Natural resource management in the drylands in the Horn of Africa

Brief 1

Technical Consortium for Building Resilience to Drought in the Horn of Africa

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Natural resource management in the drylands in the Horn of Africa

Technical brief prepared by the Technical Consortium for Building Resilience to Drought in the Horn of Africa hosted by the CGIAR Consortium in partnership with the FAO Investment Centre

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Abbreviations

CBD	Convention on Biological Diversity
DFID	Department for International Development [UK]
FAO	Food and Agriculture Organization of the United Nations
GDP	gross domestic product
IGAD	Intergovernmental Authority on Development
ILRI	International Livestock Research Institute
LAPSSET	Lamu Port and Lamu Southern Sudan–Ethiopia Transport Corridor
NAPCD	National Action Plan to Combat Desertification
NGO	non-governmental organization
NRM	natural resource management
ODA	Overseas Development Assistance
PSNP	Productive Safety Net Programme
UNCCD	UN Convention to Combat Desertification
UNFCCC	UN Framework Convention on Climate Change
UNOCHA	UN Office for the Coordination of Humanitarian Affairs
WFP	World Food Programme

Terms

Term	Countries
COMESA	Burundi, Comoros, Democratic Republic of Congo, Djibouti, Egypt, Eritrea. Ethiopia, Kenya, Libya, Madagascar, Malawi, Mauritius, Rwanda, Seychelles, South Sudan, Sudan, Swaziland, Uganda, Zambia, Zimbabwe
East Africa	historically, Kenya, Tanzania, Uganda
East African Community	Burundi, Kenya, Rwanda, Tanzania, Uganda
Greater Horn of Africa (eastern Africa)	Burundi, Djibouti, Eritrea, Ethiopia, Kenya, Rwanda, Somalia, South Sudan, Sudan, Tanzania, Uganda
Horn of Africa	Djibouti, Eritrea, Ethiopia and Somalia
IGAD	Djibouti, Eritrea (suspended), Ethiopia, Kenya, Somalia, South Sudan, Sudan, Uganda

Executive summary

The Intergovernmental Authority on Development (IGAD) region, comprising seven[1] discrete countries in the Horn of Africa, consists largely of lowlands with arid, semi-arid or dry sub-humid climates. These landscapes are predominately pastoral and agro-pastoral systems that are characterized by productivity dependent upon low and inconsistent precipitation, soils of low fertility, and subsequent risks of recurring drought. Small pockets of hunter-gatherers also exist. This environment supports a human population growing at rates that range between –0.3% and 3.7% per year. The natural resource base and the services it provides underpin the majority of livelihoods for the people of the Horn of Africa; it is therefore of fundamental importance to ensure that policies, institutions, practices and processes are in place to improve resilience and productivity, in order to reduce recurring droughts and food insecurity within the context of a changing climate. Doing so will save and improve lives and livelihoods among the region's 160 million inhabitants.

There are two basic properties of the dryland ecosystems in the Horn of Africa: instability and resilience. Instability is unpredictability and the quality of not being in equilibrium. These characteristics have of necessity caused land managers to deploy a number of risk-spreading strategies. Pastoralists safeguard herds in the harsh environment and farmers diversify their farming systems to avoid crop failures. Pastoralism—economically and ecologically speaking—appears the most appropriate livelihood strategy in most of the drylands of the Horn of Africa, for two reasons. First, these landscapes are grazing dependent; grazing stimulates vegetation growth, prevents bush encroachment, fertilizes the soil, enhances the soil's water filtration capacity by hoof action, aids in seed dispersal to maintain pasture diversity; and enhances the cycling of nutrients across the ecosystem through both wet and dry seasons. Second, pastoralists are able to manage herd dynamics—herd size, breeds and movements—to capitalize on the availability of natural pasture and water or address their fluctuating scarcity. Farmers and agro-pastoralists in zones that can support crop production also diversify their farming systems: they mix crops and integrate livestock and trees into their systems, and they conserve and manage soil, water and nutrient resources to sustain productivity. Land managers and the ecosystem species themselves in these drylands are by nature adaptive.

From another perspective, the combination and confounded relationship of biophysical and social constraints in place in these systems has led to a combination that in overall terms has become far more vulnerable to risks and less resilient. The sustained disruption of interrelated ecosystem processes (water and nutrient cycles, biological diversity and energy) and seasonal variability within an already fragile and water-scarce environment—along with protracted crises exacerbated by climate change and intermittent disasters—threaten the capacity of these systems to sustainably support food security and livelihoods in the future.

Institutional challenges undermining continued adaptability and resilience come in the form of trends that are associated with access to and tenure of land resources, disruption and loss of grazing rights, limited access to productive inputs and basic services, social marginalization, increased conflict over resources, disintegration of traditional institutions, dynamic cross-border relationships, lack of infrastructure, low development funding, and the nature of planning, administration, decision-making, and policy formulation and implementation. These have resulted in, among other results, a broader spectrum of livelihood strategies. For pastoralists the situation has meant in some cases leaving pastoralism behind forever, settling into non-pastoralist lifestyles, or adding cropping or other enterprises to their production portfolio. Only a wealthy minority have been able to fully

[1] Djibouti, Ethiopia, Kenya, Somalia, South Sudan, Sudan, Uganda.

benefit, increasing herd sizes through appropriation of resources in a context of tenure insecurity. Smallholder farmers are increasingly unable to afford production inputs and are often forced into dryer areas or threatened by a trend in proliferation of land allocations by large commercial and intensified operations.

Notwithstanding, numerous lessons have been learned from development successes and failures. A movement is growing to enhance development in order to reduce emergency response time. A number of initiatives are under way that have the potential to support the sustainable management of natural resources in the arid and semi-arid lands of the Horn of Africa. These initiatives can serve as the basis for identifying priorities in research, practice, processes and policies—and investment strategies—that will enhance the resilience, growth and productivity of livelihoods and landscapes in the Horn of Africa.

Priority areas of intervention have been identified:

- policy and legal frameworks dealing with land tenure.
- landscape and livelihood planning and decision-making built upon integrated multi-sectoral, multi-stakeholder and multilevel processes supporting pastoralists, agro-pastoralists and ecosystem processes.
- capacity development of stakeholders and institutions in leadership and facilitation skills and practices that build resilience of agro-environments.
- infrastructural development that is related to sustainable water development and access roads to markets.
- research and knowledge management that provide evidence for informed decision-making and policy development, scaling up appropriate practices and valuing ecosystem services.
- harmonized funding mechanisms from both public and private sources, focused on resilience and growth-enhancing interventions in order to provide incentives for land users to manage the natural resource base in a sustainable manner.

Background and Introduction

Importance and value of the natural resource base to sustainable livelihoods and resilience in the drylands

About 3.4 million km^2, or 80% of the IGAD (Intergovernmental Authority on Development) region's total area, consists of lowlands with arid, semi-arid or dry sub-humid climates, where precipitation is low and uncertain (100–600 mm per annum) (Niemi & Manyindo 2010). The per capita availability of fresh water varies from about 1666 m^3 in Uganda to 460 m^3 in Djibouti (LOG Associates 2010). The IGAD member states have significant pastoral and agro-pastoral populations with around 17% of total population in pasture-based production systems. Predicted population growth across the member states from 2004 to 2015 ranges from –0.3% in Djibouti to 3.7% in Uganda (IGAD 2007). Djibouti and Somalia have the greatest proportion of their populations in pasture-based production systems (71% and 76% respectively); while Sudan, Somalia and Ethiopia have the largest pastoral and agro-pastoral populations (around 8.1, 7.4 and 5.1 million respectively) (Sandford & Ashley 2008).

Interconnectedness of land, water, nutrient and energy dynamics

Arid and semi-arid lands provide numerous goods and services that have great economic, social, cultural and biological value in all geographical aspects: locally, nationally and globally (Mortimore 2009). Drylands cover a range of different ecosystems resulting in a patchwork of vegetation types, different vegetation states, and variation in the limiting factors of water and soil nutrients. The different key components of drylands (land, water, nutrients and energy) are deeply interconnected: changes in one component will affect the others. The capacity of rangelands to produce commodities and to satisfy societal needs on a sustained basis depends on internal, self-sustaining ecological processes such as soil genesis, water and nutrient cycling, energy flow and the structure and functional dynamics of plant and animal communities. Humans depend on these natural processes and their capacity to regenerate and restore the ecosystem after natural and human-induced disturbances. Security of access to land and resources is vital for sustainable development.

Dryland species and ecosystems have developed unique strategies to cope with low and sporadic rainfall. They are hardy and recover quickly or even positively benefit from prevailing disturbances such as fire, herbivore pressure and drought. Plant species, for example, often have large below-ground root or tuber systems to store water and nutrients, or corky bark to insulate living cells from desiccation and fire. Dryland people have engineered pastoral, hunter-gatherer and farming systems that are adapted to these conditions and have sustained the livelihoods of inhabitants for centuries. They have acquired extensive knowledge of species, habitats and key ecological processes in grazing lands, and they have developed efficient management skills for these systems (e.g. (Dubasso et al. 2012; Rugadya 2005)).

Logic of pastoral livestock production

Many drylands are grazing-dependent systems. Due to strong seasonal variation, the seasonal risk of overgrazing is short. Grazing stimulates vegetation growth, prevents bush encroachment, fertilizes the soil, enhances the soil's water filtration capacity by hoof action breaking the soil crust, aids in seed dispersal to maintain pasture diversity, and enhances the cycling of nutrients through the ecosystem through the wet and

dry seasons (Savory 1999; Bolwig et al. 2011). Evidence exists to support the view that light or moderate grazing increases rangeland productivity in many grazing systems. It has been shown that productivity is higher under controlled and repeated grazing with adequate recovery times in between rather than complete exclusion from grazing: overprotection can result in a decline of species richness (Oba 2010). On the other hand, uncontrolled, intensive grazing without appropriate rest can lead to the degradation seen in many pastoral areas today.

The two basic properties of dryland ecosystems in the Horn of Africa—instability (unpredictability, not being in equilibrium) and resilience—support the continued practices of transhumance and nomadism. Pastoralists employ a number of highly specialized risk-spreading strategies to safeguard herds in the harsh environment (see Box 1). The main objectives of pastoralists are not just increasing herd size but also increasing milk yield, maintaining appropriate herd structure and ensuring disease resistance by breeding. Priorities may change depending upon the circumstances of the household.

Crop production systems

Box 1. Risk-spreading and management strategies of pastoralists to safeguard herds in face of severe climatic events:

- building up herd numbers as insurance against drought.
- splitting herds across different locations to lessen risk from lack of grazing, exposure to diseases, etc., and to allow livestock to feed on pasture that suits it best, thus reducing competition among livestock and dispersing stocking pressure.
- keeping different species and breeds to make use of different ecological niches.
- selecting animals for different traits that enable survival in prevalent conditions.
- loaning or giving surplus animals to family and friends, which also serves to develop and strengthen social relations as a form of social capital.
- matching the number of animals to the availability of natural pastures and water.

Source: Hesse and MacGregor 2006

Though land use across much of the Horn of Africa drylands is pastoral focused, increasingly crop production farming systems have been well established in less arid parts. To preserve diversity in an environment that can be highly unpredictable, crop production is often combined with pastoralism in mixed crop (e.g. millet–sorghum or cereal–root crop) or in settled integrated crop–livestock systems. Agro-pastoral millet–sorghum systems are found mostly in Somalia and the central Kenyan highlands; maize mixed systems are more prevalent in Kenya and Ethiopia (along with significant areas of teff), where trees and livestock are also important components. Crop failure can readily occur in drought years and mixed systems offer risk-reducing diversification. Less than 1% is irrigated crop production (see Figure 1). Due to the small size of holdings, variable rainfall, often-poor nutrient availability, degradation and erosion risks as well as a lack of productive input supplies, crop production can be challenging (Bahiilgwa et al. 2005). Increasingly, however, smallholding agriculturalists are moving into more dry marginal areas as population has increased in higher productivity lands[2] or these lands are being allocated to commercial investors and companies (Flintan 2011). In these more marginal areas, evidence suggests that it is exceedingly difficult for smallholder crop producers to get an

[2] In Ethiopia, for example, almost 40% of farm households have less than 0.5 ha of land, and more than 60% have less than 1 ha, from which to support a family of about six to eight people. With the exception of Uganda, only 4–10% of the land area of the Horn of Africa is classified as arable.

adequate return on investment to consistently lift them above the poverty level (Harris and Orr 2012). There is also an increasingly important trend in some districts of Kenya for pastoralists to plant crops near rivers (V. Carucci, personal communication). Overall, unsustainable management of the fragile ecosystem has resulted in reduced biomass, biodiversity and water infiltration, and increased runoff and soil erosion—exacerbating environmental degradation and further lowering agricultural productivity (Mortimore 2009). Though irrigation may be the solution in areas of higher rainfall or permanent water sources, in the majority of these drought-prone areas, and in particular in those areas that have no permanent sources of water and poorer quality soils, it is not cost-effective. Further, it can have a destabilizing effect on pastoral production systems that depend on these same water and grazing resources at certain times of the year. If the full production of drylands is to be realized, there needs to be greater emphasis and investment in more suitable and effective integrated cropping and pastoral systems that capitalize upon and sustain the dryland ecosystems and environment.

