

Connecting poverty & ecosystem services

A series of seven country scoping studies

Focus on Kenya



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Connecting poverty and ecosystem services: A series of seven country scoping studies

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Published for the United Nations Environment Programme by the International Institute for Sustainable Development

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Background

Ecosystems provide more than the resources needed for material welfare and livelihoods. In addition to supporting all life and regulating natural systems, they specifically provide health and cultural benefits to people. Moreover, their loss is a significant barrier to the achievement of the Millennium Development Goals related to reduction of poverty, hunger and disease. The Millennium Ecosystem Assessment (MA),¹ released in 2005, reported, though, that 15 of the 23 ecosystem services assessed were being degraded or used unsustainably.

In light of these findings, this report sets out to provide a preliminary overview of ecosystem services in Kenya and the corresponding constituents and determinants of well-being related to the availability of these services. This paper is one of seven scoping studies prepared by the International Institute for Sustainable Development for the United Nations Environment Programme. Other countries examined in this series are Mali, Mauritania, Mozambique, Rwanda, Tanzania and Uganda. All of the papers are available online at <http://www.iisd.org/economics/>

The objective of the series is not to provide a detailed assessment of the poverty-environment linkages, but to identify the regions within the countries where critical ecosystem services for human well-being are stressed, signalling the need for immediate attention. This information is expected to inform and guide the selection of potential areas where a more detailed local-scale integrated assessment of the links between ecosystem services and human well-being can be carried out.

These reports do not cover previous policy interventions, as the local-scale integrated assessment would gather such information and report on the impacts these policies have had in the past. Lessons learned can then be used together with new knowledge gathered on the links between ecosystem services and human well-being to design more finely-tuned intervention strategies that would seek to promote the reduction of poverty and improve well-being while protecting and enhancing vital ecosystem services.

¹ The Millennium Ecosystem Assessment was a four-year study requested by the United Nations Secretary General in 2001 to provide an overview of the state of the global ecosystems and the consequences of ecosystem changes on human well-being.

Executive Summary

1. All ecosystem services and constituents of human well-being are stressed and threatened in all provinces except Nyanza and Western provinces. When needs are so great, prioritization can be difficult.
2. Kenya's system of protected areas is facing increasing pressure for woodfuel and food as land outside their boundaries is being transformed into agricultural land.
3. Encroachment on protected areas also impacts catchments that regulate water supply which is especially important in Kenya as it has a relatively low internal renewal water rate.
4. Scarcity of water and energy, and the gathering of wild foods add to the burden of women and children who must spend more time gathering these necessities, which takes away from their agricultural productivity thereby increasing their economic and nourishment vulnerabilities.
5. Agricultural productivity is declining and more work is needed to examine how to increase productivity and value by harnessing more sustainable land management practices.
6. Relying on woodfuel and charcoal for energy demands is unsustainable and alternative energy sources will have to be identified. In addition, a sustainable biomass energy plan may provide some solutions for curbing woodfuel shortages.

Ecosystem services

The literature review of Kenya's ecosystem services revealed four critically stressed ecosystem services: maintenance of biodiversity; food and fibre provision; water supply, purification and regulation; and fuel provision.

Maintenance of biodiversity

Kenya supports abundant and varied wildlife of both scientific and economic value with forests providing habitat for a large portion of the country's biodiversity. However, habitat loss and degradation are affected by ongoing small-holder agriculture, wood plantations, selective cutting and clear-cutting, wood extraction, livestock rearing, infrastructure development and introduced pathogens. Aquatic wildlife also suffers due to pollution of waterways.

Ecosystem services and constituents of well-being: degrees of threat by province

| Province | Maintenance of biodiversity | Food production | Water supply | Energy resources | Adequately nourished | Clean water | Energy for warmth and cooking | Earn livelihood |
|---------------|-----------------------------|-----------------|--------------|------------------|----------------------|-------------|-------------------------------|-----------------|
| Central | X | X | X | X | X | X | X | X |
| Coast | X | X | X | X | X | X | X | X |
| Eastern | X | X | X | X | X | X | X | X |
| North Eastern | X | X | X | X | X | X | X | X |
| Nyanza | X | X | X | X | O | X | X | X |
| Rift Valley | X | X | X | X | X | X | X | X |
| Western | X | X | X | X | O | X | X | X |

- X indicates an ecosystem service or well-being constituent under threat in the particular province
- O indicates that an ecosystem services or well-being constituent is not under threat
- **Bold** highlights those areas of immediate priority

Food and fibre provision

Small-holder subsistence farmers make up 80 per cent of the active agricultural population in Kenya along with beef farmers and fishers. Cash crops in Kenya consist of horticulture (cut flowers) along with traditional currency earners such as tea, coffee and tourism. Kenya's food supply is insecure and the country has a food deficit. Natural constraints to food production include erratic rainfall, low soil suitability, steep slopes and inadequate water. Soil fertility loss and the degradation of water resources have directly undermined agricultural production with deforestation from agriculture, timber-based industry and energy generation being contributing factors to soil degradation and watershed function.

Water supply, purification and regulation

Agriculture accounts for the largest withdrawals of water in Kenya and, due to inconsistent and poor distribution of water, 50 per cent of Kenyan households do not have access to safe drinking water. Naturally occurring water regulation mechanisms, including wetlands and close canopy forests, appear to be stressed. Pollution from urban and industrial waste is also severely deteriorating water quality. Infestation of water hyacinth is also causing considerable problems—eutrophication and nutrient enrichment—for the health of Lake Victoria.

Fuel provision

Woodfuel accounts for about 70 per cent of all energy consumed in Kenya, but woodfuel is becoming increasingly scarce as forest area declines. Deforestation is largely being caused by woodfuel demand for tea processing, timber for domestic and export markets, agricultural production, etc. Households also use crop residue as a supplementary energy source, however, the use of crop residue as a fuel source is entirely dependent on the availability of woodfuel and the size of the harvests. The decline in agricultural and livestock productivity imply similar circumstances for the supply of dung and crop residue.

Human well-being

Human well-being is multi-dimensional with many constituents and is closely linked with the state of ecosystem services. This report focuses on those well-being determinants that are affected by the state of

ecosystems services which include: ability to be adequately nourished; ability to access adequate clean water; ability to have energy and to keep warm; and ability to earn a livelihood.

Ability to be adequately nourished

As subsistence crop production dominates the agricultural economy, the main factor determining poor nourishment is the inability to grow food. This is closely linked with the ecosystem service of food production as food supply is characterized by over-dependence on variable precipitation, degraded water catchments, soil degradation and low economic entitlements. Food insecurity affects the population at large which can be attributed to a downward trend in the production of key crops, while the population of Kenya steadily rises.

Ability to access adequate clean water

Despite significant investments, only 43 per cent of the rural population has access to a source of water within less than a 15-minute walk, though 83 per cent have the same access in urban areas. The ability to access clean water is also a function of economic entitlements. This well-being entitlement is dependent on the ability of ecosystems to provide clean water, and these services are under stress in Kenya.

Ability to have energy to keep warm and cook

In Kenya the main fuels consumed are wood, charcoal and crop residues and 84 per cent of the population does not have access to electricity. As the population increases, woodfuel utilization is expected to increase, further constraining fuel supply. This increase in woodfuel demand negatively impacts on biodiversity and other provisioning services that forests provide.

Ability to earn a livelihood

Kenya's economic entitlements are low with the national incidence of poverty standing at 52 per cent. Although agriculture provides 70 per cent of Kenya's employment, and is the lifeline of 80 per cent of Kenya's rural poor, it contributes to just over 25 per cent of GDP. Women represent the majority of the poor and constitute over 50 per cent of the total poor in Kenya. Given the state of stress of the agricultural industry, this will negatively impact the future ability of Kenyans to earn a living from agriculture.

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Introduction

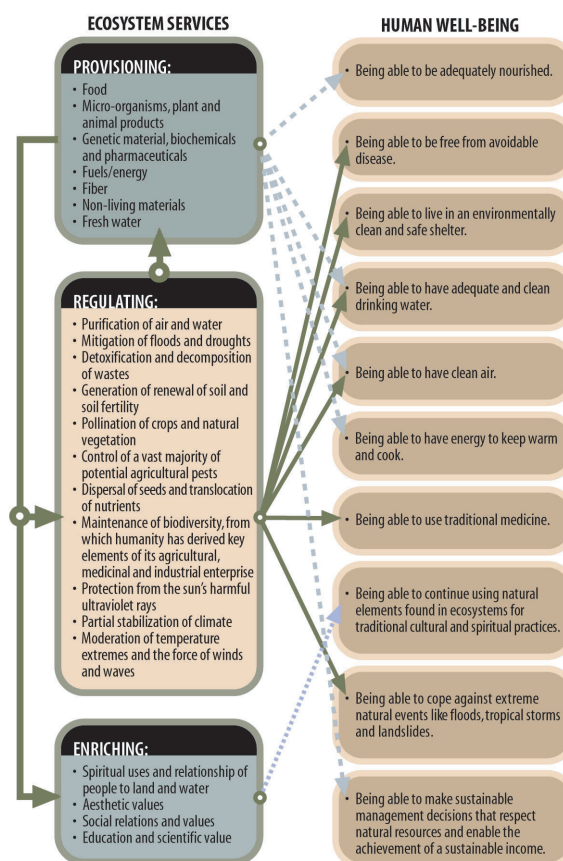
The primary objective of this report is to provide an overview of the state of human well-being and environment in Kenya. Unlike most reports on the environment, this report focuses on the state of ecosystem services and uses categories of ecosystem services developed by the Millennium Ecosystem Assessment, which are illustrated in Figure 1 (Alcamo *et al.* 2003; Duraiappah 2002; and Daily 1997). This review does not intend to be an exhaustive description of all ecosystem services. Instead, it identifies those ecosystem services in Kenya found to be deteriorating or in danger of deteriorating in the near future—in other words, ecosystem services that are stressed. Furthermore, when considering human well-being, we broaden our attention beyond the traditional constituent of material wealth (economic growth and livelihood) to also include other constituents, including: the ability to be adequately nourished; the ability to have access to freshwater; and the ability to have access to energy to keep warm and to cook, among others (Duraiappah 2004). Like ecosystem services, we only report on human well-being constituents directly or indirectly related to ecosystem services and, hence, this report should not be viewed as a comprehensive survey of all constituents of human well-being.

