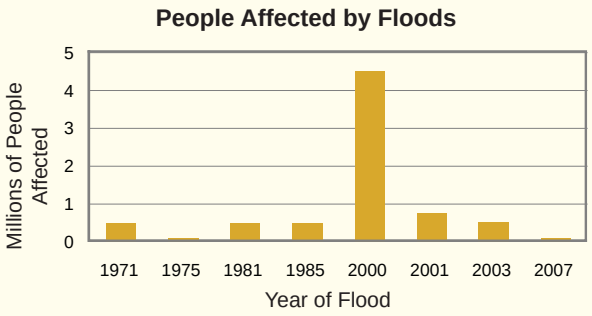
Water Access and Natural Disasters

Levels of access to potable water and adequate sanitation facilities in Mozambique are among the lowest in Africa, although the situation has improved somewhat. The problem is most widespread among rural residents, which account for nearly three-quarters of the total population. Access is also lacking in urban slums, which account for 94 per cent of all city dwellers (UN 2007).

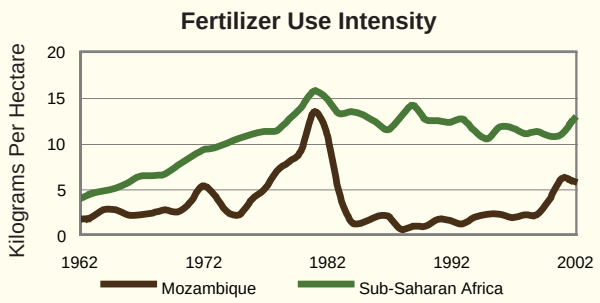
Natural disasters such as droughts, floods, and cyclones frequently strike Mozambique, exacerbating water and sanitation problems, destroying crops, and threatening food security and human health. In 2000, the worst floods in over 50 years destroyed 140 000 hectares of crops and affected millions of people (UN 2000).



Source: EM-DAT Disaster Database

Land Use

Mozambique has immense agricultural potential, with 36 million hectares of arable land, equivalent to almost half of the total country area. Fewer than five million hectares are currently being utilized, however, predominantly by poor, smallholder farmers using minimal chemical inputs, irrigation, and machinery (FAO 2005). As a result, land degradation is not as severe in Mozambique as in other African countries, although continued population growth could alter this trend.

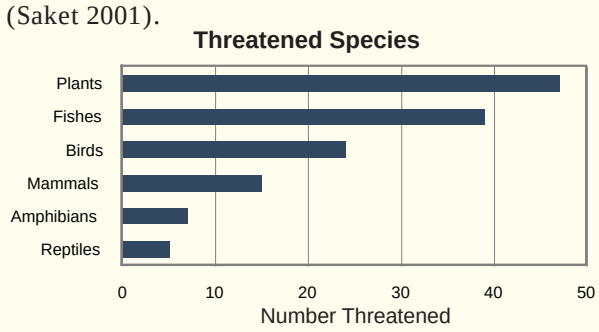


Source: FAOSTAT

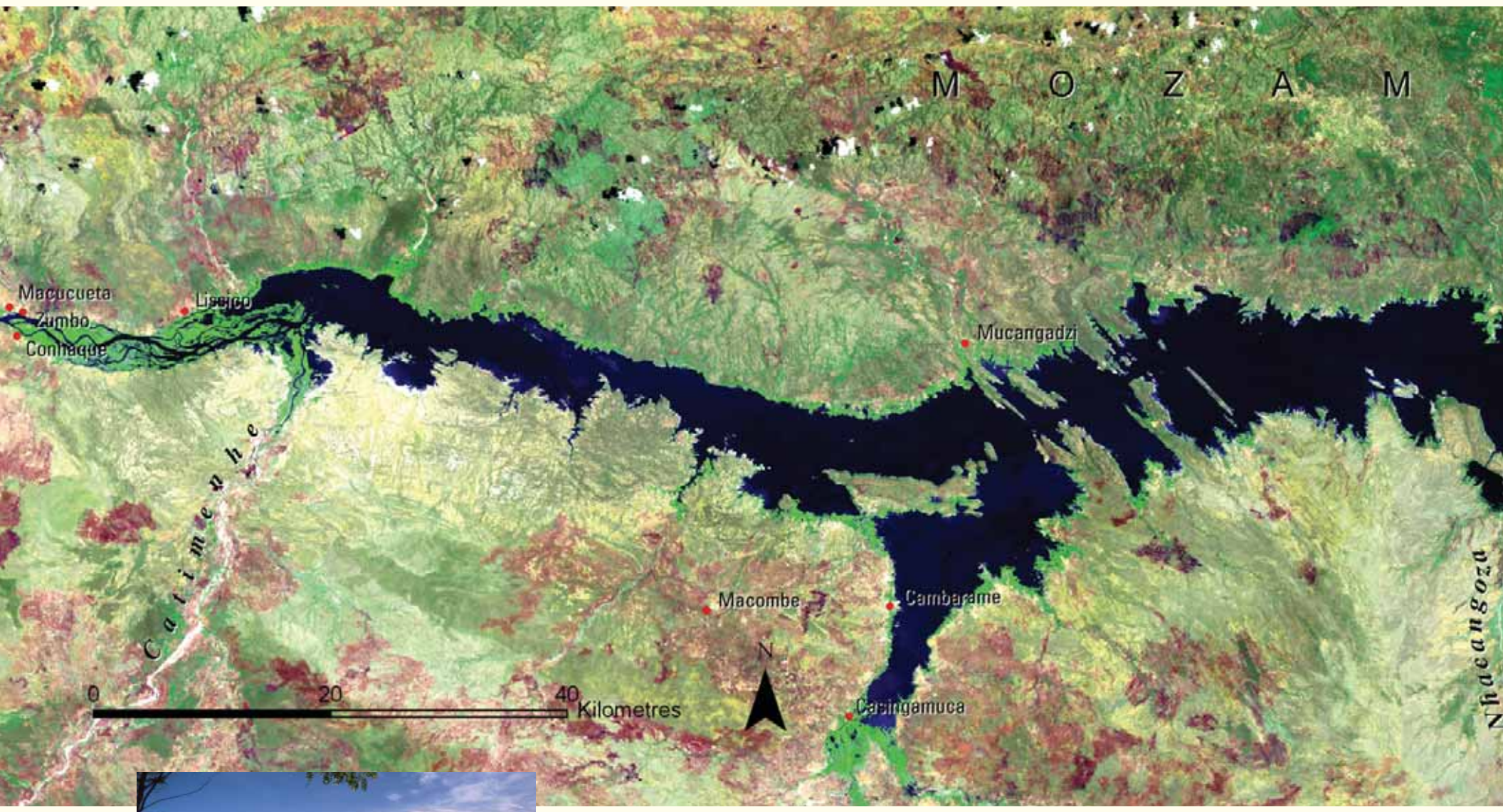
Protecting Wildlife and Forests

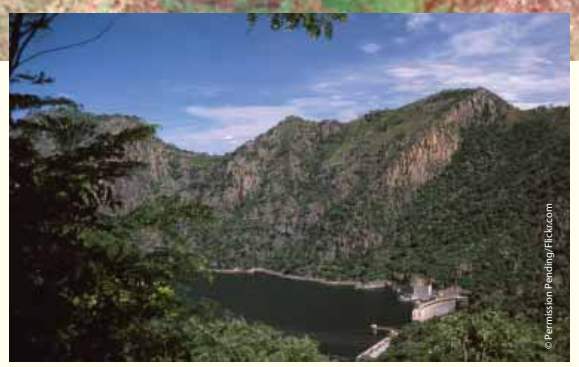
Civil war during the 1970s and 1980s disrupted conservation efforts in Mozambique, taking a heavy toll on the nation's wildlife. Although still among the poorest countries in the world, Mozambique is now expanding its protected areas. It shares a section of the Great Limpopo Tranfrontier Park—Africa's largest wildlife refuge that spans 35 000 km^2—with South Africa and Zimbabwe.

Wildfires remain a significant threat to Mozambique's forests and wildlife. Every year, approximately 40 per cent of the country is burned by fire, of which 80 per cent is forest. Human activities, and particularly slash-and-burn agriculture, are suspected to be responsible for 90 per cent of all fires (Saket 2001).



Source: IUCN Red List

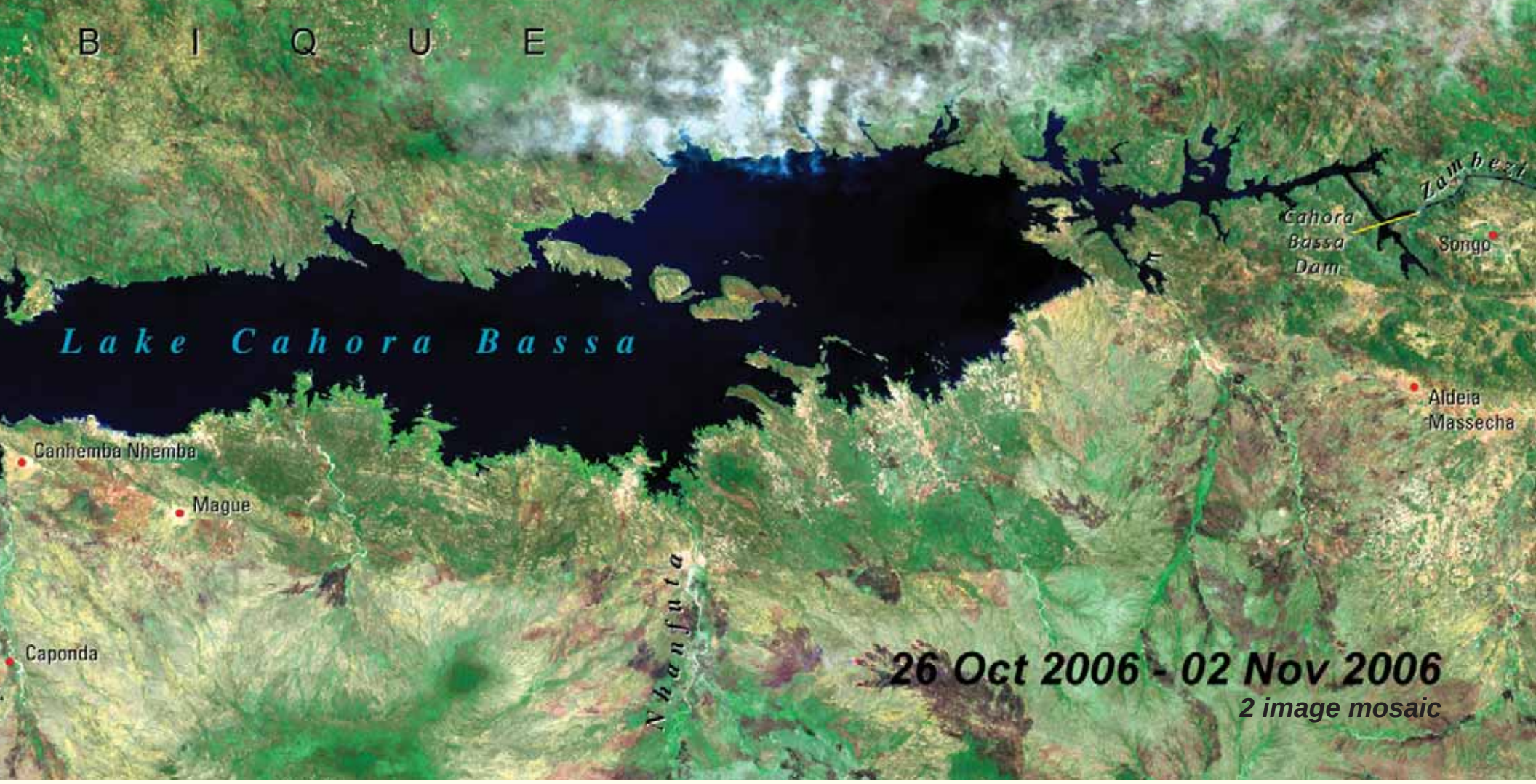




Cahora Bassa Dam: Zambezi River, Mozambique

The Zambezi River drains an area of roughly 1.5 million km^2 from Angola to Mozambique. In 1974, the Cahora Bassa Dam was completed about 300 km upstream from where the Zambezi River empties into the Indian Ocean. The dam created Lake Cahora Bassa, the second largest human-made lake in southern Africa. Prior to the dam's construction, surrounding natural ecosystems and traditional agriculture were shaped by annual floods.

As the dam neared completion, experts recommended that Lake Cahora Bassa be filled slowly, over a period of at least two years. Furthermore, they recommended that a minimum flow



be maintained, with extra releases to simulate natural flooding, and that the filling of the reservoir should not begin until after the 1975 flooding season. These recommendations were not followed.

The 1972 image shows a 250-km stretch of the Zambezi River prior to the construction of the Cahora Bassa Dam. The same stretch was flooded, in a single year, following the dam's completion in 1974. In the ensuing years, flooding of the lower Zambezi has been notoriously mistimed. These erratic water releases have negatively impacted hundreds of thousands of downstream residents and decimated the ecosystem of the Zambezi River delta. The 2006 image shows the current extent of the reservoir. Strategies to better manage Cahora Bassa Dam are being explored in order to restore damaged ecosystems and some traditional land use.

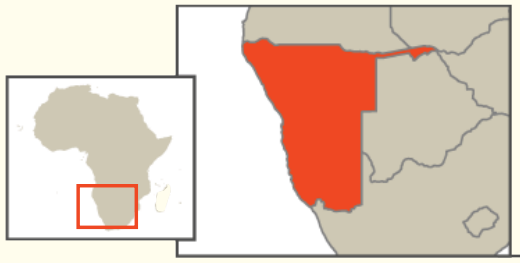

Alex Quisberg/Flickr.com

Fire Scars: Beira, Mozambique

During Mozambique's dry season—May to October—fires leave burn scars on the landscape. Over one-third of the country is affected by fire each year. NASA's Earth Observatory recorded an especially large number of fires in August 2006. The widespread nature of the fires suggests that they may have been intentionally set. Population growth in Mozambique has drastically intensified the need for agricultural land as well as for forestry and wildlife products, thus putting increased pressure on limited resources. Fires have become a primary means of clearing land for cultivation.

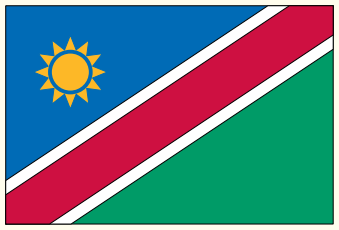
The 21 May 2006 satellite image was acquired at the beginning of the 2006 dry season, before many fires had left their mark. The 9 August 2006 image shows the same area roughly 2.5 months later. Pink, dark red, and black fire scars cover much of the landscape.

Many plants in Mozambique are adapted to periodic fire. However, the increasing frequency of fires affects the natural regeneration of vegetation and is believed to be reducing species diversity in Mozambique's forests. Frequent fires can also increase soil erosion and negatively impact hydrology.



Republic of Namibia

Total Surface Area: 824 292 km²
Estimated Population in 2006: 2 052 000



Namibia is the most arid country south of the Sahara Desert, receiving an average of only 258 mm of rain per year (FAO 2007). With only 2.5 people per square kilometre, it is also among the least populated countries in the world (UNESA 2005). Namibia is divided into three topographical regions. A coastal desert strip, which includes the Namib Desert, follows the country's entire Atlantic coast. Stretching from north to south, an inland plateau covers more than half of the country and is home to the majority of the population. Finally, the Kalahari (Kgalagadi) Desert to the east and south of the inland plateau contains a variety of localised ecosystems.

Important Environmental Issues

- Land Degradation and Desertification
- Aridity and Water Scarcity
- Threats to Biodiverstiy

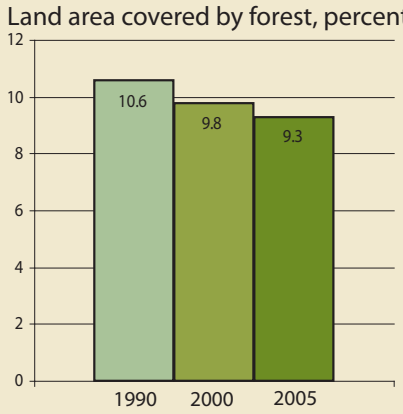
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

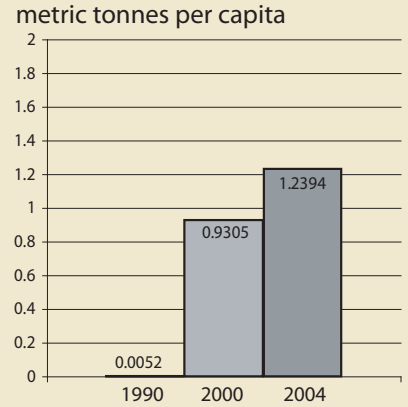
Although Namibia has seen an increase of 30 per cent between 1990 and 2004 in the access of its people to improved water sources, the country's primary environmental concerns remain water pollution and insufficient water resources for its growing population. Deforestation and soil erosion also threaten Namibia's land. The percentage of protected land area remained constant between 1990 and 2005.

★ Indicates progress

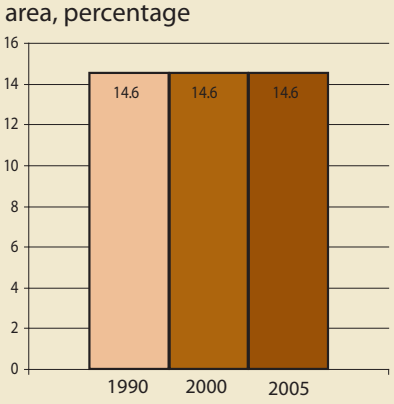
Land area covered by forest, percentage



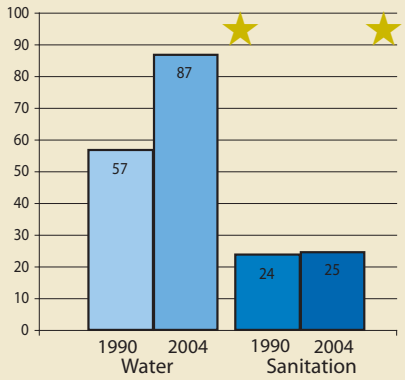
Carbon dioxide (CO_2) emissions, metric tonnes per capita



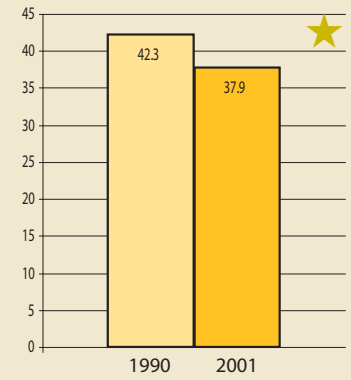
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



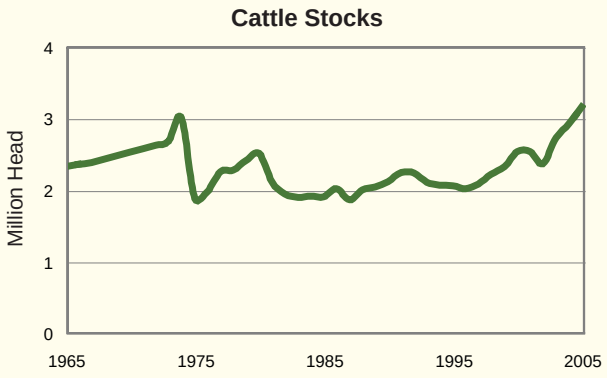
Slum population as percentage of urban



At 55 million years, Namib is the world's oldest desert.

worldwildlife.org (2001)

Land Degradation and Desertification



Source: FAOSTAT

Desertification is the foremost environmental problem in Namibia—an estimated 99 per cent of lands are at high risk (FAO AGL 2003). Despite the scarcity of arable land, almost half of the population is involved in agriculture (FAO 2007b), which is characterized by low-input, continuous cultivation of naturally poor soils. Overgrazing is the largest threat since cattle, which outnumber people in Namibia, have surpassed the carrying capacity of the land. Current evidence of desertification includes declining groundwater levels, soil erosion, reduced soil fertility, increased salt content in soils, and loss of woody vegetation.

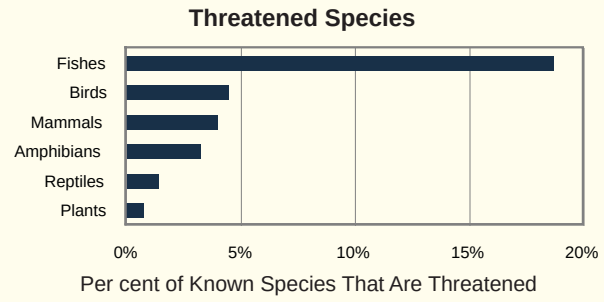
Aridity and Water Scarcity

Water availability is the single greatest factor limiting development in Namibia. Extreme temporal variability and uneven spatial distribution of water resources constrain livelihoods, particularly for the 64 per cent of the population that live in rural areas (UNESA 2006). There are limited perennial surface water resources located primarily along the northern and southern borders, but all of these sources suffer from significant population pressure and degradation. Groundwater accounts for roughly half of all water consumption (Namibia Ministry of Environment and Tourism 2001), but only one per cent of Namibia's meager rainfall goes towards recharging groundwater (FAO 2005), making over-extraction a growing concern.

Threats to Biodiversity

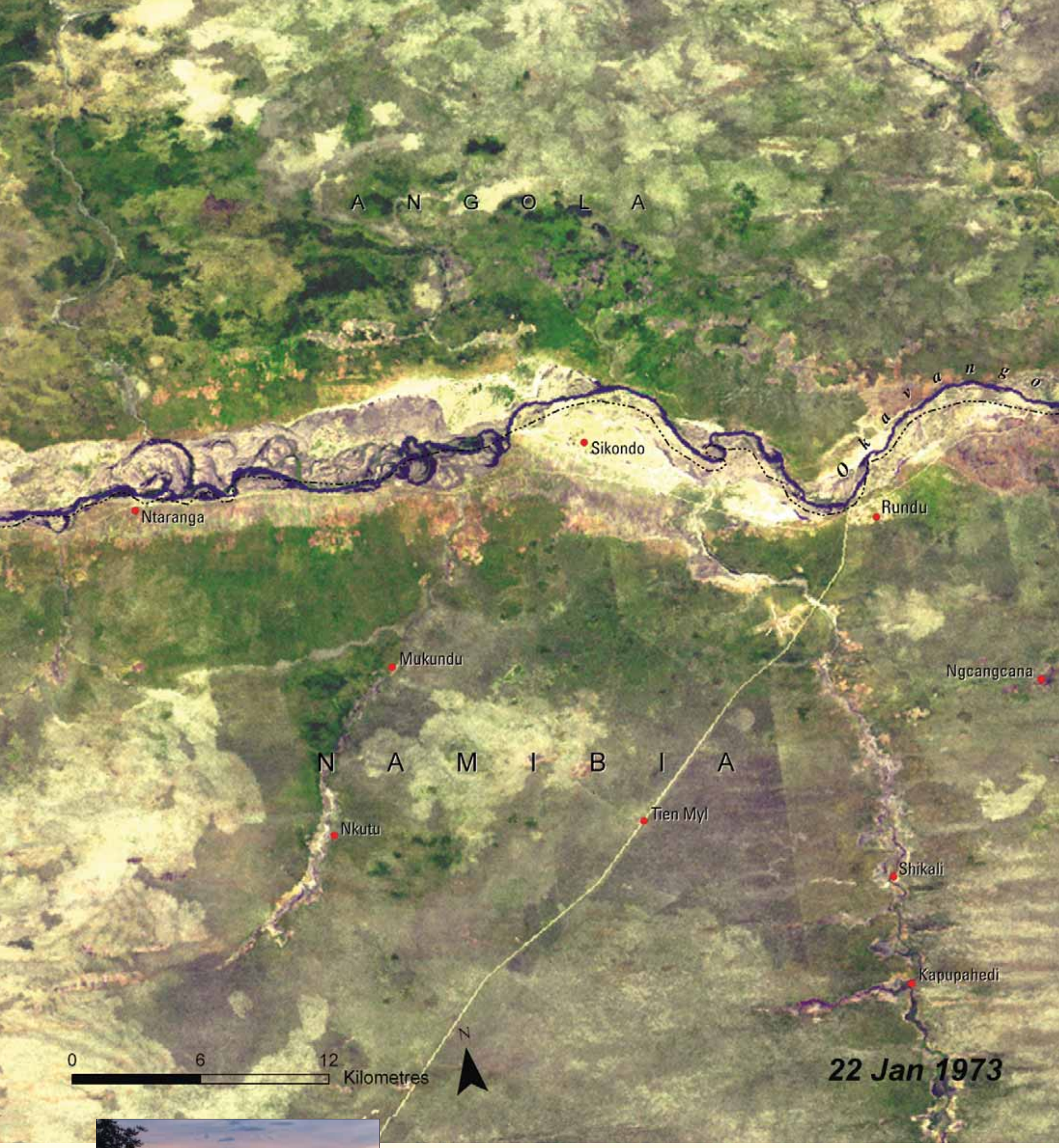
Namibia is home to abundant biodiversity, including unique desert-adapted ecological communities, charismatic megafauna, and productive coastal fisheries. The Succulent Karoo of the Namib Desert is one of the few arid biodiversity hotspots in the world. It contains the richest collection of succulent flora on Earth and an estimated 2 439 endemic plant species (CI 2007). Threats to this region include grazing, agriculture, and mining, although low population densities have allowed for enhanced preservation.

Namibia also has one of the largest remaining populations of black rhinos, a highly endangered species threatened primarily by poaching. Roughly three-quarters of the national rhino population can be found in Etosha National Park (WWF 2006) where poaching has been virtually eliminated, making it a conservation success story in a country where illegal poaching was once rampant.



Source: IUCN Red List

Namibia's fisheries are some of the most productive in the world, thanks to nutrient-rich upwelling from the Benguela Current System. Prior to independence in 1990, overfishing by European fleets threatened several fish stocks with collapse. Over the past decade, national fisheries management has improved dramatically, and most major commercially exploited species are regulated under a Total Allowable Catch system (Nichols 2003).



Kavango Region: Namibia

The Kavango Region, located in Namibia's relatively wet northeastern corner, is part of the eight per cent of the country that receives about 500 mm of rain per year—the minimum considered necessary for non-irrigated agriculture. However, because this rainfall is irregular and evaporation rates are high, it is often inadequate for successful farming. Many of the soils in this area, with low nutrients or high salinity, are also marginal for farming. Nevertheless, roughly 55 per cent of the region is used for subsistence agriculture with pearl millet being the predominant crop.

Savannah woodlands are the natural vegetation in the sandy soils surrounding Rundu, near the Okavango River. Many of the woodlands along the river were cleared for agriculture long ago. More recently, government-dug wells have enabled settlement and farming further from the river, leading to further deforestation, particularly in the dry river beds (omurambas), where the soils are better for farming.

The Namibian government considers this area an important focus of economic activity and supports many water and agricultural projects. Along with rapid development, the population of Rundu is growing at a staggering pace—911 per cent between 1981 and 1991. These images, from 1973 and 2007, show the dramatic increase in the land area cleared for agriculture (light yellow patches) around Rundu and elsewhere along the river.

ATLANTIC OCEAN

Walvis Bay

Walvis Bay

Walvis Bay Wetlands

N A M I B I A

Namib Desert

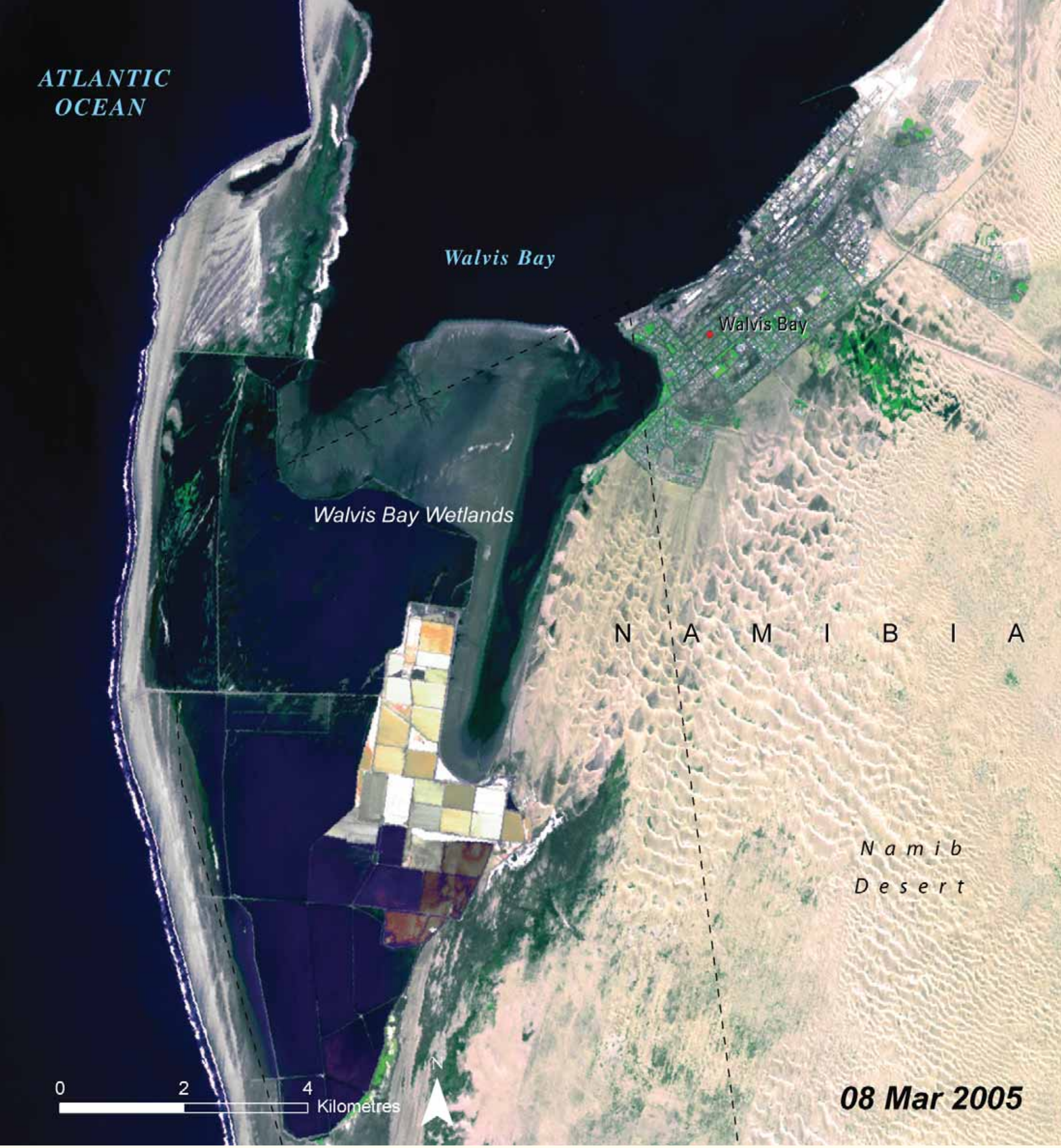
0 2 4 Kilometres

N

10 Aug 1973

Salt Production and Wetlands: Walvis Bay, Namibia

Walvis Bay is an economic and environmental hotspot in Namibia. It has been designated as a free-trade area and placed on the Ramsar List of Wetlands of International Importance. The Walvis Bay lagoon, the largest area of shallow, sheltered water on the Namibian coast, supports a wide range of birdlife. Walvis Bay's tidal channels, mudflats, and sandbanks support roughly 150 000 birds, including the African black oystercatcher, lesser and greater flamingo, chestnut banded plover, and blacknecked grebe.

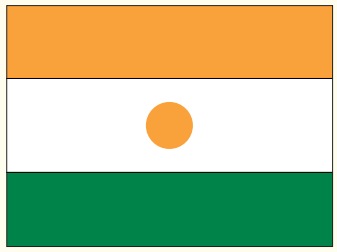


Walvis Bay's solar evaporation facilities process 24 million metric tonnes of seawater each year, producing more than 400 000 metric tonnes of high-quality salt. The solar evaporation process occurs in a series of connected ponds through which seawater flows, evaporates, and deposits salt in crystallizing ponds. In 1973, the salt evaporation ponds were still relatively small (red and blue rectangles in the centre of the image). By 2005, however, they had grown to cover 3 500 hectares in the lagoon.

Most of the energy required to extract salt from seawater comes simply from sunlight and salt produced by this method is 99.7 per cent pure. About one-third of worldwide salt production uses this method, which, when properly managed, is very environmentally friendly.

Republic of the Niger

Total Surface Area: 1 267 000 km²
Estimated Population in 2006: 14 426 000



Niger is the fourth-largest country in Africa, although 65 per cent of the territory lies within the Sahara Desert and is largely uninhabited (FAO 2005a). Moving from north to south, the climate transitions from arid desert to semi-arid savannah to a small tropical zone along the edges of the Niger River Basin. Niger shares a portion of Lake Chad on its southeastern border with Nigeria and Chad.

Important Environmental Issues

- Desertification and Deforestation
- Threats to Wildlife
- Environmental Consequences of Mining

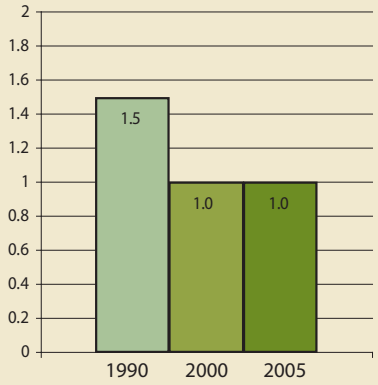
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

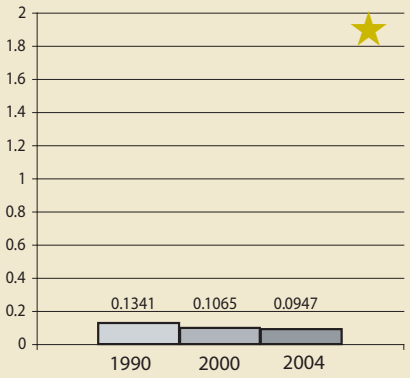
Niger has a serious problem of vegetation depletion. This is caused by the burning of bush and grass to prepare for the planting of crops, overgrazing of rangelands, and by tree cutting for fuel and construction—all on marginal lands. Soil erosion and increasing desertification are also factors. The increase in slum population coincides with the urban population growth rate, which was 5.5 per cent between 2000 and 2005.

★ Indicates progress

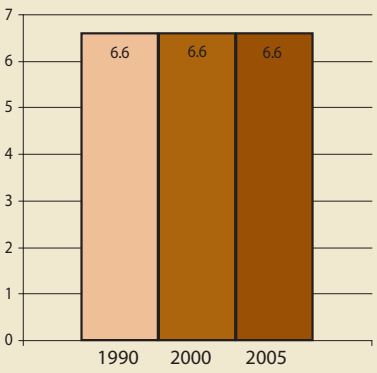
Land area covered by forest, percentage



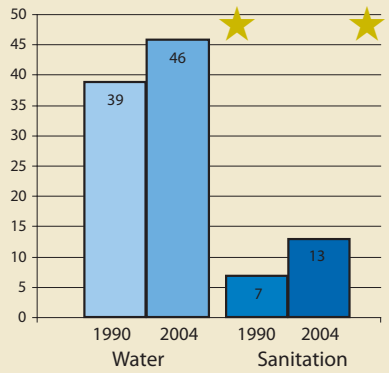
Carbon dioxide (CO_2) emissions, metric tonnes per capita



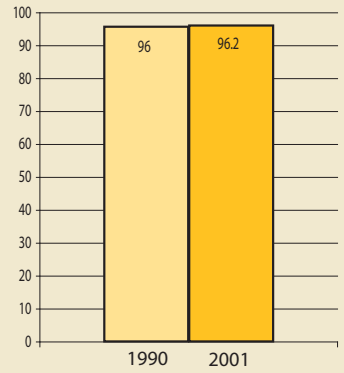
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



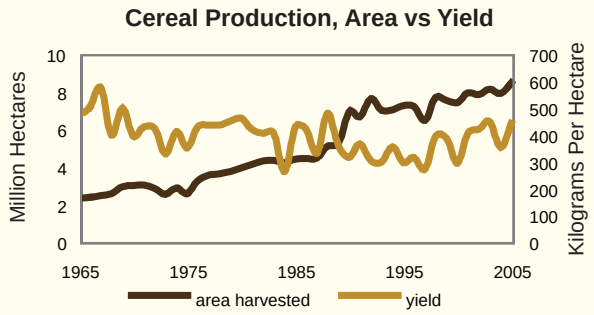
Niger is one of the hottest countries in the world, with four-fifths of its territory lying in the Sahara desert.

news.natinalgeographic.com (2008)

Desertification and Deforestation

It is estimated that the desert in the Republic of Niger is expanding by approximately 200 000 hectares per year (Mongabay 2006), overtaking degraded agricultural land and encroaching on human settlements. Government efforts to combat desertification through reforestation have been promising, but recurrent drought and poor cultivation practices continue to pressure vulnerable lands.

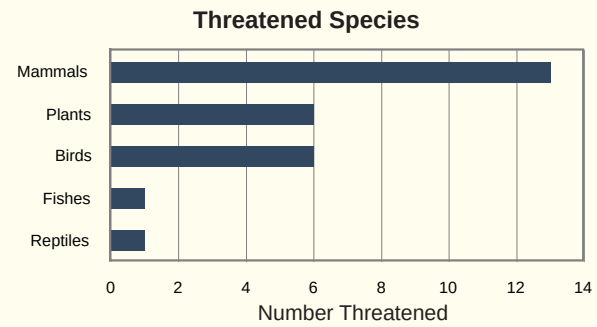
Niger's forests are its most important buffer against desertification, but they are threatened by a rising demand for agricultural land and fuelwood, driven by the fourth-highest population growth rate in Africa (UNESA 2005). Niger has lost one-third of its forest cover since 1990, and now only one per cent of the land is forested (UN 2007).



Source: FAOSTAT

Threats to Wildlife

Niger is remarkably rich in plant and animal life, especially considering that three-quarters of the country is desert. Although hunting is banned nationwide, poaching and habitat loss are taking a heavy toll on biodiversity; wildlife populations are less than one-tenth of the size they were in the 1960s (CBD 2004). Competition with domestic animals over resources and conflict with farmers are particularly problematic in the densely populated southern regions.

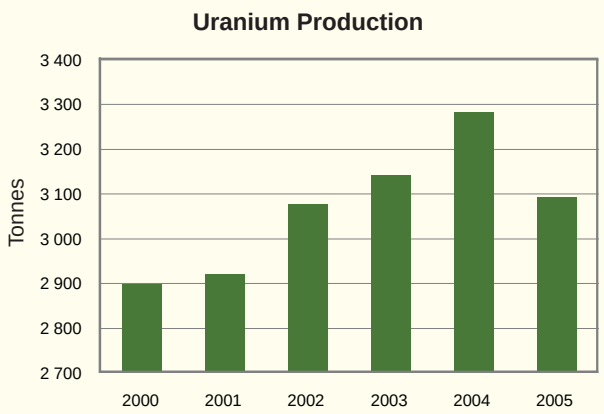


Source: IUCN Red List

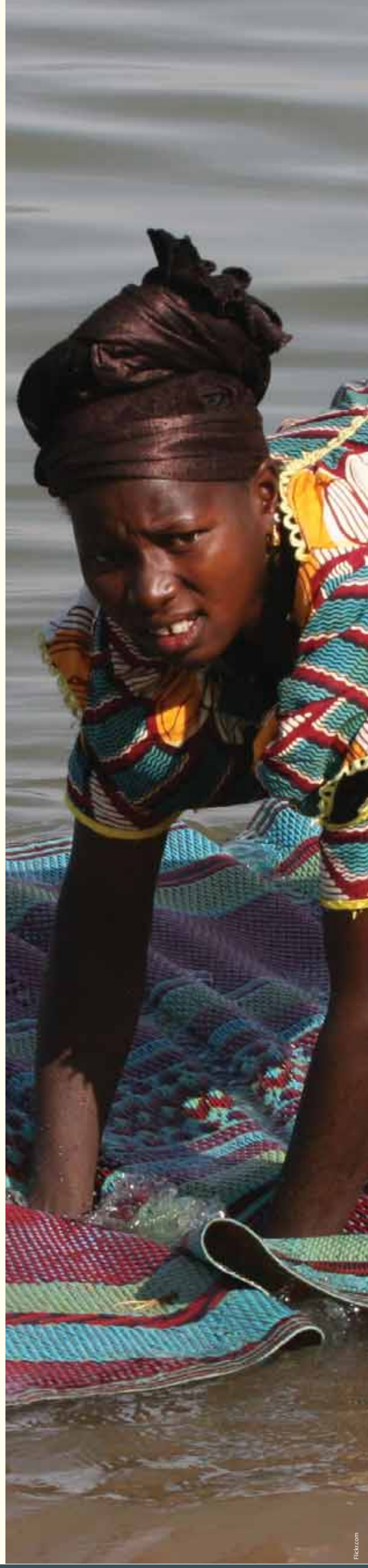
The last remaining giraffes in West Africa are found in Niger only 60 km from the country's capital, Niamey. Thanks to conservation measures, the giraffe population has slightly recovered from a low of only 40 individuals in the 1990s; a few decades ago there were over 3 000 (UN 2001).

Environmental Consequences of Mining

Niger is the world's third-largest producer of uranium, generating over 3 000 metric tonnes in 2005 (Omarya 2006). The government announced intentions to increase production to 10 500 metric tonnes in 2007, eliciting concerns regarding the environmental and human health consequences of further exploration. In addition to the environmental degradation that occurs at uranium extraction sites, the cities and towns that spring up near mining activities increase human pressure on natural resources such as wildlife and timber. There are also concerns that phosphorus and iron mining in "W" National Park, which is a haven for 80 per cent of the country's biodiversity, may threaten the ecological integrity of the area.



Source: USGS International Mineral Statistics and Information



Nwala Dan Sofoa
Guidan Sori
Maradi
N I G E R
Dan Degueji
Dan Adjara
Male Saboa
Dan Kano
Baban Rafi Forest
Badaria
Baban Rafi
N I G E R I A
0 5 10 Kilometres
12 Jan 1976

Forest Degradation: Baban Rafi Forest, Niger

Along the southern border of Niger in the Department of Maradi, population has increased by roughly 400 per cent over the past 40 years. The area under agriculture in the department as a whole grew by 26 per cent between 1975 and 1996. In the south of the district, this expansion of population and agriculture has meant the loss of a large portion of the Baban Rafi Forest to agriculture. The remaining woodlands are being degraded by overexploitation for fuelwood and non-wood forest products.

This May 2007 Quickbird image shows the edge of the Baban Rafi Forest. This open savannah is a grazing area that is being lost as the rapidly growing population converts land to agriculture. Trees scattered throughout the farm fields help maintain farmland productivity. More dense concentrations of grass and trees can be seen in some of the moister low areas [depressions].

Baban Rafi Forest is the most significant area of woodland in the Maradi Department. Located at the southern extreme of the Sahel, it has areas of both savannah and Sahelian vegetation. In the savannah areas, the balance of trees, grasses, and shrubs varies. The wooded areas are dominated by just four species of trees—*Guiera senegalensis*, *Combretum micranthum*, *Combretum nigricans*, and *Acacia macrostachya*—likely as a result of selective exploitation and some combination of drought and disease.

These satellite images show the loss of a significant fraction of the natural landscape (darker green areas) of Baban Rafi Forest to agriculture between 1976 and 2007. The intensity of demand for agricultural land has also led to near continuous use of farmland in the area, with shortened or no fallow period for it to recover fertility. Continuing population growth will put further demands on this already dramatically changed landscape.

N I G E R

Tahoua Province

Maiouata

0 0.25 0.5 Kilometres

N

Autumn 1975

Revitalised Land: Tahoua Province, Niger

A band across the southern third of Niger receives enough rain (250-750 mm) to sustain most of the country's rain-fed agriculture and pastoralism. This stretch of semi-arid Sahel is also where most of Niger's rapidly growing population lives. However, the Sahelian climate is quite variable and in this ecologically frail region this poses serious problems for traditional livelihoods.

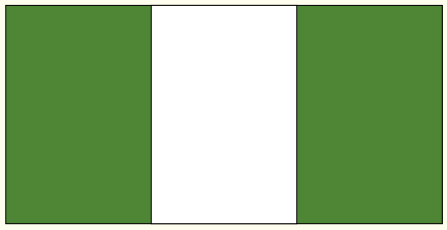
In recent decades, Niger's climate and its demographic problems have negatively impacted its agricultural land by forcing agriculture onto land that had been historically used for livestock—

land receiving less than 350 mm of rain per year. This intense pressure on fragile lands led to acute environmental degradation (1975 image).

More recently, a combination of various projects and farmer initiatives has led to significant revitalization of the land in large part by the planting and protection of trees. Farmers no longer clear tree saplings from their fields before planting crops. Instead they protect and nurture the trees, carefully plowing around them when sowing millet, sorghum, peanuts, and beans. A recent study revealed 10 to 20 times the number of trees across three of Niger's southern provinces than there were in the 1970s (2005 image). This transformation of the land has reduced drought vulnerability and will help people diversify their livelihoods so as not to rely solely on rain-fed crops.

