Land Degradation


Christian Lambrechts/UNEP

As the land use section earlier in this chapter shows, demands on the land for economic development and pressures from a burgeoning population are leading to unprecedented land use change. In turn, unsustainable land use is driving land degradation. The result is a loss of land productivity with impacts on livelihoods and the economy. This section describes land degradation trends in Kenya as an introduction to the following pairs of satellite images that show this degradation on the ground.

Symptoms of land degradation and desertification

Land degradation is defined as the long-term loss of ecosystem function and productivity caused by disturbances from which the land cannot recover unaided (Bai and others 2008). Land degradation occurs slowly and cumulatively and has long lasting impacts on rural people who become increasing vulnerable (Muchena 2008). The UN Convention to Combat Desertification (CCD), of which Kenya is a signatory, recognizes land degradation as a global development and environment issue. Desertification is the most severe form of land degradation. The CCD defines desertification as land degradation in arid, semi-arid, and dry sub-humid areas (also referred to as drylands) resulting from various factors, including climatic variations and human activities.

Table 1: Degrees of desertification potential, 1997

Degree of Desertification	Area (in %)
None to slight	13.0
Moderate	64.0
Severe	21.0
Very severe	1.7

Source: Macharia 2004

Pressures that lead to land degradation

Unsustainable human activities that take place in already fragile areas and that are aggravated by natural disturbance such as drought or flooding lead to land degradation and desertification. Kenya's 2002 National Action Programme on desertification reported the following: "The existing ecological conditions in drylands are harsh and fragile. These conditions are exacerbated by frequent drought and the influx of people from the high potential areas into the drylands. Overgrazing and subdivision of land into uneconomic land parcel sizes have further worsened them. Under

Deforestation and a heavy rainfall often lead to erosion and soil loss


Christian Lambrechts/UNEP

Table 2: Degraded areas 1981-2003

Degrading area (km^2)	Per cent of territory	Per cent of globally degrading areas	Total NPP Loss (tonne C/23yr)	Per cent of total population	Number of affected people
104 994	18.02	0.294	6 612 571	35.59	11 803 311

Source: Bai and others 2008

these circumstances, drylands are getting more and more vulnerable to desertification in Kenya" (GoK 2002). The land use section of this chapter shows how population growth is contributing to the influx of more people into arid and semi-arid land (ASAL), land is being fragmented into uneconomical parcels, marginal lands are increasingly being cultivated, pastures are being overgrazed, and forests encroached upon. All these conspire to degrade the land (Muchena 2008, KLA n.d.).

Land degradation is increasing

Studies in 1997 showed that 64 per cent of Kenya's land area was potentially subject to moderate desertification and about 23 per cent were vulnerable to severe to very severe desertification (Table 1). In the northern rangelands, 12.3 per cent suffered from severe land degradation, 52 per cent to moderate land degradation, and 33 per cent faced slight vulnerability to degradation. The latter study identified degradation in ASALs as a potential precursor to widespread desertification (KLA n.d.). In the early 2000s, approximately 30 per cent of Kenya was affected by very severe to severe land degradation (UNEP 2002) and an estimated 12 million people, or a third of the Kenya's population, depended directly on land that is being degraded (Bai and others 2008). The droughts of 1970-2000 accelerated soil degradation and reduced per-capita food production (GoK 2002).

More recent studies extrapolating on local findings of spatial and temporal patterns of land degradation estimate it is increasing in severity and extent in many areas and that over 20 per cent of all cultivated areas, 30 per cent of forests, and 10 per cent of grasslands are subject to degradation (Muchena 2008). A 2006 pilot study found that potential areas of land degradation, defined as places where both net primary productivity and rain-use efficiency (the ratio of net primary productivity to precipitation) were declining, occupied 17 per cent of the country and 30 per cent of its cropland. The expansion of cropping into marginal lands accounts for much of this degradation. It identified the drylands around Lake Turkana and marginal cropland in Eastern Province as the areas of sharpest decline (Bai and Dent 2006). One measure of land degradation is the loss of net primary productivity (NPP), although such losses do not always indicate land degradation (Bai and others 2008). A 2008 study that used remote sensing to identify degrading areas based on loss of NPP between 1981 and 2003 found that 18 per cent of Kenya's total land area was degraded (Table 2).

The consequences

The impacts of land degradation and desertification include a reduction in crop and pasture productivity and fuelwood and non-timber forest products, which are closely linked to poverty and food insecurity. The damage to soil, loss of habitat, water shortages, and siltation reduce biodiversity and ecosystem services and have economic consequences (KLA n.d.).

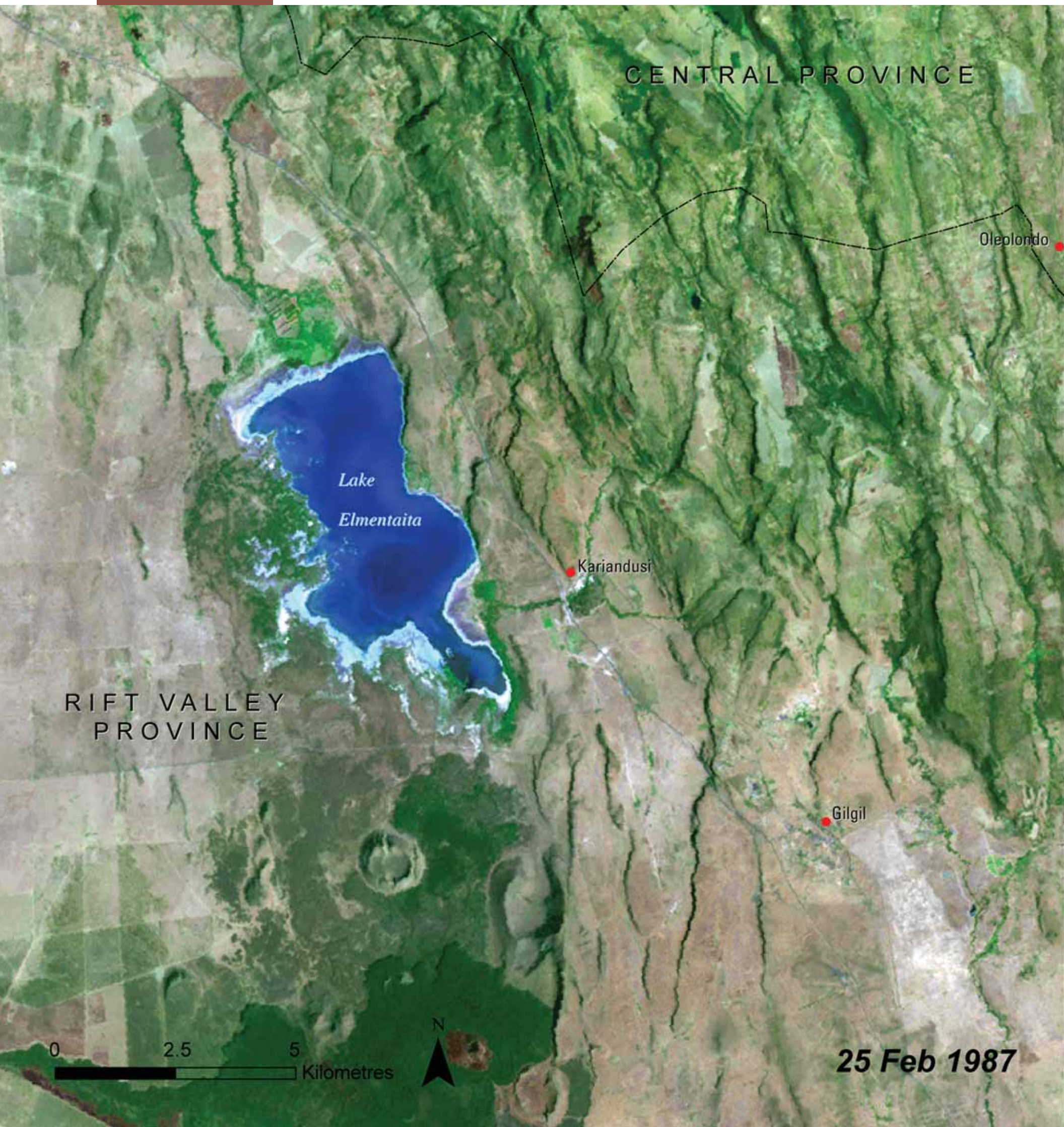
Land degradation manifests itself in many forms; among them are soil erosion, increased sediment loading of water bodies (such as Lake Olbollosat, the Winam Gulf, and Lake Baringo, all of which feature in satellite images in this Atlas), loss of soil fertility, salinity, reduced ground cover, and the reduced carrying capacity of pastures (as in Amboseli National Park, for example).

Lake Elmentaita

Flamingoes Leave Habitat

Lake Elmentaita lies at the bottom of the Central Kenyan Rift Valley, at 1 786 m above sea level. Zebra, gazelle, eland, and families of warthog graze its salty shores. Approximately 10 000 years ago, Elmentaita was part of a much larger lake that included modern-day Lake Nakuru. Changes in climate conditions since then have reduced the lake's size to its present extent.

Ornithologists have recorded as many as 40 000 flamingoes at Lake Elmentaita. The vast flocks of flamingoes feed on the algae that thrive in its shallow alkaline waters. One of the great spectacles of Africa, these vast flocks of flamingoes are threatened by silt from farms surrounding the lake that inhibits the growth of the blue-green spirulina algae on which the flamingoes feed.



In addition, a record of the lake's water levels since 1958 shows a steady decline. Lake Elmentaita's level has fluctuated dramatically in the past, and changes to the ecosystem caused by rising or falling water levels have dispersed many of the flamingoes and pelicans to other lakes in the Rift Valley. Since the 1970s, the shallow alkaline lake has gradually shrunk from 18.5 km^2 to less than 14.3 km^2 and it could vanish entirely in the future. Changes in the watershed, especially the dramatic increase in farmland, are thought to be the cause of the recent rapid changes in water levels. Much of the watershed's forests have also been removed or degraded.

