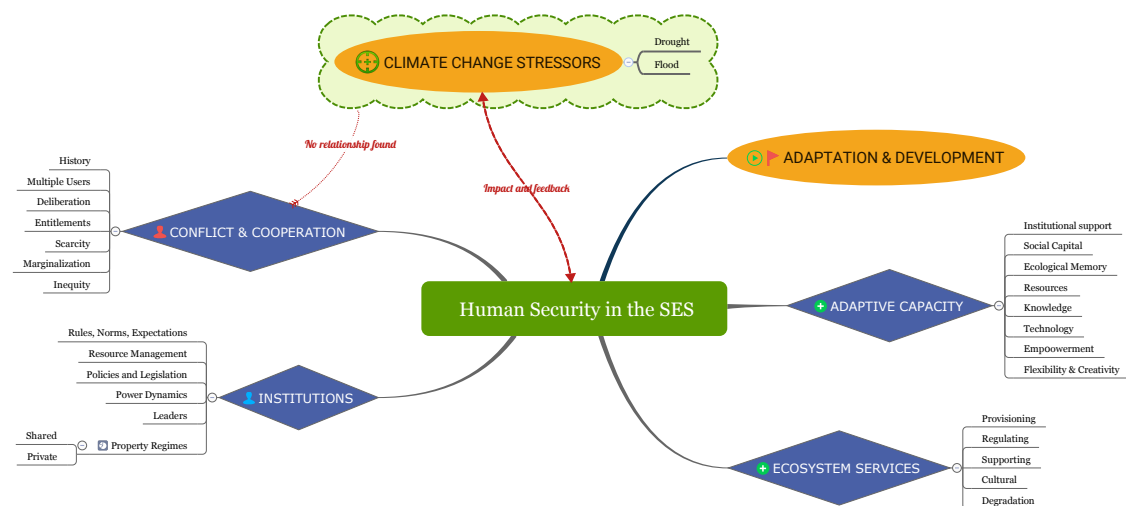
1.4.1 Introducing divergent adaptation

Based on SES theories, the term divergent adaptation refers to those adaptations that promote the success or adaptive capacity of one individual/community in a shared ecosystem which leads to a reduced adaptive capacity of an alternative individual/community in the same ecosystem. The theory of divergent adaptation was established as a direct result of empirical work in Niger where the author lived or worked as both a scholar and a development practitioner from 2005 to 2015. Divergent adaptation analyzes adaptive capacities of multiple users in order to learn about and understand conflict and cooperation dynamics between these users. The concept of divergent adaptation aims to support and broaden the scholarship on adaptation by addressing the linkages between human security, adaptation and development processes, adaptive capacities of multiple users, change and degradation to ecosystems, conflict and cooperation dynamics, and the institutions (Figure 1.1). These concepts, which have been briefly explained in this literature review and more thoroughly explained in the succeeding chapters, make up the elements of the process of divergent adaptation (Chapter 4).

The framework presented in Chapter 4 of this thesis unpacks and defines the various elements of the divergent adaptation concept and provides a case study illustrating how it is used empirically. To do so, the relationships between adaptive capacity, multiple users, institutions, ecosystem ser-

vices and conflict and cooperation in a complex, multi-scale SES are examined (see also Figure 1.1). By examining a well-known conflict between pastoralists (defined as a socio-cultural and livelihood group characterized by mobility of humans and animals and whose primary revenue is derived from rearing livestock) and pastoralists as well as between pastoralists and agro-pastoralists (one who derives his/her primary revenue from agriculture but retains both some livestock and his/her socio-cultural origins in pastoralism), the thesis can more carefully explain direct and indirect relationships between multiple concepts related to hydrological events such as drought and flood to the human security in an SES, emphasizing the influence of social relations, institutions, power, interest, and knowledge on the SES across multiple scales. To understand the linkages between climate change adaptation, changes to ecosystem services, institutions, equitable adaptive capacities, and cooperation and conflict, this thesis examined these interactions in a SES (Turner 2003; Adger et al. 2006; Ostrom 2007) and examined multiple scales (global/regional, national, sub-national, individual/community).

Figure 1.1 Diagram of key concepts explored in this dissertation.



Human security serves as the overall framing concept for the purpose of policy explanations. The SES is the object of study. The orange ovals represent the main concepts being addressed in this study, and the blue diamonds express the minor concepts explored in relation to the two main concepts.

1.4.2 Research questions for the thesis

Given that divergent adaptation is a concept that explains the potential that adaptations can create unequal adaptive capacities between users, and given that this is a process that builds more cooperation and equity in society or enhances entrenched patterns of injustice and inequality, the

purpose of this thesis is twofold. Primarily, the thesis develops the divergent adaptation framework and provides an empirical case study to demonstrate divergent adaptation. Secondly, specific institutional, ecological, and social dynamics relevant to divergent adaptation are explored in relation to cooperation and conflict dynamics.

The Main Research Question for this thesis thus explores the linkages between conflict and cooperation dynamics and divergent adaptation:

How does divergent adaptation link to conflict and cooperation in a rural ‘farmer-herder’ SES?

To answer this question, I conducted a case study of a SES shared by pastoralists and agro-pastoralists in rural Niger, asking the following three Research Sub-Questions, which are each answered through one of the thesis empirical chapters:

How do patterns of degradation, understood through multiple perspectives of the causes and consequences of past, present, and future changes to Niger’s ecosystem services relate to divergent adaptations? (Chapter 5)

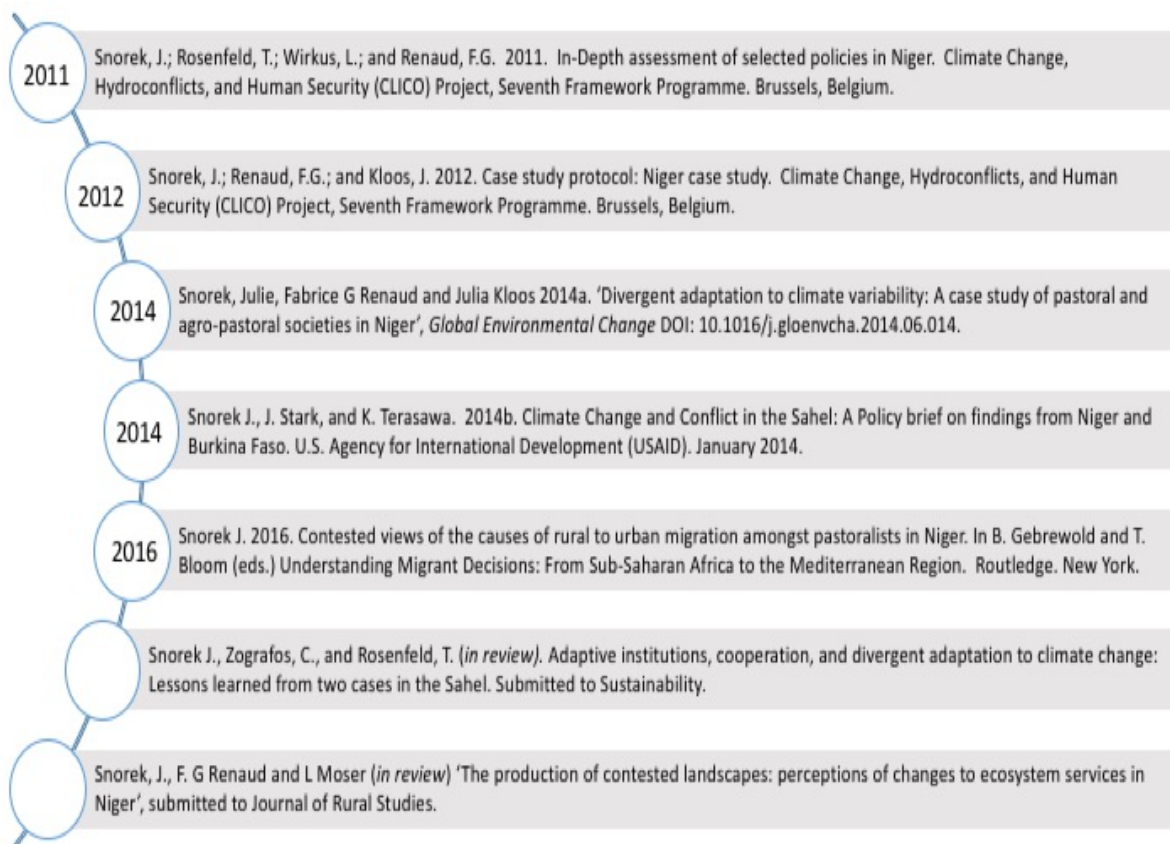
How do changing natural resource property regimes such as the privatization of commonly shared water resources relate to divergent adaptation and its social dynamics? (Chapter 6)

In what ways do institutions influence divergent adaptation and contribute to and/or reduce related conflict dynamics? (Chapter 7)

The chapters that follow in this thesis explain the various components of the divergent adaptation framework and how institutions and multiple users interact in the context of unequal adaptive capacities in a SES. Chapter 2 gives a brief overview of the methodology used for this dissertation’s case study in Niger, one that relies on a highly multi-disciplinary approach. Chapter 3 explains the social and economic context of the case study by examining reasons that pastoralists are migrating from rural to urban areas in Niger. Chapter 4 lays out the fundamental elements of the concept of divergent adaptation that guide the research throughout the thesis. To explain the concept, I provide case studies in multiple locations along a North-South axis in Niger to describe the concept

and summarize the case study examples. The chapters that follow elaborate specific parts of divergent adaptation. Focusing on the southern agro-pastoral zone, Chapter 5 presents the unequal distribution and degradation of ecosystem services and how this relates to divergent adaptations between multiple users. Presenting a case from the northern pastoral zone, Chapter 6 further elaborates upon the shifts occurring in the pastoral system, highlighting divergent adaptations of pastoralists who are settling at a high rate near ephemeral and permanent lakes. Finally, Chapter 7 examines the two southern case studies to explain best practices for institutions relevant to divergent adaptation, specifically how to manage conflicts that may result from climate change and divergent adaptation, examining institutional mechanisms that promote cooperation in the case study area. Chapter 8 discusses the findings of the thesis and provides a summary and conclusions to the thesis. Figure 1.2 provides the list of publications and reports stemming from this thesis.

Figure 1.2 Published and non-published works based upon thesis.



Chapter 2: Methodology

2.1 Overview of design principles

2.1.1 Studying social ecological complexity in the Sahel

Development efforts in the Sahel have largely been based upon two modes of thinking: the first, an environmentally deterministic paradigm presuming that the region's inhabitants are victims of continuous cycles of drought (Raynaut 2001); the second, a neo-Malthusian vision that high levels of population growth are producing patterns of resource scarcity, conflict over scarce resources, and further degradation (Klare 2001; IPCC 2001; STERN 2006). To support the easing away from these assumptions (Thébaud and Batterbury 2001), the best overall approach for this thesis is a critical examination of change in social ecological systems.

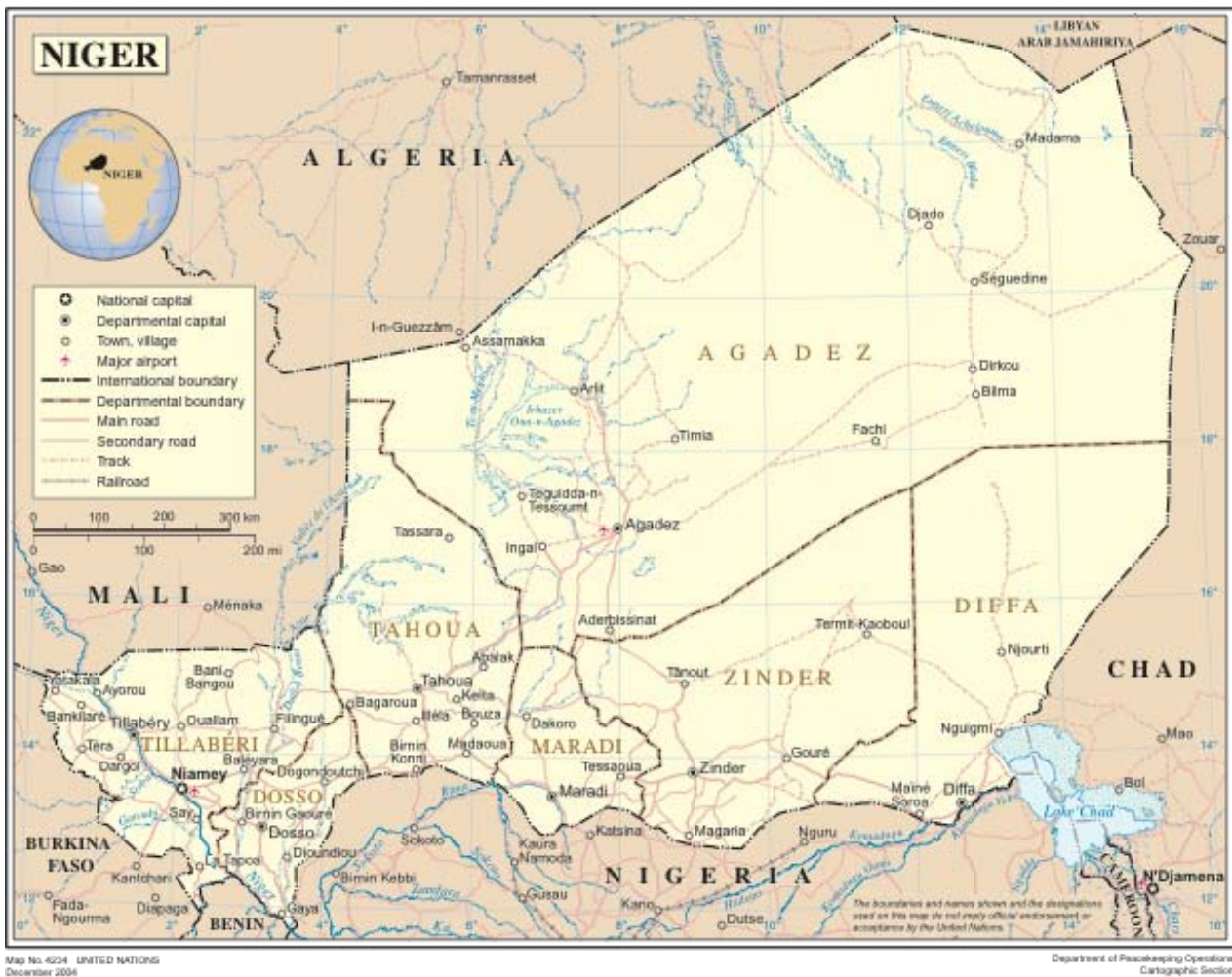
Numerous scholars have demonstrated that human and environmental systems are intrinsically linked (Holling 2001; Ostrom 2007; Robbins 2012). By critically examining understanding the complex changes taking place in the SES, one can uncover the linkages between the concepts being explored through divergent adaptation (Figure 1.1). Critical socio-environmental approaches intrinsically link humans to their environments and demand a multi-scalar and contextual approach. A contextual approach could be attributed to, for example, pasture degradation and its linkages to the political economy of local livestock markets as they are influenced by the wider regional markets and their price fluxations. Proffering another example, such an approach examines how soil degradation in the southern Sahel is linked to the in-migration of returnees induced by the fall of the Libyan regime, and concurrent loss of favorable migrant conditions in that host country. The coupling of humans and nature in a critical socio-environmental science approach is such that development programs such as irrigation near common livestock watering holes integrate the possibilities of conflicts with pastoralists into the planning and thinking of the analysis. These examples are explored throughout the multiple cases of this thesis, sometimes using explicitly a critical socio-environmental science approach (chapter 6), and other times framing this with other methodological approaches such as ecosystem service assessment (Chapter 5) and institutional analysis (Chapter 7).

As such, theories supporting a critical examination of the SES support the overall design and approach of this thesis by providing multiple lens through which one can understanding farmers

and herders (agro-pastoralists and pastoralists) and conflict related to their resource use and access. Firstly, this approach challenges perceptions that so-called peasant societies are simply victims of drought and a process of desertification, as opposed to political and social actors that are shaping and shaped by these conditions and intrinsic to a process of finding solutions (Blaikie 1985). It rebukes the idea of solely 'natural' disaster and introduces that possibility of drought as socioenvironmental phenomena (Kallis 2008). This chapter gives an overview of the design principles, but not the theories guiding the analysis. The latter is explained in each of the empirical chapters (4 – 7).

When studying complexity, simplistic approaches provide few answers. Yet, by way of clarifying the methodological approach to climate events, diverse adaptive capacities, and multiple actors in a complex SES, Lavingne Delville's premise that "immediate impacts can only be evaluated in their social context" (in Warren et al. 2001: 84) is certainly instructive. The point of departure is 'farmer-herder' conflict, referred to as pastoral (herder) and agro-pastoral (farmer) conflicts throughout the thesis. As demonstrated by the allegory of Cain and Abel (Genesis 4:1-8), disputes between these two livelihood groups are not only common but anticipated (Breusers et al. 1998). This conflict is the object of the conceptual frame 'divergent adaptation,' in which I analytically describes multiple complexities in the way multiple users' adaptations interact and relate to this conflict. While all concepts are not critiques in the course of this thesis, divergent adaptation borrows from multiple scholarship: Ostrom's institutional analysis (Ostrom 2005), Turner's and Damm's place-based vulnerability (Turner 2003; Damm 2010), and the Climate Change, Hydro-Conflict, and Human Security, Seventh Framework Program's Theoretical Framework (Kloos et al. 2014). The way that these concepts are linked to the overall approach and divergent adaptation framework is further explained in each chapter. To provide a multi-sectorial understanding of adaptive capacity as well as examine its relationship to cooperation and conflict in the context of climate change, the case studies of this thesis contribute scholarship to a broader understanding of divergent adaptation, the overall contribution of this thesis.

Figure 2.1 Map of Niger.



(Source: United Nations 2004)

2.1.2 Selection of nomadic and sedentary research sites

The study was carried out in multiple locations in Niger (Figure 2.1). A scoping study was conducted to identify key government-scale stakeholders, gather policy documents relevant to climate change adaptation, and establish the research proposal and research protocol (Figure 2.3). During this phase, interviews with experts from multiple government ministries, non-governmental organizations, and research institutions were carried out (see Annex 2). Based on these expert interviews, certain biophysical and non-physical elements that contribute to ongoing pastoralist-agro-pastoralist conflict in Niger were identified. The first of these are water points including traditional (private) wells, seasonal or ephemeral lakes, modern (cement, public) wells, pumping stations (boreholes), and permanent lakes or water bodies in and around the field sites. The second consists of official and unofficial pastoral grazing territories and livestock corridors. The third relates to land tenure practices in southern Niger. Other elements contributing to conflict are behavioral patterns such as collection of hay or forage from the pastoral ter-

ritories (Mohammed 2004; 2005). The historical political economy of these biophysical and institutional elements and patterns of behavior were later explored in the selected case study areas.

Based on this initial assessment from the scoping research, Tahoua was chosen as the most interesting region in which to carry out the research due to its potential for pastoral and agropastoral convergences and relevant geographies. The Tahoua region is defined both by high economic migration and a strong concentration of livestock and farming activities. The livestock markets in Badaguichiri and Abalak (both in Tahoua) are known as the largest in the country. Yet, the region has the least coverage for potable water (Tahoua has 53.2% coverage and Zinder has 63.3% coverage according to the Ministry de L'eau). The region also possesses large areas of compacted soil, huge variance in water table depth (0 to 200 meters), and a large percentage of the official pastoral zone (in the North). Furthermore, the region exhibits a strong concentration of cultivation in the South and high numbers of sedentary formal pastoralists in the North. After the fall of the Libyan regime, Tahoua received the most returnees than any other region of Niger (IOM 2011).

During Phase 1 of the Tahoua-based study (Figure 2.2), more detailed expert interviews were held in five departments of Tahoua (Birni'n Konni, Illela, Keita, Bouza, and Madaoua). Northerly departments (Tchintabaraden and Abalak) were only visited by research assistants due to security restrictions. To narrow the scope of the study, after an initial survey of the five aforementioned departments, Keita, Bouza and Madaoua were chosen as the primary departments of southern Tahoua, and Tchintabaraden was chosen for northern Tahoua. More thorough expert interviews were thereafter carried out in these departmental capitals, in order to identify communes and villages in which to carry out household interviews. Also during Phase 1, pastoralist households were concurrently interviewed, as they could easily be found along the livestock corridors in the region. The expert interviews were based upon the expert interview guide (Annex 1), but varied based on the qualitative needs of the study and site selection process. These interviews were carried out during both Phase I and Phase II of the research.

Village sites were chosen based on the following criteria: 1) History of impact from drought and flooding events (high rainfall variability); 2) limited water access due to groundwater table depth, desiccation, and development; 3) prevalence of conflicts over natural resource regimes; 4) di-

verse cultural makeup; 5) prevalence of seasonal or distress migration; 6) safety and security of researchers; and 7) approval and protection from national and regional officials for carrying out the study. In order to choose sites that reflected these selection criteria, we consulted documents collected at the national and sub-national scales and held expert interviews at three sub-national scales: regional, departmental, and communal.

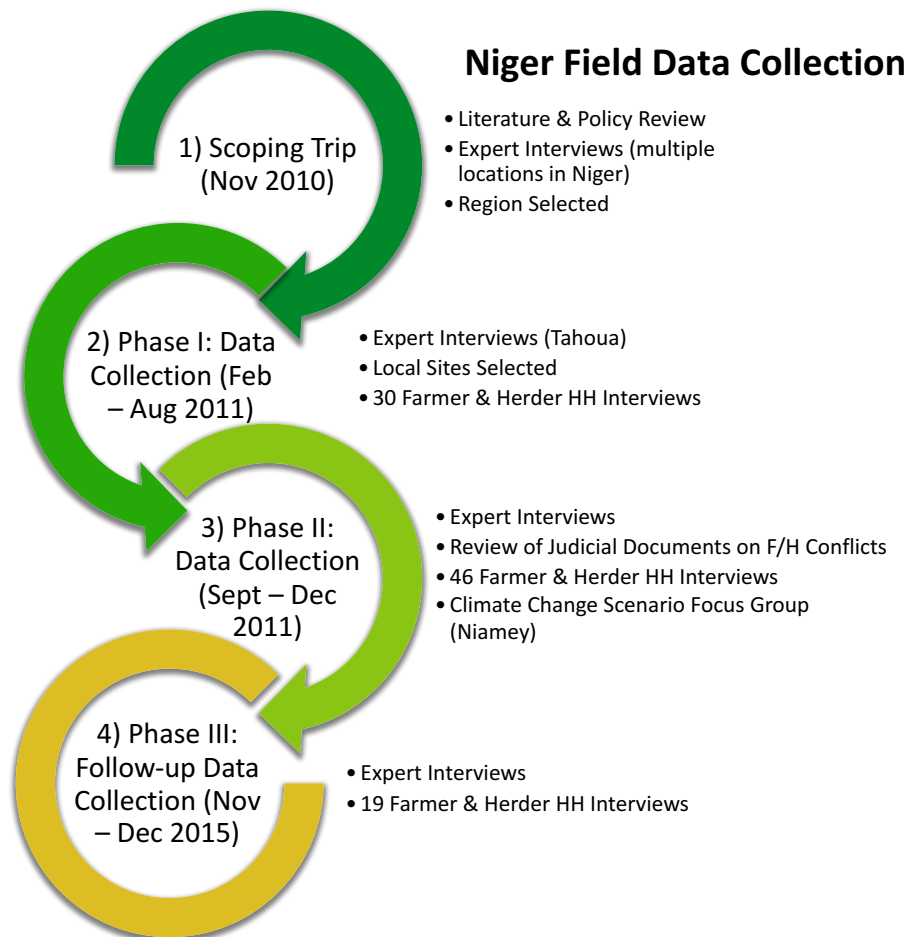
The research areas are located in southeastern Niger in the region of Tahoua (Figure 2.1 and 4.2). Thus, to differentiate between the levels of rainfall and social and ecological dynamics the research sites are located along a North-South axis at approximately the 190 mm rainfall isohyet, the 380 mm isohyet, and the 440 mm isohyet (based on 1960-1990 averages of rainfall). Rainfall averages have since reduced by 10, 43, and 54 mm, respectively for the more recent 1990 - 2009 annual rainfall averages (see also Table 5.2). Village sites were evaluated and chosen based on the information gathered during expert interviews with sub-national government and traditional (*chef du canton* and *du groupement*) stakeholders, as well as by visiting the sites themselves. Such sites include both nomadic camps and sedentary villages, and where possible there was an even distribution of participants from both livelihood type (Table 2.1). Security was also an important factor in determining research sites to protect the researchers and participants.

Table 2.1 Participants during Phases 1,2, and 3.

Department	Phases 1&2			Phase 3		
	Past.	Agro-P.	Expert	Past.	Agro-P.	Expert
Tillia	16	0	0	4	11	4
Keita	16	25	2	0	0	0
Madaoua	10	9	2	0	0	0
Konni	4	2	3	0	0	0
Niamey/Tahoua	0	0	15	0	0	0
TOTAL	45	36	22	4	11	4

The table depicts pastoral (Past.) and agro-pastoral (Agro-P) participants at the local scale and experts at multiple scales in all the departments where the research took place.

Figure 2.2 Temporal phases of data collection in Niger over a period of 2010 to 2015.



2.1.3 Case study participants

The primary unit of analysis for Phases 1, 2, and 3 is the household. Information about household adaptation actions and vulnerability was collected through expert interviews, focus groups, and from individual household interviews with male or female householders. Participants chosen include 95 sedentary and nomadic households. Half of the participants from each group were agro-pastoralists; the other half were pastoralists, with a representative segment of the various ethnic groups of the locality. Based on the focus groups and interviews, I analyzed institutional relationships, entitlements to ecological assets, extreme types of adaptation and vulnerability, and conflictive and cooperative modes of behavior, and triangulated this with data gathered through the survey of conflict (Phase 2), information garnered from the Stakeholder Focus Group (Phase 2), and data gathered during the final field visit (Phase 3).

To understand these interactions and how conflict and cooperation relate to actors' adaptations requires that one identify and understand how cultural values systems shape participant re-

sponses. In cultural relativism, it is recognized that moralities and behavior are shaped by one's cultural framework and that all cultural groups are essentially equal. While I based the methodology upon this principle, I found it difficult to analyze inequities in adaptive capacity and conflict without creating 'groupings' based on culture and livelihood (Table 5.2) I identified specific nuances of the cultural identities of the groups involved in the study. The cultural groups most prevalent in the region include the: Hausa (primarily sedentary) groups, Fulani (primarily agro-pastoral and some mobile) groups, and Kel Tamasheq or Tuareg (primarily agro-pastoral and some mobile) groups (see also Chapter 5, Table 5.2). The Tuareg in Tahoua are represented by three sub-ethnicities and caste groups (Ouillimeden Exlan, Ouillimeden, and Kelgeres). These cultural and livelihood groupings are seen as necessary for the purposes of a clearer analysis within the divergent adaptation framework and are aggregated by livelihood, yet this thesis provides only a perfunctory ethnographic analysis of cultural realities for each group, which is discussed more in Section 2.4. It is not assumed that the role actors play in the conflict is static, nor that because an actor is considered dominant in one case, his cultural group will be dominant in all cases.

2.2 Multiple approaches to complexity

The research methodology stems from qualitative research, highlighted and complemented by remote sensing-based data collection and analysis (Table 2.2). Driving these approaches were examples of research approaches gathered from the same theoretical frameworks used to derive our concept 'divergent adaptation.' These include: vulnerability and adaptive capacity assessment (Turner 2003; Folke 2006; Damm 2010; Gupta 2010), SESs and institutional analysis (Ostrom 2005; 2007; Dietz et al. 2003; Agrawal 2013; Ratner et al. 2010), political ecology approaches (Batterbury and Bebbington 1999; Turner 2004; Benjaminsen and Ba 2009) remote sensing data collection and land use land change analysis (Collado et al. 2003; Turner 2003), and climate change scenario analysis (Goulden et al. 2010). This mixed methods approach permits a broad and deep understanding of the SES, climate change, and adaptation phenomena. The difficulty to this approach arises from the multiple cultural identities, that differ across regions and shape actors' responses to climate hazards and social ecological phenomena. For this reason, participants were approached both individually and in focus groups in order to understand the sometimes hidden facets of the politics surrounding the users sharing this diverse SES. Each focus group interviewed

consisted only of members of the same group, which permitted individuals to elaborate and dramatize their accounts of conflict in what has rightly been ‘frontstage discourse’ (Murphy 1990).

The methodology consists of six main methods of data collection (Figure 2.3): 1) A thorough review of climate change and adaptation-relevant policies and literature at the national and sub-national scales; 2) expert interviews with administrative and customary leadership, agricultural and pastoral technicians, farmer and herder associations, and non-governmental organizations; 3) a qualitative place-based vulnerability and institutional assessment, which included multiple local-scale methods (village timeline, semi-structured household interviews, focus groups, hazard mapping); 4) a quantitative review of recorded natural resource-based conflicts (litigation) from department-scale institutions; 5) a day-long climate change scenario focus group of multiple stakeholders; and 6) Remote sensing-based data collection and analysis; These methods are explained with some more detail below.

Figure 2.3 The six methods of data collection.

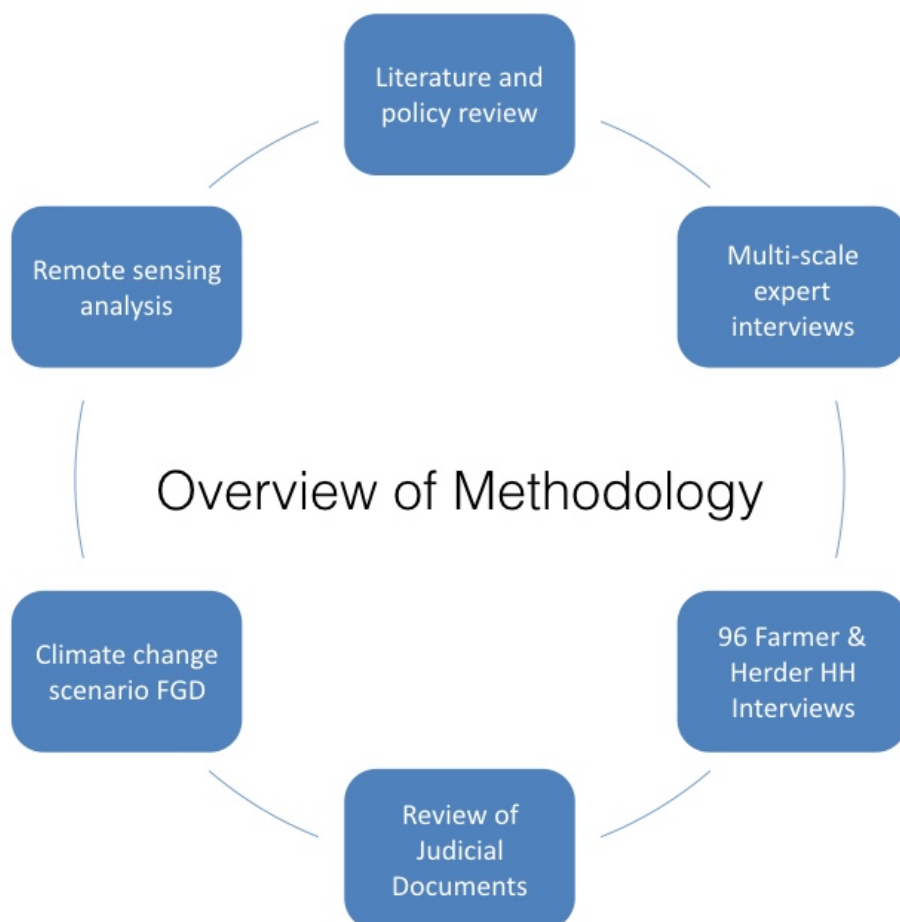


Table 2.2 Methods used to respond to each research sub-question.

	Research Sub-question	Methods	Chapter
1	How do the multiple perspectives of the causes and consequences of past, present, and future degradation of Niger's ecosystem services relate to divergent adaptations?	Expert interviews at national and sub-national scale Village timelines Semi-structured, household interviews Focus groups Village Hazard Mapping Climate change scenarios	5
2	How do changing resource regimes such as the privatization of commonly shared water resources promote conflict dynamics in the context of divergent adaptation?	Expert interviews at national and sub-national scale Semi-structured, household interviews Focus groups Remote sensing-based analysis	6
3	In what ways do institutions contribute to and reduce conflict dynamics related to divergent adaptation?	Expert interviews at national and sub-national scale Village timelines Semi-structured, household interviews Focus groups Content analysis of key policies (<i>Procès Verbale</i>)	7

Method 1: Literature and Climate Change Policy Review: Initially, during the Scoping Trip, I gathered and analyzed literature relevant to Niger's SES and climate change, legislation and policy documents to understand how others were addressing farmer herder conflict, climate change adaptation, and resilience. Documents consisted of both non-published reports and scientific literature.

Method 2: Expert Interviews at Multiple Scales: I met and consulted with governmental and non-governmental stakeholders at the national scale (Scoping Trip). Primarily, I chose individuals who were involved in or whose ideas contributed to the development of policies that directly impacted the rural sphere's adaptations to climate change events. While such actors are numerous, the approach focused on policies relevant to land and water development, access, and use in rural areas (see Chapter 7 for a thorough analysis of these policies). The list of experts interviewed for this method is available in Annex 3.

Method 3: Qualitative place-based vulnerability and institutional assessment: The qualitative study makes up the majority of field-based study in the region of Tahoua, Niger and was carried out in three phases, after an initial scoping trip (Figure 2.2 and 2.3). We carried out expert interviews at the regional, departmental, commune, and local scale (for Phases 1, 2, and 3), producing a total of 95 semi-structured household interviews and focus groups with pastoralists and agro-pastoralists from multiple ethnic groups. These were selected based on both a random and in-

formed (purposeful sampling) selection process from field sites located along the north-south rainfall continuum. With the help of Tamasheq (Tuareg), Fulfulde (Fulani) and Hausa- speaking assistants, the assessment began with an extensive meeting with village leaders¹ after which we spent several days per each visit in the village speaking with more than 115 married men and women aged from 15 to 100.

Based on the divergent adaptation framework (Figure 4.1), the qualitative portion of the study incorporates institutional and vulnerability assessment to understand from the perspective of rural participants what ecosystem services are utilized, how ecosystems have changed, what adaptation mechanisms are employed by conflicting groups of users, and how institutions support or fail to support this adaptation (Table 2.1). When talking with participants about conflict with alternative cultural groups, it is important to understand the cultural frameworks that support individual's analysis of an action arena (Table 2.1). Focus groups were held to discuss wider livelihood adaptations such as migration, pastoralism, and agro-pastoral adaptations. This portion of the study was executed over 9 months (Phases 1 and 2), with a pause during the most active time of the rainy season. Due to the nature of the study, trust between researcher and participants is essential. The following actions were carried out for the vulnerability and institutional assessment:

3a. Establish a timeline (social-ecological history). The purpose of the timeline is to have a single frame of reference when discussing historical events and social and environmental change with households. This process was accomplished in each location through both focus groups and individual interviews with typically the oldest men and women of the locale. Also, this established perceptions of environmental change of multiple actor and age groups and how ecosystems and their services have changed vis à vis these different actors. This method is elaborated in Chapters 5 and 7.

3b. Map the actor groups and natural resource management (local institutional framework). Identify actors, their positions and actions through one-on-one household interviews and through consulting with *chef du canton*, *chef du groupement*, and other local and sub-national officials. Evaluate the level of control and information participants have relevant to land and water com-

¹ Pastoralists, as their livelihood is based on mobility, do not have village leadership to represent them and organize researcher-participant discussions. Thus, we met pastoralists on a one-to-one basis, in their camps, with their explicit permission and invitation.

mon pool resources (forests, seasonal lakes, valleys, pasture areas). To understand ecosystem services and their management, assess common versus private regimes and examine access to common pool resources, especially water points (Chapter 6). Investigate deliberate obedience or disobedience to rules related to water access and management. Compare this with other factors influencing their actions, such as governmental policies, development programs, and societal norms (Chapter 5, 7).

3c. Assess multiple adaptation actions (vulnerability analysis). Utilize a livelihoods approach to understand place-based vulnerability and adaptation mechanisms engaged. Assess the assets and ecosystem services that would be exposed to a climate-based threat such as drought. Understand how broader dynamics such as migration, education, political party involvement, development projects, and humanitarian aid have influenced actors' adaptation decisions (Chapter 3). Identify barriers (the inability of SES to adapt to rate and magnitude of climate change, technological, financial, cognitive, and behavioral and social and cultural constraints, social networks, entitlements, institutions, human resources, technology). Compare to historical timeline of climate events and perspectives of social and ecological change (Chapter 4).

3d. Identify conflictive and cooperative adaptation mechanisms (conflict analysis). To identify these requires a deep understanding of both the hydrological and ecological changes in the Sahel and social institutions and processes. The research design aims to uncover the causal mechanisms related to conflict as well as individuals' decision making processes when faced with issues of poverty, scarcity, and marginalization. Some potentially conflictive adaptation mechanisms include: the accumulation of cattle, cultivation at ephemeral lakes, water scarcity at dry season wells, differential entitlements to water in North and South Niger. I identified areas of adaptability and social learning, trends of weakening or strengthening customary or modern institutions, contradictory or complementary politics, favoritism of certain groups over others, and marginalization. With the help of the quantitative survey of conflicts and theft, I examined the content of conflictive events and related this to rainfall events (drought, flood) to identify potential linkages (Chapter 7).

Method 4: Content analysis of natural resource-based conflicts: To obtain data for the quantitative survey of conflict our local research team consulted locally-available judicial records (called *procès verbaux* or *procès verbale* or *PV*) on water-based conflicts and held semi-formal interviews

with traditional leaders such as the *chef du canton* (Canton chief) and *chef du groupement* (Group Chief). This portion of the research took place during Phase II (Figure 2.2). However, this data was not complete enough to be analyzed quantitatively. The team of two local research assistants traveled to the regional centers nearby the research site (Keita, Bouza, and Madaoua) and accessed the written files on natural resource conflict - PVs. These documents explained the type and participants in violent conflicts (Annex 4). While very few cases related to farmer-herder conflict were found, the team calculated the number of natural resource conflicts and recorded several notable examples. Following this survey, a research assistant and I met with traditional chiefs to discuss the prevalence of land and water-based conflicts and consult their written records, yet most conflicts are handled orally and no PV is produced. Due to the void of data, we chose to examine theft, as the records were more prevalent and consistent. However, due to time constraints, this was only carried out in one of the departments (Keita).

Method 5: Climate change scenario focus group of national-scale stakeholders: Social, political, and economic structures in Niger are influenced by rainfall. Not only are the main economic units (field crops and livestock) directly dependent upon rainfall, social stability and continuity are also more secure with consistent rain. The climate scenarios developed by the Cyprus Institute (2010) were developed into four social and environmental future scenarios (Chapter 6). On December 10, 2011 at the headquarters of the African Centre of Meteorological Applications for Development (ACMAD) in Niamey, a group of 18 experts, practitioners, and politicians convened to discuss the scenarios and devise institutional means of preparedness and prevention of conflict. Those invited include members of the commission on pastoralism (3), experts in hydrology, meteorology, social science, and climate change (8), policymakers (5), and development practitioners (2).

Method 6: Remote Sensing Analysis: The remote sensing analysis was carried out in collaboration with the German Aerospace Centre (see Chapter 6) from 2013 to 2014. The analysis focused on the growth rate of enclosed (fenced) areas being established in the pastoral zone. Very high resolution (VHR) images from Quickbird-2 and WorldView-1 available in satellite data archives between 2003 and 2013 were acquired. The VHR data served as a primary data source, supported by high resolution (HR) optical satellite data from RapidEye (Table 2). Archive images from before 2006 were available for only few areas in northern Tahoua, among them the regions around Tillia and Droum, for which also new imagery from 2012 and 2013 was available (Table 2). Due to the

large size of the Droum site three different image swaths had to be used. Three different archive images (west: 2005, center: 2006, east: 2004) were combined and analyzed.

2.3 Data analysis

Divergent adaptation is an analytical concept, drawing from specific scholarship relevant to SES theories to develop and explain adaptive capacities and their social dynamics. For the analysis, we examined multiple categories in order to explain this concept, which is further elaborated in the chapters of the thesis. Relevant literature, qualitative and expert interviews were analyzed using AtlasTi 7.0.92 (AtlasTi GmbH), software that allows one to codify, categorize and synthesize multiple forms of data systematically. The data were organized by the following categories: climate change perceptions, changing ecosystem services over a 20-year timescale, and the adaptations for pastoralists and agro-pastoralists; and social, institutional and political dimensions. More specific analyses were performed for each chapter as part of an iterative learning process; the modus operandi of data analysis is further elaborated into more detail in each chapter.

2.4 Research constraints and shortcomings

The research was carried in multiple periods under strict security constraints. Since especially 2010, Al Qaida of the Islamic Maghreb has been carrying out kidnappings of Western foreigners to garner potential ransom money and evoke terror throughout the country. This has resulted in a militarization of many parts of Niger, and great limitations to researchers. During the first year of field study (2011), our team managed to maintain high levels of mobility and spontaneity in order to ensure our safety, basing our decisions sometimes on nuances in conversation, feelings or welcome and trust in the location of study, and information from trusted participants. Only highly trusted individuals were aware of our movements and itineraries. While this was the best way to accomplish this research, we could not spend significant periods of time in any one place in order to avoid detection and potential of security risks. Thus, the research was accomplished in multiple site visits. This limited a few of the more participatory methods planned for the Phase 1 and 2 of the research. For example, to ascertain the historical frameworks from each village, we shifted from hosting a day-long participatory timeline development meeting to individual meetings with the oldest individuals in the village. This did not seem to impact the quality of the data, due to triangulation with multiple non-relational individual informants.

Primarily male research assistants supported the data collection in 2011 and 2015. As a result of this choice of personnel, female contributions and perspectives in this study were more limited. Niger is a Muslim society and women were not as accustomed in some locales to speak with a male research assistant and foreign woman. Also, women were often unavailable especially within pastoral households due to the tendency of pastoralists to leave their families in a home based during the transhumance. Despite this weakness in the design, the perspectives gained from men proved to be nuanced and detailed in relation to productive livelihoods and conflicts over access to resources, which made up the primary elements of the data collection. Women, however were more capable of explaining dietary and household food security changes over time. Future studies of this kind should account for seasonal and cultural dynamics in order to be more inclusive of women.

In consequential research visits after the initial 9-months in 2011, it was necessary to exercise even more caution, due in part to the non-governmental organizations hosting me and their stringent security protocols. For instance, the government has taken on the business (literally and figuratively) of protecting Western visitors and recommends that any vehicles leaving the capital to be accompanied by heavily armed government military escorts, consisting of two vehicles, one carrying ground to air missiles and 12 armed military personnel. This placed restraint on data collection, especially on topics related to human security and conflict. Thus, consequential visits (2014, 2015) were not as fruitful as the original data collection period in 2011. To compensate for this limitation, we worked with the same research assistants throughout the study, who understood the topic and objectives, and who were able to return and repeat site visits. These individuals went alone to the regions where the primary researcher could not obtain access.

In the divergent adaptation framework, actor groups are described primarily based upon the details of their livelihoods and use activities. Thus, certain cultural idiosyncrasies relevant to decision-making processes in adaptation (Nielsen and Reenberg 2010) were not incorporated into the study. These details would have been especially important to the study of institutions, as the institutions in Niger have been highly framed by the historical cultural norms, including the relationship of animist practices with clearing of the land in Hausa culture (Manvell 2005). While the lack of cultural detail may provide for some inaccuracies in the data analysis, the livelihood-based focus still provided the key details to develop the theory of divergent adaptation. Throughout the

three main rainfall zones of the case study area, it became rapidly clear that one group was marginalized in their entitlements over the space, namely pastoralists. Thus, understanding this element proved to be useful in defining winners and losers (User A and User B in Figure 4.1), but not as useful in supporting our understanding of agro-pastoralism, or a phenomenon in which both actors in divergent adaptation begin to resemble each other. More basically, as pastoralists settled into agro-pastoral villages, they gradually also gain more entitlements and access to resources, including social capital with the State. While I touch briefly in the study about agro-pastoralism, this area deserves more study, due especially to the fact that within agro-pastoral groups, there also tends to be winners and losers in adaptation. Yet, for the purposes of this thesis, to explain the concept of divergent adaptation, using such different livelihood groups - pastoralist and agro-pastoralists was in fact still a very useful way to frame the research, despite lacking nuance of mixed cultural-livelihood identities.

Chapter 3: The social ecological context in Niger²

3.1 Geo-political impacts on Niger's main adaptation

In the course of only seven months in 2011, more than 89,000 Nigeriens returned to Niger from the northerly neighbor Libya, escaping revolution, war and racial violence, some of which is based upon perceptions of Sub-Saharan Africans being 'Al Gaddafi's mercenaries' (IOM 2011). The majority of these returnees had been supporting their families through the more plentiful economic opportunities in Libya prior to the civil war. These repatriated migrants were 99 % males aged 20 to 40 years, not formally educated (82%) and working primarily in construction or agricultural labor while in Libya (IOM 2011). For the most part (93%), these individuals returned alone to their homes in Niger, those in which they had been supporting an average of 5 family members with the remittances from Libya (IOM 2011). Of registered returnees, 36.5% returned to areas in the pastoral zone of Tahoua in Niger, a region that experiences particularly high levels of out-migration (FEWSNET 2011). Approximately 384,400 Nigeriens were affected by the loss of remittances, and 137,386 of these are within the Tahoua region alone (IOM 2011).

The Libya crisis also permitted the filtering of arms into the arsenals of several latent non-state militant groups in the Sahel, including the Movement National pour la Liberation de l'Azawak (MNLA), the Movement for Unity and Jihad in West Africa (MUJAO), and Al Qaeda of the Islamic Maghreb (AQIM). Previous rebellions led by Tuareg leaders of groups similar to the MNLA took place 1962-1964, 1990-1995, and 2007-2009 but never achieved the extent of success as this uprising in Mali. Since the Malian civil war broke out in January 2012, over 470,000 refugees and internally-displaced persons have been reported by UNHCR (2013). More than 23,000 of the refugees are being hosted in Tahoua (April 2013 UNHCR). This has exacerbated current problems in the region including food, water, and livelihood insecurity and has promoted remigration into neighboring countries, including Libya.

At the global scale, many communities are experiencing multiple climate hazards, which have produced increasing human insecurities and enhanced the potential of individuals and groups to

² A similar version of this chapter has been published as: Snorek J. 2016. Contested views of the causes of rural to urban migration amongst pastoralists in Niger. In B. Gebrewold and T. Bloom (eds.) *Understanding Migrant Decisions: From Sub-Saharan Africa to the Mediterranean Region*. Routledge. New York.

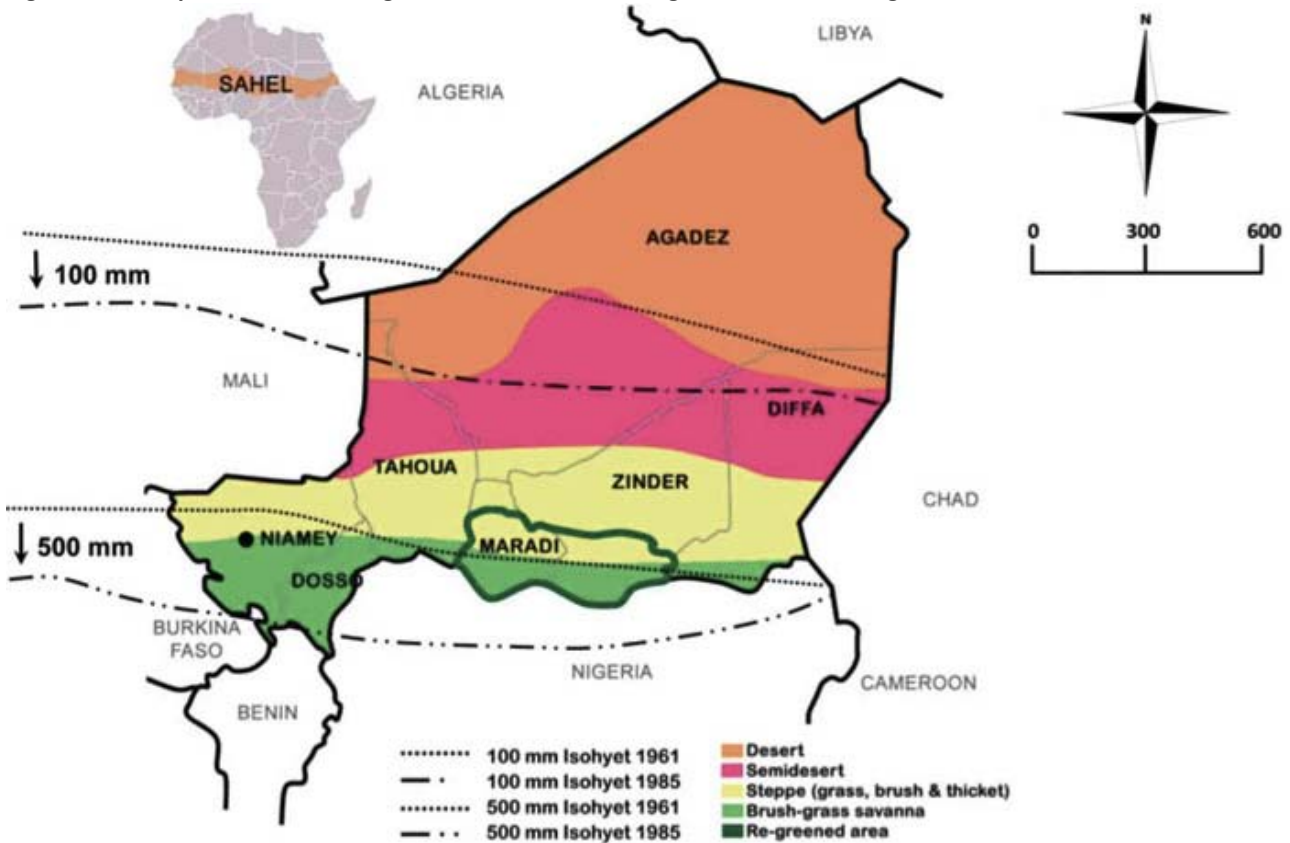
migrate, sometimes on a large scale, on a temporary or permanent basis. António Guterres, the United Nations High Commissioner for Refugees, points to the emergence of globalization, unresolved poverty and enduring human insecurity as new trends in global displacement patterns (Guterres 2008). In Niger, annual economic migration is a necessity for most rural households due to frequent climate hazards and low levels of adaptive capacity. Nearly 17 million people were displaced by natural hazards (including drought) in 2009 and 42 million in 2010 (Foresight 2011) and evidence has emerged that more than 260,000 migrants landed in Europe during the first eight months of 2016 over half of which crossed the Mediterranean from Libya (IOM 2016).

3.2 A citizen of the poorest country in the world

Niger the lowest-ranking country according to the Human Development Index (UNDP 2015) is home to 19.9 million people (World Bank 2015). If one were to imagine the average citizen of this Sahelian nation, he would be male, of the Hausa ethnic group, and would be earning approximately 370 USD per year (INS 2014). This hypothetical citizen lives in a rural village located along the thin southern band of arable land, which represents only 11.3% of the country's total land (CIA 2011). Due to heavy degradation on his one cultivated field and frequent droughts in his wind-swept village, our citizen is often dependent on support from friends, family, or government projects, the latter of which is more abundant especially during drought periods. Often, the man borrows money from relatives to travel to Nigeria or Libya, where he stays (depending on his earnings and next rainy season's outlook) for a little under a year. With his earnings, the Nigerien citizen purchases small ruminants, which are kept by his two wives and whose milk furnishes extra nutrition to the 8 young children. The oldest son, who has just married is landless due to his family's poverty and leaves the village on a northward trajectory after learning of a relative who has cultivated without any conflict from local inhabitants in the pastoral zone around Tillia. On the way, the son makes a stop in a small semi-pastoral Fulani village, where he visits his father's three steers, which are dwelling with a shepherd in a northern Fulani village due to the heavy cultivation in the South as well as his father's discretion about showing any signs of wealth. The son sells one, using these earnings to build his new residence in the North. Despite the higher variability of rainfall, our citizen's son has been lucky in the North, as the government has recently furnished motorpumps to those willing to produce vegetable gardens. While the citizen's son has learned from pastoral populations that cultivation in this land is not welcome, he is content with his luck, takes up gardening in a pastoral valley, and seeks to earn

enough to bring his wife and child to join him in in this village in the semi-desert region (Figure 3.1). While our citizen is a fictitious character, his livelihood status and behavior reflect some of the elements that are contributing to conflicts throughout the country, namely the stronger mobility and capacity of agro-pastoral societies to adapt to changing social and ecological conditions.

Figure 3.1 A depiction of cities, regional boundaries, and vegetation zones in Niger.

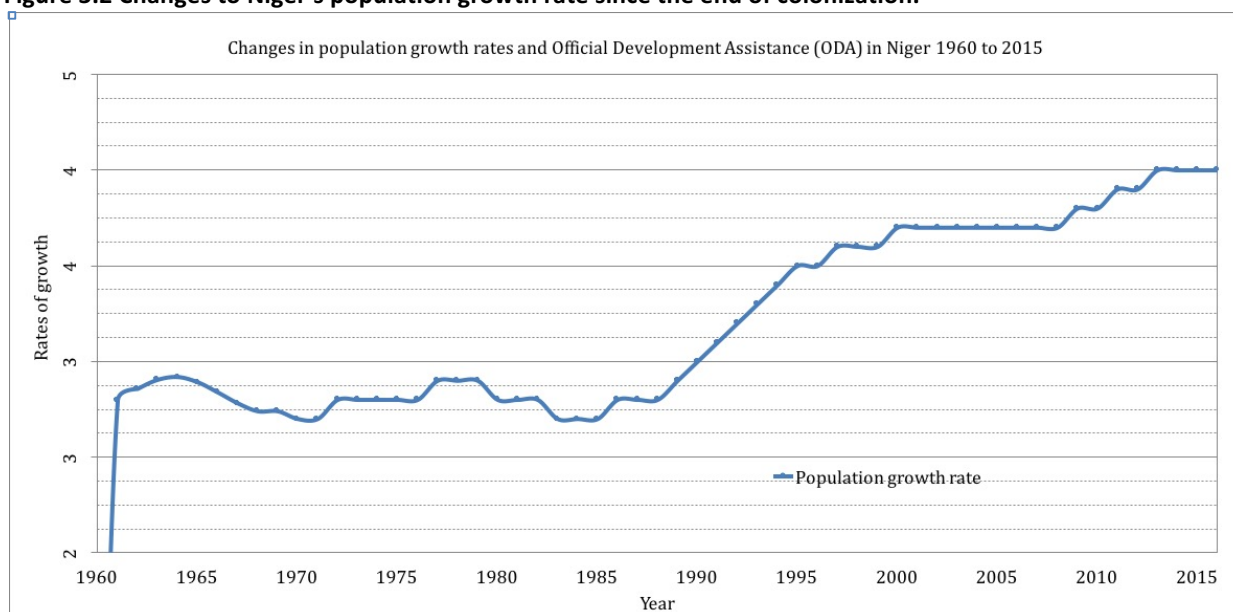


Hatched and dotted lines show the southward shift of the 100-mm and 500-mm rainfall isohyets during the period of desiccation from 1970 to the late 1980s (Koechlin 1997:17). The colored boundaries between vegetation zones represent gradual shifts in species distributions (Sendzimir et al 2011).