Federal Republic of Nigeria

Total Surface Area: 923 768 km²
Estimated Population in 2006: 134 375 000



Credit: © Flagart.com

Nigeria is the most populous country in Africa with over 134 million inhabitants, or approximately one-seventh of the continent's total population (UNESA 2005). The climate is generally tropical and natural resources are plentiful, including dense coastal mangroves, abundant ground and surface water resources, a high proportion of arable land, and vast oil reserves. The Niger River Delta region covers 75 000 km² of the Nigerian coast, making it the third-largest wetland in the world (UNDP 2006).

Important Environmental Issues

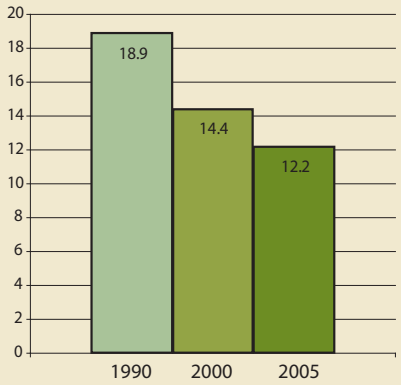
- Desertification
- Deforestation and Threats to Biodiversity
- Oil Pollution

Progress Towards Environmental Sustainability

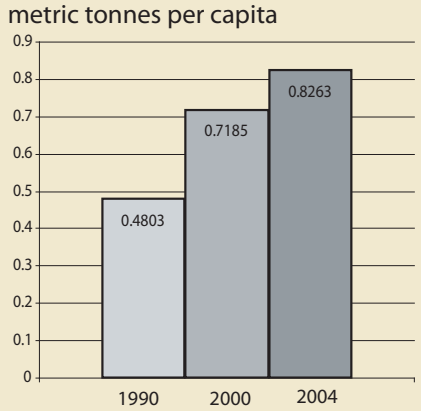
As defined by the United Nations Millennium Development Goal 7 Indicators

In the early 1990s, Nigeria was among the world's top 50 emitters of carbon dioxide, and this upward trend continued through 2004. Nigeria has the highest deforestation rate of natural forest on the planet, including old-growth forests, which are its most biodiverse ecosystems. Between 1990 and 2005, the country lost 79 per cent of its old-growth forests.

Land area covered by forest, percentage

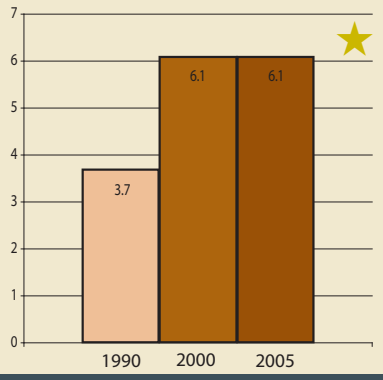


Carbon dioxide (CO_2) emissions, metric tonnes per capita

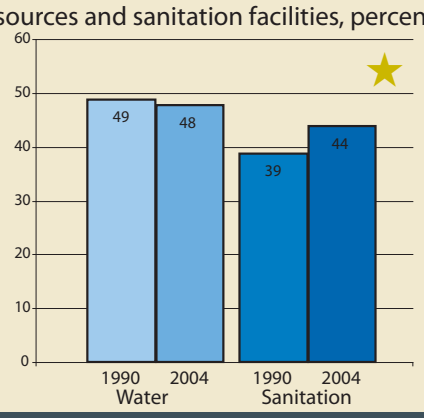


★ Indicates progress

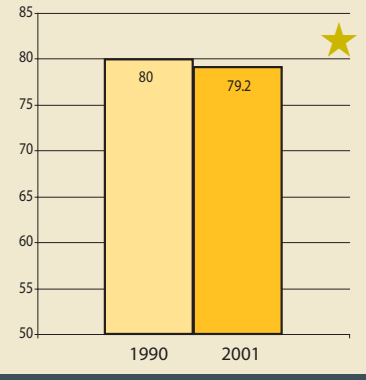
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



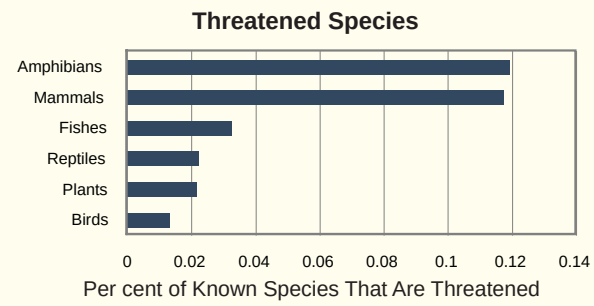
Nigeria is the largest producer of oil in Africa and the eleventh largest producer of crude oil in the world.

eia.doe.org (2007)

Desertification

Desertification affects Nigeria's semi-arid northeast region, where extensive agriculture, river damming, and periodic droughts have resulted in significant land degradation. The Sahara Desert is thought to be expanding southward by one kilometre every year (FAO 2001), accounting for nearly three-quarters of the total cost of all environmental degradation in the country, which is estimated at US$ 5 110 million per year (UNESCO 2000).

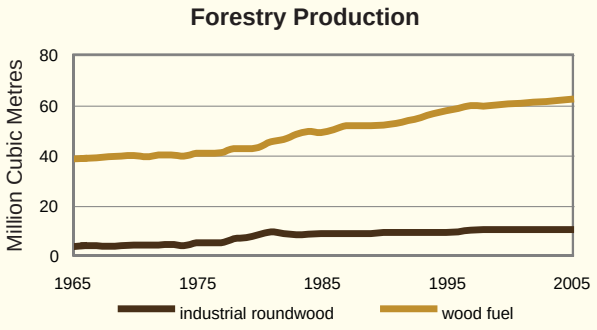
Desertification is just one of the threats facing Nigeria's 7 856 plant species and 22 000 vertebrate and invertebrate species (CBD 2007). Other forms of land use change and ecosystem degradation resulting from agriculture, urbanisation, and direct exploitation of biological resources threaten at least 250 species with extinction (IUCN 2007).



Source: Nigeria NBSAP and IUCN Red List

Deforestation and Threats to Biodiversity

Nigeria has one of the highest deforestation rates in Africa at 3.3 per cent per year (FAO 2005), and roughly 90 per cent of its original forest cover has already been lost. Although the government banned the export of unprocessed logs in 1976, rising domestic demand for fuelwood and timber make Nigeria the largest wood producer on the continent (FAO 2001).



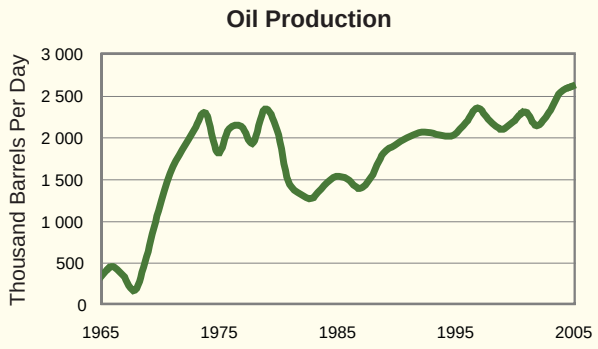
Source: FAOSTAT

Nigeria's mangrove ecosystems are the third largest in the world (FAO 2004) and provide critical habitat for migratory birds and many endangered aquatic and terrestrial species. Forty per cent of mangroves had been destroyed by 1980 (UNEP 2002), and those that remain are threatened by oil production and exploration, coastal development and erosion, and by invasive plants such as nipa palm and water hyacinth.

Oil Pollution

Nigeria is the eleventh-largest oil producer in the world (EIA 2007), deriving over 90 per cent of its national income from the petroleum industry (National Biodiversity Strategy and Action Plan n.d.). Oil production, which primarily takes place in the Niger Delta region, has resulted in considerable water and air pollution from oil spills and gas flaring. To check, monitor, and respond to oils spillage, Nigeria established the National Oil and Spill Detection Agency. Alongside this, the country has been gradually reducing the amount of gas flared, with the aim of stopping the practice altogether (World Bank 2007)

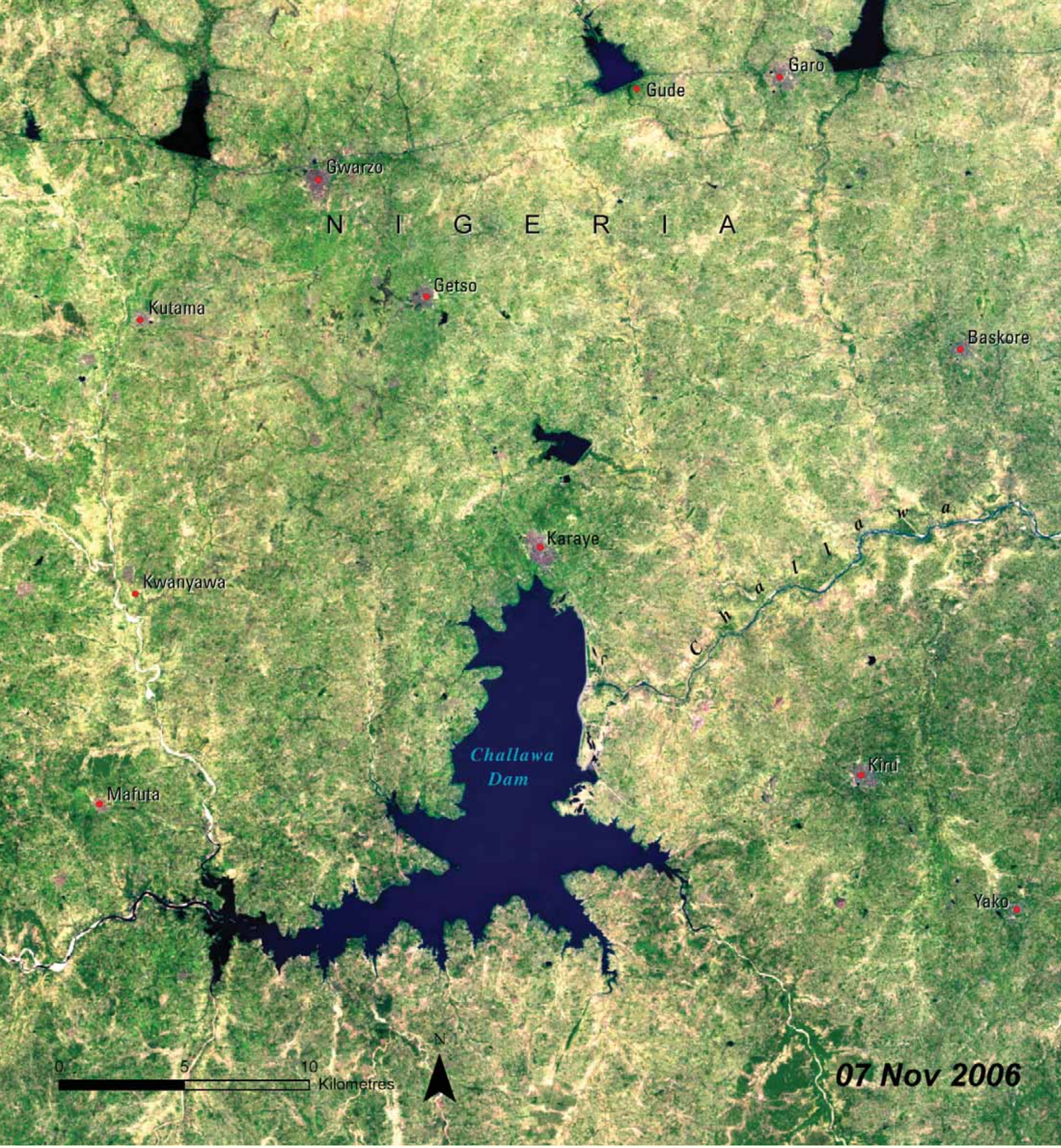
In addition to the petroleum industry, Nigeria's growing urban centres produce significant quantities of solid waste and local air pollution. Nearly half of the country's population resides in cities, which are growing by 3.7 per cent per year (UNESA 2006).



Source: BP Statistical Review of World Energy 2007

Impacts of Challawa Dam: Nigeria

The Challawa Dam in Kano State, Nigeria, was built to control flooding caused by seasonal and variable rainfall and to support irrigation. It also supplies water to Kano, Nigeria's third-largest city with a population of seven million. The Challawa River feeds into the Hadejia River, which then flows into the Hadejia-Nguru wetlands. Local rainfall peaks in August, with a subsequent dry season lasting from November to April. This rainfall pattern makes water levels in the Hadejia-Nguru wetlands highly seasonal.



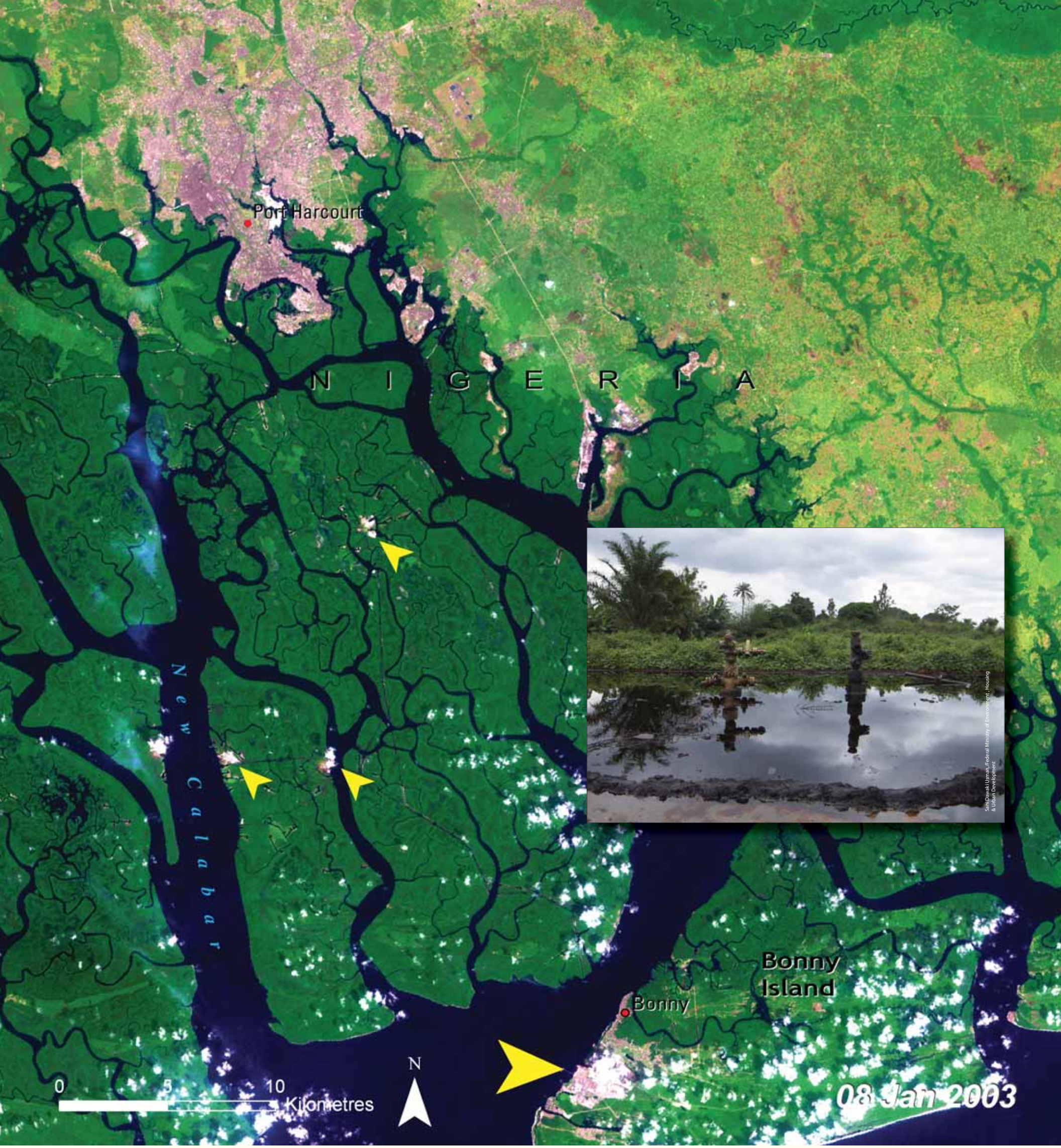
The Challawa Dam has tamed highly seasonal downstream flooding at the expense of the Hadejia-Nguru wetlands. The combined effect of drought and the dam reduced the extent of seasonally flooded land from 300 000 hectares in the 1960s to between 70 000 and 100 000 hectares in recent years. Such severe reduction of the annual flooding extent has put the wetlands at risk and reduced the economic and environmental benefits they provide, including agriculture, cattle, fuelwood, fish, shallow aquifer recharge, and habitat for migratory and local bird species.

The economic impact of the Challawa Dam (and the Tiga Dam further upstream) has also been negative, eventually incurring millions of dollars more in losses than were yielded in benefits. In addition, while flood control was among the intended benefits of the dam, heavy rains often cause serious flooding above the dam.

Oil Development: Niger River Delta, Nigeria

The Niger River Delta spans the coast of Nigeria from the Benin River in the west to the Imo River in the east. The delta supports the world's third-largest mangrove forest, and is home to over 150 species of fish, West African manatees, hippopotamuses, spot-necked swamp otters, and rare pygmy hippos.

Since the discovery of oil in the delta in the 1950s, the promise of improved lives through a share of the oil wealth has eluded area residents. Instead, they have found their traditional livelihoods increasingly undermined by environmental degradation.

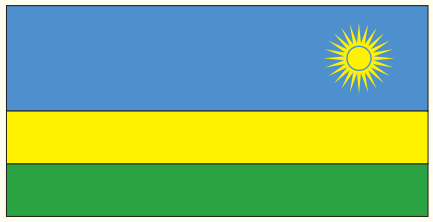


The 1984 image shows the delta 20 years after oil operations began in the early 1960s. The 2003 image shows concentrations of oil wells (small yellow arrows) as well as pipelines connecting them. Also visible are a large storage facility, liquified natural gas plant and terminal station on Bonny Island in the lower right corner of the image (large yellow arrow).

Currently, about 66 gas fields and over 500 oil wells are located in the delta area. Between 1976 and 1996 there were more than 4 640 oil spills totalling three million barrels of oil. In addition, between 70 and 90 per cent of the natural gas from these oil fields is flared (burned as waste), releasing massive amounts of carbon dioxide into the atmosphere, causing local air pollution and acid rain, and wasting roughly US$300 million per day worth of energy.

Republic of Rwanda

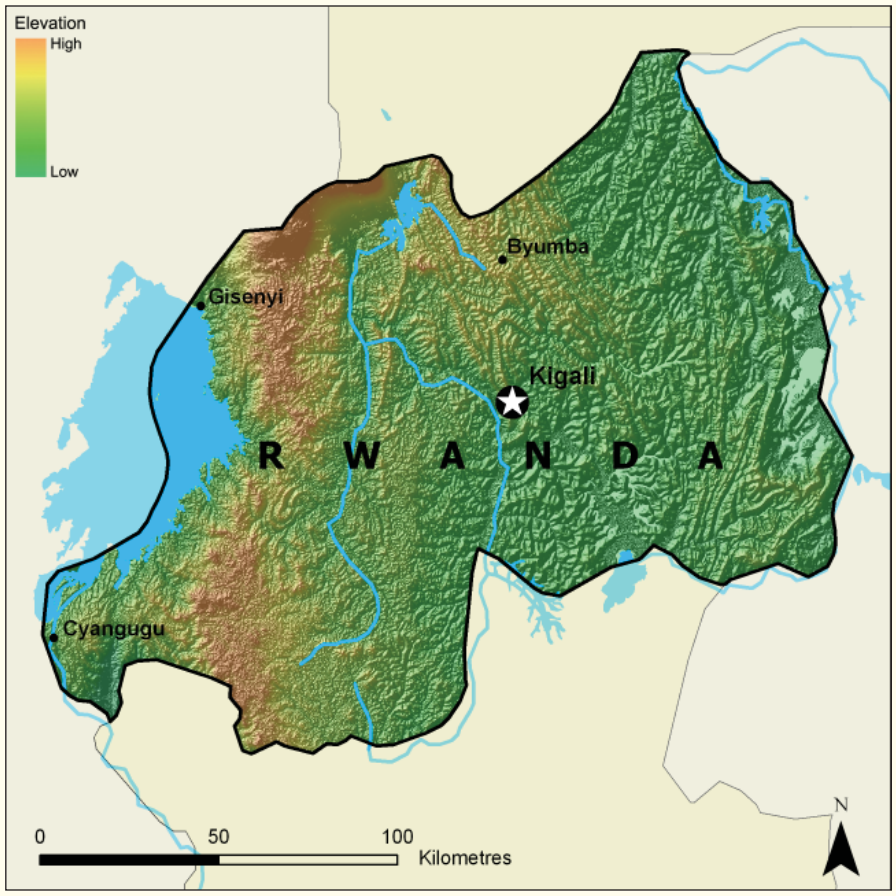
Total Surface Area: 26 338 km²
Estimated Population in 2006: 9 230 000



Rwanda is a small, mountainous country located only a few degrees south of the equator, but its high elevation provides for a tropical temperate climate with two rainy and two dry seasons. Terrain is dominated by the hills and valleys of the central plateau, which are bordered to the east by marshy lowlands, to the north by a chain of volcanoes, and to the west by a mountain system that forms the boundary between the watersheds of the Nile and Congo River Basins. Surface water is relatively abundant in Rwanda, covering over eight per cent of the country (FAO 2005).

Important Environmental Issues

- Population Pressure on Land
- Soil Erosion and Sedimentation
- Deforestation and Threats to Biodiversity



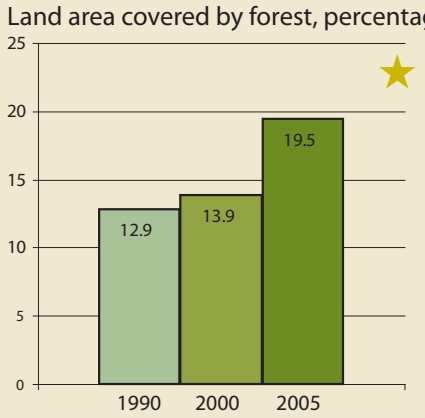
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

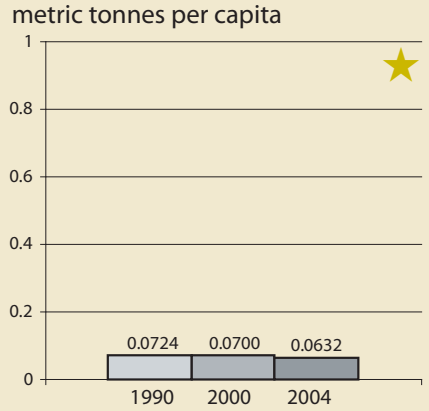
The slum population in Rwanda has seen an increase between 1990 and 2001, alongside an urban population growth rate of 4.2 per cent from 2000 to 2005. Rwanda is the most densely populated country in mainland Africa. Rwanda's protected area increased by 3.7 per cent between 1990 and 2005. Volcano National Park is one of the last existing habitats of the mountain gorilla.

★ Indicates progress

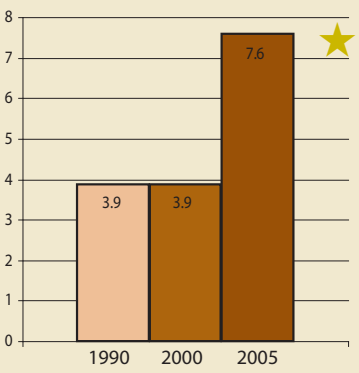
Land area covered by forest, percentage



Carbon dioxide (CO_2) emissions, metric tonnes per capita

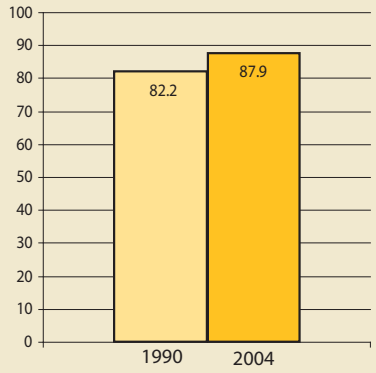


Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage

Slum population as percentage of urban



Nyungwe National Park is the largest block of montane forest in East and Central Africa, and among the largest on the continent.

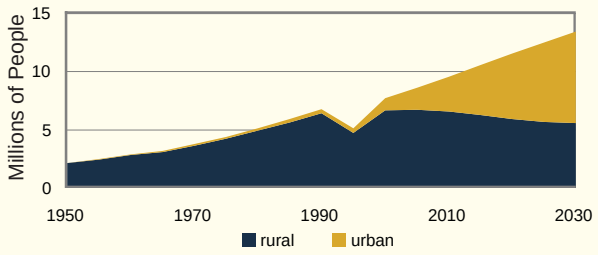
rwanda-nyungwe-forest.com (2007)

Population Pressure on Land

Rwanda is the most densely populated country in mainland Africa. Rwanda's current population density is 382 people per square kilometre (Earth Trends 2006, FAO 2005a). Approximately 80 per cent of the population is rural and engaged in agriculture, placing significant pressure on land resources and biodiversity. Modification and destruction of natural ecosystems for agriculture, and particularly the drainage and reclamation of wetlands, has resulted in the loss of many plant and animal species. An estimated 115 different plant species are threatened with extinction (CBD 2003).

As a result of a declining availability of arable land, the urban population is increasing by nearly 12 per cent per year, the highest urbanisation rate in Africa (UNESA 2006). Nearly nine out of ten urban residents in Rwanda are slum dwellers, where access to improved sanitation facilities barely exceeds 50 per cent (UN 2007).

Population Growth and Urbanisation

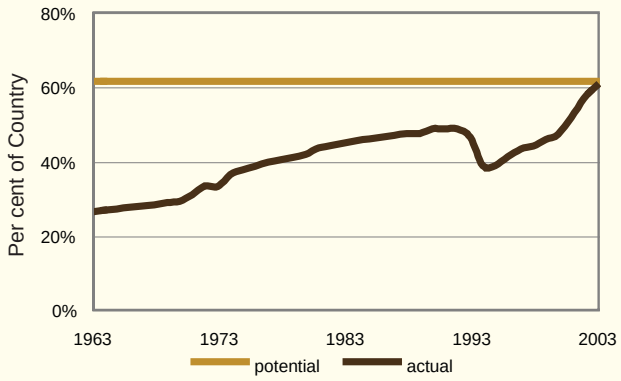


Source: UN Population Division, World Urbanization Prospects 2005 Revision

Soil Erosion and Sedimentation

Rwanda's rich volcanic soils are historically fertile, but population pressure has resulted in over-cultivation and expansion onto marginal lands and steep slopes. As of 2003, arable land accounted for over half of the country's surface area and approximately 98 per cent of all potentially cultivatable land in the country (FAO 2005b). An estimated 71 per cent of land is considered to be severely degraded (FAO AGL 2003) and approximately 500 metric tonnes of soil are lost to erosion each year, an amount that could support crops to feed 40 000 people (USAID 2004). Excessive siltation resulting from erosion constitutes a major threat to many of Rwanda's lakes and wetlands.

Actual Versus Potential Cultivatable Land



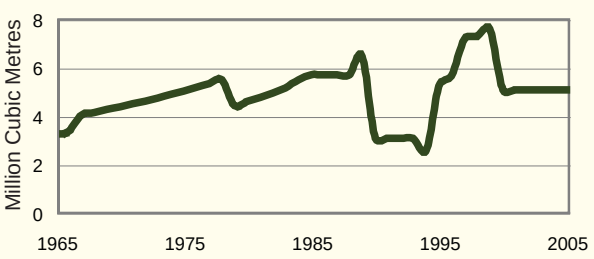
Source: FAOSTAT and AQUASTAT

Deforestation and Threats to Biodiversity

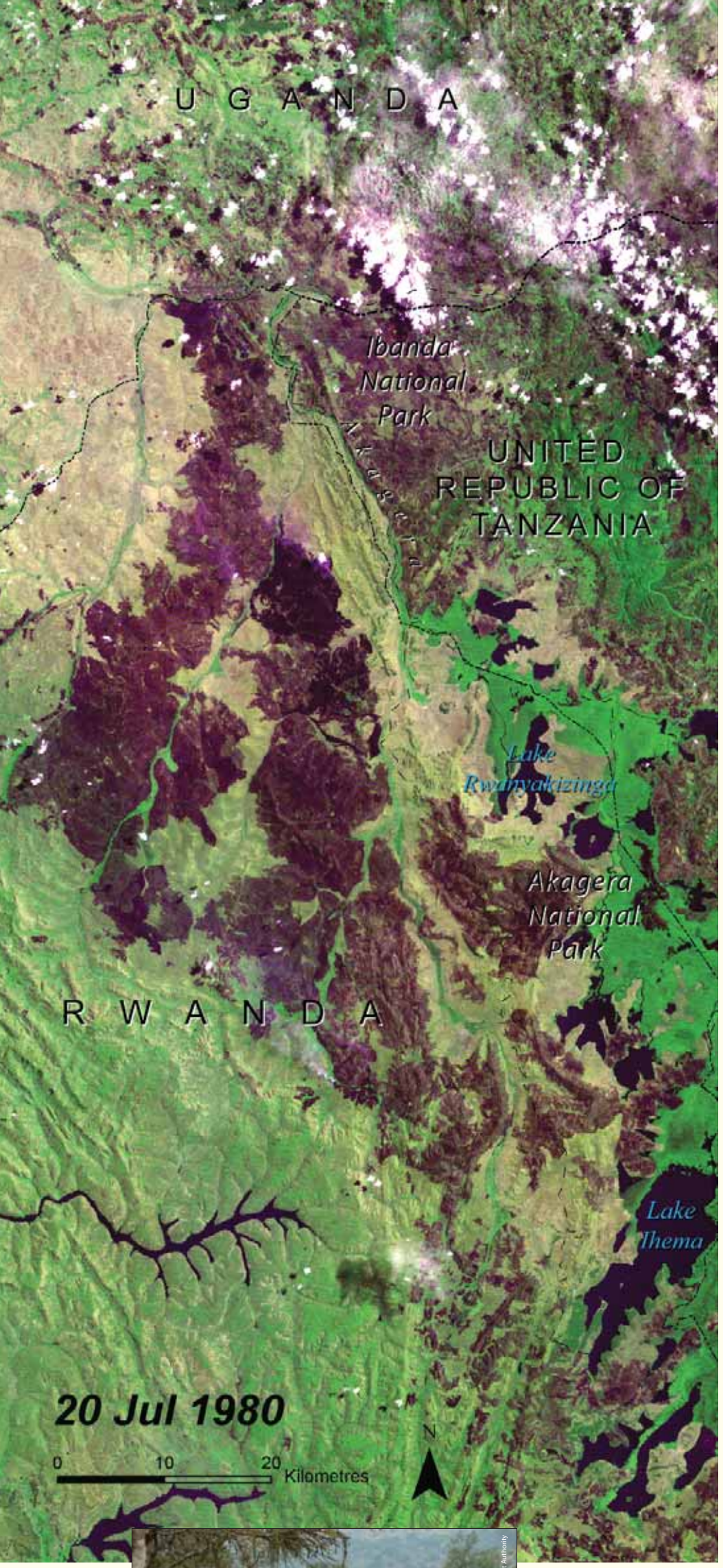
Forests were once extensive throughout Rwanda, but they are now concentrated primarily in the western mountains. The swampy gallery forests that historically characterized the eastern lowlands now exist only in small stands. Despite recording a net increase in overall forest cover since 1990 (UN 2007), natural forests remain threatened by human encroachment and high dependence on fuelwood and charcoal.

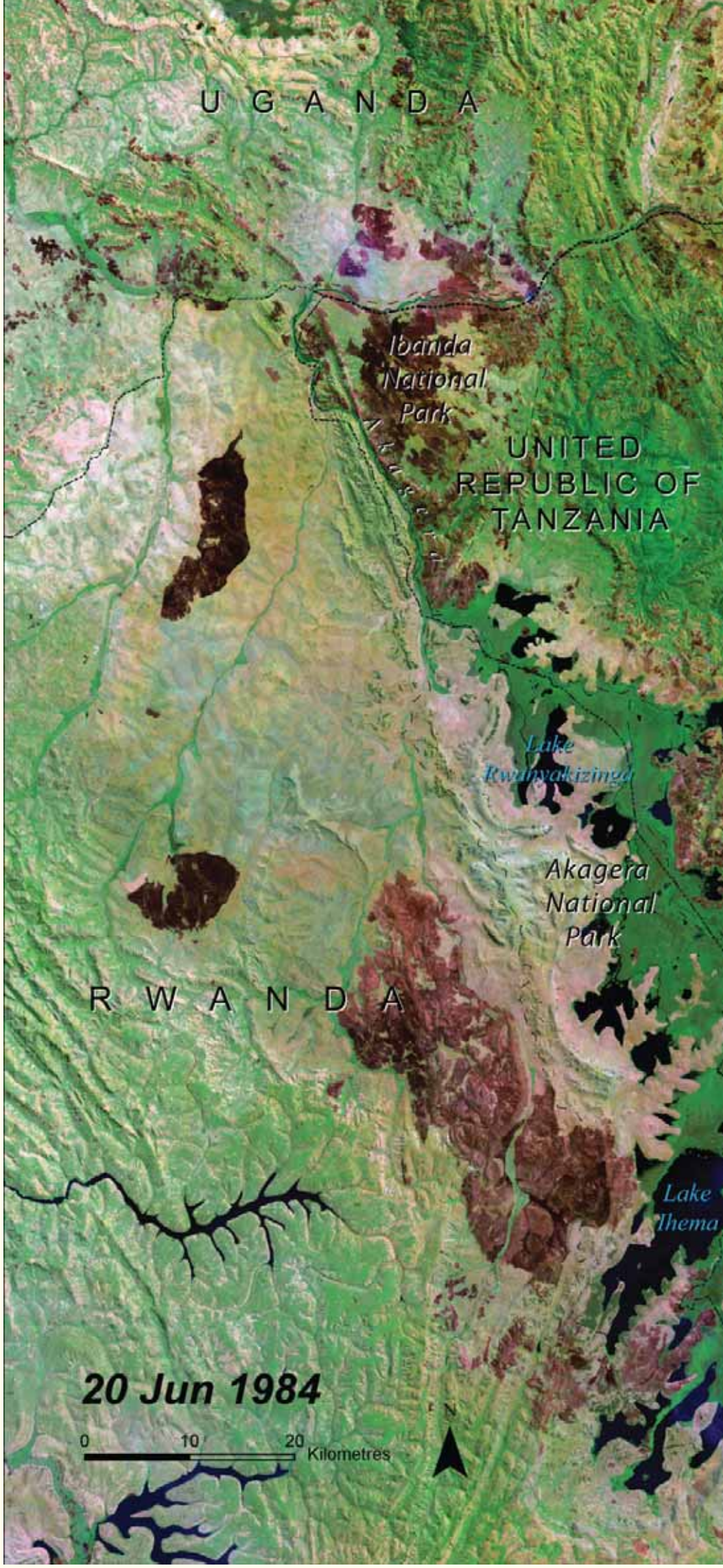
Nyungwe National Park is the largest tropical montane forest in Africa, covering over 1 000 km² of rain forest, bamboo, grassland, swamps, and bogs. It harbours 13 different primate species, 62 Albertine Rift endemic species, and one of the largest surviving populations of chimpanzees (WCS 2007). Buffalo and elephants have been extirpated due to human encroachment and illegal poaching, and fires started by honey collectors have damaged large tracts of forest.

Fuelwood Production



Source: FAOSTAT



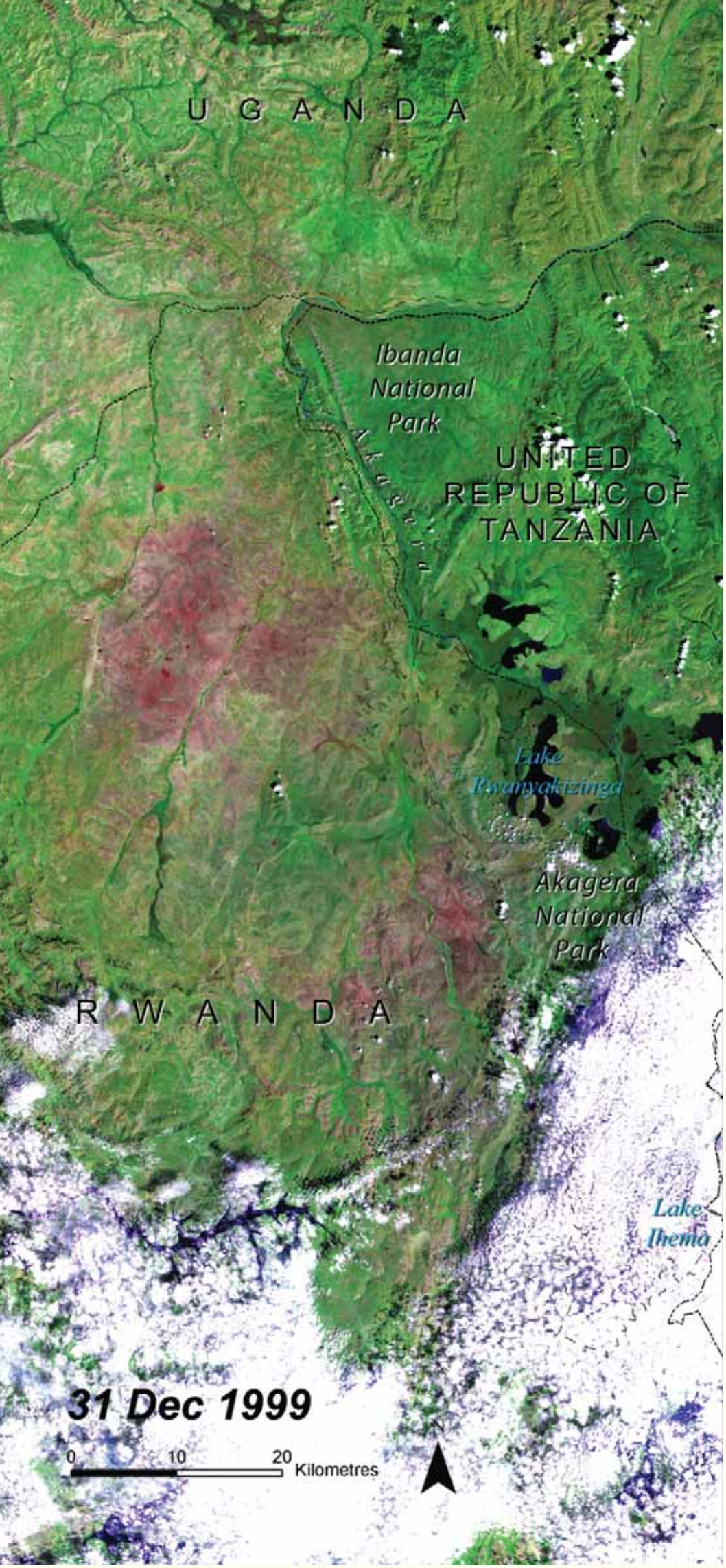


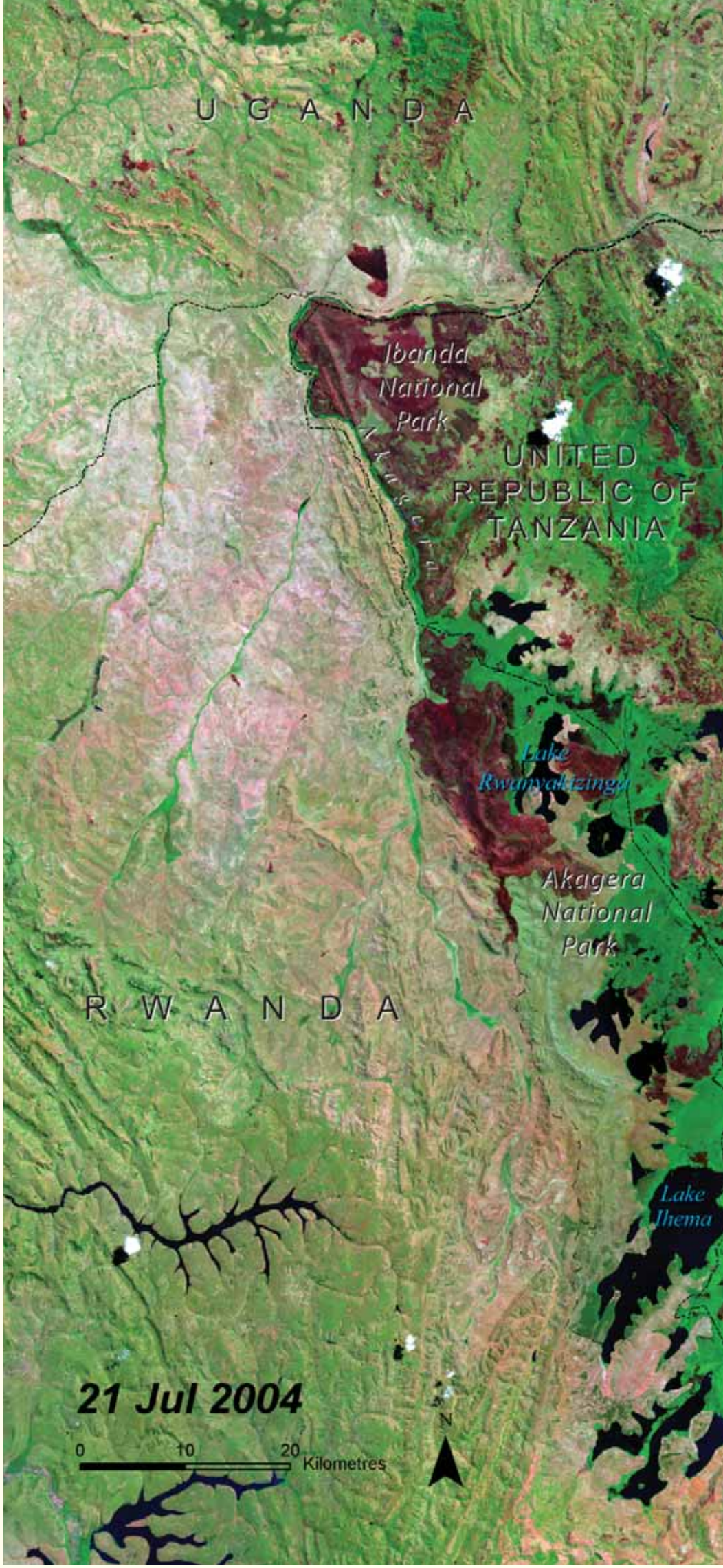

Pilar Marie Vianney Mbanj, Rwanda Environment Management Authority

Fire Scars: Akagera National Park, Rwanda

Akagera National Park in northeastern Rwanda is considered to be among the most complex savannah ecosystems in eastern Africa. Across its landscape are areas of tangled acacia trees interspersed with patches of open grassland, patches of gallery forest in the north, and wetlands and lakes along the course of the Akagera River.

Fire is common in the savannah portions of the park. Fire tends to maintain the savannah's vegetation structure, composition, nutrient cycling, and distribution. Satellite images from July





1980, June 1984, and July 2004 show the area surrounding Akagera National Park with large fire scars (dark purple patches). In 1980, fires left a scar 35 km wide and well over 100 km long. In 2004, fires burned nearly one-third of the park; they are believed to have been set by poachers. In contrast to these dry season images, the December 1999 image shows the region during the rainy season, when fires occur infrequently.

The size of Akagera National Park was reduced by approximately two-thirds in 1997 to allow for the resettlement of large numbers of refugees. Heavy grazing pressure, agricultural encroachment, charcoal production, the felling of trees for fuelwood and construction, and deliberately set fires have seriously fragmented the ecosystem. Wildlife populations are now concentrated in scattered enclaves.

Colline Gatatara
Collline Kinihira
Colline Mutamo
Colline Bugu
R W A N D A
Gitwa
Colline Rwankoma
Colline Kabirizi
Colline Rugerero
Gishwati Forest Reserve
Gatare
Colline Nyamyumba
Colline Gihinga
Colline Muhanda
Colline Gitwa
Lake Kivu
Colline Kataretare
Colline Mabuye
N
0 4 8 Kilometres
06 Feb 1978


Eléan Marie Vianney Minani, Rwanda Environment Manage

Dramatic Deforestation: Gishwati Forest, Rwanda

Gishwati Forest Reserve in northwestern Rwanda is one of the most severely deforested areas in the country. Exploitation of the forests for commercial products such as charcoal, timber, medicine, and food has been the main driver of this deforestation. The 1978 satellite image shows the Gishwati Forest Reserve as a dark-green carpet of dense forest nearly covering the entire protected area. The 2006 image shows that most of the forest has been cleared; the

Colline Gatatara
Collline Kinihira
Colline Mutamo
Colline Bugu
R W A N D A
Gitwa
wankomo
Colline Kabirizi
Colline Rugerero
Gishwati Forest Reserve
Gatare
Colline Nyamyumba
Colline Gihinga
Colline Muhanda
Colline Gitwa
Lake Kivu
Colline Kataretare
Colline Mabuye
0 4 8 Kilometres
N
16 Jun 2006 - 03 Nov 2006
2 image mosaic

dark-green areas have been replaced by patches of pink and light green where the vegetation has been largely removed. Only a fraction of the forest that was intact in 1978 remains; what is left is in degraded condition.

