



**INSTITUTIONAL INNOVATION AND THE PROTECTION OF LIVESTOCK
CORRIDORS IN AGROPASTORAL DRYLANDS**

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Abstract:

The need to protect livestock mobility in the Sahel has been demonstrated by researchers and is increasingly acknowledged by national governments. Nonetheless, broad statements in support of pastoral land rights have not translated into effective policy design. Policy tends to be based on an abstract conception of mobility that insufficiently addresses the multiple dimensions of resource use and access. This study used participatory mapping to collect data on the corridors, resting points, and water resources used by pastoralists in eastern Senegal. The GIS database (including 5000 km of corridors, 744 encampments, and 1010 water points) depicts how mobility functions within a network of linked resources. Adopting a network approach can address the “paradox of pastoral tenure” by maintaining flexible resource use within a framework of protected resources. Finally, qualitative data from 14 municipalities along the mapped corridors was used to characterize institutional challenges to corridor protection. Resource users hold two competing perspectives on corridors. The first is control-oriented, focusing on preventing crop damage and reducing conflict; the second is access-oriented emphasizing corridors as a means to maintain access to pastures. Without a clear understanding of the functions of corridors, formalization can result in corridors restricting livestock mobility.

Key words: corridors, decentralization, land use planning, participatory mapping, pastoralism

I. History of Pastoral Development Policy

State policy has historically been implicitly or explicitly antagonistic to livestock mobility in the Sahel. Colonial and post-colonial governments mistrusted mobile populations. As part of efforts to extend their control over rural populations they attempted to settle nomadic peoples. An image of pastoralism as backwards and primitive accompanied the drive toward modernization. From the colonial period through the 1990s, the dominant policy narrative depicted pastoralism as an anachronistic and irrational production system. The droughts of the 1970s and 1980s amplified the negative perception of pastoralism. Low intrinsic soil fertility and vegetative production were long misinterpreted as evidence of human-driven degradation due to overgrazing. The 1950s and the 1960s were characterized by a wet period in which annual rainfall averaged over 2 times more than the long-term mean.¹ Following two relatively wet decades, the 1970s signaled the beginning of a dry period. Scientists and technicians originally interpreted the droughts of the 1973 and the mid-1980s as the result of desertification caused by overgrazing. In response to the perceived ‘environmental emergency’, development programs used multiple project models to promote sedentarization of pastoralists and their livestock, including forced settlement, land titling, and group ranches (Batterbury and Warren, 2001). Development interventions focused on rectifying overgrazing and degradation assumed to result from herders’ mismanagement of rangelands (the “tragedy of the commons”, see Hardin, 1968). Efforts to restrict mobility and promote destocking became the norm.

Starting in the 1980s, range scientists began developing a new understanding of dryland ecology that acknowledge variation in environmental conditions as characteristic of semi-arid ecosystems. Fluctuations in rainfall are so frequent that the paradigm of an equilibrium or climax state is poorly suited to describe vegetation dynamics. Rangeland productivity is controlled less by grazing pressure than by variability in rainfall (Ellis and Swift, 1988; Behnke et al., 1993; Sullivan, 1996; Sullivan and Rohde, 2002). The “non-equilibrium” perspective thus suggested that rangeland management should focus on facilitating ongoing adjustments to grazing pressure in response to changing rainfall-vegetation conditions (Niamir-Fuller, 1999; Scoones, 1994). 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 (Bonnet & Hérault, 2011; Scoones, 1995).

At the same time, social science research on common property institutions contested the false conflation of common resources with open access systems. Hardin’s “tragedy of the commons” ignored the role of social management institutions. His dire parable is based on the assumption that herders act solely to maximize their immediate individual interests and are not subject to any form of

¹ Based on NOAA’s calculation of 100 year averages using a moving window.

social sanctions. However, common property regimes include shared rules of access, withdrawal, management, exclusion and alienation that structure individual behavior. This body of research provided valuable empirical evidence that communities' frequently self-organize to create institutions to sustainably manage common resources.

Together, these new scientific understandings of rangeland ecology and pastoral tenure systems have contributed to a gradual shift in development approaches starting in the late 1990s. The need to protect livestock mobility is increasingly recognized in national policy in semi-arid West Africa (Bonnet and Hérault, 2011; Dongmo et al., 2012; Touré, 2004). Many governments in the region, including Mauritania (2000), Mali (2001), Niger (2003), and Burkina Faso (2010), have passed pastoral codes that protect livestock mobility and pastoral access rights. By integrating a formal recognition of mobility into national policy these laws represent a major step forward. Whereas in the past agricultural production was explicitly or implicitly given priority, these codes create a legal basis for the priority of pastoral rights to common rangelands. Nonetheless, broad statements in support of mobility have yet to translate into effective policy design. While the new legislation rhetorically acknowledges pastoralists' customary rights, it offers only a starting point for grappling with the complex governance requirements of livestock corridors. To effectively protect pastoral resources, policies must adequately address both the material geography that structures livestock movement and the institutional dynamics that shape effective governance. There has been limited attention to the materiality of transhumance corridors at the national level, leaving the work of the recognition and designation of transhumance corridors to local jurisdictions.

II. Patterns of Livestock Movement in semi-arid West Africa

The Sahel is the dryland savanna region of West Africa that is dominated by grasslands and sparse woodland cover. Receiving between 200 and 600 mm of annual rainfall, the region is characterized by inherently low vegetation productivity. Much of the Sahel can be characterized as agropastoral, with land cover in the region consisting of grazing lands interspersed within a cropland and woodland mosaic (Homewood, 2004). Fallow fields and crop residues are important grazing resources; similarly, seasonal livestock encampments on fallows provide manure as a soil amendment for cultivation. Rural households vary along the continuum between an agricultural and pastoral production system, but most combine some level of small-scale agricultural production and investment in livestock.

