

THE SOCIAL DIMENSIONS OF LIVESTOCK MOBILITY: CLIMATE RISK,
INFORMATION NETWORKS, AND RESOURCE GOVERNANCE IN CENTRAL
SENEGAL

by Erin Kitchell

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Thesis Committee:

Professor Matthew D. Turner, Chair

Professor Lisa Naughton

Associate Professor Samer Alatout

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Introduction

The Sahel is one of the regions of the world expected to be most impacted by human-induced climate change, with predictions pointing to decreases in annual rainfall and increased variability in the temporal and spatial distribution of rainfall (Boko et al. 2007; Thornton et al. 2007). Livestock are an important part of livelihoods in the Sahel and play a prominent role in the resilience of poor households to climate and market shocks. They represent one of a limited number of available investment options to increase assets and diversify household risk exposure (Barrett et al. 2001; Anderson 2003; Thornton et al. 2007). Livestock are likely to become increasingly important for the persistence of rural livelihoods in semi-arid areas (Jones and Thornton 2009; Fraser et al. 2011). Throughout the Sahel, climatic shifts are already contributing to transformations in occupancy and land use. Due in part to the marked decline in rainfall in the region over the past decades, pastoralists are moving further south within the Sahel and into the Sudano-Guinean farmbelt and the timing of migration patterns is being altered (de Bruijn and van Dijk 2003; Bassett and Turner 2007; Bocar Sow, personal communication). Climate change is likely to exacerbate competition for land resources and may impact the relative allocation of household labor between cropping and livestock production.

In the past decade, national policy and development programming in dryland areas has shifted dramatically with a new focus on enabling livestock mobility as an ecologically adapted production system in variable environments (IIED 2010; Hesse and Thebaud 2006). The recognition of non-equilibrium dynamics in rangelands starting in the 1990s catalyzed a dramatic shift in views of the role of mobility. Prior to this, poor intrinsic soil fertility and vegetative production was long misinterpreted as evidence of human-driven degradation due to overgrazing (the “tragedy of the commons”). Since the mid-1990s these assumptions have been supplanted

by ecological understandings of arid and semi-arid lands as characterized by low net primary productivity and high variability in composition and productivity; these ecosystems are dominated by cyclical patterns of change and heterogeneity at the micro-level (Ellis 1995). Further, studies have shown that climate is a more important factor in determining vegetation structure than either grazing or internal ecological processes (Ellis and Swift 1988; Behnke and Scoones 1993; Sullivan and Rohde 2002). In response, a new rangeland paradigm emerged that emphasizes mobile husbandry as core to the resilience of social-ecological systems in arid landscapes. Indeed, the comparative advantage of pastoral production in drylands lies in the ability to cope with variability (Scoones 1995; Bonnet and Herault 2011; Turner 2011).

Pastoralists make use of adaptive strategies that allow the opportunistic use of variable resources, tracking ecological variability through constant monitoring of ecological conditions and ongoing adjustments to herd behavior in response (Niamir-Fuller and Turner 1999). As an opportunistic management system, mobile pastoralism successfully maximizes returns from a highly variable resource base (Behnke and Scoones 1993; Ellis 1995; Reid, Galvin, and Kruska 2008; Galvin 2009). Movement is critical to access forage and water unevenly distributed in space and varying across time. Only a small percentage of pastoralists discover relevant information about pastures themselves, with the majority relying on either specialized scouts or news gained at markets and from personal contacts; one's position within these social structures will impact both access to and ability to use information (Adepetu et al 1988; Turner and Hiernaux 2008). While information is an important requirement for pastoral movement, access to grazing lands and water points play a dominant role in restricting the ability to act in response to information (Niamir-Fuller 1999). Given the unique information requirements associated with

mobility, agropastoralist livelihoods in the Sahel offer a unique case study for assessing the role of information in the political economy of vulnerability and adaptation.

Over the past decade, research on the human dimensions of climate change has begun to focus on local communities as the primary site for adaptation; the role of autonomous adaptation by resource users is increasingly emphasized, with changes in livelihood strategies viewed as mechanisms for coping with climatic variability (Agrawal 2009). However, understanding how local resource users cope with change requires increased attention to the role of local institutions in facilitating coping strategies. Frameworks of adaptive capacity prevalent in the literature on human dimensions of climate change have recently begun to emphasize the role of social networks in promoting the resilience of linked social-ecological systems to climate variability. Governance of ecosystems is complicated by the uncertainties, complex dynamics, and scale dependencies that characterize both human societies and natural systems. In light of this, a vital role is accorded to common norms and practices, conflict resolution, the negotiation of various trade-offs, information sharing, and building common knowledge in enhancing resource governance. Informal institutions are believed to have greater flexibility to engage in these processes and to incorporate multiple actors than centralized, top-down forms of management (Bodin 2009; Ostrom 1990; Folke et al 1998).

Calls for new conceptions of resource governance are emerging in parallel with work on adaptive management. Governance is a term that is meant to represent a departure from government as the primary source of authority in order to embrace a wider range of institutional forms that play a role in resource management (Cash 2006; Folke 2005; Holling and Gunderson 2002). Serious consideration of diverse modes of governance requires grappling with divergent epistemologies and sources of knowledge (Haraway 1991). Some authors have noted significant

differences in perceptions of mobility held by researchers and by pastoralists, indicating fundamental divergences in their respective points of departure. Within scientific accounts, the mobility of pastoralists is depicted as a response to variation in natural systems. However, for pastoralists mobility is understood in terms of the need to ensure the well-being of livestock, with important distinctions made between the mobility of the herd and the mobility of people (Adriansen 2008; Adriansen and Nielsen 2002). Similarly, divergences in fundamental assumptions about the nature of information and its social function impact how climate forecasts are compiled and disseminated (Patt and Gwata 2002; Suarez et al. 2009). In the pastoral context the availability of information affects competition, with information about forage losing value as it becomes more widely known. The widespread dissemination of information on ecological conditions may be in tension with the social frameworks that have traditionally facilitated access to resources. A transition from socially mediated information exchanges to those mediated by technology and external sources may contribute to fundamental restructurings of local resource governance (Suarez et al 2009; Niamir-Fuller and Turner 1999).

Much like the turn toward social networks in the climate change literature, the literature on pastoralism in West Africa highlights the role that social institutions play in mediating access to both information and resources. Traditionally, writing on common property focuses on bounded user groups with exclusionary powers; however, mobile pastoralism offers a more diffuse reality than conceptions of a fixed insider/outsider dichotomy, indicating the need for a mix of flexible and exclusionary rules in governance of common pool resources (Clever 2002; Niamir-Fuller and Turner 1999; Turner 1999; Galvin 2009; Turner 2011; Legrosse 1999). Arising from the demands of resource use in a variable environment, pastoral tenure is characterized by the continuous reallocation of access rights. Although mobility is now

acknowledged as central to the resilience of pastoral livelihoods in the Sahel, growing levels of fragmentation in rangelands due to agricultural extensification and privatization of land are placing increasing pressure on pastoral institutions (Galvin 2009). Study of the social geographies of resource access can illuminate ways in which customary and emergent norms may provide a basis for the difficult process of negotiating land-use priorities between farmers and herders (Turner 2011; Djire 2004).

This case study of institutions for information transfer among agropastoralists in Senegal builds on current literature on the human dimensions of climate change, environmental governance, and pastoral mobility. Focusing on information networks can acknowledge the political dynamics of adaptation, in which differential access to and use of information has significant implications. Deeper understandings of changes in forms of information sharing can illuminate how access to information may be linked to control over processes that mediate access to resources. In the case of mobile pastoralism, this requires considering enhanced dissemination of forecasts alongside changing regimes of resource governance. This study examines the impacts of the methods and the breadth of information dissemination on institutions that are central to facilitating pastoral mobility. In addition, it explores interactions between social networks and institutions for resource governance. Chapter 1 focuses on the information sought by agropastoralists in order to make production decisions, patterns of information exchange, and the impact of information on the ability of households to cope with livelihood shocks. Chapter 2 builds from this analysis to contextualize these dynamics within discursive practices of territorialization and shifts in resource management. By tracing changes in social networks, the second chapter analyzes how the transition toward state-based management is altering the terms of connections among social groups.

Statement of Research Questions

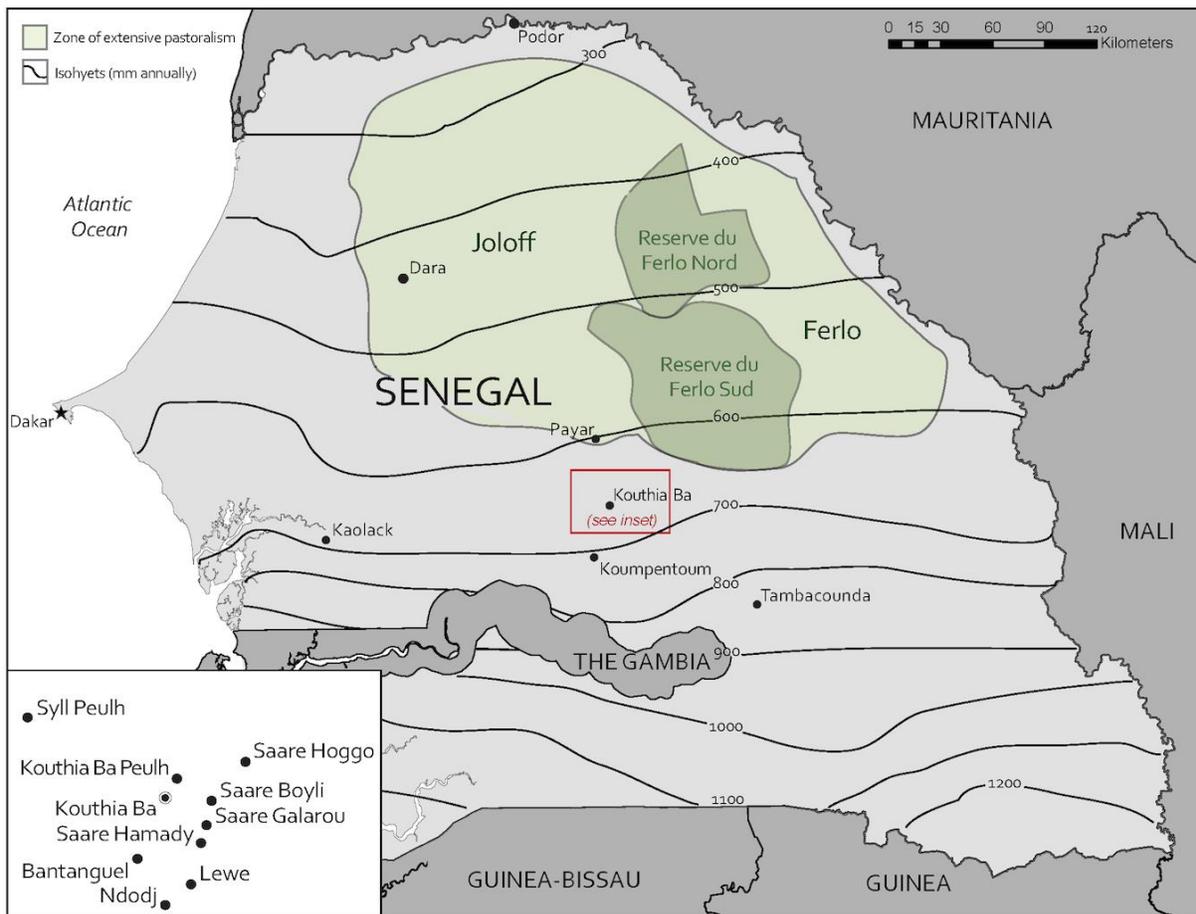
- 1) How is information transferred among pastoralists? What is the relationship between transfers of different types of information (climate forecasts, location of water points/forage, market prices)?
- 2) How is information used in decision-making about herd movement?
- 3) How are patterns of information exchange changing with the use of new technologies? What is the role for expanded access to information in relation to the politics of land use planning?
- 4) How are changes in social networks affecting the norms and institutions governing resource access? What are the implications for differential climate risk among groups?

Site Selection

Data collection was carried out in ten villages in the district of Kouthia Ba in central Senegal. Kouthia Ba is a rural commune (*communauté rurale*) in the arrondissement of Koumpentoum located roughly 50 kilometers south of the Ferlo. The rural commune includes 59 villages with a total population of just over 20,000. Kouthia Ba is also the name of the market town that serves as the seat of the administrative council of the rural commune. Receiving between 500 and 800mm of rainfall annually, the region is dominated by mixed agro-pastoral livelihoods with the cultivation of millet, sorghum, and peanuts and the rearing of cattle, goats, and sheep as the main sources of income. The area includes part of the protected sylvo-pastoral reserve of Panal. Due to its location directly south of transhumant routes in the Ferlo, the rural commune of Kouthia Ba has experienced increased interaction between sedentary agro-pastoralists and transhumant pastoralists from the Senegal River Valley. Figure 1 (below) shows the location of the study sites.

Villages were chosen based on their participation in both an information technology project in 2007 and land-use planning projects in the 1980s and 1990s on which contemporary management plans are modeled. Since 2001, the Centre de Suivi Ecologique (CSE), a public

Figure 1. Map of the Study Sites in the communauté rurale of Kouthia Ba



utility established by the Senegalese Ministry for the Protection of the Environment, has implemented a series of interventions centered on diverse aspects of pastoral resource management. Initial project phases in Kouthia Ba focused on the utilization of information technology to strengthen pastoralists' access to and exchange of information about ecological conditions. Cell phone service reached the region as early as 2004, but ownership of cell phones was not widespread until after 2008. The first two phases of CSE's work trained herders from ten villages to use GPS technology to track herd movements and to use satellite phones with a link to an internet-based map to which they could download and upload data on real-time ecological conditions (notably forage quality and existence of rain-fed water points). Current phases of

CSE's work focus on reinvigorating *unités pastorales* and developing land-use plans for concerted resource management between farmers, sedentary herders, and transhumant pastoralists based on shared understandings of shifting resource availability. The *unités pastorales* are based on territorial units centered on boreholes originally delineated by land use plans in the mid-1980s and early 1990s (personal communication, Bocar Sow). These units focus on grazing lands and management for pastoral use, rarely the dominant productive land use in planning throughout the Sahel (Adriansen 2006).

Study Methods

A mixed methods approach was used to elucidate the ways in which social processes contextualize the meaning of climate information for individuals and how political economic processes enable or constrain mobility. A series of focus groups were held to elicit discussion of observed environmental changes, local perceptions of uncertainty and risk, understanding of and confidence in external information sources, and the role of formal and informal institutions in information exchange and local decision-making. Semi-structured interviews were used to document personal social networks and the processes of individual decision-making. Finally, a survey was conducted to collect data on the availability of information, factors impacting access to information, types of strategies used in response to ecological and market signals, the impact of assets on action in response to climate information, and the impact of land-use pressures on the ability to act on information. Data collection in Kouthia Ba was carried out over the course of six weeks in June and July 2012. Focus groups, interviews, and surveys were all conducted in Pulaar, the local language of Fulani agropastoralists. A research assistant from the district was hired to assist with the facilitation of focus groups and completion of the surveys.

1) *Focus Groups* : Five focus groups were held with discussion centering on local perceptions of uncertainty and risk, perceptions of historical climate variability and future trends, understanding of and confidence in external forecasts, and the role of formal and informal institutions in information exchange and local decision-making. Focus groups ranged from 1.5 to 2.5 hours in length and an audio recording was made of each. The first focus group was composed of 11 participants in the CSE information technology project drawn from 8 villages across Kouthia Ba. The second focus group was composed exclusively of external herders who migrate into the region seasonally; participants included herders from both eastern and northern Senegal, but all were ethnically Fulani. A third focus group was conducted with 5 youth directly responsible for supervising local herds in Saare Boyli. The final two groups were composed of 7 to 12 heads of household in two Fulani villages, Kouthia Ba Peul and Saare Boyli. During the first meeting in Saare Boyli a chronology was constructed using local events such as municipal elections and drought years to establish a shared understanding of time periods starting in 1985. This timeline was used to facilitate discussion about trends in rainfall and production strategies for cropping and livestock in both Kouthia Ba Peul and Saare Boyli. A series of three sessions was held with the group in Saare Boyli to allow greater depth of discussion about how institutional structures for resource access affect the usefulness of various types of information. Discussion included the relative importance of various sources of information, types of information disseminated, level of confidence in each source, and changes in each of these over time.

