Economic Importance of Goods and Services Derived from Dryland Ecosystems in the IGAD Region

IGAD Region

Source: World Bank

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ECONorthwest specializes in the economic and financial analysis of public policy. ECO has analyzed the economics of resource-management, land-use development, and growth-management issues for municipalities, state, and federal agencies, and private clients for more than 30 years.

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Acronyms and Abbreviations

$	US Dollar, of 2008 unless otherwise indicated
GDP	Gross Domestic Product
ha	hectare
km	kilometer
IGAD	Intergovernmental Authority on Development
IUCN	The World Conservation Union

EXECUTIVE SUMMARY

Drylands—lowlands with arid, semi arid, or dry sub-humid climates—constitute about 80 percent of the area of the seven East African countries (Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, and Uganda) in the Intergovernmental Authority on Development (IGAD). These drylands are home to almost 70 million residents, most of whom practice a pastoral way of life or live in small urban centers. Many in the region and elsewhere see the drylands as economic wastelands, because they exhibit persistent levels of deep poverty and consume large amounts of food aid and other assistance during frequent droughts. This perception underlies a widespread belief that doing something—anything—different with the drylands' natural resources would necessarily yield local and national economic benefits. Common proposals call for diverting water from rivers to irrigate crops and mining for oil and other resources.

This view overlooks the economic benefits derived from the drylands. These ecosystems provide food, water, shelter, cultural references, and many other goods and services that enable most residents during most years to survive, maintain a way of life they cherish, and pursue improvement in their standard of living. Goods and services derived from the drylands also contribute to the food supplies, foreign-exchange earnings, job opportunities, and gross domestic products (GDP) of IGAD countries. The overall value of these goods and services remains unknown, but the limited, relevant research provides distinct, but useful insights. Much of the value materializes as drylands provide forage and water for pastoralists and their livestock, a primary source of milk, meat, and hides. Some of these products pastoralists consume directly, but others they sell into markets, with many of the benefits accruing to urban dwellers. Studies of forage, water, and other dryland goods and services that support livestock production vary across the region, with studies documenting values of about $9–80 per hectare per year, and an average value of about $45 per hectare per year. A separate line of research has found that dryland forests, woodlands, and bushlands can offer building materials, medicines, natural foods, firewood, and other elements of domestic consumption and commercial trade with a value of about $30–130 per hectare per year.

Not all of the economic value associated with dryland goods and services materializes through the activities of pastoralists. Carbon sequestered in drylands, for example, has an asset value of $700–4,200 per hectare. Past overgrazing has diminished the amount of sequestered carbon, and taking reliable actions that allow the ecosystem to recover can reverse this effect. Such practices may increase sequestered carbon by 0.1–5.3 tons per hectare per year. Current estimates indicate the economic value of sequestering additional carbon would be about $5–25 per hectare per year. Markets currently do not exist to support payment for sequestering carbon, but the prospect of carbon markets suggests dryland communities may in the future be able to receive payment for sustaining or increasing reservoirs of stored carbon.

Drylands in the region also support wildlife diversity of global economic importance. The IGAD countries capture some of the wildlife-related value, largely through the tourism industry. They may be able to capture more: a private ranch that rears cattle primarily for commercial beef production in northern Kenya, for example, found that managing its lands for both livestock and wildlife, rather than for livestock alone, can raise annual earnings from $1.50 to more than $27 per hectare.

Activities that impede the ability of the region's dryland ecosystems to provide these goods and services can impose economic harm locally, nationally, and globally. Converting drylands to new uses can displace their ability to support pastoral communities, produce livestock, sequester carbon, sustain wildlife, and create related tourism opportunities. These losses offset at least some, and perhaps all, of whatever economic benefit comes from the new uses.

Streams and rivers, though small in number, play key roles in the production of goods and services from dryland ecosystems. The value of goods and services from healthy wetlands likely exceed $100 per hectare per year, and may exceed $2–10,000 per hectare per year. Their role as a refuge during dry periods is especially important, when their ability to provide water and forage supports pastoralists, livestock, and wildlife attracted from the surrounding area, which may extend as far as 100 km. They also can provide refuge for birds that range across national and continental borders.

Changes in the use of land and water can substantially affect the value of the goods and services derived from drylands. Many in the region, for example, expect economic benefits can be achieved by diverting water from dryland streams and cultivating nearby land for irrigated agriculture. Small-holder and industrial irrigation schemes aim to provide higher incomes for local residents, increase the homegrown supply of food, fiber, and fuel, and reduce the imports of these products. These goals are difficult to accomplish, however, raising questions about the feasibility of irrigated agriculture in dryland ecosystems. Notable examples in Kenya and Sudan have fallen short of their targets leaving investments in infrastructure unrewarded and the hopes of participating farmers unfulfilled.

Moreover, whatever the economic benefits from these irrigation schemes, they always are offset, in part or in whole, by economic losses associated with the displaced, alternative uses of the land and water. Both local and national economies experience losses when irrigated agricultural schemes displace pastoralists who otherwise would use the land and water to sustain their livelihood. This displacement diminishes pastoralists' production of livestock for their own consumption, and their sale of meat and other products for export or for consumption by urban residents. In some cases, those displaced seek to continue their lifestyle by encroaching on neighboring land and water resources, increasing the likelihood of violence. In others, they lose the lifestyle, moving to urban areas with different cultural and spiritual values. In addition, the development of irrigated agriculture can adversely affect wildlife habitat, perhaps threatening the continued existence of endangered species or diminishing the basis for wildlife-oriented tourism.

Two case studies in Kenya indicate that these economic costs can equal or outweigh the economic benefits. One, involving about 2,000 people irrigating 176 hectares finds the participants unable to earn enough from the sale of crops to sustain the irrigation infrastructure. The village elders fear the scheme will collapse within a decade and express a belief that they and their families would be better off if they lived a pastoralist lifestyle. On a nearby river, diversions of water for irrigation and other purposes diminish the flows reaching a swamp that long has provided refuge to pastoralist communities, their livestock, and wildlife. Here, the elders fear their way of life also will collapse within a decade, and most of the community will have to leave the area. Both groups are highly susceptible to the rigors of drought, and have experienced prolonged periods of violence with their neighbors.

The second case study involves a proposal for industrial development of 20–30,000 hectares in Kenya's Tana River Delta for irrigated production of sugar cane. Sufficient data to support full assessment of the potential benefits and costs have not been made available for review. The data that are available, however, suggest that, although investors in the project likely would realize net benefits (their earnings would exceed their costs), the costs imposed on society as a whole would be even larger. These societal costs would materialize through the displacement of pastoralists up to 100 km distant who depend on the area to survive dry periods, the loss of livestock production, harmful impacts on at-risk species, and the general reduction of river flows and the loss of habitat in a highly productive delta ecosystem.

A third case study, in Uganda, finds that oil exploration/production has the potential to yield similar outcomes. Exploration activities have located sufficient deposits of oil to warrant production in dryland areas of the Albertine Rift. Many Ugandans relish the prospect, anticipating a large boost in economic well-being spread throughout the country. The experiences of other countries, however, shows things are not that simple.

Oil production certainly will generate large revenues, but it also will entail large costs. Many of the costs will materialize as the industry, and the economic activity it induces, occupy, disrupt, and pollute large areas, including highly sensitive and valuable wetlands near Lake Albert and the Albert Nile. These actions will reduce the ecosystem's ability to produce goods and services on which local communities depend for their livelihood, and they may diminish the attractiveness of key attractions that generate jobs and incomes in the tourism industry. Of special concern is the possibility that pollution might adversely affect important fisheries, degrade habitat for wildlife, and impair the health of those living nearby, downstream, and downwind. Already, degradation of wildlife habitat as a result of oil exploration has resulted in loss of wildlife in Murchison Falls National Park.

The experiences of other oil-producing states also highlight the possibility that the widespread economic benefits anticipated by so many may not materialize. Oil production often is associated with weakness in other sectors of the economy, intensification of poverty among those who do not receive benefits from oil production, and outbreaks of conflict.

Water diversions, mining, and other developments in the drylands can promise substantial economic benefits, but the overall outcome will reduce economic well-being for the people of the IGAD nations if appropriate steps are not taken to explicitly recognize the accompanying loss of ecosystem goods and services and ensure that the benefits outweigh the costs.

The drylands comprise such a large share of the land base that IGAD nations probably cannot accomplish their economic objectives unless they manage these lands so they make the greatest possible contribution to local, national, and global economies. Progress toward this end will require efforts—by national and community leaders, resource managers, and business leaders, as well as by advocates for poverty alleviation, environmental health, and secure livelihoods—to explicitly incorporate into their decision-making the value of the goods and services currently derived from dryland ecosystems by the pastoral and urban communities who live there.

- *Leaders – at all levels of society, in all sectors of the economy, and in all corners of each country –* should acknowledge that dryland ecosystems provide multiple goods and services important to the economic well-being of individuals, families, communities, and nations

in the IGAD region, and to the world as a whole. Those who make decisions affecting the drylands should account for the impacts of each of their actions on the value of goods and services derived from the drylands and avoid actions that reduce this value unless they yield replacement goods and services of greater value.

- *Decision-makers and others* should recognize that most dryland goods and services are not traded in markets, but the absence of market prices does not mean the value of a good or service derived from drylands is zero, or that it necessarily is less important than those that are traded in markets. Those who make decisions affecting the drylands should consider all relevant information about the economic importance of the different goods and services that will be affected.
- *Environmental managers and economic planners* should initiate research to improve the accuracy of information about the economic importance of goods and services derived from dryland ecosystems. Failure to do so will increase the likelihood that drylands will be treated as wastelands, to the detriment of local communities and national economies. Focus on estimating the incremental tradeoffs—benefits vs. losses—associated with actions that alter the supply of different types of goods and services. Over time, describe the accumulated, incremental impacts of different actions affecting the drylands to determine if their ability to contribute to local, national, and regional economic well-being is sustainable. Create and implement incentives that promote sustainable management of dryland resources. Macroeconomic and sectoral planners should explicitly recognize the value of dryland goods and services, devise policies and programs to enhance this value, and avoid those that would reduce it absent clear evidence that the benefits would outweigh the loss.
- *National accountants* should incorporate the effects of development actions and resource-management decisions on the value of the goods and services derived from dryland ecosystems. This accounting should build gradually, year by year, focusing on aggregating the incremental changes to determine first the direction, and then the magnitude of the change in value.
- *Leaders in pastoral communities* should advocate for practices, programs, and policies that improve the value of goods and services their communities derive from drylands. Seek to improve the efficiency of on-going activities, enhance the quality of consumption amenities households derive from the drylands, and increase the revenues they receive for products they sell for consumption by others. Pursue opportunities for improving economic well-being not just with livestock but also with wildlife-related tourism, commercialization of natural products, carbon sequestration, and other activities.
- *Business leaders and investors* should look for opportunities to derive higher returns from sustainable management of drylands.
- *Everyone seeking to improve economic well-being in the IGAD countries* should oppose activities, programs, and investments that would degrade the ability of dryland ecosystems to provide valuable goods and services unless the proponents demonstrate that their benefits would offset the loss. These efforts should focus outside as well as inside the IGAD region, seeking, for example, to reduce the global emissions of gases that change climate, as well as the local diversion of water from valuable wetlands, such as Lorian Swamp and Tana River Delta.