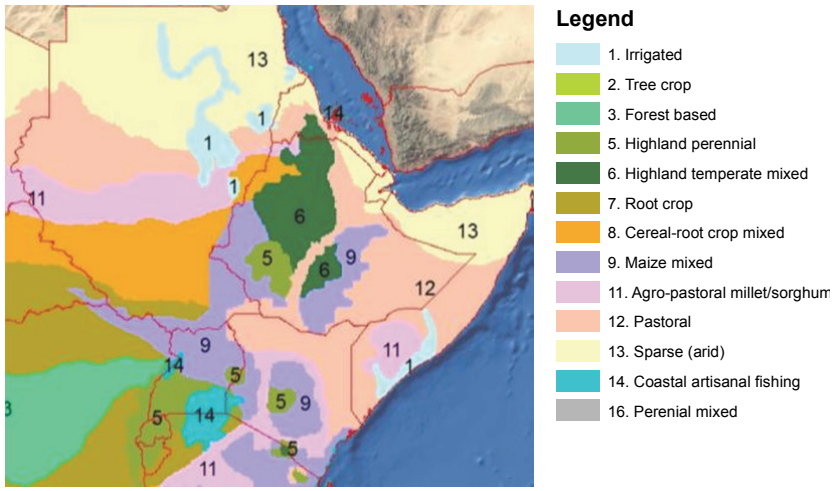

Figure 1. Farming production systems in the Horn of Africa (from Harvest Choice, Bill and Melinda Gates Foundation, FAO and the ICRAF (World Agroforestry Centre)–ACIAR (Australian Centre for International Agricultural Research) Farming Systems Update Team, 2012)

Managing for effective and resilient ecosystem functions

Pastoralists are adaptation specialists. They respond to and use variability, even choose and profit from it. Unpredictable and often scarce rainfall dictates where, when and how much vegetation is available for livestock. Mobility enables pastoralists to inhabit areas of harsh and volatile climate and to transform seemingly unproductive areas into productive assets. Mobility and the management of herd dynamics allow them to track changes in feed supply, avoid areas where forage is insufficient, and take advantage of surpluses when and where they are abundant (Behnke 1994). More surface covered by biomass leads to more effective rainfall capture.

The variability found in the drylands explains why crop farmers experience huge inter-annual differences in yields and harvest success (Anderson et al. 2009). To mitigate some of the risks of growing crops in a context of such variability, traditional and integrated crop–livestock–tree farming systems have been developed, nurturing biodiversity despite pressures to convert to mechanized monocropping. These systems generate multiple uses and products rather than specialize in productivity, such as recycling nutrients among the

different components. For example, in a study of indigenous practices in farming systems and crop planting methods in eastern Kenya, Mathenge (1999) described no fewer than 10 distinct farming systems. Promotion of crop genetic diversity is part of farmers' coping strategies for mitigating weather unpredictability; it also reduces the hunger period by spreading availability of food products over time. Today, as pressures on farmers to grow crops on more marginal lands, and competition with large commercial farms and other land uses is increasing, these more effective and resilience-building activities are being compromised.

Current situation

Policies and legal framework for natural resource management

Development and investment policies across the region have favoured the high agricultural potential areas of nation states, often ignoring dryland areas. This is despite the clear comparative advantages arid and semi-arid areas have: their strategic position, livestock trade, tourism, natural wealth, resilience and cohesion of their people, and their ability to manage climate variability. Investments in drylands are often falsely perceived as being inefficient in terms of output and providing low returns on investment. Where interventions have been carried out, they were often sectoral in nature, focusing on agricultural commodities and on the intensification of livestock production (ranching). They did not take into account the dryland ecosystem and climate dynamics (Nassef et al. 2009). As a result, dryland areas record the highest levels of poverty and the lowest development indices (UNDP 2008).

Resource access, tenure and use are the greatest threats to sustainable management of natural resources. Increasingly, however, in East Africa and the Horn of Africa, policies and legislation provide a more facilitating environment for sustainable use and management of drylands and their natural resources. Despite these positive policy moves, the full implementation of facilitating policies and legislation that protect dryland resources for and by local populations has yet to be achieved, resulting in many of the challenges facing pastoralists, hunter-gatherers and other rangeland users described below. Though much of this can be put down to lack of political will, there has also been inconsistency among scientists about appropriate drylands management. Further, administrative and financial resources have not materialized to implement and enforce legislation on the ground.

Institutional actors (local, national, regional, formal/informal)

In most countries in the East Africa and Horn of Africa regions a hierarchy of formal institutions is charged with policy, management and research related to natural resources and land. In addition a number of regional bodies and strategies seek to enhance the integration of natural resource concerns into development frameworks for environmentally sustainable economic development in the region, and to intensify cooperation among member states to reverse environmental degradation. These include IGAD's Environment and Natural Resources Strategy, the Nile Basin Initiative, the East African Community, the Common Market for Eastern and Southern Africa (COMESA), and the Environment Action Plan for Eastern Africa of the New Partnership for Africa's Development (NEPAD), as well as global environment conventions and agreements ratified by countries in the region including UNCCD (UN Convention to Combat Desertification), CBD (Convention on Biological Diversity) and UNFCCC (UN Framework Convention on Climate Change). NGOs (non-governmental organizations) and community-based organizations also play a role.

In most dryland areas strong traditional institutions and customary mechanisms of resource management and conflict resolution exist. Increasingly these are open to new ideas and engagement with formal government institutions. However, political representation of pastoralists and other rangeland users such as hunter-gatherers in many countries in the region is ineffective. Absent is an overall framework for pastoral rights, and often the capacity of elected officials to represent their constituencies is weak (Nassef et al. 2009). In general, customary rights and pastoral social institutions are not recognized by law, for example in Ethiopia, Somaliland, Sudan (Dyer 2008) and Uganda (Rugadya 2005).

Decentralization in nation states has often failed to take full advantage of customary institutions (where strong), even though they offer opportunities for good governance as they have a better understanding of local dynamics, and often receive greater respect and authority. Often customary systems operate in parallel with state institutions, which results in contradictory rules, competing authorities and 'forum shopping'.[3] In other parts, continued intervention of the state in customary resource tenure and its administration is eroding customary institutions.

In some parts of the region, public sector collapse has left a particularly large vacuum and weakness in economic spheres such as telecommunications, banking and transportation. Here the private sector has found a new role, stepping in to provide services. In Somalia for example, public–private partnerships have flourished in providing education and water, often facilitated by development agencies such as FAO (Food and Agriculture Organization of the United Nations) (2011). Additionally, bilateral partners are increasingly working through the private sector to disburse and manage funds; for example in Ethiopia, DFID (Department for International Development, UK) has partnered with KPMG in their Strategic Climate Institutions Programme.

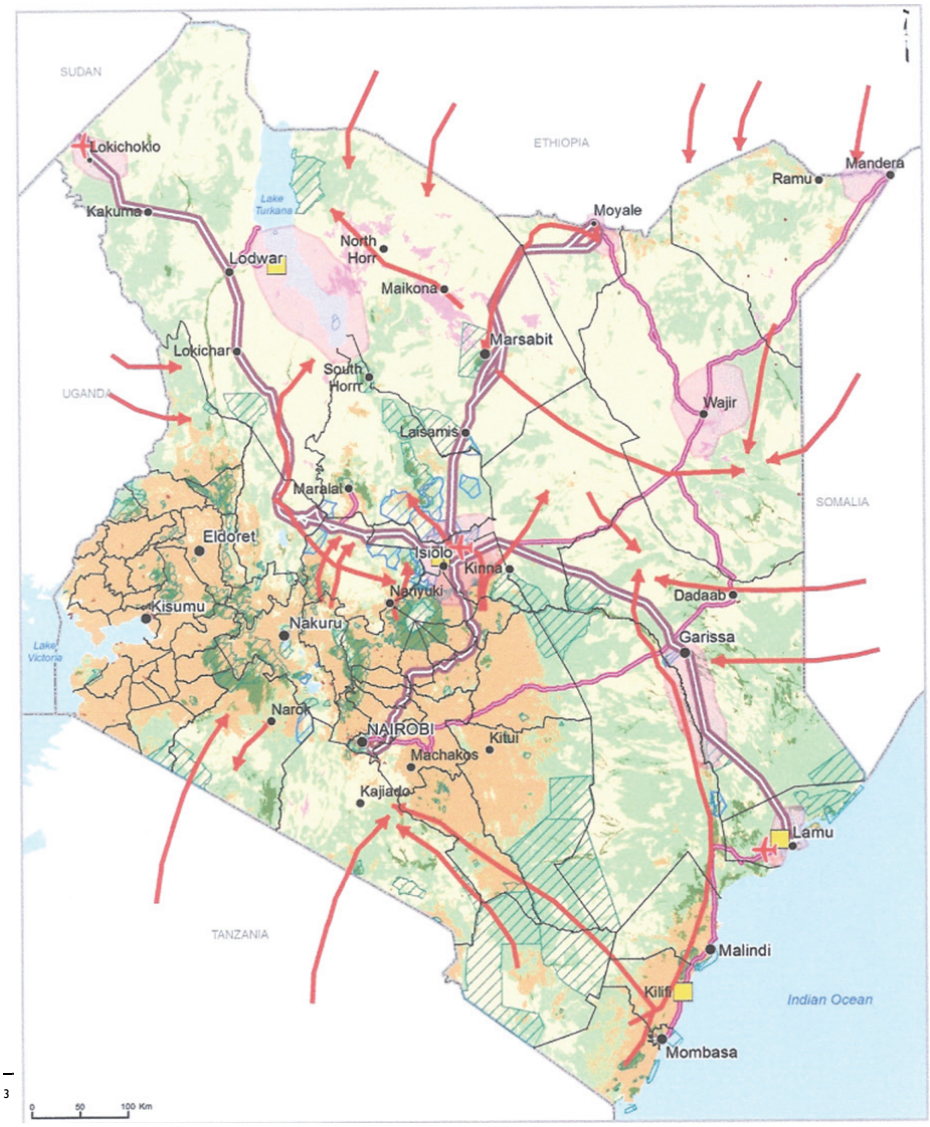

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Figure 2. *The projected LAPSSET corridor and current mobility patterns of pastoral communities (source: ILRI).*

Infrastructure and services for natural resource management

Most of the drylands are remote and are constrained by rudimentary transport, communication and information infrastructure. Markets are underdeveloped or not functioning. Limitations placed on cross-border trade and mobility are a major cause of health (human and livestock) and security hazards (see below). Renewable energy and groundwater sources can be substantial in dryland areas, but they are rarely exploited. Water development, where it has taken place, is often poorly planned and may have created more costs than benefits to dryland production systems in the long term. Health, education and livestock services for people and livestock are few. Supportive public advisory services for livestock keepers or poorer farming communities are minimal.

Though the development of infrastructure such as roads, rail and ports is seen as being critical for growth in the region, it can also lead to further challenges for local communities and for the natural resource base. Roads and other infrastructure can attract a rapid influx of outsiders who dominate economic activities. This influx can result in reducing communities' potential for sustainable use of natural resources (Homewood et al. 2009). Large infrastructural development (for example the Gibe dams in Ethiopia and the Turkwell Electricity Project and Olkaria Geothermal Project in Kenya) mean displacing large numbers of people from the sites of the projects and related irrigation schemes. In Kenya the LAPSSET (Lamu Port and Lamu Southern Sudan–Ethiopia Transport Corridor) development will take away more pastoral lands and/or further challenge mobility (see Figure 2). And though many countries in the region have policy and legislation in place requiring social and environmental impact assessments on infrastructural developments, implementation is lacking.