Rainfall patterns in the Sahel are highly erratic, with the coefficient of variation of annual rainfall exceeding 30% (Hulme, 2001). In ecosystems that exhibit non-equilibrium dynamics, external factors such as rainfall variability are the dominant control on vegetative productivity. 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). In this context, livestock mobility has demonstrated benefits for both livestock productivity and rangelands (Diallo 1978; Penning de Vries and Djitèye 1982; Wagenaar et al. 1986). Livestock mobility is critical to animal productivity in a highly variable environment. Mobility allows pastoralists to take advantage of spatial and temporal shifts in nutrient concentration, optimizing the use of a resource base that varies in space and time (Niamir-Fuller 1999). Livestock movements also play a critical role in maintaining grassland diversity, promoting nutrient cycling, and facilitating nutrient transfer to croplands through manure.

Seasonal movements, called transhumance, allow pastoralists to make use of predictable variations in pasture quality and availability. The classic transhumance pattern in the Sahel is the movement of livestock north from the more heavily populated and wetter Sudanian zone in the south to northern pastures in the semi-arid Sahel. These north-south movements are oriented along sharp gradients in rainfall and resource quality. Annual rainfall increases moving from north to south; in contrast, a north-south gradient in forage quality also exists with higher nutrient content forage located to the north (Penning de Vries and Djitèye 1982; Le Houérou 1989). Transhumance is a response to cyclical fluctuations in resource conditions along these gradients. 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. 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.

The distance that transhumant herders' traverse on an annual basis varies depending on the location of their home base and their specific herd management strategies. Herds based in eastern Senegal may move up to several hundreds of kilometers into northern Senegal along the Senegal River Valley (16.5-17 degrees north latitude) and as far south as Kédougou in Senegal and Kéniéba in Mali (12-12.5 degrees north latitude). Levels of mobility vary significantly with some herds managed in semi-sedentary fashion (moving within a 40 km radius during the year) and others traveling across the full latitudinal range described (Turner, McPeak, & Ayantunde, 2014).

Where agricultural pressure is limited, livestock paths are best described as zones of movement oriented in the same direction within a broad band of land. However, where mobility is constrained by cropping, corridors play a vital function. By providing points of passage corridors help maintain access to dispersed pastoral resources in the face of cropping pressure. Corridor networks are means of connecting spatially dispersed resources, creating functional complementarities in terms of variety

of forage types, quality, and temporal availability. Livestock corridors are physical paths of 5-25 meters in width worn by repeated livestock passage. Important features of these corridors are pastoral encampment points, often near water, from which livestock disperse to graze. The health of a corridor system is often less about the presence of a path of sufficient width to allow movement between points A and B and more about the quality of pasture and water accessible from each resting point. A decline in such accessibility at locations along the corridor undermines the usability of the entire corridor. In Senegal, corridors are particularly important in the middle latitudes (13.5-15 degrees north) where mixed land use is common and agricultural expansion is rapidly occurring.

The importance of a resilient corridor system has taken on increased importance due to several key changes in production systems over the past 10 to 15 years. Competition over land in the semi-arid and sub-humid zones of West Africa is increasing, reflecting a relatively recent transition from land abundance to land scarcity (Berry, 2002; Moritz, 2006). Cropland has expanded significantly since the 1960s, with particularly marked expansion in wetlands that offer valuable dry season grazing, flood recession farming, and opportunities for irrigated agriculture (Tappan et al., 2004). While informal arrangements between farmers and herders historically facilitated mobility, these arrangements are under increasing pressure due to heightened land use competition. In addition, as elsewhere in the Sudano-Sahelian zone (Bassett & Turner, 2007; Blench, 1994; Dongmo et al., 2012; Tonah, 2006), over the past two decades transhumance movements have extended further south and the amount of time spent in southern areas has increased. A growing proportion of transhumant livestock remain late in the dry season to catch the earlier rains to the south before moving north (Diop et al. 2012). These shifts in the timing of movements affect the presence of the livestock in the more heavily cultivated areas in the middle latitudes. The longer duration in the south increases the likelihood of crop damage due to livestock in the middle zone because of the temporal overlap between migration and the harvest season.

Changes in livestock ownership are also contributing to increased tensions between farmers and herders. Social institutions for resource access were built on a reciprocal exchange of manure and milk for access to crop residues. However, beginning in the 1960s, reciprocal arrangements between sedentary farmers and transhumant herders began to decline as farming communities diversified into livestock and pastoralists engaged in cultivation (Mwangi & Dohrn, 2008; Turner et al., 2011). As their livestock ownership increased, farmers became less dependent on pastoralists for the provision of animal products and manure. In addition, settled farming communities became more concerned about preserving pastures for locally held animals. In addition, customary institutions that managed livestock mobility were also eroded through a series of administrative and land tenure reforms (Kitchell, 2013; Thebaud & Batterbury, 2001). Tenure policy favoring cropland over rangelands

increased private pressure on resources, leading to agricultural encroachment on common property grazing lands.

III. A Closer Look at What Exactly “Mobility” Means

As Turner (2011) points out, both policy and the scientific literature the term mobility is used to capture a wide range of diverse spatial and temporal dimensions of livestock movements. Abstract references to mobility implicitly collapse these disparate characteristics into a single aggregate measure. The lack of conceptual clarity about livestock mobility contributes to the failure of more recent paradigms for pastoral development. Recent approaches represent a step forward in embracing mobility as an adaptive strategy. However, they often have a simplistic view of mobility as an inherent characteristic of pastoralism that has clear benefits and low costs (Turner 2011). The effective application of new policy commitments to protect mobility requires a detailed understanding of herders’ management goals and practices. Livestock mobility cannot be considered separately from the productive rationales and ecological relationships in which it is rooted. Rather than being an end in its own right, mobility is a production strategy that has benefits for livestock productivity, rangeland health, and agropastoral risk management.