The statistics about Niger present a dire picture of endemic poverty. Of the 18.5 million people in Niger, 40.8% are living below the poverty line on less than \$1.25 per day, and the majority or 89.8% experience multidimensional poverty, or multiple deprivations at the household level in education, health and standard of living (UNDP 2015). Despite its poverty, Niger has the highest population growth rate in the world (4%), a rate that has grown significantly especially during the period of democratic advancement in the 1990s, jumping from 2.7% to 3.7% in a single decade (Figure 2). All but 10 % of the country's population lives less than 100 miles from the greener southern border with Nigeria, and 86 % of the population lives in rural areas (République 2011).

The large, polygamous (culturally pastoral groups such as Tuareg and Fulani also have large families, but are not often polygamous due to the matrilineal historical frameworks) families of the southern farming cultural groups are the primary contributors to high birth rates, based on the 95 households participating in this study. Also, a woman in a polygamous family desires more children than her cowife to better garner her husband's favor according to multiple experts in this study. Fertility is more strongly concentrated in adolescent mothers (20%, ages 15 - 19 years), and Niger exhibits disparagingly high rates of fistula amongst young women (UNDP 2015). A striking lack of health and sanitation heightens the child mortality rate and for every 1,000 births, there are 115 deaths (World Bank 2015); less than half of the total population has access to formal health services (UNDP 2015).

Figure 3.2 Changes to Niger's population growth rate since the end of colonization.



(Source: World Bank 2015)

High population growth in Niger coupled with a fiercely agrarian development framework produce persistent competition for land and water resources. Though the majority is reliant on the land for all or part of their livelihoods, it has been shown that 25% of the population is subsisting on degraded land, with the cultivated area migrating gradually northwards (World Bank 2015; UNDP 2015). The scarcity of land induced by social and ecological constraints is produced due to especially heavy levels of soil degradation in the country, which are further exacerbated by rainfall variability, rapid rates of urbanization, the commercialization of natural resources and increasing industrialization of the territory. These processes are relevant to development patterns throughout the Sahel and frame the adaptive capacities of the majority of the region's citizenry.

3.3 Desertification and climate hazards

The climate of Niger is characterized by a long dry season with interspersed cool and hot periods, followed by a short three-month humid season, during which the majority of biomass of land cover (grasses, shrubs, trees) and agriculture is produced. The abundance and diversity of flora and fauna in the region depend upon the relative amount of rainfall, which decreases moving latitudinal from South to North (Image 3.1). The Sahel region has experienced vast environmental changes over the past several decades due to a variety of reasons, including ocean and atmospheric dynamics such as the El Nino southern oscillation (ENSO) cycles (Nicholson 2001), sea-surface temperatures caused by non-ENSO-related variations (Giannini et al 2003; Brooks 2004; Hermann et al 2005), large-scale land degradation land-atmosphere interactions (Charney et al 1975; Hulme and Kelly 1993; Nicholson 2000; Hulme et al 2001), and anthropogenic climate change (Giannini et al 2003). Temperature has increased gradually since the 1970s, with important increases in the minimum temperatures of +1°C. The period of 1990 – 2007 has seen particularly high temperatures, in comparison to the period 1951 – 1979 (Agrhymet 2007).

Image 3.1. Niger's ecological variation.

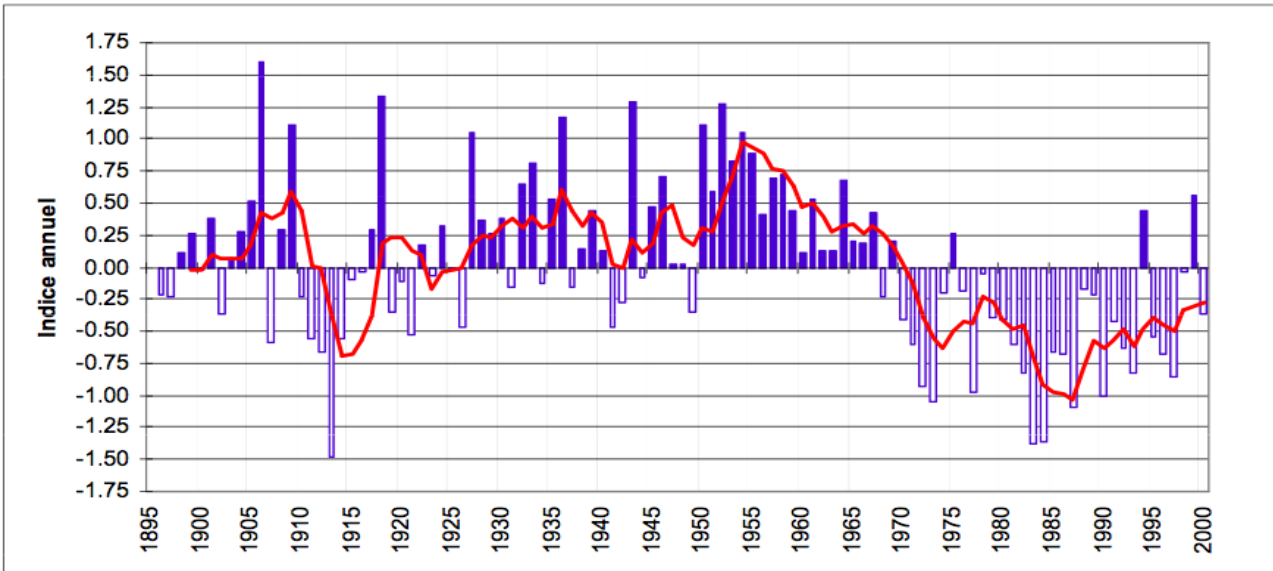


(Left) Tillia, Niger. Northern rangeland dominated by *Aristida mutabilis*, *Cenchrus biflorus*, *Eragrostis tremula*, *Brachiaria xantholeuca* and *Schoenefeldia gracilis*. (Fode 2009; Irrichid, 11.2011). (Right) Bangui, Niger. Highly cultivated, humid valley in the south near the Nigerian border (Snorek 11.2011).

3.3.1 Persistent rainfall variability

One thing that is constant in the Sahel is persistent spatio-temporal rainfall variability. Throughout the past century (Figure 3), fluctuations in rainfall are related to slow and fast onset social and ecological change, including mass rural to urban migrations during the two Great Droughts in the 1970s and 1980s. Such changes of rainfall have left indelible marks on the landscape, and prompted shifts and upheavals for the population.

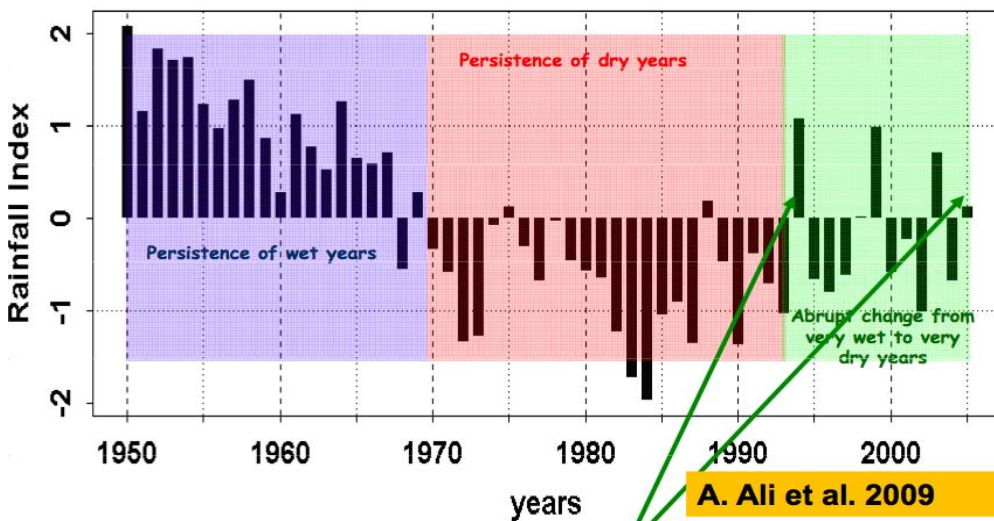
Figure 3.3 Rainfall Anomalies in the Sahel.



In the Permanent Inter-state Committee for the Battle Against Desertification in the Sahel (CILSS) countries since the 1900s, rainfall anomalies have had a negative tendency. (Agrhymet 2011)

Rainfall variability is perceived to be increasing as a result of climate change. In recent times, small- to large- scale droughts occur every two to five years in frequency (Hangsdijk and van Keulen 2002). Since the beginning of the 20th Century, the Sahel has seen seven major droughts during 1910 – 1916, 1941 – 1945, 1968, 1971 – 1974, 1984, 1987, 1989, 2004, 2009, 2011 (National Direction of Meteorology 2008, FEWSNET 2011). Indeed, extreme low rainfall years are so frequent, that some (Hulme 2001) wonder if the term “normal” rainfall is relevant in the Sahel.

Figure 3.4 Inter-annual evolution of rainfall variability observed since the 1950s

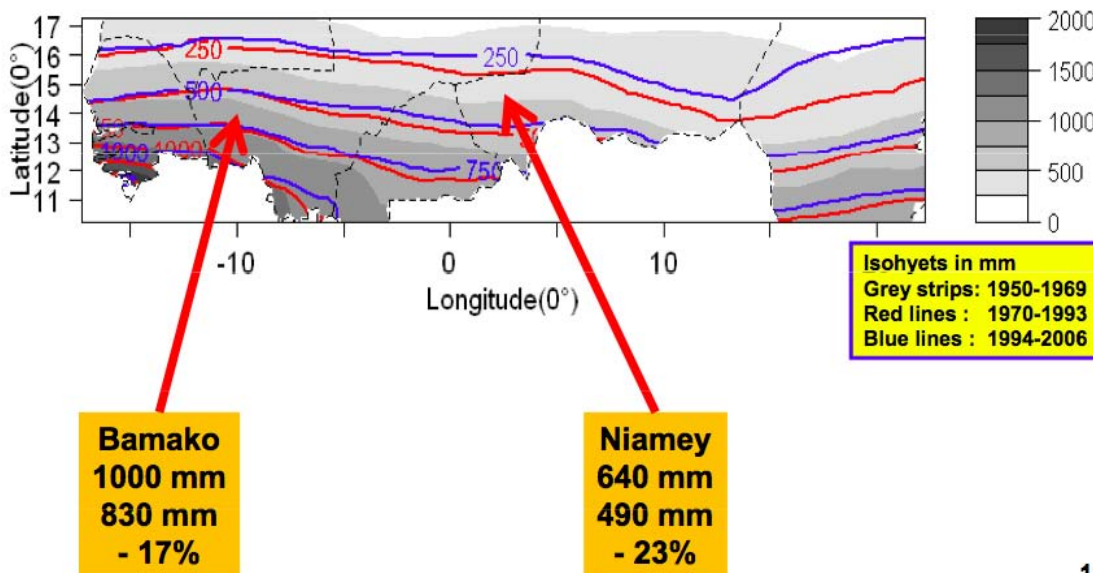


Trend of inter-annual variability

Rainfall variability depicted in standard deviations. (Agrhymet 2009).

In the past century, meteorologists have observed a southward shift of the climate isohyets in the Sahel, especially drought and desiccation period of the 1970s and 1980s (Wittig et al. 2007). While the reasons for these shifts vary from changes in seas surface temperatures to variations in the ENSO cycles, the biophysical consequence of these shifts is a general reduction of average rainfall throughout the region. While more humid conditions began to reappear in the mid-1990s, the region has not returned to the climatic period observed in the 1950s and 1960s.

Figure 3.5 Isohyets shifted 200 km south since the humid period of the 1950s.



11

(Agrhymet 2011).

3.3.2 Desertification and 'greening'

Along with the change in rainfall variability, the human- and climate- induced process termed 'desertification' has caused the Sahara desert to spread into the Sahel, and the Sahel into the more humid Sudanian zone (Aubreville 1949, Delwaulle 1973, El-Baz and Hassan 1986). While many accepted the early presumptions that livestock of pastoral groups was the main cause of desertification and drought in Niger (Charney et al 1975), the spread of the Sahel and Sahara desert via wind and water erosion has been shown by 48% of studies on the Sahel reviewed by Wittig et al (2007) to be caused primarily by the intensification and extension of cultivation. In fragile dryland ecosystems, extending croplands into former rangelands results in the overgrazing of remaining pasture and degradation of vegetation, reducing biodiversity and biomass (Dube and Pickup 2001).

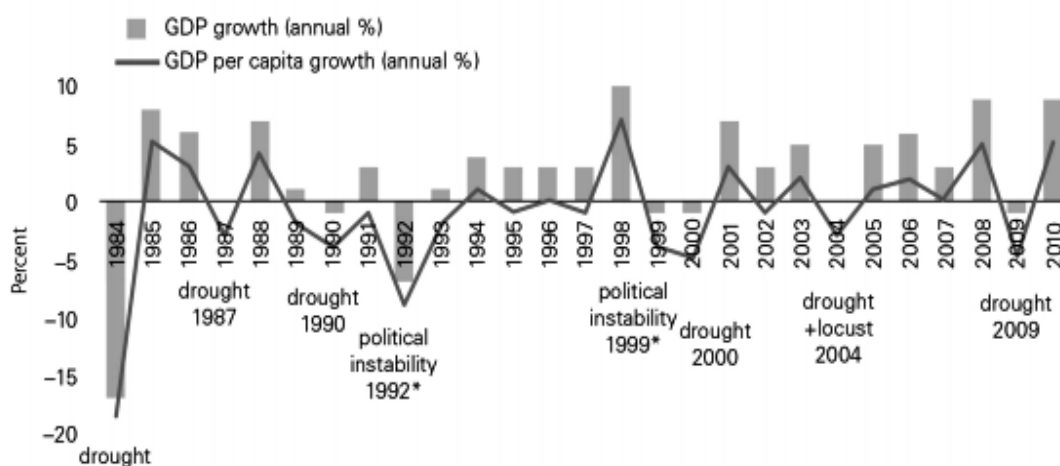
Vegetation recovery has been sparsely observed in certain areas of Niger where farmers have taken up agro-forestry practices (Redj 2005) or projects have initiated reforestation programs

(DiVecchia 2007). However, such practices have not been widely adopted despite the benefits (increases in agricultural yields and greater livelihood security during drought), and the slight increases in rainfall observed in recent decades have not been sufficient to counteract the forces of human-induced land and soil degradation. New analyses of vegetation growth estimated using remote sensing and rainfall data for a timescale of 1982 to 2006 suggest that land degradation has impacted over 50% of the Sahel (Shepherd 2006). The continuation of current cultivation practices will result in critically poor soil health and a risk of long-term damage to the ecosystem services that support the population.

3.3.3 Socio-political aspects of drought

Widespread poverty and instability coupled with the mismanagement of aid (Guichaoua 2008), a population stuck in continuous cycles of debt and environmentally harmful coping mechanisms leaves the majority of Niger's population in a constant cycle of human insecurity. In 2005, drought caused famine-like conditions throughout the country, but President Tandja refused to declare a situation of emergency that would allow for an in-flow of aid to the country. The 2005 crisis affected more than 3.6 million people. In the worst hit regions, the mortality rates reached 4.1 deaths per 10,000 people per day (UNDP 2005). Given that the majority of exports are primary products, drought crises wreak havoc on Niger's growth performance and overall economic performance. For example, in 1998, 2001, 2003, and 2008 Niger experienced relatively normal rainfall, resulting in strong agriculture production, reflected in the GDP (Figure 6). To ensure overall stability, the World Bank has recommended that Niger diversify its economy away from

Figure 3.6 Annual GDP growth (percent) and GDP per capita (percent), 1984–2010.



Source: Touré et al 2014.

rained agriculture, yet this shift would demand adaptation support for nearly 80% of the population.

3.3.4 Future outlooks of climate variability

Most climate models (IPCC 2007) predict that the Sahel will be drier and more prone to hydro meteorological hazards such as drought and flooding in the 21st Century. Warmer, drier conditions resulting from even small temperature increases of 1°C to 2°C bring about the ecological conditions for drought and desertification, reducing the length of the growing season, and heightening the risks of rainfall-dependent populations. According climate outlooks developed for this research (Bruggeman 2010), mean annual temperatures are to increase by 2°C to 2.5°C for the climate change scenarios based on the IPCC 2007 outlooks for two logical timeframes (Figure 3.7). Rainfall for the same scenario is likely to increase annually by 7%, based primarily on a 12% increase during September to February (typically the dry season in Niger). On the contrary, rainfall is due to decrease by 6% in March to May and 4% in June to August. These decreases appear during the critical rainy season, which occurs during the months of May, June, July, and August, generally. Such results point to increased variability of rainfall.

Figure 3.7 Future climate change outlooks for Tahoua, Niger

		<u>2031-2050 vs 1980-1999</u>		<u>2040-2069 vs 1961-1990</u>		
	Scenario	Change	Models projecting same change dir.	Change	Range	Precipitation (mm) 2040-2069
Tahoua (°N °E)	14.90	5.27				
Mean annual precipitation	B1			2%	-15-21	542
	A1B	7%	14 /20	4%	-23-30	563
	A2			10%	-25-26	586
DJF precipitation	A1B	12%	13 /20			
MAM precipitation	A1B	-6%	11 /20			
JJA precipitation	A1B	-4%	10 /20			
SON precipitation	A1B	12%	13 /20			
Runoff	A1B	4%	7 / 12			
Mean annual temperature	B1			2.0 (°C)	1.1-2.3	
	A1B	2 (°C)		2.5 (°C)	1.7-3.2	
	A2			2.5 (°C)	1.5-3.0	
DJF temperature	A1B	1 (°C)				
JJA temperature	A1B	2 (°C)				

DJF: December, January February; MAM: March, April, May; JJA: June, July, August; SON: September, October, November. (Bruggeman et al 2010).

Based on data from multiple climate scenarios (A1B, A2, and B1) from the IPCC, the Cyprus Institute estimated local climate change scenarios for the case study's region of Tahoua in Niger (Bruggeman 2010). Due to the variability in rainfall from South to North in this region, this scenarios represents a comprehensive understanding of the whole region. Temperature data has high levels of certainty, while rainfall data is much more uncertain.

The future scenarios of Niger's climate events produce a high likelihood of increasing drought and flood events (Niasse et al 2004, Agrhymet 2007). In August 2010, residents across Niger, but particularly in Tillaberi, Tahoua, Maradi, Agadez, and Zinder regions saw flash floods that affected the homes and livelihoods of over 56,800 residents. Residents in Tahoua, ironically related the period in 2010 to a "return to the former times" referring to the period of high rainfall in the 1950s and 1960s. At the time of writing (August 2016), floods struck the northern town of Abalak, causing huge losses to infrastructure and livestock [personal communication with Abalak resident 15 August 2016]. To Nigerien citizens, drought is perceived as harsher and more damaging than flood. Despite their long history of dealing with and adapting to droughts, the country experiences chronic food insecurity and high levels of vulnerability, some of which could be avoided with greater coordination and management on the part of government actors.

3.4 State and rural economies

Of its 1.27 million square kilometers, two-thirds of the country of Niger consists of the Sahara desert. The country's majority agrarian population lives primarily on farming, which is the dominant activity of the southern, greener part of the country. Agricultural activities, which include both livestock rearing (nomadic herding and sedentary breeding) and cultivation (dry and irrigated cropping) employs nearly 80% of the population, generating about 40% of the country's GDP (Toure et al. 2015). The service sector makes up 41% of the country's GDP and 10% of the workforce. Mining makes up between 10 and 40% of GDP, depending upon the market fluctuations (World Bank 2005; 2015; Toure et al. 2015). Primary rain-fed crop production includes millet, sorghum, cotton, and corn. Animals (sheep, goats, camels, and cattle) are exported by the thousands to neighboring countries such as Nigeria, where they demand a higher price than in Niger. This creates much anxiety over the Naira-FCFA exchange rate, which is a critical factor in the country's macro economic stability.

3.4.1 Niger's decline through structural adjustment

In 1981, changes in the global economy caused a reduction in the demand and price of Niger's primary export – uranium. By 1982, Niger export revenue had declined to 6,700 million FCFA or 7.65% of government revenue (Table 4, Collier and Hoeffler 1998). To further exacerbate the problem, persistent drought in 1984 caused food production to decrease by 22% along with mas-

sive declines in livestock (by 1986 numbers had declined to 59% below pre-drought times) (Dorosh and Nssah 1993). After the uranium market crashed, the government no longer had the economic security to borrow from exterior banks to re-stimulate growth in the economy. The IMF stepped in, providing Niger with a conditional loan. In 1983, Niger dismantled its protectionist regime as part of the Structural Adjustment Program (SAP) imposed by the IMF. The government, Niger's main employer, cut jobs of over 5,000 employees, reduced wages by 30%, decreased state subsidies and price controls, and liberalized banking and commerce (Adji 2000). The tiny private sector could not absorb the newly available workforce, so living conditions degraded further (Weisbrot and Baker 2002). Employment fell by 23% between 1978 and 1990. Niger by the 1990's had abolished quantitative import restrictions and many tariffs as well, amounting pressure on the private sector to compete.

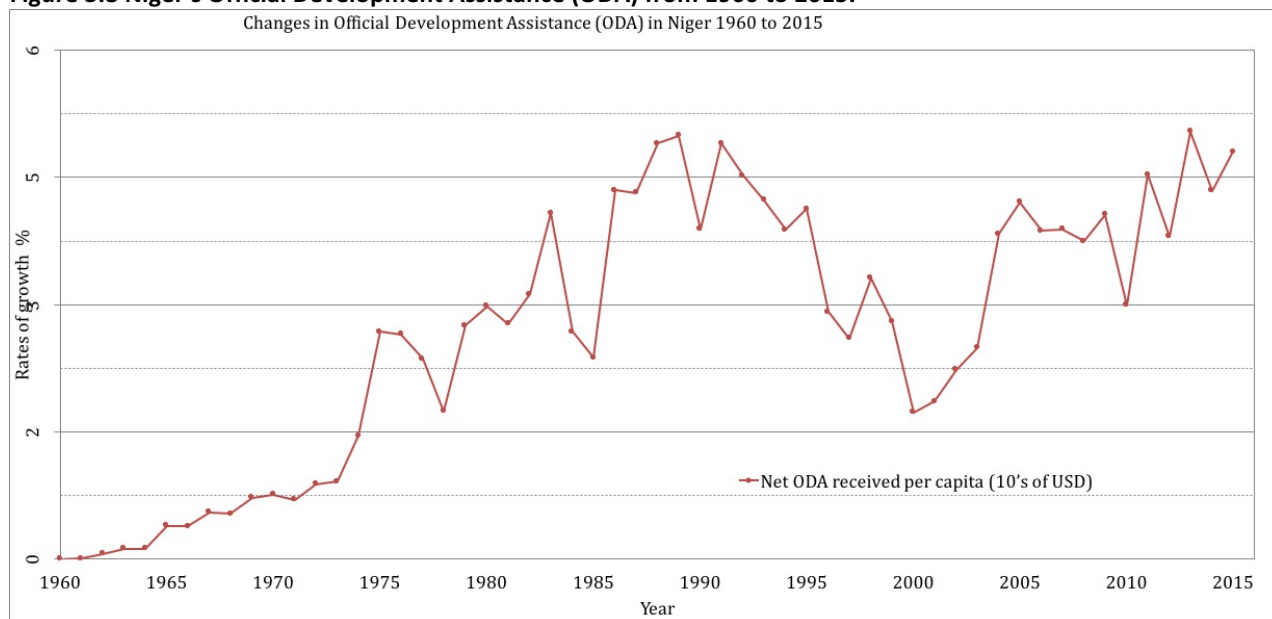
In 2005, according to the IMF's measurement of trade restrictiveness, Niger was at the lowest level for restrictions (World Bank 2005). The openness and liberalization brought about by the SAP, slowed economic diversification and produced negative growth. Foreign investment in Niger decreased from 1997 levels of 46.4 billion FCFA (US\$86 million) to 5.8 billion FCFA (US\$10 million) in 2002 (World Bank 2005). Since 1983 and the institutionalization of the SAP, Niger has experienced exponential growth in foreign debt. Niger's current trade deficit, according to the World Bank, is not likely to change rapidly, given the country's narrow range of exports, erratic demand for food imports due to domestic food shortages, and strong dependence on the importation of capital goods (World Bank 2005). Referring to the heavy influence of international financial institutions in Niger, Souley Adji of Geneva's International Institute for Labor Strategies stated, "It is only out of courtesy that one speaks of the sovereign state of Niger today" (2000:18).

3.4.2 Tax and assistance income

The government is funded primarily on revenues from taxes; 90% government income is taxes or 140.7 billion FCFA or \$281 million (Zafar 2005). However, two-thirds of the economy in Niger is informal and, thus, much potential government revenue escapes taxation. In fact, because income tax is primarily limited to the formal sector, 300 companies paid the majority of income tax in 2000 (ibid.). Assistance makes up for what is lacking in government tax revenues; Niger received an average of \$256 million per year of Net Official Development Assistance (ODA) be-

tween 1997 and 2001 (World Bank 2005). This assistance tends to be volatile; during the rebel conflict of the 1990s, and three coups d'état in 1996, 1999, and 2010, ODA took sharp declines (Table 3.8).

Figure 3.8 Niger's Official Development Assistance (ODA) from 1960 to 2015.



Data compiled from World Bank 2015 by Author.

3.5 Social and political development

3.5.1 100 years of governance

Niger's independence in 1960 coincided with the end of a period of high rainfall and steady agricultural production. Diouri Hamani, the son of government health officer and trained Hausa and Djerma language teacher was a founding father of the fledgling nation ushered into power by the former colonial government. His tenure was marked with a few modest successes, including the commercialization of groundnut, for which export taxes provided a support to the salaries of government workers. However, Diouri's lack of attention to the problems of the rural population during the 1973 drought, coupled with accusations of stolen food aid and student protests paved the way for the coup d'état in April 1974.

After Diouri's fall, Colonel Seyni Kountché's tenure saw significant increases in the price of uranium, booming agricultural exports, and radically increasing external debt. The uranium boom was short-lived, influenced by the change in Western public opinion about the safety of nuclear energy. Kountché, along with increasing modern infrastructure throughout the regional capitals of the country, initiated a policy to improve agricultural yields and presumably to prevent future

food crises through self-sufficiency. Any willing farmer who cleared the land became its owner. During these years, Niger lost a great deal of tree cover, catapulting it into the next drought in the 80s and raising concerns of human-induced drought (Charney et al 1975). The department of Keita (in the Tahoua region) alone was transformed from forest-covered plateaus, slopes, and valleys to a completely barren landscape in 1984 (DiVecchia 2007).

After Kountche's death in 1987, Ali Saibou took control, creating a new constitution and the political party the *Mouvement National pour la société de développement* (MNSD). Saibou's term was characterized by his promotion of the democratic system, as well as his laissez-faire attitude that often permitted the spread of corruption amongst administrators, whose power was expanding as part of the process of decentralization.

Decentralization was an attempt to break with the centralized type of 'Jacobin' administration, which often considers the rural population as unfamiliar to the practice of democracy (Tijani 1998). The full implementation of decentralization was initiated partially by the second Tuareg rebellion in the 1990s, framed by the peace agreements between the Nigerien government and the rebels. The final laws and documents controlling the decentralization process were not released until 1996 under Mahamane Ousmane. This period (from the democratization in 1987 to the framing of decentralization in 1996) marked the beginning of the experiment of decentralization, which many complain is actually 'pluralistic governance' due to the mixture of the 'democratic' system and the customary system of cantons established by the French (Mohammadou 2009). Many rural participants interviewed during this study point to this period of 'democracy' as the point at which much of the respect for the rule of law was disturbed.

Mamadou Tandja was the first president to be reelected during his eleven-year term, which ended in 2010 with a coup d'état. In 2004 -2005, Niger experienced another significant drought, that decimated much of the livestock of populations in the north (Tuareg and Wodaabe herdmen primarily) and saw extreme levels of malnutrition amongst the southern populations due to high grain prices, a poor harvest, and little initial action on the part of the government. Four years later during 2009 - 2010, Niger experienced another drought that affected the harvest and demanded large quantities of food aid. The pastoral population was particularly affected during the crisis, as only one third of the required amount of pasture grew due to insufficient rains

(FEWSNET 2010). Analysts summarized the effects as more desperate than even the 1968-1974 crisis, which decimated one third of all livestock in Niger (FEWSNET 2010; IRIN 2010). Aid for the crisis came late due to the void left by international aid and assistance that retracted following the coup d'état. Rains in 2011 also were not sufficient for pastoral and agro-pastoral populations, a crisis that was handled under Mahamadou Issoufou's new administration.

3.6 Social ecological decline

Since the onset of colonialism in Niger in the early 1900s, pastoralism has been confronted with a bias by observers, especially colonial but also post-colonial institutions (Mortimore 2009). It has been regarded as a "backward, uneconomic and environmentally destructive land-use" practice (Hesse and Thébaud 2006: 15), which has resulted in discriminatory measures affecting pastoral livelihoods including the establishment of multiple political and structural limitations on mobility, loss of large tracts of pastoral territory to cultivation and mining, and development policy that neglects the development of pastoral areas. Yet, there is strong evidence that pastoral livelihoods can be the most sustainable way of life for semi-arid ecosystems, when the pasture is managed appropriately (Warren, 1995; Savory and Parson, 1988; Krätli et al. 2013). Moreover, it provides numerous local to national scale economic benefits to the country, many of which are often ignored, uncounted, and marginalized in development planning.

Figure 3.9 Distribution of various ethnic groups in Niger by location.



The Tahoua region is dominated by Hausa, Tuareg, and Fulbe (also Fulani) people. The Hausa have the highest population, making up 56% of the population of Niger (Source: Schultz 2008).

Though the pastoral populations are a small minority in the country, the territory they co-manage is vast. Governmental institutions and legislation have not sufficiently always been beneficial to the co-management of scarce resources in the pastoral zone (Afane 2015). Population growth in the south is significantly higher than in pastoral households, due in part to the cultural and livelihood demands of farming households, which have an average of 7.4 children per woman, according to our data sets (see also Chapter 6). Land resources in the pastoral zone are seen as the last frontier for individuals seeking to cultivate. Local pastoralists observe illegal cultivation (illegal due to the 1961 pastoral zone decree, Chapter 4 and 7), wood or pasture extraction (P9A, P13A) and the penetration by large herds owned by southern land-holders (Woodke 2008; Snorek et al. 2014a). Southern herds have been using the northern pasture since as early as 1940 (Marty and Bonnet 1989), but the influx of livestock has greatly increased in the last 10 years (Woodke 2005).

Thus, many pastoralists feel abandoned in their attempts to face climate-induced extreme events and insufficient environmental resources. Every pastoralist in Abalak stated that their

primary reason for sedentarizing was due to persistent drought and slow-onset environmental change and losses to their herds. As stated by an Abalak migrant, "If I am living in the bush without animals, what will I do to survive" (P9A)? To pay for the various complements to sustain a pastoralist's herd, remittances are often the greatest source of support. Based on a report spanning the pastoral zone performed by Tearfund, 94 % of pastoralist households in Niger mentioned sending someone abroad as a method of household economic diversification (Woodke 2005).

Pastoral groups have also used political means to counter their marginalization. In 1992, the Tuareg Rebellion began as an ideological response to the government's inaction during the 1984 drought. Pastoralists suffered huge losses in 1984 and 1985, resulting in large-scale migrations to city centers, with many heading North to Libya, following Al-Ghaddafi's offers of work visas to Tuareg migrants. The Nigerien and French governments convened a National Conference at the close of the rebellion, which provided the first formal recognition of the suffering and social upheaval experienced by the pastoralists due to the drought in 1984. Pastoralists perceive, however that neglect by the Nigerien government and international aid community continues unrelenting, prompting out-migration, social disintegration, and continued rebellion amongst pastoral groups. With the increasing conflict and insecurity in the wider Sahel/Sahara and Mediterranean Region, migrants now have greater access to weapons, a factor that has promoted some participants to mention that theft and banditry is becoming uncontrollable.

This chapter examined the multiple geo-political, economic, social, institutional, and ecological factors that make up this dissertation's SES. The degradation of the pastoral system in Niger has been an ongoing process since colonization. France established arbitrary national borders, blocked pastoral movement and changed the social structure of pastoral societies (eliminating tribute and slavery), which suppressed pastoral modes of adaptation to drought. After Niger's independence, policies and terms of trade continued to limit pastoral activities, favoring an expansion of agricultural production into pastoral areas. Development policies also promoted pastoral settlement and integration into a market system by commercializing both livestock and the pasture they consume and establishing commodity markets that exploit small holders, all of which are contributing to a decline of pastoral life in Niger.

Chapter 4: A theoretical framework of divergent adaptation to climate variability³

4.1 Introduction

A significant amount of security-based literature about climate change has been published in the past couple of decades. Many analyses have purported that climate change threatens human and environmental security and could lead to greater conflict (Barnett and Adger, 2007; Burke et al, 2009; Brown and Crawford, 2009; Dalby, 2009; Scheffran et al, 2012; Hsiang et al, 2013; Gleick 2014; Hsiang and Meng 2014; Kelley et al. 2015). Other studies have shown empirically that the links between climate change and violent conflict are indirect, non-existent, or need to be evaluated with a coupled qualitative – quantitative approach (Buhaug, 2010; Theisen et al, 2011; Benjaminsen et al, 2012; Solow 2013). Furthermore, it has been shown that vulnerability from climate change could accentuate pre-existing social inequities of some of the world's more economically impoverished and marginalized groups (Kates, 2000; Adger, 2003b; Thomas and Twyman, 2005). Such inequalities and marginalization have been shown in social science literature as a social condition that leads to conflict (Collier and Hoeffler, 1998; Stewart, 2002; Cramer, 2003). Thus, climate events, while not a single factor enhancing conflict or cooperation do impact vulnerabilities, marginalization, and inequality, which can have greater impact on social dynamics (Kloos et al. 2013).

This chapter presents a theoretical framework that analyzes how adaptation as a process can reduce the vulnerability to impacts of climate change for some and increase the vulnerability for others, which can trigger social responses such as cooperation or conflict. Previous work on barriers to adaptation has shown that obstacles that reduce one's adaptive capacity can be overcome with concerted effort, creative management, and shifts related to resources, land use, and institutional arrangements (Adger et al, 2009; Moser and Ekstrom, 2010); yet, no framework sufficiently addresses the unintended consequences that could result from inequities, marginalization, and biases.

³ A similar version of this chapter has been published under: Snorek, Julie, Fabrice G Renaud and Julia Kloos (2014) 'Divergent adaptation to climate variability: A case study of pastoral and agro-pastoral societies in Niger', *Global Environmental Change* DOI: 10.1016/j.gloenvcha.2014.06.014.

This framework is not seeking to contribute to the neo-Malthusian discourse that climate change induces conflict (Miguel et al, 2004; Burke et al, 2009; Black, 2009). Rather, it provides an empirical analysis of adaptation as a localized, complex, and dynamic process that is framed by multiple factors including non-climate factors (Moser and Ekstrom, 2010) and includes responses that are sometimes complex social and institutional dynamics. Examined through the lens of societal incongruities, this chapter discusses the paradox that those who stand most in need of adaptation are often those who will benefit the least (Turner, 2010; 2011).

The overall purpose of this chapter is to clarify and reveal if climate variability and related vulnerabilities can be linked to social dynamics such as conflict and cooperation. We introduce a divergent adaptation framework for which the main concepts (adaptive capacity, conflict and cooperation, and institutional mechanisms) are unpacked and explained. The framework is empirically demonstrated through a case study in the Sahel that critically analyzes multiple users' rural adaptation mechanisms in two livelihood zones of Niger and under conditions of water-related stress. Natural resource conflicts including those related to water access are central to the discussion of divergent adaptation. The divergent adaptation concept is relevant to current discourses on conflict and development in the context of climate resilience and adaptation in the Sahel and in other regions.

4.2 A theoretical model for divergent adaptation

4.2.1 Adaptation as a complex social process

When faced with an adversarial environment, humans are inherently adaptive (Engle, 2011). Adaptation is a response to human or environmental stimuli and can be structural or behavioral, occur before or after the event or stimuli, and may buffer or sustain activities, or transform the state of the social-ecological system or SES (Folke, 2006; Renaud et al, 2010; Berrang-Ford et al, 2011).

Adaptation does not have a tendency to eliminate social inequities. It is perceived that local level climate change impacts will affect different sectors of society differentially, especially in the developing world (Smit et al, 2001; Paavola and Adger, 2002; Adger et al, 2003b; Osbahr et al, 2010). In both development and adaptation initiatives, there are always 'winners' who benefit directly from the intervention and 'losers' who benefit less or are adversely affected (Dreze and Sen, 1989;

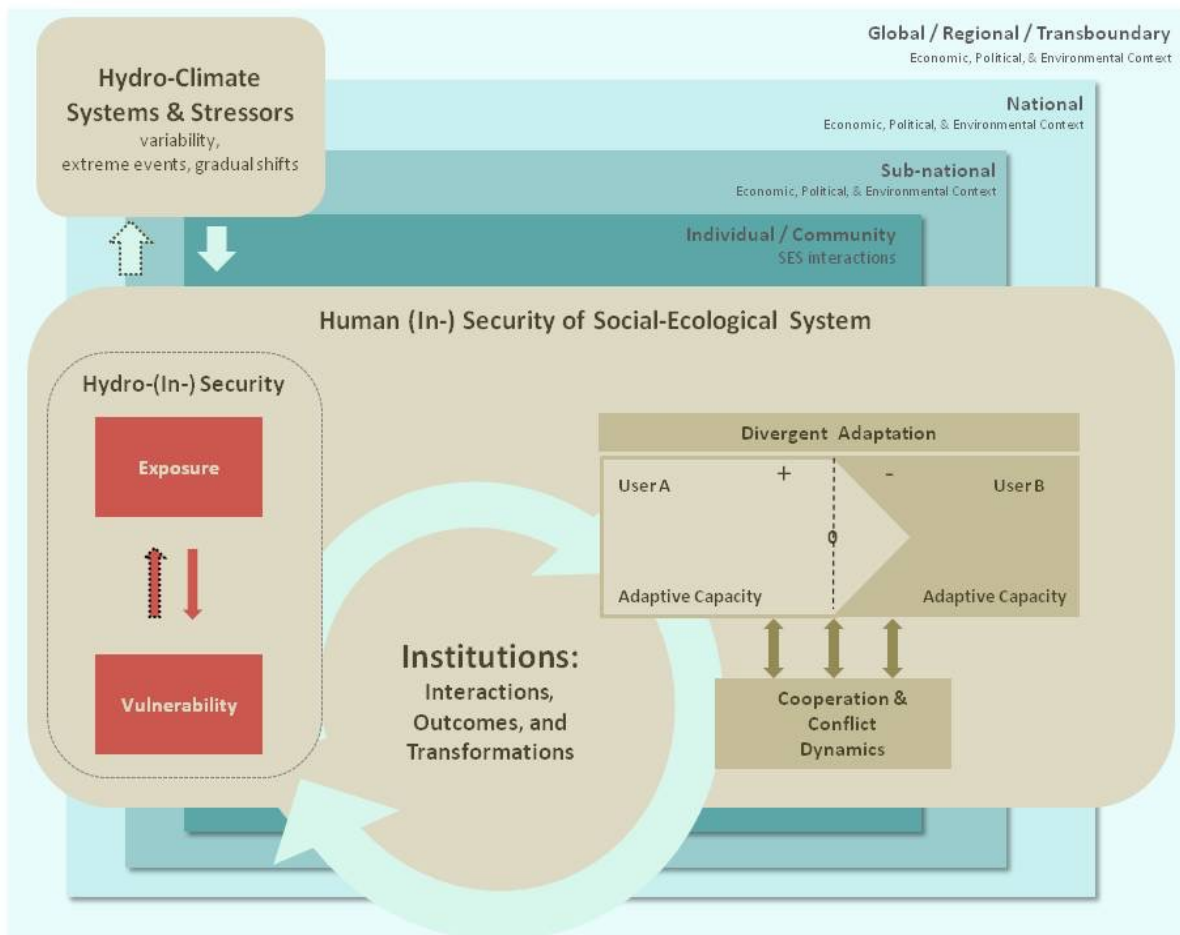
Kates, 2000; Adger, 2001). In fact, the process of adaptation often reinforces existing social hierarchies and, thus, inequities (Adger and Kelly, 1999).

4.2.2 Introducing Divergent Adaptation

The concept of 'divergent adaptation' outlines the relationship between conflict and cooperation, adaptation and adaptive capacity, and institutional mechanisms (Figure 4.1). In social-ecological systems, we define the term divergent adaptation as those adaptations that promote the success or adaptive capacity of one individual/community (User A) in a shared ecosystem which leads to a reduced adaptive capacity of an alternative individual/community (User B) in the same ecosystem. The purpose of analyzing divergent adaptation is to identify which users win or lose in adaptation, enhance adaptive capacity for marginalized groups, and promote equal adaptive capacity in the adaptation process. Institutions have an influence on adaptive capacity and therefore impact divergent adaptation (Yohe and Tol, 2002; Tol et al, 2004; Brooks and Adger, 2004; Vincent, 2007).

In areas experiencing climate stressors such as floods or drought, opportunities and risks impact the social-ecological system (Figure 4.1). This chapter identifies adaptive actions at the local scale, which are framed by the social, political, and institutional dynamics as well as power, knowledge, and values/interests across multiple scales. For instance, some users (User A in Figure 4.1) may prevent others (User B) from accessing key resources due to different entitlements. If no suitable institutional arrangement helps to enhance the adaptive capacity of User B, the divergent adaptation can produce conflict or cooperation, and result in temporary or permanent transformations, such as the loss of social capital between groups. The process of adaptation, as well as social responses provides feedback to cross-scale institutions, which can reduce the divergence in adaptive actions (Figure 4.1). This cycle transforms societal norms, including ethics and cultural moralities (Turner, 2004). Each key concept is unpacked and explained in the following section.

Figure 4.1 Conceptual Framework for Divergent Adaptation



(Adapted from: Snorek et al, 2012, Goulden and Porter, 2010, and Ostrom, 2007, and Kloos et al. 2013).

4.2.3 Unpacking Key Concepts framing Divergent Adaptation

4.2.3.1 Adaptive Capacity

To engage with adaptation, an actor needs to have the means and capacity to do so (Gallopín, 2006; Eisenack and Stecker, 2011). Adaptive capacity or the ability to ameliorate negative and take advantage of positive changes to an SES can reduce the social vulnerability of communities (Tol et al, 2004). Indicators that measure the adaptive capacity of alternate actors include (Adger and Kelly, 1999; Yohe and Tol, 2002; Adger et al, 2003a; Brooks and Adger, 2004; Pelling and High, 2005; IPCC, 2007; Engle, 2011): the amount of economic and natural resources (access to capital, land, and water resources); viable links in the social network (transactions and trust shared with neighboring groups); access to entitlements (the extent to which communities or individuals are permitted to make use of resources); multiple levels of institutional support (information and skills, infrastructure, governance, equity, collective action); human resources (production potential of individuals); and technology (communication, transportation ease and availability).

A society is only as vulnerable as its 'weakest link' (Tol and Yohe, 2007), and certain regions, social groups, or localities have intrinsically lower adaptive capacity due to social structures (O'Brien et al., 2006; 2008). Past studies have shown that adaptive capacity is directly related to the ways in which institutions structure power relations, entitlements, and rights at multiple scales (Vincent, 2007; Osbahr et al, 2010; Berman et al, 2012), and others state that institutions have a greater influence on adaptive capacity than all other factors (Brooks and Adger, 2004; Engle, 2011).

4.2.3.2 Conflict and Cooperation

We discuss here conflict and cooperation without considering either state of engagement as preferential. Conflict, or variable expressions of discord is generally perceived as either socially undesirable or an institutional failure (Moore, 2005), but some have found that this is not necessarily the case (Bierschenk and Olivier de Sardan, 1997) especially when conflict originates in political and economic practices (Goulden et al, 2010; Turner, 2010) and has the potential to support actors to invoke change in institutional arrangements (Knight, 1998; Turner, 2010; Ratner et al, 2013). Cooperation, while generally perceived as beneficial can be a mask for latent conflict (Keohane, 2005), or based along long-standing discriminations related to social, ethnic, or religious norms, which break down with structural or ethnic shifts. Studies of ethnic conflict have found that, as groups become more fearful and uncertain about the future, they tend to form social alliances with members of their own group (Lake and Rothchild, 1996, Esteban and Ray, 2008). When studying these social phenomena of a changing SES it is useful not to put higher value upon one state over the other.

With the mounting pressures derived from environmental degradation, population growth, economic recession, political uprisings, and climate change hazards, the access to and regulation of natural resources especially in common pool regimes is becoming increasingly contested. It has been shown that drought does not produce natural resource conflicts, but rather can induce cooperation between different user groups (Prediger et al, 2011; Benjaminsen et al, 2012), especially as SESs are adapting to the rate and magnitude of change (Ostrom, 2005). In the context of climate variability and change, conflict is not perceived as a scramble over scarce resources, but a political, strategic and social response related to access to and control of important natural resources (Lake and Rothchild, 1996; Turner, 2010; 2011). Structural and governance failures are

highly frequent in natural resource management conflicts (Bierschenk and Olivier de Sardan, 1997; Ostrom, 2005; Pahl-Wostl, 2009). To understand these expressions of discord beyond the simplistic deductions of the environmental security debate (Rahim et al, 1991; Homer-Dixon, 1999; Peluso and Watts, 2001), it is necessary to examine conflict and cooperation as a myriad of social and political positions defined by the varied tones of human interactions and not as two opposite ends of a continuum (Zeitoun and Mirumachi 2008). When community members have equally developed trustworthiness, self-organization, collaboration, and co-management, equitable and fair ecosystem management becomes more attainable (Pretty and Ward, 2001; Olsson et al, 2004).

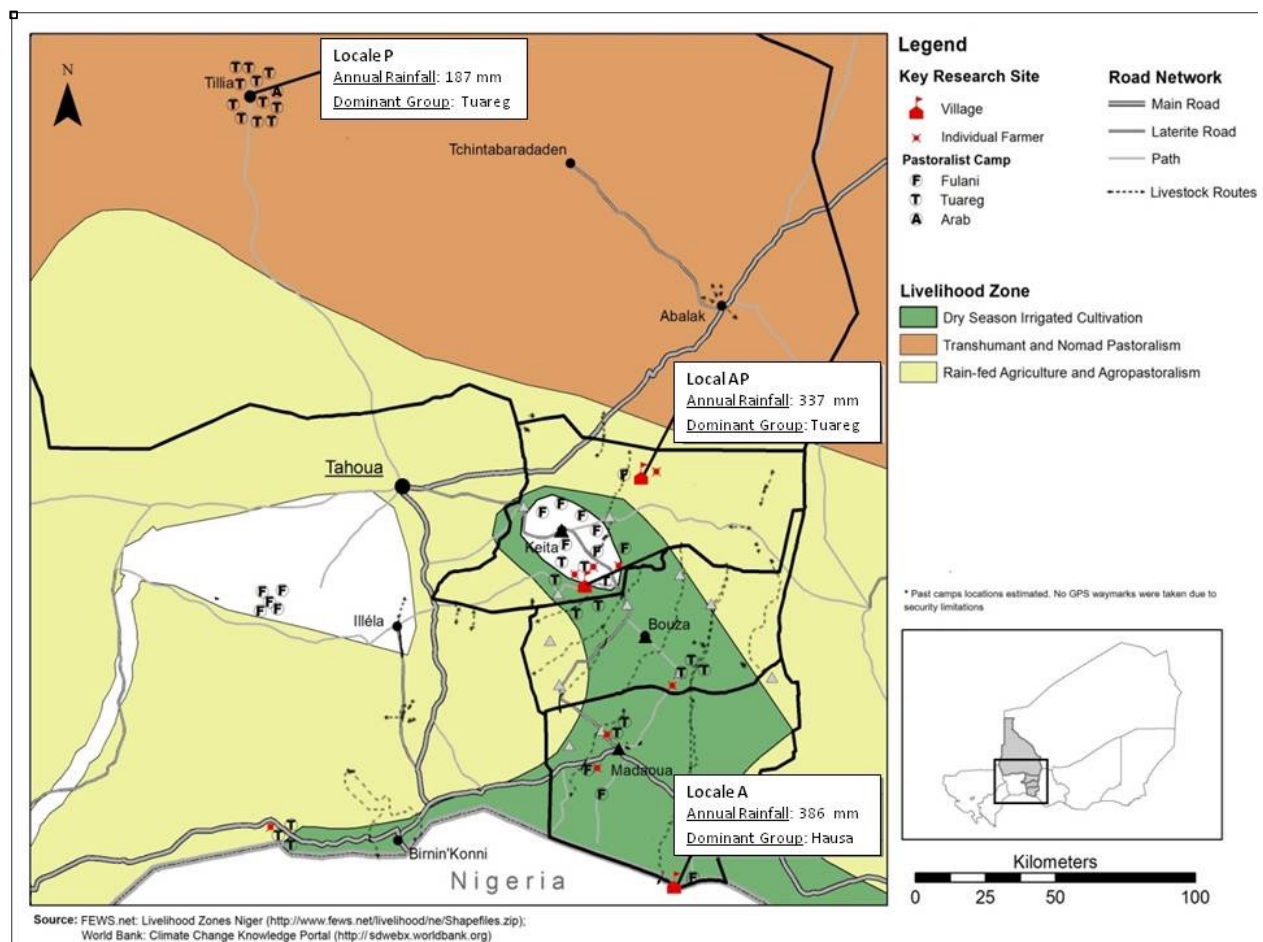
4.2.3.3 Institutions

Institutions, or the formal and informal rules governing complex systems across multiple scales, frame the choices available in adaptation actions. Social, political, and economic practices are defined and enacted based on the institutions of a specific time and place and are governed by bounded rationality (Simon, 1957; Jones 1999) and collective action (Ostrom 1998). While not all institutions are rigid, in the context of climate change, institutions should have the flexibility to manage high levels of uncertainty and adapt to complex adaptive systems that are difficult to predict and control (Pahl-Wostl, 2009). Individual actors in adaptation are embedded within institutions possessing multiple objectives (Moser and Ekstrom, 2010) and such institutions determine for whom adaptation resources will or will not be supplied (Engle, 2011). Limits to adaptation are not insurmountable, but can be reshaped and molded based on the social and institutional conditions (Adger et al, 2009). Developing effective institutions for adaptation is a process of double and triple-loop learning from the feedback from social and environmental patterns of interactions such as overuse, collapse, stability, and increasing returns that can produce conflict or cooperation (Ostrom, 2007; Pahl-Wostl, 2009).

4.3 Research Design

To best demonstrate the relationship between climate- and water-related stress and social interactions in the SES, the research was carried out along a rainfall gradient in both the official pastoral zone of Niger (hereafter referred to as the ‘pastoral zone’ or ‘the North’) and in the southern cultivation zone of Niger (also referred to as ‘the South,’ Figure 4.2). Key research sites in the water-stressed region of Tahoua were selected based on a review of judicial documents and interviews with democratically elected and customary officials in the following research areas – Tchintabaraden, referred to as Locale Pastoral (P), Keita, referred to as Locale Agro-pastoral (AP), Madaoua, referred to as Locale Agricultural (A), and pastoral camps found along livestock corridors near and around these sites (Table 4.1).

Figure 4.2 Map of research sites within the region of Tahoua, Niger.



Livelihood zones demonstrate the relative locations of the pastoral zone and the cultivation zone, but these areas are not exclusive to these activities. The three key research sites (Locales P, AP, and A) are described by tables listing annual rainfall for 1990 to 2009 (World Bank Climate Knowledge Portal) and the dominant ethnic group. Interviews held in a pastoral camp are represented by symbols related to each ethnic group. The camps around Locale P are estimates; the remaining camps are exact locations of the interviews. The exact names of the villages are not displayed to respect the anonymity of respondents. Source: own figure.

Criteria for site selection included: ethnic and cultural groups, challenges to water access and availability, high ratio of out-migration, history of conflict between users, presence of pastoral spaces and corridors, and appropriate level of security for the research team. Pastoral camps were selected randomly during the northern and southern transhumance of pastoralists along a north-south axis in Tahoua. Specific names of village sites have been withheld to protect the anonymity of respondents.

Table 4.1 Characteristics of research site.

<i>Locale</i> (Department)	Aver. Annual Rainfall 1960- 1990	Aver. Annual Rainfall 1990- 2009	# focus groups/ inter- views	Major & Minor Li- velihoods	Major & Minor Groups	Cultivation	Animal corridor in vici- nity	Surface water availability (& usage)	State of modern water points
Locale P. (Tchintabaraden)	197 mm	187 mm	16	P, TP	iT, F, A	Little to none	n/a	Yes (pri- marily pastoral)	Borehole, deep wells
Locale AP. (Keita)	380 mm	337 mm	43	AP, AH, A, P	iiT, H, iT, F	Mostly cultivated	Yes	Yes (pas- toral and some gar- dening)	Functional and dry wells
Locale A. (Mad- aoua)	440 mm	386 mm	21	AH, A, AP, P	H, kT, F, iT	Densely cultivated	Yes	Yes (mos- tly garde- ning)	Abundance of wells

Livelihood abbreviations: Pastoralist (P), Transhumant Pastoralist (TP), Agro-Pastoralist (AP), Agriculturalist (A), Agri-Herder (AH). ² Abbreviations for majority and minority groups are as follows: iT (Iwellemeden Tuareg), F (Fulani), A (Arab), iiT (Iklan Iwellemeden Tuareg), kT (Kelgeres Tuareg), H (Hausa). Rainfall data: Climate Change Knowledge Portal (<http://sdwebx.worldbank.org>).

Households interviewed consisted of the primary livelihood and actor groups in Tahoua (Table 4.2). Pastoralists, defined as “a human and social group that is historically and socially characterized by its mobility, and whose principal activity is rearing livestock” (Hammel, 2001) were considered to be the most vulnerable group in light of future climate events and social paradigms (Snorek et al, 2012). Agro-pastoralists (one who derives his/her primary revenue from agriculture but retains both some livestock and his/her socio-cultural origins in pastoralism) are related in both classification and vulnerability. Agriculturalists are a human or social group that is historically and socially characterized by sedentary lifestyles supported by cultivation and exploitation of the soil and whose primary livelihood is derived from the harvest of their cultivation (Table 4.3). Within this category, there are also agri-herders or those for whom the main part of his/her activities are based on agriculture, but s/he also takes part in herding, relying mostly on shepherds (mostly

Fulani) to drive the livestock. Thus, the terms agro-pastoralist and agri-herder represent a mixing of activities, but cultural distinction is still relevant especially in terms of conflict. For the purpose of this study, we focus on the different ethnic groups of pastoralists, agriculturalists, agro-pastoralists, and agri-herders from the Hausa, Fulani, KelGeres Tuareg, Arab, Iwellemeden Tuareg, and Iklan Iwellemeden Tuareg (Table 4.2 and 4.3).

Table 4.2 Classification of User and Livelihood Groups in Tahoua.