Capacity of key stakeholders and institutions involved

To date IGAD member states have contributed little to regional cooperation over sustainable drylands management such as in environmental assessments, the establishment of suitable incentive measures for good practice, and in appropriate fiscal regimes that fully account for the contribution of dryland environments and natural resources. Governments require assistance to identify and develop such measures to complement regulatory enforcement—developing guidelines for promoting private sector voluntary compliance in environmental matters, monitoring systems, strengthening regional and integrated approaches to natural resource management in the drylands, developing modalities for mineral development and renewable energy, and carrying out necessary research (IGAD 2007).

The multitude of actors and scattered responsibilities and mandates across governments, donors, organizations and institutions is a major challenge to development in the drylands, and for early response to crises. Better coordination and sharing of information is required at all levels. Decentralization processes in some IGAD countries offer greater opportunities for coordination at a level nearer to dryland users—in Kenya, for example, the recent devolution of much authority to the counties makes provisions for local land-use planning and natural resource management.

Building the capacity of communities to overcome drought and make the most of social and economic opportunities being created in the drylands is challenging—they lack information, assets and skills and are faced with many new obstacles (detailed below). Despite significant progress at an aggregate level, the development of nation states remains challenged by hard-to-reach populations in the drylands. For example, investing in programs of education and health services that fulfil their needs will contribute to building a solid foundation for sustainable growth in the future. It will also help governments to meet their international obligations and commitments.

Financing instruments and mechanisms

Drylands, and in particular livestock-related sectors, have received disproportionately fewer investment and financial resources than non-dryland areas despite their rich natural resources, potential productivity and contribution to environmental services nationally and regionally (Mortimore 2009) (see Table 1**).** The sustainable management of these resources has not been prioritized by national governments in the region (IGAD 2007). External financial resources have proved to be a vital source of investment. Some innovative schemes have been established by conservation organizations making payments for environmental services such as paying local Maasai landowners around the Masai Mara National Reserve and Nairobi National Park[4] for allowing free movement of wildlife on their land.

Opportunities exist for realizing greater financial resources domestically from the region's natural resources. For example, IGAD member states are yet to benefit significantly from the emerging carbon market and other ecosystem services (see below). IGAD countries in general are having difficulty in accessing financial resources through the Clean Development Mechanism of the Kyoto Protocol of the UNFCCC. Furthermore, additional resources can be accessed from the provisions of other multilateral environmental agreements such as the CBD and the UNCCD. However, once again the IGAD region has not received its fair share of the available financial resources from existing environmental instruments and facilities. The constraints to accessing potential incremental financial resources are largely technical and can to a large extent be overcome by building the capacity of member states. IGAD itself is also in a position to facilitate access by the region to funds from legally binding agreements such as the African, Caribbean and Pacific Group of States and the European Union Cotonou Agreement, and is creating a regional IGAD Environment and Natural Resources Endowment with seed capital from member states. Indeed, one key principle for IGAD involvement is that the mobilization of domestic resources will be used to leverage external funds (IGAD 2007).

Increasingly the private sector is also looking to benefit from and invest in dryland areas as resources and land become scarcer in other areas; see for example the increased trends of large-scale land acquisitions being undertaken in dryland areas for commercial agriculture (see below). New public–private partnerships are also being developed as donors seek to increase efficiency and value for money. IGAD is playing a facilitating role in some of these endeavours.

Implications of climate change

Climate change poses serious threats and challenges to East Africa and the Horn of Africa. It is expected to exacerbate existing risks such as water stress, spread of infectious diseases and food insecurity. Climate change models predict that across Africa the median temperature increase by the end of this century will be 3–4°C. Future warming is likely to be greatest over the interior of semi-arid regions and central southern Africa. There are likely to be significant increases in temperature and changes in rainfall patterns, resulting in the potential for increased drought and flood events. A rise in sea level represents a threat to the region through saltwater intrusion and coastal erosion (Nassef et al. 2009).

Climate change interacts with many other types of changes that together contribute to increased vulnerability of dryland populations. Indigenous strategies alone are insufficient to cope with the effects of climate change. Both positive and negative societal transformations are taking place, in some cases undermining the adaptive capacity of dryland users and further increasing their vulnerability. Parallel increases in changes in land use leading to loss of key resources and fragmentation of lands further erode resilience and exacerbate the effects

[4] See: http://www.farmbizafrica.com/index.php?option=com_content&view=article&id=152:pastoralists-earn-for-conserving-ecosystem&catid=24:climate-change&Itemid=160.

of climate change. This situation suggests that any single formula or policy will be insufficient for addressing climate change and it is likely that building the capacity of communities to adapt to change will be more effective than trying to predict and mitigate any one impact.

Table 1. Financing livestock-related activities

Livestock-related sector or industry	Financing
Livestock breeding and production	Public financing remains low Donors and NGOs continue to be active in financing activities Pastoral livelihood is less attractive to investors
Water	Financing is largely public Investment levels remain inadequate Underdeveloped infrastructure requires huge capital outlay Recent developments show Greater Horn of Africa member governments increasing their funding in the sector Strategies for public–private partnerships need to be developed
Pastures	Public financing is nearly absent Private sector involvement is still lagging Funding on research is low
Land	Funding for policy enactment has been on the rise regionally Public sector financing of reforms is on the increase Private sector funding is normally targeted to change use from pasture to other industries
Environment	Financing of environmental policies by public sector remains low Institutional funding from public and private sectors is inadequate Reward for environmental services is being explored
Industry and trade	Private sector participation has been on the increase Trade and industry policies are still non-responsive to the needs of the regional market

Source: LOG Associates 2010; Silvestri et al. 2012

Reducing vulnerability through building the resilience of communities and their capacity to adapt to change involves more than technological or engineering measures to reduce the biophysical impacts of climate change. Rather, a suite of strategies is needed that will address the factors that generate vulnerability (Eriksen et al. 2008). Although most of the National Adaptation Programmes of Action developed in the region do focus on a mix of interventions such as strengthening disaster early warning systems, developing small-scale irrigation in drylands, promoting water development and afforestation, and in some cases improving pastoral production and rangeland management, the greater need is to focus on building pastoralists' and farmers' adaptive capacities, on trends in changes in livelihood strategies, on the root causes of vulnerabilities (Nassef et al. 2009) and on ensuring livelihood options are available and accessible. A summary of the vulnerability contexts of different countries is provided in Table 2.

Challenges

The fundamental challenge posed by drylands in East Africa and the Horn of Africa is their vulnerability brought about by variability in amount of rainfall, lack of investment, insecure land and resource tenure, and externally driven decision-making resulting in inappropriate development of resources. Over the last decade or so, national governments and international donors have developed early warning and emergency response systems to cope with the humanitarian risks posed by an erratic environment. The challenge now is to move beyond coping with environmental liabilities and to develop policies that more appropriately exploit the productive and conservation benefits provided by these dynamic dryland systems.

In the Greater Horn of Africa, resource managers must also address two fundamentally different types of environment: areas more suitable for sustainable agricultural intensification, and areas more suitable for extensive livestock production and for wildlife and biodiversity conservation. Different management approaches are appropriate to each of these environments. Moreover, in many parts it is necessary to manage a combination of high- and low-potential areas that lie adjacent to one another, for example river basins, watersheds and wetlands that are situated within and linked biologically and economically to surrounding extensive rangelands. Successful management of these complex semi-natural resource systems requires policymakers to address a series of management issues, which are discussed below.

Seasonal and inter-annual variability

There is a correlation between average rainfall levels and the reliability of rainfall: the less rainfall an area receives on average, the more unreliable and unpredictable rainfall will be from year to year. This means that those parts of eastern Africa with the harshest climates are also those exposed to the highest levels of risk from periodic drought (Ellis 1995). Reduction or loss of surface vegetative cover is a critical factor as it results in evaporation, accelerated runoff and soil erosion, all of which increase the severity and extent of degradation and further reduce resilience to drought. Estimates of more than 70% water loss to evaporation have been noted on bare ground (Donovan 2007)—an unaffordable loss at a time of increasing drought risk. Unlike producers in more stable and temperate climates, livestock owners in these environments can ill afford to plan for the 'average' rainfall year, which they may actually experience very infrequently. They may also—quite understandably—be less concerned to maximize livestock output under favourable conditions than to buffer themselves from the threat of large, unpredictable climate-driven fluctuations in output.

Mobility is one technique that East African livestock managers employ to buffer themselves from climate-induced stress. In climatically unstable and harsh environments, it is often necessary to move herds, both to avoid seasonal extremes of heat, cold, drought or insect infestation and to exploit areas of unusually high but temporary resource productivity (Niamir-Fuller 1999; Behnke et al. 2011). In these circumstances, migratory movement is an effective husbandry practice.

Table 2. Climatic challenges, vulnerable sectors and vulnerability context of countries in the region (shaded area indicates a real or potential problem)

Challenges	Type of risk	Eritrea	Ethiopia	Kenya	Sudan	Uganda
Climatic challenges	Increase of temperature	■	■	■	■	■
	Increased incidence of droughts	■	■	■	■	■
	Decrease in rainfall					
	Seasonal shifts in rainfall	■	■	■	■	■
	Heavy snowfalls and winds					
	Cyclones					
	Localized floods	■	■	■	■	■
	Overflowing of large rivers		■		■	■
	Lakeshore flooding			■		■
	Decline in lake levels			■		■
	Decreased or varying river flow	■	■	■	■	■
	Wildfires	■	■	■	■	■
	Rise in sea level	■		■		
	Salt water intrusion	■		■		
	Bleaching of coral reefs	■		■		
	Landslides in mountainous areas			■		■
Vulnerable sectors	Water scarcity		■	■	■	■
	Biodiversity loss, decrease in tourism	■	■	■	■	■
	Health: disease outbreaks	■	■	■	■	■
	Hydropower			■		■
	Coastal ecosystems, islands and cities	■		■		
	Infrastructure	■	■	■	■	■
	Fisheries	■		■	■	■
	Agriculture and food security	■	■	■	■	■
	Livestock	■	■	■	■	■
Vulnerability context	Urbanization	■		■	■	■
	Spread of cash crops				■	
	Shift from pastoralism to cultivation			■	■	■
	Shift of pastoralism and cultivation to drier areas			■		■
	Insecurity in conflict, post-conflict situations	■		■	■	■
	Inequitable land distribution			■		
	Low education	■	■	■	■	■
	Poor infrastructure	■	■	■	■	■
	Gender inequality	■	■	■	■	■
	Dependence on climate-sensitive resources	■	■	■	■	■
	Poor water access for population	■	■	■	■	■
	Poor health status		■	■	■	■
	HIV and AIDS	■	■	■	■	■

Source: Eriksen et al. 2008

Based on assessment of available information, which varies in quality among countries; there may also be large geographical variations in the variables within countries

Shifting herd dynamics

Contemporary pastoral production systems are increasingly market oriented as falling per capita herd wealth encourages the exchange of protein for calories, that is, the sale of high-priced animal products in order to purchase cheaper grain (Ensminger 1996; Bollig 2006). Pastoralists have embraced new marketing opportunities, as many national planners had long hoped, but at some cost. Milk that was once available for household consumption—and is a particularly important food for children—may be either sold or left for consumption by young animals to promote their growth and the improved production of meat for sale. Especially for poorer households with small herds, the effect of increased market involvement on milk availability and child nutrition is a concern (Sadler et al. 2010, 2012). From a natural resource perspective, smaller herds also tend to be less mobile and their owners often live and find employment in new rural towns that are springing up in pastoral areas (Fratkin and Roth 2005; Devereux 2006). The concentrations of sedentary livestock around these towns can cause localized overgrazing while town residents deforest surrounding areas in their search for firewood for domestic use or sale. Change in the species composition of pastoral herds has also been documented in some areas, with camels and goats replacing cattle as aridity increases or woody vegetation replaces grasses.