While not exhaustive, this overview does point out what ecosystem services and constituents of human well-being are most in need of attention and where they are located at the provincial level. By taking this unique approach and using a finer spatial lens, areas where human-ecosystem areas are stressed emerge and clarify difficult trade-offs being made locally.

This report is organized into four sections with the first briefly describing the people and landscape of Kenya, thus providing a backdrop for the rest of the overview. Section 2 scopes out the main ecosystem services under stress and pinpoints their location at the provincial level. Section 3 then discusses the related

constituents of well-being which are increasingly being threatened by these deteriorating ecosystem services and, as with ecosystem services, locates them in provinces. The concluding section co-locates those regions where ecosystem services are stressed with those where the constituents of human well-being are threatened and then briefly outlines the more outstanding trade-offs being made.

Figure 1. The links among ecosystem services and human well-being

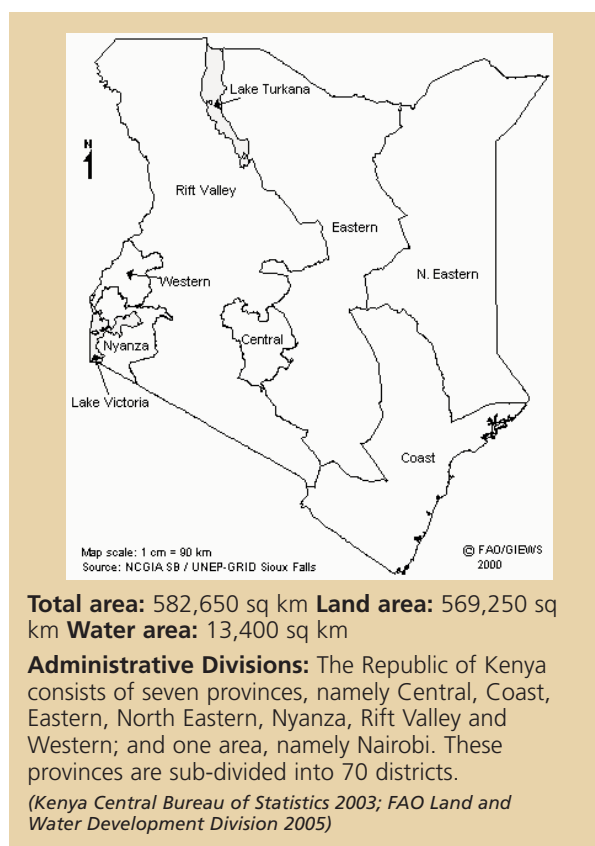


(Source: Duraiappah 2002)

1. Kenya in Brief

Kenya abounds in environmental diversity ranging from coral reefs and mangroves along the Indian Ocean coast to arid shrub land in the north, to thick mountain forests and to the shores and waters of Lakes Victoria and Turkana. This ecosystem diversity is exploited by an active tourism industry and growing population, but conservation efforts are evident; there are 31 parks and protected areas listed at the Kenyan Wildlife Service Web site. The economic potential varies across the various ecosystem types; much of northern and northeast Kenya is arid and semi-arid with sparse population.

Map 1. Kenya Regions (FAO/GIEWS 2001)



1.1 Physical geography and natural environment

Kenya straddles the equator at the southeastern edge of the Great Horn of Africa, bordering the Indian

Ocean. It has five distinct ecosystem types: shrublands, savannah and grasslands (67 per cent); cropland/natural vegetation mosaic (20 per cent); sparse or barren vegetation, snow or ice (six per cent); forests (five per cent); and wetlands and water bodies (two per cent) (World Resources Institute 2003c).

A narrow belt of forest follows the coast and extends inland for about 30 km; mangroves grow along the inter-tidal coastal zones, estuaries and creeks (United Nations Environment Programme 1998; FAO 2003). Grassland, tropical dry woodlands and mixed evergreen forest stretch to the southeast, while full evergreen forest covers the southwest at higher altitudes (FAO 2003). The central upland plateau consists of some grassland and semi-deciduous and tropical moist montane forest at 1,200–2,000 m in elevation (FAO 2003).

Climate

Kenya's central areas have a highland, montane climate characterized by higher rainfall and lower temperatures while the remaining territory experiences tropical climate with a long dry season (FAO 2000c; FAO Land and Water Development Division 2000). National average annual rainfall is 630 mm, which varies from less than 200 mm in northern Kenya to over 1,800 mm on the slopes of Mt. Kenya (FAO Land and Water Development Division 2005). Throughout most of the country, "long rains" fall from March to June and "short rains" fall from October to November (FAO Land and Water Development Division, 2005). Kenya's climate varies considerably, ranging from true desert in Chalbi desert in Marsabit district in the North, to permanent snow and glaciers above 4,600 m on Mt. Kenya (FAO Land and Water Development Division 2005). Accordingly, its temperature ranges from 40°C to freezing (FAO Land and Water Development Division 2005).

Topography

"Kenya rises from a low coastal plain on the Indian Ocean in a series of plateaus to more than 3,000 meters in the center of the country" (United States Library of Congress 2005). Most of the inland region consists of semi-arid, bush-covered plains, while in the northwest there are high-lying scrublands and in

the southwest are fertile grasslands and forests of the Kenya Highlands. These highlands are bisected by the Great Rift Valley which runs from north to south in two branches. Mt. Kenya, the country's highest mountain is located in the eastern section of the Rift Valley (United States Library of Congress 2005).

Hydrology

Kenya has five main drainage basins: Lake Victoria basin covering eight per cent of the country; the Rift Valley and inland lakes basin covering 22.5 per cent of the country; the Athi River and coast basin covering 11.5 per cent; the Tana River basin covering 21.7 per cent; and the Ewaso Ng'iro basin covering 36.3 per cent (FAO Land and Water Development Division 2005). Most lakes are saline except for Lakes Victoria, Naivasha and Baringo (FAO Land and Water Development Division 2005). In addition, Kenya has a number of rivers, including the Uмба, Mara, Pangani, Soi, Malaba, Malakisi, Omo, Daua and the Nile (FAO Land and Water Development Division 2005).

Arable land

About 80 per cent of the country is arid or semi-arid land and potentially cultivable land covers 99,420 sq km or 10 million ha (FAO Land and Water Development Division 2005). Permanent crops and arable land spread across the lake regions in Rift Valley, Nyanza and Western provinces, the highlands in Eastern Province and coastal plains in Coast Province (FAO/GIEWS 2001b; FAO 2005c). In total, 33 per cent, or 5.2 million ha, of Kenya's area is cultivated (FAO Land and Water Development Division, 2005). The western plateau which covers 17 per cent of the country, has high potential for agriculture and sustains 75 per cent of the population (FAO Land and Water Development Division 2005).

1.2 Demographics

Kenya's 30 million people, encompassing more than 70 tribes who have migrated here over the centuries, are a mixture of northern Nilotic and Cushite peoples who were followed by Bantus, Arabs, Asians and then Europeans. The tribes vary in language and culture and have their own way of dressing and decorating themselves, making Kenyan culture regionally based rather than national. People are grouped according to their linguistic origin: about 65 per cent are Bantu tribes living in the central highlands, the southeast and coastal regions; 30 per cent are Nilotic and mainly live in the southwest and central Rift Valley; while

three per cent are Cushites inhabiting northern areas. Indigenous languages are spoken along with Swahili and English, the official languages (United States Library of Congress 2005, 7).