On a positive note, reforestation efforts in parts of the region, using agroforestry techniques such as radical terracing, progressive terracing, and live mulches, are currently being researched and implemented. Seedlings of species such as *Calliandra calothyrsus* and *Leucaena diversifolia* are being planted in several provinces of the country with collaboration from stakeholders and the local community. If such efforts continue and are successful, the Gishwati Forest Reserve may experience considerable regeneration within the next five to ten years.

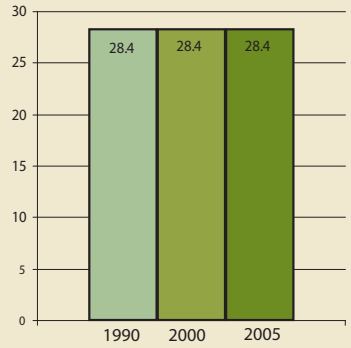
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goals 7 Indicators

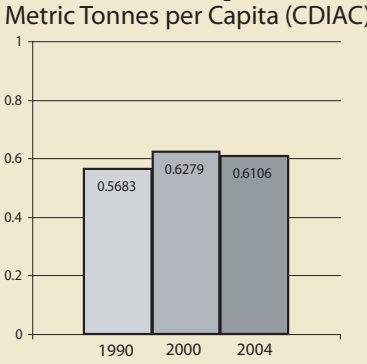
Water and land pollution are the most significant problems in São Tomé and Príncipe. Soil erosion and soil exhaustion are other major environmental challenges.

★ Indicates progress

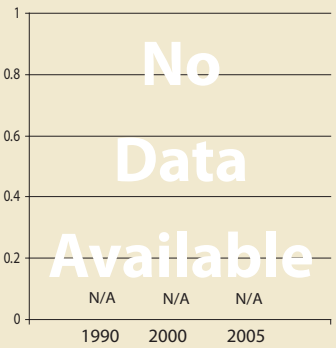
Land Area Covered by Forest, percentage



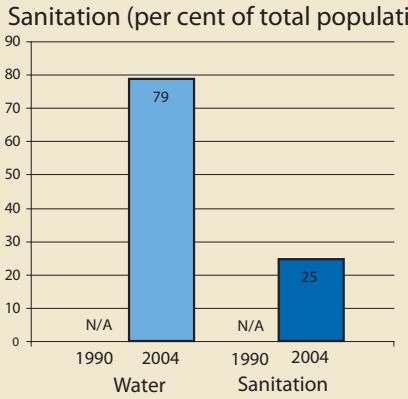
Carbon Dioxide (CO_2) Emissions, Metric Tonnes per Capita (CDIAC)



Protected Area to Total Surface Area in per cent



Access to Improved Water Source and Sanitation (per cent of total population)



Slum Population as per cent of Urban Population

Democratic Republic of São Tomé & Príncipe

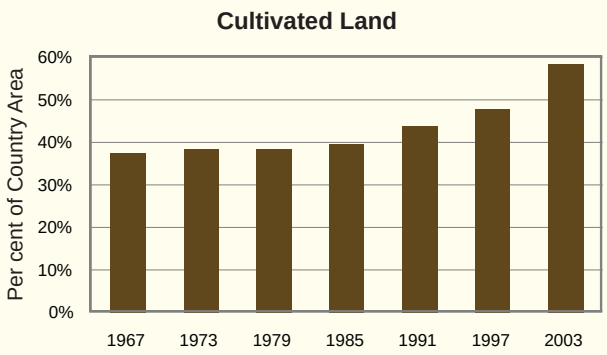
Total Surface Area: 964 km²
Estimated Population in 2006: 160 000

The two major islands of São Tomé and Príncipe, together with a number of smaller islands and islets, form one of the smallest nations in Africa in terms of both population and total surface area. The islands are of volcanic origin and quite mountainous, and their irregular relief contributes to dramatic variations in rainfall, temperature, and vegetation. These islands are among the most densely populated countries in Africa with almost 171 inhabitants per square kilometre (Earth Trends 2006 and FAO 2007).

Important Environmental Issues

- Degradation of Forest Ecosystems
- Threats to Biodiversity

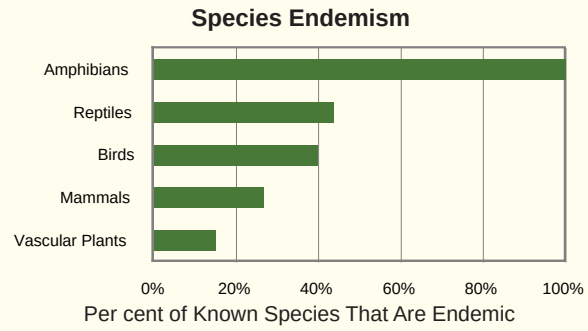
Degradation of Forest Ecosystems



São Tomé and Príncipe have three forest types: low altitude moist closed forest, moist submontane evergreen forest, and closed cloud forest. While total forest cover has held steady over the past several decades, much of the island's primary forests have been cut and many tree species remain threatened. This is particularly true of the low altitude forests, which were almost completely cleared to make way for expanding cocoa farming, the nation's most important cash crop (FAO 2000). As a consequence of deforestation, erosion has substantially reduced the islands' soil fertility.

Threats to Biodiversity

São Tomé and Príncipe's biodiversity is characterised by exceptionally high rates of endemism, meaning that many of the islands' species are found nowhere else in the world. Several of these native species display unusual evolutionary features such as gigantism (for example, the São Tomé giant sunbird) and dwarfism (for example, the dwarf olive ibis). The threats to biodiversity are numerous, including coastal erosion, pollution, deforestation, hunting, and the introduction of exotic species. As a result, 93 plant and animal species are threatened with extinction (IUCN 2007).



Source: National Report on the Status of Biodiversity

The geographic isolation of São Tomé and Príncipe has resulted in high levels of endemism, notably among plants.

nationsencyclopedia.com (2007); rainforests.mongabay.com (2007

Urban Expansion: São Tomé Island, São Tome and Príncipe

São Tomé is the capital city of the island that shares its name. Located in the island's Agua Grande district, the population of São Tomé increased from a mere 8 431 in 1940 to 51 886 in 2001.

The satellite image shows how settlements, especially along roads, have expanded inland from the city. While much of the island still retained its natural vegetation in 2007, vegetation loss is obvious near the capital city and surrounding settlements, where forests have been converted to croplands. Substantial oil reserves have recently been discovered off the island of São Tomé, which will most likely fuel increased development.

Republic of Senegal

Total Surface Area: 196 722 km²
Estimated Population in 2006: 11 936 000

Senegal is a low-lying and flat country subject to seasonal lowland flooding and periodic droughts in the semi-arid north. It is drained by four perennial rivers: the Senegal, Gambia, Saloum, and Casamance. The climate is Sahelian with well-defined wet and dry seasons and rainfall ranging from 1 500 mm per year in the south to only 200 mm per year in the north. Over 80 per cent of the population lives within 200 km of the coast (FAO 2005) and 42 per cent lives in cities (UNESA 2006).

Important Environmental Issues

- Urban Pollution
- Deforestation
- Coastal Wetlands and Fisheries Over-exploitation

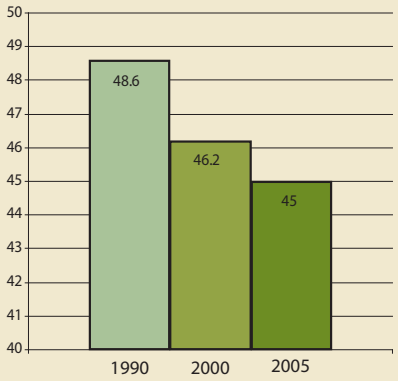
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

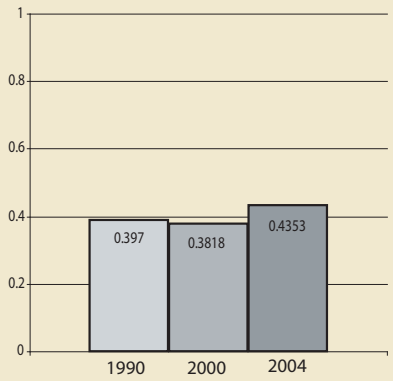
Senegal is highly vulnerable to declining rainfall and desertification. Vegetation varies in different areas of Senegal, depending on the average precipitation. Approximately 46 per cent of Senegal is classified as semi-arid. The capital city, Dakar, suffers from typical urban problems such as improper sanitation (especially during the rainy season, when sewers overflow) and air pollution from motor vehicles.

★ Indicates progress

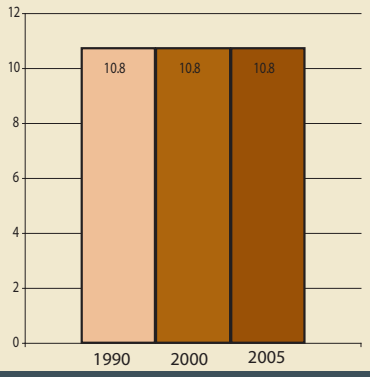
Land area covered by forest, percentage



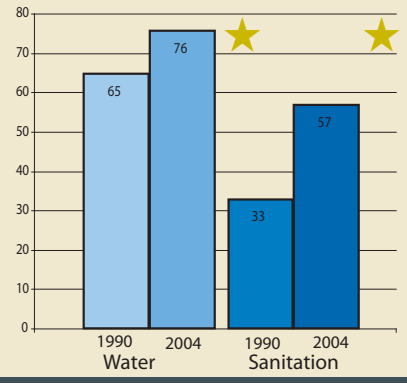
Carbon dioxide (CO_2) emissions, metric tonnes per capita



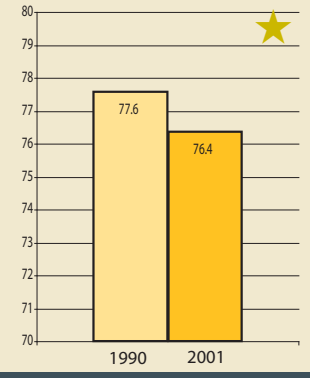
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

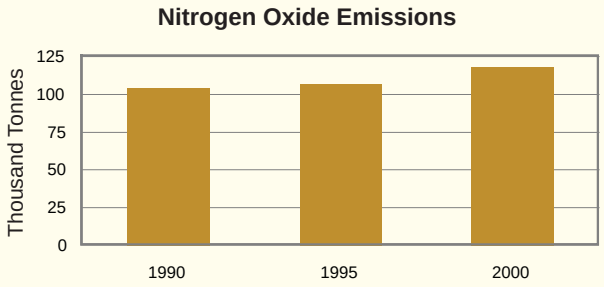


Senegal is one of the world's most famous migratory bird sanctuaries.

cites.org (2000)

Urban Pollution

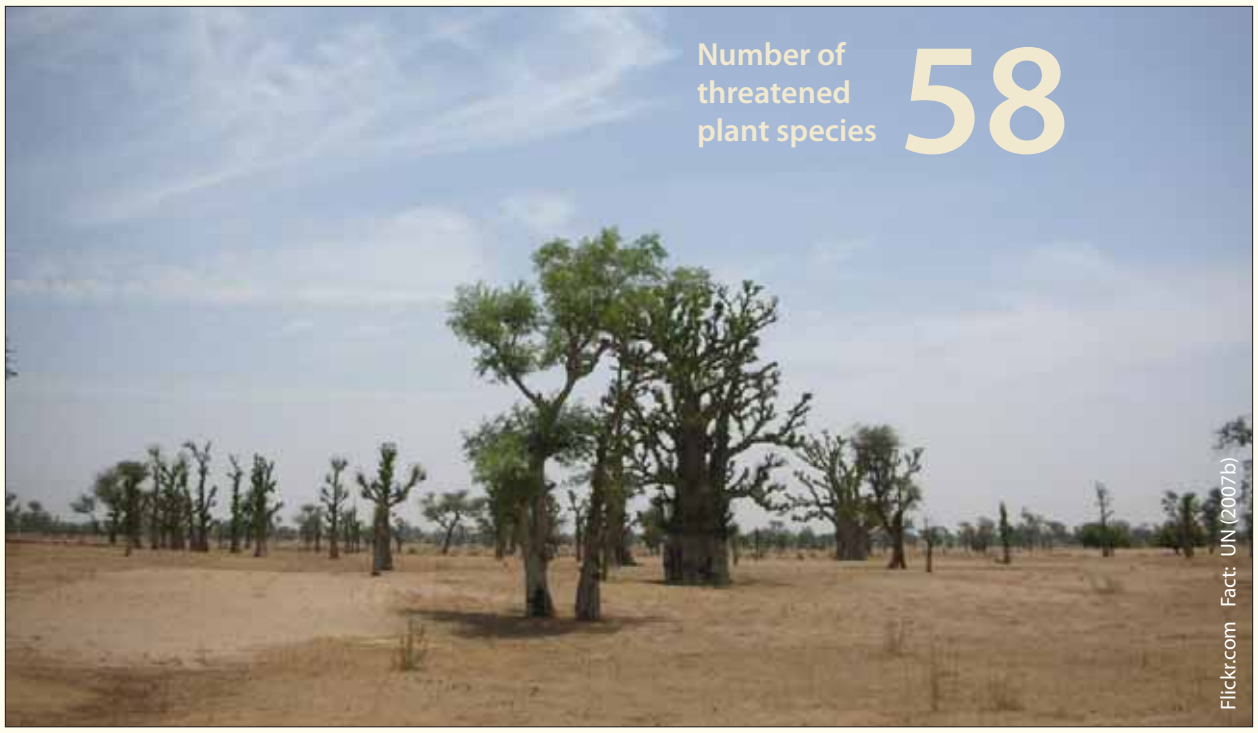
One out of four Senegalese people (approximately 55 per cent of the urban population) lives in the coastal capital city Dakar (FAO 2005). The urban growth rate is 3.6 per cent per year, compared to 2.3 per cent for the country as a whole (UNESA 2006). Due to rapid population growth and poor urban planning, road traffic and congestion have increased significantly. As a result, air pollution is estimated to result in health costs equivalent to five per cent of the GDP (UNEP 2002). Recent investments in urban transport infrastructure are expected to relieve traffic congestion, but probably at the cost of increased carbon dioxide emissions.



Source: EDGAR, Netherlands Environment Assessment Agency

Deforestation

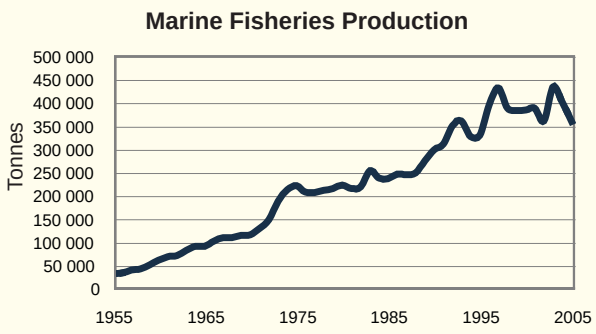
Forests cover nearly half of Senegal's land surface, although this forest cover is steadily declining (UN 2007a). Agriculture claims more than 80 000 hectares of forest each year, and wildfires, which are used for land clearing and hunting, degrade an additional 350 000 hectares annually. On the coast, approximately 50 per cent of mangroves have been degraded as a result of over-exploitation and drought. Overall, deforestation has been blamed for recent increases in soil erosion, desertification, and flooding.



Coastal Wetlands and Fisheries Over-exploitation

Senegal's biologically important wetlands are threatened by invasive plant species, mangrove degradation, and coastal development and erosion. The Djoudj National Bird Sanctuary is a large wetland on the floodplain of the Senegal River delta, covering 16 000 hectares of seasonally flooded lakes, ponds, and streams. It provides a haven for over three million migrant birds as well as large breeding populations of flamingos, pelicans, and other species.

Fish account for three-quarters of local protein consumption and fishing accounts for 17 per cent of employment in Senegal (FAO 2000-2007). However, overfishing by European vessels and the degradation of coastal ecosystems have threatened fish stocks, leading to decreased catches for local fishermen.



Source: FISHSTAT

S E N E G A L

ATLANTIC OCEAN

Dakar

Gorée Island

Madeleine Island

0 2 4 Kilometres

N

1942

Urbanisation of Cap Vert Peninsula: Dakar, Senegal

Like many West African cities, Senegal's capital city of Dakar has grown dramatically over the past several decades. Growth is expected to continue. While birth rates have begun to decline, natural growth still accounts for much of Dakar's expansion. In addition, Dakar experienced a large rural-to-urban migration beginning in the 1960s, when Senegal suffered from declining precipitation and periods of extreme drought. By 2005, Senegal's urban population exceeded its rural population. By 2030, two-thirds of the country's population is expected to be urban.

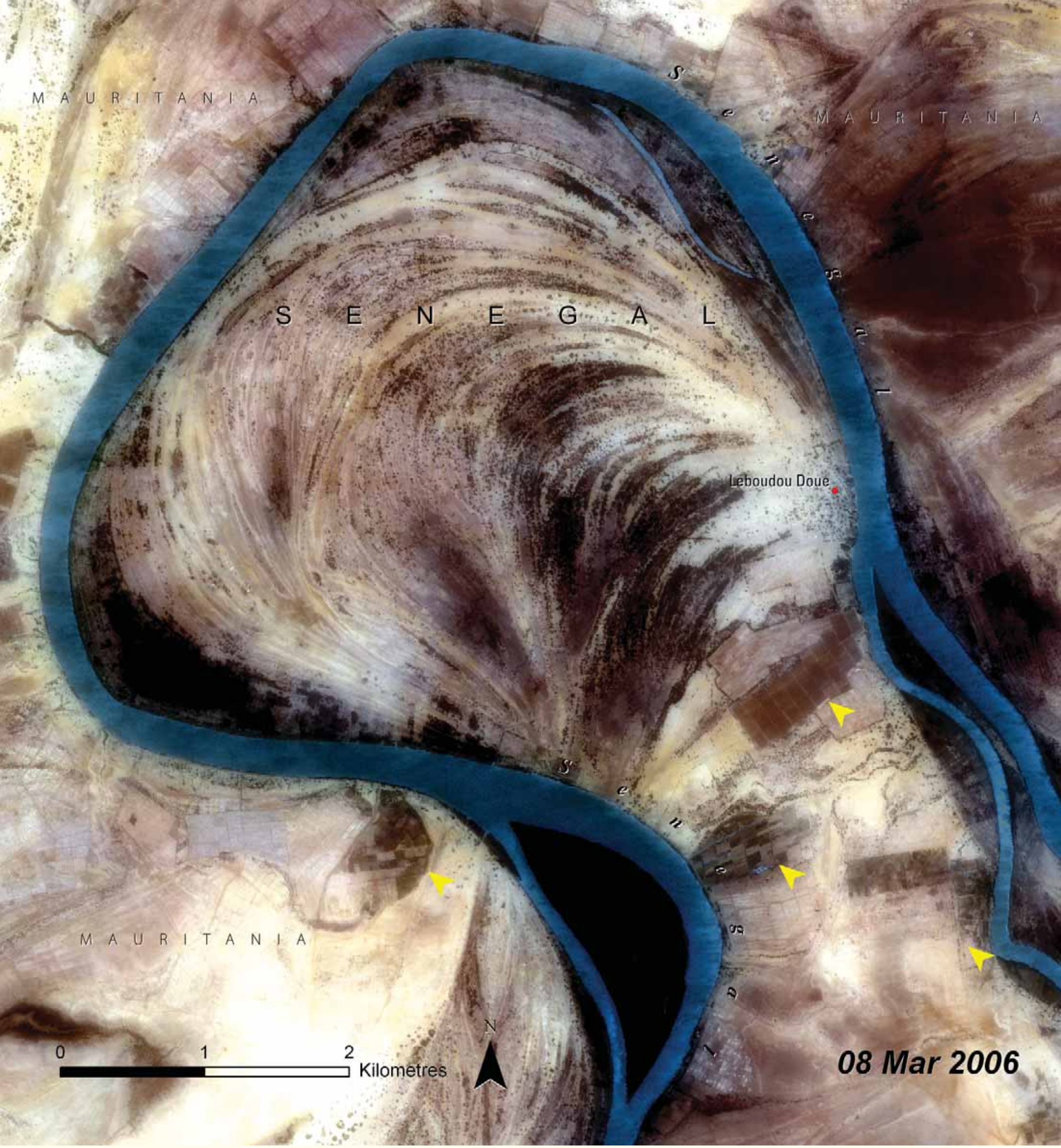
Roughly half of Senegal's urban population lives in the greater Dakar metropolitan area. Urban population growth has turned the Cap Vert Peninsula into a sprawling metropolis, where settlements reach ever-further inland and onto the prime farmland that has historically supported the city. Pikine, initially begun as a resettlement of urban slum dwellers 15 km east of Dakar, has grown to over one million people. Its location in the fertile Niayes region displaced large areas of urban and peri-urban agriculture that once provided livelihoods for a substantial portion of the population.

In the aerial photo mosaic from 1942, Dakar is concentrated at the southern tip of the peninsula, with only the airport and a few scattered roads and settlements to the north. The 2006/2007 image shows only a portion of the greater Dakar area, which currently stretches another 14 km to the city of Rufisque (not shown).

Riverine Forest Degradation: Leboudou Doue, Senegal

In the black and white image, the darker areas of the land enclosed by this great loop on the Senegal River show the extent of the riverine forest in 1966. The 2006 image shows very little of that forest remains.

Similar deforestation has occurred in the fertile floodplains along hundreds of kilometres of the Senegal River. Much of the forest was cleared by local people to make way for subsistence agriculture. The most common riverine tree species, *Acacia nilotica*, is also the preferred source of



wood for fuel and construction, and for charcoal production. Production of charcoal for sale as far away as Dakar and Saint Louis has further increased the pressure on what remains of these woodlands. *Acacia nilotica* woodlands that covered 39 000 hectares along the Senegal River in 1966 had been reduced to 9 000 hectares by 1992—a reduction of 77 per cent.

These pressures were compounded by two developments in the late 1980s. In 1988, the Manantali Dam was built upstream in Mali. The dam controls roughly half of the Senegal River's discharge. While controlled releases of water from the dam can recreate natural flooding, below-normal flood levels may be contributing to loss of *Acacia nilotica* stands. The area's population has also grown dramatically over the past several decades, including the influx of some 120 000 Mauritanian refugees and Senegalese expatriates following an ethnic conflict in 1989.

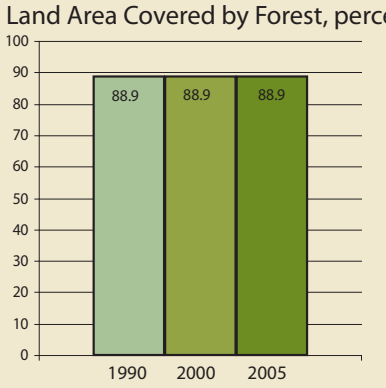
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goals 7 Indicators

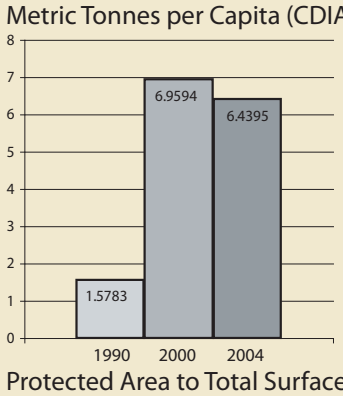
Seychelles does not have the resources to maintain a comprehensive program of environmental regulation, evident in the MDG graphs. The monitoring of the environment is complicated by the fact that the nation consists of 15 islands distributed over a 1.3 million km² area.

★ Indicates progress

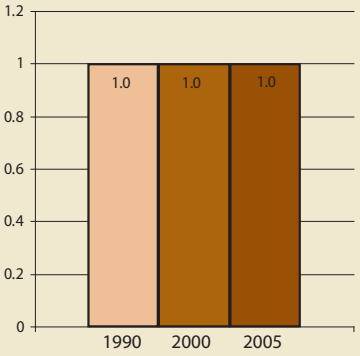
Land Area Covered by Forest, percentage



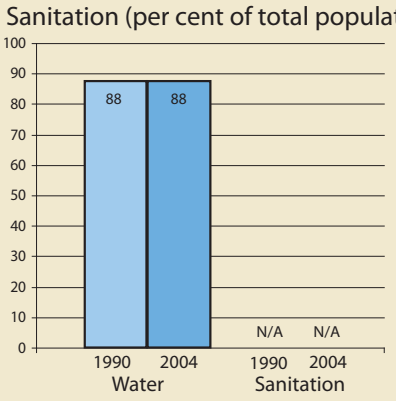
Carbon Dioxide (CO_2) Emissions, Metric Tonnes per Capita (CDIAC)



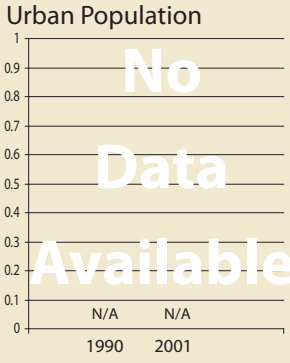
Protected Area to Total Surface Area in per cent



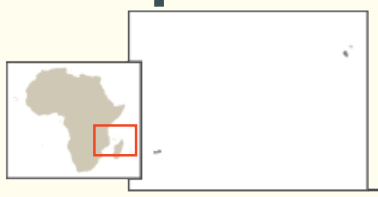
Access to Improved Water Source and Sanitation (per cent of total population)



Slum Population as per cent of Urban Population

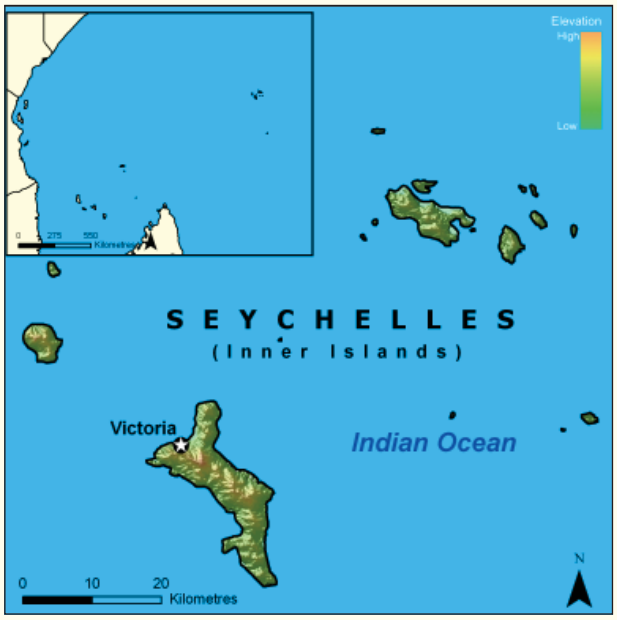


Republic of Seychelles



Total Surface Area: 455 km²
Estimated Population in 2006: 83 000

Seychelles is a large archipelago of 115 islands located north of Madagascar in the western Indian Ocean. Forty-two of the islands are classified as "micro-continental," having been left behind by the Indian subcontinent during its northward drift towards Asia. The remaining 73 islands are coral atolls and sandbanks that formed in the region's shallow waters. Lying only four degrees south of the equator, Seychelles has a tropical wet climate dominated by patterns of monsoons.



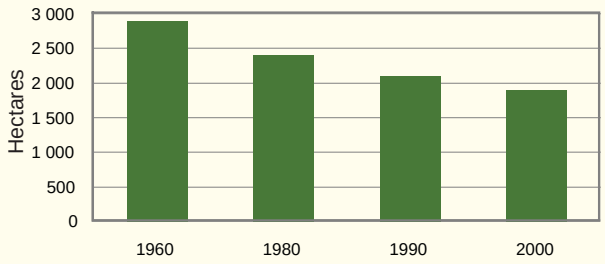
Important Environmental Issues

- Severe Weather and Coastal Erosion
- Loss of Mangrove Forests and Protection of Coral Reefs

Severe Weather and Coastal Erosion

While Seychelles lies beyond the western Indian Ocean's main cyclone belt, its islands have experienced increasingly frequent and intense storms over the past decade (UNEP 2006), resulting in millions of dollars in damage. Global climate change is expected to contribute to rising sea levels and even more extreme weather events, which is particularly threatening in light of increased coastal erosion. Stabilisation efforts and a national beach monitoring program were initiated in 2003 to address this problem.

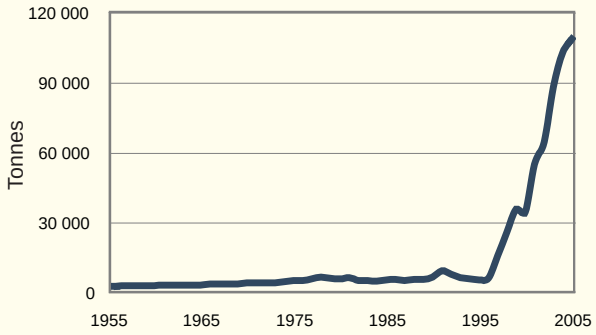
Mangrove Forest Extent



Source: Status and Trends in Mangrove Area Extent Worldwide

Loss of Mangrove Forests and Protection of Coral Reefs

Fisheries Production



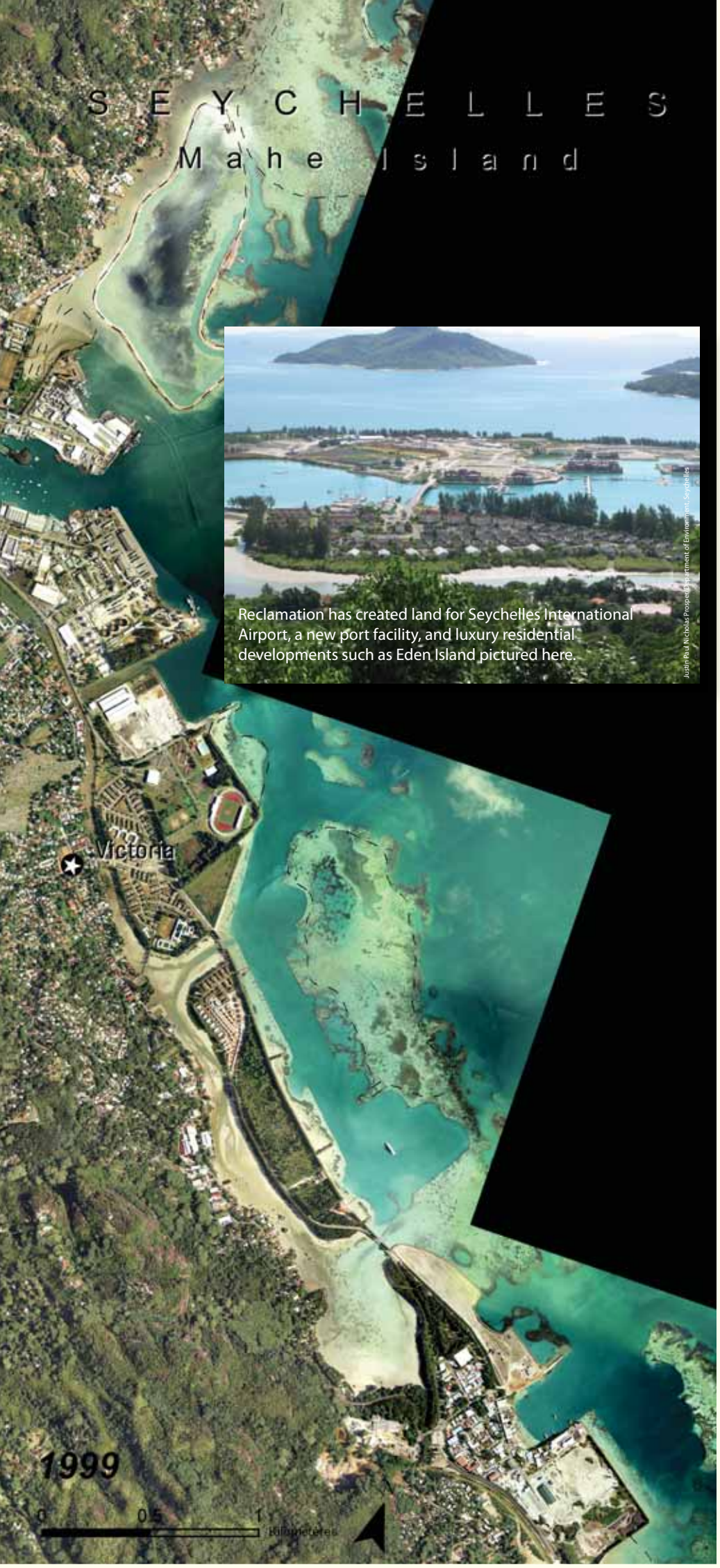
Source: FISHSTAT

Mangroves provide important habitat for fish and birds and protect coral reefs by capturing sediments before they enter ocean waters. Mangroves are found mainly on the granite islands. As a result of wetlands reclamation and coastal development, one-third of Seychelles' mangroves have been lost since 1960 (Wilkie and Fortuna 2003).

Aldabra atoll in the western Seychelles is a UNESCO World Heritage Site and one of the most exceptional examples of the country's coral reefs, which span 1 690 km² (UNEP-WCMC 2001). Aldabra is home to 152 000 giant tortoises, the largest population of this reptile in the world (UNESCO 2007).

The smallest country in Africa made up of 115 islands in the Indian Ocean, Seychelles also has the smallest population.

UN (2007)



Reclamation has created land for Seychelles International Airport, a new port facility, and luxury residential developments such as Eden Island pictured here.

Justin Paul Nicholas Prospect Department of Environment, Seychelles

Land Reclamation: Mahe Island, Seychelles

The east coast of Seychelles' Mahe Island has undergone major environmental change during the last 30 years, primarily due to land reclamation projects. In 1973, land was reclaimed to create a site for the Seychelles International Airport, and in 1986, for a new port facility. Two further phases of reclamation were completed in the early 2000s, parts of which can be seen in the 2007 image above (yellow arrows).

These reclamation projects have impacted both marine and coastal environments. Several new wetland areas have been created, some of them colonized by mangroves, which provide valuable bird habitat and nursery areas for marine species. However, sedimentation from reclamation projects has killed some of the coral along Mahe's eastern coast as well.

Republic of Sierra Leone

Total Surface Area: 71 740 km²
Estimated Population in 2006: 5 679 000

Sierra Leone has a humid tropical climate, with the highest average rainfall on the African continent—over 2 500 mm of rain per year (FAO 2007). There are four main topographical regions: coastal plains, low inland plains, an upland plateau, and small mountain ranges in the north and east. The country is rich in natural resources including minerals, fish, forests, and wetlands.

Important Environmental Issues

- Deforestation
- Land Degradation
- Overfishing

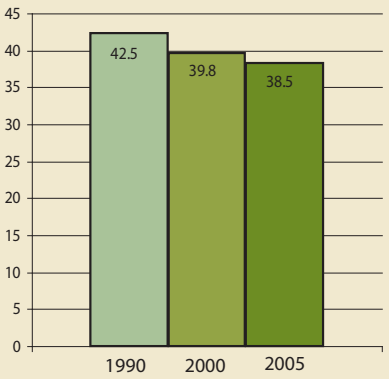
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

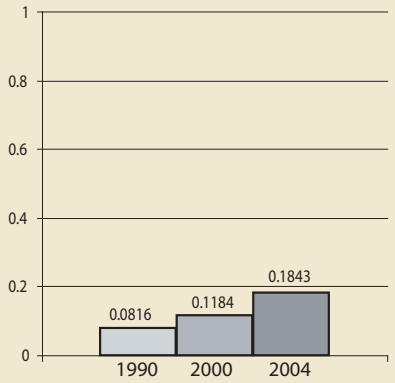
Water pollution is a significant problem in Sierra Leone due to mining by-products and sewage. An increase in slum population can be attributed to population pressure that has led to an intensification of agriculture resulting in soil depletion. Logging, cattle grazing, and slash-and-burn farming have decimated the primary forest. The mining sector officially accounts for over 90 per cent of the country's export earnings.

★ Indicates progress

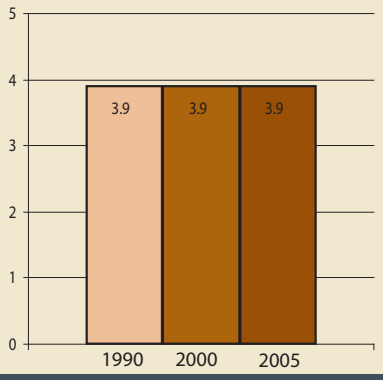
Land area covered by forest, percentage



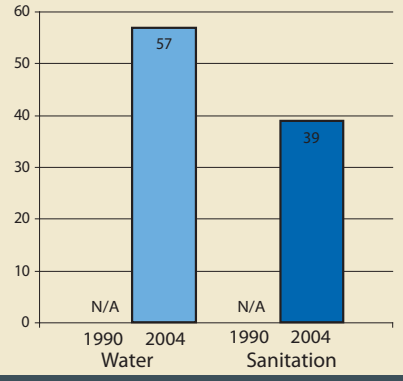
Carbon dioxide (CO_2) emissions, metric tonnes per capita



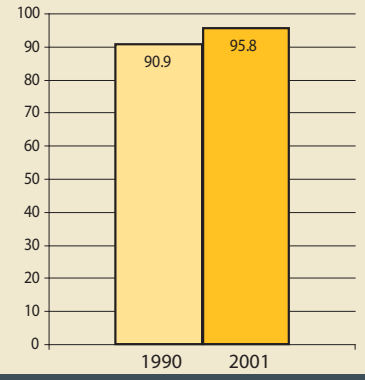
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

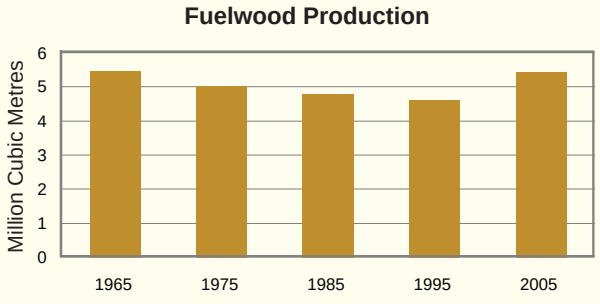


Sierra Leone had the second highest population growth rate in Africa between 2000 and 2005—4.2 per cent per year.

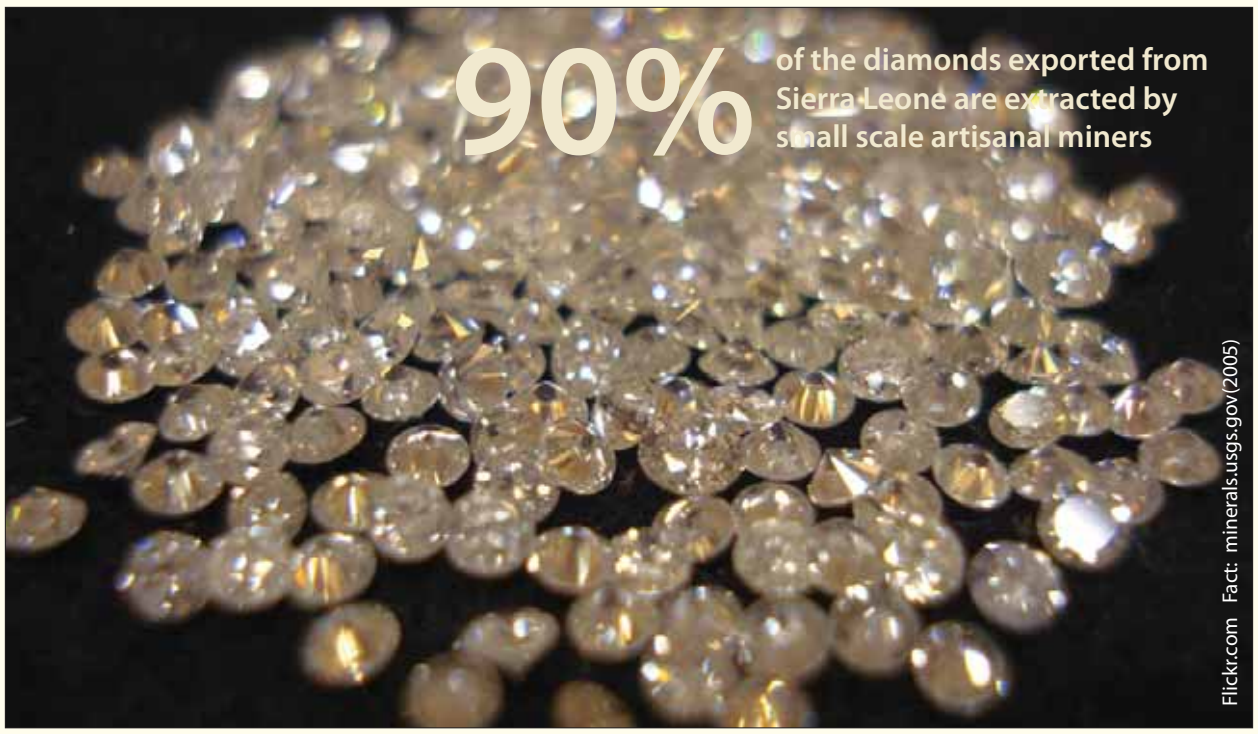
geodata.grid.unep.ch (2006)

Deforestation

Sierra Leone's forests are rich in biodiversity, including over 2 000 plant species, 74 of which are found nowhere else in the world (CBD n.d.). It is estimated that dense tropical forests once covered 65 per cent of the country; these have been reduced to only five per cent today (UNCCD 2004). There are many human pressures on the forest, including logging (both legal and illegal), slash-and-burn agriculture, mining, and dependence on fuelwood by 85 per cent of the population (CBD n.d.).



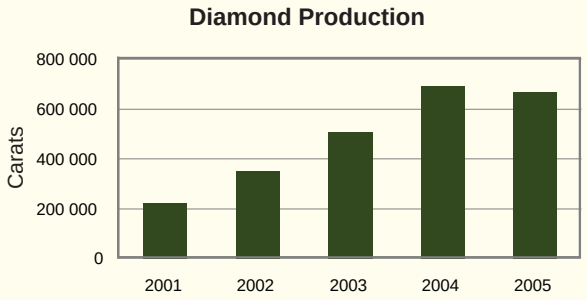
Source: FAOSTAT



Land Degradation

Sierra Leone's population and economy depend heavily on agriculture. Population pressure has reduced fallow periods to less than five years and encouraged clearing of forests for cultivation (CBD n.d.), resulting in soil erosion and nutrient leaching. Land degradation very likely has reduced yields of major crops such as rice.

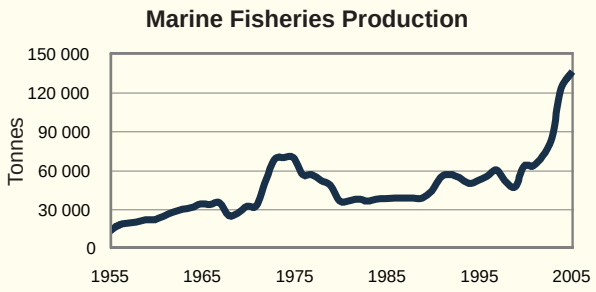
Mining is a significant source of localised land degradation. Diamonds are Sierra Leone's primary export commodity and are mined by both large international companies as well as small artisanal operations. Both have brought about significant environmental degradation including deforestation, soil erosion, pollution, and siltation of water resources; plans for rehabilitation are lacking.



Source: USGS International Mineral Statistics and Information

Overfishing

Sierra Leone's marine and inland fisheries are biologically rich. Although production significantly declined during the decade-long civil war that ended in 2002, the sector is again on the rise. Widespread illegal fishing is increasing concerns about overexploitation. Although not yet believed to be overexploited, several fish stocks may be in decline, although reliable data is lacking (Blinker 2006).



Source: FISHSTAT

SIERRA LEONE

Windi

Gbangbatok

Gbangbaia

Mogbwemo

Junctuela

Segbewema

Kabati

Kanga

N

0 2.5 5 Kilometres

07 Jan 1974

Rutile Mining: Moyamba District, Sierra Leone

Sierra Leone is mineral rich; titanium minerals such as rutile and ilmenite are its principle mineral exports. Before war erupted in 1991, mining represented 90 per cent of Sierra Leone's registered exports and roughly 20 per cent of its GDP—rutile accounted for well over half of that. The Moyamba District, which borders the Atlantic Ocean in the west and Bonthe to the south, is the most active rutile mining area in the country. Although mining companies left during the war, they returned when the war ended in 2002.

Rutile is mined by creating large artificial lakes which are then dredged, leaving behind large water-filled pits up to 600 m long. In Sierra Leone, these activities have left vast areas of land deforested and degraded. It is estimated that between 80 000 and 120 000 hectares of land have been mined out in different parts of the country with minimal efforts at restoration.

In the 1974 image, one small mining operation is visible (centre); however, much of the Moyamba District was still covered with relatively intact forests at that time. By 2003, mining activities had replaced large portions of forest with water-filled pits. These mining sites have extremely poor health and sanitary conditions; the pits teem with mosquitoes and bacteria that are linked to a high incidence of malaria, cholera, and diarrhoea.