The most problematic aspect of herd dynamics, however, is the unstable relationship between animal numbers and feed availability in drought-prone environments. Herd sizes that are appropriate in wet or normal years may suddenly become unsustainable in a dry year or a series of dry years, leading to emergency livestock sales, increased rates of animal mortality and unusually high levels of grazing pressure on pasture resources (Homewood 2008). Thus how pastoralists manage herd dynamics and ensure mobility for grazing to capitalize on available feed resources is key to reducing the necessity of extreme measures. Devising policies to minimize the detrimental impact of these feed supply and demand imbalances is one of the persistent challenges to managing natural resources in eastern Africa.

Resource access and tenure

Insecure or inappropriate land-tenure systems are arguably the single greatest contemporary threat to livestock production, small-scale agricultural production and sustainable resource use in eastern Africa (Catley et al. 2012). This problem has multiple dimensions.

There is evidence of the positive impact—in both economic and environmental terms—of private agricultural tenure in high-potential areas suitable for agricultural intensification (Tiffen et al. 1994). However, the opposite holds true for low-rainfall, semi-arid rangeland areas suited to extensive livestock production. In these areas, fragmentation of range and forest lands into small, individually owned plots can cause environmental degradation and reduce livestock output (Galvin et al. 2008). Properties created in this way may also be too small to support their owners, while land consolidation to create larger private holdings would result in the dispossession of vulnerable households. Nonetheless, there is increasing evidence that livestock owners in East Africa are adopting individual tenure and enclosing rangelands because individual titles offer them improved security of ownership (Woodhouse 2003; Mwangi 2007).

The spread of private tenure in rangeland areas reflects the uncertain and weak nature of collective pastoral property rights. In eastern Africa there is a consistent agricultural bias in land-tenure legislation and farming is routinely given priority over seasonal pastoral use in the settlement of disputed land-tenure claims (Behnke 2008). While pastoral land rights have been recognized in the constitutions of a number of East African states, the abrogation of these rights by the state is not uncommon and few legal mechanisms exist that pastoral communities can use to challenge arbitrary state appropriation of collectively held resources. Significant areas of pastoral land have been lost in this way. Communally owned rangelands have been expropriated in the

interests of dam building, creation of large-scale irrigated agricultural plantations, and creation of protected areas for wildlife and conservation (Scudder 1996; Turton 2002; Flintan 2011). Others have been lost to the invasion of non-local 'alien' species as weak land-management practices fail to halt their spread (see below).

These trends look set to continue or accelerate following the 2008 spike in agricultural commodity prices that provoked a global wave of large-scale agricultural land acquisitions by international investors. While not confined to pastoral areas, in eastern Africa the sale or long-term lease of large land concessions to outside interests is likely to heavily influence pastoral communities. In a study on the potential effects of increased water use through converting land to intensive agricultural cropping in Ethiopia through foreign direct investment (Bossio et al. 2012), the authors find that much of the land to be converted is currently grassland. The World Bank describes unforested, unprotected and low-density areas as suitable for expanding agricultural production—a description that includes many pastoral rangelands. The Bank also noted an inverse correlation between the rule of law and legal transparency and the granting of land concessions to foreign investors. Controlling for other factors, the countries where rural land users have the weakest tenure rights are those that have attracted the most investor interest and projects (World Bank 2010).

Marginalization, conflict and social disintegration

Few scientific or development projects are funded long enough for outside researchers or aid workers to experience first-hand the full range of climatic, political and economic volatility that prevails in the region. Rural communities have adapted to these realities and their resource management practices provide important indications as to what is viable over the long term. It is therefore doubly unfortunate that pastoral communities are frequently marginalized and—despite participatory rhetoric—excluded from the planning and implementation of natural resource management policies. This exclusion is often based on perception by the general public that pastoralists are primitive, a perception occasionally reinforced by statements made by senior government officials. While anti-pastoral biases may be genuinely believed by those who espouse them, these attitudes are also used to justify self-interested appropriation of valuable pastoral natural resources—wildlife, wetlands and floodplains, grazing lands and mining sites—by non-pastoralists.

Across eastern Africa—from Somali Region in Ethiopia, Karamoja in Uganda, Somalia, Darfur and South Kordofan in Sudan—pastoralists inhabit zones of conflict and are both perpetrators and victims of violence. It is unclear to what extent these conflicts are the result of local factors—land pressure and communal competition over resources—versus wider ideological and international rivalries (Rettberg 2010). Conflict over pastoral resources is a persistent risk in climatically unstable rangeland environments where people and their animals are routinely moving in search of water, forage and markets. It would appear, however, that these local tensions are also exploited by non-pastoral interests to obtain support in national electoral contests, regional border disputes, professional market-oriented poaching and cattle theft, and international conflicts (Galaty 2005; Young et al. 2005, 2009; Eaton 2010). Linking local conflicts involving pastoralists with wider political, ideological or commercial agenda is particularly destructive. Once local disputes are broadened in this way, violence escalates and customary conflict resolution mechanisms are no longer effective. The spread of weaponry and armed extortion also undermines internal systems of social control within pastoral communities. In terms of natural resources, the result of these processes is a spiral of increasing scarcity as conflict further diminishes resource availability by creating no-go areas—buffer zones between armed groups where resources might go unused for years and degrade as a result of neglect (Conant 1982; McCabe 2004; Bollig 2006).

Cross-border relations

In East Africa many pastoral groups straddle national borders. This creates positive opportunities for international trade, but it also creates problems for the free movement of people and animals. These problems are particularly acute for groups that annually use natural resources on both sides of a political border. For these producers, concerns about national security, the transmission of livestock diseases or smuggling may lead to the disruption of normal productive activities and ultimately affect how natural resources are managed. Borders create multiple jurisdictions and thereby complicate the management of flows of people, livestock, wildlife and water across non-natural boundaries. A lack of facilitating mechanisms to support and develop cross-border trade has meant that much trade occurs outside government controls and endorsement; this has meant a significant loss of revenue in the form of taxes and other revenues for government.

Planning, administration and decision-making

Pastoral areas impose unusually severe constraints on routine administrative activity. The per hectare productivity of eastern African semi-arid rangelands is generally low; so the cost of their management must be as well, if it is to be sustainable in the sense of generating improvements in production that equal or exceed marginal increases in management costs. Despite this modest revenue base, rangeland administration must address a number of severe problems—the sheer size of administrative units, the independent nature of pastoral cultures, the high levels of environmental variability and the complexities of managing semi-natural ecosystems. The distribution of natural resources often does not coincide with official administrative boundaries, and frequently environmental flows of goods and services benefit consumers of environmental goods off site. A pertinent example in this context is the upland areas of river basins, which frequently receive great amounts of rainfall; the rainfall is transmitted to a network of streams that coalesce downstream to provide major water bodies and underpinning water sources to sustain both pastoralists and agriculture. On a temporal basis too, the seasonal, flexible dynamics of pastoral systems rarely fit with the more constrained and rigid yearly administrative government cycles of planning, finance and similar activities.

Planners must also confront the additional challenge of managing the interface between high-and low-potential areas that are functionally interdependent. Scattered across semi-arid rangelands are pockets of high- and medium-potential resources that make possible the profitable exploitation of surrounding low-potential rangelands by providing drought and dry-season refuges for livestock. More and more these landscapes are becoming dissected into a patchwork of agricultural and pastoral land uses. The economic performance of pastoralism, its capacity to support human populations and to ride out droughts, depends on continued access to these key assets, especially river valley lands. Across East Africa, the loss of pastoral access and the alienation of this land to other uses is a widespread occurrence (Galvin et al. 2008). The migration of populations into key dryland production areas is a reality that cannot be ignored and will continue to increase as long as there are opportunities. The challenge is how to integrate landscape and ecosystem planning with administrative boundaries where the land policy and national constitution favour private land ownership. For commercial developers, it is sufficient to calculate the profitability of excising key resources from the surrounding landscape and developing them for their own purposes—enclave development. On the other hand, regional planners cannot simply ignore the opportunity costs of excluding pastoral users and thereby imperilling the survival of human and livestock populations and the efficient exploitation of surrounding rangeland areas. For responsible public planners, the external regional effects of enclave development must be taken into account (Behnke and Kerven 2013). The increased incidence of drought emergencies in East Africa is often erroneously attributed to declining rainfall and climate change alone. In many cases it may instead be caused by flawed regional planning that undermines pastoral livelihoods by permitting or encouraging the

alienation of the key resources that help to stabilize herd performance in droughts (Kloos 1982; Gamaledinn 1987). Planning, and particularly natural resource management, needs to take place on a systematic landscape or river basin approach when water and access to this resource are fundamental to sustainability.

Opportunities through cosystem/integrated approach and adaptive management

The climatic and cultural diversity of the drylands of East Africa and the Horn of Africa offers significant economic and livelihood opportunities, most of which are either untapped or not fully exploited. These dryland landscapes are rich in biodiversity. There are untapped underground water resources as well as stretches of land that could be used for producing food and animal feed, and for tourism and enterprises based on non-timber forest products. In addition the region is rich in oil, gold and other minerals. The potential is great for renewable energy development. These resources and opportunities offer sustainable and prosperous livelihoods for the inhabitants and economic growth for nation states if well managed and exploited, and if supported by reliable infrastructure and human well-being services.

There is a need to consider alternative ways of working in drylands, taking into account the particular social and environmental characteristics of these areas, including mobility, relatively low population density, and the distinctive institutional arrangements that underpin pastoralism and other dryland livelihood systems. The interconnectedness of the different components of drylands is highlighted in the first section, 'Background and introduction'. Such interconnectedness demands an integrated ecosystem approach for managing land, water and life resources that supports appropriate, often collective, governance structures. This is reflected in an increasing number of government policies and strategies in the region. See for example Vision 2030 (Kenya 2012).

The following section provides examples of good practices, innovations and approaches, overcoming constraints and challenges through an integrated ecosystem-driven approach to development.

Land- and resource-use planning

Rangeland users, and in particular pastoralists, rely on different parts of a rangeland or landscape at different times of their year for their livelihood production systems. For example, in Djibouti most herds are moved from the lowland areas in the south and western parts of the country to the highlands or coastal zones in the cool season (November to May). The system demands land-use planning across different landscapes, integrated and flexible in nature.

Such systems of livestock movement between dry and wet season grazing areas exist across most of the pastoral areas in the region, and are planned and controlled by customary institutions, where they are functioning. These traditional systems have often conflicted with (and thus been marginalized by) government land- and resource-use planning that has usually occurred within much smaller administrative units (as indicated above). However, today it is increasingly recognized by government and non-government actors alike that if extensive and integrated production systems such as pastoralism are to be supported, then land- and resource-use planning needs to occur at a scale that is more appropriate for livestock production, including mobility (see examples: Somaliland's National Agricultural Policy 2008 and the Ministry of Pastoral Development's Strategic Plan 2008,[5] Kenya's National Land Policy 2009 and Vision 2030 Strategy for Development of Northern Kenya and Other Arid Lands, and through the introduction of the Legal Code on Sustainable Natural Resource Management in Djibouti). Well-implemented land-use planning will include all

[5] See also FAO SWALIM (Food and Agriculture Organization of the United Nations–Somalia Water and Land Information Management) guidelines for land-use planning in Somaliland by Venema et al. (2009).

resources and all actors with a vested interest in the rangeland or landscape, and may require cross-border (including international border) planning, negotiations and agreements.

A number of NGOs have supported local participatory land and resource use planning. It builds on traditional knowledge and prioritization of land use based on ecological characteristics and the potential of the land to produce. Increasingly conservation organizations are working with communities to plan land uses that will also facilitate protection and movement of wildlife as well as livestock—the Northern Rangelands Trust and the African Wildlife Foundation in Kenya, for example, have assisted communities to zone land (for grazing, agriculture, conservation, etc.) and to set up 'community conservancies' (Campbell et al. 2009). Similar initiatives have been developed in Kenya's southern rangelands as well, with assistance from the African Conservation Centre.

To date, however, there are few local examples of participatory resource- and land-use planning being incorporated into government land-use plans. An exception can be found in Kitengela, Kenya, where communities and other stakeholders worked together to form a land-use plan that has been approved by the Ministry of Lands and signed by the minister and the Olkejuado County Council through a full-council resolution (see Fitzgerald and Nkedianye forthcoming). Pilots are also being carried out in Ethiopia and Uganda to integrate disaster risk reduction and climate change adaptation within local government planning, working with local communities. Additionally, important lessons can be learned from these pilots such as watershed planning in more highland areas (see Flintan forthcoming).