CENTRAL PROVINCE

Oleolondo

Lake

Elmentaita

Kariandusi

Gilgil

RIFT VALLEY
PROVINCE

0 2.5 5 Kilometres

N

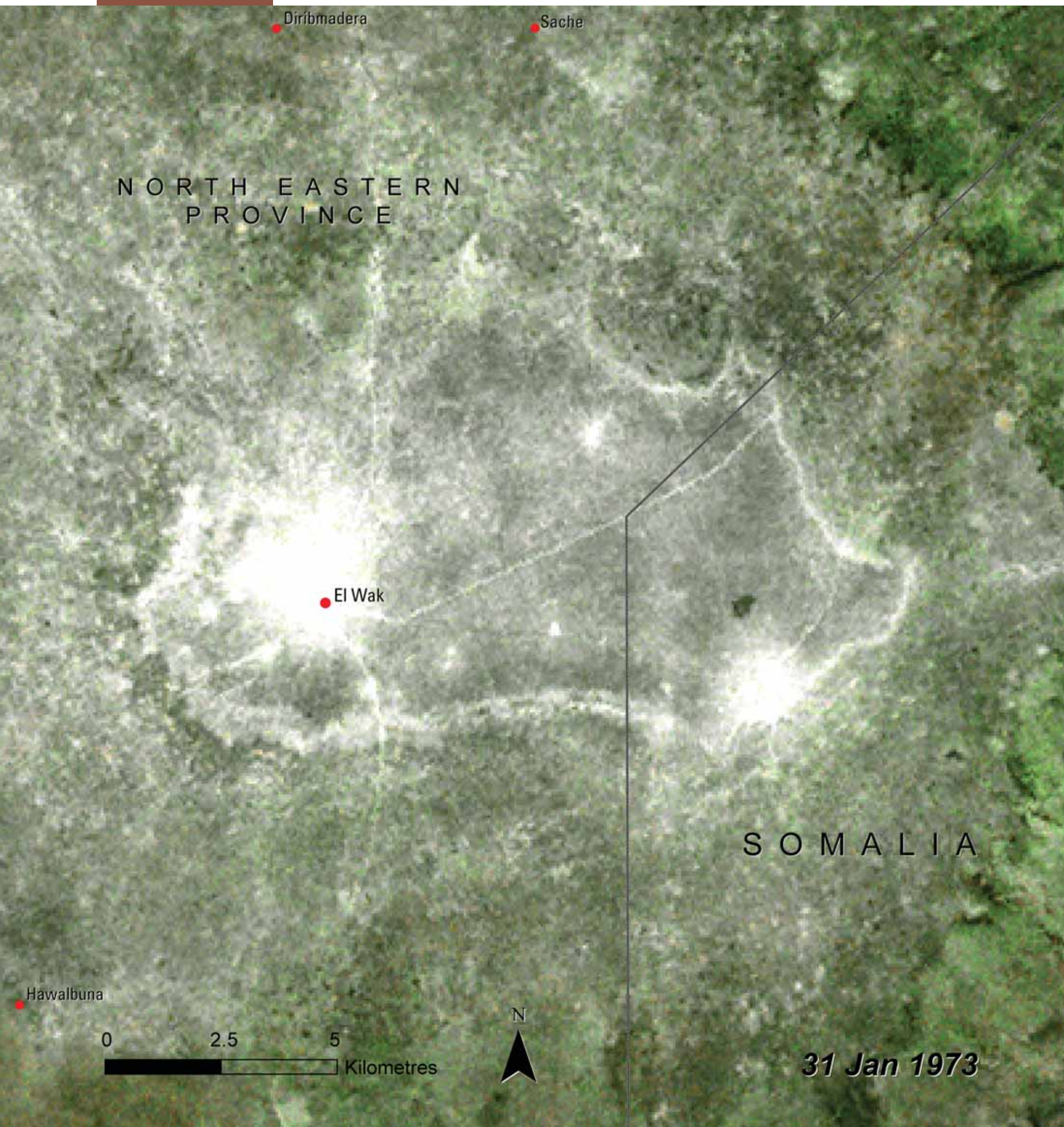
2 Feb 2008

El Wak

Boreholes and Overgrazing

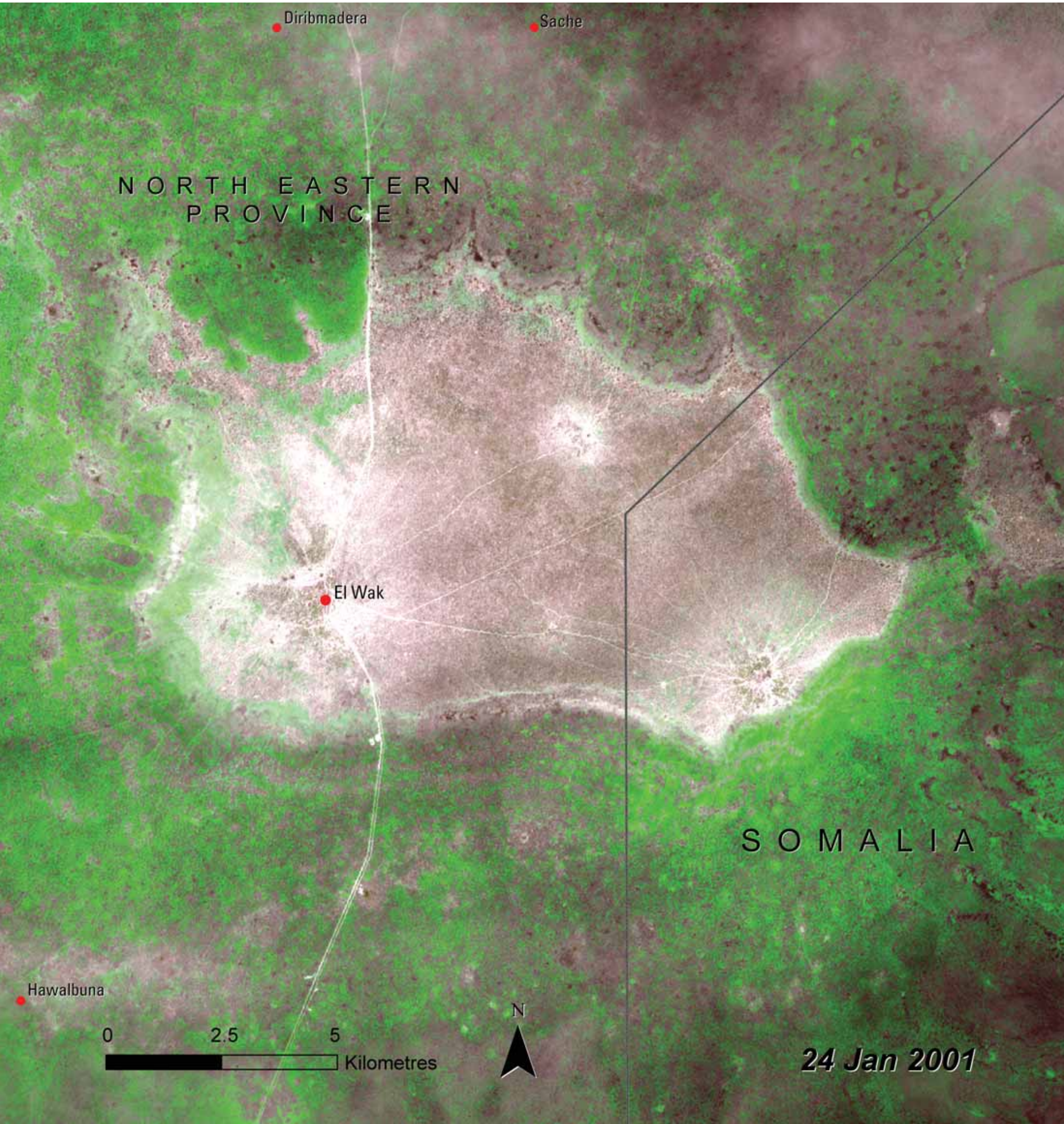
El Wak is located in the Mandera District of Kenya's North Eastern Province. It is in arid lands with very low potential for rangelands, given its average annual rainfall of about 250 mm and temperatures as high as 35° C to 40°C. In addition to these harsh conditions, North Eastern Province is rated the poorest province in Kenya with 74 per cent of the population living below the poverty line and 50 per cent of the population under the age of 15, giving it among the highest dependency ratios in Kenya.

Nomadic pastoralism has traditionally been the backbone of the economy in North Eastern Province, with herds moving across large expanses of rangeland to access adequate food and water. The area sees frequent droughts usually



accompanied by livestock diseases. Recent droughts and the resulting reduction in herd size have reduced the viability of a purely pastoral livelihood.

The government, non-governmental organizations, and multi-lateral donor organizations have created boreholes, wells, and earthen dams to provide water in the most arid districts. Boreholes surrounding El Wak have attracted permanent settlements and increased livestock populations causing serious land degradation. The satellite images from 1973 and 2001 show this increase in the intervening 33 years. This degradation poses a new threat to local people's livelihoods as the land's capacity to support rangeland surrounding the borehole decreases.