ATLANTIC
OCEAN

S I E R R A L E O N E

Sierra Leone

Aberdeen

Freetown

Allen Town

Cockerill
Bay

Wellington

Kongo
Reservoir

Western
Area
Forest
Reserve

Hastings

Guma
Reservoir

Waterloo

03 Jan 1986

0 2.5 5 Kilometres

N

Western Area Forest Reserve: Freetown, Sierra Leone

Freetown, Sierra Leone's capital city, shares a peninsula with the Western Area Forest Reserve—a small remnant of the Guinean Forests that historically stretched from Guinea to Cameroon. The century-old reserve covers a chain of forested hills that are home to approximately 300 species of birds and a small population of chimpanzees.

Intense population growth began in Freetown in the 1970s. However, a buffer of forested land remained between the Reserve and the edge of the city. By the mid-1980s, however, the growing

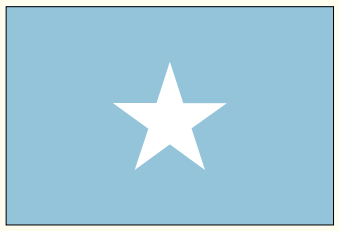
The urban expansion of Freetown is encroaching on the forest and at many places into the Western Area Reserve. *Image courtesy of DigitalGlobe Quickbird.*

city had expanded into the buffer zone and much closer to Reserve borders (1986 image). Between 1991 and 2002, as many as one million people fled to Freetown as a result of war in Sierra Leone. Many of these refugees moved into the hills of the Reserve, where they relied on its resources to survive. Deforestation and land degradation of these valuable protected lands was the result. By 2003, the border of the Reserve had been breached in many places (2003 image), with urban populations encroaching from several directions.

The Reserve is now recognized as vital, not only to the biodiversity and natural systems it supports, but to the people of Freetown as well. The forest is crucial for recharging of Freetown's reservoirs, which are already struggling to meet the city's water needs.

Somali Republic

Total Surface Area: 637 657 km²
Estimated Population in 2006: 8 496 000



Credit: © Flagart.com

Somalia is a large, relatively flat country located on the Horn of Africa. Its coast is the longest in Africa and borders the Gulf of Aden to the north and the Indian Ocean to the east. The climate is highly arid and hot year-round with seasonal monsoon winds and low, sporadic rainfall arriving in two rainy seasons. Average annual rainfall is estimated at less than 280 mm.

Important Environmental Issues

- Threats to Biodiversity
- Desertification, Overgrazing, and Deforestation
- Water Scarcity and Drought

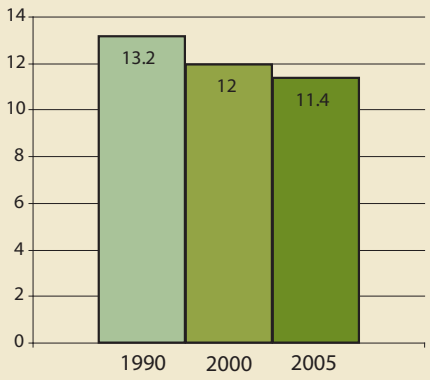
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

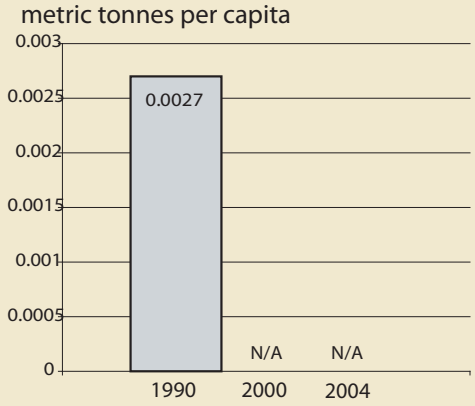
The increasing aridity of Somalia climate, coupled with excessive timber cutting and overgrazing, has led to deforestation and expansion of the desert area. The Indian Ocean tsunami of December 2004 affected stretches of coast. Ongoing internal conflict, which began in the 1980s, has severely hindered sustainable management of natural resources.

★ Indicates progress

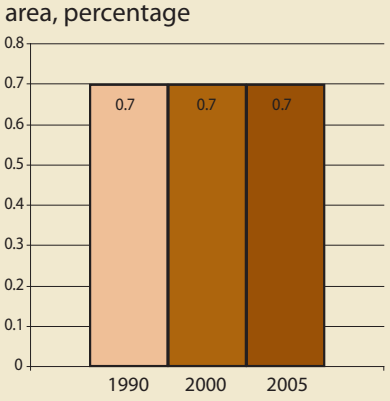
Land area covered by forest, percentage



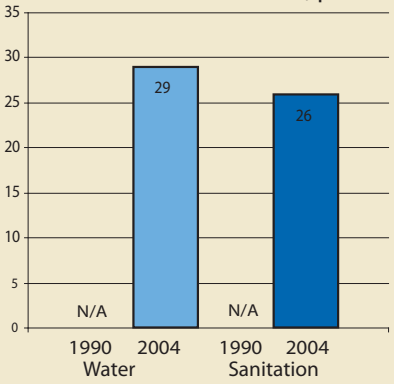
Carbon dioxide (CO_2) emissions, metric tonnes per capita



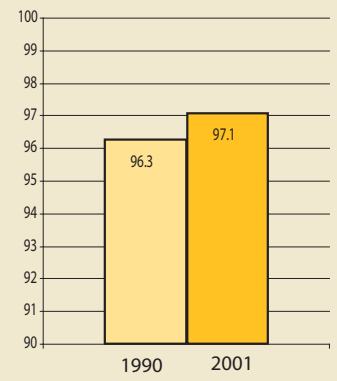
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



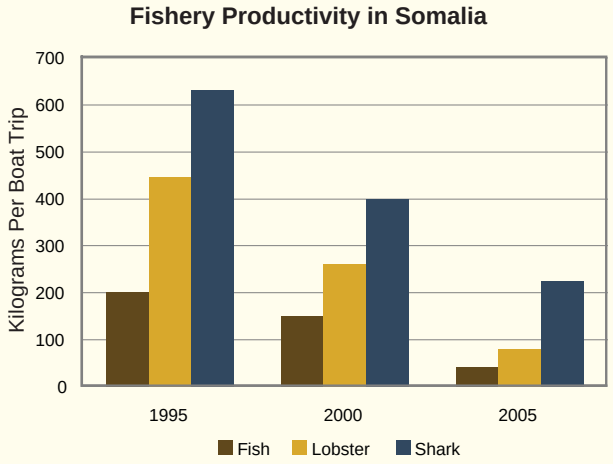
Northern Somalia is the world's largest source of myrrh and other incense.

uneca.org(2002)

Threats to Biodiversity

Seventeen per cent of all identified plant species in Somalia are endemic, which is the second-highest level of floral endemism in continental Africa (UNEP 2005). The coastal region is home to extensive coral reefs, mangrove forests, seabird colonies, and turtle nesting beaches that are currently unprotected and suffer from heavy exploitation. Although the state of most fish stocks is unknown, sharks, lobsters, and certain fish species are thought to be over-exploited. Although Somalis do not traditionally consume much fish, fish exports are important to the economy and illegal fishing by foreign fleets is common.

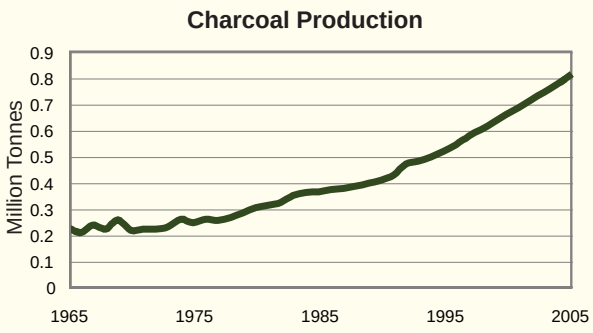
Somalia wildlife has also been severely over-exploited and many species, including the black rhino and elephant, are approaching national extirpation. Lack of official protection and loss of habitat due to agriculture-related land degradation are major threats.



Source: UNEP 2005 State of the Environment in Somalia: A Desk Study

Desertification, Overgrazing, and Deforestation

Due to overall aridity and drought frequency, 100 per cent of land is at high risk of desertification (FAO AGL 2003). Despite water and feed constraints, however, Somalia has the highest proportion of pastoralists in Africa; livestock accounts for 40 per cent of the GDP product (UNEP 2005). Overstocking and overgrazing have resulted in declining fertility of pastureland, which accounts for nearly 70 per cent of Somali Republic's total land area (WRI 2007).



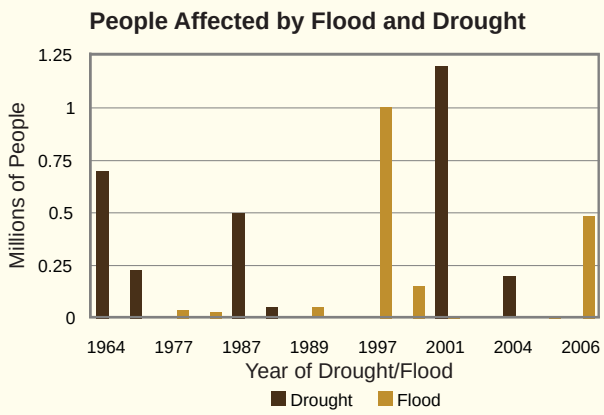
Source: FAOSTAT

Deforestation is another leading driver of land degradation and desertification. Charcoal, produced primarily from slow-growing acacia trees, is an important domestic energy source, although its production in Somalia is largely driven by foreign demand. In 2006, a ban on charcoal exports was imposed in an attempt to curb uncontrolled deforestation of acacia forests, which are also under heavy grazing pressure.

Water Scarcity and Drought

In the Somalia's arid north and east, sub-surface water resources are generally saline; deep boreholes are the only permanent source of freshwater. In the south, two perennial rivers, the Juba and Shabelle, play a major role in water access. Due to prolonged civil conflict, lack of water management, and erratic rainfall, Somalia has the second-lowest level of access to safe water in Africa, at only 29 per cent of the total population (UN 2007). In the tsunami-impacted regions, where many wells were clogged or buried, the situation is particularly severe.

Natural rainfall variation, exacerbated by climate change, contributes to regular droughts every two to three years that are often followed by severe floods. In 2002, water shortages caused losses of up to 40 per cent of cattle and 10 to 15 per cent of goats and sheep (FAO 2005).



Source: EM-DAT Disaster Database

El Niño Flooding: Juba River, Somalia

Late in the fall of 2006, the Horn of Africa received heavy rains generally believed to have been the consequence of an El Niño weather pattern over the Pacific Ocean. By late November and early December, flooding had displaced roughly half a million people, destroyed crops and villages, and caused outbreaks of disease. The severity of the floods made relief efforts extremely difficult. By December these floods were the worst Somalia had seen in ten years. In March 2007, predictions of above-normal spring rains in the upper reaches of the Juba River watershed threatened more flooding.

On the left page, September 2006 and December 2006 images show a portion of the Juba River before and after the rains came, respectively. Flooded areas appear as dark-green to black. Small portions of these images (yellow rectangles) are shown above in greater detail.

In spite of profound negative impacts of the flooding in the Juba River region, two consecutive seasons of heavy precipitation may have benefited cereal grain production and improved pastoral conditions in the region, substantially reducing the need for humanitarian assistance.

Republic of South Africa

Total Surface Area: 1 221 037 km²
Estimated Population in 2006: 47 594 000

South Africa is the southern-most country in Africa, with a long coast spanning across both the Atlantic and Indian Oceans. Although the climate is generally temperate, at least 65 per cent of the country is too arid to support rain-fed agriculture (FAO 2005). The Great Escarpment, a stretch of rugged and scenic terrain running from the northeast to the southwest of the country, separates a wide central plateau from a narrow coastal plain. The mineral riches beneath these lands make South Africa the world's largest producer of platinum, gold, and chromium (CIA 2007).

Important Environmental Issues

- Water Availability and Quality
- Land Degradation
- Threats to Biodiversity

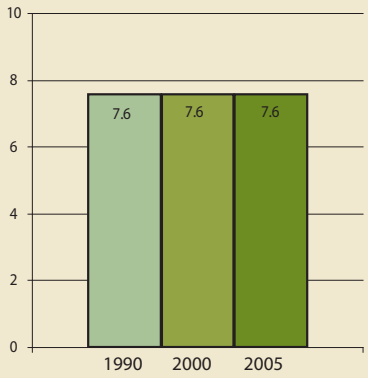
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

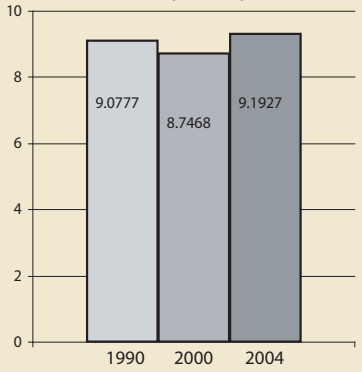
South Africa's limited water resources have been impaired by mineralization, eutrophication, and acidic mine drainage. In 2002, 74 per cent of total energy consumption in South Africa came from coal. Because coal is a highly carbon-intensive fossil fuel, overreliance on it for energy needs can have negative environmental impacts, including air pollution due to coal combustion, groundwater pollution, and disruption of ecosystems due to mining.

★ Indicates progress

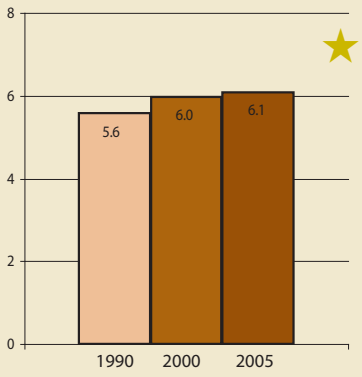
Land area covered by forest, percentage



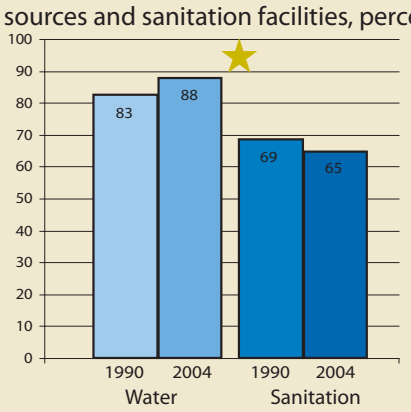
Carbon dioxide (CO_2) emissions, metric tonnes per capita



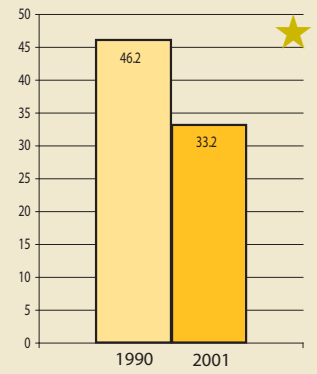
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



The South African Fynbos, with 8 500 species of vascular plants, is one of the six botanical kingdoms of the world and has a richer flora than any other comparable sized area in Africa.

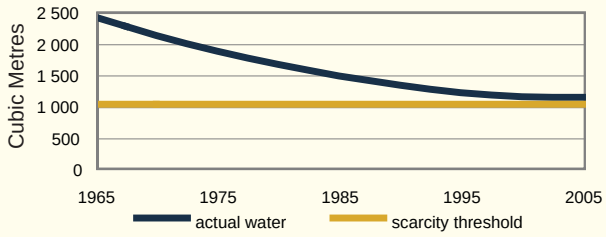
panda.org (2006)

Water Availability and Quality

South Africa is a semi-arid country with unevenly distributed rainfall. In northern regions in particular, freshwater resources are nearly fully-utilised and many are under stress. Population and economic growth are anticipated to increase water demand by 52 per cent between 2000 and 2030 (SoE 1999), making freshwater availability one of the primary constraints on development.

There are over 320 large dams in South Africa, with a total capacity of 32 400 million cubic metres (SoE 2006). Sedimentation has reduced the capacity of some dams by as much as 25 per cent (SoE 1999). Of the 30 dams in Africa with the highest levels of sedimentation, 18 are in South Africa (FAO 2007a). Furthermore, the spread of alien invasive plant species has decreased the national mean annual run-off by three per cent (SoE 2006). Finally, pollution from industrial and domestic effluents has reduced the quality of groundwater and surface water resources, especially near urban areas.

Renewable Water Resources Per Capita

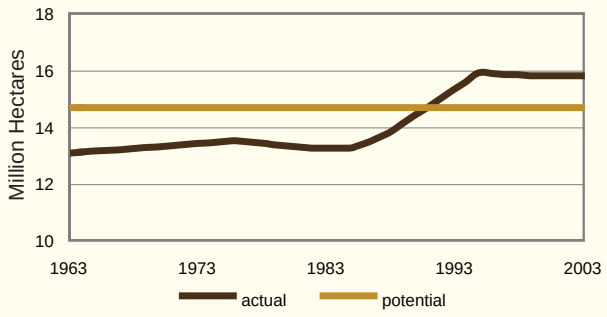


Source: AQUASTAT

Land Degradation

An estimated 67 per cent of South Africa's total land area is severely degraded (FAO 2007b). The primary drivers are wind and water erosion, spurred by overgrazing and cultivation of land unsuitable for agriculture specifically on the steep slopes of enscarptments in the Limpopo, KwaZulu Natal, and Eastern Cape (SoE 2006). Declining soil fertility has affected many farmers, with an average of 2.5 metric tonnes of topsoil lost per hectare per year, which is approximately eight times the rate of natural soil formation (SoE 1999).

Potential Versus Actual Cultivated Land



Source: AQUASTAT and FAOSTAT

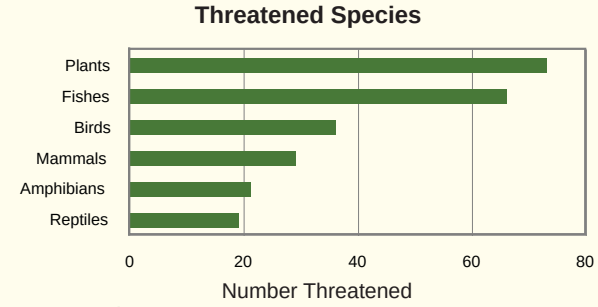
Mining is another significant contributor to land degradation in the form of acid mine drainage, water pollution, and the drastic alteration of landscapes. The Witwatersrand region near Johannesburg, South Africa, has the richest concentration of mineral resources in southern Africa. Mine wastes cover over 200 000 hectares in South Africa (SoE 2006).

Threats to Biodiversity

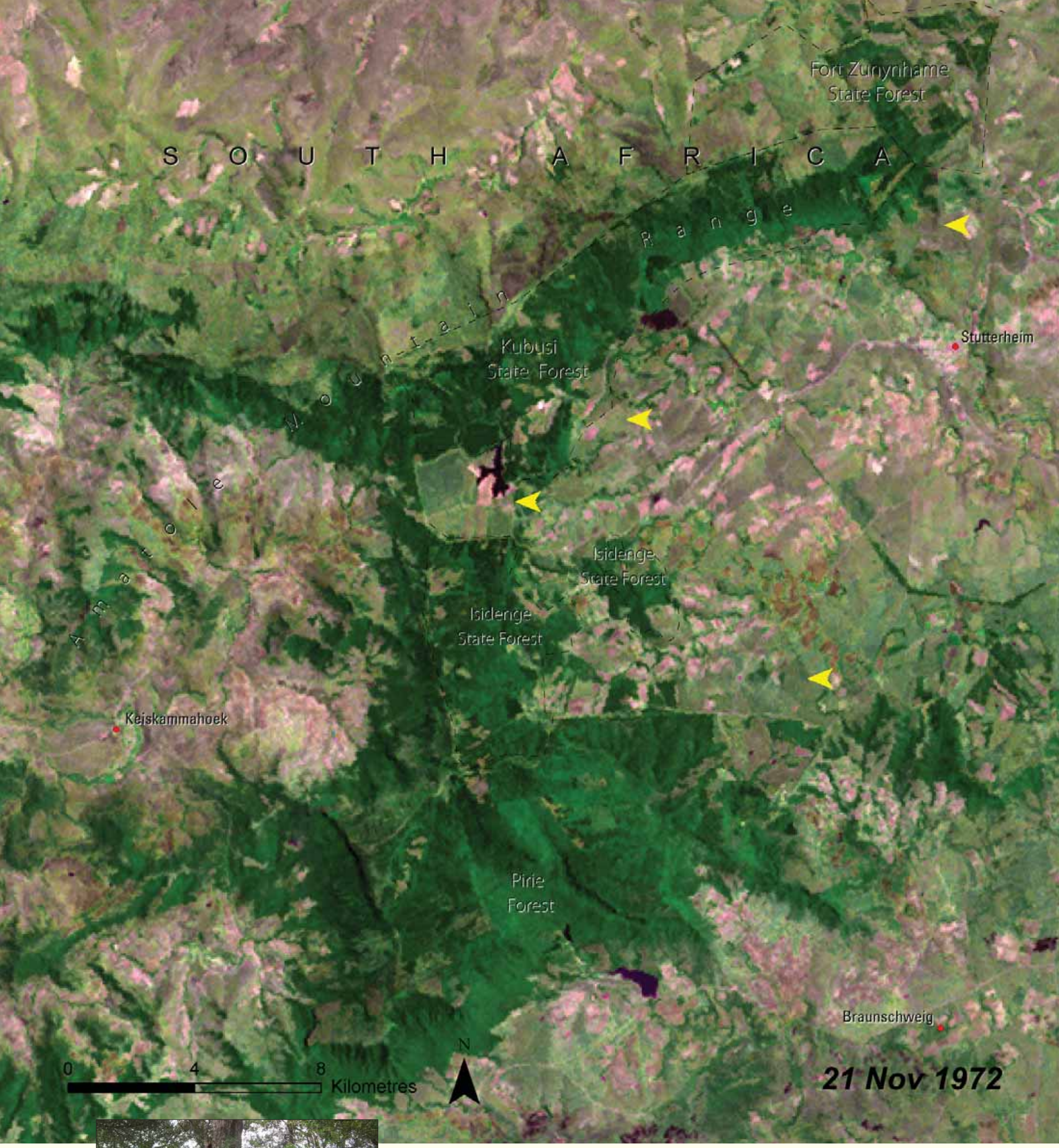
South Africa is one of the most biodiverse countries in the world, with almost ten per cent of the world's plant species, six per cent of its mammal species, 16 per cent of its marine fish species, and eight per cent of the world's bird species (CBD 2005). The country also has the fifth-highest level of endemism on the African continent.

Many species are threatened due to agricultural activities, urban development, mining, the spread of invasive alien species, and over-harvesting. An estimated 34 per cent of terrestrial ecosystems and 82 per cent of river ecosystems are considered threatened, and approximately half of all wetlands have been lost (CBD 2005). Marine ecosystems are especially endangered due to rapid coastal development, pollution, and reduced freshwater inflow from estuaries. Approximately 1.3 million m^3 of sewage and industrial effluent are discharged into the sea daily (SoE 2006).

Threatened Species



Source: IUCN Red List



Indigenous Forests: Amatole Mistbelt, South Africa

While forests are not believed to have ever covered a large part of South Africa, logging, clearing for agriculture, and forest plantations have much reduced their original extent. Indigenous forests now cover only 0.33 per cent of South Africa's land area.

South Africa's Amatole Mistbelt Forests are part of the southernmost areas of Afromontane forest in Africa. They contain some small remaining patches of indigenous forest. These forests fall within the Maputaland-Pondoland-Albany biodiversity hotspot and are home to variety of unique plant and animal species, including several endemic species such as the endangered

Priscilla Burgoyne/ South African National Biodiversity Institute

The Yellowwood (*Podocarpus falcatus*)is an important native species in this ecosystem, but is also harvested for wood and non-wood products.

giant golden mole (*Chrysospalax trevelyani*). They are also important resources for local people who rely on them for wood and non-wood products. Some of the characteristic tree species are yellowwood (*Podocarpus falcatus*), (see photo), red currant (*Rhus chirindensis*), and black ironwood (*Olea capensis*).

South Africa's Department of Water Affairs and Forestry defined the areas of Isidenge and Pirie as "irreplaceable" patches of indigenous forest. While nearly half of the forests in the Amatole Mistbelt Forests are under state management, less than 1.5 per cent are under strict protection. Comparison of these 1972 and 2001 images shows some new areas of tree cover, (yellow arrows); however, these are primarily plantation forests of pine and eucalyptus, which threaten to alter the hydrology and reduce the biodiversity of these ecosystems.

Vanriebeeckstrand

SOUTH AFRICA

Blouberg Nature Reserve

Bloubergsvlei

Kalkoond

Vissershoek

Tableview

N

0 2 4 Kilometres

22 Jun 1978

Rosendal

Natural Area Loss: Cape Floristic Region, South Africa

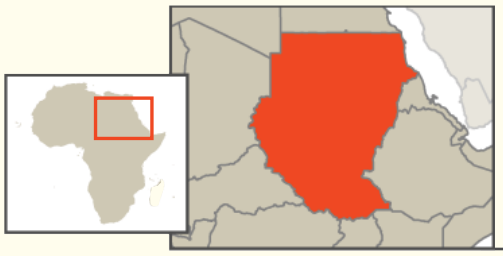
The Cape Floristic Region is a Mediterranean-type ecosystem unique to the southwest tip of Africa. It has the greatest concentration of plant species in the world outside of tropical ecosystems, with 6 210 of its 9 000 species occurring nowhere else in the world. Although the region is relatively small, its plant biodiversity is the richest per unit area on Earth, prompting its designation as a biodiversity hotspot.

The characteristic and most widespread type of vegetation in the Cape Floristic Region is fynbos, an Afrikaans word that translates as “fine bush.” Covering some 46 000 km^2, fynbos is

a shrubland comprising hard-leafed, evergreen, fire-adapted shrubs. Fynbos covers half of the surface area and accounts for 80 per cent of the plant varieties of the Cape Floristic Region.

The 1978 image shows large, relatively intact areas of native fynbos vegetation. Over subsequent decades, however, large tracts of fynbos have been cleared for agriculture or lost to urban expansion around Cape Town. The 2007 image shows how roads, urban development, and agriculture have overtaken much of the area.

Fynbos areas are also threatened by invasive alien species, particularly wattle and acacia species from Australia, as well as pine plantations. Many fynbos species have gone extinct, and more than 1 000 are endangered. Their conservation is a priority, and reserves have been established in many areas.



Republic of the Sudan

Total Surface Area: 2 505 813 km²
Estimated Population in 2006: 36 992 000

As the largest African country, Sudan extends over three major climatic zones: the Saharan north, the Sahelian centre, and the equatorial south. The population is concentrated largely along the Nile River and its tributaries, where soil fertility and agricultural productivity are high. Rainfall is widely variable throughout the country, ranging from only 25 mm per year in the dry arid north to over 1 600 mm per year in the tropical rain forests of the south (FAO 2005a).

Important Environmental Issues

- Soil Erosion and Land Degradation
- Poaching and the Ivory Trade
- Forests and Fisheries

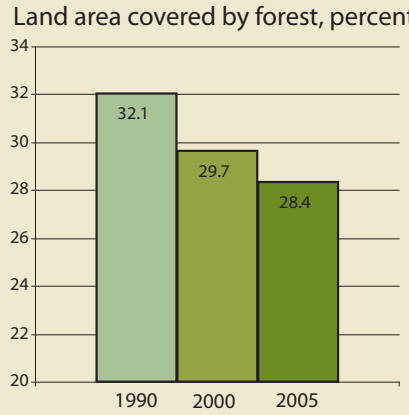
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

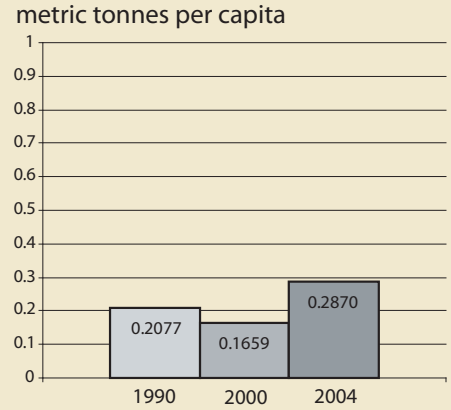
Sudan faces a number of critical environmental challenges, including land degradation, deforestation, and the impacts of climate change. There has been a southward shift—ranging from 50 to 200 km—of the boundary between semi-desert and desert since rainfall and vegetation records were first kept in the 1930s. This boundary is expected to continue to move southwards due to declining precipitation.

★ Indicates progress

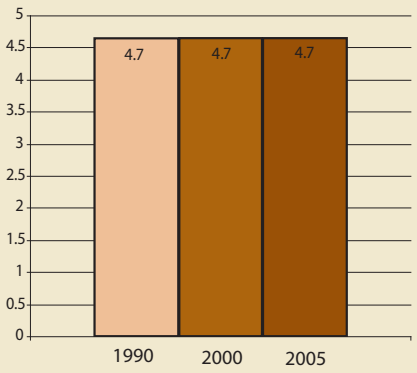
Land area covered by forest, percentage



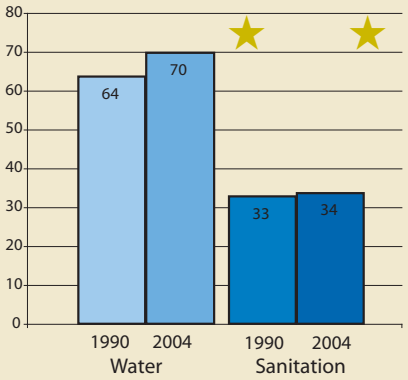
Carbon dioxide (CO_2) emissions, metric tonnes per capita



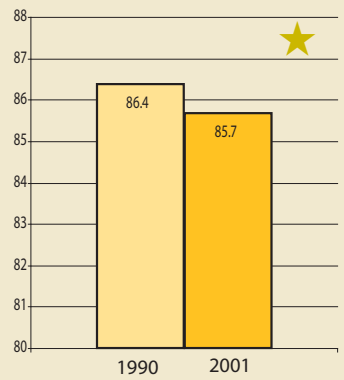
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



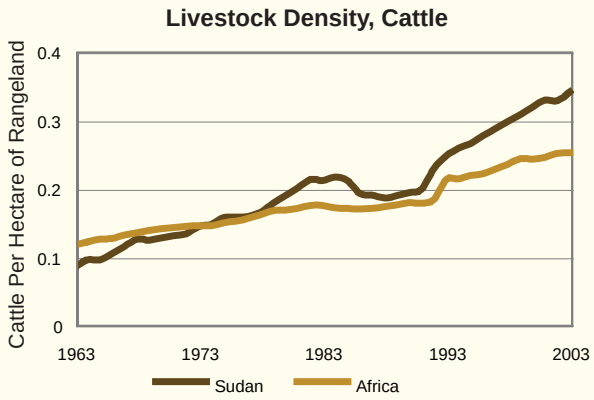
Slum population as percentage of urban



Sudan is the largest country on the African continent; likewise, its Sudd Wetland—one of the largest tropical wetlands in the world—is Africa's largest.

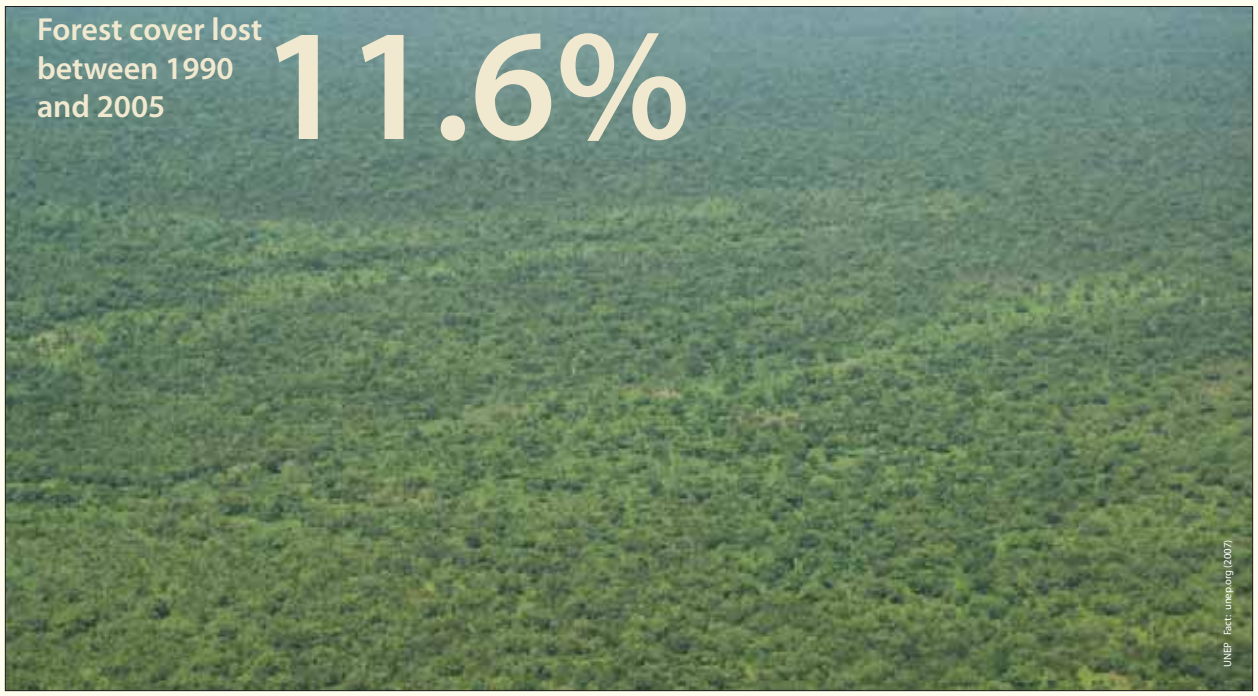
ramsar.org (2006)

Soil Erosion and Land Degradation



Source: Earth Trends (from FAOSTAT)

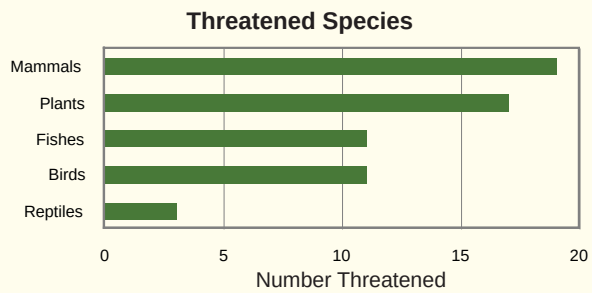
In the agricultural areas surrounding the Nile River, population densities reach 370 people per square kilometre (Salih 2001). Sudan is a land of relatively fertile soils and it has the second-largest irrigated area in Africa, which accounts for 11 per cent of cultivated area and over half of all production (FAO 2005ba). However, poor cultivation practices as well as overgrazing have led to pollution and land degradation. Resulting soil erosion has already consumed nearly one-fifth of the storage capacity in the country's four primary dams and damaged irrigation canals. Reduced irrigation capacity has decreased production by up to 40 per cent in some areas (FAO 2005b).



Poaching and the Ivory Trade

The Republic of the Sudan has significant biodiversity, much of which can be found in the tropical south. However, decades of civil war have facilitated illegal poaching, increased subsistence hunting, and thwarted meaningful conservation measures. Surveys in Boma National Park in southeastern Sudan have found a 75 per cent decrease in wildlife populations since 1980 (USAID 2002).

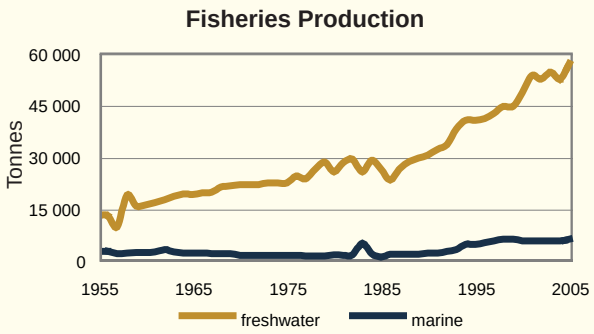
The elephant ivory market in Khartoum is thought to be one of the largest in the world. Sudan accounts for over one-third of elephants' range in eastern Africa, yet fewer than 300 individuals are estimated to remain in the country (Blanc and others 2007). Sudanese poachers have also targeted wildlife in neighbouring countries, such as the rhinos and elephants of Garamba National Park—a UNESCO World Heritage Site—in Democratic Republic of the Congo (Lovgren 2004).



Source: IUCN Red List

Forests and Fisheries

The majority of Sudan's forest resources are located in the country's centre and south, where growing demand for fuelwood and agricultural encroachment contribute to a deforestation rate of nearly one per cent per year (FAO 2005a). It is estimated that crop production advances into virgin forests at a rate of 3 000 km^2 per year (Salih 2001).



Source: FISHSTAT

Inland fisheries account for 90 per cent of the total fish catch in Sudan. Some major reservoirs associated with the Nile and its tributaries, such as the Gebel Aulia and Roseires, are being fished at a level close to 90 per cent of their estimated capacity. Marine fisheries along Sudan's Red Sea coast, however, are thought to be underexploited, with only half of their estimated potential fish stocks currently being utilised (FAO 2000-2007).

Nabaqai

S U D A N

Dibis

Kass

Dilu

Daura

Gerd Pidi

12 Nov 1972

0 4 8 Kilometres

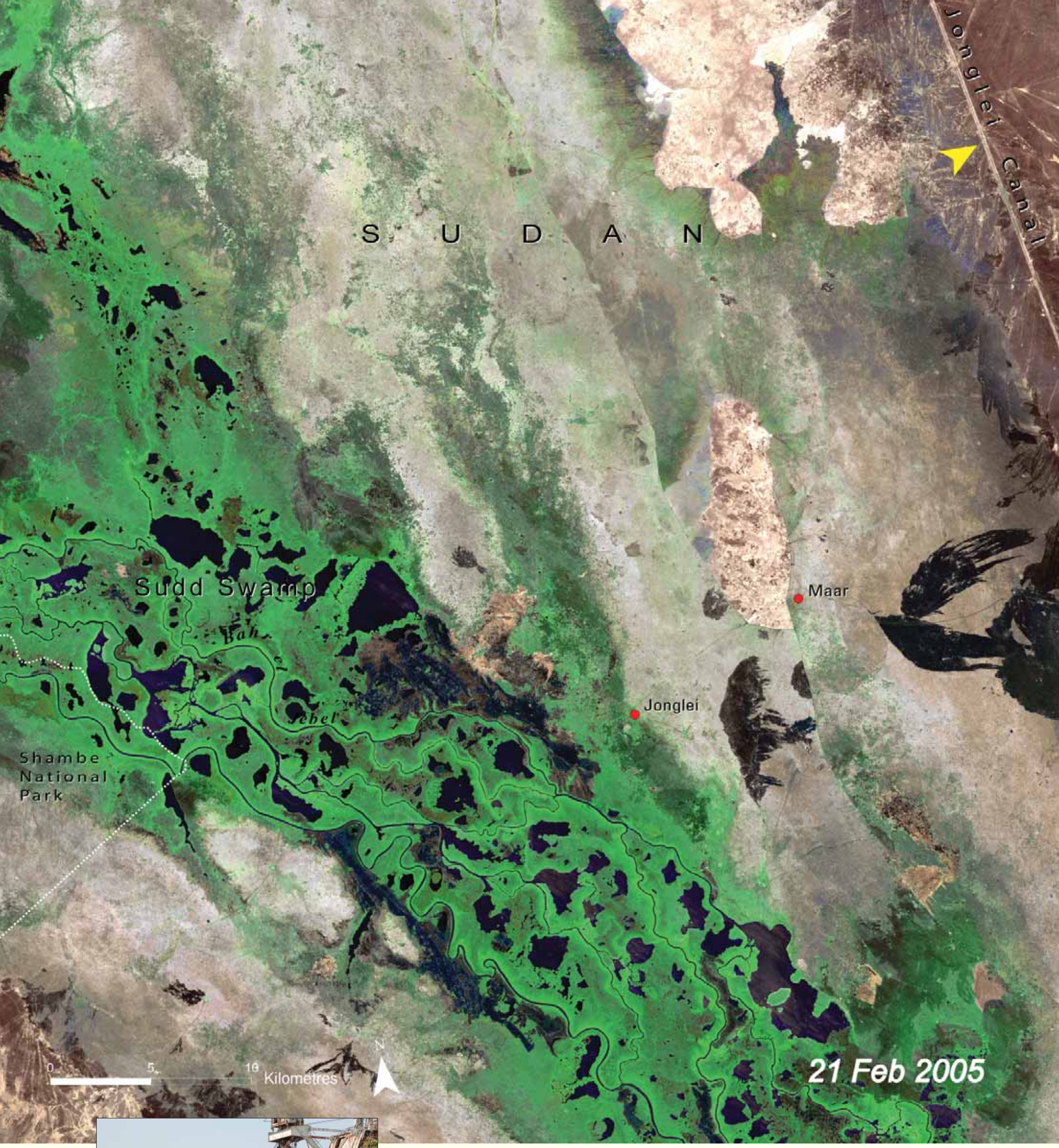
N

Tree Loss in the Foothills: Jebel Marra, Sudan

The Jebel Marra Massif is a region of high, jagged peaks and fertile valleys in western Sudan. The southern foothills of the Jebel Marra receive an average of 600 to 800 mm of precipitation annually, just above the minimum needed to support rain-fed agriculture. Crops include sorghum, millet, groundnuts, and cowpeas that are raised along watercourses and adjacent areas. Pastoralists seasonally graze their cattle on the natural vegetation in the region; the number of grazing herds has increased in recent decades as droughts have made water and pasture scarce further north.

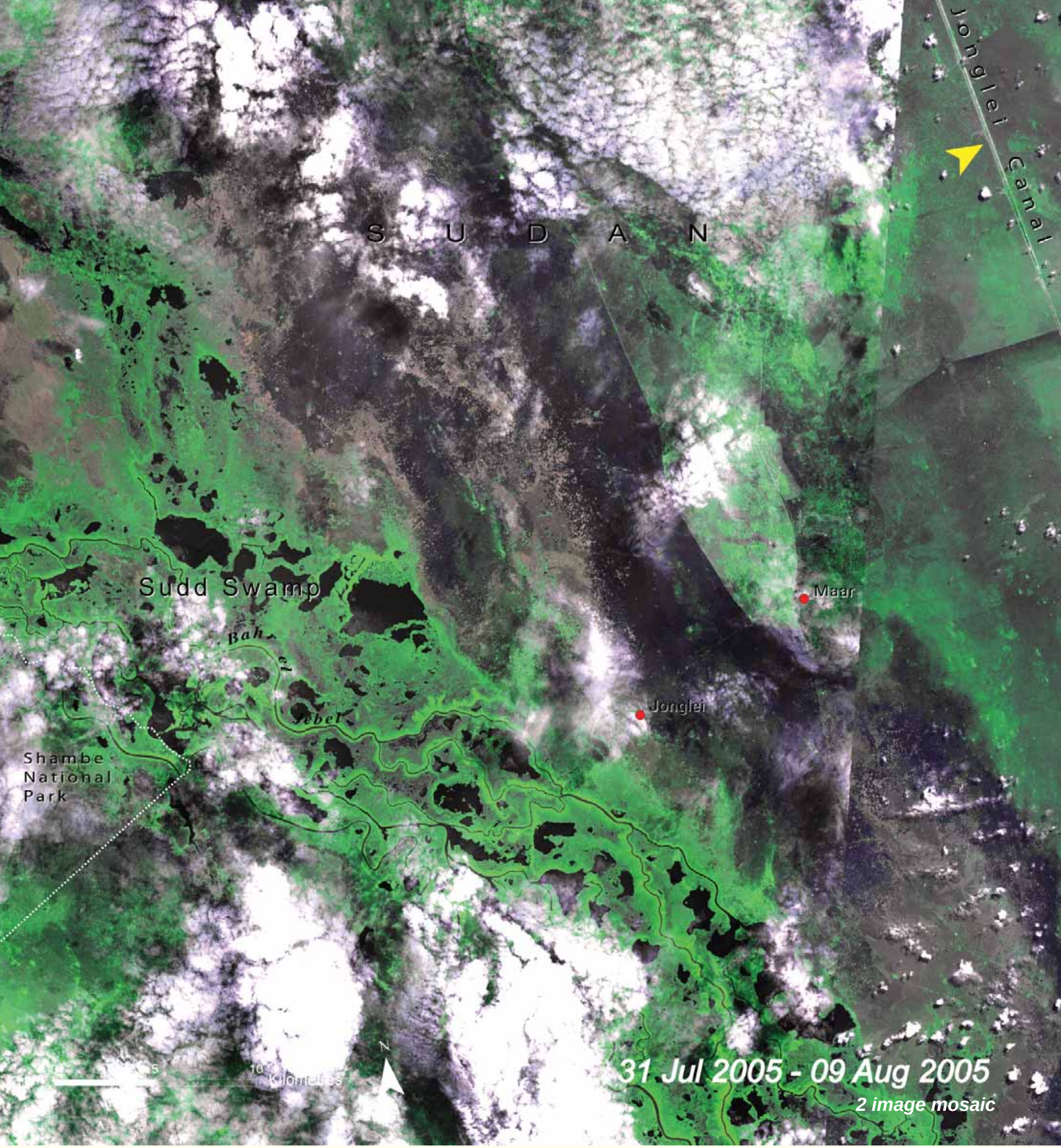
Population growth , especially in the latter half of the 20th century, coupled with an influx of refugees from drought and conflict in Northern Darfur have put increasing pressure on this fragile ecosystem. Human activities have greatly altered the natural open-savannah woodlands.