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INTRODUCTION

The Intergovernmental Authority on Development (IGAD) is an international body that promotes peace, prosperity, and regional integration among its member nations: Djibouti, Eritrea, Ethiopia, Kenya, Somalia, Sudan, and Uganda. Table 1 provides summary data from several widely accepted sources. About 3.4 million km², or 80 percent of the IGAD region's total area, consists of lowlands with arid, semi arid, or dry sub-humid climates, where precipitation is lower and more uncertain than elsewhere, and drought is common. These drylands are home to almost 70 million residents, most of whom practice a pastoral way of life or live in small urban centers, and to much of the region's wildlife. When rain falls, the pastoralists, livestock, and wildlife disperse over the landscape to feed on the sparse grass; when it doesn't, they congregate at the few rivers and wetlands where there is some forage and water.

Although the pastoralists have maintained their way of life for centuries, severe droughts create a precarious existence and produce pressure for change, made more intense by fear that past and continuing emissions of carbon dioxide and other greenhouse gases will bring about changes in climate that entail even more severe droughts. Recurrent famines in the region have induced many, in and out of the region, to conclude that the drylands cannot sustain current pastoral practices. Moreover, the costs associated with providing emergency assistance during droughts support a belief that the drylands have become a burden on economic development elsewhere in the region, and prompt proposals to change the use of the drylands. These include proposals to siphon off water from the region's few rivers before it reaches the drylands, to convert the region's wetlands to irrigated agriculture, and to focus economic development in the drylands on extractive industries.

There is a widespread belief that development of extractive industries and irrigated agriculture offers opportunities to boost the overall economic benefits derived from drylands that otherwise would yield much smaller benefits through pastoralism. Ethiopia, for example, has about 3,328,910 ha of irrigable land, but only about 214,720 ha is irrigated, and Kenya has about

Table 1. Characteristics of the IGAD Countries

Country	Dryland Hectares[a]	Dryland Km²	2008 GDP ($ bil)[b]	2008 National Population[c]	1999 Dryland Population
Djibouti	1,579,000	15,790	$0.982	709,196	594,000[e]
Ethiopia	65,308,000	653,080	$25.66	82,544,838	20.5 million[e]
Eritrea	10,068,000	100,680	$1.48	5,502,026	3.13 million[e]
Kenya	39,761,000	397,610	$30.24	37,953,838	9.9 million[d]
Somalia	51,075,000	510,750	$2.6	9,558,666	8.8 million[e]
Sudan	167,554,000	1,675,540	$57.91	40,218,455	22.2 million[e]
Uganda	3,934,000	39,340	$14.53	31,367,972	2.1 million[e]
Total	339,279,000	3,392,790	$133.4	207,854,991	67.2 million

[a] (Deichmann and Eklundh, 1991), [b] (CIA, 2009), [c] (U.S. Census Bureau, Population Division, 2009), [d] (Barrow and Mogaka, 2007), [e] (Murray, et al, 1999)

540,000 ha of irrigable land, but irrigates only about 52,000 ha, leading many to believe there is great potential to increase food production and economic growth through increased irrigation (Saundry 2007). Recent years have seen numerous large-scale acquisitions of drylands by foreign investors for industrial agricultural developments. One survey of these acquisitions found they accounted for more than 600,000 hectares in Ethiopia and almost 500,000 hectares in Sudan (Cotula et al. 2009).

Against this backdrop, the World Conservation Union (IUCN) presents this report, to improve understanding of (1) the economic importance of the region's dryland ecosystems; (2) the potential economic consequences of alternative uses of the drylands; and (3) the steps IGAD and others might take to conserve the drylands' ecosystems and reinforce their ability to provide sustainable contributions to economic well-being.

This report contributes to IUCN's overall objective, to provide macroeconomic planners and others making decisions about the management of dryland ecosystems with useful information about the value of dryland ecosystems under alternative resource-management regimes, to clarify the tradeoffs among the alternatives, and improve understanding of sustainable investment options.

The preparation of this report is part of a project, funded by the International Development Research Centre (IDRC), entitled, Making the Linkages – Conservation as a Core Asset for Livelihood Security.[i] It aims to improve understanding of the linkages in eastern Africa between sustainable management of natural resources and the well-being of rural communities, where the latter is indicated by their ability to enjoy both secure livelihoods—sustainable capacity to generate and maintain a desired means of living for themselves and future generations—and economic growth. IUCN gives this definition of livelihood: "a livelihood comprises the capabilities, assets - including both material and social resources - and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capacities and assets both now and in the future, while not undermining the natural resource base."[ii] The project focuses on important linkages between poverty and the environment, including those between resources and the security of the livelihoods of communities in dryland areas.[iii]

The major activities of the project are:

1. Community workshops, and dissemination of the lessons learned at them, to improve the understanding and awareness on the linkages at the community level.
2. In-depth studies—including this report—on the linkages.
3. Community-level dialogues and interactions to improve the understanding of the linkages and their policy implications.
4. Efforts to influence policy at the IGAD level through studies and conferences of directors of conservation, health and economic planners to facilitate the dialogue between senior decision-makers for different sectors.

The project embodies a number of other testable assumptions, one of which is that rural communities have rich knowledge about their natural resources and about how to manage them effectively, and with appropriate support they can become important agents of change to

improve the sustainability and security of their livelihoods. It is further assumed that if policy and decision-makers are given the opportunity to witness poverty-environment linkages first hand and discuss this with communities then it will influence their behavior and understanding to the extent that they will make better policy and planning decisions in future. The project also assumes that, for development to yield meaningful benefits for people in poor, rural communities, the communities must have support to engage in policy-making processes, from drafting of policy documents through implementation and monitoring of policy impacts. It is further assumed that changing policy to provide meaningful benefits for poor, rural communities requires changing attitudes and practice in government and empowering champions for these communities, both within and out of government.

CONCEPTUAL FRAMEWORK

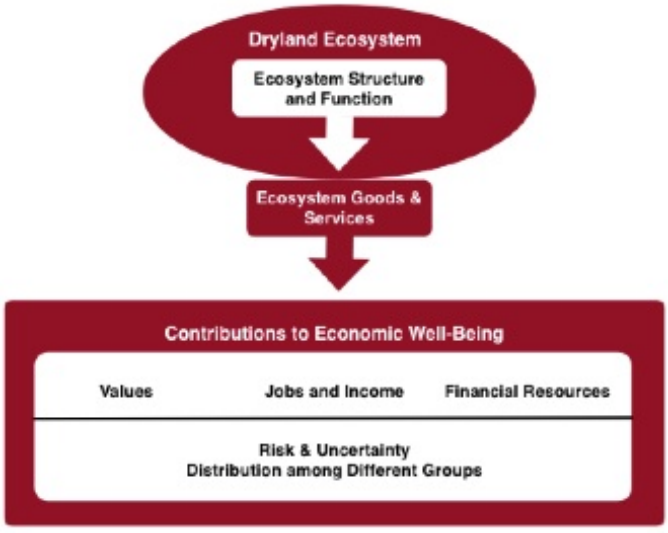
Figure 1 illustrates the general relationship between the drylands and the economy. Contributions to economic well-being occur as the physical and biological structure, and the biophysical functions of a dryland ecosystem produce goods and services important to those living in the drylands, visitors, and those living elsewhere.[iv] The goods and services can contribute to the economy in five different ways: (1) increase the value of goods and services available for consumption or investment; (2) create jobs and incomes for workers; (3) generate financial resources for households, businesses, and governments; (4) reduce levels of risk and uncertainty; and (5) shift the distribution of well-being among different groups.

Goods and Services Derived from Dryland Ecosystems

Over the past several decades, ecologists and economists have greatly expanded their understanding of economically important ecosystem goods and services, such as those illustrated in Table 2 (Daily 1997, and NRC 2004). Some are economically important when they are extracted, as when drylands provide forage for livestock that are sold for consumption elsewhere; others are important when they remain *in situ*, as when tourists visit the IGAD region to enjoy dryland cultures, landscapes, and wildlife.

The ecosystem's contributions to the economy are realized through the two pathways shown in Figure 2. In one pathway, dryland goods and services are economically important because they become production amenities, i.e., they facilitate and are inputs in the production of other things that consumers want to have. Some of these are produced by commercial enterprises, such as pastoralists who use the drylands to produce livestock for sale as part of the process that yields meat, hides, and other products. Others are produced by governmental entities, when they use the drylands to construct roads and other infrastructure for the general use of

Figure 1. Dryland Ecosystems and the Economy



Source: ECONorthwest, adapted from NRC (2004).

Table 2. Illustrations of the Functions, Goods, and Services of Dryland Ecosystems

Functions		Examples of Goods and Services Produced
1	Production and regulation of water	Drylands capture, filter, retain precipitation.
2	Formation & retention of soil	Lands accumulate organic matter, prevent erosion.
3	Regulation of atmosphere & climate	Biota produce oxygen, sequester carbon dioxide.
4	Regulation of disturbances	Drylands store flood waters, reducing flood height.
5	Regulation of nutrients, pollution	Some trees fix nitrogen in the soil, remove air pollutants.
6	Provision of habitat	Drylands provide habitat for migratory birds and wildlife.
7	Food production	Biota convert solar energy into edible plants and animals.
8	Production of raw materials	Biota generate materials for housing, fuel, and fodder.
9	Pollination	Insects facilitate pollination of wild plants and crops.
10	Biological control	Birds and microorganisms control pests and diseases.
11	Production of genetic & medicinal resources	Genetic material in wild plants and animals provide potential basis for pharmaceuticals.
12	Production of ornamental resources	Products from dryland plants and animals provide materials for handicraft, jewelry, worship, and decoration.
13	Production of aesthetic resources	Drylands provide pleasurable scenery.
14	Production of recreational resources	Drylands provide recreation for local residents, visitors.
15	Production of spiritual, historic, cultural, and artistic resources	Drylands serve as basis for spiritual renewal, folklore, group identity, advertising.
16	Production of scientific and educational resources	Drylands provide inputs for research and focus for on-site education.

Source: ECONorthwest.

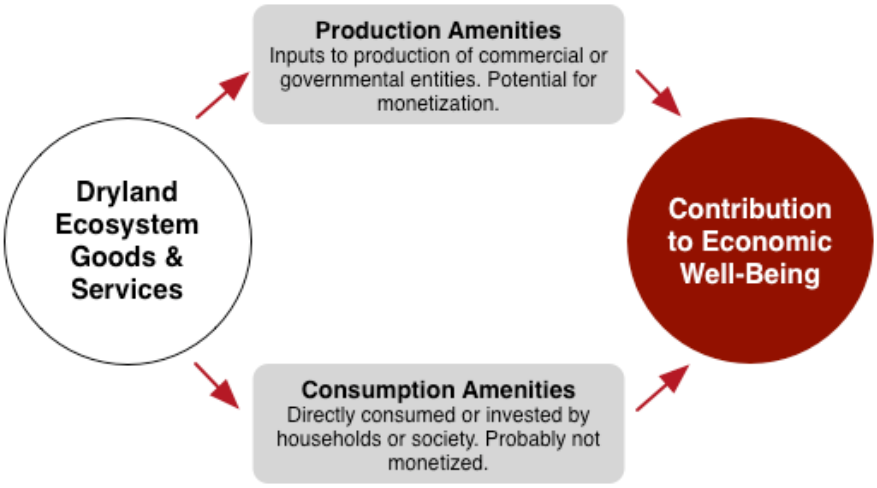
their citizens, for example. In the other pathway, the connection to consumers is more direct.