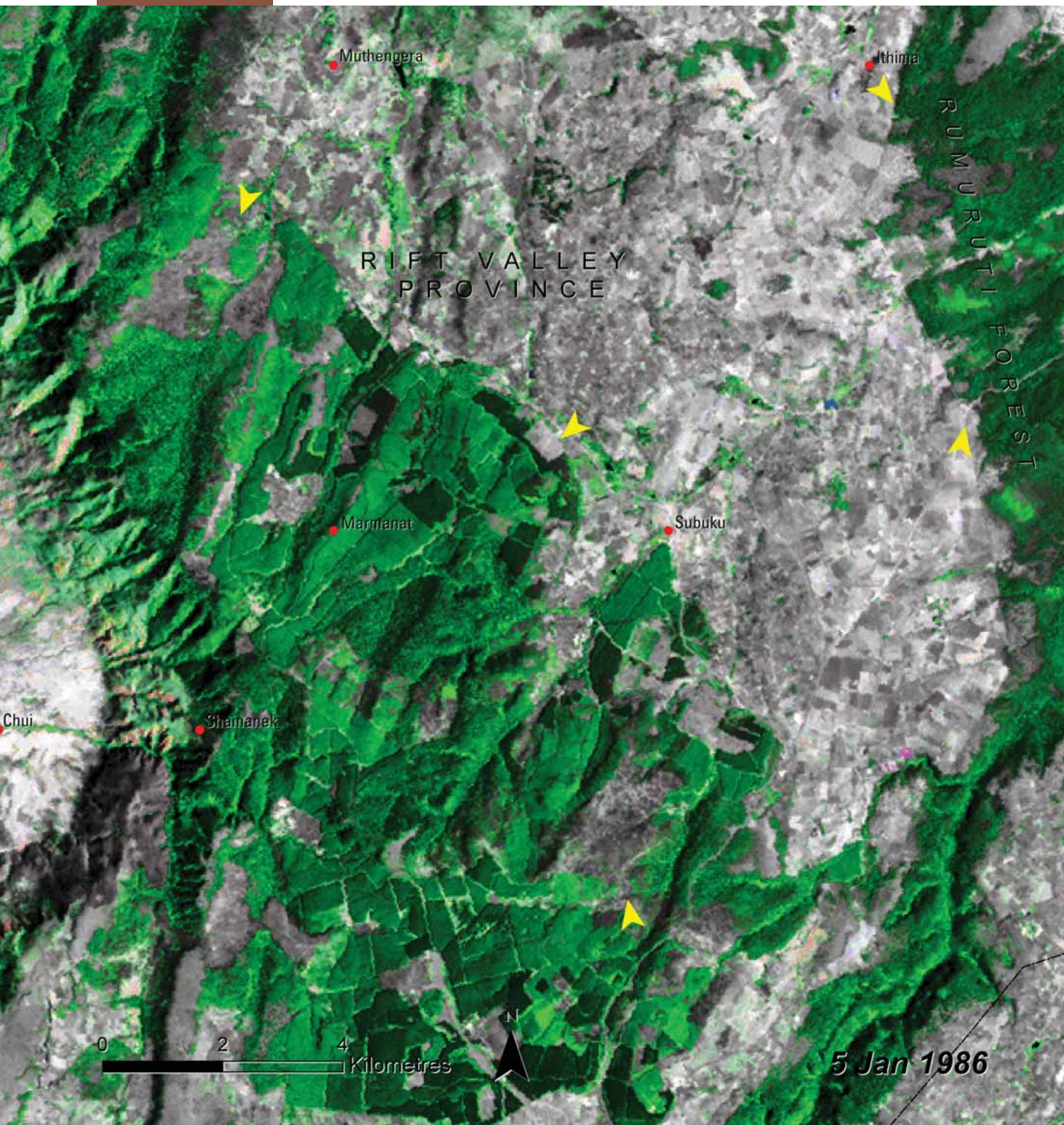


Laikipia District

Land Division and Population Growth

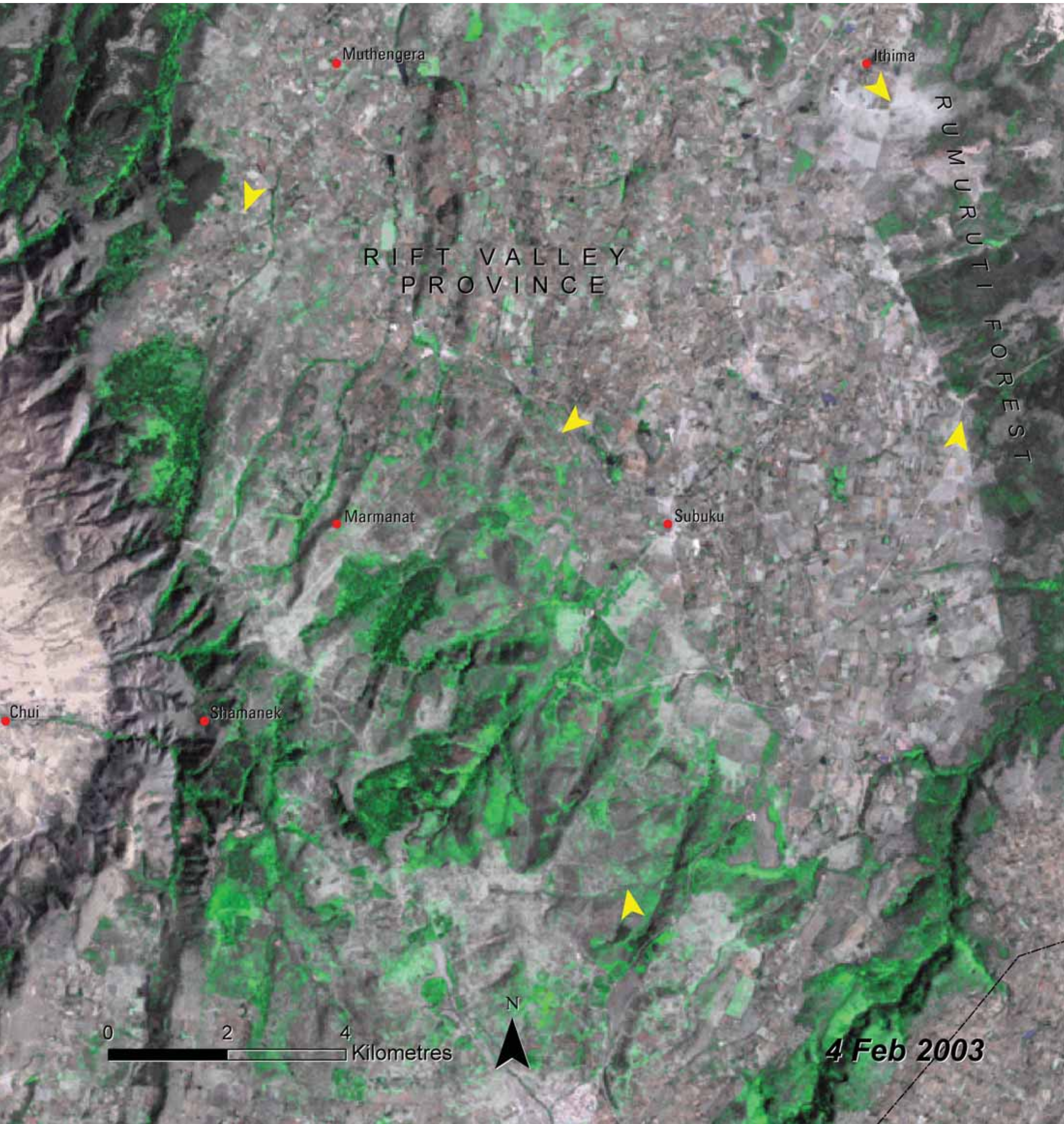
Rainfall across the Laikipia Plateau ranges from around 900 mm near the Mt. Kenya and Aberdares Massifs in the south to less than 500 mm in the more arid areas to the north. This savanna landscape is traversed by the Ewaso Nyiro River, a vital water source particularly to the drier north. The Plateau supports among the highest wildlife populations in Kenya including all of the native large carnivore species and an impressive diversity of large mammals in spite of the fact that only a small fraction of the district is formally protected.

In the early 20th century, the plateau was home to the pastoral Maasai communities. By following the rains and utilizing the vast expanse of grazing land to support their cattle, the Maasai were able to support themselves sustainably.



During the colonial era, most of the plateau was converted to large commercial ranches pressing the Maasai into the northeast corner of the plateau. The population of Laikipia District has grown rapidly since the 1960s with an annual growth reaching over seven per cent between 1967 and 1979. Much of this growth was in the arable southwestern corner.

In the central plateau, the large, sparsely populated ranches enjoy the luxury of balancing their use of the land to match the land's regenerative capacity. In the District's southwest and northeast corners, however, pressures from growing populations are forcing the land's viability. The impact of increasing numbers of people and small farms between 1986 and 2003 can be seen the satellite images of the southwest corner of Laikipia Plateau.

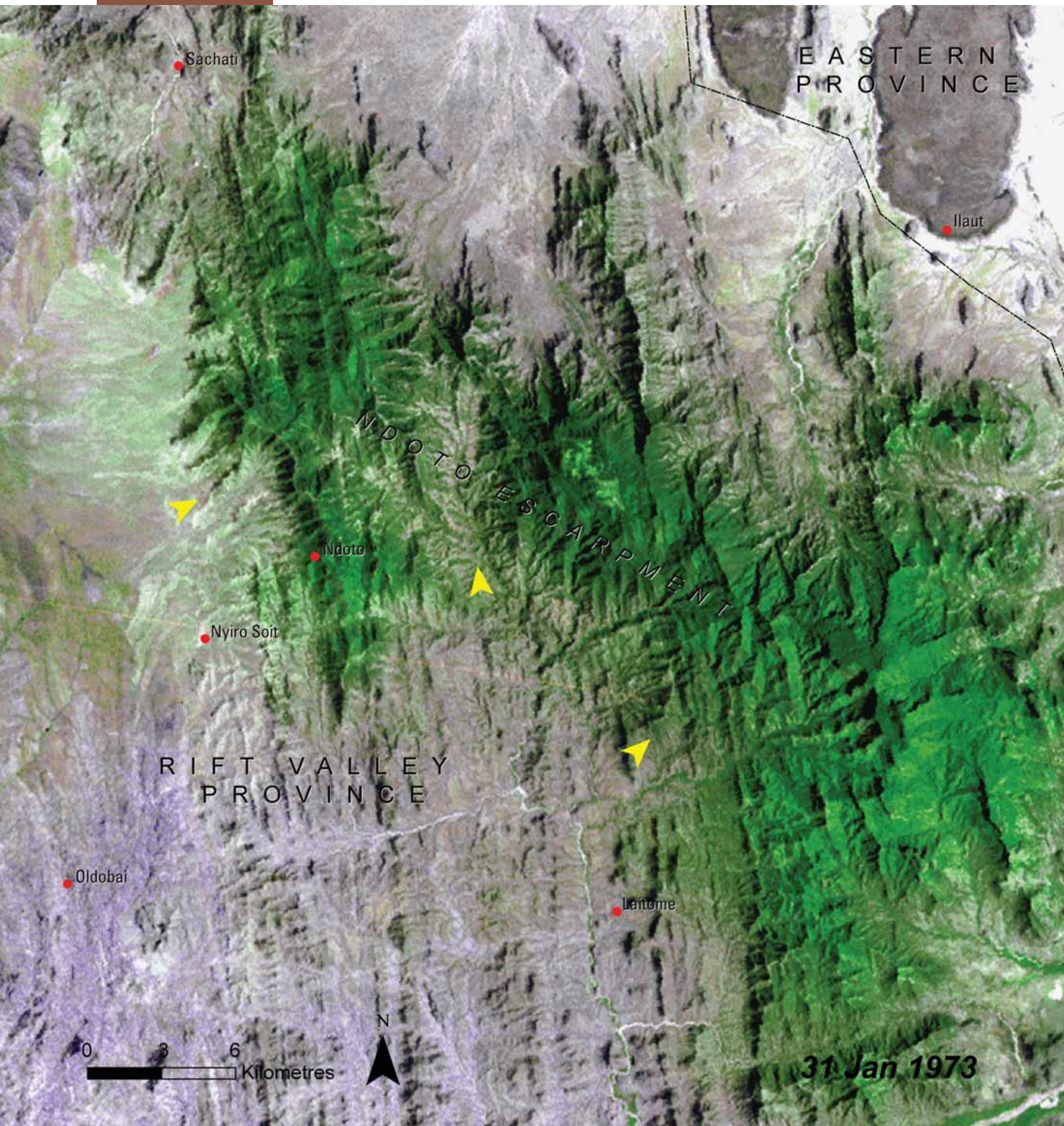


Samburu District

Increasing Livestock

Samburu District, in the Rift Valley Province, stretches north from the Ewaso Nyiro River to the south of Lake Turkana. It is an expansive, predominantly pastoral area. Among the major physical and ecological features in Samburu District are Mount Kulal, the Samburu National Reserve, the Buffalo Springs National Reserve, and the Loriki Forest.

The semi-nomadic pastoralist Samburu people, the main ethnic group in the district, keep cattle, sheep, goats, and camels. Traditionally, the Samburu have been able to co-exist in relative balance with the area's wildlife, which includes elephants, lions, giraffes, ostriches, cheetahs, and leopards. As the population in Samburu has grown, some of these



pastoralists have adopted increasingly settled, western lifestyles, including some farming. Nevertheless, a predominantly pastoral approach to cattle-raising has been maintained.

The cattle population has grown along with the human population. This puts increasing pressure on this fragile arid environment. In particular, the increasing livestock population has led to localized areas of land degradation where cattle are concentrated during the dry season. Loss of forest and vegetation cover is evident in the changes between these two images from 1973 and 2000.

Khuvasale and Murang'a
Landslides

Scores of lives have been lost to landslides in Kenya in recent decades. In addition, productive farmland, personal property, roads, railways and bridges have been destroyed. It is estimated that millions of Kenyan shillings of property damage have been caused by landslides in the past decade alone. Most of these landslides occur in the southwestern quarter of the country where steep slopes and heavy rainfall create dangerous conditions during the rainy season. Unfortunately, these areas also have dense populations which settle in these areas because of their high agricultural potential. While these disasters are prompted by periods of heavy rainfall their likelihood is often increased by human

A landslide in Gatara, on the eastern slopes of the Aberdares, destroyed homes and 1 000s of tea bushes

A section of Massii-Makueni highway where a major bridge was destroyed in a late 1990s land slide

activities such as removal of vegetation, altered drainage, overgrazing and cultivation on steep slopes. Removal of trees and other natural vegetation changes drainage and infiltration patterns and destabilizes soils on slopes.

The Murang'a District on the eastern footslopes of the Aberdare Range has high rainfall, intense population and intense farming. The area's soils are prone to landslides, exacerbated by the removal of forests and shrubs for farming (Feb 2003 image). Between 1960 and 1980 the district experienced 40 landslides. In Kakamega North District, following a night of very heavy rain in August 2007 two landslides occurred at Khuvasale village. The disaster killed seven people and left at least 39 injured. The village is located along the Nandi Escarpment (Feb. 2005 image) in an area of intense small scale agriculture and heavy rains.