2) *Semi-structured interviews* : Semi-structured interviews of 60 to 90 minutes were conducted with 28 research subjects in order to document personal social networks and individual decision-making. Key informants included 18 local Fulani agropastoralists from 7

villages in Kouthia Ba. These informants were chosen based on past participation in pastoral management projects and local perceptions of them as individuals who are particularly knowledgeable about livestock management. Additional interviews were conducted with 6 transhumant Fulani pastoralists from outside the district (4 *garsinkoobe* and 2 *waalankoobe*). Finally, 4 interviews were conducted with officials from the rural commune and government agents in the forestry service and the ministry of animal husbandry. Interviews provided insight into historical changes in sources of information and networks of exchange, factors determining access to information, responses to climate information in individual decision-making, and how formal and informal institutions enable or constrain preferred strategies. An interview template outlining a set of topics and guiding questions was used as a reference when conducting interviews. However, the template served as a prompt to identify issues for further exploration rather than as a checklist; questions covered in each interview differed according to the informant and the flow of conversation.

3) *Surveys* : 61 heads of household were surveyed to collect data on access to climate information and livelihoods. For the purpose of the survey, a household was defined in terms of the members of a family who share a single *hiraande*, or dinner; this term is commonly used to define the boundaries of shared work relationships within a kinship group. Members of a household partaking in a single *hiraande* share fields, a common herd, and a grain supply. Although individual ownership of livestock and other assets may exist within a household, a single head of household, usually a father or elder brother, is responsible for household expenses and production decisions. The surveys were conducted in ten villages selected according to participation in the CSE project and earlier land use planning activities under PDESO in the 1980s. Five to seven households were surveyed in each village; although the size of villages

varied, the majority consisted of 30 to 40 households. Sampling was purposeful in order to include a cross-section of ages, socioeconomic groups, and lineages. Data gathered in initial focus groups and interviews was used to create a typology of information sources and coping strategies in response to various signals. The survey questionnaire consisted of closed questions and open prompts that were subsequently categorized. The survey provided additional data on determinants of access to information, rates of use of external forecasts, the prevalence of types of coping responses to particular shocks, the impact of assets and entitlements on coping strategies, and the effect of land-use pressure on available options for herd movement.

Data Analysis

Audio recordings of focus groups and interviews were transcribed using a mix of gisting and verbatim transcription. I used a process based on grounded theory to develop an analytical schema for qualitative data. I first coded transcripts using an open coding of themes and subcategories within themes. These categories were then analyzed to determine conceptual connections between the broad category and its subcategories to identify a central phenomenon, explore causal conditions, identify distinct strategies, elucidate how different contexts indicate intervening factors, and delineate consequences associated with the central phenomenon. Finally, these sets of codes were further defined in a process of selective coding in which core categories were related to other categories; the conceptual relationships identified were validated in an iterative process of searching for examples that confirmed and disconfirmed my interpretation. This process of refining a conceptual schema was central to developing my arguments about identity, attitudes toward the state, and changes in resource governance. Quantitative data were used to substantiate the conceptual framework developed on the basis of interview and focus group data. Survey data provided a means for systematically comparing responses across age

groups and socioeconomic characteristics using descriptive statistics. This data was particularly important in generating detailed information about coping responses; use of information at the household level; and the relationships among land use pressure, environmental shifts, and changes in management strategies.

To answer my first research question about the methods of information transfer, data from focus groups was used to create a typology of the various sources and types of information available. Data from surveys was used to assess rates of use of each type of information in decision-making; in addition, survey responses about the information source and means of obtaining information used during the last rainy season were analyzed to understand patterns in information sharing within each broad category for types of information (ecological conditions, prices, disease, and theft). This was integrated with diagramming of social networks for information sharing carried out during individual interviews.

In answering question 2, I created a framework for the information requirements of mobility from interview data on the use of various types of information used in individual decision-making about herd movement. Survey data on changes in management in response to information were then analyzed to support conclusions about how specific types of information figured in decision-making.

Changes in information exchange were interpreted in terms of participants' reflections on current and historical patterns, with additional attention to differences in perspectives across age groups on the use of cell phones, the nature and sources of knowledge, and the role of state technical agencies. Multiple focus group sessions focused on the perceived importance of various sources of information and varying confidence levels in each. Themes that emerged in the coding of these transcripts were contextualized with narratives from one-on-one interviews

about shifts in information sources over time and impacts on the social relations that constitute information networks. These qualitative accounts were compared to survey data on use of different information sources, in particular rates of use of external forecasts.

Finally, I integrated information from each of the research methods to address the intersection between information networks and resource governance, question 4. Approaching this question required interpreting the ways in which social relations mediate the transfer and meaning of information and how changes in information dissemination may impact both information use and the social relations that facilitate mobility. This question also necessitated specific attention to the impact of land-use pressure on the value of information. During focus groups and interviews with administrative officials the spatial location of increased land-use pressures were identified. Survey responses for the factors that mediate the ability to act on information to reduce risk allowed a categorization of household characteristics associated with increased vulnerability. Data on differential access to information from surveys and constraints to action identified in interviews and focus groups was synthesized to interpret the political dynamics of information exchange in the context of changing formal and informal rules about land-use. During fieldwork, discussion of the role of information in mobility inevitably led to conversations about the nature of access to pastures. Exploration of this theme in my qualitative data generated the grounds for analysis of broader changes in resource governance in relation to changes in social relations among livelihood groups.

Chapter 1: Information Sharing and Climate Risk Management among Senegalese Agropastoralists

Introduction: The Role of Information in the Political Economy of Adaptation and Vulnerability

The drylands of the Sahel are one of the regions of the world expected to be most heavily impacted by climate change. As noted in the 2007 IPCC report, significant increases in the range of climatic variability in the region mean that local resource users will need to respond to climate variations beyond the breadth of their historical experience (Boko et al. 2007). Given this reality, pathways for developing new knowledge in relation to shifting ecological conditions emerge as particularly important. Early work focusing on adaptation largely took a broad-scale approach and frequently framed adaptation as a technological problem in which adaptation consisted of planned interventions based on scientific predictions of climate impacts (Brooks, Adger, and Kelly 2005; Haddad 2005; Downing 1991). However, over the past decade, the focus has shifted to acknowledging local communities as the primary sites for where adaptation occurs and the role of autonomous adaptation by resources users is increasingly emphasized, with changes in livelihood strategies viewed as mechanisms for coping with climatic variability (Eakin 2006; Agrawal 2009). Many scholars have distinguished anticipatory adaptation as a prospective process from coping, a reactive response to specific experienced shocks. However, given the recurrent nature of many climate hazards, livelihood strategies adopted in response to climate risks can also be considered prospective in reference to future experiences of scarcity (Agrawal and Perrin 2009; Morton 2007) and may translate into long-term adaptive practices that shape land use at the regional scale (McCusker and Carr 2006). Conceptually and in practice the focus of adaptation has shifted to how to strengthen the adaptive strategies already used by households to cope with risk (Agrawal 2008).

The integration of adaptation and development is thus often framed by risk management perspectives. A significant portion of this literature builds from information theory. The basic underlying assumption is that additional information reduces uncertainty thereby leading to better decisions and better management outcomes (Luseno et al. 2003; Andersen 2003). Although a significant element of subjectivity is acknowledged in individual assessment of probabilities of risk exposure, the effect of information gathering on subjective distributions is often understood to operate in predictable ways. First, wider access to new information and relevant personal experiences is seen to decrease the amount of subjective variability between individuals as knowledge accumulates in a community (Andersen 2003). Second, information gathering is likely to shift the location of the overall distribution of individual attitudes, leading to a “change in the subjective mean” (Andersen 2003: 164). Sometimes labeled the ‘perfect information paradigm,’ this approach prioritizes the refinement of projections of future conditions and assumes that expanded information on climate impacts will in and of itself lead to the appropriate adjustments in systems as rational actors weigh alternatives (Suarez et al. 2009). Policy recommendations following from this line of thought emphasize investment in the use, enhancement, and dissemination of climate forecasts (Luseno et al. 2003). External interventions thus often focus on the provision of information to local resource users in order to reduce uncertainty in decision-making.

Accurate assessments of likely future scenarios continue to be identified as vital and making climate information more relevant to local populations is seen as central to enabling autonomous adaptation (Patt, Suarez, and Gwata 2005; Pfaff, Broad, and Glantz 1999; IUCN 2010). Although climate information has the potential to reduce vulnerability to the impacts of climatic shifts, differing conceptions of vulnerability lead to divergent understandings of how

this occurs. In addition to the perfect information paradigm, there are two other major frameworks for understanding vulnerability with different implications for the role of climate information. The first is the ‘vulnerability to hazards approach’ that emerged from the disaster risk literature starting in the 1980s. This view conceives of vulnerability in terms of susceptibility to an exogenous event that causes harm; a clear separation is maintained between causal events and outcomes and vulnerability reduction is understood as achievable through preparedness and targeted response (Wisner 2004). Although unlike the perfect information paradigm this perspective recognizes existing limitations on response capacity, climate information is still viewed as essential to reducing vulnerability by allowing the reorganization of intrinsic characteristics of units at different scales to reduce exposure to exogenous shocks (IFRC 2008; Suarez et al. 2009). A second approach emphasizes ‘vulnerability to outcomes’ by analyzing how political economic structures and socio-political relations produce the vulnerability of certain individuals and groups. In this framework, climate information can be a helpful tool but is neither necessary nor sufficient to reducing vulnerability. Instead, the emphasis is on increasing access to entitlements and thereby resilience of livelihoods to diverse shocks (Sen 1981; Ribot 1995; Suarez, Ribot, and Patt 2009).

Recent approaches to the formulation of a pastoral early warning system for the Sahel emphasize the need to conceptualize risk as both a structural and a long-term phenomenon. By conceptualizing adaptation as a process shaped by political dynamics, a vulnerability to outcomes approach offers the greatest potential for identifying multiple constraints to adaptive responses at the individual and community levels. This perspective focuses attention on access to resources as a constraint on the ability to act on information about an impending shock (Luseno

et al. 2003). It also offers opportunities to examine access to information itself through a resource access frame.

Many scholars have analyzed the social implications of differential access to information within societies (see Lievrouw and Farb 2005). Choices made by scientists and researchers about the kinds of expertise and products to provide also determine the potential utility for diverse socioeconomic groups and management objectives (Pfaff, Broad, and Glantz 1999). Information can be understood as something which, if found and understood correctly, could change one's knowledge or beliefs about a matter. Information is an attribute of the receiver's knowledge and interpretation of a particular signal; consequently, whether any particular object, document, or event is seen as informative is situational, depending on the inquiry and the expertise of the inquirer (Buckland 1991). Analyses of the role of information in promoting adaptive capacities should be sensitive to the distinctions between 1) 'information-as-thing'; 2) 'information-as-knowledge'; and 3) 'information-as-process' (Suarez et al. 2009; Buckland 1991). Information-as-thing attributes the term information to an object (e.g. data) that is viewed as instructive. In contrast information-as-knowledge focuses on information as the knowledge communicated about a particular fact, subject or event. Finally, information-as-process refers to the act of communicating knowledge about something—i.e. the act of informing. The distinction between information-as-thing and information-as-knowledge can be viewed as a distinction between tangible and intangible while the fundamental difference between information-as-thing and information-as-process is the distinction between entities and process (Buckland 1991). Fundamental assumptions about the nature of information underlie tensions that exist in understandings of knowledge as a public good, as a proprietary commodity, or as a collective and complex, path dependent activity (Antonelli 2005).

Each of these perspectives produces divergent policy prescriptions about the role of the external interventions in facilitating information flows. From the perspective of knowledge as a public good, the public provision of technical and scientific knowledge is the means to remedying under-provision and inadequate access to information (Antonelli 2005). Knowledge is not viewed as appropriable nor is there competition in the ability to make use of it. Public subsidies to fund scientific research and its dissemination are “regarded as the basic instruments to push ... innovation” (Antonelli 2005: 54). In contrast, concern for inequity in access to information has frequently prompted analyses based on the conceptualization of knowledge as a private good or commodity. In this view, information is treated as a productive good with material properties. Individuals use social and economic advantages to acquire more or higher quality information, creating an unequal distribution of information. Seen this way, the question of how to obtain improved outcomes for socioeconomically disadvantaged groups is a straightforward matter of redistribution (Lievrouw and Farb 2005). Finally, an alternative to both of these approaches views knowledge as the outcome of interactions between a variety of heterogeneous agents each holding complementary bits of information. As Antonelli (2005) argues, the alignment of individual learning processes plays a critical role in the collective processes that lead to the generation of new knowledge. The capability to generate knowledge is thus “embedded in a network of qualified relations” typified by the level of receptivity and connectivity of different actors (Antonelli 2005: 65).

Institutions have often been analytically treated as conduits for information, with insufficient attention to the social context that shapes individuals’ perceived information needs and social norms about reciprocity and trust that establish the credibility of information sources (Lievrouw and Farb 2005; Patt and Gwata 2002). While additional study is needed linking

information requirements to particular livelihoods and coping strategies (Agrawal 2008), more robust understandings of local institutions for information transfer within their particular social, political, and ecological contexts are required to assess the role of information in the political economy of vulnerability and adaptation. Local institutions play a central role in regulating access to resources and exposure to risks; they shape the adaptive capacity of households and communities by structuring the impact of climate hazards on different groups, by acting as the mechanism linking individual and collective action, and by mediating external interventions (Agrawal 2008).

This study builds on the vulnerability to outcomes approach and an understanding of information as a collective process to explore what changes in forms of information sharing among agropastoralists can reveal about the links between access to information and control over access to resources. A case study of networks for information exchange among Fulani agropastoralists in central Senegal is used to illuminate how access to information affects coping capacity. This chapter addresses three questions: 1) How do agropastoralists use information on ecological conditions, markets, and disease prevalence in decision-making about herd movement? 2) What patterns exist in information exchange among pastoralists? 3) What is the role for information provision in relation to the politics of land use planning? I will first outline the nature of resource variability in the region and the use of mobility as a coping strategy. Next, the prevalence and severity of diverse livelihood shocks will be examined. I then turn to the potential roles of climate information in coping capacity by outlining the information requirements associated with mobility and identifying the means through which information on pastures, water, markets, disease, and thieves or government agents is currently accessed. Finally, I examine the constraints on households' coping capacity, particularly with respect to

land use pressure, and address the implications of differential access to information on pasture conditions within the context of shifts in livelihoods and changes in the organization of livestock production.

Resource Variability and Mobility as a Coping Strategy

The Sahel is composed of arid and semi-arid lands characterized by low net primary productivity and high variability in composition and productivity; these ecosystems are dominated by cyclical patterns of change and heterogeneity at the micro-level. Rainfall patterns in the Sahel are highly erratic, with the coefficient of variation of annual rainfall exceeding 30% (McIntosh 2000; Hulme 2001). Widespread spatial and temporal heterogeneity in resource quality is also characteristic of the Sahel. Soil, elevation, and topography create patches of heterogeneous vegetation; heterogeneity is exacerbated by patchiness and broad-scale gradients in the distribution of rainfall. Fluctuations in rainfall and variations in edaphic conditions result in variations in vegetative production in a given location on a daily, seasonal, and annual basis (Ellis 1995; Luseno et al. 2003; Turner 2004; IIED 2010). Land cover in the region consists of grazing lands interspersed within a cropland and woodland mosaic and most rural households combine small-scale agricultural production with livestock keeping (Homewood 2004).

Agrawal (2008) developed a typology of five basic mechanisms through which households buffer climate risk: mobility, storage, diversification, communal pooling, and market exchange. A number of studies have examined processes for promoting storage, diversification, and communal pooling, but comparatively little work in the adaptation literature has focused on the institutional requirements for mobility, a strategy critical for managing risk arising from high levels of climatic variability (Agrawal 2008). Mobile livestock husbandry provides a means for coping with high intrinsic levels of variability in resource availability in African rangelands.