Here, dryland resources directly contribute to consumers' well-being, by producing medicines, housing materials, and subsistence foods, for example, or by providing the spatial and ecological basis for the way of life and cultural identity of pastoral communities. Drylands also provide economic benefits directly to consumers on larger scales: to the IGAD nations by regulating the movement of water, nutrients, wildlife, and human communities; and to the world as a whole by sustaining the world's biological diversity and regulating levels of carbon dioxide and other gases in the atmosphere. Such goods and services are known as consumption amenities.

Measuring Economic Importance

The five ways in which ecosystem goods and services can contribute to economic well-being are distinct, though related, and each has its own indicator(s) of importance. Contribution to value receives the most attention because, all else equal, society's economic well-being is highest when it manages an ecosystem to yield goods and services with the highest value.

Figure 2 Ecosystem Goods and Services Contribute to Economic Well-Being Via Two Major Pathways



Source: ECONorthwest.

Values. Economists typically measure the economic value of a good or service in terms of what a person, group, or business, which does not have it, is willing to give up to acquire it. It is not necessary to measure value in monetary terms, but doing so simplifies the measurement of what amount the person, group, or business is willing to pay. When a person, group, or business already possesses a good or service, the value equals the amount the owner is willing to accept as compensation for relinquishing it. In most settings, the two indicators of value, willingness to pay and willingness to accept compensation, are the same or similar. But, in some settings—when relinquishing control of a resource would lead to an outcome seen as morally repugnant, for example—the amount people require as compensation to relinquish a good or service can exceed, sometimes by a large margin, the willingness-to-pay measure of value (Hanemann 1991 and 2003 and Amiran & Hagen 2003). For example, members of a dryland community desiring to sustain their way of life may have little money they would be willing to pay to gain access to additional grazing lands but require considerable compensation before they would relinquish control over lands they already control.

Market transactions indicate the value of some goods and services providing production amenities, as when a community rents land to a tourism corporation seeking access to the land's wildlife-viewing opportunities, households purchase water from a borehole, or livestock owners sell cattle raised on dryland forage. Market prices often are poor indicators, though, as buyers and sellers in the region rarely exhibit the conditions necessary for prices to serve as good indicators of value: full, equal, and competitive access to financial capital and information about market conditions.

Most dryland goods and services, especially those that provide consumption amenities, are not traded in markets. This does not mean they have no value, only that they are not traded. Economists use non-market techniques for measuring their value, but these are cumbersome, and few have been completed in the IGAD region. Hence, indicators of value must come from

studies completed elsewhere, with appropriate care to see that the results are reasonable (EPA 2000). A comprehensive assessment must consider the values, called use values, that involve human interaction with drylands as well as those, called nonuse values, that do not (NRC 2004). Some use values involve direct interaction, as when pastoralists graze livestock to extract nutrients from drylands. With others, the involvement is indirect, as when people rely on the biota of drylands to recycle soil nutrients to sustain forage production. Nonuse values can have great value. In general, they represent the importance people place on being responsible stewards of natural resources. Many want to conserve the region's pastoral way of life and dryland landscapes, for example, or to prevent the extinction of wildlife.

Jobs and Income. Drylands make important economic contributions when they support the creation of jobs and income that enable workers and families to participate more fully in the economy's monetized sectors. Such impacts need not boost overall well-being, though, for the value of an ecosystem can be diminished to create jobs. For example, managing drylands for irrigated agriculture might yield products with lower value but higher wage employment than managing them for pastoral livestock production.

Finance. Drylands are economically important when they generate cash revenue for governmental agencies, businesses, or households. The revenue derived from a good or service need not correlate with its value, however. When villagers encroach on lands managed for tourism they sometimes reduce governmental revenues but increase the value of the goods and services they derive from the lands, for example (Norton-Griffiths and Southey 1995).

Risk and Uncertainty. All else equal, most people, communities, businesses, and governments prefer to face less, rather than more, uncertainty and risk. Hence, dryland goods and services that reduce risk and uncertainty contribute to economic well-being. Diverting water from a river for an irrigation scheme, for example, might decrease the long-run economic risk for irrigators, but increase it for pastoralists by reducing the probability that they would be able to find water for their livestock in river-fed wetlands during drought periods.

Distribution of Economic Well-Being. A full understanding of the drylands' contributions to economic well-being requires knowing their distribution among different groups. Many groups may be affected: current and future generations inside and outside the drylands, or inside and outside the IGAD region. In some circumstances, the distribution may, itself, affect economic well-being in the IGAD countries. Management of dryland areas to provide goods and services for industrial developers may benefit investors and consumers living elsewhere, but reduce the goods and services available for use by local residents, for example. Or, extracting goods and services at rates that cannot be sustained may degrade the ecosystem's ability to provide services to future generations in IGAD countries.

RESEARCH METHODS

This report integrates the results of past research with information from three case studies that aim to increase understanding of the potential economic consequences of common, major proposals for changing the management of drylands in the IGAD region. The first considers the overall effects of dispersed water diversions to support irrigated agriculture by small landowners, in the Garbatula area of Kenya. Of particular interest are the benefits realized among irrigators in the Rapsu community and the losses realized by pastoralists from reductions in flows the nearby Ewaso Ng'iro river delivers to Lorian Swamp, an area that provides refuge for pastoralists, livestock, and wildlife during dry periods. The second looks at proposals to develop large-scale, irrigated agriculture in the delta of the Tana River, Kenya, and diminish the supply of goods and services for pastoralism, tourism, fishing, and other activities. These two cases studies examine issues associated with a widespread belief that irrigated agriculture will substantially increase the amount of food and the level of economic benefit derived from drylands. They also address issues associated with concerns about large foreign investments that are converting lands in Africa to industrialized agriculture. The third examines the potential benefits and losses associated with oil development, focusing on the Albertine Rift, in Uganda. It examines issues associated with concerns that oil/gas production might not yield the economic benefits that many expect from the production of valuable mineral resources and about the potential economic harm that might materialize if oil/gas development significantly harms the environment and displaces communities from their current livelihoods. Each case study compiles and interprets information from on-site observations, key-person interviews, governmental data, and the reports of past studies.

The assessment focuses mostly on Kenya and Uganda, reflecting the case studies and the greater availability of relevant information for these countries, but effort was made to incorporate evidence from other IGAD countries, and the findings generally apply equally to drylands throughout the region. Each estimate of economic importance necessarily embodies unquantifiable, but considerable uncertainty, reflecting the limited set of relevant data, ambiguity in the accuracy of information from all sources, and the shallow record of past research. Confidence is higher in findings supported by information from multiple, independent sources than in those from a single source, and in the general order of magnitude of each estimate than in its specific numeric quantity.

RESEARCH FINDINGS

The research examines all five indicators of the economic importance of dryland goods and services, but focuses on their value, reflecting the greater availability of relevant information for this variable and its central role in indicating the drylands' contribution to economic well-being.

Indicators of the Economic Value of Ecosystem Goods and Services

The case studies, plus reports from previous research, clearly show that the goods and services derived from dryland ecosystems have economic value, both in their current relationship to human society and when this relationship is altered, e.g., through irrigation schemes and other economic development projects. The following paragraphs and tables summarize this information and, where it allows, presenting estimates of the values associated with different types of goods and services. Many of the estimates indicate the potential value of different sets of goods and services derived from a representative hectare of land, which has become a common convention for this type of assessment. Expressing value in this way, however, should not be interpreted to mean that a particular estimate necessarily applies to a specific parcel, for the values will vary from place to place, depending on site-specific characteristics. The reader should use all the estimates carefully, recognizing the uncertainty embedded them. Combining different estimates should be avoided or undertaken carefully, as they may not be compatible.

Pastoralism-Related Goods and Services. Drylands provide cultural resources, food, materials for housing, and other goods and services for domestic consumption by resident pastoralists, as well as forage, water, and other goods and services that support the commercial production of livestock pastoralists take to market. In each instance, the pastoralists and the ecosystem work together jointly and, hence, the full value of domestic consumption or livestock sold in the market represents both the ecosystem's contributions and the labor and managerial skills that humans contribute. Attributing the full value to the ecosystem, alone, may overstate the value of its contributions, but the ecosystem also supports the pastoralists' presence in the drylands, so it is reasonable, for the purposes of this report to attribute all contributions to the ecosystem.

Table 3 provides estimates, for each of the IGAD nations, of the land area, human population, and livestock population associated with areas in which livestock make the predominant contribution to pastoral livelihoods. The estimates come from the integrated analysis of data from satellite imagery and more prosaic sources on agricultural systems in each country (Cecchi et al. 2010). To the extent possible, the collection and analysis of the data were conducted in a consistent manner to give comparable estimates of the extent of pastoralism in the different countries. The data distinguish between areas with pastoral and agro-pastoral production systems, and show the total for the two. In pastoral production systems, household income derived from livestock is more than four times the income derived from crops. In agro-pastoral systems, the ratio is less than four but more than one. Livestock populations are reported in tropical livestock units (TLUs), which adjust for differences in the size of different species of livestock. One TLU equals 250 kg of biomass. The number of TLUs is calculated using these conversion factors: camels (1.0), cattle (0.7), pigs (0.5),sheep and goats (0.15), and chickens (0.02).

Table 3. Land Area and Population Associated with Pastoral and Agro-Pastoral Livestock Production Systems,[a] by Country

	Pastoral	Agro-Pastoral	Total
Land Area			
Djibouti	2,153,900	–	2,153,900
Eritrea	5,977,000	4,079,400	10,056,400
Ethiopia	34,046,700	8,263,900	42,310,600
Kenya	33,636,700	11,208,100	44,844,800
Somalia	50,190,500	9,537,500	59,728,000
Sudan (Southern)	6,784,500	19,031,500	25,816,000
Uganda	1,331,300	4,878,200	6,209,500
Total	134,120,600	56,998,600	191,119,200
Population (thousands)			
Djibouti	135	–	135
Eritrea	776	1,249	2,015
Ethiopia	4,585	6,722	11,307
Kenya	2,048	6,392	8,440
Somalia	4,947	1,372	6,319
Sudan	3,263	14,926	18,189
Uganda	282	3,696	3,978
Total	16,026	34,357	50,383
Livestock Population (Tropical Livestock Units, thousands)[b]			
Djibouti	489		489
Eritrea	1,010	803	1,813
Ethiopia	6,733	5,114	11,847
Kenya	4,028	3,008	7,036
Somalia	13,654	3,121	16,775
Sudan	2,784	31,788	34,572
Uganda	608	2,166	2,774
Total	29,306	46,000	75,306

Source: Cecchi et al. (2010).

[a] In pastoral production systems, household income derived from livestock is greater than four times the income derived from crops. In agro-pastoral systems, the ratio is less than four but greater than one.

[b] To facilitate comparison among different cultures and conditions, livestock populations are expressed as tropical livestock units (TLUs), equivalent to 250 kg of biomass, using these conversion factors: camels (1.0), cattle (0.7), pigs (0.5),sheep and goats (0.15), and chickens (0.02).