The 1972 image shows substantial tree cover across much of the lower left half of the image. The 2006 image shows the degree to which vegetation has been reduced, particularly in the less hilly areas and away from croplands concentrated along the watercourses. The loss of trees and shrubs in this fragile environment is leading to land degradation and reduced capacity to support the area's ever-increasing population.



Flooding and the Jonglei Canal: Sudd Swamp, Sudan

The Sudd is a vast wetland ecosystem in southern Sudan where the Nile River meanders for nearly 645 km through the landscape. During the dry season (February 2005 image), the wetlands contract to approximately 8 300 km^2 of permanent swamp. During the wet season (July / August 2005 image), the Sudd floods, expanding to cover 80 000 km^2. This annual pattern of water rising and receding shapes the entire ecosystem and is crucial to the survival of the wetlands' plants and animals and to the nomadic lifestyle of the Nuer, Dinka, and Shilluk people who live in the region.



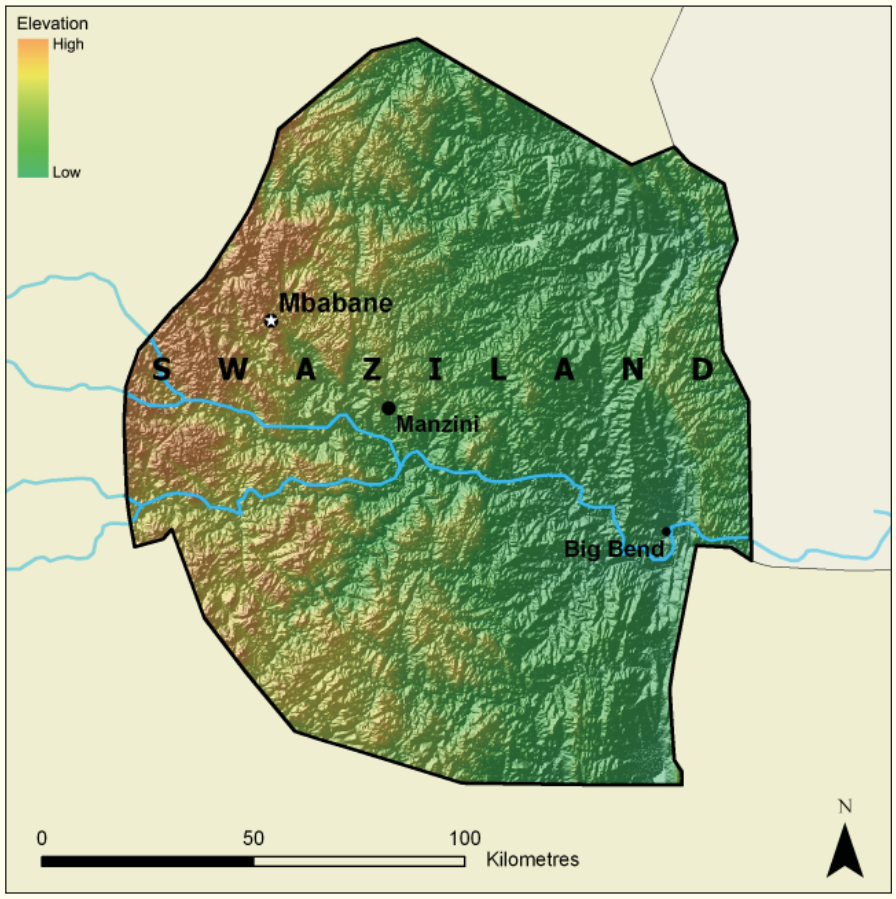
The Jonglei Canal project (yellow arrow), begun in 1978, was designed to speed the movement of Nile water around the Sudd wetlands, reducing evaporation and making more water available downstream. Despite the possible downstream benefits, the proposed 360-km canal could have a devastating effect on the wetlands of the Sudd. Recent studies also show that the project could impact the regions's climate, groundwater recharging, and water quality as well.

Construction of the canal stopped in 1983 because of armed conflicts in the area during the second Sudanese civil war. This conflict has now ended and plans to resume the canal's construction are being evaluated. Efforts to preserve the wetlands received a major boost in 2006 when the Sudd was added to the Ramsar List of Wetlands of International Importance.

Kingdom of Swaziland

Total Surface Area: 17 364 km²
Estimated Population in 2006: 1 029 000

Swaziland is a small, land-locked country surrounded by South Africa on three sides and by Mozambique to the east. The population is three-quarters rural, with the majority of the residents engaged in subsistence agriculture (FAO 2005). Swaziland has a unique system of land tenure, with 46 per cent of the country owned by private individuals and the remainder occupied by communal lands managed by the government (FAO 2005).



Important Environmental Issues

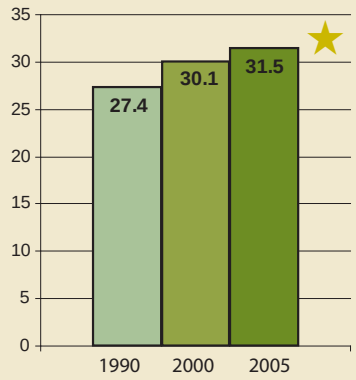
- Population Encroachment and Land Degradation
- Irrigation and Soil Degradation
- Threats to Biodiversity and Invasive Alien Species

Progress Towards Environmental Sustainability

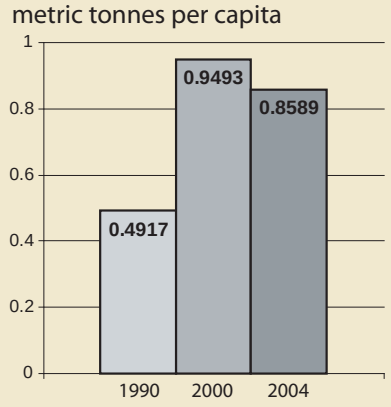
As defined by the United Nations Millennium Development Goal 7 Indicators

Swaziland's major environmental problems are soil erosion and land degradation, particularly because of overgrazing. Air pollution from transportation vehicles and emissions from other countries in the area is another significant environmental concern. Grassland, savannah, mixed bush, and scrub cover most of Swaziland. There are some forests in the highlands, which have seen a small but steady increase since 1990.

Land area covered by forest, percentage

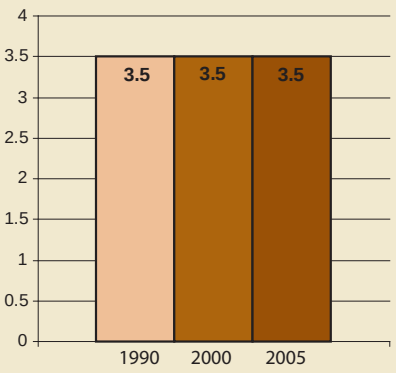


Carbon dioxide (CO_2) emissions, metric tonnes per capita

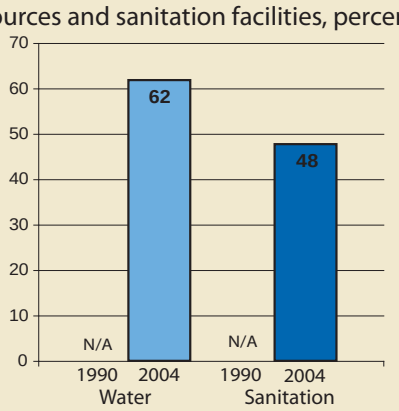


★ Indicates progress

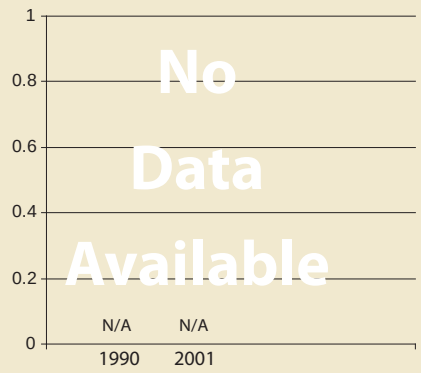
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

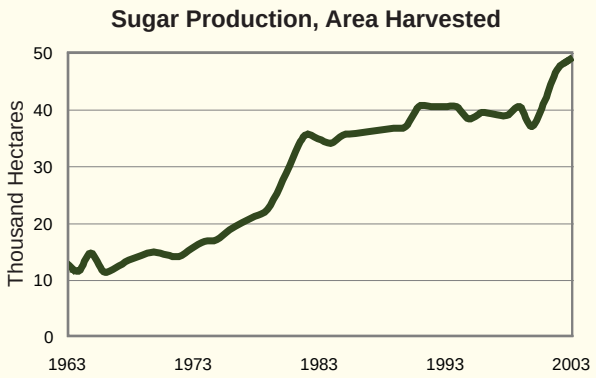


Swaziland has 1 400 km² of forest plantations, which cover 8.1 per cent of the country's total land area.

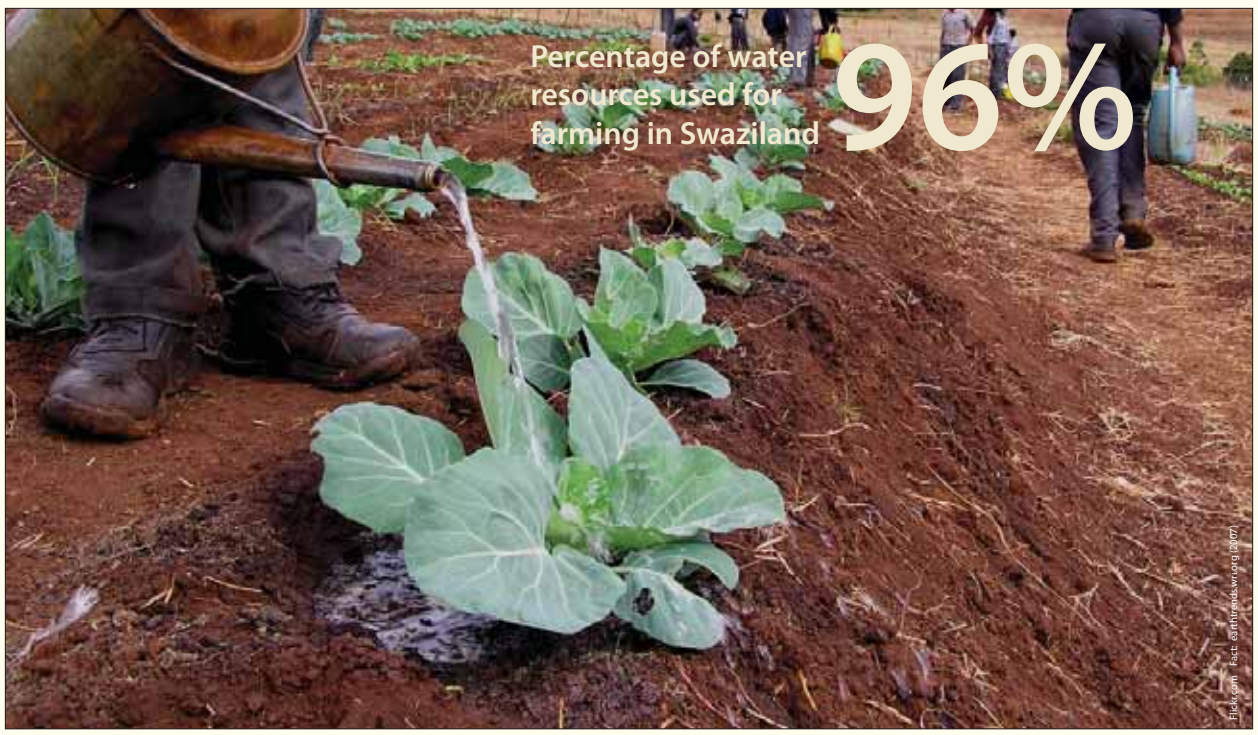
fao.org (2003)

Population Encroachment and Land Degradation

Agriculture accounts for 80 per cent of total land use in Swaziland and is the principal driver of land degradation. Overgrazing is a dominant factor, particularly on communal lands, where more than half of soils are seriously affected by soil erosion (SoE 2001). Rapid population growth has also added to the land degradation problem by putting increased pressure on land resources for shelter and food production. The population density in Swaziland has nearly quadrupled since 1950 (UNESA 2005) and sugar plantations have subsequently claimed an additional 520 km^2 of virgin savannah ecosystems (SoE 2001).

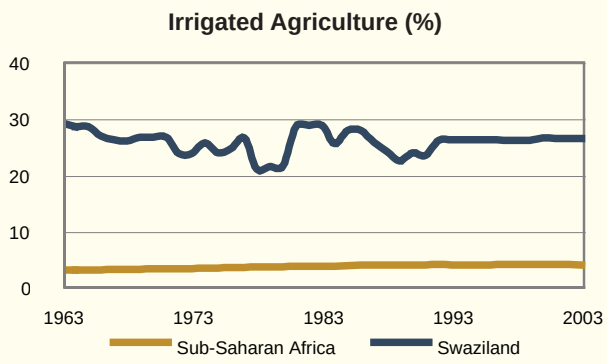


Source: FAOSTAT



Irrigation and Soil Degradation

Irrigation accounts for over 95 per cent of total water use in Swaziland, and irrigated cropland for roughly one-quarter of the total cultivated area (FAO 2005). While irrigation generally increases production levels, the use of poor quality or excessive amounts of water has also led to increased soil salinity and water-logging. In one large sugar plantation alone, more than 2 500 hectares of cropland have been abandoned due to these problems (SoE 2001). To provide for irrigation, Swaziland has already constructed seven large dams and has plans to build more (FAO 2005).



Source: AQUASTAT

Threats to Biodiversity and Invasive Alien Species

Swaziland is topographically and climatically diverse and supports a wide array of unique species and ecosystems of global significance. The eastern region forms part of the Maputaland Centre of Plant Diversity, known for its floral and faunal species richness and endemism. To the west, lies the Drakensberg Escarpment Endemic Bird Area.

Land degradation and pollution due to agriculture and the recent explosion of invasive non-native plants such as eucalyptus and triffid weed are the greatest threats to Swaziland's biodiversity. Non-native plant species have crowded out indigenous competitors, reducing biodiversity and even impacting agricultural productivity. In 2005, the Swazi government declared invasive alien species a national disaster and committed US$1.4 million to their eradication.

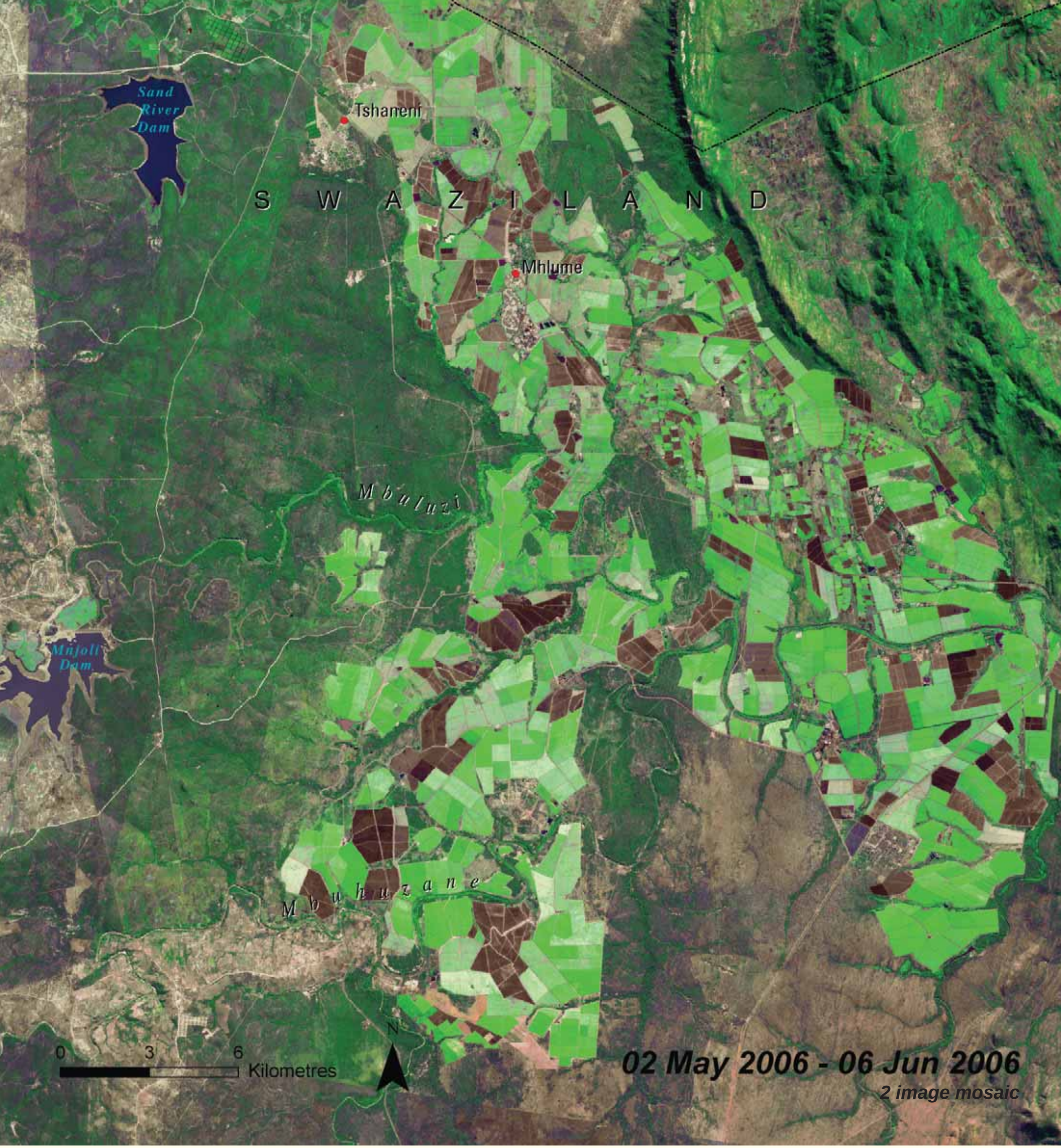
Sand River Dam
Tshaneni
S W A Z I L A N D
Mhlume
Mbuluzi
Mnjoli Dam (under construction)
Mbuthuzane
0 3 6 Kilometres
N
10 Jun 1979


Wikipedia

Sugar Cane Farming: Lubombo Province, Swaziland

Sugar cane production has become Swaziland's biggest industry as large-scale producers have been joined by hundreds of small-scale farmers. Much of this growth can be attributed to government promotion of sugar cane farming. While this growth has come at the expense of natural flora and fauna, it has brought significant benefits for the eastern province of Lubombo.

Sugar cane plantations are found primarily in northeastern Swaziland where temperatures are optimal. However, this region is also characterized by erratic rainfall with periods of drought; precipitation provides only 25 per cent of the water sugar cane crops need. To meet the sugar

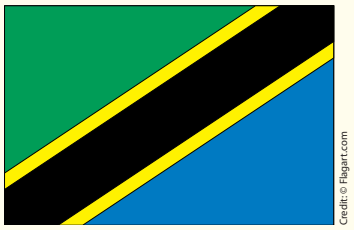


cane industry's remaining water requirements, several dams have been constructed along major rivers, including the Sand River and Mnjoli Dams. These satellite images, from 1979 and 2006, show the dams and how the area devoted to sugar cane plantations has increased over time.

Sugar cane exports bring in roughly US$1 500 million annually to Swaziland. Lubombo Province, in particular, relies heavily on income from sugar cane as well as social services that the industry provides, including medical care, education, housing, and access to clean water. Yet fluctuating sugar prices have prompted the Swazi government to promote the production of other crops. Such a transition, however, is far easier for small-scale farmers than for large-scale producers with extensive plantations.

United Republic of Tanzania

Total Surface Area: 945 087 km²
Estimated Population in 2006: 39 025 000



United Republic of Tanzania is named after its two principal regions—the large mainland section of Tanganyika and the Zanzibar islands located off its coast. The country is surrounded by several large bodies of water, including 1 300 km of coastline on the Indian Ocean and 2 375 km of shoreline along Africa's three largest lakes; Tanganyika, Victoria, and Malawi (Nyasa) (FAO 2005). Lake Tanganyika, which spans United Republic of Tanzania's western border with Democratic Republic of the Congo, is the deepest lake in Africa (Tanzania National Bureau of Statistics 2005).

Important Environmental Issues

- Water Pollution and Aquatic Ecosystems
- Land Degradation and Deforestation
- Threats to Biodiversity and Ecosystems

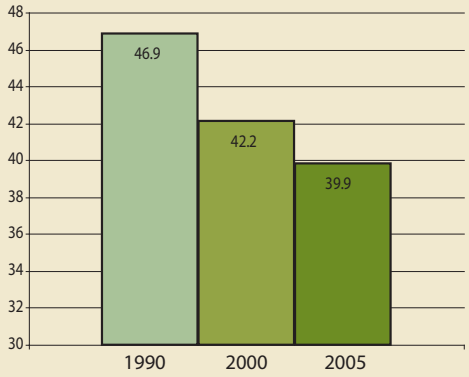
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

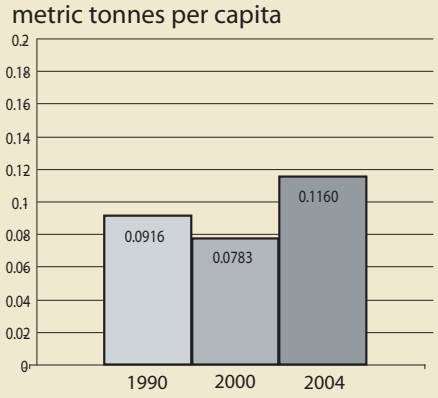
Even though United Republic of Tanzania lost 14.4 per cent of its forest and woodland area between 1983 and 1993, the country is now experiencing a remarkable increase in its forested area. Much of United Republic of Tanzania's environment is protected by a system of national parks. Four of these—Serengeti National Park, Ngorongoro Conservation Area, Kilimanjaro National Park, and Selous Game Reserve—are World Heritage Sites.

★ Indicates progress

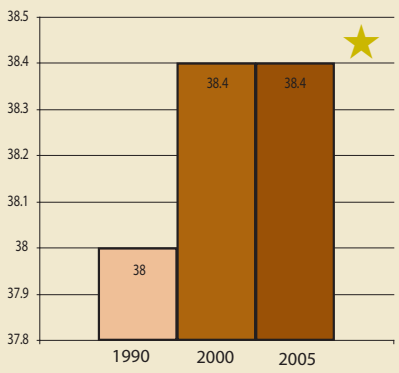
Land area covered by forest, percentage



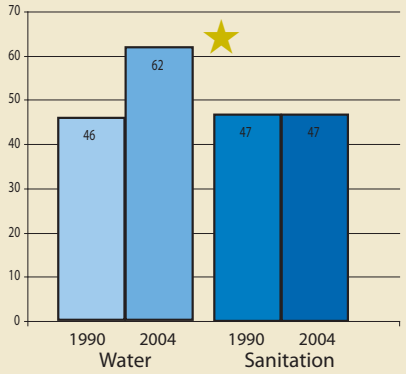
Carbon dioxide (CO_2) emissions, metric tonnes per capita



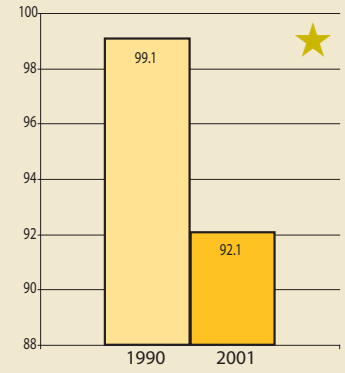
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

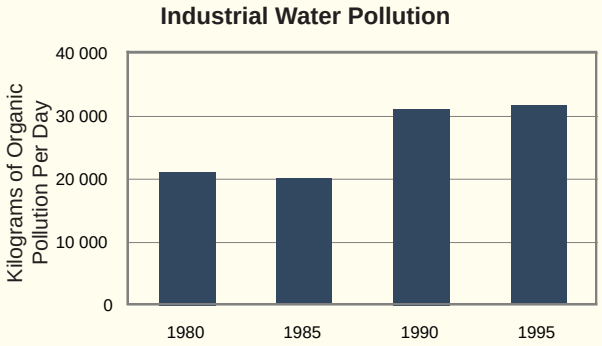


With large numbers of zebra and gazelle and millions of wildebeest, Serengeti National Park is unequalled for its natural beauty and scientific value.

glcom.com (n.d)

Water Pollution and Aquatic Ecosystems

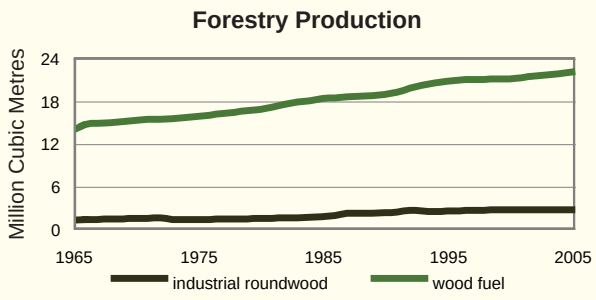
The three largest lakes in Africa—Lake Victoria, Lake Tanganyika, and Lake Malawi (Nyasa)—cover roughly 5.7 per cent of United Republic of Tanzania's total surface area (FAO 2005). Incredibly rich in biodiversity, the lakes are estimated to contain a total of 1 100 endemic fish species (Froese and Pauly 2007). However, pollution from agriculture, industry, mining, and households is threatening the country's water resources. Although the level of industrialisation is low in United Republic of Tanzania,untreated industrial waste causes significant levels of localised pollution. About 80 per cent of the industries, including agro-chemical and chemical industries, breweries and steel manufacturing industries, are located in the coastal Dar es Salaam. It has been estimated that almost 70 per cent of the industries directly or indirectly pollute the Indian Ocean (Mgana and Mahongo 2002). Besides damaging aquatic ecosystems, this pollution also leads to higher incidence of water-borne diseases.



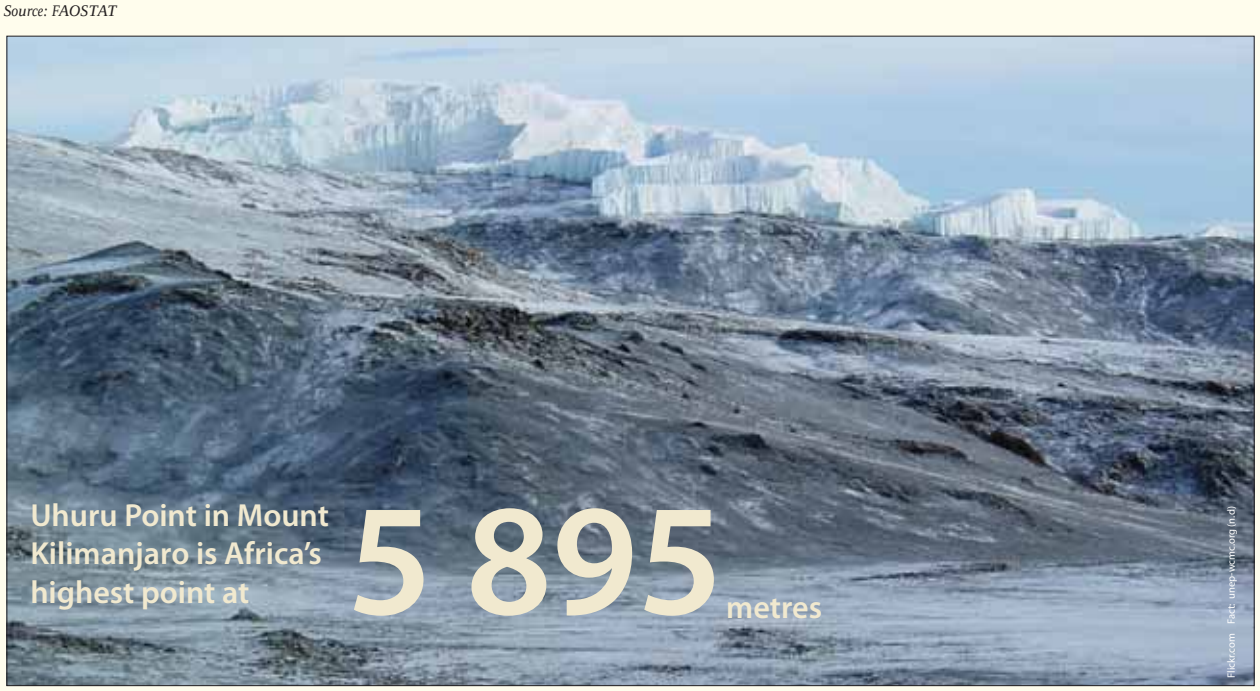
Source: Earth Trends (from World Development Indicators)

Land Degradation and Deforestation

Currently, 25 per cent of land in United Republic of Tanzania is considered severely degraded (FAO AGL 2003), and unsustainable farming practices, overgrazing, and deforestation continue to remove vegetation and sap soil fertility. Despite the creation of large tracts of protected lands and innovative community-based forest conservation projects, United Republic of Tanzania had the third-largest net loss of forest area in Africa (and the sixth largest in the world) between 2000 and 2005 (FAO 2005b). Primary drivers of deforestation include logging for domestic use and export, agricultural conversion, and demand for fuelwood (Tanzania National Bureau of Statistics 2005).



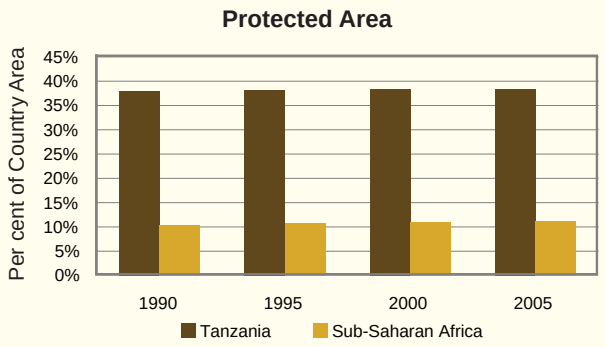
Source: FAOSTAT



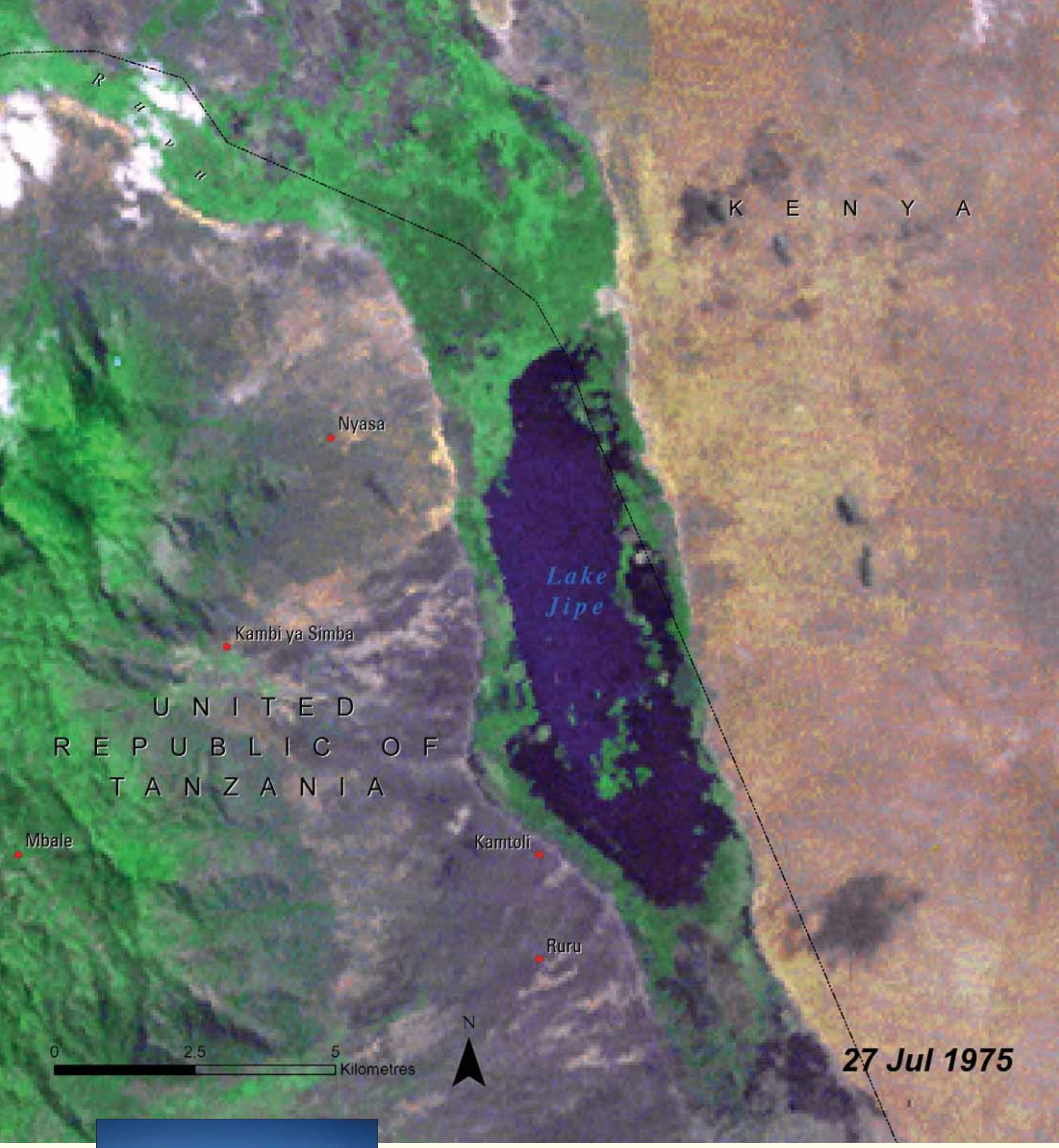
Threats to Biodiversity and Ecosystems

Serengeti National Park is the flagship of United Republic of Tanzania's tourism industry and its ecological and cultural distinction has been recognized by both the World Heritage Commission and the Man and the Biosphere Program. Covering 1.5 million hectares of savannah (UNESCO 2007), the park is famous for the vast herds of wildebeest, gazelles, and zebras that undertake a long and arduous migration to fresh grazing lands each year.

In addition to its terrestrial biodiversity, United Republic of Tanzania's coral reefs are the second largest in Africa, occupying 3 580 km^2 (Spalding and others 2001) along its coast and nearby islands. The reefs are estimated to contain over 150 coral species (CORDIO 2005), which provide habitat for a host of other aquatic organisms. This rich ecosystem is endangered by over-fishing and anchor damage, increased sedimentation from agriculture and deforestation, and water pollution.



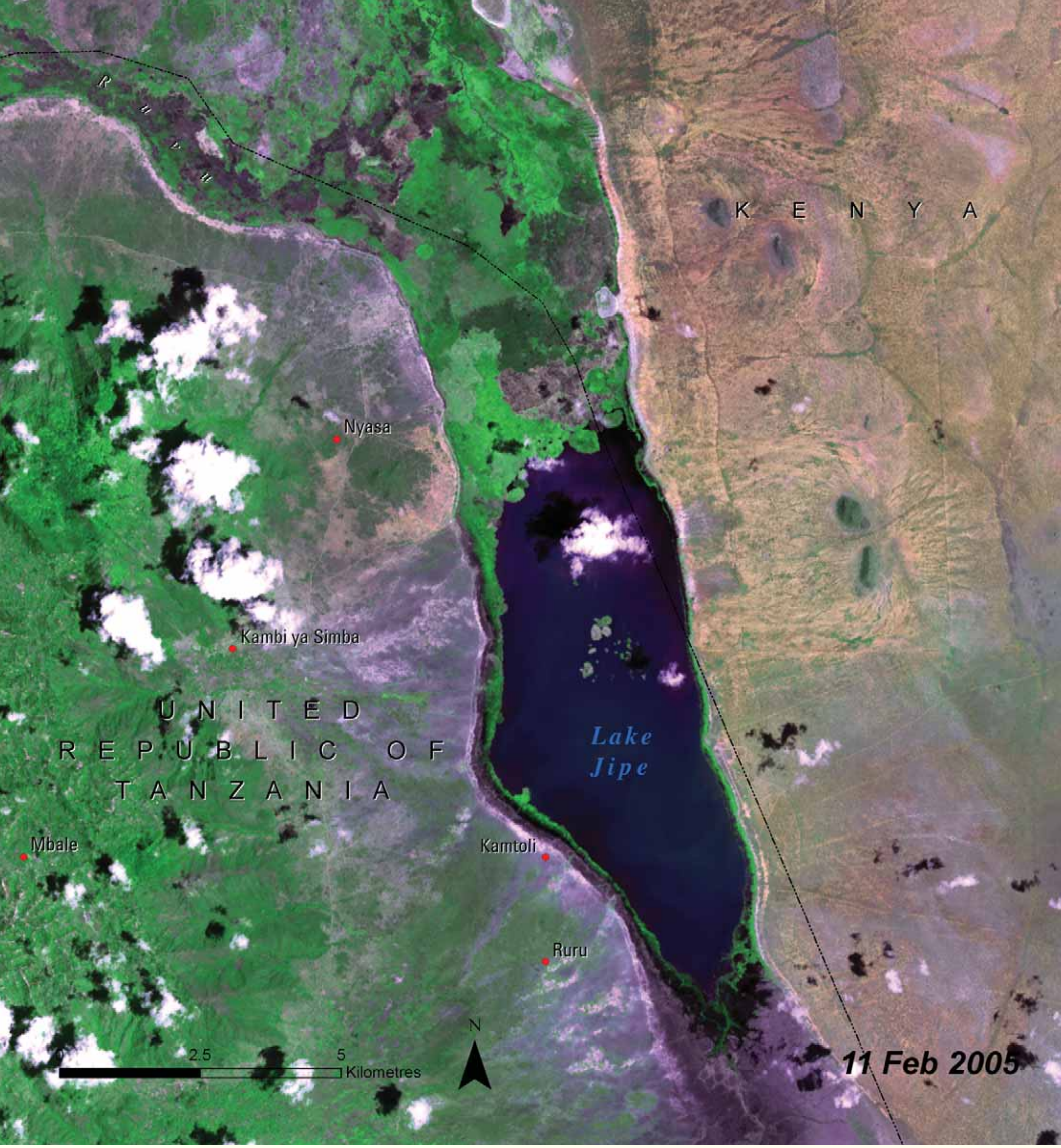
Source: MDG Indicators



Invasive Plants: Lake Jipe, United Republic of Tanzania

Lake Jipe, along United Republic of Tanzania's border with Kenya, is an important source of the Pangani River. As much of 75 per cent of the lake is infested by invasive aquatic plants, particularly cattails (*Typha domingensis*) and papyrus, or bulrush (*Cyperus papyrus*).

The bright green areas at the waters edge in the 1975 and 2005 images show these invasive plants covering parts of Lake Jipe. Coverage in 2005 is notably more extensive, especially at the northern end of the lake. The greyish patch there is evidence that the lake is actually drying up. Research indicates that if current conditions continue, the lake may dry up completely within the next ten years.



The situation in Lake Jipe is the result of a vicious cycle. Drought reduces water levels in the lake, creating conditions in which the invasive plants flourish. The plants, in turn, encourage siltation and help draw down water levels even further.

The Pangani River Basin provides water for hydroelectric power plants at Nyumba ya Mungu and Pangani Falls, which provide at least 20 per cent of United Republic of Tanzania's electricity. Increasingly low water levels in Lake Jipe and elsewhere have the potential to reduce power production. Low water levels have already affected the local fishing industry, forcing fishermen to move south to the Nyumba ya Mungu Dam. Projected water scarcity may also impact wildlife in Kenya's Tsavo National Park.

K E N Y A

T A N Z A N I A

Erica excelsa Forest Extent 1976

Erica excelsa Forest Extent 2000

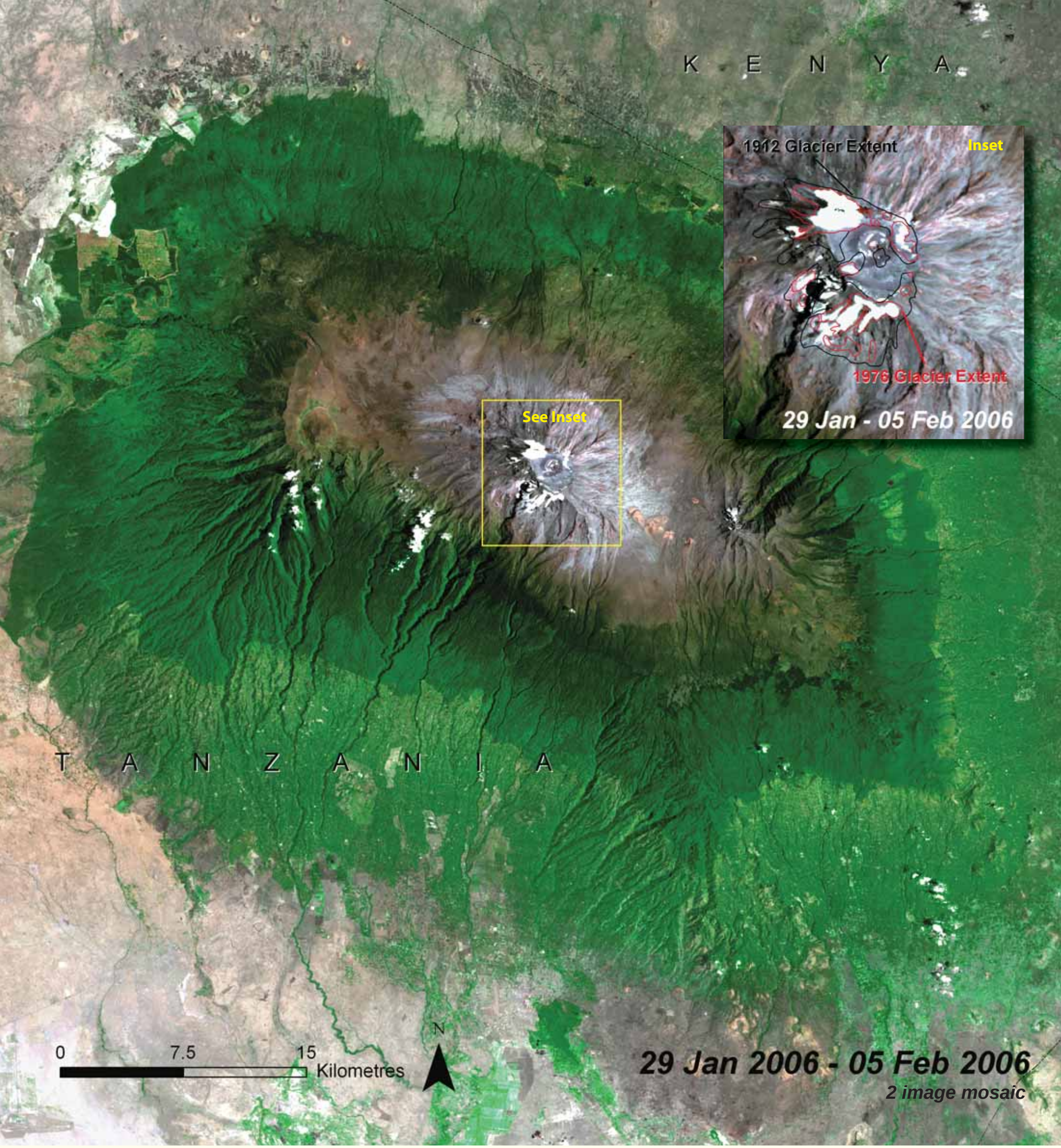
24 Jan 1976

0 7.5 15 Kilometres

N

Mount Kilimanjaro: United Republic of Tanzania

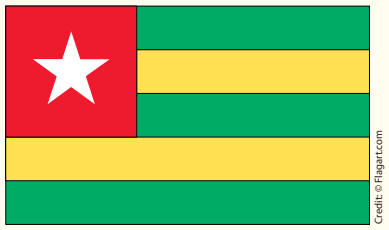
Glaciers on the summit of Mount Kilimanjaro have decreased in area by 80 per cent since the early 20th century. While glacial retreat globally has been linked with rising air temperatures, there is evidence that the decline of Kilimanjaro's glaciers (see inset, above right), along with changes in the boundaries of vegetation zones on the mountain, may be due in large part to a more local trend of decreasing precipitation that began in the 1880s.



It has also been found that water from the melting of Mount Kilimanjaro's glaciers provide little, if any, water to lower elevation streams, as most ice is lost through sublimation; water from the small amount of melting evaporates very quickly. A greater impact on the mountain's hydrology may result from increased burning under the drier conditions since 1880. The upper limit of the forest zone has descended significantly, as nearly 15 per cent of Kilimanjaro's forest cover has been destroyed by fire since 1976. In the 1976 image above, the upper limit of the *Erica excelsa* forest is shown in yellow. By 2000 the upper limit had moved noticeably downslope (red line) as a result of frequent fires. Changes in the hydrological and ecological functioning of Kilimanjaro impact a growing population living on and around the mountain.