Box 1. Demographics of Kenya

| | |
|--|--------------|
| Population: | |
| Total : | 31.9 million |
| 0–14 years: | 40.6% |
| 15–64 years: | 56.5% |
| 65 years and over (2004 est.): | 2.9% |
| Life expectancy at birth (2002): | |
| Average: | 45.2 years |
| Male: | 44.0 years |
| Female: | 46.4 years |
| Fertility rate (2003): | |
| Number of births per woman: | 4.8 |
| Annual population growth rate | |
| Per cent of population: | 1.8 |
| Population density (Inhabitants per sq km): | |
| Average: | 56 |
| Most dense province: Western | 406 |
| <i>Note: Nairobi Area in Central Province has more than 1,880 inhabitants per sq km.</i> | |
| Least dense provinces: North Eastern and Coast | 4–25 |
| Ethnic groups: | |
| Kikuyu: | 22% |
| Luhya: | 14% |
| Luo: | 13% |
| Kalenjin: | 12% |
| Kamba: | 11% |
| Kisii: | 6% |
| Meru: | 6% |
| Other African: | 15% |
| Non-African (Asian, European, and Arab): | 1% |
| Religion: | |
| Protestant: | 45% |
| Roman Catholic: | 33% |
| Indigenous beliefs: | 10% |
| Muslim: | 10% |
| Other: | 2% |
| <i>Note: the majority of Kenyans are Christians, but the estimates of the percentage of the population that follows Islam or indigenous beliefs vary widely.</i> | |

Languages:
English (official), Kiswahili (official), numerous indigenous languages

(World Bank 2005; United Nations Development Programme 2004; FAO Land and Water Development Division 2005; FAO/GIEWS 2001; United States Central Intelligence Agency 2004)

Population density is highly skewed with 80 per cent of the population concentrated on 17 per cent of the land area. As the north and northeast areas of the country are arid and not hospitable, population is sparsely scattered and density hardly reaches eight people per sq km there, but rises to as much as 280 people per sq km or

more in western areas where there is a more salubrious climate (Kenya Ministry of Education Science and Technology 2005, 10). Approximately 25 per cent of the population lives in urban centres such as Nairobi, Mombasa, Nakuru and Kisumu (Kenya Central Bureau of Statistics, 2003).

1.3 Economy: Observable constraints

During the period from 1991 to 2000, Kenya recorded an average growth of two per cent per annum, but with population growth factored in per capita growth was -1 per cent (World Resources Institute 2003b). Kenya's economic performance has been hampered by corruption, especially noticeable in the judicial system, and by the reliance on several primary products whose prices have remained low. In 1997, the IMF suspended Kenya's Enhanced Structural Adjustment

Program because of the government's failure to maintain reforms and rein in corruption (United States Library of Congress 2005). In addition, a severe drought between 1999 and 2000 caused water and energy rationing, reduced agricultural output and compounded Kenya's economic problems, resulting in a 0.2 per cent decrease in GDP in 2000 (United States Central Intelligence Agency 2005). Despite strong rains in 2001, weak commodity prices, endemic corruption and low investor confidence limited Kenya's economic growth to 1.2 per cent and again, in 2002, GDP growth lagged at 1.1 per cent due to erratic rains, meager investment and political infighting leading up to the elections (United States Central Intelligence Agency 2005). In December 2002, Kenya elected a new government, and in 2003, progress to root out corruption and encourage donor support has boosted GDP growth to 1.7 per cent (United States Central Intelligence Agency 2005).

Box 2. Development and macro-economic indicators

Natural resources:

Gold, limestone, soda ash, salt, rubies, garnets, fluorspar, wildlife, hydropower
GDP (constant 1995 US dollars), 2003: \$14.4 billion

Allocation of GDP by sector (2004 estimates):

| | |
|---|-------|
| Agriculture: | 25.7% |
| Industry: | 14% |
| mainly comprised of small-scale consumer goods including plastic, furniture, batteries, textiles, soap, cigarettes, flour, agricultural products processing, oil refining, cement | |
| Services and Other: | |
| Trade, restaurants and hotels: | 13.8% |
| Transport and communications: | 6.9% |
| Government services: | 15.6% |
| Other: | 24.0% |

Main foreign exchange by sector (2000):

Imports: US\$3,690 million:

Machinery and transportation equipment, petroleum products, motor vehicles, iron, steel, resin, plastic

Exports: US\$2,744 million:

Tea, horticultural products, coffee, petroleum products, fish, cement

Main employment sector:

Agriculture employs 75% of the population (2003 est.)

Per capita income (per year): US\$350

Income distribution:

| | |
|---|-------------------------------|
| Gini coefficient: | 45 (100% is perfect inequity) |
| Percentage of total income earned by richest 20% of population: | 51.2% |
| Percentage of total income earned by poorest 20% of population: | 5.6% |

Adult literacy rate (per cent ages 15 and above), 2002: 15.7

Human Development Index (HDI) value, 2002: 0.488

Human Development Index (HDI) rank (out of 177): 148

(World Resources Institute 2003b; United Nations Development Programme 2004; FAO Livestock Information, Sector Analysis and Policy Branch 2004; African Forum and Network on Debt and Development 2003; United States Library of Congress 2005)

2.

State of Ecosystem Services

The literature review identified maintenance of biodiversity; food provision; water supply, purification and regulation; and energy resources as the four critical ecosystem services deteriorating in Kenya. We discuss each in detail below, outline some of the main factors influencing their deterioration and, where possible, identify the regions in which they are declining. We start with biodiversity, which is maintained by ecosystems and underpins ecosystem functioning and hence availability of ecosystem services overall.

2.1 Maintenance of biodiversity

Only very recently, theoretical and empirical work has identified linkages between changes in biodiversity and the way ecosystems function (Schulze and Mooney 1993; Loreau, Naeem and Inchausti 2002). The common perception of the value of biodiversity is limited to specific uses of a limited number of specific species for human use. However, there is increasing theoretical and empirical evidence of a much more complex relationship between biodiversity—defined as the variability among living organisms; this includes diversity within species, between species and of ecosystems—and ecosystem services. Species perform numerous services for ecosystems; for example, in many ecosystems, there are a variety of species that fix nitrogen in the soil. The importance of the composition of the species is determined by how much a loss in the ecosystem service is experienced when one or more of the species is lost. The lower the impact of a loss in species to ecosystem functions, the higher is the level of redundancy in the system.

“Functional biodiversity (the variety of different ecological functions in a community independent of its taxonomic diversity) shows patterns of association (biota typical of wetlands, forests, grasslands, estuaries and so forth) with geography and climate known as biomes with ecosystems and ecoregions being smaller divisions of biomes” (Duraiappah and Naeem 2005, 21). Based on this, and according to an ecoregion classification system developed by the World Wildlife Fund, there are seven predominant terrestrial ecore-

gions in Kenya. They are listed below along with the provinces in which they are located.²

- Masai xeric grasslands and shrublands (AT1313): mainly Eastern Province and small portion of Rift Valley Province
- Somali Acacia-Commiphora bushlands and thickets (AT0715): North Eastern Province
- Northern Zanzibar-Inhambane coastal forest mosaic (AT0125): Coast Province
- Victoria Basin forest-savannah mosaic (AT0721): Nyanza Province
- Southern Acacia-Commiphora bushlands and thickets (AT0716): Nyanza and Rift Valley provinces
- East African montane forests (AT0108): Rift Valley, Western provinces
- Northern Acacia-Commiphora bushlands and thickets (AT0711): Coast, Central, Eastern, and Rift Valley provinces

(After World Wildlife Fund 2001)

Status of biodiversity in Kenya

Due to its unique physiography, Kenya supports abundant and varied wildlife of both scientific and economic value. Of known species, Kenya has 6,506 higher plant; 359 mammal; 344 breeding bird; 261 reptile; 63 amphibian; and 314 fish species (World Resources Institute 2003). Furthermore, it is home to eight mangrove and nine seagrass species, and 54 genera of scleractinia coral (World Resources Institute 2003a).

Most of Kenya’s climax forest lies above 2,000 m with only a few large blocks existing below this elevation (FAO Forestry Department 2003). The largest upland forests occur between 2,000–3,500 m on Mt. Kenya and Mt. Elgon in Western Province, the Aberdare range in Central Province, the Laikipia escarpment and the Mau-Elgeyo-Cherangani mountain system in Western and Rift Valley provinces

² As a map with both ecoregions and provinces could not be found, this list was compiled by comparing the ecoregion map with one of the provinces and estimating location visually.

(FAO Forestry Department 2003). Forests provide-habitat for a large portion of the country's biodiversity: coastal forest communities show high levels of species endemism and close forests harbor 40 per cent of large animals, 30 per cent of birds, and 35 per cent of butterflies (United Nations Office for the Coordination of Humanitarian Affairs 2000; Ogodo 2003; KIFCON 1994 in Bernard 2001, 6).

Kenya has 336 protected areas, adding up to 12.3 per cent or 7,194,000 ha of its total land area (World Resources Institute 2003). Its nature reserves and wilderness areas cover 3,432,000 ha and marine and littoral protected areas cover 355,000 ha (World Resources Institute 2003). Furthermore, Kenya protects four Ramsar wetlands of international importance covering 488 sq km and 14 marine or littoral protected areas (United Nations Environment Programme 2004; World Resources Institute 2003a). Wetlands of international importance for biodiversity conservation include Lakes Nakuru and Naivasha in the Rift Valley Province (FAO Land and Water Development Division 2005; United Nations Environment Programme 2004). This country also has one UNESCO Biosphere Reserve covering 1,335,000 ha and three World Heritage Convention reserves, including one near Lake Turkana in Eastern Province and one in Central Province (World Resources Institute 2003; United Nations Environment Programme 2004). Kenya's protected areas are concentrated in the Rift Valley, Eastern, Central and Coastal provinces (FAO Forestry Department 2003b).