Table 4. Estimates of Economic Value, Dryland Goods and Services[a]

Good or Service	Estimated Value per Year	
Goods & Services Associated with Pastoralism		
Consumption amenities to pastoralists (Kenya)	$280/person	$42/ha
Production amenities to pastoralists (Kenya)	$20/person	$3/ha
Total (Kenya)	$300/person	$45/ha
Cost of providing refugees with services they otherwise would receive from drylands (Uganda, Tanzania)		$20–32/ha
Water and Wetland Goods & Services (Examples for Different Types of Streams and Wetlands)		
Production amenities, small-holder irrigation (Garbatula, Kenya)		$130/ha
Production amenities, livestock (Lorian Swamp, Kenya)		$125/ha
Production amenities, large-scale irrigation (Tana R. delta, Kenya)		$230/ha
Production & consumption amenities, without large-scale irrigation (Tana R. delta, Kenya)		$140–$390/ha
Production & consumption amenities (Uganda)		$300 – $10,000+/ha
African wetlands		up to $2,300/ha
Global median value, freshwater forested wetlands		$250/ha
Natural Products (for Different Types of Dryland Ecosystem)		
Savannah woodland/bushland (Uganda)		$30/ha
Turkana ecosystem[b] (Kenya)		$130/ha
Papyrus (Uganda)		$120/ha
Sequestered Carbon		$5–25/ha
Wildlife-Related Goods and Services		.
Foreign visitors' expenditures on wildlife-related tourism and willingness to pay for wildlife protection (Kenya)		$370–970 mil
Spiritual and Cultural Resources[d]		$450/ha

Source: ECONorthwest, from information described in text

[a] Estimates come from separate lines of research and may not be compatible. Addition or subtraction of estimates should be undertaken carefully and with consultation of original reports. Estimates apply generally to the IGAD region; values applicable to individual parcels may be higher or lower. See text for more information. See text for explanation.

[b] Fruits, charcoal, materials for basketry, honey, medicines for humans, and medicines for animals. Value per household scaled to the population and area associated with pastoral production systems in Kenya. See text for explanation.

[c] Assumes price of $50 per ton. See text for explanation.

[d] For illustrative purposes only, to indicate the potential cost to replace some spiritual and cultural resources. Estimate derived from expenditures to compensate for the loss of spiritual and cultural resources by Alaskan Natives. See text for explanation.

The top of Table 4 presents estimates of the value of dryland goods and services associated with pastoralism. The estimates from Kenya come from Davies (2007), which summarizes and distills the results from past analyses and other data that, together, suggest Kenya's drylands provide production and consumption amenities with an average total value of about $300 per person, or

$45 per hectare, per year. These figures come from first estimating the value, about $2.12 billion per year, of all the things pastoralists derive from the dryland ecosystem either for their own consumption or for for sale in commercial markets, and then dividing this by estimates of Kenya's pastoral population, 7.2 million, and its dryland area, 46.61 million hectares. Davies (2007) also estimates that nearly all—93 percent—of the goods ands services produced by Kenya's drylands and pastoralists are consumed by the pastoralists, themselves. These goods and services have a value of about $280 per person and $42 per hectare per year. Only 7 percent of the total value of these goods and services—or $20 per person and $3 per hectare per year—is associated with livestock and related products sold to commercial markets.

Considerable uncertainty surrounds these numbers. Davies (2007) reports that the estimated value, $45 per hectare per year, reflects a middle point of a range of estimates, from $9 to $79 per hectare per year. Moreover, the underlying data on pastoralists' consumption cover only livestock and related products, and the data on sales cover only livestock, and exclude sales of milk and hides. The data also exclude consumption and sale of other products, such as firewood, charcoal, honey, fruits, gums, and medicines. Additional uncertainty occurs in the estimates of population and area associated with pastoralism in Kenya. Davies (2007) uses estimates different from those for Kenya in Table 3. These show a higher number for population but a lower number for area than those employed by Davies (2007), although the differences are minor. Other estimates have larger differences. The data in Table 1 show a smaller area, 39.76 million hectares, for drylands in Kenya, and the Kenyan government has estimated that only 24 million hectares of drylands are suitable for livestock production (Kenya Ministry of State for Development of Northern Kenya and other Arid Lands 2008).

Studies of the cost of replacing dryland goods and services when communities are displaced come to conclusions similar to those of Davies (2007). Dorsey and Opeitum (2002) provide evidence indicating that, when dryland communities in the Acholiland sub-region of Uganda were displaced, they lost access to goods and services—associated with housing, crops and livestock, human health, tourism, etc.—that cost about $60 per person per year to replace at minimum levels. Applying this number to Uganda's total dryland population and area, shown in Table 1, indicates the loss was about $32 per hectare per year. [$60 per person/yr x 2.1 million persons ÷ 3,940,000 ha = $32/ha/yr] Data on the cost of the assisting refugees in Tanzania (UN Refugee Agency (2009) comes to roughly the same conclusion, suggesting that the cost of replacing the consumption amenities pastoralists derive from drylands is about $20 per hectare per year. These numbers do not account for the incalculable value of other goods and services, such as those associated with communities living peacefully in their traditional environment.

Dryland goods and services are economically important not just to pastoralists but also to those living in the cities of the IGAD nations. For example, if city residents were unable to obtain livestock from the pastoralists, they would have to pay extra to obtain meat, hides, and milk from elsewhere. Information in Davies (2007) suggests that, in Kenya, the replacement cost, when averaged over the country's dryland areas equates to about $42 per hectare per year. In other words, city dwellers can avoid this cost when the country's drylands and pastoralists are successful in producing livestock for market.

All this information, considered together, indicates that the estimates from Davies (2007) of the value of the goods and services produced by Kenya's drylands and pastoralists likely are

reasonably reliable indicators of the actual values. Accordingly, Table 4 shows $300 per person per year and $45 per hectare per year for all goods and services produced by drylands and pastoralists; $280 per person per year and $42 per hectare per year for the value of goods and services consumed by pastoralists; and $20 per person per year and $3 per hectare per year for goods and services sold into commercial markets.

Water and Wetlands. Water-related goods and services are especially valuable in the drylands. Wetlands that collect water and make it available to humans, livestock, and wildlife are especially important and, accordingly, the value of goods and services derived from these elements of the dryland ecosystems are higher than for other lands. They are especially valuable during dry periods, when they provide refuge for and sustain pastoralists, livestock, and wildlife that, at other periods, are dispersed over large landscapes.

The Garbatula case study, in the companion report to this one, illustrates the values affected by the small-scale diversion of water from dryland streams to irrigate crops. It finds that 2,000 persons (330 households) in the Rapsu community growing irrigated crops on 176 hectares realize gross earnings from crop sales of about $23,000 per year, or $130 per hectare per year. In addition, they produce foodstuffs for their own consumption. The case study also examines Lorian Swamp, a nearby wetland pastoralists within a radius extending more than more than 50 km have historically depended on as a source of water and forage during dry periods. In the past, it had the ability to provide these goods and services at a rate of about $125 per hectare per year. As water has been diverted for small-holder irrigation upstream, the wetland's ability to provide these goods and services has diminished.

Other information suggests wetlands have higher, perhaps much higher value. Research reported in Uganda indicates goods and services directly derived from the country's wetlands are worth about $300-600 per hectare per year, and less tangible services, such as using wetlands to purify wastewater and sequester carbon, may be worth $10,000 per hectare per year. (UMFPED 2004). Two recent studies highlight the economic importance of wetlands in the delta of the Tana River, Kenya. Mireri et al. (2008) concludes that, if land were converted to industrial sugar production, the lost services associated with the commercial production of pastoralists and others would be $140–320 per hectare per year, and additional value would be lost as the land no longer would provide consumption amenities for displaced communities. Emerton (1994) finds that reductions in water flows in the delta, resulting from a proposed dam upriver, would diminish the value of goods and services provided in the delta by about $390 per hectare per year. Schuijt (2003), looking at a small sample of African wetlands, finds that the total economic value of goods and services they provide could be as high as $2,300 per hectare per year. Costanza et al. (1997) estimates that the global average value of ecosystem goods and services is about $21,000 per hectare per year for wetlands and $28,000 for swamps and floodplains. In a subsequent review of the global literature, though, WWF sets these estimates aside and finds that the median value reported worldwide for freshwater, wooded wetlands is about $250 per hectare per year (Schuyt and Brander 2004).

Natural Products. Dryland ecosystems produce many items, besides livestock and irrigated crops, for personal consumption and commercial production. Plant products derived from woodlands include wood used for construction, as fuel, and to produce charcoal; resins, tannins, dyestuffs, and gums used as inputs to commercial products; nuts, seeds, tubers and

roots used for food; and roots, bark and leaves used for medicines. Animal products include honey, bees wax, game meat, game trophies, butterflies, and insect larvae and pupae (Kahuki and Muniu 1998, Ezeldeen 1998). These products typically are widely dispersed, time-consuming to collect, and infrequently traded in markets.

Table 5 Representative Fruits Having Potential to Diversify Food Supplies, Improve Nutrition, and Foster Sustainable Economic Development in IGAD Drylands

*** = Outstanding ** = Notable * = Average	Overall	Nutrition	Food Security	Rural Development	Sustainable Landcare
Balanites[a]	***	***	***	**	***
Baobab	***	***	***	***	***
Carissa[b]	**	**	*	**	**
Horned melon[c]	*	*	*	*	*
Marula[d]	***	***	***	***	***
Melon[e]	**	*	*	**	*
Tamarind[f]	***	***	***	***	***
Watermelon[g]	**	*	*	**	*
Aizen[h]	***	**	***	**	***
Black plum[i]	***	**	***	***	***
Custard apples[j]	**	**	*	**	*
Ebony[k]	***	**	***	***	***
Iacina[l]	**	**	***	**	**
Medlar	***	**	***	***	***
Monkey orange	**	?	***	***	***
Tree grapes	**	**	**	***	**

Source: U.S. NRC 2008.

Common names: [a] Desert date (English); ghossa , dyemo, shifaraoul (Amharic); mnyra, njienjia, mjunju (Swahili); ader, goot, kiti, kulan, kullan (Somalia); heglig, heglieg (Sudan Arabic); laloub, korak, tira, kuri (Nuba). [b] Agam (Ethiopia). [c] Spiny cucumber, horned cucumber, jelly melon, (English); nku, mutete, mugaika, mukaka, uhufafa (Bantu). [d] Elephant plum, cider tree (English); mupfura (Bantu. [e] Mageye (Swahili); malange (Kenya); agur, ajur, fagus, senat-tibish, shammam (Sudan Arabic); yek'ura-haresa (Ethiopia); akobokobo, akolil, olujo, kuliji (Uganda). [f] Indian date (English); omukooge, enkoofe (Bantu); hemor, homor, humar, komar, tommar, aradeb, b/roka, rucahu, dareho, dindie, ghroma, gianko, omar (Ethiopia); hamar (Solamia); aradeib, tamri hindi, (Sudan Arabic); kuashi, danufi (Nuba); esukuru, e/apeduru, iti, chwa, pitei (Uganda). [g] Mtikiti, masindi (Kenya); kare (Somalia); khujar, bateech, buttiku (Sudan Arabic). [h] MUkheit (English); bokkhelli, kursan (Arabic). [i] Chocolate berries (English). [j] Baboon's breakfast (English). [k] Persimmon (English). [l] False yam (English); pané (Sudan).