People work to unearth those buried by the Khuvasale landslide in August 2007

The Khuvasale landslide, August 2007

Biodiversity

As it is everywhere on the planet, biodiversity, or the diversity of species, genes, and ecosystems, is declining in Kenya. Of all African countries, Kenya ranks second highest in bird and mammal species richness. It also has high levels of species endemism, or species that live nowhere else on earth. The loss of Kenya's rich variety of wildlife species diminishes the planet's store of living things; it is also an enormous threat to the nation's tourism industry, a mainstay of its economy, and it undermines the livelihoods of those reliant on local resources for their livelihoods. This section, which complements a brief discussion of biodiversity in Chapter 1, introduces the following satellite images that vividly illustrate how human activities are threatening the ecosystems that provide habitat for the country's rich biodiversity.

Kenya's landscapes are immensely diverse, so the organisms they harbour are also rich in variability. Kenya is home to some 35 000 known species of flora and fauna (Thaxton 2007). Kenya's grasslands contain a unique assembly of megafauna, and as shown in Chapter 1, the nation's closed canopy forests, which hold about half of Kenya's tree species, provide habitat for about 40 per cent of its larger mammals, 30 per cent of birds, and 35 per cent of its butterflies (KFWG 2008). The coastal forests, western plateau forests, and the northern end of the Eastern Arc Mountains (Taita Hills) are the most diverse forest regions (Peltorinne 2004). Kenya's marine and coastal areas also contain a large diversity of species, with about 456 species of fin fish, 169 coral species, 9 species of mangroves, 11 species of seagrasses, 344 mammal species, 5 species of reptiles, as well as uncounted numbers of phytoplankton, zooplankton, and other species (GoK 1998).

Habitat loss and fragmentation

Globally, habitat loss is the greatest threat to biodiversity. Kenya's increasing population, poverty, and the drive for economic growth are the underlying pressures that contribute to habitat loss and fragmentation. Land degradation, described earlier in this chapter, also threatens biodiversity. To some degree, all forest areas in Kenya are fragmented, while parts of grass- and shrub-lands are highly degraded (Duraiappah and Roy 2007). Gaps in vegetation cover caused by fragmentation can isolate populations of certain species and lead to their demise (Peltorinne 2004), while land and water degradation render habitats unhealthy thus threatening species survival.

Invasive alien species

Invasive species are the second greatest threat to biodiversity. Kenya has been subject to the invasion of at least 34 alien species, with negative impacts on biodiversity, agriculture, and human development as such species compete with native ones or invade new areas. They include eleven arthropods, ten microorganisms, nine plant species, and four vertebrates. Notable examples include the larger grain borer (*Prostephanus truncatus*), the water hyacinth (*Eichhornia crassipes*), and Prosopis spp. Few of these species are under control, although Kenya has initiated measures to mitigate their impacts (Chagema and Kuria 2003).

Threatened species

As already mentioned in Chapter 1, Kenya's threatened species include 33 species of mammals, 28 breeding bird species, 5 species of reptiles, 4 of amphibians, 29 of fish, 16 molluscs species, 11 species of other invertebrates, and 103 plant species.

Biodiversity hotspots

Biodiversity hotspots (as opposed to Kenya's generic "environmental hotspots" highlighted in this chapter), are internationally recognized as the richest and most threatened reservoirs of plant and animal life on earth. Each of the world's 34 places identified as biodiversity hotspots contain at least 1 500 species of vascular plants (>0.5 percent of the world's total) as endemics and has lost at least 70 per cent of its original habitat.

There are eight such spots in Africa, two of which partially occur in Kenya: the mountains of the Eastern Afromontane hotspot; and the Coastal Forests of Eastern Africa (CI 2007).

The former consists of mountainous areas scattered along Africa's eastern edge. The main part of this hotspot is the Eastern Arc Mountains and Southern Rift, which stretches from southeastern Kenya to southern Tanzania and Malawi. In the Eastern Arc Mountains, represented in Kenya by Mount Kenya and Mount Elgon, vegetation types include upper montane, montane, submontane, and lowland forests. Afroalpine vegetation, which grows above 3 400 m, is characterized by giant senecios (*Dendrosenecio spp.*), giant lobelias *(Lobelia spp.*), and Helichrysum scrub (CI 2007).

The Coastal Forests of Eastern Africa hotspot is made up of tiny and fragmented forest remnants, but they contain extraordinary biodiversity, with more than 1 750 endemic plant species and 28 endemic plant genera. Kenya's portion is a relatively narrow (up to 40 km) coastal strip and a 120 km extension along the Tana River (Burgess and others 2004). The Tana River is home to the Tana River red colobus and the Tana River mangabey, two critically threatened and endemic primates (pictured in Chapter 1 of this Atlas). Kenya's Kiunga Marine National Reserve in this hotspot supports the world's largest breeding colony of roseate terns (WWF 2008). The Kwale-Usambara subcentre of endemism, on the Kenya-Tanzania border, is an exceptionally important part of the hotspot. The Kenyan and Tanzanian coastal forests are the origin of the 40 000 cultivated varieties of African violet, which form the basis of a US$100 million global trade in house plants. Subsistence and commercial agricultural expansion is the biggest threat to these already fragile ecosystems (CI 2007).

Important Bird Areas

Internationally Important Bird Areas (IBAs) have also been identified as places where biodiversity needs urgent protection. IBAs do one (or more) of three things: hold significant numbers of one or more globally threatened species; are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species; and have exceptionally large numbers of migratory or congregatory species (BirdLife International 2008).

In 2004, there were 60 IBAs in Kenya, many of which are already protected areas, including Arabuko Sokoke Forest Reserve, a refuge for six globally threatened bird species, and Lake Nakuru National Park, with its immense numbers of flamingoes and other waterbirds. Other IBAs are not yet protected, including densely populated valleys where Kenya's endemic Hinde's Babbler survives. The most significant threats to IBAs are overgrazing and illegal grazing, which seriously threaten the conservation status of 57 per cent of them, while more than half are under serious threat from illegal selective logging and vegetation destruction. The most severely threatened sites include Yala Swamp, Busia Grasslands, Mukurwe-ini Valleys and Mau-Narok/Molo Grasslands (Otieno and others 2004).

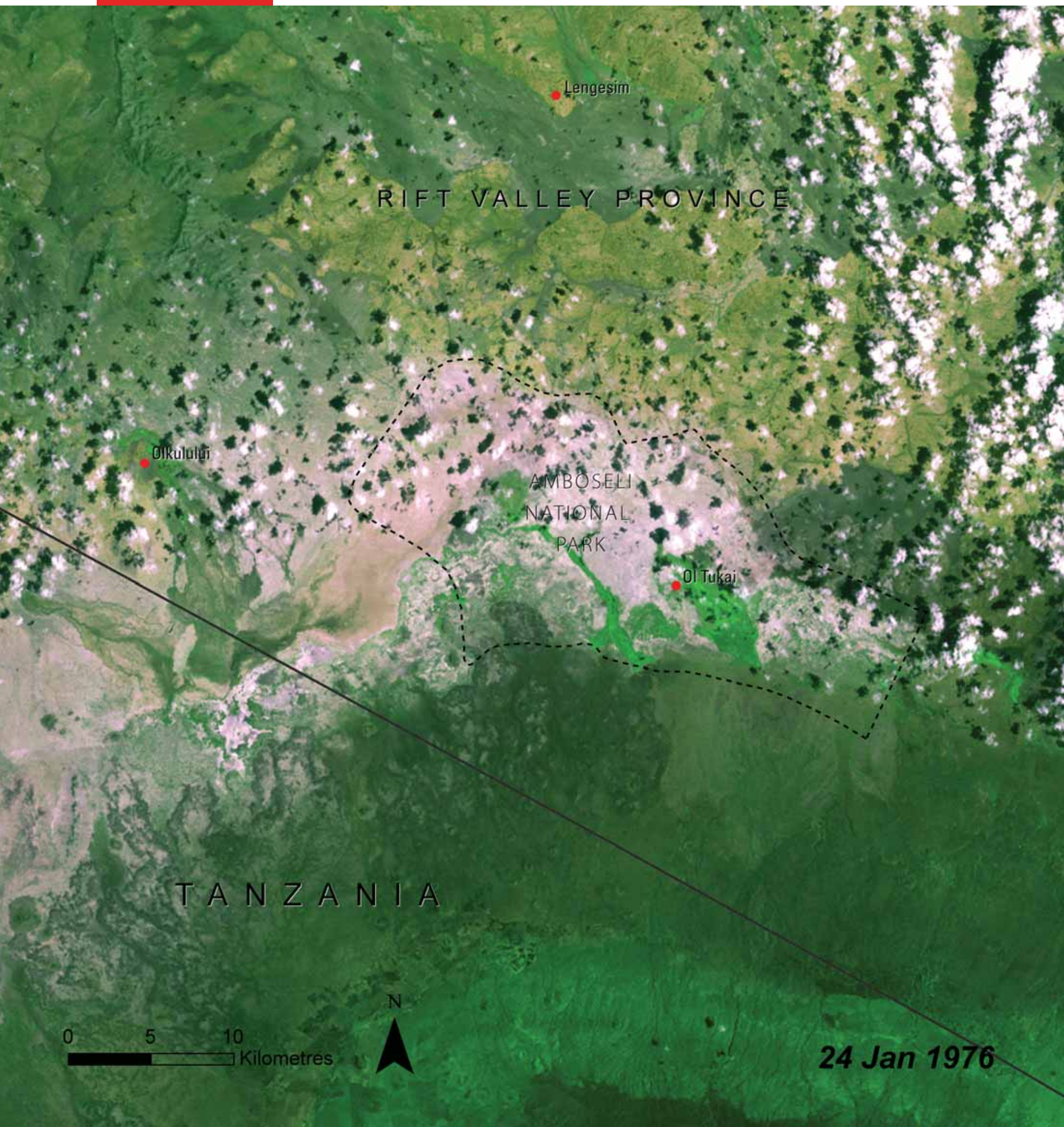
Protected areas

One of the key methods governments take to protect biodiversity is the setting aside of national parks, wildlife refuges, and other types of legally protected areas. As shown in Chapter 2, in 2007, Kenya had 348 designated protected areas, representing 75 238 km^2 or 12.7 per cent of Kenya's territory. Of these protected areas, 14 are internationally recognized.