Social science analyses depict change as the natural state of pastoral livelihoods, emphasizing that management strategies are based on assessments of how best to buffer against variability and uncertainty rather than attempts to optimize production in a given year (Toulmin 1995; Galvin 2009). Pastoralists make use of adaptive strategies that allow the opportunistic use of variable resources, tracking ecological variability through constant monitoring of ecological conditions and ongoing adjustments to herd behavior in response (Niamir-Fuller and Turner 1999).

The timing and distribution of nutrient availability in Sahelian rangelands is variable and relatively unpredictable and is driven by the interactions among rainfall, soil quality, vegetative composition and plant phenology; movement allows pastoralists to take advantage of spatial and temporal shifts in nutrient concentration. Herd mobility is driven by the need to obtain high nutrient-content forage during the wet season in order to ensure sufficient weight gain to enable survival through the dry season (IIED 2010). Mobility can also serve to mitigate the negative impacts of drought, allowing the transfer of grazing pressure from areas of low vegetative production to those less impacted. Movement of this sort is possible where secondary rights allow pastoralists to access grazing lands in areas that they do not normally use (Toulmin 1995; Fernandez-Gimenez 2002). Many pastoralists also reduce risk by maintaining mixed herds of multiple species with different forage preferences and different physical resilience to drought and heat stress (Morton 2007).

Predictable regional gradients in rainfall volume and onset are well understood but localized variability at pasture sites lead to the need for real-time, site specific information in decision-making about migration. Annual rainfall volume increases as one moves south from the border with Mauritania into central Senegal. In contrast, there is also a north-south gradient in forage quality with higher nutrient content forage in the Ferlo and areas to the north of the study

zone (Penning de Vries 1982). Transhumant patterns of herd movement are a response to predictable cyclical fluctuations in resource conditions along this north-south gradient.

Pastoralists throughout Senegal rely on the Tambacounda region for access to forage during the dry season and at the onset of green-up early in the rainy season. Transhumant herds from the north and west then return to their home territories to make use of high quality forage during the height of the rainy season.

Studies using modeling based on GCMs predict significant changes in rangeland species distribution, composition, and patterns with a sustained increase in mean temperatures; increased heat stress; reduced water availability due to changes in runoff and groundwater recharge rates; and changes in disease vectors (Thornton et al. 2007). These are all predicted to impact extensive livestock production systems in complex ways. The Sahel has already undergone a marked downward shift in rainfall regimes over the past four decades, with significant increases in inter-annual and spatial variability as well as in the intensity of drought events (Hulme et al. 2001; Tarhule and Lamb 2003). Changes in the number of days of rainfall and frequency of interruptions in the month of August are particularly relevant. As this is the period during which crops reach maturity, rainfall perturbations during this time are highly correlated with levels of crop failure.

When asked about environmental changes observed over the past decades study participants most frequently reported the loss of several preferred species of forage and tree browse. Decreases in overall volume of rainfall, increased inter-annual variability, and increased frequency of rainfall perturbations within a single season were also often cited. A smaller number of interview subjects also noted reductions in tree cover and increases in the incidence of bush fires. These responses reflect the rainfall data and mirror many of the predictions of future

changes. Many participants perceived the drivers behind these environmental changes as a combination of climatic shifts and land use change. Although reduction in total rainfall was emphasized, conversion of land to cropping and high levels of deforestation were cited as aggravating factors behind loss of certain grass and tree species. Further, several evoked a causal link between reductions in forest cover and decreases in rainfall.

Climate change is only one of multiple drivers impacting pastoral and agropastoral systems. Fragmentation of rangelands and changes in livestock ownership and marketing with commercialization exert strong effects on livestock production systems and the livelihood strategies available to agropastoralists (Morton 2007; Galvin 2009). Since the colonial period, national policy promoting agricultural development has often explicitly or indirectly sanctioned encroachment of agricultural fields onto grazing lands and transhumance corridors in the Sahel (Kirk 2000; McPeak et al. 2011; Watson and van Binsbergen 2008). Recent national legislation passed in Mali and Burkina Faso codifying pastoral rights to mobility reflects a growing recognition of pastoralism's contributions in terms of GDP and ecological sustainability. In Senegal, these protections remain confined to sylvo-pastoral reserves in the Ferlo, north of Kouthia Ba. This study examines the effects of multiple stressors on local livelihoods by integrating analysis of information exchanges on ecological conditions, markets, disease, and thefts with broader changes in resource access.

Local Livelihoods and Shocks to Household Production

Although households in Senegal vary along the continuum between an agricultural and pastoral production system, most residents in the district of Kouthia Ba invest in some number of livestock and grow some grain crops for household consumption. The Fulani agropastoralists in the study produce millet and sorghum for their own consumption and rely on livestock

production for most household expenses and to cover grain shortfalls. They practice limited transhumance of 30 to 100km from their home territory and a small number also grow peanuts for food and as a cash crop. Of the 61 households surveyed, only 25% are self-sufficient in grain in a normal rainy season. Those households whose grain stocks are not sufficient for the entire year generally experience grain shortages of 3-4 months in duration. Livestock play a central role in consumption smoothing in the hungry season and during poor cropping seasons, with an average of 54% of respondents relying on livestock sales as the primary means for addressing grain shortages. Many interview subjects stated that livestock assets allowed households to avoid distress sales of productive assets in response to successive shocks; however, they also noted a trend in depletion of herds due to sales of livestock to cover deficits from household expenses as crop yields decreased over the past decades:

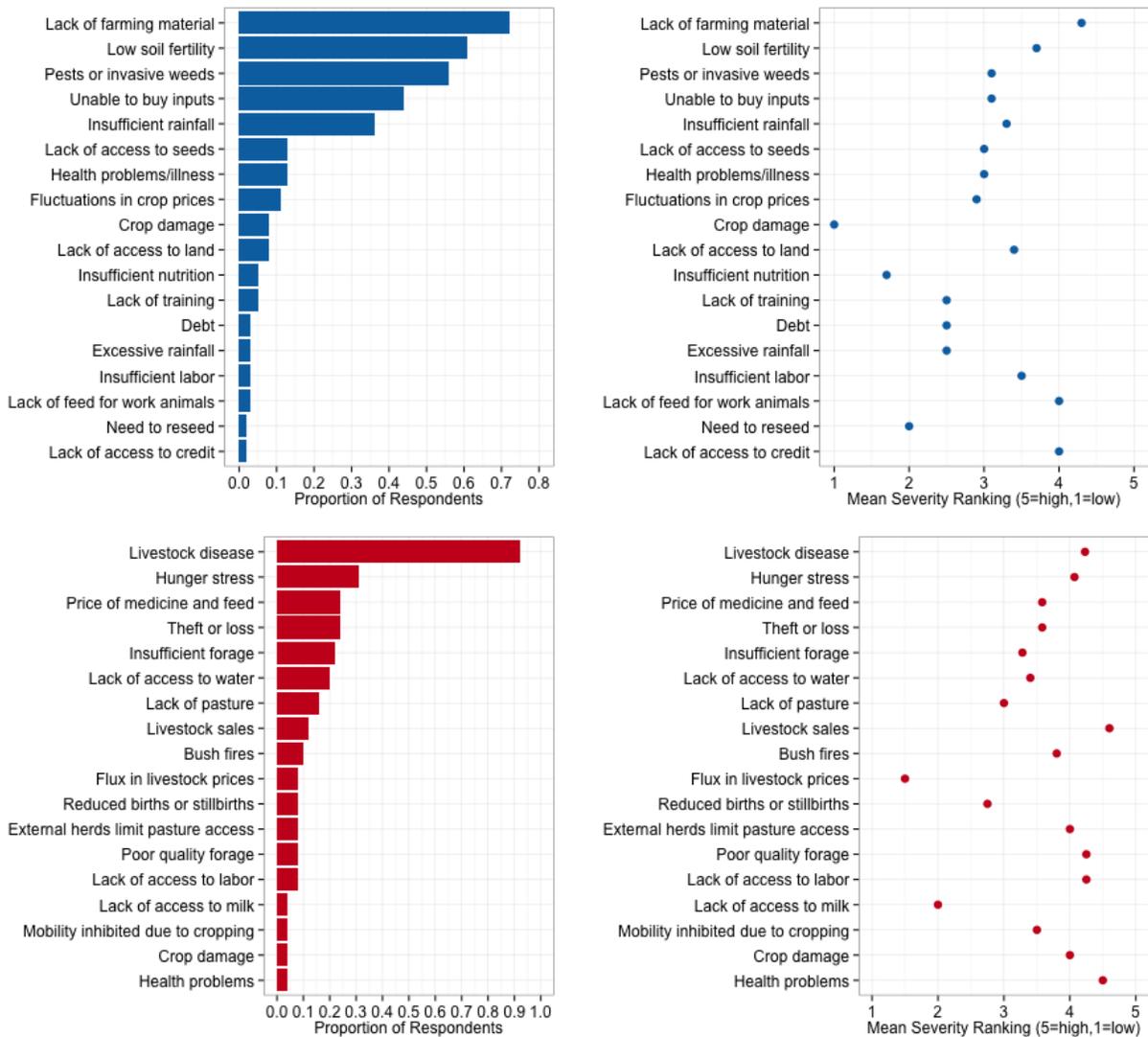
My herd has decreased over the past 5 years because of problems that have to be addressed using money from livestock. Whether it fits in with your herd reproduction levels or not, you don't necessarily have a choice—even if you are decimating your herd, you have to meet your household's needs.

If yields are lacking, you will eat off your livestock. You will sell some for food, pay for marriages, buy clothes, pay bills at the health post. Practically all large expenses are paid for through livestock. If you can fulfill your household food needs from farming, that allows you to build your livestock assets in case you have an unexpected expense...but if you have bad years, you will draw down your livestock.

Rebuilding livestock assets after depletion, whether caused by climatic shocks or extensive sales, was viewed as extremely difficult to accomplish through crop surpluses.

As shown in Figure 2, the most commonly experienced causes given by informants for shocks to agricultural production over the past five years were lack of access to farming equipment (plows and draft animals) and low soil fertility. Insufficient rainfall was also identified as a driver of yield reductions by 36% of respondents; although less frequently cited than other factors, it was often ranked as having the most severe impact. For livestock

Figure 2. Prevalence and Perceived Severity of Shocks to Household Production reported by 61 survey respondents in Kouthia Ba



production, disease and hunger stress were considered the most frequent causes of negative shocks. Livestock disease is particularly prevalent, with over 90% of respondents identifying high rates of disease incidence as a major factor in livelihood outcomes. Livestock production was considered more resilient than cropping to fluctuations in rainfall, with research subjects observing that forage production still occurs in years when crops fail. Due to the resilience to

environmental fluctuations and greater relative returns to labor, investment in livestock was viewed as the most expedient means of accumulating assets in the region.

Information Requirements for Mobility

Agropastoralists identified livestock mobility as essential for both coping with climatic fluctuations and increasing livestock productivity. However, extensive information requirements about the spatial structure of environmental variability are associated with herd mobility (Niamir-Fuller and Turner 1999; Agrawal and Perrin 2009). Rainfall and the quality of forage at a particular site were most often given as the factors of concern about which information was sought when migrating for the rainy season. During interviews and focus groups, herders in Kouthia Ba identified the start date and location of the first rains as the most important piece of information in decision-making on migration. The timing of rainfall onset is critical as hunger stress on livestock is at its peak near the end of the dry season. Successfully anticipating the location of green-up may reduce incidence of mortality for weakened stock; similarly, a delay in the onset of the rainy season regionally or locally signals the need to increase use of tree browse or purchased feed supplements. The timing of information is thus essential in determining its utility.

Table 1. Decision-Making on Rainy Season Migration as reported by 61 survey respondents within the study area

Information sought about sites when selecting rainy season pastures in 2011

Forage quality	65.2%
Rainfall	37.0%
Extent of cropping nearby	37.0%
Forage quantity	28.3%
Spatial extent (ha) of grazing lands/forest	13.0%
Disease prevalence	10.9%
Concentration of livestock	6.5%

As reflected in Table 1, while rainfall is critical to migration decisions early in the rainy season, over the course of the season the dominant factor shaping choice of migration sites is forage quality. Water availability constrains production in the dry season and at the beginning of the rainy season, but the nutrient content of forage is the limiting factor for most of the growing season. As is the case in Kouthia Ba, zones to the south may have significant vegetative production but animal condition and weight gain is constrained by the low nutrient content of dry matter. While the quantity of forage production is highly correlated with rainfall, there is considerable spatial heterogeneity of outcomes for vegetative production in terms of both quantity and quality due to micro-variation in relief, soil quality, and seed banks in combination with local distribution of rainfall.

Opportunistic movement responds largely to the location of available forage and water. However, the information sought by agropastoralists also reflects important constraints on mobility including the concentration of other herds and crop pressure around a potential pasture site. Of the pastoralists surveyed, 13% relied on information about the spatial extent of grazing lands at a site and 37% on the extensiveness of cropping nearby to decide whether to migrate to an area. Although only a small number required information on livestock concentrations prior to moving to a site, this was widely reported to be a factor in prompting relocation from a prospective camp upon arrival. The choice of pastures was also inflected by familiarity with the area, past migration patterns, and the habits of a household and their herd. During interviews, some stated that a migration site was chosen simply as a matter of personal preference. The prevalence of this in decision-making about mobility is likely related to the objectives of management and the multiple livelihood activities pursued by a household. Although he relied on livestock as the primary means of meeting household expenses, one interviewee observed that he

had been using the same site for 21 years and would wait for the rains to arrive in this location rather than migrating to an area that received earlier rainfall. Many interview subjects also emphasized the importance of cattle's habituation to a certain site, noting both the difficulty associated with changing their movements once accustomed to a site and the potential for improved nutrition outcomes and reduced labor requirements if livestock are familiar with a particular landscape.

Patterns of Information Exchange

When migrating, decisions are made on the spot and require real-time information specific to a particular location. Historically, scouts skilled in assessing pasture condition were sent in advance of the herd to find suitable pastures. Changes in production systems have decreased the use of specialized scouts, but reliance on one's own visual observation remains the primary means of selecting a pasture. In a survey of herders' reliance on different information sources, the exchange of environmental information differed from the patterns of information flow for market prices, disease prevalence, and presence of thieves or government agents (Table 2, below). Information about pasture conditions was most often obtained oneself with secondary use of in-person exchanges with friends and relatives. Market information was usually obtained from people in the same village, particularly those with higher personal mobility, and from local traders who traveled between weekly markets. For both pasture conditions and market information, there was little evidence of information exchange between previously unacquainted parties. Information on livestock disease is drawn from a diversity of sources, but shows a higher concentration of exchanges occurring at the weekly market or through cell phones. Information about thieves or government agents is centralized within intra-village exchanges, yet for this as

Table 2. Information Sources by Type of Information as reported by 61 survey respondents within study area

<i>Source of information</i>	<i>Forage and water availability</i>	<i>Market prices</i>	<i>Livestock disease</i>	<i>Theft or presence of government agents</i>
Oneself	65.3%	37%	19.1%	22.2%
Relation within one's village	14.3%	35.2%	21.3%	48.9%
Relation outside one's village	10.2%	3.7%	21.3%	20.0%
Rainy season work partner	6.1%	0%	4.3%	4.4%
Unknown herder	0%	0%	10.6%	4.4%
Animal health worker	0%	1.9%	10.6%	0%
Local livestock trader	0%	22.2%	6.4%	0%
Other	4.1% (habit, customary knowledge)	n/a	6.4%	n/a

<i>Means for obtaining the information</i>	<i>Forage and water availability</i>	<i>Market prices</i>	<i>Livestock disease</i>	<i>Theft or presence of government agents</i>
Personal observation	70.8%	34.5%	18.9%	17.6%
In-person contact with a friend	37.5%	47.3%	32.1%	58.8%
Cell phone	20.8%	9.1%	28.3%	31.4%
Meeting someone in the forest	6.3%	0%	3.8%	15.7%
Weekly Market	14.6%	36.4%	39.6%	15.7%
Radio	2.1%	5.5%	7.5%	2.0%
Other	2.1%	n/a	n/a	2.0% (none)

well as disease occurrence, a relatively greater role can be played by exchanges between herders unknown to one another.