Livelihood Characterization	Ethnic Groups	Observations of current livelihood situation
<p>All Pastoralists (P, LP, TP)</p> <p>Local Pastoralist (LP)</p> <p>Those Ps who possess home territories in the pastoral zone and make a limited transhumance within this zone.</p>	<p>Iwellemeden Tuareg (iT)</p>	<ul style="list-style-type: none"> - Serve also as shepherds (typically for extended family) - Transhumance limited primarily to pastoral zone - Economic migration primarily to northern countries - Home territories in Pastoral Zone - Winter territories in N. Tahoua*
	<p>Arab (A)</p>	<ul style="list-style-type: none"> - Strong involvement in commercial herding - Transhumance routes limited primarily to pastoral zone - Links to institutional and political networks - Home territories in Pastoral Zone - Winter territories in N. Tahoua
<p>Transhumant Pastoralist (P, TP)</p> <p>Those pastoralists who make yearly transhumance from the southern to northern pasture, but do not typically possess northern home territories</p>	<p>Fulani (F)</p>	<ul style="list-style-type: none"> - Long transhumance - Economic migration during dry season - New home territories being established in Pastoral zone - Work as shepherds for various sedentary groups - Villages and strong social networks in S. Tahoua - Winter territories in N. Tahoua
	<p>KelGeres Tuareg (kT)</p>	<ul style="list-style-type: none"> - Long transhumance from Nigeria to Sahara - Serve as shepherds primarily for sedentary kT - Strong social networks in N. Tahoua - Winter territories in S. Tahoua, and (formerly) Agadez
<p>Agro-Pastoralist (AP)</p> <p>One whose primary livelihood is based on agriculture but retains both some livestock and his/her socio-cultural origins in pastoralism</p>	<p>KelGeres Tuareg (kT)</p>	<ul style="list-style-type: none"> - Livestock stay transhumant except in case of need or when passing through village - Large land holdings in South even before colonization - « Chefs du groupement » located in S. Tahoua - Extensive farming and gardening activities - Settled in S. Tahoua
	<p>Iklan Iwellemeden Tuareg (iiT)</p>	<ul style="list-style-type: none"> - Former slave caste of iT, freed under colonialism - Transformed into agro-pastoralists - Greater access to power than majority of iT - Settled in N. and S. Tahoua
	<p>Iwellemeden Tuareg (iT)</p>	<ul style="list-style-type: none"> - Lost livestock during droughts - Minimal farming/gardening activities - Still retain small herd, some go on transhumance - Not well-integrated with other sedentary groups - Settled in N. (primarily) and S. Tahoua

	Fulani (F)	<ul style="list-style-type: none"> - Lost livestock during droughts - Minimal to extensive farming - Integrated with other sedentary groups - Settled in N. and S. Tahoua
<p>Agriculturalist (A) one whose livelihood is founded primarily on agriculture</p> <p>Agri-Herder (AH) One whose primary livelihood is based on agriculture but retains livestock and relies on shepherds</p>	Hausa (H)	<ul style="list-style-type: none"> - Long history of seasonal economic migration - Dominant group in power networks in S. Tahoua - Extensive farming, dispersed fields - Growing dependence on livestock - Extensive farming/and irrigated cultivation - Highly diversified livelihood - Settled in N. and S. Tahoua

These groups are based on profiles of participants in household interviews and focus groups in Tahoua, Niger but we do not assume that they are representative of all pastoral and agricultural groups. *Geographical arrangements were determined based on empirical data from the study and supported by literature. Home territories for pastoralists represent dry season camps. North Tahoua is made up of the pastoral zone, South Tahoua is everything south of this line.

Data for this phase of the research were collected during a period of eight months (April to August 2011, October to December 2011), with a break in September during the busy harvest period. A total of 77 qualitative interviews and focus group discussions with more than 115 married men and women aged from 15 to 100 were conducted, recorded, and transcribed with the help of Tamashek (Tuareg), Fulfulde (Fulani) and Hausa-speaking assistants. In each key village, we completed: an institutional analysis, a village resource map (which entailed the identification of environmental hazards such as denuded land or extreme erosion), historical timeline for key social and environmental events, focus group discussions with economic migrants, focus group discussions with local user groups, and interviews with randomly selected households (sample of 3% of total households). Due to the security limitations for Locale P, only focus groups were performed by our Nigerien (Tuareg) counterpart in Tamashek and Hausa and were recorded and transcribed. This information was triangulated with expert interviews in Tahoua and Niamey.

Relevant literature, qualitative and expert interviews were analyzed using AtlasTi 7.0.92 (AtlasTi GmbH), software that allows one to codify, categorize and synthesize multiple forms of data systematically. The data were organized by: climate change perceptions, changing ecosystem services over a 20-year timescale, and the adaptations for pastoralists and agro-pastoralists; and social, institutional and political dimensions.

The following section explains and demonstrates the theoretical framework for divergent adaptation (Figure 4.1). Section 4.4 systematically lays out the hydro-climate stressors impacting the SES,

historical, institutional, social, economic and ecological interactions, and the current state of adaptation for all users. User groups are described by their socio-economic attributes, history of use of the ecosystem, location(s), norms/social capital, knowledge of the SES, and dependence on the resource (Ostrom, 2007). The aspects of the users in the SES form the basis for determining how the divergent adaptation of one might be limiting the adaptive capacity of another. The end of Section 4.4 identifies several divergent adaptations and determines who are the users sharing the SES and the context of their human in/security. Section 4.5 thereafter presents data specific to changing adaptive capacities of alternate users as well as the social, institutional, and ecological interactions in the SES. The discussion further elaborates on how divergent adaptation has impacted various livelihoods in the SES and the conclusion provides a summary and recommendations.

4.4 The SES of Tahoua, Niger

4.4.1 Rainfall variability as the key stressor

Research on both future and past rainfall shows a history of desiccation, drought, and variability in the Sahel (Hulme, 2001; Brooks, 2004; Shanahan, 2009). There were major drought events in the 17th, 18th, and 19th Centuries (Baier, 1976) followed by seven severe droughts in the 20th Century during 1910 – 1916, 1941 – 1945, 1968, 1973 – 1974, 1984, 1987, and 1989 (FEWSNET, 2011). The 1990s showed a slight increase in rainfall (Brooks, 2004), and this was followed by a higher frequency of drought events, in 2005, 2010, and 2012 and flooding events in late 2010 and 2013 (FEWSNET, 2011; OCHA, 2013).

During the period leading to the 2000s, rainfall in the Sahel is characterized by few rainy days but with an increase in median intensity of daily rainfall (Giannini et al, 2013). Future climate models for the Sahel are highly uncertain (Brooks, 2004; Biasutti et al, 2008; Bruggeman et al., 2010) and are typically depicted by periods of drought and flooding with increasing rainfall variability (Desanker and Magadza, 2001, Hengsdijk and van Kuelen, 2002). Recently Giannini et al (2013) demonstrated that the Sahel will continue to be relatively wet as long as North Atlantic warming continues but this could be achieved through higher intensity precipitation and not through an increase in frequency of precipitation, thus rainfall variability would remain a challenge for rural users in the region. On the other hand, Shanahan et al (2009) warned that much more intense drought episodes than those observed in the 1970s and 1980s have occurred at the scale of mil-

lennia and could occur again in the future. It should also be noted that rainfall trends over various areas of the Sahel region differ (for 1990-2007, see Lebel and Ali, 2009). Overall, great uncertainties remain with respect to future climate in the Sahel, with the latest projections from the IPCC (2013) indicating moderate decreases (towards the west) to moderate and large increases (central and eastern part) in average mean precipitations to the end of this century when compared to the reference period of 1986-2005 and for scenarios RCP2.6 and RCP8.5. However, the spread of model projections in the region is large (IPCC, 2013).

4.4.2 Historical approaches to drought adaptation

Traditional modes of adaptation to drought in both North and South zones have evolved over time based on the institutional arrangements that frame adaptation decisions. Prior to the establishment of colonial territories, both pastoral and agricultural populations practiced mobility within and without the trans-Saharan trade network, especially during an extended drought crisis (Baier, 1976). To avoid famine, agricultural groups migrated into the forested southern regions. Pastoral groups (primarily Tuareg) held tenure as far south as Katsina and Kano and residents traded, paid tribute, and provided refuge to lording pastoralist groups during times of drought. When herds were reconstituted, the pastoralists would return to the northern pasture (Nicolaisen, 1963). After colonization, as tenant farmers became independent of their former masters and land began to be valued based on a market- as opposed to livelihood-oriented system of production, social contracts or interdependencies between agriculturalists and pastoralists began to disappear (Rossi, 2009), and the two livelihoods took up more spatially and socially distinct patterns.

These social ecological shifts were also driven by legislation aimed to shift the rural system from a commons regime governed by customs and sometimes tyrannical leaders to a centrally-governed regime of private ownership. In 1961, the Nigerien government separated two distinct livelihood zones prohibiting cultivation in the northern 'pastoral zone,' located at the 350-mm isohyets of 1961, (Geesing and Djibo, 2006) and designating all land to the South as available for cultivation (Figure 4.2, Table 4.3). This new law, along with changing terms of trade, favorable rainfall and population growth triggered an expansion of agricultural production into northern formerly pastoral territories. When the 1973-74 drought struck the country, the former system of social contracts and migration were no longer functional. Massive livestock death and grain shortages produced a famine and influx of impoverished families into urban centers. The pre-colonial social

networks have since been recognized as a key element of drought resilience (Watts, 1983; Mortimore and Adams, 2001).

4.4.3 Land to the tiller and the marginalization of pastoralists in the South

In the wake of the drought of 1973-74, President General Seyni Kountché took power through a coup d'état and quickly promoted the privatization of southern lands through his speech 'Land to the Tiller' that essentially gave all agricultural workers who had been cultivating fields permanent rights to said fields regardless of any prior arrangement (Terraciano, 1998). Cultivation intensified dramatically during this period; a study of Maradi showed a 24% increase of agriculture space replacing fallow land from 1957 to 1996 (Mortimore and Turner, 2005). Kountché's statements, while providing enormous opportunities to certain underprivileged or landless groups, were never officially codified and therefore evolved into ownership conflicts that are still prevalent today (Terraciano, 1998).

In 1987, following the death of Seyni Kountché, the government recognized the multi-functional nature of the southern cultivation zone (Decree N°87-077, Table 4.3), thus permitting pastoral activities to ensue within designated areas (livestock routes or 'parking' areas) or at the completion of the harvest. Yearly, a department-scale, government-organized committee declares the date of "*libération des champs*" or 'freeing of the fields,' which falls typically in December or January. After this time no compensation can be pursued for crop damage to one's harvest and pastoralists are free to wander into cultivated fields, essentially creating a semi-commons in the South. While this law seems to protect and organize livelihood activities, in practice, it has limited the pastoralists' main adaptation mechanism – mobility or transhumance. Pastoralists often descend 'early,' or when the water from seasonal lakes dries up and pasture becomes scarce in the North and before the *libération des champs*. Normally, they follow livestock routes until reaching pasture areas in the south, but increasingly such routes are blocked by cultivation.

Table 4.3 Legislation pertinent to the divergent adaptation in Niger.

Legislation relevant to divergent adaptation in Tahoua

Year	Name	Description
1961	Law N°61-05	Sets the northern boundary of cultivation, beyond which agriculture is forbidden (with the exception of small gardens)
1987	Decree N°87-077	Recognizes the multi-functionality of the southern agricultural zone, permit-

		ting pastoralists the right to circulate and graze after harvest or in designated areas
1993	Ordinance N°93-15, 'Rural Code'	Recognizes equal rights to the use of Niger's natural resources, including the creation of livestock corridors and pasture areas
1993	Law N°93-14	Determines that all, even private water (ponds, wells, boreholes) must be accessible to herders, provided the load capacity of the infrastructure allows for this
1997	Decree N°97-007/PRN/MAG/EL	Sets up home territories (<i>terroir d'attache</i>) in which pastoralists have priority rights over natural resources, but cannot limit others' access
1997	Decree N°97-008/PRN/MAG/EL	Deals with the organisation, attribution and functioning of institutions in charge of the implementation of the principles of the Code Rural
1997	Decree N°97-368/PRN/MHE	Organises the attributes and modalities of the land commissions of communes, villages and indigenous groups
2001	Law N°2001-23	Created administrative constituencies and local authorities
2002	Law N°2002-12	Transferred State competencies to local authorities
2010	Ordinance n°2010-09, 'Water Code'	Determines the terms for the management of water resources over the entire Nigerien territory
2010	Ordinance n°2010-029, 'Pastoral Code'	Deals with pastoralism, codifies a pastoralist's right to mobility

Multiple institutions (customary and governmental), within the framework of the Rural Code (Table 4.3) are supposed to secure pastoral routes, access to water points, and livestock parking areas in the South, but in many areas they have completely failed due in part to the dominant perception of land as 'for the tiller.' In many places the Code is not fully implemented or is deliberately disobeyed, according to the undersecretary of the Rural Code in Niamey. Even livestock routes officially delineated with cement markers remain unprotected, and such markers are often damaged or removed at will by local agriculturalists (Image 4.1). Pastoral commons in the South have since become increasingly colonized by cultivation, which is considered by the central government as the principal rural activity (WISP, 2008; Oxby, 2011).

The government administrators, we listen to them, but they are complicit with the [ones cutting trees and planting pastoral spaces]. It is because these are elected officials and they are looking for votes. If they refuse the [planting of] fields, they don't find votes. It is through [allowing] fields that they make their political campaigns (Locale A, AP, P17 [P17 is the code assigned to this interview with an agro-pastoralist (AP) in Locale A]).

The disputed border of the pastoral zone edges northward every year, and the pastoral zone is perceived by several sedentary respondents to be the last available land for cultivation. To gain tenure in accordance with the Rural Code, the *Chef du Canton* in Keita explained that it is necessary to show former ownership by presenting the statements of two witnesses to departmental

officials. This practice consistently weighs in favor of private land accumulation and against the preservation of pastoral space, due in part to the short term institutional memory and ease of corruption of elected officials. Only in areas where customary officials have made grand efforts to protect pastoral resources have rural constituents failed to use the various weaknesses of the Code to secure exclusive rights to land in pastoral areas.

Image 4.1 Destruction and blocking of livestock corridors in Niger.



Markers for these international livestock routes in Madaoua are often destroyed by local farmers (left photo, Author's photo, June 2011) or blatantly ignored when building infrastructure, such as this primary school in the village of Bangui, Madaoua (right photo, Author's photo, October 2011).

4.4.4 Pastoral management in the northern pastoral zone

During the unimodal rainy season, pastoral livelihoods are easier, as water is abundant in temporal lakes and pasture can be found throughout the North. To supply their herds with minerals and salt, pastoralists in Tahoua migrate towards Algeria on annual transhumance. Thereafter, during the 9-month dry period, the same groups typically settle near a water source in the southern part of the pastoral zone with their families and herds.

Since its establishment in 1961, the pastoral zone has experienced changes to its cultural, ecological, and institutional composition, reflecting also international and national development policies and initiatives. New laws and changing development initiatives in southern Niger have contributed to changing institutions and norms of pastoral management (see also Chapters 6 and 7), reflecting an expansion of commercial use of the pastoral system (Anderson and Monimart, 2008). The ECOWAS Decree (N°97-007/PRN/MAG/EL) of pastoral migration (Table 4.3) supports the import of livestock from exterior territories including southern Niger and neighboring countries into the northern pastoral zone. Furthermore, in 2010, the Pastoral Code was signed into law after a 10-

year effort of many parties to push the legislation through. While the Pastoral Code has the potential to enhance the system of pastoral resource governance, some propose that it undermines the local systems of governance, enhancing vulnerability for local pastoralists in the North, while formally opening the pastoral zone to new groups and over-exploitation (Oxby, 2010). While it is beyond the scope of this chapter to give a full analysis of this legislation, Chapter 7 provides a thorough analysis of legislation relevant to divergent adaptation.

4.4.5 Adaptations of mobile and sedentary groups

Rainfall variability and drought characterizes the livelihoods of the Sahel, which are well-adapted to a non-equilibrium system of climate variability (Behnke et al, 1993; Thébaud and Batterbury, 2001). More than 82% of Niger's 17 million inhabitants work manually on rain-fed fields, which generates about 39% of the country's GDP (FAOSTAT, 2011), producing millet, sorghum, ground nut, and cow pea as subsistence crops and cotton and corn as cash crops. Geographically, all but 10% of the population (GON, 2013) lives less than 100 miles from the southern, more humid border, which receives the highest amount of precipitation during the rainy season, but this quickly growing population (7.6 children per woman on average according to GON 2013) is shifting northward in search of available land. The average household consumes 190 kg of grain per capita per year (Hoddinott, 2013). Yet household resilience has been enhanced through diversification with the confluence of agriculture and pastoral activities in agro-pastoralism and agri-herding (Toulmin, 1983; Thébaud and Batterbury, 2001; Mortimore and Adams, 2001; Bassett and Turner, 2007; Sambo, 2011).

To live in the context of rainfall variability, land degradation, high demographic growth, and challenging social and institutional dynamics, households rely on a variety of adaptation mechanisms (Table 4.4). The highest-ranking adaptation decisions (i.e. ones that the most research participants reported include: economic migration, livestock ownership, purchasing fodder to support livestock, wood-cutting and selling, and settlement of pastoralists into agro-pastoral villages. Some of the adaptations shown in Table 4.4 are impacting the adaptive capacity of alternate users (User B, Figure 4.1) and are, as a result categorized as divergent adaptations.

Table 4.4 Adaptation mechanisms most utilized

Key adaptations Most to least prevalent	Responses by locale % of N (# of N)		
	Locale P (N=16)	Locale AP (N=37)	Locale A (N=24)
Economic migration and remittances	56 (9)	46 (17)	43 (10)
Livestock ownership*	56 (9)	38(14)	48 (11)
Purchase fodder	63 (10)	27 (10)	39 (9)
Wood-cutting and selling	19 (3)	43 (16)	52 (12)
Settlement (pastoralists)	38 (6)	30 (11)	43 (10)
Transhumance: change routes or itineraries	63 (10)	16 (6)	30 (7)
Extend agriculture (into pastoral areas)*	19 (3)	38 (14)	39 (9)
Payment for water *	44 (7)	22 (8)	26 (6)
Cut and store pasture	56 (9)	22 (8)	4 (1)
Shepherding for livestock owners	13 (2)	27 (10)	30 (7)
Collect/sell farming residues	0	19 (7)	48 (11)
Market gardening (enclosing ponds)*	0	8 (3)	48 (11)
Reliance on humanitarian aid	6 (1)	27 (10)	17 (4)
Transport water to pasture-rich areas	44 (7)	3 (1)	0
Contract herders to fertilize fields	0	11 (4)	30 (7)
Change to drought-tolerant production	0	22 (8)	13 (3)
Small commerce of purchased goods	19 (3)	5 (2)	6 (1)
Soil and water management techniques	0	11 (4)	17 (4)
Loan during drought	6 (1)	8 (3)	9 (2)

Information was collected during the household interviews and focus groups in the case study area. Mobile = P and sedentary groups = AP, A, N = the total number of interviews/focus groups in each locale for which respondents mentioned having used or observed said adaptation in the past five years. * = Divergent adaptation with another user in the shared SES.

By analyzing the different impact of adaptations on two distinct groups, defined as Users A and B, some of the adaptations in Table 5.4 are found to be divergent including: increasing livestock holdings, extending agriculture into pastoral areas, and payment for water use and access. In the southern Locales AP and A, Users A in this paper are considered to be all sedentary, land holding groups (A/AH/AP), while Users B are considered to be all mobile groups (P). In the North (Locale P), two groups of pastoralists were involved in divergent adaptation, local pastoralists (LP, User A) and transhumant pastoralists (TP, User B). While Table 5.4 lists some of the responses found to be divergent adaptation, the next section qualitatively describes how divergent adaptations in the

case study areas have impacted the adaptive capacity of other users and altered social and institutional outcomes and livelihood transformations.

4.5 Divergent adaptation in Tahoua, Niger

4.5.1 Extending Agriculture and increasing livestock holdings

4.5.1.1 Link to climate variability

In the past 15 to 35 years, rainfall variability and heavy exploitation has shifted the SES in the agricultural zone, producing losses to soil quality, biodiversity and forest cover in some areas. The location and production of fields has changed such that respondents found that the harvest of a single field prior to the droughts of the 1970s and 1980s now requires four similarly sized fields. The easiest way to increase production has been to expand agriculture into areas once considered too marginal for farming, encouraged and even promoted by the government and other institutional frameworks. Some of the soil degradation that has resulted from cultivation was moderated in recent decades by factors that contributed to the ‘greening’ phenomenon including: high rainfall, introduction of agricultural intensification measures, organic soil improvements, regeneration of forests, and non-farm incomes driving economic transitions away from agriculture (Mortimore and Turner, 2005; Sendzimir et al, 2011), but these measures were only adopted in one of the three research sites (Locale A).

4.5.1.2 Adaptations

Dryland agriculture is understood to be insufficient to meet the needs of a rapidly growing population (Bastin and Fromageot, 2007), and alternative modes of livelihoods are developing. Subsidized through government programs, irrigated market gardening in valleys and near seasonal lakes has quadrupled since the 1980s. Market gardening provides a dry season and drought-resistant adaptation activity producing mangoes, tomatoes, high yield sorghum, onions, manioc, and other vegetables (Table 4.4). As a representative from the Ministry of Water stated, ‘he who is sitting on water must not be hungry,’ and the Ministry is actively promoting irrigated agriculture as a key adaptation to climate variability. As a result, agriculture has not only spread into pasture areas in the south, but also into many seasonal lakes and river valleys previously accessible to pastoralists (Image 4.2).

Image 4.2 Enclosed collective water resources in southern Tahoua.



This steep descent (left photo) provides the only available access to water for livestock along an international livestock route (Ibohamane, Keita; Snorek; October 2011). Seasonal lakes in Bangui, Madaoua are heavily dominated by irrigated gardens (right photo), blocking livestock from accessing water (Snorek; November 2011).

Since obtaining the capital (at least a hand-dug well, plot of valley land, and a mode of water pumping and distribution) for market gardening is not feasible for more impoverished households, buying and selling livestock is perceived to be more cost-effective to defend the household against droughts (Table 4.4). Propelled by government programs from the 1980s promoting livestock as drought ‘insurance,’ respondents from all Locales stated that they invest earnings from economic migration in livestock. Recent data shows that the majority of livestock in Niger (donkeys, sheep, goats, camels, and cattle) are owned by sedentary peoples (Fode, 2010), utilize the northern pastoral zone, and are raised by shepherds through mobile pastoralism (70 to 90% of livestock are produced through mobile pastoralism according to OECD, 2013). Also, the numbers of sedentary-owned livestock are shown to be increasing faster than the human population, which grows at a rate of 4% per annum (World Bank, 2015). For instance, in Locale A (Madaoua), the village shepherd began his work 20 years ago with only 50 heads of cattle and small ruminants, and now herds 80 cows and over 300 small ruminants.

4.5.1.3 Social and institutional context

Southern Tahoua is thus a region of agro-pastoralism, shared by a large number of sedentary agro-pastoralists and agri-herders as well as significant numbers of pastoralists. The spread of cultivation into pasture areas and water sources has pushed pastoral activities into the North during the rainy season and becomes problematic when livestock make the southerly descent.

If pastoralists descend with their herds prior to the government declaration of the *liberation des champs*, compensation for crop damages can be relatively lucrative for sedentary groups, but also

produces violent convergences between pastoralists and agriculturalists/agro-pastoralists. The fees imposed are increasing in amount and frequency over the previous decade. The spread of fields into pastoral routes and parking areas can thus indirectly support sedentary households through damage payments. For instance, Locale AP historically was dominated by Fulani pastoralists, but this group has slowly been pushed out by cultivation, which quadrupled during the years that the Keita project (PDR-ADM) was intervening in the locale (1983 to 2003, Rossi 2009). To protect the cultivation in the region, officials in Locale AP impose heavy restrictions on pastoralists, who in turn feel they must 'run' through the region when descending 'early' (see also Chapter 7). Events of violence have been growing between pastoralists and agro-pastoralists in Locale AP, and gendarmes are frequently called in to guard the harvest when livestock are observed to be descending (Table 4.5). This armed enforcement protects the assets of sedentary groups, but often corrupt gendarmes take the crop damage compensation as payment for their work.

4.5.1.4 Divergent adaptation

Mobility is a pastoralist's main adaptation, and without it the pastoral livelihood system becomes precarious. Depending on rainfall quantity and variability, transhumant pastoralists (TPs) descend into the south to seek both water and pasture for their herds between October and December. The speed of descent is propelled by the drying of seasonal lakes in the North, but it is also dependent upon the pastoralist's knowledge of and access to alternative water and pasture sources, which depend highly on the strength of his/her social networks. The official date of the *libération des champs*, however, is often declared 1 to 3 months after the first groups begin to descend, which becomes problematic due to the extension of agriculture and increasing numbers of household livestock (Table 5.5).

The spread of cultivation into pasture or fallow areas limits pastoral mobility, especially due to the loss of pastoral corridors, water points, and pasture areas to cultivation. Corridors observed in the field were often dangerous, provided little or no access for livestock to water, and often were too small for livestock to pass without damaging crops (Image 4.2). Even livestock routes to government-designated pastoral wells were surrounded by and blocked by cultivation (Locale AP). 85% of pastoralist respondents state that water access is increasingly complex and simply forbidden in certain areas (Table 4.5). For example, the village of Nakone (Locale A), located along an international pastoral corridor, serves as an important water point for livestock, but is used locally only

for brick production. Due to past conflicts that erupted when pastoralists damaged cultivated fields nearby Nakone, the passage to the lake was closed until after the fields are cleared.

All the livestock on the route stop here. But, we prevent them because this is our bush.... Herders have a lot of animals so they make a lot of damage. So we prevent them from coming here (Locale A, AH, P33).

The nearest village to Nakone is the home of a Kelgress Tuareg pastoral customary official. He frequently meets with the chief of Nakone to reiterate the need for pastoral access to the seasonal lake, but villagers continue to cultivate the route to the water and forbid pastoralists entry. As a result, pastoralists are required to divert from well-traveled routes to find water, which in some cases leads to further conflict and crop damage because water bodies are increasingly cultivated or blocked.

Despite these limitations to mobility, participants from all rainfall zones stated that the total numbers of livestock appear to be increasing. The concurrent demand for fodder and pasture has heightened, promoting competition over space in both northern and southern zones. In the South, livestock production has resulted in an increase of cutting and storing farming and pastoral residues for household livestock (Ridder et al, 2004). This practice not only reduces nutrient cycling in the soil, but also has commercialized a formerly free fodder source, which in turn has implications for the adaptive capacities of pastoralists.

The lack of mobility and fodder impacts livestock, which is now a key adaptation for sedentary groups. Ironically, expansion of planting of crops by AH and AP groups also restrains the adaptive capacity of pastoralists who are serving as shepherds for the AH/APs. Sedentary groups thus gain multiple benefits, entitlements, and economic capital through their indirect and direct use of both zones through the mode of livestock rearing and shepherding. Despite these important dependencies, the social capital and transactions between sedentary and mobile groups are shown to be degrading (Table 4.5). Pastoralists are working as shepherds for sedentary groups (41% of pastoralist respondents). Yet, in some instances these groups no longer trust pastoralists as shepherds and rather prefer to take their own animals on the yearly transhumance or use members of their household. Furthermore, sedentary groups no longer need a contract with pastoralists for soil fertilization because they have their own manure. Perhaps most revealing is the percentage of sedentary respondents (29%) that generally do not trust or even fear pastoral groups, which is based

on fears of violence, theft, and crop damage (Table 4.5). Theft of livestock has become a business according to respondents, and governing institutions have difficulties managing this threat.

4.5.1.5 Interactions, outcomes, and transformations

To respond to limits on mobility, pastoralists have begun to find clandestine ways of passage (typically by night) and also carry arms. Several days prior to our field visit, a pastoralist shot a gendarme with a bow-and-arrow in an attempt to escape capture while passing with his herd through a field. While villagers have praised the gendarme's involvement, pastoralists mentioned the high costs.

...[T]here are many fields now and the date of the liberation of fields is a problem. Because the fields are not yet 'liberated' (even if the people have harvested) and if the military comes they are going to trap them and we are going to pay 100,000 to 300,000 FCFA (172 to 516 USD) just because they say that the fields haven't been liberated, without having touched millet... This is the reason that all the Fulani are no longer in this zone (Locale AP, P, P86).

Compensation for damage to dry land crops has increased over the past 10 years from a non-monetary 'token' to up to 5,000 FCFA (9 USD) per animal. The Rural Code demands a thorough inspection of damage to crops, but more often sedentary groups, under the leadership of the village chief count the number and type of animals that entered and ask for a flat fee per head. One pastoralist stated that he paid 50,000 FCFA (86 USD) despite what he surmised was minimal damage by only a few of his 50 cattle. Even sedentary agro-pastoralists remarked that there were moral and ethical deficiencies in the resolution of crop damages.

Now there is more crop damage than before because now people have lost their ethics, before even if someone damages your crops you let him go, you watch the fields more closely (as prevention), but, now even if a small goat enters the field, you complain. (Locale AP, AP, P49)

Groups that have land tenure, especially the politically dominant Hausa ethnic group are more likely to receive support from institutions (gendarmes, elected leaders, customary leaders, land commissions), in the collection and marketing of fodder, and favoritism in the resolution of theft and disputes (Table 4.5). This has resulted in shifts in the ownership and sharing of collective resources between the two groups, promoting expressions of exasperation from pastoralists.

Now our life has come apart. We can't get food, we can't find the bush. If the bush was enough, we'd be fine. But the farming people collect everything. It doesn't matter what you do they will accuse you and put you in jail (Locale AP, P, P86).

In response to their lack of entitlements in the agricultural zone, many pastoralists are transforming their livelihoods and have begun planting in both northern and southern zones. Motivations stated by pastoral respondents include: 'having space for raising our animals (Locale A, P, P15),' 'a desire for access to institutions, schools, and development resources (Locale AP, P, P34),' or 'everyone is cultivating now (Locale AP, P, P66).' For pastoralists, between 30 and 43% of respondents in each locale consider settlement to be a common strategy to adapt to changing social and ecological conditions (Table 4.4). Other pastoralists stalwartly stick to their way of life and seek alternative means of livelihood diversification such as taking on shepherd activities or finding alternative work in the city for part of the year; over 51 % of these, however, stated that if the status quo continues, they will abandon pastoralism entirely.

4.5.2 Restricting access to water points in the pastoral zone

4.5.2.1 Link to climate variability

Variable rainfall produces 'patchy' pasture instead of covering the whole area as was perceived to be the case in past years, and these 'patches' are said to be occurring even in 'good' rainfall years. Ecological changes in the northern pastoral zone that have accelerated over the past 20 years include changes in the quantity and quality of woody and grass species and less temporal predictability for the evaporation of seasonal lakes. A 68% loss of pasture productivity is estimated to have occurred between 1988 and 2008, as well as the disappearance of 20 trees and grass species (Fode, 2010). Milk production as well has decreased from 168L per capita in 1968 to 37L in 1994 (Geesing and Djibo, 2006). These changes are attributed to demographic growth, over-grazing and over-exploitation of the pasture, and a general lack of nutritious fodder for herds (Woodke, 2008). Nonetheless, livestock are still the second largest export (after uranium) mainly to Nigeria, where they are sold at a higher price than in Niger. The reliance on livestock to support households' security for all users is critical.

4.5.2.2 Social and institutional context

The modernization and formalization of pastoral mobility in recent legislation has increased the number of users of the northern pasture; this has also brought greater competition over natural resources. The livestock of southern land-holding groups exploit the northern pastoral system

without tax or cost for use. This act, supported by national legislation, in effect, increases the land entitlements of agri-herders and agro-pastoralists (Table 4.5). There are two types of pastoralists identified through interviews and focus groups in the pastoral zone (Table 4.2): those who have pre-colonial established *terroir d'attache* in the North, local pastoralists (LPs) and those whose pre-colonial territorial claims lie in the South (Transhumant Pastoralists or TPs). The TPs are primarily Fulani pastoralists who have gradually been pushed out of southern territories due to expansion of cultivation since colonization (Bernus, 1974). These 'newcomers' work primarily as shepherds for southern sedentary groups, returning South at the end of the rainy season. LPs include Iwellemeden Tuareg and Arabs (relevant for the research sites, as Fualni are also found throughout the North). Both have strong social and political links in the North and Arabs hold the majority of democratically-elected positions in Tchintabaraden (Locale P). Kelgeres Tuareg visit the pastoral zone on yearly transhumance and return to home territories in the South. This group has kinship ties to Iwellemeden Tuareg and pre-colonial roots in the far North. Fulani TPs, however are seen by many LPs as outsiders and free riders in the pastoral zone, as indicated by 69% of local pastoralist respondents.

The visiting [Fulani TPs] have a double benefit because they can claim the [northern] territory as their own, while it is our territory and we don't go anywhere [to the south] (Locale P, LP, P83).

The TPs 'recent' arrival corresponds to the social changes induced under the colonial regimes that eliminated indigenous (mostly Tuareg) sovereignty in the North (Baier, 1976). TPs migrate long distances to the pastoral zone, but have less entitlements to water and pasture therein. Some of them possess very few of their own animals, but have skills in herding that have made them valuable to agro-pastoralists and agri-herders who cannot take animals to the North.

Efforts have been made in more recent years to enhance the institutional support for TPs in the pastoral zone. By presidential decree, Mahamadou Tandja (1999-2010) established Fulani chieftains ("*chef de groupement*") in the North (one in Kao in 2003 and another in Tillia in 2007), which served to enhance entitlements for Fulani in this Tuareg-dominant region. Pastoral chiefs, unlike sedentary chiefs do not directly manage territory or tenure rights; rather, they represent pastoral people and can authorize or refuse permission to build wells. This latter power is particularly important in relation to control of territory in the pastoral zone (Thébaud and Batterbury, 2001; Woodke, 2008).

Before, the Fulani (TPs) didn't dwell here. In that time, they were afraid of this land because they knew that it wasn't theirs, they were always on the periphery but they didn't enter. Now, they are given the order to enter. They consider that it is even their land now. And, they have come excessively. They are more than the Tuareg (LPs) now (Locale P, LP, P7).

LPs, on the contrary have slowly lost their social networks in the South since colonization. Given it is all they have, the pasture in the North must be managed carefully, especially during times of drought to secure sufficient resources for the long dry season. The establishment of Fulani pastoral chiefs and concurrent increase in the number of livestock entering the pastoral zone has been highly contentious amongst the LPs.

4.5.2.3 Adaptation

Local pastoral governance is based on the distribution and management of water (Thébaud and Batterbury, 2001). In practice, norms of solidarity support how water is distributed amongst the various groups living in the zone, and for these the availability of and threats to pasture management dictates the functioning of such norms. In an over-simplified manner, this means that if this year I have a good amount of pasture in my home territory (*terroir d'attache*) and next year yours is good, it promotes my maintenance of good relations with you by sharing both water and pasture during my good year and vice versa (Hammel, 2001).

To maintain their livelihood, pastoralists engage in a number of different adaptation mechanisms (Table 4.4). In order to supplement animals' diets when pasture isn't sufficient, pastoralists sell animals and purchase fodder, or they cut and stockpile hay (clandestinely due to its illegality). As seasonal lakes dry and the watering of livestock demands greater labor, pastoralists must share limited water sources, which strains cooperation to uphold traditional pastoral norms of reciprocity, especially during the height of the dry season and during drought years. When conditions call for it, a common strategy is to leave family and small ruminants at a water source and set off with other livestock to seek wells and pasture on sometimes vast migrations between the two pastoral resources (reported by 63% of pastoral respondents). In order to secure winter pasture from over-exploitation by TPs during the rainy season, some pastoralists cited the need to create a permanent settlement to protect resources in their home territory. Other methods include investment in a personal well, for which one can limit the amount of use by TPs. While a more expensive strategy, pastoralists are driving their herds to areas of abundant pasture and then carry-

ing water (sometimes by truck and cistern) to these areas. When such adaptation mechanisms fail, pastoralists move generally into agro-pastoralism.

Pastoralism is our way of life, but it is true that there are people who sell their animals that are remaining and stay in the village when they see the consequences of drought... or, more simply there are some that lost everything (Locale P, TP, P8).

One day we will no longer do pastoralism. Because there are problems for the system of pastoralism. Before, there were places to rest with animals, now there are none. So, if you are tired you can't stop anywhere. You are obligated to leave tired animals behind or sell them (Locale A, P, P70).

Sedentarization as an adaptation is perceived as a livelihood failure to most pastoralists; others see it as inevitable.

4.5.2.4 Divergent adaptation

Of the respondents in the pastoral zone, 63% stated that water access was a problem and of these 25% stated that this was their biggest problem. Due to the ephemeral nature of ponds and the great depth of the water table (over 50 meters in some places), boreholes with pump infrastructure are the best water management solution. Yet the pasture around boreholes is heavily degraded (Bernus, 1974), causing their frequent closure by borehole management committees to allow for re-growth. The autonomy of committees to control exploitation of surrounding pasture is critical to natural resource management (Bernus, 1974), but committees sometimes express favoritism towards locals.

It's not that we prevent you [TPs] from accessing water, but it is only when there is drought, each family needs his water trough, and the wait is too long... and this promotes conflicts and fights that chases away those that are patient (Locale P, LP, P26).

LPs, with the intent to exclude the TPs from exploiting the territory, use two divergent modes of adaptation: limiting water access and building wells in home territories. LPs have priority use over the territories, which has been vaguely codified in the law, and these have the potential to secure their entitlements within their *terroir d'attache*. Building a well in this space in turn permits the protection of the surrounding pasture in accordance with the Water Code. Thus, owners can express a certain level of autonomy over the resources, which is the only permitted form of land tenure in the North.

Given these constraints to their access to water resources, TPs utilize their own social networks and institutional mechanisms to also build wells and create settlements in the North. Since such authorizations for well construction are in high demand, they are sometimes gained through corruption. In these instances, officials do not always abide by the requirement of a certain distance between water points, nor do they consult with LPs who have *terroir d'attache* nearby prior to issuing the permit. Conflict ensues when new wells are permitted near another pastoralist's *terroir*. This has put strains on norms of reciprocity amongst pastoralists over collective resources (Table 4.5).

4.5.2.5 Institutional interactions and related social dimensions

The transhumance between Nigeria and the pastoral zone is not a new phenomenon, yet, 54% of respondents perceive that there are increasing numbers of livestock penetrating the North. LPs accuse the TPs of being the cause of pasture mismanagement, according to 62% of respondents. The lack of cooperation between ethnic groups is further exacerbated by conflicts and sometimes violent conflicts over wait times at water sources, access to pulleys and troughs, and the intervention of formal institutions in well construction and water management.

The number of water sources (boreholes and wells) during the long dry season is limited and demand either heavy labor (wells) or payment (boreholes). To protect livestock and preserve the pasture, there are certain norms including who gets priority access, the length of stay in specific zones, how the pulleys at the well are divided between ethnic groups, and which animal troughs are accessible to whom. Yet, these norms are shifting, as perceptions of who is causing the problem of overgrazing and who has priority rights in the territory are also shifting.

Limited to the North, LPs must protect and preserve pasture to sustain their herds through the long dry season; whereas, TPs need to have mobility and social networks in the North during the rainy season. While norms of cooperation and sharing of resources are still prevalent, many LPs express distress in relation to the management and control of the territory.

One of my worries is that this land [no longer] belongs to us at 100%. At each time I see a sign, it pushes me to hate this land. Or, rather it shows me that someone wants to take it away from me or kill me because of this land, or make me run away (Locale 1, LP, P7).

Paradoxically, the modes established to protect and sustain pastoral resources through water management are contributing to social breakdown, ethnic conflict, or illegal means of claiming resources and competition over public resources, all of which undermines an important part of adaptive capacity, reciprocity and social capital, even between LPs.

Before, all pastoralists are the same. They share the same space. They like each other, they help each other. The difficulty of one is also your difficulty. Now, it's like the political parties, everyone likes their party... if you are Tuareg, you like the Tuareg, if you are Fulani, you like the Fulani... etc. Before, that didn't exist. Whomever you meet who is a pastoralist, it's the same even if you are Fulani, Arab, Tuareg (Locale P, LP, P28).

Thus while LPs are dominant politically and have greater access to natural resources, their control over the North is waning and enhancing conflict dimensions.

The Fulani even have guns now. Last week, we heard someone shoot their gun in a market, but the person walked completely away in liberty, after having been stopped for just some minutes in Tillia, but the authorities left him alone and he kept his gun. This is not normal (Locale P, LP, P26).

Now, those with greater social capital and financial means, including TPs are more capable of securing both entitlements and institutional support, regardless of the historical rights or *terroir d'attache*. Furthermore, increasing settlement in the zone, decentralized governance, overgrazing, limits to water management, power bargaining for resource access, and conflict including violent conflict at water points, are pushing the most vulnerable LPs into sedentary lifestyles (Table 4.5).

Table 4.5 Prevalent phenomena and how they explain divergent adaptation

Divergent Adaptation (DA) Response relevant to adaptive capacity (AC)		Impact of DA: User A	User A % N (# N)	Impact of DA: User B	User B % N (# N)
1. Extending agriculture (only for Locales AP and A)		A/AH/AP°	A/AH/AP° (N=34)	P°	P° (N=27)
Economic capital	Pastoralists must pay for crop damage	++	35 (12)		52 (14)
	Fodder is a commodity	+	12 (4)	-	56 (15)
	Instances of land being sold or rented	+	35 (12)	/	4 (1)
Social capital	Distrust of sedentary groups	/	3 (1)	-	56 (15)
	Distrust of pastoral groups	-	29 (10)	/	0

Entitlements	Loss of pasture to cultivation	+	21 (7)	--	67 (18)
	Water points inaccessible to livestock	+	15 (5)	--	85 (23)
Instit'al support	Authorities tend to favor landholders	++	12 (4)	--	44 (12)
	Express no trust in authorities	-	15 (5)	-	30 (8)
	Express trust in authorities	+	26 (9)	+	0

2. Livestock Ownership (only for Locales AP and A)		A/AH/AP	A/AH/AP (N=34)	P	P (N=27)
Economic capital	More livestock observed in S. Tahoua	++	29 (10)	/	7 (2)
	AHs possess more livestock than Ps	+	15 (5)	-	4 (1)
	Purchase livestock with remittances	+	15 (5)	+	0
Social capital	Ps fertilize soil (P contract)	+	24 (8)	+	15 (4)
	P contract no longer needed	+	12 (4)	-	0
	AH/APs don't trust Ps as shepherds	-	3 (1)	-	7 (2)
Entitlements	Shepherds take AP/AH herd to P zone	++	21 (7)	--	41 (11)
	Land holders stock field residues	++	32 (11)	-	15 (4)
	Landholders sell residues	++	26 (9)	--	19 (5)
	Landholders sell pasture grasses	+	24 (8)	--	11 (3)
Instit'al support	Authorities ignore livestock theft	--	15 (5)	--	26 (7)
	Authorities prosecute thieves	+	12 (4)	+	11 (3)

3. Limiting water access (only for Locale P)		LP°	LP° (N=13)	TP°	TP° (N=3)®
Economic capital	Collection of water fees	+	46 (6)	--	(1)
	More livestock in pastoral zone now	-	54 (7)	-	0
	Fewer owned livestock now	-	15 (2)	-	(2)
	Insufficient pasture to herd size	--	69 (9)	--	(1)
Social capital	'TPs are our problem'	-	62 (8)	--	0
	Presence of transactions with LP/TPs	+	8 (1)	+	0
	Frequent conflict about water access	-	46 (6)	-	(2)
Entitlements	Biggest problem is access to water	--	62 (8)	--	(2)
	Rich get priority access to water	-	23 (3)	-	0
	Must be patient to get access	-	23 (3)	-	0
Instit'al support	No trust in authorities	-	54 (7)	--	(2)

support	Trust in local authorities	++	15 (2)	+	(1)
	Authorities ignore livestock theft	-	31 (4)	-	(1)

Other qualitative data useful to the discussion of divergent adaptation are described in the text (organized by user A and B per locale). °Abbreviations are as follows: A Agriculturalist, AH Agri-herder, AP Agro-pastoralist, P Pastoralist, LP Local Pastoralist, TP Transhumant Pastoralist, ++ strong positive impact, + more positive than negative, / not clear whether positive or negative, - more negative than positive, -- strong negative impact. ®No percentages were calculated for this small N#, which, due to the time of year reflects only the number of TP settlers in Locale P.

4.6 Discussion: Institutional feedback for divergent adaptations

As shown through the examples of divergent adaptation in northern and southern resource regimes, Users B experiencing a loss of adaptive capacity provide feedback to Users A and institutions. For instance, transhumant pastoralists (TPs, Users B here) lack entitlements, financial and human capital, and social networks in the North. Users A in both the North (LPs) and South (A, AH, APs) express high levels of resentment and fear towards the TPs, especially where there are concurrent levels of violent conflict (Locales AP and P). TPs, in response have strengthened their institutional support through collective action and secured tenure through settlement in villages (Locales AP and P). This feedback in turn has the potential to enhance conflict dynamics, but based on the current institutional framework is one of the few means for livelihood security available to TPs.

The ways that institutions frame adaptive capacity is an important factor in determining winners or losers in divergent adaptation. The Pastoral Code (Table 4.3) states that the mobility is a fundamental right for pastoralists (both nomadic and transhumant) and cannot be hampered except temporarily to protect human, animal, forest, or agricultural production security (Code Pastoral, Article 3). As shown through the case study, some customary officials support mobility by defending and protecting pastoral space. Elected officials, on the contrary invest more time and enforcement for the activities benefitting sedentary users, who are more numerous and can provide more votes. This has promoted many respondents to point to ‘democracy as the problem’ that creates unequal institutional support favoring sedentary groups (see also Chapters 7 and 8).

Social networks and the effectiveness of multiple institutions can also provide support to Users B, but this is dependent upon other forces within the SES. In the case of the pastoral zone, social networks are breaking down as a result of broader and more complex social dynamics, including migration and conflict. It is apparent that the pastoral system is in a fragile condition due to climate- and human-induced degradation. Free riding, over-exploitation, and shifting water man-

agement regimes in the zone have pushed many pastoralists into migration or loss of livelihood and contribute to their vulnerability. Furthermore, recent crises in Libya and Mali in 2010 and 2012 have produced an influx of migrants and refugees into Northern Tahoua, further destabilizing an already precarious situation. In this context, powerful individuals are claiming important pasture territories for private use, by building fences, private boreholes, and/or water transport with cisterns. This difficult confluence of impacts on the SES means that despite their strong social capital and ethnic dominance in the North, small-holder, local pastoralists are a highly vulnerable user group. The instability and changing institutional dynamics of this system impact the adaptive capacity of all users in Tahoua and deserves careful attention by institutions of governance.

In the examples provided, the expression of divergent adaptation in both the North and the South is framed by multiple norms established by rent-seeking leaders, inconsistent and corrupt enforcement, and a mixture of overlapping institutions. Market forces, as well as are considerably altering the exploitation of natural resources and shaping adaptive capacity. Well-intended policies fail to protect collective resources from over-exploitation. Due to the marginalization of Users B (TPs and all Ps), these groups have greater difficulties defending their livelihood needs and have begun to rely more on individual and collective agency, sometimes resorting to violence.

4.7 Conclusion and Policy Recommendations

This chapter introduces the concept of divergent adaptation to describe a situation in which the success of one individual or group's adaptation causes a subsequent reduction in another individual or group's adaptive capacity. Divergent adaptation is not simply another term to define "winners and losers" or "haves and have-nots." Rather, the term illustrates how the process of adaptation has the ability to bring about unequal access to entitlements, institutions, and resources; change social networks; and limit one's options to respond to climatic hazards. Transformation, cooperation and conflict are possible outcomes of divergent adaptation, as discussed in the next paragraph, but may also cause more or less divergent adaptation in future interactions. Recognition of divergent adaptation is highly context-specific and based upon knowledge of social, institutional, ecological, and economic processes. As shown through the case in Niger, conflict may develop as a result of divergent adaptation, and existing institutional processes may or may not contribute to the scale and outcomes of divergent adaptation. As other studies have shown (Gupta et al, 2010), institutional processes act as a fulcrum to steer the changes to adaptive capacity of di-

verse users in divergent adaptation. The determination of which institutional processes impact and define social consequences of divergent adaptation is thus explored in consequential chapters in this thesis (Chapter 7).

Multiple user groups in northern and southern Niger including those whose livelihoods and identity depend upon mobility (pastoralists) and those who rely primarily on sedentary livelihoods (agriculturalists, agro-pastoralists and agri-herders) are trying to limit damage perceived to be caused by different users to the resources that most support their livelihoods (pasture and cultivated fields). These resources are also highly dependent upon rainfall. One example of divergent adaptation discussed is that of limiting certain groups' access to modern water points to conserve the surrounding pasture in the northern pastoral zone. Another is the closing of livestock routes in the South or forbidding access to collective water sources in order to protect crops from livestock damage. Both these divergent adaptations involve conflict, sometimes violent. Thus, when there are multiple users of collective resources in a shared SES, divergent adaptation can transform the social reality, causing changing norms, institutions, and patterns of conflict and cooperation.

In the case of Tahoua, the marginalization of the pastoral sector and poor implementation of the Rural and Pastoral Codes is critically reducing the adaptive capacity of pastoral users in both the northern and southern zones. Here, divergent adaptation promotes worsening social and ecological conditions. This is in contrast to successful adaptation that promotes system resilience, is supported by legitimate and adaptive institutions, and generates and sustains collective action (Osbahr et al, 2010; Eriksen et al, 2011). Adaptations that build social capital and are not divergent, such as protection of collective water and forest resources, soil and erosion management, and natural regeneration, should be supported by institutions and government development programs. Most important is the promotion of trust between users and multiple institutions through higher accountability, better leadership, and continuity in processes of decision and policy making.

In relation to climate variability and adaptation in this Sahelian nation, the responsibilities of each governance level, including national/regional/local authorities and the customary officials must be clearly defined. Creating institutions that value and understand the interdependence of both the pastoral and agricultural systems is necessary to enhance adaptive capacity in diverse user groups while preventing divergent adaptation. Where policy mechanisms are already in place such as the

Rural Code, multiple institutions must rebuild accountability and proper enforcement of both pastoral and agricultural regimes as well as develop flexibility in institutional mechanisms in order to learn from past mistakes and transform inequitable adaptation policies.

Adaptation relates directly to development processes, which are instigated and implemented based upon social, political and institutional forces. By recognizing and understanding divergent adaptation and how to enhance adaptive capacity for multiple users of collective resources, institutions of governance can limit the activities that contribute to divergence and provide a more adaptive form of management.

Chapter 5: Inequitable ecosystem services: present and future scenarios of ecosystem management

5.1 Introduction

Divergent adaptation to climate change does not take place without ecological tradeoffs or synergies. “In the space of a single human lifetime, society finds itself suddenly confronted with a daunting complex of tradeoffs between some of its most important activities and ideals” (Daily 1997:1). When Daily first used the term ‘ecosystem services’ in 1997, which was predicated upon prior uses of the concept (Westman 1977; Erlich and Erlich 1981), she framed it as a discussion of trade-offs. The ecosystem services concept, defined effectively by Fisher et al. (2009: p. 645) as ‘the aspects of ecosystems utilized (actively or passively) to produce human well-being,’ represents the recognition of the urgent need for the world’s international organizations, some of which in the 1990s were imposing environmentally destructive neoliberal and anti-protectionist trade policies on many of the Global South countries, to mainstream ecological principles by drawing a link to their intrinsic economic benefits. Daily’s intent was not to quantify in monetary terms individual ecosystem services, but rather to describe their value in physical magnitudes or proportions of a whole system of production, such as the proportion of crop pests controlled naturally or the proportion of pharmaceuticals derived from biodiversity (ibid.). “[E]cosystem services have infinite use value because human life could not be sustained without them” (Daily 1997:8).

In the context of climate change, the concept of ecosystem services has more urgently been ushered into the scientific, economic, governmental, and inter-governmental forums (MA 2003; 2005; IISD 2005), despite a continuing debate around the concept (Corbera et al. 2007; Robards et al. 2011; Wegner et al 2011). SESes possesses greater adaptive capacity when ecosystem services remain intact (Adger 2006). With viable ecosystem services, such as hillside stabilization, water filtration, biomass, and drinking water SESes express greater sustainability, support economic stability, and protect livelihoods. The development of schemes of payment for ecosystem services has triggered heavy criticism of the concept, noting inequities in income distribution and the problematic nature of commodifying and monetizing services of nature (Norgaard et al 1998; Tschakert 2007; Corbera et al. 2007; Corbera and Pascual 2012). This chapter, by returning to Daily’s original intent regarding the usefulness of this term, examines degradation of ecosystems, looking specifically at how divergent adaptations can generate ecosystem service tradeoffs for multiple users in

an SES. This research broadens the understanding of divergent adaptation (Snorek et al. 2014) by evaluating multiple perspectives of ecosystem service degradation in Niger.

5.1.1 Tradeoffs and synergies of managing multiple ecosystem services in the SES

It is encouraging to note that the development of the concept of ecosystem services has succeeded in bringing about greater compatibility between environmental and development goals (de Groot 2010; EC 2011). Yet, despite this progress, most development models in the Sahel prioritize the production of monocultures, which are constructed primarily to enhance those ecosystem services providing nutrition (eg. crop production), materials (eg. timber) and water (eg. irrigation schemes) (Foley et al. 2005; Shiva 1997). The Millennium Ecosystem Assessments (MA 2003; 2005) provided a clearer view of the state of the world's ecosystem services and demonstrated the intensity of degradation throughout the world, some of which was based on inappropriate development models. More recent research (CICES 2013) has clarified the classification of ecosystem services. The aim of this study is to understand how divergent adaptations relate to and will relate to tradeoffs in the degradation of ecosystem services used by multiple user groups.

When managing for multiple ecosystem services, possible outcomes can be tradeoffs or the enhancement of one service at the cost of reducing another and synergies or situations in which multiple services are enhanced (MA 2005; Bennet et al. 2009; Carpenter et al. 2009; Raudsepp-Hearne et al. 2010). For instance, in a case illustrated by Barbier et al. (2008), the destruction of mangroves for shrimp farming negated the provisioning and regulating services provided by the mangroves including wood production, flood protection, and habitat for off-shore fisheries. Alternatively, maintaining a forest patch near coffee plantations induces greater pollination and production (Ricketts et al. 2008). Examining multiple ecosystem services demonstrates that there exist consistent trade-offs between provisioning services and almost all cultural and regulating services (Raudsepp-Hearne et al. 2010; Plieninger et al. 2013; Renard et al. 2015). Also, with greater diversity of ecosystem services, the synergies with regulating services and cultural services are concurrently more abundant (Raudsepp-Hearne et al. 2010). Understanding trade-offs and synergies has been shown to be important to the formulation of best practices in ecosystem management (Renard et al. 2015).