To date, policy and development projects continue to be based on an abstract conception of mobility. The focus on livestock corridors tends to be restricted to the paths themselves without sufficiently addressing the access to pasture, resting points, and water sources upon which mobility depends. In addition, most projects focus on a single corridor in isolation, generally failing to consider the linkages among the multitude of paths used by herders. Similarly, academic research on pastoral mobility is largely based on either coarse-scale schematizations of general trajectories or detailed analysis of a single herd’s movements. In order to support new efforts to protect livestock mobility, we need a more nuanced understanding of herders’ practices, including greater clarity for how they relate to the spatial and temporal distribution of livestock grazing.

Study Methodology

In order to empirically assess the dimensions of livestock mobility, their relationship to ecological variation, and the implications for governance, this study collected fine-grain field data on the entire network of corridors, resting points, and water resources used by pastoralists in eastern Senegal. Data collection followed a participatory process involving three main steps:

1. Meetings with pastoral and other community leaders to identify corridors on which their livestock depend;

2. Collection of GPS coordinates and basic information for these corridors and the associated encampments and water points with the help of pastoralist guides;
3. Presentation and discussion of provisional maps of these corridor features with representatives of major interest groups in each municipality traversed by mapped corridors.

Major corridors used by livestock in the region were initially identified in group meetings of pastoralists and local administrators at the arrondissement level. In these meetings, corridors were simply described by listing the succession of encampments used by pastoralists when moving along the corridor in a particular direction. More detailed information was collected by following each of these paths with a herder guide. GPS coordinates were collected for the corridors, encampment points, and water points used by livestock at each encampment. In addition, encampments were characterized as to cultivation pressure, customary control, exclusionary rights, and pasture quality. Water points used by livestock were characterized as to type, seasonal availability, water quality, and cropped field presence.

Over the course of the project, we mapped and characterized 5000 km of corridors, 744 encampments, and 1010 water points in eastern Senegal. These pastoral features form a network of interconnected resources providing alternative options for travel, water, and forage as herds move along a north–south trajectory. The GIS database combines information on resource quality and availability with data on the social dimensions of resource access for each pastoral site. This includes cropping pressure, herders' access rights, payments for crop damage in the past 3 years, conflict and social contestation, and any formal recognition or protections that exist.

The final step of the data-gathering process is the sharing of provisional maps with representatives from each local district (known in Senegal as the *commune*) crossed by mapped transhumance corridors. The mapped corridors cross a total of 29 communes. These meetings were used to verify information gathered from herder guides as well as to collect additional information about the vulnerability of corridors and encampments to agriculture pressure and informal and formal recognition and protection of corridor sites. In addition, we collected qualitative data from 14 communes located along the livestock corridors mapped in eastern Senegal. The communes differ with respect to cropping pressure, dominant land uses, and the nature of institutions for managing mobility. In each commune, group interviews were conducted with 8-10 participants, including farmers, herders, and commune officials. Discussions focused on the perceived purpose of corridors and the socio-political dimensions of resource control.

Data collected over the course of the project is being incorporated into an on-line digital map available to government ministries, nongovernmental organizations, and pastoral associations. We also produced flat maps at different spatial scales for local and regional governments as well and

pastoral and farming associations. The goal of information dissemination is for all parties involved in rural land-use planning to have accurate information about the existing corridor network and its vulnerabilities.

IV. A Network Approach to Livestock Corridors

Despite increasing cropping pressure, direct competition over land between farming and herding is limited to a three to four month period of cultivation during the rainy season. Conflict between the production systems is less about land area and more about competition over key resources such as these that are critical for pastoral and agricultural production systems (Moritz, 2006). Competition with crop agriculture is particularly pronounced in riverine areas where fields may cut off animals' access to the water points along the river and irrigated fields are cultivated outside of the rainy season.

Fragmentation of rangelands and the conversion of pastures to agricultural use have become important constraints on livestock mobility. Given the level of heterogeneity in rangeland resources in the Sahel, fragmentation has a particularly strong negative effect on livestock production. Within a network of livestock corridors, the effect of the loss of key resources is disproportionate to the area of land removed from the system (Sayre et al., 2013). By limiting access to key resources distributed across space, it reduces the total number of animals that can be supported. Reduced connectivity is thus as important as increased overall pressure on land resources (Hobbs et al., 2008). The geographic distribution of cropping pressure is a critical factor that determines its ultimate effects on pastoral production systems. While cropping and mobile livestock production were historically complimentary, but new pressures have heightened land use competition between the two systems. Land use planning is necessary to address conflict between user groups, promote integration of cropping and herding, and to maintain the viability of pastoral corridor networks.

Although flexible movement is essential to pastoral resource systems, the expansion of cropping in agropastoral areas necessitates a hybrid approach to management that embraces flexibility among pastoral groups but operates within negotiated, mutually acceptable boundaries that protect pastoral resources from agricultural encroachment. Recent research using spatial analysis has shown that resource variability (notably inter-annual variability in forage phenology and the existence of key forage patches) has seasonal regularities; this means that the nature of environmental variability can be made compatible with the territorial protection of livestock corridors and key pastoral resources (Brottem et al., 2014).

Adopting a network approach to livestock corridors offers a way to accommodate the competing needs of tenure security and flexible patterns of resource use. Corridor networks facilitate herd

movements through a series of spatially-fixed resources (encampment sites, water points, and corridors). Flexibility in response to changing environmental conditions occurs within the framework of a relatively fixed set of resources that can be recognized and protected through legislation. If corridor protection is implemented with an eye to the interconnections among corridors and associated pastoral resources, protection need not constrain flexibility of movement. Secure access to multiple routes and resting points dispersed throughout the corridor network can maintain pastoralists' capacity to adapt to changing conditions. Information about the spatial distribution of resources and grazing pressure within a corridor network can be used to prioritize protection efforts around key nodes that play a functional role. Loss of a single key resource can render an entire corridor either inaccessible or simply not useful for herders. The fine-grain mapping of pastoral resources captured in the GIS database allows an analysis of how mobility functions within a set of interlinked resources.