Recent efforts have tabulated grains, vegetables, and fruits in Africa having significant potential to boost food supplies, nutrition, and economic opportunities (NRC 1996, 2006, 2008). Table 5 lists some of the fruits that appear to have untapped potential to be developed—through research, institutional support, and the emergence of new markets—as greater sources of food for communities within the IGAD countries and as sources of income from export. Some research is underway. One effort, for example, is documenting the economic importance of

Balanites aegyptiaca, a tree species commonly known as desert date (Okia 2009). It is found throughout the arid and semi-arid regions and semi-humid savannahs of the IGAD countries. The leaves, fruits, and kernels are widely consumed by humans, livestock, and wildlife, and regarded as reliable sources of nutrition during dry seasons. Oils in the fruits can be used for cooking and as a foundation for the production of bio-diesel. The fruits also are a potential source of raw materials for the manufacture of cortisone and corticosteroid drugs.

Natural products derived from savannah woodlands/bushlands in Uganda contribute $30 per hectare per year to the well-being of local households (Bush et al. 2004). Information from the Turkana area supports a higher number. The estimated value per household is: fruits ($56), charcoal ($80), materials for basketry ($347), honey ($667), human medicines ($2,136) and animal medicines ($2,136) (Barrow 2006). If these values apply across Kenya's drylands associated with pastoral production systems (44,844,800 ha) and pastoral population (8,440,000 million), and the average household contains 8 persons, then the total value is about $120 per hectare per year. [$56 + $80 + $347 + $667 + $2,136 + $2,136 = $5,422/yr/hhld x (8,440,000 pop ÷ 8 persons/hhld=1,055,000 hhlds) = $5.7 billion/yr ÷ 44,844,800 ha in pastoral production systems ~ $130/ha/yr] Wetlands in dryland areas of Uganda can produce harvestable papyrus with a value of $120 per hectare (Wetlands Management Dept. et al. 2009). Barrow and Mogaka (2007) reports that about 40 percent of the charcoal produced in Kenya, worth about $0.2 billion per year, comes from the country's drylands.

Some evidence indicates that the adaptations of plants to dryland stresses in the IGAD region may have broad economic importance, such as contributing to gene pools or medicines that can help humans, plants, and animals elsewhere resist diseases and pests, overcome illnesses, and adapt to more frequent drought and other anticipated effects of global warming (Montenegro 2001). Some Borana cattle in Ethiopia and northeastern Kenya have greater ability to go without water for three days, to resist ticks, to quickly grow to a large frame, and to calve every year, for example (Zander 2005). Research conducted for the Garbatula case study found cattle growers from less hostile environments already looking to purchase Borana cattle with these characteristics and incorporate them into their own herds, anticipating that doing so will help them cope with future climate change and mounting competition for water.

Carbon Sequestration. As plants grow, they draw carbon dioxide from the atmosphere, decreasing its potential contribution to global climate change. On average, drylands around the world hold about 14 tons of carbon per hectare, with dry subhumid and semiarid lands holding more, and arid and hyperarid lands holding less (Safriel, Adeel et al. 2005). The value of sequestered carbon remains uncertain, but the range of estimates by economists runs from about $50 per sequestered ton (Nordhaus 2009) to six times this amount (Stern 2006), indicating that the carbon sequestered in the drylands of the IGAD region may, on average, have a total value of $700–4,200 per hectare. [$50/ton x 14 tons/ha = $700/ha x 6 = $4,200/ha].

A summary of the meager literature on the topic suggests that drylands, if appropriately managed, might have the potential to sequester an additional 0.1–5.3 tons per hectare per year through establishment of systems that increase the time in which lands are left to rest from overgrazing (Neely et al. 2009). At these rates, the potential annual value would fall within a broad range, with a lower boundary of about $5–$25 per hectare per year [0.1 tons/ha/yr x $50/ton ~ $5/ha/yr; 5.3 tons/ha/yr x $50/ton ~ $25/ha/yr]. The areas to which these rates

would apply is not known, and markets or other institutions that would derive revenue from the sequestered carbon have not yet developed. It is possible, though, that they will develop in the future, allowing communities and nations in the IGAD region to earn revenue for protecting the amount of carbon stored in the drylands, adding to the amount, or both.

Wildlife-Related Goods and Services. The drylands support most of the region's tourism industry. In some circumstances, the production of wildlife conflicts with the production of livestock, crops, and other products (Norton-Griffiths and Southey 1995), but many believe livestock and wildlife can co-exist (Pearce 1997). A private ranch in northern Kenya that rears cattle primarily for commercial beef production reports, for example, that managing its lands for both livestock and wildlife, rather than just for livestock, can raise annual earnings from $1.50 to more than $27 per hectare (Ol Pejeta Conservancy 2009). Case-study research conducted for this report found that residents of drylands in Kenya and Uganda place a value on wildlife, integrating wildlife into their culture and recognizing the roles wildlife play in their appreciation of the environment. They also see that some wildlife (and wildlife-related tourism) sometimes compete with them for food, water, and land. Many the competition leading to outcomes that favor one side or the other. Increasingly, however, both pastoralists and wildlife managers are looking for resource-management options that will accommodate livestock and wildlife, pastoralist communities and the tourism industry.

Wildlife-related tourism is most important in Kenya, but even here there is no current, comprehensive estimate of the value residents and visitors place of wildlife (Kasiki 2009). Data from the early 1990s, however, indicate that visitors to game parks and reserves in Kenya are willing to pay $75–195 per visitor day (Brown et al. 1994). Kenya Ministry of Tourism (2009) reports 2,495,000 "visitors to the National Parks and Game Reserves" in 2007. Multiplication indicates that foreigners are willing to pay about $185–485 million per year for access to the wildlife as well as to the lodging, cultural events, and other services associated with wildlife tourism. Separate research (Moran 1994) indicates that the value foreign visitors place on protecting Kenya's wildlife is roughly the same order of magnitude, making the total value from visitors is $370–970 million per year. Considerable uncertainty surrounds these estimates; the actual value could be smaller or larger.

In addition, many residents of other countries likely would be willing to pay something to secure the continued existence of wildlife in the IGAD region (Kramer et al. 1996). The existence value probably far exceeds the use value associated with the tourists who actually visit the region. Research in the U.S. indicates that existence values associated with wildlife are about nine times the use value (Stevens 2001). The habitats and species of the drylands of the IGAD region are particularly iconic, well-known, and therefore associated with especially high existence values (Swanson et al. 2004). These values likely would increase, perhaps dramatically, if populations of key species, such as lions and elephants, decline so that more people inside and outside the IGAD region become concerned about their continued existence. Wildlife-related values likely also would increase in response to better communication about loss of habitat and other stresses that diminish population numbers (Martin-Lopez et al. 2008).

Commercial products derived from wildlife also have value. Hunting wildlife for bushmeat provides food and income for some hunters. Poaching animals in protected areas is supported by the demand for live animals, ivory, pelts, feathers, and other products.

Spiritual and Cultural Resources. The dryland ecosystems are linked with the spiritual beliefs and cultures of those who live in them. These linkages, by their nature, are not monetized. Studies of events, such as oil spills, that disrupt the linkage between a community and its surrounding ecosystem can, however, offer insights into their importance. An assessment (Gill and Picou 1997) of the consequences of the 1989 *Exxon Valdez* oil spill, for example, concludes: "Alaska Native subsistence culture is based on an initimate relationship with the environment. Not only does the environment have sacred qualities for Alaska Natives, but their survival depends on the well-being of the ecosystem and the maintenance of cultural norms of subsistence. The spill directly threatened the well-being of the environment, disrupted subsistence behavior, and severely disturbed the sociocultural milieu of Alaska Natives." A subsequent assessment concludes "there is much evidence to suggest that the destruction of indigenous fabric was the most serious outcome" (Snyder et al. 2003). Social service programs aimed at compensating for some of the spill's cultural impacts provide a rough replacement-cost estimate of the value of the disrupted linkages: about $2,500 per capita per year (Whitelaw 2004). Further research is required to determine if disruption of the linkages between dryland ecosystems and pastoralists—from loss of water in key wetlands, for example—have similar values. If so, then the information from Alaska can illustrate the potential value of cultural and spiritual value associated with the drylands. Expenditures of $2,400 per person applied across Kenya's pastoral population and drylands indicates that the harm from actions that sever the cultural linkages between dryland ecosystems and pastoralists would impose harm at a rate of about $450 per hectare per year [$2,400 per person per year x 8.4 million pastoralists ÷ 44,844,800 ha ~ $450/ha/yr].

OTHER INDICATORS OF ECONOMIC IMPORTANCE

Their value, alone, does not tell the full importance of dryland goods and services to the economies of the IGAD nations. Other effects materialize as dryland-related activities generate jobs and incomes; produce cash flows to households, businesses, and governments; lower risk and uncertainties, and affect the distribution of economic well-being among different groups. Table 6 shows some of the contributions.

Jobs and Incomes. Pastoralism provides employment for most of the adults living in the drylands: the young men who tend the livestock, the women who complete household chores, and the elders who manage the process. These workers typically do not receive monetary wages for their labor, but may receive indirect compensation, such as food. In addition, commercial production of livestock by pastoralists generates jobs and incomes throughout the formal sector of the economy. Letara et al. (2006) reports that, in the drylands of Tanzania, 0.24 jobs are associated with the activities that produce, slaughter, and distribute roast meat and other products from one head of cattle. Applying this ratio to Kenya, where pastoralists sell about 3.7 million cattle into commercial markets each year (Davies 2007), suggests pastoral activities support about 880,000 jobs [0.24 jobs/cow x 3.7 million cattle ~ 880,000 jobs]. This number, divided by 44.85 million hectares, the area of land associated with pastoral production systems in Kenya shown in Table 3, indicates that pastoralists' production of cattle for sale into commercial markets supports about 2 jobs per 100 hectare. Additional jobs would be generated, stemming from the production and sale of livestock other than cattle. Yet more jobs likely would be generated in the informal sector.

Tourism and travel expenditures attracted by dryland wildlife and cultural assets also create jobs. The tourism and travel industry in each country is complex and reliable calculations of the share attributable to the goods and services derived solely from dryland ecosystems do not exist (Davies 2007, Kasiki 2009). Nonetheless, available information about the tourism and travel industry indicates that tourism supports a sizeable number of jobs in the IGAD region, so that, even if the share attributable to drylands is small, it still may represent jobs for thousands of workers. Data reported by the World Economic Forum, for example, show that, in 2008, this industry directly and indirectly generated 1.3 million jobs in Ethiopia, 483,000 jobs in Kenya, and 420,000 jobs in Uganda (Blanke and Chiesa 2009). These numbers represent about seven, nine, and seven percent of total wage employment in each country, respectively. In each country, employment in the tourism and travel industry, itself, accounted for about one-half of the total, with the other half materializing through the expenditures of the industry and its employees. Information from Kenya, where tourism related to wildlife and other attractions in the drylands is particularly notable, indicates that the impact of wildlife-related is even greater, finding that the tourism-related jobs in the informal sector outnumber those in the formal sector (Kenya Wildlife Service 2009).