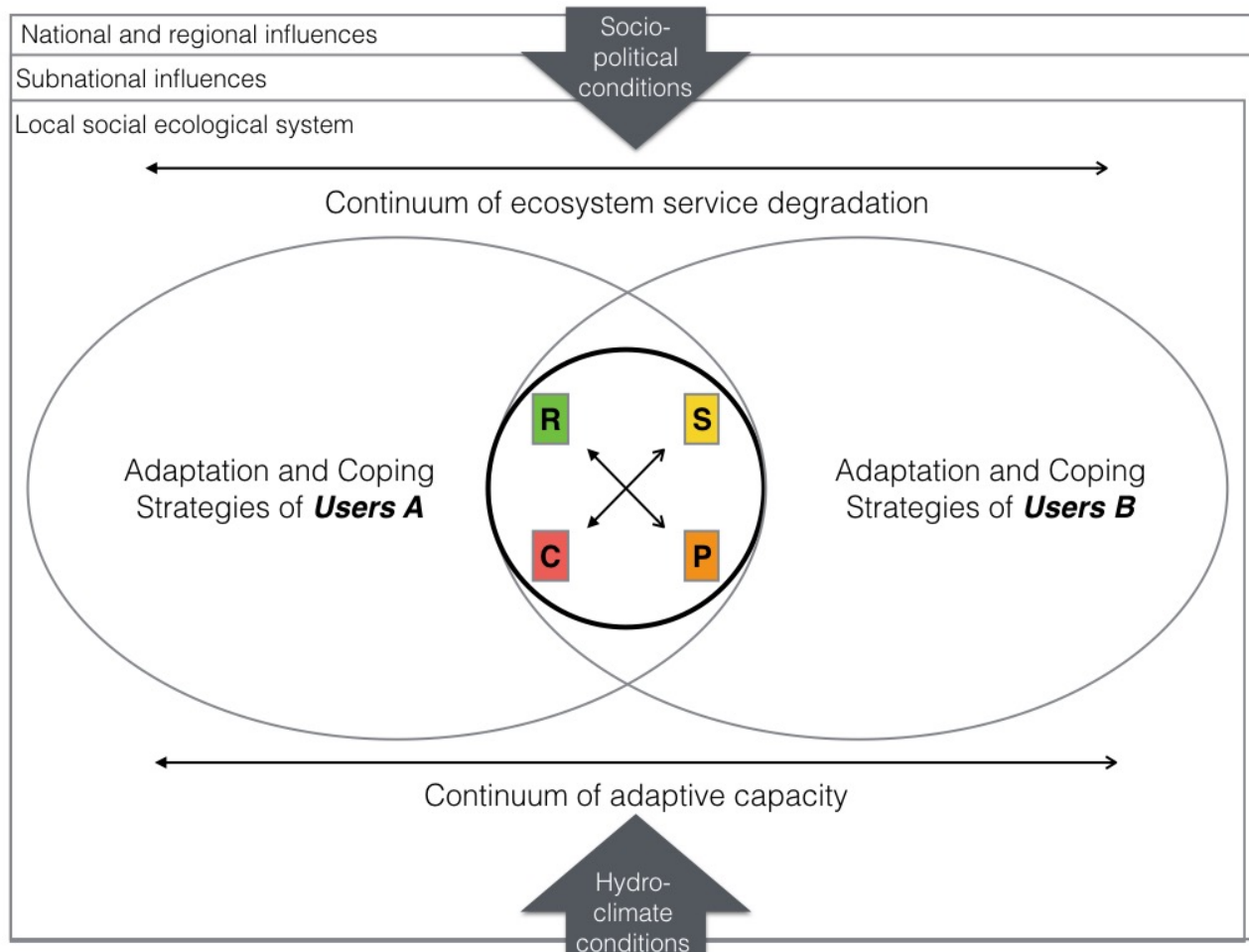
The linkages between multiple ecosystem services, tradeoffs/synergies, and the adaptive capacities of users is less clear. In the context of climate change adaptation, Fabricius et al. (2007) attribute greater ecosystem and livelihood diversity with better maintenance of ecosystem services. The MA (2005) points out the intrinsic linkages between wellbeing and ecosystem services, but does not analyze the multiple dimensions of wellbeing, in particular the plural forms of value articulation and distribution biases of markets (Wegner et al. 2011), both of which are also important to adaptive capacity in the SES (Gupta et al. 2010). Adaptive capacity is determined by ecological and social memory, or the legacies, reservoirs, and support areas that permit a SES to rebound and return to its former state after a hazard event (Folke 2008). For instance, elements of ecosystems that could support adaptive capacity include those that promote lifecycle maintenance such as grazers, pollinators, and other seed dispersers that would transfer elements from the non-disturbed systems into the disturbed system (ibid.). Elements of social systems that provide adaptive capacity and ecosystem resilience include a diversity of individuals, ideas, institutions, and networks to facilitate an inclusive process of change from disturbed to stable state (ibid.).

Studies on desirability of ecosystem services are poorly integrated into literature on resilience, sustainability, and vulnerability (Robards et al. 2011). In order to better integrate ecosystem services into development and climate change adaptation planning, we must provide a clearer analysis as to 'how the costs and benefits of changes (ecological, socio-cultural, and economic) to ecosystem services and values of multiple users (in time and space) be taken into account properly' (Plieninger et al. 2013: 261). Climate change adaptation does not always have the tendency to eliminate inequalities, promote equitable distribution of entitlements, or produce cooperation between multiple users in a SES (Snorek et al. 2014). Examining ecosystem services in isolation from social processes such as values, culture, and socio-economic conditions has not been shown sufficient for sound ecosystem management (Bennet et al. 2009; Plieninger et al. 2013). Furthermore, cost and benefit analyses of ecosystem services must also acknowledge the diverse dimensions and states of well being among numerous and diverse actors in light of divergent adaptations (Snorek et al. 2014).

Since ecosystem changes have been shown to be shaped by pluralistic values and hindered by distributional biases (Wegner et al 2011), further research would provide user-based perceptions to shape policy dialogues on ecosystem services. While many studies of ecosystem services have fo-

cused on their use (Raudsepp-Hearne et al. 2010), supply, and stock, this chapter focuses on changes to multiple ecosystem services over time. It utilizes both present-day perceptions and scenarios of future climate change to understand how users intend to manage the trade-offs and synergies that are expected to result from climate change adaptations, some of which may be divergent adaptations (Snorek et al. *in review*). The results point to important ways to manage Sahel ecosystems for an uncertain future. Divergent adaptations produce more societal inequities due to unequal adaptive capacities between users (Snorek et al. 2014), but what is unclear is the effect that ecosystem service tradeoffs and synergies have on adaptive capacities, and if there were a way to optimize ecosystems to enhance multiple groups' adaptive capacities. If there is a relationship between divergent adaptations and tradeoffs in ecosystem services, would a reduction in divergent adaptation in turn provide the conditions for sounder ecosystem management or vice versa? While much of the research on ecosystem services addresses the great inequalities in global development, which have produced tradeoffs between the so-called developed world and the rest of the world (resource extraction, waste disposal, and other forms of shifting externalities), this analysis of divergent adaptation in the Sahel looks carefully at the social, political and ecological conditions that relate to poverty and vulnerability of societies, which, through this thesis have been shown to be necessary to the study of adaptive capacity (Figure 5.1).

Figure 5.1 Framework expressing the relationship between adaptive capacity and multiple, conflicting uses of ecosystem services.



While multiple users share an array of regulating (R), supporting (S), provisioning (P), and cultural (C) services ecosystem services, changes occur along a continuum of degradation, which thereby impacts the ability of the ecosystem services to support u

5.1.2 Adaptive communities of the Sahel

In a local community, which is defined as a collection of human beings who have something in common and often share a common place of residence (Fabricius et al. 2007), a higher awareness of the social ecological interactions of one's surroundings produces greater adaptive capacity when responding to climate hazards (Folke et al. 2005). In the Sahel those communities with a similar cultural framework, shared institutions, or shared ecosystems possess greater impetus and capacity to managing multiple challenges to livelihood security (Snorek et al. 2014). The pressures that create challenges to the maintenance of ecosystems in Niger (Chapter 3) include population growth, human- and climate-induced processes of desertification, and climate hazards, such as drought (Chapter 3). Following up past research on divergent adaptation (Snorek et al 2014), this chapter has defined two communities: pastoralists or "a human and social group that is historically

and socially characterized by its mobility, and whose principal activity is rearing livestock” (Hammel, 2001) and agro-pastoralists or one who derives his/her primary revenue from agriculture but retains both some livestock and his/her socio-cultural origins in pastoralism.

In 2001, Mortimore and Adams demonstrated that communities in Niger underwent spontaneous and autonomous adaptations in the face of climate change shocks such as drought. Such SES change is driven in turn by shifting economic policies that essentially liberalized Niger’s economy, cancelling farming subsidies and pushing a transformation of agriculture away from cash crops to subsistence crops sold at localized markets. The result was increased agricultural diversity as well as a movement towards more suitable crops for the Sahel ecosystems. These spontaneous adaptations improved the livelihoods of sedentary agro-pastoralists and contributed to greater adaptive capacities for these groups, which was supported in turn by institutional frameworks benefiting sedentary livelihoods (Chapter 7). When faced with hydro-climate hazards, those actors who are coping and adapting (Fabricius et al. 2007) turn as a first resort to ecosystem services to support their livelihoods, especially women and more vulnerable groups. While the framework of this thesis defines adaptation as both planned and spontaneous changes to livelihoods patterns, for this chapter, the focus is mostly on the coping mechanisms, due to their proven (Fabricius et al. 2007) capacity to degrade ecosystems (such as wood cutting for sales).

In Niger, the expansion of cultivation has had a northward trajectory, as the southern zone is more heavily cultivated. This promotes desertification processes that are largely caused by the extension of cultivation (Witting et al. 2007), which are exacerbated by climate change (see also Chapter 3). Similarly, fluctuations in rainfall are contributing to more frequent droughts, a condition that will continue based on predictions regarding climate change (Giannini et al. 2013). There is a need to understand the way in which ecosystems serve diverse livelihoods in order to best develop adaptation programs that account for fragile ecosystems and natural resource management schemes. To do so, it is necessary to analyze the full SES including, what is promoting changes to ecosystem services (historical perspectives), how these impact multiple livelihoods in the context of climate change (current responses to hydro-climate hazards), and how the models of development shape resilience to climate events such as drought or flood (future scenarios). Strengthening the provisioning, regulating, supporting, and cultural ecosystem services for one group may contribute to social inequalities, injustice, and conflicts or may result in greater synergies and in-

creased cooperation. Given the multiple constraints facing SES adapting to climate change and the need to explore the challenges to optimization of ecosystem services for multiple users, this research asks the following questions: 1) What are the perspectives of multiple users in Niger about how degradation is occurring to ecosystem services and who or what is the cause? and 2) What are the future outlooks for these actors facing environmental change processes in light of changing ecosystem services and climate change scenarios?

5.2 Methodology: A qualitative approach to ecosystem services

5.2.1 Part A: Qualitative assessment of ecosystem bundles of multiple users

Uneven degradation contributes to our concurrent discussion of divergent adaptation processes (Snorek et al. 2014), and the premise that certain regulating and cultural services are lost when too much value is placed upon provisioning services (namely, cultivation). Data was collected based upon the perspectives of multiple users of a SES in the Sahel (Niger), examining two temporalities: the near-past (a timeframe spanning the memories of the participants) and future climate change scenarios (2031-2050), to provide multiple perceptions about temporal ecosystem service change. This is compared to available literature describing patterns of change for specific ecosystem services (crop, fodder, and timber provision) in the Sahel. Despite the limited literature quantifying these changes, the historical perspectives offered by multiple users provide important views on how ecosystems and their services have changed, data that can contribute to current descriptions of ecosystem change in this region (IISD 2005).

The ecosystem services were chosen based on available literature, relevant indicators, and related conflict dynamics between the two users. The study includes the ecosystem services found in assessments of ecosystem services of the Sahel (IISD 2005) and the CICES classification (2013), with those selected for the study in bold type. The seven key ecosystem services addressed with users are: provisioning of biomass: **cultivation of food crops**, rearing livestock, production of grassland or fodder, biodiversity of biomass (genetic material), and fuel wood production; and regulating: **climate (temperature, rainfall, wind) regulation**, soil stabilization (erosion control), and soil formation and composition (the latter counted as one service). We included ecosystems services for this study that were highly relevant to the success of the livelihoods of the two user groups in this study, that also have been demonstrated to contribute to conflicts in relation to use and overuse (Chapter 4). Data about these service was collected through household interviews and focus group

discussions with equal numbers of pastoral and sedentary participants across three localities on a North - South axis in the region of Tahoua. Only two of the three study areas were chosen for the historical analysis due to the security challenges in obtaining data in Tillia. The sites visited were in the following departments: Keita in the agro-pastoral (AP) zone and Madaoua in the heavy agricultural (A) zone. All three localities on the map (Figure 4.2): Locale P (Tillia), Locale AP (Keita) and Locale A (Madaoua) were included in the remaining analysis for this chapter.

Figure 5.2 Ecosystem services assessed for Part A of the study

<p><i>Regulating & Maintenance</i></p> <p>1) <i>Maintenance of physical, chemical, bio-conditions</i></p> <ul style="list-style-type: none"> - Climate/Atmosphere conditions* <ul style="list-style-type: none"> - modify temperature, wind, rainfall patterns - Soil composition & formation* <ul style="list-style-type: none"> - decomposition (organic matter, nutrient storage, fertility) - weathering process (Nitrogen-fixing, soil structure) - Lifecycle (pollination, seed dispersal) - Disease & pest control (birds) <p>2) <i>Mediation of mass/liquid flows</i></p> <ul style="list-style-type: none"> - Stabilization (erosion control)* <ul style="list-style-type: none"> - Buffering sediment flows (prevent quarry formation) - Flood protection (appropriate land coverage) <p>3) <i>Mediation of waste, toxins, nuisances</i></p>	<p><i>Provisioning</i></p> <p>1) <i>Nutrition (Biomass/Water)</i></p> <ul style="list-style-type: none"> - Cultivated crops* - Reared animals and their outputs* <ul style="list-style-type: none"> - Wild plants - Wild animals - Drinking water (surface, ground) <p>2) <i>Materials (Biomass)</i></p> <ul style="list-style-type: none"> - Fiber/Plants (timber, trad. medicine)* - Plant-derived (fodder, manure)* - Genetic (wild plants, animals)* <p>3) <i>Energy (Biomass)</i></p> <ul style="list-style-type: none"> - Plant-based sources (wood, straw)*
	<p><i>Cultural</i></p> <p>1) <i>Traditional ceremonies and healing</i></p> <p>2) <i>Recreation</i></p> <p>3) <i>Aesthetics</i></p> <ul style="list-style-type: none"> - Multiple art forms (also song, writing) <p>4) <i>Spaces for cultural celebration</i></p> <ul style="list-style-type: none"> - Intrinsic cultural identity linked to land

Services examined in the study are bolded and with an asterisk*

In each sedentary and nomadic locale or camp, we established a timeline (Figure 5.4) and engaged the participant in similar open-ended questions. In the sedentary villages, we established a timeline of local scale events, based primarily on the lifetimes of the main leaders or chiefs of the villages. These were used throughout the interviews with the remaining village participants, to identify specific changes or shifts in the use and degradation of ecosystem services. The rest of the questionnaire focused on understanding the changes to ecosystem services from the perspectives of multiple users, pastoralists and agro-pastoralists. Questions covered the following topic areas: the ecological services most important to one's livelihood, changes to these services over the person's lifetime, what they perceive to be the reasons for the changes, temporality of changes, and the ways in which these changes have impacted (or not) their livelihoods and the well being of

their families. All data was recorded, transcribed, and analyzed using AtlasTi qualitative analysis software.

5.2.2 Part B: Climate change scenario focus group discussion

Given the rapid change to Niger's ecosystem services, it is important to analyze how climate change may shift ecosystem synergies and tradeoffs in the SES. The impact of land use land cover change on pastoral livelihoods facing an uncontrollable expansion of cultivation has been addressed in past literature on the Sahel (Raynaut 2001; Marty and Bonnet 2006; Rasmussen et al 2012; Lambin et al 2014).

Climate change scenarios serve as a thought experiment to illustrate policy challenges and inform future policy making (Lambin et al. 2014). Using the IPCC's open access data for the scenarios, we developed, along with our collaborators at the Cyprus Institute four simple social-ecological future scenarios (Figure 5.3). The majority of research for the case study had already been conducted via a review of relevant national and international policies, expert interviews, community mapping, calculating the prevalence of conflict, and qualitative interviews with pastoralist and agro-pastoralists (see methodology in Chapter 2). The scenario developed for the focus group discussion addresses a twenty-year period examining a projected future for agro-pastoral activities from 2031 to 2050. This duration, as opposed to a single year, is necessary in our discussion of variability of climate conditions in the Sahel. The reason why we chose to conduct a scenario focus group for this study has been because it would permit a broader understanding of how divergent adaptations would result in barriers to adaptation for some groups in the future, and relate these to the local scale analyses of degradation of ecosystem services.

While climate change will have varied impact on the human well being of the population in Niger, this social scenario is based on the usage of space. This determination is associated with prior field research, where conflictive and cooperative events were related to the degree to which individuals protect or exploit pastoral zones, pathways, and water resources. Due to limitations in this focus group discussion, the analysis examines the degree to which loss of pastoral spaces in both the agricultural and pastoral zones stays the same (greater conflict) or decreases (more cooperation). Loss of pastoral spaces is defined by the encroachment of agricultural fields into pastoral areas, land degradation, and changes in ownership and access.

Figure 5.3 Climate Change Scenarios of Changing Social-Ecological Relationships

Social & Political Change: Protection of Common Space	No change in the current rate of settlement, cultivation, and fencing off of the pastoral (common) spaces	Scenario A: Average Mid-level Impacts 2031 to 2050 Implications: Human Security, Conflict, Cooperation	Scenario B: Worse Extreme Impacts 2031 to 2050 Implications: Human Security, Conflict, Cooperation
	Protection of current formally and informally designated pastoral (common) spaces by institutional and social structures	Scenario C: Optimistic Weak Impacts 2031 to 2050 Implications: Human Security, Conflict, Cooperation	Scenario D: Average Mid-level Impacts 2031 to 2050 Implications: Human Security, Conflict, Cooperation
	No change in the frequency of drought/flood events	Increase in drought/flood events	

Hydro-climatic Change: Drought and Flooding

The scenario focus group discussion (SFG) was held on the 10th of December 2011 (at the close of the second phase of fieldwork) at the headquarters of ACMAD (African Centre of Meteorological Application for Development) in Niamey. A group of 18 experts, development practitioners, and politicians were facilitated by one moderator and two assistant moderators in a discussion of the scenarios and potential institutional means for preparedness and prevention of conflict. Those who participated included members of the commission on pastoralism (3), experts in hydrology, meteorology, social science, and climate change (8), policymakers (5), and development practitioners (2). The group (Annex 5) reflected upon the various scenarios of an uncertain future based on plausible accounts of how external forces such as climate change, political dynamics, land use change, population growth, technological advances, environmental conditions, economic and social dynamics might evolve in relation to the multiple livelihood needs for agro-pastoralists and

pastoralists. The discussion was fully recorded and transcribed with permission of all the attendees, and these transcriptions were analyzed using AtlasTi software to code and identify linkages and trends in the data.

The following presentation of data is divided into three parts: 1) environmental histories, 2) differential perceptions of degradation based on the qualitative data, and 3) future outlooks based on the scenario focus group (SFG). The second section focuses the linkages between user perceptions of ecosystem changes, user's perceived changes to their adaptive capacities as a result of changing ecosystem services, and the perceptions of the reasons for these shifts in the SES. Finally, the future outlooks present the dominant viewpoints shared by experts and recommends policy measures must be in place in order to preserve pastoral space.

5.3 Results 1: Environmental histories in Tahoua

In the colonial period, the French declared that 'vacant' land belonged to France's private estate (Land tenure decree from 24 July 1906). In colonial times, multiple ethnic groups including Fulani, Wodaabe, and Tuareg (of the KelGeres tribe) herdsman and a small minority of Hausa farmers dominated Keita the department of Locale AP. At this time, home territories where the KelGeres Tuareg passed the long dry season were located in what has been designated in modern times as the Madoua and Keita departments. Keita's valleys were remembered as having many trees and abundant water, some of which flowed year round (P31). For an old AP woman in Locale AP, her childhood was marked by fear of leaving the village due to fear of being attacked by wild animals in the forest (P49). In multiple districts across Niger, participants remembered the years prior to 1974 for their abundance of ecosystem services: rainfall, agriculture production, fodder production, and milk production. "At that time, only one cow could be sufficient to nourish an entire family" (P48:1, Village Chief, Locale AP). The French outlawed slavery and in turn settled many of the former slaves into the pastoral regions of Keita. Locale AP was one such village.

Locale AP, a village in Keita named after a plant that once flourished near an old pastoral well, has observed rapid changes over the course of its history of about three generations (100 years). Founded in 1914 by Ibilite, a highly respected marabout from Abalak, the village was designated near a pastoral well and (based on the memories of participants) possessed a small forest, lush valley, permanent lake, and many wild fauna such as hyenas, warthogs, hares and antelope. In the years following the village's establishment, the French promoted cotton production in the valley and formerly pastoral villagers planted red sorghum, sweet potato, tomatoes, manioc, and calabash. A school was established in 1948, and the village steadily grew in size. By 1971, another hamlet was established, due to the staunch resolve and political connections of the losing candidate. Yet, by this time, too, much of the valley was desiccated (Figure 5.3), the fallow fields were all occupied, and the village grew only millet. The only forested areas observed were planted during the tenure of the Ader-Doutchi-Maggia rural development project (1984-2009), which planted over 20 million trees during its tenure throughout the Keita department. Now, and since the 1980s, people take out everything from their fields, even the residues that used to benefit the fertility of the soil through decomposition. Twenty-six unique plant (tree and grasses) species cited in Tamashaq and nineteen of those cited in Hausa or Fulfulde from the Keita region have disappeared from the zone (Annex 4). Today, the plant that gave the village its namesake is no longer found in the vicinity of the village.

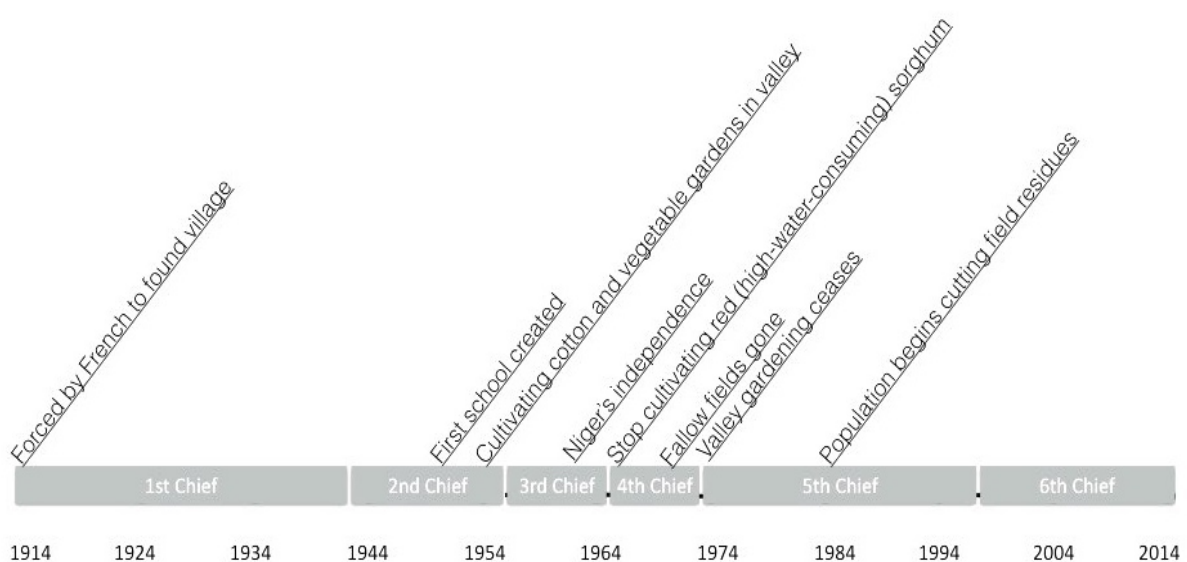


Figure 5.4 Example of historical timeline for Locale AP in Keita.

In Madaoua department, Locale A has been in existence since about the 1940s. Originally, it was named for the Tuareg inhabitants, but during the presidency of Mahamane Ousmane (1993-1996), the Hausa inhabitants named the village after their first chief. As more Tuareg began settling in the valleys in the 1940s, their Hausa neighbors in Nigeria decided to designate the territories for themselves. As a result, the Tuareg were pushed to the hillsides (dunes), and the Hausa claimed the valley. Early settlers saw many different species of wild animals such as antelopes, lions, hares, and hyenas, all of which have now disappeared, along with many tree and grass species. The water in the valley used to be permanent (year-round) and there were also at this time many fish. The valley lake began to dry up about 10 years ago, and no fish have been seen since this time, despite the return of permanent water, in which today they grow some vegetables (tomatoes) and legumes (cow pea). Where there are now dunes, the surrounding area was a forest, all of which is now cultivated.

5.4 Results 2a: Perspectives regarding the use of and changes to ecosystem services

5.4.1 Regulating: Climate and soil

The majority of respondents observe the increasing rarity of rainfall. Generally, the main tradeoffs agro-pastoralists and pastoralists refer to in relation the changes in climate are the impacts to their production systems, both of which are directly dependent upon rainfall. Changes relevant to rainfall shifts include the choices of crops or the composition of livestock produced and spatial distribution or the loss (due to heat, lack of rain) of trees, which is perceived to impact greatly the biodiversity and distribution of species, though this opinion was more often held by sedentary groups. Both rural stakeholders expressed that there exists a distinct relationship between losses to multiple ecosystem services and degradation patterns. The causal mechanism of deforestation, for instance was linked to the mediation of flows including the loss of soil-water infiltration to foster ground water and reduce sedimentation and the loss of stabilization observed in the development of quarries in Keita and losses to crop and fodder production due to flooding. Interestingly, fewer agro-pastoralists noticed changes to wind and heat, and seemed to 'blame' the ecological shifts on rainfall, negating any responsibility of human production patterns. Pastoralists, similarly explained that the lack of rain was cause for ecological change, and cited more specific ecosystem services that were lost, such as provisioning materials due to losses in biodiversity, patchy grasslands that sometimes fail to reach fruition in their production cycles, and unanimously that these

are the causes for consequential losses to the cultural and provisioning services derived from their domestic animals (and for some, a total loss of their herds). As described by a pastoralist participant, rainfall in past times covered the surface, and now rain falls infrequently, covering only part of the surface and leaving the rest. “Yes, there was a change [in rainfall]. I don’t know if peoples’ sins provoked it or not... In the rainy season now, it is difficult to get two good rains. It is impossible to have five good, successive rains. There is a bad distribution of rainfall that provokes the degradation of the pasture before it ripens” (P2:6). This variability has been confirmed by other studies as well (Giannini et al. 2013).

Genetic biota used for cultural and provisioning purposes in Locale A have either disappeared or been drastically reduced according to the accounts of the most senior villagers, who were estimated between 80 and 100 years old. Along with wild animal species, many trees and grasses are no longer available for weaving, traditional medicines, and harvesting for food or construction. There are thirty-three unique species cited in the Hausa language and thirteen unique species in other languages (Tamashaq and Fulfulde) that have now disappeared in Locale A alone (Annex 4). These changes seemed to be attributed to the loss of fallows or ‘bush,’ which was no longer available after the late 1990s. Illness and malnutrition were related to these losses to biodiversity. Women in Locale AP mentioned that there are more illnesses in the present time than before, partly because the plants they used to treat disease are no longer available and also due to the lack of milk. As stated by a woman in Locale AP, “Yes, there [are more illnesses now], but this is because before, when someone falls ill, we treat him with traditional medicine and he is healed... but, now, these medicines have disappeared” (P45:4).

Nomadic people are required to have a strong and detailed understanding of their environment (Warren 2005; Baena 2010) in order to best manage their commonly shared rangelands in effective and productive ways. Changes in rainfall coupled with the increasing influx of commercial herds (Raynaut 2001) has promoted the disappearance of many essential and nutritious grass and tree species for grazers and browsers, resulting in low milk production for camels, goats, and especially cows. Three species of grass (*Addag*, *Tamaselt*, and *Tikinit* - Tamashaq names, see also Annex 4) that are nutritious for livestock (repeatedly mentioned by pastoralists) have disappeared from the pastoral zone of Niger. Much of the pasture is now dominated by *kram kram* (*Cenchrus biflorus*) and an unwanted herb that is locally called *sida* growing more readily in the zone (Afane

2014). Pastoral participants also observed a loss of traditional medicines, due to the lack of the former biota. This reflects a similar loss of cultural knowledge that cannot be passed onto the coming generations. Pastoralists, while recognizing the role of increasing numbers of livestock in the pastoral zone in the losses to fodder, state that profiteering woodcutters have penetrated the zone to harvest fuel wood. Pastoralists utilizing important pastoral tree species for their goats and camels also would cut branches to feed livestock when the grass is gone, yet not kill the entire tree. Wood sellers are aware of the laws protecting the forests, which also permit them to collect 'dead wood' for sale. As a result, sedentary agro-pastoralists will cut key tree roots to induce collapse, often 'branding live trees until it dies, relieving themselves of the need for permits. While both pastoralists and agro-pastoralists cope with drought through the collection and sale of wood, this activity has been forbidden by local stakeholder in some commonly shared pastoral areas, according to respondents. Yet, others see the zone as un-manageable.

Participants draw clear linkages between the loss of forest, the changes to rainfall, the increasing wind, and the degradation of soil (Table 5.1, Figure 5.4). "The rain reduced when the number of trees reduced" (P19:4, Locale A). "If no rain, then there is no production. Because of the lack of rain, there isn't much usage in the soil" (P39: 1, Locale A). These also were understood by many as causes of the encroachment of the desert or desertification. A pastoralist in Tillia stated, "What has changed is the wind. Now, there is a lot of wind during the whole year, every season of the year. And when it comes, it destroys the pasture. It carries away the grass... Before, there was a specific period for this wind [Harmattan], but now the forests have disappeared" (P6:7). Another reason for loss of ecosystem services provided by forests is related to 'sales' of permits by the forest guards. Agro-pastoralists are more often accused of participating in this practice, and during the field interviews often avoid admitting that humans were the cause of the loss of forests. "Yes, there are people who cut [trees], but generally, it is the trees [themselves] that are dead. There are trees such as [Hausa names] *kuka*, *daboudi*, *diya*, all of these have disappeared because of the heat" (P18:10). These responses reflect the practices of branding and removal of 'dead' trees, as well as the observation that heat and rainfall changes promote tree die-offs. Only a few agro-pastoralists admit that humans cause forest loss. "The women cut them and men will sell them. We killed the trees" (P34:6). Agro-pastoralists pointed out that the lack of wood in the village areas pushes many to burn field residues to cook. Or, it is necessary to travel very far to seek

out fuel wood. In Locale AP, the people remarked how the loss of trees is what exacerbated the problems with the formation of a quarry and soil erosion.

5.4.2 Provisioning: Conflicting modes of production

In relation to crop production, soil infertility frames the adaptations and coping mechanisms for agro-pastoralists. These have evolved from managing a system of fallow lands to the collection of nearly all the fibers from their fields (crop residues, grasses), the latter of which has greatly reduced the organic material, decomposition, and stabilization of the soil. Some agro-pastoralists still find a pastoralist camp in the fields for purposes of fertilization or collect animal dung themselves from their livestock, especially due to the unavailability of artificial fertilizers. People primarily perceive that the reasons for the reduction of production are the rainfall variability and the degradation of soil. An average polygamous household needs about 20-30 bundles (one bundle is the equivalent of 12 to 18 kilos) of millet per month, but very few of the households we spoke with received this from their fields, even during high rainfall years. When agro-pastoral participants spoke about the past production and current production, there were vast differences. "The land was flourishing; the fields were very fertile. The water flowed easily to feed the fields. We even were cultivating sweet potatoes, tomatoes, manioc, and we made calabashes... But, unfortunately the quarries stop water infiltration, and no matter what size of field you have, it is exposed to the risk of drought" (P30, Locale AP chef du village). To compensate for the loss of production, many households explained their heavy reliance upon their livestock to purchase grain or food.

Similar to soil degradation, the as the pastoral and fodder production are degraded, other services (climate regulation, soil stability and formation, seed dispersal, biodiversity, Table 5.1) are duly reduced. During drought, the lack of ecosystem services is most greatly felt resulting in greater losses to livestock during drought for most of those participating. During the recent drought (2010), five pastoralists lost more than fifty heads of livestock; seven lost more than twenty. Twenty-four out of a total of forty-four pastoralists people believe that they or their children will completely abandon pastoral livelihoods. As both a cause and a contradictory factor, there are more livestock utilizing the pastoral space than before, a factor that caused five pastoralists to state the carrying capacity of the system has been surpassed. To respond to the reduction of pasture, the majority of pastoralists (30) and even a few agro-pastoralists (7) purchase hay and grasses. Many agro-pastoralists have made the selling of hay and field residues a prominent part of

their livelihood. Yet, the collection and sale of grasses is dichotomously a cause of the reduction of grasslands and fodder.

Local Perceptions of livelihood impacts resulting from ecosystem changes in the SES		
Ecosystem change	User: Pastoralists (# of respondents)	User: Agro-pastoralists (# of respondents)
Irregularity of climate and rainfall	Pasture reduces (28) Losses to biodiversity (18) Rainfall variability (10) Seasonal lakes disappeared (10) More wind (6) Soil degradation (5) Seasonal lakes dry more quickly (5) Floods (2)	Losses to biodiversity (20) Crop production reduced (18) Soil degradation (16) More wind (12) Quarries form (water erosion) (9) Rainfall variability (6) Pasture reduced (6) Dispersed fields (5) Floods (3)
Losses of biodiversity	Healthy species for livestock disappeared (7) Animals are not as healthy (6) No more traditional medicine (3) Species for weaving lost (1) No more wild animals (1)	No more wild animals (6) Household not as healthy (5) No more traditional medicine (1) Species for weaving lost (1) Less fruit to collect (1) No more fish (1)
Soil degradation	Losses to biodiversity (18) Herder contract: field fertilization (4) Crop production reduced (3) Fields dispersed (1) Cultivate pastoral areas (1) Using artificial fertilizers (1)	Losses to biodiversity (20) Crop production reduced (18) Using artificial fertilizers (10) Herder contract: field fertilization (8) Fields dispersed (5) Loss of fallow fields (5) Need more fields for same production (2)
Loss of forest cover	Losses to biodiversity (18) Lack of rain (17) More wind (6) Soil degradation (5) No traditional medicines (4) Sedimentation of lakes (2)	Lack of rain (27) Losses to biodiversity (20) Soil degradation (16) More wind (12) Formation of quarry (9) Sedimentation of lakes (2) More difficult to find wood (2)
Loss of fodder	Must buy hay and field residues (30) Will abandon pastoral livelihoods (21) Losses to biodiversity (18) Livestock losses (+20 heads) (12) Healthy species for livestock disappeared (7) Animals are not as healthy (6) Milk production decreased (3)	Now more livestock damaging crops (19) Must buy hay and field residues (7) Loss of fallow fields (5) Milk production decreased (4)

Loss of crop production	Crop damage payments (14) Population increase (land demand) (11) Fields spreading into pastoral space (9) Sell field residues (4) Herders fertilize fields (4)	Sell field residues (16) Crop damage payments (11) Population increase (land demand) (9) Herders fertilize fields (8) Artificial fertilizers (8) Fields spreading into pastoral space (6) Need more fields for same production (2) Insects (1)
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Table 5.1 Summary of perceptions of changes to the SES in Tahoua.

5.5 Results 2b: Differential degradation of pastoral and agro-pastoral ecosystem services

This section analyses local perspectives of degradation to the seven ecosystem services (food crops, grassland/fodder, biodiversity of biomass, fuel wood, soil formation and composition, soil stabilization, and climate regulation). Local participants perceive that the loss of forest cover was a shock to the Sahel-Saharan region of Tahoua, promoting the eventual formation of dunes, sediment filling seasonal lakes, broadening of gullies, and wind and water erosion of fertile soils. Degradation of the landscape is attributable to multiple factors: rainfall variability, drought, desertification, overgrazing, spreading cultivation, other forms of land use change and how they are experienced by local users (both pastoralists and agro-pastoralists). Land clearance in the zone, has duly modified the soil properties and infiltration capacity, leading to increases in Hortonian runoff (the amount of water on the surface exceed the infiltration rates of the soil) in numerous gullies and ponds, which has been calculated as a 2.5-fold increase of drainage density and the development of new ponds (Leblanc et al 2008). Participants in this study confirmed examples of lakes that have appeared or increased in size over the course of the past 40 years. Such lakes are increasingly becoming enclosed by cultivation, blocking not only livestock but also other groups from using the water for multiple activities: brick making, livestock, gardening, household needs.

While past research (Grainger 1983; FAO 1986; UNEP 1992; cited in Warren, 1995), has blamed grazing livestock as the primary cause for degradation of grasslands in the Sahel, these presumptions have since been attributed to political and development models (Warren 2005) as opposed to sound scientific practice. Pastoralists shift their practices along with the shifts in rainfall and pasture availability, through their mobile patterns and herd size and composition. Despite past criticisms, pastoral livelihoods have the potential to support the maintenance of multiple ecosystem services in drylands. The following section explores the dynamics related to losses of wood and fodder provisioning through alternate perspectives of pastoral and agro-pastoral users (Table 5.2).

Q: What has caused the degradation of ecosystem services?		
ES Change	Pastoral Perspectives	Agro-pastoral Perspectives
Loss of Forest	Cut for cultivation (9) Cut wood to sell (4) Drought (2) Forest service is complicit (1) Climate/heat killed trees (1)	Fuel for cooking (6) Sell wood (3) Building houses (2) Drought (1) Forest service is complicit (1) Climate/heat killed the trees (1)
Loss of Pasture	Cultivation of land (14) Collection/sale of pasture/hay (6) Too many herders, livestock (3) No laws protecting pasture (2) Sin, God (2)	Collect/sale of hay/pasture (4) Spreading of fields (1)

Table 5.2 Perceptions of both users of the causes for changes to the SES.

5.5.1 The process of deforestation and the loss of related services

The loss of forest cover has disturbed many aspects of the SES in Tahoua - soil degradation, wind and water erosion, losses to biodiversity, and more. From the pastoral zone to the highly concentrated cultivation zones of the South, forests are continually under high pressure from local populations that use them for their fodder, stabilizing properties, food, medicine, building materials, or to obtain cash through sale. Due to a speech by President Kuncé in 1974 entitled 'the land to the tiller,' it is broadly accepted that cutting trees and cultivating is the norm for land tenure acquisition, and this has been upheld also in legislation (Chapter 7). This is also the time period when respondents started using fertilizers (20 years ago (p23), 20 years ago (p40), and since 1974 (40 years P52). Respondents from all three regions remarked about the vast changes to the landscape since the period between the 1984 drought and the early 1990s. The cutting, burning (sometimes) and cultivating practices are related to losses to biodiversity, which has changed dramatically based on the cited losses of species.

"Before, there were many goods in the bush, no fields. In this time, it was only herders here. The farmers destroyed everything by cutting trees to make fields. And they forced us to leave the land. Everything became fields... Now, we understand also that we must have land to survive" (Locale AP, pastoralist, P66).

Cultivating groups are often accused of being the primary group destroying the forests. Wood has become an important commercial product, promoting greater losses to forests. Pastoral groups mentioned the importance of trees, as providing consistent fodder to browsing species.

“The one who is looking for money, they go and cut trees and look for food with the money from trees, because trees are like gold now. [Pastoralists cut the trees], but we cut [only] the branches, not all of it. Then the goats can eat. [Ziziphus mauritiana] we cut it but a little. Also we are afraid of the forest rangers” (Locale A, pastoralist, P37).

The forestry department officials are often accused of blatantly ignoring illegal woodcutting or certifying it by signing permits without heed to ecosystem impacts. Yet, while woodcutting is prohibited without proper permits, the ‘land to the tiller’ concept remains the dominant normative concept of land tenure. As a result, permits are rarely sought and wood is cut with impunity.

“The only thing that we can do is to find a space where there are trees and [cut] them in order to find a space for our children to cultivate. Then, they can one day claim that space and it will belong to them naturally following the law. This is how all the space that you see here where I am presently living just until the hill became the property of my late father, and by consequence I inherited from him” (Locale AP, agro-pastoralist, P52).

Despite this strong linkage between woodcutting and land tenure, vegetation recovery has been sparsely observed in certain areas of Niger where farmers have taken up agro-forestry practices (Redj 2005) or projects have initiated reforestation programs (DiVecchia 2007). However, such practices have not been widely adopted despite the benefits (increases in agricultural yields and greater livelihood security during drought), and the slight increases in rainfall observed in recent decades have not been sufficient to counteract the forces human-induced land and soil degradation. New analyses of vegetation growth estimated using remote sensing and rainfall data for a timescale of 1982 to 2006 suggest that land degradation has impacted over 50% of the Sahel (Shepherd 2006). “After the rain, they cut down everything. Those who cut sold everything. They sold the trees. Before, one field would be enough for the family, now it is not enough for the same number of people” (Fulani pastoralist, P36:5).

Image 5.1 Clearing and Reforesting

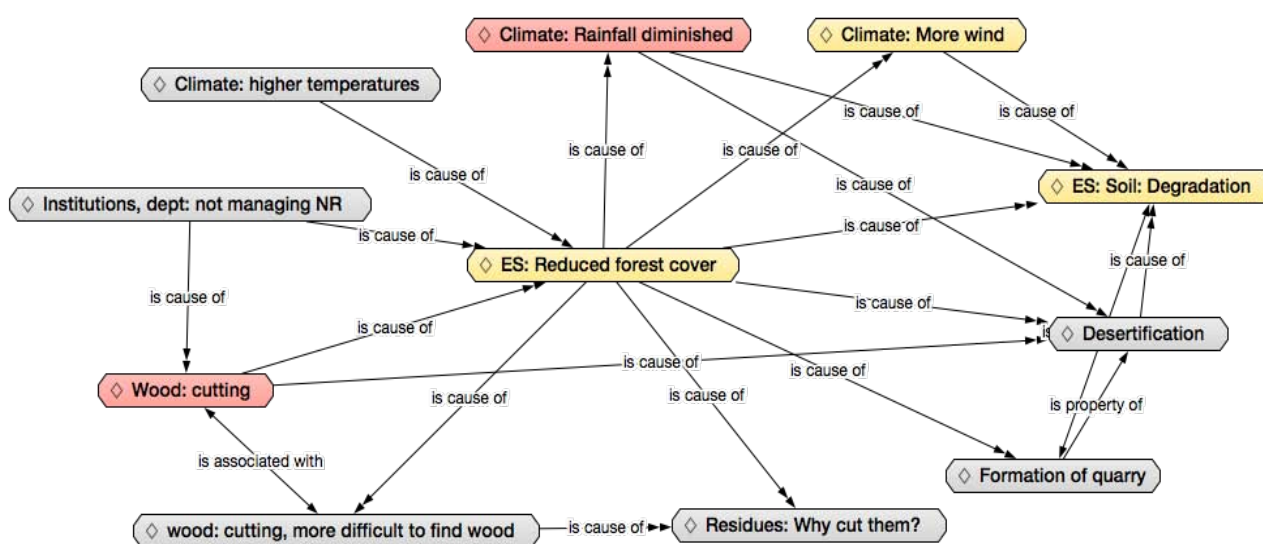


(left) Illela, Niger. Farmer illegally cuts trees to clear his fields. (right) Keita, Niger. An Italian project reforested vast areas of the department of Keita. (photos by Author, June 2011).

5.5.2 The cultivation of pasture and the loss of related services

Through our conversations, individuals most often spoke about the key changes to ecosystems that most affected their livelihoods, namely the reduction of pastoral space (loss of fodder) or crop production (loss of food). While both of these provisioning ecosystem services were perceived to be promoted and produced by diminishing rainfall (30+ similar responses), each service had an opposite causal relationship with the degradation of soil fertility (Figure 5.5). Pastoralists contextualized the discussion of soil infertility as being caused by cultivation and the loss of pastoral space. To these users, the process of cultivation ‘makes the soil red’ (P14). Others speak about

Figure 5.5 Linkages between deforestation and other services, amplifiers, or mitigation processes.



Produced with AtlasTi software, each hub is a code. Red codes have more than 30 quotations, yellow have between 10 and 30, grey have 0 to 10. The direction of the arrows represents the type of relationship (causal, association, and part of the process).

the loss of pasture that has impoverished the soil (P26). Many pastoralists speak about how the cutting and removal of field residues has 'brought problems for livestock and the fields,' (P34), referring to the loss of decomposition of plant matter and fertilization by the livestock.

"Before, if people harvest, they don't take the residues, they leave them [sic]. Now, people take everything out. And the animals don't have anything to eat. This has brought problems for both the fields and the animals. Also, now there are many fields. And they don't produce like before. And there is no more bush. Before, the fields produced well; there was albarka (blessing). For one family, if the harvest was good, then a huge granary would be necessary. Now, if you want the same production, you need four fields to produce the same as the field before." (P34, Keita pastoralist)

Similar to this pastoralist, cultivators also referred to the soil as having greater 'albarka' in times past and referred to the immense shifts in production from times before to today (a 50 to 100% change in production from similarly sized fields, according to the combined statements). Other agro-pastoralists state simply that 'the soil is tired.' More often, linkages are made between the amount of rainfall and the soil fertility (Keita, P45), sometimes this is also linked to poor production. The lack of water infiltration is observed in Keita, where water erodes the hillsides into ravines and quarries (P46, 48). Many make links to a time in the past 'when there were trees' being the time when soil fertility was greater. Several people refer to phrases in the Qu'ran of the end of the world resembling the loss of soil fertility (the years when the land will no longer benefit man, P55).

Interestingly, despite the high population growth rates in Niger (4%), only nine respondents referred to population growth in the conversations about changes to the ecosystems, and most referred to the restriction of cultivable land. Population growth is perceived to have contributed to higher land prices, due to the great demand for cultivable plots, which in turn has exacerbated the losses of pastoral space to cultivation. Land is perceived by most as an investment, and sedentary farmers conserve plots of land more than other household assets during a crisis. "Q: Can you explain how did this space disappear? A: The people were too many. People came and took land. Everyone did it." (P19, Madaoua agro-pastoralist). Expansion of cultivation is not due merely to population growth and land markets, but also to ecological and climatic changes. Fields are dispersed across the landscape, which makes for a reduction of pastoral and fallow land. "[Referring

to the advantages of separated fields] Yes, [it is advantageous] because sometimes the land doesn't have the same production and then the fields can give different quantities, or it could be that there is a field where the water [flood] destroys everything" (P17, Madaoua Agro-pastoralist).

All the respondents, especially those in the southern locales, shared the perceptions of land and soil degradation. By 1989, people began to observe that farmers no longer left their residues in their fields to decompose (and regenerate soil organic matter) or be consumed by passing livestock. By the 1990s, pastoralists were becoming increasingly sedentary. Many respondents pointed out that they would leave behind pastoralism due to the difficulties (21 participants). Harvests have decreased significantly in the past 20 years, mostly due to a lack of organic matter in the soil, which would in turn increase soil water capacity. While these changes have been discussed in past research on the Sahel, few take into account the impact of removing farming residues has had on the ability to access ecosystem services on landscape.

"Yes, the farmers restrict the pastoralists. The village destroys even the parking areas for livestock. They destroy the forest also and occupied the space that was destined for pasture. And, after the harvest, they even take out the residues and hay" (Locale A, P67).

The commercialization of residues has also impacted the mobility of pastoralists. As explained by a KelGeres Tuareg in the AP Locale:

"The herder is always asked to stop his animals in a small space until the fields are cleared... There isn't pasture on the mountain. The only choice is to eat the trees available or go to market and buy pasture. This is the drought created by man!" (Keita pastoralist, P71).

Though some refuse and cause violent conflicts, herders typically are forced to wait in villages where they have kin or designated 'parking areas' (spaces specifically reserved for pastoralists to rest), sometimes promoting degradation in this waiting space. Drought, according to some participants is caused by the destruction of pasture and the removal of all the farming residues from the fields after the harvest (P67, P36, P15, P19, P71), both of which represent symbolic enclosures of formerly common-shared ecosystem services, especially pasture (Table 5.3).

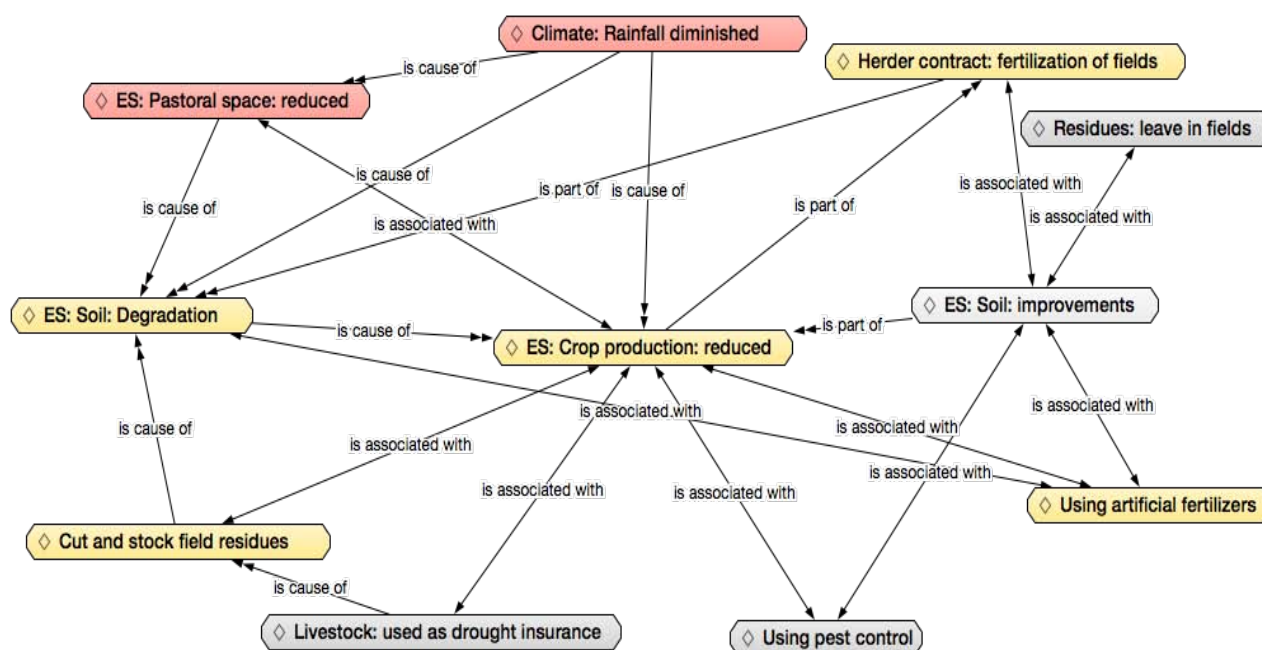
Table 5.3 Perceptions of pasture

Q: Why has the pasture diminished?	Locale P	Locale AP		Locale A	
	All Ps	Ps	APs	Ps	APs
Insufficient pasture/fallow space	10	10	3	9	4
Rainfall is not successive or abundant enough	4	2	0	1	0
Enclosed by cultivation and payment for entry	N/R	5	0	N/R	N/R
People gather and sell hay or field residues from commons	2	3	0	2	1
Cultivation	1	5	3	3	1
People cut trees	N/R	N/R	N/R	4	0
Too many livestock exploiting pasture	5	N/R	N/R	N/R	N/R
God/Allah as cause for changes	1	N/R	N/R	N/R	N/R

The responses and their frequency is presented here. Frequency is not indicative of the importance of the response, given the qualitative nature of the data collection. N/R = no responses.

Sedentary participants often stated that rainfall or food insecurity were their biggest threat to their livelihoods; pastoralists overwhelmingly stated that the one and only challenge is availability of water. Most spoke expressed nostalgia about the services available in the ecosystems in past years. The most common statements made were related to rainfall variability, losses of forest cover, losses of pasture, and losses of biodiversity (Table 5.1).

Figure 5.6 Linkages between the reduction of crop production and other SES processes.



Produced with AtlasTi software, each hub is a code. Red codes have more than 30 quotations, yellow have between 10 and 30, grey have 0 to 10. The direction of the arrows represents the type of relationship (causal, association, and part of the process).

5.6 Results 3: Future outlooks on climate and ecosystem change

5.6.1 Unanimous agreement that the future is agro-pastoralism

There was no doubt amongst the participants in the scenario focus group (SFG) that climate change events would continue unabated, which eliminated the need to discuss the A and C scenarios, which were for a status quo hydro-climate situation (Figure 5.2). As stated by one participant (P53-SFG), “We must not forget because climate change will impact the pastoral and agricultural zones and we must take into account population growth, because we are multiplying. We are obliged to have defined areas and obliged to think about where will have to be put. The pastoral zone will dwindle.” This statement also reflects the dominant model of state-controlled development, which is prevalent throughout the data gathered.

Livestock provide the second largest income for Niger, (after only uranium) and make up 30% of the GDP (World Bank 2005). The majority of livestock rely on transhumance for productivity (Zakara, 2007), despite the degradation to this SES. Moreover, pastoralists hold great power over local markets, and can ‘boycott’ a local market in order to protest an unjust administrative deci-

sion (tax, land tenure changes, etc.) that impacts pastoralism. Yet, these solidarity-based revolts are too often being replaced by small-scale, violent protests between individuals of farming and herder groups, related to divergent adaptation (Snorek et al. 2014). This conflict is evolving in direct relation to the enclosure of pastoral ecosystem services, which replace pastoral values and ecosystem service with agricultural values and ecosystem services (Chapter 6). Pastoralists, who possess a strong comprehension of the land and ecology of place, are losing their main livelihood of milk and meat production and shifting to sedentary livelihoods. This has implications for the future of pastoralism, but also for the viability of the entire ecosystem in northern and southern Tahoua, as shown by the linkages between services in the above section. Table 5.4 summarizes the impacts and adaptations that participants perceive will be the outcome of the two scenarios we examined.

Table 5.4 Summary of responses from the scenario focus group participants.

Summary of responses from Scenario Focus Group (B and D scenarios)				
Scenario B: Increase in drought/flood events with no change in the loss of pastoral space			Scenario D: More frequent drought/flood events coupled with a preservation of pastoral space	
Actor	SES Impacts	Adaptations	SES Impacts	Adaptations
Pastoralists (P)	Loss of livestock	Transformation of Ps to APs	Loss of livestock	Destocking
	Land/soil degradation	Increased price of land holdings	Land/soil degradation	New land regimes/management
	Less livestock mobility	Intensification of animal husbandry	Heavier enforcement of crop damage	Changing transhumance itineraries
	Loss of local knowledge of the land	Re-distribution of the pastoral areas	Increases in #s of livestock/Overgrazing	Appropriation of water points
	Transformation of lifestyle and culture	Changes to animal husbandry	Growth in pastoral activities	Expansion of pastoral water points
	Less water availability	Water points enclosed		Re-composition of livestock
	Loss of biodiversity	Re-composition of livestock		
	Loss of activities supplemental to livestock rearing	Restructuring of pastoral spaces		
		Changing transhumance itineraries		

Agro-pastoralists (AP)	Reduced Ag production	Agro-pastoralism as an adaptation	Reduced Ag production	
	Unemployment of shepherds	Shift in practice of activities		
	More commercial livestock producers	Fodder cultivation		
Agriculturalists (A)	Desertification	Conversion to agro-pastoralism	Decrease of agricultural productivity	A development of irrigated crops
	Decrease in production	Monetization of crop residues	Change in cultivating practices	Monetization of crop residues
	Economic migration	Adoption of irrigation practices	Decrease in accessible water resources	A change in eating habits
	Outbreak of new diseases linked to climate change	Migration in search of land for settlement	Stagnation of the conversion of space	Selling livestock
	Migration in search of land		Development of the land market; land speculation	Adaptation of improved varieties Development of a land market Sale of manure

In these scenarios, there will be a massive conversion of pastoralists to agro-pastoralism, which at first causes conflict related to the increased demand for land holdings and water access as well as past causes such as crop damage by livestock. This culture/value change will induce a loss of indigenous knowledge and natural resource management that is inherent in the pastoral lifestyle. Livestock limited in its mobility faces greater risk of disease and decreasing value. Furthermore, with the sedentarization of pastoralists there will be greater scarcity of land, a loss of milk, meat, and crafts, and changes in livestock itineraries. The increased commercial valuation of land may also produce an amelioration of land use including irrigation, fertilization of soils, and agro-forestry. Furthermore, those with land will capitalize on livestock production, intensifying this practice through the commercialization of fodder and grasses.