Amboseli Reserve

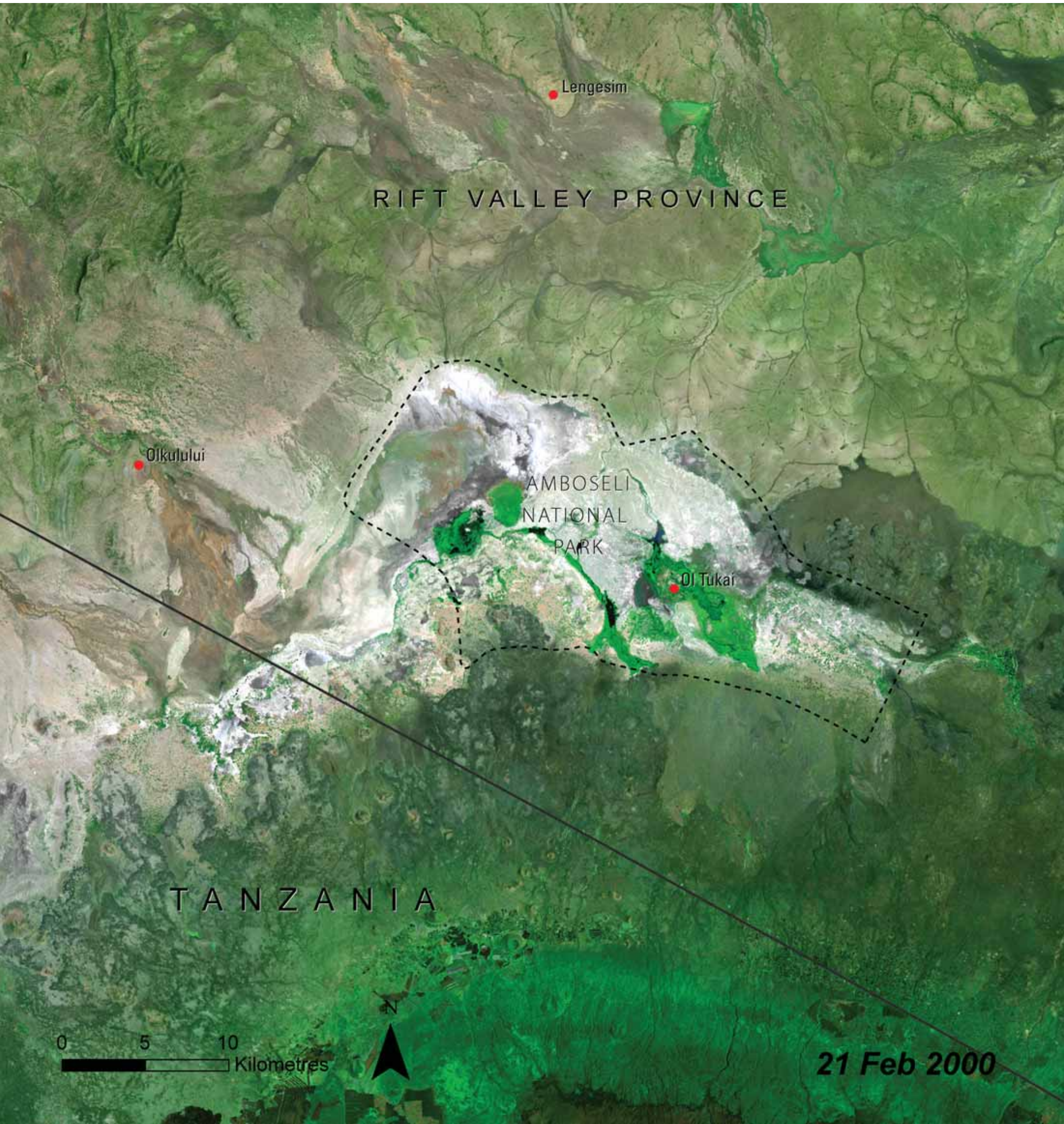
Fragmented Forests

Amboseli National Park and Biosphere Reserve on Kenya's Tanzania border lies at the foot of majestic Mt. Kilimanjaro. Its unique arid environment, with a system of swamps fed by water from the forests of Kilimanjaro, supports a remarkable variety of wildlife. Amboseli's population of elephants has grown to 1 400 since the 1980s. While the last of the park's rhinos were killed in the early 1990s, they are survived by stable populations of hippos, buffaloes, and giraffe. The large array of other wildlife includes characteristic savanna species such as zebra, wildebeest, gazelle, oryx, impala, dik-dik, lions, and hyenas and roughly 400 bird species. The park is small and relies on 4 000 km^2 of surrounding "dispersal areas" to provide migration corridors and increase the feeding and breeding grounds for Amboseli's wildlife. These vital areas are



declining as population, farming, cattle, and other human activities increase in areas surrounding the park. Fencing of some swamp areas to prevent elephants from destroying crops displaces the elephants and other wildlife species from their traditional grazing areas, blocks their dispersion, and denies them access to water.

Fragmentation of the environment is also a concern for traditional livelihoods in the area. The area's Maasai population traditionally used mobility and the ecological variety of the area to cope with rainfall variability, moving to alternative pasture when necessary. Fragmentation and private land ownership are changing these patterns toward intensive grazing and in many cases, overgrazing and land degradation.

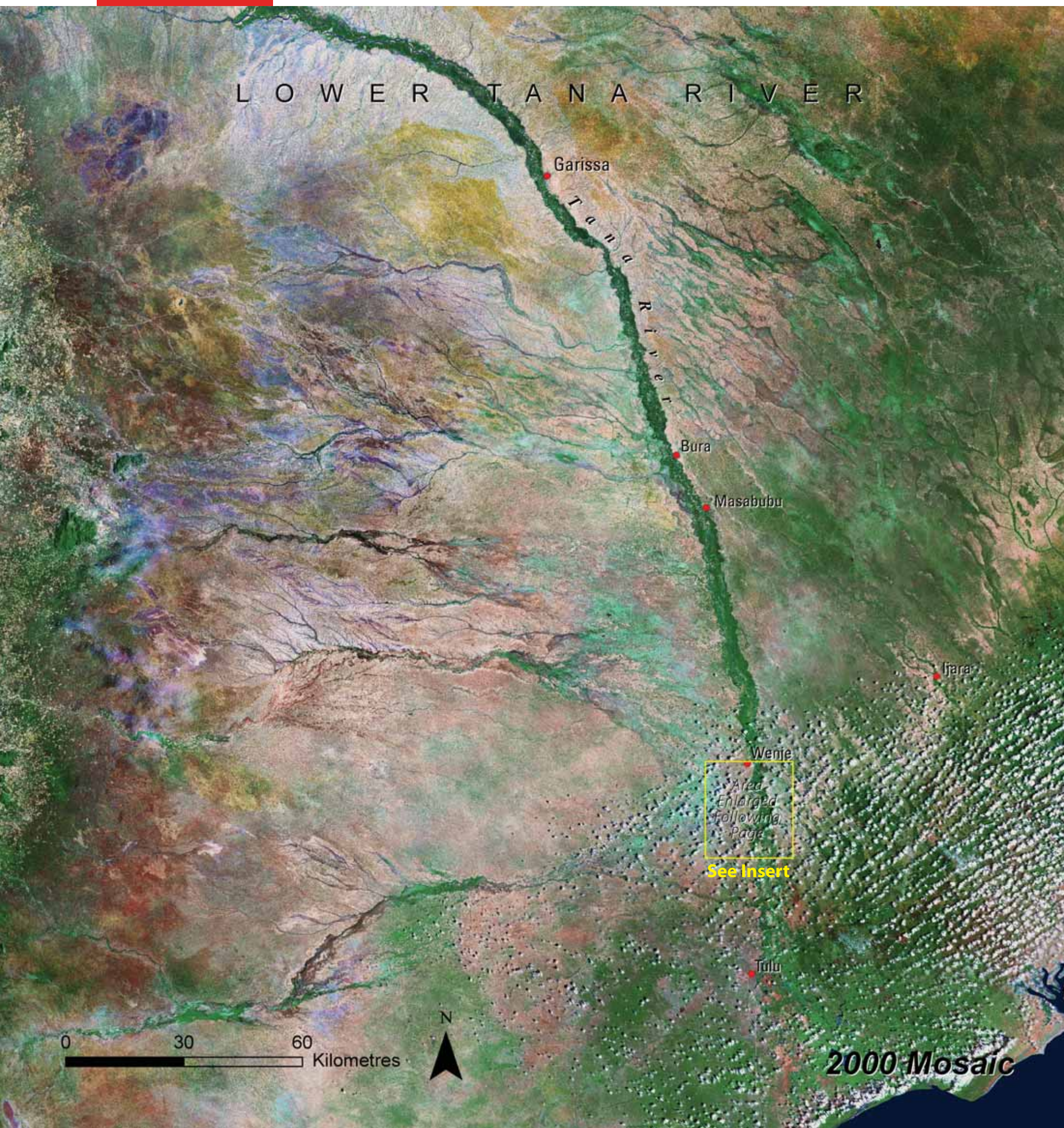


Tana River Primate Reserve

Forest Loss

The Tana River Primate Reserve, located on the river's lower reaches in the Tana River District, Coast Province, was established in 1976 to protect two endangered primate species endemic to the area—the Tana River red colobus and the crested mangabey. The riverine forests that line the lower Tana River is the sole habitat of both species and they are in decline. These forests are remnants of rainforests that covered Eastern Africa during periods of moister climate roughly 8 000 and 28 500 years ago.

Under the current drier climate, the extent of the forests is limited by the depth of the water table, which declines rapidly with distance from the river. What remains of the forests is being lost to shifting cultivation, irrigation dykes,



flooding, and other human activities, as well as natural changes in the river course. Since the 1980s, a further one-third of the forests in the area surrounding the Tana River Primate Reserve were lost. The loss has been slightly less within the reserve than outside.

The 2000 era image of the area of the Lower Tana River shows the limited extent and isolated nature of these forests. The loss of forest area and the fragmentation of the remaining forest put the endangered red colobus and crested manabey at greater risk of extinction. The total population of the Tana River red colobus is estimated to be at 1 300 individuals and their average group size is declining.

References

LAND USE AND LAND USE CHANGE

FAO (2000). "Africover". Food and Agriculture Organization of the United Nations. http://www.africover.org/ (Accessed on 29 December 2008)

FAO (2007). "AQUASTAT Information System on Water and Agriculture", Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome http://www.fao.org/nr/water/aquastat/data/query/index.html (Accessed on 9 January 2008)

GoK (2004). "Draft National Policy the Sustainable Development of Arid And Semi Arid Lands of Kenya". Government of Kenya. http://www.aridland.go.ke/inside.php?articleid=255 (Accessed on 29 December 2008)

IFPRI (2007). "Facts on Ethiopia, Kenya and Uganda". International Food Policy Research Institute, http://www.ifpri.org/media/lfl_facts.htm (Accessed on 12 October 2008)

NLPS (2007). "Draft National Land Policy". National Land Policy Secretariat, Daily Nation, Nairobi, http://www.scribd.com/doc/3107775/Kenya-Land-Alliance-Draft-National-Land-Policy-Formulation- (Accessed on 29 December 2008)

Survey of Kenya (2003). National Atlas of Kenya. Fifth Edition. Survey of Kenya, Nairobi

UNEP (2008). Africa: Atlas of our Changing Environment. Division of Early Warning and Assessment (DEWA), United Nations Environment Programme, Nairobi, Kenya

WRI; Department of Resource Surveys and Remote Sensing, Ministry of Environment and Natural Resources, Kenya; Central Bureau of Statistics, Ministry of Planning and National Development, Kenya; International Livestock Research Institute (2007): Nature's Benefits in Kenya: An Atlas of Ecosystems and Well-Being ISBN:978-1-56973-642-5, Wasgington DC Pp 24-41

Nairobi National Park

CBS (2001). "Kenya, Demographic and Population Census of 1999". Central Bureau of Statistics, Vol II, Governemt Printer. Nairobi Kenya

KWS (2006). "Cities Ecosystem and Biodiversity". Proceeding of Africities Summit, September 2006, Kenya Wildlife Service, Nairobi, Kenya. www.unep.org/urban_environment/PDFs/KWSpresentation.pdf (Accessed on 16 December 2008)

Mlolongo Township

KNBS (2008). Economic Survey of Kenya, 2008. Government Printer. Nairobi Kenya

Lake Naivasha

Alfarra, A. (2004). "Modelling Water Resource Management in Lake Naivasha". Master's Thesis, International Institute for Geo-Information Science and Earth Observation, Enschede, The Netherlands. http://www.weap21.org/downloads/naivasha.pdf (Accessed on 12 November 2008)

COC (2008). "Lake Naivasha, Withering Under the Assault of International Flower Vendors". Council of Canadians Report. http://www.canadians.org/water/documents/NaivashaReport08.pdf (Accessed on 12 November 2008)

Mergeay, J., Verschuren, d. Van Kerckhoven, L., and De Meester, L. (2004). Two hundred years of a diverse Daphnia community in Lake Naivasha (Kenya): effects of natural and human-induced environmental changes. Freshwater Biology 49:998-1013.

