Mediterranean Sea

TUNISIA

Bizerte

Lake Bizerte

Ferryville

Ichkeul Lake

Mateur

0 4 8 Kilometres

N

11 Aug 1972

Lake Ichkeul

Tunisia

Lake Ichkeul is the last remaining lake in a chain that once extended across North Africa. The construction of three dams on rivers supplying Lake Ichkeul and its marshes has cut off almost all inflow of fresh water, caus-

ing a destructive increase in the salinity of the lake and marshes. The 1972 image shows the three feeder rivers supplying the lake before they were dammed. The 2000 image shows the location of the dams (yellow arrows) built to increase irrigation and water supplies to local communities. However, the decreasing water discharge into the lake caused by the damming lead to prolonged drought of the surrounding marshlands. Changes to the prevalent vegetation and other serious ecological changes have inevitably led to a decrease in the number of birds using the lakeshores as a breeding site.

Lake Ichkeul

Lake Ichkeul is the only natural lake left in Tunisia, and the sole survivor of a chain of lakes that once extended across North Africa. The lake and its surrounding marshes are an important stopover for hundreds of thousands of migrating waterbirds, including several species of geese and ducks, storks, coots, flamingoes, and the globally threatened White-headed Duck (*Oxyura leucocephala*). All stop to feed and nest here. But recent human changes to the lake's ecology, including the damming of three of its main feeder rivers, have resulted in a significant decline in the number of birds using Lake Ichkeul as a breeding site.

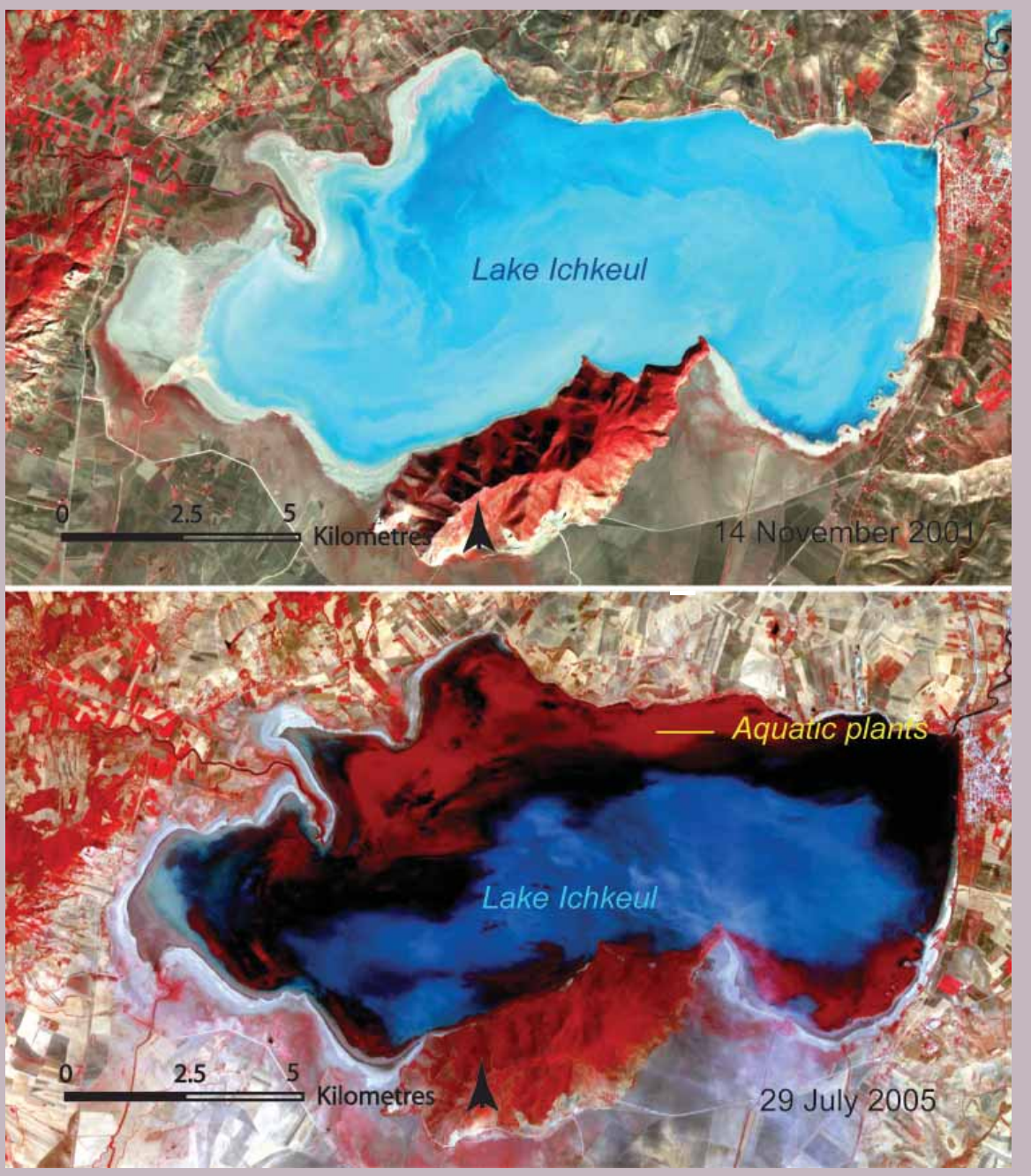
Ichkeul sits in an endorheic basin—in other words, it is a lake with no outlet. During the dry summer months, it becomes progressively shallower and more saline as a result of evaporation and salty inflows from the neighbouring Bizerte Lagoon, to which it is linked by canal. Between October and March each year, the lake receives runoff from winter rains via six inflow channels, or "oueds," which raises its levels and reduces its salinity (which averages about 13.5 per cent). However, over the past two decades, the Tunisian Government has partially implemented plans for damming all of the oueds that feed the lake—leading to a prolonged drought of the surrounding marshlands.

