# Harnessing Pastoralists' Indigenous Range Management Knowledge for Drought -Resilient Livelihood Systems in the Horn of Africa

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# Summary

This report on harnessing pastoralists' indigenous knowledge of rangeland management in three countries in East and the Horn of Africa is presented in two parts. The first part presents a review of the literature. The second presents the findings from the Orma in Tana River District of Kenya, the Afar in Amibara and Gawane Districts of the Afar Regional State in Ethiopia and the Karamojong in the Moroto District of Uganda. The report focused on the selection and application of indicators and the potential roles indigenous knowledge played in rangeland management for reducing risks of drought resilient livelihoods.

The report advocates participatory research where ecologists and policy makers would utilize herders' indigenous knowledge for assessments, monitoring and decision-making in indigenous range management. The information can be used for developing effective policies, increasing local participation and creating linkages between research and development agenda. For this reason, the research has high relevance to knowledge support system of the World Initiative for Sustainable Pastoralism (WISP) and FAO in supporting regional and global initiatives for harnessing indigenous knowledge for development and conservation of rangelands in Africa. Additionally, the findings would increase comprehension of the indigenous knowledge, develop and test theoretical and methodological frameworks for promoting community participation in the implementations of the UN Convention on Combating Desertification (CCD) and Convention on Biological Diversity (CBD), while at local community levels the research would improve the sustainability of the indigenous range management. The applications of indigenous knowledge using varieties of environmental, production and livelihood and institutional indicators can be utilized in information transfer between conventional range science and local herders as well as national policy makers and pastoralists. The lessons from the study were used to develop specific recommendations for development, policy agenda and research for applying indigenous range management knowledge for making optimal livelihood coping strategies.

The theoretical and methodological frameworks were applied across the study sites to test the applications of the indicators for achieving drought-resilient livelihood coping strategies. Herders as opposed to ecologists selected composite indicators including soils, vegetation and livestock production performance indicators. The interpretation of herder knowledge showed linkages between the current range conditions (i.e. the health) and trends (i.e. direction of change) for decision-making on livelihood coping strategies. The decisions were clearly related to livestock production performances. Range ecologists would recommend manipulation of stocking rates in accordance with range condition, avoiding over utilization by moving livestock promptly and then evaluating the efficacy of the indicators for measuring changes. The herders would practice seasonal livestock grazing movements using mobility in response to ecological indicators for decision-making for indigenous range management.

Overall, the function of indigenous range management knowledge would appear comparable to conventional range management, while they differ only on emphasis. Similar to range science, herders monitor forage plants but their focus is on key forage species. Whereas the objective of the herders is towards improvement of livestock production to increase livelihoods and reproductive capital, the range ecologists are more inclined towards environmental conservation. The type of grazing system used by range science for monitoring rangelands is at the finer scales, while the indigenous knowledge is applied at multiple scales. Indigenous knowledge of range management is defined in terms of space and time. The space describes spatial perspectives of livestock grazing movements that may be organized at multiple scales varied from geographical spaces involving movements of the herds between different agro-ecological zones and fine scale movements between heterogeneous landscapes. The pastoral space may also include the political landscapes, which the communities negotiate in order to respond to variable rainfall and risks of droughts. This happens, when groups access resources outside their traditional resource borders or cross international Frontiers. Simultaneously, herders would use time as a variable in indigenous range management. Time as management variable is related to social functions, including rituals, movement of herds, season of rains, dry season and drought periods. Time generates management skills and is also crucial for understanding the ecology of indigenous range management. Herders used their knowledge of the past for reconstructing environmental changes in the present. Indigenous knowledge can

therefore be used to identify the drivers that in historical times induced livestock movements in response to environmental uncertainty. The space and time in indigenous knowledge also make up social boundaries. The system can be perceived as comprising overlapping knowledge boundaries, which at the core is represented by indigenous knowledge around which the knowledge systems formed a spatial boundary marked by social institutions. The institutions in turn influenced spatial arrangements and decision-making. Social institutions provide rules for regulating resource governance. The spatial ecological and social boundaries provide the necessary flexibility for exploiting spatially and temporally varied grazing resources. The extreme variability coupled with social and political heterogeneity requires negotiations by geographically located groups to share pastures during periods of stress.

The drivers of spatial-temporal and social boundaries are varied. Climate, management and epidemics are the main drivers of grazing landscapes. Droughts create disharmony through scarcities of grazing resources by influencing livestock population movements. Historically, the movements served as time markers, which the society used for reconstructing past events. Using the time markers, herders can reconstruct environmental changes and impacts of droughts on livelihood coping strategies. Grazing movements are in response to environmental variability as well as political forces that shaped the trajectory of land use changes. The forces of change induced population drift. The intensification of conflicts along resource frontiers can be critical during periods of droughts. Regardless of social institutions that each group evolved to negotiate resource sharing, the new frontiers created by external political forces such as armed conflicts created ecological and social barriers. The dynamics of resource conflicts along trans-national borders altered patterns of land use across sites such as the Afar in Ethiopia, where the population shared resources across international borders with Eritrea and Djibouti and the Karamojong in Uganda where periodically the sub-section of Matheniko shared grazing with the Turkana pastoralists in Kenya.

*The way the system functioned was analyzed using integrated theoretical and methodological frameworks for analysing the linkages between indicator selection, integration and applications for understanding responses to livelihoods and decision-making. The theoretical and methodological frameworks were used to achieve four goals. Firstly, the frameworks promoted the integration of indigenous range management knowledge used by herders and the scientific methods used by range ecologists. Secondly, the frameworks simplified arguments coherently from perspectives of ecological and indigenous knowledge. Thirdly, the framework provided practical ways by which relationships between indicators, knowledge, livelihoods, management, decision-making and policy can be inter-related in a dynamic manner. Fourthly, the frameworks linked different management and decision-making systems. In analysing the various linkages, ecologists applying herder knowledge should be familiar with the terms and concepts used by herders for describing the relationships between the environment, livestock production and livelihood indicators. Herder indicators include ecological indicators that reflect relationships between biophysical landscapes and livestock production. Plant indicators reflect utility differences, suggesting that some landscapes because of their lower potential would always produce less than others even under most favourable weather and management conditions. Herders by linking livestock productivity performance indicators with environmental changes are more acutely aware of the performances of production indictors for decision-making than ecologists. As an example, we may consider indicators for measuring land degradation. This would vary from vegetation-based indicators; climate and livelihood indicators related to livestock production as well as social indicators related to human perceptions. The different indicators might be used to assess impacts of management on environment and livestock production. In assessing land degradation, ecologists would include plant-based indicators (such as cover and biomass) and grazing pressure indicators. The indicators are used as early warning of changing environmental conditions and impacts on livelihoods. Being diagnostic, the ecological indicators predict changes that could be used in range monitoring.*

For the herders, the relationships between plant production and livestock grazing are inferred using livestock performances. Range scientists by contrast relate the changes to stocking density. The aim is to improve monitoring of forage conditions and trends by adjusting stocking rates accordingly. The plant-based indicators are scale dependent varied from small patches measured in $m^2$ to larger landscapes in $km^2$. Thus, taking into consideration the scaling effects, ecologists would understand the behaviours of ecological indicators by simulating management effects. For example, if the goal of the research is to understand how different systems of grazing management affect forage plants, ecologists by assessing the responses to varied grazing pressures would predict which of the species is more sensitive to grazing pressure and therefore risk being lost in over-utilized areas compared to those that tolerate heavy grazing pressure. Ecologists would also scrutinize species that increase under heavy grazing pressure. The grazing sensitive species will decline or disappear, while the grazing tolerant species would increase. Based on the interpretation, ecologists would draw inferences on rangeland biodiversity. The information becomes the basis for assessing range condition (health) and trends (directions of change).

Inferential indicators (i.e. anthropogenic indicators) by contrast are not directly measured but the outcomes of management were often assessed on deductive scientific criteria or perceptions herders on how the indicators may be linked to the production parameters. The anthropogenic inferential indicators are value laden. Whereas ecologists would use the indicators to understand conditions of pasture, the herders would use anthropogenic indicators to assess grazing suitability (GS) for different livestock species during different seasons of grazing. Additionally, herders used another value-laden indicators related to landscape grazing potential (LGP). The potential is a relative measure of landscape resilience. The landscapes with low potential are more at risk of degradation than those with high potential. Whereas anthropogenic indicators are consistent in their responses to management, the ecological indicators would show high spatial and temporal variability.

By comparison, drought resilient livelihood indicators refer to sources of life support systems for drought survival. The livelihood support systems such as social networks are used to share food with neighbours to cope with drought-induced stresses. The report is interested in attitudes and perceptions of the herding communities' vis-à-vis causal relationships between environmental and livelihood indicators. For example, drought depending on level of risks (varied from low, moderate to high frequency) would have cascading effects on pastoral livelihood coping strategies.

The methodological framework links series of actions including interviews with key informants on herder perceptions, herder methods of landscape classification, assessments, historical reconstruction and seasonal management using anthropogenic indicators, vegetation indicators and livestock production indicators. In the systematic methods, herder knowledge was used for classifying grazing landscapes using soil colour, vegetation indicators and topography. The basic changes monitored are vegetation (and consequently livestock production performance) for testing impacts of management. Herders also reconstructed landscape environmental history based on past knowledge against time lines of social institutions (including age sets, yearly calendar, historical events including political perturbations). The herders categorized plant species according to livestock grazing preferences. These were evaluated in terms of changing food conditions related to milk yields, changes in livestock body weights and reproductive potential. Livestock productivity and how it is affected by rainfall variability and frequent droughts is important for rationalizing herder indigenous range management strategies. The livelihood indicators reflect the relationships between changes in livestock numbers and human needs. Livestock is used for building social networks for redistributing food from household to another. Shifts in livestock populations in relation to human needs (livestock per capita) provide a measure of livelihood indicators. Using systematic sampling methods the indicators were integrated through joint surveys. The methods have important implications for information transfer and decision making by policy makers and researchers.

The theoretical and methodological frameworks were applied across the three case study communities. The three pastoral communities used comparable systems of land classification at regional and local scales. At the regional scales the grazing lands were categorized into key-and non-key grazing resources separated by topographic variations that marked seasonal livestock grazing movements varied between the wet, the dry and drought periods. Herder range scouts referred to as *abuuru, iddo* and *ngikerebo* by the Orma, the Afar and the Karamojong, respectively, conducted grazing assessments for directing livestock grazing movements during different seasons. The systems of assessments were influenced by the dominant livestock species: cattle for the Orma and Karamojong and camels for the Afar. For the Orma and the Afar, the key grazing landscapes were the riverine floodplains, while the Karamojong used marshes and mountains. The grazing landscapes of the plains (e.g. Afar) were used after the rains, the uplands in the wet (Afar) and the dry seasons (Karamojong), while the floodplains were traditionally utilized as drought reserves (Orma and Afar). Herder land use is expressed in folklores. For example, the Orma cattle folklore called *darma* describes watering and grazing movements in different landscapes as well as between water sources. For the Afar, the camel management forms part of the camel lore (*gaala silale baaro*) that describes grazing, breeding and calving. The Karamojong used folklore of personalized ox-names to express their responses to changing environmental conditions. The folklore is the medium through which the societal values and the needs of their stock are expressed that in turn defines social norms.

Among the three pastoral communities, indigenous range management knowledge for assessing grazing lands is based mostly on soil indicators for determining livestock grazing and settlement suitability. The response of livestock to soil indicators is in terms of animal behavior, milk yields and production performances. These were applied to gauge livestock grazing suitability. The scouts combined soils and vegetation indicators for rating grazing suitability of different livestock species. Also, on the basis of soil types, herders categorized landscapes according to their potential for grazing. Landscapes with high potential supported greater stocking potential and resisted grazing pressure, while those with low potential risked degradation. The three communities used comparable criteria for regulating grazing between different landscapes. Herders categorized rangelands on degradation vulnerability scales. The results showed that the rangelands of the Orma and Afar were deteriorating. All the grazing suitability indicators were on the decline and the corresponding livestock production indicators were also deteriorating Evidences of heavy grazing pressure showed increased stocking rates and degradation indicators including expansion of the invasive *Prosopis juliflora* (i.e. at the Orma and the Afar sites) that is posing threats for pastoral production. By contrast, the Karamoja site disclosed favorable grazing conditions and absence of the invasive species. Across the three sites, threats to livelihood are through loss of access to key grazing resources, overstocking of the rangelands and in expansion of invasive species. The key floodplain pastures have been lost to commercial farming in the Orma and the Afar sites, exposing the traditional systems of livestock to risks of droughts.

*The three communities had indigenous institutions for regulating grazing and making society wide decisions on strategies for coping with droughts. The Orma used the council assembly of jaarsa mata d'eedha. Traditionally the institution had wide-ranging powers for making critical decisions using customary law for settling disputes, controlling grazing movements and negotiating access to external grazing resources with the neighbours. The jaarsa mata d'eedha had representatives from all four grazing associations in the Tana River. The Afar Makabantu (makaban pl.) is the clan based institution that has functions for coordinating grazing, negotiating with neighbors for gaining access to their resources during periods of droughts and defending the clan in times of conflicts. Among the Karamojong, the indigenous institutions functioned at two levels. Firstly, at the sub-section level, the Karamojong relied on ritual leaders for making decisions on livestock grazing movements at regional scales, while at the settlement levels they have senior elder councils (kathiko) that are responsible for making decisions. Decisions are made by the elders of the traditional settlements (ngireria) on matters that concerned livestock migration as well as protecting the community against raids or responding to stresses induced by droughts.*

Given that the goal of the present study was in harnessing pastoralists' indigenous knowledge as a foundation for sustainable drought–resilient livelihoods, the findings have implications, (a) for sharing knowledge, (b) supporting sound policies for the applications of indicators and (c) promoting interdisciplinary research for management of indigenous rangelands.

- Ecologists and the herders assessed the status of the rangelands in order to understand how herders applied them to gauge livestock production and livelihood indicators. The integrated methods may be utilized for training communities to achieve two objectives. Firstly, the local communities are capable of solving range management problems where they have the responsibility and capacity for making decisions to achieve better drought-resilient livelihood coping strategies. Secondly, the integrated methods can be used for promoting community participation in resource mapping for locating key resources, seasonal grazing routes and marking water points. Such resource maps should indicate different grazing zones, showing the neighbouring grazing associations (Orma), clan territories (Afar) and the territories of the neighbouring clusters (Karamojong). Annotated resource maps should clearly describe the indigenous system of range management at regional and local scales. Thirdly, using resource maps, the communities and range scientists and other resource managers would identify parts of the grazing lands that are threatened by land degradation as well as threats posed by invasive species. Fourthly, annotated resource mapping should describe indigenous institutions for managing rangelands for coping with risks to livelihoods.

- The resource mapping plans provide the basis for community participations in land rehabilitation in accordance with the implementation of the global environmental conventions such as the CCD and CBD at local community levels.

- At regional levels, the information from harnessing herder knowledge for purposes of promoting indigenous range management can be shared widely through the forum of WISP and its networks. Workshops and trainings might focus on three key areas of indigenous knowledge. Firstly, wide discussions and evaluation of the frameworks and criteria for indicator selection. Secondly, applications of the indicators in making management decisions. Thirdly, training on joint application of the indicators with herders. Fourthly, developing guidelines for extension workers on how to select and apply the indicators for collaborative environmental management.

- At the state levels, there is glaring lack of appreciation of herder knowledge for range management. Despite the herders' capacity to manage rangelands in absence of the conventional range science they are often blamed for causing land degradation through overstocking of the rangelands. Contrary to the claims, this study has shown that the indigenous range management knowledge can be used as a basis for identifying landscapes that are potentially at risk as well as those landscapes that show greater potential for sustainable rangeland management. The governments in the three countries as well as others should give serious attention to the application of indigenous rangeland management for achieving sustainable resource management. The government can support indigenous range management knowledge by acknowledging the indigenous systems of land use, supporting communities' empowerments and promoting participatory resource planning through resource mapping exercises. Furthermore, the governments should acknowledge and respect the traditional systems of resource use as well as providing tenure security for the key resources. The governments can support indigenous range management knowledge by integrating it into systems of resource management, deciding on priorities of investments and mobilizing local communities as active partners in development planning and promoting conservation of the rangelands.

- The study highlighted how official land use policies undermined applications of indigenous range management knowledge. Changes in land use policies altered mobility as a coping strategy, making the system exceedingly vulnerable to droughts. In the three case study communities policy interventions through commercial agriculture or state security transformed the indigenous systems of land use posing threats to livelihood coping strategies. Two of the communities are experiencing declining rangeland productivity and loss of grazing lands to commercial agriculture. For the herders, loss of access to the key grazing resources would undermine sustainable livelihoods. Additionally, land use policies in terms of re-forestation programs associated with irrigation schemes introduced the invasive *Prosopis juliflora* that has since expanded in the floodplains in Tana River in Kenya and in Awash in the districts of Amibara and Gawane in Afar, Ethiopia. Expansion of the invasive species has rendered the rangelands worthless for indigenous range management. This is so given that the local communities have limited technology for rehabilitating rangelands currently invaded by the invasive species. The introductions of the species were based on the assumption that the species would provide fuel wood and land cover. This mistaken environmental policy has had unexpected adverse environmental impacts which need to be addressed urgently before the species spreads into more rangelands.

- Another important lesson from the current study was the role played by indigenous institutions for promoting indigenous rangeland management. The indigenous institutions are however losing effectiveness under changing administrative policies that shifted power from the traditional to state-supported institutions. In the Karamoja region, Uganda, the state has introduced a new policy of placing the livestock in security settlements with a view of halting raids and armed cattle rusting. There is official perception that the traditional systems of grazing based on mobility promoted rustling. Yet, forced sedentarization undermined successful traditional rangeland management. Restricting livestock grazing movements would result in heavy stocking that is likely to induce environmental degradation. Furthermore, the indicators of livestock productivity tend to decline in the security areas, while favourable grazing conditions are found short distances from the security settlements. The risks for livestock mortality are greater under security kraaling than the traditional system of indigenous management.

- An important recommendation for future research agenda is to widely apply the theoretical and methodological frameworks for developing generalized principles of indigenous knowledge. Complete documentations of indicators for rangeland assessments and monitoring resilient livelihoods should be conducted. Existence of such generalized principles of indigenous knowledge would provide important foundation for global applications of the knowledge across varied cultures. More importantly, the integrated research could serve to guide development and policy agenda for implementing the global environmental conventions and promoting local development in the future. Research on indigenous knowledge would also be linked to the state-pastoral relations, effects of resource conflicts on resource access and impacts it has had on changes on the traditional patterns of land use. An important research area is that of understanding the relationships between ethnic conflicts, government policies and rangeland tenure. Insecurity of resource tenure in the rangelands might be the driving force of the conflicts. This needs to be disaggregated by policy, resource use and development.

- The key message of this research is that harnessing pastoralists' indigenous rangelands knowledge has implications for promoting participatory research, verifying theories and testing methods as well as sharing information widely for purposes of promoting effective policies and developing drought-resilient livelihood coping strategies for the pastoral communities in Eastern and the Horn of Africa for sustainable indigenous range management.

"No longer in control of large grazing areas, and strictly confined by institutional regulation of numerous aspects of their herding practices, these herders live along the physical and economic margins…*Yet their indigenous knowledge of range management is unsurpassed by any existing science* "[1] Ginguld et al. 1997: 567

[1] Sentences in italics added.

# 1. Introduction

Environmental hazards and risks are the main threats to indigenous range management in Eastern and the Horn of Africa. This report is about how three pastoral communities in Eastern and the Horn of Africa (Kenya, Uganda and Ethiopia) used indigenous range management for promoting indigenous drought resilient livelihoods to cope with environmental risks. The report seeks answers to the following questions: (a) what are the perspectives of the traditional range management and its uses as a coping strategy for promoting drought–resilient livelihoods in the case study countries? (b) What aspects of indigenous knowledge are useful for identifying ecological and anthropogenic indicators for managing risks that threaten livelihoods? (c) How are the indicators applied? (d) What theoretical and methodology frameworks need to be developed for testing indicators and dissemination of the research information widely? (e) What are the necessary institutional guides for applying the indicators for making rational range management decisions? (f) What lessons can be drawn from the way indicator uses are practiced through knowledge transfer. (g) What lessons are drawn for promoting appropriate policy regimes and future research on indigenous range management? Answers to these questions would demand comprehensive understanding of the roles indigenous knowledge for rangeland management play in promoting development, policy and research across comparable regions of Africa in the future.

The potential roles rangeland management plays in reducing risks to drought resilient livelihoods have been underestimated. Despite major alterations by competing uses, the rangelands in the three countries remain one of the most extensive natural resources that support significant human and livestock populations. The indigenous rangelands harbour high biodiversity and are sources of livelihoods for coping with droughts. External and internal drivers in terms of land use policies and commercial agriculture are threatening indigenous systems of range management, while invasive species in some of the sites have hugely contributed to the deterioration of livelihoods for coping with droughts (Ellis and Swift 1988; Bollig 2006). Despite past neglect by research and development agents, promotion of indigenous knowledge of range management for building robust drought-resilient livelihood systems might provide answers to problems of land use which technically oriented science failed to address in the past. The report contributes to better understanding of the functions of indigenous range management knowledge through selection and applications of ecological and anthropogenic indicators that can be applied for improving drought-resilient livelihood coping strategies.

The potential integration of indigenous knowledge into scientific methods for promoting effective policy regimes is yet to be adequately addressed. Range science uses ecological theories and scientific methods but seldom focus on how indigenous knowledge is used to improve drought resilient livelihoods (Behnke et al. 1993). Improved knowledge of indigenous knowledge and traditional range management should therefore analyse how pastoralists interact with environment and make management decisions (Oba and Kotile 2001; Muhereza and Otim 2002).

Range research previously neglected application of indigenous ecological knowledge (IEK) although this appears to be changing (Behnke et al. 1993; Oba et al. 2000a,b). Emerging research evidence shows that the indigenous systems of range management are robust for addressing management problems. The managements are in response to variable ecosystems (Briske et al. 2003; Oba et al. 2000a). Re-evaluation of old theories and methodologies are confirming the functions of indigenous range management (Behnke et al. 1993) in response to rainfall and droughts (Dalberg 2002).

This report proposes a new approach for integrating herder indigenous range management and range science. The indigenous rangeland management and the systems of assessments, monitoring and decision-making will be vital for developing integrated knowledge (Bollig and Schulte 1999; Oba and Kaitira 2006; Oba et al. 2008a; Roba and Oba, 2008). The study developed theoretical and methodological frames for testing the functions of indigenous knowledge and suggest ways by which the indigenous knowledge could be applied by policy makers (see also Abel et. al. 2002). The task for policy makers is to understand conditions under which indigenous range management knowledge functions or become dysfunctional. Firstly, the loss of functionality would occur if the traditional systems of land use are transformed and the indigenous institutions that are responsible for applying the knowledge are undermined. Secondly, increased threats from alternative land uses or conflicts might in the long run result in abandonment of indigenous range management. For those who drop out of pastoralism, indigenous knowledge for range management might overtime decay as the poor pastoralists are forced to seek new skills for alternative livelihoods (Grime and Hodgkinson 2002). In the words of a Somali elder "… a rangeland cannot be a rangeland without pastoralists [knowledge]; and a pastoralist cannot [survive]…without rangeland" (Bouh and Mammo 2008: 115)- the two are mutually interrelated. The implication being that without access to rangelands indigenous range management is bound to become dysfunctional.

How would the application of indigenous range management knowledge improve development of effective policies, increase local participation and create linkages between future research and development agenda and how would the knowledge contribute to the World Initiative for Sustainable Pastoralism (WISP) and FAO efforts for supporting regional and global agenda for harnessing indigenous knowledge for development and conservation of the rangelands? The findings of this report highlight these questions, firstly, by improving better comprehension of the indigenous knowledge and secondly by using indigenous knowledge for promoting community participation in environmental research and decision-making. At global level, the articles of the UN Convention on Combating Desertification (CCD) and Convention on Biological Diversity (CBD) would require application of indigenous range management knowledge, while the conventional range science has had limited influence because the methodologies developed are too technical for promoting community participation. A new approach is therefore needed for integrating the indigenous knowledge and scientific methods for promoting drought-resilient coping strategies. This would demand that range scientists become more familiar with indigenous knowledge, its concepts and functions (Mapinduzi et al. 2003). The report is aimed at developing and testing theoretical and methodological frameworks for integrating indigenous knowledge and ecological methods for understanding drought – resilient livelihood coping strategies using country case studies. The applications of indigenous knowledge using varieties of environmental, production and livelihood and institutional indicators were utilized with a view of information transfer between conventional range science and local indigenous knowledge as well as national policy makers and pastoralists. The lessons from the outcomes were utilized for developing specific recommendation for development, policy agenda as well research for applying indigenous range management knowledge in other regions of Africa.