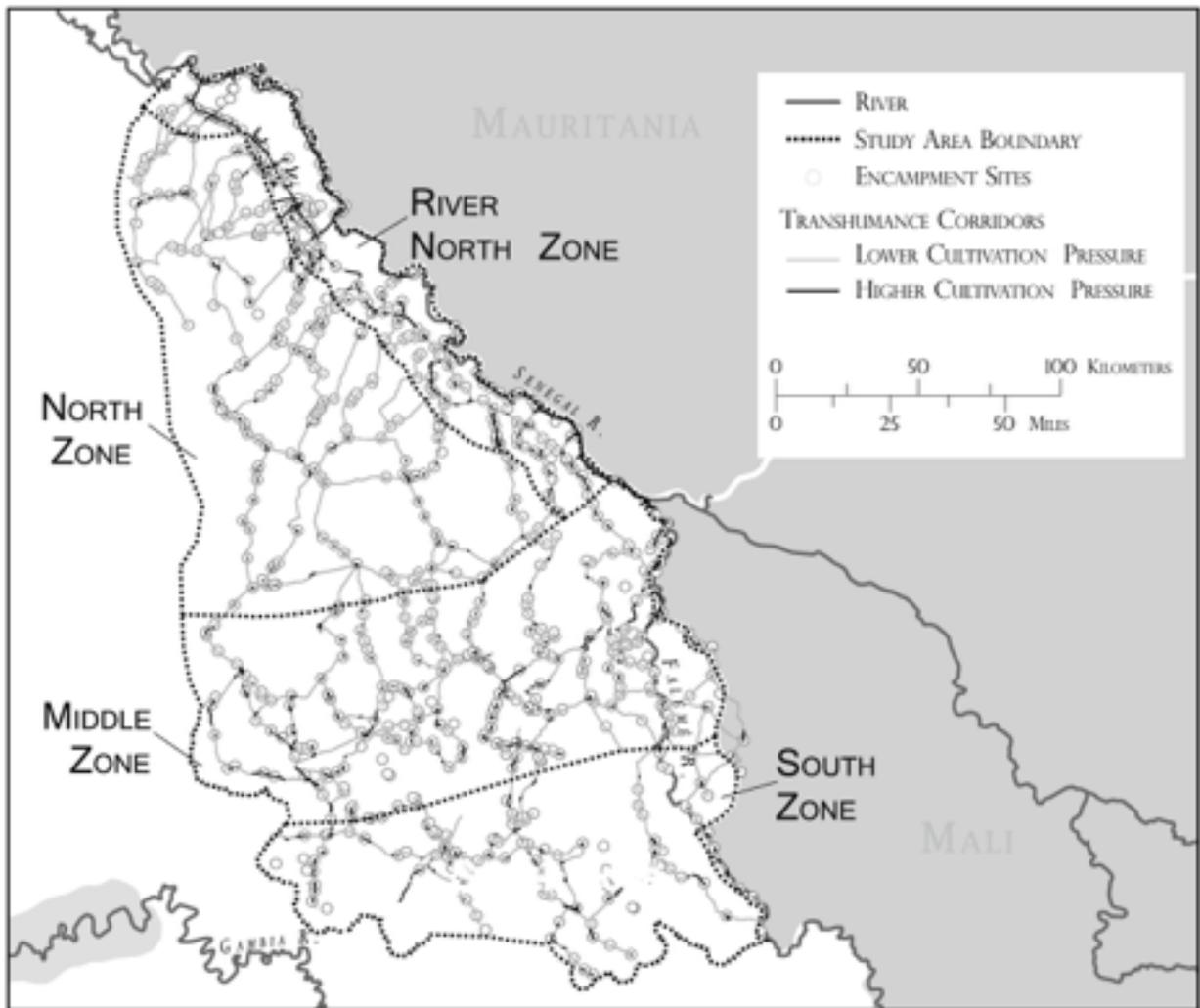


Figure 1. Map of the study area depicting the corridors, encampment sites, and water points for which GPS data was collected.

A few key observations can be made about patterns of movement and resource variability within the mapped area.² First, the distances that herders reported crossing between their home base and their final destination point varied widely, ranging from 40 to 360 km. A significant proportion of herders within the study area practice shorter-range movements (*petite transhumance*, usually < 60 km). Meanwhile, herders outside of the study zone, mostly located to the northwest in the *Futa Tooro*, also use the corridors and tend to move across the entire mapped area. Second, the density of villages, pastoral encampment sites, and water points are higher in the River North and Middle zones. A strong positive correlation exists between the number of villages and the number of encampment sites within a 7 x 7 km grid ($p < 0.0001$, $R^2 = 0.15$, $n = 970$; see Turner et al. 2016 for additional detail about methods of analysis). This relationship reflects herders frequent dependence on village water sources (wells and water towers). In addition, both village settlement and the location of encampment sites are closely related to surface water access, including seasonal ponds. Third, cultivation pressure varies significantly across the corridor network. As expected, cultivation pressure tends to be highest along the Senegal River in the River North zone. In the Middle and South zones, cultivation pressure around corridors and encampment sites is higher than expected given the relatively low percentage of cultivated land across the zones. This reflects the spatial correlation between villages and encampment sites.