Regardless, Kenya's bountiful biodiversity is steadily declining. Currently, 20 freshwater fish species are threatened, 14 plant species are endangered and another five are critically endangered (IUCN 2005 in FAO Forestry Department 2003; World Resources Institute 2003d). Altogether, Kenya has 50 endangered species, and 21 critically endangered species (IUCN 2005 in FAO Forestry Department 2003). Lake Kanyaboli (Nyanza) and Lake Victoria (Nyanza and Western) are home to more than one critically endangered fish species (IUCN 2005 in FAO Forestry Department 2003).

Examples of biodiversity use³

Savannahs are home to large charismatic wildlife that attracts tourism, an industry that accounts for approximately 19 per cent of Kenya's GDP, and is the

second largest foreign exchange earner (Association for Strengthening Agricultural Research in Eastern and Central Africa 2002; Kenya 2000). Moreover, Kenya's forests have several important non-wood forest products (NWFP) including fodder plants such as *Combretum spp.* and *Acacia spp.*; medicinal plants (e.g., *Warburgia salutaris*); dyes (*Bixa orellana*) and other non-wood forest products such as tannins, essential oils and beeswax (FAO Forestry Department 2003). Most non-wood forest products are derived from the western, montane, coastal and mangrove forests, and more than 2.9 million people are still living adjacent to many forests. Near Mt. Kenya, 10 per cent of the population collects NWFP, and Mau, Arabuko Sokode and Kakamega forests are commonly used for household level hunting, grazing and bee-keeping (FAO Forestry Department 2003).

Factors influencing biodiversity loss

Habitat loss and degradation from ongoing small-holder agriculture; wood plantations; selective cutting and clear-cutting; wood extraction; infrastructure development; and introduced pathogens/parasites affect the sub-tropical and tropical moist montane forest (IUCN 2005 in FAO Forestry Department 2003). Tropical dry forest and shrub land are threatened by many of the same activities with additional stressors being livestock rearing; non-woody vegetation collection; harvesting for subsistence use and local trade; and infrastructure development for tourism (IUCN 2005 in FAO Forestry Department 2003). Grassland/tropical dry lowland wildlife is affected by agriculture, livestock, drought, pathogens and parasites. Habitat loss and degradation also occurs from mining extraction and animals face ongoing threats from wildfire, natural disasters and from human disturbance, particularly tourism and civil unrest (IUCN 2005 in FAO Forestry Department 2003). Some animals are harvested for medicinal purposes and regional and international trade and horticulture pesticides threaten Lake Naivasha's local hippopotamus populations (IUCN 2005 in FAO Forestry Department 2003; United States Central Intelligence Agency 2005; FAO 2002). Bird populations also have declined as result of logging and extreme forest degradation through charcoal burning; in Kakamega, for example, hole-nesting birds and even termite populations have declined due a lack of dead branches in which they make their nests (Ogodo 2003).

³ Few studies link changes in biodiversity with changes in ecosystem functioning to changes in human well-being (Duraiappah and Naeem 2005, 22). This particularly applies to studies on biodiversity links to regulating services. Hence, the only examples found were on provisioning services.

In addition to the above factors, aquatic wildlife suffers due to pollution of wetlands and permanent river, stream and creek habitat (IUCN 2005 in FAO Forestry Department 2003). In addition, habitat loss from fishing activities and invasive species (predators) affect marine wildlife (IUCN 2005 in FAO Forestry Department 2003).

Provinces most affected by biodiversity loss

- Central: Unsustainable water use, frequent grassland burning and over-grazing by domestic livestock have led to habitat fragmentation, increased land degradation and desertification. Illegal hunting for skins, ivory and rhinoceros horns have severely reduced populations of large animals, particularly elephants and rhinos.
- Coast: Many threatened species—around 50 per cent of the plants, 60 per cent of the birds and 65 per cent of the mammals; forest is highly fragmented; unsustainable water use, frequent grassland burning and overgrazing by domestic livestock have led to habitat fragmentation, increased land degradation and desertification.
- Eastern: Most habitats of this ecoregion have been considerably degraded by heavy grazing of domesticated livestock causing soil degradation and threat of desertification; habitats are not particularly fragmented, but the populations of large wild mammals are greatly reduced.
- North Eastern: Habitats have become degraded in many places through grazing by livestock and woodfuel collection, particularly close to villages and towns.
- Nyanza: Forest habitats of this ecoregion have been mostly replaced by savannah, farmland and pasture; remaining forest patches are small and fragmented and people continue to exploit them; many protected areas, but loss of viable corridors between protected areas; increased negative interactions between pastoralists and wildlife; and unsustainable killing of wildlife.
- Rift Valley: Many protected areas, but loss of viable corridors between protected areas; increased negative interactions between pas-

toralists and wildlife; and unsustainable killing of wildlife; unsustainable water use, frequent grassland burning and over-grazing by domestic livestock have led to habitat fragmentation, increased land degradation and desertification; rapidly expanding human population that has transformed habitat right up to the boundaries of the protected areas; continued hunting of large mammals outside protected areas; conflicts between local people and large mammals that venture outside protected areas to feed on crops.

- Western: Rapidly expanding human population with land in many places being transformed right up to the boundaries of the protected areas.

2.2 Food and fibre provision

Ecosystems provide the medium for growing the food on which humans and domesticated animals depend; this includes the vast range of food products derived from plants, animals and microbes. If the cultivation of plants for food and livestock is to succeed, then natural factors such as fertile soils, adequate soil moisture, suitable climatic conditions and a rich source of plant and animal species are necessary. Deficiencies in some of these elements or attributes can be augmented by technology through the use of fertilizers, irrigated water, high yielding seeds and domesticated animals over the short term and for long periods of time if managed sustainably.

Small-holder subsistence farmers make up some 80 per cent of the active agricultural population and generate the most food in Kenya (Kenya 2000; FAO Land and Water Development Division 2005). The main subsistence crops are maize, wheat, rice, sorghum, millet, cassava, Irish and sweet potatoes, bananas, other fruits and vegetables (FAO Land and Water Development Division 2005). Kenyans derive most of their calories from cereals (51 per cent); then sugars (12 per cent); oil and fats (nine per cent); milk, eggs and derivatives (eight per cent); roots and tubers (eight per cent); vegetables and fruits (four per cent); meat and poultry (four per cent); pulses (three per cent); and fish (one per cent) (FAO/GIEWS 2001a). Maize is the principal staple crop, however, comprising over 80 per cent of total cereal production; of the 3.12 million ha cultivated, about 1.5 million ha are designated to maize production (FAO 2000a; FAO Land and Water

Development Division 2005). Kenyans grow maize in the southern and western portions of the country, specifically in Western, Nyanza, southern Rift Valley (Kericho, Nandi, Trans Nzoia and Uasin Gishu districts), Central, southern Eastern, and southern Coast provinces (FAO/GIEWS 2001b; FAO 2000).

Beef, a major source of animal protein, largely sustains the livelihoods of the populations living in arid and semi-arid areas along with other types of livestock such as sheep, goats and camels (FAO Land and Water Development Division 2005). Kenya has 10 million beef cattle and produces 120,000 tonnes of beef annually, 50–60 per cent of which comes from small-holder farmers who own 80 per cent of grade cattle. These farmers also produce 76 per cent of the milk in the country from approximately three million dairy cattle (Orodho 1998). Altogether, cattle are most dense in Western, Nyanza, southern Rift Valley and Central provinces and are concentrated in medium- to low-potential areas where roughly seven million sheep, eight million goats and several thousand camels are also kept (FAO 2005; Orodho 1998).

Fishing provides another source of food and income for Kenyans; fishery products amount to six kg/person and fish protein provides three per cent of the total protein supply (World Resources Institute 2003a). Although only eight per cent of the population lives within 100 km of the coast, Kenyans catch 4,733 mt of marine fish annually and this industry, including aquaculture, employs 59,565 people (World Resources Institute 2003a). Annual exports in fish and fish products have increased 4,808 per cent since 1980 and are worth US\$38,874,000 annually (World Resources Institute 2003a).

Many Kenyans supplement their diets with wild foods; they consume edible seeds, nuts, fruits, vegetables, beverages, honey and bush meat (FAO 2003). For example, in Machakos district during the rainy season, wild leaves contribute 35 per cent by weight to the human diet and in northern semi-arid Pokot region, people consume the leaves of *Balanites aegyptiaca* during drought years (FAO 2003). In Kathama area, wild fruits are valued as a buffer food source during famine and food shortage. Forest wild berries, including gooseberries and raspberries, not only provide important food, but also income as self-employed young people commonly offer them for sale (FAO 2003). Local people consume wild tubers and roots for health beverages due to their high starch or sugar content (Kahuki and Muniu 1998 in FAO 2003).