Taken as a whole, the data revealed a high reliance on personal observation and a low use of exogenous information. Most people within a village make use of the same information sources, relying on one another and by extension one another's broader social networks. One's

own mobility whether due to migration, outside work, or commerce, is a primary determinant of access to information. Some important changes in patterns of information exchange are noticeable. Animal health workers and small-scale livestock traders have emerged as important links bridging distinct village-based and kinship networks. A number of research participants also reported relying on *waalankoobe*, Fulani transhumants from the regions of Joloff and Podor, for information on disease. For local residents, the *waalankoobe* are an important source of information not only because of their expanded geographic range of movement but also because they have experiential knowledge of diseases new to the Kouthia Ba area. Cell phones have taken on a large role in decision-making processes, decreasing displacement for scouting and allowing regular contact between a herder and the head of the household. In particular, they have been important in decreasing time lags in the exchange of information on rainfall and the loss of an animal. They have also enabled increased contact with more distant social connections, effectively facilitating maintenance of and investment in social networks.

Despite the importance of climate information in herd management, only a minority of survey respondents indicated that they used climate forecasts in decision-making (shown below in Table 3). Access to forecast information is an important factor, with less than half of respondents having heard the forecast directly. Of those that did hear the forecast, only 22% responded that it had affected their decision-making on herd management. Agropastoralists most frequently reported integrating forecasts into their decision-making about the relative allocation of household labor between cropping and livestock production. In seasons with a predicted low volume of rainfall, many households stated they would prioritize herding with some abandoning all cropping for the season. Although the use of forecasts for cropping decisions was also relatively low, at 41.5% it is nearly double the rate of use for livestock management. Interview

Table 3. Utilization of Seasonal Forecasts as reported by 61 respondents within the study area

	<i>Yes</i>	<i>No</i>	
Own a radio (main avenue for forecast transmission)	54.1%	41%	
Heard the seasonal forecast	45.9%	32.8%	<i>Indirect/Second hand</i> 21.3%
<i>Of those that heard the forecast:</i>			
Used the forecast in decisions about cropping	41.5%	39%	
Used the forecast in decisions about herd management	22.0%	75.6%	
<i>Of all respondents:</i>			
Forecasts are useful in livestock management	80.3%	6.6%	<i>NR</i> 13.1%
<i>Of those that responded yes, forecasts were identified as useful for:</i>			
Determining migration distance		24.5%	
Knowledge's sake		20.4%	
Buying or storing feed		18.4%	
Change in labor or monetary investment		14.3%	
Disease prevention		12.2%	
Anticipating income shortfalls		8.2%	
Buying or selling livestock		4.1%	
Avoid sites with poor drainage		4.1%	
Other		12.3%	

subjects emphasized that the lack of interpretation of how to apply forecast information in livestock production was an important factor that limited rates of use. Several noted that climate forecasts were reported along with planting recommendations about timing and seed varieties likely to fare well under the predicted conditions. No similar recommendations were forthcoming for livestock management that might enable herders to operationalize climate information. This reflects a bias toward agricultural production in the production and dissemination of forecasts that is even more apparent when considering the fit between forecast outputs and the indicators of interest to livestock producers (Sommer 1998; Luseno et al. 2003; Thornton et al. 2004).

Research participants indicated that forecast predictions of total rainfall volume for the season were of ambiguous utility due to complexities in the interactions between rainfall and livestock outcomes. Studies in East Africa showing similarly low levels of forecast use among pastoralists, indicate that the utility of forecasts for herd management is quite limited due to the

inability of forecasts to address the variables of interest at fine enough spatial and temporal scales (Barrett 2001; Luseno et al. 2003). These findings are similar to those of other studies that forecasts have little direct economic value in herd management decisions in semi-arid areas. Models have shown that optimal decision-making using forecasts can enhance asset accumulation across years but may also lead to greater variation in annual income, effectively limiting their value for small-scale producers (Thornton et al. 2004). The ability of herders to respond *ex post* through mobility rather than *ex ante* also decreases the value and use of forecasts (Ellis 1995; McPeak et al. 2011). In Kouthia Ba, the ability to use forecast information on the timing of rainfall was further diminished as the official release of the data was delayed at the national and local levels. The forecast was released after the start of the rainy season in June and was not broadcast locally until after the first rains. By this time, most research participants had already purchased seeds and inputs for cropping and the potential benefit of forecasts for anticipating rainfall for migration purposes was lost. Interestingly, despite the low reported use rates, most livestock owners reported that they view forecasts as valuable for herd management (see Table 3). About 25% highlighted the potential utility of forecast information in determining migration distance and over 18% identified it as useful in decisions about feed supplements. However, nearly as many livestock owners stated that they valued rainfall forecasts for their own sake, often referencing less tangible effects including a sense of hope about the upcoming season.

While access to information on pastures was generally viewed as good, difficulty in verifying its accuracy was perceived to be a more prevalent problem. Misinformation is considered common from both acquaintances and strangers; first-hand confirmation is usually sought before acting on exogenous information, though verification can also require significant

labor. Confidence in outside information is highly related to personal knowledge of the informant and a history of mutual exchanges was emphasized as a primary factor in establishing the credibility and reliability of information. For pasture information in particular, assessments of an informant's credibility reflected not only the relationship between the two people but also estimation of his skill and expertise as a herder. While trust (*holaare*) was limited to a narrow range of informants for pasture sites, assessments of the credibility of a particular information source varied depending on the type of information sought.

The diversity of information sources relied upon for disease information may reflect both the prevalence of disease as a livelihood shock and the perception it as a shared difficulty. Successful treatment and prevention of disease epidemics also requires coordination among owners, making wide sharing of information and knowledge about disease mutually beneficial. Training on livestock disease has also historically been closely associated with development interventions. State projects for pastoral land management in the 1980s trained animal health workers (*auxiliaires*) on the diagnosis and treatment of disease as one of the first steps in promoting pastoral development. Initiatives to enhance local capacity to deal with livestock disease have had greater continuity in the region than efforts to establish committees for management of grazing lands. Advances in local knowledge about disease and access to medicines were often cited in interviews as the most significant contribution of development projects in the past decades. Survey respondents more frequently sought exogenous information or information from the state about disease patterns and treatment than any other type of information.

A more generalized social forum was considered an appropriate and credible medium for the exchange of some types of information. Many were informed about theft and cases of local

conflict through gossip and public talk. There were divergent views of radio as a mode of communication. Some viewed it as a transparent form of communication with greater accountability due its wide audience, with one participant suggesting that it functions as a platform for building consensus about social values (in this case interpretations of Islam). Others emphasized its divisive potential because it frequently sensationalized stories of conflict and violence over crop damage or land use. For these informants, radio broadcasts functioned more to heighten tensions than as a forum for conflict resolution or consensus building.

Constraints on Coping Capacity and the Role of Climate-Related Information

Although information requirements for mobility are high, access to information on pasture conditions was not seen as a constraint on livelihoods. Due to the heavy reliance on visual observation, significant time costs were still associated with decision-making about migration. However, visual observation was also considered well-tailored to the specific needs and possible actions for a household. Prevalence of visual observation and reliance on an intimate personal network for pasture information also restricts information on distant regions and can create difficulties for obtaining non-climate information including information about the location of corridors. Market information was considered less available than information on pastures, though most research subjects considered annual fluctuations in price to be somewhat predictable and relied little on prior access to market information in decision-making. Access to information was listed as one of the factors that could mitigate household vulnerability to livestock disease, hunger stress, and fluctuations in sales prices for livestock. In keeping with the prevalence of and concern over disease already mentioned, information about disease occurrence and training on diagnosis, treatment options, and how to administer injections were seen to confer particular advantages in mitigating negative impacts. State agents were important sources

of early information on disease trends and bush fires (considered by many to be the main cause of increased hunger stress during the dry season). However, access to information through informal channels was prevalent for disease treatment and relative prices at regional markets.

Agropastoralists in Kouthia Ba expressed greater uncertainty about the drivers behind both climatic and market trends than about the nature of the trends themselves. The agropastoralists interviewed felt unable to discern if recent downward shifts in rainfall were part of historical cycles or represented a distinct phenomenon; several also stated they lacked understanding of the relative importance of supply-side and demand-side factors in market fluctuations. Although relatively confident in their ability to navigate short term risks associated with fluctuations in rainfall or prices, the majority expressed a sense of long term insecurity. This was amplified by their perceived exclusion from decision-making processes about land use. While several research participants highlighted a potential role for early warning about livelihood shocks in enhancing their capacity to mitigate adverse outcomes, many constraints structure a particular household's ability to use mobility and other coping strategies. Labor availability, household assets, ability to mobilize social connections for resource access, and changing disease vectors can all limit the utility of information at the household level by constraining the ability to act.

Labor availability is crucial to the allocation of effort between components of a household's livelihood strategies. For agropastoral households, the temporal overlap and spatial segregation of cropping and herding result in labor being a significant constraint on production. Labor shortages are compounded by increases in the distance of seasonal pastures and frequency of movement between camps and the need for increased supervision of the herd to avoid crop damage and to deter theft. Recent increases in livestock theft create the need for constant

supervision of the household's herd, greatly augmenting the labor demands associated with herding and limiting the ability to pursue multiple livelihood activities. Small households and those with heads of household under the age of 30 had a relatively lower ability to command sufficient household labor, with some ranking this as the greatest risk they had experienced in terms of livestock production. Subdivision of an extended family into smaller production units can be a coping strategy in times of scarcity; however, in the study area the trend toward household fragmentation was perceived as increasing long-term vulnerability to both climate and market fluctuations.

Household assets shape labor allocation and the particular adaptive strategies that are possible. Livestock assets can be crucial for accessing farming inputs including seeds and fertilizer at a time when other household resources are depleted. The number of livestock owned is also one determinant of the use of mobility as a risk mitigation strategy. Below a certain number of livestock the risk and opportunity costs of mobility exceed the potential returns. In normal rainfall years, the amount of livestock owned by a household plays a dominant role in determining a household's pattern of movement. Low-asset households stated that their inability to cover expenses for grain and other goods needed while migrating was a barrier to mobility. Lack of access to necessary equipment for migration, such as a horse cart, also limited the distance of the rainy season pasture. Families owning less than 5 head of cattle could provide sufficient feed by cutting and storing grass without migrating. However, herds of cattle over 20 head and herds of sheep of more than 40 head necessitated movement between seasonal pastures. In drought years, herd mobility decreased for some households because of anticipated need to sell livestock and increased reliance on milk as a food source. Several households also chose to

split their herd, sending small ruminants to rainy season pastures while keeping cattle pastured near their village.

Social connections that facilitate resource access are another form of assets that mediate a household's ability to act on available information. The density and geographic extent of a pastoralists' social network are indicative of the potential pastures they may be able to access in times of need. Kinship networks and ties made through personal mobility play important roles in developing networks for resource access. However, the strength of social claims based on reciprocity has weakened with growing pressure on grazing lands in the region, thus reducing its reliability as a form of safety net. High levels of covariate risk within communities may also be putting stress on herd entrustments and livestock gifts, social institutions that also served as safety nets by facilitating the redistribution of livestock wealth to poorer members of the community (Morton 2007).

In addition to constraints at the household level, two important external factors are exerting important pressures on the livestock production system at the community and district levels. High disease prevalence and changes in pasture access are dominant factors constraining the use of mobility to cope with climate risk for both high and low asset households. In recent years, research participants experienced higher incidences of disease and the presence of previously unknown maladies. Both local agropastoralists and the livestock technician in the district linked these changes to climate change and the increased movements of outside livestock into the region. Likelihood of exposing the herd to disease has become a strong factor in decision-making about mobility, with many households delaying migration several weeks until most external herds have left the zone. Households with relatively fewer livestock sometimes chose to forgo migration because of increased risk of exposure to disease. Access to information

on disease was variable and closely tied to one's mobility and the geographic extent of a pastoralist's social network.

Interview subjects in Kouthia Ba repeatedly cited the negative impacts of expanded cropping on animal nutrition and mobility, identifying future access to grazing land as a primary concern. Nearly 67% of survey respondents in the area mentioned cropping of corridors as impacting their ability to access pastures. The table below shows survey responses to a question about changes in access to pastures over the past 10 years. One research participant stated:

In the past livestock had grazing lands, but now they don't even have space to stand. Everything has been farmed. Everywhere cattle might wander, they find a field. We used to migrate to Joloff near Velingara, but where we used to pasture has all been farmed. This year we don't even know where we are going to go.

The implications of reduced ability to access pastures go beyond restrictions on patterns of movement to more fundamental changes in how Kouthia Ba residents articulate the reasons behind herd movements. While historically the main motivation for herd mobility in the rainy season was to improve the nutrition of animals in order to reduce mortality and increase reproduction rates, research participants stated that high levels of agricultural expansion in recent decades have led to the predominance of land use change as the driver of migration. As shown in Table 4, responses to these pressures varied significantly among pastoralists. Despite the high perceived impact on livestock production, the majority of families reported making no changes in herd management in response, sometimes expressing constraints on their ability to change their production strategies. However, for nearly a quarter of respondents constraints on movement locally are leading to increases in the distance of migration with a small number of households migrating well outside of the region for the first time. Restrictions on pasture access have also led many households to change the location of their final pasture site, move more frequently between camps, or altered the timing of departure.

Table 4. Percentage of respondents mentioning particular changes in access to pasture in Kouthia Ba, Senegal in response to an open-ended question

<i>Describe changes you have experienced in access to pastures over the past 10 years.</i>	
corridors narrower	42.1%
corridors completely farmed	24.6%
decreased forest cover	17.5%
increased concentration of livestock	19.3%
greater restriction on movement due to fields	12.3%
insufficient forage/forage destroyed	12.3%
corridors established/clarified	10.5%
no pasture around village	10.5%
increased migration distance	5.3%
increase in compensation claims for crop damage	3.5%
Other	12.3%
None	7.0%

<i>How have these changes impacted your household's herd management?</i>	
Increased distance of final migration site	23.4%
More frequent movement between camps	21.1%
Earlier departure	17.5%
Later departure	12.5%
Change in location of final pasture site	10.6%

Changes in livelihood strategies

Shifts in livelihood strategies should be understood as responses to multiple, interacting stressors. Given the many factors that mediate the capacity to cope with climate fluctuations, heterogeneous outcomes are evident across households. Nonetheless, several dominant trajectories are apparent in the study site, many of which reflect trends discussed elsewhere in the literature on pastoralism (Little et al. 2001; Pedersen and Benjaminsen 2008; Turner 2011). First, herd composition is shifting with small ruminants increasingly more prevalent than cattle. This is driven by higher resistance to drought, the greater ease of restocking sheep and goats given lower prices, and growing opportunities for the marketing of sheep for Tabaski (*Eid al-Adha*). Second, the most vulnerable families are likely to be squeezed out of livestock production as a result of

successive shocks and rising household expenses. For some, the lack of other assets as a buffer may lead to a downward spiral in which the next climate shock leads to the sale of productive assets and/or the incurrence of debt. This trend is related to a third—the growing importance of informal wage labor as a supplement to agropastoral livelihoods. The growth in the importance of wage labor has fueled increasing rates of seasonal and permanent emigration (> 2 years). Emigration to perform seasonal paid labor has long been an accumulation strategy for young men hoping to marry in pastoral societies; however, it is increasingly common for households to have one or more family members emigrating on an annual or permanent basis. Households whose herd has been depleted or drawn down to a certain level increasingly rely on emigration for informal paid labor to cope with grain deficits. As one interview subject put it, *“This year lots of people fled because of the poor rainy season. They couldn’t pay their loans [for inputs], so they ran and left. They are not in their compounds. Even now, they are moving around looking for ways to make money to repay their debt.”* Although households with more livestock assets usually met deficits through livestock sales, reliance on paid labor was frequently preferred as a strategy in years of extreme shortfall (defined as grain yields of 25% of household’s yearly consumption).