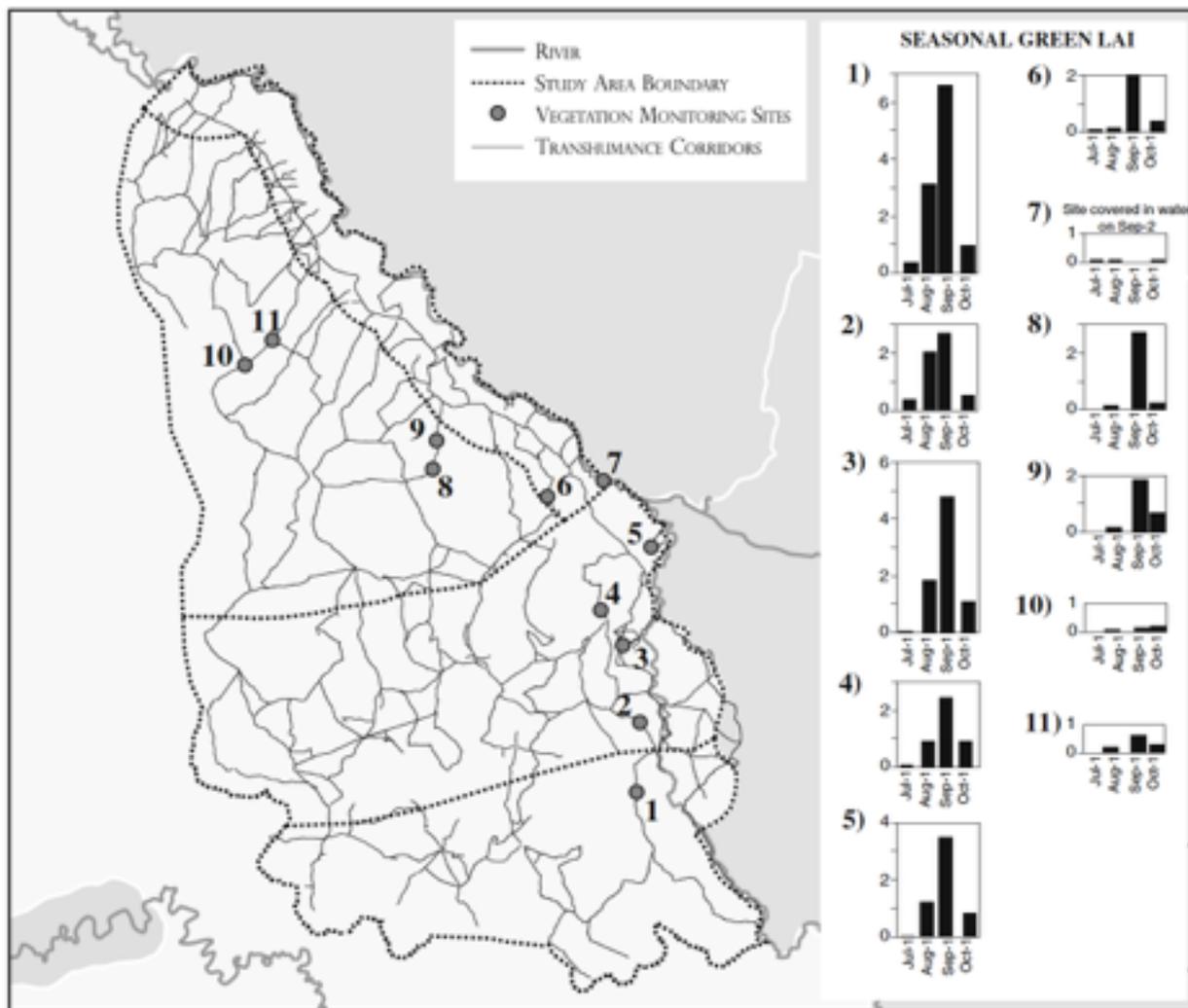
In terms of resource availability across the network, there are clear variations in water availability and forage production. Seasonal water availability varies widely across the zones. While seasonal ponds in the south last an average of 5.5 months into the dry season, those in the Central and North zones rarely last more than 2 to 3 months. Because of the strong link between seasonal rainfall and net primary productivity in the Sahel and Sudano-Sahel, forage availability closely mirrors the trends in water availability. Green forage is available earlier and longer into the season in the south than in

Zone	Corridors	Water points	Encampment sites
River-North	0.60	0.42	0.37
North	0.13	0.51	0.40
Middle	0.25	0.52	0.55
South	0.22	0.36	0.29
Full study area	0.27	0.46	0.43

Table 1. Measures of cultivation pressure around corridors, encampment sites, and water points in the study area (Source: Turner et al. 2016).

² We provide a more complete analysis of patterns of environmental variability within the mapped corridor network in Turner et al., 2016.

Figure 2. Map of variation in resource availability across the study area. The Leaf Area Index (LAI) was calculated using vegetation samples taken along 1km transects in 11 ecological monitoring sites. LAI The graphs indicate differences in both the timing of initial vegetative growth with the onset of the rainy season and overall vegetation production.



the north. The longer duration of green forage availability is one of the reasons that herds moves south with the onset of the dry season. Herds that remain in the south until the end of the dry season and the onset of the rainy season also benefit from earlier germination and access to green forage at a time period during which livestock are in their weakest condition (Turner et al., 2016). In addition to variation along a latitudinal gradient, the graphs of LAI also show significant heterogeneity at sites located at or near the same latitude (ibid). This reflects the importance of small-scale variation in rainfall distribution, local soil conditions, and existing seed banks in determining vegetative growth.