Fibre provision (cash crops)

Commercial and cash crop production are an important source of income and account for 65 per cent of exports (Kenya Project 2002). Industrial and cash crops include coffee, tea, pyrethrum, flowers and cotton, and cover 500,000 ha of cultivated land (FAO Land and Water Development Division 2005). Horticulture is the fastest growing sector of Kenya's economy, earning over US\$270 million in 2000, with cut flowers representing US\$110 million (FAO 2002). Although the industry began in 1972, its revenues currently compete with Kenya's traditional hard currency earners, namely tea, coffee and tourism, and generates vital income and supports food security (FAO 2002). In Central Kenya's Nyeri, for example, over 5,500 women's groups grow high-value export crops such as flowers, snow peas and legumes as an alternative to subsistence farming (FAO 2002).

State of food and fibre provision

Kenya's food supply is insecure and the country has a food deficit (FAO Land and Water Development Division 2005). In 1999, total maize production was approximately 2.25 mt, compared to 2.44 mt the previous year (a decrease of eight per cent) and the 2.7 mt average for the past five years (-17 per cent) (FAO 2000). In 2000, bean harvest was nearly normal, however, maize harvest was 20 per cent below the seasonal average and that same year, an estimated 103,000 farmers required agricultural assistance, primarily seeds and tools for planting. At that time, drought affected 4,200,000 people, the greatest number of Kenyans any drought has affected in the last 25 years (United Nations Environmental Programme 2004; FAO 2000b). In 2004, more than 60 per cent of crops failed in five out of eight provinces, requiring 156,000 mt of food aid at an estimated cost of US\$76 million over six months (British Broadcasting Corporation 2004).

The supply of animal protein from livestock and fish is also dropping. The annual growth rate of livestock populations declined 0.1 per cent from 1990 to 2000, as compared to 3.5 per cent annual growth in the decade before. Moreover, livestock resources per capita have fallen from 40 livestock units (average livestock animal biomass) for every 100 people in 1980 to 30 in 2000 (FAO Livestock Information, Sector Analysis and Policy Branch 2004; FAO 2004). Annual capture of marine fish also has declined since the 1990s, from roughly 10,000 mt to less than five mt by 2000, though freshwater aquaculture produc-

tion remained steady at 126 mt from the late 1980s to late 1990s and freshwater fish catch increased between 1990 and 2000 from 190,993 mt to 210,343 mt (World Resources Institute 2003a; 2003d). Unfortunately, freshwater fish catch has decreased to less than 150,000 mt in recent years (United Nations Environment Programme 2004).

Factors influencing food provision service

Natural constraints to food production include erratic rainfall and/or cold stress in many areas and low soil suitability in the north in Rift Valley, Eastern and North Eastern provinces and parts of Western and Nyanza provinces (FAO 2005b). Rift Valley Province also has steep slopes and mountains and the Northeast Province and northwestern Rift Valley have portions of dry and/or cold areas with low production potential. Lastly, low- to medium-production potential are found in southern portions of Rift Valley, Nyanza, Eastern, North Eastern and Coastal provinces (FAO 2005b).

In arid and semi-arid areas, the main constraint to income generation and food provision is inadequate water (Kenya 2000). The Crop Soil Water Index—indicating soil moisture content—is low in many provinces. Despite the fact that 80 per cent of the country is arid or semi-arid, rain-fed agriculture dominates, thus increasing risks to food security (FAO Land and Water Development Division 2005). For example, drought affected large numbers of livestock in 2000 and required US\$10.5 million in emergency assistance to recover livestock production (FAO 2000b).

In addition to recurrent drought, there is low access to production resources such as quality seeds; appropriate production technologies for small-holder farmers; and credit and inadequate rural infrastructure, in particular feeder roads, power supply and market facilities (FAO Land and Water Development Division 2005; Kenya 2000). In some cases inefficiencies lower productivity; for example, Kenyans lose roughly 95 million litres of milk to spoilage and waste, at a value of US\$22.4 million per year (FAO 2004).

Soil fertility loss and the degradation of water resources have directly undermined agricultural production with deforestation from agriculture, timber-based industry and energy generation being contributing factors to soil degradation and loss of watershed function (Kenya 2000). Invasive aquatic species impede aquatic fish production. Water hyacinth pro-

liferation in Lake Victoria threatens the abundance of fish stock by interfering with light penetration, reducing dissolved oxygen, fish breeding sites and aquatic ecology as well as impeding human navigation and access to fishing grounds in the Lake (Ochieng 2003).

Provinces most affected by stressed food and fibre provision

- Central: severe soil degradation
- Coast: drought; severe soil degradation; marine fish production decline
- Eastern: drought and loss of large number of livestock
- North Eastern: drought and loss of large number of livestock
- Nyanza: severe soil degradation; fish production has declined in Lake Victoria basin
- Rift Valley: severe soil degradation; drought and loss of large number of livestock
- Western: severe soil degradation; fish production has declined in Lake Victoria basin

(FAO 2005b; British Broadcasting Corporation 2004; FAO 2000b; 2000).

2.3 Water supply, purification and regulation

Ecosystems play a key role in the provisioning of clean freshwater and regulating the flow of water. The effectiveness of ecosystems to provide these services is determined largely by the quality of the country's watersheds (see Box 3).

Box 3. What is a watershed?

A watershed is the area of land that catches rain and snow (if applicable) and drains or seeps these into a marsh, stream, river, lake or groundwater. Their primary function is to capture, store and safely release water. This function is indicated by The Internal Renewable Water Resource (IRWR). For example, as snow melts on mountain peaks in the spring, much of the water soaks into the ground, replenishing soil moisture and groundwater. This water will be a source of flow to local streams and rivers during dry seasons. Healthy soils and vegetation in the watershed are essential to proper watershed functioning (Donaldson and Swanson 2001).

The country receives on average 30 cu km of renewable water resources including inflows from other countries, roughly 947 cu m per person (World Resources Institute 2003d). Approximately 10 cu km of river water flows into the country annually (World Resources Institute 2003d). Its total internal renewable water resources are 20 cu km, consisting of 17 cu km of surface water, and three cu km of groundwater recharge, and per capita internal renewable water resources are 633 cu m (World Resources Institute 2003d). Mozambique, by comparison, has an Internal Renewable Water Resources (IRWR) rate of 99 cu km a year or 5,214 cu m per capita and Tanzania has an internal renewable water resource value of 82 cu km per year and a per capita level of 2,227 cu m (World Resources Institute 2003f). The annual safe abstraction yield of groundwater is an estimated 0.6 cu km, of which 0.4 cu km comes from shallow wells and the remaining 0.2 cu km is estimated to come from boreholes (FAO Land and Water Development Division 2005).

State of freshwater supply, purification and regulation services

Total annual water withdrawals are roughly two cu km, or 87 cu m per capita: agriculture accounts for 76 per cent of water withdrawal, followed by domestic use at 20 per cent, and industrial use at four per cent (World Resources Institute 2003d). These withdrawals are 9.2 per cent of actual renewable water resources, which is low suggesting that currently there is little pressure on Kenya's water system in meeting demands (World Resources Institute 2003d). Many factors, however, determine the country's renewable water resources. The *National Development Plan 2002–2008* considers Kenya a water-scarce country, supporting the findings of earlier studies that found that the internal capacity of Kenya's watersheds to capture, store and safely release water are deteriorating; out of Kenya's 164 sub-basins with perennial river flows, 90 will face surface water deficit by 2010 and already 33 sub-basins without perennial river flow have noticeable water shortage (FAO Land and Water Development Division 2005).

Due to inconsistent and poor distribution of water, 50 per cent of Kenyan households do not have access to safe drinking water (Kenya 2000). In addition, we know that the United Nations' minimum standard is 1,000 cu m of water per person annually (Biggs *et al.* 2004). Thus, in order for the ecosystem to meet population demands, Kenya requires an internal renew-

able water resource of approximately 33 cu km annually. Currently, neither natural renewable water resources nor total internal renewable water resources are sufficient to meet Kenya's water needs. Water demand currently exceeds renewable freshwater resources. Furthermore, water demand is projected to increase by 5.8 per cent by 2010 (FAO Land and Water Development Division 2005).

Naturally occurring water regulation mechanisms, such as wetlands that moderate flood and drought episodes, also appear to be stressed. Although Kenya generally has one drought per decade, four successive droughts occurred between 1991 and 2000 (United Nations Environment Programme 2004). The last and most severe drought in 1999–2000 affected 4,200,000 people and caused the death of nearly 100 (United Nations Environment Programme 2004). At this time, inter-ethnic armed conflicts over scarce water occurred and again in 2005, when more violence over water scarcity led to the deaths of at least 20 people (FAO 2000; United Nations Office for the Coordination of Humanitarian Affairs 2005). In between drought years, flooding has occurred, affecting nearly 600,000 people in 1998 (United Nations Environment Programme 2004).