Data on incomes derived from dryland ecosystems are more scarce. Davies (2007) estimates that pastoral producers in Kenya selling livestock in commercial markets annually earn about $150 million per year. The cash they receive from the sale of their animals and animal products is called direct income. As they spend this cash, they generate income for shop owners and others, and their respending, in turn, generates still more income for a broader group. This process continues, producing indirect income from the original production and sale of livestock, until the total, resulting income is a multiple of the original, direct income. Multipliers vary from industry to industry, and country to country. Analysis of commercial activities in drylands in southern Africa found a multiplier of 1.8, with every dollar of direct impact leading to $0.80 of indirect impact (Madzwamuse et al. 2007). (The data for the tourism industry, discussed above, indicates a multiplier for that industry of about two, i.e., the total number of jobs is about twice the number of direct jobs.) Applying the multiplier, 1.8, to the estimate of pastoralists' direct income suggests that the total, national income from commercial production and processing of livestock from the drylands in Kenya is about $300 million per year [$150 million per year x 1.8 ~ $270 million]. Additional income likely is realized in the informal sector.

GDP. Davies (2007) estimates that the total value of livestock and related products produced by pastoralists in Kenya, for their own consumption or for sale into commercial markets, is equivalent to about 14 percent of the country's GDP. This estimate seems to reflect a level of GDP that is about one-half the current level, though, indicating that a more accurate estimate would be 7 percent. Hatfield and Davies (2006) reports that the value of livestock production by pastoralists in Ethiopia and Uganda is equivalent to about 20 percent and 8.5 percent, respectively, of each country's GDP.

Tourism and travel associated with wildlife and cultures supported by dryland ecosystems also contributes to GDP in IGAD nations. This is especially true in Kenya where, prior to the post-election instability of late December 2007, the tourism sector accounted for about 12 percent of Kenya's GDP, 20 percent of the national government's revenue, and $28 million in revenue for the Kenya Wildlife Service (Davies 2007, UNEP 2008). Data for 2008 indicate that the tourism industry and related activities account for 8.6 percent of GDP in Ethiopia, 11 percent in Kenya,

and 9 percent in Uganda. These percentages translate to $2.2 bil., $3.3 bil., and $1.3 bil, respectively, when multiplied times the GDP amounts in Table 1. Additional economic activity would occur in the informal sector. Not all of the tourism activity and revenue is attributable to drylands, and the portion attributable to them remains undetermined. There is widespread understanding that the drylands are major attractions and, hence, represent a major component of the tourism industry's importance to the economy.

Table 6. Some Other Indicators of the Economic Importance of Goods and Services Derived from Dryland Ecosystems[a]

Indicator of Economic Importance	Estimate	
Jobs Directly and Indirectly Related to Production and Processing of Pastoralists' Livestock Sold in Commercial Markets		
Kenya	880,000	2 per 100ha
Jobs Directly and Indirectly Related to the Tourism and Travel Industry, 2008[b]		
Ethiopia		1.3 mil.
Kenya		480,000
Uganda		420,000
Annual Income in the Formal Sector Directly and Indirectly Related to Production and Processing of Pastoralists' Livestock Sold in Commercial Markets[c]		
Kenya		$270 mil.
Value of Livestock Produced by Pastoralists for Their Own Use and for Sale, as a Percentage of GDP		
Ethiopia		20%
Kenya		7–14%
Uganda		8.5%
Tourism-Related Annual Contribution to GDP, 2008[b] (Percent of Total, Amount)		
Ethiopia	8.6%	$2.2 bil.
Kenya	11%	$3.3 bil.
Uganda	9%	$1.3 bil.
Dryland-Related Exports[c]		
Ethiopia, 2008-09		
Oil Seeds		$355 mil.
Livestock and Meat		$76 mil.
Leather and Leather Products		$105 mil.
Sudan, 2004		
Sheep and Sesame		$200 mil.

Source: ECONorthwest, from information described in text.

[a] Estimates derived from different underlying data and may not be compatible. Addition or subtraction should of estimates should be undertaken carefully and only with consultation of original reports.

[b] Underlying data reflect multiple tourism attractions, and estimates probably overstate the importance of drylands, alone.

[c] Underlying data reflect exports from all lands, and estimates probably overstate the importance of drylands, alone.

Finance. Production amenities derived from dryland ecosystems help generate earnings for private and public entities, and revenue for national treasuries. Some of the most visible impacts on finance and incomes occur through exports of goods derived from drylands. Formal exports are recognized by governmental authorities, informal exports occur as goods are moved across borders without formal recognition by government. Formal exports generate financial resources and income businesses and individuals associated with dryland livestock producers, traders who purchase the livestock and transport them to a national boundary, inspection and certification systems, and port authorities; and they generate revenue for local, provincial, and national governments that collect taxes or fees on the process (el Dirani et al. 2009).

A comparison of Ethiopia, Kenya, Somalia, and Sudan (Aklilu and Catley 2010) found that livestock trade plays important, but different roles:

- Ethiopia formally exports about 200,000 live animals of all species and about 6–8,000 tons of meat, mainly goat, per year. It informally exports animals to Somalia, Kenya, Sudan and Djibouti. Meat and livestock exports in 2007-08 were valued at $15.5 million and $41 million, respectfully.[v]
- Kenya, is a net importer of animals, mostly through the informal market. In recent years, has exported a few thousand animals (bulls, cattle, and goats) to Mauritius, beef carcasses to South Sudan, and shoat carcasses to Dubai.
- Somalia exports livestock to Gulf states and Kenya. In just the last four months of 2008, exports through the port at Berbera 640,00 sheep and goats, 34,000 cattle and 700 camels.
- Sudan, in 2008, exported 610,832 sheep, 140,757 camels, 14,337 goats, and 1,198 cattle, as well as mutton, goat meat, and beef, primarily to Gulf states.

Sheep and sesame seeds exported from Sudan in 2004 produced earnings of about $200 million, for example (Chamay 2007). In 2008-09, Ethiopia's exports of products derived in part or in whole from drylands included oil seeds ($355 million), live animals and meat products ($76 million), and leather and leather goods ($105 million) (Tadesse 2009).

Risk and Uncertainty. The interaction between dryland ecosystems and pastoralists, which has evolved over centuries, enables the pastoralists and, hence, each IGAD nation, to dampen the risk and uncertainty that accompany the harsh environmental conditions. Herders move livestock to take advantage of forage and water resources that are limited at any single site but prevalent across large landscapes. Livestock in the region have developed the ability to withstand and recover from drought more rapidly than other breeds. Pastoral cultures embody mechanisms for sharing wealth across groups, reducing the risk to individuals.

These adaptations provide pastoralists with insurance against economic hardship and other services, not unlike the services available to farmers in more developed economies from financial institutions. Most pastoralists have little or no access to credit institutions where they can borrow money, banking institutions where they can store money safely, or insurance institutions where they can mitigate risk. Consequently, they look to livestock to provide these services. Through investments of time and effort they can increase their herd and their store of wealth, the additional livestock become wealth against which they can borrow, and, in general, the larger the herd, the greater the insurance against harmful events (Baldwin et al. 2007).

Distribution of Economic Well-Being. The economic values, jobs and incomes, financial resources, and risk and uncertainty derived from dryland ecosystems constitute the primary indicators of their economic importance. The distribution of these economic outcomes also can be an important indicator of economic importance. This is especially the case where one group perceives that it bears the costs of producing goods and services, but does not enjoy the benefits associated with them. Such situations can induce those who bear the costs to reduce their efforts to produce the goods and services, thereby improving, perhaps, their own economic well-being, but reducing the overall well-being of society as a whole.

Distributional issues accompany all aspects of economic activity in the drylands. Dryland-based tourism, for example, can be an important engine of economic development, but unequal distribution of costs and benefits can undermine its sustainability. Data from the early 1990s, for example, indicate that what foreign visitors actually paid to visit game parks in Kenya was about half of what they were willing to pay (Pearce 1997). In other words, they were able to enjoy some of the benefits they derived from these lands for free. At the same time, though, the revenue local communities received from tourism generally fell short of the costs they incurred as land and water were used to support wildlife and tourism rather provide crops and other products that would benefit them directly (Norton-Griffiths and Southey 1995). Insofar as a similar pattern still applies, Kenya and the other IGAD nations are providing economic benefits for the rest of the world without commensurate compensation, and dryland communities have little or no direct economic incentive to forgo activities, such as occupation of habitat, that benefit them but harm wildlife populations. This pattern of incentives contributes to continued declines in wildlife habitat and populations that reduce the overall economic well-being of those who place a value on these things and, eventually, reduce the ability of wildlife to generate jobs, incomes, and revenues for the residents of IGAD countries.

Unequal distribution of costs and benefits can occur through less direct channels as well. The dryland areas of the IGAD region typically exhibit lower levels of public investment and social services than other areas, reducing the likelihood that pastoralists will earn the highest returns for embracing practices that will yield the highest sustainable economic benefit for them and their country. Poor levels of transportation, education, and access to market information likely reduce the price pastoralists receive for their livestock below what they would receive with better services (Baldwin et al. 2007). Hence, some have incentive to move to urban areas, where the national economy must bear the expense of replacing the services they otherwise would receive from the drylands. Those who remain have diminished incentive to incur the costs associated with livestock-production practices that would improve the market value of their livestock, reducing the quality of meat and other products available for consumers or export. Some livestock producers also may see added incentive to increase the number of livestock to levels that reduce the ecosystem's sustainable capabilities.

Many factors can diminish the ability of future generations to enjoy the benefits the current and previous generations have realized from the production of goods and services by dryland ecosystems. Some, such as dewatering key rivers and wetlands, industrial development, and climate change, reduce the ecosystem's future ability to provide the goods and services. Some, such as the absence of road networks and competitive markets that would allow pastoralists to receive a higher price for their livestock, reduce the likelihood that this generation will be able to encourage future generations to pursue traditional livelihoods and take advantage of the

ecosystem's goods and services. And others, such as pricing and revenue-sharing policies that allow foreign tourists to enjoy wildlife without bearing the full costs of their actions, and revenue-sharing policies that provide local communities little incentive to support the maintenance of wildlife and their habitat, increase the likelihood that future generations—in the IGAD countries and around the world—will find the habitat and valuable species gone.

ANALYSIS

The case study findings combine with past studies to provide useful insights not just into the economic importance of the goods and services derived from the drylands but also into what is at risk when climate change, resource-management decisions, trade policies, and other factors alter the drylands, themselves, and the activities of the people living in them.

All three case studies show that changes in the use of dryland resources can yield economic benefits for some but impose costs on others. The costs would materialize as the changes negatively affect the ability of nearby communities to realize the benefits from goods and services enjoyed through on-going uses of the resources. These changes also can adversely affect wildlife populations, as well as the workers, businesses, institutions, communities, and national governments that realize economic benefits from wildlife-related tourism. Activities that reduce wildlife populations can diminish the contribution biodiversity in this region makes to the well-being of people around the world, in this and future generations.

Case Studies

Three case studies examine the unintended economic consequences that might occur as development efforts intended to change the use of dryland resources and increase the output of new products also diminish the ecosystem's ability to support the on-going activities of existing communities. Two look at the potential consequences of diverting water from rivers to irrigate crops, the third looks at the potential consequences of oil and gas production.