# 2. The indigenous knowledge and its uses

Growing interests in application of indigenous range management knowledge follows shift in the thinking of range management that puts more emphasis on community knowledge and participation. The indigenous system of range management has complex features reflecting inter-relationships between human adaptations and environmental variability, systems of land use, political and socio-economic drivers (Little 2003). It proposes innovative approaches to provide more insightful understanding on how local indigenous knowledge can be used to achieve sustainable management of the grazing lands. This may be achieved by linking indigenous knowledge and ecological methods (Berkes et al. 2000). The problem has been in ignoring indigenous knowledge in research protocols (Mistry and Berrardi 2006; Oba et al. 2008a).

Despite this, there is growing interest in indigenous knowledge in adaptive research related to management of natural resources by herders (Barrow 1991; Oba and Kotile 2001). Herder knowledge is influenced by environmental conditions, livestock production and social milieu (Boardman et al. 2003). Indigenous knowledge might vary in detail from area to another. We are however less informed about knowledge structure and its critical empirical functions that would inform policy makers and development agents. The challenge is in interpreting how herders view linkages between the current range conditions (i.e. the health) and trends (i.e. direction of change) for decision-making on livelihood coping strategies (Fernandez-Gimenez 2000).

There is however evidence that science of range management and indigenous knowledge shared several features as well as disclosing differences. For example, using the example of livestock grazing, the science of range management considers grazing as the main driver of vegetation change. Range ecologists would recommend manipulation of stocking rates in accordance with the status of pasture, avoiding over utilization by moving livestock promptly before damaging the environment. Range scientists would then evaluate the efficacy of the system by assessing indicators for measuring changes in range condition. The trends would be assessed in relation to the trajectory of plant species composition. The focus is on total plant species present, where changes would be correlated with pressures of livestock grazing. For the same rangelands, herders build rotational grazing in terms of cyclic seasonal herd movements. In contrast to ecologists, herder decisions would be influenced by social and ecological heterogeneity of the grazing lands but most importantly rainfall variability in space and time. These are the factors that influenced herd mobility. The system of land use is based on management of multi-livestock species -comprising cattle; small stock and camels for exploiting varied ecological niches (Bennet and Barret 2007).

Through the process of livestock seasonal movements, the rangelands are conserved. The purpose of indigenous range management would therefore appear to differ from the conventional range management, even though environmental outcomes are similar in both systems. Similar to range science, herders monitor forage plants but their focus is on key forage species. Whereas the objective of herders is towards improvement of livestock production to increase their livelihoods and reproductive capital, range ecologists by comparison are more inclined towards environmental conservation. The type of grazing system used by range science for monitoring rangelands is at the finer scales, while the indigenous knowledge is applied at multiple scales. Thus conventional range science by focusing on linkages between plant performances under different systems of grazing (see later sections) often miss out the livestock production side of the management, albeit making indirect inferences (Ford and Martinez 2000; Fernandez-Gimenez 2000; Oba and Kotile 2001). Indigenous knowledge of range management is defined in terms of space and time (Scharieka 2001).

### *2.1. Space and time in indigenous range management*

The space describes spatial perspectives of grazing resources that may be organized at multiple scales varied from geographical spaces involving movements of herds between different agro-ecological zones and local micro-patches of landscapes that offer key grazing during different seasons. The spaces also include political landscapes, which the communities might negotiate in order to respond to variable rainfall and risks of droughts. This happens, when groups access resources outside their traditional borders or a cross international Frontiers. Simultaneously, herders would use time as a variable in indigenous range management. Time for pastoral communities is related to social functions, including rituals, movement of herds, season of rains, dry and drought periods (Ebei and Oba in press). Herders have their perceptions of the past for reconstructing environmental changes from societal memory. Indigenous knowledge can be used to identify the drivers that in historical times induced environmental changes. Environmental reconstruction at the scale of grazing landscapes therefore serves as the "store" of past memory. The space can also be defined in terms of spatial ecological and social boundaries. The system has several components separated by knowledge boundaries. The boundaries overlap with each subsequent mosaic more encompassing than the previous. Operating at the core is the type of indigenous knowledge around which the knowledge systems formed the next spatial boundary. The next mosaic is formed by social institutions, which in turn influence spatial arrangements and decision-making. Social institutions provide the rules of management and regulation of resource governance. Rituals and religious worldviews of indigenous knowledge occur in this part of spatial boundary. The spatial ecological and social boundaries provide the necessary flexibility herders need to exploit grazing resources in response to variable rainfall. The spatial and temporal and social boundaries can also be influenced by environmental and social heterogeneity (Fernandez-Gimenez 2002). Thus, the system discloses extraordinary similarity in management goals and shared methods across diverse pastoral communities as well as differences even within the same system. For example, the camel managing pastoralists might disclose different systems of knowledge from cattle managers, despite the shared basic units of resources utilized and the ecological knowledge.

The grazing landscapes are the terrain over which the systems of management are applied across communities. The drivers of landscape change are human and livestock populations that influenced history of the environment. The landscapes that suffer droughts would change in terms of grazing resources. Droughts create disharmony by inducing population movements and serving as time markers, which the society uses for reconstructing past events. Using the time markers, herders would reconstruct impacts of past droughts (Angassa and Oba 2007). Consequently, using time-drought reconstruction, indigenous knowledge provides better guidelines for understanding how past droughts transformed livelihood coping strategies (Tache Dida 2008).

In each of the sites, the pastoral production systems evolved distinct institutions that regulated responses to environmental variability as well as policy drivers that shaped the trajectory of range management change. The intensification of conflicts along resource frontiers can also be critical during droughts. Regardless of social institutions that each group evolved to negotiate the traditional frontiers, the new frontiers created by external political forces such as armed conflicts created social barriers. The dynamics of resource conflicts along resource frontiers altered patterns of land use. Pastoral survival across the dynamic frontiers depends on the spatial and temporal variations of grazing resources and socio-political negotiations. This is applicable to two of the study sites: the Afar in Ethiopia, where the population shares resources across international borders with Eritrea and Djibouti and the Karamojong in Uganda where periodically the herders shared grazing with the communities in Kenya. The Orma in Tana River District of Kenya experienced encroachments by pastoralists from neighbouring districts.

Across the resource frontiers, the herders evolved in-depth knowledge in terms of systems of landscape classification for re-directing livestock grazing. Landscapes classification is based on diverse environmental features such as topography, soil, and the dominant vegetation. The knowledge is of critical importance as it pre-determines the spatial distributions of livestock grazing (Scharieka 2001). The landscapes are given geographical or specific names. The names describe the physical topography, soils and vegetation and historical events. The type of landscape might be geographically replicated. The landscape classification criteria may therefore combine cultural sites, such as burial sites of prominent persons, river valleys or mountains and hills (Dabasso 2006). The names describe the types of landscapes, their histories and the stock suited for grazing. Some landscapes are avoided because they harbour biting flies (Mills et al. 2002). Others are malaria-infested marshes or floodplains that are used only during the dry season or drought years. Using the systems of knowledge herders would divide their grazing landscapes into key and non-key grazing resources.

### *2.2. Access to key grazing resources as response to drought stresses*

Grazing landscapes used by herders include those that offer resources of such critical importance that they are vital for survival. These are key-resources. The key resources serve as ecological refuge for the herds during drought stresses (Illius and O'Connor 2000; Angassa and Oba 2007). They may include marshes, mountain grazing lands, river valleys and floodplains. The non-key grazing resources comprised grazing landscapes utilized during the wet season. For the herders, access to the key resources would determine extent to which their livelihoods can be sustained or threatened. The rights to key resources and the need for flexibility to cope with risks of droughts might be hugely influenced by policy drivers; including transfer of key resources to alternative land uses thereby exposing herders to greater risks of losing livelihoods during periods of stress (Fernandez-Gimenez 2002). Because of the critical roles key resources play in pastoral herd management, they form part of the human folklore about livestock- environmental relations. For example, the Karamojong who have the culture of ox-names use symbolic personification of their bulls as part of folklore narration. The composer would narrate how he "listens to the demands of his bull" during a year of plenty and drought. One of the verses is roughly translated as follows:

> " You [i.e. bull] graze in *arro* and travel to *eketela*[2] to sleep…
> The drought has come and you want to migrate to Gritome….
> Because of hunger you have lost weight [and], I hear you crying (bellowing)
> Calling the name of the kraal leader to take you to Gritome…"[3]

The narration describes the features of drought coping strategies. It presents times of plenty and periods of stress. It shows how a herder "listens to and observes" his stock to make appropriate decisions. The herder expresses his concerns in what he believes his bull needs by migrating between the wet season landscapes (*arro* and *eketala*, see case study section) by simply alternating grazing between to the two grazing landscape types. The drought year is a different matter. The animal condition deteriorates because of grazing shortages and the cattle symbolized by the bull lose body condition. The herder expresses "the wishes of his bull" asking the kraal leader to take the cattle to Gritome-which is a drought refuge in Karamoja. This example is used to emphasize the important functions of key grazing resources during periods of stress. The state of environmental production and how each affects livestock production performance is part of the meta-narratives of the herders' folklore.

One would reflect the consequences of the changes in relation to past drought coping histories. Histories of droughts and human survival marked human memory of the environment on coping with changing livelihoods. The regions of East Africa, including the Horn have drought histories that have common recurrence. Every pastoral community would tell of past droughts and famine and the effects on human and livestock populations. Drought events induced specific responses by the indigenous systems of range management. Even though they only have vague ideas of the historical famines, brief interviews with herders would show that it is possible to reconstruct responses to past droughts in terms of population movements. The migrations were of different kinds, varied from local movements between the key and non-key resources to long-distance, often across inter-district and inter-national borders. Other causes of migration were loss of livelihoods, forcing impoverished households out of pastoral system (Henry et al. 2004). The changes would in most cases transform household livelihood coping strategies, where those households with livestock below livelihood requirements resort to crop cultivation or practice agro-pastoral livelihood strategies. In other cases, the indigenous range management is closely linked to crop cultivation-in form of home gardens, usually cultivated by women. Where these systems co-exist, cropping systems are usually located in key grazing landscape patches. This can be contrasted with politically motivated alienation of key resources that undermined social institutions that traditionally regulated tenure rights. Global economic narratives that put greater emphasis on monitorizating the grazing lands as opposed to subsistence pastoral economy influenced the latter. The challenge is how to maintain adaptive management

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[2] These are key grazing landscapes.

[3] The folklore of the different groups were collected during the current study

as well as resilient capacities of indigenous knowledge when resource managers lacked influence over policy directions (Mills et al. 2002). The approach used in the present report seeks to integrate the indigenous and scientific knowledge aimed at influencing policy (Howden et al. 2002; Griffin 2002; Warren 1991; Oba et al. 2008a,b).

### *2.3. Components of indigenous knowledge*

Indigenous range management knowledge is based on priorities related to pastoral production and social relations. The knowledge is the tool for adaptive management for utilizing variable rangelands for extensive grazing (Homann et al. 2008). Another unique feature of indigenous knowledge is that it is a shared knowledge. Indigenous knowledge is functional, replicable and adaptable to most situations under comparable conditions of management (Mapinduzi et al. 2003). The type of knowledge has been called by different names[4]. In the present study, the aim is to link systems of knowledge with range management and avoid using confusing taxonomies prevalent in the literature. For purposes of herder indigenous knowledge the nametags used played no significant roles in the way the grazing lands are utilized.

The asset of indigenous range management knowledge used by herders in the three focus countries is practical knowledge that evolved around exploitation of heterogeneous landscapes for livestock grazing. Indigenous knowledge is the product of time, social and environmental management. The useful parts of the knowledge would persist through time, while the dysfunctional components are discarded. The dysfunctional parts are deleted because it fails to achieve repeated uses. The knowledge because it is time dependent could be generational in nature where older members of the communities would be well informed more than the younger generation. Transferring knowledge from one generation to another is mediated through local institutions (Muhereza and Otim 2002). Most importantly, the knowledge has local contexts, as actors that practice it are also local (Olsson et al. 2004). Yet, through similar types of production-in our cases, livestock production, communities exploiting comparable environments developed similar concepts that represent a generalized indigenous knowledge.

The cue is from how herders' indigenous knowledge is used for coping with variable environments. For the purpose, we also need to understand the functions of social institutions that regulate and modify the application of indigenous range management knowledge (Fernandez-Gimenez 2000). This is a common denominator shared by all the pastoral communities for whom institutional changes would serve as indicators of change in indigenous knowledge. The indicators can be physical, biological (hereafter ecological indicators) or social (hereafter referred to as anthropogenic indicators). Some indicators such as those related to livestock production are inferred. Indigenous knowledge is therefore not isolated. Rather, it represents component of production (Bonny and Vijayanragavan 2001; Kimmerer and Lake 2001). The implication being that herder indigenous range management knowledge can be incorporated into conventional range management (see also Turner et al. 2000). An important function of indigenous knowledge is developing the criteria for selecting indicators for restoration of degraded rangelands. Ecologists might make selection based on extent of damage to the environment, while for the herders used the potential of individual landscapes is an important criterion. Herder landscape classifications divide the rangelands into high and low potential. Degradation vulnerable landscapes would receive less grazing pressure or for only short periods, while highly resilient landscapes would resist greater grazing pressure. The use of indigenous knowledge has more chances of success if applied for decision-making systems in range management and for promoting drought-resilient livelihood coping strategies. An important aspect of the transfer of the type of knowledge is in its capacity to provide framework for the conventional science for redirecting research towards pastoral production (Sheuyange et al. 2005; Mapinduzi et al. 2003) for selecting and applying varieties of environmental and production indicators.

[4] Different names exist that describes similar concept. In this paper, the use of such varied taxonomies of indigenous knowledge as applied by Palmer and Wadley (2007) will not be repeated.

# 3. Range health indicators

The brief research among the communities in the Horn of Africa was aimed at identifying, selecting and applying ecological and production indicators for assessing the conditions and trends of rangelands in response to land use (Hodgkinson and Shroeder 2002). There are three types of indicators, which are described in this report. These include diagnostic ecological indicators and inferential anthropogenic indicators and livelihood indicators.

### *3.1. Diagnostic ecological indicators*

As a general rule diagnostic indicators are sensitive to management change. Diagnostic indicators are independent of changes they measure. They can be plant based or physical indicators (e.g. soil nutrients) (Oba et al. 2008b,c). The diagnostic indicators are of greater interest to resource management because of their predictive powers (NAS 2000). The indicators are scale dependent, varied from local, landscape scale, geographical to national scales. The criteria for selecting diagnostic indicators following Spangenberg et al. (2002) include:

- Responsive at appropriate scales
- Meet the goals of management
- Easy to understand
- Conceptually well founded
- Limited in number
- Dependable for data validation

Criteria of indicator selections can be further summarized into consistency, reliability and predictive capacity (Romstad 1999). Other important properties of diagnostic indicators are that they reflect changes in the quality of life concerned with grazing lands. For example, they show flexibility and adaptations under varied ecological and management conditions. Additional criteria for selecting suitable indicators include the following features (NAS 2000):

- Sensitivity to environmental change
- Must have history of use
- Based on established scientific theory
- Response to temporal and spatial scales
- Powers to make short or long-term predictions

Most importantly, the indicators are useful for application in comparable systems of land use (Brouwer and Crabtree 1999; Dale and Beyeler 2001). Such indicators include soils, forage plants, livestock populations and number of herder movements. The relationships between pressures of use and the status of indicators might also reflect variation of the resources (Kassahun et al. 2008). Users of ecological indicators, however, need to be alert about scales that would limit indicator application. This would include spatial heterogeneity based on landscapes that should be differentiated from spatial patterns induced by land use. The majority of indicators functioned at limited spatial scales but would become imprecise if applied at different scales (Oba et al. 2003; Oba et al. 2008c). Users of ecological indicators also need to be conscious that some indicators are products of others, and therefore could not be directly measured or used alone (NAS 2000).

The ecological indicators would reflect relationships between biophysical landscapes and livestock productivity. Plant indicators reflect physical and utility differences, suggesting that some landscapes because of their lower potential would always produce less than others even under most favourable weather conditions and management. Herders by linking livestock productivity performances to environmental changes are more acutely aware of the performances of production indictors for decision-making. As example, we may consider indicators for measuring land degradation. The indicators vary from vegetation-based indicators; climate and livelihood indicators related to livestock production as well as value indicators related to human perceptions. The different indicators might be used to assess impacts of management on environmental and livestock production changes. In assessing land degradation, ecologists would include the plant-based indicators (such as cover and biomass) and land use pressure (e.g. grazing pressure). The multiple indicators may be combined to understand the proximate causes of land degradation (Oba et al. 2008b,c). Herders perceived that degraded rangelands reduced herd productivity. They also recognized that structural degradation caused by invasive species would reduce grass production. The assessment is in terms of livestock production performances. Thus, the main functions of indicators are in early warning of changing environmental conditions and livelihoods. Being diagnostic, the indicators predict possible causes of the observed changes (Dale and Beyeler 2001). Indicators used by ecologists are purposely selected. For the herders, changes in ecological indicators reflect changes in livestock production performances. Herders use indicators to make decisions, while ecologists need them for promoting conservation plans or validating hypotheses.

There are fundamental differences at least in principle between the indicators used by range scientists and herders. The ecological indicators are inadequate for assessing resilience of the grazing lands, while the anthropogenic indicators are purposely selected for directly linking livestock production performances with landscape potential. The functions of purposely-selected indicators would not be a one-time affair; rather it should be capable of producing information compared against the benchmark. In the majority of the cases, the benchmark would be related to historical knowledge of herders. Impacts of invasive species on local livelihoods are one such example that needs to be built on historical knowledge of the communities to understand its long-term impacts on livelihoods (Andreasen et al. 2001). Ecological assessments in absence of long-term monitoring lack such functional properties.

Anthropogenic indicators provide information on how livelihood indicators are related to productivity of livestock. The indicators include: milk yield, body condition, and mating frequencies as well as general body weights. Adverse changes in these indicators would imply declining livelihoods. The decline would be reflected by corresponding changes in pasture conditions. The deductions are made two levels. Firstly, the herders by making inferences from livestock production performances would deduce that grazing conditions are deteriorating. If one of the options were to move the herds, this would normally be preceded by assessments of pasture conditions. Secondly, herders take the cue from condition of the forage at large scales, but for the fine tuned assessments, they would focus on availability of key forage species. Assessments at the two scales are done simultaneously by making inferences towards livestock grazing preferences and production performances.

For the herders, the relationships between plant production and livestock performances are inter-related. Range scientists by contrast applied stocking density by monitoring impacts on forage conditions and adjusting stocking rates accordingly. The type of plant-based indicators are scale dependent varied from small patches measured in $m^2$ to larger landscapes in $km^2$. Thus, taking into consideration the scaling effects, ecologists would understand the behaviour of ecological indicators by simulating management effects. For example, if the goal of the research is to understand how different systems of grazing management affect forage plants, ecologists by assessing indicator responses to varied grazing pressures would predict which of the species is more sensitive to grazing pressure and therefore reflect risks of over-utilization compared to tolerant species. Using the changes observed, more preferably over longer periods, ecologists can diagnose, plant species that are more sensitive to grazing under different management systems. The grazing sensitive species will decline or disappear, while the grazing tolerant species (or not grazed at all) would increase. Based on the interpretation, ecologists would draw inferences about impacts of livestock grazing on rangeland biodiversity. The information becomes the basis for making deductions on range condition (health) and directions of change (trends). The measurements imply that there are varied options for applying diagnostic indicators for making decision-making. Evaluation of the grazing lands using the type of plant-based indicators would need periodic adjustments of stocking density commensurate with seasonal variability. The herders in their indigenous range management precisely practice this approach.

### *3.2. Inferential anthropogenic indicators*

Anthropologic indicators are value laden implying that there are considerable differences of opinions on indicator outcomes (Oba et al. 2008a). The anthropogenic indicators are part of human-environmental history (NAS 2000) and are products of people's perceptions of local environments (Dale and Beyeler 2001). In contrast to ecological indicators that are mostly based on biophysical environment, anthropogenic indicators have both the component of ecology and production. The value of anthropogenic indicator is in their social acceptance related to human experiences (Shields et al. 2002). The types of indicators work in the inter-phase of environment and society, reflecting landscape potential, sensitivity to anthropogenic pressures and utility values. In reality, anthropogenic indicators are components of the pastoral production system. Whereas ecologists would use ecological indicators to understand conditions of pasture, the herders would assess grazing suitability (GS) for different livestock species during different seasons of grazing. Additionally, herders recognize other value-laden indicators related to landscape grazing potential (LGP). The potential is a relative measure of resilience of landscapes. The landscapes with low potential are vulnerable to heavy pressure (Oba et al. 2008a). The GS is plant based and would therefore reflect high spatial variability, while LGP is based on the physical environment and is expected to be stable. The interpretations should take into consideration that GS and LGP are measured on ordinal scales that reflects herders' values (this may be coded from low = 1, medium = 2 and high = 3). The implication being empirical relations between ordinal data and measured data need to be cautiously treated. The responses between the predictor and the response variable might merely indicate causal relations as opposed to reflecting effects of management. Thus, if the interest of management were to understand the association between changes in cover of invasive plant species and GS index, a negative correlation would suggest that the status of the rangelands is undesirable for purposes of livestock grazing (Sheuyange et al. 2005; Oba et al. 2008a), whereas lack of responses might imply that the relationships might not disclose strong natural associations. Ecologists would want to understand how indicator responses could be interpreted by taking into consideration different units of analysis. The ordinal-scaled indicators reflect relative levels of change that might reflect cultural values in terms of acceptance by the general public (Wascher et al. 1999) as opposed to being predictive.

### *3.3. Integration of indicators*

Indigenous range users by bridging ecological and anthropogenic indictors would develop diversified knowledge hitherto lacking in range science. One of the reasons that herders focused on key forage species is for their superior nutritive quality. Ecologists are also interested in the nutritive values of forage plants. The herders have ideas on preference by different livestock species (Kyagaba 2004). Ecologists would know the nutritional status of plants if they run laboratory analyses or observed livestock feeding followed by nutritional analysis (Walker et al. 1999). For the herders, the rangelands serve as a laboratory for developing knowledge for livestock feed preferences. The herders are aware that livestock grazing preferences are dynamic, changing with seasons or shifting with shifts in vegetation.

Ecologists are also interested in understanding livestock responses to shifts in vegetation but they would require repeated monitoring in order to understand the trends of vegetation, while herders are well equipped with historical knowledge from their past experiences (Roba and Oba 2008). Linking past changes with present land use responses is fundamental to understanding indigenous range management. As alluded to earlier, the indigenous system of landscape classification is based on the physical environment, with vegetation coming in the secondary position. Soil colour, suitability for placing pastoral camps and grazing by different livestock species makes an important base for making decisions in indigenous range management. Their decisions on what soils and plants to monitor are influenced by their utilities. For purposes of forage plants, the herders would reason that understanding the responses of a few key species provides a general overview of changes than focusing on the whole vegetation. Rangeland degradation according to herders might apply to one type of livestock species (browser or grazer) but not other species (Oba and Kaitira 2006).

Local community participation in monitoring indicators are linked to livestock management and therefore livelihoods (Roba and Oba in press; Barnard et al. 1999; Oba et al. 2008c). The approaches proposed combined the ecological and anthropogenic indicators (Krugmann 1996). At grass root levels, local herders might be interested in the values of biodiversity that has high utility than total plant species present. They would contribute to conservation of "good" as opposed to "bad" (e.g. invasive species) biodiversity (Oba et al. 2008b; Roba and Oba 2009; in press). The aim should be to work at the inter-phase of ecological and anthropogenic indicators (Ribaudo et al. 2001; Turker 1999). A better reason for integration is for understanding the functions of the resilient livelihood indicators.

### *3.4. Drought resilient Livelihood indicators*

Drought resilient livelihood indicators as used in this report will be defined as sources of life support system that pastoral households used for coping with droughts. The sources of livelihood may be of pastoral or non-pastoral origin. This would include income from livestock and livestock products and natural resources such as the consumed parts of plant biodiversity. The livelihood support social networks are used to share food with neighbours. Local customary institutions and household composition to mitigate drought induced livestock losses (Dovie et al. 2005; Davies and Bennet 2007).