As one participant (P78 SFG) said, “Now with the disappearance of the pastoral zone, I believe everything will become an agricultural zone. That is why we said collaboration of both activities pastoralists and farmers, will co-exist, will find solutions between themselves and reduce land based conflicts.” While pastoral leaders in the focus group observed strong social capital between pastoral users, this was confirmed only in one one the three case study areas (Chapter 7). “What

has to be said is that farmers nowadays are reinvesting in livestock producing as a bank (...). One should not consider pastoralism only as pastoralism because it is also a source of investment and of capitalization. Therefore, there is a vulnerability of the system which has a consequence on the whole chain" (P110 SFG). With the loss of pastoralists, the rural investment 'bank' is similarly at risk, as are the cultural ties that secure farmer-herder relationships.

5.6.2 Recommendations from the SFG supporting sustainable adaptation of livelihoods

At the close of the SFG, participants devised recommendations of how to avoid the worst case scenario. The first and primary objective to prepare Niger for such scenarios as described above is a continuation of rural development, with a focus on strengthening education and governmental capacity. As stated by participants, the Rural Code was implemented with the aim of establishing a juridical framework for agricultural, silvi-cultural and pastoral activities in the perspective of territorial management, environmental protection, and support of inhabitants. It is carried out in accordance with the decentralization process that the country has been undergoing, which sometimes has confused the lines of jurisdiction between the customary and administrative powers (Chapter 7). The Code assures the security of rural producers through the recognition of their rights to land tenure and water and pasture access; thus it facilitates development through the rational organization of the rural world (SPCR 2006). The text guides all agricultural and pastoral activities, natural resource management, and property regimes and has attempted to meld the modern and customary systems of natural resource management.

Participants agreed that what would improve and secure the current pastoral system is not the development of new institutions, laws, and programs, but the enactment of the current Rural Code, with a stronger focus on reducing divergent adaptations (Table 5). The laws on pastoralism is not at present sufficiently disseminated and explained to pastoral communities by government authorities (though some pastoral associations and NGOs take on this role). Furthermore, it is necessary to create synergies and communication between the various governing bodies (pastoralist cooperatives, administrators, customary officials, lawmakers) to avoid 'reinventing the wheel' when a new administration takes office. Most importantly, there needs to be a broad enforcement of the current laws. Small conflicts are amplified by the simple confusion that arises from too many diverse methods for law enforcement. Both customary and democratically elected officials must be well versed in the Rural Code and should follow it to the letter.

Table 5.5 Institutions that will prevent divergent adaptations during livelihood transitions.

Adaptation	Institutions
De-stocking/ Amplify Mo- bility	State and pastoral associations
	Customary authorities
	Non-governmental organizations
	Administrators
	Veterinary Service
Improved water access	Hydraulic Service
	Technical Service (supported by Rural Code)
	Administrators
Transitioning to Agro- pastoralism	Customary officials
	Administrators
	Land Commissions
	Veterinary Service
	Media
	Research and Education

5.7 Discussion and conclusions

This chapter has explored the relationship between divergent adaptations and tradeoffs in ecosystem services. There is greater adaptive capacity in an SES when the diversity of multiple ecosystem services remains intact (Adger 2006; Fabricius et al. 2007; Foley et al. 2005; Shiva 1997). This chapter contributes to this discussion of ecosystem services by analyzing the diverse and conflicting perspectives of multiple users. Divergent adaptations, which can produce conflict in and SES have been one causal factor creating unequal degradation of ecosystems. For instance, pastoral groups in Tahoua have experienced significant losses to a highly valued ecosystem service – pasture (fodder) production. Perspectives of causes linked to this shift in productive pasture systems stem vary from climatic to human-induced destruction of pastoral resources. Yet, overall, the divergent adaptation of cultivating pastoral spaces, which is concurrently related to provisioning food production services, is perceived to have caused high levels of pasture degradation. Thus, divergent adaptation tends to promote unequal degradation of ecosystem services between users and monocultures, primarily through attempts by users to capture and control the productive uses of ecosystems (wood, water, fodder, crops). The resulting unequal adaptive capacities are relevant to conflict and cooperation dynamics.

Reasoning along the lines of sustainable adaptations and promoting of multiple ecosystem services in a changing SES, the model moving forward for Niger does not support the reduction of poverty either for agro-pastoralists or for pastoralists. Strong institutional shifts will be necessary

to manage the on-going loss of pastoralism, as there are concurrently cultural implications. A focus on diversity of services, ideas, and development paradigms (Folke 2008) will increase the potential to support more sustainable climate change adaptation and reduce divergent adaptations. While not the purpose of this chapter, if a mechanism of payments for ecosystem services were to be established in Niger, it would make sense that high payments were received for livestock production and, depending on the management of pasture, its multiple services (fodder production, biodiversity, and soil conservation), due to what was revealed in this study as regards its mutual benefits across multiple ecosystem services. Yet, the current development models are still focused on supporting agricultural practices, despite their proven detrimental properties for a fragile arid ecosystem. The tradeoffs from a model supporting agriculture include the other five ecosystem services studied in this chapter, whereas pastoral production systems tend to produce more synergies with services such as biodiversity, forest maintenance, and fodder production when these services are managed within a common pool regime system (Chapter 7).

Furthermore, the reasons for the multiple tradeoffs stemming from agriculture production systems are related to the impunity of some sedentary groups. While measures are in place (Chapter 7) to protect many of the commonly shared ecosystem services (Chapter 7), these are not being enforced, contributing to tradeoffs that also impinge upon the success of agricultural systems, namely soil loss and degradation. Thus, by changing the paradigm that 'valued space' is cultivated space and by creating more boundaries to protect common pastoral space, these measures will better enhance agro and pastoral ecological services including those that promote the protection of soil and reduce the impacts of climate hazards. Multiple users in the SES could benefit from local ecosystems and the conflicting elements of divergent adaptation would be reduced.

Based on a focus group discussion of future climate change and land use land cover changes in Niger, more and greater numbers of pastoralists will be transforming their livelihoods and thus, the pastoral landscape into cultivated plots. Cultivation, however, is the one ecosystem producing the most tradeoffs with the other ecosystem services analyzed (fodder and wood production, biodiversity, climate regulation, and soil fertility). Thus, given these future outlooks, the changes to ecosystem services will most likely resemble the ecological changes observed in Locale AP in Keita, which showed gradual levels of deforestation due to population growth and the transformation of a formerly pastoral people to sedentary farmers (supported by the French colonial policies). Such

deforestation transformed the department's forested plateaus into cultivated fields, which in turn shifted the soil water properties and fertility due to increasing levels of runoff and formation of quarries. A broader phenomenon related to cultivation and sedentary livestock rearing - the commercialization of field residues - further exacerbates soil degradation. While some agro-pastoralists leave field residues in their fields for their livestock, many others sell them as a coping mechanism for a poor harvest due to drought and other related ecological changes. Thus, the impact of such divergent adaptations on this trajectory of increasing agro-pastoralism will be greater soil degradation coupled with lower yields, unless there are more local and national efforts for agro-forestry and soil conservation.

The examples of 'greening' in Niger discussed briefly in this chapter and more extensively in Chapter 3 provide some insight into what might be done to transform the current ecosystem service reducing practices. Divecchia et al. (2007) and Rossi (2009) discussed the massive efforts in the Keita region that promoted the regeneration of forest. Concurrently, despite many and numerous benefits resulting from the project, population increases stemming from the investments of the Ader-Doutchi-Maggia development work promoted the spread of cultivation even into areas that the project attempted to protect as pastoral space. In Maradi and Zinder, where natural regeneration was established and shared freely amongst farmers, the results have been more lasting and the 'greening' more spontaneous (Reij 2005). These agro-forestry practices and this type of implementation shed light on the potential for future work to maintain more equitable and sustainable adaptation.

Chapter 6: The production of contested landscapes: Enclosing the pastoral commons⁴

6.1 Introduction

6.1.1 Defining the contested landscape

Divergent adaptation (Snorek et al. 2014) describes how adaptation to climate change within a social-ecological system (SES) produces the potential for greater inequities, conflicts, and/or cooperation resulting from adaptation decisions. The term divergent adaptation is defined as those adaptations that promote the adaptive capacity of one individual/community in a shared ecosystem which leads to a reduced adaptive capacity of an alternative individual/community in the same ecosystem, and through this process, one can identify which users win or lose in adaptation, enhance adaptive capacity for marginalized groups, and promote equal adaptive capacity in the adaptation process (Snorek et al. 2014). Divergent adaptation is related to unsustainable forms of adaptation (Eriksen et al. 2011) and policies that have promoted land use conversion and/or sales that, in turn, dispossess small holders, reducing their adaptive capacity (Adger and Paavola 2006; Peluso and Lund 2011; Cotula 2012). The Inter-governmental Panel on Climate Change (IPCC)'s AR5 chapter on human security (Adger et al. 2014), as well as other literature highlights how adaptations can enhance inequalities, impact resilience and disrupt overall human security of an SES (Raleigh 2010; Eriksen et al. 2011; Kloos et al. 2013; Snorek et al. 2014).

Contested landscapes and how and why they are contested has been illustrated in previous research (Bender 1998; Robinson et al. 2009; Duinveld and Van Assche 2011). Socio-geographical spellings of landscape point to the impact of humans in altering the physical landscape (Birks et al. 1988). Historically, landscape is in effect a progressive debate amongst societies and cultures (Cosgrove 1984), which is expressed through man's adaptation of nature in the effort to satisfy his needs (Bryan 1931). Contested landscapes are shaped by multiple and contradictory discourses (Pollini 2010) as well as large-scale land use changes (Lukas 2014). To contribute to this discussion, we define 'landscape' as the physical and psychological manifestations of space, represented by social and ecological phenomena that can be described by observation. The significance of divergent adaptations on the landscape emerges in the manifestations of peoples' diverse relationships

⁴ Snorek, J., F. G Renaud and L Moser (*in review*) 'The production of contested landscapes: perceptions of changes to ecosystem services in Niger', submitted to Journal of Rural Studies Aug 10 2016.

with landscape, and how social, political, and economic factors influence this relationship and conflict dynamics (Cosgrove 1984; Robbins 2012).

The development and shifting of land tenure regimes is a malleable process that also shapes a contested landscape. A recent study in Ethiopia relates government sedentarization programs to changing property regimes and a scramble for land holdings in a formerly pastoral commonly shared landscape (Schmidt and Pearson 2016). FAO (2002) defines communal land tenure as a common space within a community wherein each member has a right to use the holdings independently, and for which the rights of users are defined by the community (cited in Herrera et al 2014). As common land resources become mapped into divisible, saleable space (Bender 1998), laws establishing property rights and the commoditization of parcels of the social ecological landscape promotes fractured and divided systems, which can be bought and sold for their relative benefits (Illich 1983). The transformation of commons to private property regimes (space possessing a definite assignment of property rights) encloses spaces and can essentially dispossesses some actors of their rights to the landscape, such as the division of the English landscapes and enclosure of common fields dispossessing English peasants (Barrell 1983; Bermingham 1986). Those who have lost their livelihoods through this process of enclosure can potentially fall into abject poverty and dependency on those who have taken it away (Goldsmith et al. 1992).

The process of moving from a common pool to private property regime produces a contested and disputed landscape (Cheria and Edwin 2011), which is highly relevant to adaptive capacity and divergent adaptation (Snorek et al. 2014). These processes of development have been exemplified also in adaptation processes (Eriksen et al. 2011). Like the 'poverty-reducing' sedentarization schemes in Ethiopia (Schmidt and Pearson 2016), divergent adaptations to climate events in Niger (Snorek et al. 2014) tend to exclude certain users, creating the potential for further marginalization and conflict. As we show through a case study in the de facto commonly shared regime in northern Niger, the dynamics of divergent adaptation can be visualized as 'inscriptions' on the landscape through remote sensing (Lukas 2014) where the context is sufficiently described upon the contested landscape (Robbins 2012).

6.1.2 Using geospatial analysis in a contested landscape

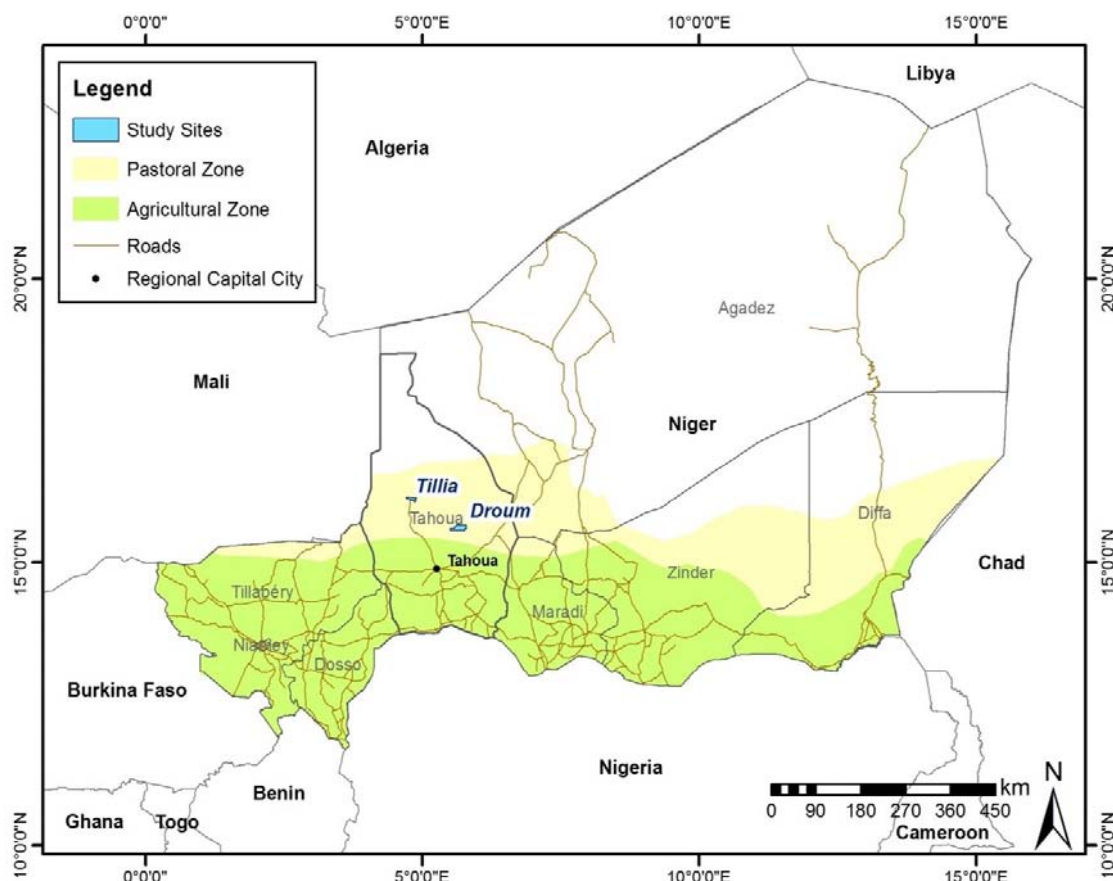
Deriving a correlation between geo-observed land use changes and conflicts at the landscape scale requires views from above and strong contextual understanding from below (Turner 2003). Medium to low spatial resolution remote sensing data (250 m - 4 km pixel size) enable the detection of trends and anomalies of remote-sensing derived indices or biophysical variables over large areas. Applications in the Sahel include studies on the dynamics of vegetation, land use, and land degradation (Dardel et al. 2014; Brandt et al. 2014a; Horion et al. 2014; Mbow et al. 2015), water bodies and wetlands (Moser et al. 2014) and precipitation (Nicholson 2005). Yet, this data is insufficient to elucidate more specific social-land use practices (Turner 2003), which are sometimes benefitted by the use of high to very high spatial resolution data (Elmqvist and Khatir 2007; Brandt et al. 2014b).

Analysis of linkages between social conflict and environmental change demands strong analysis of the social ecological landscape (Lukas 2014; Witmer 2015). Only a few recent remote sensing studies in Africa (Turner 2003; Akuwumi and Butler 2008) shed light on the discrepancies between the human interactions and the material needs versus the ecological realities. Integrating remote sensing and a critical socio-environmental science approach has enhanced the examination of social and ecological changes across a landscape (Nyerges and Green 2000; Turner 2003; Lukas 2014). Lukas (2014)'s approach examines land grabs by political elites and its relationship to soil erosion on hillsides, which in turn demonstrates how a contested landscape is 'inscribed' with human and environmental features that link back to historical conflicts. This approach provides multiple perspectives of land use and land cover change and permits a teleologically strong examination of the complexity of the struggle to maintain the commonly shared space in Niger (Turner 2003). Thus, this approach more effectively explains how a landscape may change based on the changing imaginaries of the communities living in that place. In divergent adaptation, these imaginaries might produce unequal adaptive capacities, as some users are effectively pushed off the land through enclosure. Stemming from the theoretical underpinnings of divergent adaptation and its consequential cooperation and conflict dynamics, this paper presents a case study of a contested social ecological landscape in the pastoral zone of northern Niger (Figure 6.1). The study shows how inscriptions are manifested as enclosure of common pool water resources, as well as how they can be analyzed through geospatial information and be related to long-standing natural resource access conflicts. Furthermore, it shows how such conflicts are, in turn, heavily influenced

by the modes of adaptation that produce winners and losers, especially in the context of drought or other extreme climate events. In this way, the chapter exemplifies how, when examined from the scope of these inscriptions, a combined political ecology and remote sensing approach can explain divergent adaptations (Snorek et al. 2014).

The paper is organized as follows: The following section 6.2 describes the mixed methodology for the case study. Section 6.3 illustrates the pre-colonial and colonial context that has framed the contemporary contested landscape. The results in section 6.4 demonstrate profiles of multiple users, land use and land cover change temporality, the conundrums of shifting land and water access regimes, economic impacts on livelihoods, and the role of institutions. The discussion in section 6.5 highlights contradictions in the development of Niger's pastoral system in the context of climate change and the conclusion summarizes study insights and makes recommendations for future research.

Figure 6.1 Map of research sites.



Livelihood zones represent only principal livelihood activities and are not exclusive. Livelihood Zones
Data Source: GAUL/FAO data: <http://www.fao.org/geonetwork/srv/en/metadata.show?id=12691>,
own figure.

6.2 Mixed remote sensing and qualitative methodologies

6.2.1 Overview of research design

The research methodology consisted of a qualitative case study research strategy (Yin, 2003), highlighted and complemented by remote sensing-based data collection and analysis. Data collected during a first phase served to specify potential types of inscriptions and case study areas for the remote sensing study. The first phase of qualitative data collection was carried out from April to December 2011 in northern Tahoua, including the region of Tillia (Figure 6.1). After a brief analysis of initial results, remote sensing data were acquired for Tillia and Droum during September 2012 and February 2014. Results of remote sensing analysis were then compared with a second phase of qualitative data collection in Tillia and Droum (November - December 2015). Droum was added in the second phase for comparison purposes. Data collection in Tillia and Droum was highly precarious due to security restrictions and thus was carried out by local field team members; conversations were recorded and transcribed for both research phases.

6.2.2 Site selection criteria, data collection, and analysis

The region of Tahoua (Figure 6.1) is located in the central west of Niger, bordering the region of Agadez in the North, Nigeria in the South, and Mali in the West. The geographical features along the North to south axis of Tahoua change relative to the amount of rainfall. For instance, the South or agro-pastoral zone, with approximately 300-500 mm of rainfall per annum supports cultivation, and the North with 100-300 mm is primarily marginal, pastoral land. Spatially based conflicts between pastoralists and agro-pastoralists over land tenure are endemic in this region and vary in degree and typology along this north-south axis.

Site selection was based upon the following criteria: (1) multiple ethnic and cultural groups, (2) history of conflict between users, (3) existence of land use features of relevance such as seasonal lakes, enclosures, fields and possible man-made structures, (4) appropriate level of security for the research team and (5) availability of VHR imagery in satellite data archives. The total number by type of users (Table 6.1) was based upon the seasonal availability of actors in the zone. It is important to note that more pastoralists may have been present in the non-garden season between April and June, though the presence of gardeners and gardens would have been reduced during this time. During Phase 1, we held 9 focus groups (FG) in nomadic areas around Tillia and Droum

with only pastoralists, and in Phase 2, we carried out a total of 19 individual interviews with pastoralists, gardeners and institutional actors. Individual gardeners were selected with the help of local informants using a snowball selection process. Access to participants' gardens, grazing territories, or homes was gained through face-to-face, open discussions. The majority of individual interviews were conducted with only the participant, and the discussion focused on historical social and ecological changes, types and locations for institutional support, and the evolution of land and water access conflicts, using an interview guide to structure the conversation. All interviews were recorded with the permission of participants, and recordings were transcribed into French.

Table 6.1 Characteristics of qualitative and remote sensing research sites

Village, Commune	Annual Rainfall 1960-1990	Annual Rainfall 1990-2012	# Interviews & FG	# Actors from livelihood groups	Major and (minor) ethnicities	Presence of cultivation	Seasonal lake availability (usage)	Type of modern water points
Tillia, Tillia	225 mm	209 mm	10 (Phase 3)	P (2) G (6) I (2)	Tuareg (Fulani)	Some	Yes (mostly pastoral)	Lake, wells
Droum, Kao	267 mm	244 mm	9 (Phase 3)	P (2) G (5) I (2)	Tuareg (Fulani, Hausa)	Some	Yes (mostly gardening)	Lake, wells
Nomadic Camps (Outside Tillia)	225 mm	209 mm	9 (Phase 1&2)	P (9)	Tuareg (Fulani, Arab)	none	No (other water sources)	Bo-reholes, deep wells

Focus groups (FG), Pastoralist (P), Gardeners (G), and Institutional Representatives (I). Rainfall data: Climate Change Knowledge Portal (<http://sdwebx.worldbank.org>). (adapted from Snorek et al., 2014).

A preliminary inspection of available satellite images in Google Earth presumed the presence of physical enclosures in Tillia. Thereafter, very high resolution (VHR) images from Quickbird-2 and WorldView-1 available in satellite data archives between 2003 and 2013 were acquired. The VHR data served as a primary data source, supported by high resolution (HR) optical satellite data from RapidEye (Table 6.2). The spatial resolution (pixel size) is typically between 0.5 x 0.5 m and 1 x 1 m for the VHR data with typically 10 to 15 km in swath width.

Table 6.2 Characteristics of remote sensing data used for the Droum and Tillia regions

Village	Satellite	Time step	Acquisition date	Spatial resolution	Relevant spectral bands
Droum	Quickbird-2	t1	26 May 2004	0.6 m	4 (B, G, R, NIR)

Droum	Quickbird-2	t1	27 Jul 2005	0.6 m	4 (B, G, R, NIR)
Droum	Quickbird-2	t1	23 Feb 2006	0.6 m	4 (B, G, R, NIR)
Droum	WorldView-1	t2	05 Aug 2013	0.5 m	1 (pan)
Droum	WorldView-1	t2	05 Aug 2013	0.5 m	1 (pan)
Droum	RapidEye	t2	19 Sep 2013	6.5 m	5 (B, G, R, re- dEdge, NIR)
Tillia	Quickbird-2	t1	27 Sep 2003	0.6 m	(B, G, R, NIR)
Tillia	Quickbird-2	t2	12 Dec 2012	0.6 m	(B, G, R, NIR)

Satellite name, time step (time 1 = t1, time 2= t2), acquisition date, spatial resolution (in meters) and spectral bands (blue = B, green = G, red = R, near infrared = NIR, and panchromatic = pan).

The applicability of the remote sensing change analysis depends on the availability of new (year 2012/2013) and archive data (going back to at least 2006). Archive images from before 2006 were available for only few areas in northern Tahoua, among them the regions around Tillia and Droum, for which also new imagery from 2012 and 2013 was available (Table 6.2). Due to the large size of the Droum site three different image swaths had to be used. Three different archive images (west: 2005, center: 2006, east: 2004) were combined and analyzed. Tillia was originally a site for the Phase 1 qualitative research, and Droum was added to compare the livelihoods in both zones of pastoral excellence.

6.2.3 Data analysis

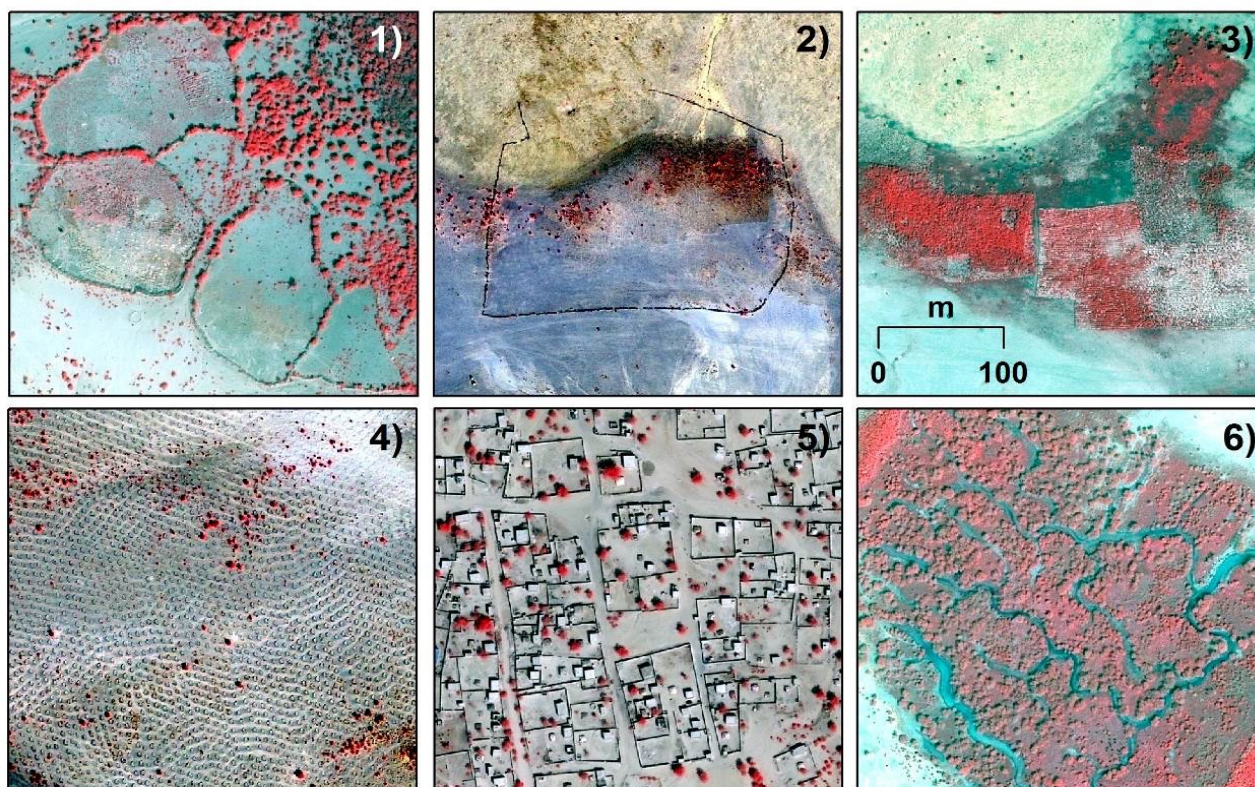
Qualitative data was transcribed and literature, individual interviews, focus groups, and expert interviews were analyzed using AtlasTi 1.0.43 (AtlasTi GmbH), qualitative data analysis software that permits the codification, categorization, and synthesis of multiple types of data including images, text, pdfs, videos, and audio recordings. Primary categories analyzed for this paper include: perceptions of environmental change, changes to water and pasture access, historical events, conflict and cooperation, and divergent adaptations for multiple users.

The analysis was based upon two main actor groups: pastoralists and gardeners. These are defined as gardeners — typically sedentary, possessing a garden and also taking part in other livelihood

activities (especially livestock rearing) and pastoralists — a livelihood and a socio-cultural group who use mobility in livestock rearing (but also possess territorial rights in local pastoralist).

In the visual analysis of pre-processed satellite images, land features were identified and manually digitized as polygons using Geographic Information Systems (GIS) software. This was carried out for the two different time steps: archive images were acquired between 2003 and 2006, and new images between 2012 and 2013. Image pre-processing in terms of geometric correction, pan-sharpening (merging of panchromatic information in higher resolution with spectral information in lower resolution), spectral enhancement and visualization as near infrared false color composite images were applied in order to provide best conditions for visual interpretation of land use features, which are classified as follows: enclosures (closed fences) with or without fields inside (class 1), open enclosures such as broken or incomplete fences that may or may not contain cultivated fields (class 2), cultivated fields without enclosures (class 3), land and soil restoration features such as 'half-moons' and *zai* holes (class 4), settlements and dwellings (class 5), and seasonal lakes and wetlands (class 6). Using GIS techniques and spatial statistics a change detection approach was applied thereafter, revealing changes between the two different time steps. In these near infrared false color composites in Figure 6.2 the appearance of the red color represents green vegetation and chlorophyll activity, and soil without green vegetation appears in colors from beige to grey and light blue.

Figure 6.2 The six classes of land use features.



The six classes are shown based on a near infrared false color composite of Quickbird-2 imagery (0.6 m) from 12 Dec 2012: (1) enclosures (closed fences); (2) open fences; (3) cultivated fields without enclosures; (4) land restoration features; (5) settlements; (6) seasonal lakes and wetlands; Source: Quickbird-2 ©DigitalGlobe.

6.3 Context of Niger's Pastoral System

Human security in the Sahel has been precarious in the past two decades due to geo-political, social-ecological, and climatic forces. Since the beginning of the 20th Century, the Sahel has seen eight major droughts during 1910 – 1916, 1941 – 1945, 1968, 1971 – 1974, 1984, 1987, 1989, 2005, 2009, 2011 (FEWSNET 2011), and more recently these have been increasing in frequency (Hengsdijk and van Keulen 2002). Future rainfall scenarios for the Sahel (Desanker and Magadza, 2001; Hengsdijk and van Kuelen, 2002) predict increasing rainfall variability (drought and floods) (Giannini et al., 2013), which could further exacerbate land degradation. Despite reforestation efforts (Dardel et al. 2014), the ecology of the region will continue to be fragile without improved ecosystem management further deepening the poverty and vulnerability of some communities (Tschakert, 2007). Furthermore, the fall of the Libyan regime in 2011 has been accompanied by multiple shocks to human security — an influx of arms prompting rebellion movements, more dangerous migrant routes, shifts in remittances due to repatriated migrants, and an influx of security-based aid to northern Niger. These threats to human security may have deleterious effects on natural resource management challenges in the Sahel, which is based upon broad and diverse

strategies of control and appropriation (Mohamadou 2010), dependent upon rivalries and alliances that unite or divide the many competitors and partners in the SES (SES).

6.3.1 Niger's first enclosures

To prevent the extension of agriculture into the pastoral regions of Niger, the colonial government traced a 'northern limit of cultivation' in 1953 (Mohamadou 2010). In one of his first acts as president in 1961, Hamani Diori visited the pastoral zone in Northern Niger (Figure 6.3). Following this visit, a governmental decree, which later was made Law 61-005 (27 May 1961) authorized a separation of north from south, establishing an official limit to cultivation and pastoral zone (south of what was then the 350-mm rainfall isohyets). Law 61-005 was a novel way to protect pastoral space and serves as the first post-colonial 'enclosure' that was initiated from the national scale. While more symbolic as an enclosure, it was the first time the pastoral space had been limited in this way, and in turn resulted in an opening of new territory (south of the line) to cultivation. New rain-fed cultivation is forbidden in the pastoral zone (Article 1 Law 61-005), but oasis or irrigated cultivation (Article 4) is permitted. On the contrary, the appropriation of land is not allowed (Article 5). The new border to the pastoral activities did not stop the northward migration of farmers seeking land, especially with the abolition of slavery, and this line of cultivation continues to march northward every season.

6.3.2 Divergent adaptation triggered by the two Great Droughts

The two extreme droughts in 1973-74 and 1984-85 (Figure 3) fundamentally reshaped the landscape of the pastoral zone, including species diversity and abundance. President and General Seyni Kountché came to power through a *coup d'état* in 1974, promising to prevent the famine that was endured during the drought (Figure 6.3). The president attributed much of the famine to the peasants' lack of control over land, which they worked in order to pay patronage to local chieftains. In a broad-sweeping change in the patron-tenure status of land, the president gave a radio address that has since become known as the 'land to the tiller' speech (December 18, 1974) (Ngaido, 2000). While not backed by any legislation (Ngaido 1995), his statements established the norm that land ownership could be obtained by cutting trees and cultivating land, which undermined the tenant farmer regimes and gradually promoted the clearing of vast areas of land that had previously not been cultivated. Participants stated the period of 1984's famine as a 'turning point'

that steadily brought on more and more degradation including a loss of open (pastoral) space and highly concentrated cultivated (privatized) space (see also Chapter 6).

During his tenure as governor of Tahoua (1981-1988), Mahamadou Tandja encouraged pastoralists who had lost their livestock in 1984 to plant fields or gardens in the valleys (Figure 6.4). The government gave them land and tools to start gardening, which brought about the first garden plots in the valleys around the pastoral zone. While some pastoralists managed to reconstitute their herds and returned to pastoral livelihoods, the sedentarization had already attracted landless migrants (primarily Hausa) from the South, who also settled in villages in the valleys.

6.3.3 Pastoral livelihoods, vulnerabilities and adaptations

The common Tamashaq phrase (Tuareg) “*amman imman, akh issudagh*,” or “water is life and milk is food” typifies life in the SES. The pastoral zone receives an average of 100 to 250 mm of rainfall per annum during a 3 to 4-month rainy season (July to September). Rainfall determines the amount and abundance of grassland biomass, which is estimated at an average of 2,5 kg of m²/ha per millimeter of rain (Hammel 2005) and the quantity of water in ephemeral and permanent lakes. The activity of actors in the SES is influenced by rainfall, the quality and type of soil, water access, types of vegetation, and local institutions.

Multiple actors are active in the pastoral zone: 1) local pastoralists or those nomadic and semi-nomadic groups who dwell year-round in the pastoral zone, 2) transhumant herders who typically shepherd theirs and others’ livestock to the northern pasture only during the rainy season, and 3) those former pastoralists and landless agriculturalists cultivating rain-fed and irrigated plots of land. When rains begin in June, transhumant herders leave the southern agricultural and agro-pastoral zones, some crossing multiple national boundaries to arrive in Niger’s pastoral zone. These northern migrations, coupled with the large size of herds are perceived as factors that overwhelm the fragile grassland ecosystems (Touré 2015; Snorek et al. 2014). The expansion of croplands further degrades the fragile ecosystem, reducing overall biodiversity and biomass (Dube and Pickup 2001) as well as water infiltration.

Wetlands and lakes have strategic importance in the pastoral zone as an open access resource for multiple actors (Brouwer 2009). Denudation of the land throughout Niger has promoted lakes to

increase in size and the water table to rise as a result of higher runoff flows (Favreau et al. 2012). As waters recede, pastoralists dig wells in seasonal lakes, providing a permanent and free water source for many months after the rains have subsided. Through their gardening endeavors, these cultivators garner entitlement to water and possess not only greater control over the surrounding natural resources (trees, pasture, soil), but also authority and influence (Thébaud and Batterbury 2001). At certain periods of the dry season, the more geographically scarce deep wells and pumping stations (boreholes) are the only available water source. Such water points are often poorly managed or in ill-repair and typically require payment for use. The annual *soudure* or period when resources are mostly depleted (April/May - June/July) requires pastoralists to herd their livestock between water points and pasture areas, sometimes at extreme distances and at high morbidity levels of livestock. Drought adaptation includes the transport of hay and water to weak herds, at high monetary costs. More impoverished pastoralists have stated that these high costs have made their livelihoods untenable in light of climate change (Chapter 5).

6.4 Results: enclosures in the pastoral zone of Niger

6.4.1 Social ecological history of Tillia and Droum's valley lakes

The valleys of Tillia and Droum are refuges from drought and provide key water sources throughout the year. Their geographical significance is denoted by their namesakes, as told by study participants. Tillia, situated near the border of Mali, is an area that even today is considered a prime grassland 'reserve' due to great depth of the water table and the lack of hydraulic works. To exploit this zone, more well-off pastoralists will fill cisterns on trucks and transport water to the areas of abundant pasture to give to their herds. Finding a water-rich valley in such a region, Tuareg herdsman became so devoted to the place that they called it Tillia or 'I belong to her,' in Tamashaq. Droum, as perceived by the Tuareg, was a zone of special ecological richness (water, forest, pasture) and used primarily for pastoralism and as safe haven from drought. In the Tuareg's matrilineal culture, the women would have such an easy life in Droum, their plumpness would provoke '*tchideram*' or stretch marks, from which Droum was derived.

According to research participants, the first gardens appeared in Tillia and Droum during and after several severe drought periods. In Tillia, gardens began after the second Great Drought in 1984-1985. In 2005, another drought period, a second valley southwest of Tillia (see inset of Figure 6.5) began to be exploited for gardening. In Droum, the land was first cultivated by former pastoralists after the first big drought in 1973-74. When the second big drought occurred in 1984, customary

and democratically elected leaders encouraged pastoralists in distress to cultivate gardens. These initial gardens were most likely to produce sorghum, cowpea, beans, tomatoes, watermelon, squash, and okra. Actors involved with these initial gardens were primarily former pastoralists, though others (primarily cultivators of the Hausa ethnic group) were attracted to the zone as well (Table 6.3). This creates multiple profiles for gardeners in the zone, disaggregated by timing in situ, time gardening, their former locations and activities, and diversification of activities (Table 6.3).

In recent times, the reasons and causes of cultivation of the valleys have shifted, as new actors and rules take precedence. In Tillia, according to the mayor, Tuareg groups make up 70% of the population, Fulani 22%, Hausa 6% and Arab 2% (P105). Locals account that there are many more Tuareg from the Eghawilen (former slave) group than Imazawagh (nobles) Tuareg in Tillia's gardens (Table 6.3).

In Droum, the majority is also Eghawilen Tuareg, though there are about 200 individuals exploiting the garden area, including individuals from the Tuareg, Fulani, and Hausa ethnic groups. According to one Droum respondent, garden activities were not sustained by former pastoralists (Tuareg Imazawagh); however, southern cultivators (Hausa) and Eghawilen Tuareg stayed and occupied the land. The duration that gardens were being exploited varied from forty or more years (Droum) to less than one (Tillia). Reflecting the statement of one participant, the Hausa gardeners have had the longest tenure in garden work in the pastoral zone and the Eghawilen Tuareg are the most prevalent group of pastoralists-turned-gardeners.

Table 6.3 Characteristics of gardeners in Tillia and Droum.

Characteristics of Garden Actors (by location and ethnicity)						
Defining characteristics of gardeners	Location		Ethnic Group			
	Droum	Tillia	Fulani	Hausa	Tuareg Eghawilen	Tuareg Ima-zawagh
Former pastoralists w/ garden	6	11	5	0	11	3
Gardener w/ livestock	5	2	3	2	1	3
Gardener coming from South	1	3	4	3	0	0
Time Gardening: 40 years	1	0	0	0	0	1
Time Gardening: 10-40 years	2	0	1	1	0	0
Time Gardening: < 10 years	1	3	0	1	3	0
Time in situ: < 1 year	0	1	1	0	0	0
Time in situ: 30+ years	2	2	0	3	0	1
Time in situ: 1-30 years	1	0	2	0	0	1

Numbers indicate the total count of similar, coded responses based on qualitative, guided questionnaires, organized by actor category.

6.4.2 Evidence of increasing enclosures around lakes

Garden exploitation and fencing of pastoral territory is expanding geographically for both Droum (Kao Commune) and Tillia (Tillia Commune). Of the 81 km² of area analyzed using remote sensing in the region around Tillia (Figure 6.5), enclosures of closed fences increased by almost 102% with respect to the area in the archive image in 2003, corresponding to a change from 1.03 km² (2003) to 2.08 km² (2012) of enclosed area (Table 6.4). The area of open fences, which we determined represents claimed territory that may or may not be cultivated, increased by 147%, whereas the area of cultivated fields without fences decreased by -88%. These changes exemplify potential shifts in land use and access regimes, which were explored further in the individual interviews. Significant areas (41%) have been restored through land management projects such as digging water-holding trenches and planting trees, activities that may preclude cultivation.

Table 6.4 Area covered and number of features (Tillia)

DROUM (KAO) 2004/05/06 - 2013	AREA [km ²]				NUMBER OF FEATURES [count]			
	2004/05/06 [km ²]	2013 [km ²]	Change [km ²]	Change [%]	2004/05/06 [count]	2013 [count]	Change [count]	Change [%]
Closed fence	4.71	10.58	5.86	124.2%	226	625	399	176.6%
Open fence	3.17	13.07	9.89	312.0%	80	73	-7	-8.8%
Field without fence	17.14	15.02	-2.13	-12.4%	71	113	42	59.2%
Land restoration	2.73	3.29	0.55	20.1%	13	20	7	53.9%
Settlements	0.58	0.81	0.23	39.9%	225	791	566	251.6%
Dwellings	na	na	na	na	580	854	274	47.3%

Area and features for each land cover class in 2004/05/06 (according to data availability) and 2013 for Droum. The number of features represents the total number of each type of feature (fence, land restoration, settlement, dwelling). Not applicable data is marked as "na".

The settled parcels of the town of Tillia increased by 39% within the 9-year period, and the number of single dwellings (Figure 6.5) scattered around the area increased by 129% (Table 6.4). In 2012, new settlements southeast of Tillia were detected, which are in the vicinity of new fences. In this same area, open cultivated fields (inset, Figure 6.5) transformed into fenced areas (green), which is reflected by the decrease of cultivated open area, and increase of closed and open fences (Table 6.4).

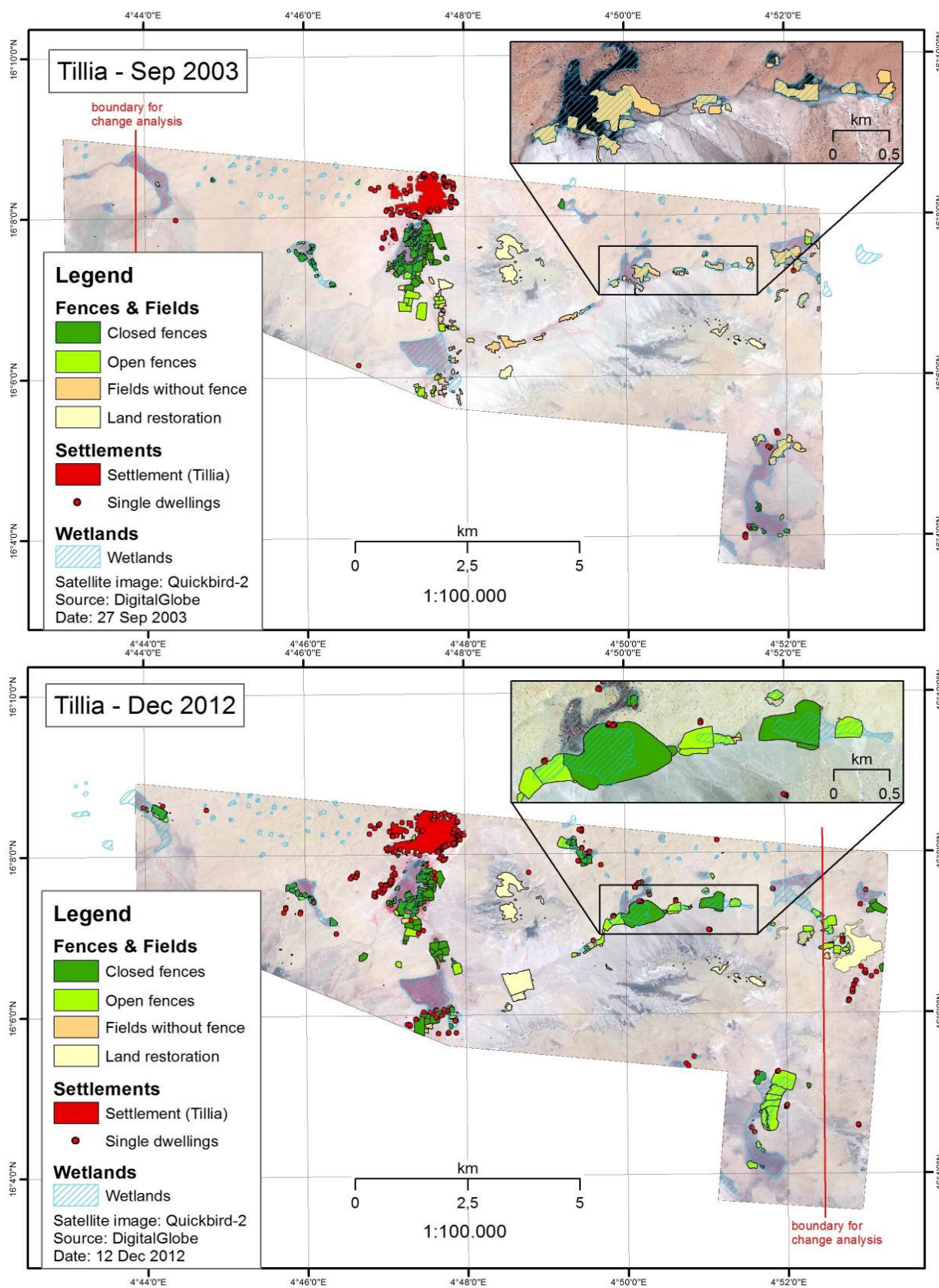
Table 6.5 Area covered and number of features (Droum)

TILLIA 2003 - 2012	AREA [km ²]				NUMBER OF FEATURES [count]			
	2003 [km ²]	2012 [km ²]	change [km ²]	change [%]	2003 [count]	2012 [count]	Change [count]	change [%]
Closed fences	1.03	2.08	1.05	101.9%	172	219	47	27.3%
Open fences	0.48	1.18	0.70	147.1%	48	56	8	16.7%
Fields without fence	1.27	0.15	-1.12	-88.0%	64	12	-52	-81.3%
Land restoration	0.55	0.77	0.23	41.1%	33	42	9	27.3%
Settlements (Tillia)	0.63	0.87	0.25	39.0%	na	na	na	na
Dwellings (SW Tillia)	na	na	na	na	125	286	161	128.8%

Area and features for each land cover class in 2003 and 2012 for Tillia. The number of features represents the total number of each type of feature (fence, land restoration, settlement, dwelling). Not applicable data is marked as "na".

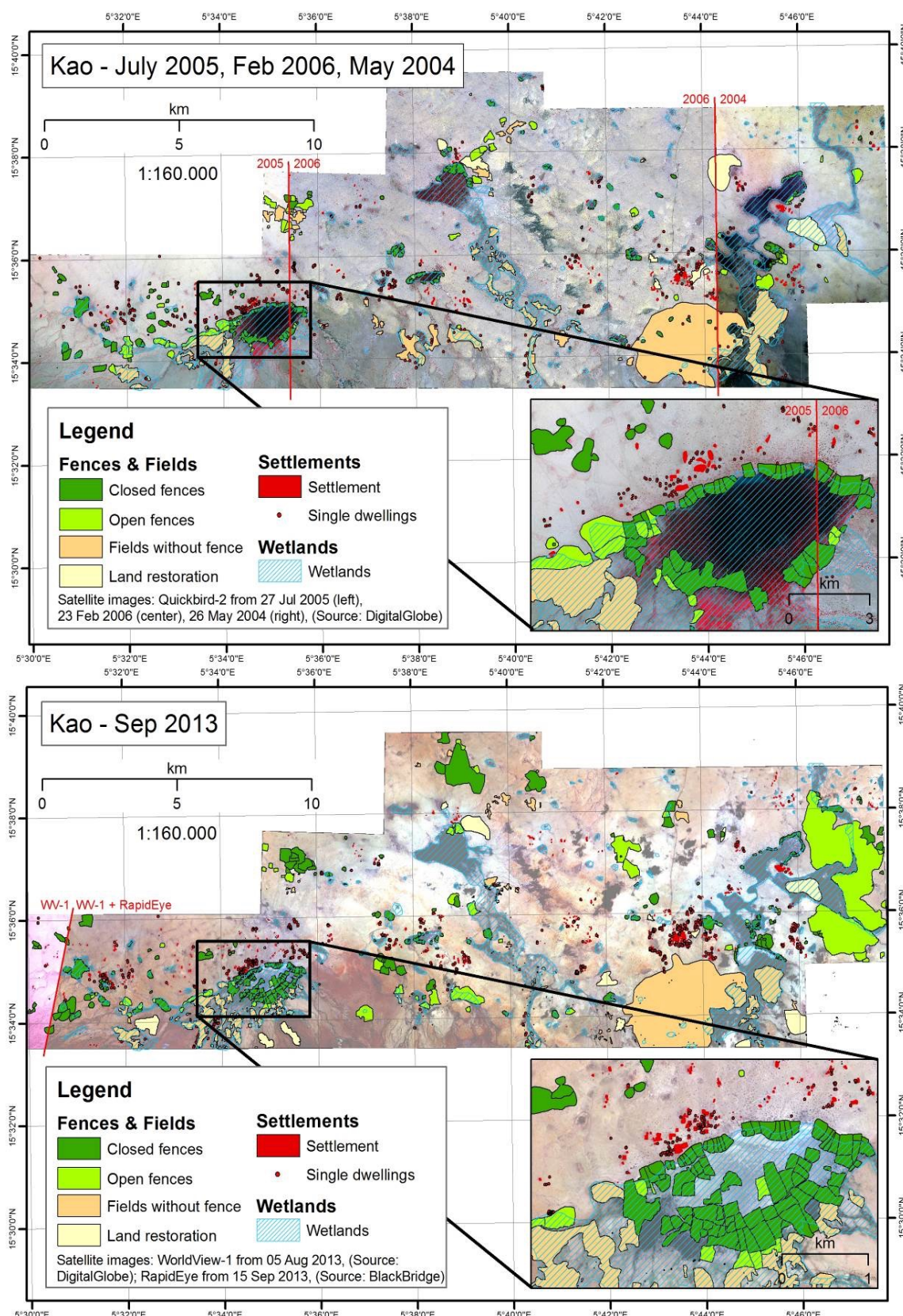
The second study site located northwest of Kao, called Droum consisted of 263 km² and was three times larger than the Tillia site. There was a 124% increase in the area of closed fences, an area change from 4.71 km² to 10.58 km², and the increase in number or count of fences (features) by 176% (Table 6.5). Most of these stretch around the contour of the wetlands. The strong increase of open fences by more than 300% is mostly due to one very large area that has been fenced on the east of the study site (Figure 6.5). The total area of open fields remained the same, but there were many changes in the locations of the fields. The total settlement area increased by 39%, and the number of single dwellings by 47% over a period of approximately 9 years.

Figure 6.3 Land use map of Tillia



Shows 6 different land use classes for two different points in time: Quickbird-2 archive (27 Sep 2003) and new (12 Dec 2012) imagery; background is uncultivated space. A newly cultivated valley in the east of Tillia is displayed in the inset. Image source: Quickbird-2 © DigitalGlobe.

Figure 6.4 Land use map of Kao (Droum)



Shows 6 different land use classes for two different points in time: Quickbird-2 (temporal mosaic from 26 May 2004, 27 Jul 2005, 23 Feb 2006) and mosaic of WorldView-1 (5 Aug 2013) and RapidEye (19 Sep 2013); background is uncultivated space. Droum lake is displayed in the inset. Image source:

©DigitalGlobe @BlackBridge

The four classes: enclosures (closed fences), open fences, land restoration features, and settlements are reliably detectable and visually interpreted in all VHR images independent of seasonal dynamics. Enclosures and fences created by thorny branches show low reflectance with respect to other land cover in all image bands, which made them easily detectable. Enclosures can also contain high near infra-red reflection in case they are vegetated, which results in a high contrast to the surrounding land (Figure 2). Interpretation errors are more possible for cultivated fields without enclosures, since fields are better detected during the growing season, for which VHR images were not always available (Table 2). This class was mapped in addition to enclosures, and is not of particular focus in this study. Seasonal lakes and wetlands are the most dynamic classes due to seasonal variations in their extent and would require inter-annual time series of satellite imagery. The limited time steps of VHR data allowed the derivation of one wetland mask, which was created from all VHR images in combination with a Landsat 8 image from the rainy season 2013.

6.4.3 Outsiders cultivating the commons

While the majority of gardeners are former pastoralists who are indigenous to the zone, the zone is also attracting outside groups to take up subsistence farming. Four cases of gardeners emigrated to the Tillia and Droum from elsewhere (Participants 76, 81, 110, 111). All of the gardeners but Participant 111 settled in their respective areas more than 30 years prior (1984/85). A Fulani gardener (111) arrived less than a year ago from Dogon Doutchi (a small town in southern Niger). Participant 111 was raised in pastoralism, yet he no longer had livestock and was seeking land. Of the three Hausa participants, all had spent more than 30 years in the zone; two of them came as children with their fathers, who engaged in small business activities such as selling sugar, tea, and tobacco to pastoralists. The Droum gardener (76) came with his family due to the fact that there was no more exploitable land and very few trees (for wood sales) in Tamaske, his home village.

Two gardeners (76 and 81) perceived that cultivation is the *modus operandi* to develop the pastoral zone, and one (76) referred to president Kuncé's "land to the tiller" speech from 1974 (Table 6) as part of the reason he was permitted to cultivate in the North. The Fulani (111) who emigrated from outside the pastoral zone tended to base his decisions for land tenure and settlement on the level of social capital with current gardeners or administrators.

6.4.4 *The pastoral zone's fuzzy land tenure rules*

Despite the perception that land can be claimed by any able cultivator (a phenomenon in both the agricultural and pastoral zones), there were contradictions in behavior for formalization of ownership and the right to sell the land. Respondents recognize priority rights of the indigenous pastoral groups and perceive that they are cultivating in the pastoral zone. Yet, there were multiple interpretations of how the common zone should be used and by whom. Some respondents stated that the pastoral space belonged to the pastoral groups who have possessed home territories in the zone for centuries (primarily of the Tuareg Imazawagh), yet concurrently recognized norms in place granting ownership to cultivators, stemming from the “land to the tiller” speech as well as adaptation policies of 1984.

Multiple administrative officials (including one representative of land commissions) made statements that land titles are not available to individuals in the pastoral zone, implying that one cannot sell land and upholding the Law of 1961 that allowed only subsistence farming in cases of vulnerability. “The land commission does not have the right to deliver land titles... but there are agreements that can be made with customary chiefs to enable one to exploit the land” (P105). The 1961 law permits the establishment of oasis gardens, which in turn would grant rights to land titles for this purpose.

“The pastoral space, we say that it is for them [pastoralists], but agriculturalists take more advantage of it” (personal communication, P112 Expert Droum).

“I have said that the fact of putting fields in the pastoralists' spaces is disparaging because, the disparagement is derived from the fact one is finding and installing something in a space that does not belong to him. However, there is a policy in place, following the [drought]... that pushes those who no longer have livestock (vulnerable) to make gardens” (personal communication, P77 Gardener Droum).