Garbatula District. The first case study, in the Garbatula area of Kenya, describes some of the potential economic benefits of diverting water for small-holder irrigation, and some of the potential costs when such diversions shrink a downstream wetland that otherwise would provide water and forage essential for the survival during dry periods of pastoralists, livestock, and wildlife from throughout a much larger, surrounding area.

Garbatula District and the surrounding area, in Kenya's Eastern province, is representative of drylands throughout the IGAD region and provides an appropriate case study of the downstream unintended consequences of river diversion for small-scale irrigated agriculture. The district has an area of 9,817 km^2 and a population of 31,995, with 71 percent living in absolute poverty (Kenya Ministry of State for Planning, National Development and Vision 2030, 2008).

A small-holder irrigation scheme at Rapsu, on a tributary of the Bisanadi River near Meru National Park, has evolved over about three decades as an attempt to provide economic opportunities for members of pastoral communities who have few or no livestock and, hence, limited prospects for sustaining a pastoral lifestyle. The scheme irrigates 176 hectares. According to community elders, it provides vegetables and grains for a community of about 2,000, and revenues from crop sales of about $10 per person, or $130 per hectare, per year. The elders believe that they could earn more if road access, credit, and communications were better. The available stream flow has been diminishing for the past decade and the irrigation infrastructure is not being fully maintained, so that the elders anticipate that the irrigation scheme will cease to function in about a decade. Given a choice between an irrigation lifestyle

and a pastoral lifestyle, all the elders said they would prefer the latter, concluding that they were poor when they entered the irrigation scheme, they remain poor, and see no prospects that farming would raise them from poverty.

Livestock provide milk, meat, and other products for the district's pastoralists and urban dwellers. Sales of livestock by pastoralists in the district yield revenues of about $190 per person per year. During wet periods, when pastoralists disperse and grazing occurs throughout the district, the earnings per hectare are about $4 per year, but, during dry periods, when the survival of pastoralists and livestock depends on key wetlands, the earnings from the wetlands are more concentrated, about $130 per hectare per year. The potential yield from one wetland, Lorian Swamp, which covered about 231,000 hectares in the past, may have been much higher before the amount of water reaching it declined in response to upstream diversions and other factors. The elders of a pastoralist community near Lorian Swamp report that reduced flows to the swamp, which they mostly blame on upstream diversions but also recognize stem from changes in climate, have reduced cattle herds from about one million to about 40,000. The magnitude of the reduction is extreme, but not out of line with estimates that one-year droughts in the past have reduced cattle herds by 40 percent. Moreover, the elders anticipate that, within a decade, water supplies in the swamp will diminish to the point where most of the community will have to abandon the pastoral lifestyle and migrate to urban areas. Like their counterparts in Rapsu, they believe that improved transportation, finance, and communications would increase their lifestyle security.

These findings suggest that the costs experienced by downstream pastoralists may equal or exceed the direct benefits enjoyed by small-holder farmers who divert water to irrigate crops. Pastoralists and irrigators face common problems: inadequate transportation, finance, and communications that impede their ability to realize higher earnings, drought reduces their productivity, and declining trends in the availability of water threatens their ability to sustain their current lifestyles.

Tana River Delta. This case study also looks at the potential consequences of irrigation, but at an industrial scale. The Tana River Delta covers approximately 135,000 hectares. Although its central feature is water, it embraces bushlands, grasslands, and woodlands, as well as riverine forests, lakes, mangroves, dunes, estuaries, and beaches. Rainfall is bimodal and erratic, and the area experiences both drought and flooding.

The 2005 population of the Tana River District, which extends upriver of the delta, was about 217,219 and growing 3.4 percent per year. Another one million pastoralists from outlying drylands, plus part-time fishers and fish-traders seasonally depend on the area for subsistence and commercial earnings. Typical population density ranges from 2.2 people per square kilometer in the arid areas to 25.5 people per square kilometer in some areas adjacent to the river. Densities swell seasonally and during droughts, when pastoralists and others come to the area. Two-thirds of the district's population lives in poverty. During extreme dry periods, the delta provides the only reliable access to fresh water and forage within a radius of 100 km or more, extending into Ethiopia and Somalia.

Over the past five years, the Government of Kenya has been engaging private investors to develop large-scale irrigated agriculture in the Tana River Delta. One proposal would occupy about 20–30,000 hectares and use one-third of the river's volume to produce cane sugar, ethanol

as a biofuel for domestic consumption, molasses for livestock feed, and electricity); another would be four times as large and produce fruits and vegetables for both domestic consumption and export. Justification for such development has three major elements:

a) It would increase the nation's supply of goods, such as sugar and fuel, reducing the demand for imports and increasing the nation's exports and foreign-exchange earnings.

b) It would improve local economic conditions by providing jobs and diversifying the economy in one of the country's poorest areas.

c) It would increase the net economic benefits derived from the delta's land and water resources.

Quantitative information about the expected benefits of the proposed sugar cane development have not been released by the developers or the government, but the information available indicates the investors might realize revenues of about $7 million per year, or $230–$350 per hectare per year. Analysis conducted on behalf of critics of the proposal suggests, however, that groups currently using the delta's resources, and Kenyan society as a whole, would incur costs of about $140–600 per hectare per year. If the costs materialize at the upper end of this range, but the benefits at the expected level, the costs to society would exceed the benefits to investors, and overall well-being for the delta's current residents and for Kenyans as a whole would decline. The failure of past attempts to establish large-scale irrigated agriculture in the area, plus an analysis of industrial agriculture in Sudan raise additional doubt about the ability of this type of development in drylands to generate benefits sufficient to offset the losses.

Albertine Rift. The third case study examines efforts to produce oil in the Albertine Rift area in western Uganda. The Albertine Rift is the western segment of the East Africa's Great Rift System. It has no precisely defined borders but generally extends from north of Lake Albert to Lake Tanganyika, and forms the boundary between the Democratic Republic of the Congo and its western neighbors, Uganda, Rwanda, Burundi, and Tanzania. Petroleum is being explored in Uganda's northern Albertine Rift. This case study, however, focuses on Hoima and Masindi districts that constitute Bunyoro Kingdom where the majority of petroleum deposits have so far been discovered. This focus area lies within an altitude range of 621–1,158 meters above sea level, and the region is divided into three major climatic (rainfall) zones: high rainfall (>1000mm), medium rainfall (800-1000mm) and low rainfall (<800mm). It covers 15,258 sq km, of which water bodies (mostly Lake Albert) occupy 3,068 sq km. Areas protected for wildlife occupy approximately 5,528 sq km, and forest occupies 2,774 sq km. The area's population is about 1.25 million.

Again, details about the proposed development are limited, but information that has been released by oil companies and the government create expectations that production might yield revenues for the government of about $120 million per year. Such expectations do not guarantee improvement in economic well-being, however. The residents of countries with similar economies that have become oil producers have often experienced a decline in their economic well-being, as corruption siphoned off much of the revenue, growth in non-oil sectors of the economy slowed, prices for consumer goods rose, environmental conditions deteriorated, and incidents of conflict became more pervasive. Production and related activities likely will occur in and near wetlands—including the Murchison Falls–Albert Delta Wetland System, a Ramsar wetland of international importance—that provide goods and services of local, national, and

global value. Some of the potentially affected areas exhibit levels of biological productivity among the highest in Africa. Already, spills of waste products and other aspects of oil exploration have resulted in degradation of wildlife habitat and loss of wildlife in Murchison Falls National Park.

Other impacts likely will affect goods and services derived from Lake Albert, the Albert Nile, and nearby forests and bushlands. Oil production promises to reduce the supply and value of goods and services thousands of households derive from ecosystems affected not just by oil production; the displacement of existing communities; and the development of new roads, a pipeline and other infrastructure, and new communities. Reductions could occur through:

- Habitat conversion, degradation and fragmentation.
- Aesthetic destruction.
- Changes in wildlife grazing arrangements, breeding capacity, and migration patterns.
- Contamination of fisheries resources.
- Air pollution dust and emissions from vehicles and engines on drill pads.
- Water pollution caused by hydraulic fracturing, drilling fluids, and produced water.
- Fluctuations in ground water levels that affect wildlife habitat and community water.
- Soil compaction and pollution on drill pads.
- Noise and light pollution.
- Deforestation.
- Soil erosion and sedimentation of waterways.
- Contamination from improper waste disposal or oil spills.
- Introduction of invasive alien species.
- Loss of productive capacity and degradation of ecosystem functions.

The Economic Importance of Goods and Services from Dryland Ecosystems: Synthesis for the IGAD Region

Together, the case studies reaffirm the findings of a large body of prior research: the dryland ecosystems produce multiple goods and services that support many communities and produce livestock, natural products, and wildlife valuable not just to local residents but also to the residents of distant cities, national economies, and the world as a whole. Available information is too incomplete and inconsistent to support a full accounting of the value of all the goods and services. It does, however, support the estimates in Tables 7 and 8.

Table 7 shows the estimated annual value, by country, of two categories of products that might be derived from dryland ecosystems, if the ecosystems and economic systems of each country were to closely resemble those of Kenya and Uganda, which provide most of the foundation for the estimates. The first column shows the estimated value of livestock and related products that are produced by pastoralists and either consumed by them or sold into commercial markets. Calculation of the estimates entails multiplying $300, the value per person from Davies (2007) times the human population associated with pastoral production systems in each country, reported in Table 3. [For Djibouti, e.g., $300 per person x 135,000 persons ~ $40 million]. The second column shows the estimated value of natural products that might be derived from the drylands. Table 4 shows two estimates of the value per hectare: $30 for savannah bushlands/woodlands in Uganda, and $130 from a case study of the Turkana region. The

Table 7. Estimated Potential Value of Livestock-Related and Natural Products that Might Be Derived from Dryland Ecosystems, by Country

	Livestock	Natural Products	Total
Djibouti	$40 mil.	$170 mil.	$210 mil.
Eritrea	$600 mil.	$800 mil.	$1.4 bil.
Ethiopia	$3.4 bil.	$3.4 bil.	$6.8 bil.
Kenya	$2.5 bil.	$3.6 bil	$6.1 bil.
Somalia	$1.9 bil.	$4.8 bil.	$6.8 bil.
Sudan	$5.5 bil.	$2.0 bil.[a]	$7.5 bil.
Uganda	$1.2 bil.	$500 mil.	$1.7 bil.

Source: ECONorthwest.

[a] Based on the area reported for Southern Sudan, in Table 3.

midpoint of these two, $80 per hectare per year, multiplied times the area for each country reported in Table 3 gives a rough estimate of the potential value of natural products from lands associated with a pastoral livelihood. [For Djibouti, e.g., $80/ha/yr x 2,153,900 ~ $170 million.]

The totals shown in the last column of Table 7 indicate the overall economic importance of the goods and services derived from the dryland ecosystems of the IGAD countries. The estimated total values of livestock-related and natural products are equivalent to about 19 percent of the GDP figures reported in Table 1 for Djibouti and Kenya. The estimated values are equivalent to 13 percent, 11 percent, and 5 percent of the GDP figures reported for Sudan, Uganda, and Ethiopia, respectively. These percentages suggest that, although most of the goods and services derived from the drylands have no effect on the formal sector of the economy represented by GDP, they constitute major components of the overall economic activity and production occurring in these countries. The importance is even greater in Eritrea and Somalia, where the estimated values in Table 7 are larger than GDP.