The summary provided in Table 1 was used as a guide in the three case studies. The purpose here is to focus on societal perceptions of environmental and socio-economic indicators in relation to drought-induced changes in livelihood coping strategies. The interest was on attitudes and perceptions of the herding communities vis-à-vis causal relationships between environmental and livelihood indicators. For example, how the status of the environment influences livelihood coping strategies would of interest. For example, drought depending on level of risks (varied from low, moderate to high frequency) might have cascading effects on household livelihoods in terms of levels of livestock mortality. Loss of livestock would shift household wealth ranks and increase risks of poverty. Increasingly, the poor households are dropping out of pastoral system. Weakening of indigenous institutions would make households non-viable obliging them to seek alternative sources of livelihoods in urban environments. Under most severe droughts that devastated pastoral herds a substantial proportion of the population were uprooted from the pastoral system and settled in pre-urban environments to survive on food hand outs given by the aid agencies.

The threat to pastoral livelihood is accelerated by environmental changes that create shortages of grazing and water, triggering conflicts. Depending on the level of shortage, long distance walk to water weakens the livestock and particularly the most vulnerable species such as cattle are adversely affected (Oba 2001; Angassa and Oba 2007). Research may put to important use the comprehensive knowledge related to drought coping strategies (Oba 2001; Desta and Coppock 2004; Tache 2008; Angassa and Oba 2007). In the case study communities drought stresses are compounded by inter-ethnic conflicts or armed livestock rustling that undermined livelihood coping strategies (Getachew 2001; Unruh 2005; Mburu 2005; Mkutu 2007). The report uses theoretical and methodological frameworks for implementing integration of ecological and anthropogenic indicators for comprehending the complexities of indigenous range management.

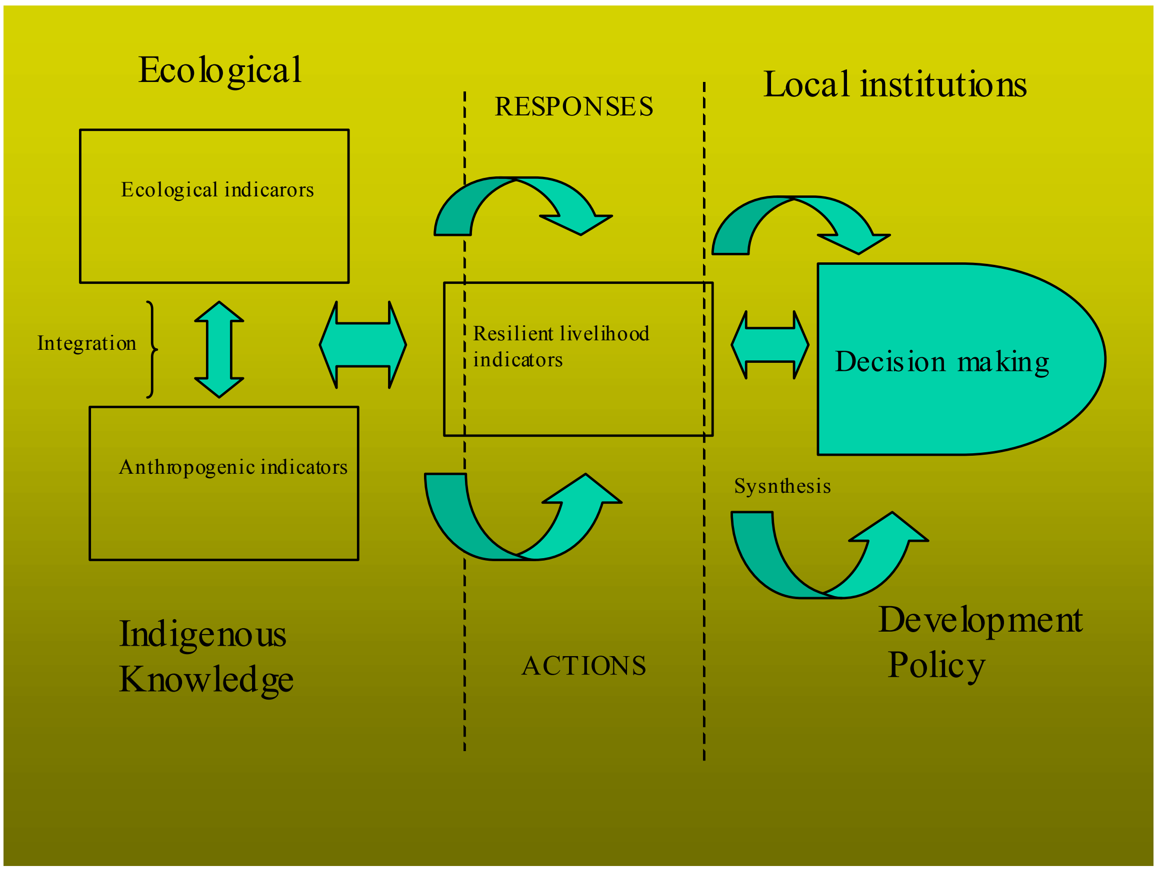
| Threats | Indicators | Impacts |
|---|---|---|
| Drought | High frequency | Increase in livestock mortality<br>Lower prices of stock<br>High grain prices<br>Increased dependency on food aid<br>Increased poverty<br>Urban migration and weakened social security institutions |
| Water | Sources dry up, available get crowded | Long distance walk to water<br>Livestock loses condition<br>Reduction in reproductive performance<br>High calf and lactating animal mortality<br>Migration into insecure areas<br>Increased conflict |
| Forage scarcity | Decline in quantity & quality | Livestock lose condition<br>Reduced reproductive performance<br>Migration to insecurity areas |
| Animal diseases | Increased incidence of external parasites, ticks and internal, worms<br>Absence of services | Increasing calf mortality<br>Animal reproductive performance declines<br>Marketing value reduced |
| Shrinking grazing lands | Fragmentation of grazing landscapes | Loss of key landscapes for grazing<br>Increased threats from alternative forms of land use |
| Agro-pastoralism | Crop cultivation | Increased competition over grazing lands<br>Increased risks during droughts |
| Vegetation cover | Over-grazed rangelands | Loss of forage species and increased threats of bush encroachment |
| Biodiversity | Key forage species decline or lost | Range grazing quality deteriorates |

**Table1. Drought threats to resilient livelihoods (Modified from Kassahun *et al.* 2008)**

## 4. Theoretical framework for applying indicators

*The integration of indicators has two important purposes. Firstly, the knowledge system would be essential for integrating the scientific and the indigenous knowledge for developing common methods for rangeland assessment and monitoring. Secondly, and most importantly, the integration is the basis for building common approaches to improving drought-resilient livelihoods. The integration would be achieved by identifying key building blocks of different knowledge systems: focusing on indicator selection, assessments and feedbacks. The integrated framework would support policies for promoting the indigenous range management and supporting drought- resilient livelihood strategies (Fig. 1).*

*Figure 1. Framework for integrated applications of indicators, decision-making and policy instruments for improving resilient livelihoods for drought management*



### *4.1. Integrated theoretical framework*

The framework is an attempt to bring into clarity how selected indicators can be used in the field and how the outcomes can be organized to influence policy and decision making by institutions that are concerned with the welfare of herders. At the same time, the framework achieves two additional goals. Firstly, it promotes integration of indigenous range management knowledge used by herders and the scientific methods used by range ecologists. Doing so will require training by both parties in order to produce information that meets production goals for improving resilient livelihood of the herders while at the same time presenting accessible packages of information to policy makers and non-academic development agents. It is also hoped that the framework would promote integration and produce more synthesized knowledge that the indigenous range managers would find more accessible through practical actions to tackle recurrent droughts. Finally, the aim of the integrated approach is to produce knowledge (theoretical and methodological), which would coincide with broader policy goals of WISP at regional levels and FAO at the global levels.

The framework is an attempt to simplify the arguments coherently from the perspectives of ecological and indigenous knowledge. Firstly, the framework provides practical ways by which various relationships between indicators, knowledge, livelihoods, management, decision-making and policy can be explained in a dynamic manner. The framework also offers an integrated approach for linking different processes in order to reach rational decisions at local and regional levels. Thus, the framework can be used to meet multiple goals for advocating sustainable environmental management (Tsing et al. 1999). The past approach was mostly on advocacy (e.g. Lado 2004), rather than creating integration of ecological methods and indigenous knowledge under varied ecological and cultural conditions (Oba et al. 2008a,b; Roba and Oba 2008, 2009).

The present framework offers a practical approach for additional reasons. Firstly, it adequately captures local knowledge systems, which are related to indigenous range management. Secondly, the framework could be used for identifying environmental problems that pose risks to pastoral livelihoods. Thirdly, the framework provides an excellent opportunity for testing varieties of indicators, which are suitable for assessing and monitoring environmental changes and for understanding threats posed to livelihoods. Fourthly, the framework provides opportunities for feedback between indicators, livelihood responses and institutions for decision-making. Fifthly, the feedback systems provide management decisions, deductions from outcomes and evaluation of performances of indicators (Roba and Oba 2008). Sixthly, the integration of the ecological and anthropogenic indicators requires continuous dialogue between ecologists and herders. Seventhly, the framework allows for parallel application of the indicators.

*The framework integrates different methods that utilize large body of scientific knowledge for improving indigenous rangeland management for promoting resilient livelihoods. The different bodies of scientific knowledge have not necessarily shared indicators for assessing and monitoring indigenous range management. Retrospectively, we have considered that anthropogenic indicators could be used to reconstruct long-term impacts on pastoral economy. Other methods (e.g. anthropological) provide understanding of institutional networks, resource sharing, while pastoral economic indicators can be used to predict interactions (correlative) between environment and livelihood diversification indicators (Ebei et al. 2008). The responses are in terms of management decisions by the herders, while at state levels the information is the basis for developing policies. Using the frameworks combines the work of ecologists and the herders for selection and application of indicators. It also provides opportunities for integrating different steps in integrating ecological and anthropogenic indicators using appropriate methodological framework.*

# 5. Developing methodological framework

*5.1. Rationalizing methodological framework*

*The pastoral communities in the three countries shared aspects of indigenous range management. Land use by livestock grazing uses mobility for exploiting seasonal grazing. Thus, mobility at different scales provides the framework for selecting and testing different ecological and anthropogenic indicators for evaluating responses to forage variability (Baker and Hoffman 2006). Fodder availability declines during the drought years and increase during the wet years. The fluctuations in fodder availability induce fluctuations in livestock body weights (Schareika 2001). Forage fluctuates reflects range condition dynamics. Ecologists and herders would consider presence of high herbaceous biomass and low invasive covers occur as indicators of favourable range condition.* [5] *However, when the majority of the indicators are unfavorable, rating reflect fair to poor conditions (Roba and Oba 2008).*

*The main concerns of range ecologists are that indigenous knowledge lacks standardization or it is biased as it lacks objectivity, which is necessary for validating hypothesis (Oba and Kotile 2001; Oba et al. 2008a,b; Oba and Kaitira 2006). In contrast to ecologists, herders treat landscapes as visual maps by disaggregating different patches and invoking history of land use using the soils and vegetation indicators. The landscapes vary in grazing suitability and landscape grazing potential. Using these indicators herders would then assess individual landscapes (Bauer 2009). The advantages of using anthropogenic indicators are that the herders are better able to gauge changes in livelihood indicators than relying on ecological indicators alone (Mapinduzi et al. 2003).*

*5.2. Building integrated environmental indicators*

Building integrated indicators should begin with the interviews of key informants-often knowledgeable elders selected from studied communities (see Figures 2, 3 and Table 2). As the initial step (see Figure 2) the interviews should build the composite lists of terms and concepts frequently used to describe changes in the environment that influenced herders' perceptions on livestock production performances and therefore impacts on household livelihoods. It is also through use of interviews that herder historical knowledge of environment reconstructed. This would include drought histories and different forms of threats to land use. Herder oral accounts are descriptive, adapting the cultural contexts of the stories told on changes in community perceptions of grazing lands and impacts of droughts. Herders using personalized knowledge would describe the impacts of droughts on forage availability. Historical reconstruction of land use change is based on herder memory against time lines of social institutions (age sets, yearly calendar, historical events including political perturbations) (Reid et al. 2000). Changes compared the present to the past knowledge in terms of qualitative and quantitative variations of vegetation cover and distinguishing invasive from non-invasive species (Roba and Oba 2008).

As the second step, the interviews should be followed by rapid surveys aimed at identifying and describing indicators and concepts used by the herders. Such surveys might include discussions with herders on indicator functions in relation to livestock production. The vegetation covers and forage species indicators would be applied at suitable scales (Helleir 1999; Coppolillo 2000). For example, if the goal of joint-ecological and indigenous knowledge surveys is to describe processes involved in rangeland degradation. The relative severity of land degradation can be related to herder landscape classifications (Oba and Kaitira 2006; Oba et al. 2008a). Herders would describe the processes relative to livestock grazing suitability and forage availability in relation to grazing preferences and availability of forage species (Oba and Kaitira 2006). Based on soils and vegetation indicators the grazing suitability (GS) and landscape grazing potential can be assessed. Plant and soil indicators and the corresponding livestock production performances influenced herder decisions. Thus, when considering soil classification herders would group them by color,

[5] Conventionally, range condition is rated on scales varying from excellent (when all indicators are favorable, good (when most of the indicators are favorable), fair (when only few of the indicators were favorable) and poor (when all indicators were unfavorable).

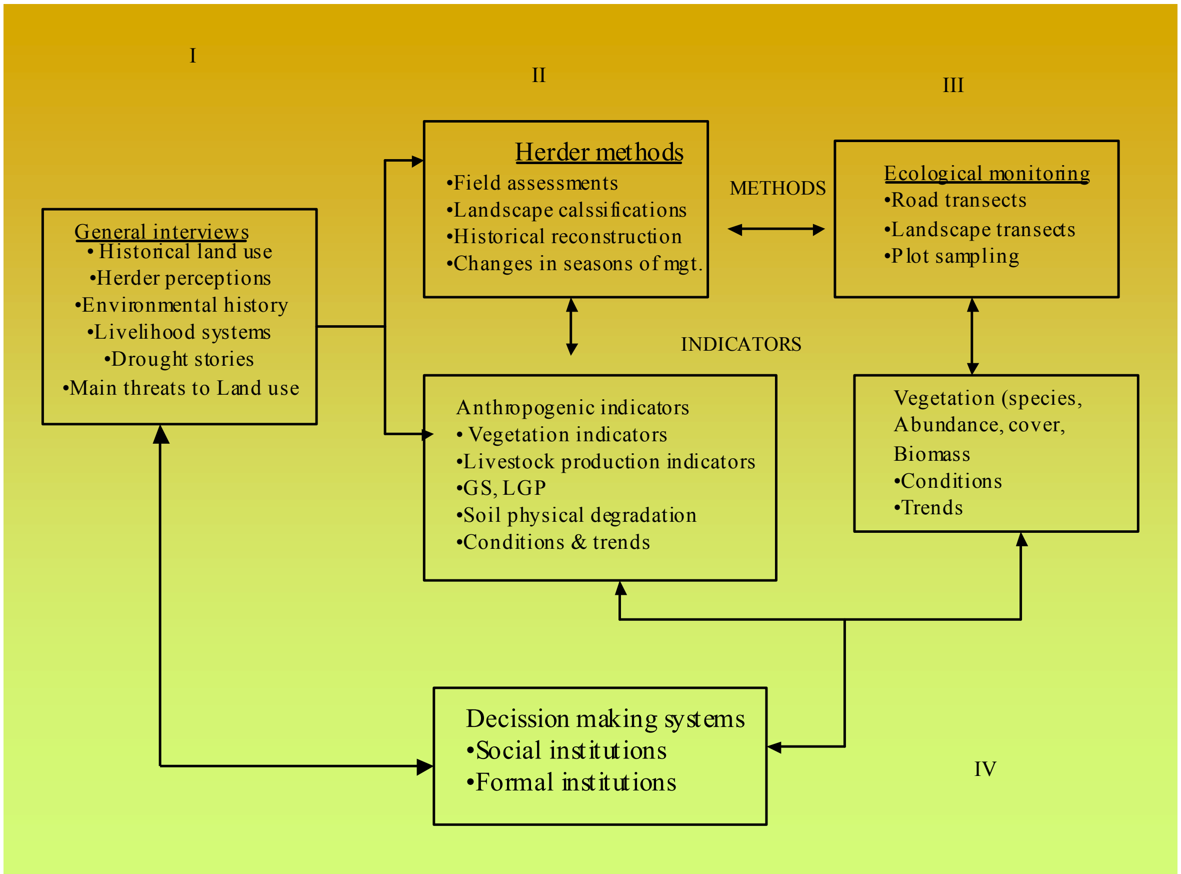
texture or "temperature". Each type of livestock species might prefer different soil types and conditions. Camel herders would prefer some soil types, while cattle and small stock prefer others. This is reflected by livestock gazing distribution (Oba and Kaitira 2006; Roba and Oba 2009; Stave et al. 2001; Oba and Kaitira 2006). Herders would also determine landscape degradation in terms of disappearance of key forage species as well as conditions of the cover. In most cases, herder narratives of environmental change might imply that the changes have adverse impacts on livelihoods. The narratives provide the perspectives of local conditions inferred from past herding experiences (Roba and Oba 2008). Also noticeable from herder narratives is that the changes are not uniform across landscapes but some landscapes are more vulnerable than others (Oba et al. 2000; Oba and Kotile 2001; Bollig 2006; Roba and Oba, 2008, 2009). From the changes herders would deduce the status of range condition and trends. Herders by comparison, are knowledgeable in vernacular taxonomy being able to identify plant species even without aid of floral parts, which ecologists seldom achieve. Furthermore, herders understand different uses of plant species varied from grazing suitability, medicinal, rituals, and food, making utensils and for building materials (Stave et al. 2007). Using the type of knowledge herders would reconstruct environmental changes.

In the third step ecologists would use road transect and landscape transects to assess changes in vegetation indicators. From the changes range indicators could be built, while the trends would be based on herder historical knowledge. Ecologists should learn to incorporate the different indicators and evaluate their performances (Mapinduzi et al. 2003). The pre-condition of integrating ecological and anthropogenic indicators is participatory assessments (Shanley and Rodrigues Gaia 2002). Ecologists should be able to systematically collect field data, conduct analysis and interpret the data. Descriptions of the methods for building integrated indicators should combine the ecological and indigenous knowledge. The descriptions are necessary if researchers working in different environments are to compare the methods (Yoccoz et al. 2001). Range ecologists working in unfamiliar environments are often ill equipped to recognize forage plant specimens. The fourth step should lead to decision making as well as sharing information (Figure 2).

*5.3. Building livelihood indicators*

Our definition of livelihood indicators is a modification from Ginguld et al. (1997:577) which denotes "livelihood strategies" as varieties of activities undertaken by a particular household in order to secure its economic well-being and, specifically, its long-term survival" (see earlier partial definition). In the present report we have used the definition more widely to capture diverse processes involved in environmental-pastoral production relationships. Livelihood indicators disclose the sum total of all the indicators related to pastoral production. It has components of the environment in relation to ecological and anthropogenic indicators as well as household production indicators and social network indicators. This means that the different indicators function in holistic form. For example, livestock productivity and how it is affected by frequent droughts is central to understanding the rationale of herder coping strategies. The indicators also reflect the relationships between changes in livestock numbers and human needs. Livestock is the means for building social networks and redistribution of food from household to another. Shifts in livestock populations in relation to human dependants (livestock per capita) are used as an index of self-sufficiency as well as measuring poverty. Droughts weaken social institutions, increasing risks of livelihoods. The rates of recovery of the herds and therefore improvements of household livelihood would take long time forcing households to diversify livelihoods (Oba 2001; Msangi 2004). The economic and social contexts of risks of drought are greater where the overall susceptibility is due to weak institutions, risky environment and weak or non-existent policy for protecting pastoral assets. Researchers should take advantage of the indigenous knowledge for reconstructing past livelihood changes in terms of historical patterns of rainfall, droughts and famine (Angassa and Oba 2007; Oba 2001; Bollig 2006; Tache Dida 2008). The present report due to limited time in the field concentrated on general information related to society wide livelihood coping strategies as opposed to household level livelihood coping strategies.

*Figure 2. Schematic framework for integrating indigenous knowledge and ecological methods and decision systems, represented by I, II, III & IV, which are the different general steps used in information transfer systems*



### *5.4. Information transfer system*

*The methodological framework is the basis for information transfer. Methods of information transfer between herder scouts and ecologists were investigated, providing details for possible replications of the methods (Table 2). The indigenous and ecological methods are implemented concurrently. The different steps are for integrating data collection, recording and data interpretation. For practical reasons, the surveys were used for information transfer between herders and the author. The interviews were located at community levels as well as in the field. The general interview provided an overview of the whole situation of range management and problems of livelihoods for coping with drought as experienced by the case study communities. The field interviews were necessary for making clarification of the terms and concepts but more importantly for developing the joint survey protocols as well as understanding symbolic terms used by the herders (Roba and Oba 2008). It is also at this stage of the survey that the terms related to grazing suitability and landscapes grazing potential or comparable terms were defined. For the present work, motor road transects were used. For each selected landscapes along the road transects, detailed examination of ecological and anthropogenic indicators were assessed using the steps described by Figures 2 and 3. The most important step in information transfer is landscape classification. The classification can be at geographical or local landscape scales. The geographical scale describes resources in accordance with agro-ecological zones. The indicators for landscape classifications are sketched in Figure 3. These are combined with the detailed descriptions of the steps developed in Table 2. The field surveys in the three study communities followed the steps 1-7 in Table 2. The remaining steps required more time and were therefore not evaluated by the present survey.*

**Figure 3. Indigenous knowledge systems of landscape classification**

**Landscape classification**

- Landscape taxonomic classification-main indicators
- Geographical
- Cultural
- Names are monomial or binomial descriptions
- Soil characteristics and their inferences for pastoral land use
- Degradation vulnerability
- Grazing suitability
- Landscape grazing potential
- Vegetation history
- Key or non-key resources
- Key forage species and their trends and reasons
- Changes in seasonal grazing patterns-ecological vs. other explanations
- Decision making parameters

*Table 2. Methods for rangeland assessments using ecological and anthropogenic indicators (modified from Oba et al. 2008a: 71)*

| Steps Description |
|---|
| 1. Select study community (pastoral/agro-pastoral) where the functions of indigenous range management knowledge need to be evaluated using the Framework given in Figure 1. Conduct initial discussions with key informants. Most knowledgeable individuals can be identified with help of the community (Go to 2) |
| 2. Conduct group discussions with range scouts about traditional systems of range management in general, range classifications, assessments and monitoring and knowledge of resilient livelihood strategies for coping with droughts. Compile key words and concepts and the indicators that are frequently used. The information reflects the regional scales. Given that at this stage most knowledgeable traditional scouts can be identified (then return to 1 for final selection of the survey team and proceed to 3) |
| 3. Conduct preliminary field survey and go through the procedures of data collection at landscape patch scales. Identify indicators used by traditional range scouts. Revise data format by displaying key indicators for repeated measurements (Go to 4) |
| 4. Start the field survey-using road transects (and "landscape walk"). Explain the objective of the survey. Identify and discuss concepts and indicators that are used in the assessments. Given that there are different scales involved when making the surveys, the scouts should be informed to scale-down using traditional methods. The scales of measurement should be plots, patches and landscapes (Go to 5) |
| 5. Describe landscape categories. Identify soils and vegetation types, each described by herder scouts and ecologists. Terminologies used to be agreed on; usually landscape names used by herders should be selected. Both the scouts and ecologists describe the biophysical characteristics of each landscape patch and the key forage species. Historical vegetation changes to be reconstructed by herders and seasons of grazing described by them. Location of sampling stations selected and geo-referenced using GPS (Global Positioning System) if available and general land use described (Go to 6) |
| 6. Allow the scouts to conduct assessments. By discussing the problems of the range, they reach consensus. The scouts describe livestock grazing suitability, landscape grazing potential, threats of degradation, loss of key forage species; specify season of livestock grazing that are most preferred (i.e. wet, dry or drought years) (Go to 7) |
| 7. Ecologists and herder scouts jointly describe range conditions, while the scouts describe trends (Go to 8) |
| 8. For the same patch conduct ecological assessments (using plots).[6] Plant species in the plots to be identified by herder scouts (deposit voucher samples in National Herbaria). Ecologists and herder scouts count the number of species. Ecologist to estimate standing biomass, bare ground, invasive species, grazing pressure and degradation threats using nested plots; [(1 x1 m plots for sampling herbaceous vegetation, 2 x 2 m plots for sampling shrubs and 25 x 25 m plots used for sampling tree species)]. Allow herder scouts to describe trends of individual species and condition and trends (Go to 9) |
| 9. Return to Step 5 to repeat the survey at new stops in the road transect (and return to 1 to start with a new study community) |

*Steps 1-3* The goal is to have an overview of indigenous range management used by the selected communities. The discussion should provide general information about the geographical and ecological divisions of the grazing lands in the past and present. The description of ecological zones and the historical patterns of land use, the causes of change and impacts on livestock production would be the basis for all other analysis. At a more local level, herder systems of landscape classification and resource partition between different seasons of grazing and the rationale of such management need to be understood. The general discussion session should cover risks to pastoral livelihood strategies. It is also at this point that drought management; risks from ethnic conflicts, impacts of development and the role played by government policies in influencing indigenous range management may be discussed.