Integrated and participatory rangeland and natural resource management

Community-based natural resource management has a long history in eastern Africa (see for example Awimbo et al. 2004). Many NGOs have built on these traditional management systems and assisted communities to formalize them together with their rights of access to resources. This has been particularly successful in the case of community or participatory forest management (see below).

Building on these experiences, and to fulfil the need to develop approaches and processes of integrated rangeland and landscape management that better fit with both community and government systems and priorities, a number of participatory rangeland management systems have been developed and are being piloted in the region**.** Though these systems may differ slightly in their detail, their key principles are the same (Box 2).

Box 2. Common principles and components of participatory rangeland management approaches

- built on a clear understanding of current practices of NRM and access regimes.
- an ecosystem approach recognizing the interconnectedness of drylands and rangelands with river basins.
- governance structures that can effectively control access to resources and represent different groups of actors.
- sound management principles and structures in place, including monitoring systems that combine indigenous knowledge with scientific methods; adaptive management undertaken.
- the importance of dialogue, negotiation and consensus building among different actors.
- formalization of agreements and enforcement mechanisms in place.

However, national bodies are limited in their capacity, both financial and other, to scale up such processes. And to further develop these approaches it is necessary to enhance the understanding of ecosystems such as rangelands and drylands; to evaluate ecosystem services so that decisions on land use are better informed; to firmly commit that local communities will be involved in managing the ecosystem and will equitably share in the benefits and costs of its use; and to standardize assessments of ecosystem health and long-term monitoring.

In addition, it is necessary to incorporate mechanisms for adapting to climate change within these processes and systems. Though community adaptation, knowledge and action should be the starting point, there is room for combining them with scientific tools. For example, satellite remote sensing has offered a new, synoptic perspective on vegetation variability and change, with continuous and standardized measures across time and space. The normalized difference vegetation index exploits the distinctly different reflectance characteristics of vegetation and bare soil and can be used to measure soil coverage over time. Once such details have been verified on the ground, this information can feed into different types of modelling, which can be used to predict future changes, including different scenarios resulting from climate change. This information can be transformed into more accessible messages and give local communities guidance in planning and decision-making, including how best to manage grazing and water.

Water development, conservation and management

Although six countries of the IGAD region share one of the greatest rivers in the world and studies have shown that the Nile River has enough water to sustain its population, many inequities over this common resource exist and are especially difficult to redress. Djibouti, for example, has no permanent rivers and Eritrea has only one. Although some countries do work together on water development including through the Nile Basin Initiative, and on strategies such as groundwater development between Djibouti, Kenya and Ethiopia, increased cooperation among member states is called for, as well as in utilizing the countries' wetland resources and other freshwater bodies (IGAD 2007).

Most countries in the region have moved to an integrated water resource development approach with related master plans. But there is room for improving the effectiveness of field water resources such as increasing access to water through water harvesting, storage and spreading through techniques such as road runoffs, roof catchments, sand dams, pans and small reservoirs, as well as their scaling up (LOG Associates 2010). Many of these techniques have been used for centuries across the region, such as in Sudan, but they now need to be modified to meet increased demand.

There is no doubt that improving the productivity of water in the drylands will continue to be a priority for nation states. Efforts to direct new research and to transfer available technologies and institutional arrangements to overcome water shortages are much needed. Coordinating these efforts within an agreed upon framework is likely to enhance their effectiveness. For improved water use, land-use systems need to be developed that are economically competitive and that respond to changing markets and demands in various agro-ecological and socio-economic situations. In some dryland areas in the region, increasing numbers of people are moving out of pastoral production and looking towards alternative livelihoods. They require assistance in managing the available resources, including where appropriate developing irrigation systems that do not conflict with other land uses and promote water-use efficiency.

The development of water infrastructure must go hand in hand with the development of management and governance structures; indeed, this can be the most challenging part of water development. The decentralization of management in many countries has provided opportunity to establish local water resource user associations. Through these organizations there should be greater opportunity for links between land-use planning (including water) between local and higher-level bodies. Also important is the need to monitor and

assess the spatial and temporal variability of water so that comprehensive management plans can be built using realistic data of the resource available. To do this will require investment in monitoring networks and capacity building to install and maintain them, preferably using standardized protocols between country bodies.

Soils management and erosion control

Arid and semi-arid landscapes are particularly vulnerable to degradation because vegetation cover is sparse and the annual rainfall is distributed in a small number of intense storms. Soils provide an important array of underpinning ecosystem functioning such as providing a medium for plant growth and sequestering carbon. The adoption of conservation agricultural practices such as zero tillage and crop residue management, green manure and agroforestry, as well as appropriate crop rotations, lessens the risk of accelerated soil erosion. At a global scale it is suggested that over the next 40 years, conservation agricultural practices will have the technical potential to restore more than half of the carbon lost (50 gigatons) from the world's agriculture soils currently under cultivation. In turn, reducing soil erosion risk and increasing land productivity enhance the strength of the carbon flux from the atmosphere to biomass and from biomass to soils (El-Beltagy and Madkour 2012). Different activities to curb soil erosion and loss in the region are listed in Box 3, and more specific examples of good practice in the region can be found in a workshop and case study report by FAO and others (2008).

Box 3. Different activities and achievements in relation to soil management and erosion control

- **Djibouti**—Global Environment Facility (GEF) project on soil sustainability in pastoral areas and coastal region.
- **Eritrea**—23 projects developed under the National Action Plan to Combat Desertification (NAPCD); soil and water conservation through establishing enclosures.
- **Ethiopia**—National Platform for Sustainable Land Management; integrated watershed management projects; NAPCD.
- **Kenya**—NAPCD.
- **Uganda**—soil fertility enhancement program; Nakasongola District sustainable land management.

Source: IGAD (2007)

Agroforestry, silvo-pastoralism and non-timber forest products

Trees are a valuable part of both farming and pastoral systems in the drylands. Farmers have long appreciated the value of tree cover to improve soil fertility, increase water infiltration and reduce evaporation losses, increase soil water and carbon storage, prevent soil erosion, and increase fodder and firewood production. Similar benefits are seen in pastoral systems, as well as from some tree species that offer particularly high opportunities for generating income from tapping gums and resins. Trees can also serve to improve tenure security (see below).

Following long-term unsustainable grazing of grasslands and limitations on traditional management regimes (due, for example, to banning the use of fire in rangelands in Ethiopia or the breakdown of customary institutions) woody vegetation is gradually invading them. In some parts this invasion has caused a shift from grazers to browsers,[6] which are also more able to cope with protracted periods of drought. As livestock types continue to change, the quantity and quality of browse will become ever more important.

Thus planting trees as part of integrated farming and pastoral systems has many benefits. The key to success is the appropriate choice of species and the optimum management of tree–crop–livestock interactions. Farmer-managed natural regeneration is a simple practice involving the selection and husbandry of native tree species that establish themselves in fields from either seeds or roots (the underground forest). Thus, the practice involves minimum investment cost and is rapidly diffused among farmers and villages in the drylands. Farmer-managed natural regeneration is widely practised in the dryland farming systems of Ethiopia (Hadgu et al. 2011), particularly based on the regeneration of *Faidherbia (Acacia) albida,* an exceptionally valuable indigenous leguminous species.[7]

The commercialization of non-timber forest products such as gums and resins, honey, palm, and medicinal and botanical plants has great potential, with steadily growing markets in the Middle East, Asia, Europe and the US. China is the biggest single importer of frankincense and myrrh with Ethiopia, Somalia and Kenya providing, from 1997 to 2004, annual averages of Ethiopia 700 tonnes, Somalia 500 tonnes, and Kenya 150 tonnes. The European Union is the next most important market, taking 170 tonnes. Prices vary according to the type and grade or quality, ranging from USD 1.30 to 3.50/kg in 2005. It should be noted that in 1994 top grade Somalia frankincense was priced at USD 6.00/kg (Wren and Mamo 2009). Djibouti, Eritrea and Sudan also produce such products: in the early 2000s farmers in Sudan earned about USD 50 million per year from the export of gum arabic (*Acacia senegal*) (Chamay et al. 2007). There are few data concerning the actual area of potential gum and resin trees in the region, but the trees are widespread. For example, in Turkana District, Kenya, gum arabic woodlands cover an area of over 2000 km^2 (Barrow and Mogaka 2007).

Other dryland forest products in the region include henna *(Lawsonia inermis)* and other dyes, various ingredients in the soap industry (neem, leleshwa), medical plants such as *Aloe* spp., as well as the more direct values of foods, fruits and forage for people and their livestock. And 'new' products and uses are being 'discovered', although pastoralists may have used them for centuries. These products may not yield much on their own in economic terms, but taken in combination with pastoralism they provide much needed additional income and help to spread risk. Growing them on a commercial scale or domesticating them can improve their marketability. A number of successful projects and enterprises are scaling up production: dryland products being marketed include Biotrade and Honey Care in Kenya; Ecological Products of Ethiopia (Ecopia), Beza Mar, Agri-CEFT Plc, Ariti Herbal Company and Aromabyssinia Plc in Ethiopia; Integrated Beekeepers Association and others in Uganda; and Organization Food Enterprises and Maridi in South Sudan.

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6 Camels can readily browse on thorny species with leaves that other species cannot reach. Studies have shown that the system of feeding dwarf shrubs (largely *Indigofera*) to camels, which then produce camel milk, is one of the most efficient in terms of capture of energy and nutrients. It is responsible for 43% of the energy consumed by the Ngisonyoka Turkana (Coughenour et al. 1985).

7 It provides abundant nitrogen-rich leaf litter in crop fields and supplies fodder through its leaves and pods during late dry season drought periods (World Agroforestry Centre, 2010). The species is unique in that it exhibits reverse phenology, whereby the trees are dormant during the rainy season and uncompetitive with cereal crops (Barnes and Fagg 2003). Ethiopia recently launched a national program to assist farmers establish 100 million additional *Faidherbia* trees on farmlands during the next three years.

Dryland forest management and afforestation

Dryland forests in the region are rich in genetic resources, with many species well adapted to the harsh environmental conditions, e.g. in Djibouti (Kiambi 1999). Many trees are important sources of food and medicinal plants for humans and livestock, especially during the dry season. Others play a significant role in creating more ameliorating environments. *Juniperus procera* found in the higher altitude areas of the region, for example, is important for condensing atmospheric humidity and it provides conditions suitable for undergrowth of herbaceous and pasture plants to develop.

Traditional forest management systems exist across the region (see Eritrea, for example, Ogbazghi and Bein 2006). However, for them to be optimized communities require greater levels of empowerment to increase their sense of ownership and security over resources. A number of community and participatory forest management initiatives have been developed across the region. In Ethiopia, participatory forest management has now been mainstreamed across four of the country's regions, not only improving management of the forests but also increasing the security of communities' rights to the forests and their products (Tache and Irwin 2003). Such initiatives require further scaling up and can be developed in conjunction with new opportunities to benefit from funding mechanisms such as REDD (Reduced Emissions from Deforestation and Degradation). There is also room to expand forest extension services across the region.

Charcoal production is a key supplementary livelihood activity for dryland inhabitants, especially in times of drought. In Kenya it is estimated that there are over 200,000 charcoal producers (full or part-time) in the arid and semi-arid lands. The trade is worth around KES 16 billion (USD 200 million) per year (Barrow and Mogaka 2007). An estimated 846,720 sacks of charcoal, each weighing 30–35 kg, are produced each year in one district alone in Somali Region, Ethiopia (Oxfam GB 2011). Produced on a sustainable basis, charcoal can make an important contribution to local livelihoods, but sustainability is not assured. Its short-term benefits to local economies are far outweighed by the long-term costs to the environment and longer-term assets (Barrow and Mogaka 2007). Key species that make good charcoal are often the ones preferred by wildlife or livestock. Though there are opportunities to better regulate the charcoal trade, tax it and put in long-term plans for sustainable production, there is an urgent need to assess the cost–benefit analysis of charcoal production and to identify ways to reduce reliance on charcoal.