Seven respondents (5 in Droum and 2 in Tillia) explained that they obtained land through purchase, even outsiders (Figure 7). Still two others (1 in Droum and 1 in Tillia) mentioned to have received land titles from the land commission during time when Tandja was governor of Tahoua (1981 - 1988), a practice that is now officially forbidden; in all cases, land sales show evidence of a private regime.

6.4.5 Gardening to receive project aid

During an interview in Niamey in November 2010, the representative to the minister of Niger's Ministry of Water, Environment, and the Fight against desertification stated that: "He who is sitting on water need not be thirsty," and another technical assistant in the same ministry mentioned that only 1% of Niger's surface water was being exploited (personal communication, Oct 2010, Niamey). Since 2003, the country's adaptation policy has focused on improving the exploitation and utilization of ephemeral and permanent lakes and ponds for food production.

Multiple projects (NGOs cited include: EIRENE, AdKool, Aharog) have responded by cultivating the valleys in Droum and Tillia, prompting an acceptance of pastoral zone cultivation and a rush to receive lucrative support from government and non-government actors and to legitimately claim the public land through garden development. Twenty years ago, project aid supported the adaptation of former pastoralists into sedentary livelihoods; those with gardens "received a bit more than those who did not [cultivate]" (P112). According to the institutional actors in Tillia, specific garden aid arrived in Tillia beginning in 2002 with support from an international non-governmental organization (NGO). In Droum, an international NGO is installing (at no cost) ten trial drip irrigation systems for selected gardeners (P77). Pastoralists expressed more frustration

Actor (Locale)	Quotes expressing local perceptions of "Land to the Tiller"
Hausa Gardener (Tillia)	<i>Since 1984, we earned the right to authorize each person to look for places in the valleys where we can exercise our agriculture activities.</i>
Tuareg Gardener (Tillia)	<i>Since each person can take land as he wishes, I also took mine; I fenced it so it became my plot. Before, this place was full of trees, which I cut to transform it into a garden.</i>
Tuareg Gardener (Tillia)	<i>No one gave the land to me. When I arrived, it had never been cultivated. I prepared the land.</i>
School Director (Droum)	<i>They [outsiders] have water [in the South] but barely a few meters squared [of land]. And here, one can claim a hectare... or even two!</i>
Hausa Gardener (Droum)	<i>(Why did you come here from Tamaské?) It's because of agriculture. (So, there isn't space in Tamaské?) Right, the space is crowded, insufficient.</i>

Table 6.6 Perceptions based on "Land to the Tiller" speech of 1974.

and uncertainty about available aid, stating that it was only given to sedentary households and that some gardeners strategically exploit gardens to receive aid.

“[Cultivators]... hope also to have project aid [from their gardens]. (Projects help them?) It is what we hear. They receive sacks of millet during the rainy season. (So, they seek aid through their cultivation?) That's right, because we haven't seen someone who spent the year eating his harvest production” (personal communication, P14 Tillia Pastoralist).

Project aid is a lucrative benefit for gardeners. Along with NGO aid, the government distributes complimentary seeds on a yearly basis for cultivation in both Tillia and Droum. Types of cultivation-based governmental/non-governmental aid cited include: donkey carts, motor-pumps, water piping, seeds, watering cans, wells, and subsidized fodder.

“...It is normal [to cultivate in the pastoral zone]... because the authorities have given us permission. At present, in the city, there is an agriculture agent that the State sent here... Also, the State provides seeds... if the State has authorized it, it is normal” (personal communication, P110 Hausa Gardener Tillia).

Very few pastoralists stated that they had received aid; recipients cited such aid as animal fodder, grain, medicine, and hydraulic infrastructure from NGOs (namely NGOs Amman Imman and EL-RENE). Government livestock services charge fees for livestock treatments (not for vaccinations, which are free). Pastoralists receiving support to rebuild a modern well estimated paying up to 300,000 FCFA. Contrariwise, gardeners receiving generators and water infrastructure paid no compensation. The distribution of project aid is a normative force framing the development of the pastoral zone.

6.4.6 *Build a fence, sell water access*

Fencing is the main requirement for a successful garden venture in the pastoral zone. As observed in both Tillia and Kao (Droum) (Figures 5 and 6), fenced-in garden plots have colonized the valley. The temporal and spatial changes occurring in both Tillia and Droum have impacted water access for non-gardener actors (pastoralists, brick-makers, households gathering water). Figure 7 shows fences made of thorny branches which are visible as linear structures in the satellite images.

In 2003, a land commission (*commission foncière*) was established in Droum in order to organize the rural space and maintain peace and security for all users. Despite over 10 years working in

Droum, users in Droum expressed multiple conflicts related to water access, livestock corridors, alternative water facilities (wells, boreholes), costs of water and crop or livestock damage, excessive wood cutting, and dangerous access points for livestock (Figure 8). Overall, the mechanisms for compensation benefit only landholders, who are also able to exclude livestock and privatize the land in Droum, actions equivalent to the southern private land regimes (Snorek et al. 2014). Pastoralists in Droum frequently pay damages to gardeners, sometimes with the lives of their animals, who are violently chased out of the space.

In Droum, temporal and spatial constraints limit livestock access, especially during the end of the gardening period, which coincides with the hot period of the year when livestock are heavily demanding water (March and April). Strong fencing activities as visible in the satellite images in Figure 6 (inset: Droum lake) imply restricted water access for livestock. Gardeners refuse access and have closed certain corridors in order to protect their garden produce. These acts are contrary to the government's rules of water access (article 25 de *l'ordonnance* n° 2010-029), yet enforcement is lacking. Pastoralists feel unable to discuss these problems openly (P116 and P118) and have been turned away by local and sub-national institutional actors. Livestock, in turn, are forced to pass into areas that are narrow and dangerous due to thick mud and sinkholes (similar to Image 6.1, right), leading one pastoralist to state that gardeners are, "...hoping for the misfortune of pastoralists" (P108).

Gardeners have begun to commercialize lake water, which provides a safe and sufficient option for pastoralists' livestock. Using pumps received from project aid for its distribution, gardeners sold water for as much as 10,000 to 15,000 FCFA per herd, variable based on the number of animals. This serves as a sure source of revenue for gardeners during the long dry season, though land commissions and pastoralists are condemning this practice.

"The gardeners stated — we will never open here [the livestock corridor]... on the other side [of the lake], it is mud, but the cows are obliged to drink there... or they will pay money [to the gardeners]...they are preventing livestock access completely during the months of March and April." (School Director Droum).

"[Gardeners] are beneficiaries of a motor-pump and sell water to the pastoralists... for each passage of an animal next to his so-called garden" (Pastoralist from Droum).

Leaders in Droum stated openly that they cannot uphold natural resource management plans. Gardeners act with impunity, closing government-arranged corridors to suit their livelihood activities. These perceptions provoke conflict between gardeners and pastoralists; many sedentary actors (gardeners and institutions - P115, P118, P77, P116) expressed sympathy for pastoralists who are unable to exploit “their own territory” (P115).

Image 6.1 Water access challenges for pastoralists.



(Left) Here a garden near Kao (Droum lake, see inset in Figure 6.6) where the seasonal lake is surrounded by cultivated fields, with only 3 access points for livestock (Abdoulrahmane, Droum, Nov 2015). (Right) Brick-makers quarry in the lakes, and unsuspecting livestock are easily injured (Snorek, Madaoua, Dec 2011).

Tillia, on the contrary, upholds a more transparent system and organization of the rural geographical space. As explained by the mayor of Tillia, conflicts occur around man-made water infrastructure in Tillia, due to their rarity and cost. Lakes are a free, open source of water for multiple pastoral groups — visiting herders and local pastoralists (Table 6.7). Visiting herders complain about the long wait times at boreholes and the lack of priority use, which sometimes provokes conflicts. The taxing of livestock owners for crop damage is unfeasible in Tillia. Both livestock and gardens must be guarded by their proprietors, promoting greater cooperation and an ethic of prevention amongst users.

“Because the village, it is a village with a lot of cows. If the cows come during the night and damage the fields, the owner of the field has not alternative. It is Tillia. If you make a field here without a fence and if all the cows eat your plantings, even if you complain, it will not matter. They will only tell you, ‘why didn’t you guard your field?’ there is is!” (P83:11).

The entire northern part of the lake is open for livestock access, and cultivation is only possible in small plots in the South. There are, as a result fewer conflicts in Tillia at the garden site resulting from lake water access. Conflicts in Tillia commence upon the desiccation of the lake (March/April), when reliance on hydraulic infrastructure increases.

Type of Response	Locale: Droum Phase II	Locale: Tillia Phase II
Perceive that pastoral zone is territory of pastoralists	4	0
Livestock corridors: Multiple benefits	1	3
Livestock corridors: Problems	7	1
Water access (pos.): Corridors are sufficient	0	2
Water access (pos.): No access problems	0	3
Water access (neg.): Dangerous	4	0
Natural Resource Management: Not functional	20	5
Natural Resource Management: Functional	7	20

Table 6.7 Frequency of statements about natural resource management in both locales. Highlighted cells represent important trends or comparisons between localities.

6.5 Discussion: Do gardens benefit the pastoral zone?

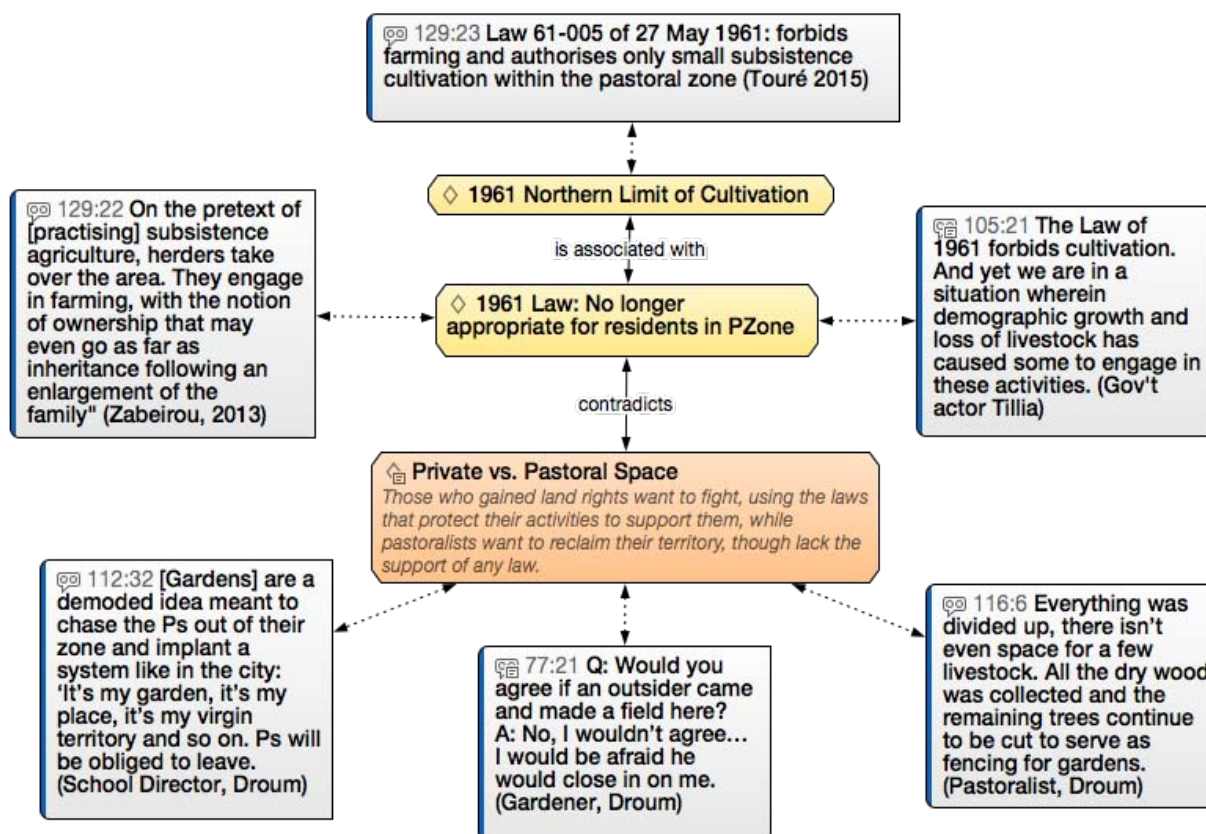
On 23 February 2015, the Office of the Prime Minister established a committee made up of representatives and directors from all of the government bodies concerned with the practice of livestock rearing and pastoralism (*Arrêté N°0016/PM/SGG* of 23 Feb 2015) with the stated purpose to instruct and propose to the government of Niger how to solve the problem of increasing occupation and privatization of pastoral space. The statement reiterates that the following acts are unauthorized: limiting of pastoralists' access to pastoral resources north of the limit to cultivation (without State and community approval) and "the individual appropriation as a way to indiscriminately and privately control public water points" (*ibid.*). According to the mayor of Abalak (south-east of Tillia in the pastoral zone), none of the local administrators have yet been approached to discuss the problems of land appropriation. This in-action, he stated, "is due to perceptions of the intractability of the problem" (personal communication, November 2015). While gardening was not explicitly declared as part of the problem of occupation, all enclosures and barriers to pastoral activities to essential pastoral resources are discouraged.

It is indisputable that sedentarization and garden activities are an essential pastoral adaptation. Gardening activities are not illegal in the official pastoral zone of Niger, and they do support the transition of pastoral groups out of pastoral livelihoods, which has the potential to build adaptive capacity for this population on the margins. Irrigated 'oasis' gardening is an adaptation promoted both by government policy and authorized by the landmark 1961 limit of cultivation law. However,

these two case studies have shown that the individuals benefitting are not only the indigenous pastoralists of the zone. Remote sensing has shown the rapid expansion of this activity, and the qualitative interviews demonstrated that such exploitation is based in the attitude that the 'land is for the tiller.' The 'losers' in this divergent adaptation are inevitably pastoral users of the water, as the costs for access have increased through fees, dangerous access points, and harm to livestock who are chased away by gardeners. The norms of use in this region, once based upon a de facto commons management regime now conform to a private regime where water is a commodity owned by a selection of few who have positioned themselves around the seasonal lakes. Privileged access is garnered by land holders and tools to enhance exploitation are available only to gardeners. Gardens are shifting the de facto commons regime to a de facto private property regime through a process of enclosure. Thus, this irrigated gardening is a clear divergent adaptation, and has been promoting conflicts due to the limits on pastoral mobility, the loss of ecosystem services supporting pastoral livelihoods, and a dramatic and swift shift in entitlements, as shown by the pace of garden development.

As a divergent adaptation, gardening in the pastoral zone has the potential to limit pastoral activities, prompt conflicts, and enhance vulnerability of pastoral groups in the pastoral system if resources are not managed properly. As shown especially by the Droum example, gardening reduces the adaptive capacities of pastoralists by forbidding access to highly strategic pastoral resources — valley lakes — and promoting a new land regime that usurps the pastoral commons (Figure 9). As the geographic space within the valley becomes enclosed (as seen in Figure 6), the norms of use for both institutional actors and direct users of the resources shift, rendering even democratically elected officials in Droum 'powerless' to uphold laws contrary to such norms of the population (garden communities). The similarity of the context in Tillia, yet differential results point to institutions of natural resource governance as the motivating factor for local norms or acts of conflict related to this divergent adaptation. This dialectic promotes gardening as livelihood diversification and a government-promoted adaptation to drought, yet ignores the manner in which gardens reduce the adaptive capacities of pastoralists as a whole. The appropriation of territories and the water enclosed therein promotes a conflict between those who perceive the land to be pastoral and those who perceive that the land, once cultivated can be bought, sold, and protected using the same modes of land tenure of the South (Figure 6.6).

Figure 6.5 The 1961 Limit of Cultivation and current-day realities.



Grey boxes represent specific quotes from research participants, identified by the number before the colon. P = pastoralist (e.g. 105:21 is Participant 105).

Has the time arrived to change the 1961 law limiting the North to a commonly-shared regime? Gardeners appropriate the land, water, and the surrounding resources, and require sanctions or payment for its use. While this increases the capacities of gardeners in times of drought, without natural resource management and division of space, pastoralists will continue to be dispossessed of land and water, which greatly impact pastoral livelihoods, especially in the context of increasing climate variability and the related vulnerability of pastoral groups. As a result, pastoralists are moving out of the zone and seeking alternative means to protect their livelihood during drought, sometimes through conflict (Snorek et al 2014).

One unintended impact linked to this development scheme is the reduction in revenue for the State (Marty and Bonnet 2006). As study participants stated, taxes in markets alone on livestock (meat, leather, lives animals) are higher than grain, and the compliments to livestock production

are a significant income even for gardeners. Aside from participants' statements, the power of livestock to shift the success or failure of markets has been demonstrated by pastoralist (primarily Fulani) 'boycotts' of local markets in order to produce favorable policies for pastoralists. The institutional support provided through seeds, tools, and technical services for the production of garden produce, versus a near void of support to the development of livestock production in Tillia and Kao reflect continual disproportional development policies. Furthermore, primordial state-making tends towards enclosing and limiting a common to enhance and control the electorate. While innovations in garden production would provide alternative nutritious food sources, few gardeners expressed a desire to sell their produce and some were giving it away to friends and neighbors, despite the presence of motor pumps for irrigation. On the contrary, fodder sales (primarily collected hay stored in garden plots), project aid (grain, water infrastructure, seeds, tools), wood (trees within garden plots), and water sales protected the garden 'investment' in the valley lakes. Yet, these systems of production contribute to higher conflicts by reducing the adaptive capacities of pastoralism in the zone.

The development of contested landscapes like those illustrated in this case study will continue unabated, especially as irrigated gardening is utilized as an adaptation to climate change in Niger. Yet, under what conditions should such gardens and their respective enclosures be established (see also Torou et al. 2013)? While pastoral groups have long been considered experts of adaptation to climate and ecological changes, such divergent adaptation programs in Niger have reduced pastoral livelihoods and push some into greater poverty, due to types of enclosures that do not reflect the needs of the pastoralists in the zone. Enclosures redefine the political and social order of a system with new rules and institutions on how the environment is accessed and managed (Schmidt and Pearson 2016), who benefits, and who is able to decide on boundaries. The pastures in Niger are being lost to enclosure, pushing the remaining pastoral groups into smaller areas and limiting mobility and adaptive capacity. Enclosure undermines common pool resource management by creating competition over access to and use of shared natural resources, and enclosures multiply at surprisingly high rates across the pastoral zone. Most importantly, it usurps the traditional systems of common pool regime management such as who has priority rights over the territory.

6.6 Conclusion

The beginning of the conversation about enclosure in Niger's pastoral zone has already begun. To contribute to this dialogue, this chapter examines enclosure in the framework of divergent adaptation to climate change. This study combines qualitative case study research and remote sensing-based visual interpretation and change detection using very high resolution satellite images. This represents a new combined approach to the study of enclosures and contested landscapes in Niger's pastoral zone, which have not been exploited yet using remote sensing. In two different study sites (Tillia, Droum) in the pastoral zone similar processes were found, and such inscriptions on the landscape are likely to occur in pastoral areas across the Sahel, which are worth a broader investigation, especially given the more recent investments, such as the World Bank's Regional Sahel Pastoralism Support Project (PRAPS) in Sahel's pastoral system.

As shown with the Tillia case, the enforcement and protection of common pool resources (the North part of the valley) has the potential to benefit the entire pastoral system, while permitting some former pastoralists to transform to sedentary livelihoods including gardening. When pastoral resources are managed properly, enclosure is limited, priority rights of pastoralists are recognized and enforced, and projects support mutually beneficial activities for both groups, thus, enclosure and the related conflicts will be reduced. The perceptions that land in the pastoral zone is available "to the tiller" needs to be reversed through sound policies and enforcement that takes into account all the realities of the pastoral zone.

The enclosure of pastoral resources is nothing new. It has been the storyline for development around the world for centuries. What makes this case interesting is not the evolution of development in this zone. Rather it is the contradiction within which such development has been placed — as a way of reducing vulnerability. Indeed, the garden development has the potential to reduce vulnerability for some, but not all actors will benefit from this divergent adaptation without appropriate enforcement and protection of pastoral space.

Chapter 7: Adaptive institutions, cooperation, and divergent adaptation to climate change: Lessons learned from two cases in the Sahel

7.1 Divergent adaptation and institutions

Divergent adaptation introduces new and complex challenges for SES and brings about an opportunity to challenge the paradigms that impede the building of more inclusive models of adaptive capacity for multiple users. It has been established that adaptation, while necessary in the face of inevitable climatic and environmental change (Smit and Wandel 2006; De Perthuis et al. 2010), sometimes fails to build cohesion in societies, and instead can potentially worsen preexisting or create new social inequalities in SES (Ericksen et al 2011; Snorek et al. 2014a; Adger et al. 2006; Thomas and Twyman 2005; IPCC 2012). Yet, under what institutional conditions and through what institutional mechanisms are these unequal adaptive capacities being experienced and enhanced, especially in common and semi-common natural resource management regimes?

Divergent adaptation takes place in a SES in which there are multiple land use regimes (common pool resource regimes [CPRs] and private ownership regimes) and socio-cultural dynamics (Snorek et al, 2014a). In a CPR such as a community pasture, forest, or trans-boundary waterway, it is difficult to exclude or limit users once the resource is provided (Ostrom 1999), and the problems of free riders and over-use demand consistent and adaptive responses (Dietz et al 2003). As individuals or communities lose their capacity to adapt due to shifting rules and norms, multiple users sharing the dynamics of the SES respond by whatever means they have available. Responding with conflict may stem from the persistent motivation to increase the marginalized user's adaptive capacity in the face of multiple climatic and ecological stressors (Snorek et al. 2014a; Turner 2010; Hamza 2012).

Institutions or the informal and formal rules, values, norms, and cognitive processes that constrain individual and collective behavior as well as access to resources and information (Dennett 2013; Gupta et al. 2010) have a distinct influence on adaptive capacity of actors with the SES (Brooks and Adger 2004; Brooks 2004; Hill 2013). Gupta et al. define adaptive capacity as: "inherent characteristics of institutions that empower social actors to respond to short and long-term impacts either through planned measures or through allowing and encouraging creative responses from society

both *ex ante* and *ex post*” the hazard event (Gupta et al. 2010:461). By enabling users to obtain entitlements, access resources, and garner information necessary to their adaptive capacity, institutions frame adaptation (Berman et al 2012). Yet, adaptive capacity may be unequally distributed across and within societies (Adger et al 2007). Thus, institutions can support the development of resilient societies and sustainable adaptation (Ericksen et al 2011; Berman et al. 2012) or bring about greater inequality through processes such as the enclosure of CPRs, and limit the capacities of some to the benefit of a few (Ericksen et al 2011).

In societies facing rapid or slow-onset environmental change, some of which is exacerbated by climate change hazards, societies are most capable of responding when they have built strong and inclusive social capital (Adger et al 2003; Berman et al. 2012; Sanginge et al. 2010). Several Intergovernmental Panel on Climate Change (IPCC) reports confirm the ways in which social capital supports the alleviation of suffering and can enhance human security (IPCC 2007; IPCC 2012; IPCC 2013). Yet, not all social networks enhance community-scale capacities. Those social networks that remain closed and exclusive may result in less innovation and diversity, which are essential elements to successful climate change adaptation (IPCC 2012). Rather, the behaviors promoting the social capital that builds bridges within societies include attitudes that reflect trust, trustworthiness, generosity, kindness, sharing, and transparency with both ideas and information (Berman et al. 2012).

While some paradigms for adaptation and disaster risk management are dominated by top-down hierarchical approaches (Allen et al. 2011), the institutions that empower stakeholders to participate and make decisions to support adaptation demonstrate bottom-up, equitable and democratic processes (Olsson and Folke 2004; Ostrom 1999; Brooks et al. 2005; Lebel et al. 2006; Engle 2007; Engle and Lemos 2010). Polycentric, adaptive institutions have also been shown to produce greater cooperation and adaptive capacity between users (Vincent 2007; Ostrom 2005; Allen et al. 2011). When actors are able to question socially embedded ideologies, frames, assumptions, claims, roles and procedures that dominate problem solving in the SES, there is theoretically more learning and thus greater adaptive capacity (Gupta et al. 2010).

While it is certain that the study of adaptive institutions can support more cooperative, equitable societies, this assertion has not been examined in the context of divergent adaptation to climate

hazards. How would societal norms, cognitive processes, rules and values support and enhance social capital and cooperation in the context of inequitable adaptive capacities? Clarifying the institutional mechanisms that favor certain groups in adaptation over others is an element that needs to be understood in order to reveal the mechanisms that contribute to divergent adaptation and the related social consequences, such as conflict or cooperation (Snorek et al. 2014a). The relationship between divergent adaptation, social capital, and the ways in which institutions enhance adaptive capacity is explored in this chapter.

7.2 Research design

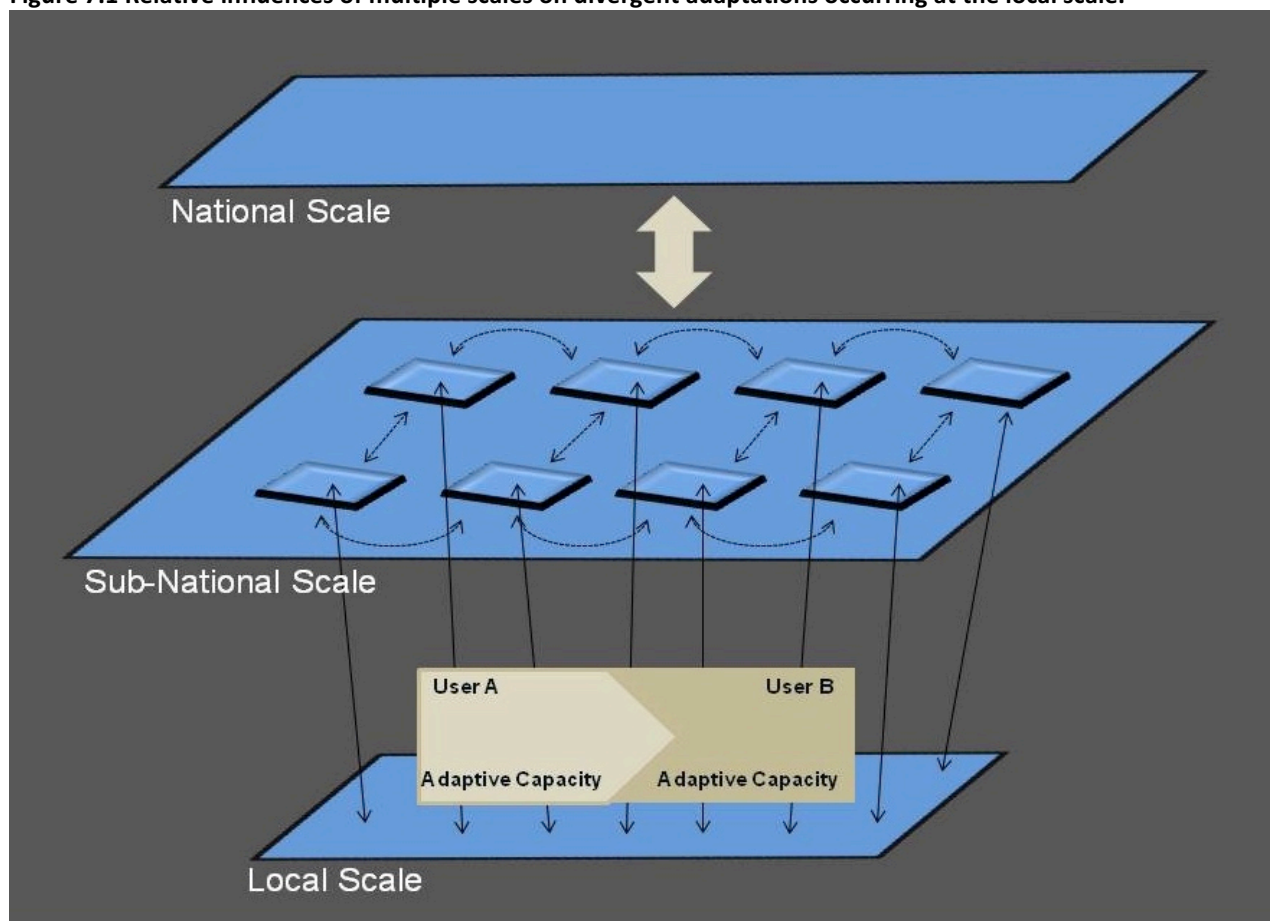
Successful adaptation is highly location-specific (De Perthuis et al. 2010; Locatelli et al. 2008). In sub-Saharan Africa, Kpandonou et al. (2012) points out that national policies have on average failed to improve the living conditions of the poorest communities because their implementation is not compatible with the complex needs of local actors. Designing adaptation planning is best achieved with participation and input from local scale actors, demanding a high level of social cohesion in order to find consensus (De Perthuis et al. 2010). Along these lines, this chapter focuses on multiple scales of analysis (national, sub-national, and local), with a deeper analysis of the local scale (Figure 7.2). Examining cases by looking at multi-scale influences on the SES is a necessary step for improving our understanding of how communities achieve sustainability (Berman et al. 2012). The aim of this chapter is to identify the institutional mechanisms that create more or less conflict dynamics in divergent adaptation between groups and explain how they produce this effect.

7.2.1 Framework for institutional analysis

Institutions frame divergent adaptation. Complex adaptive systems consist of both human and non-human elements (Olsson and Folke 2004; di Gregorio et al. 2008), whose behaviors are multiple and non-linear in nature, complex and cross-scale in time and space, and often unpredictable (Ostrom 2007). To frame the methodology for this chapter, I borrowed concepts from Ostrom's Institutional Analysis and Development (IAD) framework (Ostrom 2005) and Ratner et al.'s (2010) framework (Figure 3) to examine the way institutions influence divergent adaptation and to collect and classify data for an in-depth qualitative case study. The framework assesses how institutions impact multiple users and how resources are produced and developed in CPR regimes (Ostrom 2010). The IAD framework allows rules to be classified in accordance with their impact on the el-

ements of what it terms as an “action arena” or in this case the ‘Divergent Adaptation Arena,’ where social ecological choices and decisions take place. The interactions, outcomes, and

Figure 7.1 Relative influences of multiple scales on divergent adaptations occurring at the local scale.



While the national scale has broad influence (large arrow) on other scales, the majority of interactions take place at the sub-national and local scales in relation to divergent adaptation (represented by grey box).

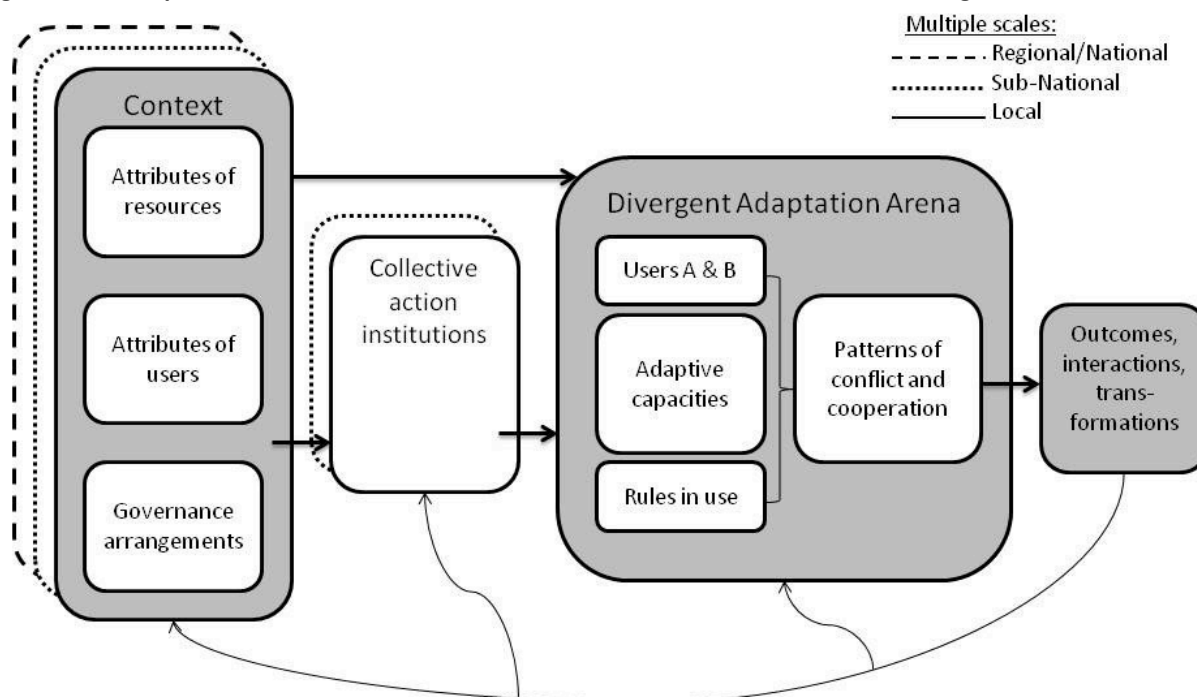
transformations that result from choices in the arena influence collective action institutions and produce social learning as well as (sometimes) hidden forms of social disruption and conflict.

At the outset, the research framework requires an initial understanding of the attributes of resources such as the local environmental hazards, attributes of the users such as the types of work performed, and the governance arrangements such as a land tenure regimes (Figure 7.3). The DA arena is made up of actors involved in a situation, their positions, actions they are entitled to take, possible outcomes, available information, and the ways in which actors’ adaptive capacity is gained or lost with each outcome. Thus, the arena (Figure 7.3) represents the location where coping and adaptation to past climate events (choices based upon the rules in use) can be challenged and analyzed for adaptive capacities of multiple actors, which may shift or change as a result of actions (outcomes). For instance, in a common pool regime, certain rule-based actions may push

multi-scale actors (such as pastoralists, agro-pastoralists, and the land commissioners) to discuss the designation and enforcement of a specific corridor to a pastoral well, thus shifting the users' rules for that specific well. Ostrom defines these outcomes as a 'collective choice situations' given that most individuals involved are affected by the rules in use and can take part in their modification (Ostrom 2011). Similarly, divergent adaptations and conflicts or cooperation can produce a shift in future adaptations, and lead to more sustainable adaptations or more equal distributions of human security (Ericksen et al. 2011; Zografos et al. 2014).

To examine multi-scalar institutions and the ways that they influence divergent adaptations, this chapter focuses on the questions: What role do institutions play in divergent adaptation? How are institutions both contributing and reducing conflict dynamics? What institutions in which localities

Figure 7.2 Conceptual framework on resource conflict, collective action, and social-ecological resilience



(adapted from di Gregorio, Ostrom 2007, and Snorek et al 2014a).

are most contributing to patterns of cooperation in the context of divergent adaptation? The chapter determines how institutions influence divergent adaptation and related conflict in CPRs and semi-commons regimes across various scales including local, sub-national, national, and regional institutions, in order to provide a model for future sustainable adaptation systems.

7.2.2 Legislation and implementation document review

To set the scope of the research, I first collected and evaluated legislation relevant to climate change and adaptation, according to the Organization for Economic Cooperation and Develop-

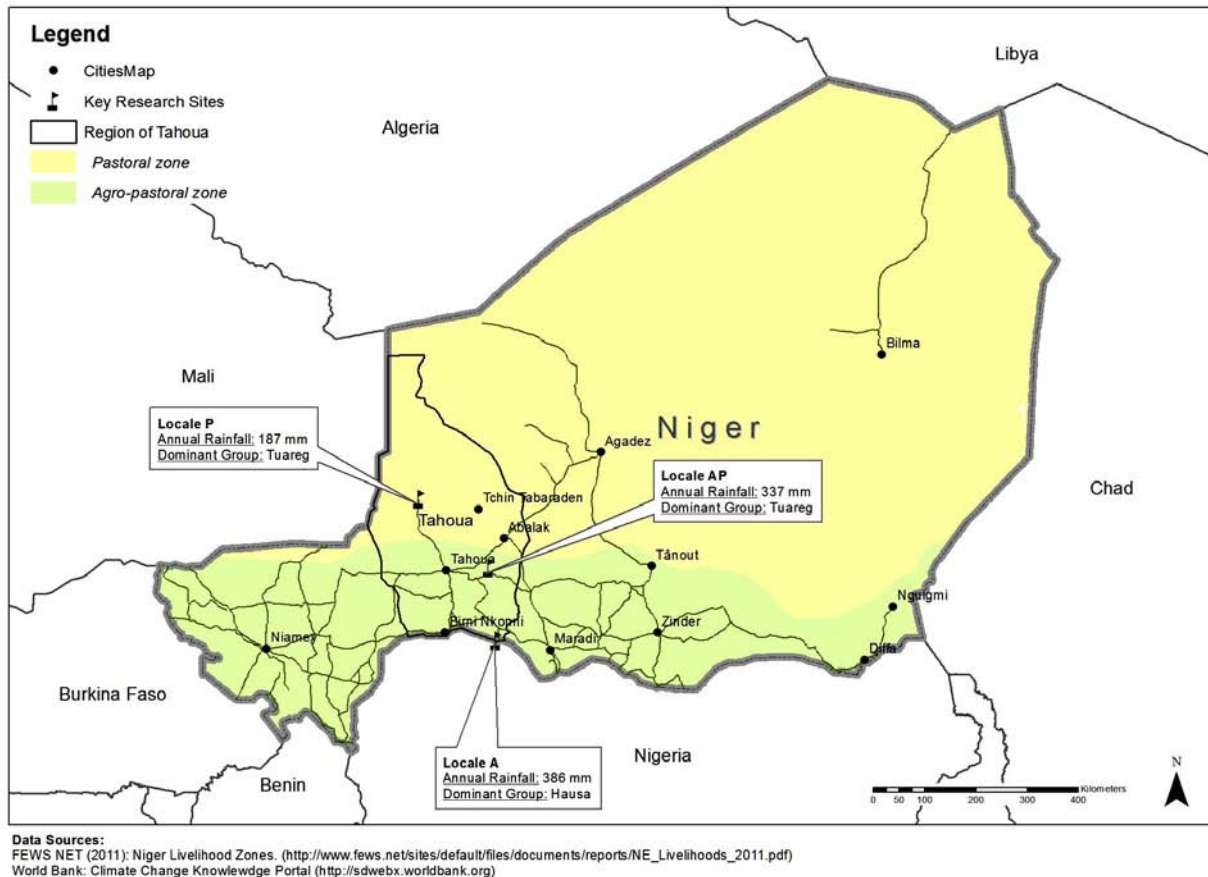
ment's (OECD) evaluation criteria for policy effectiveness, which includes the relevance, effectiveness, efficiency, impact, and sustainability of legislation (ODA 2012). To complement the evaluation and select sites for the household interviews, my team and I held expert interviews, focus groups, and participatory observation in Niamey and the regions of Zinder, Tahoua and Maradi in 2010 and 2011. Through this process, it became clear that the action situation most interesting to the theoretical framework is the transformation of pastoral (common) land to cultivated (semi-common) land, due to the related conflict dynamics. Thereafter, at the sub-national scale, I engaged with members of the *Commissions Foncières* (COFOs) or Land Commissions, court officials, administrators, and experts from governmental and non-governmental associations to analyze the content of *Procès Verbaux* (PVs) or the documents filed for litigation as well as other judicial documents related to land and water access and use and cattle theft. This assisted in understanding how legislation was being implemented and what documentation of conflicts was available.

7.2.3 Site selection

To study the institutional dynamics relevant to these decision-making situations, specific sites in the water-stressed, administrative region of Tahoua, Niger were selected to conduct a deductive analysis of best practices in land and water management, and thus complement our desk-top evaluation of policies. The administrative region of Tahoua is characterized by large transhumant livestock herds that migrate along the north-south axis between Nigeria and Niger's pastoral zone, high levels of economic and rural-to-urban migration, and chronic dependence on drought relief. Sites were selected after a review of PV and interviews with democratically-elected and customary officials based on criteria including: perceptions of water scarcity, high ratio of rural to urban migration, accounts of violent conflict between users, presence of pastoral spaces and corridors, and appropriate level of security for the research team. Customary chiefs representing both the pastoral (Fulani and KelGeres and Ouilimiden Tuareg) and agricultural (Hausa) ethnic groups were sometimes difficult to find as they were on the move or located in far-off villages. The research was carried out on a low to high rainfall gradient including the northern pastoral zone, the southern agro-pastoral and high cash crop production areas (Figure 7.4). The residents in Locale P are majority pastoral households, and the region receives 187 mm rainfall per annum. Locale AP is populated by a majority of agro-pastoral households and receives 337 mm per annum. In Locale A, the majority takes part in multiple agricultural activities including dry and irrigated cultivation and

also some localized and mobile livestock production, receiving 386 mm of rainfall per annum (Figure 7.4).

Figure 7.3 Map of study sites



Depicting the region of study (Tahoua - thin black outline of region) and the three village study sites (Locale P or pastoral, Locale AP or agro-pastoral, and Locale A or agricultural). Data sources: FEWSNET, 2011, World Bank Climate Change Knowledge Portal, and Snorek et al. 2014a.

7.2.4 Data collection and analysis

Field observations illustrating high institutional diversity across different scales and localities, resulting in variable levels of adaptive capacities between users (Snorek et al. 2014a) shaped the methods of data collection. Paradoxically, higher levels of natural resource-based conflicts were prevalent in the northern, more sparsely populated agro-pastoral zone compared to the highly concentrated, southern irrigated gardening and agricultural zone of Tahoua, contradicting common assumptions about Sahel societies and scarcity (Raynaut 2001). The South concurrently had greater numbers of customary officials. To better understand these dynamics, I carried out a thorough analysis of challenges, successes, and practices in commons and semi-commons land and water management. A total of 43 pastoral and 34 sedentary households interviews and focus groups were conducted across the three Locales based on both a random and informed (purpose-

ful sampling) selection process, with more limited numbers of participants in Locale P due to security restrictions. Cultural groups interviewed include both traditional sedentary and nomadic groups from the Hausa, Fulani, KelGeres Tuareg, and Ouillimiden Tuareg at both the local and sub-national scales. Users were aggregated by their activities and status as a local (strong place connection) or non-local to the zone – local pastoralists (semi-nomadic, livestock as their primary capital), local agro-pastoralists (sedentary, land and livestock as capital), and non-local, visiting herders (mobile, sometimes serving as shepherds).

To understand the evolution and implicit rules-in-use requires significant time at a site and non-threatening, context-sensitive inquiry about rule configurations (Ostrom 2011). To this end, we discussed two conflict-relevant dynamics relevant to the divergent adaptation of spreading cultivated fields (crop damage and theft). Multiple types of leaders (customary, administrative, technical experts) and equal numbers of mobile pastoral and sedentary agro-pastoral households participated. The questionnaire used at the sub-national and local scales was developed based on the theoretical framework (Figure 7.3 and Table 7.1). Data from qualitative interviews were triangulated with expert interviews and policy analysis; the qualitative data were treated with AtlasTi qualitative analysis software.

Conceptual Frame	Topics of Questionnaire	Inquiry Method	National Scale	Departmental Scale	Local Scale
Attributes of resources	Environmental and climate hazards, water sources, forest, soil types and quality, impacts from climate events	HH and Expert Interviews		X	X
Attributes of users	Types of work performed, demography, cultural makeup, material assets, common assets, seasonal migration patterns, infrastructure, history, political and religious leaders	HH and Expert Interviews		X	X
Governance arrangements	Land tenure, land titling, transactions between users, exploitation of common goods, livestock routes, water access and use, sanctions for rule-breaking	OECD analysis relevant legislation, HH and Expert interviews	X	X	X

Conceptual Frame	Topics of Questionnaire	Inquiry Method	National Scale	Departmental Scale	Local Scale
Divergent adaptation arena	Divergent adaptations, actors: agro-pastoralists and pastoralists, water access, pasture availability, crop damage, theft, violent conflict	HH and Expert Interviews		X	X
Outcomes, interactions, transformations	Shifts in rules in use, leadership practices to shift interactions in the action arena, cooperative behaviour between users, increasing conflict dynamics	HH and Expert Interviews		X	X

Table 7.1 Multi-scalar approach to the IAD framework

7.3 Multiple scales of formal and informal institutions in Niger

7.3.1 Agro-pastoralism: the favored livelihood of Niger

In 2007, the National Adaptive Capacity Index, using quantitative indicators relevant to climate change adaptation, ranked Niger as the country with the least adaptive capacity in the world (Vincent 2007). Nearly 85% of Niger's total population, which grows at a rate of 4% per annum (WBG 2016) depends primarily on rural livelihoods including those based upon rain-fed agriculture (producing primarily millet and sorghum) and livestock. More than 20% of Niger's export earnings are generated by livestock, which relies on commons regimes and mobility (Zakara and Abarchi 2007). Yet mobile livestock producers or pastoralists' livelihood needs tend to be marginalized, neglected, and ignored by adaptation and development planning (Thébaud and Batterbury 2001; Zakara and Abarchi 2007; Snorek et al. 2014a). Democratic participation is typically highest amongst the more populous sedentary farming population, but is further constrained by chronic poverty (55% of rural population), widespread illiteracy (84% of those older than 15), and frequent droughts that devastate the rural economy (IFAD 2016). As a result, the laws, codes, and texts related to land rights tend to favor farming, which is considered to be the principal rural activity (Lund 1998; Oxby 2011). Thus, the protection of commons in Niger is highly marginalized, and texts stating the protection of the commons are rarely disseminated or enforces across national to local scales. As a result, the norms and rules governing CPR resource access and use are primarily a problem handled by local scale actors, with some interaction with the sub-national scales and also with customary officials. The decisions of multiple users over the use and distribution of entitlements for CPRs is related to conflict-related divergent adaptation responses (Snorek et al. 2014a). One's abil-

ity to improve one's access and entitlements depends upon how they influence collective action of institutions at these two scales (Ostrom 2007; Ratner et al 2010).

During a multi-stakeholder focus group discussion of future climate scenarios, it was determined that pastoralists would eventually cede to a sedentary, agro-pastoral livelihood, as pastoral land would inevitably be transformed to privatized, cultivated land without drastic institutional change (Snorek et al. 2012, see also Chapter 6). There is a high level of confidence that Niger's Tahoua Region will experience an increase in temperature by 2°C by 2050, and slightly less confident predictions of an overall increase in annual rainfall (+7%) with decreasing rainfall during the typical rainy season (-4 and -6% respectively) (Bruggeman et al. 2010). These data, along with other reports on rainfall projections for the Sahel (Biasutti 2008; Shanahan 2009) point to increasing rainfall variability as a result of climate change, which has consequences for institutions relevant to divergent adaptation (Snorek et al. 2014a). Rainfall variability coupled with overgrazing, poor soil quality, the commercialization of land and water resources, precarious pasture spatial and temporal availability (Bode 2011; Touré 2015) and decreasing agricultural production yields (Snorek et al. 2014a) stimulates competition over common pool resources. The following examines national-scale institutions that have framed pastoralist livelihood transformations (User B, Figure 7.1) in Niger's SES.

7.3.2 National to departmental scale governance arrangements

Late pre-colonial and colonial frameworks shape the modern system of national-scale institutions in Niger, which in turn have framed how entitlements to common land and water are distributed. During the period from 1860 to 1900 called *Zamani*, the Tuareg *Imagheren* (the noble and warrior caste of the nomadic herdsman) dominated both nomadic and sedentary populations of Tahoua, who in turn paid tribute to and endured frequent raids by these warriors (Rossi 2002). In 1901, after significant battles between the Kelgress Tuareg (the semi-nomadic tribe dominating southern Tahoua during that period) and the French, the Kelgress Tuareg ceded control of their territories to the French, but remained in the same territories. To control the newly suppressed territories, the colonial government established territories called *Cercles* (called 'regions' in modern day Niger) managed by Commanders, Sectors managed by military lieutenants, and two indigenous-managed institutions - the *Canton* and *Groupement* (Tuareg and Fulani ethnic groups each had *groupement*). *Chef du canton* is the unit of rural power serving as the administration, justice, and police for rural peoples. The *cantons* (Figure 7.5) are defined by territories that were arranged

based on colonial interests; whereas the *groupements* were based on ethnic groups linked to pastoralist actors (Fulani and Tuareg) and do not control territory. To encourage acceptance of these conditions, pastoralists were told that their territory was essentially ‘everywhere,’ but laws only permitted their jurisdiction over individuals. The colonial period ended in 1960 with the election of Hamani Diori as the first president post-independence, but the system of Cantons and Groups remained (Figure 7.5). Today, *Chefs du Groupement* or Group chiefs have strong commitment to maintaining pastoral rights to pasture and water, but possess little jurisdiction to enforce these rights, which often results in the loss of pastoral territories to cultivation. Moreover, their distribution across administrative departments is not equal; Keita has only one Group chief, whereas Madaoua possesses seven (Figure 7.5).

The first legislation establishing an official pastoral territory, declared in 1961 (Law N°61-05, Table 7.2) divided the country into two sections; the North was designated for pastoralism and the South for cultivation (Figure 7.4). While seen by some as strengthening the pastoral system, this division served to frame divergent adaptations by both its lack of enactment and perpetual debate about its exact location. As a result, cultivation continues to creep into the northern pastoral zone with impunity. The second piece of legislation formalizing pastoral space is a 1987 decree (Table 7.2), designating the South as a semi-commons regime (Zakara and Abarchi 2007). This decree affirms pastoralist rights to access and consume fodder in the agricultural zones, but only after the harvesting of crops has been completed and a *liberation des champs* officially declared. This ‘freeing of the fields’ is a date determined by a department-scale committee made up of individuals from the government administration and customary authorities (Figure 7.5) as well as the technical services from the ministries of livestock and agriculture, and it typically occurs between November and January. Prior to the *liberation des champs* livestock are only permitted to graze in fallow or uncultivated pastureland (Niger Decree N° 87-077 1987). This also established a mechanism to permit agro-pastoralists (cultivators) to collect compensation if crops or residues are damaged prior to the *liberation*, at a rate determined by local and sub-national institutions (Table 7.2).

Table 7.2 Relevance of key legislation to divergent adaptation

Name	Relevance to Divergent Adaptation
<i>Law N°61-05, 1961, Northern boundary of cultivation</i>	Limited local pastoralists’ management of territory while concurrently permitting de facto infiltration of cultivation by non-enforcement
<i>Decree N°87-077, 1987, Established semi-commons in South and the Libération des champs</i>	Limited temporal nature of pastoral mobility, created land-holder’s right of censuring and taxing pastoralists, and promoted violent conflict

<i>Ordinance N°93-15, 'Rural Code', 1993, Organized the rural zone</i>	Provides system of rural (commons and semi-commons) organization but has not been properly implemented or understood by decision makers
<i>Law N°93-14, 1993, Declared that all water sources must be accessible to pastoralists</i>	Created open access regimes on northern pastoral territories, though has not been implemented in the South.
<i>Decree N°97-007/PRN/MAG/EL, 1997, Established pastoral home territories with priority resource rights</i>	Home territories remain an enigma due to the legislations vague treatment of this important historical pastoral territorial tenure practice
<i>Decree N°97-008/PRN/MAG/EL, 1997, Supported the organization of the Rural Code's activities</i>	As part of decentralization, this law has established COFOs, yet the power over land tenure decisions is disconnected and thus more corruptible.
<i>Decree N°97-368/PRN/MHE, 1997, Describes modalities of land commissions</i>	There is a lack of implementation of COFOs at the village level, and a lack of representation of pastoral groups
<i>Law N°2001-23, 2001, Established sub-national administrators</i>	Land tenure decisions have thus devolved from a single customary authority to multiple authorities, causing many to blame 'democracy' for land tenure issues
<i>Ordinance n°2010-029, 'Pastoral Code', 2010 Codifies pastoral rights to mobility and natural resources</i>	Projected hope for more protection of pastoral territories, but due to its emphasis on mobility, enhanced open access regimes that are subject to over-exploitation by outsiders
<i>Ordinance n°2010-09, 'Water Code', 2010, Sets the terms for water management</i>	Created open access regimes on northern pastoral territories, though has not been implemented in the South. Has permitted the trend of pay-for-use, private wells.

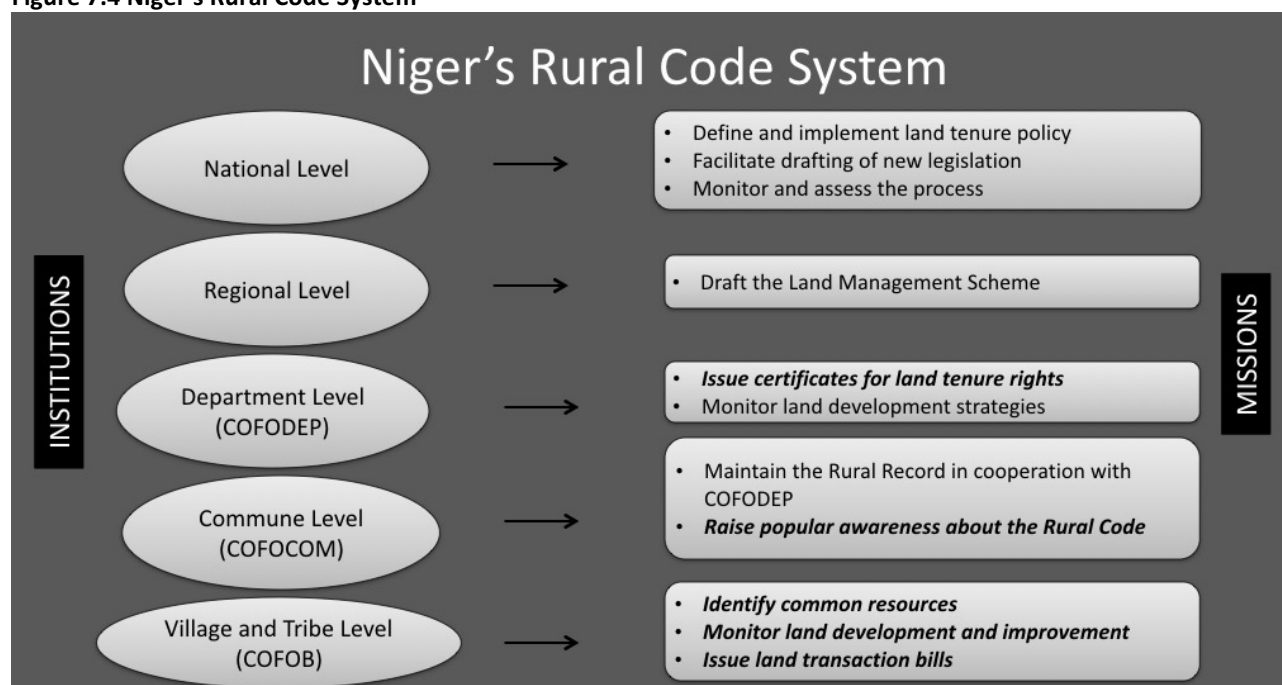
(Adapted from Table 4.3)

Another important and relevant piece of legislation is the Rural Code, which was adopted in 1993. The Code formalizes land and water common pool resource property regimes for both sedentary and mobile groups (Lund 1998; Hammel 2005; Touré 2015). It defines land tenure policy and monitors the process of its implementation, with the overall goal to reduce conflicts over natural resources. One important aspect of the Code concerns privatization of territory. Appropriation of land or water is garnered first through the permission by customary authorities (Canton chiefs handle all land claims in southern Tahoua). To do so, an individual's claim to a territory must be supported by a verbal reference from two separate individuals. The protection of commons proves to be much more difficult and requires the organization of multiple administrative actors including land commissions (COFOdep, Figure 7.6) and customary authorities in order to designate and defend an official pastoral area in the South. While the Rural Code aims to secure rural operators by recognizing rights that produce an agrarian organization of the rural sphere (Lund 1998), pastoral territories are often neglected.