*Steps 4-6* In the joint field surveys that cover large geographical areas, the most ideal method is the use of road transects. Vehicle odometer is used to mark sampling intervals with rural roads serving as transects. Depending on the size of the area covered, the intervals of sampling can be set at 2, 5, 10 or more

[6] For the present study only steps 1-7 were implemented due to time limitations.

appropriate distance intervals. Each subsequent stop should be on different sides of the road. Sampling should be conducted about 200 m from the roads in the selected landscapes to avoid “road effects”. At this distance another 100 m transect is paced or estimated. The herder range scouts are requested to downscale and conduct traditional assessments at landscape patch scales. Using anthropogenic indicators the herder scouts would discuss and provide the ratings for grazing suitability (GS) for different livestock species and assess landscape grazing potential (LGP). In evaluating the anthropogenic indicators herder scouts would scale the GS and LGP indices. These values are relative to the livestock species being grazed. Hence, a given landscape may have high LGP for camels but might have low for cattle and vice-versa. Conversely, GS would vary for different species as well as varying in time. GS reflects the status of forage as opposed to the potential. Thus, the same landscape might present different value ratings during different seasons depending on forage condition. Key landscapes would meet the needs of all livestock species.

The herder scouts could also attempt to assess the current grazing pressure (as non, low, moderate, heavy and very heavy). The levels are dependent on multiple-indicators including: levels of plant utilization (non-moderate, heavy or very heavy), density of hoof tracks (non, moderate to numerous), density of faecal deposits (low, moderate to high) and density of present and previous human settlements (none to dense). The herders should also be asked to describe degradation vulnerability in terms of vegetation and surface soils. The impacts on vegetation cover from grass dominated to invasive species cover dominated on range condition and trends need to be discussed. In describing key forage species for each landscape, the herder scouts would indicate which landscapes are most threatened and which are not. Key forage species for each landscape should be described. For each landscape surveyed, herder scouts should be able to rate risks of land degradation (Oba et al. 2008a).

*Steps 7-8* The steps integrate the ecological and anthropogenic indicators. Ecologists conduct measurements at the plot scales while the herder scouts conduct the assessments at landscape patch scales within which the plots are nested. The ecological indicators capture the present conditions of the rangelands, while the anthropogenic indicators would inform on trends. Furthermore, in defining range condition, herders and ecologists might be using different concepts. Ecologists use the present ecological indicators to gauge range condition, while for the herders, range condition is not a single measurement; rather, they use value-weighted criteria (termed as highly desirable, moderately desirable, desirable and undesirable) for each patch. Thus, landscapes with non-or low invasive species, high grass cover, presence of all key forage species would receive high condition ratings as opposed to landscape patches where the invasive species have replaced key forage species, or the areas being severely degraded. Ecologists might in turn be interested in the status of biodiversity (in terms of species richness, plant cover, biomass etc.) at landscape scale. In so doing they would be able to tests if differences between landscapes can be expressed in terms of their biological productivity and therefore conservation value (Oba et al. 2008b). For each plant species sampled herders are able to place them on livestock grazing preference index, which varies from one species to another (the preferences may be coded as 1,2,3…4 for goats and in a different order for cattle or camels). For all sampled plants, herders can also use their historical knowledge to describe trends (i.e. increasing, decreasing and stable). Figure 3 is the visual representation of the implementation protocol for the field surveys conducted in the selected three study sites. The step-wise (1-7) in Table 2 was tested in the study sites in Kenya, Ethiopia and Uganda.

The remaining sections of the report presents brief background to the country case studies followed by the case studies in Kenya, Ethiopia and Uganda respectively. The final section of the report presents a synthesis of the lessons for knowledge transfer and policy application and future research implications.

*6. Background to the country case studies*

There are socio-political and ecological factors that are shared by the three case study communities as well as differences. The present report focused on the indigenous range management knowledge related to the selection and applications of ecological and anthropological indicators for promoting drought-resilient livelihood strategies and decision-making. The three pastoral communities inhabit a highly diverse environments varied from arid to semi arid (Orma and Karamojong) and arid and very arid (the Afar). In each site, historical socio-political and environmental drivers interacting across space and time created environmental adaptations. The systems of resource distribution influenced the communities grazing patterns at geographical and local scales. The effectiveness of the indigenous systems of range management is influenced not only by the diversity of rangelands but also the diversity of social institutions that are responsible for regulating resource use. The patterns of regional and local grazing resource use have been hugely transformed by external political and development factors. In all the three communities, common ecological and anthropogenic indicators were applied. Table 3 summaries the basis of indicator comparisons.

Table 3. Comparisons of indicator selections for the three sites

| Indicator selection | Orma | Afar | Karamojong |
|---|---|---|---|
| Landscape | + | + | + |
| Soils | + | + | + |
| Vegetation | + | + | + |
| Topography | + | + | + |
| Key livestock | Cattle | Camel | Cattle |
| Seasons of grazing | + | + | + |
| Key resources | + | + | + |
| Mobility | + | + | + |
| Home gardens | | | + |
| Livelihood | + | + | + |
| Social institutions | + | + | + |
| Land use conflict | + | + | |
| Armed conflicts[7] | + | + | + |

*The case studies were used to test the theoretical framework given in Figure 1 and methodological framework in Figure 2 following the steps in Tables 1 & 2. The objectives of the surveys were explained to the key informants and the traditional scouts who were selected by the community to assist the author. Interviews were conducted with key informants on general indigenous knowledge including grazing systems at regional and local scales, seasons of grazing and how these traditional strategies were used to cope with droughts and changes in livelihoods. The key informants described systems of rangeland classifications, indicators used for livestock production performances, historical and social reconstruction of environmental change using the road transects (see Figure 3 and Table 2). Due to brief periods, only limited numbers of indicators related to landscape classification, grazing suitability, landscape potential, threats of degradation; range condition and trends were assessed.*

*Drought-resilient livelihood coping strategies were discussed following the structure given in Table 1. Indigenous knowledge of drought and traditional systems of coping were discussed with key informants. Where the communities showed such knowledge, drought histories were reconstructed and survival strategies discussed. The drought coping strategies were related to regional and local systems of grazing and how external interventions alienated key resources in terms of changes in resource tenure affecting the coping strategies of the herders. Additionally, development projects and Non-Government organizations working with the three pastoral communities were interviewed in order to understand the impacts of*

[7] This indicator is not the subject of the present study but is mentioned to show the important role it plays in influencing indigenous range management in the three sites.

*development interventions on the traditional system of range management. Impacts of external interventions on environmental changes in terms of altered tenure regimes and expansion of invasive species were also discussed. In the fourth section, discussions with key informants highlighted systems of indigenous institutions for the application of indicators, social security networks for promoting drought-resilient livelihood strategies. Among the surveyed communities, the Orma shared comparable development profile with the Afar in Ethiopia. The two sites in turn shared the profile of resource conflicts with the Karamojong in Uganda.*

# 7. Kenya: The Orma indigenous range management knowledge

*The Orma, traditionally had access to one of the richest grazing lands in East Africa. There were historical contacts with coastal trade going back to the Portuguese occupation of East Coast of Africa in the 1500s. The Orma historically had occupied both the Tana and the trans-Juba region of the present day Lower Juba of Somalia. From the latter region the Orma were conquered and enslaved by the Darood and the Hawiya Somalis in the mid nineteenth century.*

The remnants Orma from the mid-nineteenth century were confined to the Tana River. Other pastoral groups found in the region are the Somali clans from Wajir, the Garissa and the Dujis Districts. Continued infiltration by Somali clans from southern Somalia after the fall of the Government of Siad Barre in 1991 contributed to an increase in the pastoral herd population in the district. Also, present are the Wardeh, who claim ancestral Oromo, but being part of the population that was historically captured and assimilated by the Darood Somali clans of Mohamed Zubeir, Abd Wak, Abdalla and Aaulihan to which the different Wardeh families are linked. The district also has other indigenous populations of farmers and hunter and gathers mostly found along the Tana River and the Tana delta. These included Munyo Yaya, Wata, Malakote and Pokomo among other groups.

Whereas land use by the Orma remains pastoral, the district has attracted large-scale experimentation with irrigated agriculture comprising the Bura and Galole schemes and other smaller schemes in the delta region where rice and cotton were tried. The schemes established between the late 1970s and early 1980s attracted huge agricultural populations from the rest of the farming communities of Kenya. The schemes have taken out huge chunks of the grazing lands of the Orma. Also, curved out of the grazing lands are the prime rangelands of the Tsavo National Park and the Galana ranches and the Kora national Reserve. Presently, the *chaaffa* (delta) is being proposed for large-scale sugar cane plantations for fuel production.

The district has favourable climate and droughts in the past was far in between. The Orma communities interviewed in the present study would only remember few facts about historical droughts. They rather mention extended dry stresses (*boona dheera*). The key grazing resources in the district is the floodplains of the Tana River and other seasonal *laaga* (dry streams) served as fallback during periods of stress. Clearly, the most important grazing resource in the District is the Tana River delta (*Chaaffa*). In the drier areas the grazing lands are served by local wells and surface dams (natural and human made) that created mosaics of overlapping grazing resources around which systems of land use through livestock mobility evolved over periods of several centuries. The other threats are conflicts over the grazing lands between the Orma and the immigrant Somali clans from the neighbouring districts that in the process disrupted the traditional patterns of livestock grazing. The present report will highlight the latter problem only in so far as it influences grazing systems and the Orma's failure to adjust to environmental stress. The immediate impression made during the survey period was that the Bura – Hola district had been heavily overstocked and overgrazed. The greatest threats are from the expanding invasive *Prosopis juliflora* apparently introduced through forestation programs. The species presently covers 20-30% of the grazing lands in the lower Tana, where it has eliminated grass growth.

### *7.1. The broader scale grazing system*

Indigenous knowledge of the environment including historical and social reconstruction of environmental change, livelihood systems, droughts and their coping strategies were identified using interviews with key elderly informants. The author had the opportunity to interview most knowledgeable elders. The representative of the arid lands Program and the Peace Committee in the District were interviewed to understand the forms of interventions for maintaining resilient livelihoods. The interviewed elders were between the ages 50- 80 years. Interviews were also conducted at community self-help training involving the communities of Bura and the surrounding areas. The institution dealing with traditional resource management called *Mata d'eedha* was identified and the representative elders from two grazing zones interviewed. Additionally, with the help of traditional range scouts, surveys of the grazing lands were conducted along 150 km road transects and the methods described earlier were tested for selecting and applying ecological and anthropological indicators.

*The Orma oral history is sketchy and their environment least understood. It is for this reason that this report has used both the general viewpoints and specific indigenous knowledge. The Orma indigenous knowledge is built around grazing lands and cattle management. The concept of land ownership has two perspectives: property rights and the rains. The property right of the land is vested with the whole community but according to the Orma tradition the care takers are the Irdida (the first half of the Orma moiety) who are referred to as uta laaficha (the owners of the land) and the Bareytuma (the second half of the moiety) as rainmakers. The Orma had expansive grazing lands on which they developed special breed of cattle mostly of white color selected for their resistance to tsetse flies.*

*Their systems of grazing at the broader scales combined key grazing resources divided into four grazing associations (mata d'eedha).*[8] *Each d'eedha formed mosaics of grazing resources of different quality, which allowed the Orma to establish access through mutual grazing associations. The Orma described the grazing associations comprising the four rivers (or streams).*[9] *Within individual grazing associations were grazing landscapes that were allocated to the wet, the dry and drought grazing. The wet season grazing landscapes were visited during the rainy season when the rain pools (hoora) are filled with water. As soon as the rain pools were exhausted the communities returned to their traditional dry season grazing lands: these being the river floodplain and the delta. The grazing resource that the Orma considered as key for their survival is the chaffa system. The Orma elders were of the view that the loss of access to the Tana River Delta for any reason would destabilize the pastoral production. One of the informants emphasized the importance of the delta to pastoral grazing in the following words: "The chaffa of Tana is not just grazing land for cattle, it is a symbol of our survival…" During the field survey, the greater proportion of the livestock from the neighboring districts and Tana River had moved into this critically important grazing reserve.*

The Orma informants suggested that their systems of range management were built on conservation of grazing lands-albeit not in any prescriptive sense of the word but through rotational grazing between seasonal grazing landscapes. They achieved this by regulating grazing livestock movements between different *d'eedha* associations during seasons of grazing. Access to the river floodplain and the delta are socially negotiated with other groups through ritual performance. The Orma believed that the grazing resources of the floodplain and access to the river crossings (*maalka*) belonged to different user groups. The rivers belonged to the Riverine groups (i.e. Malakote, Munyo Yaya and Pokomo), while the crossings (*maalka*) belonged to the Orma. The riverine environment harbors crocodiles and tsetse flies that would endanger the livestock. There are cultural beliefs that the Munyo Yaya, Malakote and Pokomo possessed ritual powers that controlled crocodiles and the tsetse from harming cattle and people. Thus, before the livestock returns to the floodplain, the elders from both sides would meet and exchange rituals items and shared the food they produced. The livestock when they arrive at the river crossings according to an informant "…must be blessed… in exchange for milk and meat of the slaughtered bulls, while they [riverine groups] in return provided food from their farms". [10] The sharing of food is called *giifu*.[11]

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[8] The four d'eedha included Kora-Bura, Galole-Hola and Waldena and the river delta (*chaffa*). The term *chaafa* also apply to the river floodplain pastures.

[9] These are Galole (delta), Hirman and the Tula (the well zones)

[10] Elaborate prayers described the rituals. As the cattle approached the river crossing, the elders from Orma and the riverine group would stand on the windward side and remain silent. The Pokomo elders would scoop the muddy water in their mouths and spray it on cattle followed by a prayer. The prayer reads: "*Olfoola, olfoola (*the rough translation of which is be saved, be saved…) flies will not bite you, crocodiles will not harm you (*baarbaa, baarbaa, kaana nagaya taa*"-multiply and stay in peace). The belief is that the Pokomo and the Munyo Yaya are able to "order" crocodiles and tsetse from harming the cattle. The Pokomo in particular are feared for possessing powerful ritual powers, which if ignored would bring disaster on the Orma cattle. The shared rituals create social networks and political alliances by the communities sharing the river.

[11] Social networks come with rights that members may demand when needed.

As soon as the rains return, the grazing of the floodplain is terminated and the population returns to the wet season grazing. However, when the dry stress is extended and the river pastures were exhausted, the cattle camps were moved out to the dry season grazing areas from where the livestock walked to the river for watering. The Orma watered cattle at intervals of two-days and watering on the third day. The second alternative is for the households to return to the wells. The specific clans of the Orma excavated the wells. The families that initiated the digging of the wells claimed property rights (*konfi*). These rights were passed from generation to another. All the wells have names that either reflects the ancestral owners or the biophysical features such as tree species (*Eil Roqaa*). Conflict over wells by the Orma clans is very rare. The informants claimed that the wells would stop yielding if heir property rights were disputed.[12] The Orma symbolically compared wells (springs of water) with the semen (spring of fertility) of the breeding bulls. Neighbors shared both "springs". Thus, wells, though private property is considered a public resource managed for the welfare of the society.

The indigenous range management among the Orma is a social as well as environmental construct. The livestock is the medium through which the Orma express values of grazing lands; expressed in folklore through which information about the past environment and present are communicated. The cattle folklore called *darma* describes, livestock watering, grazing movements and coping with environmental stresses. Each song is the means of communicating how the livestock respond to changing environmental conditions. The expression that "this or that grazing land has *darma*" implies grazing suitability for the specific species of livestock. An area that fails to catch the attention of the composers' *darma* were claimed to be unsuited while the key resources including wells have verses. Thus *darma* is the cultural mechanism of communication of indigenous range management and landscape grazing suitability.

### *7.2. Indigenous range management at the fine scale*

At the landscape scale the Orma indigenous knowledge of range management is in terms of the types of soils and vegetation. The grazing landscapes are characterized by different soils and vegetation. The Orma categorized the grazing landscapes into different livestock grazing suitability classes (low, medium and high) during different seasons. These are expressed to reflect the potential of the land. Symbolically these are described as the "hump" (*dhaallu*) and the breast or rump (*andaaraaf*) of cattle, which are claimed to be of high quality-fatty meat. In a similar manner, the grazing lands with *dhaallu* and *andaaraaf* equivalents are most preferred for grazing. This would be their inference of the key and non-key grazing lands. For example, the Orma do not prefer to graze livestock in landscapes with red soils (*wayaama*) during the dry season. They prefer white-gray (*omaar*) soils to the red *wayaama* soils preferred for the wet season grazing. The forage of the red soils grows rapidly after the early rains. The livestock that grazed them are claimed to recover rapidly from the weakness of the dry season. The *omaar* landscapes and its vegetation are claimed to be highly nutritious and the livestock that grazed them would not lose body conditions even during stress periods. Conversely, the livestock grazed in the red *wayaama* soils would suffer loss of weight. The characteristic feature of the red soil is dusty condition, which the Orma consider as unsuitable for cattle management. They claim that the cattle grazed in the red soils during the dry season breath in dust, which is harmful to animal health. Under similar dry season herders would prefer to graze in the *omaar* landscapes. The herders would acknowledge that the livestock grazed in the *omaar* landscapes might be leaner but stronger than those grazed in other landscape types. Thus, given choices, the Orma herders would utilize dry season grazing in the *omaar* landscape followed by the floodplain and the delta landscapes. The black soil (*Kooticha*) is suited for wet season grazing. The Orma perceived that the *kooticha* landscapes are unsuitable for placing pastoral settlements. The soils are claimed to be "cold" during the night and the livestock kraaled in them would lose body condition rapidly. According to the informants, the soil conditions were not permanent but changed from time to time. Herders after night camping would examine the preference in terms of changes in livestock behavior. Landscapes where livestock become restless

[12] The Orma would generally oppose any unlawful claims to wells' property rights because of the belief that wells are "holy places". After their conversion to Islam, these views are not widely expressed publically but some informants mentioned that the Orma have such believes.

during the night and the body conditions rapidly declined were unsuitable. Herders would move the camps sometimes-for short distances only.

From wide ranging discussions with the Orma herders, soil is the main indicator influencing indigenous range management. The production and reproductive performances of cattle are reflected by soil conditions. The grazing landscapes were therefore grouped into those suitable for grazing and those not suited. The landscapes with soils with favorable livestock conditions during the dry and the wet season were claimed to posses an inherent property referred to as *geebiba*. The herders perceived that the *kooticha* (black soil) lacked *geebiba*. The indicators for the deficiency are types of forage that the herders claimed to be of low nutritive quality. There is more roughage than nutritive species. The herders used two types of indicators to determine the low quality of forage and unsuitability of the forage in the black-*kooticha* soil. Firstly, the cattle grazed in the *Kooticha* soils have enlarged rumen, which is an indication of poor forage nutritive quality. Secondly, the herders perceived that the cattle grazed in the *Kooticha* deposited large pats as indicators of poor forage quality. From this evidence the Orma acknowledged that livestock would lose body condition in unfavorable soils and gain more weight and improved reproductive performances in more preferred soils.

As part of the same knowledge the Orma herders also perceived that the suitability would vary with the two species of livestock (i.e. cattle and small stock) they managed. For cattle, the *omaar* soils are most suitable, while for the small stock the *wayaama* are better suited. The latter soil type is associated with browse plants, which are preferred by goats. Presence of *Cordia* species (*madheera itile qaaya*) reflects *geebiba* soils of the *omaara* landscapes. The herders would test the soil by poking the surface with sharp sticks to determine the extent of the gray-white soils. If the layer of the red *wayaama* soils were found near the surface, the camp would be moved. The most reliable indicator used is the presence of *Cordia* species, which are absent from the red *wayaama* landscapes. The Orma do not prefer mixed soils of *omaar* and *wayaama* for livestock grazing. They refer to such soils as *omaar ufte baaru* (the spotted *omaar* soils). The sandy *ramata* landscapes, which tend to form piles of soils due to soil movements, were also not preferred for placing pastoral settlements. The implication being that the herders at any one time would utilize different landscape patches for the management of different livestock species (*section 8*.3 for more details).

Livestock grazing at landscape scale is based on extensive surveying and assessments of range indicators (see also section 8.3). The range scouts (*abuuru*) usually young experienced herders are sent out by the elders to conduct assessments for rainfall and range conditions. The range scouting is conducted soon after the initial rains. The initial goal is to examine the distribution of rainfall, the quantities of surface water in the natural pools and the conditions of forage. There are different types of rainfall showers recognized by the Orma. The isolated light showers (*koono*) would create patchy grazing. The water available would support grazing for only short duration. Unless the heavier rains return, the *abuuru* would not recommend moving the livestock to new areas. The heavier or k*omorene* rains would be heavy and better distributed. Such rains would fill up natural pools that vary from simple depressions (*chiita*) to the ponds of different types (*hoora* pl.). If the water in the different rain pools were found sufficient, the range scouts would then survey forage conditions. The most important assessments are that of determining potential stocking commensurate with the available water and grazing for a given period.

The Orma recognized three types of pasture conditions resulting from different types of rainfall showers. The *koono* showers that fall in the dry season might initiate browse regeneration but would be insufficient to induce the growth of grass and therefore would not be the reason for migration. The second type is where the rainfall is heavy and induces pasture growth. The regenerating vegetation and the rain pools would be attractive for recommending livestock migration if other conditions are equally acceptable (see below). The third series of indicators are conditions of the livestock already present in the surveyed rangelands. The range scouts would assess the composition and texture of the cattle pats. The inference is that the grazing landscapes where cattle dropped large pats are said to lack *fiina.*[13] The *abuuru* would also

[13] This is some undefined property in the range that sums up all the conditions of the livestock. *Fiina* as indicator has spatial and temporal variability. Grazing lands that might have sufficient forage production

closely examine the body condition and the behavior of livestock present. The playful behavior of cattle, increased bull activities, cattle-night "sleeping" (*chiisa*) for long periods and chewing curd, full rumen and "polished" body hair are indicators disclosing favorable conditions. The *abuuru* would also assess settlement landscapes. Every landscape that is surveyed has history of settlements and decisions would be based on past experiences. If the places visited were new to the *abuuru* they would not be satisfied with environmental indicators until they poked the soil surface with sticks to assess the soil indicators. The soil types are the most reliable indicators for locating settlements. For the reason, settlement sites are carefully selected. Dusty soils would not be preferred for cattle kraaling.[14]

Livestock grazing might be constrained by the presence of tsetse flies that transmit a depleting disease. The riverine grazing landscapes harbor the tsetse flies. Theses landscapes were used only during the dry season, when tree foliage drops. The Orma perceived that when undergrowth and the canopy opened up the habitat of the tsetse fly would shrink and the grazing become possible. In the areas such as the delta known to harbor mosquitoes and flies that bite cattle, the Orma burn the dry cattle dung to create smoke screen for repelling mosquitoes. The *abuuru* would return with these comprehensive assessments and transfer the information to the elders. Given that the spatial grazing resources are historically known, the assessment geographically locates each grazing resources when presenting the information to the elders. The elders would evaluate the information by asking questions related to water availability, the pasture conditions, the existing stocking, numbers of settlements and the reproductive performances of cattle already present in the area. Based on the information, the elders would recommend the moving of the dry herds (*foora*) or if unsatisfied order the repeating of the surveys.