Factors influencing water supply, purification and regulation

Close canopy or climax forests are crucial to the functioning of water catchments; they regulate microclimate, humidity and light regimes and thus affect water flow both directly and indirectly (Ogodo 2003; United Nations Office for the Coordination of Humanitarian Affairs 2000). If forests are damaged, there is increased risk of both floods in the rainy season and drought in the dry season. The close canopy moist montane forests in Kenya, about three quarters of the total native forest in Kenya, provide much of the nation's water, but are stressed (FAO Forestry Department 2003; United Nations Office for the Coordination of Humanitarian Affairs 2000). There are numerous examples illustrating these vital links and services. Roughly 10 million people depend entirely on the endangered Mau forest catchments for their source of water (Water Conservation Portal 2005). Shortages of water in Nairobi city are likely related to the degradation of forests in the Mount Kenya and Aberdare range (United Nations Office for the Coordination of Humanitarian Affairs 2000). Deforestation reduced water flow in rivers from Mt. Kenya Forest and thus compounded the 1999–2000

national drought (Ogodo 2003). Although indigenous close forests⁴ cover only two to three per cent of Kenya's soil, they provide a disproportionately large service in terms of climate regulation and water catchment for the country (United Nations Office for the Coordination of Humanitarian Affairs 2000).

Pollution from urban and industrial waste is severely deteriorating water quality. After the sewer treatment plants broke down many years ago, local authorities in Kisumu, Kakamega and Homa Bay in Nyanza Province in the Lake Victoria basin are discharging raw sewage and industrial effluent into the lake, while water is also drawn from the same lake (Oywa 2003; Ochieng 2003). Water quality degradation has also increased due to increased use of pesticides and fertilizers. Pesticides, such as highly-toxic methyl bromide, are applied to flower plantations, threatening nearby Lake Naivasha, one of Kenya's few freshwater lakes (FAO 2002). Horticultural farmers often lack technical support and full information about appropriate pesticide use and integrated pest management practices that would encourage natural predators of crop pests, thus reducing chemical pesticides (FAO 2002). Other pollutants include organic water pollutants (BOD), which have risen to 46,000 kg/day, an amount equivalent to 0.24 kg of BOD per worker per day (United Nations Environment Programme 2004).

Water hyacinth infestation in Lake Victoria also contributes to water quality and supply problems. This plant (*Eichhornia Crassipes*) is doubling its mass every 15 days in Lake Victoria as a result of eutrophication and nutrient enrichment of the lake (Ochieng 2003). Kenya lags behind its neighbours, Uganda and Tanzania, who have had some measure of success in controlling waste disposal and weed growth into their portion of the lake (Ochieng 2003). Kenya owns six per cent of the lake and has spent US\$1.5 million on a project to control water hyacinth, with limited success (Ochieng 2003).

Provinces most affected by stressed water supply, purification and regulation services

- Central: Uneven water distribution between and within basins, water use conflicts between irrigation, livestock, wildlife and environmental conservation

- Coast: Uneven water distribution between and within basins, water use conflicts between irrigation, livestock, wildlife and environmental conservation
- Eastern: Severe water scarcity
- Nyanza: Water hyacinth affects the Lake Victoria basin; water pollution
- North Eastern: Severe water scarcity
- Rift Valley: Severe water scarcity; water quality degradation has also increased due to increased use of pesticides and fertilizers
- Western: Water hyacinth affects the Lake Victoria basin

2.4 Fuel provision

Woodfuel accounts for 70 per cent of all energy consumed (Kenya 2000). Kenya produces 12,260,000 metric toe in energy, of which 11,512,000 metric toe are from primary solid biomass (World Resources Institute 2004). Woodfuel consumption is followed by petroleum at 21 per cent, and electricity which constitutes the remaining nine per cent (Kenya 2000).

Households also use crop residue, particularly maize cobs and stalks in maize growing areas and coconut shells and husks in coastal areas, as an important supplementary energy source (Fleuret 1983; Sparknet 2004). Kituyi *et al.* (2001, 77) found that 22 per cent of the population, mainly in Central, Nyanza, Rift Valley and Western provinces, use maize cobs, but that this level of consumption was dependent on woodfuel supplies and availability of crop residue after harvests. The constraints listed earlier for food production will also be constraining factors for the availability of dung and crop residue as a fuel.

State of fuel provision

Kenya has 17,096,000 ha of forest area from which woodfuel is potentially gathered, but woodfuel is becoming increasingly scarce as forest area declines. From 1990 to 2000, natural forest area decreased by five per cent and total forest area by three per cent to approximately three per cent of total land area in 2005 (World Resources Institute 2003c; FAO Land and Water Development Division 2005). Kenya

⁴ Over-harvesting of non-wood forest products, including medicinal plants, particularly threatens close forests (Ogodo 2003). Although it is very hard to monitor the scale of deforestation in the country, forest loss affects wooded areas in grassland regions as well as closed canopy forests (United Nations Office for the Coordination of Humanitarian Affairs, 2000). The impacts of deforestation in closed canopy forests, however, are much greater (United Nations Office for the Coordination of Humanitarian Affairs 2000).

established significant areas of tree plantations in the 1970s and 1980s, but the area planted declined in the 1990s (Kenya MENR 1994 in FAO 2000c). Between 1990 and 2000, the average annual rate of deforestation was 0.5 per cent or 90,000 ha annually (FAO Forestry Department 2003). Moreover, the decline in agricultural and livestock productivity imply similar circumstances for the supply of dung and crop residue as fuel. In part to meet growing domestic woodfuel demands, plantations of *Acacia spp.* and other coniferous species have been established at an average annual rate of one per cent (World Resources Institute 2003c). In recent years, tree planting has increased in farmland areas, as individual farmers plant wood for their own needs, while in larger operations, farmers plant wood for commercial purposes (United Nations Office for the Coordination of Humanitarian Affairs 2000). Most of the forest areas under management in Kenya are industrial forest plantations and some native forest areas under protection (FAO 2000c).

Factors influencing drop in biological fuel sources

Rural domestic woodfuel demand is not the main driver of deforestation, as rural people tend to collect woodfuel from their own food farms, secondary forests or fallow lands (Ardayfio-Schandorf 1998). Rather, deforestation is primarily caused by woodfuel demand for tea processing, timber felling for domestic and export markets, agricultural production, urbanization, bushfires and demand for fuel in urban households (Ardayfio-Schandorf, 1998). To illustrate the seriousness of the issues further, despite a presidential ban issued in 1986, large-scale logging for timber occurs in Kenya now, more than ever (United Nations Office for the Coordination of Humanitarian Affairs 2000).

In urban centres, other sources of biomass fuel such as dung and crop residue do not exist and due to the cost and limited availability of commercial alternatives

such as kerosene, liquefied petroleum gas (LPG) and electricity, the many urban poor also rely on woodfuel (Ardayfio-Schandorf 1998). Logging to meet woodfuel and charcoal demand drastically degrades forest resources. Charcoal is a substitute cash crop which many rural poor produce for sale in towns and contradictory legal frameworks, such as the banning of charcoal production, while legally allowing its sale have contributed to the destruction of the tree resource base (FAO 2000). The Kenya Wildlife Service discovered 2,465 charcoal kilns in the Mount Kenya reserve and some are advocating that legalizing and monitoring charcoal production and felling may be more sustainable (FAO 2000; United Nations Office for the Coordination of Humanitarian Affairs 2000).

Provinces most affected by stressed fuel services

- Central: Large-scale logging particularly affects camphor and cedar trees in the indigenous forest surrounding Mount Kenya
- Coast: Deforestation, much of it for woodfuel
- Eastern: Large-scale logging particularly affects camphor and cedar trees in the indigenous forest surrounding Mount Kenya
- North Eastern: Deforestation, much of it for woodfuel
- Nyanza: Deforestation, much of it for woodfuel
- Rift Valley: Wood cutting of savannah vegetation for charcoal production

(FAO 2000; Water Conservation Portal 2005; (United Nations Office for the Coordination of Humanitarian Affairs 2000).

2.5 Summary of ecosystem services stressed

All four ecosystem services are stressed in all provinces, with the one exception being that of wood-fuel services in Western Province. Even though data could not be found about woodfuel supply in Western Province two other findings suggest that woodfuel supply services are likely stressed here also. First, this province is the most densely populated in Kenya at 406 people per sq km and, second, most forests outside of protected areas have been transformed into agricultural land.

Table 1. Summary: Ecosystem services stressed by province

| Province | Ecosystem services stressed |
|---------------|---|
| Central | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| Coast | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| Eastern | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| North Eastern | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| Nyanza | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| Rift Valley | Biodiversity loss Food production Water supply, purification and regulation Fuel |
| Western | Biodiversity loss Food production Water supply, purification and regulation |

3.

State of Human Well-being

Human well-being is multi-dimensional with many constituents and determinants closely determined by the state of ecosystem services (Duraiappah 2004). However, not all constituents may be under serious threat in a country and not all of these constituents are directly dependent on the state of ecosystem services. Therefore, as emphasized in the beginning, only constituents and/or determinants of well-being directly affected by the state of ecosystem services are addressed in this report. Our preliminary review identified the following critical constituents which appear to be under serious threat among many social groups within Kenya.

3.1 Ability to be nourished

The ability to be adequately nourished is dependent on two factors: the ability to grow food and the ability to buy food. While the supply of food is critical, economic entitlements that individuals are able to secure such as income from non-farm labour, are also important (Sen 1990). There are several measures of the ability to be adequately nourished including that of food (in)security and the incidence of malnutrition, among others.