During interviews, Fulani agropastoralists resident in Kouthia Ba also noted a shift in the motivations behind mobility. In the past migration was primarily used to enhance weight gain and reproduction rates by increasing access to highly nutritious forage, but many respondents stated that today movement is driven by decreased access to grazing lands locally and rising incidence of crop damage.

Now migration is running. You used to be able to find quality forage in lots of spots—inside and outside of the forest and on government land that didn’t belong to anyone. Now, you can only find it in the forest. You can move until you are tired and not find forage elsewhere. Now it is let’s run to the forest, let’s get far away from farmers. That’s

how migration is now. You have no choice: you have to go to the forest. If you aren't in the forest, you have nowhere to keep your livestock.

These drivers differ significantly from the objectives cited by pastoralists from Joloff, the Ferlo, and eastern Senegal who pasture in Kouthia Ba during the dry season and early in the rainy season. While agropastoralists within the district mainly practice subsistence-oriented production, herders coming in from other regions often have larger herds produced for urban markets. For these groups, commercial production of sheep for Tabaski was a central motivation for using mobility to maintain animal nutrition during the dry season. Herders from eastern Senegal also identified the reduction in other livelihood options with salinization of cropping land as a factor, while those from northern regions identified limited water access in their home territories as a primary driver of migration.

Changes in the organization of livestock production have weakened established social norms that regulate resource access. Noting the growing number of paid herders coming into the region, one interview participant described the trend saying, *“[If] I have lots of cows . . . I will get a herder and only sell. Commerce is faster than herding. That is bringing big changes. Lots of people are leaving herding to enter livestock trading. That is what can bring the biggest returns in livestock production.”* Commercialization of livestock production has led to greater proportions of absentee ownership by urban residents. These groups may hold a political advantage in access to land or are able to act outside of longstanding local arrangements for resource governance. In this sense, the wide dissemination of climate information can enable external herders moving into the district to make more intensive use of local resources. Although this may increase their adaptive capacity, it has negative impacts on resident herders' access to pastures. These dynamics reveal divergent risks for actors who are differently positioned in terms of economic, social, and political capital and highlight trade-offs between increased aggregate

livestock production for commercial markets and sustainable livelihoods for subsistence agropastoralists (Lybbert et al. 2004).

With the expansion of agricultural fields, much of the grazing lands in Kouthia Ba are concentrated in the sylvo-pastoral reserve of Panal that covers nearly 30% of its area. As the forestry agency manages the reserve with little regulation of grazing, control of information is one means of controlling access to resources in a de facto open access system. Migration decisions require spatially explicit information in real time; however, experience in an area over many years can yield an understanding of micro-scale spatial and temporal trends. This place-based knowledge embeds information exchanges necessary for mobility in social relations. Tension between the adaptive strategies employed by different groups is reflected in the fact that each relies on distinct social networks for information with few points of overlap.

Conclusion

Agropastoralists rely on real-time information about rainfall and vegetative production in pastures to guide herd mobility. Climate and ecological information is central to pastoral production and its ability to adapt to environmental fluctuations. In particular, information on the first rains and green-up in the study area and to the south of it are critical for transhumance. After the onset of the rainy season, forage quality and the spatial extent of pastures in potential destinations become more important in shaping decisions about herd movement. Herders also often seek information on disease prevalence at various sites and increasingly alter both the timing and destination of movements to avoid disease transmission to their herds. Market information plays a limited role in decision-making for most herders, though the growth in numbers of small traders and middlemen has produced networks for the transfer of information on market demand and prices among these groups. The ways in which different types of

information are accessed and exchanged reveal the social dynamics of information-as-process. Reliable information on environmental conditions, particularly pasture quality and the ability to anticipate climatic shifts, is considered to be linked to skill as a herder. Both for this reason and due to the links between information on pastures and access to pastures, the majority of herders continue to rely on their own scouting and on the assessments of close friends or relatives. This differs from the production and exchange of information on disease and theft, both of which are more widely shared and solicited among acquaintances and strangers. It is likely that this reflects the increasing negative impact of disease and theft on livelihoods as well as the perception that these issues present a shared problem that will require social intervention to mediate or resolve.

Despite the centrality of information access to herd mobility, multiple factors constrain the ability to effectively act on information in order to reduce climate risk. Land use pressure and changes in household economies have particularly marked effects on adaptive capacity. The extensification of cropping has largely restricted pastures to the protected forest, while growing numbers of outside herds present in Kouthia Ba heighten competition over forage resources. In addition, the split up of extended families into smaller management groups has resulted in decreased labor availability for herding. Many small and low-asset households have progressively sold off all livestock, leaving them more vulnerable to climatic shocks to cropping. Shifts in management objectives and related changes to the social institutions for resource governance are also significant for the utility of climate information. Divergent experiences of risk and uncertainty within the pastoral sector mean that the dissemination of climate information is likely to produce differential outcomes for different groups. A pastoral case study makes readily apparent the deficiency in failing to acknowledge the ways in which the availability of information affects competition. Information about forage availability in a certain location loses

its value when widely disseminated. The indiscriminate expansion of access to information on ecological conditions is in tension with the social frameworks that have traditionally facilitated resource access. A transition from socially mediated information exchanges to those mediated by technology and external sources may contribute to fundamental restructurings of local resource governance (Suarez et al. 2009; Niamir-Fuller and Turner 1999).

Vulnerability can be a more useful concept than current measures of poverty for pastoral societies because it explicitly emphasizes disproportionate risk relative to other sectors of national and local economies and highlights the dynamic nature of exposure to specific risks (Ancey et al. 2009). Recent approaches to the formulation of a pastoral early warning system for the Sahel emphasize the need to conceptualize risk as both a structural and a long-term phenomenon. Rather than measuring exposure to a climatic hazard at a particular point in time, SIPSA¹ attempts to identify integrative indicators that account for availability of and access to resources (de Cao et al. 2008; Ancey et al. 2009). Ancey et al. (2009) proposed that the distinction between probabilistic risk (calculations of likely exposure to an adverse event) and uncertainty (neither the likelihood nor the nature of outcomes is known) can be understood as a shift in the temporal scale of analysis. Obtaining access to resources requires the mobilization of diverse skills; pastoralists necessarily adopt a complex combination of strategies that change in relation to shifting configurations of risks and social safety nets. Because uncertainty is integrated into daily practices, there is not a clear distinction between routine practices and those adopted expressly to mitigate a shock (Agrawal and Perrin 2009; Ancey et al. 2009).

¹ The Information System on Pastoralism in the Sahel (SIPSA) was developed under the coordination of the Pôle Pastoralisme et Zones Sèches (composed of CIRAD, CSE, ISRA, and UCAD). It attempts to fill a gap arising from early warning systems' primary focus on crop production with little attention to relative price effects and forage production, the indicators of importance for pastoralists.

Analysis of the trajectories of livelihood strategies can reveal both intentional choice and the role for social dynamics. From this perspective, vulnerability should take into account not only the combination of productive activities but also shifts in the knowledge systems and social relations that structure pastoral livelihoods (Ribot and Peluso 2003; Adger 2006; Ancy 2009). Social networks for information exchange are connected in various ways to social institutions that mediate access to pastures and other resources. Flows of information that are disembodied from their social context are likely to shift the dynamics of resource access. Interventions that use forecasts or climate models to help local populations anticipate environmental changes need to explicitly address land use issues and socio-economic barriers to mobility in order to reduce the vulnerability of agropastoralists.

Chapter 2: Rooted Networks and Shifting Resource Access Regimes in Kouthia Ba

Introduction: Network Concepts as a Tool in Political Ecology

Frameworks of adaptive capacity prevalent in the literature on human dimensions of climate change have begun to emphasize the role of social networks in promoting the resilience of linked social-ecological systems to climate variability. Informal institutions are believed to have greater flexibility than formal institutions to facilitate processes for information sharing, the building of common norms, and conflict resolution that are central to the governance of complex, dynamic systems (Bodin 2009; Ostrom 1990; Folke, Berkes, and Colding 1998). From the perspective of adaptive governance, the development of flexible management systems that emphasize learning processes and the ability to respond to changes is central to enhancing adaptive capacity. Social networks are seen as providing sites for iterative, shared learning, and research is beginning to focus on the ways in which information is processed through interpersonal relations (Adger 2003; Armitage, Marschke, and Plummer 2008; Pahl-Wostl 2009; Tschakert and Dietrich 2010). While the increasing recognition of the importance of social relationships to both livelihood and ecological resilience is vital, the current focus on social networks as sources of social capital frequently underemphasizes the role of politics and conflicting interests within and across communities. In addition to viewing institutions as structures of cooperation that resolve collective action problems, institutions must also be understood as critical leverage points in which the exercise of power determines the direction and magnitude of flows of resources to different social groups (Moe 2005; Thomas and Twyman 2005; Agrawal and Perrin 2009).

Understanding how local resource users respond to climate change requires increased attention to the role of local institutions in structuring the coping strategies available to

households. New patterns of resource use emerging in the district of Kouthia Ba may enhance the adaptive capacity of some while increasing the vulnerability of others. This study's analysis of livelihood stressors and the role of information in coping must be contextualized in relation to the spatially and temporally shifting relationships that connect processes of social power, territorial space, mobility, and ecological change (Birkenholtz 2011). The intersection between modes of governance and analytical frameworks of resilience to climate change turns on the question of engaging actors at disparate scales. For planned interventions (e.g. land-use planning), the question of identifying ways in which formal and informal modes of governance can be mutually reinforcing is complicated how they interact across scales (Adger 2006; Brosius 2006; Lebel 2006; Sayre 2005; Roth 2004). These issues converge in ways specific to pastoralism because pastoral mobility requires both flexibility and coordination across locales, creating rather extensive demands in terms of governance (Turner 2011). Territorial contestations reveal the ways in which resource governance is reconfigured as resource availability and social relations change. The ways in which territory, mobility, and environmental shifts articulate with one another have material impacts on resource and livelihood outcomes.

Bridging advances in the human dimensions of climate change and pastoral resource governance will require contextualizing abstract discussions of adaptive governance and mobility within particular social, ecological, and institutional realities with careful attention to power dynamics. The incorporation of network approaches into political ecology can connect locally particular and broad-scale approaches to vulnerability analysis while integrating biophysical and social processes as causal mechanisms (Birkenholtz 2011). This approach offers a useful way of framing research that seeks to contextualize pastoral information networks within both local

ecological dynamics and formal and informal governance systems. Network concepts emerging in diverse disciplines seek to enhance our ability to interpret complexity by emphasizing alternatives to binary thinking and acknowledging the world as embedded and interconnected (Rocheleau 2011). The growing application of network frameworks can be seen in the integration of human and non-human agents in actor-networks in science studies, the diffusion of knowledge through stakeholder networks in sustainability science, the emergence of network structures within social movement studies, and self-organization in complex networks in ecological theory (Latour 2005; Berkes, Colding, and Folke 2000; Escobar 2004; Holling and Gunderson 2002). Political ecology, with its long tradition of research on the interactions between broad political economic processes and regional resource use systems, is well placed to examine how interacting networks become grounded in particular material flows of energy and beings in specific places/territories (Rocheleau 2011; Birkenholtz 2011). The network metaphor also “allows us to reconcile our thinking about cooperation, communities, and local knowledge, with structural explanations of power in national and international structures of economies and politics” (Rocheleau 2011: 214).

Network approaches thus provide a conceptual means for analyzing social structures as dynamic and “shot through with power” (Rocheleau 2011: 212); however, networks are not confined to the social, but are also ecological and material. The concept of “rooted networks” emphasizes the ways in which relational webs are entangled with physical territories and directs attention to the biophysical and material dimensions of power (Rocheleau 2011). Power relations are embedded in the patterns and processes of connection that network actors together (Rocheleau 2011); in contrast to the dominant perspectives in the analysis of social capital (Putnam 2000; Bebbington 1997), connections are not all viewed as positive, but rather can be

negative, neutral, or positive. Connectivity in network analysis involves explicit modeling of multiple dimensions, including the polarity, strength, continuity, and density of connections (Rocheleau 2011; Carrington, Scott, and Wasserman 2005). As Rocheleau (2011) notes, “the terms of connectivity are a major arbiter of power” and an individual’s distinct position within a network frames their experience of shifts in the terms and configurations of connection. Network concepts can draw on feminist theories of power and knowledge, particularly the implications of positionality (Haraway 1991; Rose 1993). Such an approach stresses the need to see through the perspectives of a diversity of actors differently located within social, political, and ecological assemblages. Departing from the hierarchical chains of causation characteristic of political ecology, social organization and political economic processes are instead understood as situated in a multidirectional, webbed network in which impacts flow in both directions (Birkenholtz 2011; Rocheleau 2011).

Neumann (2009) argued that by transcending single spatial scales networks produce new relational spatialities. Within the framework of network political ecology, territories are understood as contingent and relational rather than spatially fixed, and a co-constitutive relationship exists between territories and networks (Swyngedouw 1997; Rocheleau and Roth 2007; Rocheleau 2011). The emergence of a network political ecology mirrors the recognition of new regimes of territorialization within African studies. As elsewhere, a “spatial turn” is occurring fueled by studies of the political and social configurations that are arising under urbanization and globalization. Attempts to make sense of the drivers of spatial organization that originate outside the state realm has led to an emphasis on migrancy and the politics of belonging. Viewing space as a constitutive dimension of social relations is a very different way of approaching issues of resource governance, particularly given the past dominance of political

science perspectives that focused on defined organizational levels and tended to essentialize geographic space (Smith 1993; Swyngedouw 1997; Engel and Nugent 2010). The understanding that social space is not geographically defined is central to this perspective; place is instead viewed as one particular nexus at which local/regional/national/global processes articulate and intertwine with one another (de Bruijn 2008; Howard and Shain 2005; Sayer 1985). If we hope to understand how networks become rooted to resources in the form of particular territories of identity, influence, and extraction we need to attend to the articulation of horizontal and vertical connections in a particular place (Rocheleau 2011).

Examining pathways of movement within networks is a means to illuminating the types and terms of rooting that occur in processes of mobility, circulation, and production. While contemporary scholarship on mobility and territoriality often focuses on transnational phenomena, this chapter examines shifts in the territoriality of rural livelihoods in light of external interventions to enhance the capacity to cope with climate change. If networks and territories are co-constitutive, there is much to be gained from understanding the social and cognitive processes through which imagined spaces emerge and become physically grounded in particular sites. The physical and discursive spaces that open and close as social networks are reworked has important implications for differential vulnerability to climate risk. By analyzing the links between social networks and adaptive capacity with explicit attention to the ways in which networks root, a network political ecology analysis can illuminate the dynamic nature of connections between local ecologies, information exchange, and pastoral governance.

In the case of Kouthia Ba, reductions in grazing land and changes in migration patterns in response to climatic shifts are occurring while the commercialization of livestock production is increasing the number of external herds present in the area. At the same time, state projects for

territorial administration in the post-independence era and particularly since the 1980s have played an important role in reworking mechanisms for resource access. Together these dynamics put significant pressure on the social relations that underlie customary management institutions. In central Senegal the basis of resource management is shifting from a socially mediated process of negotiated access toward reliance on state-based territorial management. A network analysis reveals how the socio-spatial relations among user groups are restructured in emergent regimes of resource access; this is both reflected in and productive of discursive claims to control over land use. As I will describe, the functionality of social networks for allocating land rights has been eroded due to the influx of new herding groups and the diminished land area administered through customary arrangements. External pressures on customary management regimes are paralleled by an internal reconfiguration of the social relations that structure resource use. As resident agropastoralists lose social control over land access, they increasingly appeal to a discourse of territoriality in which authority is rooted in a particular definition of belonging. These territorial claims are based on state definitions of the collective domain at the local administrative level. Changes in intra-household dynamics, means of communication, and knowledge systems are also accelerating the individualization of social networks. As the terms of connection become more centered on personal connections than historical ties and communal norms, networks of resource governance are altered in ways that reduce both their ability to function as a safety net and their capacity to mediate conflicts among resource users.