Whereas the principles of indigenous range management have been unaltered in terms of indicators for assessments and decision-makings, the Orma informants were of the view that their grazing patterns had been disrupted by increased immigration of other pastoralists from the neighboring districts. The immigrant herders ignored the traditional system of grazing and decisions made by the Orma herders. The immigrant herders grazed the areas reserved for the dry season grazing during the wet season when such rangelands would be rested. Consequently, the guideline for grazing (see later sections) is ignored. This has resulted in overstocking of the rangelands. The dry season grazing landscapes were overgrazed due to changes in seasonal grazing patterns. According to the Orma informants, environmental degradation changed the quality of the rangelands but it did not change the indicators of the soil. The changes were in terms of vegetation indicators. The Orma herders claimed that the key grass species were declining in the grazing landscapes invaded by *Prosopis* species. They claimed that the seedpods of the species were dispersed in cattle pats from which the species regenerate. Huge areas of grazing lands in the Tana River have been invaded from locations of irrigation schemes. The riverine environment especially has suffered the greatest invasion rates. This regional scale knowledge was then applied using participatory assessments.

*7.3. Selection and testing of indicators*

The *abuuru* scouts helped establish the identity of the surveyed landscapes geographically. They used two types of names: the personified names reflecting historical settlements, name of prominent persons and the physical shape of the landscape. The results of the surveyed landscapes by the joint team of herder range scouts (*abuuru*) are summarized in Table 4. The place names such as Moye Buya Guyo refers to geographical identity after a person's name (Table 4). The word "Moye" refers to Hornless cattle, it probably refers to a historical settlement where the "hornless" cattle of Buya Guyo once settled. The informants however suggested that the name might refer to clay pots (*mooye*) that were made at the site by the family. Whatever the historical interpretation, there are no other landscapes by the same name, making it a geographical space that can be used to direct grazing and settlements. The other location was called Komora Jiila that refers to the depression in the landscape (komora)-which might infer location where

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for unexplainable reason might continue to lose condition forcing the herders to move to other areas, where the condition might exist.

[14] The opposite is the case for the camel management for which dusty soil is a requirement for "soil bath" for controlling external parasites.

historical cattle herds were kraaled, whose hooves overtime, created the depression.[15] This interpretation is probably accurate because of the hint in the second name- *Jiila*, which refers to a ceremonial ground where the Orma historically conducted the *gada* ceremonies (see later section). The other names: Qote (*Cordia* species), *Jijiga* (settlement) and *Onmirti* (actually the names are in two parts Oon, Mirti) referred to the main tree species and old settlements and named after Mirti-a person respectively. From the landscape names we might deduce that the herders similar to cartographers presented place names with historical derivation. But unlike cartographers, the herders attached meanings to all place names that were landmarks for directing herd mobility.

The ecological classification of the landscapes included soil as a key indicator and vegetation as the other indicator. Thus, a more accurate landscape classification of the first transect (Table 4) is *wayaama-ameesa* (the red soil of *Commiphora africana*). This is a typical species found in red soils often forming thickets. This type of landscape is wide spread throughout the region where the soil condition is the defining factor. By comparison, the soil type of *omaara,* which is highly preferred for cattle grazing, occurred in combinations: *omaara-adhi*, the white soil is characteristic of cattle country and has specific key perennial grass species. Its variant is *omaara saala*; this is a typical habitat of the Oryx-hence, the prefix *saala* added to the compound name.

The importance of indigenous landscape classification using soil and vegetation indicators is central for the assessments of rangelands. The Orma herders using indigenous knowledge of the variants of landscapes developed historical understanding of landscape grazing suitability and landscape grazing potential which are important anthropogenic indicators for guiding livestock grazing at landscape scales. Herders using this prior knowledge would interpret suitability of each landscape and based on the indicators made the suitability ratings for different livestock species. Therefore from the name *omaara saala* herders would understand that the particular landscape would not be ideal for human settlements. On the basis of the indicators including key forage species the *abuuru* scouts described, the species of livestock that preferably grazed the landscapes. In the majority of the landscapes surveyed the main threats to the grazing suitability were bush cover and heavy grazing pressure. The latter was deduced from the presence of bare grounds from which the herbaceous vegetation had been removed. The grazing suitability was aggravated by the invasive species, which was present in all the landscapes that were sampled along the Buura-Hola highway. The *abuuru* scouts confirmed that grazing suitability was the variable of landscapes as opposed to the potential that was a permanent feature of livestock. The two-anthropogenic indicators varied with the species of livestock managed. Grazing suitability for the landscapes (with one exception) had deteriorated according to the *abuuru* scout assessments. The ecological assessment by the author and the interviews with the Orma elders were confirmed by the assessments of the *abuuru* scouts. The conditions of the rangelands were rated as either fair or poor, suggesting that the rangelands had deteriorated. The landscapes in the category offered limited support for livestock grazing. Hence, the trends (direction of change) of range conditions were declining for the majority of the landscapes. Considering that the surveys were conducted during an extremely dry year, the conditions observed might change when the rains return. Yet, given that the same rangelands were being threatened by the expanding invasive *Prosopis*, the trends are likely to maintain the downward trends. From the evidence it can be tentatively suggested that the Orma rangelands showed negative trends for both the ecological and anthropological indicators. Evidences of heavy grazing pressure indicated increased stocking rates in recent years. The degradation indicators confirmed this fact. However, the Orma perceived that the rangelands are resilient and can recover if management practice followed the traditional systems of seasonal grazing. The *abuuru* range scouts in their assessments showed clear linkages between rangeland assessments, monitoring and drought-resilient livelihood coping strategies.

### *7.4. Drought resilient livelihood coping strategies*

The indigenous range management knowledge and livelihoods coping strategies are closely inter-linked. The ultimate goal of the Orma herders is to improve their welfare and future prosperity through improved

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[15] The Borana Oromo would use the term Komora when referring to the place where herds of horses were kraaled. Their hooves would tend to dig and create a depression in the ground.

livestock production. The indigenous knowledge for range assessments is the main tool used for ensuring sustainable livelihood. The threat to livelihood is loss of access to key grazing resources, overstocking of the rangelands and expansion by the invasive species. The planned establishment of sugar cane plantations for fuel production in the delta region is creating an apprehension by the community. Accesses to other key grazing resources have also been lost to the national parks. The Kora national reserve, the Galana ranch and the Tsavo national park were formerly part of the traditional wet and dry season grazing areas of the Orma. The Kora national reserve in particular supplied salt licks and saline water, which the herders claimed increased livestock productivity. Additionally, from discussions held with herders there was evidence that the Tana River rangelands are heavily stocked. The greater proportions of stock from outside the district caused the current overgrazing. The informants suggest that the heavy stocking induced decline in range conditions that subsequently reduced livestock productivity. Under the changed land use, even the normal dry spells appeared to have adversely affected livestock productivity.

Table 4. Selection and testing of ecological and anthropogenic indicators for assessing Orma rangelands

| Transect name | Landscape classification[16] | Soil indicator[17] | Season of grazing | Grazing suitability[18] (GS) | Landscape grazing potential[19] (LGP) | Condition[20] | Trends[21] WC | GP[22] | Degradation[23] |
|---|---|---|---|---|---|---|---|---|---|
| Moye Buya Guyo | *Wayaama* | Red soil | Wet | Goats-High Cattle-low | Low -cattle | Moderate | 25% - Stable | VH[24] | Threat high But resilience |
| Qote Jijiga | *Omaara sala*[25] | Grey | Dry | Cattle-high Goats-low Reduced by bush encroachment | High -cattle | Good-cattle Fair-goats | 50% Declining | VH Bare ground – 80% | Threat high but resilience |
| Onmirti | *Omaara-adhi*[26] | White | Wet/dry | Cattle-high | High-cattle | Poor | Declining, invasive sp. WC 30% | VH Bare ground 60% | Threat high But high resilience |
| Komora Jiila | *Omaara-adhi* | White | Wet/Dry | Cattle-high Goats-moderate | High -cattle | Moderate | Stable WC no change | H Bare ground 30% | Threat moderate |
| Bura-Komora | *Biiy-boora* | Dark soil | Wet | Only camels | Low | Poor | Declining, WC 50% | Bare 80% | Threat high |

[16] Classified by the *abuuru* scouts
[17] Classified by the abuuru scouts
[18] Rated by the *abuuru* scouts
[19] ibid
[20] Jointly rated by ecologist and the *abuuru* scouts on the survey Team
[21] Rated by the *abuuru* scouts and woody cover estimated by ecologist
[22] Grazing pressure (GP) rated by the *abuuru* scouts
[23] Joint rating by *abuuru* scouts and ecologist
[24] Very high (VH)
[25] The *omaara* soil of the Oryx (*saala*)
[26] White *omaara* landscape with gray soils showing presence of limestone.

Furthermore, diseases reduced livestock productivity. The Orma oral sources recalled that in the late nineteenth century rinderpest pandemic induced historical famine, which they referred to as *Madobesa Galdesa*. The disease was named after the person who introduced the infected cattle to the Ormaland. The Orma informants suggested that their traditional system of disease management was to quarantine infected herds. This was when they were in control of their grazing lands (see below). Presently, the infiltrating livestock from neighboring province is blamed for introducing new livestock diseases from across international Frontiers with Somalia.

Similarly, the Orma livestock previously survived extended periods of dry weather using the fallback *chaafa* delta and the floodplain pastures. Based on interviews with key informants and field observations (see later section) there was evidence that the present Orma rangelands are experiencing greater stocking pressure. The Orma observed the overstocking during the past two decades. The majority of the indicators showed declining trends (*see section 8.3*). The forage condition had declined resulting in the decline of livestock productivity according to the Orma informants. The present breakdown in the land use system would ultimately result in rangeland degradation, risking the drought-resilient livelihood coping strategies.

The Orma used livestock production indicators to gauge livelihoods. In several of the discussions, the informants suggested that before the drought of 1984 the Orma were among the wealthiest pastoralists in Kenya. Before this period they relied on their herds for food. There was limited population that dropped out of pastoralism to live in peri-urban areas. However, the 1984 drought wiped out their herds and greater proportions of the population was impoverished. Before this period, the Orma loathed urban life due to its aberrant social habits such as chewing *khat* (miira) and reliance on food handouts.

According to the informants, the livelihoods of the Orma have deteriorated after that drought. Their coping has suffered because of the large herds that infiltrated the district. The rainwater that previously was exploited for long duration was exhausted within short period forcing herds to move into the drought fallback areas much earlier than usual. Large-population of migrants' herds were also blamed for the scarcity of forage that when combined with stress of walking to the fall back areas induced greater livestock mortality. The indicators of livelihood stresses were reflected by dramatic declines in livestock productivity, increased livestock sales and consumption of non-pastoral foods.

Additionally, the Orma key grazing areas are being threatened by invasive *Prosopis* species.[27] The species is likely to pose the greatest threats to drought-resilient livelihoods in the future. The species covered several thousand hectares from the Bura to the Hola irrigation schemes. The floodplain grazing lands have also been invaded threatening biodiversity as well as loss of dry season grazing. According to the Orma informants and also confirmed by the field survey, the herbaceous species have disappeared in most places where *Prosopis* cover exceeded 40%. Presently, there is no commercial use of the invasive species. The Forestry department is hesitant in allowing the communities to exploit the species for charcoal. However, trials with charcoal making aimed at controlling the invasive species might be investigated for controlling the species, while at the same time benefiting the community as an additional source of income. Given the level of invasion, which has spread widely, controls of the invasive species under the traditional systems of land use would be unlikely.

### *7.5. The Orma indigenous institutions for applying range management*

The selection and application of indicators and livelihood coping strategies (Figure 1) show feedback between indigenous knowledge and decision-making system. Figure 2 summarizes the detailed methodological steps. The decisions were for regulating livestock grazing systems between different landscapes based on the ecological and anthropological indicators applied by local institution. The institution of *jaarsa mata d'eedha* (elder councils of grazing associations) is responsible for governing the grazing zones across the four dry river valleys (*laaga*) that represented the grazing associations. Proper understanding of the institution of the assembly (*guumi jaarsa mata d'eedha*) and the roles it played has implications for future support of indigenous range management. The remaining part of the Orma case

[27] The invasive species is locally called Mathenge perhaps after the Forestry Officer who introduced the planting of the species in the arid areas of Kenya.

study, describes the functions, the strengths and threats to the indigenous institution. The institution of *jaarsa mata d'eedha* used custom (*aada*) and laws (*seera*) that functioned under the former *gada* system concerned with the use of grazing and water resources and systems of grazing movements. Most significantly, the ritual sites previously used by the *gada* assemblies became the focal point for holding the annual assembly of *Jaarsa mata d'eedha* from across the Ormaland (see below).

*7.5.1. The institution of* Jaarsa mata d'eedha

The Orma are one of the sections of the larger Oromo populations, presently spread across Northern Kenya and Ethiopia. Similar to other groups such as the Borana they had earlier practiced the institutions of *gada* (Legesse 1973). The Koffira Orma lost their *gada* institution in the mid-nineteenth century after the Darood Somalis conquered them, while the Barareta abandoned *gada* in the early twentieth century after conversion to Islam. Prior to the abandonment, for political institutions they relied on the *abba gada* and the assembly of *hayu* councillors. The *hayu* were representatives of the different Orma clans while the *abba gada* (father of the *gada*) represented all Orma. They also had ritual leaders (*qaalu*) who were selected into the office. The institution of the *qaalu* was responsible for the spiritual lives of the Orma and the office holders served for life. The *gada* had institution for managing the grazing lands called *abba korra saadhe*. This institution was responsible for enforcing the laws passed by the *gada*. The system had remained functional until after the arrivals of the Somalis and the European colonial powers.

As Islam gained a foothold, the *gada* institution weakened and was abandoned after the last office holders of the *abba gada* (Godana Jaara) and the *hayu* (Buya Guyo) died. The elderly informants suggested that the Orma after abandoning the old institution ran into difficulties because they lacked functional system for managing their affairs. Islam was not a substitute to the *gada*. It did not present the Orma with alternative systems of resource management and coordination and regulating grazing as well as resolving internal and external conflicts. Indeed, the Orma found themselves as victims of the Moslem Somalis who were over running their grazing lands. They therefore elevated another institution, which previously functioned under the guidelines of the *gada* laws. The institution coordinated the activities of the grazing associations that they called *jaarsa mata d'eedha* (the elder heads of grazing associations). The institution received support from the British administration under the indirect rule. The British increased the committee from two to four. The Orma referred to the elder committee by the name of the *gada* office of *hayu* despite the different functions it played. One of the members was elected as the head and held the office for five years; this was also another symbolic representation of the *gada*, where the *abba gada* remained in the office for eight years. The leadership rotates among the four members and the position in each case is inherited, implying that leadership of the *jaarsa mata d'eedha* returned to the same family after twenty years. For the period they were in power, the head of the *jarsa mata d'eedha* played similar roles (except performance of rituals) as in the previous *gada* serving all the Orma clans. The institution of *jaarsa mata d'eedha* has representatives selected from all the four *d'eedha* that administered the decisions at local community levels.

The *Jaarsa mata d'eedha* institution has political, social and decision-making functions. The assembly is a place for discussing conflicts over grazing lands with other pastoral groups as well as being the traditional institutional medium through which government policies are communicated to the communities in different *d'eedha*. The function of the assembly is to reinforce community wide decision-making. The decisions made at the annual assembly have wide ranging powers including inclusion and exclusion of others from the Orma grazing lands. Decision made and resolutions passed at the multitudes of *Jaarsa mata d'eedha* are binding to all the Orma across different clans. Decisions found difficult to implement would however be renegotiated at the different sittings of the assembly and replaced with new ones for easy application. The assembly meets once every year at Chiffiri[28] to discuss all matters that concerned the Orma including customary marriage law, regulation of grazing and settling of disputes and the electoral politics. The assembly's function is regulatory. All decisions reached at the multitudes of *Gumi Chiffirri* (the multitudes of Chiffirri) are communicated through the *d'eedha* representatives.

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[28] This is a *gada* ritual site with high religious symbolism to the Orma. The venue has not changed its significance even after the community became Moslem. The last annual meeting in 2008 involved greater than 3000 Orma elders from all the Tana River District.

## *8. Ethiopian: The Afar, indigenous range management knowledge*

The Afar inhabit Region 4 of the Federal Republic of Ethiopia. They comprise one of the largest pastoral populations in Ethiopia, accounting for about 29% of the total pastoral population (Fassil Kebebew et al. 2001). Ecologically, the region is one of the harshest environments in the Horn of Africa. Volcanic rocks, with lava flows, sand deserts and salt lakes, characterize the grazing lands. Geopolitically the Afar people are distributed between Ethiopia, Djibouti and Eritrea. The geopolitical distributions play a significant role in survival strategies for coping with droughts. External relations with neighboring pastoral communities have also forced on them important adaptive range management strategies. Similar to the other case study communities, the Afar practiced pastoral production and their livelihoods are directly related to the welfare of their herds.

The main livestock species is the camel, while the small stock and cattle are also important sources of livelihoods. The shifting resource borders between the Afar and the Isse Somali by armed conflicts has adversely affected the indigenous systems of range management. The conflict excluded the groups from shared traditional wet season grazing lands (Unruh 2005). The insecure grazing lands in the buffer zones were under-utilized, while the secure areas were heavily overgrazed. Additionally, establishment of the Awash National Park and the commercial agricultural developments in the Awash River floodplain have removed greater lands required for dry season grazing from the clan and communal use. The loss of the floodplain pastures along the sections of the Awash River is a real blow to the Afar pastoralism. These externally driven changes altered clan-grazing territories (Getachew 2001). The indigenous range management in the districts of Amibara and Gawane is also under threat from the expanding invasive *Prosopis juliflora*. The productivity of the invaded rangelands has drastically declined, posing risks to future sustainability of pastoral economy in central Afar.

### *8.1. Broader scale of indigenous range management*

Interviews with knowledgeable informants during three days of field work in the districts of Amibara and Gawane were helpful in understanding the indigenous knowledge of range management, drivers of land use changes, social reconstruction of environmental change, threats to livelihood systems by droughts and institutional coping strategies. The interviews with key informants were used to understand the structure of the indigenous grazing system. The interviews were also used to analyse seasonal livestock grazing patterns between communal grazing lands and the clan-territories. The Afar grazing patterns are based on investigations and assessments of the range by the traditional range scouts (*iddo*). They used environmental and livestock production indicators to assess rangelands. The Afar utilized mobility between different grazing landscapes distributed in space and time. The grazing rangelands are geographically divided between the uplands (*ale*), lowlands (*bahari*), narrow (*duulul balaa*) and wide valleys (*daaba*). The floodplain with their key grazing resources (*kaalo*) and the valleys served as dry season grazing reserves, while the uplands were used for wet season grazing. The plains were grazed soon after the rains when the soils dried and the grass flowered. The system of grazing movements and the selections of different grazing landscapes varied with the types of livestock species (see below).

At the broader scale, the Afar grazing lands are categorized into communal grazing, where all the neighbouring clans shared grazing and water during the wet season. Each clan however has territories (*faage*) to which their livestock returned during the dry season. The clan territories are preserved while the communal grazing areas were exploited. The system of grazing is regulatory for controlling the population of the stock that grazed in clan territory. The system conserves grazing during the wet season for use during the dry season or drought periods. At that time of the year the communal grazing has been exhausted.

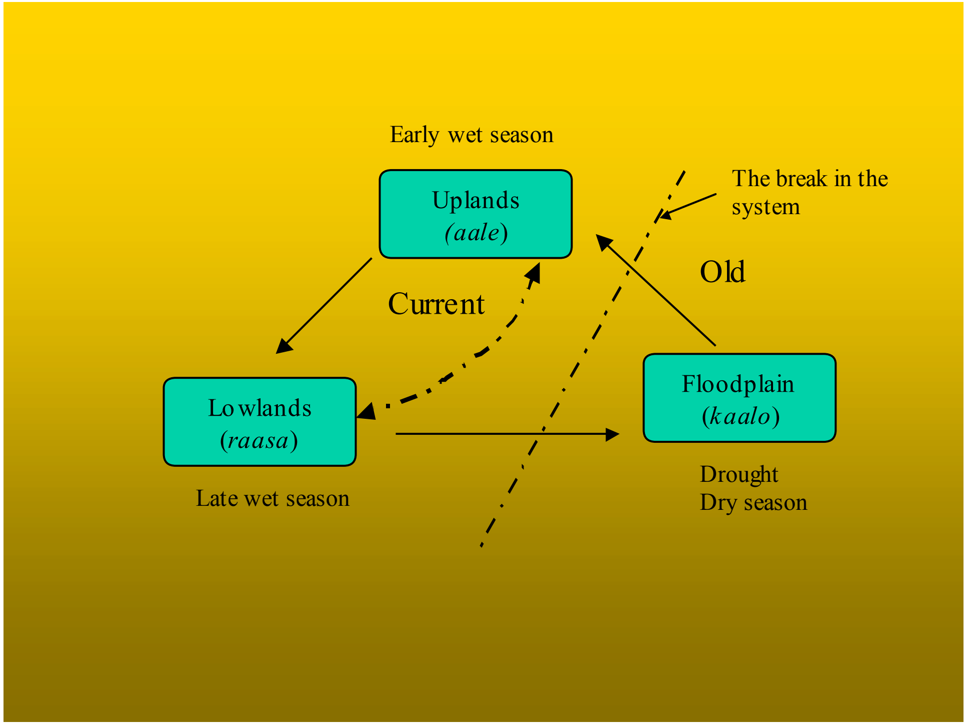
The system of indigenous rangeland assessments would take into consideration the requirements of different livestock species. The camels being browsers have different needs of grazing compared to cattle. Thus, *iddo* scouts in their assessments would take into consideration the needs of different livestock species. They would pay greater attention to the availability of browse if the interest is for camel management, while for purposes of cattle grazing they would assess the condition of grasses. In each case, the assessments would pay attention to key forage species and their availability. Depending on the time of the year they would also consider the stages of plant growth-varied from early season to late season of growth. They perceived that degraded environments would not be preferable for grazing. Other factors assessed would include access to salt licks and salty plants for browse, particularly for camel management.

The grazing requirements of different livestock species would vary during the wet and dry seasons or the drought year. During above average wet year, the Afar rangelands produced abundant grazing resources for the three species of livestock. The herders and their herds have wide ranging choices as to where to graze. However, when the rains arrive, the problem is not availability of forage, rather, the physical requirements of different livestock species. For example, camels would avoid muddy soils of the low plains and would be moved into the uplands where the ground is firmer under their feet. Small stock would also prefer the uplands, as they are better adapted to walk on rocky surface. Cattle by comparison, would prefer the lowlands but avoid the stony uplands. Thus, camels and the small stock would come down the uplands and return to the landscapes of the plains after the soil surface has hardened, while during droughts they returned to the floodplain of the Awash (Fig. 4). The *iddo* scouts would assess different types of landscapes. Soil indicators were assessed for livestock grazing suitability. When planning pastoral encampments, the herders would break up the soil surface to assess if sand and grits or pebbles were present. The soils that lack these characteristics were considered unsuitable for kraaling livestock.

In the surveyed rangelands there are soils of different types including pebbles spread on the surface and hard ground (*inde laala*), white soils (*adosisa*), black soil (*raasa*) and rocky landscapes (*dalle baaro*). The different livestock species would prefer different soil types. The camels would prefer *raasa* for grazing. The small stock would prefer *dalle baaro* and *inde laala*, while cattle would prefer *adosisa baaro* (white soil). The black-gray soil (*stakala*) is preferred for grazing by all livestock species but unsuitable for establishments of pastoral encampments. The soft soil without pebbles (*doole baaro*) is not preferred for the small stock management. The Afar herders perceived that if they grazed goats in the type of landscape their hooves would tend to grow, which is an unhealthy sign that herders watched out for. The herders would instead graze the small stock in *inde laala* (soils with pebbles and hard surface) to trim off the hooves. The *iddo* scouts and the elders understood the entire place names visited and their soils and vegetation characteristics. The key landscapes with suitable grazing would be visited and assessed for forage availability and their stock densities determined.

The *iddo* scouts would return to the main pastoral camps where the elders interviewed them closely to evaluate the information. Making errors of judgment in the assessments were considered risky due to potential livestock losses and for this reason it is obligatory that all information were carefully evaluated. The elders would consider the evidence of assessments presented and the potential risks of moving into areas surveyed by the *iddo* scouts and if unsatisfactory re-deplored the *iddo* scouts to survey different areas. When the information was considered favourably, the clan elders would order two possible strategies, either splitting the milk and dry herds or move the whole production units. The information and decisions made were communicated through the system of *daago* to neighbouring clans who might use the same information to migrate.