Great opportunities exist for expanding plantation and woodlots in the region. To date public forest plantations dominate and have a history of low productivity. Private sector forest plantations are a more recent development and tend to be better managed. However, the overall investment climate is still not conducive to their growth. Private woodlots cover around 2 million hectares in the region and play a significant role in livelihoods of communities and national economies. Most woodlots, however, have poor-quality trees due to use of seed of low genetic quality. Silvicultural advice is limited and management requires improvement. Well-managed woodlots and plantations provide a range of social and environmental services (Chamshama 2011). In the past plantations have focused on planting fast-growing species such as eucalyptus, but these have had both social and environmental impacts (German et al. 2012). More investment should be made in planting indigenous and multipurpose trees.

Coastal resources and fisheries

The IGAD region is endowed with a shoreline of approximately 11,618 km with extensive and diverse coastal and marine resources. In line with the UN Convention Law of the Sea, the shorelines have exclusive access to a large economic zone with potential for marine fisheries, seaweed harvesting, tourism, mining, and oil and gas exploration (IGAD 2007). Threats to achieving their full potential include effects of climate change, such as the

El Niño-induced floods; habitat loss and degradation such as tar-balls, as this coastline is the world's main transport route for hydrocarbons with tankers transporting some 590 million tonnes of oil a year; over-fishing; silting of estuaries and coral gardens; and inadequate investment in coastal zones.

Fresh-water fishery activities in the dryland areas are practised in many parts of the region: in Lake Turkana in Kenya, the string of Rift Valley lakes in Ethiopia, and Lake Victoria in Uganda. The warm climate in these areas is conducive for fast growth of tilapia. Facilitated by local government grants, fish farming in ponds as part of integrated farming systems is taking off in some rural areas including in semi-arid parts of Kenya's rangelands. In coastal areas too, the development of fisheries has high potential, including potentially with the involvement of the private sector. In both areas, there is need to develop capacity and increase training in order to strengthen sustainable fishing practices. It is also necessary to develop fish processing and value addition, to develop related industries such as ice making, boat construction, packaging and transport, and to improve management of the fish environment by reducing pollution and the loss of water through evaporation.

Conservation of biological diversity[8]

A healthy rangeland is likely to be more diverse than an unhealthy one (Bonkoungou 2001). A major threat to sustaining biodiversity is the reduced size of contiguous habitats. In rangelands, fragmentation can occur by overall size, pattern and dispersion of rangeland community types, as well as division into parcels, which may be under different management practices. Over half of the most productive rangelands in Kenya that used to hold the great majority of wildlife are now supporting agricultural production with an associated rapid evolution of property rights from large land parcels held communally to small land parcels under private ownership. As a result wildlife is being displaced and eliminated (Norton-Griffiths and Said 2009).

There are cases where pastoralists and dryland users are benefiting from wildlife conservation, for instance the various ecotourism ventures on both community and private (company) lands and ranches. In Kenya, examples are found in Samburu, Laikipia, Isiolo, Narok, Trans Mara, Kajiado and around Amboseli. The incentives for dryland communities to invest in wildlife need to be improved to prevent further conversion of rangelands to wildlife-unfriendly land uses.

Invasive and non-native plants also threaten biodiversity as well as changed management regimes such as a reduction in the use of fire; in the IGAD region invasive alien species have been identified as the second greatest cause of biodiversity loss after habitat alteration as well as contributing to human vulnerabilities (IGAD 2007). In Ethiopia over 1 million hectares have been invaded by *Prosopis juliflora* in one region alone. In Kenya, despite its being labelled a 'noxious plant' by the government, *Prosopis* is still spreading across dryland areas. Yet when properly managed the plant can be a source of income for local communities as charcoal, timber or animal feed (though the pods need to be ground to prevent further dispersal). Other invasives that are particularly problematic for rangelands in the region are *Sansevieria*[9] spp., *Parthenium hysterophorus* and *Opuntia* spp. Though a number of small local schemes have had some success in removing species (albeit often temporarily), this effort has done little to contain the much wider spread across the region. A better-informed, coordinated and cross-regional response is therefore urgently required.

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8 Biological diversity is taken to mean 'the variety of life and its processes', which encompasses 'the variety of living organisms, the genetic differences among them, and the communities and ecosystems in which they occur'. The components of biodiversity have been described as landscape, community, population and genetics (in Joyce and Heitschmidt no date).

9 See for example its spread in Turkana (Okoti et al. 2004) and Laikipia (King and Franz no date).

Development and expansion of renewable energy use

The predominant source of energy in the IGAD region is firewood and charcoal; however, these energy sources are not sustainable. The region urgently needs to look at other energy sources, and particularly those from renewable sources. A number of countries have produced strategies and master plans for developing renewable energy sources. The region enjoys regular solar radiation round the year, offering substantial potential for solar energy. For example, the potential for solar energy in Kenya is estimated at 4–6 kWh per m^2 per day of insolation, which translates into about 250 million tonnes of oil equivalent. Yet there is virtually no large-scale commercial production of energy from solar radiation in the region.

Another significant potential exists in geothermal energy where reservoirs suitable for generation of power have been identified in the region. Kenya is the first African country to tap geothermal power in a significant fashion. The geothermal potential of Ethiopia has been estimated at 4000 MW. Djibouti in partnership with Eritrea is also exploring geothermal energy. A complete geothermal energy assessment is needed, and financial support is required to selected research institutions to pioneer development of renewable power options within the region (IGAD 2007). There have been some small-scale innovative examples of energy projects in the region, and scaling them up is a priority (Box 4).

Box 4. Innovative energy projects in the region

- **Eritrea**—introduction of award-winning Mogogo stoves. Working with **Djibouti** to develop geothermal energy.
- **Ethiopia**—dissemination of energy-efficient stoves, introduction of fast-growing trees, 1000 biogas energy plants installed, wind farm in Adama.
- **Sudan**—500 villages covered with improved stoves; introduction of LPG (liquefied petroleum gas) for communities around national parks to reduce use of firewood.
- **Kenya**—proposals to develop wind energy, study on geothermal development, East African power master plan with **Uganda.**

The development of hydropower has received increasing investment in recent years and large schemes such as the series of Gibe dams in Ethiopia offer potential for significant sales of electricity generated from them, including to neighbouring countries. These dams are likely to have both positive and negative effects on local land use and livelihoods, which are only recently beginning to be addressed (Kloos et al. 2010), as well as impacts on neighbouring ecosystems (Avery 2010).

Oil and gas are other sources of energy in the region. Off- and on-shore exploration is ongoing in Djibouti, Eritrea, Ethiopia, Kenya and Somalia. Significant discoveries of oil and gas in the region are likely to have profound effects, negative as well as positive, on the economy, environment, and peace and security. The tools required to deal with these challenges need to be developed.

Tourism

Tourism makes a sizeable contribution to national economies in some countries in the Horn and East Africa, where national parks and other protected areas fall predominantly within the drylands. Tourism contributes 13% to Kenya's gross domestic product (GDP) (Kirkbride and Grahn 2008) and over 9% for Uganda (Hesse and MacGregor 2006). Other countries such as Eritrea and Djibouti are seeking to develop their tourism industry (domestic and international) over the next few years. Dryland communities are also seeking to develop their own tourism ventures and across East Africa there are a number of successful community-run lodges to learn from.

Much tourism depends upon the presence of large wildlife. It has been shown that pastoralism is a more favourable land-use system for wildlife than agriculture. Given facilitating conditions, it is possible for livestock and wildlife to co-exist. In the past little revenue generated from national parks and tourism reached pastoralist communities. However, a number of new schemes are seeking to change this situation (Nkedianye et al. 2009). Studies have shown the economic benefits of integrated wildlife and livestock production systems. Communities are keen to manage their wildlife themselves rather than rely on foreign investors (Okello et al. 2011).

Payment for environmental services and carbon sequestration

Mobile pastoral systems confer a broad range of ecosystem services and are the only form of agriculture that is compatible with maintaining large populations of migratory wildlife. However, they are rarely paid for the broader environmental services that they provide. It is difficult to share the benefits of payment-for-environmental-services schemes fairly, and in particular to those who may have greatest costs. Successful payment-for-environmental-services schemes are difficult to set up, requiring strong and supportive institutional structures as well as high earning activities. As a result there is less incentive for rangeland users to amend their behaviour in ways that support conservation.

Carbon sequestration in rangelands may provide an option to capitalize on existing rangeland management practices of livestock keepers and capture additional incentives for more effective management. Most attention is on forests as a terrestrial carbon sink, but while forests may add only about 10% to their total weight each year, savannahs can reproduce 150% of their weight annually, and tropical savannahs have a greater potential to store carbon below ground (in roots and soils) than any other ecosystem. Carbon stocks have been found to reduce when drylands are converted from pasture to plantation or arable land, while in some cases increases in carbon stocks are seen when native forests or croplands are converted to pasture (IUCN-WISP 2010). Carbon capture is increased with improved grazing management of rangelands, and high-diversity perennial grassland species have 5–6 times greater soil carbon and nitrogen than monocultures (IUCN-WISP 2010). Though payments for ecosystem services may not be large, they are disproportionately valuable to communities in stabilizing and diversifying their incomes.

Well-managed rangelands can also contribute to reducing wind erosion and improving water productivity including maintaining higher levels of soil moisture, increasing infiltration and preventing excessive runoff. Effects are felt at a range of levels from global to local and by a multitude of groups of beneficiaries.

There is little evidence to suggest that the African livestock sector contributes in a significant way to global climate change. Nevertheless, there are options for mitigating climate change that may provide other incentives for improved livestock production. These options include a range of methods for reducing rumen emissions, improving waste management, and improving carbon capture by rangelands and complementary activities such as silvo-pastoralism. Improving grasslands management practices and reversing degradation are considered two of the technical practices with the highest mitigation potential (IPCC 2007).

Lessons learned

Planning frameworks

Increased and intersected crises have provided an impetus for cross-sectoral and multi-stakeholder planning and implementation. A recent example is Kenya's comprehensive Vision 2030. The Kenya Vision 2030 development process was launched by the president through a National Vision Steering Committee. It included carrying out a consultative approach with stakeholders from all levels of the public service, the private sector, civil society, the media and NGOs throughout the country. This was meant to ensure an in-depth understanding of the full spectrum of development problems and what strategies could be used to overcome them with a view to addressing social, economic and political pillars that would have an economic impact and result in poverty reduction. Vision 2030 now serves as a framework for evaluating future plans. For example, it underpins a plan by the Agricultural Sector Coordination Unit of Kenya, which brings together 10 ministries and aims to have a food-secure and prosperous nation, and the National Environmental Management Authority, whose mandate is to ensure a clean, healthy, secure and sustainably managed environment for all. This plan could provide a foundation for more coherent programming.

Multi-stakeholder, multi-scalar and multi-sectoral planning frameworks that can test investment and implementation decisions towards desired equitable, social, environmental and economic outcomes have historically not been the norm as a few examples show.

After several decades of avoiding investment in large infrastructural projects, particularly big dams, dam building is back on the development agenda in many parts of East Africa. Accelerated dam development will directly adversely affect pastoral welfare and livestock productivity (Lautze et al. 2010). There is evidence that large-scale irrigation schemes and plantation agriculture do not necessarily provide economic benefits that equal or exceed those from pastoral production (Adams 1992; Behnke and Kerven 2013). Outside developers—or government departments—can make money by simply transferring control of land suitable for irrigated agriculture from local communities to investors, while claiming that such transfers are in the national interest. These claims should be carefully evaluated. Irrigated agriculture is not new in East Africa; policy formulation would benefit from a balanced, large-scale evaluation of what irrigation schemes and scales (smallholder or small groups of smallholders or large-scale schemes) have actually achieved in recent decades, relative to what they promised and taking into account the opportunity costs, economic and societal.

Producers in drought-prone regions obtain no long-term benefit from technical innovations that optimize output only in good years or under ideal conditions. More useful are innovations that stabilize income over a run of good and poor years. Livestock insurance schemes (currently being pioneered by ILRI) may help pastoral communities spread risk, sharing the cost of climatic variability with parts of the national and international economy that are not directly exposed to drought.

Pastoral systems

Mobile pastoralism makes more productive and sustainable use of extensive rangelands than any competing form of land use, including industrial forms of commercial ranching (see Table 3). Lingering prejudice against mobile forms of livestock husbandry is outdated and unscientific.