Social Diversity and Migration Patterns in Kouthia Ba

The district of Kouthia Ba is transected by a proliferating number of transhumance routes. Located just to the south of the area traditionally dominated by pastoral land use, over the past 2 to 3 decades the region has become a waypoint and destination for an ever larger number

of transhumant herds. Herding groups using pastures in the region have distinct management practices and objectives and differ from agropastoralists in the zone in important ways. The Fulani have the largest population of ethnic groups resident in Kouthia Ba, but Mandinka and Wolof constitute significant minorities. Fulani villages in the area have been sedentary for at least sixty-five years, though male youth frequently migrate with the main herd on a seasonal basis. According to a preliminary survey conducted by CSE for the participatory information project, over 60% of herd owners in the rural commune practice transhumance with 16 principal itineraries charted. While CSE surveys of Kouthia Ba herders identified a larger number of routes than in other pastoral districts, a greater proportion of the routes were internal to the arrondissement (made up of Kouthia Ba and three adjacent rural communes). Most resident agropastoralists are subsistence producers who rely on cropping for their household grain source and livestock husbandry as a source of cash income for large expenses and as a means to buffer production shocks.

Several distinct herding groups use seasonal pastures in Kouthia Ba. The two largest groups are also ethnically Fulani. The first, the *waalankoobe*, is from the Toucouleur subethnic group and migrates into the region from the Waalo and Ferlo to the north in the Senegal River Valley. *Waalankoobe* tend to follow established transhumance routes and camp near the same pastures for multiple seasons. Members of this group began migrating to Kouthia Ba during severe droughts of the 1980s. Currently they migrate with large herds of sheep (for sale to urban markets for Tabaski) while often leaving cattle in their home district. Forage quality is superior in their home pastures, but water shortages drive their migration south. In many *waalankoobe* households, family members who remain in their village produce some grain crops; however, livestock production is the main livelihood activity. The members of the household who migrate

generally spend up to 9 months outside of their home region and only 2 to 3 months in their village of origin.

The second group of Fulani, the *garsinkoobe*, come from the west around Linguere and Touba. These herders are newer entrants to the region and frequently practice more unbounded opportunistic mobility. The final destinations of many *garsinkoobe* vary from season to season and they rarely establish ties with a particular local village, preferring to camp in or near the protected forest. In comparison to Kouthia Ba residents, they tend to have significantly greater livestock wealth and are oriented toward the sale of both cattle and sheep destined for urban markets in Dakar and Touba. *Garsinkoobe* have only begun to be present in Kouthia Ba in significant numbers over the past decade or so. Their presence in the region has increased rapidly with the growth of investment in the livestock sector and increasing pressures on land in their districts of origin. Another group of herders, the Sereer also from the west of Senegal, are frequently grouped with the *garsinkoobe* from the perspective of Kouthia Ba residents. The Sereer are an ethnic group concentrated in the Kaolack region of Senegal and historically were agriculturalists or fishermen. However, in recent times many Sereer youth have begun to work as paid herders for large urban investors. Local agropastoralists describe them as solitary and little concerned with maintaining positive relations locally.

Governance Regimes and the Reconfiguration of Relational Webs

Social science analyses depict change as the natural state of pastoral livelihoods, emphasizing that management strategies are based on assessments of how best to buffer against variability and uncertainty (Galvin 2009). As a case study of a long-standing indigenous system of adaptive management, mobile pastoralism in the Sahel has much to offer to analyses of how social networks affect adaptive capacity. Arising from the demands of resource use in a variable

environment, pastoral tenure is characterized by the continuous reallocation of access rights. Pastoral resource governance is at the core of the adaptive capacity of pastoralists. Pastoralists rely on reciprocal rights to common pool resources belonging to other groups in order to access forage and water resources (Galvin 2009; Turner 2011). Non-exclusive customary tenure systems provide the flexibility that allows household production to persist through unpredicted swings in forage productivity in a drought (Turner 2011). Pastoral management prioritizes flexibility rather than the maintenance of stability; flexibility is expressed through spatial movement, but is fundamentally enabled by the structure of social relations (Bassett and Turner 2007; Legrosse 1999; Turner 1999). Social norms for access to pastoral resources (grazing pastures, tree browse, crop residue, and water sources) historically formed the bounds within which opportunistic tracking of forage production occurred (Niamir-Fuller and Turner 1999; Fernandez-Gimenez 2002).

At the macro-level, mobility is made possible by a range of rights and claims to a wide area of potential pastures; these claims are mediated by internally cohesive social institutions and require recurrent investments in social networks. Significantly, the informal institutions that mediate access to both information and resources are not instrumental but rather are embedded in a web of diffuse social relations connected to kinship, marriage, and livestock entrustment relationships (Cleaver 2002). Reciprocity plays a central role, complicating strict definitions of insider/outsider and results in flexible boundaries. The malleability of group membership facilitates access to grazing resources in times of scarcity and acts as a form of safety net that allows pastoralists' to buffer climatic shocks (Niamir-Fuller and Turner 1999; Fernandez-Gimenez 2002). However, herd movement imposes heavy demands in terms of information and

networking requirements in order to gain access to grazing resources (de Bruijn and Van Dijk 2003).

Mobility has long been an adaptive response that enabled rural populations in the Sahel to cope with wide oscillations in food production and economic returns resulting from variations in rainfall. The cultural and historical prevalence of mobility has led to the development of cultural and social ways of incorporating mobile livestock herders and agricultural migrants into rural communities, including socio-cultural institutions that regulate host-stranger relationships (Niamir-Fuller and Turner 1999; de Bruijn and van Dijk 2003; Turner 2004). Historically, herders migrating into an area develop a host relationship with a resident patron. This social attachment to a host, often called a *jaytigi*, allows the exploitation of local pastures and forage resources and provides the incomer with an advocate in case of difficulties (de Bruijn and van Dijk 2003). These relationships facilitate inter-village, inter-regional, and inter-ethnic contacts and make the process of arriving in a new environment much more predictable. Further, “these points of attachment do not just serve as the entrance of a specific individual to a specific site, rather they seem to act as ‘gateways’ that facilitate the movements of a much larger group of people than the person who is formally attached to sedentary society” (de Bruijn and van Dijk 2003: 305). Relationships such as these are also implicated in reciprocal access to distant pastures (e.g. the guest serving as a host elsewhere). They are important connections that can be called upon in times of need but require ongoing investments in these social relationships to maintain. These investments include gifts of milk or cash, exchange of livestock, obligations to fulfill requested favors, and investment of time in greetings and visits.

In the study site, the form and evolution of these host relationships was discussed by one interview subject from Podor who has been migrating to the study area each dry season since

2001. A *waalanke*, he originally entered the district through a relative in his extended family who had an established *jaytigi* at the eastern edge of the commune. He stated that he and several households from his family began coming to Kouthia Ba in this way, but after a number of years he developed his own relationship with another host in a village 10km away. Frustrated by the increasing concentration of herds and difficulty in accessing water at his first site, in 2005 he and two of his brothers began camping just outside his new host's village. Since then, he described his relationship with his host and the village as quite close, noting that he accesses government aid and vaccination campaigns through the village. Further, although he considers Podor his home, he pays taxes and is registered to vote in the district of Kouthia Ba.

His story points to multiple ways in which territoriality can be defined. It simultaneously highlights the material benefits he is able to mobilize by occupying a sanctioned role in the local community (further demonstrated by administrative recognition of him as a resident) while revealing an underlying sense of identity that is subject to a very different politics of belonging. Despite the fact that he spends more time in Kouthia Ba than in his village of origin, neither he nor local residents consider him to be a full member of the local community. Reflecting centuries of inward and outward migration in the Sahel, heterogeneity within and between communities is the norm; membership within a community can be highly fluid, with nested sets of connection and belonging mobilized in different contexts depending on the particular problem or opportunity facing a group (Hesse and Trench 2000). Heterogeneity of user groups for a particular resource departs significantly from the emphasis on homogeneity in much of common property theory (Ostrom 1990). Instead, flexibility is a fundamental characteristic of social relations in the context of a highly mobile culture exposed to significant insecurity; processes of inclusion and exclusion are part and parcel of this flexibility, leading to the continuous

redefinition of these relationships (de Bruijn 2008). Recurrent renegotiation of social relations is characteristic of livelihoods in the region, marked by degrees of co-operation and competition as multiple groups attempt to gain and maintain access to a fluctuating resource base (Hesse and Trench 2000). Despite differences in livelihood practices and territorial identity, herders from other regions are included in a broadly shared group identity when common difficulties are encountered. As one Waalankooobe herder stated:

All of us share the same problems. Everywhere we go, even in our own territory, there are problems. There is no good grazing land left—the forest is practically dead. The price of feed supplements is going up. Yet no one is working to help herders. The state says that livestock aren't good for anything... [Farmers] are the ones that control the water towers. They are the state. Herders are being chased away on their behalf.

At the same time, strong tensions exist between local and external herders over access to grazing lands. While these tensions have always been at work, they are being exacerbated by the weakening of social institutions for resource management. Growing pressure on the land base and increasing commercialization of livestock production have increased the incentives to operate outside of customary management institutions. New entrants into the livestock sector further confound interactions between groups. Urban investment in livestock managed by paid herders is a recent but growing phenomenon (see Turner and Hiernaux 2008). Paid herders and ethnic groups such as the Sereer that have a limited history of engagement in mobile livestock production less frequently develop relationships with local hosts. The presence of these actors affects longstanding relationships between other groups by diminishing the sense that herders from disparate territories are all following a set of mutually intelligible norms.

Local residents and external herders articulated very different perceptions of the need to establish a host relationship. During a focus group with herders from Joloff and the Ferlo, participants referenced the need to maintain good relationships locally due to shared problems at

the national level and the reciprocal nature of back and forth movements between their home territory and seasonal pastures. However, while reliance on local grain production and a mutual interest in avoiding crop damage linked them to local residents, they tended to view these connections as diffuse and informal. One *waalanke* herder said that a formal arrangement with a *jaytigi* was unnecessary because as soon as he arrived in a location he would strike up acquaintances with other Fulani at market over a pot of tea. When external herders expressed a lack of understanding about why village chiefs demand that they camp near villages, a local herder chimed in with a very different conception of the structure of host-stranger relationships; he argued that external herders should establish clear relationships with a particular village in order to promote trust and create a basis for resolving any disputes over crop damage. In his mind, formalizing the relationship signaled acceptance of an agreed upon set of terms of interaction and resource use.

The degree to which socially mediated access to resources characterized by reciprocity have been eroded is evident in local herders' statements about the presence of external herders in Kouthia Ba, particularly the relatively recent *garsinkoobe* arrivals. There is a prominent discourse in Kouthia Ba that views this group as the culprit behind a rising incidence of theft and as capable of extreme violence with little provocation:

Since they first started to come, problems started... If you are lying down, you are afraid to sleep. If they can, they will kill you and steal the money out of your pocket. If you tie up your horse, they untie it. If you tie up your cows, they untie them. If you tie up your sheep, they untie them and take them. If they see you they can kill you and just go on about their business.

A marked dissolution of trust is occurring, with even those outside herders with a longstanding local presence increasingly viewed with suspicion. Herders rely on situating one another within networks known to them to dissipate distrust. During an encounter in the forest, they will ask an

unknown herder about themselves, including where they are from, where they have been, and where they are going, in order to assess the likelihood that they are perpetrating any wrongdoing. The prevalence of larger numbers of external herders operating outside of established access arrangements reduces the likelihood that these encounters will reveal any intersections in social connections.

Approaches to negotiating crop damage are one sign of the growing uneasiness between local and external herding groups. When a field is damaged by a local livestock owner, arbitration is generally carried out by the village chief in concert with representatives chosen by each party to negotiate on their behalf. Damage to grain fields is frequently forgiven or repaid with labor for replanting, while peanuts and cash crops are generally compensated with cash payments. If external herders have a local *jaytigi* or other close personal relations, arbitration may be carried out in the same manner, though likely with larger remuneration. However, for the growing number of herders with no local connections, rural commune officials are increasingly called upon to settle the dispute. In these cases, informally negotiated consensus is being replaced with a turn toward dispute resolution through formal state intervention. This evidence of the degradation of informal arbitration networks has significant implications for the broader capacity of customary institutions to mediate the overlapping claims of heterogeneous user groups (Turner et al. 2012).

The weakening of social institutions for resource access is exacerbating a local sense of loss of control over resource access and heightening a sense of belonging founded in particular territorial claims, as hinted at in this statement by the former head of the PDES management committee in Kouthia Ba:

Everyone migrating from Joloff and Mauritania heads for here...they come here and stay for a month then move on as soon as the forage is exhausted. This year some of my

livestock died from hunger because they couldn't get enough feed locally. We have no power over them. We have talked to the state....We told them to control this, but they told us that Senegal belongs to everyone. There's nothing we can do about it.

Shifts in the boundaries of group identity are articulated in direct relation to the penetration and contestation of state authority. Divergent attitudes toward the state are reflected in the earlier statement referencing common difficulties as a source of unity and this statement emphasizing changes in the locus of control over resources. Juul (2001) has argued that the discourse of “strangers” and “locals” among indigenous groups in northern Senegal have evolved to exploit the emphasis on exclusionary rights in decentralization frameworks. Emerging rhetoric about territorial claims likely reflects local agropastoralists’ attempts to bolster their interests in the context of changing resource governance regimes. In Kouthia Ba decentralization has decreased the power of resident agropastoralists vis-a-vis farmers. The state has been viewed as favoring farmers due to a long history of agricultural and land use policies that promoted the extension of cropping. In interviews agropastoralists specifically viewed decentralization as the state handing over power to farmers. In addition, the state has also often failed to adequately recognize distinctions among herding groups in programming and policy. For example, PDESO included no provisions for the impact of external herders on local land use agreements. This ignores the pressure of external herds on grazing resources and fails to recognize that problems caused by external herders render the maintenance of positive relations between local farmers and herders more difficult.

The increasing reliance on state arbitration of conflict with external herders is indicative of changing expectations of the state in terms of service provision and policy intervention; state agents and official policy have come to be viewed as much more powerful in determining land use arrangements than customary rules. Yet the attitude toward the appropriate realms for state

intervention reveals the complexities of the cross-cutting identities of herders resident in Kouthia Ba. While exhorting the state to protect their shared control over district territory was considered acceptable, agropastoralists hesitated to appeal to state power to expand their access to land in cases of conflict within Kouthia Ba:

We don't want to go to the authorities because they are our relatives, but they have taken what should rightfully be set aside for livestock. They took the arable land. The forest is supposed to belong to herders, but they are taking that too. There is nothing left for livestock... We are stealing from ourselves. They think we are stealing land from the state, but really we are just stealing from one another.

In the perspective of local herders, agriculturalists were either actively or passively exploiting state policy for their own benefit. While they viewed this as a moral transgression, social sanctions against causing harm to their relatives inhibited their ability to protect their access to grazing lands. This statement implies that decentralization has shifted relationships between local livelihood groups by fomenting local contestation. As has been demonstrated in other analyses of resource conflicts in the Sahel, this can be understood as an example of how “land-use pressures resulting from state action are often reoriented by local configurations of power toward farmer-herder conflicts” (Turner 2004: 880).

Institutional changes under decentralization have altered the allocation of powers and responsibilities for resource management and reshaped the legitimacy of particular forms of resource governance. As these resulting shifts in power are contested, processes of decentralization become enmeshed in the production and reproduction of hierarchy at the local level (Poteete and Ribot 2011; Gray 2006). Elected rural councils established in 1990 entered an already complex institutional environment where contestation and renegotiation between actors is ongoing. Customary authorities have managed local resources for centuries, with or without recognition by a central state. While administrative decentralization efforts frequently cited

enhanced local participation in resource management as a goal, the devolution of powers occurred at the supra-village level through the artificial creation of the commune as a territorial and political entity; villages and pastoral camps were given no formally recognized role in management despite being the level at which long-standing tenure institutions function (Benjaminsen 1997; Hesse and Trench 2000).

However, relevant institutional forms are not limited to locally elected councils and customary norms. State policy and development organizations have also facilitated the formation of user committees and project management committees. Significantly, in this time period development projects began relying on the socio-spatial concept of the *terroir* as the anchor in which natural resource management projects could take hold (Bassett, Blanc-Pamard, and Boutrais 2007). The *terroir* is both a cultural landscape with which inhabitants have historical and affective ties and a mode of governance that facilitates the control of the people and resources within its boundaries (Bassett, Blanc-Pamard, and Boutrais 2007). Reflecting on the land use planning activities executed under PDES0 in Kouthia Ba in the late 1980s and early 1990s, a participating technician remarked that because of the amount of resources put at their disposition the project committee was in direct competition for authority with the newly created rural commune government.