**Figure 4. The Afar seasonal grazing systems showing the past and current land use patterns after the floodplain pastures were converted into commercial crop cultivation**




However, the movements by different clans might not be synchronized. Coordination would be a necessity for purposes of mutual defence. Thus, each clan has sets of priorities that would influence range management decisions. The Afar would not only evaluate the conditions of the pasture but would evaluate livestock production performances. After the grazing landscapes are selected, the herders would focus on livestock body conditions, milk yields, and the activities of the males. Using livestock production performance indicators as cue, herders would decide on changing the grazing grounds by either sending out the *iddo* scouts or changing the encampments. The assessments were made at the fine landscape scales.

*8.2. The Afar indigenous range management at the fine scaler*

The camel is symbolically considered as belonging to all Afar clans and for the reason not as much restricted across clan grazing territories as other livestock species. According to the Afar herders, camel management forms crucial aspects of the indigenous range management. The camels require a narrow range of grazing landscapes during different seasons of the year. The choice between grazing in geographically distributed grazing resources as shown in Figure 4 is not only in terms of physical conditions but also in accordance with dietary requirements of camels. Yet within the geographical range, camels according to the Afar herders have fewer landscapes of choice that would be considered suitable for management. The herders would explain this as "camels being selective in their feeding habits" as opposed to cattle that had wide ranges of choices of grazing while the small stock formed the medium range in dietary choices.

According to the Afar herders, camels unlike other livestock species disclosed behavioural habits that accurately linked camel management to the changing conditions of the rangelands. Camels sometimes ignored herder guidance with the lead she camel picking the direction of the preferred browsing grounds while the herder might have other ideas. When herder decisions and camel preferences fail to coincide the herder would have only a limited control over camel grazing movements. Unlike other livestock species, camels would stall and refuse to cooperate with the herder. There are times when camels regardless of plentiful browse refuse to feed and instead walk for distances to find the sorts of browse they required. The herders suggested that the camels "monitored their own physiological changes" and sought salty plants when they have the urge. In so doing, they would travel distances to reach landscapes where such plants grew. In other places, the camels required "dust baths" which are found in the *raasa* landscapes. Camels would also avoid muddy grounds. The herders understanding camel behaviour would respond quickly to their changing preferences. Sometimes, the herders would make deliberate efforts to stop camels from browsing in landscapes that might have plant species that would upset to the camel's digestive system. At other times camels might show signs of thirst while the forage is still green. Herders would stop camels from drinking water; while the forage is still green perceiving that it would have a detrimental effect to the camel health.

The Afar camel herders have developed knowledge of camel requirements and preferences, which they base on selections of soil types that are suitable for camel encampments and grazing. In the words of a key informants "camels and the herder communicate with each other…the camel might not talk but their behaviour is sufficient to influence herder decisions". The herder gauges responses of camels to management. However, occasionally, the herder based on past experiences, might consider particular soil conditions suitable but for unknown reasons camels would respond unfavourably. This would force the herder to make assessments of the soil conditions. According to another informant "…a camel is a better expert of soils than the herder" and therefore changes in camel behaviour are a better indicator of changing soil conditions. Some soils are cold at night and others are warm, camels responding preferentially to the warm soil conditions. Thus, when soil conditions are not suitable, camels might become restless and shift in their crouching positions. Conversely, when camels showed preference for soils, on arrival they would take up their crouching positions, chewing curd. The herder using the behavioural disposition if unfavourable would decide re-locating the camping site, sometimes just for short distances.

Other indicators that herders assessed were general body conditions. Under suitable grazing, the Afar informants claimed that the suitable responses could be inferred from changes in body hair. Additionally, milk yields would increase, while the rutting of the bull would be longer and stronger. Active bulls were likely to mate with more dams. Other indicators assessed are the rumen fills. Shrinking rumen in the morning and partial fills in the evening when the camels returned home would infer that the conditions of the range were deteriorating. The indigenous knowledge of camels is part of the camel lore that describes grazing, breeding and calving. Using the lore, the herder dialogues with the camel describing their gaiety and awkward behaviour. A herder would sing " …because you pass urine on your legs, you are viewed as unhygienic but you are a clean animal …[Your] herder selects the bull for you but it is you who chooses the calf you want to reproduce…." Other folklores would describe the different grazing lands camels visit and their stubbornness-yet providing nourishments for human survival. The folklore sums up the symbolic relations between herders and camel virtues (*gaala silale baaro*) in which every aspect of camel behaviour and its values formed certain aspects of the prose. Camels are adapted to go without watering for as long as possible while the forage is still green, while during the dry season and drought years camels would drink after every five to six days compared to cattle that required water on daily basis in the wet season and every second day during dry season.

### *8.3. Selection and testing of ecological and anthropological indicators*

The *iddo* range scouts assessed rangelands at geographical and local landscape scales. The scouts assessed the spatial and temporal distributions of rainfall and availability of grazing as well as security. They would evaluate range conditions, understand distributions of pasture suitable for different species of livestock and investigate availability of surface water. The assessments would consider landscapes grazing suitability for the different livestock species and the soils for encampments. Incidences of diseases as well as conditions of livestock in the area would be carefully evaluated. The scouts had names for geographical grazing areas (see Fig. 4) as well as names for landscapes. The Afar *iddo* scouts who worked on the transects with the author provided place names such as *Diktaa Boora* referring to settlement named after traditional dance. Others were called *Daiiddo-Rassa* (throwing stones) comprising gray-black soil or *Daamo*, which refers to land overlooking a pool of water. The Afar *iddo* scouts unlike the *abuuru* of the Orma did not appear to have explanations for the historical place names. They simply stated that the names were "historical and they did not know why the names were given". Nonetheless, the Afar similar to the Orma and the Karamojong had clear knowledge of rangeland degradation. They referred to severe levels of land degradation as *aboroiti baaro*. These are bare of herbaceous cover. Other landscapes that lost the herbaceous cover and invaded by *Prosopis* species were also referred to as *aboroiti baaro*, while presence of dry litter and standing grass hay were classified as *kafiin isoole baaro*. Conversely, highly productive landscapes were called *andarhaarra* (Table 5). The joint team using these scales identified ecological and anthropogenic indicators at landscape scales. The indicators selected for identifying different landscapes are soils and vegetation. Each landscape type had key woody and herbaceous species. The *iddo* scouts would suggest that the different landscapes were associated with specific plants species that when present served as indicators of rangeland grazing and the stability of range condition. The condition assessed was in terms of forage and degradation status of the landscapes. According to the Afar *iddo* scouts, degraded rangelands had lost the key forage species and would therefore have no value for livestock grazing.

Due to the invasive *Prosopis* species the grazing suitability of the majority of the landscapes had declined. Herder ratings for most of the surveyed landscapes were low, with the exception of one landscape that was rated as excellent. The latter landscape was in a buffer zone between the Afar and the Isse Somali. Despite the low ratings of grazing suitability, which reflects the current conditions, the landscape grazing potential in most cases were considered to be high. From this we might infer that the grazing landscapes have regenerative potential, albeit risks from the expanding invasive *Prosopis* species. The majority of the landscapes invaded by *Prosopis* lacked herbaceous layer in the under tree canopy. Large areas of the rangelands have therefore been rendered worthless for purposes of livestock grazing. Both the river basin and the surrounding rangelands in the Amibara and Gawane districts are affected, forming impenetrable stands with estimated cover of 60-100% in places. The main risk is that the species is expanding into the open rangelands. The only rangelands free from the invasion are the uplands. In the plains of Amibara that were previously left for wet season grazing, the perennial grasslands have disappeared. A nearby Elfora ranch showed the presence of the same grasses.

According to the herders the severe levels of degradation caused by the invasive species reduced grazing suitability for all the livestock species. Rehabilitations of the affected rangelands at the current costs would be beyond the capital allocated for pastoral development in the region. Nothing short of mass campaigns could achieve the eradication of the invasive *Prosopis* that covers several thousand hectares of the Afar rangelands. The status of range condition from field observation could not therefore be related to the absence of rainfall alone. Rather, the combined effects of invasive species and heavy grazing and lack of rainfall has resulted in poor range conditions for the majority of the landscapes with only a minority being in fair or excellent condition. The *iddo* scouts considered the whole area as *aboroiti baaro* (overgrazed and degraded). From these assessments there was evidence of an ecological breakdown in the central Afar districts. The impacts of the invasive species on pastoral livelihoods according to the informants have reduced livestock production performances.

### *8.4. Drought -resilient livelihoods coping strategies*

Pastoralism is the main source of livelihood in the Afar region. At the level of livelihood strategies, Afar pastoralism serves both as subsistence as well as linked to commercial networks. The community historically participated in caravan trade linking the Red Sea Coast with the Ethiopian Highlands. Each caravan has a leader (*arhotabba*). The caravans functioned as regional social networks for information sharing (*daago*) as well as exchanging livestock and salt from the lowlands with grains from the highlands. At the household level, the livestock particularly camels are managed for milk production and occasional meat for guests and for household consumption. The small stocks are the main currency for the households, sold to purchase non-pastoral consumer goods to meet immediate food requirements. The households are linked through social security networks for sharing milk herds and livestock products (*haato* system). The poor (*bahite*) are assisted in various ways. Sharing is not only between relatives but also among neighbours. Food and animal gifts are voluntary. For example, when families lost their livestock to tribal raids, neighbours would contribute to revive their sources of livelihoods. The informants emphasized that unlike the neighbouring pastoral groups, the poor among the Afar rarely dropped out of pastoralism. Rather, they were retained through sharing of stock and other forms of social security assistance. This means that the broad-based social security networks are of crucial importance for sustaining the livelihoods of the poor. They would also participate in cultivation of crops along the Awash, where they plant small plots of land with sorghum and cotton, the latter for commercial purposes.

Table 5. Selection and testing of ecological indicators at landscape scale in Afar rangelands

| Transect name | Landscape classification[29] | Soil indicator[30] | Season of grazing | Grazing suitability[31] (GS) | Landscape grazing potential[32] (LGP) | Condition[33] | Trends[34] WC | GP[35] | Degradation[36] |
|---|---|---|---|---|---|---|---|---|---|
| Diktaa Boora | *Raasa* | Black | Dry | Camels –high Goats-high Cattle-High | High-for all species | Fair | Stable WC < 20% | Heavy | *Kaffiin isoole baaro*[37] But resilient |
| Dadaamo | *Koma* | Rocky | Wet | Goats-moderate Camel-low | Moderate-goats | Poor | Downward invasive sp. expanding WC > 40% | Heavy | *Aboroiti baaro*[38] This land would require heavy investment |
| Adoptili | *Hududo* | White | Wet | Low for all species | High | Very poor | Downward WC 70% *Prosopis* | Zero herbaceous cover | *Aboroiti baaro* Requires heavy investment |
| Intiasso | *Daale-Raasa* | Black with pebbles | Wet | Camel-low Goats-low | High | Poor | Downward Invasive sp. | Very heavy | *Aboroiti barro* Requires heavy investment |
| Hunda halaidi | *Dalle-Raasa* | Black with pebbles | Wet/dry | High for all sp. | High | Excellent | Stable | Little | *Andarhaarra*[39] |

29 Classified by the *addi* scouts
30 Classified by ecologist and *iddo* scouts
31 Rated by the *addi* scouts
32 ibid
33 Jointly rated by ecologist and the *addi* scouts on the survey Team
34 Rated by the *addi* scouts and woody cover estimated by ecologist
35 Grazing pressure (GP)
36 Joint rating by *addi* scouts and ecologist
37 Slight, the landscape has dry grass cover 20-30% cover
38 Degraded of herbaceous layer
39 Excellent condition, the area is a buffer zone between two conflicting groups

The informants suggested that on occasions that the number of *bahite* (poor) exceeded the capacity of social networks they would sale large livestock such as camels and use the money to restock them with small stock. A camel would be exchanged with 30-40 heads of small stocks, which are then distributed to those who were below the acceptable poverty line, which for the Afar was taken to be 40 goats. Sustaining such livestock distribution is often interrupted by frequent droughts.

Drought is a recurrent problem in the Afar region. The herders' indigenous knowledge of drought and coping strategies is widely applied. However, the Afar drought indigenous knowledge and coping strategies would demand cautious interpretation. The herders quite often report that the current or the most recent droughts were severest. In all probability they had suffered far worse droughts in the past. The pain caused by the suffering is however felt when the stress is more immediate than the effect of past droughts, which are often forgotten. Nevertheless, understanding indigenous knowledge of drought would be helpful for identifying normal from abnormal conditions. The Afar expects three types of rainfall. The *karma* main rains, the *daada* showers and the late *sugum* showers. If one or two of the expected showers fail, it creates extended dry conditions (*jillal*). Any time the expected showers fail and become continuous with the *jillal*, a drought (*abaar*) would be a likely outcome. Droughts are categorized according to their severity: severe (*kadaabaar*) and mild (*uhandaabaar*) droughts. Each type of drought requires different livelihood coping strategies. Making adjustments in local livestock management is sufficient for survival during mild droughts, while during severe droughts the reproductive performances of all livestock species would be adversely affected, with cattle suffering more than the small stock. The camels are more resistant.

The Afar oral tradition for reconstructing drought events would require long periods of interviews to probe the memories of the herders. The chronological history of droughts is not well remembered but actual events experienced during lifetime can be recalled. Droughts were given names according to events. For example, the drought that induced livestock starvation throughout the Afar region is remembered as *gerajiite*-which means holding the tails of livestock. The name is metaphorical in implying that the community activated all possible survival strategies by literally holding onto the few livestock that survived. It might also infer that during the particular drought the livestock was so emaciated and weakened that they needed assistance to "stand on their feet". According to an elderly informant the *gerajiite* drought was so severe that greater proportions of the livestock died of starvation. Another severe drought recalled was called *kadaabaar*.[40] The particular drought was said to have impoverished the clans throughout the Afar land. Other more recently recalled droughts included one by the name *abaal* (blood in the urine). The informant described the drought severity due to a cattle disease.  Due to the risks posed by *abaar* to the pastoral production, the Afar have systems of early warning to help them cope. They relied on traditional astrologers (*hitikibia*) who study signs and forecast the approaching weather conditions including the impeding drought.  A widespread drought would induce wide spread forage scarcity including the territories of the neighbouring clans. The scarcity of forage would induce decline in livestock production performances. Greater losses of livestock would force households into livelihood diversifications.

Regional droughts would impose limited choices. The Afar region would be the first to suffer drought stress. They have two options, which are not mutually exclusive. Firstly, they would migrate to the neighbouring pastoral and agro-pastoral communities' grazing lands through negotiations. The movements might also be towards the territories of other Afar clans, in which case, there would be inter-clan negotiations. The Afar herders would also negotiate access across international frontiers with their kith in Eritrea and Djibouti. In all cases, influential elders would be sent to negotiate access to the neighbouring grazing lands. An important point to underscore is that the migration is peaceful in response to stressful conditions. The Afar would request to be treated as "guests". The system of negotiating access to other groups' pastures creates reciprocity, which other groups would exploit in future. Secondly, on occasions when access is refused the Afar would employ force. Different clans would collaborate in raising sufficient military strength with sole intention of intimidating their neighbours or using combative force to occupy grazing lands in the buffer areas. Thus, whereas negotiations implied the desired co-existence, the use of force would perpetuate conflicts. The Afar would claim that their use of arms is justified because they risked losing their pastoral economy. The choice is part of the struggle against uncertainties. The confrontation posed additional risks, which the Afar were compelled to balance between risking livestock

[40] The term *kada* implies the "greatest" or severest.

loss to drought and sparking off perpetual armed conflicts with their neighbours. Indeed, the Afar informants would suggest that some of the extended droughts they suffered in the past were not necessarily induced by climate but by conflicts. By squeezing them into smaller grazing areas, conflicts induced severe levels of overgrazing that induced greater losses of livestock to starvation.

The additional threats of drought coping strategies are from two sources. Firstly, the widespread invasion by *Prosopis* has diminished productivity of the key grazing landscapes such as the Awash floodplain. The second threat is from the commercial agriculture in the floodplain that replaced the former clan dry season grazing reserves. The combined effects of commercial agriculture and expansion of the invasive species reduced access to the former dry season grazing reserves. Additionally, the external pressures might have forced the Afar as community to allow the transformation of their dry season grazing lands. The re-allocation of clan territories along the river to commercial agriculture implied that new forms of land use conflicts are likely. The area of Gawane in particular has suffered such conflicts. The investors developing commercial cotton farming rented the clan floodplain grazing lands by influencing clan leaders by paying them paltry salaries. The minimal financial benefits according to some observers have not offset the loss the Afar suffered during drought years when they needed access to the floodplain grazing lands. The arrangement made with the commercial farms is to allow the Afar stock to graze crop residues after the harvest. But this has not been a desirable substitute to the rich traditional pastures replaced by cotton plantations. Analysis of Afar herder responses to the changes in resource tenure and invasive species that had undermined the productivity of the grazing lands, which weakened the indigenous drought coping strategies require to be placed within context of priorities of national development policies for alternative land uses of the rangelands. The policies need to be carefully evaluated for two reasons, firstly, the alternative forms of land use competed with pastoral land use and by removing them from key resources exposed them to greater dangers of livestock loss during periodic stress.  Secondly, the land use changes would undermine the social institutions that previously regulated grazing systems.

### *8.5. Indigenous institutions for range management*

The Afar social institutions can be divided into indigenous and formal institutions. At clan level, there are customary leaders called *makabantu* (*makaban* pl.) involved in decision making related to matters of clan grazing lands, relationships with other clans and the neighbours and the state. The clan leaders from the associated grazing (*ulooto*) would as part of the drought coping strategy set a side grazing lands needed during periods of scarcity. Such system of preserving grazing for drought years is called *digdeeso*. The preservation is not through physical policing but consensual agreements until such times when the grazing is opened for the communities. The system is applied to the sections of the communal grazing lands where grazing potential is greater. As the drought stress becomes severe and the grazing for livestock declines elsewhere, the clan elders would meet again to evaluate the situation and allow the preserved grazing to be utilized. If the conditions deteriorate, the elders would allow the herders to lop tree branches to feed the livestock as supplementary feed. The next coping strategy is to seek grazing in the neighbouring territories.

The traditional practice of mutual sharing of grazing and water is practiced with neighbours such as the Karayu Oromo. The negotiation is done through clan leaders (*makaban*). The informants suggested that the traditional system of resource sharing reduced conflicts. Additionally, survival in Afar depends on sharing of information between individuals, pastoral camps and neighbouring clans. Communication is by word of mouth where every individual is an agent of information transmission (*daago*) that might concern market prices, distribution of rainfall, situation of pasture, livestock and human diseases and armed conflicts. The herders share the information at water points. The *daago* system is the means for coping with risks and allowed communication between different clan *makaban* elder councils. The *makaban* institutions have additional social and political functions. The clan leaders are responsible for the security. They would adjudicate cases of revenge killings and collect bloodstock (*dili mekla*). Most severe punishments are handed down to individuals who violate customary laws. The *fiimat abba* play the clan-policing roles by enforcing judgements (*chaara*) made by *makabantu*. Additionally, the religious leaders are responsible for social functions. They have the responsibility for marriage matters and collection of *zakat* (i.e. payment of ten percent), which involves distribution of livestock from the wealthy to the poor. Every year, all the households having more than 40 small stocks are expected to contribute *zakat* for redistribution to the poor households.

# 9. Uganda: Karamojong, indigenous range management knowledge

In the Ugandan case study, we selected the Matheniko, who make up the Karamojong cluster.[41] The home rangelands of different Karamojong clusters are in terms of geographical locations of their ritual shrines. Following the procedures described in Table 2, interviews were conducted with key informants and with groups of elders of the Matheniko in the pastoral settlements near Moroto. The interviews discussed the indigenous knowledge of range management related to the geographical distributions of the seasonal grazing lands-divided between the wet, the dry and the drought year grazing migrations. The discussions also covered the relations with neighbouring pastoral and agricultural groups, their system of dividing grazing lands into settlement rangelands (*Ngireria* pl. *Ere* singl.), private range enclosures (*Ngaperor* pl.), home gardens (*Nikiror amana a ekal* pl.) and communal grazing lands (*neni edakasi angaatuk*). The group discussions were used to define concepts and terms for range management in relation to assessments and monitoring applied by the herders using the prescribed indicators. The Matheniko unlike the communities of the other two case studies have maintained their cultural values and the herders had terms for describing every environmental condition that the author asked. Only a limited of these are reported. The interviews created livelily discussions about rangeland assessments and monitoring, selection of indicators and the decision-making systems.

The Karamojong in contrast to the other two case study communities have traditions of practicing home gardens (*Nikiror*) that are located within short distances of the main settlements. The settlements are semi-permanent. The author was informed that some of the settlements have been in the same place for several generations.[42] The home gardens are livelihood features of the Karamojong households. The sorghum from the gardens is an important source of staple food as well as ingredients for locally brewed broth of alcohol for local consumption and for purposes of performing rituals and marriage ceremonies. The women conduct the tilling using hand held hoes, weeding and harvesting when the sorghum crop ripens. When selecting to locate home gardens the Karamojong considered the types of soils and their capacity to store water. The soil type and vegetation indicators are used to identify suitable sites for crop cultivation. For example, the dwarf shrub *emekwi* (*Indigofera* sp.) is a suitable plant indicator for suitable soil conditions for growing sorghum. The limiting factor to the growing of sorghum is principally soil moisture and for the reason the Karamojong women and men are selective in locating the gardens with respect to topography. Gradually sloping grounds where surface water movement is gradual are preferred to steep slopes. Sites where water stands are considered as suitable indicators. The dark soil (*orro*) is perceived to be most suitable for crop cultivation while the light sandy soils of the *eketela* landscapes through which water rapidly seeps are considered unsuitable. Grazing in the home gardens is not permitted until after crop harvests when livestock would be allowed to graze crop residues.

The home gardens or *ekuroro amana a ekal* are private lands. Women who cultivate *ekuro* would know the borders of their land and those of their neighbours, despite the absence of border markers by either live fences or other physical structures. The women are responsible for management of the home gardens. Using social security networks the home gardens could also be given to friends and relatives or purchased. The sorghum gardens are however not necessarily commercialised but exchanging them with cattle is a symbolic transfer of property rights. The home gardens are therefore symbols of household independence. Also associated with settlement lands are the semi-private grazing enclosures (*Ngaperor* pl.). Unlike the *ekuroro amana a ekal* that are owned and managed by women, the grass enclosures are owned and managed by men. They are for grazing sick, old and drought weakened livestock. The owners have exclusive use but they might accommodate their bond-friends through social networks. There is closer linkage between management of home gardens and indigenous range management.

[41] The subjections are *Ngimonia* (bush people), *Ngimongoth* (ancestral dispersal) and *Ngitopon* (stars).

[42] An informant suggested that four generations of his fathers were buried in the same site. The settlement had grown into independent settlements.

*9.1. The broad scale indigenous range management knowledge*

The communal rangeland management of the Karamojong involved seasonal livestock migrations between the wet and the dry season grazing lands. Livestock grazing is geographically distributed in terms of the mountain grazing lands allocated to the dry season and the plains grazed during the wet season. The geographical distribution of grazing landscapes is identified using place names. The places are endowed with diverse grazing landscapes that varied from marshes to dry valleys and uplands. The grazing landscapes were categorized according to the conditions of the soil and vegetation indicators. Seasonal livestock grazing movements used comprehensive assessments by the traditional range scouts (*ngikerebo*). The assessments would vary between the wet and the dry season grazing lands. The wet season assessments due to high spatial distributions of grazing and water sources is likely to cover large geographical areas, while the assessments during the dry season are limited in scope. The types of resources would have been rested during the growing season. At that time of the year the assessments would focus on the dry perennial grass and green vegetation for the marshes. The dry season pastures have high grazing potential and would support high livestock stocking rates.

The wet season grazing, which is highly varied would be assessed by experienced *ngikerebo*. The scouts would consider varieties of indicators when assessing rangelands. The indicators were grouped into grazing availability in the targeted grazing landscapes, availability of water and fencing materials for the mobile cattle camps. The Karamojong being cattle people would place more emphasis on cattle management than the small stock. The status of pasture would be assessed in terms of plant growth varied from early regeneration (*eparat echalichal*) after initial rainfall showers, the maturing and flowering stages of grasses (*kelebat*) and the standing dry hay (*athakan*). Incidences of diseases would also be investigated, as well as security situation. The *ngikerebo* scouts would watch out for footprints of people they suspect as cattle rustlers. If other herds already occupied the grazing area, the scouts would determine existing livestock stocking density based on the number of kraals in relation to available grazing and water sources.