Ramsar (2005). "Information Sheet on Ramsar Wetlands – Lake Naivasha". Compiled by Anderson, Wetlands Advisor, Kenya Wildlife Service. http://www.wetlands.org/reports/ris/1KE002_RIS2005en.pdf (Accessed 12 November 2008)

World Lakes (n.d.). "Managing Lake Naivasha". http://www.worldlakes.org/uploads/naivasha.htm (Accessed on 12 November 2008)

Loita Plains

Anderson, T.M., Richie, M.E., and McNaughton, S.J. (2007). "Rainfall and Soils Modify Plant Community Response to Grazing in Serengeti National Park". Ecology 88(5):1191-1201

Boone, R.B., Thirgood, S.J., and Hopcraft, G.C. (2006). "Serengeti Wildebeest Migratory Patterns Modeled from Rainfall and New Vegetation Growth". Ecology 87(8):1987-1994.

Homewood, K., Lambin, E., Coast, E., Kariuki, A., Kikula, I., Kivelia, J., Said, M., and Thompson, M. (2001). "Longterm Changes in Serengeti-Mara Wildebeest and Land Cover: Pastoralism, Population, or Policies"? Proceedings of the National Academy of Sciences 98(22):12544-12549

Maundu, P. Berger, D., Saitabau, C., Nasieku, J., Kipelian, M., Mathenge, S., Morimoto, Y., and Höft, R. (2001). "Ethnobotany of the Loita Maasi, Towards Community Management of the Forest of the Lost Child". People and Plants Working Paper. http://www.peopleandplants.org/storage/working-papers/wp8.pdf (Accessed on 19 December 2008)

Mduma, S.A.R., Sinclair, A.R.E., and Hilborn, R. (1999). "Food Regulates the Serengeti Wildebeest: a 40-year Record". Journal of Animal Ecology 68:1101-1122

Serneels, S. and Lambin, E.F. (2001). 'Impact of Land use Changes on the Wildebeest Migration in the Northern Part of the Serengeti-Mara Ecosystem". Journal of Biogeography 28:391-407

Serneels, S. and Lambin. E.F. (2001b). "Proximate Causes of Land use Change in Narok District, Kenya: a Spatial Statistical Model". Agriculture Ecosystems & Environment 85:65-81

Yala Swamp

BirdLife International (2008). "Online World Bird Database Version 2.1". Cambridge, UK BirdLife International. http://www.birdlife.org. (Accessed on 21 November 2008)

Aloo, P. A. (2003). "Biological Diversity of the Yala Swamp Lakes, with Special Emphasis on Fish Species Composition, in Relation to Changes in the Lake Victoria Basin (Kenya): Threats and Conservation Measures." Biodiversity and Conservation 12: 905–920

Flanders, L. (2007). "Obama's Ruined Homeland". The Nation, 31 January. http://www.thenation.com/doc/20070212/flanders (Accessed on 14 December 2008)

KWF (2006). "Rapid Assessment of the Yala Swamp Wetlands", Kenya Wetlands Forum/East African Wildlife Society, Nairobi, Kenya. http://www.eawildlife.org/programme_areas/Yala%20Assesment%20Report.pdf (Accessed on 24 November 2008)

Thenya, T., Wassmann, R., Verchot, L., and Mungai, D. (2001). "Degradation of the Rparian Wetlands in the Lake Victoria Basin – Yala Swamp Case Study". Proceedings of 11th World Lakes Conference, Nairobi, Kenya

Nakuru National Park

Shivoa, W.A., Muchiri, M. Kibichi, S., Odanga, J., Miller, S.N., Baldyga, T.J., Enanga, E.M., and Gichaba, M.C. (2007). "Influences of Land Use/Cover on Water Quality in the Upper and Middle Reaches of River Njoro, Kenya". Lakes & Reservoirs: Research and Management 12:97-105

UNEP (2005). "Mau Complex Under Siege; Continuous Destruction of Kenya's Largest Forest". United Nations Environment Programme, Kenya Wildlife Service, Kenya Forests Working Group. http://www.iapad.org/publications/mau_crisis_2005f.pdf (Accessed on 18 November 2008)

Vareschi, E. and Jacobs, J. (1985). "The Ecology of Lake Nakuru". Oecologia (Berlin) 65:412-424

WATER

FAO (2006). "AQUASTAT". Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome http://www.fao.org/nr/water/aquastat/countries/kenya/index.stm (Accessed on 29 December 2008)

GoK (2008). "Draft Water Report 2008", Ministry of Water and Irrigation, Government of Kenya, Nairobi.

Macharia, P. (2004). "Gateway to Land and Water Information: Kenya", Land and Water Development Division, Food and Agriculture Organization of the United Nations, Rome http://www.fao.org/ag/Agl/swlwpnr/reports/y_sf/z_ke/ke.htm#wet (Accessed on 29 December 2008)

NEMA (2004). "State of the Environment Report 2003". National Environment Management Agency, Nairobi.

Ramsar (2001). "World Wetlands Day 2001: Kenya". The Ramsar Convention on Wetlands. http://www.ramsar.org/wwd/1/wwd2001_rpt_kenya1.htm (Accessed on 29 December 2008)

Survey of Kenya (2003). National Atlas of Kenya. Fifth Edition. Survey of Kenya, Nairobi.

Twong'o, T. K. and Sikoyo, G. M. (2002). Chapter 5 - Status of the resources of coastal aquatic ecosystems of Kenya and Tanzania. In Shared aquatic ecosystems of East Africa: status and trends (ed T.K. Twong'o, G.M. Sikoyo, J.W. Wakhungu), African Centre for Technology Studies. http://www.acts.or.ke/pubs/books/docs/TBNRM%20-%20Status%20and%20Trends%20Chpt5.pdf (Accessed on 29 December 2008)

UNEP (2008). Africa: Atlas of our Changing Environment. Division of Early Warning and Assessment (DEWA), United Nations Environment Programme, Nairobi.

UNESCO (2006). "Case Studies: Kenya". In Water, a Shared Responsibility. United Nations World Water Development Report, Report 2. United Nations Educational, Scientific and Cultural Organization, http://www.unesco.org/water/wwap/wwdr/wwdr2/ (Accessed on 29 December 2008)

WRI and others (2007). Nature's Benefits in Kenya, An Atlas of Ecosystems and Human Well-Being. World Resources Institute, Department of Resource Surveys and Remote Sensing, Ministry of Environment and Natural Resources, Kenya, Central Bureau of Statistics, Ministry of Planning and National Development, Kenya, and International Livestock Research Institute, Washington, DC and Nairobi.

WWF (2005). "Global Lakes and Wetlands Database (GLWD-3) – Level 3". World Wildlife Fund. http://www.worldwildlife.org/science/data/item1877.html (Accessed on 29 December 2008)

Seven Forks Dam

Jacobs, J.H., Angerer, J. Vitale, J., Srinivasan, R., and Kaitho, R. (2007). "Mitigating Economic Damage in Kenya's Upper Tana River Basin: An Application of Arc-View SWAT". Journal of Spatial Hydrology 7(1):23-46.

Saenyi, W.W. (2003). "Temporal and Spatial Sediment Modelling in Masinga Reservoir, Kenya." In: Jomo Kenyatta University of Agriculture and Technology: International Civil Engineering Conference on Sustainable Development in the 21th Century, Nairobi, Kenya.

Winam Gulf

Osumo (2001). "Effects of Water Hyacinth on Water Quality of Winam Gulf, Lake Victoria". The United Nations University, Reykjavik, Iceland.

UNEP (2008). Africa: Atlas of our Changing Environment. Division of Early Warning and Assessment (DEWA), United Nations Environment Programme, Nairobi.

Lake Ol Bollosat

BirdLife International (2008) "BirdLife's Online World Bird Database." Version 2.1. BirdLife International, Cambridge, UK. http://www.birdlife.org (Accessed on 17 November 2008)

Kigamba, J.N. (2005). "Significance of Land Use Changes on African Lakes". In Proceedings of 11th World Lakes Conference, Nairobi, Kenya

WildlifeDirect (2007). "A Lonely Lake Ebbs Away". The Water Hole. http://thewaterhole.wildlifedirect.org/2007/11/01/a-lonely-lake-ebbs-away/ (Accessed on 17 November 2008)

FORESTS

FAO (2003) "Forestry Outlook Study for Africa". African Development Bank, European Commission and the Food and Agriculture Organization of the United Nations, Rome.

UNEP and DRSRS (2004): "Changes in Forest Cover in Kenya's Five "Water Towers" 2000 -2003". http://www.unep.org/dewa/assessments/EcoSystems/land/mountain/Tower/index.asp. (Accessed on 15 October 2008)

JICA (n.d.). "Guidance in Forestry for Semiarid Regions". Japanese International Cooperation Agency. http://www.jica.go.jp/english/global/natu/kenya.html (Accessed on 25 September 2008)

KFWG (2008). "Kenya's Forests". Kenya Forests Working Group http://www.kenyaforests.org/index.php?option=com_content&task=view&id=61&Itemid=74 (Accessed on 17 November 2008)

Ogola, J. S. (n.d.). "Climate Change: Kenya's Responses". Voices from Africa No. 6. Sustainable Development Part 2. http://www.un-ngls.org/documents/publications.en/voices.africa/number6/vfa6.11.htm (Accessed on 25 September 2008)

Peltorinne, P. (2004). "The Forest Types of Kenya". In Taita Hills and Kenya (ed. P. Pellikka, J. Ylhäisi and B. Clark), 40: 8-13. Department of Geography, University of Helsinki. http://www.helsinki.fi/science/taita/reports/Peltorinne_Forest_types.pdf (Accessed on 29 December 2008)

Survey of Kenya. (2003). National Atlas of Kenya. Fifth Edition, Nairobi http://www.knsdi.go.ke/sokfinal/others/atlas/Table per cent20of per cent20contents.pdf (Accessed on 25 September 2008)

Twong'o, T. K. and Sikoyo, G. M. (2002)."Chapter 5 - Status of the resources of coastal aquatic ecosystems of Kenya and Tanzania." http://www.acts.or.ke/pubs/books/docs/TBNRM%20-%20Status%20and%20Trends%20Chpt5.pdf (Accessed on 12 October 2008)

Wass, P. (1995). "Kenya's Indigenous Forests: Status, Management and Conservation". IUCN Forest Conservation Programme, Gland and Cambridge.

World Bank and Government of Kenya (2000). "The Status of Plantation Grown Timber and its Implications on Sustainable Management and Rational Utilisation of the Resource". Report Number: 18805. Nairobi. 1-34.

UNEP (2006). Africa Environment Outlook 2, United Nations Environment Programme, Nairobi.