Table 3. Comparative productivity of commercial ranching and open-range pastoral production under comparable ecological conditions (ranching = 100%)

Country	Pastoral vs ranch productivity	Units of measure
Botswana	188% (relative to Botswana)	Kg protein production/ha per year
Ethiopia (Borana)	157% (relative to Kenya)	MJ/ha per year of gross energy edible by humans
Kenya (Maasai)	185% (relative to East Africa)	Kg protein production/ha per year
Mali	80–1066% (relative to United States) 100–800% (relative to Australia)	Kg protein production/ha per year Kg protein production/ha per year
Uganda	667% (relative to Uganda)	Uganda shillings/ha per year
Zimbabwe	150% (relative to Zimbabwe)	Zimbabwe dollars/ha per year

Source: Behnke and Abel 1996 and Ocaido et al. 2009

Livestock also make an unexpectedly large contribution to national economies in East Africa. Recent collaboration between IGAD and IGAD member states has documented large underestimates of the value livestock add to the GDP in the official national accounts of four of its states. The perceived inefficiency of current livestock production systems in the region may owe as much to previous official underestimates of the benefits they provide as to any deficiency in their actual performance (Table 4). Highland dairy producers such as those in

Table 4. Economic performance of livestock production systems in four states in 2009

State	Official value added (billion USD)	Re-estimated value added (billion USD)	Increase on official estimate (%)
Ethiopia	2.511	3.668	46
Kenya	1.651	4.124	150
Sudan	12.236	14.525	19
Uganda	0.282	0.527	87

Source: IGAD 2011a, 2011b, 2012a and 2012b

Kenya have taken advantage of favourable milk prices to finance the environmentally sustainable intensification of their smallholdings. Across the region, extensive pastoral producers provide the bulk of the meat and live animals consumed domestically and traded internationally. These are efficient production systems that have evolved rapidly in recent decades and therefore provide a firm foundation for further development. Studies on nutrition security indicate how critical small quantities of nutrient-dense foods, such as meat and vegetables, are to bring staple-based diets up to meet human nutritional requirements (Deckelbaum et al. 2006). Additionally, complete-diet frameworks show that modest quantities of meat in diets can require less land resources and make better use of cropland suited only to pasture and perennial crops than high-fat vegetarian or high-meat diets (Peters et al. 2006). The production systems of the Horn of Africa have inherent strengths in these respects and can be reinforced to address both nutritional security and sustainability in the region.

Land access and tenure

The promulgation of new land-tenure regimes should be viewed with caution. Frequently, programs that promote radical tenure changes are ideologically motivated, are inappropriate for rangeland environments, and provide an opportunity for local or national elites to grab resources (Catley et al. 2012). Any attempt at reform should be based on an understanding of how the current land-tenure system actually functions and on an analysis of who would stand to gain or lose from the proposed changes. Policymakers also need to ask if the

proposed changes are affordable and can be consistently implemented within existing administrative and human resource constraints. In the place of large-scale tenure reform, policy can usefully concentrate on developing procedures for resolving land disputes, on specifying who is entitled to make legal judgements regarding land ownership, how they may legitimately go about doing so, and how these decisions can be enforced (Toulman and Quan 2000). Support should be given to civil society groups in countries where it is possible to use the courts, national media and political processes to represent pastoral interests and rural land rights. International forums and funding conditionality can be employed to support the land rights of rural communities when the genuine representation of their interests at national level is obstructed by powerful interest groups.

Protection and preservation of ecosystem services

Innovative policies are needed to defuse the unnecessary conflict between pastoral land rights and national parks and wildlife. Mobile pastoral systems confer a broad range of ecosystem services and are the only form of agriculture that is compatible with the maintenance of large populations of migratory wildlife. Payments for ecosystem services may not be large but they are disproportionately valuable to pastoralist households in stabilizing and diversifying their incomes. There is, however, firm evidence that payments for ecosystem services do not routinely reach pastoral producers in East Africa. Since compensation rarely reaches the rural residents who actually bear the costs of maintaining wildlife, rural people do not amend their behaviour in ways that support conservation (Homewood et al. 2009). In Kenya, for example, despite the gazetting of conservation areas and community-based wildlife management efforts, there have been spectacular declines in the populations of large migratory mammals since records began (Norton-Griffiths 2007). It is time to bring the reality of community-based conservation into line with development rhetoric.

Growing international interest in combating climate change by paying communities to sequester carbon makes recognition of the governance problem and its resolution even more urgent. Simple interventions include improved monitoring of the financial affairs of community-based natural resource management projects and the piloting of innovative methods to directly transfer payments for ecosystem services to individual rural residents. More radical solutions would include transfer of the ownership of wildlife from national wildlife agencies to rural communities. Unlike private land owners in Britain or southern Africa, for example, East African livestock owners on common rangeland do not own the wild animals that use their land. In southern Africa, tentative steps towards giving rural communities more control over wildlife have been enthusiastically received. Implied here is a shift in conservation policy away from emphasizing enforcement and regulation towards developing positive economic incentives built around clear property rights that allow rural people to profit from conservation—harnessing property rights to conservation objectives (Norton-Griffiths 2007).

Physical infrastructure

In East Africa and globally, research demonstrates that there is little grazing-induced degradation in rangelands with relatively variable precipitation, because livestock populations collapse in periods of drought, which enables the vegetation to recover (Wehrden et al. 2012). Despite low and variable rainfall, degradation is a risk around permanent water sources and settlements that concentrate and stabilize livestock populations (Hary et al. 1996). The creation of permanent water sources that attract resident livestock populations should be avoided in low rainfall areas that are used for seasonal grazing. Integrated land-use planning that provides space for communities to actively participate, should be supported.

Suggested interventions

This concluding section aims to draw lessons from interventions and approaches to the challenges presented by dryland management that have worked or offer promise. It considers the best way forward in attempting to resolve, in the long term, the problems facing arid and semi-arid lands and their management in the Horn of Africa with a view to production, and environmental and societal resilience.

Policy and legal framework

Within the context of policy and legal frameworks, there is a clear need to ensure that multi-stakeholder processes are capitalized upon for outlining and understanding the holistic context within which policies are being designed and implemented. In all cases, policies must be analysed to ensure that they are addressing the root causes of the issues they intend to address rather than treating symptoms that will inevitably give rise to further problems. Following are policy dimensions that need immediate attention.

Support equitable and secure land tenure

Pro-poor livestock policies that address the barriers and bottlenecks faced by (agro-)pastoral peoples are required. These policies must support a paradigm shift to build local and policy-level awareness and capacity for good grassland management and secure tenure in the community and at the landscape. Transparent, equitable, participatory land-tenure reforms and implementation can ensure that pastoralist communities are not disadvantaged as pressure increases on limited land resources. In Kenya the new land policy requires enactment and implementation, and the definition of community land requires clarification. The work of the National Land Commission will be crucial in ensuring equity and harmonizing land laws. In Uganda too, there is optimism that the new land policy will help resolve some of the complex issues surrounding land rights in the rangelands. Capacity building is necessary in all countries of the Horn of Africa so that administrative bodies—for example the regional state land administration agencies in Ethiopia—are able to accurately apply regulations locally. Land registries need to be established and title deeds provided where appropriate. Policies and legislation should explore creative approaches to using customary land systems. In countries such as Ethiopia, what is needed are specific laws that put into practice pastoral land rights that are already enshrined in the country's constitution. Models for framing legislation that recognizes and protects livestock mobility and seasonal land use are available from West African countries, where pastoralism is recognized as an economically vital activity (Hesse n.d.). Special emphasis is needed on developing ways to ensure that marginalized groups are able to benefit from and share in land distribution programs.

Develop a policy framework for peace and security

Despite the growing conflicts that have been noted among competing land users, the strong social and religious networks throughout much of the Horn of Africa form a basis for developing peace-building mechanisms in the community. A coordinated and inclusive national and regional policy framework for peace and security can build on the strong traditional institutions and customary mechanisms of conflict and dispute resolution. The Kenyan National Peace Building and Conflict Management Policy, for example, aims to proactively identify and sustainably resolve the grievances that trigger intercommunity conflict. Initiatives supporting cross-border peace have proved to have positive effects, e.g. between Ethiopia and Kenya.

Over the long term, civil society groups are one way of channelling the escalated conflict in many rangeland areas of the Horn of Africa into non-violent forms of administrative, judicial or political competition between opposed interest groups, or between citizen groups and the state. International donors and national governments alike have a long-term interest in the growth in sophistication and power of these groups, and programs should be implemented to support their development.

Landscape and livelihoods planning and decision-making

Integrated multi-sectoral, multi-stakeholder and multilevel processes

Processes are necessary that address the range of natural resources (land, water, croplands, rangelands, forests, livestock, energy, biodiversity) and social dimensions with active involvement by all those concerned. These holistic approaches and partnership processes must take advantage of win–win options that target local, national and global goals. This approach can build upon concrete efforts pursued by the Ministry of Development of Northern Kenya and Other Arid Lands. The ministry is using an integrated seasonal livelihood-programming tool developed and supported by the World Food Programme to identify livelihood-based responses and concrete multi-stakeholders' integrated actions to tackle short- and long-term food insecurity in drought-affected communities in the arid and semi-arid lands. Other community-based landscape planning approaches currently being tested or ongoing that could be scaled up include watershed development in the highlands of Ethiopia, local government climate change planning in Uganda, and river basin development in Kenya (by governments in partnership with development partners such as SVC-US, WFP, FAO, SOS Sahel and Oxfam)

Carry out consultative scenario-based impact path development in country

A key to building development paths that will enhance both landscape and livelihood resilience and productivity will be to clearly articulate and analyse possible scenarios to identify entry points for interventions that will lead to best possible outcome as identified by all stakeholders, providing a framework for decision-making around potential but unpredictable outcomes. This exercise, which can be carried out at country level, can be based upon existing scenario and decision-making tools and approaches that link qualitative efforts and quantitative work through models of global economic and land-use change and food security. A further advantage of consultative scenario efforts is the acknowledgement of trends and realities around sedentarization, agro-pastoral communities and pastoral dropouts to ensure their issues and priorities are included in planning and implementation strategies.

Adopt an integrated approach to land-use management

The deceptive complexity of the dryland environment—with multiple resource components against an ever-changing physical, social and economic background—requires a carefully crafted, multi-layered and balanced approach. Innovative solutions are needed that complement rather than compromise pastoralist systems, such as bio-enterprises based on the use of dryland products. A coordinating body, such as the Ministry for Development of Northern Kenya and Other Arid Lands, has much to offer in commissioning research, analysing value chains, screening proposals, coordinating investment and linking potential buyers with producers. Rehabilitation of degraded land is a major priority.

Support mobility and pastoral production systems as well as development

Dryland management policy within an overall national development framework needs to accommodate the mobility that is inherent in nomadic pastoral production systems, which will entail land-use planning at a scale that cuts across administrative boundaries. Issues requiring urgent policy attention include access to and management of water and other natural resources, rationalization of settlements and the competing needs of different users. Protecting mobility and maintaining livestock corridors will increasingly become a key challenge with the advent of new projects for the development of arid and semi-arid lands, such as the LAPSSET initiative, launched in March 2012, which includes construction of an oil pipeline and improved transport networks as components of an ambitious development program. Against that background, agreements that formalize the flexible needs of pastoralists within the overall land administrative system need to be formulated as a matter of urgency.

Protect and preserve ecosystems and their services

In planning land use, full recognition should be given to the value of ecosystem services and their role in the livelihoods of pastoralist peoples. In Kenya, for example, wildlife is a national heritage and a key foreign currency earner, and pastoralism is the only land use compatible with its conservation. Yet the support that pastoralists receive to assist them to coexist with wildlife is often minimal and tends to be reliant on conservation organizations rather than government. Kenya's new Wildlife Bill (2011) strongly advocates community participation in wildlife management and has the potential to build innovative approaches, such as conservancies and the program on the edges of Nairobi National Park to compensate pastoralists and landowners for not erecting fences that obstruct migration corridors. There are issues to be resolved around the contribution of livestock to managing lands for conservation as is currently employed in areas in Kenya. This same aspect applies to agricultural production systems, particularly with a focus on sustainable intensification of crop production. For example, creating positive incentives can advance the capacity to incorporate the value of the natural resources and ecosystem services into agricultural input and output price policies.