The *ngikerebo* scouts would also consider the condition of the grazing landscapes. The landscapes were classified based on soil and vegetation indicators. The major landscape categories for the Matheniko grazing lands are *arro* (black cotton soils) and the *eketela* (sandy loam uplands and the plains) that are extensively distributed. Other landscapes are *asinyonoit*. These landscapes have sandy soil with high diversity of woody species. Another dominant landscape type is *angromit*. The types of landscapes have characteristic features of pebbles and small stones spread on the ground surface often mixed with soils of various colours. Based on the types of soils and vegetation indicators the *ngikerebo* scouts would categorize the landscapes into different seasons of grazing. The knowledge of soils and vegetation is used to assess livestock production performances. The *ngikerebo* scouts would also study landscapes suitable for locating mobile pastoral camps.

In establishing livestock camps, soil types and conditions are key indicators for making the selection. The soil should not stick on the bodies of livestock. For the reason *asinyonoit* (sandy soil) is highly preferred for placing cattle camps. The landscape preference is reflected by the livestock production performances. Herders would assess cattle behaviour in the morning after overnight kraaling. The livestock body condition would also be assessed to infer the condition of the given site. If the cattle preferred the location this would be reflected by their behaviour. They would tend to sleep for longer periods, while the immature ones would be playful. The males would be active in mating and the milk yields would increase. Animal coat is polished and general weight gains can be observed. Each night when the herds returned home from grazing, herders would pay attention to the rumen fill as a sign of favourable foraging. By the morning, the rumen would still show appreciable evidence of the previous day’s feeding. If however the camping areas were not preferred opposite conditions would be experienced. The livestock production and reproductive indicators would show deterioration. At night cattle would remain standing, showing restless composure and the herd moving about in the kraal. Using cattle behaviour as the cue, the herders would change the encampment

Discussing the factors that made some sites favourable and others less needed careful interpretation. The Karamojong elders informed the author that while livestock grazing and management focused on vegetation, the soil (*ngalup*) played crucial roles in determining whether or not cattle had shown preference. Variations of soil conditions are highly localized. The herders perceived that for the same landscape there were "hot" and "cold" patches during the night. The herders perceived that warm patches "breathed out hot air" at night and tended to be too warm. They considered such landscapes unfavourable for night kraaling. They claimed that the sites within landscapes that "breathed out hot air" were associated with the livestock and human diseases. The link between hot air at night and the diseases will remain unclear for now, but some valid explanation can be conjured. What the herders referred to as "breathing out hot air" might be related to soils that stored heat during the daytime. But at night, as the air cools-the lighter warm air rises, which the herders detect as "breathing out hot air". The stored heat is dissipated through conventional air currents giving the impression that the land was "breathing". In other sites, the herders claimed that the warmth alternated with cool conditions. They considered such soils suitable for night kraaling. The observation of the Karamojong differed with perceptions of the Afar and the Orma. The two communities described cold soil as undesirable for night kraaling, while warm soils were preferred. The difference might depend on the fineness of observation between warm and cold soils. However, in the three cases, herders would investigate the phenomenon by moving about the kraal at night by crouching and feeling the soil surface for heat in various spots to reach such conclusions. The decision would be to abandon the unsuitable site. The scientific credence of the claims would remain speculative.[43]

An important anthropogenic indicator the herder scouts used for classifying landscapes is grazing suitability and landscape grazing potential for different species of livestock. The Karamojong focused more on cattle management. Cattle being more mobile than small stock have access to expansive areas than the small stock that tended to be managed within proximity of the main settlements. Furthermore, the greatest difference between the two species is their dry season grazing lands. Cattle would utilize the mountains and marshes, which are less preferred for purposes of small stock management.

The *ngikerebo* scouts are knowledgeable about landscapes grazing suitability. Some landscapes are appropriate for grazing during the dry season, while others are used for the wet season grazing. The herders are aware that some landscapes could only be grazed for brief periods. Such landscapes have patchy vegetation. Conversely, other landscapes with high grazing potential would resist degradation even when overstocked for extended periods. Such landscapes have the capacity to recover rapidly compared to those that disclosed less grazing potential. For example, the Karamojong perceived that the *eketela* (sandy landscapes) are more vulnerable to heavy grazing than the *arro* (black soil) landscapes. The latter landscapes have greater potential for resisting heavy livestock grazing and recovering rapidly after grazing. The types of landscapes are grazed during the dry season or drought year, while *eketela*, which is sensitive to heavy stocking, is grazed mostly during the wet season. Continuous grazing of *eketela* would result in severe degradation that would take longer periods to recover. The Karamojong would in relation to the status of grazing pressure rate conditions of grazing that might vary from poor to excellent based on presence of the relative levels of indicators. In reconstructing landscape change, therefore, the herders considered, trends based on historical knowledge of grazing compared to the present. Adverse land use changes altered plant species composition, while the landscapes that disclosed no changes compared to historical knowledge showed stability. The Karamojong have terms for describing the gradients of grazing pressure from heavily grazed (*adedeu*), moderately grazed (*erekeny*) to ungrazed (*adakar amoore*). These indicators were applied in joint field assessments.

### *9.2. Selection and testing of ecological and anthropological indicators*

In order to select and test the ecological and anthropogenic indicators we surveyed 80 km long road transects and randomly conducted the assessments at 10 km intervals. The survey results are summarized in Table 6. Each sampling station corresponded with the geographical distribution of the grazing landscape types. The *ngikerebo* scouts in contrast to the Afar *iddo* scouts were able to explain the origination of the

[43] It is a common knowledge that desert temperatures would be high during the daytime, but would be much cooler at night. The explanation in relation to solar energy is well documented. The explanation of the herders would be explained by the same principles.

geographical names of the landscapes (Table 6, see footnotes). The landscapes were classified on the basis of soil surface features, topographic locations and soil color. There were permutations of names, each showing varied conditions, which are reflected in the classification. For example, *angromit* is a general classification given to landscapes that have pebbles and small stones on the soil surface. The particular landscapes would also disclose other features in terms of soil color including *Angromit nagor* (dark soil with pebbles), *Angromit narangan* (red) or in relation to topographical locations (*angromit nalokob emoru*) i.e., sloping from the mountain.

For each landscape surveyed, the *ngikerebo* scouts judged the seasons of grazing by different livestock species, confirming information given by elder informants during group interviews. Of critical importance for determining seasons of grazing were the vegetation indicators and the topographical locations. The scouts also considered grazing suitability by different livestock species during different seasons. The scouts' ratings were high for the greater majority of the landscapes confirming that the Matheniko rangelands were generally highly suited for grazing by the species of livestock they managed. Furthermore, in contrast to the two other case study sites, there was no evidence of invasive species in the Karamojong rangelands. Additionally, all the surveyed landscapes disclosed positive indicators for high grazing potential. About 40% of the landscapes showed fair conditions, while 60% disclosed good to excellent conditions. The trends for the majority of the landscapes were stable. The landscapes that showed downward trends were those that were under home gardens or near the main settlements. Grazing pressure varied from heavy (near settlements) to none in the distance grazing landscapes. However, none of the landscapes showed any evidence of *adedeu.* Rather, the status of the rangelands could be judged to be between *erekeny* -heavily used to *amoone* (little used) with *Nginarekeny* in transition. The overall assessment of the Karamojong rangelands during this brief survey was favorable. The deductions were that the rangelands had the potential for supporting higher stocking rates if the traditional systems of seasonal grazing were maintained. The system of rangeland assessment was closely related to drought –resilient livelihood coping strategies.

### *9.3. Drought-resilient livelihood for coping strategies*

The Karamojong inhabiting the remote parts of northeastern Uganda have access to local markets but for the most part, their livelihoods is based on livestock products and the produce of home gardens. The main threats to livelihood coping strategies are droughts and cattle rustling. The Karamojong used age sets to reconstruct droughts (*akamu*). Droughts were of different severity and their effects on livestock and people were also varied. Droughts would also be varied duration from several months to the whole year. The droughts that occurred between January and July is called *lotekonyen*. Droughts were given names according to the effects on people and livestock. For example, the drought of *lorenlaga* four generations ago was related to scarcity of livestock products. "There was no ghee, which women applied on their bodies" according to one informant. The drought was associated with overall decline in livestock productivity. Historically, there were few times when famine (*lokio*) occurred. The term *lokio* refers to "human weeping" symbolizing the agony caused by hunger. The droughts during the senior age set of *etikoi* were recurrent. The famine called *eron* induced the collapse of livestock and the human populations also during the period of the *etikoi* age set. The few people that survived hunted the wildlife and gathered wild foods. The elderly informants put the period to before coming of the Europeans.[44] The Karamojong killed elephants and exchanged the ivory for cattle with the foreigners they referred to as *Ichumpa*-comprising Swahili, Arabs, Europeans and Ethiopians hunting elephants. The *Ichumpa* using guns raided other tribes and collected slaves and cattle and traded them with ivory. During the next age set of *emoru* (i.e. the sons of *eron*) several droughts were recalled. This included the droughts called l*ukakoit*-which referred to emaciation of the stock as evidenced by loss of bone marrow. Other droughts were called *lokia, lochuu* and *todupak*. Each drought impoverished the population. The Karamojong relied on indigenous social security systems to redistribute livestock.

[44] The period probably referred to the rinderpest epidemic of the 1890s.

Table 6. Selection and testing of ecological indicators at landscape scale in Karamoja rangelands

| Transect name | Landscape classification[45] | Soil indicator[46] | Season of grazing | Grazing suitability[47] (GS) | Landscape grazing potential[48] (LGP) | Condition[49] | Trends[50] WC | GP[51] | Degradation[52] |
|---|---|---|---|---|---|---|---|---|---|
| Moru Kakero[53] | *Angromit nalokob emoru*[54] | With Pebbles, soil colour varied[55] | Dry | Cattle-High | High-cattle | Excellent | Stable WC 30% | Light | *Amoone*[56] |
| Nakiloro[57] | *Angromit nararuakinit*[58] | Lava stone, dark soil | Wet/dry | Camels-high Goats-moderate | High-camels | Fair | Declining WC 40% | Heavy HC < 20% | *Erekeny*[59] |
| Kautakowu[60] | *Eketela longiro*[61] | White- red | Wet | Cattle–high | High-cattle | Good | Stable WC 25% | Light-Moderate > 40% | *Amoone napachol*[62] |
| Morlinga | *Ekowath*[63] | Mixed | Home garden | Cattle-high | High-cattle | Good | Stable | Moderate | *Nginarekeny*[64] |
| Namorungora | Arro | Black | Dry | Cattle-high | High-cattle | Fair | Downward | Heavy | *Erekeny* |

[45] Classified by the *ngikerebo* scouts
[46] Classified by ecologist
[47] Rated by the *ngikerebo* scouts
[48] ibid
[49] Jointly rated by ecologist and the *ngikerebo* scouts on the survey Team
[50] Rated by the *ngikerebo* scouts and woody cover estimated by ecologist
[51] Grazing pressure (GP)
[52] Joint rating by *ngikerebo* scouts and ecologist
[53] Mountain of shrine
[54] Landscapes with pebbles (*angromit*) that slopes (*nalokob*) from mountain (*emoru*)
[55] *Angromit nagor* (dark soil with pebbles), *Angromit narangan* (stony and red)
[56] High grass cover little evidence of grazing
[57] Bushy
[58] Lava stones with dark sandy soil
[59] Heavily grazed with low grass cover
[60] Plateau like
[61] Bushed grassland
[62] High grass cover with open spaces
[63] Transitional landscape between *Arro* (black) and *eketela* (sandy)
[64] Some level of use-between *erekeny* heavily used to *amoone* (little used). The transition is called *Nginarekeny*

At household level the society is structured into the wealthy (*akaparan*) and the poor (*ekulakate*). Traditional household livelihood coping strategies were promoted through social security networks between bond friends, relatives and in-laws. The bond friends (*ekonne*) made up the bulk of social sharing. These are established through sharing of incidentals, loaning of livestock or treating visiting friends to a meat feast, giving out livestock for marriage as well as exchanging livestock for augmenting milk supplies. Bond friends are maintained through regular contacts and exchanges of gifts. A man may have numerous bond friends depending on his wealth-the wealthier households having more bond-friends than the poor. Individuals built wide-ranging networks of bond friends in their lifetime to serve as an insurance against loss of livelihoods due to raids and droughts. The social security webs shared among the Karamojong implied that individuals with limited means would remain within pastoral system. The poor provide herding labour for their wealthier friends to gain access to food and occasional livestock gifts. Only in extreme cases would husbands leave their families behind to seek informal jobs and send remittances to support their families. However, because of the stronger relations through age set systems, in the past, the poor did not necessarily drop out because of poverty alone. The success of the Karamojong drought-resilient livelihoods was dependent on the social institution.

*9.4. Indigenous institutions for indigenous range management*

In the traditional institutions, powers for making decisions were vested with the elders of senior age sets. The elders have ritual and decision making powers. The senior elder council (*kathiko*) are responsible for making decisions. In the process each cluster acts independently from others. The traditional settlements (*ngireria*) are the centres for making-decisions by elders. The senior elders would meet and discuss migration of the livestock or protecting the community against raids or responding to stresses induced by droughts. The decisions would be further discussed with the elder councils of the next settlements. The meeting is organized at the "tree of men" where all the elders would be in attendance and the pressing issues deliberated further. If the issue were about grazing scarcity, the elders would send the *ngikerebo* scouts to survey the grazing before livestock movements commenced. Most experienced individuals from the *ngite* age set (the next to the senior age set) would be sent to make the surveys. They would return with information about the conditions of the rangelands before migration is ordered. The *ngikerebo* scouts would evaluate both quality and quantity of available forage. This is necessary for determining stocking that can be supported. Thus, the scouts would match the stocking and determine the numbers of days or weeks that the grazing and water would last. The *ngikerebo* scouts would provide a brief to the elders about their findings. The elders would evaluate all the information and if they have doubts about the status of the grazing and water conditions, they would send other scouts to different areas. Their decisions would be influenced by the population of livestock population relative to grazing and water available in the target area.

The decisions would be guided by elders with specialized knowledge including those that can read entrails of livestock, shoe-throwers, astrologers and foreseers who played roles of predicting the coming drought events as well as grazing routes to be used or provide prediction of raids by their neighbours. The elders using the traditional early warning information would prepare the community to activate different drought coping strategies. The *emuron* might advice against livestock migration to a particular zone, while recommending movements to other directions. Drought escape regions might be within the grazing territories of the Karamojong clusters or would involve negotiated access to the land of the neighbouring farming communities. After the livestock had reached the new grazing sites information on their performance would be monitored. The kraal leaders from each *ere* would return with information on livestock performance in the new grazing area. This would include milk yield, bull activities, conditions of previously drought weakened livestock, cattle rumen fill and their behaviour when they returned to the kraals in the night and in the morning when they left for grazing. Increased milk yield would imply that livelihoods had improved. The daily monitoring of livestock production performance would influence herder management decisions. The elders would in particular be interested in recovery of previously drought-weakened stock. The elders would then order mothers, young children and the elderly to join the herds to take advantage of the surplus milk production.

The traditional range management system and institutions of the Karamojong similar to the pastoralists in the other case studies have adversely been affected by political challenges. The processes began during the colonial era when the traditional territorial systems were dissolved and replaced by colonial administrative borders. The modern borders altered the concepts of seasonal grazing movements. Furthermore, the new administrative borders lumped together formerly independent groups. Regardless of the superimposed colonial and post-independence borders the Karamojong sections had continued to share grazing during periodic droughts. However, increased competition might be the reason behind endemic cattle rustling in Karamoja.

# 10. Lessons for knowledge transfer, policy and research applications

This study on harnessing of pastoralists indigenous rangelands knowledge as a foundation for sustainable drought –resilient livelihoods achieved developing theoretical and methodological frameworks for testing ecological and anthropogenic indicators for conducting environmental assessments. The review provided comprehensive overview of indigenous knowledge and functions. Different perspectives on rangeland degradation and the indicators used for measuring the changes were discussed both from the perspectives of conventional range science and indigenous knowledge. The main deductions from the review was that the pastoralists perceived environmental changes using the context of livestock production performances, while ecologists used ecological (mostly plant) indicators alone. The wide-ranging indigenous knowledge systems that were reviewed were applied across the three study sites. The theoretical and the methodological frameworks and the stepwise methods for implementing the integrated methods were successfully applied. The frameworks developed were widely applicable and can be generalized to meet different environmental and social-cultural contexts. The indicators were replicable across sites and produced comparable results. The frameworks were interdisciplinary allowing integration of indigenous and ecological methods for transfer of knowledge between herders and ecologists for decision-making for sustainable rangeland management. The principles of indigenous range management built around the concepts of traditional management strategies advocates for mobility that would capture the spatial and temporal productivity of the grazing lands. However, the sustainability of such systems depends on accessibility to key grazing resources.

Differences observed in the three case studies can be attributed to their different languages and cultures, while the production and environmental indicators applied were comparable. This study can therefore conclude that the pastoralists' indigenous knowledge used common principles in indigenous range management. The knowledge was in terms of landscape classifications, grazing suitability, potential stocking rates, knowledge of key and non-key grazing resources, degraded and non-degraded grazing landscapes. The indigenous knowledge can support resource mapping to evaluate grazing landscapes that are at risk of degradation. The indigenous knowledge applied composite indicators that had wide-ranging utility for conventional science for developing holistic rangeland management in areas used by pastoral communities.

The three communities used oral knowledge to reconstruct past environmental changes to understand the impacts of past droughts on livelihood coping strategies. The societies used social security networks for supporting families whose livelihood sources have fallen short of their requirements. For the pastoral communities covered by the current study their capacity to cope with increasing poverty as evidences of internal support systems would require additional research. Nonetheless based on increasing reliance on external food aid one is given an impression that the indigenous systems might be weakening. An alternative view can also be supported by the systems support to the poor members.

Successful application of the indigenous knowledge for the management of rangelands in the past had depended on indigenous institutions. The institutions had three inter-linked functions. Firstly, they were foundations for society mobilization as well as information sharing. Secondly, the institutions regulated use of the grazing lands during different seasons of the year. Thirdly, the indigenous institutions served as the bridge between pastoral societies and the state. The functions varied from the community wide decision-making systems to clan based functions that were concerned with access, regulation and negotiations with neighbours for access to external grazing resources during periodic droughts.

Given that the goals of the present study were in harnessing pastoralists' indigenous knowledge as a foundation for sustainable drought–resilient livelihoods the findings might have several implications including: (a) sharing knowledge, (b) developing sound policies for the applications of indicators and (c) promoting future development agenda and (d) promotion of interdisciplinary research for management of indigenous rangelands.

- The report had demonstrated the potential for sharing information between herders and ecologists for applying indigenous knowledge for range management using scientific criteria of indicator selections and systematic methods of data collection and analysing the information. Although the present study was for only brief periods the methods outlined is sufficiently robust to gather empirically reliable indicators that can be scientifically applied for making decisions. The integrated methods may be utilized for training communities and extension workers and ecologists to achieve several purposes. Firstly, the research had shown that environmental assessments combining ecological and anthropogenic indicators can be used to achieve the objective of environmental monitoring across widely distributed rangelands within reasonably shorter time than were hitherto achieved by ecological research alone. Secondly, ecologists working with herders would understand the rationale behind herder choices of the anthropogenic indicators. The functions of the indicators could be compared with empirically measurable ecological indicators. Thirdly, ecologists should be aware that the ecological and anthropogenic indicators used different units of measurements, suggesting that their analysis for testing hypothesis would have a limited range of either correlative relationships (X by Y) or cluster ordination using appropriate statistical tools. The results would then be used for deducing the relationships between different variable indicators. Using the types of information ecologists would be able to make inferences on the types of relationships for possible decisions. Fourthly, at community levels the approach used in the present study can be effectively applied for planning participatory training and planning research. For example, the integrated methods can be applied to promote community participation in resource mapping. Resource mapping developed by the communities would locate key resources, seasonal grazing routes and marking water points. Such resource maps developed by the communities should indicate different grazing zones, showing the neighbouring grazing associations (Orma), clan territories (Afar) and the territories of the neighbouring clusters (Karamojong). Annotated resource maps should clearly describe the indigenous system of range management at regional and local scales. Fifthly, using resource maps, the communities and range scientists and other resource managers need to identify parts of the grazing lands that were threatened with land degradation, areas where indigenous biodiversity was overexploited or threatened by the invasive species. The resource maps are the plans for indigenous range management. It provides bases for community participations in land rehabilitation in accordance with the implementations of the global environmental conventions such as the CCD and CBD at local community levels. Sixthly, annotated resource maps should be used to implement grazing management by indigenous institutions for promoting livelihood coping strategies and identifying challenges that would threat the functions of the institutions. Support to the indigenous institutions by the state should be obligatory if pastoralism were to maintain viability in the future.

- At regional levels, the information from harnessing herder knowledge for purposes of promoting indigenous range management can be shared widely across pastoral communities using the medium of WISP in collaboration with regional partners. Regional trainings and workshops can provide the forum for sharing the information more widely. The workshops and trainings might focus on four key areas of indigenous knowledge including: firstly, wide-ranging discussions and evaluations of frameworks and criteria for indicator selection. Secondly, applications of the indicators for making management decisions. Thirdly, training on joint use of the indicators with herders. Fourthly, developing guidelines for extension workers for the applications of indicators for collaborative environmental management.

- At the global level, through FAO support and facilitation, the results of indigenous knowledge research on range management can be communicated widely for facilitating international negotiations on applications of the Articles of the UN Convention on Combating Desertification (CCD) and Convention on Biological Diversity (CBD) for supporting community participation. The latter convention could for example be used to support community support to the control of the invasive species and setting criteria on plant introductions into the rangelands for purposes of re-forestation programs. Linkages between implementations of the conventions, indigenous range management and local livelihood coping strategies need to be emphasized.

- At the state levels, there is lack of appreciation of herder knowledge for range management. Despite the herders' capacity to manage rangelands they are often blamed for causing land degradation through overstocking of the rangelands. Contrary to the claims, this study has shown that the indigenous range management is not only robust but can be used to identify high potential grazing landscapes that show greater potential for sustainable rangeland management. The governments in the three countries as well as others should therefore give serious attention to the application of indigenous rangeland management and the applications of indigenous knowledge for achieving sustainable land resource management. The government may support indigenous range management knowledge by acknowledging the indigenous systems of land use, supporting communities' empowerments and community participatory resource planning. Furthermore, the governments should acknowledge and respect the traditional systems of resource use as well as providing tenure security for the key resources. Most importantly, it is time that pastoralism is considered as an important source of economic production. The governments can support indigenous range management knowledge by integrating it into systems of resource management, deciding on priorities of investments and mobilizing local communities as active participants in development planning for promoting conservations of the rangelands.

- The present study has shown how government development and land use policies have undermined applications of indigenous range management knowledge. Changes in land use policies altered mobility as a coping strategy, making the system exceedingly vulnerable to droughts. In the three case study communities political interventions in the name of commercial agriculture or state security have transformed the indigenous systems of land use increasing risks of loss of livelihood coping strategies. The greatest threats are in loss of key grazing resources such as floodplain pastures in Tana River in Kenya and the Awash in Afar in Ethiopia. The two communities suffered double jeopardy from declining rangeland productivity and loss of grazing lands to commercial agriculture. The key grazing resources traditionally served as ecological refuge to drought-induced stresses. For the herders, therefore, loss of access to the key grazing resources would undermine their sustainable livelihoods. Additionally, land use policies in terms of re-forestation programs in the floodplain introduced the use of invasive *Prosopis juliflora*. The species has expanded throughout the floodplains in Tana River in Kenya and the districts of Amibara and Gawane in Afar, Ethiopia. Expansion of the invasive species has rendered the floodplain and the surrounding rangelands worthless for indigenous range management. The indigenous knowledge system has little means and technology for rehabilitating the rangelands currently invaded by the invasive species. As a first step the governments in the three countries need to take extra-care when introducing alien species in the name of land rehabilitation. Often, the introductions of alien plant species are not based on substantive evidence of environmental degradation, nor are the benefits for using the introduced species investigated adequately. The introduction of the species was associated with irrigation schemes, where the assumption was that the introduced species would provide additional sources of fuel wood and land cover. This mistaken environmental policy has had unexpected adverse environmental impacts. In the long run the invasive species would pose a threat to the local and regional biodiversity. Given the lack of experiences with the control of *Prosopis* its control might be on production of commercial charcoal. Firstly, for the local communities this would increase income. Secondly, the removal of the species might promote recovery of the rangelands and conservation of indigenous biodiversity. However given the species' aggressive coppicing potential, complete removal from across the thousands of hectares of rangelands currently invaded could not be restored without technological uses that combined physical and biological control. So far, there are no such experiences to borrow from. The cost of leaving the invasive species to spread would result in the loss of indigenous biodiversity, threatened livelihoods and disruptions of livestock grazing movements.