Togolese Republic

Total Surface Area: 56 785 km²
Estimated Population in 2006: 6 306 000



Togo is a relatively small country, but its long, narrow shape allows it to span several unique geographic and climatic zones. Half of the population lives in the coastal region, where the climate is tropical and the landscape is dominated by extensive lagoons and marshes. The semi-arid north is characterised by savannah vegetation and is vulnerable to drought.

Important Environmental Issues

- Land Degradation and Deforestation
- Threats to Aquatic Ecosystems
- Threats to Biodiversity

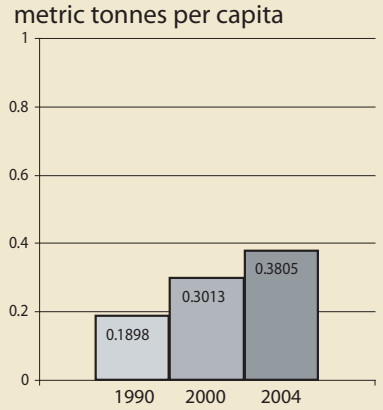
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

Although much of the Togo once was forested, slash-and-burn agriculture and the cutting of wood for fuel have depleted the forest, resulting in the country now having to import wood. Soil and water are threatened by pesticides and fertilizers. The government has taken steps to protect the nation's environment, however, through a comprehensive legislative package.

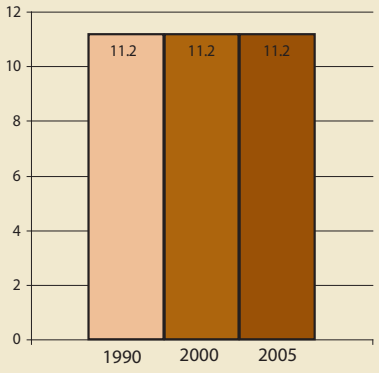
Land area covered by forest, percentage

Carbon dioxide (CO_2) emissions, metric tonnes per capita

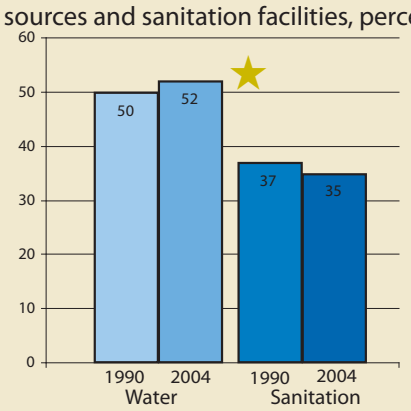


★ Indicates progress

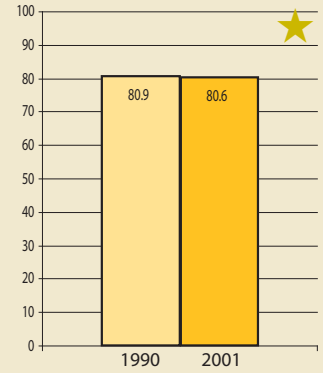
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



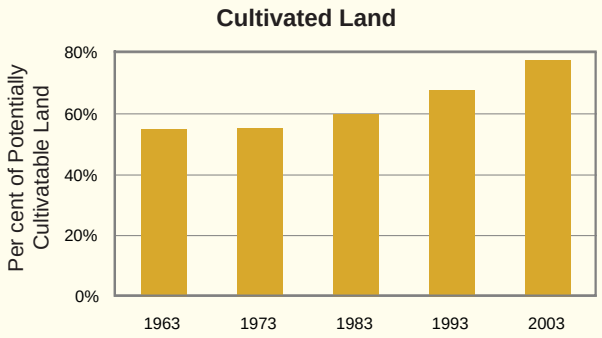
Nearly half of Togo's land is considered arable, making it one of only two countries in Africa with more than 40 per cent of its land suitable for farming.

fao.org (2006)

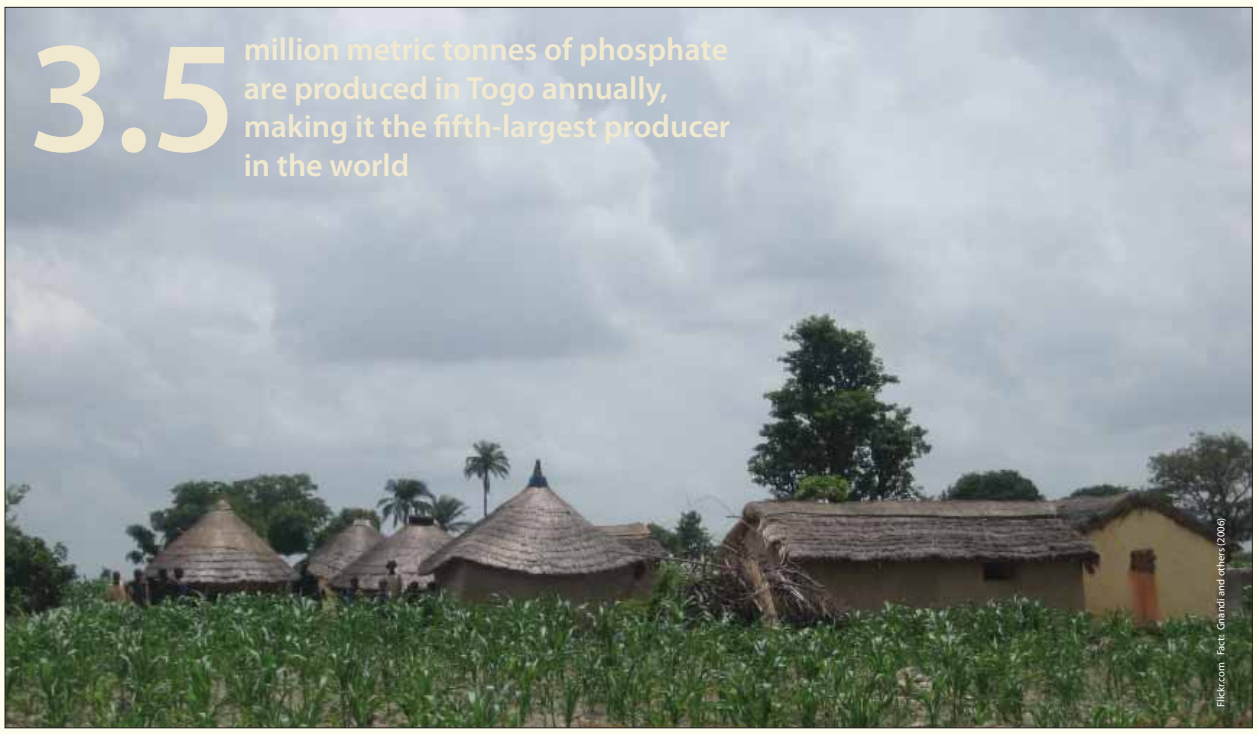
Land Degradation and Deforestation

Over half of the total land area in Togo is heavily degraded (FAO AGL 2003). Causes include reductions in fallowing intervals, intensive harvesting of forest resources, and overgrazing. These trends are exacerbated by the country's high population density and the fact that nearly 80 per cent of potentially arable land is already being utilised (FAO 2005).

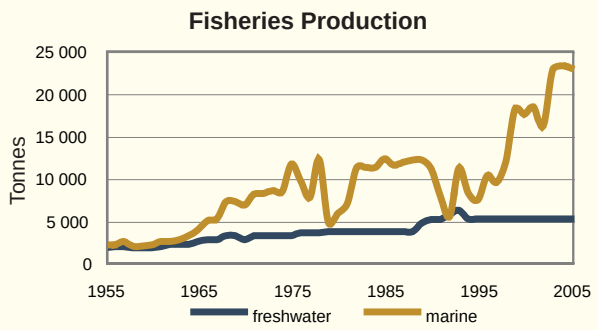
Forests once covered large areas of Togo, but they now occupy only seven per cent of the country (UN 2007). Forests continue to disappear at a high rate in Africa, causing remaining forest cover to decline by nearly 50 per cent between 1990 and 2005 (UN 2007). Slash-and-burn agriculture and the use of forest products for fuel are the major drivers of deforestation.



Source: AQUASTAT and FAOSTAT



Threats to Aquatic Ecosystems



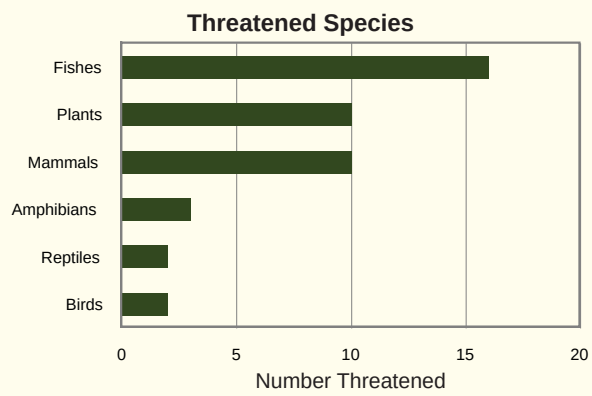
Source: FISHSTAT

Naturally poor soils and agricultural mismanagement have necessitated intensive use of fertilizers, pesticides, and other chemical inputs on farms. Resulting pollution threatens Togo's aquatic environments, which include rivers, lakes, and ocean ecosystems, which harbour over 1 000 aquatic animal species (CBD 2003). Overfishing is another threat to aquatic biodiversity, particularly in the marine sector. Evidence of over-exploitation includes reduced yields and the disappearance of certain species.

Threats to Biodiversity

Togo is one of the smallest countries in West Africa, but its diverse ecosystems create a land rich in biodiversity. Some 3 472 animal species inhabit the country, including the African elephant, Diana monkey, and West African manatee (CBD 2003).

Protected areas comprise 11.2 per cent of total land area (UN 2007) but are under constant threat from agriculture, poaching, and insufficient institutional and legal enforcement. To address these problems, reserves such as the Missahoè Forest have sought local community involvement to restore and sustainably manage protected lands.



Source: IUCN Red List

T O G O

Mono

Akpaka

Glito

Ayero

Tchoubpupoue

Ountivou

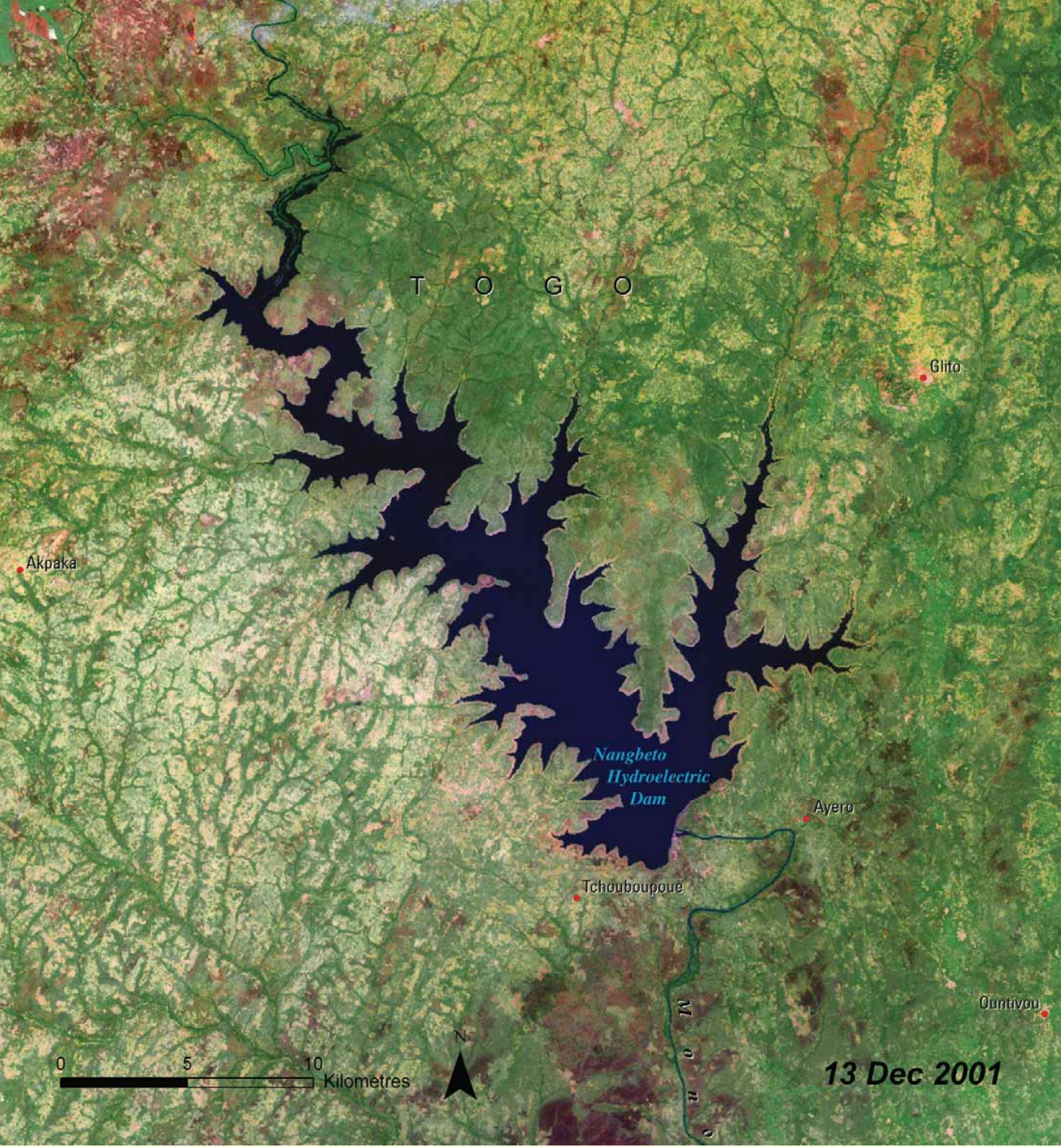
0 5 10 Kilometres

13 Jan 1986

Nangbéto Hydroelectric Dam: Togolese Republic

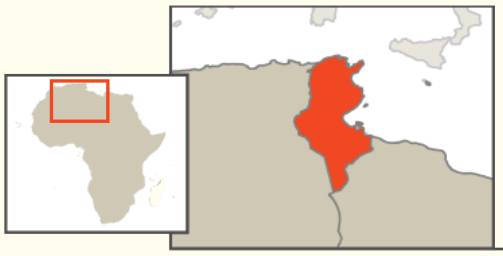
A feasibility study in the 1960s identified the Nangbéto region as the best location for hydroelectric power development in Togo. The site—160 km upstream from the coast—is the only place where a dam of sufficient volume to regulate the flow of the Mono River was possible. As demand for electricity grew, the decision was made in the 1980s to proceed with the Nangbéto Hydroelectric Dam.

Satellite images from 1986 and 2001 show the region before and after the dam's construction. The completed dam created a reservoir with a surface area of approximately 180



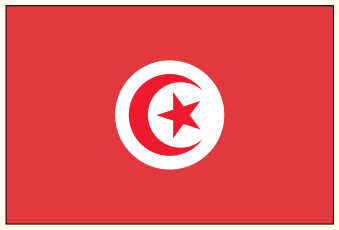
km² and a volume of 1 465 million m³. In addition to generating electricity for domestic and commercial use, the dam also provides water for agricultural irrigation and is a source of commercial fishing and tourism. However, these benefits have been offset by environmental costs.

Construction of the dam, creation of the reservoir, and installation of transmission lines resulted in the loss of nearly 150 km² of savannahs and gallery-forests that provided habitat for rare local fauna. The reservoir submerged 1 285 households and 5 500 hectares of agricultural land. Loss of the natural vegetation in the region has altered the climate enough to have had a negative impact on nearly 350 hectares of banana plantations. The creation of the reservoir has also increased the population of two species of aquatic snails that serve as intermediate hosts of the parasite that causes the disease bilharzia.



Republic of Tunisia

Total Surface Area: 163 610 km²
Estimated Population in 2006: 10 210 000



Credit: © Flagart.com

Tunisia is a small country with a relatively long coast sculpted by many natural harbours and inlets. The Atlas Mountain range extends into northern Tunisia and reaches altitudes of 1 500 m. The temperate and hilly regions surrounding these mountains have fertile soils, although irregular rainfall leads to periodic drought. The semi-arid central region merges into the Sahara Desert at the southern tip of the country.

Important Environmental Issues

- Land Degradation and Desertification
- Water Scarcity
- Air and Water Pollution

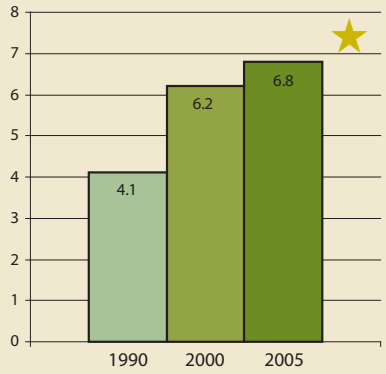
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

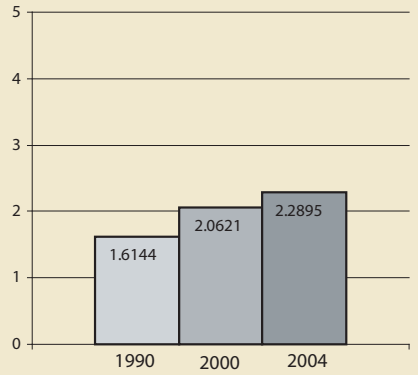
Loss of agricultural land to erosion, which threatens 76 per cent of Tunisia's land area, and degradation of range and forest lands because of overgrazing or overcutting of timber for fuel, are major concerns. Also, pollution from industry and farming activities threatens the nation's limited water supply. Forested lands cover about 510 000 hectares, a large proportion of which is state owned. This may be the reason for a gradual increase in forested area.

★ Indicates progress

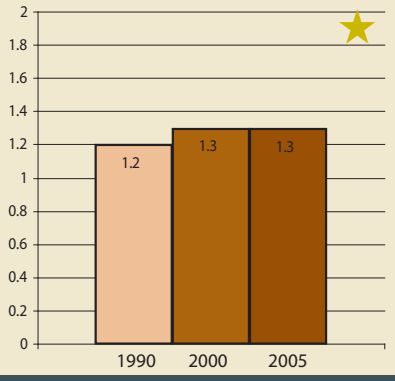
Land area covered by forest, percentage



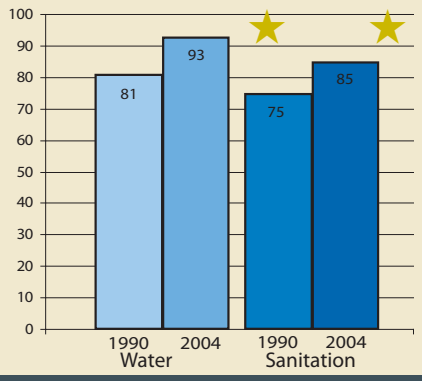
Carbon dioxide (CO_2) emissions, metric tonnes per capita



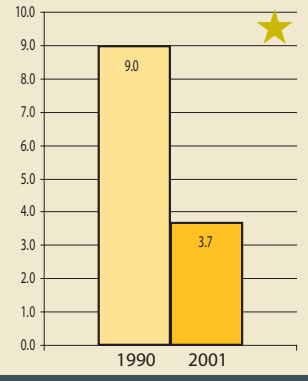
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

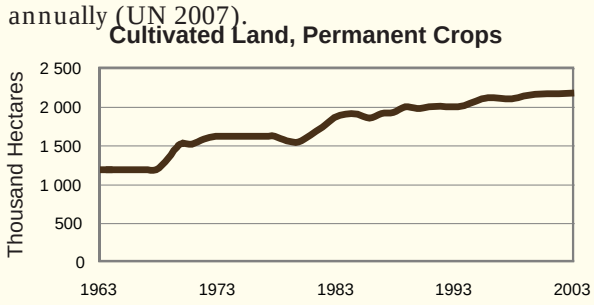


Tunisia's Cape Blanc (Ra's al Abyad) is the northernmost tip of Africa.

fao.org/geonetwork (n.d)

Land Degradation and Desertification

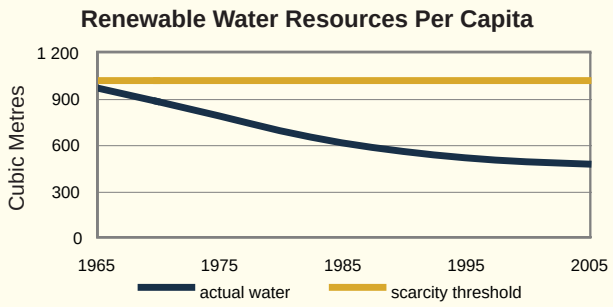
Agriculture is a major driver of land degradation in Tunisia. At least 8 000 hectares of land are lost annually to the encroaching Sahara, costing an estimated US$100 million each year (IUCN and WWF 2003). Approximately one-fifth of Tunisia's land north of the Sahara is affected by salinisation (Mtimet 2004), reducing agricultural productivity and forcing farmers onto rangelands and other marginal soils prone to desertification. Tunisia's forests, currently covering roughly seven per cent of the country, are a critical buffer against continued soil erosion and desertification. Tunisia is one of the few African countries reporting an annual net increase in forest cover, of nearly two per cent annually (UN 2007).



Source: FAOSTAT

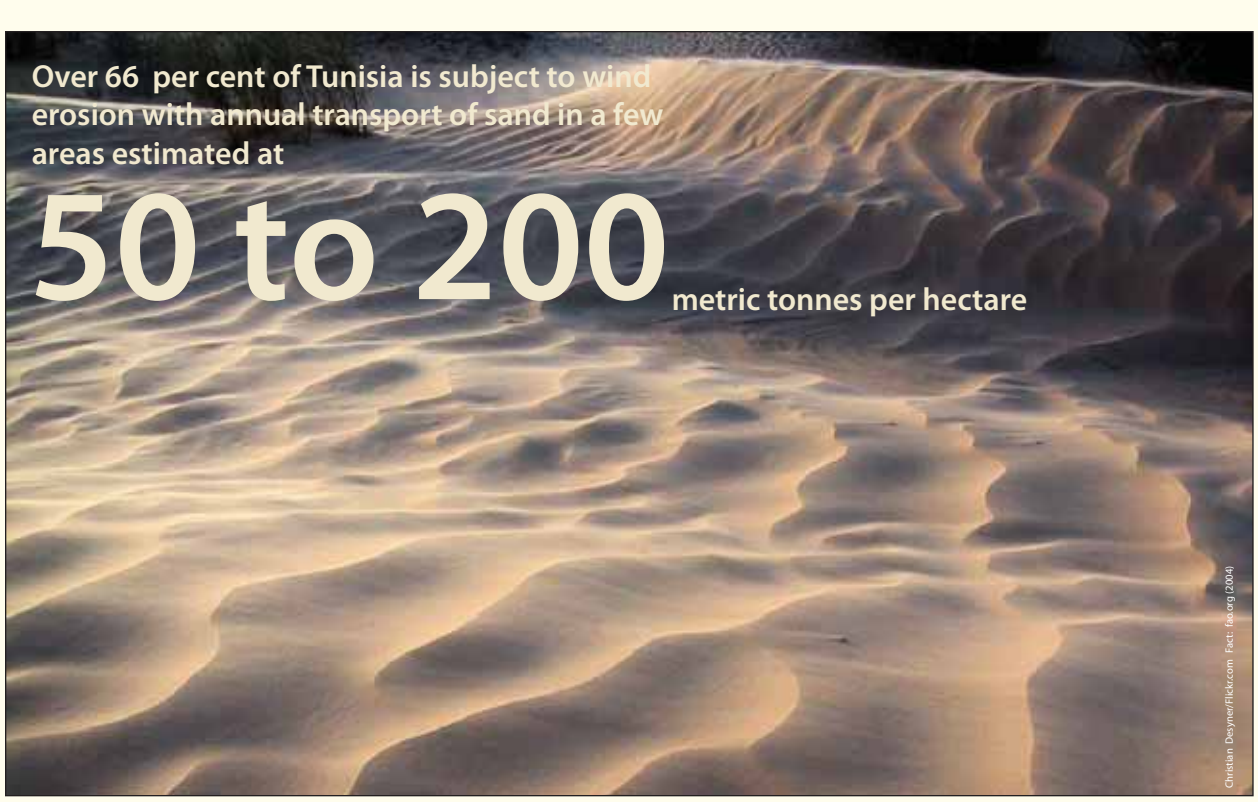
Water Scarcity

Tunisia is one of the most water-scarce countries on the continent, with only 458 m^3 available per person per year (FAO 2007). The north receives the vast majority of rainfall and has over four-fifths of all surface water resources, but even relatively moist regions are subject to drought. Eighty per cent of groundwater resources are already being exploited, primarily for irrigation (Mtimet 2004).



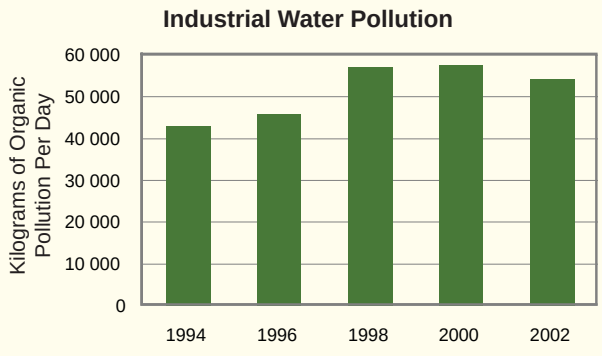
Source: AQUASTAT

Lake Ichkeul, a UNESCO World Heritage Site, is the last remaining freshwater lake in a chain of lakes that once extended along the northern African seaboard. Lake Ichkeul and its marshes are extremely important for migratory waterfowl, but these habitats are threatened by three dams that have substantially reduced freshwater inflow, causing a detrimental increase in salinity (UNESCO-WCMC 2007).



Air and Water Pollution

Tunisia is one of the most urban countries in Africa, with 63 per cent of the population living in cities (UNESA 2006). In the capital, Tunis, air pollution from motor vehicles is a growing issue, although the problem has yet to become severe. In industrial cities, fertilizer manufacturing is a major source of both air and water pollution. Phosphorus mine tailings have contributed to elevated levels of arsenic and heavy metals in Tunisia's only major perennial river, the Madjerda, which eventually feeds into the Gulf of Tunis (Jdid and others 1999).



Source: The World Bank 2006

MEDITERRANEAN SEA

TUNISIA

Bizerte

El Houach
Zarzouna

Menzel Djemil

Lake Bizerte

Sejnane

Tinja Channel

Lake
Ichkeul

Dawwar Tinjah

Menzel Bourguiba

Melah

Ghezala

Joumine

Ghezala
Dam

Matfur

0 5 10
Kilometres

N

25 Jun 1987

Changes in Lake Ichkeul: Tunisia

Ichkeul National Park includes Lake Ichkeul and surrounding wetlands that form an important wintering and breeding area for migratory birds. It has been designated as a UNESCO Biosphere Reserve and a Ramsar Wetland of International Importance. Lake Ichkeul is fed by seven small rivers but is considered a lagoon because of its connection with the sea via Lake Bizerte (1987 image). During the wet season, Ichkeul fills with fresh water from these rivers. During the dry season, the lake's water level falls, allowing an influx of saltwater from Lake Bizerte. These

alternating conditions create an ideal environment for *Potamogeton pectinatus* (yellow arrows)—a pondweed and principal food source of migratory birds and waterfowl.

Construction of three dams along rivers that feed Lake Ichkeul modified this fragile ecosystem by decreasing freshwater inflow and increasing salinity during the dry seasons of 1977, 2001, and 2002. Two periods of drought (1993-1995 and 2001-2002) aggravated this trend, leading to a total disappearance of *Potamogeton pectinatus* from 1994 to 2002. In 2002, a mere 10 000 migratory birds came to Lake Ichkeul, the lowest numbers ever recorded.

The Tunisian government responded by increasing water releases from the dams. Helped by favorable rainfall conditions, the *Potamogeton pectinatus* started to recover in 2003, reaching 70 km^2 in 2006 (2005 and 2007 images). Concurrently, migratory birds began returning. In 2004/2005 their numbers had climbed to 30 000.

T U N I S I A

Bordj Sidi Toui

0 4 8 Kilometres

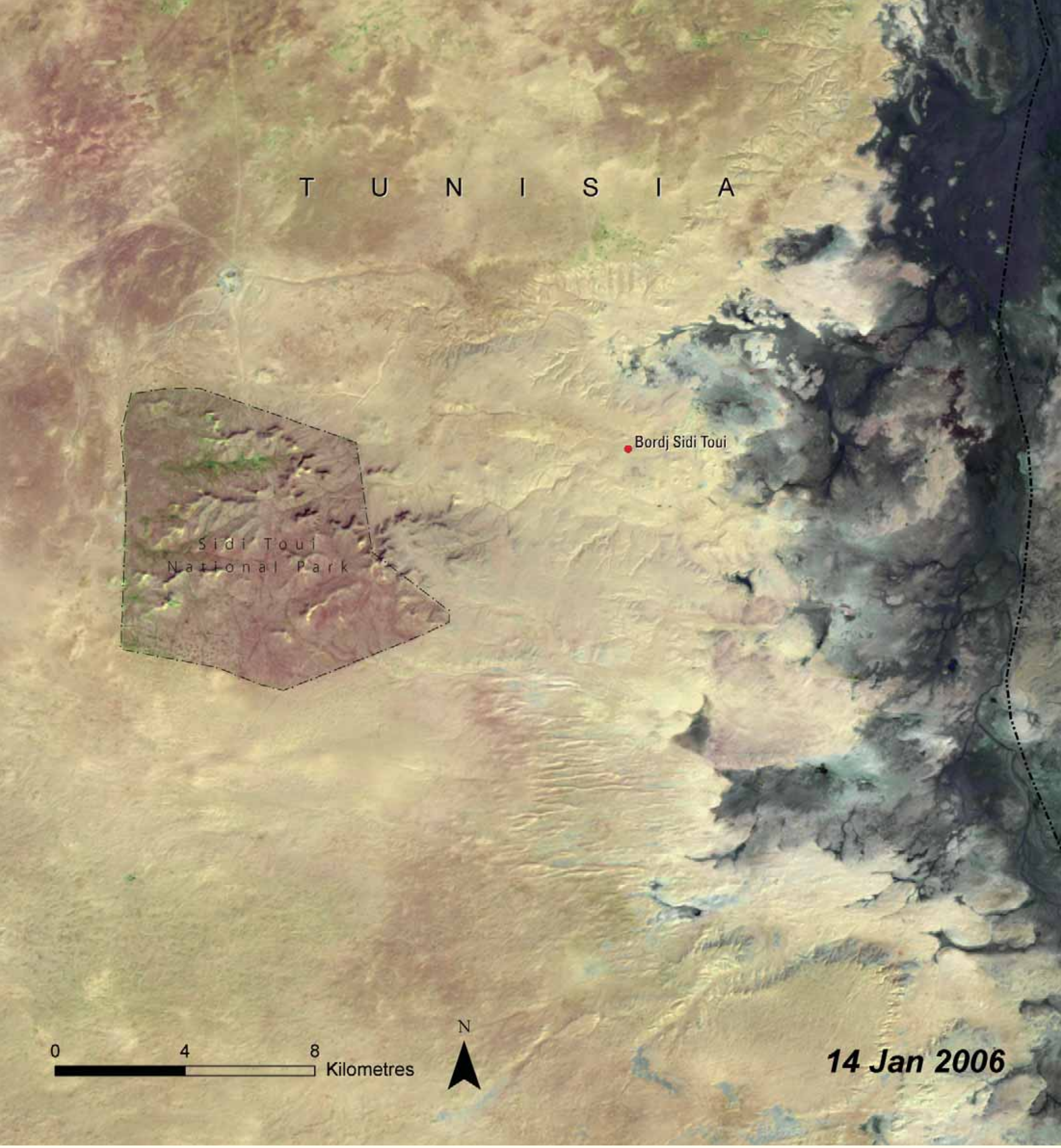
N

02 Jan 1987

Dorcas Gazelle (Gazella dorcas)

Habitat Regeneration: *Sidi Toui National Park, Tunisia*

The semi-arid Sahelian grassland and scrub of southern Tunisia has been profoundly altered by human activities during the last century. Located on the northern fringe of the Sahara Desert, this ecosystem is susceptible to erosion and desertification brought on by droughts, overgrazing, and agriculture. In 1993, Sidi Toui National Park was established. Within the bounds of this protected area, natural vegetation began to return. The 1987 image shows the barren condition of the region before the park was created. In the 2006, image the outline of the park, which is protected from

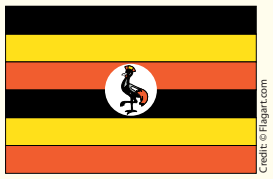


the effects of grazing cattle, contrasts markedly with the surrounding landscape. Protection substantially increased the vegetation density and species diversity, particularly of the grasses.

The Scimitar-horned oryx (*Oryx dammah*) and five other species of gazelles and antelope native to this area had been brought to near extinction by lack of habitat and overhunting throughout the 20th century. Classified as critically endangered in 1996, a small population of Scimitar-horned oryx was introduced into Sidi Toui Park in 1999. If the population inside the park thrives, it may enable future reintroductions of Scimitar-horned oryx elsewhere, Sidi Toui also provides habitat for several native species of antelope, as well as a variety of birds species.

Republic of Uganda

Total Surface Area: 241 038 km²
Estimated Population in 2006: 29 857 000



Uganda is a land-locked country that borders Lake Victoria, the second-largest freshwater lake in the world. Most of the country is fertile and well-watered, with many natural lakes and rivers. Generally, the climate is tropical with one to two thousand millimetre of rain falling annually in two rainy seasons, although roughly seven per cent of the country is classified as arid or semi-arid.

Important Environmental Issues

- Land Degradation and Deforestation
- Habitat Degradation and Threats to Biodiversity
- Water Availability and Pollution

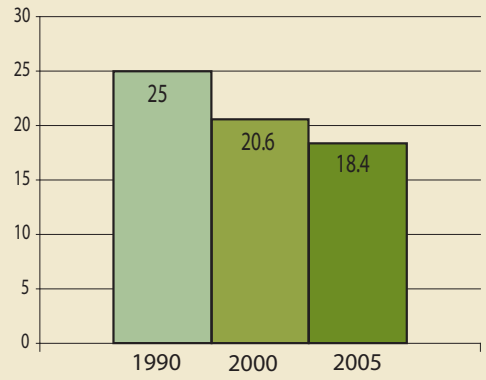
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

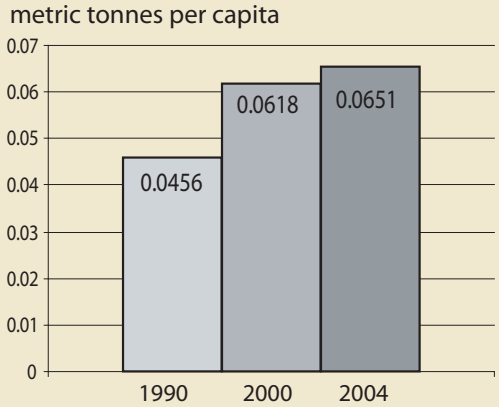
About half of the forested area in Uganda is savannah woodland. Uganda's economy is predominantly agrarian and one-third of the land area is under cultivation. Even wetlands are being drained for agricultural use. Major environmental problems in Uganda include overgrazing, deforestation, and agricultural expansion, all of which lead to soil erosion.

★ Indicates progress

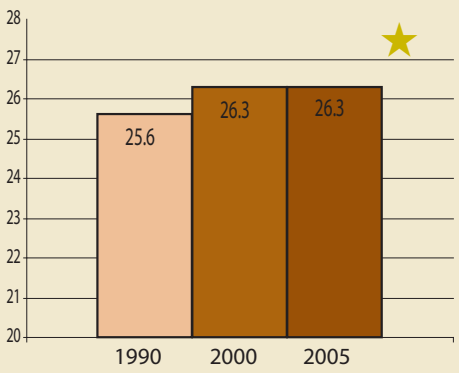
Land area covered by forest, percentage



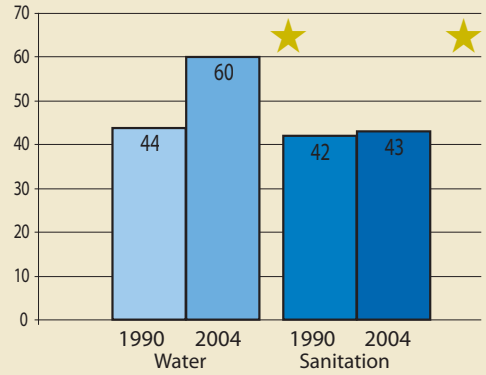
Carbon dioxide emissions (CO_2), metric tonnes per capita



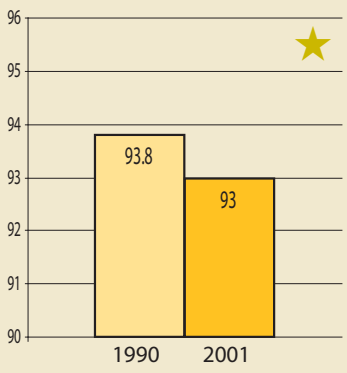
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



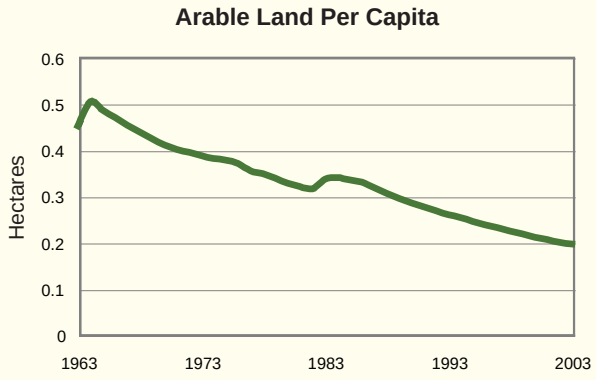
Slum population as percentage of urban



Uganda is home to over half of the World's 720 remaining Mountain Gorilla's (Gorilla beringei beringei). Most of them live in Uganda's Bwindi Impenetrable National Park.

sciencedaily.com (2007)

Land Degradation and Deforestation



Source: FAOSTAT

Seventy-one per cent of Uganda's land area is potentially arable, the largest proportion of any East African country. However, rapid rural population growth, lack of access to improved inputs, overgrazing, and conversion of forests for agriculture have resulted in significant land degradation. Forests are also threatened by harvesting of wood for fuel; over 95 per cent of the population relies on fuelwood as a primary source of energy (WHO 2006). Resulting soil erosion now accounts for over 80 per cent of the total cost of all environmental degradation in Uganda (SoE 2000/2001). In the worst affected districts, over 80 per cent of soil is considered to be severely degraded.

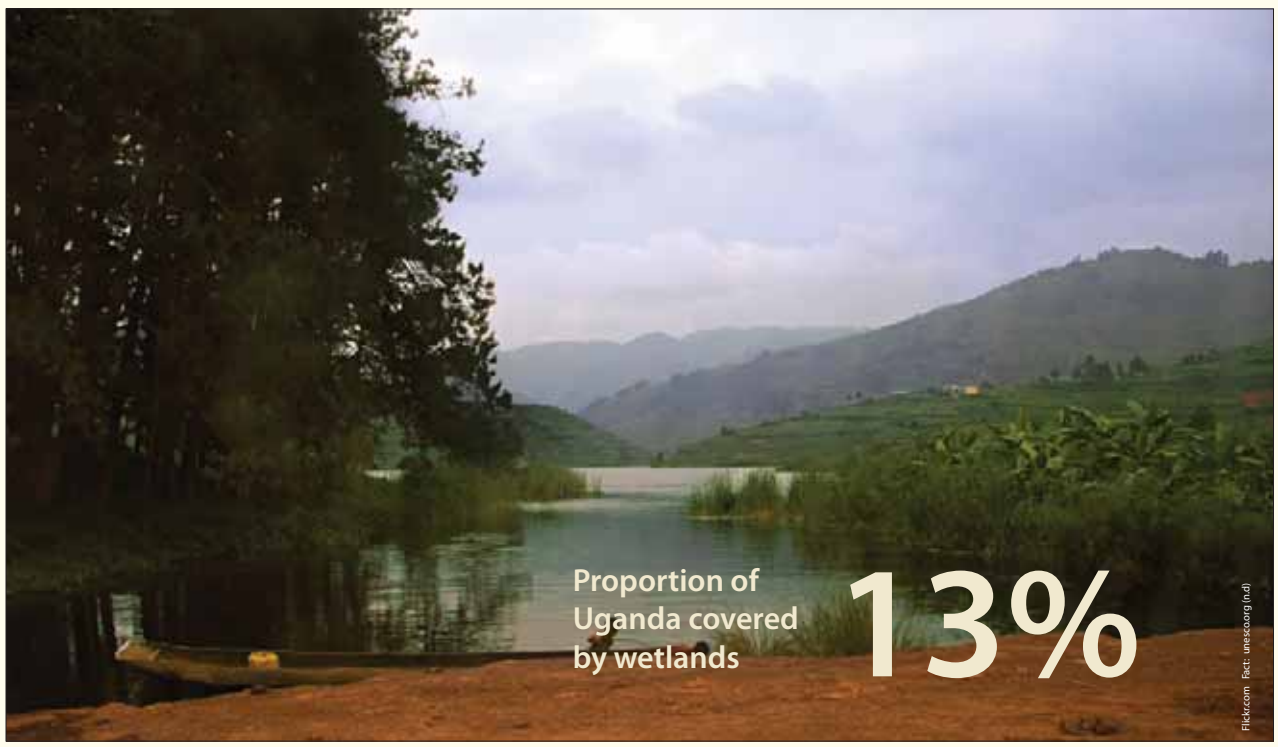
Habitat Degradation and Threats to Biodiversity

Uganda is home to diverse plant and animal species, reflecting its high variability of landscapes and ecosystems. Threats to biodiversity include poaching, deforestation, conversion and pollution of wetlands, and invasive species.

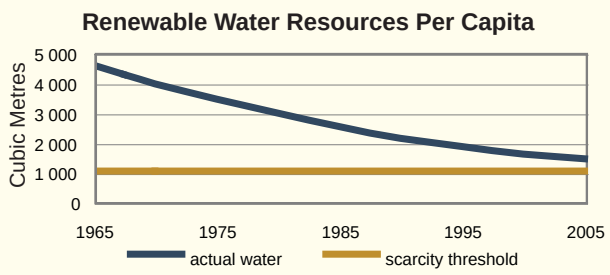
Bwindi Impenetrable National Park, a UNESCO World Heritage Site, is one of the largest and most biologically rich natural forests in East Africa. Covering 33 000 hectares, it contains over 350 species of birds, 120 species of mammals (including 14 primate species), 200 species of butterflies, and half of the world's remaining 700 mountain gorillas (UNESCO 2007).

	1960	1995/98	% Loss
Antelope	141 300	41 300	70%
Elephant	25 000	1 900	92%
Rhinocerous	600	0	100%
Hippopotamus	26 000	4 000	85%
Rothschild's giraffe	2 500	200	92%
Buffalo	60 000	18 000	70%

Source: State of Environment Report for Uganda 2000/2001



Water Availability and Pollution



Source: AQUASTAT

Fresh water accounts for over 15 per cent of Uganda's surface area (FAO 2005). However, rapidly rising demand, uneven distribution of water resources, and pollution have placed Uganda in a state of water stress, with less than 1 500 m^3 of water available per person per year (FAO 2007). Water from available sources principally affected by pollution from residential, industrial, and agricultural discharges into open water bodies is also an area of concern.