Our analysis of the network of transhumance corridors in the study area demonstrates the key role it plays in increasing livestock’s access to forage and water both within and across years (Turner et al., 2016). Livestock mobility involves both classic north-south movement as well as more varied movements in response to changing needs for forage, water, livestock disease, potential for theft, and

other factors. The web of encampment sites and interlinked corridors facilitates flexible, opportunistic movements in response to changing environmental and social conditions. When approached from the perspective of a functional network, our research provides new insights on how to overcome what has been called the “paradox of pastoral tenure” (Fernandez-Gimenez, 2002). Pastoralists need flexible access to resources in order to adapt to constantly shifting variations in resource availability. However, efforts to protect pastoral resources from competing land uses conventionally rely on territorially-based, exclusionary forms of land tenure. We suggest that viewing transhumance corridors as an interlinked, functional network opens possibilities for reconciling flexible resource access with tenure security. While the location of corridors are fixed, movement among them remains fluid and flexible. Formal protection can focus on pastoral corridors and pastures near key encampment sites without necessarily rigidifying livestock movements.

V. Current Recognition and Protection of Livestock Corridors

Despite the growing encroachment of agricultural fields onto pastoral resources, formal recognition of livestock corridors and pasture areas remains severely limited. Corridor management is a major issue for village and commune level government because of the competing needs of farmers and herders. However, corridor networks extend well beyond local administrative boundaries, meaning that decision-making at this level often lacks the coordination required to maintain uninterrupted corridors. In cases where corridors are closed due to agricultural expansion, local authorities may attempt to identify alternative corridors through their jurisdictions. Unfortunately, these decisions are likely to be made with limited consideration of how a given corridor connects to regional corridor networks or to how a given corridor section connects to water and forage. As a result, the quality of many corridor stretches has deteriorated, increasing livestock’s vulnerability and the potential for farmer-herder conflict.

Development interventions aiming to strengthen pastoral resource management have paradoxically also contributed to the deterioration of regional corridor networks. Over the past two decades there has been an increased interest in supporting community-based natural resource management (CBNRM). Most CBNRM projects have been directly influenced by some of the core tenets of common property theory. This includes 1) the assumption that the resource in question has defined boundaries, 2) an emphasis on a clearly defined and bounded group of resource users, and 3) the assumption that the members of the social group responsible for resource management overlaps fully with the group of resource users (Turner, 2011; Ostrom, 1990). CBNRM approaches prioritize the local scale and typically take the village level to be the key unit of management.

Bassett *et al.* (2007) show how the concept of the village *terroir* was taken up by development planners as the operational planning unit in West Africa. As land-holding patterns and the boundaries

of rural communities became central development concerns, the concept of village lands simplified a complex system of resource rights and altered the balance of power among various rights holders in favor of settled cultivators (Bassett, Blanc-Pamard, and Boutrais, 2007; Painter, Sumberg et al., 1994). In the process, the clarification of land rights exacerbated land-use conflicts. Rural producers, both farmers and herders, use dynamic strategies that exploit a wide range of geographic sites; the *terroir* approach excludes these more mobile modes of resource management. The dominant focus on the village-scale in land policy and development projects has privileged agricultural interests and marginalized pastoralists, effectively resulting in enclosures (Marty 1993; Painter, Sumberg and Price 1994).

CBNRM approaches miss two key institutional aspects that are central to pastoralism. First, the geographic scale of movement is much larger than the area controlled by any given social group. In the Sahel, inherently low levels of vegetative production mean that a significant area of rangeland is required to sustain even a single herd. Local groups control areas much smaller than the spatial extent required do not control nearly enough pastures to sustain even a single herd over the course of the year (Turner, 2011). Second, relatedly, outsiders' access to local pastures is central. Because no single group controls sufficiently extensive pastures, herders necessarily need to access pastures controlled by others beyond their social group. Reciprocity is a key feature of pastoral tenure systems. Flexible access to pastures outside one's home territory acts as a safety net in times of drought while maintaining priority access for particular groups in normal years. The related principles of reciprocity and flexible access allows pastoral groups to adjust to changes in environmental conditions. However, this also means that herders using a common pasture do not necessarily have management rights over it. Given the scale of livestock mobility in the Sahel, a local governance group generally constitutes only a minority of the users grazing its pastures; further, members of the governance group are also likely to depend heavily on resources controlled by other groups during different parts of the year (Turner, 2011). Management institutions thus need to explicitly focus on facilitating regulated access (timing, duration) for outsiders.

Due to the fundamental misunderstanding of livestock mobility and pastoral tenure, widespread CBNRM interventions have ultimately promoted a reduction in herders' access to distant pastures, a reinforcement of insider/outsider politics, and the expansion of cropping onto pastures. The common property literature that shaped CBNRM approaches focuses on small-scale ecologies and institutions (e.g. irrigation systems and community forests). However, the semi-arid rangelands of the Sahel are an example of a commons that operates at a regional scale. Unlike the emphasis on clearly bounded user groups in much of common property theory, group membership tends to be diffuse and access is constantly renegotiated among different users who use and value land in different ways. Management thus necessarily involves negotiation among different groups with divergent values, including those

who may be considered “outsiders”. Further, the scale of range ecologies necessitates interactions among governance institutions at multiple levels, including village leaders, local administrative districts, national ministries, and international regulation of livestock movements across national borders. Many of these institutions have been ignored in the narrow focus on CBNRM.

VI. Addressing Governance Challenges: The Coordination Dilemma

There is a fundamental disconnect between the scale at which corridors operate and the management institution of a village or commune. Most ecosystem services are provided at the landscape scale, thus coordination across administrative jurisdictions is required. However, the need for coordinated governance has yet to be integrated into the logic of decentralization and local management of natural resources. Officially, the decentralization reform of 1996 (Loi 96-06) transferred responsibility for land use planning and natural resource management to the rural commune, rural districts composed of multiple villages and administered by elected local governments. There are currently more than 370 rural communes in Senegal. 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 (Hesse & Trench, 2000; Benjaminsen, 1997; O’Bannon 2006). Decentralization superimposes new governance structures on existing customary institutions, bringing the commune’s administrative authority into competition with pre-existing management institutions (Hesse & Trench 2000). The commune’s authority over resource management also remains ambiguous due to the continued power of state technical agencies (e.g. the forest service and the ministry for livestock development) in decision-making over natural resources.