State of ability to be nourished

As subsistence crop production dominates the agricultural economy, the main factor determining poor nourishment is the inability to grow food. Food supply is characterized by over-dependence on spatially and temporally variable precipitation, impoverished forest catchment water regulation, soil degradation and low economic entitlements. Food insecurity affects the population at large; specifically, the incidence of food poverty is 51 per cent in rural areas and 38 per cent in cities and food poverty has increased more than absolute poverty during the past 25 years (Kenya 2000). This can be attributed to a neutral or downward trend in the production of key crops such as maize and beans while population numbers have been steadily increasing (Haan, Farmer and Wheeler 2001, 8).

The ability to be nourished depends not only on food supply, but also on the economic entitlements such as income from non-farm labour that individuals can secure to buy food (Verwimp 2001; Sen 1990).

Depending on income levels, households may cook between one and four meals per day (Sparknet 2004). Reflecting crop shortages in 2000, maize prices were very high and rising, consequently limiting access to food, particularly for the poor (FAO 2000a; 2000c). Although retail maize prices increased throughout the country throughout 1999 and 2000, in the major consuming centers of Nairobi, Mombasa and Kisumu, prices rose most by 91 per cent; 98 per cent; and 75 per cent respectively (FAO 2000). In 2004, food shortages were exacerbated by damp storage conditions causing aflatoxin contamination of 80 per cent of maize stocks (British Broadcasting Corporation 2004; United States Department of Health and Human Services 2004). In addition, live-stock prices were poor due to the low quality of the animals and along with high and rising grain prices, pastoralists faced food crisis and starvation-related deaths among children (FAO 2000a).

Child malnutrition was measured in Kenya's 2003 *Demographic and Health Survey*, showing that "one-fifth of Kenya children are underweight, with four per cent classified as severely underweight" (Kenya Central Bureau of Statistics *et al.* 2003, 25). When the data is disaggregated by province, North Eastern Province has the highest rate of child malnutrition at 34.4 per cent while the province with the lowest rate is Central at 15 per cent.

Box 4. Percentage of malnourished children/province (2003)

| | |
|----------------|-------|
| Central: | 15.0% |
| Coast: | 25.9% |
| Eastern: | 21.7% |
| North Eastern: | 34.4% |
| Nyanza: | 15.4% |
| Rift Valley: | 24.4% |
| Western: | 18.6% |

Provinces most affected

Central: Drought and contaminated food stocks have caused acute food shortages

Coast: Just over 25 per cent of children malnourished

Eastern: Drought and contaminated food stocks have caused acute food shortage

Eastern: Livestock losses, falling livestock prices and rising cereal prices

North Eastern: Livestock losses, falling livestock prices and rising cereal prices; almost 35 per cent of children malnourished

Rift Valley: Livestock losses, falling livestock prices and rising cereal prices; almost 25 per cent children malnourished

(British Broadcasting Corporation 2004; United States Department of Health and Human Services 2004; Nicholson et al. 1999 in Kiura et al.).

3.2 Ability to access adequate clean water

Access to adequate and clean drinking water is essential for a healthy life. The minimum standard set by the United Nations as required by an individual to satisfy human needs is 1,000 cu m per year (Biggs et al. 2004, 13). Clean water can be provided in a number of ways. Filtration plants using modern technology provide clean water, but watersheds in pristine condition can offer the same quality of water. In a well-known example, the city of New York was able to provide clean water to its habitants by restoring and preserving the Catskill watershed which basically captures, stores, purifies and releases water. The cost saved by preserving the watershed vis-à-vis building a modern water filtration plant was about US\$4 billion (Daily and Ellison 2002; Duraipah 2005).

State of ability to access adequate clean water

Despite significant investments, only 43.1 per cent of the rural population has access to a source of water within less than a 15-minute walk, though 83.8 per cent have the same access in urban areas. Those with piped water in their households are low: 3.6 per cent in rural areas and 19.2 per cent in urban areas (Kenya Demographic and Health Survey 2003 in Society for International Development 2004, 19). Furthermore, access is declining due to the failure of existing schemes, as most efforts have tended to primarily benefit the better off (Kenya 2000). The ability to access clean water is also a function of economic entitlements. Between 40 and 60 per cent of Nairobi's informal settlement population lacks access to safe drinking water and pays almost 20 times more than well-to-do residents (International Water and Sanitation Centre 2005). Data disaggregated by province from the 2003 Kenya Demographic and Health Survey is found in Table 2.

Table 2. Access to water/province

| Province | Percentage of households with piped water in dwelling | Percentage of people with water source within less than 15-minute walk |
|---------------|---|--|
| Central | 11.8 | 70.9 |
| Coast | 8.1 | 63.9 |
| Eastern | 4.1 | 38.7 |
| North Eastern | 0.6 | 22.1 |
| Nyanza | 0.6 | 31.6 |
| Rift Valley | 4.5 | 50.5 |
| Western | 1.3 | 44.6 |
| Kenya | 7.6 | 53.2 |

(After 2003 Kenya Demographic and Health Survey in Society for International Development 2004, 19).

Provinces most affected by threatened access to adequate clean water

Based on the data in the 2003 Kenya Demographic and Health Survey, few people have water piped into their dwelling, indicating that the daily need for water requires the expenditure of a great deal of time and energy. Even though just over half the population can access a water source within a 15-minute walk, this still leaves a huge number of people without even this level of access. Furthermore, in rural areas, there are large disparities in access to water. In the North Eastern Province, only 22.1 per cent have access to a water source within a 15-minute walk, whereas in Western Province, this number is higher at 44.6 per cent, but when looking at the numbers for piped water into dwellings, the number is very low for both provinces: 0.6 per cent for North Eastern and 1.3 per cent for Western (Kenya Demographic and Health Survey 2003 in Society for International Development 2004, 19). In Eastern Province, women and children walk 2–10 km every day to collect water and some children have been known to walk 30 km to find water, forcing them to regularly miss school (Quest Overseas 2005). Central and Coast provinces are the only areas where over 70 per cent of the population has access to adequate clean water, either through a piped connection or within a 15-minute walk.

3.3 Ability to have energy to keep warm and cook

A reliable source of energy is a necessary component of human well-being; it is required for daily activities like cooking and for keeping warm. In Kenya, the main fuels consumed are wood, charcoal and agricultural crop residues, as 83.9 per cent of the population does not have access to electricity and far fewer have access to liquid petroleum gas (Kituyi *et al.* 2001, 79; Kenya Demographic and Health Survey 2003 in Society for International Development 2004, 19). In fact, residential use consumes the largest proportion of energy in Kenya at 68 per cent while transportation consumes 12 per cent, industry 11 per cent, and agriculture seven per cent (World Resources Institute 2004). Moreover, Kenyans rely on woodfuel for 70 per cent of their energy needs and total woodfuel demand is 33,511,491 cu m, or 1.19 cu m per person per year (Kenya 2000; World Energy Council 1999). Space heating is needed in the highland areas, mainly in the evenings and July–August when it's coolest (Sparknet 2004).

On a national level, Kenya produces 26,713,000 cu m of woodfuel and 4,155,000 cu m of charcoal to meet demand. Theoretically, there is enough forest stock for future woodfuel production, but localized woodfuel shortages already exist. As the national population expands, however, woodfuel utilization is expected to increase further constraining fuel supply (World Energy Council 1999; Ardayfio-Schandorf 1998). Indeed, total energy production increased 55 per cent from 1980 to the present, but per capita energy consumption decreased by six per cent between 1990 and 1997 (World Resources Institute 2004).

Accurate woodfuel energy information in Kenya is generally lacking, though (Kituyi 2002). A 2003 policy briefing from Energy Alternatives Africa found that firewood for household use is increasingly being “supplied from private small-holder lands and farms woodlots,” but that wood for charcoal is mainly harvested from communal savannah woodland and rangelands in the arid and semi-arid areas or from land being cleared for agriculture and is contributing to forest depletion in dryland savannah (Energy Alternatives Africa 2003).

Evidence of localized differences in access to woodfuel are clarified in a 2002 paper on woodfuel scarcity and reforestation in Kenya, which argued that woodfuel

for rural household use is mainly collected by women⁵ who are experiencing ongoing scarcity issues “related to significant environmental strain, demanding workloads, health and nutrition concerns and the ignored specifics of knowledge and use requirements” (Chandler and Wane 2002). Despite government programs, these rural women report increasing problems; due to deforestation and decreased availability of indigenous species they must walk further to find suitable woodfuel (Chandler and Wane 2002).

Provinces most affected by threatened ability to access energy to keep warm and cook

When using deforestation as a proxy for scarcity of woodfuel, the following provinces are most affected:

- Central: Large scale logging
- Coast: Deforestation, much of it for woodfuel; invasion of rain forests in Shimba Hills National Reserve by wood harvesters
- Eastern: Large-scale logging
- North Eastern: Deforestation, much of it for woodfuel
- Nyanza: Deforestation, much of it for woodfuel
- Rift Valley: Wood cutting of savannah vegetation for charcoal production; indiscriminate logging, encroachment and excision in major forest blocks
- Western: High population density and transformed landscape up to borders of protected areas suggesting that woodfuel is scarce

(Kituyi *et al.* 2001, 80; Ardayfio-Schandorf 1998).