Promote sustainable intensification through integrated crop–livestock–tree systems

Sustainable intensification is emerging as a priority in areas where expansion is not an option. This system builds upon the ecosystem or eco-functional approach in agricultural management that uses factors including land, water, seed sources and nutrients to complement the natural processes with an aim of increasing food, nutrition and energy security, resilience of ecosystem processes and adaptation to and mitigation of climate change. There is a great deal of experience in the region to build upon in conservation agriculture (leaving soil undisturbed, rotating crops, and maintaining soil cover), conservation agriculture with trees and other agroforestry practices.

Building capacity of stakeholders and institutions

To take up the challenge of integration, it is necessary to build multi-stakeholder, inter-institutional, and interdisciplinary innovation and learning platforms focused around landscapes and territories, food systems and value chains. A capacity development strategy must address the current lack of integration among sectors and institutions while also overcoming on-the-ground obstacles to achieving sustainable, functional food- and energy-producing landscapes. Transitioning to a fully integrated approach requires capacity development from

the household to national and regional levels; it places responsibility on government, civil society and the private sector to work together in partnership. While what the different stakeholders accomplish separately through capacity development varies, the key is what they can accomplish together. Following are key elements of capacity development.

Ensure awareness and build capacity around ecosystem function and resilience

At the heart of building resilience is a full appreciation for the ecosystem processes that ensure healthy land, clean water in adequate supply and biodiversity, and that support livelihoods. A capacity development strategy must address the current lack of integration among sectors and institutions while also overcoming on-the-ground obstacles to achieving sustainable, functional food- and energy-producing landscapes.

Enhance leadership for facilitation and meaningful participation in learning and innovation platforms

It is essential to build skills in facilitation, conflict management and negotiation. Facilitation of multi-stakeholder learning platforms is a skill set that is going to be increasingly required to assist in information exchange, debate, policy dialogue and scenario setting, and in planning and evaluating approaches. Innovation and learning platforms should include personnel from relevant ministries and key agencies, university representation, national focal points for local government and municipal authorities, international conventions and committees; environmental, agricultural and development NGO leaders; farmer and pastoralist leaders; trade unions, consumers, the private sector and the media.

Promote and invest in empowering women and youth

Rural women are responsible for producing 60–80% of the food in developing countries; therefore, they must manage the natural resources needed to support food production. Increasing the leadership and entrepreneurial skills of women and girls will further contribute to sustainable food security and serve to focus the use of resources.

Appropriate education is essential if pastoralists or their children are to exit from pastoralism into formal sector employment. Many youth are looking for supporting or alternative livelihood options to pastoralism that better fit with their own aspirations. But without appropriate knowledge or skills, the valuable opportunities that this young and vibrant workforce provide are being lost from rural areas as they revert to unskilled manual labour in towns and cities as a last resort. Enterprise and skills training as well as micro-credit facilities in pastoral towns are needed for ex-pastoralists or those who have opted out of pastoralism. Finally, policies are needed to tackle the ecological problems and localized overgrazing associated with restricted mobility and pastoral sedentarization. In sum, what is needed are settlement policies that address the environmental effects of growing rural towns, explicitly recognize the legitimacy of mobility, and prepare pastoralists with the skills they will need if they choose to settle.

Infrastructure

Infrastructure considerations are contingent on planning for long-term outcomes—understanding the positive and potentially negative consequences of one decision on other aspects. With that in mind, there is good reason to promote key infrastructure components that will assist in promoting resilient livelihoods and landscapes in the Horn.

Promote sustainable water development

Priority needs for water development are multiple. The largest requirement is to build capacity and maintain local expertise in implementing best practice in relation to a systems-based (watershed, river basin, etc.) approach. In relation to water for agricultural production the major issues are to do with access to water. This entails the development of rainwater harvesting and management strategies and the capacity to maintain them. For more formal water installations to serve both small-scale irrigation and household needs, early participation from the community is necessary to ensure systems are designed that serve multiple community needs and to encourage ownership. Large water points have often resulted in environmental degradation in low-rainfall areas where grazing-induced pasture degradation is otherwise uncommon. Training and capacity building in integrated watershed management that specify the kinds of water development are critical for future investments that are cross-sectoral and are not constrained by small administrative boundaries. In the short term, the Livestock Emergency Guidelines and Standards Project (LEGS 2009) has already compiled minimum standards for emergency water provision for livestock. These standards should be promoted through a program of demonstration and raising of awareness.

Build on integrated water management as a component of sustainable land management

Programs such as MERET (MOARD-WFP)[10] *and other* stakeholders (e.g. GTZ, World Bank, NGOs such as REST[11] and Ireland Aid Watershed Project) have in Ethiopia successfully applied principles of integration (from participatory landscape planning to water harvesting and soil management, biomass recycling and use, access to markets, etc.), with the amount of implementation reaching considerable scale. The relevance of scale, while difficult to achieve in a number of challenging settings (e.g. degraded, vulnerable and highly food-insecure areas), has been critical to generating multiple benefits. A combination of efforts of scale, of participation, and of the creation and management of quality assets became possible (e.g. significant recharge of superficial aquifers, generation of small-scale irrigation schemes, enabling of fodder tree planting in dry and degraded areas, diversification and reduction of the food gap).

Encourage local, food-safe meat processing facilities, linked to sustainable land and livestock management

One way to tie sustainable land management to livestock production is to promote community-owned small-scale and food-safe abattoirs that can provide an incentive associated with sustainable grazing practices while reducing transport distances to processing facilities. An example is the Keekenyokie slaughterhouse in Kenya, which focuses on conserving meat. It is used as an educational facility and generates biogas from slaughterhouse waste. Keekenyokie is linked to a pastoral innovation field school that teaches good practices in grazing planning, animal health, marketing and advocacy.

Develop all-weather roads

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10 MERET – Managing Environmental Resources to Enable Transition (to More Sustainable Livelihoods through Partnership and Land User Solidarity); MOARD – Ministry of Agriculture and Rural Development (Ethiopia).

11 GTZ – Deutsche Gesellschaft für Technische Zusammenarbeit (German Society for Technical Cooperation); REST – Relief Society of Tigray.

An all-weather rural road network is needed for commercial drought destocking programs. Unlike livestock in good physical condition, animals weakened by drought cannot be walked to market; neither can they be transported on poor roads without many animals dying. Loading docks and holding areas can be improvised, but traders need road access if they are to retrieve animals from drought-stricken areas.

Research and knowledge management

Build knowledge as a basis for informed management

In many rangelands of the Horn of Africa there is no consolidated information on the extent of rangelands, how they are being used, what tenure and management systems are in place, and what is the potential for development based on systematic scientific studies. This dearth of knowledge makes informed policymaking difficult. Knowledge where generated tends to be stored well away from the rural areas that it is meant to serve. A full resource inventory of rangelands and natural resources is a necessary basis for making strategic and participatory decisions on land-use planning, management and development, and how pastoralism can best be supported and integrated. In Uganda, for example, the Ministry of Agriculture, Animal Industries and Fisheries is ambitiously eager to undertake such an inventory and develop a rangeland management resource centre, depending upon the availability of funding. In Ethiopia, a large amount of data has already been generated, for example through the river basin studies of the Ministry of Water Resources and Development, and efforts are ongoing to fill data gaps and build databases using formats that are conducive to cross-referencing. Regional research centres based in dryland areas should be developed.

Enhance knowledge systems based on agro-environmental approaches

Research and knowledge sharing are needed on technologies that increase or maintain productivity and enhance the natural resource base, and on ecological services provided by agriculture systems. This can be done, for example, by investing in the increased use of spatial data that improve the understanding of relationships between environment and agriculture, for informed decision-making that also takes into account social dimensions.

Implement a methodology for estimating economic value of environmental goods and services

An agreed system for both assessing and taking into account the value of environmental goods and services and associated opportunity costs needs to be incorporated in investment decision-making. The System of Environmental–Economic Accounting (SEEA) is an internationally recognized methodology (UN 2003) and is the environmental equivalent of the System of National Accounts, the standard system for estimating national economic output (GDP) currently employed by the IGAD member states under supervision of the International Monetary Fund (IMF). The SEEA is important because it contains standardized definitions, classifications, concepts and accounting rules for producing internationally comparable statistics on the relationship between environmental conditions and economic output. The construction and eventual adoption of the SEEA by all IGAD member states, with the program initially piloted in states with the most nearly complete databases and research resources, will highlight knowledge gaps and identify neglected topics or regions that merit further investigation. When complete, these accounts should provide an objective assessment of the environmental contribution of rangeland areas to national economies and help determine the level of financial resources that Horn of Africa governments allocate to these regions. In addition, FAO has commissioned a paper to review the full economic value—both indirect and direct—of the grasslands of

Africa. While the author found that there is a paucity of data on key questions such as how grasslands contribute to effective water cycles, mechanisms for estimating these values are provided (FAO, 2013 forthcoming).

Support specific research for informed policy formulation and best practice implementation for greater impact

There are at least three areas in which additional environmental research is urgently needed to support informed policy formulation. First, research needs to be conducted on the economic and environmental consequences of the alternative uses that can be made of lowland river basins in pastoral areas. It is routinely assumed that irrigated agriculture makes more productive use of riverine resources than pastoral grazing, but the comparative environmental and economic costs and benefits have rarely been investigated. The few studies that have been conducted reveal that pastoralism can, on occasion, be the economically superior option. Pressure on scarce and valuable riverine resources is growing and informed regional planning would benefit from research that develops standardized methods to identify the most advantageous systems of riverine land use.

Second, the extent and severity of rangeland degradation caused by overgrazing remains—despite decades of research—a much-debated issue. The official perception that pastoralists cause widespread environmental damage undermines the rights of pastoral communities to manage their own resources. Much ambiguity is generated by the conflicting ways different scientific disciplines and interest groups define degradation. Land-use planning would benefit from a region-wide program to collect new data, amalgamate and analyse existing information, and clarify the central analytical concepts used to determine the extent and causes of rangeland degradation in the Horn of Africa. This should be framed by the developing policy paradigm of ecosystem services and should consider all ecosystem functioning and associated values.

Third, research needs to be carried out to identify opportunities and constraints on preserving or enhancing the upstream areas of these river basins to ensure further losses do not occur or to ascertain where enhancements can be made to benefit the downstream lowland rangelands. These research portfolios should have a large demonstration component that will pilot best practice.

Funding and funding mechanisms

Both public and private financial streams offer potential for taking advantage of the contribution that extensive livestock systems, integrated sustainable farming systems (crop–livestock–tree) and forestry can make to production linked to resilience. Investments in regenerating the natural resource base are key to the long-term health and well-being of both landscapes and the people that depend on them.

Promote incentive mechanisms

Rewards (financial or non-financial) for environmental services and voluntary and regulatory arrangements can support a change in behaviour towards sustainable and adapted management of these fragile ecosystems, which is critical. Incentive mechanisms should capitalize on the synergies of increased carbon stocks, sustainable use of biodiversity, reversal of land degradation, and increase of water capture and holding capacity, all of which serve to enhance livelihoods and reduce vulnerability of pastoral and agro-pastoral peoples (Neely and Fynn 2011).

Promote collaborative, harmonized and consistent resource investments tied to resilience indicators

Investments by donors and partners must be tied to the impact pathway and outcome indicators associated with productivity and resilience. To this end, donors in a collaborative way can contribute outcome-based investments with a view to long-term sustainability and resilience.

Other recommendations

In summary, it is evident that a number of initiatives are under way that have the potential to support the sustainable management of resources in the arid and semi-arid lands of the Horn of Africa. It is important to build on those innovations that are in play and working. In most countries, new policies and legislative measures reflect greater awareness and understanding of the characteristics and needs of dryland ecosystems and their inhabitants. Institutional arrangements are increasingly reflecting the need for a holistic, integrated approach to land management, with due recognition given to the central role played by pastoralist, agro-pastoralist and other rangeland communities. Capacity building is crucial to enable institutional bodies and individual actors to achieve competence in implementing new measures. Finally, it is vital that funding and budgetary allocations are brought into line with the contribution that arid and semi-arid lands make both to national economies and to global well-being.

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