Another issue is that the local and regional administrations responsible for land use planning are dominated by agricultural constituencies in many areas. Although informal negotiation at local sites has considerable benefits in terms of flexibility, given the expansion of agriculture and the increasing political dominance and material control of certain zones by farming interests, it is inadequate for maintaining flows of ecosystem services from grazing. Intervention of higher-level state authorities is necessary to protect the livelihood security of herders and ensure coordination with respect to transhumance corridors that cross multiple jurisdictions (Moutari & Giraut, 2013; Bassett, 2009; van Driel, 1997). The governance of pastoral mobility involves a multitude of institutions and actors operating at a variety of scales. Maintaining transhumance as a regional resource use system thus requires both some form of co-management and a pro-active role for state authorities.

Land use planning is necessarily multi-level and is influenced by both formal and informal institutions. In the case of the Sahel, co-management is complicated by the proliferation of institutional actors. Various actors frame the problem of land use planning differently and have

different perceptions of the incentives and disincentives for engaging in coordinated management. In eastern Senegal, the direct link between ecosystems and livelihoods is the primary incentive for sustainable management. However, in this case tensions exist among the resource uses associated with different livelihood systems. Herders emphasize forage availability and quality, vegetative composition, and characteristics of vegetative communities (e.g. density of underbrush). In contrast, farmers talked about crop yield and soil fertility, as well as the availability of promising lands for expanding field area. There is also some competition between domestic use of water services (quality, availability) and use for livestock. This is particularly acute around village wells and seasonal ponds located near settlements.

Farmers, herders, and agropastoralists from communities across the study area all emphasized conflict prevention as one of the primary purposes of locally-recognized corridors. People usually referred to conflict between farmers and herders resulting from crop damage, but corridors were also sometimes discussed in terms of their potential role in mitigating tensions between herding groups. Under prevailing conditions of overlapping land uses with multiple claimants holding different use rights, corridors provide a means of clarifying access and channeling livestock pressure through known routes. However, diverse actors interpret the role of corridors in reducing conflict in quite different ways; one perspective views corridors as a means to keep livestock away from fields while another emphasizes the role of corridors in enabling access to a broader ensemble of pastoral resources. Depending on their understanding of the purpose of corridors, resource users hold two related but competing perspectives on corridor protection. The first is control-oriented, emphasizing the prevention of crop damage and reduction of conflict; the second is access-oriented emphasizing corridors as a means to ensure access to pastures (Kitchell, Turner, and McPeak, 2014).

While these perspectives can potentially be complimentary, creating opportunities for negotiation between groups motivated by different ends, regulations on corridors are alternately used to claim access rights and to exclude certain users or uses. Understandings of corridors as a means to keep livestock away from fields acknowledge only a right of transit, eliding the broader issue of agricultural encroachment onto pastures. Without a clear understanding of the functions of corridors in pastoral mobility (i.e. requirements of water and pasture associated with stopping points along corridors), formalization can result in corridors acting as restrictive spaces for livestock. Maintaining the possibility of mobility in only this narrow sense will have a significantly negative effect on livestock production and ecosystem service delivery.

Further, divergent views of the appropriate authority for protecting corridors reveal a distinct institutional politics associated with formalizing corridors. Across the study districts, there was considerable variation in the prominence of customary leaders, locally-elected commune officials,

state-sponsored pastoral associations, and sector agencies in decision-making about livestock mobility. In different local contexts, effective authority over livestock mobility is shaped by the shifting power of these institutions resulting from several factors, notably the level of political organization among pastoralists, village density, the prevalence of protected areas, and the history of livestock movements in the area. In addition, the levels at which farming and herding interests are represented differ. As representatives of local settlements, village chiefs and the commune are likely to favor cultivation interests. Herders lack formal representation in decision-making over land use in the districts outside their home territory, despite their extended presence locally and the regional importance of livestock production. Instead, herders exercise political authority through clan or family heads, pastoral associations, and by appealing to the regional livestock service. The allocation of responsibilities for protecting corridors within formalization processes has two implications. First, different institutions are likely to embody vested interests in a particular land use. Second, when understood as an issue of precedent among competing poles of authority, contestation over the specific issue of corridors becomes a symbol in broader social struggles for control over resources.

Village chiefs are often the primary level at which questions of access are negotiated. This is the case due to their customary authority to allocate cropland and arbitrate conflict but also because of their geographic proximity to the resources in question. The commune is also widely acknowledged as an important source of authority over livestock mobility, particularly through upholding and legitimizing the decisions of village chiefs. In addition, commune officials played a central role in addressing conflicts that were unable to be successfully resolved among the two parties at the village level. Although with decentralization the district government of the commune is closer to the local level at which management questions arise and are resolved, it has a limited enforcement capacity and continues to rely on village chiefs as the mechanism for implementing its decisions. Ambiguity between customary authority and the elected officials of the commune government is particularly strong in areas where new communes had only recently been created.

Given the prominence of agricultural interests at the village and commune levels, the activity of pastoral associations is also important in the context of authority over corridors. Herders who participated in the meetings saw these associations as a means of redressing their political marginalization at the commune level. Pastoral associations can serve as a counterpart to territorially-based management institutions (e.g. village chiefs, the commune). District officials themselves often view pastoral associations or committees as a necessary mechanism for regulating livestock movement. The inability of both village chiefs and the commune to enforce unilateral decisions about corridor use lead to their realization that it is necessary to implicate herders themselves in the elaboration and enforcement of rules. However, for this to occur external herders need an organized form of local representation.