Table 8 shows estimates of the potential number of jobs and the potential income in each country's formal sector that might be generated by the production and processing of livestock pastoralists sell into commercial markets. Calculation of the number of potential jobs for each country entails multiplying 2 jobs per 100 hectares, the estimate reported in Table 4, times the number of hectares associated with pastoral production systems, reported in Table 3, and dividing by 100. Calculation of the potential income for each country begins with the $270 million, the estimate for Kenya reported in Table 4, and scaling this number to reflect the extent to which the livestock population reported in Table 3 for other countries is smaller or larger than the population in Kenya. For example, the potential income for Djibouti is calculated by multiplying $270 million by the ratio of the livestock population in Djibouti, 489,000 TLUs to the livestock population in Kenya, 7,036,000 TLUs [$270 million x (489,000/7036,000) ~ $19 million].

The numbers in Tables 7 and 8 represent only a portion of the total economic value of the goods and services derived from the dryland ecosystems of the IGAD region. Additional value is generated as these areas support cultural and social systems, sustain an important component

Table 8. Estimated Potential Jobs and Income in the Formal Sector Related to Production and Processing of Livestock Sold into Commercial Markets by Pastoralists, by Country

	Jobs (thousands)	Income
Djibouti	43	$19 mil.
Eritrea	200	$70 mil.
Ethiopia	850	$450 mil.
Kenya	900	$270 mil.
Somalia	1,200	$640 mil.
Sudan	520	$1.3 bil.
Uganda	120	$110 mil.

Source: ECONorthwest.

of global biodiversity, provide security for the livelihoods of the pastoral and urban residents of the region, support economic activity in the tourism and travel industry, sequester carbon, and contribute in other ways to the well-being of local residents, the citizens of the IGAD countries, and people throughout the world.

It is important to bear in mind that the estimates in Tables 7 and 8—and throughout the report—are just that, estimates. They embody uncertainty stemming from imperfect knowledge about the general relationships between ecosystems and the economy and about the specific relationships associated with the dryland ecosystems and economies of the individual countries in the IGAD region. Additional uncertainty arises from differences in the economic systems of the IGAD countries, particularly differences in the extent of the formal sector and its relevance to activities in the drylands. Additional uncertainties arise from differences in cultural practices, climate, transportation and other infrastructure, security, and other factors. Because of the overall uncertainty, which is so pervasive that it is not possible to describe it quantitatively, one should use the numbers in Tables 7 and 8 with caution. The true numbers for values, jobs, and incomes may be larger or smaller than those shown in the tables. The same is true for all the estimates in this report. Nonetheless, the estimates in Tables 7 and 8 are useful insofar as they provide a starting point for understanding to economic importance of the drylands in the IGAD countries.

Resource-Management Implications

The information reported above documents the economic importance of the current livelihoods of pastoral and urban communities in the drylands of the IGAD region. Policies, programs, and actions that would significantly alter these communities, by changing the availability and use of land and water resources, place these economic contributions at risk. Many of the lands associated with pastoral livestock production systems are capable, on average, of producing livestock and related products worth about $45 per hectare per year, and natural products worth about $70 per hectare per year. These products, and others that cannot be measured given current information, sustain the livelihoods of millions of people living in the pastoral

communities and urban areas of the drylands. Each of these individuals, on average, produces livestock and related products worth about $300 per year, plus natural products of even greater value.

The production of these products requires both the large landscapes that pastoralists disperse over during wet periods, and the concentrated wetlands that provide refuge during dry periods. Reducing the productivity of these areas—by polluting or diverting water away from them, for example—can significantly reduce the economic well-being of the people who depend on them and undermine the security of their ability to sustain their livelihoods. Hatfield and Davies (2006) provides an illustration, showing that converting a hectare of dryland, currently used for pastoral livestock production in the Afar Region of Ethiopia, to irrigated farming is accompanied by a loss of $78. The information presented in the preceding sections of this report presents a broader view, indicating that the loss, whether from converting land to irrigation or from other actions, can range from about $4 per hectare per year for land other than wetlands, to more than $100, even several thousands of dollars per hectare per year for wetlands. Failure to account for this loss when making management decisions regarding dryland natural resources might readily reduce the economic well-being, not just of the affected pastoralists but for the economy as a whole.

Conversely, actions that expand pastoralists' ability to derive greater economic benefit from their use of land and water resources might readily enhance their economic well-being and increase the level of security associated with their livelihood. Such actions entail giving livestock producers better returns on their investments by improving:

- Their access to markets, e.g., by improving roads and port facilities.
- Their bargaining power, e.g., by improving their access to information about prices and short-term financing that allows them to defer selling livestock when prices are low.
- The quality of their products, e.g., by providing better access to veterinary care to reduce the impacts of diseases and other factors that impair the quality of meat.
- Their access to viable substitutes for some of the services pastoralists derive from livestock, e.g., by providing insurance through financial instruments so pastoralists need not rely on large herds as a source of insurance.
- Their levels of education, e.g., by structuring educational institutions and curricula to match the mobile lifestyles of pastoralist families and communities. (Akililu and Catley 2010; Leonard 2008; el Dirani et al. 2009)

RECOMMENDATIONS

The drylands comprise such a large share of the land base that IGAD nations cannot accomplish their economic objectives unless they manage these lands so they produce the highest value goods and services. Progress toward this end will require actions by different groups:

- *Leaders – at all levels of society, in all sectors of the economy, and in all corners of each country –* should acknowledge that dryland ecosystems provide multiple goods and services important to the economic well-being of individuals, families, communities, and nations in the IGAD region, and to the world as a whole. Those who make decisions affecting the drylands should account for the impacts of each of their actions on the value of goods and services derived from the drylands and avoid actions that reduce this value unless they yield replacement goods and services of greater value.
- *Decision-makers and others* should recognize that most dryland goods and services are not traded in markets, but the absence of market prices does not mean the value of a good or service derived from drylands is zero, or that it necessarily is less important than those that are traded in markets. Those who make decisions affecting the drylands should consider all relevant information about the economic importance of the different goods and services that will be affected.
- *Environmental managers and economic planners* should initiate research to improve the accuracy of information about the economic importance of goods and services derived from dryland ecosystems. Failure to do so will increase the likelihood that drylands will be treated as wastelands, to the detriment of local communities and national economies. Focus on estimating the incremental tradeoffs—benefits vs. losses—associated with actions that alter the supply of different types of goods and services. Over time, describe the accumulated, incremental impacts of different actions affecting the drylands to determine if their ability to contribute to local, national, and regional economic well-being is sustainable. Create and implement incentives that promote sustainable management of dryland resources. Macroeconomic and sectoral planners should explicitly recognize the value of dryland goods and services, devise policies and programs to enhance this value, and avoid those that would reduce it absent clear evidence that the benefits would outweigh the loss.
- *National accountants* should incorporate the effects of development actions and resource-management decisions on the value of the goods and services derived from dryland ecosystems. This accounting should build gradually, year by year, focusing on aggregating the incremental changes to determine first the direction, and then the magnitude of the change in value.
- *Leaders in pastoral communities* should advocate for practices, programs, and policies that improve the value of goods and services their communities derive from drylands. Seek to improve the efficiency of on-going activities, enhance the quality of consumption amenities households derive from the drylands, and increase the revenues they receive for products they sell for consumption by others. Pursue opportunities for improving economic well-being not just with livestock but also with wildlife-related tourism, commercialization of natural products, carbon sequestration, and other activities.

- *Business leaders and investors* should look for opportunities to derive higher returns from sustainable management of drylands.
- *Everyone seeking to improve economic well-being in the IGAD countries* should oppose activities, programs, and investments that would degrade the ability of dryland ecosystems to provide valuable goods and services unless the proponents demonstrate that their benefits would offset the loss. These efforts should focus outside as well as inside the IGAD region, seeking, for example, to reduce the global emissions of gases that change climate, as well as the local diversion of water from valuable wetlands, such as Lorian Swamp and Tana River Delta.

CONCLUSION

Development of the drylands in the IGAD region can promise large economic benefits. In particular, the production of oil and gas, and the development of industrial agriculture offer new revenue streams, jobs, and wealth from lands that otherwise appear to be wasted. The drylands are not economic wastelands, however. Instead, they provide goods and services of paramount importance to the millions of residents and to the overall economies of the member nations. Although relevant data are scarce and of limited quality, they clearly show that dryland goods and services are economically important in multiple ways:

- They make valuable contributions to the domestic consumption of dryland residents and the production of livestock and other products for sale into commercial markets.
- Their asset value constitutes a considerable element of the economic wealth of dryland residents and each IGAD country.
- They generate jobs and incomes for thousands of workers, revenue for families, business, and governments, and provide the foundation for major contributions to each country's GDP.
- Their wetlands, such as Lorian Swamp and the Tana River Delta, mitigate climate-related economic risks for millions of people who live nearby or up to 100 km or more distant.
- They are affected by actions, policies, and programs that distribute the benefits and costs so that those who enjoy the benefits often do not bear the full costs. This is especially true as residents of other countries enjoy wildlife-related benefits but local residents bear much of the cost without compensation, as upstream communities and industrial developers diminish wetlands and other lands without compensating those who are dependent on them, and as other countries emit carbon dioxide and other gases that increase the risk of drought in the IGAD region without compensating those in the region who suffer the consequences.

Development projects that diminish the supply and value of the goods and services pastoralists derive from the drylands impose real economic harm on these people and undermine the security of their existing livelihoods. They also can diminish the economic well-being of non-pastoralists and even those who live in other countries These effects constitute real economic costs for the local, national, and global economies. Most of these effects do not appear on formal economic accounts, but this does not mean they are insubstantial, only that they are hard to measure. Development projects will improve economic conditions for society as a whole only if their benefits outweigh the costs that materialize from disruption of the on-going flow of goods and services derived from the drylands.

Affirmative action to measure and sustain the economic importance of dryland goods and services is recommended.

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NOTES

[i] For more information about the project, see http://cms.iucn.org/about/union/secretariat/offices/esaro/our_work_drylands/drylands/making_the_linkages__idrc___project_overview/.

[ii] IUCN. no date. "Sustainable Livelihoods." Retrieved 7 April 2010 from http://cmsdata.iucn.org/downloads/ mbsustliveli.pdf

[iii] The project also focuses on linkages between HIV/AIDS and the environment, and between marine resources and the security of the livelihoods of nearby communities.

[iv][iv] This formulation of the interaction between dryland ecosystems and the economy inherently places humans at the center and views drylands as important only insofar as they affect the quality of life of humans. Many may find this anthropocentric view incomplete, at best, for it ignores the biocentric view that an ecosystem has value in and of itself. The anthropocentric focus is warranted in this instance to keep the analysis from becoming intractable and because examination of an ecosystem's contribution to human quality of life informs concern about how human actions affect the ecosystem. Moreover, at least some biocentric perspectives are addressed by taking a broad view of the ways in which the ecosystem affects human standards of living and quality of life, including humans' aesthetic, cultural, and spiritual values.

[v] Aklilu and Catley (2010) report meat exports were valued at $15.5 "billion," but, based on comparison with statistics reported by Tadesse (2009), we interpret this should read $15.5 "million."

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