Associative movements and cooperatives, often established with outside facilitation, are also part of the proliferation of institutional actors. Following the end of PDES0, several initiatives to support the collective organization of pastoralists were implemented in the region. The most notable is Galle Aynaabe, a state-sponsored pastoral association established in 1996; however, cooperatives such as this one formed under the impetus of the state were subject to some degree of state control of their actions. Further, although the extent of successful

Table 5. Institutions for Resource Governance in Kouthia Ba

<i>Institution</i>	<i>Structure</i>	<i>Source of Authority</i>
<i>Jaytigi</i> relationships (<i>tutorat</i>)	Informal arrangements based on communal (e.g. kinship) or individual (e.g. labor-sharing) ties	Custom; principle of reciprocity
Village chief	Generally an inherited post rooted in customary authority, but also allocated some responsibilities by the state (e.g. tax collection)	Custom; state policy of indirect rule
<i>Communauté rurale</i>	Administrative unit established by decentralization reforms in 1996; governed by an elected local council, but influenced by national party politics and local elites	National legislation; ability to allocate resources
Associative movements (e.g. <i>Galle Aynaabe</i>)	Voluntary associations governed by their members; some are recognized and promulgated by the state	Mutual adherence; state support
PDES management committees	Established by a development project, local committees were either appointed by project managers or chosen by community members; little legal authority, but access to considerable resources created competition with newly established local governments (<i>communautés rurales</i>)	Patronage; some support from sector agencies
Sectoral agencies (e.g. Forest Service, Agricultural Service, Livestock Husbandry Service)	Administered by ministries based in the capital with local agents at the arrondissement or commune rurale levels; due to an ambiguous legal relationship with <i>communautés rurales</i> , agents maintain significant control over resource governance at the local level	State décrets; history of use of force (e.g. fines, imprisonment)

centralized state control over resource management is questionable, the colonial and post-colonial administration has developed a trained corps of professional managers (foresters, veterinarians, and agricultural technicians) with a mandate to propagate technocratic solutions at regional and local levels. District employees of the forestry service, the ministry of livestock husbandry, and the agricultural service are all actively involved in land administration within Kouthia Ba, often with little coordination between them.

Competing local systems of resource management often appeal to different sources of legitimacy, though the need for reciprocal but regulated access regimes is also widely recognized (Hesse and Trench 2000). While competition historically existed amongst multiple customary systems of governance, interdependencies among social groups created the grounds for negotiated consensus. In this context, institutional pluralism satisfied the paradoxical requirements for coordination and flexibility in resource use. However, in the modern era the proliferation of institutional actors has often complicated resource management due to the ambiguity in the roles and authority held by disparate institutional forms. Formal state efforts to clarify administrative powers tended to stress the importance of well-defined user groups and clearly delineated territorial boundaries (Turner et al. 2012; Bassett 2007). For example, the decentralization law of 1990 defined local management in terms of village units and elected councils at the district level. In practice, the *terroir villageois* approach used in much of Francophone West Africa frequently resulted in the exclusion of resource users whose action space was larger than a single village territory (Turner 2004; Bassett, Blanc-Pamard, and Boutrais 2007).

Even in Kouthia Ba where many agropastoralists have a theoretical stake in village zoning there is a strong sense of exclusion from decision-making about the distribution of

resources in the context of the new political powers formalized under decentralization. One village chief explicitly referred to the rural commune government as an association for farmers, saying: *“Herders cannot hold land individually, but the way they have formed farmers into an administrative council, if only they [had] organized herders in the same way....”*. This perspective links territorial control directly to land use and livelihood practices rather than elucidating decentralization as a democratic process that increases local participation in management. Studies of the decentralization process in Senegal and elsewhere on the continent have emphasized the problems of accountability embedded in the transfer of powers to local level administrative councils (Poteete and Ribot 2011; Ribot, Chatree, and Lankina 2008). As reflected in the following statement, many residents express limited understanding of the responsibilities held by the district council and the sous-prefet at the arrondissement levels: *“If [policies] change and keep changing, you don’t know the law—you can’t understand the principles they are operating by.”*

State land policy privileging agricultural use articulates with the dominance of farming interests in local elected councils to diminish herders’ access to grazing land. In combination with climatic drivers that promote extensive farming, this has led to growing reliance on publicly protected forests as grazing reserves. Protected forests are managed by the Water and Forestry Service, signifying a fundamental departure from informal social institutions as the governance regime. In essence, beyond restrictions on cutting of firewood and tree browse, protected forests function as an open access grazing system in which no user group exercises a more legitimate claim. Herders resident in Kouthia Ba argue that they should be able to place some constraints on external access to pastures in the region, with many stating that the inability to do so has material impacts on their own production. In addition, they receive little support from local state

institutions or customary authority. Focus group participants viewed avoidance of conflict as a priority for both the rural commune and local village chiefs:

The village chief is aware of it, but it's his own villagers, his own people who are doing it... He will tell the herders to leave early so that they won't damage fields and cause conflict. But he knows that it is the farmers' fault. His main desire is just to avoid conflict, so he asks the herders to bear it and be patient.

In other areas it has been shown that a state preference for taking the “path of least resistance” when mediating between resource users does little to resolve conflicts in the long term (Gray 2006). This approach dramatically constrains herders' ability to press their own claims, particularly given the existing power differential between farmers and herders. As one local herder put it, *“If farmers and herders aren't cooperating, livestock owners will bear the burden. Any area that is good for farming farmers will eventually take.”*

While they have few levers to limit the expansion of cropping, agropastoralists are employing alternative strategies to shape the possibilities open to external herders. In Saare Boyli, the village chief refused external herders access to the village well as a means to avoid potential conflicts. Critically, water shortages are one of the main drivers that force herders from the Ferlo and Joloff to move south during the dry season in order to sustain their herds. In addition to the drying up of seasonal water points, infrastructure plays a significant role as high demand and frequent breakdowns of water towers in the north also result in shortages or long delays in obtaining access. In light of a land use policy that undermines local groups' ability to exclude others, control of water resources has been used as pressure point to constrain herd movements, both at village wells and at water towers.

By tracing changes in the patterns and terms of connections that structure resource access we can better understand the material effects of power as it circulates in different regimes of resource governance. Agricultural use continues to be privileged at the national and local levels,

with the district council serving as a new source of local authority that can be manipulated to sanction the distribution of land for cropping. Herders using Kouthia Ba pastures seasonally also have more unrestricted access to resources within the forest of Panal than they might under *jaytigi* arrangements. The ability to allocate land access, a structural feature of customary tenure arrangements, is increasingly displaced from social networks for resource access. Meanwhile, agropastoralists attempt to use social pressure and control over water access to exert influence. In turn, the co-constitutive relationship between networks and territories is evident in the discursive strategies through which local actors try to contest the reconfiguration of access regimes. Contestations of power center on land use and emergent articulations of territorial identity, both of which are intimately linked to particular knowledge about local ecologies and social pathways that structure the sharing of both knowledge and information.

Risk Management, Communication Ecologies, and the Individualization of Social Networks

Current pastoral development policy promotes intensification and sedentarization of livestock production through improved breeds and purchased feed while simultaneously acknowledging the “inevitability” of some degree of mobility. Significantly, mobility is to be made acceptable as a land use by being “rationalized” with the aid of technocratic expertise and planning. Despite the passage of legislation to protect pastoral mobility in neighboring countries, an emphasis on intensification remains dominant in national perspectives on rural development in Senegal, including within the ministry of livestock husbandry itself (personal communication, Bocar Sow). This perspective has origins in tenure reforms and the prominence of *mise en valeur* clauses in national land policy; in these arenas productive use was explicitly defined as agricultural use with pastoral lands often implicitly viewed as reserves of agricultural land (Thebaud and Batterbury 2001; Kirk 2000; Benjaminsen 1997).

In contrast to the focus in national agricultural development and land use policy, in the past decade a number of risk management interventions have emphasized the importance of mobility in reducing pastoralists' exposure to climate risk. These interventions have sought to facilitate opportunistic movement through the provision of accurate information on local ecological, climatic, and market conditions. While risk management interventions are generally more attuned to non-equilibrium dynamics and the ecological basis for mobility, they may also fail to adequately grasp the nature of the social institutions that support mobility. For decades interventions in pastoral development frequently focused on effective resource governance (tenure institutions) without attending to the other institutions implicated in pastoral tenure systems (notably labor-sharing, ways of gaining resource access, and information sharing) (Turner and Brottem 2011). Recent approaches to climate risk management tend to emphasize hazard exposure while downplaying the ways in which risk is socially mediated. Thus, enhanced availability of information on ecological and market conditions has frequently been identified as a mechanism for reducing risk exposure without a full examination of the social and institutional contexts that structure the use of such information.

Attitudes to the circulation of information and knowledge in risk management projects have been predominantly shaped by the development discourse on information communication technologies (ICTs). With the rapid expansion of ICT capabilities in the 1990s and early 2000s, ICTs came to be seen as a means to extend modernization into rural areas at an unprecedented pace. Improvements in communication were understood to lead to direct improvements in the welfare of the rural poor (de Bruijn 2008; Donner 2008). Because initiatives operating from the risk management perspective have often viewed enhanced information flow as a public good, there has been little attention to the weakening of social institutions that mediated resource

access and inadequate analysis of how alterations to patterns of information sharing reshape the terms on which external herders access pastures. This perspective likewise fails to sufficiently appreciate the sociocultural basis of flexible tenure rights and the need to address land use issues as a fundamental constraint on households' adaptive possibilities.

Since mobility and communication are closely intertwined, what effect have new forms of communication had on what de Bruijn (2008) calls the "ecology of communication" associated with movement? If the world is "a web of relations that is never in balance and where place and power are continuously being redefined and renegotiated", new pathways of communication produce interactions in which "a moment of reciprocal appropriation of an individual or society and environment is enclosed" (de Bruijn 2008: 7). The spread of ICTs in the region has allowed the maintenance of connections with acquaintances across long distances, playing a pivotal role in the emergence of new translocal (and transnational) networks. In Kouthia Ba the use of cell phones has increased rapidly in over the past five years. Cell phones have generally tended to reduce reliance on established regimes of resource access, though with contradictory effects on networks of access. For external herders, particularly *garsinkoobe* from eastern Senegal, cell phones have allowed groups of extended family members or residents from the same home territory to move in tandem based on the information relayed by a single scout. Due in part to the presence of large groups of compatriots in camps within Kouthia Ba, they also frequently remain socially isolated upon arrival. By opening new avenues for the rapid transfer of information on site-specific ecological conditions cell phones have reduced external herders' need to forge strong relationships with local agropastoralists. In contrast, some Kouthia Ba residents and *waalankoobe* from northern Senegal have used cell phones to broaden the reach of their social network by maintaining contact with new acquaintances in other regions. For

example, several informants noted that they began migrating to Joloff two years after forming a relationship with a youth from the region who had worked for them as a paid herder for a season; they stated that cell phones were integral to the development and maintenance of this connection. In each case, cell phones have enabled networks to root in new territories, though the dynamics of each strategy are distinguished by the temporal duration of rooting in a site and by the tendency to establish local connections or rely on existing social networks.

Studies of both translocal networks and the use of ICTs emphasize the tendency for relations over greater distance to take on a more important role in daily life while relations with those geographically nearby become less prominent (de Bruijn 2008). In addition, many have posited that these trends in the structure of social relations foster the emergence of more individually-centered networks (Castells 2000; de Bruijn 2008). In pastoralists' depictions of strategies for extending their networks, they spoke predominantly in terms of their personal network, with kinship networks and other longstanding communal ties playing a more understated role. Work relationships formed through labor sharing when at rainy season sites have been particularly important in the growth of personal networks, especially for information exchange about ecological conditions. This is significant for the distinction between herding groups because there is little overlap in the timing of migration patterns, meaning that few such contacts are established between herders in Kouthia Ba and *waalankoobe* or *garsinkoobe*.

While mobility has a longstanding historical role in the region, emergent shifts in communication are changing the nature of movement as both a livelihood strategy and as an aspect of social institutions (de Bruijn 2008). Mobility is in itself a way of communicating that shapes social institutions and ways of relating (de Bruijn 2008). In the past, people would send news with others whose paths they crossed; however, this is being supplanted by the ability to

communicate directly with someone at a distance via cell phone. Elaborating on the ubiquitous collections of scraps of paper scribbled with names and numbers, one herder said, “*We keep detailed lists of phone numbers—up to 100 people. Every phone owner has this. Everyone you meet and get to know, you exchange numbers. After that, you continue to stay in touch. This is especially important for herders.*” Social networks appear to be geographically broader and more dispersed than in the past, due in part to this new ability to maintain ties.

The perceived utility of different types of knowledge also plays an important role in reconfiguring the types and terms of connections between actors. Utility is defined in relation to the ability to anticipate or interpret ecological dynamics. The degree to which particular knowledge systems can discipline the environmental context or render it sensible to human actors determines its status and local demand for it. In this sense, climatic shifts have fundamentally altered the intergenerational transfer of environmental knowledge and associated relationships of reliance and authority. While expressing deep reverence for knowledge acquired through personal experience, many members of the younger generation voiced doubt as to the applicability of customary knowledge and methods for anticipating seasonal outcomes given the growing range of environmental variability:

Our elders had ways of knowing that differed from the meteo. They would pull water from the well and cut the rope and they would know today it will rain. They could look at the angle of the sunset with a particular tree and know it would rain. That was in their years, but since the seasons have changed, it is no longer clear to them. Now it’s only the meteo that knows.

Or according to another herder, “*It’s hard for [the elders] to predict now; only those who have studied can do it now.*” They continue to understand knowledge as a function of custom and routine, but many agropastoralists in the region increasingly turn to state agencies for information, knowledge, and training. This is indicative of a growing demand for the state to

play an active role in providing services. However, the evaluation of the reliability of certain information is not confined to its accuracy, but also remains conditioned by the relationship of trust that exists between the information source and a local producer. In some cases, the level of confidence in information distributed by technicians was linked to an understanding of how it was produced; in one focus group, several participants validated their use of advice from the agricultural service by referring to it as a compilation of local knowledge that technicians gleaned from conversations with different farmers.

Yet utility is not the only axis along which knowledge is valued. In one focus group, household heads aged 30 to 40 spoke about the cultural and emotional value they placed on knowledge from their elders and common traditions. For many, the experience of transitioning to different sources of knowledge and information is emotionally fraught and raises difficult questions about family dynamics and adherence to Pulaar identity. The shift in knowledge systems is particularly important because identity tended to be articulated in terms of the knowledge base underlying herding rather than associated with the productive activity itself: *“Herders have certain awareness that they gain in the forest without ever studying. The ability to know the forest and cows, to recognize animals you have seen before. We recognize the lowing of our individual cattle. We never studied, but god gave use these abilities for herding.”* Divergent attitudes toward varied sources of knowledge are linked to changes in livelihood strategies. The younger generation contrasted their reliance on multiple information sources with what they saw as their elders’ exclusive reliance on tradition, explicitly distancing their “modern” outlook from this backward-looking orientation. They elaborated on their exposure to more expanded networks of people from different regions and more extensive personal mobility within Senegal while emphasizing their generations’ greater willingness to deviate from customary production

strategies including using new crop varieties and incorporating modern financial instruments like bank loans and interest.

They believe in what they can see. They want to be able to go out and look at their cattle. They don't believe in what is done inside the bank that they can't see. They don't believe in papers. They believe in getting up in the morning and seeing their cattle. But us, we are more willing to believe these things for two reasons. On the one hand, we are more mobile, we make more connections with others, we speak with people more than they ever did. There are things we have seen that they haven't. The only knowledge they have is from tradition. But knowing the world... today we have more knowledge than they do.