DEMOCRATIC REPUBLIC OF THE CONGO

Mt. Speke

Mt. Stanley

Mt. Baker

U G A N D A

0 1 2 Kilometres

N

07 Aug 1987

Glacial Recession: Rwenzori Mountains, Uganda

A comparison of satellite images from 1987 and 2005 shows a decrease in the extent of glaciers on Speke, Stanley, and Baker peaks in the Rwenzori Mountains, which lie on the equator between Uganda and Democratic Republic of the Congo, and are a major source of water for the lower plains like Kasese. Seasonal changes in snow and ice cover prevent simple visual analysis from conclusively measuring the decline of these glaciers. However, scientific findings from studies

DEMOCRATIC REPUBLIC OF THE CONGO

Mt. Speke

Mt. Stanley

Mt. Baker

U G A N D A

0 1 2 Kilometres

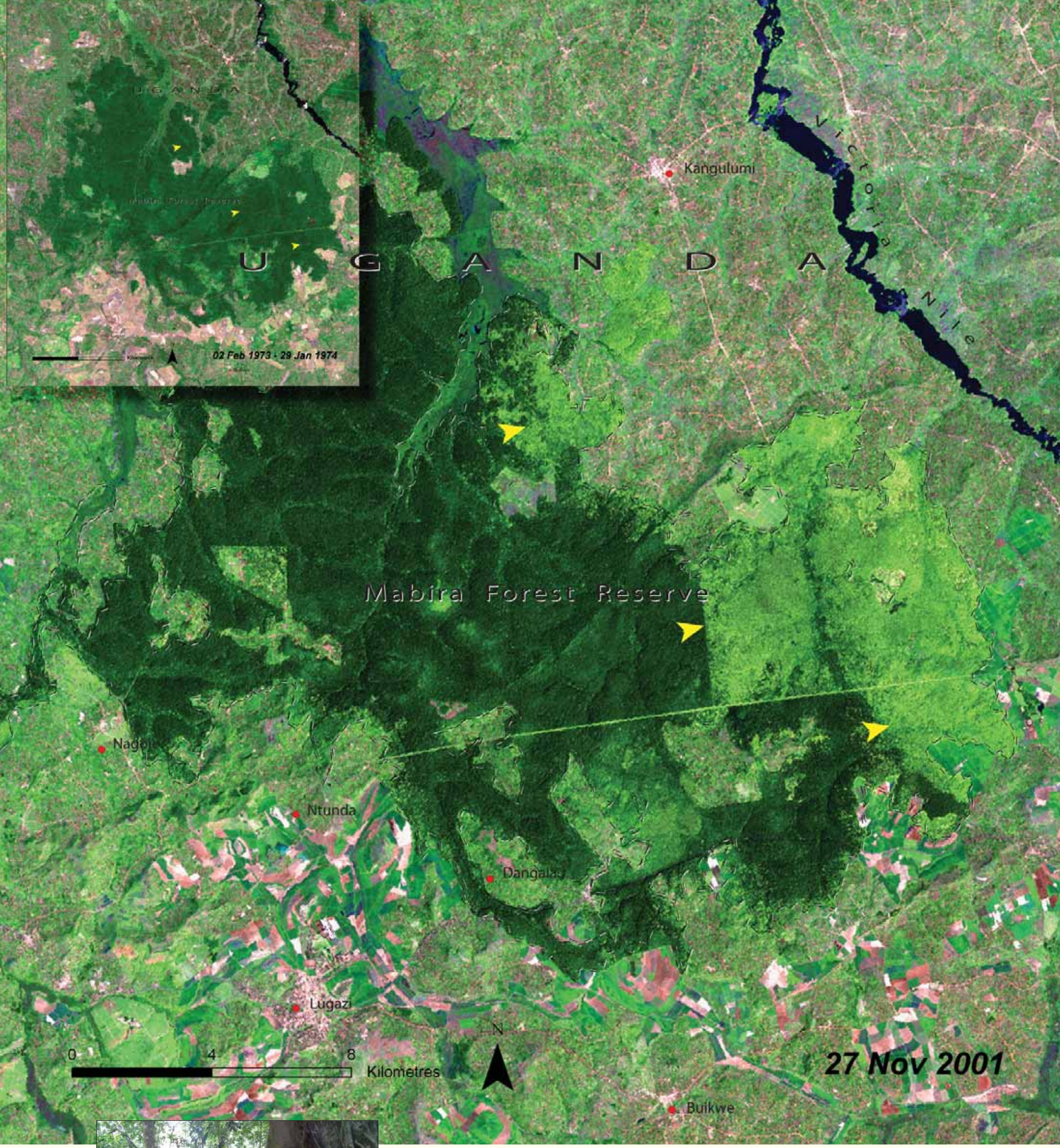
N

21 Feb 2005

in 2003 and 2006 show that the glaciers at the tops of the Rwenzori Mountains are rapidly receding. The glaciers declined by 50 per cent between 1987 and 2003.

This glacial recession is generally attributed to increased air temperature and decreased snow accumulation during the 20th century. It has recently been suggested that decreasing cloud cover during that same time period has contributed to a higher rate of sublimation (vaporisation of ice without melting) of these glaciers as well.

A century ago the glaciers of the Rwenzori Mountains covered nearly 6.5 km^2. If the glaciers continue to recede, as they have since 1906, researchers estimate they will be gone in the next 20 years.



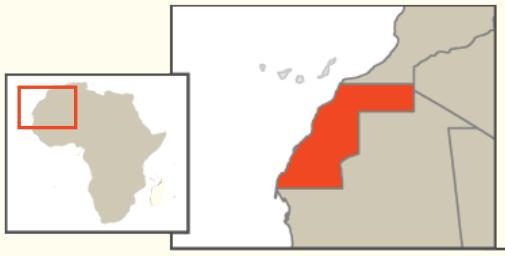
Secondary Forest Growth: Mabira Forest, Uganda

Mabira Forest, located in one of the Uganda's most densely populated districts, is the country's only protected area of medium-altitude, moist, semi-deciduous forest. The forest contains a wealth of biodiversity, provides a variety of services to local inhabitants, and is important to the area's hydrology. The forest is under intense pressure from timber harvesting, charcoal production, fuelwood collection, and agricultural encroachment.

A 1989 study estimated that 29 per cent of Mabira Forest was lost between 1973 and 1988. The report also noted a significant increase in ecological disturbance in the areas of forest that

remained. In the 2001 image, a large portion of the forest described in 1987 still shows the light green colours of young secondary growth (yellow arrows). The 2006 image shows that this secondary forest still remains largely intact and is maturing.

The Ugandan government plans to give much of this portion of Mabira Forest to the Sugar Corporation of Uganda (SCOUL) to expand its sugar plantations. This prospect sparked opposition protests in Kampala, 50 km to the southwest. While the government argues that the need for economic development justifies the loss of the forest, many environmental groups have opposed the move, citing the value lost in biodiversity, ecosystem services, timber production, eco-tourism, and carbon sequestration credits, which can be traded on the world market.



Non-Self-Governing Territory of
Western Sahara

Total Surface Area: 266 000 km²
Estimated Population in 2006: 356 000

Western Sahara, a non-self-governing territory in Africa, is highly arid with a long Atlantic coastline. The terrain is mostly low, flat desert with a few small mountains rising in the south and northeast. The territory as a whole is one of the least densely populated areas in Africa with less than two inhabitants per square kilometre. Over 90 per cent of the population is concentrated in urban areas (UNESA 2006). Natural resources on land are limited to phosphate and iron-ore deposits but there are rich offshore fisheries.

Important Environmental Issues

- Land Use and Food Production
- Water Resources
- Marine Fisheries

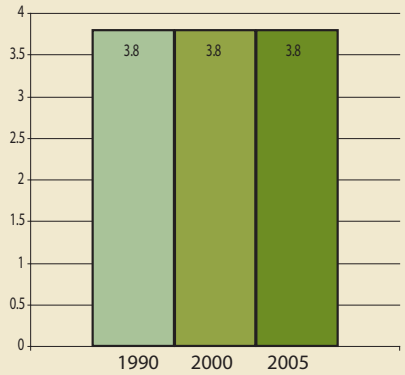
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

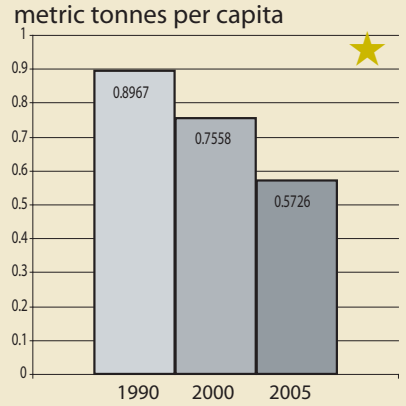
As in all semi-arid and arid regions, annual rainfall in Western Sahara is highly variable, with average rainfall ranging from about 20 mm to just over 50 mm per year. Sparse water and lack of arable land largely limits crops in Western Sahara to fruits and vegetables that can be grown in the territory's few oases. Ninety-four per cent of the population lives in urban areas. Western Sahara has one of the continent's highest urbanisation rates, at 96 per cent.

★ Indicates progress

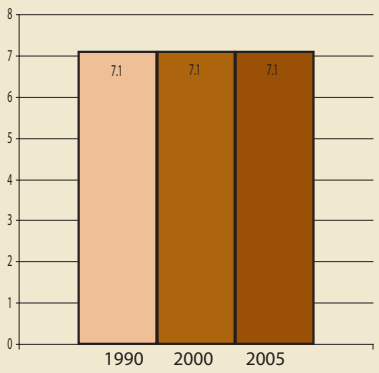
Land area covered by forest, percentage



Carbon dioxide (CO_2) emissions, metric tonnes per capita ★



Protected area to total surface area, percentage



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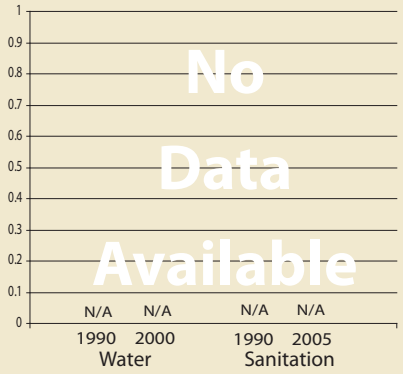

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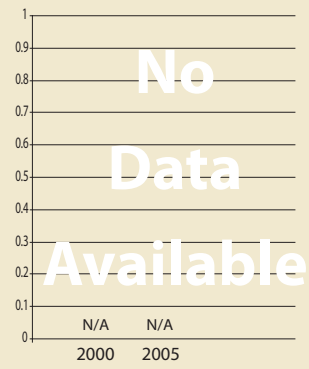
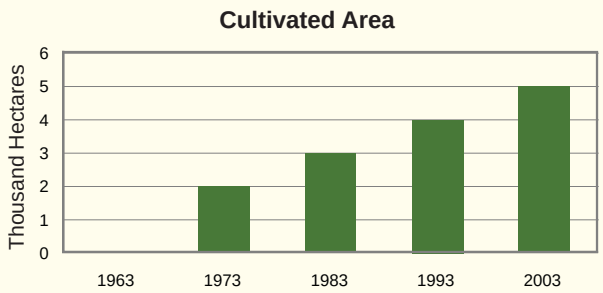


Western Sahara contains one of world's richest phosphate deposits. Saharan phosphate is mineral rich and is of great importance for use as fertilizer.

richardknight.homestead.com
revolutionarydemocracy.org

Land Use and Food Production

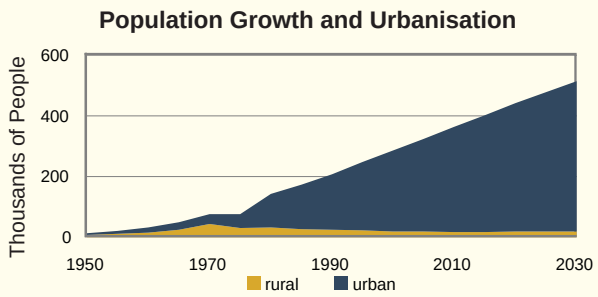


Source: FAOSTAT

Western Sahara has a hyper-arid climate and lacks sufficient and reliable rainfall for agriculture. Crops occupy only 5 000 hectares of land, which is less than half of one per cent of the total surface area (FAO 2006). As a result, most food must be imported to meet the needs of the population.

Water Resources

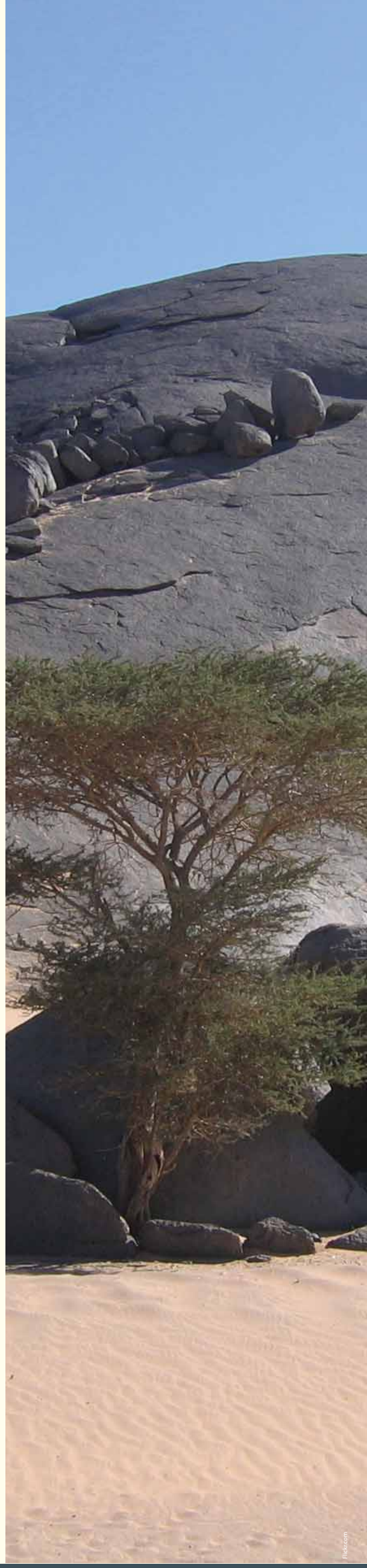
The climatic conditions in Western Sahara are harsh and water infrastructure is underdeveloped. Although official statistics are lacking, access to water and sanitation in Western Sahara is thought to be lower than in neighbouring countries. Occasional flooding brought on by rare, torrential rains disrupts livelihoods, although these temporary floods are important for the territory's fragile desert ecosystems.

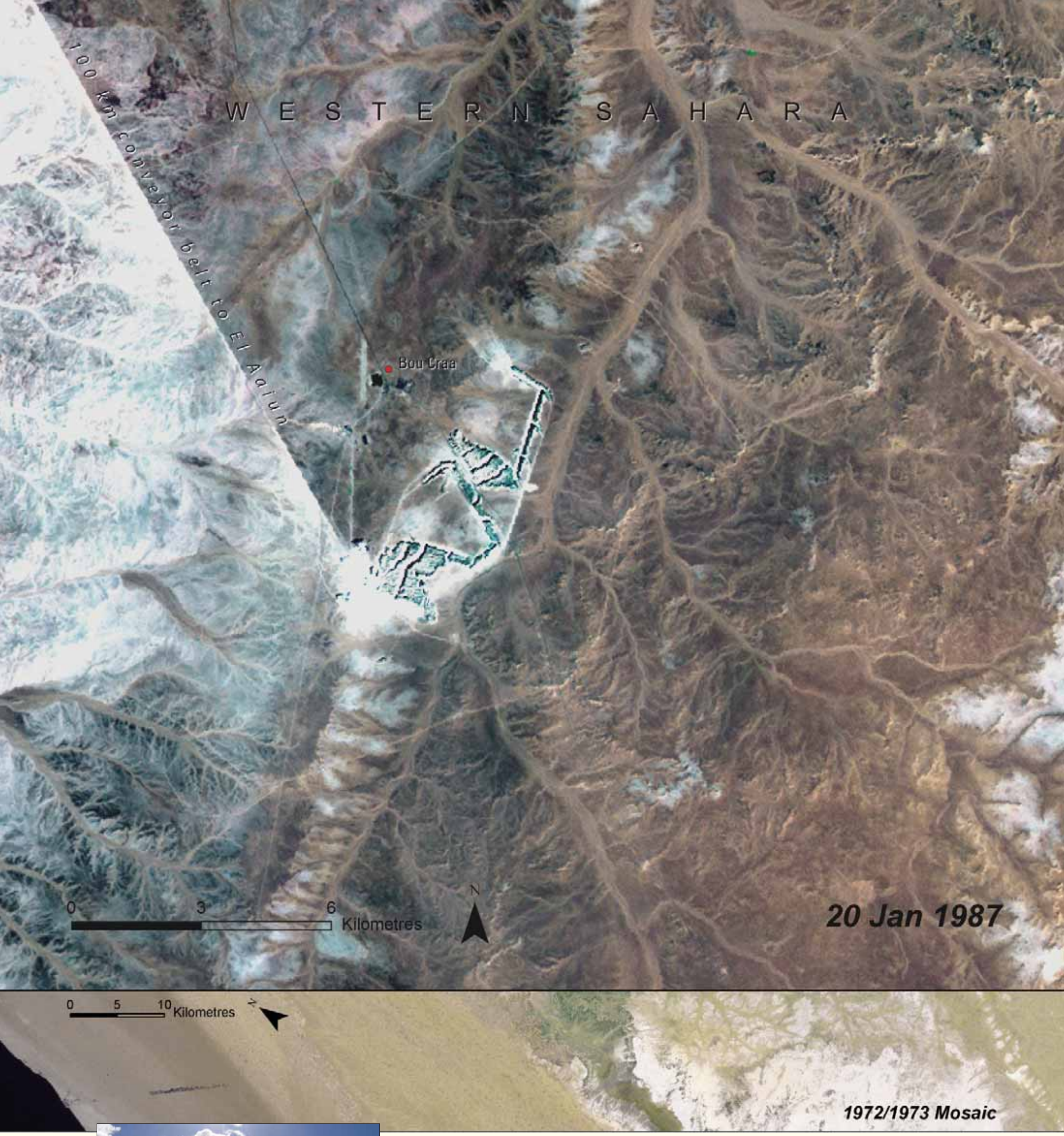


Source: UN Population Division, World Urbanization Prospects 2005 revision

Marine Fisheries

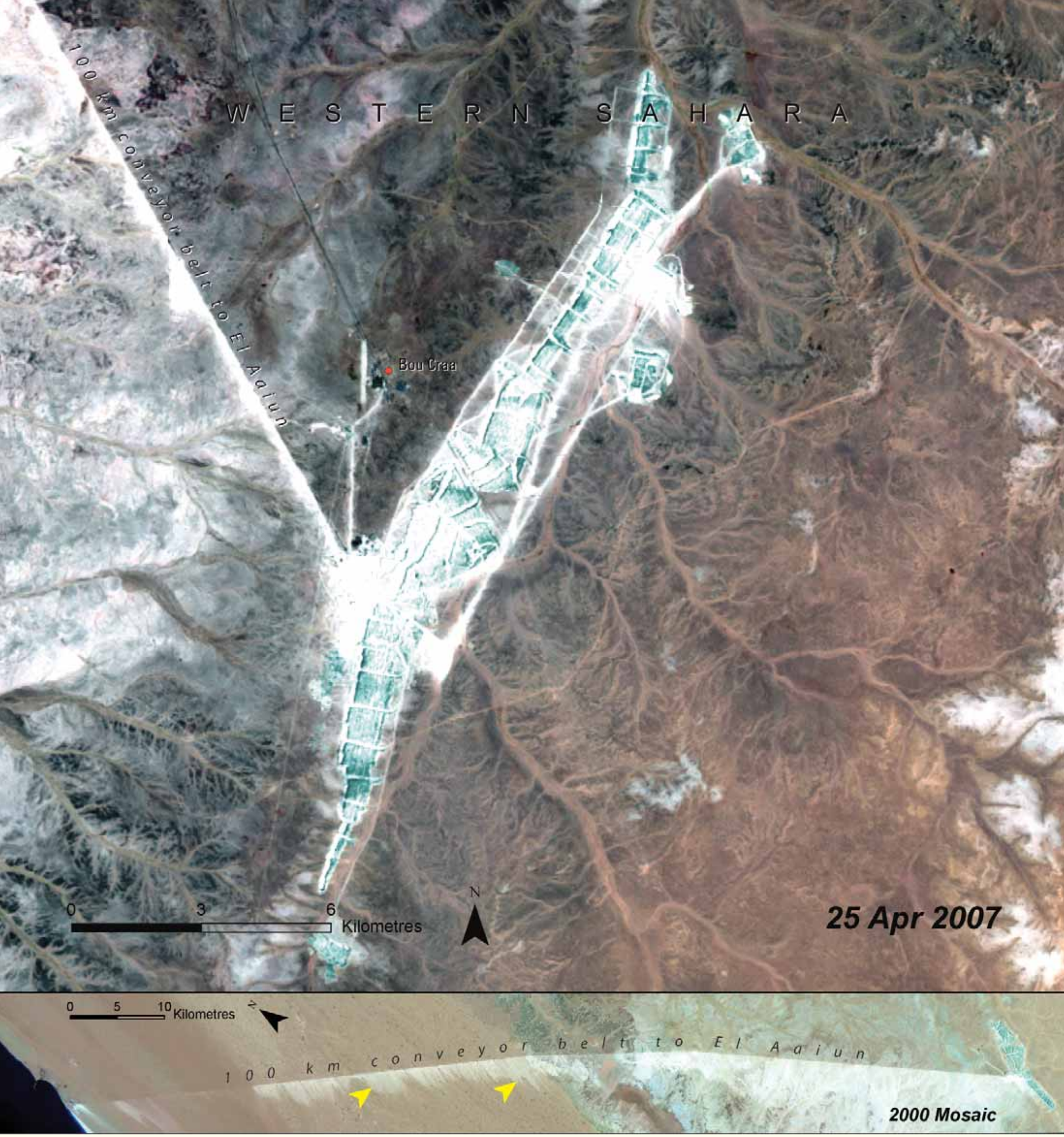
The waters off the coast of Western Sahara are rich in fish and other marine life. These resources are currently exploited by European fishing fleets through an agreement between the European Union and Morocco. Fish caught in Western Saharan waters are thought to account for over half of Morocco's annual fisheries yield of nearly one million metric tonnes. On the other hand, the amount of fish caught by the people of Western Sahara is estimated to be less than 0.5 metric tonnes per year (FAO 2007).





Phosphate Mining: Bou Craa, Western Sahara

The Bou Craa phosphate mine is located 100 km inland from the capital city of El Aaiun. The Bou Craa area's phosphate resources were discovered by the Spanish in 1947; phosphate deposits are near the surface and are very pure. Phosphate mining, however, did not begin until the 1960s. Since 1974, the Bou Craa mining operation has been growing steadily. In 2000, the mine covered more than 1 225 hectares. In 2001, its output was approximately 1.5 million metric tonnes of phosphate.

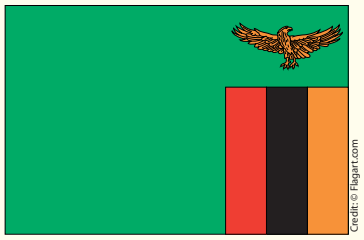


Morocco controls the area of Western Sahara where the mine is located and jointly operates the mine with Spanish interests. While the mine amounts to only two or three per cent of Morocco's phosphate production, the reserves are valuable because of the uranium that can be extracted from them.

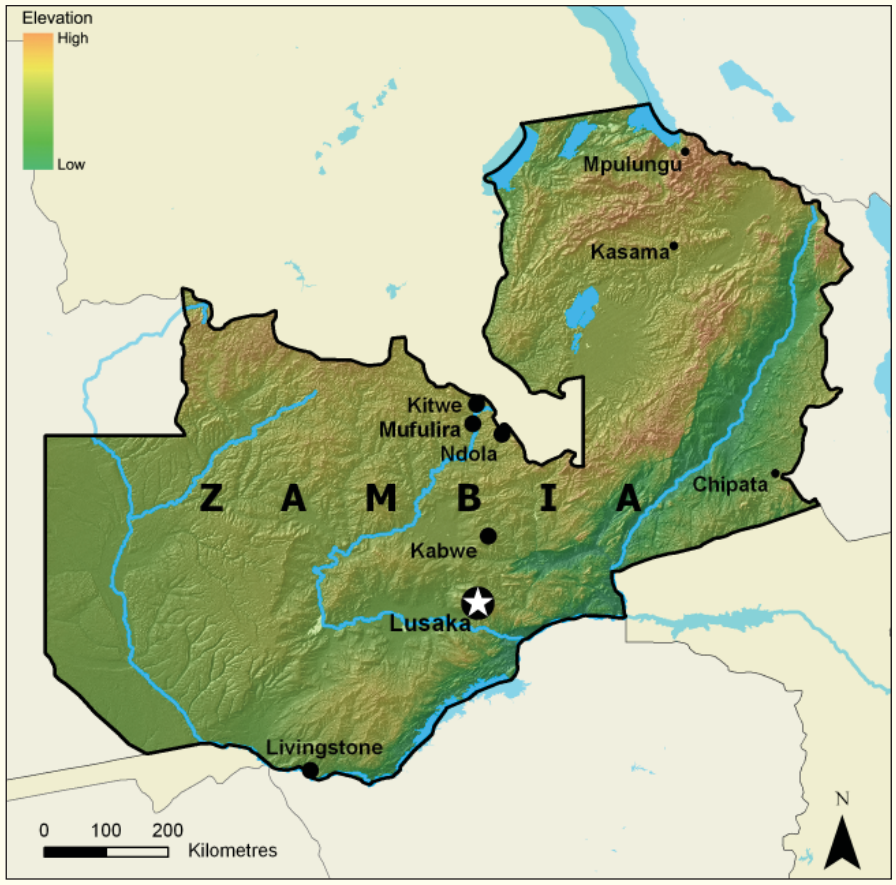
The phosphate-containing rock is transported from the Bou Craa mine to the port at El Aaiun via a 100-km-long conveyor belt, which can move 2 000 metric tonnes of rock per hour. The conveyor belt is visible as a straight line from the upper left corner toward the centre of the 1987 and 2007 images above. Below these images are two long, horizontal images, captured in 1972/1973 and 2000. The conveyor belt is visible in the 2000 image running from the mine to the coast. Note the fringe of drifting sand spreading downward from the belt's path (yellow arrows).

Republic of Zambia

Total Surface Area: 752 618 km²
Estimated Population in 2006: 11 861 000



Zambia rests upon a high plateau with a subtropical climate characterised by a single rainy season, a cool, dry winter, and a hot, dry summer. Savannah is the dominant ecosystem and covers the centre of the country, separating the rain forest in the northwest from the semi-desert region in the southwest. Along Zambia's border with Zimbabwe, the Zambezi River flows over the famous Victoria Falls. Both countries also share the Kariba Dam built to generate hydro electric power and is also now a major recreation and fisheries area.



Important Environmental Issues

- Copper Mining and Water and Air Pollution
- Deforestation and Wildlife Depletion
- Urbanisation

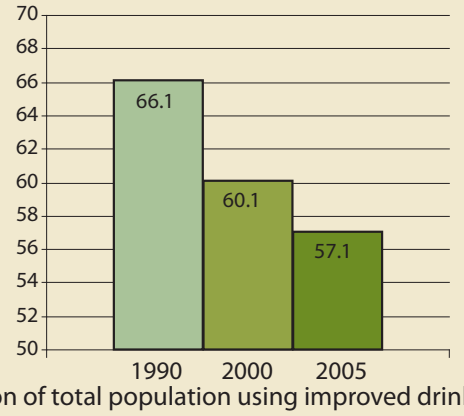
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

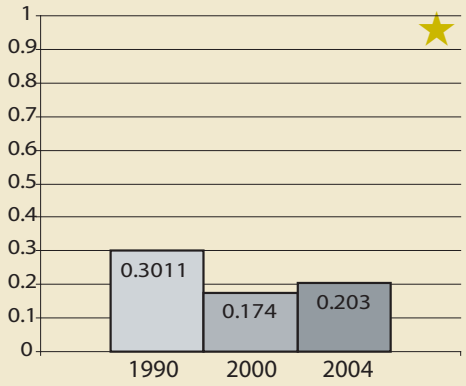
In Zambia, traditional and modern farming methods involve clearing large areas of forest. Home to Africa's largest (and the world's second largest) open-cast mine (Nchanga), Zambia is plagued with water pollution arising from contamination by sewage and toxic industrial chemicals. Yet the country shows progress in access to improved water sources and sanitation.

★ Indicates progress

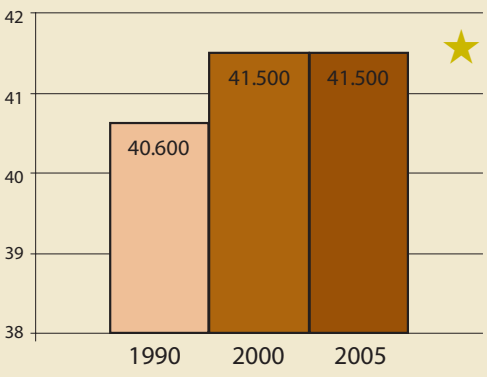
Land area covered by forest, percentage



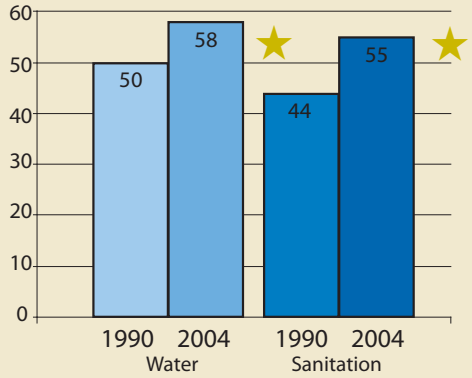
Carbon dioxide (CO_2) emissions, metric tonnes per capita



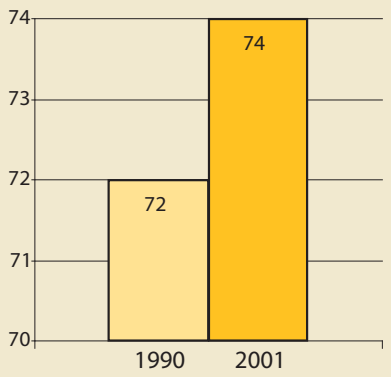
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban

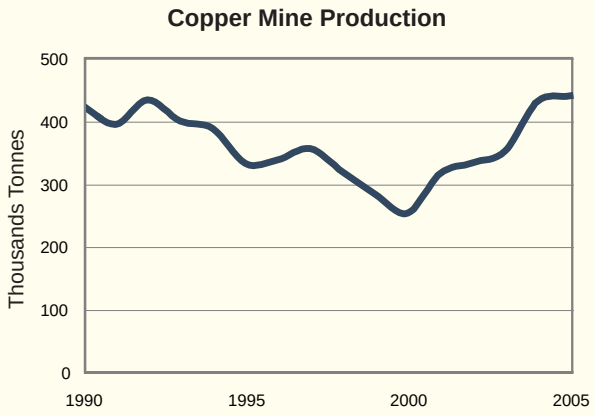


Kafue is Zambia's oldest park and largest park, spreading over 22 400 km².

zambiatourism.com (n.d)

Copper Mining and Water and Air Pollution

Zambia's large copper reserves in the north-central "Copperbelt" region have made it a world leader in copper production. The industry has played a significant role in the national economy since mining began in the late 1920s. Copper mining involves environmentally damaging activities, including open-pit and underground digging, pumping and disposal of large volumes of waste water, and smelting operations that emit sulphur dioxide. Lack of effective environmental regulation of the industry has led to widespread air, soil, and water pollution (World Bank 2002).

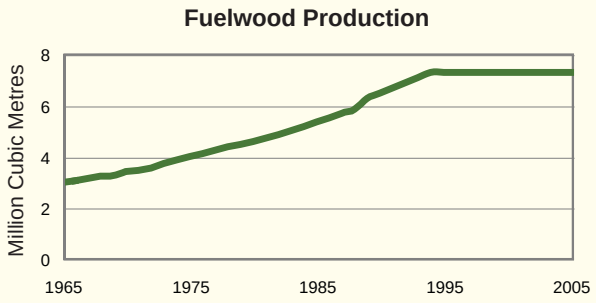


Source: USGS Mineral Commodity Summaries

Deforestation and Wildlife Depletion

Zambia is home to 8 017 different plant and animal species, of which 316 are endemic (UN 2007), 174 are rare, and 38 are endangered or vulnerable (IUCN 2006). The Miombo Savannah woodlands constitute the most biodiverse region in the country, containing elephants, Lichtenstein's hartebeest, lions, and spotted hyenas.

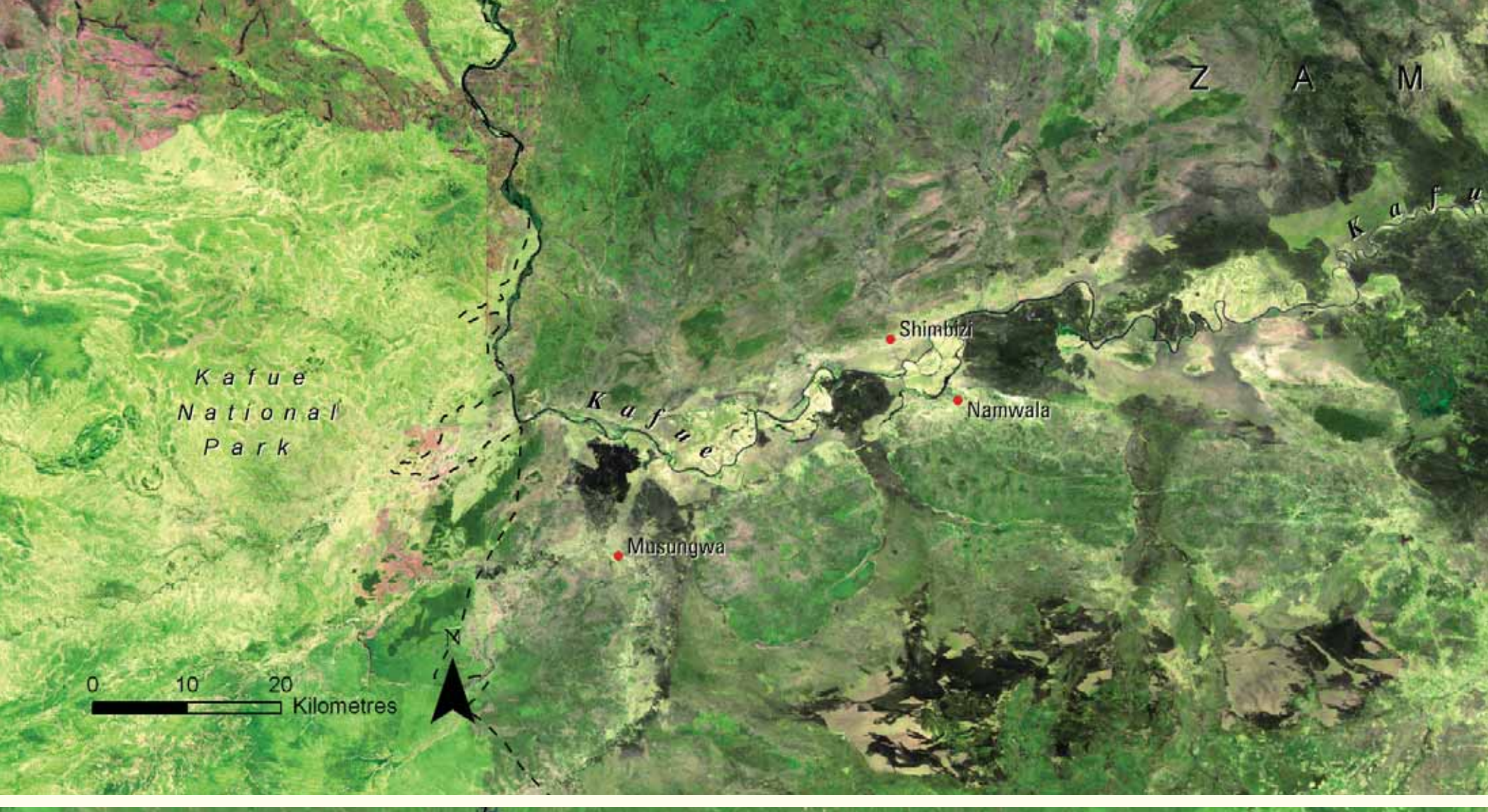
Zambia's wildlife is threatened by illegal hunting and other exploitation, land-use change, dam development, and other human pressures. Between 2000 and 2005, Zambia lost 2.67 million hectares of forest—the second-highest total in Africa and the fifth-highest in the world (FAO 2005). Agriculture is the principal driver of deforestation, but it is also exacerbated by the collection of wood for fuel, the consumption of which is expected to increase by 35 per cent between 2000 and 2020 (FAO 2003).



Source: FAOSTAT

Urbanisation

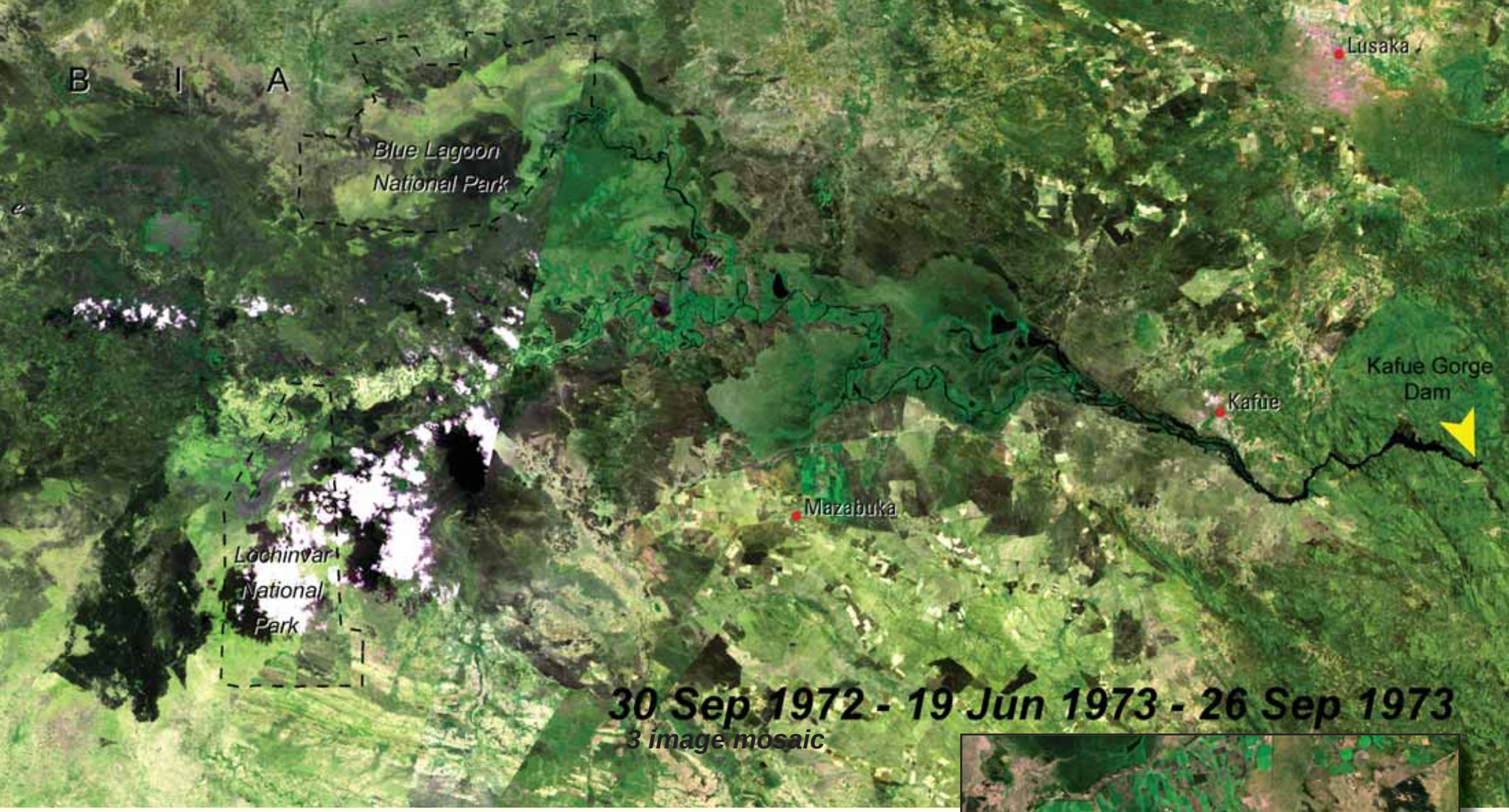
Africa is the fastest urbanising region in the world and Zambia is the third most highly urbanised country in Sub-Saharan Africa. Zambia experienced high levels of rural-urban migration, as citizens sought to benefit from urban-based employment opportunities and subsidized food and infrastructure. Lusaka, the capital city, was—and continues to be - the main destination for rural migrants, closely followed by the Copperbelt province (World Bank 2002). Lusaka and Copperbelt account for 69 per cent of the total urban population (UN-HABITAT 2007). The major urban areas are faced with serious environmental problems such as soil erosion, loss of soil fertility, and changes to the microclimate resulting from rampant illegal quarrying, illegal development, deforestation, and the over-exploitation of forest resources (UN-HABITAT 2007).



Natural and Managed Flooding: Kafue Flats, Zambia

In southern Zambia, the Kafue River crosses a broad floodplain roughly 255 km long. Before the Itezhi-tezhi Dam was built on the river in 1978, flooding beginning in December would cover much of the plain well into the dry season. Although the dam was built to allow the release of sufficient water to cause seasonal flooding, this mimicking of the natural floods has in general not been practised.

The Kafue Flats floodplain provides important habitat for rare and endemic species, including the Kafue lechwe (antelope) and wattled crane, and supports local livelihoods, especially cattle-



Water use across the Kafue Flats is a critical issue. Nearly 1 000 000 m^3 of water is extracted from the Kafue River for commercial agriculture, and most of it goes to the 13 413-hectare Nakambala Sugar Estate.

raising and fishing. Limited seasonal flooding following the construction of the dam has been linked to a decline in fish production and in the Kafue lechwe population. The number of lechwe fell from around 90 000 before the dam was built to around 37 000 in 1998. In 2004, a partnership between World Wildlife Fund, the Zambian Ministry of Energy and Water Development, and the Zambian Electricity Supply Company put new rules in place for water releases from the dam to mimic natural flooding patterns more successfully.

The 1970s image shows Kafue Flats in the dry season, with water levels retreating. The Kafue Gorge Dam can be seen in the lower right corner of the image (yellow arrow). Itezhi-tezhi Dam was built a few years later to provide more storage capacity for electricity generation at the Kafue Gorge Dam. The 2007 image shows the Kafue Flats during wet season floods, helped for the first time by the release of adequate water from the Itezhi-tezhi Dam.

Chililabombwe
Mufulira
Chingola
DEMOCRATIC
REPUBLIC OF
THE CONGO
Garneton
Kitwe Nkana
Kalulushi
Kafue River
Ndola
Luanshya
Z A M B I A
Copperbelt Province
0 10 20
Kilometres
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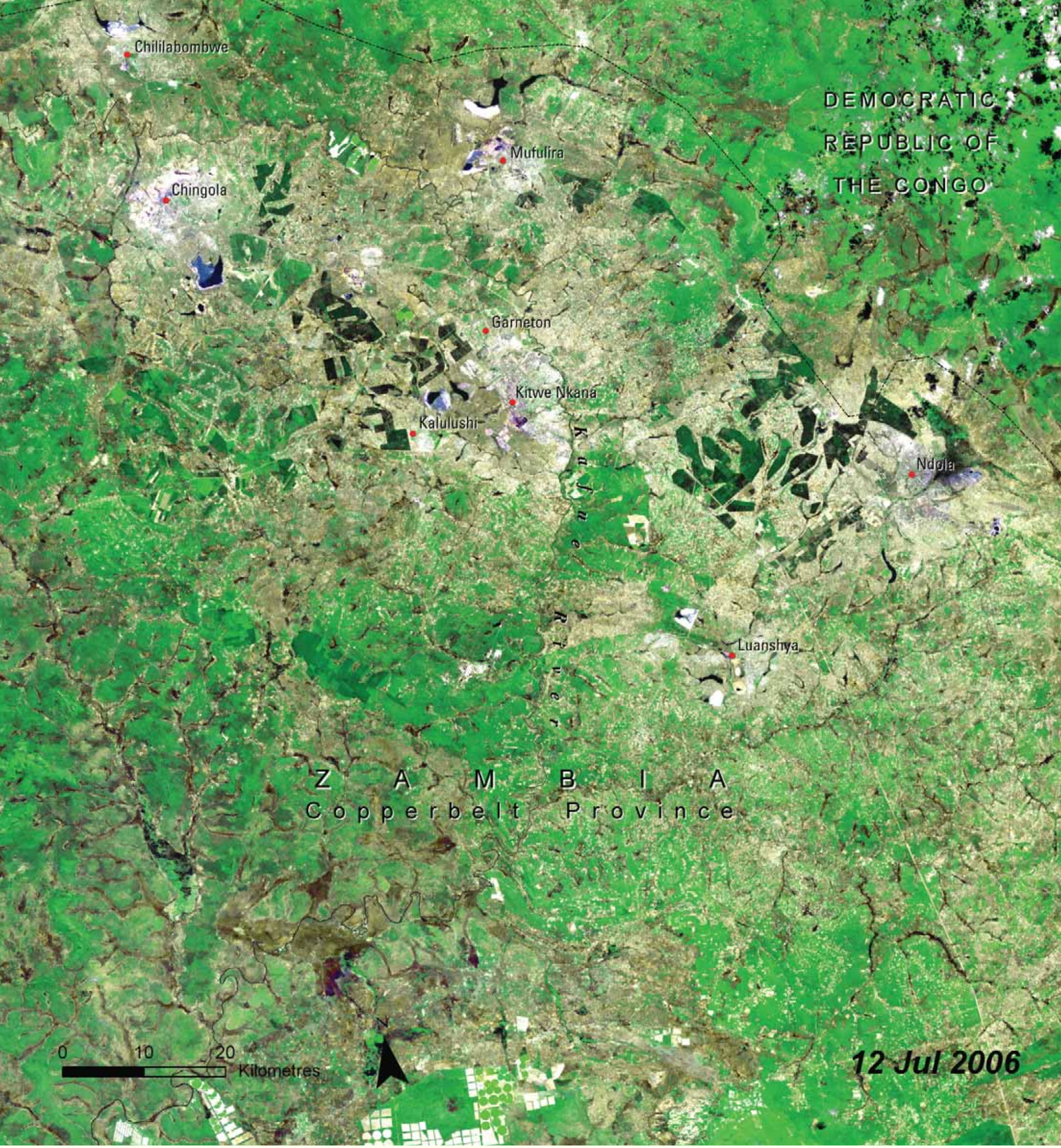
13 Sep 1972 - 30 Sep 1972
2 image mosaic

Copper Mines: Copperbelt Province, Zambia

Large-scale copper mining began in north-central Zambia's Copperbelt Province during the 1930s, attracting workers and turning this biologically rich savannah woodland into a heavily populated area with several large cities. Until the 1960s, the mining industry used wood from surrounding lands to generate power for the copper mines; this resulted in the clear-cutting of approximately 127 000 hectares between 1947 and 1956 and selective harvesting of trees in an area of similar size. The mining industry converted to hydroelectric power in the early 1960s, but the growing population continued to rely on wood for fuel.