WRI (2007). Nature's Benefits in Kenya, An Atlas of Ecosystems and Human Well-Being. World Resources Institute, Department of Resource Surveys and Remote Sensing, Ministry of Environment and Natural Resources, Kenya, Central Bureau of Statistics, Ministry of Planning and National Development, Kenya, and International Livestock Research Institute, Washington, DC
and Nairobi

WWF (2006). "Environmental Problems in Kenya". World Wildlife Fund. http://www.panda.org/about_wwf/where_we_work/africa/where/kenya/environmental_problems_in_kenya/index.cfm. (Accessed on 12 December 2008)

Kakamega Forest

BirdLife International (2008), BirdLife's Online World Bird Database Version 2.1. Cambridge, UK. http://www.birdlife.org (Accessed on December 15, 2008)

Brooks, T.M., Pimm, S.L. ,and Oyugi, J.O. (1999). "Time Lag Between Deforestation and Bird Extinction in Tropical Forest Fragments". Conservation Biology 13(5):1140-1150

Bleher, B., Uster, D., and Bergsdorf, T. (2006). "Assessment of Threat Status and Management Effectiveness in Kakamega Forest, Kenya." Biodiversity and Conservation 15:1159-1177

Farwig, N., Sjita, N., and Böhning-Gaese, K. (2008). "Conservation Value of Forest Plantations for Bird Communities in Western Kenya." Forest Ecology and Management 255:3885-3892

Kokwaro, L.O. (1988). "Conservation Status of the Kakamega Forest in Kenya: the Eastern Most Relic of the Equatorial Rainforest in Africa". Monograph of Botany at the Missouri Botanical Gardens 25: 471-489

Poissonnet, M., Brudo, V. and Dosso M. (2006). "La Forêt Protégée de Kakamega (Ouest Kenya) Entre Deux Futurs Immédiats : Destruction Annoncée ou Gestion Concertée »?, Cahiers Agricultures 15(5)

Lambrechts, C., Woodley, D., Litoroh, M., and Kamwara, P. (2007). "Aerial Monitoring of Forest Boundaries". Joint publication of Kenya Wildlife Service and Kenya Forest Service with support from UNEP.

Lung, T. and Schaab, G. (2004). "Change-detection in Western Kenya: the Documentation of Fragmentation and Disturbance for Kakamega Forest and Associated Forest Areas by Means of Remotely-sensed Imagery". In ISPRS Archives Vol. 25 Part B. Proceedings of the ISPRS 20th Congress, Istanbul, Turkey.

Wagner, P., Köhler, J., Schmitz, A., and Böhme, W. (2008). "The Biogeographical Assignment of a West Kenyan Rain Forest Remnant:Further Evidence from Analysis of its Reptile Fauna.' Journal of Biogeography 35:1349-1361.

Kenya's Mangroves

Abuodha, P.A.W. and Kairo, J.G. (2001). "Human-induced Stresses on Mangrove Swamps along the Kenyan Coast." Hydrobiologia 458:255-265.

FAO (2005). "Status and Trends in Mangrove Area Extent Worldwide:., Working Paper no. 64. Forest Resource Division. Food and Agriculture Organization, Rome. Unpublished

Kairo, J.G., Lang'at, J.K.S., Dahdouh-Guebas, F. Bosire, J., and Karachi, M. (2008). "Structural Development and Productivity of Replanted Mangrove Plantations in Kenya". Forest Ecology and Management 255:2670-2677

Lang'at, J.K.S. and Kairo, J.G. (n.d.) "Conservation and Management of Mangrove Forests in Kenya". Mangrove Reforestation Program, Kenya Marine and Fisheries Research Institute. http://www.wrm.org.uy/countries/Africaspeaks/Conservation_and_managemen_mangrove_Kenya.pdf (Accessed on 21 October 2008)

LAND DEGRADATION

Bai, Z.G., Dent, D.L., Olsson, L., and Schaepman, M.E. (2008). "Global Assessment of Land Degradation and Improvement 1: Identification by Remote Sensing". Report 2008/01, FAO/ISRIC – Rome/Wageningen

Bai, Z.G., and Dent, D.L. (2006). "Global Assessment of Land Legradation and Improvement. Pilot Study in Kenya". Report 2006/01, FAO/ISRIC – Rome/Wageningen. http://www.isric.org/isric/webdocs/Docs/ISRIC_Report_2006_01.pdf (Accessed on 30 December 2008)

IFPRI (2002). "Reducing Hunger, Poverty and Environmental Degradation in the Highlands. Conference on Polices for Sustainable Land Management in the East African Highlands, Addis Ababa, Ethiopia". International Food Policy Research Institute. http://www.ifpri.org/events/conferences/2002/042402.htm. (Accessed on 30 December 2008)

IRIN (2002). "Kenya: Desertification Threatening Millions, Government Warns". UN Office for the Coordination of Humanitarian Affairs http://www.irinnews.org/report.aspx?reportid=32763. (Accessed on 30 December 2008)

KLA (n.d.). "Land Use in Kenya: The Case for a National Land Use Policy", Kenya Land Alliance, Nakuru.

Macharia, P. (2004). "Gateway to Land and Water Information – Kenya National Report". Food and Agriculture Organization of the United Nations, Rome http://www.fao.org/ag/Agl/swlwpnr/reports/y_sf/z_ke/ke.htm#cover (Accessed on 30 December 2008)

Muchena, F. N. (2008). "Indicators for Sustainable Land Management in Kenya's Context". GEF Land Degradation Focal Area Indicators, ETC-East Africa. Nairobi, Kenya

GoK (2002). "National Action Programme: A Framework For Combating Desertification in Kenya in the Context of the United Nations Convention to Combat Desertification". Government of Kenya, Ministry of Environment and Natural Resources, http://www.unccd.int/actionprogrammes/africa/national/2002/kenya-eng.pdf. (Accessed on 30 December 2008)

UNEP (2002). African Environment Outlook: GEO-4, United Nations Environment Programme, Nairobi.

Lake Elmentaita

Dühnforth, M., Bergner, A.G.N., and Trauth, M.H. (2006). "Early Holocene Water Budget of the Nakuru-Elmenteita Basin, Central Kenya Rift". Journal of Paleolimnology 36:281-294

EAWLS (2006). "A Report of a Fact Finding Mission to Lake Elementeita Wetlands", East African Wild Life Society

Murimi, S.K. (1994). "Falling Water-levels in Saline Lakes of the Central Rift Valley of Kenya: the Case of Lake Elmenteita," International Journal of Salt Lake Research 3:65-74

El Wak

Browne, S., Chinogwenya, W., Hersi, O., King, A., Langford, G. ,and Vignoud, F. (n.d.). "Vulnerability and Dependence in Four Livelihood Zones in North Eastern Province of Kenya".

Laikipia District

Frank, L.G., Woodroffe, R. ,,nd Ogada, M.O. (2005). "People and Predators in Laikipia District, Kenya". In People and Wildlife: Conflict or Coexistence? (ed. R. Woodroffe, S. Thirgood and A. Rabinowitz. The Zoological Society of London, Cambridge University Press.

Gichuki, F.N., Liniger, H., MacMillan, C., Schwilch, S., and Gikonyo, J.K. (1998). "Scarce Water: Exploring Resource Availability, Use and Improved Management". In Towards Sustainable Regional Development in the Highland-Lowland System of Mount Kenya. Eastern and southern Africa Geographical Journal 8:15-27.

Kiteme, B.P., Wiesmann, U., Kunzi, and Mathuva, J.M. (1998). "A Highland-Lowland System under Transitional Pressure: A Spatio-Temporal Analysis". In Towards Sustainable Regional Development in the Highland-Lowland System of Mount Kenya. Eastern and southern Africa Geographical Journal 8:45-53.

LWF (2008). "The Laikipia District". Laikipia Wildlife Forum Website. http://www.laikipia.org/content/view/71/63/ (Accessed on 21 November 2008)

Mkutu, K. (2001). "Pastoralism and Conflict in the Horn of Africa". Africa Peace Forum/Saferworld/University of Bradford. http://www.saferworld.org.uk/publications.php/75/pastoralism_and_conflict_in_the_horn_of_africa (Accessed on 20 November 2008)

Mizutani, F. (1999). "Biomass Density of Wild and Domestic Herbivores and Carrying Capacity on a Working Ranch in Laikipia District, Kenya.:"African Journal of Ecology 37:226-240

Samburu District

DRSRS (2008). "Trends of Large Herbivores and Livestock in Kenya, between 1977 and 2007". DRSRS Technical Report. (In prep)

Gross, M. (2007). "Mapping Hidden Resources". Current Biology 17(10):340-341

Lesorogol, C.K. (2005). "Privatizing Pastoral Lands: Economic and Normative Outcomes in Kenya". World Development 33(11):1959-1978.

Nanyingi, M.O., Mbaria, J.B., Lanyasunya, A.L., Wagate, C.G., Koros, K.B., Kaburia, H.F., Munenge, R.W., and Ogara, W.O. (2008). "Ethnopharmacological Survey of Samburu District, Kenya," Journal of Ethnobiology and Ethnomedicine 4(14)

Landslides

Davies, T.C. and Nyambok, I.O. (1993) The Murang'a landslide, Kenya. Environmental Geology 21:19-21.

Hijmans, R.J., Cameron, S. and Parra, J. (2005) WorldClim Climate Surfaces, Version 1.4. Accessed December 19, 2008 at: http://www.worldclim.org/

Ngecu, W.M., Nyamai, C.M. and Erima, G. (2004). The extent and significance of mass-movements in Eastern Africa: case studies of some major landslides in Uganda and Kenya. Environmental Geology 46:1123-1133.

NDOC (No Date) Landslides. National Disaster Operations Centre. Accessed 26 November 2008 at: http://www.noc.or.ke/inside.php?articleid=7

Ngecu, W.M. and Mathu, E.M. (1999). The El-Nino-triggered landslides and their socioeconomic impact on Kenya. Environmental Geology 38(4):277-284.

Ngecu, W.M. and Ichang i, D.W. (1999). The environmental impact of landslides on the population living on the eastern footslopes of the Aberdare ranges in Kenya: a case study of Maringa Village landslide. Environmental Geology 38(3):259-264.

BIODIVERSITY

Birdlife International (2008). "Important Bird Areas (IBAs)." BirdLife International http://www.birdlife.org/action/science/sites/index.html (Accessed on 29 December 2008)

Burgess, N., Gordon, I., Salehe, J., Sumbi, P., Doggart, N., Rodgers, A.,, and Clark, G.P. (2004). "Coastal Forests of Eastern Africa", In Hotspots revisited. (ed. R.A. Mittermeier, P.R. Gil, M. Hoffmann, J. Pilgrim, T. Brooks, C.G. Mittermeier, J. Lamoreux, G.A.B. Da Fonseca), Cemex/ Conservation International.