3.4 Ability to earn a livelihood

The ability to earn a livelihood is essential to human well-being and is measured using various indicators such as per capita GDP, household consumption levels and so on. In efforts to identify those needing government support, poverty lines are established using an estimate of the cost of food and non-food basic needs for individuals and families.

5 Men typically fell trees for charcoal sales, with charcoal being consumed mainly in urban areas. Household woodfuel consumption is no longer considered a major cause of deforestation (Chandler and Wane, 2002).

State of ability of earn a livelihood

Kenya's economic entitlements are low. The poor constitute more than half of the population and the national incidence of poverty stands at 52 per cent (Kenya 2000). Specifically, 26.5 per cent of the population lives on less than \$1 a day, and 62.3 per cent lives on less than \$2 a day (World Resources Institute 2003b). The number of income poor has increased from 3.7 million in 1972–1973 to 12.5 million in 1997 (Kenya 2000), and is currently estimated at over 17 million (Kenya 2004).

Although agriculture provides 70 per cent of Kenya's employment and is the lifeline of 80 per cent of Kenya's rural poor, it only contributes just over 25 per cent of GDP (Kenya 2000; World Resources Institute 2003b). While the poor generally cultivate more land and have more livestock than the non-poor, the non-poor earn more than 2.5 times more income through the sale of cash crops and 1.5 times more through livestock sales (Kenya 2000). And, cash crops such as tea production can generate income. In 2003, for example, tea production was 8,000 tonnes, an amount 2.4 per cent higher than the previous year due to favourable weather conditions and the opening of five new factories (FAO 2004).

Women represent the majority of the poor. Of the working female population, 69 per cent are subsistence farmers and constitute over 50 per cent of the

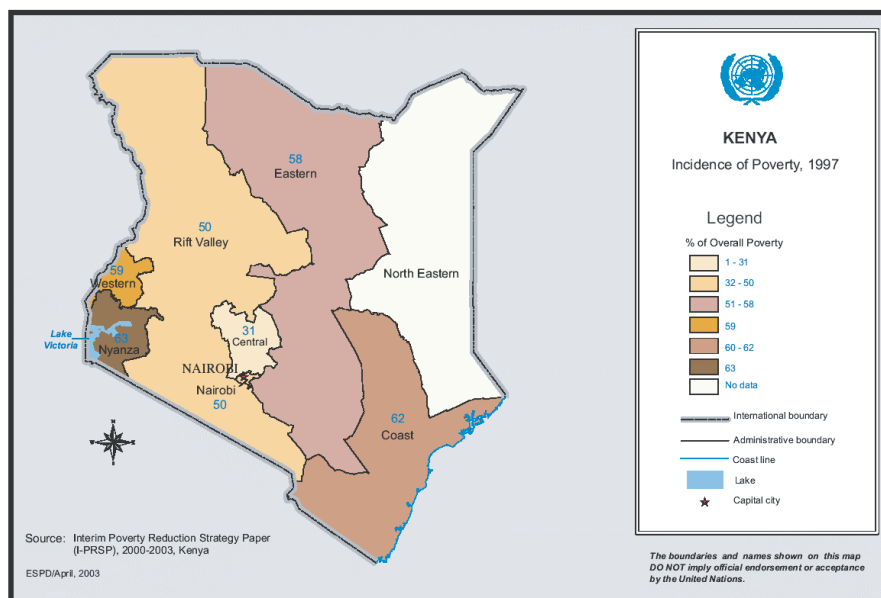
total poor in Kenya (Kenya 2000). In addition, the landless, small-holder farmers, pastoralists in arid and semi-arid areas, agricultural and casual labourers, female-headed households, the physically impaired, HIV/AIDS orphans and street children are the poorest Kenyans (Kenya 2000).

Provinces most affected by inability to earn a livelihood

Three quarters of the poor live in rural areas with the majority located in the highly-populated region stretching south to south-east from Lake Victoria to the coast, straddling the rail and road corridors (Kenya 2000). Whereas 49 per cent of the urban population is poor, 53 per cent of the rural population is poor (Kenya 2000). Subsistence farming households are also most poor in arid and semi-arid areas of the country, where women spend a great portion of their time searching for water and fuel (Kenya 2000). The North Eastern and Coast provinces have the most poor households while Nyanza historically has a highest incidence of poverty.

Map 2 shows spatial variations in the incidence of income poverty with Central Province having the lowest incidence possibly because there are a higher percentage of wealthier households living in Nairobi, which is situated there. Indeed, in Kenya the 10 per cent richest households control more than 42 per cent of incomes and in Nairobi the top 10 per cent of

Map 2: Kenya: Incidence of poverty by province



households command 45 per cent of the income (Society for International Development 2004, xiii, 13). Based on the inequality in incomes prevalent in Kenya and incidence of poverty data, all provinces have an unacceptable incidence of income poverty.

3.5 Summary of constituents of human well-being threatened

The four constituents of human well-being assessed are threatened in all provinces to a notable degree, except Nyanza and Western. For these two provinces, food security data was not found, suggesting that it is not as highly threatened there as elsewhere. This assumption is partially supported by the child malnutrition data; rates were at the lower end of the range for both provinces with Nyanza at 15.4 per cent and Western at 18.6 per cent. The incidence of poverty data, though, contradict this view, as these two provinces have the highest incidence of poverty of all the provinces indicating that economic entitlements are low. Indeed, a 2001 paper on chronic vulnerability to food insecurity identified that in some districts in Nyanza and Western provinces pockets of food insecurity exist, but are not visible at the level of aggregation of this overview (Haan, Farmer and Wheeler 2001, 21).

Table 3. Constituents of well-being threatened by province

| Provinces | Constituents threatened |
|---------------|--|
| Central | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Coast | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Eastern | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| North Eastern | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Nyanza | Adequate and clean drinking water Energy Earn a livelihood |
| Rift Valley | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Western | Adequate and clean drinking water Energy Earn a livelihood |

4.

Linking Ecosystem Services to Human Well-being

All ecosystem services and constituents of human well-being are stressed and threatened in all provinces except Nyanza and Western and these exceptions are probably due to the level of aggregation on food security, as the evidence suggests that district-level food insecurity appears to exist there. When needs are so great and uniform, setting priorities can be difficult.

Kenya already has a mature system of protected areas, but there are increasing pressures on them for woodfuel and food, as land outside their boundaries is being transformed into agricultural land, deforested or experiencing soil degradation. Encroachment also endangers forest catchments that regulate water supply; this ecosystem service is especially important in Kenya as it has a relatively low internal water renewal resource rate compared to bordering countries. Indeed, scarcity of water, energy and wild foods from the forest add to the burden of women and children who must spend more time gathering these necessities, taking away from agricultural productivity, thus increasing vulnerability and threats to capabilities.

The draw-down of the country's forests is a serious problem needing immediate attention. The impacts on water regulation as well as on a rich source of food for the poor during times of stress suggests an area where there can be maximum returns for reducing poverty and improving well-being. The system of protected areas may need to be revisited as it is definitely not having the desired outcomes. Recent results from the Millennium Ecosystem Assessment suggest that Protected Areas (PA) may need to be designed in

a fashion that involves and provides benefits to the local communities directly.

Another problem worth addressing immediately is declining agricultural productivity. Such an investigation would seek to find ways of increasing productivity and value added by harnessing more sustainable practices. The high proportion of population engaged in subsistence farming points to high returns to poverty reduction if these farmers can be provided support for the various inputs needed to engage in sustainable farming practices.

The issue of deforestation and energy demands is the third area worth addressing to reduce poverty and reduce the deterioration rate of ecosystem services. Relying purely on woodfuel and charcoal for energy demands is unsustainable and alternative energy sources will have to be identified. In addition, a sustainable biomass energy plan may provide some solutions for curbing woodfuel shortages as well as improving the Internal Renewable Water Resources (IRWR) level.

There are a number of synergies and potential rewards to be reaped if a proper ecosystem management approach is undertaken. Solutions to water scarcity, woodfuel shortages and food security can be simultaneously addressed. However, all three problems can be further exacerbated if a more holistic approach is not taken whereby the interdependencies among the various ecosystem services and their contribution to poverty reduction are acknowledged explicitly.

Table 4. Summary of human well-being and ecosystem stress

| Regions | Ecosystem services stressed | Constituents threatened |
|---------------|--|--|
| Central | Biodiversity Food production Water supply, purification and regulation Fuel | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Coast | Biodiversity Food production Water supply, purification and regulation Fuel | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Eastern | Biodiversity Food production Water supply, purification and regulation Fuel | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| North Eastern | Biodiversity Food production Water supply, purification and regulation Fuel | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Nyanza | Biodiversity Food production Water supply, purification and regulation Fuel | Adequate and clean drinking water Energy Earn a livelihood |
| Rift Valley | Biodiversity Food production Water supply, purification and regulation Fuel | Adequately nourished Adequate and clean drinking water Energy Earn a livelihood |
| Western | Biodiversity Food production Water supply, purification and regulation Fuel | Adequate and clean drinking water Energy Earn a livelihood |

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