However, the same group also lamented a persistent loss in local ecological knowledge and herding expertise over successive generations. In addition to shaping decision-making about household production, intergenerational dynamics also affect engagement with different governance regimes. Older generations in Kouthia Ba historically had an ambivalent position relative to the government, often contesting state power through strategies of avoidance while also being incorporated into the post-independence administration as mouthpieces for official edicts and active participants in the local allocation of resources. In contrast, the current generation is more comfortable in invoking state arbitration under certain conditions, expect more extensive service provision, and claim to be savvier in navigating state policy. Along with challenges to the role of local or customary knowledge, new relationships of communication also alter the position of Kouthia Ba elders in resource governance. The radio in particular has obviated the need for regional officials to operate through a network of village chiefs to disseminate official pronouncements and technical information.

Conclusion

Two fundamental changes are occurring in the structures of the networks in which resource access is embedded. First, networks of social relations based on communal membership are being supplanted by the growing importance of individually-directed networks (similar to

Castells' [2000] concept of "networked individualism"). Pastoral social networks are increasingly modular with denser connections within a core circle supplemented by sparser connections to herders in other social groups. Although a stronger level of mutual interconnection exists between Kouthia Ba residents and *waalankoobe* herders, in general there is less interpenetration at the community level of herding groups from different home regions. This does not, however, preclude the growing geographic breadth of social connections that some individual actors are able to mobilize. Land tenure remains deeply intertwined with social identities and social networks; however, as connections become more individualized and dyadic, they may be less able to serve as the basis for shared collective norms of resource management.

Second, there is an ongoing substitution of legal control for the social institution of *tutorat* among herding groups in Kouthia Ba. *Tutorat*, the set of mutual obligations between a host and an incomer, has historically been the crux of a form of co-residence in which modes of resource access are never fully separate from modes of incorporation into the local community (Chauveau et al. 2006). This shift in the sources of legitimacy of control over resources is intimately entangled with changes in the terms of connection between different groups. Social connections with a local interlocutor are no longer the primary means of gaining land rights for many external herders. Instead, state policy and the state territory of the protected forest are increasingly the channel through which external herders access land. This effectively alters the relationship between residents and incomers, disentangling land access from incorporation into local citizenship with the obligations that community membership entails. In response to the loss of their institutionalized role in mediating resource access, resident agropastoralists are reimagining their own social identity with an emphasis on territorial belonging. Social institutions for resource access were built on the principles of flexibility, subsidiarity, and

reciprocity; however, emergent forms of territoriality lend themselves to an exclusionary rhetoric. By eroding the basis for informal conflict resolution these fundamental shifts in the terms of connections between different groups reduce the overall capacity for adaptive resource governance. In addition, when conflicts do arise among groups, they are more likely to be mediated by cash than social negotiations. This leads to a situation in which not only is resource access reworked among groups, but within social groups wealth may be of greater importance than traditional authority.

Examining the multiple processes of connection that are occurring in the district of Kouthia Ba reveals the dimensions along which power is exercised and contested. Local networks of users with ties based on sociopolitical membership in a community and a longstanding presence in Kouthia Ba are rooted in the commune territory by asserting a sense of identity defined in terms of place. They thus reimagine the state's discourse on decentralization, seeking to adapt the rhetoric of a fixed collective domain with clearly defined user groups to sanction their claims to territorial control over land access. The state also attempts to put down local roots via the institution of the rural commune and its administrative council. Here the terms of connection are defined by legal mandates and the ability to assert a presence at the local level through discourse, internal hierarchies, and pressure on local political processes. The state's ability to claim authority locally is enhanced by its role in the arbitration of conflicts among resource users. It is also facilitated by the increasing turn toward the state as a service provider and toward sectoral agencies for technical information. Management by technical agencies constitutes an avenue for entry outside of local networks; this is undergirded by perceptions of herding groups as members of the same population and statements that no one can be refused access to public lands. At the same time, networks of herders are establishing roots in territories

outside of their own through *jaytigi* relationships or personal interactions. Once closely linked to incorporation into the local community, these networks are increasingly more mobile and able to enter new territories through openings created by various forms of state management. Local residents sometimes experience this as a forced connection which they contest through emergent attempts to control resource access and a discourse of territoriality. As all of these networks interpenetrate, they alternately facilitate and constrain each other's territorial claims.

As the relationships between actors in the resource use system shifts, the social structure of mobility is being reconfigured. The ecological context acts to create a certain configuration of relationships between individuals, their environment, and the social networks that enable flexible resource access. However, climate change has altered these connections by increasing the demands on the land base and altering the drivers and timing of herd movements. While historically the degree of environmental variability bound multiple herding and farming groups together in relations of reciprocity, these connections are being reconfigured by emerging market relationships, land policy, and altered resource availability under climate change. Each of these factors has had marked effects on the resource governance regime. Mobile livestock production is increasingly dominated by commercial producers and development policy implicitly favors large producers and those located in traditional "sending" regions.² In addition, tension in the adaptive strategies employed by farmers (extensification) and those used by agropastoralists in Kouthia Ba are heightening conflicts over land use. Decentralization has further refracted the social relations that have historically structured resource access in the region. State attempts at resource management are not neutral but have instead altered the balance of power at local levels. Changes in formal land administration are linked to shifts in the host-stranger

² Sending regions are areas dominated by pastoral production such as the Ferlo; these areas are the home territories for the many of the herders who practice seasonal transhumance.

relationship. Historically incomers' access to land was contingent on observance of the associated socio-political obligations. However, shifts in the nature of connections between incomers and residents have reduced the extent to which external herders are incorporated into the sociopolitical community. In the context of larger political-economic changes, local conflicts over land use are increasingly politicized around the notion of belonging and local citizenship (Chauveau et al. 2006).

Conclusion

Agropastoral mobility in Senegal can be understood as opportunistic movement rooted in 1) a knowledge base about cattle needs and inter-annual trends in environmental conditions in specific locations, and 2) a system of socially mediated access to resources. Commercialization of livestock production, increasing absentee ownership by urban residents, and labor shortages due to the split up of households are transforming the organization of livestock production and patterns of ownership, with significant implications for the constellation of risks faced by smallholders. Much of the uncertainty in smallholder production arises from changes in the ability to command access to grazing lands. The expansion of cultivation and interventions in pasture management, including those that impact pathways for accessing information, are creating new patterns of exclusion from resources. Social networks for information exchange are connected in various ways to social institutions that mediate access to pastures and other resources. Flows of information that are disembedded from their social context are likely to shift the dynamics of resource access.

Approaches to risk management enter into an area where contestation over resource access is already taking place and they actively shift the terrain of contestation. Place-based knowledge gained through first-hand experience was in the past part and parcel of institutions for regulating resource access and may be an important means of control in a de facto open access situation. For example, a herder could develop an understanding of micro-level trends in a particular location and decide whom to share this information with. Place-based environmental knowledge is both a part of one's conception of territory (tied to one's range with varied forms of connection to different places) and a means of mobilizing claims to that territory. Emphasizing knowledge as portable and ignoring the ways that information exchange is

embedded in social relationships produces an approach to information dissemination that has differential outcomes for different livelihood groups. Making ecological information widely available can enhance the ability of external herders to use local resources more intensively. Interventions aiming to use forecasts or climate models to help local populations anticipate environmental changes need to explicitly address land use issues and socio-economic barriers to mobility in order to reduce the vulnerability of agropastoralists.

Promoting autonomous adaptation by households requires efforts to build local actors' understanding of long-term climate trends to contextualize decision-making based on short-term seasonal forecasts. This necessitates bridging local, place-based knowledge systems and knowledge produced from GCMs. Promoting appropriate early action in administration (at multiple scales, from the community to the national level), will require tighter streamlining of adaptation and development programming as well as a clear assessment of interactions and trade-offs between different land use decisions and the stability of local livelihoods. Attention must be paid to the winners and losers in different policy scenarios and the implications for the stability of the broader social-ecological system. I argue that assessments of the vulnerability of communities must take into account shifts in knowledge systems and the social relations within which information sharing is embedded. Any attempt to enhance the adaptive capacity of communities must take the idea of knowledge as a complex and path dependent activity seriously. Reexamination is needed of the connections between information access, knowledge creation, and adaptive capacity. The interaction between global scientific paradigms and place-based knowledge can be complex and difficult for particular individuals and organizations to navigate. Rather than focusing on info transfer, we need more subtle ways of engaging with knowledge as fundamentally placed and situated in experience.

Interventions that aim to reduce risk for rural smallholders by enhancing access to information services should carefully consider connections between information transfer and the structure of social relations that determine resource access. Pastoralists' access to grazing land is constrained by access to information about local ecological conditions. Increasing reliance on state agencies for production information can broaden pastoralists' geographic reach while reducing reliance on local relationships. At the same time, control over accumulated knowledge about local ecological conditions in can be mobilized to contest open access systems under state management. These patterns of information exchange reveal how broad-scale processes shape and are reshaped by changes in the structure of pastoral social networks. Ultimately new regimes of resource access play a greater role in mediating households' adaptive capacity than do changing climatic patterns in and of themselves.

In Kouthia Ba, regimes of resource access are shifting from reciprocal and socially-mediated arrangements to state-based management. Land remains the basis of social connections in rural Senegal; land rights are embedded in social obligations, effectively entangling ownership and identity. Historically, a host relationship mediated both the incomer's interaction with the physical space and his entrance into the local community and its social life. However, currently grazing lands are accessed outside of socially-mediated channels. Institutional changes associated with decentralization and the expansion of agriculture have weakened customary management systems. In response to the erosion of local controls, resident agropastoralists invoke claims based on belonging and long-term settlement that are grounded in the state administrative division of the commune. However, reliance on a narrow understanding of community membership as the basis for resource access leads to a rhetoric of exclusion and heightens the stakes of conflict. This is only one axis along which local people understand their

interrelationships and assert identity-based claims; the basis for achieving informal resolutions to resource conflicts exists, but will require new means of reaching negotiated agreements about resource access. State policy on land tenure should aim to support local modes of land regulation, with an emphasis on negotiation and clear acknowledgement of the sociopolitical nature of land tenure (Chauveau et al. 2006).

Appendix: Household Survey Form

Village: _____ Date: _____ Code: _____

1. Number in Household	2. Name of Head of Family and Wives	3. # of chi	4. Num. of brothers in the concession Wives Children	5. Number of animals	
Ethnic Group : <hr/> Adults: _____ Children: _____	C:		FR1 _____	B	1-3
	F1, Origin:		FR2 _____	4-9	10-20
	F2, Origin:		FR3 _____	M	1-4
	F3, Origin:		Son _____	5-15	16-30
				C	1-4
				5-15	16-30
				31-50	>50

6. Num. of work animals	7. Num. of fields	8. Non-agricult. Revenue
Donkeys	Owned	Islam
	Bought	Com
Horses	Loan	Fab
		Med
Rette	Rent	Sal
		Exode
Rrue	Gage	Other

9. Destination of herd in rainy season:

10. Distance of rainy season pasture from village:

<40km >40km

11. What information did you use when deciding where to pasture during the past year?

Reason	HV	SS	
Quality of forage (species composition of vegetation)			1
Spatial extent of available pastures			2
Density of the vegetation			3
Number of livestock herds already present			4
Amount of rainfall at site			6

Presence/absence of agricultural fields			7
Presence/absence of thieves or government agents			8
Presence/absence of livestock diseases			9
Other:			10

12. From whom do you get information related to livestock? Please rank them in order of importance.

Source	Pasture and water	Prices	Disease	Theft/govt agents	Vaccination availability	Rank
Own observation						
Friend/family in village						
Friend/family outside village						
People spent past rainy seasons with						
Acquaintance						
Stranger						
Government						
Other:						

13. Through what means do you get this information?

Means	Pasture and Water	Market Prices	Disease	Presence of thieves or govt agents	Vaccinations	Rank
Personal displacement						
Direct						
Telephone						
Encounter in bush						
Livestock market						
Radio						
Other:						

14. Do you own a cell phone? Yes No
 If yes, since when?

15. What info, if any, do you share or receive through cell phone that is used in making decisions about the herd (e.g. when on transhumance, timing of sales, vaccinations)?

16. How do you know if it is likely to be an especially dry year?

17. Do you own a radio? Yes No

18. Did you hear the forecast (meteo) for last rainy season? Yes No
 a) If yes, how did it influence your decision concerning the destination where you would pasture your animals?

b) If yes, how did it influence your decisions about field crops?

19. If livestock owners could learn (e.g. by radio broadcast, etc.) that the region would receive too much or insufficient rain during the rainy season (but no information about particular sites), would that information be useful for herding? Yes No
 Why ?

20. In the last five years, has your household experienced any of the following risks related to agriculture (A)? For the shocks you experienced, which had the most important impact (C)? In relation to other families in your village, were you more, less, or equally able to cope with each particular risk (D)? Why (E)?

	A	B	C	D	E
Risk/Shock	Y/N	Early alert (Y/N) ?	Rank	Ability to cope (better, equal, worse)	Why ?

Price changes for inputs						1
Changes in price received for crops						2
Loss of harvest because of drought						3
Lack of agricultural equipment or labor						4
Lack of sufficient agricultural land						5
Lack of seeds						6
Low fertility of fields						7
Debts that needed to be repaid						8
Lack of access to credit						9
Invasion of fields by pests or weeds						10
Crop damage by livestock						11
Flooding of fields (excessive rainfall)						12
Other:						13

21. If you heard from a source you trusted that the rainy season would be relatively drier in a given year, are there preventative measures you would take to avoid economic losses and hunger?

Action	Y/N
Save grain or change the timing of sales	
Buy grain after harvest when inexpensive	

Put off large expenses	
Change the timing of livestock sales	
Store or buy feed for livestock	
Migrate further with livestock during rainy season	
Use early maturing seeds	
Change the crops planted (specify _____)	
Change the number of hectares farmed	
Share labor with another household	
Seek an additional revenue source (specify _____)	
Other:	

22. In any year, if your harvest was sufficient for only 25 to 50% of your household's needs for the year, what measures would you take to make up the deficit? Please rank them in order of relative importance (1, 2, 3.....).

Measure	50%	25%	
Eat less			A
Finish the stock of grain			B
Sell or barter cash crops to buy grain			C
Collect "hunger foods" (plants or wild animals)			D
Demand the repayment of a gift or a debt			E
Ask for aid from friends or parents			F
Ask for aid from patrons or relations farther afield			G
Send children to live in another household temporarily			
Borrow money from the bank or a merchant			
Increase paid labor or commerce within the village			H
Send more members of the household to work outside the village			I
Put off major expenses (marriage, school fees, etc)			J
Sell livestock			K
Sell work animals (horses, donkeys, etc)			L
Other:			M

23. During the past three years, have your harvests been sufficient for your grain needs for the year? What revenue sources have you used to buy any additional grain needed?

Year	Sufficient (Y/N)	Sources of revenue to buy or (trade ??) grain
October 2011-Sept 2012		
October 2010-September 2011		
October 2009-September 2010		

24. In the past 5 years (since 2006) has your household any of the following risks or difficulties related to livestock husbandry?

Risk	A	B	C	D	E	
	Y/N	Signaled early Y/N	Rank	Ability to cope (better, equal, worse)	Why ?	
Fluctuations of prices of supplements						1
Fluctuations of price of animals						2
Lack of pasture						3

Poor quality of forage						4
Insufficient water						5
Loss of animals because of lack of pasture						6
Death of animals from disease						7
Loss of animals due to theft or loss						8
Lack of access to pasture because of increased total value of stock in area						9
Lack of access to pasture or water because of agricultural fields						10
Lack of access to corridors inhibiting movement						11
Conflicts with herders or farmers						12
Debts that must be repaid						13
Other:						14

25. During the last two droughts, how did the movement of your herd outside of the village territory change?

Name of the Drought (year)	Changes in movements and reasons for the changes
1.	
2.	

26. Describe changes in access to pasture (both within and outside the village territory) for your livestock over the past 10 years. In your opinion, what were the principal causes of these changes?

27. How have these changes in access to pasture influenced the movement of your livestock ?

Characteristics of Mobility	Influence of changes on the character of mobility
Final destinations outside of the village territory	
Frequency of movement between resting points (gites)	
Timing of departure or return from territory outside the village zone	
Daily movements for pasture around resting points within the village territory	
Other :	

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