Finally, the activities of technical agencies are implicated in the interactions between different institutions at the local level. As has been discussed elsewhere, ambiguity exists in the allocation responsibilities for land management between the commune and sectoral ministries, notably the forestry and livestock ministries (Poteete and Ribot 2011; Ribot 2009). The tensions between them with respect to decision-making about land use can be exploited by residents and extra-local herders alike, with each party seeking intervention from the authority it perceives as most likely to support its own interests (what has been termed “forum shopping”, see Ribot & Peluso, 2003). Geographic differences in ministry activities are also important for shaping attitudes toward corridors. The livestock ministry has historically focused its interventions on the northern zone and has been an important source of development financing there. In contrast, the prominence of protected areas and forestry agents in the southern zone has decidedly different effects. In these districts the dialogue on transhumance and corridors is dominated by concerns about forest cutting. This has been exacerbated by a species shift in use of corridors from grazers to browsers and a new push to the southeast by corridor users. The forestry agency’s perception of livestock herding as a source of forest degradation has contributed to shaping both local officials and residents’ attitudes toward corridors.

In the context of overlapping institutions for resource management, authority over corridor recognition is highly contested. Variations in the relative authority of different institutions mean that the management of pastoral mobility is effectively in different institutional hands at different points along the corridor. Relations among these various institutions are typified by both cooperation and contention over the right to manage resources (Kitchell, Turner, and McPeak 2014). Building institutions to support livestock mobility is political because recognition requires negotiation among competing authorities. Resource management can become a proxy for struggles over authority among various institutions; competition over authority and issues of precedent thus pose significant barriers to coordination.

Informal institutions may offer an important starting point for defining shared norms among transhumant herders and commune residents. These include understandings of customary rights and responsibilities in which mutual obligations among user groups are emphasized. The historical integration of livestock paths into customary systems of land management was often referenced in discussions of decision-making about corridors, particularly in areas to the east and north of the study area. In some cases the precedence of customary arrangements protected mobility by restricting the ability of commune officials to alter existing land-use agreements; however, since land-use planning and allocation for cultivation take place at the Commune level, its diminished role in regulating corridors could also indirectly promote agricultural encroachment. In the northern zone, populated mainly by Fulani, one participant explained that a shared socio-professional identity defused conflict, emphasizing “we’re all Fulbe.” In addition, participants in northern districts explicitly placed

responsibility for preventing crop damage on *both* farmers and herders. Similarly, in other areas close social relations between groups can facilitate negotiation. This tends to be the case in localities where transhumant herders pass a significant portion of the year and return in successive years, leading to closer relationships among groups and diluting strict definitions of ‘insider’ and ‘outsider.’ In areas where farmers own a significant number of livestock and also make use of corridors there are also increased incentives to engage in negotiated planning.

VII. Conclusion

The mapping of transhumance corridors can provide information needed to support the development of co-management systems. Regional-scale information about the location of corridor stretches, associated resting points, and water sources can provide a clearer understanding of the role of specific resources in maintaining production systems. In turn, this information can be used to ground discussion about divergent priorities among stakeholders for current and future use. If approached with a clear understanding to the spatial needs of diverse production systems, land use planning offers a means to preserve complementarities in livestock-cropping systems by integrating competing land uses.

However, in addition to the technical dimensions of planning, the process also requires navigating overlapping claims to natural resources. Divergent priorities for land use can also lead to conflict. The land use planning process thus represents a forum for open negotiation among competing perspectives about how to divide a territory into zones with distinct rules regulating land use. Land use planning must be approached as an inherently political process of arriving at a set of compromises that are acceptable to all stakeholders. However, while negotiation processes can be understood as a means of institution building, they necessarily confront histories of conflict among diverse resource users. Effectively protecting pastoral resources requires cultivating shared norms among transhumant herders and commune residents. Existing social institutions that emphasize a sense of mutual obligation can offer a starting point.

If corridor mapping is approached as part of an ongoing process of negotiated land use planning, it can be an important step in enabling coordination. A clearer understanding of the dependence of different livelihoods and resource use systems on specific resources can inform decision-making about trade-offs. In particular, spatial targeting of critical pastoral resources for protection can provide a means for integrating livestock and cropping production. This involves 1) identifying areas that play key roles in the functionality of the broader corridor network and 2) assessing the spatial distribution of cropping pressure. A participatory process of identifying trade-offs in land uses for a given area can also enhance enforcement by increasing the local perception of land use plans as legitimate.

Community-based management will continue to play a fundamental role in the Sahel. However, while critical to successful management, it is only one level in a nested governance system. The scale of livestock mobility requires supra-local coordination. In particular, there is a role for higher-level state agencies in enabling land use planning that spans multiple administrative jurisdictions. In the context of overlapping institutions in the Sahel, this necessitates coordination among formal and informal authorities operating at different scales. In this sense, although conventionally treated as a problem within groups of local actors, in this case collective action also encompasses the state.

Rather than a sole focus on strengthening communities' governance of local resources, a more appropriate approach to pastoral governance entails coordinated co-management that combines state-based territorial management with a point-based system of flexible access governed by pastoral groups. Maintaining sufficient levels of livestock mobility in the face of growing cropping pressure requires a minimum level of state engagement in establishing territorial protections for pastoral resources. Multi-level governance of this kind is complicated by competition among institutions over power and authority. The development of management strategies is hindered when debates about corridors become proxies for struggles over authority. The effective implementation of protections for livestock corridors requires acknowledging conflictual relations among institutional authorities and focusing on the political process in which rules and powers are defined (Ostrom's collective choice rules). Participation of all user groups in rule-making and planning processes is essential. Meaningful participation and investment in planning processes are enhanced when collective choice rules are transparent and seen by local actors as legitimate.

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