Chagema, K. and Kuria, B. (2003). "Invasive Alien Species in Kenya: Status and Management". In Identification of risks and management of invasive alien species using the IPPC framework, Proceedings of a workshop in Braunschweig, Germany. Secretariat of the International Plant Protection Convention, Food and Agriculture Organization of the United Nations http://www.fao.org/docrep/008/y5968e/y5968e10.htm (Accessed on 29 December 2008)

CI (2007). "Biodiversity Hotspots", Conservation International http://www.biodiversityhotspots.org/xp/Hotspots/Pages/default.aspx (Accessed on 29 December 2008)

Duraiappah, A.K. and Roy, M. (2007). "Poverty and Ecosystems: Prototype Assessment and Reporting Method – Kenya Case Study". International Institute for Sustainable Development. http://www.iisd.org/pdf/2007/poverty_eco.pdf (Accessed on 29 December 2008)

GoK (1998). "National Biodiversity Strategy and Action Plan", National Report to the Conference of Parties (COP), Ministry of Environmental Conservation, Government of Kenya, Nairobi. http://coastalforests.tfcg.org/pubs/Kenya%20biodiversity%20strategy%201998.pdf (Accessed on 29 December 2008)

IUCN (2008). "IUCN Red List of Threatened Species 2008", International Union for Conservation of Nature. http://www.iucnredlist.org/documents/2008RL_stats_table_6a_v1223294385.pdf (Accessed on 29 December 2008)

KFWG (2008). "Forests in Kenya Overview", Kenya Forestry Working Group. http://www.kenyaforests.org/index.php?option=com_content&task=view&id=61&Itemid=74&limit=1&limitstart=2 (Accessed on 29 December 2008)

Otieno, N., Mwangi, S., Bennun, L., Musila, S., Mulwa, R., and Kiragu, A. (2004). "Kenya's Important Bird Areas: Status and Trends, 2004". Nature Kenya. http://www.naturekenya.org/IBAs.htm (Accessed on 29 December 2008)

Peltorinne, P. (2004). "The Forest Types of Kenya". In Taita Hills and Kenya (ed. P. Pellikka, J. Ylhäisi and B. Clark), 40: 8-13. Department of Geography, University of Helsinki. http://www.helsinki.fi/science/taita/reports/Peltorinne_Forest_types.pdf (Accessed on 29 December 2008)

Thaxton, M. (2007). "Integrating Population, Health, and Environment in Kenya". Population Reference Bureau, Washington, D.C. http://www.prb.org/pdf07/phe-kenya.pdf (Accessed on 29 December 2008)

WWF (2008). "Coastal East Africa: Species". World Wildlife Fund, http://www.worldwildlife.org/what/wherewework/coastaleastafrica/species.html (Accessed on 29 December 2008)

Amboseli National Park

Croze, H., Sayialel, S., and Sitonik, D. (2006). "What's on in the Ecosystem, Amboseli as a Biosphere Reserve", A Compendium of Conservation and Management Activities in the Amboseli Ecosystem. Amboseli Elephant Trust, Nairobi, Kenya

Okello, M.M. and D'Amour, D.E. (2008). "Agricultural Expansion within Kimana Electric Fences and Implications for Natural Resources Conservation around Amboseli National Park, Kenya. Journal of Arid Environments 72:2179-2192.

Burnsilver, S.B., Worden, J., and Boone, R.B. (2008). "Processes of Fragmentation in the Amboseli Ecosystem, Southern Kajiado District, Kenya". In Fragmentation in Semi-Arid and Arid Landscapes: Consequences for Human and Natural Systems. (ed. K.A. Galvin, R.S. Reid, R.H. Behnke Jr., and N. Thompson-Hobbs) Springer Netherlands http://books.google.com/books?id=TJw47hoyH8YC&pg=PA226&lpg=PA226&dq=Processes+of+Fragmentation+in+the+Amboseli+Ecosystem&source=bl&ots=u8gXSstQuj&sig=6_3gQfN6AByVlawZZWcqtqEBMsE&hl=en&sa=X&oi=book_result&resnum=2&ct=result#PPA227,M1 (Accessed on 20 December 2008)

Tana River Primate Reserve

Malonza, P.K., Wasonga, V.D., Muchai, V., Rotich, D., and Bwong, B.A. (2006). "Diversity and Biogeography of Herpetofauna of the Tana River Primate National Reserve, Kenya." Journal of East African Natural History 95(2):95-109, http://www.naturekenya.org/Downloads/jldownloads/malonzatoprint.pdf (Accessed on 28 December 2008)

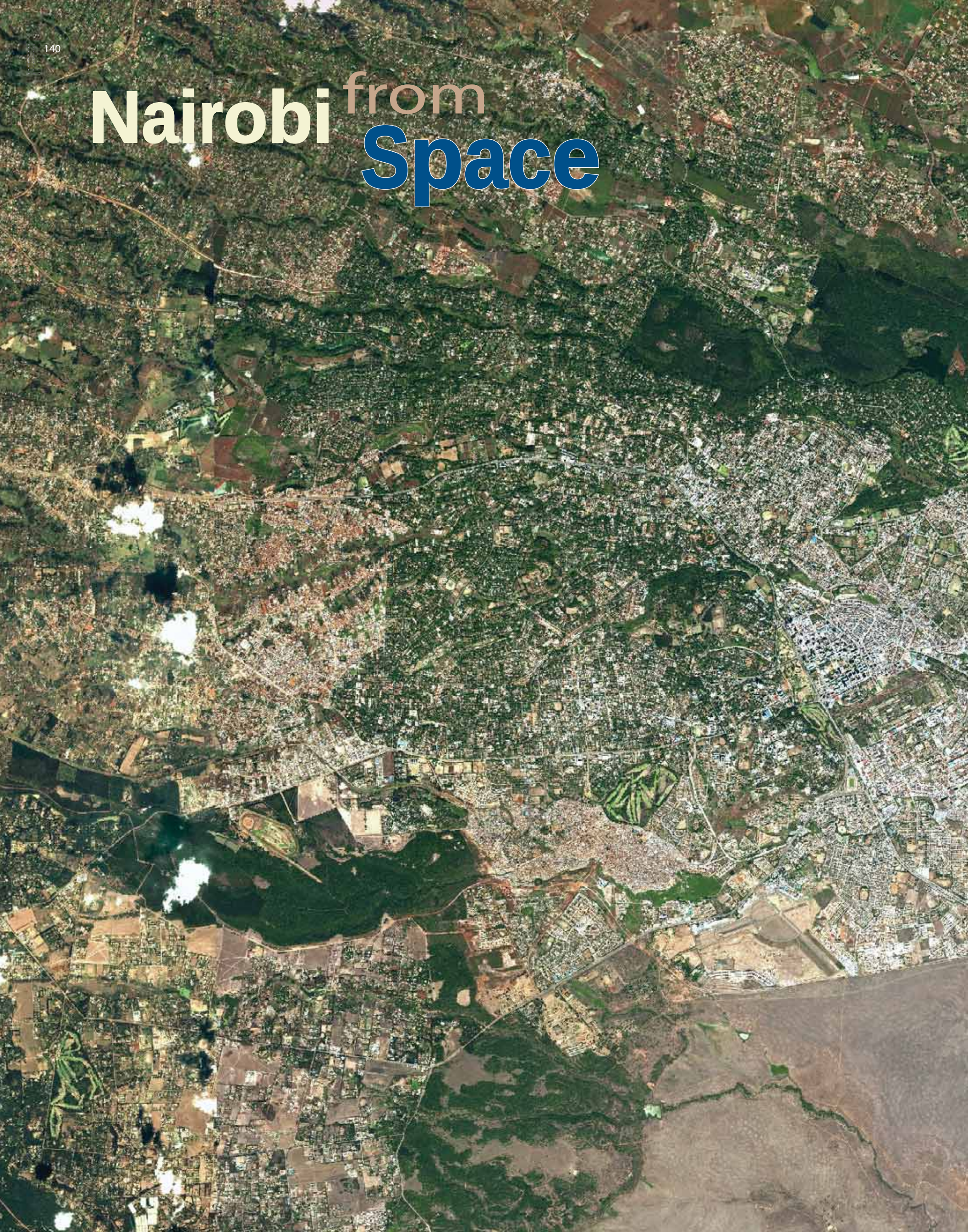
Medley, K.E. (1992) "Patterns of forest diversity along the Tana River, Kenya". Journal of Tropical Ecology 8:353-371.

Medley, K.E. (1993) "Primate Conservation along the Tana River, Kenya: an Examination of Forest Habitat." Conservation Biology 7:109–121.

Moinde-Fockler, N.N., Oguge, N.O., Karere, G.M., Otina, D., and Suleman, M.A. (2007). Human and Natural Impacts on Forests along Lower Tana River, Kenya: Implications Towards Conservation and Management of Endemic Primate Species and their Habitat". Biodiversity Conservation 16:1161-1173.

Mbora D.N.M. and Meikle, D.B. (2004). "Forest Fragmentation and the Distribution, Abundance and Conservation of the TanaRiver Red Colobus (Procolobus rufomtitratus). Biological Conservation 118:67–77.

Nairobi from Space

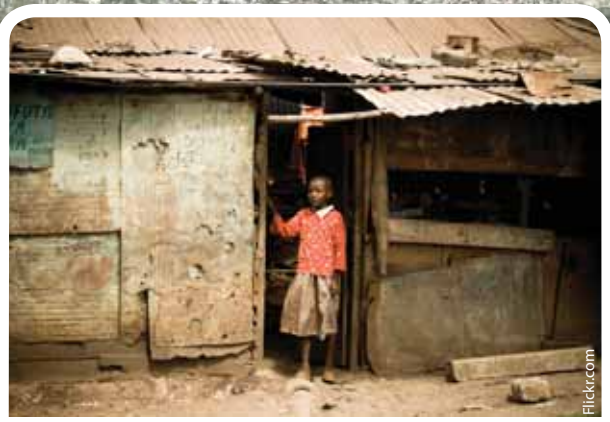


Nairobi and its Environment

In addition to being Kenya's capital, Nairobi is its largest and most populous city, with about eight per cent of the nation's citizens, and it accounts for about half of Kenya's economic activity. A high rate of natural growth and the influx of rural migrants are exploding the city's population. Huge areas occupied by informal settlements and slums, ubiquitous traffic jams, and a lack of adequate city planning challenge its ability to address environmental problems such as air and water pollution. Given its importance and its impact on all aspects of Kenya's development, this chapter focuses on environmental change in Nairobi.

Ngong River / Tom Maruko / Flickr.com

Nairobi's rivers are increasingly choked with uncollected garbage and human waste from slums and overflowing sewers. The growing population places increasing burdens on the rivers from its waste production, inappropriate waste treatment, and a lack of comprehensive environment policies.



Flickr.com

With at least 700 000 inhabitants, the Kibera slum in Nairobi is Kenya's biggest informal settlement. Slum dwellers often have inadequate access to safe water supplies and sanitation and are subject to severe disease outbreaks.

Nairobi Dam / UNEP

Nairobi consumes about 350 000 m^3 of water a day. Despite the fact that production exceeds demand, only about 42 per cent of households in Nairobi have proper water connections (MWI/WSP 2005). Moreover, 50 per cent in volume is lost due to leakages and illegal connections (UNEP/DRSRS undated). Nairobi Dam is now polluted and infested with water hyacinth.


Tom Makuko / Flickr.com

Nairobi generates 1 530 tonnes of solid waste a day, of which 68 per cent comes from domestic sources. The city collects about 40 per cent of the waste, while the private sector collects about 20 per cent and the balance is left uncollected (CCN 2007).


Neeks / Flickr.com

Compared to other urban centres in Kenya, Nairobi has the greatest concentration of industrial and vehicle air pollutants. Car congestion is an increasing problem and traffic-related costs are estimated at 50 million Ksh a day through increased fuel consumption, mechanical damage, and pollution (Moody 2007).


Flickr.com

Nairobi is a major contributor to Kenya's economy. It generates about half of the nation's GDP, employs 25 per cent of Kenyans and almost half of the country's urban workers (CCN 2007).


Flickr.com

Nairobi is nicknamed the "Safari Capital of the World" due to the high number of tourists visiting the region each year. Its airport, the largest in East and Central Africa, handled close to 4.4 million passengers in 2006.


Flickr.com

Located only seven kilometres from the city centre, Nairobi National Park serves as an important recreational area and provides essential ecosystem services. With 100 000 visitors annually, it is also an important contributor to Kenya's tourism economy.

Eugene Apindi/UNEP