Copper mining began to decline in the 1970s when oil prices rose and copper prices dropped. By the 1990s, the industry had collapsed, leaving large numbers of workers unemployed. Many of these unemployed miners turned to small-scale agriculture and charcoal production to make a living, putting additional pressure on the surrounding woodlands.

Large urban centres, open-pit mines, and areas of deforestation are already apparent in the 1972 image. These urban areas continued their rapid growth, resulting in the much larger areas of degraded and deforested woodlands visible in the 2006 image. Record copper prices in recent years have revived the area's copper industry. Copper accounted for an average of 67 per cent of Zambia's annual total export receipts between 2002 and 2005.

Republic of Zimbabwe

Total Surface Area: 390 757 km²
Estimated Population in 2006: 13 085 000

Zimbabwe is a land-locked country bordered by the Limpopo River to the south and the Zambezi River to the north. A high plateau stretches across most of the country, with a sub-tropical climate in an otherwise tropical location. The famous Victoria Falls is located on the border with Zambia, midway along the course of the Zambezi River. During its highest flood stage, the river widens to over 1.6 km directly above the falls before plunging 110 m into the gorge below, forming the largest curtain of falling water in the world (UNEP-WCMC n.d.).

Important Environmental Issues

- Land Degradation and Deforestation
- Water Access and Drought
- Wildlife Poaching and the Black Rhinoceros

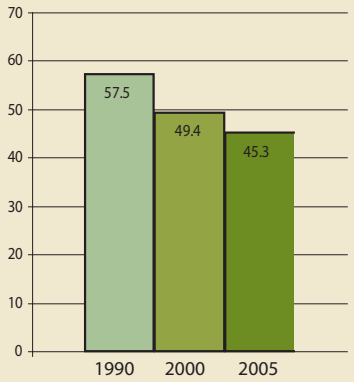
Progress Towards Environmental Sustainability

As defined by the United Nations Millennium Development Goal 7 Indicators

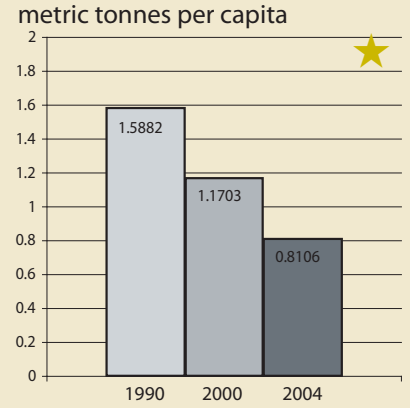
Among the most serious of Zimbabwe's environmental problems are erosion of its agricultural lands and deforestation. Zimbabwe's air is polluted by vehicle and industrial emissions, while water pollution results from mining and the use of fertilizers.

★ Indicates progress

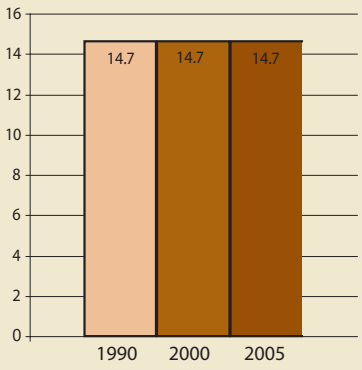
Land area covered by forest, percentage



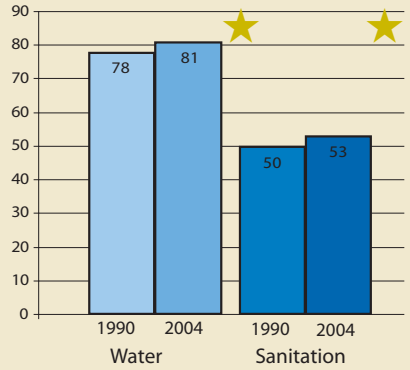
Carbon dioxide (CO_2) emissions, metric tonnes per capita



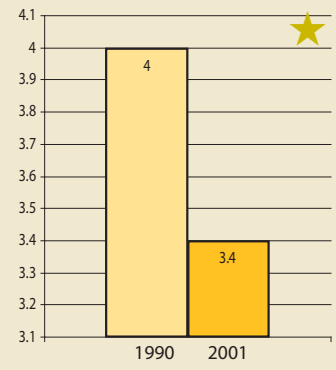
Protected area to total surface area, percentage



Proportion of total population using improved drinking water sources and sanitation facilities, percentage



Slum population as percentage of urban



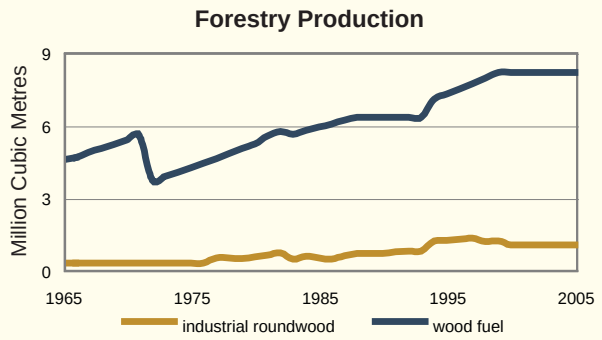
Zimbabwe's population of the critically endangered black rhinoceros has grown from 370 in 1993 to around 500 now.

rhinos-irf.org (n.d)

Land Degradation and Deforestation

Nearly 40 per cent of Zimbabwe's land is categorized as moderately degraded. The regions of greatest concern are in the north and east, where topsoil losses of more than 100 metric tonnes per hectare have been recorded (FAO 2004). The major drivers of land degradation are overgrazing (particularly on communally managed rangelands) and deforestation.

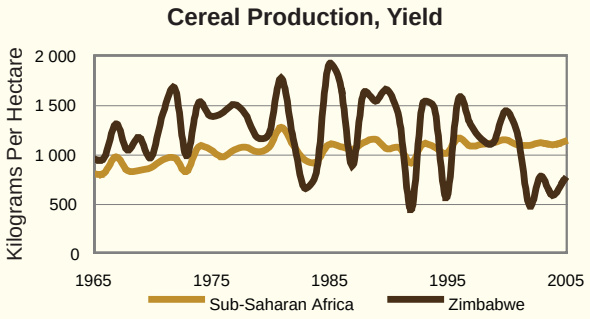
Between 2000 and 2005, Zimbabwe had the sixth highest rate of deforestation in Africa, averaging 3 130 km^2 per year (FAO 2005). Agriculture is estimated to be responsible for approximately 700 km^2 (roughly one-quarter) of this annual loss (CBD 1998), while heavy dependence on wood for fuel and commercial logging account for the rest.



Source: FAOSTAT

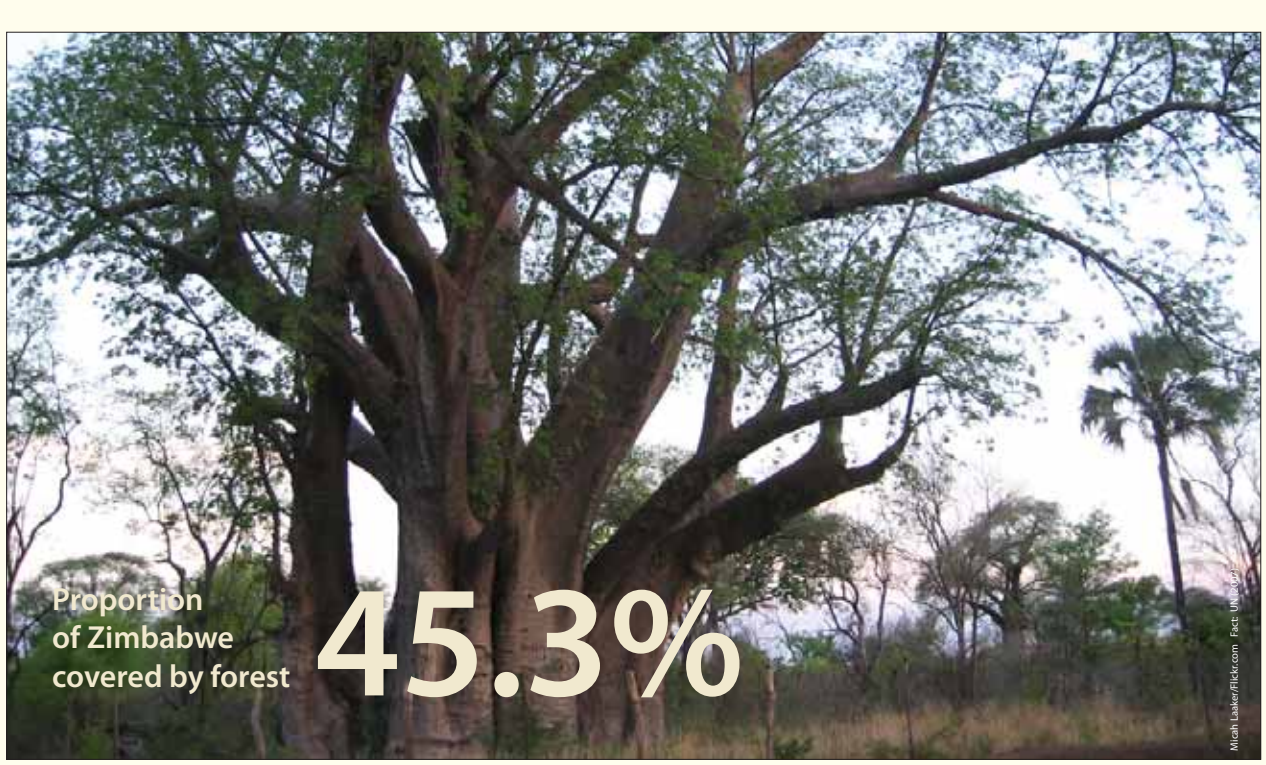
Water Access and Drought

Zimbabwe has few perennial rivers and no natural lakes, so a network of over 8 000 dams makes up the most significant surface water resource. However, siltation has reduced dam capacity and poor infrastructure prevents many people from accessing the water they need. In the major cities of Harare and Bulawayo, residents have gone without water for as long as two weeks during recent years (UN 2006).



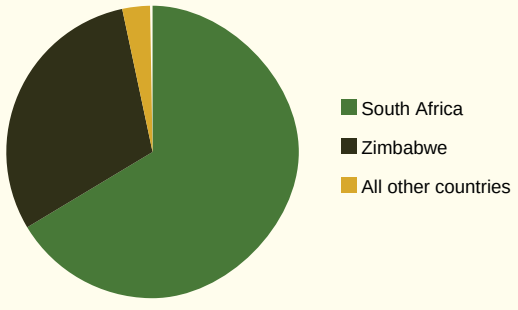
Source: FAOSTAT

In rural areas, highly variable rainfall and drought are a constant threat to social and environmental stability. Between 1991 and 1997 alone, Zimbabwe experienced three major droughts that necessitated the importation of food in order to avert shortages (FAO 2004).



Wildlife Poaching and the Black Rhinoceros

Zimbabwe is home to charismatic megafauna such as the elephant, leopard, black rhinoceros, and giraffe. The black rhinoceros population in Africa declined by over 90 per cent in the last 60 years, reaching a low of 2 410 individuals worldwide in 1995 (IUCN 2007). During the 1980s, Zimbabwe lost over 1 500 black rhinos due to heavy poaching, but enhanced conservation measures have increased the population to an estimated 800 individuals today, making Zimbabwe an important stronghold for this critically endangered species. However, a recent severe economic crisis has reintroduced the threat of poaching, and at least 40 black rhinos have been killed in the past three years alone (Reuters 2007).



Source: International Rhino Foundation

Z I M B A B W E

Lake Chivero

0 2 4 Kilometres

N

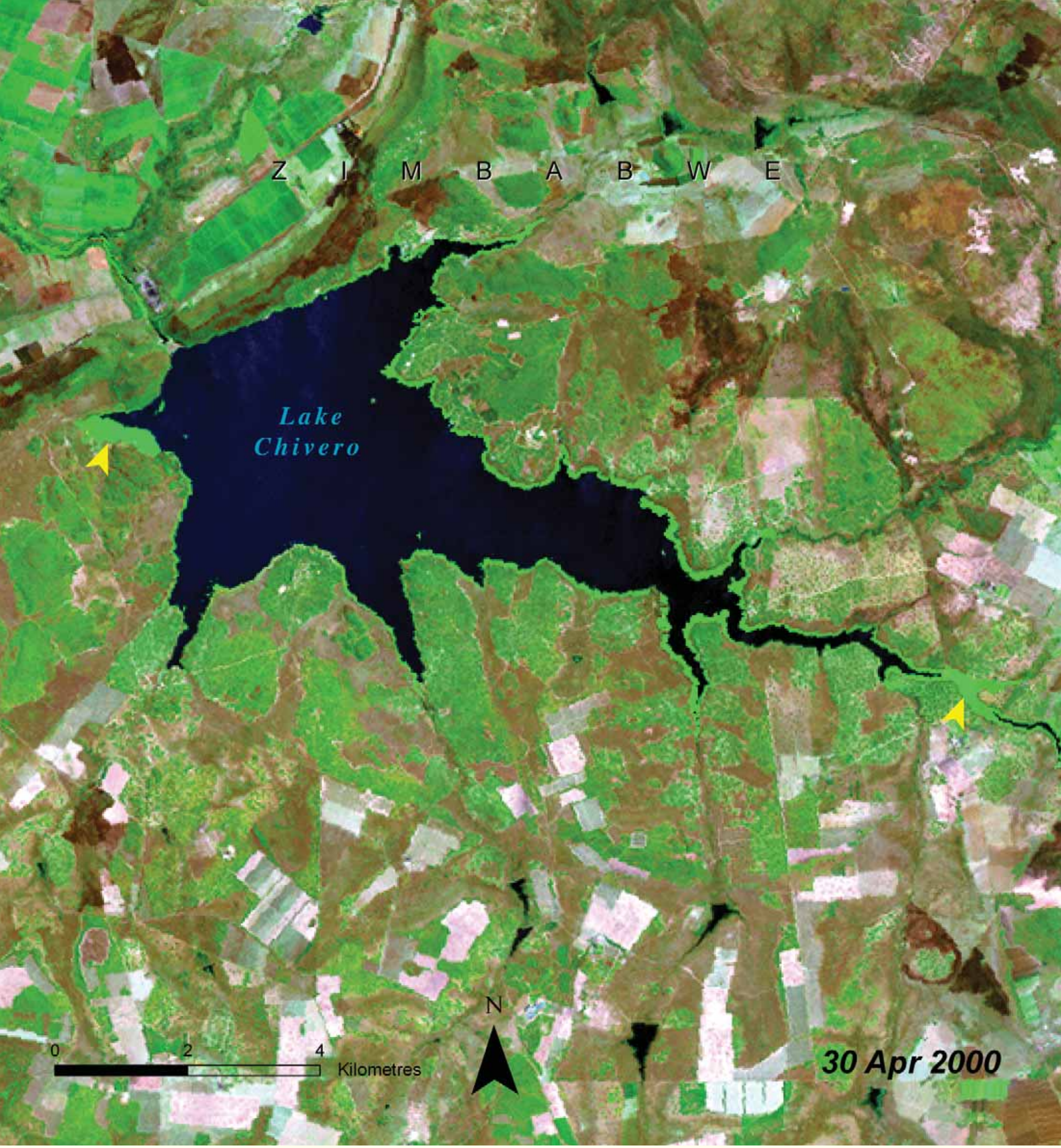
19 May 1989

Permission Pending/Flickr.com

Invasive Plants: Lake Chivero, Zimbabwe

In 1952, the Manyame River was dammed 40 km southwest of Harare, creating Lake Chivero. The Lake was intended primarily as a water supply for Harare, but it is also a source of water for irrigation and industry and serves as a local fishery.

One year after Lake Chivero was created, water hyacinth, an invasive wetland plant, made its first appearance, as a result of the influx of nutrients from nearby agricultural lands and municipal and industrial wastes from Harare. In 1955 / 1956, the first serious water hyacinth outbreak occurred and was successfully treated with chemical herbicides. The next outbreak

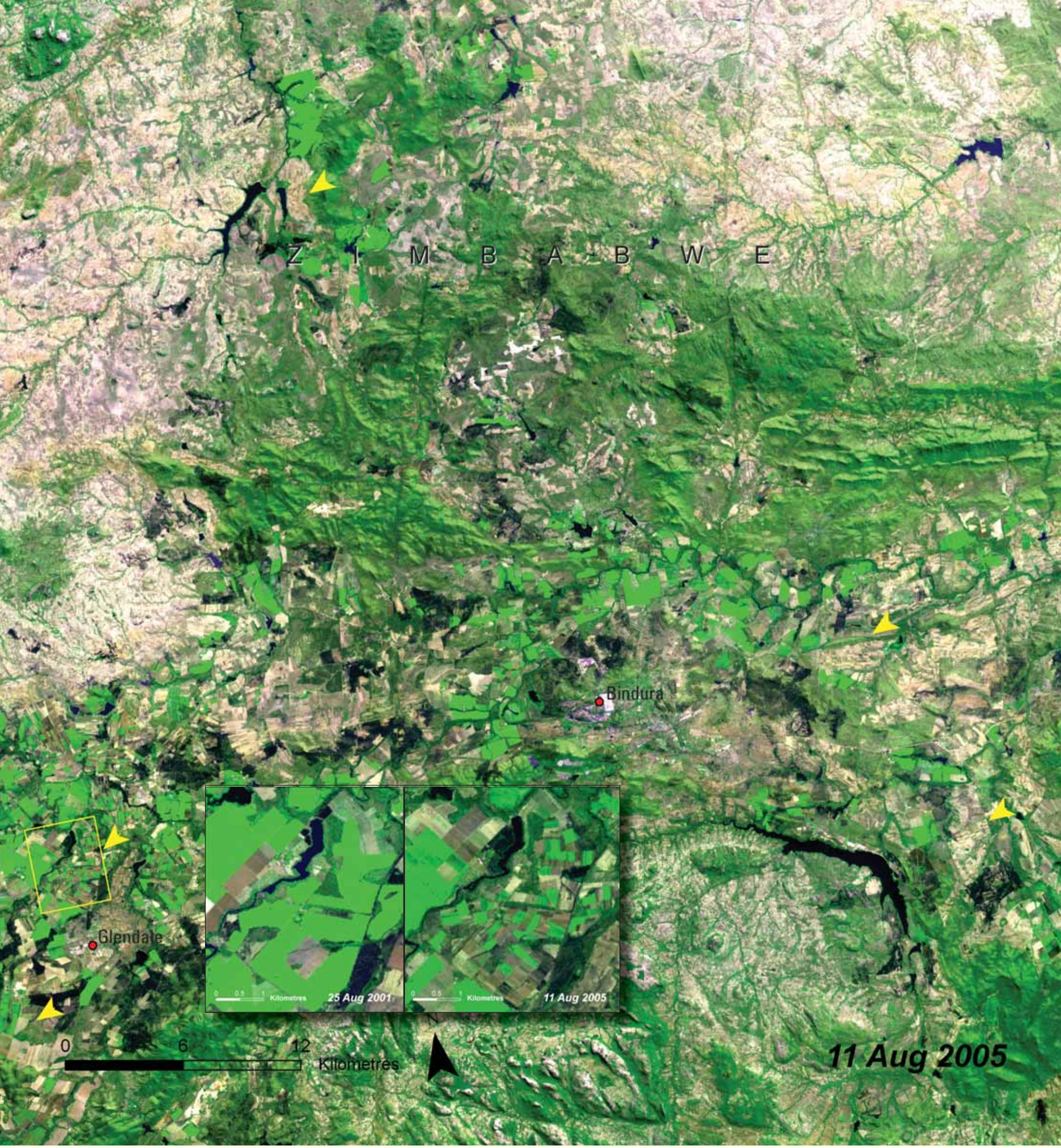


in 1971/1972 covered approximately 25 per cent of the lake. Attempts to end a third outbreak in 1986 used mechanical and chemical controls until public concern about the chemicals brought an end to their use. By 1989, water hyacinth covered 20 per cent of the lake's surface (1989 image, yellow arrows); by 1990, it covered 35 per cent. Weevils that feed on water hyacinth were released as a biological control; mechanical and new chemical controls continued. By 1997, it appeared that water hyacinth had been brought under control (2000 image, yellow arrows). By 2005, however, the invasive plants had returned again, reportedly covering as much as 40 per cent of the lake. In addition to water hyacinth, this most recent infestation includes massive amounts of another invasive plant, spaghetti weed (*Hydrocotyle ranunculoides*).

Agriculture Changes: Mashonaland, Zimbabwe

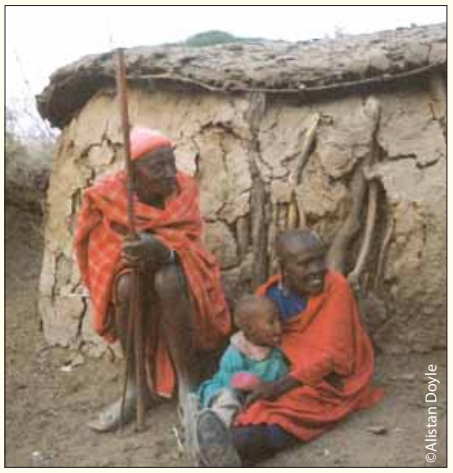
Located in Northern Zimbabwe, Mashonaland Central is a province with a growing population of over one million people. It is in one of the most productive agricultural areas in the country, with maize, a staple in Zimbabwe, as a major crop.

Four different land tenure systems exist in Zimbabwe: communal areas, resettlement areas, large-scale commercial farms, and small-scale commercial farms. In the last decade, the Government of Zimbabwe embarked on an ambitious land reform process that was aimed at redistribution of land, particularly the large scale commercial farms, to previously landless



citizens living in communal areas. This land redistribution effort has had the effect of subdividing previously large commercial parcels into much smaller parcels predominated by subsistence agriculture. This subdivision, coupled with adverse weather conditions, constrained capacities for input acquisition (seeds and fertilizers), and lack of appropriate machinery, is blamed for a drop in food production in Zimbabwe.

The satellite images above show the subdivision of several large commercial farms into smaller farms in a region of Mashonaland Central Province. In the August 2001 image, many large farm fields can be seen as large blocks of bright green. By August 2005, many of these same farms have been broken into smaller fields (yellow arrows).



"The snows are getting smaller year by year…"

- Kinyaol Porboli,
Maasai village chief
of Esiteti village

At the foot of Mount Kilimanjaro, an elderly Maasai village chief, Kinyaol Porboli, notes how snows atop Kilimanjaro are shrinking. According to the chief, twenty years ago droughts never killed cattle, because in the old days droughts were short. Longer droughts are becoming a very big problem, increasing poverty and affecting everyday life.

The Maasai village chief squints up at the summit and says only God can explain the shrinking snowcap and worsening droughts. Cattle in the village died in droughts in 2005, 1997 and 1989, said Porboli, who does not know his exact age but reckons he may be 100. This year, some tiny green shoots are coming up through the dust around the village. "It's linked to the mountain," he said, wrapped in a red robe and sitting on a stool outside his village of 70 people who live in windowless huts made from branches and dried cow dung (Excerpted from: Alister Doyle / Reuters 13 November 2006).

The village chief's voice is one of many powerful ones delivering an important message, which we, as stewards of the earth, cannot afford to ignore. Using the universal language of imagery, this Atlas corroborates that very message—putting us on notice that Africa's ecosystems, wildlife, and natural resources are in peril. Scientific measurements of the Millennium Development Goal indicators, such as percentages of forest cover and access to potable water, send us the same alarming prognosis on the environment.

These signs not only show us present conditions in Africa, but also serve as a pointer to the global environment's future. While natural conditions in many of Africa's arid and semiarid regions contribute to some of its environmental problems, most may be attributed to impacts from human activities including pollution, unsustainable agricultural practices, and growing and moving populations.

Despite some attempts by governments to halt and reverse environmental degradation, conditions continue to decline and poverty is worsening. It is here then, that we must also consider the role of each individual in taking action to take back the environment. Whether as a member of a government body holding a nation's resources in trust, or as a citizen beneficiary of the earth's bounty, we can play our part in protecting and restoring the environment.

Looking ahead, more challenges lie before us. Scientists agree that global warming, exacerbated by greenhouse gas emissions, is now changing the climate in many parts of the world. Africa is no exception. In fact, Africa is poised to suffer disproportionately from the consequences of global climate change. New studies confirm that Africa's capacity to adapt to climate change is low, making the continent exceptionally vulnerable to its potential impact. In many regions, even small changes in precipitation and water availability could have a devastating effect on agricultural output and thereby on food security.

As evidenced by Kinyaol Porboli's village, people are adapting as best they can to the effects of climate change that are already being felt, recognizing that the changing conditions around them and the effects are, as the chief said, "linked." However, as climate change intensifies and its impact deepens, adaptation will be much more difficult, as will achieving the Millennium Development Goals at local, regional, and national levels across the vast and wonderfully diverse African continent.

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Acronyms and Abbreviations

AARSE	African Association of Remote Sensing of the Environment
ACOPS	Advisory Committee on Protection of the Sea
AMCEN	The African Ministerial Conference on the Environment
ASAR	Advanced Synthetic Aperture Radar
bbl/d	barrels per day
BCLME	Benguela Current Large Marine Ecosystem
BP	British Petroleum
CAR	Central African Republic
CARPE	Central African Regional Program for the Environment
CBD	Convention on Biological Diversity
CDIAC	Carbon Dioxide Information Analysis Center
CFCs	Chlorofluorocarbons
CI	Conservation International
CIESIN	Center for International Earth Science Information Network
CITES	Convention on International Trade in Endangered Species
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CRED	Centre for Research on the Epidemiology of Disasters
DEWA	Division of Early Warning and Assessment
DMS	dense media separation
DOE	Department of Energy
DRC	Democratic Republic of the Congo
EIA	Energy Information Administration, United States Department of Energy
EIS–Africa	Environmental Information Systems – Africa
EM-DAT	Emergency Events Database
ENSO	El Niño/Southern Oscillation
ENVISAT	European Space Agency Environmental Satellite
EPA	Environmental Protection Agency
FAO	Food and Agriculture Organisation of the United Nations
GDP	Gross Domestic Product
GEO	Group on Earth Observations
GIS	Geographic Information Science
GLCF	Global Land Cover Facility
GLTP	Great Limpopo Transfrontier Park
GMMR	Great Man-made River
HABs	Harmful Algal Blooms
HIPC	heavily indebted poor countries
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
ISO	International Standards Organization
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature and Natural Resources
IUSSP	International Union for the Scientific Study of Population
kg	kilograms
km	kilometres
km^2	square kilometres
km^3	cubic kilometres
LME	Large Marine Ecosystem
m	metres
m^2	square metres
m^3	cubic metres
MDGs	Millennium Development Goals
METAP	Mediterranean Environmental Technical Assistance Program
mm	millimetres
MODIS	Moderate Resolution Imaging Spectroradiometer
NO_2	Nitrogen Dioxide
N_2O	Nitrous Oxide
NASA	National Aeronautics and Space Administration
NDVI	Normalized Difference Vegetation Index
NOAA	National Oceanic and Atmospheric Administration
NOSA	National Occupational Safety Association
NP	National Park
NWSA	North-West Sahara Aquifer
ODA	Official development assistance
ODP	Ozone depleting potential
OECD/DAC	Organization for Economic Co-operation and Development/Development Assistance Committee
OMVS	Oganisation pour la mise en valeur du fleuve Sénégal (Organisation for the Development of the Senegal River)
PPP	Purchasing Power Parity
RCMRD	Regional Centre for Mapping of Resources for Development
RS	Remote Sensing
SADC	Southern African Development Community
SADCC	Southern African Development Coordination Conference (Group of nine countries—Angola, Botswana, Lesotho, Malawi, Mozambique, Swaziland, Tanzania, Zambia, and Zimbabwe—surrounding or surrounded by the Republic of South Africa)
SAIC	Science Applications International Cooperation
SCOUL	Sugar Cooperation of Uganda
SDSU	South Dakota State University
SOE	State of the Environment
TWh	terawatt hour (it corresponds to 1 000 000 000 kWh (kilowatt hours) or one thousand Gigawatt hours)
UMD	University of Maryland
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
UNECA	United Nations Economic Commissions for Africa
UNEP	United Nations Environnent Programme
UN ESA	United Nations – Department of Economic and Social Affairs
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
USGS	United States Geological Survey
USSP	Uganda Strategy Support Program
UV	Ultra Violet
WAP	W-Arly-Pendjari
WCMC	World Conservation Monitoring Centre
WHO	World Health Organization
WIO	West Indian Ocean
WRI	World Resources Institute
WWF	World Wildlife Fund
yr	year

Annex I

Changes in MDG Goal 7: Environmental Sustainability Indicators	Forested Land as % of Land Area		Carbon Dioxide emissions (CO_2), metric tons of CO_2 per capita		Protected area to total surface, area percentage		Access to Improved Water source (% of total population)		Access to Improved Sanitation (% of total population)		Slum Population as percentage of urban population	
Country Names	1990	2005	1990	2004	1990	2005	1990	2004	1990	2004	1990	2001
Algeria, People's Democratic Republic of	**0.8**	**1**	3.0471	5.994	5	5	94	85	**88**	**92**	11.8	11.8
Angola, Republic of	48.9	47.4	0.4413	0.5051	12.1	12.1	**36**	**53**	**29**	**31**	83.1	83.1
Benin, Republic of	30	21.3	0.138	0.2902	23	23	**63**	**67**	**12**	**33**	80.3	83.6
Botswana, Republic of	24.2	21.1	1.5876	2.3693	**29.4**	**30.2**	**93**	**95**	**38**	**42**	59.2	60.7
Burkina Faso	30.6	29	0.112	0.0812	**14.9**	**15.4**	**38**	**61**	**7**	**13**	**80.9**	**76.5**
Burundi, Republic of	11.3	5.9	0.0341	0.0291	**4.4**	**5.6**	**69**	**79**	**44**	**36**	**83.3**	**65.3**
Cameroon, Republic of	52.7	45.6	0.1312	0.2205	**5.4**	**8.9**	**50**	**66**	**48**	**51**	62.1	67
Cape Verde, Republic of	**14.3**	**20.7**	0.2476	0.5553	0	0		80		43	**70.3**	**69.6**
Central African Republic	37.2	36.5	0.0658	0.0614	**15.1**	**15.7**	**52**	**75**	**23**	**27**	**94**	**92.4**
Chad, Republic of	10.4	9.5	0.0234	0.0127	9.3	9.3	**19**	**42**	**7**	**9**	**99.3**	**99.1**
Comoros, Union of the	6.5	2.9	0.1253	0.1132		2.7	93	86	**32**	**33**	**61.7**	**61.2**
Congo, Republic of the	66.5	65.8	0.4844	1.0034	**6.4**	**14.1**		58		27	84.5	90.1
Congo, Democratic Republic of the	62	58.9	0.1047	0.037	**7.2**	**8.4**	**43**	**46**	**16**	**30**	**51.9**	**49.5**
Côte d`Ivore, Republic of	**32.1**	**32.7**	0.4217	0.2825	16.4	16.4	**69**	**84**	**21**	**37**	50.5	67.9
Djibouti, Republic of	0.2	0.2	0.6278	0.4639			**72**	**73**	**79**	**82**		
Egypt, Arab Republic of	**0**	**0.1**	1.369	2.2116	**6.5**	**13.3**	**94**	**98**	**54**	**70**	**57.5**	**39.9**
Equatorial Guinea, Republic of	66.3	58.2	0.3454	11.4748	**4.9**	**14.3**		43		53	**89.1**	**86.5**
Eritrea	16	15.4		0.1735	3.2	3.2	**43**	**60**	**7**	**9**	69.9	69.9
Ethiopia, Federal Democratic Republic of	13.8	11.9	0.058	0.1037	16.9	16.9	23	22	**3**	**13**	99	99.4
Gabonese Republic	85.1	84.5	6.5306	1.0796	**4.7**	**16.2**		88		36	56.1	66.2
Gambia, Republic of the	**39.1**	**41.7**	0.1981	0.1821	3.9	4.1		82		53	67	67
Ghana, Republic of	32.7	24.2	0.2419	0.326	**14.6**	**14.7**	**55**	**75**	**15**	**18**	**80.4**	**69.6**
Guinea, Republic of	30.1	27.4	0.1677	0.1515	**3.3**	**6.1**	**44**	**50**	**14**	**18**	**79.6**	**72.3**
Guinea-Bissau, Republic of	78.8	73.7	0.2056	0.1752	**3.2**	**7.3**		59		35	93.4	93.4
Kenya, Republic of	6.5	6.2	0.2485	0.3054	**12.5**	**12.7**	**45**	**61**	**40**	**43**	70.4	70.7
Lesotho, Kingdom of	**0.2**	**0.3**			0.2	0.2		79	37	37	49.8	57
Liberia, Republic of	42.1	32.7	0.2179	0.1401	12.7	12.7	**55**	**61**	**39**	**27**	**70.2**	**55.7**
Libyan Arab Jamahiriya, Socialist People's	0.1	0.1	8.6612	10.331	0.1	0.1	71		97	97	35.2	35.2
Madagascar, Republic of	23.5	22.1	0.0783	0.1506	**1.8**	**2.6**	**40**	**50**	**14**	**34**	90.9	92.9
Malawi, Republic of	41.4	36.2	0.0637	0.081	16.4	16.4	**40**	**73**	**47**	**61**	**94.6**	**91.1**
Mali, Republic of	11.5	10.3	0.055	0.0501	**1.6**	**2.1**	**34**	**50**	**36**	**46**	**94.1**	**93.2**
Mauritania, Islamic Republic of	0.4	0.3	1.3551	0.8866	1.7	1.7	**38**	**53**	**31**	**34**	94.3	94.3
Mauritius, Republic of	19.2	18.2	1.3844	2.598	**0.5**	**0.9**	100	100		94		
Morocco, Kingdom of	**9.6**	**9.8**	0.9473	1.3654	**0.8**	**1.2**	**75**	**81**	**56**	**73**	**37.4**	**32.7**
Mozambique, Republic of	25.5	24.6	0.0736	0.1079	**7.6**	**8.6**	**36**	**43**	**20**	**32**	**94.5**	**94.1**
Namibia, Republic of	10.6	9.3	0.0052	1.2394	14.6	14.6	**57**	**87**	**24**	**25**	**42.3**	**37.9**
Niger, Republic of the	1.5	1	0.1341	0.0947	6.6	6.6	**39**	**46**	**7**	**13**	96	96.2
Nigeria, Federal Republic of	18.9	12.2	0.4803	0.8263	3.7	6.1	49	48	39	44	80	79.2
Rwanda, Republic of	**12.9**	**19.5**	0.0724	0.0632	**3.9**	**7.6**	**59**	**74**	**37**	**42**	82.2	87.9
Sao Tome and Principe, Democratic Republic	28.4	28.4	0.5683	0.6106				79		25		
Senegal, Republic of	48.6	45	0.397	0.4353	10.8	10.8	**65**	**76**	**33**	**57**	**77.6**	**76.4**
Seychelles, Republic of	88.9	88.9	1.5783	6.4395	1	1	88	88				
Sierra Leon, Republic of	42.5	38.5	0.0816	0.1843	3.9	3.9		57		39	90.9	95.8
Somali Republic	13.2	11.4	0.0027		0.7	0.7		29		26	96.3	97.1
South Africa, Republic of	7.6	7.6	9.0777	9.1927	**5.6**	**6.1**	**83**	88	69	65	**46.2**	**33.2**
Sudan, Republic of the	32.1	28.4	0.2077	0.287	4.7	4.7	**64**	**70**	**33**	**34**	**86.4**	**85.7**
Swaziland, Kingdom of	**27.4**	**31.5**	0.4917	0.8589	3.5	3.5		62		48		
United Republic of Tanzania	46.9	39.9	0.0916	0.116	**38**	**38.4**	**46**	**62**	47	47	**99.1**	**92.1**
Togolese Republic	12.6	7.1	0.1898	0.3805	11.2	11.2	**50**	**52**	37	35	**80.9**	**80.6**
Tunisia, Republic of	**4.1**	**6.8**	1.6144	2.2895	**1.2**	**1.3**	**81**	**93**	**75**	**85**	**9**	**3.7**
Uganda, Republic of	25	18.4	0.0456	0.0651	**25.6**	**26.3**	**44**	**60**	**42**	**43**	**93.8**	**93**
Western Sahara, Non-Self-Governing Territory of	3.8	3.8	0.8967	0.5726	7.1	7.1						
Zambia, Republic of	66.1	57.1	0.3011	0.203	**40.6**	**41.5**	**50**	**58**	**44**	**55**	72	74
Zimbabwe, Republic of	57.5	45.3	1.5882	0.8106	14.7	14.7	**78**	**81**	**50**	**53**	**4**	**3.4**

* Improvements are marked in "**Green and Bold**"

About Remote Sensing Images and Aerial Photographs Used in this Publication

The Landsat satellite program, jointly managed by NASA and the U.S. Geological Survey, has collected and archived images of the Earth's surface for over 35 years. This historical record provides a unique opportunity for identifying and documenting areas of environmental change anywhere on the planet. The majority of the remote sensing images used in this atlas are Landsat images.

The sensors used in the Landsat series are referred to as "multispectral" sensors. They collect reflected electromagnetic energy from the visible range (400 to 700 nanometers) as well as wavelengths that the human eye cannot see (700-2 350 nanometers) and thermal energy. Multi-spectral sensors divide the electromagnetic spectrum into a small number of "bands" or ranges of wavelength. For example Landsat-7 collects electromagnetic radiation in eight different bands or ranges of wavelength (see table). Each of these ranges of "light" can tell us something different about the Earth's surface.

To create viewable images from multi-spectral sensors, three of the available bands are selected and displayed, each through one of the three colours of standard monitor displays—red, green and blue. This can sometimes yield an image that is not intuitive for the non-specialist to interpret (left image). By selecting certain bands and adjusting the distribution of brightness, the overall brightness and the contrast, a more intuitive looking image can be achieved (right image). The images in this atlas have been adjusted so that non-expert readers can interpret these images more easily. The specific sensors and the band combinations used in chapter three can be found the references at the end of the chapter.

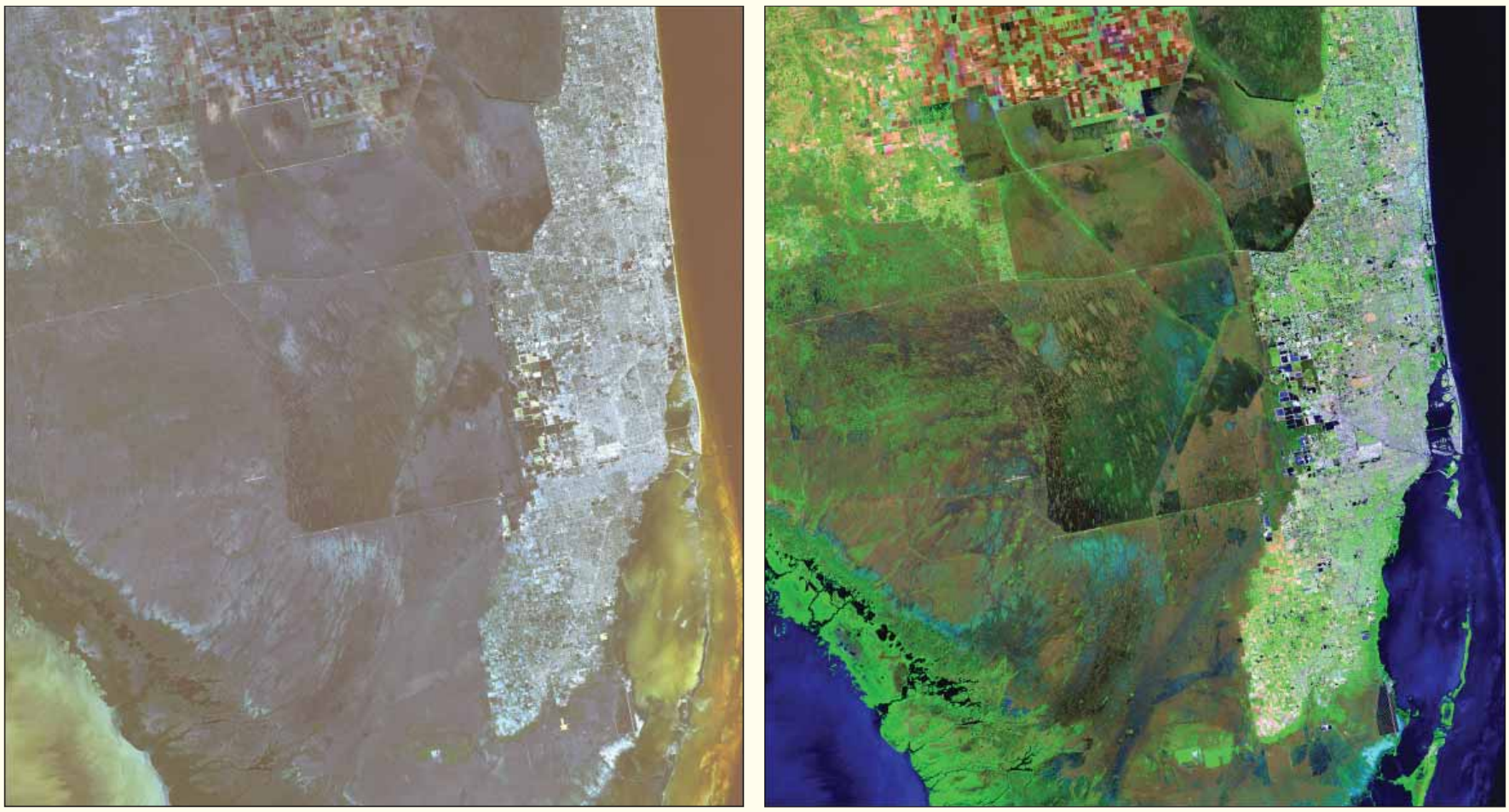
In general, the images are displayed so that growing vegetation shows as various shades of green. Conifer forests will generally show as darker shades of green as will mangroves to a lesser degree. Broadleaf forests are typically a slightly brighter shade of green. Agricultural fields with actively growing crops can show as a still brighter shade of green; however this is dependant on the crop and its state of growth. The patterns of brightness are often important clues as to the nature of the vegetation as well. Senescent or inactive vegetation generally appears as shades of gray and brown.

Water bodies will generally be blue to black in appearance, however when sediment is present or the water is shallow it will appear lighter even taking on a pink caste. Areas of bare ground will show as bright usually almost white while urban areas and roads generally appear as a shade of pale purple. Clouds, when they cannot be avoided, will appear as bright white.

In addition to Landsat images, data from other sensors such as ASTER[1] and MODIS[2], have been used as well as the high resolution commercial sensors QuickBird[3] and IKONOS[4], declassified spy satellite images (Corona and Argon)[5] and aerial photography.

Landsat-7 ETM+ Bands		
Band	**Spectral Range (nm)**	**Description**
1	450 to 515 nm	blue-green light
2	525 to 605 nm	green light
3	630 to 690 nm	red light
4	775 to 900 nm	near-infrared radiation
5	1 550 to 1 750 nm	mid-infrared radiation
6	10 400 to 12 500 nm	thermal-infrared radiation
7	2 090 to 2 350 nm	mid-infrared radiation
8	520 to 900 nm	pan-chromatic

Both of these images are from the same Landsat-7 remote sensing image taken over the Everglades of Florida, USA in March of 2002. On the left bands 1, 2 and 3 are shown as red, green and blue respectively with the contrast and brightness determined by the default settings of a standard Geographic Information System software program. On the right bands 7, 4 and 2 are displayed as red, green and blue and the contrast and brightness have been adjusted.



1 ASTER (The Advanced Spaceborne Thermal Emission and Reflection Radiometer) is a sensor aboard the TERRA satellite is a joint effort between National Aeronautics and Space Administration (NASA) and Japan's Earth Remote Sensing Data Analysis Center (ERSDAC).

2 MODIS (Moderate Resolution Imaging Spectroradiometer) is a sensor carried on NASA's TERRA and AQUA satellites.

3 QuickBird is a high resolution commercial multispectral sensor aboard the QuickBird satellite, operated by DigitalGlobe.

4 IKONOS is a high resolution commercial multispectral sensor aboard GeoEye's IKONOS satellite.

5 Corona and Argon are U.S. photographic surveillance satellites flown from the 1950s through the early 1970s.

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Along the beach in Zanzibar, United Republic of Tanzania

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