- Another important lesson from the current study was related to the functions of indigenous institutions for promoting indigenous knowledge for rangeland management. The indigenous institutions that played significant roles in support range management as shown by the study are losing effectiveness under changing administrative policies that shifted power for making decisions and regulating grazing from the traditional to politically recognized state-supported institutions. The Orma informants suggested that the institution of *jarsa mata d'eedha* is facing threats from external forces. Firstly, they perceived that following Kenya's independence, the functions of j*arsa mata d'eedha* have been taken over by the chiefs. This was in contrast to the colonial period when the British administration used the *jarsa mata d'eedha* as the medium through which the government communicated its policies. In some cases, the office holders doubled up as chiefs, maintaining smooth transitions between the indigenous and the formal system of administration. The second problem the office of *jarsa mata d'eedha* is experiencing is deregulation of the district grazing borders that the colonial administration put in place to control movements of pastoral groups outside their assigned districts. The regulatory law (e.g. District Ordinance of the 1930s) protected the Orma from incursions by the more powerful Somali clans from the neighbouring districts. The Orma claimed that the migrant incursions could not be controlled because the Kenya administration ignored such policies. The migrants used force instead of peaceful negotiations. Consequently, grazing regulations between the wet and dry season landscapes were disrupted. Through the use of firearms, the Orma have been displaced from the southern grazing *d'eedha* such as tulla in Bagale Division. The remaining grazing lands are overstocked as the infiltrating groups ignored the guidelines, which the *jarsa mata d'eedha* had laid down for sustainable management of the indigenous rangelands. As result, degradation of the grazing lands has become persistent.

- The indigenous institutions for range management and societal functions among the Afar is also facing challenges from external forces. For example, the imperial government of Haile Sillasie appointed clan leaders as *balabat* that played the traditional and formal administrative roles. The communist government of Mengistu Haile Mariam removed the indigenous and formal systems of *balabat* because of the suspecion that the institution operated outside the formal government institutions. Despite the disruption, the Afar maintained some of the indigenous institutional structures. In the current Federal government structures, the *makabantu* are accepted by the state for maintaining peace. However, new administrative structures such as local *kebele* as alternative forms of power centres in rural areas under the Regional administrative structure created conflicts with the traditional functions. Some Afar academics suggested that the change in the roles played by the clan elders had not strengthened the indigenous institutions because it conflicted with their traditional functions, as their positions were not flexible enough to balance the clan and the official obligations.

- In the Karamoja, in Uganda, the state has introduced a new policy of placing the livestock in security settlements with a view of halting raids and armed cattle rusting. The political administration perceived that migratory movements are the main causes of cattle rustling. Under the guise of insecurity individual groups are restricted. Consequently, the territorial groups are breaking down. In response to cattle raiding the government policy placed the population under quarantine. The current kraaling of the livestock by the army in security villages will have detrimental effects on livestock production particularly when drought occurs. The livestock restricted within short reduced production performances. Yet, the rangelands within 4-5 km radius of the quarantine areas were in highly favourable condition. The decision to kraal pastoral herds would pose a serious threat to the sustainability of the livelihoods of Karamojong pastoral production. The Karamojong rangelands require simple solution of removing the quarantine as a policy priority if disaster is to be avoided.

- The study has achieved in showing the empirical value of incorporating indigenous knowledge into future interdisciplinary programs. One of the recommendations for future research agenda is to widely apply the theoretical and methodological frameworks in other pastoral areas for developing generalized principles of indigenous knowledge for developing participatory research. Complete documentation of indicators for rangeland assessments and monitoring resilient livelihoods need to be developed. Existence of such generalized principles of indigenous knowledge would provide important foundation for global applications of the knowledge across varied cultures and geographical and ecological conditions. More importantly, the integrated research could serve to guide development and policy agenda for implementing the global environmental conventions and promoting local development agenda. Research on indigenous knowledge would also be linked to investigations on state-pastoral relations, effects of resource conflicts on resource access and impacts it has had on changes in rangeland conditions. An important research question that needs addressing is the relationships between ethnic conflicts, government policies of land use and rangeland tenure. Insecurity of resource tenure in the rangelands might be serving as driving force of the conflicts. This may be applied by disaggregating the indicators into policy, resource, development and traditional systems rangeland management.

- The key message of this research is that harnessing pastoralists' indigenous rangelands knowledge has implications for promoting participatory research, verifying theories and testing methods as well as sharing information widely for purposes of promoting effective policies and developing drought-resilient livelihood coping strategies.

## References


Abel, N., Gachugu, Langston, A., Freudeberger, D. Howden, M., and Marden, S. 2002. policies, planning and for sustainable resource: a participary approach. In Grice, A.C. and Hodgkinson, K.C. (Eds) *Global rangelands: Progress and prospects*. CABI publishing, Wellingford UK. Pp. 221-234.

Andreasen, J. K., O'Neill, R., Noss, R. and Slosser, N.C. 2001. Considerations for development of a terrestrial index of ecological integrity. *Ecological indicators* 1: 21-35.

Angassa, A. and Oba, G. 2007. Relating long-term rainfall variability to cattle population dynamics in communal rangelands and a government ranch in southern Ethiopia. *Agricultural Systems* 94: 715-725.

Angassa, A. and Oba, G. 2008. Herder perceptions on impact of range enclosures, crop farming, fire ban and bush encroachment on the rangelands of Borana, southern Ethiopia. *Human Ecology* 36: 201-215.

Baker, L. E. and Hoffman, M.T. 2006. Managing variability: Herding strategies in communal rangelands of semiarid Namaqualand, South Africa. *Human Ecology* 34: 765-784.

Barnad, P., Robertson, M. and Zeidler, J. 1999. Developing an early warning system for environmental degradation in Namibia. In Elldridge, D. and Freudenberger, D. (Eds) *People and Rangelands: Building the future*. VIth International Rangeland Congress Proceedings Vol. 2. Townsville, Queensland Australia July 19-23. Pp. 662-663.

Barrow, E.G.C. 1991. Evaluating the effectiveness of participatory agro-forestry extension programs in a pastoral system, based on existing traditional values: a case study of the Turkana in Kenya. *Agroforestry Systems* 14: 1-21.

Bauer, K. 2009. On the politics and the possibilities of participatory mapping and GIS: using spatial technologies to study common property and land use change among pastoralists in central Tibet. *Cultural Geographies* 16: 229-252.

Behnke, R.H., Scoones, I. And Kerven, C. (Eds) *Range ecology at disequilibrium, new models of natural variability and pastoral adaptation in African savannas*. ODI, London.

Bennet, J and Barret, H. 2007. Rangeland as a common property resource: contrasting insights from communal areas of central Eastern Cape province, South Africa. *Human Ecology* 35: 97-112.

Berlin, B. 1973. Folk systematic in relation to biological classification and nomenclature. *Annual Review of Ecology and Systematics* 4:259-279.

Berkes, F., Colding, J. and Folke, C. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological applications* 10: 1251-1262.

Boardman, J., Poesen, J. and Evans, R. 2003. socio-economic factors in soil erosion and conservation. *Environmental science and Policy* 6: 1-6.

Bollig, M. and Schulte, A. 1999. Environmental change and pastoral perceptions: Degradation and indigenous knowledge in two African pastoral communities. *Human Ecology* 27: 493-515.

Bollig, M. 2006. *Risk management in a Hazardous environment: A comparative study of two pastoral societies*. Springer, New York.

Bonny, B. P. and Vijayaragavan K. 2001. Evaluation of indigenous knowledge systems of traditional via farmers in India. *Journal of sustainable Agriculture* 18: 39-51.

Bouh, A. M. and Mammo, Y. 2008. Indigenous conflict management and resolution mechanisms on rangelands in Somali Regional State, Ethiopia. *Nomadic Peoples* 12: 109-121.

Brouwer, F. and Crabtree, B. 1999. *Environmental indicators and agricultural policy*. CABI, Publishing, Wallingford, Oxford, UK.

Briske, D. D., Fuhlendorf, S.D. and Smeins F. E. 2003. Vegetation dynamics in rangelands: a critique of the current paradigms. *Journal of Applied Ecology* 40: 601-614.

Coppolillo, P.B. 2000. The landscape ecology of pastoral herding: spatial analysis of land use and livestock production in East Africa. *Human Ecology* 28: 527-560.

Dabasso, B.H. 2006. Herder knowledge of landscape scale biodiversity monitoring in Marsabit central, northern Kenya. MSc Thesis, Norwegian University of Life Sciences, Ås, Norway.

Dale, V.H. and Beyeler, S.C. 2001. Challenges in the development and use of ecological indicators. *Ecological Indicators* 1: 3–10

Dalberg, A.C. 2000. Interpretation of environmental changes and diversity: a critical approach to indications of degradation-the case of Kalamate, north west Botswana. *Land Degradation & Development* 11: 549-562.

Davies J. and Bennet R. 2007 Livelihood Adaptation to Risk: Constraints and Opportunities for Pastoral Development in Ethiopia's Afar Region. *Journal of Development Studies*, 43: 490–511.

Desta, S., and Coppock, D. L. 2004. Pastoralism Under Pressure: Tracking System Change in Southern Ethiopia. *Human Ecology* 32: 465 487.

Dovie, D. B.K., Witkowski, E.T.F. and Shackleton, C.M. 2005. Monetary valuation of livelihoods for understanding the composition and complexity of rural households. *Agriculture and Human Values* 22: 87-103.

Ebei , P. A. and Oba, G. in press. *"KIYOTO ATANG'AA* – Step aside I open: Ethno-oral narratives of drought of Turkana pastoralists. Global Pastoralism (in press)

Ebei. P.A., Oba, G. Akuja, T. 2008. Long-term impacts of droughts on pastoral production and trends in poverty in northwest Kenya: An evaluation of 14-year drought early warning data series. In Sánchez, J.M. (Editor) *Droughts: causes, effects and predictions*. Nova Science Publishers, New York, USA. Pp. 103-166.

Ellis, J.E. and Swift, D.M. 1988. Stability of African pastoral ecosystems: alternate paradigms and implications for development. *Journal Range Management* 41: 450-459.

Ezra, M. and Kiros, Gebre-Egziabher 2001. Rural out-migration in the drought prone areas of Ethiopia: a multilevel analysis. *International Migration Review* 35: 749-771.

Fassil Kebebew, Dirres Tsegaye and Gry Synnevåg 2001. Traditional coping strategies of the Afar and Borana pastoralists in response to drought. DCG Report, No. 17.

Fernàndez-Gimenez, M. A. 2000. The role of Mongolian nomadic pastoralists' ecological knowledge in rangeland management. *Ecological Applications* 5: 1318-1326.

Fernàndez-Gimènez, M. E. 2002. Spatial and social boundaries and the paradox of pastoral land tenure: A case study from post-socialist Mongolia. *Human Ecology* 30: 49-78.

Ford, J. and Martinez, D. 2000. Traditional ecological knowledge, ecosystem science, and environmental management. *Ecological Applications* 10: 1249-1250.

Getachew K. N. 2001. *Among the pastoral Afar in Ethiopia: Tradition, continuity and socio-economic change*. International books in Association with OSREA, Utrecht, The Netherlands.

Ginguld, M., Perevolotsky, A. and Ungar, E.D. 1997. Living on the margins: livelihood strategies of Bedouin herd-owners in the Northern Negev, Israel. *Human Ecology* 25: 567-591.

Griffin, G. 2002. Indigenous peoples in the rangelands. In Grice, A.C. and Hodgkinson, K.C. (Eds) *Global rangelands: Progress and prospects*. CABI publishing, Wellingford UK. Pp.29-41.

Grime, A.C. and Hodgkinson K.C. 2002. Challenges for rangeland people. In Grice, A.C. and Hodgkinson, K. C. (Eds.) *Global rangelands progress and prospects*. CABI Publishers, Wallingford, Oxon, UK. Pp. 1-9.

Hellier, A., Newton, A.C. and Gaona, S.O. 1999. Use of indigenous knowledge for rapidly assessing trends of biodiversity: a case study from Chiapas, Mexico. *Biodiversity and Conservation* 8: 869-889.

Henry, S., Piché, V., Ouédraogo and Lambin, E.F. 2004. Descriptive analysis of the individual migratory pathways according to environmental typologies. *Population and Environment* 25: 397-422.

Hodgson, D.L. and Schroeder, R.A. 2002. Dilemas of counter-mapping community resources in Tanzania. Development and Change 33: 79-100.

Homann, S., Rischkowsky, B., and Steinbach, J. 2008. The effect of development interventions on the use of indigenous range management strategies in the Borana lowlands in Ethiopia. *Land Degradation & Development* 19: 368-387.

Howden, S.K., Foran and Behnke, R. 2002. Future shocks to people and rangelands. In Grice, A.C. and Hodgkinson, K.C. (Eds) *Global rangelands: Progress and prospects*. CABI publishing, Wellingford UK. Pp. 11-28.

Hudak, A.T. 1999. Rangeland mismanagement in South Africa: Failure to apply ecological knowledge. *Human Ecology* 27: 55-78.

Illius A.W, O'Connor T.G. 2000. Resource heterogeneity and ungulate population dynamics. *Oikos* 89:283–294.

Kimmerer, R. W. and Lake, F. K. 2001. Maintaining the mosaic, the role of indigenous burning in land management. *Journal of Forestry* 99: 36-41.

Kyagaba, E. 2004. Range resource assessment and monitoring techniques among the pastoral Bahima in Uganda. *Nomadic Peoples* 8: 81-97.

Kassahun, A., Synman, H. A., and Smit, G. N. 2008. Impact of rangeland degradation on the pastoral production systems, livelihoods and perceptions of the Somali pastoralists in Eastern Ethiopia. *Journal of Arid Environments*, 72: 1265-1281.

Krugmann, H. 1996. towards improved indicators to measure desertification and monitor the implementation of the desertification. In Hambly H. and Angura, T.O. (Eds). *Grassroots indicators for desertification: experience and perspectives from Eastern and southern Africa*. IDRC, Ottawa, Canada. Pp. 20-37.

Lado, C. 2004. Sustainable environmental resource utilization: a case study of farmers' ethnobotanical knowledge and rural change in Bungoma district, Kenya. *Applied Geography* 24: 281-302.

Leach, M., Means, R. and Scoones, I. 1999. Environmental entitlements: dynamics and institutions in community based natural resource management. *World Development* 27: 225-247.

Little, P.D. 2003. Pastoral ecologies: Rethinking interdisciplinary paradigms and the political ecology of pastoralism in East Africa. In Bassett, T. J. and Crummey, D. (Eds) *African savannas: Global narratives and local knowledge of environmental change*. James Currey, Oxford. Pp. 161-177.

Mapinduzi, A. L., Oba, G., Weladji, R. B. and Colman, J.E. 2003. Use of indigenous ecological knowledge of the Maasai pastoralists for assessing rangeland biodiversity in Tanzania. *African Journal of Ecology*, 41: 329-336.

Mills, D., Blench, R., Gillam, B., Martin, M., Fithardinge, G., Davies, J., Campbell, S. and Woodhams, L. 2002. Rangelands: People, perceptions and perspectives. In Grice, A.C. and Hodgkinson, K.C. (Eds) *Global rangelands: Progress and prospects*. CABI publishing, Wellingford UK. Pp.43-54.

Mistry, J. and Berrardi, A. 2006. *Savannas and dry forests: linking people with nature*. Ashgate, England.

Mburu, N. 2005. *Bandits on the border: The last Frontier in the search for Somali unity*. Red Sea Press, Trenton, USA

Mkutu, K.A. 2007. Impact of small arms insecurity on the public health of pastoralists in the Kenya-Uganda border regions. *Crime Law Social Change* 47: 33-56.

Msangi, J. P. 2004. Drought and Desertification management in the drylands of southern Africa. *Environmental Monitoring and Assessment* 99: 75-87.

Muhereza, F. and Otim, P. 2002. *Pastoral Resource competition in Uganda: Case studies into commercial livestock ranching and pastoral institutions*. International Books in Association with OSREA.

National Academy of Sciences (NAS) 2000. *Ecological indicators for the Nation*. National Academy Press, Washington, D.C.

Nyerges, A.E. 1982. Pastoralists, flocks and vegetation: processes of co-adaptation. In Spooner, B. and Mann, H.S. (Eds.) *Desertification and development: Dryland ecology in social perspective*, Academic Press, New York, Pp. 221-245.

Oba, G. Stenseth, N.C. and Lusigi, W. 2000a. New perspectives on sustainable grazing management in arid zones of sub-Saharan Africa. *BioScience* 50:35-51.

Oba, G., Post, E., Stenseth, N.C. and Lusigi, W. 2000b. Role of small ruminants in arid zone environments: A review of research perspectives. *Annals of Arid Zone* 39: 305-332.

Oba, G., Post, E., Syvertsen, P.O. and Stenseth, N.C. 2000c. Bush cover and range condition assessments in relation to landscape and grazing in southern Ethiopia. *Landscape Ecology* 15: 535-546.

Oba, G. 2001. The effect of multiple droughts on cattle in Obbu, Northern Kenya. *Journal of Arid Environments* 49: 375-386.

Oba, G. and Kotile G. 2001. Assessments and landscape level degradation in southern Ethiopia: pastoralists versus ecologists. *Land Degradation & Development* 12: 461-475.

Oba, G., Weladji, R. B., Lusigi, W. J. and Stenseth, N.C. 2003. Scale-dependent effects of grazing on rangeland degradation in Northern Kenya: A test of equilibrium and non-equilibrium hypothesis. *Land Degradation & Development* 14: 83-94.

Oba, G. and Kaitira, L. M. 2006. Herder knowledge of landscape assessments in arid rangelands in northern Tanzania. *Journal of Arid Environments* 66: 168-186.

Oba, G. 2007. Challenges and opportunities for pastoralism in Africa: Degrading rangelands or maintaining resilience? In Rosati, A. . Tewolde A. and Mosconi, C (Eds.) *Animal production and animal science worldwide*: WAAP book of the year 2006. Wageningen Academic Publishers, Pp. 317-338.

Oba, G., Sjaastad, E. and Roba, H.G. 2008a. Framework for participatory assessments and implementation of global environmental conventions at the community level. *Land Degradation & Development* 19: 65-76.

Oba, G., Byakagaba, P., and Angassa, A. 2008b. Participatory monitoring of biodiversity in East African grazing lands. *Land Degradation & Development* 19: 636-648.

Oba, G., Weladji, R.B., Msangameno, D.J., Kaitira, L.M. and Stave, J. 2008c. Scaling effects of proximate desertification drivers on soil nutrients in northeastern Tanzania. *Journal of Arid Environments* 72: 1820-1829.

Olsson, P., Folke, C. And Berkes, 2004. Adaptive comanagement for building resilience in social-ecological systems. *Environmental Management* 34: 75-90.

Palmer, C. T., Wadley, R. L. 2007. Local environmental knowledge, talk, and scepticism: Use `LES` to distinguish `LEK` from `LET` in Newfoundland. Human Ecology 35:749 760

Reed, M.S. and Dougill, A.J. 2002. Participatory selection process for indicators of rangeland condition in the Kalahari. *The Geographical Journal* 168: 224-234.

Reid, S., Robin, L., Kruska, R., Muthui, N., Taye, A., Watto, S.,Wilson, J. C., and Mulatu, W. 2000. Land Use and Land Cover Dynamics in Response to Changes in Climatic, Biological and Socio-Political Forces: The Case of Southern Ethiopia. *Landscape Ecology* 15: 339 355.

Ribaudo, M.O., Hoag, D.L., Smith, M.E. and Heimlich, R. 2001. Environmental indices and the politics of the conservation Reserve Program. *Ecological indicators* 1: 11-20.

Roba, H. G. and Oba, G. in press. Framework for integrating indigenous knowledge and ecological methods for implementation of Desertification Convention. In Desertification, NOVA Scientific Publishers, (in press).

Roba, H.G. and Oba, G. 2008. Integration of herder knowledge and ecological methods for land degradation assessment around sedentary settlements in a sub-humid zone in Northern Kenya. *International Journal of Sustainable Development & World Ecology* 15: 251-264.
Roba, H.G. and Oba, G. 2009. Community participatory landscape classification and biodiversity assessment and monitoring grazing land in northern Kenya. *Journal of Environmental Management* 90: 673-682.
Romstad, E. 1999. Theoretical considerations in the development of environmental indicators. In Brouwer, F. Crabtree, B. (Eds) *Environmental indicators and agricultural policy*, CABI Publishing, Wallington, Oxford, 13-24.
Schareika, N. 2001. Environmental knowledge and pastoral migration among the Wodaabe of south-eastern Niger. *Nomadic Peoples* 5: 65-88.
Shanley, P. and Rodrigues Gaia, G. 2002. Equitable ecology: collaborative learning for local benefit in Amazonia. *Agricultural systems* 73: 83-97.
Shields, D. J., Solar, S.V. and Martin, W.E. 2002. The role of values and objectives in communicating indicators of sustainability. *Ecological indicators* 2 :149–160 .
Sheuyange, A., Oba, G., and Weladji, R. B. 2005. Effects of anthropogenic fire history on savanna vegetation in northeastern Namibia. *Journal of Environmental Management*, 75: 189-198.
Sinclair, A.R.E., and Fryxell, J.M. 1985. The Sahel of Africa: ecology of a disaster. *Canadian Journal of Zoology* 63: 987-94.
Spangenberg, J. H., Pfahl, S. and Deller, K. 2002. Towards indicators for institutional sustainability: lessons from an analysis of Agenda 21. Ecological Indicators 2: 61-77
Stave, J., Oba, G., and Stenseth, NC 2001. Temporal changes in woody-plant use and the *ekwar* indigenous tree management system along the Turkwel River, Kenya. *Environmental Conservation* 28: 150-159.
Stave, J., Oba, G., Nordal, I. And Stenseth, N. C. 2007. Traditional ecological knowledge of a riverine forest in Turkana, Kenya: implications for research and management. *Biodiversity Conservation* 16: 1471-1489.
Tache Dida, B. 2008. *Pastoralism under stress: Resources, institutions and poverty among the Borana Oromo in southern Ethiopia*. PhD Thesis, in Environment and Development Studies, Norwegian University of Life Sciences, Ås, Norway
Tsing, A.L., Brosius, J.P. and Zerner, C. 1999. Assessing community-based natural-resource management. *Ambio* 28: 197-198.
Tucker, G. 1999. Measuring the impacts of Agriculture on biodiversity. In Brouwer, F. Crabtree, B. (Eds) *Environmental indicators and agricultural policy*, CABI Publishing, Wallington, Oxford, 89-103.
Turner, M.D. and Hiernaux, P. 2002. The use of herders' accounts to map livestock activities across agro-pastoral landscapes in semi-arid Africa. *Landscape Ecology* 17: 367-385.
Turner, N.J., Ignace, M.B. and Ignace R. 2000. Traditional ecological knowledge and wisdom of Aboriginal peoples in British Columbia. *Ecological Applications* 10: 1275-1287.
Unruh, J. D. 2005. Changing conflict resolutions in the Ethiopian pastoral commons: the role of armed confrontations in rule-making. *GeoJournal* 64: 225-237.
Walker, D. H., Thorne, P.J., Sinclair, F. L., Thapa. B. Wood, C.D. and Subba, D. B. 1999. A systems approach to comparing indigenous and scientific knowledge: consistency and discriminatory power of indigenous and laboratory assessment of the nutritive value of tree fodder. *Agricultural Systems* 62: 87-103.
Warren, D.M. 1991. *Using indigenous knowledge in agricultural development.* World Bank Discussion Paper No. 127. Washington DC. The World Bank.
Wascher D. M., Mugica, M. and Gulinck, H. 1999. Establishing targets to assess agricultural impacts on European landscapes. Romstad, E. 1999. Theoretical considerations in the development of environmental indicators. In Brouwer, F. Crabtree, B. (Eds) *Environmental indicators and agricultural policy*, CABI Publishing, Wallington, Oxford, 73-87.
Yoccoz, N.G., Nicholls, J.D., Boulinier, T. 2001. Monitoring of biological diversity in space and time. *Trends in Ecology and Evolution* 15: 446-453.