During the fieldwork, we observed one such conflict in Birnin' Konni (Southern Tahoua) in November 2011. While meeting with the Fulani *chef du Groupement*, a group of Fulani pastoralists entered, requesting audience over a conflict about a pastoral area that had been cultivated. The *chef*

explained that he had addressed the same territorial conflict the year prior and the decision made in conjunction with the local administration and *chef du Canton* was to protect this area as a pastoral commons. Yet, with the ensuing elections of new representation, the cultivator obtained a land title for the same piece of land and began cultivating. While typically litigations of this nature must issue a *Procès Verbal* (PV), or the records used for cases handled by multiple scales of administrators, including customary officials, some customary officials fail to record cases and lack transparency (Table 7.3). Unlike government administrators, customary chiefs receive no state salary. Due to the lack of implementation of the Rural Code's mechanisms of territorial organization, there is a void of appropriate records for common space. When conflicts occur, land commissions (*commissions foncières* or COFO) serve in both reconciliation and judgment processes along with administrative actors (Table 7.3, Figure 7.6). The most common problems are land related, such as heritage claims, crop damage, and disputes over pastoral commons. While the governance of common pastureland issues is sufficiently addressed in the Code, implementation often proves to be much more complex.

Figure 7.4 Niger's Rural Code System



The systems presents a decentralized manner to disseminate, communicate, and implement rural legislation (bolded text more relevant to conflict dynamics). **COFO = Commission Foncière or Land Commission.** [61].

A process of administrative decentralization began in 2002, establishing municipal administrative units (Commune Mayors, Departmental *Préfets*, and Regional Governors, Figure 7.5). Decentralization has contributed to a gradual shift of power from customary chieftains to democratically elect-

ed leaders (de Sardan 2009). This shift has the potential to limit the bias of power some assign to traditional leadership (elected for life) through the short-term hold of power and overall community support represented by democratically elected officials. In turn, this gradual shift in Niger has resulted in a multitude of confusing arrangements, undulating alliances, and political bargaining. Based on the data collected, participants at both the commune and local scale accused 'democracy' of being the cause of increased corruption, the loss of protection of commonly shared natural resources, and the conflation of customary and administrative decisions. It remains to be seen how decentralization will more broadly impact the population, especially in the context of divergent adaptation.

Table 7.3 Litigation from Proces Verbale (PV) relevant to divergent adaptation

Summaries of PV data gathered in Keita and Madaoua				
Date	Department	Authority	Object	Decision
Aug 1997	Keita	Administration	Pasture Area	A farmer was exploiting a field adjacent to the pastoral area and the livestock corridor used by herders to water their herds. The committee decided to return the field to its original size, protecting the pastoral space.
Jan 2004	Keita	Gendarmes	Crop Damage with violence	A farmer's bean field was damaged by a herd, incurring a fee of 189 USD, which was declared by the justice due to the presence of violence, arms, and wounded
Oct 2004	Keita	Gendarmes	Crop Damage with violence	The herder paid 1205 USD and this case was treated by the Justice due to the fact that there were violence and wounded
Sept 2007	Keita	Gendarmes	Crop Damage with violence	The justice found those involved in the fighting (including arms and wounded) to be guilty and required an amendment for the damages
April 2010	Keita	Gendarmes	Crop Damage with violence	The guilty party (herder) paid 207 USD conforming with the damages to a mango garden committed, including armed violence
Jun 2010	Keita	Gendarmes	Crop Damage	Referred to the justice, who found reconciliation between the parties
Dec 2010	Keita	COFODep	Crop Damage	16 cows belonging to herder destroyed harvest of a farmer in same village. Herder paid 180 USD, 28 USD of which was paid to the farmer, while the remaining paid for the litigation costs
Mar 2011	Keita	Multiple	Crop Damage	38 camels of the accused herder (a resident of the same village) entered the field, eating valley produce. The herder paid 296 USD in damages, 81 USD of which was returned to the farmer.
Dec 1999	Madaoua	Village chief	Livestock corridor	A farmer was planting in the corridor to a lake. The farmer agreed to stop planting the route, which will be reinforced by the village chief.
Jan 2004	Madaoua	Village chief	Crop Damage	The herder will pay 17 USD in reparations for damaging the field.
July 2004	Madaoua	Village chief	Crop Damage	The herder will pay reparations of 103 USD for damaging crops.
May 2007	Madaoua	Chef du canton	Access to lake	The Chef du Canton outlawed planting in a lake, stated that herders can water their animals. The accused must construct a route to the lake so that livestock can pass.
Apr 2010	Madaoua	Chef du canton and Chef du	Pasture area	Certain fields were encroaching into pastoral area. The area and corridor were determined to be protected from

	groupement		all cultivation by the Group chief and Canton chief. They stopped all cultivation and demanded that farmers respect the current borders.
Madaoua	Justice	Crop Damage with violence	The farmers saw animals in one field and called the owner, confiscating the accused herder's animals. After some discussion, a fight broke out and the farmers followed the herder to his camp to destroy it. The gendarmes arrived the same day 2 hours after the fighting began.

Payments were converted to USD from FCFA at a rate of 1 USD = 581 FCFA.

In 2010, another key piece of legislation was adopted: the Pastoral Code. Heralded by international pastoral advocates, this new legislation emerged after increased pressure and lobbying by local pastoral organizations to address the inequities pastoralists face with regard to cultivators (Oxby 2011). The Code's aim was to fill the gaps, define and specify the rules and principles concerning pastoralism and what the 1993 Rural Code had previously established (Lund 1998). The Pastoral Code acknowledges the essential pastoral adaptation mechanism – mobility - and is supportive to all types of animal husbandry activities in Niger. Furthermore, it mandates livestock safety of passage and access to water points and areas of pasture in the zone of cultivation. Finally, it creates a legal framework for interaction between people whose livelihood is based on animal husbandry and other groups such as agriculturalists, mining companies, or commercial livestock production on ranches (Snorek et al. 2011). While these developments were heralded as important advances in the recognition of pastoralists' rights, the government was criticized for trying to replace what it considered being a messy system of customary collective institutions with a new centrally managed modern governance system (Oxby 2011).

The explanation of national-scale institutions would not be complete without discussing the role that internationally funded governmental or non-governmental projects (hereafter referred to as 'projects') have played in shaping the institutional adaptations of local actors. The architecture of institutions within projects tends to follow Western models of natural resource arrangement and management - arranged by sectors, influenced by funders, and following specific models of development (de Sardan 2009). Such models are imposed upon local actors, who conform their own institutions to fit the expectations of projects including the election of delegates, management committees, offices, and general assemblies reflecting specific quotas of female participants and participation by multiple community actors (ibid.). In this model, the low-level field agents (*animateurs*) serve an important role as 'local brokers of development' (de Sardan 2011) who support local actors to adapt their own institutions to that of 'modern' development. Yet, despite their

vast comprehension of the rural sphere, *animators* are not empowered to support the development of sustainable project models. Thus, local scale conflicts, problems in implementation, elite capture, and incongruities as to who is vulnerable are not translated into greater efficiency within projects. Upon the departure of the project, such systems are often quickly replaced by the former normative institutions.

The national-scale institutions presented here are often translated to the local sphere in multiple, indirect ways. The next section compares two case studies, one in the northern agro-pastoral zone (Keita) and one in the southern cultivation zone (Madaoua), which are characterized by the dominance of different livelihood activities (agro-pastoralism and irrigated or rain-fed agriculture) to illustrate both how social dynamics play out in situ and how such dynamics are related to institutional influence upon divergent adaptation and conflict.

7.4 Case study in the agro-pastoral Keita department

7.4.1 A confluence of livelihoods

The agro-pastoral department of Keita (Figure 7.4, Locale AP) sits in a precarious location with its northern border on the shifting and disputed edge of the pastoral zone and arid mountains and humid valleys to the South. The Keita Valley, which currently receives on average 337 mm of rainfall per annum (Figure 7.4), unites four watersheds in the region of Tahoua, the Adouna, Tarka, Jangay, and Jaboyé valleys and is surrounded by mountains and plateaus. Because of its potential for water management, the French colonial authorities built a dike in Keita in 1952, forming a large lake suitable for fishing, wheat production, and bird-watching. Prior to this time, Keita was primarily inhabited by the *Borroro* (a sub-group of Fulani people) pastoralists and their cattle. The colonial investment brought migrant farmers, established 2 *chefs du Canton* in Keita and Tamaske, and established wheat cultivation, developments which essentially pushed the *Borroro* northwards in search of sufficient pasture. The KelGeres Tuareg also had one *Chef du Groupement* near the Akawal Plateau, whose people migrated on transhumance between Agadez and Keita up until the drought in 1974. This *Chef* vehemently defends the Tuareg's historical dominance of Keita, and complains about how it has been overtaken by Hausa farmers. He is the only customary chief representing pastoral rights living in Keita.

In the 1950s, water was abundant, nourishing low-lying areas with nearly year-round agriculture; however, according to Keita's *chef du Canton*, when the dike of Keita broke for the first time in 1964, the valley became eroded and the water table lowered, leaving behind many dry wells and sediment-filled waterways. The loss of this infrastructure, coupled with the quickly increasing farming population produced vast deforestation in the zone, promoting erosion, soil degradation, landslides, and property loss in the department. These biophysical changes resulted in the desiccation and runoff, which contributed to the formation of a lake in the North, called Tabalak. As socially-based example of the desiccated, typically a woman will receive a donkey as part of her dowry due to the distance she must travel to gather household water (Image 7.1). Water scarcity in Keita has shaped societal and landscape relations.

Image 7.1 Keita, Niger



(Left) Denuded hillside shows extreme erosion of Keita, Niger (Snorek, Nov. 2011). (Right) Women travel by donkey in search of water (Keita, Snorek, Nov. 2011).

7.4.2 A history of project interventions

After the disastrous drought of 1984, the Italian-funded Ader Douchi Majiya Project began a massive reforestation effort and concurrently built many water-retaining infrastructures throughout the department to increase food security by stopping desertification in the region (Rossi 2006). More than \$88 million was invested in the regeneration of the region during the 25 years of work. Such investment attracted high in-migration of primarily sedentary groups (Hausa) and promoted an expansion of cultivation, which permanently displaced the many nomadic groups in the area (ibid.). The new inhabitants along with the project intervention shifted the property regimes in the zone from a primarily pastoral common to a burgeoning private property zone. Some of this was due to the project promising land to those involved in restoration activities. Along with water shortages, the department hosts a variety of conflicting actor interests, especially when the for-

mer inhabitants of the territory (pastoralists) descend from the northern pastoral common regime early, due to a lack of water resources in the North.

While pastoral infrastructure such as wells, corridors, and pasture areas (*aires de pâturage*) have been installed throughout Keita, especially by the Ader Doutchi Majiya project, marginal effort has supported maintaining these resources for pastoral purposes, as conflicting interests often favor the adaptation needs of sedentary users. For example, Image 7.2 depicts a pastoral well that has been surrounded by cultivation (left) and a field that has been installed on a formerly pastoral area called Plateau Akawal (right). Furthermore, adaptation policies from the 1990s enhancing livestock production as drought insurance promoted the extraction of field residues as fodder. Having lost this key fodder source and pasture areas, pastoralists expressed a great deal of fear about passing through the Keita department, due to limited corridors, blockages to water access, commercialized fodder, a lack of representation in the department or commune administrations, and the high payments derived from crop damage and water access that are extracted by local actors at both the village and sub-national scales (Snorek et al. 2014a).

Image 7.2 Crop encroachment in Keita



(left) of a pastoral well surrounded by fields taken in June; (right) Hausa agro-pastoralists stands near field planted on formerly pastoral area of Plateau Akawal (Keita, Snorek, Nov 2011).

7.4.3 Pastoralists 'run' through the department

Locale AP is not only an important agro-pastoral area, but an essential transhumance zone for pastoralists. The pastoralists passing through Keita were the recipients of conflict-ridden statements about their adaptation behaviors from administrators and local agro-pastoralists (Table 7.4). According to the vice mayor in Ibohamane (commune capital) “[They believe] that if their cows spend 3 months grazing in that valley, they can withstand a drought.” This context framed the higher expressions of fear and violence experienced by respondents (Table 7.4). The livestock and

pastoralists descend into Keita as the seasonal lakes dry in the Northern pastoral zone, typically in October and December. Agro-pastoral work of clearing the harvest has now doubled due to the extraction of residues, which in some cases bring in more revenue than grains due to drought, though their removal has reduced soil fertility. The official declaration of the *liberation des champs* typically occurs in Keita during November or December. Pastoralists descending earlier than this declaration remain on designated corridors and in pasture areas, but in some cases they are cultivated or destroyed (Table 7.4). Agro-pastoralists equate the livestock's descent to conflict and violence and expressed high levels of distrust of the other actor group (Table 7.4). While the expanse of cultivation is due to an overall lack of available land and low yields due to soil infertility and rainfall variability to increase agro-pastoralists' adaptive capacities in the face of drought, cultivated also serves as a way to push out or profit from sanctioning pastoralists. To avoid conflict, pastoralists travel through fields under the cover of night, escaping to the mountains before they can be detected and their livestock confiscated as 'payment' for 'crop damage,' which costs on average 8 USD for large and 5 USD for small ruminants. And, village chiefs have responded by calling the gendarmes when the pastoralists begin to descend (Table 7.4). "Before, when the Fulani herders put their livestock in our fields, we intervene ourselves to chase them away, but we noticed that when the gendarmes intervene, it is us farmers who are punished, so since then, we do not intervene anymore" (P29). Several pastoral groups stated that they must 'run' through Keita to avoid problems with gendarmes.

7.4.4 The spread of 'trap' fields

The *liberation du champs* declaration tends to benefit the adaptive capacity of sedentary populations more than mobility needs of pastoralists, resulting in defensive behaviors from pastoral actors, whose adaptive capacity is thus limited.

Moreover, these actions have spurred the development of 'trap fields,' that are illegally cultivated in traditional pastoral zones in hopes that livestock will wander in and damage fields, resulting in significant bounty of compensation to the owner. This economic gain is a support to cultivators especially in times of drought. As stated by an agro-pastoralist from Konni, "Each

Image 7.3 Gendarme vehicle with confiscated sheep



(Keita, Snorek Nov 2011).

one who damages [crops], the Hausa [farmers] make him pay money. But [before] there was pasture and the camels could go where they wanted, but now there are people everywhere. And there are fields of onions everywhere.” Moreover, in many cases official infrastructure protecting pasture or livestock corridors is damaged and ignored by sedentary groups, acting with impunity due to the normative lack of repercussions for such behaviors. Thus, as all pastoral territories are overcome with fields, farmers receive no penalty. Furthermore, the Keita gendarmes guarding fields concurrently profit from the ‘early’ descent, and were observed packing several sheep into the back of a government vehicle during our passage one morning. According to the village chief, these sheep were the bounty from the gendarme’s protection of a villager’s field (Image 7.3).

7.4.5 Promoting an ‘every man for himself’ mentality

The presence of gendarmes has not been welcomed by all. Agro-pastoralists prefer localized forms of compensation and resolution for crop damage (Table 7.4), as gendarmes tend to garner any compensation that should rightfully return to the field owner. Moreover, several participants from Locale AP found that this enforcement service disrupts the long-standing cooperative system of negotiation between users. In the Locale, cultivators expressed generally cooperative behaviors, clearing their fields more swiftly when the pastoralists began to descend and negotiating a nominal token for crop damage. Despite these efforts, however, pastoralists have become so fearful of passing through Keita, they take their protection into their own hands. Some have responded by shooting arrows at farmers and even gendarmes. This has resulted in several severe injuries amongst local agro-pastoralists and enhanced the fear and distrust between both groups. In Keita, when the problem cannot be resolved at the local level, violence replaces the endemic systems of livelihood protection including cooperation, negotiation, and discussion to maintain pastoral mobility in this department.

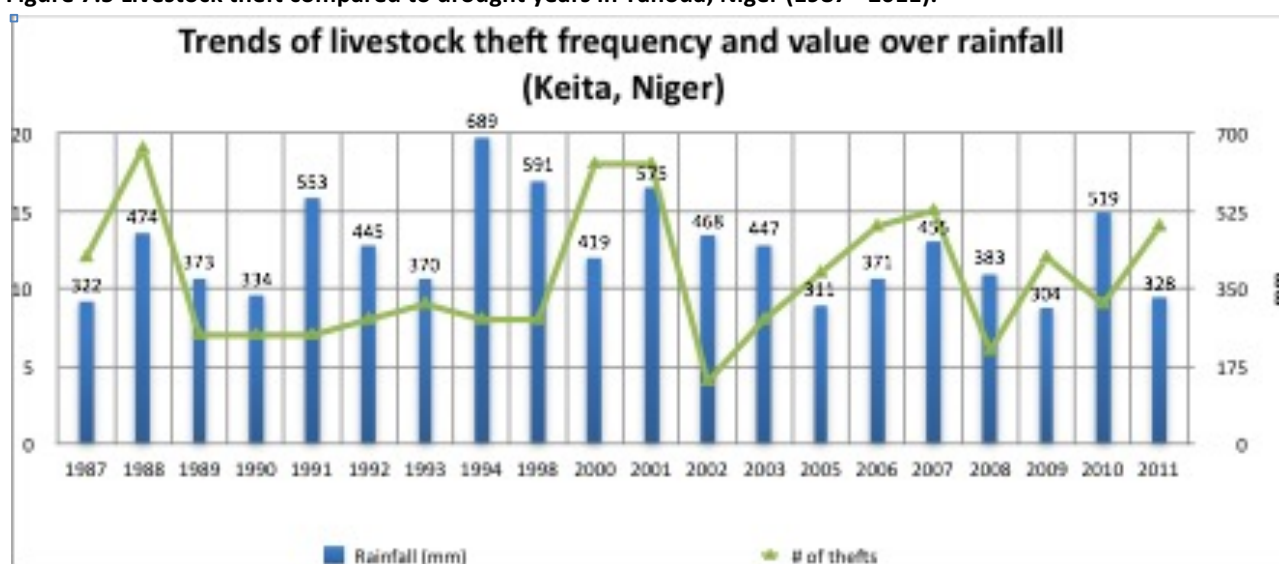
7.4.6 Types and amounts of litigation in Keita

While the Rural Code (Table 7.2) has framed a situation in Niger’s southern semi-commons regime that favors farming, privatization of natural resources and access, and even the passage of livestock through cultivated fields (payments for crop damages), the actors involved in these disputes are mostly local and commune level actors. As a result, very few cases of litigation reached the formal departmental scale, where a PV would document the case. Thus, during the study’s review of PVs in Keita, the PVs related to only 8 cases during 1997 - 2011. The majority were related to crop damage costing more than 172 USD, and for four of these, there were cases of violence.

Three of the crop damage cases were handled by the gendarmes and one was negotiated by the land commissions (COFO). Only one litigation was relevant to protection of pastoral space (see Table 7.3), and was resolved in favor of protecting the pasture area.

Due to the limited records available for land and water litigation, we examined cases of cattle theft (Figure 7.7), which were much more prevalent at this scale. Cattle theft, a growing problem in the region, is managed by gendarmes and the court of appeals, who tend to play a larger role in defending pastoralists and livestock owners. According to participants, theft typically occurs during drought periods, and is the result of poverty. Others mentioned cases of professional thieves, who gather livestock at night and herd them to a vehicle that transports them to markets in Nigeria beyond detection by gendarmes. Despite the high awareness of theft at the departmental scale, very few pastoralists stated that they received compensation for losses.

Figure 7.5 Livestock theft compared to drought years in Tahoua, Niger (1987 - 2011).



Source: Own figure, with data collected from the court of Keita, Niger and Direction of Meteorology in Niamey.

7.5 Case study in the heavily cultivated Madaoua department

7.5.1 High concentration of livestock and cultivation

In comparison to Keita, the rainfall in Madaoua (Locale A) is slightly higher (386 mm, Figure 7.4) and supports many seasonal lakes and a high water table. The department is considered an intensive agricultural production area, and exports both livestock and onions to produce significant tax revenue. A significant feature of Madaoua is the large number of Canton (one) and Groupement (six Tuareg, one Fulani) chiefs that live within the zone and defend the rights of pastoralists there-

in (Figure 7.6). Their control over the territory has resulted in a history of cooperation between sedentary and pastoral groups, despite the great differentiation in territorial holdings resulting from the colonial arrangements (Table 7.3). Based on the *Procès Verbal* (PV) from Madaoua, only six cases of land and water conflicts were recorded from 1999 to 2010. Of these, three were handled and recorded by village chiefs, two for crop damage and one related to the protection of a livestock corridor. The other litigation was managed by the *Chefs du Canton* (2) and *Chef du Groupement* (1) and the Court of Appeals (1). Three of the recorded conflicts enforced the protection of pastoral commons (Table 7.3).

Bangui is the commune capital of Locale A that lies directly on the Nigeria border. It was at one time dominated by Fulani people, who came from Sokoto, Nigeria to dwell there. The Fulani herdsman that dominated the zone at this time called the place Bangui after a large cow died in that location. Today, many sedentary Fulani live in the commune, but the dominant actor group is Hausa farmers, who are intensively cultivating the rich territory. Thousands of livestock pass through Bangui every year to markets in Nigeria, where livestock prices are higher. Based on records from Bangui's small border patrol office, nearly 4 million FCFA (8,000 USD) in tax were collected in October and November 2011 alone (Figure 7.7), with an approximate annual income of 30 million FCFA or 60 thousand USD. Bangui is also located along an international livestock corridor established in 1968 and stretching for 90 kilometers from Nigeria to Keita (Image 7.4).

Image 7.4 Bangui pastoral water



(left) Bangui has grown around the pastoral well on the international livestock corridor and (right) disputed seasonal lake north of Bangui is forbidden to pastoralists by the village leaders. (Author, Bangui Nov 2011)

Despite large tax income from livestock, pastoral space is not well protected in Bangui. “[N]ow with the democratization, [protection of pasture] has become a problem. Even if you see someone planting in the *air du pâturage* (pasture area), they [the administrators] will say that they are com-

ing, but they never arrive" (Fulani *Chef du Groupement*, P16:3). Prior to the turn of the century, one charismatic and powerful Fulani Group Chief would mount his horse each time cultivators planted the pastoral areas in Bangui, but upon his death in 1999, cultivators overtook these zones. Despite pastoralists' complaints, elected officials did nothing, using their control over common pastoral spaces to garner favor (votes) amongst the more populous Hausa people (Image 7.4, right). While there are many pastoral wells along this corridor, villages have grown up around some, essentially displacing pastoralists (Image 7.4, left). All of the pastoralists in this area complain of the lack of corridors for their safe passage (Table 7.4). While there are multiple pastoral areas, cultivators often dispute over this land, declaring that it was cultivated by their ancestors and is their private property (Image 7.5).

7.5.2 Cooperative agricultural-pastoral relationships

In the valleys of Locale A, some of which are moist nearly year-round, the villagers grow high-value crops such as cow pea and sell the residues to livestock owners once the harvest is complete. This also includes late maturing sorghum varieties that grow primarily in valleys. On the dune behind the valley, the villagers grow primarily millet, but the soil is poor and must be fertilized in order to receive a good harvest. Due to the high cost of commercial fertilizers, much of the village depends upon informal contracts with pastoralists to fertilize the land with their herds at a rate of one sack of millet per month (dependent upon the size of herd and land). The valley production in Locale A has rarely been damaged by livestock, despite the fact that there is only one small route for livestock to access water. Along with herding 'contracts,' owners of valley territories sell residues at higher rates, making for a lucrative business.

Payment for damaging dry land crops is higher than in Keita, which might force pastoralists to take more care within the zone, but also costs for damage can be negotiated with local villagers. Valley cultivation, however is rarely protected with a fence, despite that its productivity period coincides with the *liberation des champs*. Pastoralists in the region are fearful of damaging such crops, since the costs for damage are nearly 20 times higher (86 USD per head of livestock) than millet and sorghum damage. For rain-fed crop damage the average cost per head for a large ruminant is 14 USD and for a small ruminant it is 6 USD. For garden damage, costs are higher, typically 215 USD. Costs for crop damage were higher in Madaoua than in Keita. Some of the agro-pastoralist interviewed tended to forgive crop damage, even for visiting herders, but these were not many (Table

7.4). Other villagers in Locale A thought that damage was the fault of the field owner for not guarding his field properly or charged high payments to discourage pastoralists (Table 7.4).

7.5.3 Strong administrative trust and support

Lower levels of crop damage are due in part to the type of production and the administrative support of peaceful resolution. Administrators, Group and Canton Chiefs in Madaoua (Figure 7.5, Image 7.5) take a more polycentric approach focused on prevention of conflict. At the beginning of the descent, Fulani and Tuareg

Chiefs from five groups travel with administrators to every commune in Tahoua to encourage conflict prevention behaviors, yet when these tours are finished, the Chiefs return to their home villages, many of which are in Madaoua. Locale A is very strict about pastoralists entering the village, even along the international livestock corridor, which is just south of the moist valley. Only when the harvest is complete do village chiefs permit pastoralists entry, and if their warnings are not understood, higher-level customary chiefs are quickly called to negotiate; thus, pastoralists are required to wait in a neighboring village until the fields are cleared. Crop damage is frequent, though without violence; the village chief is aware that he can call the administrators in the commune capital Bangui (20 kilometers away) when local negotiations fail. Overall, the village experiences few violent conflicts (Table 7.4), but communicates frequently with both pastoralists and local and regional institutions. If local chiefs need assistance with a conflict, local officials engage both parties in face-to-face conversation about the problem, evoking discussion amongst multiple parties. When asked how they manage to maintain peace despite the descent of pastoralists into the village, an agro-pastoralist replied: “The herders need to talk with the farmers. Otherwise, we don’t have many ideas. Calling the administrators is the best solution.... Yes, [sometimes the customary chiefs have discussions with the population], and it is valuable” (P23). Quick response coupled with more frequent and better interactions with customary chiefs has increased cooperation in this highly cultivated zone (Table 7.4). Overall, individuals in Madaoua expressed the idea that conversation was not only possible between actor groups (Image 7.5), but essential to cooperation and peace. In Locale A, local agro-pastoralists use communication with in-coming pastoralists instead of sanctions as a control mechanism. The pastoralists, understanding the rules explained by

Image 7.5. Discussion about crop encroachment into pasture area



(Author, Bangui, Nov 2011).

authorities wait outside of the village until the harvest is complete, even if the *date de libération des champs* has passed. This local mechanism for preventing both damage and conflict is possible both because of the prior communication and also the presence of physical pastoral enclaves where herds can wait (in areas north of Locale A). The customary pastoral advocates defend both enclaves and herder routes to commonly owned lakes, though these efforts are not always successful due to the national norm favoring agricultural space (Table 7.4).

Table 7.4 Percentages of qualitative responses about specific dynamics relevant to this study.

Codes for similar responses	Locale AP		Locale A	
	# of Agro-pastoralists (22)	# of Pastoralists (16)	# of Agro-pastoralists (9)	# of Pastoralists (10)
Conflict Dynamics				
Existence of arms	9% (2)	13% (2)	0	10% (1)
Presence of livestock theft	41% (9)	38% (6)	22% (2)	30% (3)
Conflict about water access	5% (1)	13% (2)	0	30% (3)
Damaging crops	68% (15)	38% (6)	44% (4)	10% (1)
Violence	55% (12)	0	44% (4)	0
Rules, Sanctions, Enforcement				
Livestock corridors not protected	0	31% (5)	0	100% (10)
Locally-derived enforcement	23% (5)	0	33% (3)	10% (1)
Payment for damaging crops	27% (6)	44% (7)	44% (4)	50% (5)
No payment for crop damage	27% (6)	6% (1)	11% (1)	0
Governance				
Trust in gendarmes	36% (8)	6% (1)	0	0
Trust in customary officials	18% (4)	6% (1)	44% (4)	30% (3)
No trust in administrators	14% (3)	25% (4)	22% (2)	60% (6)
Leaders are corrupt	41% (9)	13% (2)	0	10% (1)
No trust in customary chiefs	4% (1)	12% (2)	11% (1)	10% (1)
Administrators favor cultivators	9% (2)	56% (9)	11% (1)	50% (5)
Social Capital between Groups				
Inter-ethnic marriage	5% (1)	6% (1)	0	20% (2)
Other group as problem	55% (12)	63% (10)	22% (2)	50% (5)
Transactions between groups	14% (3)	4% (1)	66% (6)	20% (2)

Cooperation and acts of kindness	5% (1)	6% (1)	0	50% (5)
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Data collected in Keita and Madaoua from multiple pastoral and agro-pastoral households and analyzed with Atlas Ti software. Codes for similar responses are listed on the left, and the percentage of each actor group by Locale is displayed.

This section has presented two case studies of divergent adaptation - Keita and Madaoua, to understand how institutions manage conflict and cooperation dynamics of multiple users in divergent adaptation. This presentation has demonstrated two models of conflict management and the historical and physical components related to these institutional models. The next section provides a summary of the findings and relates the case studies to the literature reviewed.

7.6 Discussion and Conclusions

Divergent adaptation is highly influenced by institutional processes (Snorek et al. 2014a). This chapter set out to identify the mechanisms and characteristics that contribute to conflict and cooperation dynamics in divergent adaptation by analyzing institutions in two areas. Understanding how institutions foster cooperation through divergent adaptations has implications for the development of institutions, or the informal and formal rules, values, norms, and cognitive processes that constrain individual and collective behavior (Adger 2001; Gupta et al. 2010). While institutions have been shown to enhance adaptive capacity, defining 'whose' adaptive capacity and examining unequal adaptive capacities between user groups is necessary to understand the distribution of costs and benefits across society (Adger et al. 2007). The purpose of this chapter was to demonstrate through two comparative case studies how institutions influence unequal adaptive capacities by examining cases of divergent adaptation in Niger.

While the pastoral legislation presented in this case study holds potential to protect common pool resources in Niger, the dissemination of national legislation has not reached the local scale, nor has it protected pastoral entitlements to the benefit of these pastoralists. Commonly shared resources, which would normally be protected and accessible to all by law, are often forbidden to pastoral users and claimed as property by sedentary groups (see also Chapter 6). In the context of divergent adaptation to climate change, pastoral users have a reduced adaptive capacity due to enclosure, cultivation, and privatization of CPRs by Users A (Figure 7.1). Table 7.3 highlights the institutions that have supported each user involved in divergent adaptation. In the context of weak democracies, legislation rarely trickles down to the local scale, but this does not prevent local populations from experiencing the effects of new national and international policies, laws, and

norms. In the cases examined in this chapter, sub-national and local institutions have thus a greater impact on divergent adaptation, which occurs between different users in the same, shared ecosystem or common pool resource regime.

The two local scale cases demonstrate that actors in divergent adaptation respond with greater cooperation where institutions are more polycentric, accessible, and equitable. Based on a multiple scale institutional analysis, I identified and examined interactions and outcomes to divergent adaptation ‘action arenas’ (based on Ostrom 2005 and Ratner et al. 2010) in a northern and southern department of Niger, following a low to high rainfall continuum. Specifically, we sought to understand how institutions fostered a sense of empowerment, social linkages, and equity amongst multiple actors either “through planned measures or through allowing and encouraging creative responses from society” (Gupta et al. 2010: 461). The pastoralists, agro-pastoralists, and multiple customary and administrative officials in Locale AP (a pastoral-agro-pastoral transition zone) and Locale A (a heavily cultivated, humid zone) report similar scenarios of divergent adaptation and social dynamics: 1) a high prevalence of crop damage, 2) the closing of livestock routes by cultivation, 3) limited water access, and 4) presence of tensions between pastoralists and agro-pastoralists (Table 7.4). Yet, higher levels of violence were observed in Locale AP, while higher levels of cooperation and greater trust of local officials were observed in Locale A. This finding is seemingly contrary to biophysical constraints in Locale A, which is a heavily cultivated zone where pasture is more scarce and the population is greater. These dynamics contradict the common, though false neo-Malthusian logic primarily held by international development organizations that perceives that high levels of scarcity, greater numbers of people, and constricted natural resources can lead to conflict. Yet the characteristics of institutions in both regions were vastly different, supporting past research that has demonstrated the importance of institutional characteristics in the development of cooperation (Rustagi et al. 2010; Ostrom 1999). Some elements in Locale AP that we found contributed to greater human insecurity amongst pastoralists – who in turn engage in violence – included: perceptions of marginalization, an overall lack of pastoralist representation, low levels of trust of administrators from both groups, strict top-down management styles, and heavy sanctions for crop damage.

While both Locales are managing similar social dynamics (Table 7.4) due to divergent adaptations like the extension of cultivation into pastoral areas, each possesses different institutions and

therefore different conflict dynamics. In Locale AP, institutions from the sub-national to local scale take a top-down hierarchical approach, using an external law enforcement body (gendarmes) to protect what is perceived to be the key assets of the zone – cultivated fields. The gendarmerie chase away pastoralists from this zone, in some cases confiscating pastoral property with impunity. This relates to high perceptions of corruption in the zone and low levels of social capital between user groups (Table 7.4). In Locale A, there is more evidence of polycentric, adaptive institutions at the local and department scale (Ostrom 1999; Gupta et al. 2010). Actors in Locale A mentioned fewer conflict dynamics and more locally derived systems of enforcement (Table 7.4). Moreover, the behaviors mentioned during conversations with individuals at the local scale exemplify that actors are informed of how to seek help from leadership (via cell phone), are empowered to solve their own problems (through dialogue with the chief), and understand planned measures and support systems (a step process of seeking support from local and external sources), which are elements that are reflected also in adaptive management best practices in building adaptive capacity (Gupta et al. 2010) and cooperation in common pool regimes (Ostrom 1999; Rustagi et al. 2010). For example, villagers in Locale A stated that they would ask the help of outside administrators or customary officials for the purpose of preventing conflict. Administrators and customary officials from sub-national scales participate in deliberation processes and negotiate solutions through face-to-face dialogues with multiple actors. Such characteristics of institutions have been demonstrated in past literature to enhance scenarios of cooperation (Olsson and Folke 2004; Ostrom 1999; Engle 2011; Engle and Lemos 2010; Brooks et al. 2005; Rossi 2006; Lebel et al 2006; Haddad 2005).

When faced with climate and ecological change, reproducing equitable, flexible, polycentric, and adaptive institutions has been shown through these cases to support creative, cooperative responses when actors with unequal levels of adaptive capacity are able to deliberate and advance solutions to enhance their livelihood security. On the contrary, when certain societal groups have privileged information or access to institutions excluded groups are further marginalized, the result sometimes includes conflict or defensive positioning, as shown in the Locale AP example. When faced with increasingly challenging social and environmental conditions exacerbated by climate change events such as rainfall variability and drought, marginalized actors' livelihood measures may promote more fear than friendship, more distrust where trust should be apparent. In Locale AP, this was especially true between the two actor groups; both hold high levels of dis-

trust or fear of the other groups as well as of institutions (Table 7.4). The marginalized pastoral groups only found support (sometimes through paying bribes) at the departmental scale through the formal justice system (Table 7.3).

Thus, we conclude that institutions possessing greater characteristics of polycentric adaptive management are more capable of addressing the social dynamics of divergent adaptation. Leadership, face-to-face communication, and careful but not violent enforcement can enhance cooperation and trust amongst multiple users in divergent adaptation situations, as shown in Locale A. National-scale institutions set the context of how divergent adaptations take place by establishing dominant norms and promoting them through legislation. Sanctioning groups in accordance with these norms is beneficial only when there is a strong process of dialogue and cooperation already in place. To establish this requires a strong base of customary institutional support in the context of Niger, since these institutions are abler to represent marginalized voices (User B) in divergent adaptation. Also, more local, collective action institutions are abler to promote trust, cooperation, and reciprocity through face-to-face discussion of rules and expectations, and this was especially true where there were greater numbers of pastoral Group leaders. What could be explored further is whether the socio-cultural framework of pastoralists, one honed within common pool regimes that require reciprocity and sharing norms is useful as a paradigmic framework to enhance cooperation norms in other areanas. Finally, in areas where there are limited resources and access problems, increasing the number of transactions (economic, social, and cultural exchange) reduced the potentiality for conflict even when divergent adaptations persist. While this state of affairs is not ideal in the long term, it sheds light on the importance of multiple and polycentric institutions that represent multiple actors and coordinate multiple land use regimes. This chapter shows that such polycentric institutions and adaptive management practices tend to lessen the tensions experienced from unequal development and divergent adaptation responses as well as reduce farmer-herder conflict. The findings of this case study could be applied to other social and political contexts, to further demonstrate the analytical utility of the divergent adaption concept in bringing about greater peace and cooperation in light of unequal adaptive capacities. Furthermore, broader case studies (possibly using action research methodologies) should specifically address the reduction of divergent adaptation through more equitable and adaptive institutional frameworks.

Chapter 8: Discussion and Conclusion

*A lost number in the equation.
 A simple, understandable miscalculation.
 And what if, on the basis of that,
 The world as we know it changed its matter of fact?
 Let me get it right: What if we got it wrong?
 What if we weakened ourselves getting strong?*

(Excerpt from Lemn Sissay, 'What if?')

8.1 If pasture is shrinking, why are the herds burgeoning?

Divergent adaptation processes in Niger express an ethical paradox. Increasing rainfall variability, swiftly growing populations, declining soil fertility, changing social identities contribute to an ever-expanding northward shift of cultivation to the 'marginal' lands in the North. Climate factors are still pivotal in shifting the nation's economic stability. More wealthy actors capitalize on climate shocks and related low prices to buy grain, land and livestock. Government policies are dependent on aid and international development funding. International development policies are driving a model of market-based adaptation, despite the fact that the marketization has detrimental ecological consequences, such as continued soil degradation (Chapter 6). There is a build-up of livestock holdings amongst sedentary groups, which in turn are a driver for the high rates of commercialization of natural resources and enclosure of commonly shared spaces (Chapters 4 and 6). It would seem that one explanation for the dichotomy of growing herds and shrinking pasture stems from a de facto crisis of ethics, in which the model for adaptation actions in Niger is centered on competing preparations for the market as opposed to a wider, social and ecological ethic for sustainability.

Markets are crucial to social ecological adaptation as they have the capacity to enhance networks (Pahl-Wostl 2009), create more efficient models of natural resource management (Rustagi et al. 2010), and provide learning opportunities (Woodke 2008). Yet, the adoption of a neoliberal models of market-based development is concurrently destructive to both the moral economy (Bryceson 2002) and the environment. A market-based approach to adaptation concurrently produces a 'crisis ethic,' in which divergent adaptation actions tend to be focused on the individual householder versus the wider community, and in which proliferates an 'every man to himself' attitude to

one's adaptive capacities (see also Chapter 4). This replacing of the moral economy with an individualistic 'crisis ethic,' is an intrinsic part of the social ecological changes in divergent adaptation, and is supported by development models that shift along with each contemporary crisis discourse that is *en vogue* (Rossi 2004). The crisis ethic defines individual behaviors in divergent adaptation and promotive of over-exploitation of newly commodified natural resources, enclosure and payment for formerly commonly shared resources, and the broadening of migrant labor pools, based on a greater need for commodities and cash (Bryceson 2002).

Karl Polanyi's perspective on economic change is instructive and supportive of this argument. When one considers the commercialization and enclosure of commonly shared natural resources in Niger, these resemble what Polanyi calls 'fictitious commodities' (2001). The production of land, water, and money (Polanyi's fictitious commodities) as elements to exchange tends to shift societies away from the primary purpose of the market, which is to serve the needs of the society. This process of commodification, in turn can have violent effects, leading to social, ecological, and economic crises (Polanyi 2001). Such a process is akin to what has been presented throughout the chapters of this thesis, though the forces that have evolved these social, ecological, and ethical crises stretch beyond the market to the wider SES.

While at one time there used to be clear distinctions established between pastoralists and their territories and activities and agriculturalists and their territories and activities, the lines are blurring as each cultural group becomes an adapting or divergently adaptive actor as opposed to an individual integrated into his/her social constructs, livelihood, and culture. This transformation of behavior and the resulting 'individual-over community' character has shaped divergent adaptation and the crisis ethic. Thus, one's cultural role is less important than one's productive role because, as Polanyi predicted, the market in the neoliberal development model usurps all other forces for change and creates a new conceptualization of one's livelihood (2001). This process contributes to the adaptations described in this thesis, and to the pursuit and divergent adaptation of agro-pastoralism.

Pastoralism itself has developed a multiplicity of livelihoods - sedentary and mobile, migrating to find labor and fixed to a home territory, and stalwartly holding to cultural tradition while communicating on smartphones with migrating relatives. Yet, most of the pastoralists interviewed no-

ticed that the amount of livestock penetrating the pastoral zone has been increasing, resulting in an over exploitation of commonly managed resources. The conflicts occurring (Chapter 4) as a result of these ecological shifts were based in impatience, frustration, and a strong view by local pastoralists of being 'invaded' by 'outsiders.' Yet, these same pastoral groups spoke in the same conversation of the need for reciprocity norms in order to protect themselves from drought, due to an ethic of 'if it rains in my territory today, tomorrow it might rain in yours.' Yet, the crisis ethic, moreover sometimes takes precedence when smallholders must wait in line at the well or borehole all day in order to quench the thirst of the livestock of the rich, commercial owner who lives in the agro-pastoral South.

The adaptations of pastoral societies are juxtaposed with those of agro-pastoralists, a group made up of all ethnicities in Niger who possess both land and livestock, but who derive his/her/their primary revenue from agriculture. It was decided by the participants of the scenario focus group held in Niamey that the latter group (agro-pastoralists) were perceived to be the more resilient livelihood group, due to their multiple forms of capital – land and livestock (Chapter 5). This stands in contradistinction to the common bias made by Niger government and non-governmental entities that establishes pastoralists as 'rich' and thus not beholden to the many vulnerabilities of southern agro-pastoralism, most of which are related to rain-fed farming practices. Such a bias, stemming from colonial historical perspectives is one which has prevented development and governmental projects from investing in the North. Yet, sometimes because of this bias and the resulting institutional favoritism for sedentary agriculture, pastoralists in Niger are one of the more vulnerable groups. Thus, vulnerability and the lack of adaptive capacity is based not only in a destructive drought and the lack of adaptive capacity, but also in the inability of a marginalized livelihood group, individual, or community to compete with those who are the accepted 'most vulnerable' group. This 'rush to the bottom' has contributed to the individual crisis ethic, as part of one's adaptive practices. Such is socially and politically constructed through a power-based discourse (Foucault, cited in Ferguson 1994) as 'the most vulnerable.' Thus, as agro-pastoralist and pastoralist groups compete for land tenure, livestock fodder, and market access, they concurrently compete to become 'the most vulnerable.' Thus, the growing crisis ethic hinders a clear understanding of the role of climate change hazards, which appears to be secondary to the other factors contributing to divergent adaptation to climate change.

8.2 Adaptation as a political process

Adaptation is inevitable (Parry 2009; Bermann and Paavola 2010), but is it sustainable and equitable? And how can adaptation that is equitable for some vulnerable groups and not others be avoided? This thesis has demonstrated the relevance of the concept divergent adaptation and proposes its use in wider academic and policy arenas.

The commonly shared regimes made up of pastoral grasslands are threatened by current development models and policies. Free riding by shepherds serving southern agro-pastoralists, over-exploitation by wood and hay cutters, and shifting water management regimes in the zone have pushed many pastoralists into migration or loss of livelihood and contribute greatly to their vulnerability. Market forces promoting wood cutting, hay cutting, fields exploited only for residues, and livestock as insurance (Chapters 4 and 5) have put multiple pressures on collective institutions, such that they are no longer sufficiently managing the commonly shared goods amidst such strong pressure from multiple and contradictory institutions (eg. The establishment of Fulani chieftans or non-governmental organizations assigning water rights [Chapter 4]). In the pastoral zone, the powerful and rich are claiming important pasture territories for private use, by building fences, private boreholes, and/or water transport with cisterns. In contrast, the poor take up farming, build hand-dug wells, or adopt irrigated gardening in order to adapt to the changing pastoral regime. The continuation of these dynamics will result in the end of the small holder pastoralist, without a change in the processes of adaptation.

8.2.1 Inequity and adaptation

Climate change hazards, without significant mitigation efforts will continue to exacerbate multiple changes to SES throughout the world, deepening the vulnerability of marginalized and poor communities whose livelihoods are dependent upon sufficient availability, access, and entitlement to ecosystem services (Adger et al 2007; IPCC 2012). While it is unsettling that those least responsible for climate change hazards have more often been the ones experiencing their greatest impacts (Tol et al. 2004; O'Brian and Leichenko 2009), adaptation has been taking place at a rapid pace (Klein et al. 2014). Yet, how has this adaptation promoted both ecological and societal resilience for multiple actor groups? Some groups are intrinsically better than others at adapting (Tol 2004), which is sometimes related to structural, socio-cultural, ecological, political, and economic factors that contribute to the production of winners and losers in adaptation (Nielsen and Feenberg 2010;

Adger et al. 2012). Climate change adaptation has not necessarily reduced vulnerability for those with the least adaptive capacity, nor does it always meet their needs (Ericksen et al. 2011; Snorek et al. 2012; Kloos et al. 2013; Snorek et al. 2014a).

Equity serves as a lynchpin in successful and sustainable adaptation to climate change, but is not always felt or experienced (Lebel et al 2006; Ericksen 2011). Inequalities are relevant to conflict and cooperation dynamics in the SES (Goulden et al. 2011). As it relates to climate change adaptation, equity is not only an egalitarian distribution of rights and entitlements, but also the protection of what one most values, whether it is biophysical, ecosystem-based, sociological, or a combination of factors (Lebel et al. 2006). Those who are most vulnerable to climate impacts and marginalization possess the least capacity to adapt to social ecological change (Corendea et al. 2012; O'Brien et al. 2006; Ericksen et al. 2011), especially when their ecosystem services have been significantly degraded (MA 2005; Lebel et al. 2006; Leary et al. 2006). Unequal adaptive capacities resulting from adaptation were connoted as 'divergent adaptation' in this thesis (Snorek et al. 2014a). Divergent adaptation is a process wherein the adaptation of one user or user group reduces the adaptive capacity of another user or user group (Snorek et al. 2014a), which in turn is relevant to conflict and cooperation dynamics (Goulden and Few 2011; Hamza 2012; Snorek et al. 2014a; Kloos et al. 2013). The main import of this thesis is to explain this concept through a case study in the agro-pastoral and pastoral zones of Niger as well as relate the concept to complementary conceptual frameworks and perspectives of SESs. Recognizing that adaptive capacities are unequally expressed across sectors, scales, and ecological zones, this thesis asked the question: How does divergent adaptation link to conflict and cooperation in a rural 'farmer-herder' SES?

8.2.2 Studying the process of divergent adaptation in Niger

There have been numerous studies on the linkages between climate change and conflict (Nordas and Gleditsch 2007; Raleigh and Urdal 2007; Buhaug 2010; Gleich 2014), some of which have been used quantitative data that expressed no relationship between climate and conflict (Buhaug 2010) and others who argue for the usefulness of quantitatively examining these linkages purporting, "hot weather is related to violence at various scales" (Cane et al. 2014:234). As one author in Science points out, "Even if it is not possible to translate a qualitative understanding of civil conflict into a quantitative model that can readily be fitted and tested, the effort would still deepen our understanding of the effect of climate on violence" (Solow 2013: 179). A fresh interchange be-

tween quantitative and qualitative data on complex, adaptive systems was for this thesis an appropriate way to better understand multiple and complex linkages.

To research complex linkages such as conflict and cooperation, adaptation, adaptive capacity, and institutional mechanisms through the theoretical framework of 'divergent adaptation' (Snorek et al. 2014a) required a complex and iterative approach including multiple temporal and spatial scales, multiple case studies, and multiple forms of analysis. Like past research, this thesis elaborates a critical socio-environmental approach to climate change, conflict, and adaptation (Benjaminsen 2012; Raleigh and Urdal 2007). The novelty of the methodology stems from the diversity of approaches utilized in the study. Niger's SESs are not related to an equilibrium-based understanding of climate, as the region itself is one that has experienced climate extremes for centuries and its societies are thus well adapted to variability. Rather, shifts in the SES are shaped by a complexity of forces (Chapter 3) stemming from socio-political (eg. President Kuncé's 'land to the tiller speech'), historical (eg. the former political dominance of the Tuareg lost to colonial restructuring), climactic (eg. the increasingly frequent rainfall variability of the 21st Century), ecological (eg. the loss of forest causing increasing runoff and less infiltration), geographical (eg. attractive economies to the North and South of the country promoting seasonal migration), and cultural (eg. the stalwart refusal of some pastoralists to sell their livestock) dynamics. This thesis has thoroughly examined these dynamics and 40 years of adaptation to climate variability and hazards such as drought within pastoral and agro-pastoral societies. The majority of research was carried out within three zones with different amounts of annual rainfall, institutional makeup, dominant (User A) actors with similar ethnic makeup, dominant livelihood regimes (pastoral and agro-pastoral), and a single type of conflict (farmer-herder). Legislation, literature and a scenario focus group at the national scale coupled with a place-based qualitative and remote sensing quantitative study juxtaposed sometimes conflicting perspectives of adaptation and development in Niger, which elaborated the conflict sufficiently. Overall, this thesis spotlights the ways that divergent adaptation and conflict and cooperation dynamics are playing out in multiple social, climactic, and ecological zones within Niger.

As shown through the chapters of this thesis, divergent adaptation can be a process that builds more cooperation and equity in society or enhances entrenched patterns of injustice and inequality, a process determined by the patterns of degradation of ecosystem services (Chapter 5), the

shifting land tenure regimes relevant to adaptations (Chapter 6), and the type and influence of institutions on the adaptation process (Chapter 7). The following three points highlight the main findings stemming from the study of divergent adaptation in this thesis, which are discussed in the sections that follow.

8.3 The main conceptual contributions of divergent adaptation

8.3.1 Divergent adaptation is determined by the patterns of degradation to ecosystem services

To understand critical social ecological changes in a system, it is important to examine change from multiple user perspectives of how each one experiences the change and how they are adapting to change. One's adaptive capacity is influenced by the availability of and access to sustainable ecosystem services (MA 2005; Corendea 2012; Lebel et al. 2006), yet the production and maintenance of these services is political (Blaikie 1985; Lukas 2014), such that local degradation can be explicitly based within a local conflict (Chapter 5, 6). Unequal levels of adaptive capacity have not previously been examined through an ecosystem service framework, specifically the degradation and protection of ecosystem services for multiple actors. Chapter 5 examines these linkages by looking at tradeoffs and synergies in the degradation of ecosystem services by multiple users. The patterns of degradation that most impact Users B in divergent adaptation include food provisioning (crop production) and fodder provisioning (fodder and hay harvesting and stocking). The ecosystem services lost to both users as a result of degradation patterns resulting from crop production and fodder harvesting (primarily crop residues and some grasses) are multiple regulating and provisioning services, the latter of which are also relevant to the entitlements of Users B (pastoralists). Improving the just distribution of ecosystem services through their management (sustainable livestock production, greater soil formation through decomposition, safeguarding forests, enhancing and protecting grasslands), the adaptive capacity of all vulnerable groups is concurrently improved (Lebel et al. 2006; Klein et al. 2014).

The linkages between changing ecosystem services and divergent adaptation have been explored in this thesis. This research contributes to scholarship on tradeoffs of multiple ecosystem services and adds the element of multiple users and their respective adaptive capacities. Negative impacts on services such as soil formation and composition, genetic diversity, and forest biota concurrently impact fodder production (pasture) for mobile pastoralists. This unequal degradation of ecosystem services reduced User B's capacity to adapt, which in turn was related to pastoralists passing

through fields by night or using violence to garner access to fields. Yet, patterns of conflict were further highlighted through the extraction and commercialization of farming residues, due to the loss of fodder and potential to damage a monetarized product. These adaptive actions (cutting of residues) degraded services utilized by both users A and B, and promoted feedback for more divergent adaptation and degradation (Chapter 5). Thus the relationship between unequal degradation of ecosystem services and divergent adaptation is that such degradation further lengthens the distance between groups whose activities have the potential to produce greater ecosystem management for all, if the norms of commons management are upheld. Yet, these systems, which are based on cooperation, are being lost due to differential adaptive capacities between these groups and top-down institutional models. Furthermore, the variations in perspectives over how ecosystem services are being degraded are relevant to conflict dynamics in divergent adaptations.

8.3.2 Divergent adaptation is determined by the shifting land tenure regimes relevant to adaptations

At extreme rates, the land regimes in northern Niger's pastoral zone are shifting from a common pool regime to a private regime. These rapid shifts have reduced the norms of cooperation between and amongst pastoral groups as well as their relationships with agro-pastoralist gardeners. This is exemplified as the fencing-in of pastoral common watering holes being enclosed by cultivated plots and is being observed in the state-owned pastoral zone. While this has been documented in several national-scale reports, no peer review literature has highlighted this shift in Niger. By combining remote sensing and a critical socio-environmental approach, the findings show clearly that institutions from the national to local scale vary in their treatment of settlement and enclosure of seasonal lakes for the purpose of gardening in the zone. Almost all have made statements linking this practice to drought adaptation, while also expressing a sense of entitlement to cultivation of the land, based on ideas stemming from the 'land to the tiller' speech in the 1970s. Quantitatively, very high rates of change were observed in both locations. In Droum, there was a 124% increase in the area of closed fences, a change in area from 4.71 km² to 10.58 km², and the increase in number or count of fences (features) by 176%. Multiple socio-economic dynamics are present in the case study area. There are multiple interpretations of how the commonly shared pastoral zone should be used and by whom. Pastoral space is perceived by both actors (pastoralists and cultivators) as 'belonging' to the pastoral groups due to their historical territorial presence, yet sedentary activities provide greater value to the land. Multiple and conflicting norms in

each location are granting ownership to cultivators, sometimes based on unwritten tenure norms. An additional benefit to those who have gardens or plots of land is that they are concurrently recipients of more development and humanitarian aid; pastoralists did not report receiving aid.

The dialectic stemming from state-led development planning (see also Turhan 2014) has promoted irrigated gardening in Niger as livelihood diversification for all rural actors. Yet, this same dialectic produces an assumption that the privatization of the lake is 'common sense' (Hoare and Nowel Smith 1971, cited in D'Alisa and Kallis 2016), and thus tenure changes and water enclosures that would normally not be permitted are usurping the mobility and commonly shared tenure rights of pastoralists. This case study, through the framework of divergent adaptation stresses the importance of critically examining adaptation programs that have a concurrent impact on land use regimes. In the government-promoted divergent adaptation presented in this case in the pastoral zone, maladaptive impacts including the loss of entitlements to important pastoral water sources and payments for access in an open access regime have resulted in confusion, conflict, and tenuous relations between gardeners and pastoralists. The garden development, while a highly viable system of adaptation for pastoralists who have lost their herds or farmers seeking land ignores the manner in which gardens reduce the adaptive capacities of pastoralists as a whole and promotes conflicts. This case study provides an example of what Oxby (2011) referred to as 'too little too late' for the development of a viable pastoral code, as already the trend of enclosing water points and grabbing of pastoral land is ubiquitous throughout the pastoral zone. The original 1961 text that established a pastoral zone is quickly becoming a contradictory body of law, due to the inadequate implementation over the course of 50 years. Should a commonly managed pastoral system remain? Such will not be possible without the strengthening of local scale rangeland management and empowerment of local actors to resolve the contradictions between legislative text, development or adaptation planning, and the adaptation actions desired by multiple actors. The findings of this study suggest a critical need to readdress development models for the pastoral zone.

8.3.3 Divergent adaptation is determined by the type and influence of institutions on the adaptation process

The last chapter explored how societal norms, cognitive processes, rules and values (institutions) support and enhance social capital and cooperation in the context of inequitable adaptive capaci-

ties. The chapter clarified the specific institutions influencing divergent adaptations and illustrated in turn how institutions can exacerbate or shift the related social consequences, namely conflict or cooperation. As demonstrated by Herrera et al. (2014), good rangeland management requires local solution supported by national policies, and without undermining the principle of subsidiarity. The laws established by the Rural and Pastoral Codes define pastoralists' rights to mobility and water access. At the sub-national scale, mobility demands multiple forms of payment from rent-seeking sedentary constituents of the territories along pastoral corridors. Conflicts expressed as variable expressions of discord that are resulting from divergent adaptations such as the spreading of cultivation into pastoral territories or charging fees for water use have been shown to be reduced under scenarios of polycentric, adaptive institutions, wherein individuals and groups express higher levels of social capital, stronger trust of locally-based institutions, higher levels of face to face communication about common pool regime challenges, and greater levels of patience and cooperation. One particularly challenging piece of legislation, the 'liberation des champs,' determines when pastoral groups can descend into the cultivated territories of the South. After this date is established, the southern territory shifts to a commons regime, whereas land must be shared with pastoral users along specific agreed-upon rules determined by local constituencies.

In the southern, highly-cultivated, strictly enclosed agricultural zone of Madaoua (Locale A), community members have developed stronger levels trust between local-scale institutions and multiple users (A and B), even during this descent of pastoralists (Users B). When the potential for conflict arises such as the early arrival of pastoralists into un-harvested fields, Locale A communities expressed greater awareness of non-confrontational means of resolution based on established processes of self-organization, collaboration, and deliberation. Moreover, multiple pastoral representatives living in the department of Madaoua are obliged to support their pastoral constituencies with hospitality during the descent, with the intent to prevent conflict. These customary leaders are helped also by the presence and availability of sub-national administrative (democratically elected) leaders when needed. While the southern zone has higher levels of pastoral degradation and waterscape enclosures, the levels of violent conflict are lower and the population more cooperative.

While divergent adaptations are preventable and should be avoided, the institutional frameworks that can more easily produce sustainable adaptations and cooperation between user groups are

those based in adaptive and common pool regime management theories (Dietz et al. 2003; Pahl-Wostl 2009; Gupta et al. 2010; Ostrom 2007; Fabricius et al. 2007), wherein polycentric, redundant institutions encourage learning, cooperation, and finding creative solutions to SES challenges. Divergent adaptation occurring in common and semi-common pool regimes is based not only in changes to land tenure but also in how social capital between users is developed and maintained by institutions, a practice that is intrinsic to collective choice situations, that are often used in common pool regimes (Ostrom 2011). In the northern pastoral zone, where Fulani customary institutions have been unilaterally installed by a presidential decree, social capital has deteriorated due to conflicts over newly established Fulani tenure rights. Similarly, in Locale AP (Keita), top-down hierarchical institutional processes have disenfranchised transhumant pastoralists, resulting in violent engagement. The commercialization and enclosure of certain ecosystem services such as grasses, farming residues, and water shifts land tenure regimes and promotes divergent adaptation and unequal power dynamics.

As Folke et al. stated, “Paradoxically, management that uses rigid control mechanisms to harden the condition of social-ecological systems can erode resilience and promote collapse.” (2002:438). These types of collapse are difficult to predict, due to slow-onset changes, yet social systems with strong socio-ecological memory (ibid.) and flexibility as opposed to rigidity tend to enhance resilience of SES. Across the SES in Niger, many examples of such robust, flexible, and resilient systems of resource management are in place. In the pastoral zone, one example of adaptive, flexible management is exhibited through the co-management or collective management of pasture resources (Afane 2014), a management that sometimes excludes outsiders or limits their extraction due to clear and agreed-upon local community rules for access and use of water and pasture resources (Chapter 4).

Building up polycentric, adaptive institutions as opposed to militarization and top-down institutions is essential to prevent divergent adaptation across all ecological zones. These institutions should empower and include multiple users, and foster exchanges of ideas and information between both groups, based on the symbiotic natures of their respective livelihood specialties. Clarifying the roles of multiple institutions can create more accountability over common pool regimes and their respective natural resource users. Adaptation should build social capital, enhance multiple ecosystem services, and support the management of multiple land use regimes. Institutions

supporting sustainable adaptation should promote trust between users, express high levels of accountability, responsive leadership, and continuity in decision making processes. The responsibilities of institutions at each scale must be clearly defined, respect multiple users' adaptation needs, become accountable to all laws and codes not only to those that are politically convenient, and develop norms that are flexible (payments for crop damage, liberation des champs) and stalwartly secure commonly shared resources through more permanent measures such as geo-referencing, signage, and local-scale institutionalization (installing land commissions at the village level). This type of arrangement will support and enhance human security for all users.

8.4 Widening and broadening the concept

Sissay's poem implies a simple request for reexamination, 'What if we got it wrong?' To prevent the continuation of divergent adaptation demands a stronger insertion of equity into development planning, funding, and evaluation processes. Evidence of growing inequality in small holder communities has been growing (Turhan 2015; Snorek et al. 2014), and divergent adaptation to climate change is clearly a process that has great potential to enhance inequalities, differential power dynamics and status, and the 'crisis ethic' that contributes to the unequal degradation of ecosystems (Chapter 5). While this dissertation has only examined these dynamics within pastoral societies and between pastoral and agro-pastoral societies, the concept is useful in multiple other contexts. Inevitably, inequality and the 'crisis ethic' leads to distrust of leadership and other groups (Chapter 7), feelings of hopelessness and a desire to abandon one's livelihood (Chapter 5), loss of social capital within and between communities (Chapter 4), and, inevitably greater conflicts and migration as well as an impetus for militarization. To avoid the trend towards militarization is not only favorable, but is the best way to continue on a path towards sustainable adaptation and greater human security. The study of divergent adaptation supports this pathway and deepens the understanding of the SES and the root causes of human insecurities. Yet, this dissertation has only begun to explore these complex linkages, and further studies of divergent adaptation across user groups and societies (regionally) and within smallholder communities (locally) is urgent to support sound and sustainable adaptation policy.

8.4.1 'Adaptation for the majority'

Alexis de Tocqueville warned that "[u]nlimited power [of the majority] is in itself a bad and dangerous thing" (1900:260) and coined the phrase 'tyranny of the majority.' One way in which lead-

ers in Niger garner and maintain power is through continuous electorate support as well as the growth of their electorate (personal communication Nov 2015; Mansour 2008). Naturally, this equates to greater overall political power in southern, more heavily populated regions, which, in turn are the recipients of greater and more consistent development aid and projects. The practice of democracy in Niger is defined primarily as ‘free and fair elections,’ a definition necessitated by international humanitarian aid and development policies (demonstrated by the removal of aid during multiple coup d’états – Chapter 3, Table 3.8). As the dynamics of decentralization weaken the power of traditional leadership (Mohamadou 2009), customary leaders seek to increase the electorate through the redistribution of pastoral land to cultivators. The northern territory is thus quickly being engulfed by fields. Concurrently, decentralization fragments the leadership into regions, departments, and communes, confounding the mobility of pastoralists who are not represented by such fragmented leadership (Mansour 2008), and resulting in the loss of land and water rights for more marginal groups such as pastoralists (Clarke 1978; Thébaud and Batterbury 2001; Phillips 2007). This practice of democracy coupled with the current model of adaptation and development produces patterns of sedentarization of pastoral societies that have been observed in other parts of the Sahel (Little 2011; Bayene and Korf 2012; Milman and Arsano 2014) and is a systematic part of the neoliberal state-building (Burchell et al. 1995).

For future studies of divergent adaptation, the process and practice of democracy by multiple actors in society would deepen our understanding of divergent adaptation. Furthermore, combining remote sensing and critic social environmental methodologies in countries of the Sahel experiencing decentralization since the 1990s as well as expansion of cultivation would provide an important perspective on the linkages between governance transitions and divergent adaptations. Such research would have important implications for state-making and development processes.

8.4.2 Promoting sustainable adaptations through a broadening of ‘Do No Harm’

Despite the complexities in studying divergent adaptation, it has an important place in the discussion and policymaking surrounding climate change. Marginalization is a process being impelled by political, economic, and social change phenomena and must be integrated into dialogues on climate change adaptation. In the cases we have examined in Niger, the process of adaptation has seemed to benefit certain sedentary groups, while excluding especially mobile populations and other sedentary populations lacking entitlements and dominance in local power dynamics. To

promote sustainable adaptation, the understanding of who is divergent and why should be established on a case by case basis for each intervention promoting adaptive capacities. In light of increasing climate change hazards, a new and more equitable approach to development interventions, one that analyses cultural and power dynamics (Tschakert 2007) as well as the role of institutions at multiple scales (Fabricius 2007) would support a reduction of divergent adaptations and the enhancement of multiple forms of adaptive capacity within and across the SES.

The prevention of negative consequences resulting from humanitarian aid work has been pursued through the adopting of 'Do No Harm' principles (OECD 2010). 'Do No Harm' is founded on principles of humanity, neutrality, and impartiality as well as the idea that humanitarian efforts must take into account historical and power dynamics in the locations of intervention so that interventions do not become politicized or exacerbate conflicts or political uprisings (UNICEF 2003). While the focus of many 'Do No Harm' programs is primarily humanitarian efforts in conflict zones, this should be expanded to include development, adaptation and resilience-based programming in multiple contexts. Specifically, the incorporation of pre-project 'Do No Harm' assessments could: 1) establish multiple actor groups within the village and the wider community (including transhumant groups) and 2) provide a rapid rural assessment to identify conflicting adaptive capacities. Specific attention should be paid to how the project would impact land use regimes, social capital between these groups, and the multiple institutions that could be involved in the development and dissemination of information throughout the intervention.

8.4.3 Integration of users' capacities for adaptation planning

The discussion of and planning for climate change vulnerability would benefit from a systematic discussion of divergent adaptation and its relevant social and ecological tradeoffs. While marginalized actors, such as the pastoral groups described in this case study have often been excluded from development programs and analyses, these rationalities of development practitioners are not useful or efficient in the context of climate change. The vulnerability of pastoral (User B) actors due to inadequate natural resource governance that promotes cycles of degradation, economic instability related to drought, high levels of unemployment due to rural to urban migration, disenfranchisement, alienation and poverty, decries an urgent need to enhance the capacity of pastoral groups in the Sahel region by not only securing pastoral resources, but also creating networks of trust between customary and administrative leaders and multiple actors through the

adaptive management measures discussed in Chapter 7, especially in northern areas of the country that are experiencing disintegrating livelihoods, increasing levels of privatization of pastoral resources (Chapter 5), and high rural to urban migration rates.

During the interviews, pastoralists often stated that they don't want development, rather they simply want to control their territory and 'develop' it in the way that they see fit. This reaction to development programs stems from a rejection of the hegemonic forces of development and aid organizations and a desire for more autonomous and empowered development practices, such as those being suggested in Chapter 7 as part of the adaptive and commons management discourse. As a result of the way in which privatization has been shifting the pastoral system away from traditional co-management practices and promoting systems in which pastoralists are losing their entitlements (Chapter 6), the rejection of traditional development processes is justified. Pastoralists' voices and visions of a more autonomous development are necessary to incorporate more diversity, spontaneity, and flexibility to discussions or resilience and adaptation to climate change. The incorporation of these and other so-called 'indigenous' perspectives (Sletto 2008) enhances the potential to reestablish a more productive commonly shared land tenure system and to provide insights into a more adaptive and reciprocity-based model of natural resource management.

8.4.4 A heterodox economic approach to rural markets?

As market processes continue to be a force for divergent adaptation, the market-based development approach must take on a more Keynesian, heterodox approach. Use it to develop more equity between pastoral and agro-pastoral livelihoods. Ecosystem service provided by pastoral areas should be enhanced and valued through both monetary and policy measures. For instance, livestock sold in southern markets should pay taxes to northern natural resource managers. Vice versa, markets in the south should receive subsidized transport of fodder produced for livestock to northern markets. Moreover, due to the strongly detrimental impacts on soil fertility of removing grasses and farming residues from fields, this practice should be outlawed. Grasses and farming residues need to be banned from sale in markets, unless done through a permitted process, similar to the cutting of trees.

Annex 1: Interview Guide

CLICO Field Questionnaire

Question de recherche: Comment est-ce que les modes d'adaptation face aux aléas hydro climatiques pour deux groupes avec les activités divergent (agro-pasteurs et pasteurs) affectent du conflit ou de la coopération relative aux dynamiques institutionnelles, environnementales et sociales?

Pour les enquêteurs: Présentez-vous. Expliquez l'objectif de la recherche en utilisant des termes faciles pour la personne interrogée à comprendre. Utilisez l'historique développé avec les chefs traditionnelles pour mieux identifier les dates approximatifs pour les événements spécifiques. S'il vous plaît répondre à toutes questions ou indiquer par écrit pourquoi une question a été omise. Durée approximative de chaque entrevue: 1 heure. Si le participant a peu de temps, s'il vous plaît utiliser les questions de synthèse.

L'objectif: Pour comprendre ce qui contribue aux conflits entre les agriculteurs et les éleveurs en analysant les changements de l'écosystème des services, les mécanismes d'adaptation des agriculteurs et des éleveurs, les institutions qui régissent le système rural, et des scénarios de conflits sur les ressources en eau. Nous demanderons ces questions aux gens qui sont impliqués dans les conflits et ceux qui sont pas impliqués pour mieux comprendre si ces facteurs de sécurité humaine augment les conflits.

Les services des écosystèmes: quelques exemples sont : la nourriture pour animaux et les humains, l'eau propre et accessible, le bois de chauffage, la pluie, du sol riche, etc.

Mécanismes d'adaptation des agriculteurs (exemples) : Exode, irrigation des cultures, augmentent la taille des champs, achètent des animaux, vend de pâturage, plantations des fruits, vend du miel, etc.

Mécanismes d'adaptation des éleveurs (exemples): Utilisation de technologie pour comprendre la situation d'environnement, l'exode, l'éducation et un boulon, échanger les bovins avec les chameaux, stocker le fourrage, marcher de plus grandes distances à la recherche de pâturages ou de l'eau, ou la diversification des moyens de subsistance.

Des Institutions: Des réglementations écrites et non écrites qui régissent l'accès et l'utilisation des ressources en eau.

Les activités qui favorisent les conflits: la négociation ou de forcer l'accès aux points d'eau ou de pâturages dans la zone agricole, limitant l'accès d'un autre éleveur à un point d'eau dans la zone pastorale, ou de restreindre le temps que les pasteurs en visite sont les bienvenus sur le territoire de chez soi.

A : Questions Generaux

1. Nombre de membres dans le ménage: _____ 2. Sexe de participant: Homme ou Femme

3. Donnés sur le participant et son epoux ou epouse :

	Ethnie/tribue/groupement	Village/Terroir d'origine	Village/Terroir Actuel	Date naissance
Femme(s)				
Homme				

4. Âge approximatif des tous les membres du ménage:

Hommes :

Femmes :

5. Professional Experiences :

Profession	Concerné ?	Profession	Concerné ?
Agriculteur		Nomade (pas d'habitation fixe)	
Agro-pasteur (champs et animaux)		Eleveur (avec habitation fixe)	
Jardinier		Eleveur (grand transhumant)	
Bucher		Commerçant(e)	
Marabout		Berger	
Maçon		Forgeron(e)	
Chef du village		Chef du tribu	
Femme du menage		Sage Femme	
Leader des femmes (kungiya)		Producteur du sel	
Poissonier		Transporteur du l'eau	

6. Si éleveurs transhumants, où venez-vous et où allez-vous ?

7. Lieu de naissance du père et de

l'occupation : _____

8. Lieu de naissance du grand-père et la profession :

B : Les services écosystèmes

Les éleveurs et agriculteurs sont considérés comme des experts sur l'environnement parce qu'ils savent comment produire de la nourriture de la terre ou comment trouver de la nourriture nutritive pour leurs animaux, qui sont leur gagne-pain. Nous sommes intéressés à comprendre ce que vous avez vu par rapport aux changements dans l'environnement depuis votre enfance.

Changement	O/N ?	Nom (s) et lieu(s)	Calendrier	Raison
1. Disparition d'espèces d'arbres et d'herbes ?				
2. Les mares qui ont disparu ou changé de taille ?				
3. Puits qui ne fournissent plus d'eau toute l'année ?				
4. L'avancée des dunes ?				
5. La contamination des puits ou point d'eau ?				
6. Changements de la qualité du sol ?				
7. La perte des forêts ?				
8. D'autres observations ? (Ecrivez-les)				

9. Quels sont les ressources de l'environnement les plus importants pour votre profession ?

Ressource	Rang/Priorité	Échelon (somme tu peux payer en temps de besoin)
Eau (pluie et à boire)		
La terre (champs)		
Pâturages		
Arbres		
Poissons		
Autres (écrit-les)		

10. Au cours des dernières 20 ou 50 ans, comment est-ce les gens ont détruit l'environnement ?

Changement	Lieu (village ou autre)	Changement	Lieu (village ou autre)
L'agrandissement des champs dans les espaces pastoraux		L'augmentation de la taille du troupeau	
La contamination des eaux par les humains		La contamination des eaux par des animaux	
Brulé la terre pour le défrichage des champs		Les feu de brousse	
Couper du bois pour avoir des espace champêtres		Couper du bois pour le ménage	
Aménagement des mares pour faire le jardinage		Pa d'accès au mares	
Plus des villages des ancien pasteurs		Plus des villages des agriculteurs	

11. Décrivez-vous quels sont les aléas climatiques bizarres que vous avez vu ? Quand ? et Est-ce que ces aléas climatiques ont détruit les ressources naturelles ?

	Observation	Calendrier	Effet sur ressources
La pluie ?			
Vent ?			
Inondations ?			
Sécheresses ?			
D'autres changements ?			

12. Si les aléas climatiques et l'impact humain sur l'environnement continuent dans cette façon, qu'est-ce qui va se passer avec votre mode de vie ? Que feriez-vous pour trouver ce qu'il vous faut pour survivre ?

C. Sécurité de Ressources en Eau

1. Quels sont vos utilisations d'eaux ?

Irrigation		Animaux	
Consommation		Lessive	
Autres ?			

2. Où est-ce que vous trouvez de l'eau?

	Nom de propriétaire	Lieu ou village	La saison de utilisation	Paiement ? Combien ?	Usage humain ou animal ?	Profondeur
Puisards						
Puit Traditionnel						
Puit Cimenté						
Puit-forage						
Forage						
Mare						
Vehicule motorisé						

3. Avez-vous jamais été malade à cause de l'eau ? Qu'est-ce qui l'a contaminé ?

4. Qui a construit le puit dans votre territoire? Qui a droit de l'utilisation de ce puit ? Comment vous gerez l'accès au puit?

5. Est-ce que vous avez votre propre puit ? Si non, avez-vous jamais demandé l'autorisation de construire un puit ? Quel était le resultat ?

6. Quelles sont les regles qui gouverne la construction des puits ? Qui est chargé avec l'application de ces règles (chefs coutumiers, gouvernement, etc) ? Quelles sont les règles concernant d'eau que les gens ne respectent pas ? Pourquoi ?

7. Expliquez-nous comment un étranger (Peul, Tuareg, Haussa) trouve la permission de construire un puit dans votre territoire/village ?

8. Qui sont les propriétaires des mares ici ? Qui a droit de l'utilisation des mares ? Comment vous gerez les activités des mares ?

9. Comment est-ce que vous négotiez l'accès a l'eau quand vous arrivez dans un autre territoire ?

10. Utilisez-vous des couloirs de passage pour accéder à l'eau? Qu'est-ce qui empêche les mouvements des animaux dans les couloirs? Est-ce ils sont balisé ?

11. Comment protégez-vous les champs qui sont a coté des points d'eau contre les degats champetres ?

12. Est ce-que vous payez pour accéder aux points d'eau ? Si oui, c'était depuis quand ?

13. Avez-vous vu des conflits autour des points d'eau (puits ou eau de surface) ? Expliquez-nous ce que vous avez vu. Qui est impliqué dans ces conflits ?

14. Ya t-il plus de conflits aux points d'eau en période de sécheresse ? Si non quand ? (calendrier).

15. Avez-vous déjà voyagé à (Madaoua, Bouza, Keita) pour parler avec les autorités administratives au sujet d'un problème liés à l'eau ? Si oui, quel a été le résultat ?

16. Auriez-vous confiance au gouvernement de prendre des décisions concernant les ressources en eau dans votre territoire si les problèmes actuels continuent? Pourquoi ou pourquoi pas ?

C : Des mécanismes et institutions qui supportent l'adaptation

1. L'année dernière à cette époque, plusieurs éleveurs et agriculteurs n'avaient pas assez pour nourrir leurs familles et animaux. Quels difficultés avez-vous rencontré pendant ce temps ?

2. Avez-vous perdu de votre capital (la terre ou des animaux) ?

3. Comment avez-vous réussi à trouver assez de l'eau et de la nourriture (pour la famille et les animaux) ?

4. Quels sont les moyens que vous avez utilisé pour soutenir votre famille en temps de crise ? Expliquez-nous ce que vous faites du premier recours jusqu'au dernier recours.

Moyen	Rang/Priorité	Moyen	Rang/Priorité
Démander l'aide de ma famille/mes amis		Prendre un crédit	
Chercher l'aide d'un projet		Vendre des animaux	
Planter un champs dans les espaces pastoraux		Ramasser les tiges du mil	
Vendre un champs		Ramasser du paille	
Vendre la paille		Acheter la paille ou les tiges	
Vendre de propriété		Exode	
Laisser ma famille en la recherche de paturage et de l'eau		Utiliser un camion pour transporter de l'eau aux animaux	
Laissez le paysage pour la ville		Laissez notre village pour un autre (en brousse toujours)	
Autres ?			

5. Comment est-ce que le gouvernement vous supporte en temps de secheresse ? Les projets ?

6. Avez-vous pris un crédit au cours de cette crise ? Avec qui ? Combien etes-vous endebté ?

7. Cette année, comment allez-vous gérer vos pertes (animaux ou des terres) et rembourser le crédit ?

8. Avez-vous déjà envisagé de changer de mode de vie? Pourquoi ou pourquoi pas ? Si oui, que feriez-vous ?

9. Connaissez-vous des gens qui ont changé leur mode de vie ? Qu'ont-ils fait ? Pour quelles raisons ?

10. Est-ce que vous ou vos amis ont demanagé pour les raisons liées a l'eau? Decrivez-nous quand et pourquoi.

11. Quand est-ce que votre famille est arrivé dans cet endroit? Quel était la réception de la famille?

12. Pour accepter l'entrée d'un étranger dans votre territoire actuel, quels sont vos conditions ?

13. Avez-vous des affaires ou des transactions avec les Touaregs, Peuls, ou Haoussa? Que sont-ils ?

14. Est-ce que les (Haoussa, Peuls, Tuareg) sont intégrés dans votre société ? Pourquoi oui ou non ?

15. Aujourd'hui, avez-vous raison d'avoir peur des (Peul, Haoussa, Tuareg) ? Pourquoi oui ou non ?

16. Avez-vous jamais eu des vols du bétail? Expliquez-nous qu'est-ce qui amène ces vols?

17. Comment est-ce que vous protégez vos animaux contre les vols ?

18. Pensez-vous qu'une arme peut vous aider à se protéger contre les vols ? Pourquoi ou pourquoi pas ?

19. Comment est-ce que le gouvernement gère les vols ? Avez-vous confiance aux ces processus ? Pourquoi ou pourquoi pas ?

20. Comment voyez-vous vos avenir dans 20 ans avec tous ces aléas climatiques et les changements environnementaux, spécifiquement par rapport à l'eau, aux conflits, et à l'écosystème de votre environnement ?

E : Données à caractère personnel

Nom du participant :

Âge approximatif : _____

Langues parlées par le participant :

Lieu de l'entrevue :

village _____ commune _____ département _____

F. Observations

Nombre approximative des animaux :

Conditions de menage :

Chameaux		Eaux	
Bovins		Maison	
Chevres		Mode transport	
Moutons		Sanitation	
Ans		Nourriture	

Annex 2: List of experts interviewed at national scale

	Name	Position	Organization
1	Abey Bazou	Magistrat	Code Rural
2	Jerome Pennec	Conseiller Technique Juriste, Expert Foncier	Code Rural
3	Dambo Lawaly	Chef du Departement de Geographie	UAM
4	Prof. Boureima Ousmane	Hydrologie, Hydrochimie, Ancien minister des Mines et de l'Energie	UAM
5	Abdou Bontianti	Geography professor, researcher	UAM/IRSH
6	Dr. Amadou OUMAROU	Eneignane-Chercheur, Director Scientifique	LASDEL
7	Dr. Younoussi Issa	Researcher of water management	LASDEL
8	Dr. Sambo Bodé	Researcher	LASDEL
9	Dr. Benedetta Rossi	Researcher	LASDEL
10	Tchouso Mamane	Director CNEDD	CNEDD
11	Dr. Kamaye Maâzou	Conseil National de l'Environnement pour un Developpement Durable	CNEDD
12	Mme Bako Safi SOLANGE Mody	Unité Changements et Variabilités Climatiques/Environnement Urbaine et Cadre de Vie	CNEDD
13	Boubacar Boureima	Ingénieur en Gestion de la Faune Sauvage et des Aires Protégées	CNEDD
14	Alhassane Adams Diallo	Director General	ACMAD
15	Kadi Mohammed	Sect General	ACMAD
16	Cheikh KANE	Technical Assistant VIGRISC Project	ACMAD
17	Lazreg BENAICHATA	Coordonnateur Projet ViGIDisC	ACMAD
18	Daouda Mamadou	Ingénieur Météorologie, Chef Division Climatologie	Direction de la Meteorologies Nationale (DMN)
19	Nick Brashich	Regional Security Officer (RSO)	US Embassy
20	Alex Yu	ARSO	US Embassy
21	Syga Thomas	ARSO	US Embassy
22	General Brigade Abdou Kaza	Minister de l'eau, l'environnement, et la lutte contre la desertification	Minister of Water, the Environment, and the Fight against Desertification
23	Adamou Yacouba	Sect General du Ministre	Minister of Water, the Environment, and the Fight against Desertification
24	Radji Garba	Director	Direction des Ressources en Eau (DRE), Ministry of Water...
25	Sanoussi Rabé	Chef de Division Hydrogéologie	DRE, Ministry of Water...
26	Hassane Adamou	Hydraulic Engineer/Inventory of Water Resources	DRE, Ministry of Water...
27	Souley Hamidou	Sociologue	Director of Statistics, Ministry of Water
28	Navid Deiwakh	Hydrologist	ICRISAT
29	Shaibou Danbokwai	Niger Coordinator	PPCR/Minister of PLAN
30	Michel Bouchard	International Consultant	PPCR
31	Taoufiq Bennouna	Sr. Natural Resources Management Specialist	World Bank/PPCR

32	Minna Kononen	Specialist in Vulnerability and Social Protection	SDV-World Bank/PPCR
33	Dorsouma Al-Hamdou	Expert Adaptation aux Changements Climatiques	African Development Bank (BAD)/PPCR
34	Atto Indatou		Societe Patrimoine des Eaux du Niger (SPEN)
35	Salissou Hassan Yari		Societe d'Exploitation des Eaux du Niger (SEEN)
36	Mr Yayé Mamou		DAP Integrated Water Management
37	Mr Karim	Director of the Meteo	Minister of Meteo
38	Najib Issa	Chef de Monitoring et Evaluation	JEMED
39	Jeff Woodke	Director	JEMED
40	Dieudonné Goudou	Director of Communications	Program Kandadji
41	Mr Robert Des-souassi	Responsable de l'Observatoire du Bassin du Niger	Autorité du Bassin du Niger (ABN)
42	Dr. Abdoulaye Mohamad	Director	INRAN
43	Dr. Hubert N'DJAJA OUAGA	Geographe, Coordonnateur Regional du Projet	Agrhymet, Project "Appui aux capacités d'apatation du Sahel aux Changements climatiques", CILSS
44	Alain Samu	Reports Program Officer	World Food Program
45	Alice Golay	Reports Officer	World Food Program

Annex 3: Disappeared Species List

Vernacular names	Language	# Times mentioned	Commune	Department	Scientific Name
Aborragh	tamashek		Ibohamane	Keita	
Aborragh	Tamashek	3	Tillia	Tchintabaraden	Balanites aegyptiaca
Aborragh			Tillia	Tchintabaraden	
adarass		2	Garhanga	Keita	
adarass	Tamashek		Keita	Keita	Commiphora africana
Addag	Tamashek	3	Tillia	Tchintabaraden	Indigofera hochstetter
Addag	Tamashek		Tillia	Tchintabaraden	
Addag			Tillia	Tchintabaraden	
adouwa	Tamashek		Ibohamane	Keita	
adouwa	Hausa	2	Bangui	Madaoua	
Afagagh, afghata			Garhanga	Keita	
Afagagh, afghata		3	Tillia	Tchintabaraden	
Afagagh, afghata	Tamashek		Tillia	Tchintabaraden	Acacia raddiana
Afarad	tamashek	1	Tillia	Tchintabaraden	
Aflijite	Tamashek	1	Tillia	Tchintabaraden	
Agarou	Tamashek	1	Tillia	Tchintabaraden	
Agwur	Tamshek	1	Bangui	Madaoua	
ajein	Tamashek	1	Tillia	Tchintabaraden	
Akamjaro	Tamashek	1	Azarori	Madaoua	
Akayerou	Tamashek	1		Madaoua	
Akwara	Hausa			Bouza	Acacia laeta
Akwara	Hausa			Bouza	
Akwara		5	Bangui	Madaoua	
Akwara				Madaoua	
Akwara	Hausa			Madaoua	
Alogi (herb)	Peul	1	Ibohamane	Keita	Hyperthelia dissoluta
Amaraka	Peul	2	Ibohamane	Keita	Abutilon muticum
Amaraka	Tamashek		Tillia	Tchintabaraden	
Ametiroumte	Tamashek	1	Tillia	Tchintabaraden	
Arenkid	tamashek	1	Ibohamane	Keita	
Asuwa	Hausa	1	Bangui	Madaoua	
Attatasse	tamashek	2	Ibohamane	Keita	
Attatasse	Tamashek		Ibohamane	Keita	
Azza	tamashek	1	Ibohamane	Keita	
Bagaruwa	Hausa	4		Bouza	Acacia nilotica
Bagaruwa	Hausa			Bouza	
Bagaruwa				Madaoua	
Bagaruwa	Hausa			Madaoua	
Balaganda	tamashek	1	Ibohamane	Keita	
Birbiruwa	Hausa	1	Bangui	Madaoua	
Chigrene	Tamashek	1	Konni	Konni	

Danya	Hausa	2		Bouza	<i>Sclerocarya birrea</i>
Darga	Fulfulde	2	Garhanga	Keita	
Darza	Hausa		Garhanga	Keita	
Dogoyara	Hausa	1	Bangui	Madaoua	
Dursini	Hausa	1	Garhanga	Keita	
emiri	Hausa?	2	Bangui	Madaoua	
emiri	Peul		Bangui	Madaoua	
farou	Hausa	1	Bangui	Madaoua	
gabarra	Fulfulde	1	Ibohamane	Keita	
Gamba	Fulfulde		Ibohamane	Keita	
Gamba			Ibohamane	Keita	
gamba	Hausa		Bangui	Madaoua	
Gamba	Hausa	4	Bangui	Madaoua	<i>Andropogon gayanus</i>
Geza	Hausa	6		Bouza	<i>Combretum micranthum</i>
Geza	Hausa			Bouza	
Geza	Tamashek		Ibohamane	Keita	
Geza	Hausa		Bangui	Madaoua	
Geza	Hausa		Bangui	Madaoua	
Geza			Bangui	Madaoua	
Giga	Fulfulde	1	Garhanga	Keita	
Girssimi	Tamashek	1	Garhanga	Keita	
Gobarra	Peul	1	Ibohamane	Keita	<i>Sorghum aethiopicum</i>
Gorouba		2	Bangui	Madaoua	
Gorouba	Hausa		Bangui	Madaoua	
goursimi	Fulfulde	1	Garhanga	Keita	
hadia	Hausa	1	Bangui	Madaoua	
Iboraghane	Tamashek	1	Konni	Konni	
Igirissimi	tamashek	1	Ibohamane	Keita	
Ijane, Ijiyan		2	Konni	Konni	
Ijane, Ijiyan	Tamashek		Tillia	Tchintabaraden	
Ilikkidan	Tamashek	1	Tillia	Tchintabaraden	
Issaren	tamashek	1	Tillia	Tchintabaraden	
Itima	Tamashek	1	Tillia	Tchintabaraden	
Izzigarene	tamashek	1	Ibohamane	Keita	
Jabashi	Tamashek	1	Bangui	Madaoua	
Janbako	Hausa	1	Bangui	Madaoua	<i>Schizachyrium exile</i>
Jirga	Fulfulde	1	Keita	Keita	
Jujubies	Tamashek	1	Ibohamane	Keita	
Kabba	Tamashek		Garhanga	Keita	
Kabba	Hausa	2	Bangui	Madaoua	
Kagna	Fulfulde	1	Garhanga	Keita	
Kalgo	Fulfulde		Keita	Keita	
kalgo	Hausa		Bangui	Madaoua	
Kalgo	Hausa		Bangui	Madaoua	

kalgo		6	Bangui	Madaoua	
kalgo			Bangui	Madaoua	
kalgo	Hausa			Madaoua	<i>Peliostigma reticulatum</i>
kalgo	Hausa			Madaoua	
Kamomoa	Fulfulde		Garhanga	Keita	
Kamomoa	Hausa	2	Garhanga	Keita	
Karangiya	Hausa		Bangui	Madaoua	
Karangiya	Hausa	2	Bangui	Madaoua	<i>Cenchrus biflorus</i>
Kasuwa	Hausa	1	Bangui	Madaoua	
kaywaye	Hausa		Bangui	Madaoua	
kaywaye	Hausa	2	Bangui	Madaoua	
Kiriya	Hausa	3	Bangui	Madaoua	
Kiryā, kariya			Bangui	Madaoua	
Kiryā, kariya	Hausa		Bangui	Madaoua	
kiskithi	Hausa	1	Garhanga	Keita	
Koumtchi	Tamashek		Azarori	Madaoua	
Koumtchi	Tamashek	3		Madaoua	
Koumtchi			Bangui	Madaoua	
Kounohi	Hausa	2	Bangui	Madaoua	
kounthi	Hausa		Garhanga	Keita	
Kram kram	Peul	1	Bangui	Madaoua	
Maerki	Hausa	1	Bangui	Madaoua	
Magariya	Hausa			Bouza	<i>Ziziphus mauritiana</i>
Magariya	Hausa			Bouza	
Magariya		3	Bangui	Madaoua	
maroroua	Fulfulde	1	Garhanga	Keita	
Nobi (herb)	Peul	1	Ibohamane	Keita	<i>Cymbopogon schoenanthus</i>
Rimajogoyi	Hausa	1	Bangui	Madaoua	
Sa'bay	Peul	1	Bangui	Madaoua	
Sabarra	Hausa			Bouza	<i>Guiera senegalensis</i>
Sabarra	Hausa			Bouza	
Sabarra	Tamashek		Ibohamane	Keita	
Sabarra	Fulfulde		Keita	Keita	
Sabarra	Hausa		Bangui	Madaoua	
Sabarra		8	Bangui	Madaoua	
Sabarra			Bangui	Madaoua	
sabarra	Hausa		Bangui	Madaoua	
Sakarka	Hausa	1	Garhanga	Keita	
Sirkaki	Tamashek	1	Ibohamane	Keita	
Tabadi	Hausa	1	Bangui	Madaoua	
Tadarast (Petit adaras)	Tamachek	1		Madaoua	<i>Commiphora africana</i>
Tadlimte	tamashek	1	Tillia	Tchintabaraden	
Tafassa	Hausa	1	Bangui	Madaoua	

Tahangamt	Tamachek	1	Tillia	Tchintabaraden	
Takachmamte	Tamashek	1	Garhanga	Keita	
Takana ou Tahanna	Tamashek	1	Tillia	Tchintabaraden	Crotalaria arenaria
Takirzikillit	Tamashek	1	Azarori	Madaoua	
Takkat	Tamashek	1	Tillia	Tchintabaraden	
Tamarakhate	Fulfulde	1	Ibohamane	Keita	
Tamasalte	Tamashek	3	Tillia	Tchintabaraden	
Tamaselt	Tamashek		Tillia	Tchintabaraden	Trianthema portulacastrum
Tamaselt	Tamashek		Tillia	Tchintabaraden	
Tamat		2	Garhanga	Keita	
Tamat	Tamashek		Tillia	Tchintabaraden	Acacia erhenbergiana
Tamma	Hausa	1	Bangui	Madaoua	
Tanousse	tamashek	1	Ibohamane	Keita	
tarakkaz	Tamashek	1	Tillia	Tchintabaraden	
Taraminiya	Hausa	5	Bangui	Madaoua	
Taramiya	Hausa			Bouza	Combretum glutinosum
Taramiya	Hausa			Bouza	
Taramiya	Fulfulde		Keita	Keita	
Taramiya			Bangui	Madaoua	
tawass	Tamashek	1	Tillia	Tchintabaraden	
Tazayt		2	Keita	Keita	
tazee ou tazayt	Tamashek		Tillia	Tchintabaraden	Acacia seyal
Tchinaka	tamashek	1	Bangui	Madaoua	
Tibaremett	Tamashek	1	Tillia	Tchintabaraden	
Tigart n amadal	Tamashek	1	Tillia	Tchintabaraden	Cassia mimosoides
Tiggart	tamashek		Ibohamane	Keita	
Tiggart	Tamashek		Ibohamane	Keita	
Tiggart		7	K	Keita	
Tiggart			Keita	Keita	
Tiggart	Tamashek		Azarori	Madaoua	
Tiggart	Tamashek			Madaoua	Acacia nilotica
Tiggarte	tamashek		Ibohamane	Keita	
Tighirzigi	tamashek	1	Ibohamane	Keita	
Tihilit	Tamashek	1	Tillia	Tchintabaraden	
Tihinguimte	tamashek	1	Tillia	Tchintabaraden	
Tikinit	Tamashek	6	Tillia	Tchintabaraden	
Tikinit	Tamashek		Tillia	Tchintabaraden	
Tikinit	Tamashek		Tillia	Tchintabaraden	
Tikinit	tamashek		Tillia	Tchintabaraden	
tikkinite			Tillia	Tchintabaraden	
tikkinite	Tamashek		Tillia	Tchintabaraden	
Tikurzikilit	Tamashek	1	Madaoua	Madaoua	
Tirza	tamashek		Ibohamane	Keita	

Tirza	tamashek		Ibohamane	Keita	
Tirza	tamashek		Ibohamane	Keita	
Tirza	Tamashek	4	Ibohamane	Keita	
Tiwila	Tamashek		Garhanga	Keita	
Tiwila	Tamashek		Ibohamane	Keita	
Tiwila			Garhanga	Keita	
Tiwila		5	Keita	Keita	
Tiwila	Tamashek		Keita	Keita	<i>Sclerocarya birrea</i>
Tourfan	Tamashek	1	Konni	Konni	
Touwila	tamashek	1	Ibohamane	Keita	
Tsiria	Hausa	1	Bangui	Madaoua	
Tunwahiya	Hausa	1	Bangui	Madaoua	
yerede	tamashek	1	Ibohamane	Keita	
Zaramunu	Tamashek	1	Bangui	Madaoua	

Annex 4: Data collected from Procès Verbaux (PV)

<i>Type</i>	<i>Date</i>	<i>Depart.</i>	<i>Location</i>	<i>Reconciled by</i>	<i>Objective of litige</i>	<i>Decision</i>
<i>PV COFO</i>	27-May-07	Madaoua	Madaoua	Chef du canton	Access to mare	The Chef du canton outlaws all planting in said mare. He states that herders can water their animals but must stop digging in the mare. The accused must construct a couloir to the mare so that livestock can pass.
<i>PV Admin</i>	04-Jun-98	Abalak and Keita	Maigouibi	8 Keita and 9 Abalak administrators and chieftans	Administrative borders	12 fields are in question belong to either Keita or Abalak. The sale of these fields was reimbursed and all future sales are suspended until the borders are well defined.
<i>PV Admin</i>	22-Dec-96	Abalak	Tabalak	5 administrators (Tchinta, Abalak, and Keita)	Administrative borders and land tenure	The gardens in Tabalak are exploited by inhabitants from 3 departments. Thus, land tenure decisions must be treated now by the DDA (Direction Departmental of Agriculture). Also, if the State restores or improves land, it becomes the property of the State, which can then decide who should work said land.
<i>PV Admin</i>	06-Aug-97	Keita	Tsingalé	Prefecture (4 representatives)	Aire du paturage	A farmer in Damna has been exploiting a field adjacent to the aire du paturage and the couloir du passage used by herders to water their herds. The committee decided to return the field to its original size, protecting the pastoral space.
<i>PV Justice</i>	13-Nov-02	Bouza	Sabon Sara and Taraouarou	Justice	Aire du paturage	Decision by judge unknown
<i>PV COFO</i>	07-May-05	Bouza	Kouka	COFO dep	Aire du paturage	6 resource persons were designated to delineate the aire. These began working as a COFOb. Chefs are called upon to respect this aire.
<i>PV COFO</i>	02-Apr-10	Madaoua	Galma	Chef du groupement and chef secteur Galma	Aire du paturage	Certain fields were encroaching into Aire. The aire and couloir were determined to be protected from all cultivation by the chef du groupement and chef du secteur Galma. They stopped all cultivation and de-

						mandated that farmers respect the current borders
PV COFO	21-Aug-99	Bouza	Karkara	COFO dep	Aire du paturage and Couloir	2 herders living in Karkara brought the litigation to recognize the intrusion upon a couloir and aire du paturage. Limitations of each were acknowledged and GPSed to prevent fields from encroaching. Every disobedience of these marks will open a case at the Justice.
PV COFO	04-Dec-99	Madaoua	Sabon Guida	Chef du village (Sabon Guida)	Couloir du passage	A farmer was planting in the couloir of a mare. The farmer agreed to stop planting the route, which will be reinforced by the village chief.
PV Justice	11-Feb-04	Bouza	Americawa	Justice	Couloir du passage	50 years ago a couloir was delimited by a chef du canton. Since this time, fields have encroached into the space. The couloir was delimited.
PV COFO	27-Jul-07	Bouza	Zaguia	COFO dep	Couloir du passage	The couloir is near the Banquette site. Herders need to steer clear of the site. Fields also must not enter into the couloir.
PV COFO	05-Jan-04	Madaoua	Sabon Guida	Chef du village (Sabon Guida)	degat champetre	The herder will pay 10,000 fcfa in reparations for damaging the field.
PV COFO	28-Jul-04	Madaoua	Madaoua	Chef du Toufafi II	degat champetre	The herder will pay reparations of 60,000 fcfa for damaging crops.
PV Justice	18-Jan-07	Bouza	Tamzak	Justice	degat champetre	The herder was accused of introducing 500 animals into the field of the victim, decreasing the harvest from 200 bottes Millet/500 bottes sorghum to 24/60 bottes. He came to the city because the chef du village did nothing. The herder paid 200,000 fcfa
PV Justice	15-Feb-07	Bouza	Garadoumi	Justice	degat champetre	Between two farmers, the accused paid 250,000 fcfa.
PV Justice	29-Apr-10	Bouza	Taraouraou	Justice	degat champetre	Herder was condemned to pay 455,000 fcfa to four farmers whose crops were damaged.
PV Gend	03-Jun-10	Keita	Tabofatt	Gendarmerie	degat champetre	Referred to the justice, who found reconciliation between the parties

<i>PV COFO</i>	07-Dec-10	Keita	Akoukou	COFO dep	degat champetre	16 cows belonging to an Akoukou herder destroyed the harvest of a farmer in the same village. The herder paid 105,000 fcfa, 16,250 of which was paid to the farmer, while the remaining paid for the costs of rendering the decision
<i>PV COFO</i>	28-Mar-11	Keita	Fararatt	COFO dep, El-evage, Chef du Canton de Garhanga rep., and gendarmes	degat champetre	38 camels of the accused herder (a resident of the same village) entered the field, eating doliques, calebassiers, et pasteques. The herder paid 172,000 fcfa in damages, 47,000 which was returned to the farmer.
<i>PV Gend</i>	09-Jan-04	Keita	Labanda	Gendarmerie	Degat champetre with vio- lence	A farmer's bean field was damaged by a herder, incurring a fee of 110,000 fcfa, which was declared by the justice due to the prescence of violent conflict and wounds with arms
<i>PV Gend</i>	03-Oct-04	Keita	Birni	Gendarmerie	Degat champetre with vio- lence	The herder paid 700,000 fcfa and this case was treated by the Justice due to the fact that there were violence and wounds incurred.
<i>PV Gend</i>	05-Sep-07	Keita	Kouréga	Gendarmerie	Degat champetre with vio- lence	The justice found those involved in the fighting (including arms and wounds) to be guilty and required an amendment for the damages
<i>PV Gend</i>	15-Apr-10	Keita	Ibohamane	Gendarmerie	Degat champetre with vio- lence	The guilty party (herder) paid 120,000 fcfa conforming with the damages to a mangoe garden committed, including violence with arms.
<i>PV Justice</i>	04-Jun-10	Madaoua	Kaka	Justice	Degat champetre with vio- lence	The farmers of Kaka saw animals in one field and called the owner, confiscating the accused herder's animals. After some discussion, a fight broke out and the farmers followed the herder to his camp to destroy it. The gendarmes arrived the same day 2 hours after the fighting began.
<i>PV Justice</i>	03-Jan-99	Bouza	Bouza	Judge	Land ten- ure	Litigation about field ownership.
<i>PV COFO</i>	22-Nov-06	Madaoua	Bangui	Chef du centon	Land ten- ure	2 villagers both claimed the same site. The chef du canton divided the site in two and gave both access to the mare.

PV COFO	12-Nov-10	Madaoua	Jankadami		Land tenure	A granery was built in a disputed area. The decision was rendered that the granery can remain, but none other will be built without authorisation.
PV COFO	19-May-11	Keita	Tsoungalé	COFO dep	Land tenure	A fallow field in the village was claimed by a villager of the same village to be cultivated. Persistent argument caused a decision to be rendered in his favor
PV COFO	29-Mar-07	Bouza	Guidan Gara	COFO dep	Pastoral well	A well site was designated and the condition set for well access. A 30 x 30 meter space will surround the well and a 7 meter wide couloir will provide access to livestock.

Annex 5: Scenario Focus Group Methodology

Methodology and Organizations participating in the Scenario Focus Group Summary of Plan for Scenario Focus Group (SFG) :

Objectives:

The Climate Change, Hydro-Conflict, and Human Security (CLICO) program has been funded by the European Commission to provide empirical research on the social dimensions of climate change in the Mediterranean, Middle East, and the Sahel. This study is one of 13 case studies examining the relationship between water resources and management, climate and environmental change, and conflict or cooperation between divergent users of water resources. The Niger case study examines how rainfall variability impacts the conflicting modes of adaptation for two divergent groups – pastoralists and agro-pastoralists. The majority of research for the case study has been conducted via a review of relevant national and international policies, expert interviews, community mapping, calculating the prevalence of conflict, and qualitative interviews with pastoralist and agro-pastoralists.

As the culminating field activity, this scenario focus group will present and discuss alternative scenarios of hydro-climatic change and socio-political relations to understand the implication for human well being. Our goal in this discussion is not to predict the future, but to reflect various scenarios of an uncertain future based on plausible accounts of how external forces such as climate change, political dynamics, land use change, population growth, technological advances, environmental conditions, economic and social dynamics might evolve in relation to agro-pastoral livelihood needs. Through the discussion, we hope to develop priorities for climate change adaptation and institutional change that will ensure human well being in the long term.

Description of Scenarios:

Probabilistic climate scenarios aid in reducing uncertainty and formulating strategies to enhance disaster preparedness. Based on what is known about the processes and functions of the earth's systems, climatologists have developed a series of mathematical models to describe possible future climate scenarios and their impact on our daily lives. Such models are based upon the assumption that patterns of human behaviour and development have an impact on both the security of our environment and the variability of the climate. One example of this is the relationship between the significant increase in greenhouse gases and long-term warmer temperatures along the equator and near the poles. Such rises in temperature, in turn are perceived to impact the Inter-tropical Convergence Zone (ITCZ), contributing to droughts in the Sahel. See the chart below for predictions and their likelihood based on the IPCC AR4 report (2007).

Phenomenon and Direction of Trend	Likelihood of future trends based on Projections for the 21 st Century	Examples of Major Projected Impacts by Sector		
		Agriculture, Forestry, and Ecosystems	Water Resources	Human Health
Over most areas, warmer and fewer cold days and nights, warmer and more frequent hot days and nights	<i>Virtually certain, Greater than 99% probability</i>	Decreased yields in warmer environments, increased pest outbreaks	Effects on some water supplies	Increased human mortality due to heat waves
Warm spells, heat waves	<i>Very likely, greater than 99% probability</i>	Reduce yields in warmer regions due to heat stress; increased danger of wildfire	Increased demand for water, water quality problems	Increased risk of heat mortality especially for elderly and young
Areas affected by drought increases	<i>Likely, greater than 66% probability</i>	Land degradation; lower crop yields/failure, increased livestock deaths, increased risk of wildfires	More widespread water stress	Increased risk of food and water shortage, increased risk of malnutrition, increased risk of water and food born diseases

Furthermore, the impact from human activities such as agriculture or grazing on the land's surface reduces ground cover and soil water content. The coupling of human and climate induced environmental changes impacts human well being and challenges policymakers to seek multidisciplinary solutions.

The scenario we have developed for this focus group discussion addresses a twenty -year period examining a projected future for agro-pastoral activities from 2031 to 2050 (Figure 3.7). This duration, as opposed to a single year, is necessary in our discussion of variability of climate conditions in the Sahel. The model used in developing this scenario is based upon the Cyprus Institute's climate outlooks (Dec 2010). The model compares the years 1980 to 1999 and 2031 to 2050. According data available, average annual temperature is predicted to increase by 2°C. During the months of June, July and August, the average precipitation is predicted to decrease by 4%. During May, April, and May the rainfall will also decrease by 6%. On the contrary, during the months of September, October, November, December January, and February, (the period that does not typically receive rain) the rainfall is predicted to increase by 12%. As a result, the mean annual precipitation is expected to increase by 7%. Runoff from rainfall into rivers and aquifers is expected to increase by 4%. See table below.

Based on the climate change models (Figure 3.7), we have developed four scenarios reflecting both the social and hydrological impacts for purposes of the focus group discussion. The mixed tendency of lower rainfall during the rainy season and higher rainfall during the dry season shows a likelihood of both drought and flood events in a single year.

While climate change will have varied impact on the human well being of the population in Niger, we have chosen a social scenario based on the usage of space. The reason for this is based on the prior field research, where conflictive and cooperative events were related to the degree to which individuals protect or exploit pastoral zones, pathways, and water sources. Due to limitations in this focus group discussion, we will examine the degree to which loss of pastoral spaces in both the agricultural and pastoral zones stays the same (greater conflict) or decreases (more cooperation). Loss of pastoral spaces is defined by the encroachment of agricultural fields into pastoral areas, land degradation, and changes in ownership and access. A graphic describing these scenarios is as follows:

To begin our discussion, we will first validate these scenarios by addressing the following questions:

1. Which are the most relevant and likely scenarios to adaptation to climate change in Niger?
2. What may be the main human impacts from each scenario and upon whom are they likely to fall?
3. What groups are less well positioned to cope with such impacts (vulnerability)?

This will follow with a more open discussion regarding the implications for human well being and social stability. During this discussion, the following questions will be addressed:

- 1) What does this scenario mean for agro-pastoral and pastoral livelihoods and well-being a) for the prevention of conflicts between the two groups b) for the sustainability of their livelihoods? (*Which are the more vulnerable groups, how will they be affected?*)
- 2) What adaptations might be needed to ensure the human security of these groups? (*Is it possible to adapt to this scenario? What actions or changes might be needed to adapt? E.g. to protect the more vulnerable groups*)
3. Who should make these adaptations?

The last part of the discussion should include a more open-ended discussion concerning the adaptations and institutions needed to ensure the human security of the most vulnerable groups in the context of uncertain futures. Participants might identify the key institutions for adaptation and discuss which are the barriers and opportunities for implementation of adaptation. These might be similar for all scenarios or differ for different scenarios, so the facilitator should try and draw out these differences from the discussion. The questions asked might be:

1. What institutions are missing that might be needed for implementing adaptation? (What are the barriers or opportunities for adaptation?)
2. What modes of sustainable development might the group propose to both reduce conflict and secure both livelihoods?

Participants:

Government	<ol style="list-style-type: none"> 1. M. Abey Bazou (Secrétaire Permanent du Code Rural) 2. M. Bako Yacouba (Adaptation Specialist, Dir. De L'Eau) 3. Daouda Mamadou (Direction de la Meteorologie) 4. Amadou Boureima (Direction d'Elevage) 5. Secetaire Permanent des Chefferies Traditionnels M. Allassane Albadé
INGOs	<ol style="list-style-type: none"> 1. Mahamane Moctari 2. Amadou Ndiaye (National Disaster Reduction Advisor, UNDP)
Scientists	<ol style="list-style-type: none"> 1. Dr. Abdoulaye Gouro (Expert Agro-pastoral issues, President du Comite Scientifique RIPIESCA) 2. Dr. Amadou Oumarou (conflict & institutions, Director of LASDEL) 3. Dr. Amadou Boureima (pastoral issues, LASDEL researcher) 4. Dr. Moussa Boureima (Adaptation CC, ICRAF, INRAN Researcher) 5. Dr. Salissou Issa (Chef Dept Production Animal, INRAN) 6. Dr. Lazreg Benaichata (ViGIRisc Coordonnateur, ACMAD) 7. Dr. Nazoumou Yahaya (hydrological resources, Department of Geologie, UAM) 8. Dr. Hubert N'Djafa Ouaga (Geographe, Coordinator, Projet Supporting Adaptive Capacity in Sahel, AGRHYMET)
Pastoral Associations	<ol style="list-style-type: none"> 1. Ibankawil Iitnin (Tuareg, CAPONG), 2. Boureima Doudou (Fulani, AREN) 3. Siddo Amadou (Fulani, President, FNEN-Daddo)
Customary Officials	<ol style="list-style-type: none"> 1. Hamzata Alhoudal (Chef du Canton of Tchintabaraden)

	2. Chef du Groupement, Azarori (Tahoua)
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Proposed Schedule:

1. Introductions of participants and explanation of the purpose of the focus group (20 min)
2. Discussion of confidentiality and request consent to take notes/ record the discussion (5 min)
3. Brief presentation of CLICO project and the climate outlook information on which the scenarios are based. (15 min)
4. Presentation of the four scenarios and discussion of the scenarios themselves (20 min)
5. Outline the questions you will be asking of each scenario and ask participants to explain how they use each of the key terms used in the questions (e.g. human security/well-being, water security, adaptation) (20 min)
(20 min break)
6. For each scenario in turn, discuss the implications of the scenario using your set of questions (80 min, 20 minutes per scenario)
7. Discussion of institutions needed for adaptation (20 min)
8. Sum up – and outline your plans for feedback to the participants (10 min)

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