Ichkeul National Park

In northern Tunisia near the shore of the Mediterranean Sea, the lake and wetlands of Ichkeul National Park are an important stopping-over point for hundreds of thousands of migrating birds each year. Among the lake's visitors are ducks, geese, storks, and pink flamingoes. The park is on the United Nations Educational, Scientific, and Cultural Organization's (UNESCO) list of World Heritage sites, and since 1996, the park has also been on the group's List of World Heritage Sites in Danger. Dam construction on the lake's feeder rivers has produced major changes to the ecological balance of the lake and wetlands.

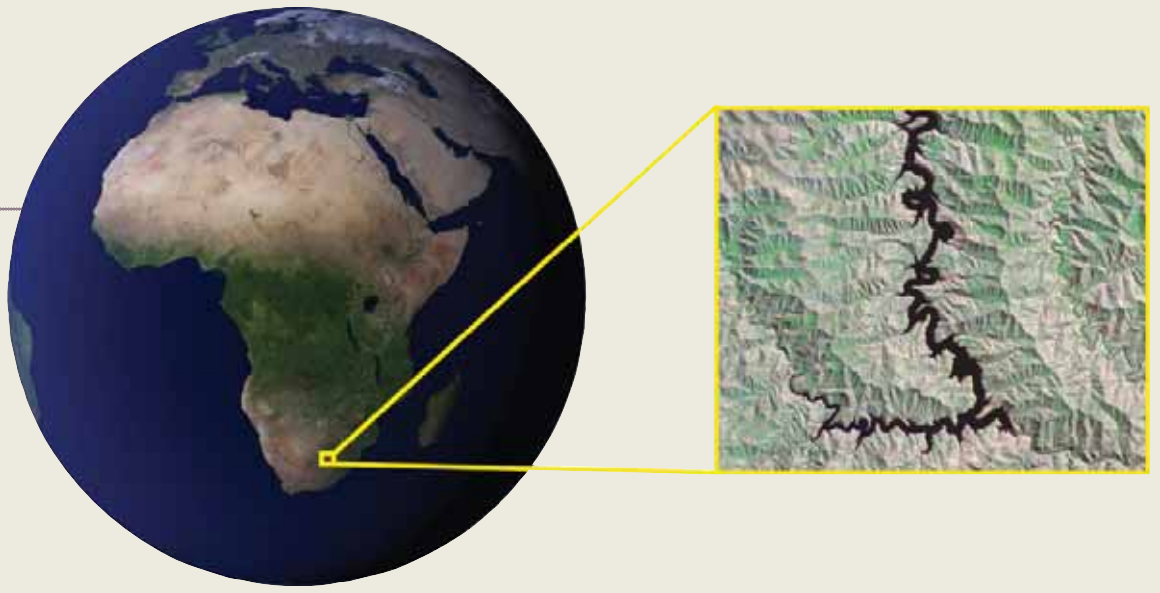
The pair of satellite images shows changes in the lake level and aquatic vegetation between 14 November 2001 (top), and 29 July 2005 (bottom). Vegetation appears red, bare or thinly vegetated ground is tan, and water is blue. Although the lake level is higher in 2005 than in 2001, a large part of the lake appears red due to the presence of aquatic plants. Because dams have sharply reduced the freshwater inflow to the lakes and marshes, reed beds, sedges, and other fresh-water plant species have been replaced with salt-loving plants. These changes have produced a sharp reduction in the migratory bird populations, which depended on the mix of plants that used to exist.

According to the UNESCO Website, the Tunisian government has undertaken some steps to retain freshwater and reduce salinity, but some reports from the World Conservation Union suggest that the salinity has already become excessively high and the possibility for rehabilitation may be rapidly disappearing (NASA 2005c).



The large images each cover an area of 11.4 by 20.0 kilometers, and they are centered near 37.1 degrees North, 9.7 degrees East.

Lesotho Highlands



The Lesotho Highlands Water Project (LHWP) is bi-national, multi-purpose undertaking between the Kingdom of Lesotho and the Republic of South Africa. It is one of Africa's largest ever water transfer projects as well as the largest ongoing bi-national construction project on the continent. The project consists of five proposed dams, 200 km (124 miles) of tunnels blasted through the Maluti Mountains, and a 72 megawatt hydropower plant that will supply power to Lesotho. Construction began in 1984 with the first dam, Katse, which was finished in 1998. Mohale, the second dam, began impoundment in Novenmber 2002 and reached over-spill 13 February 2006, indicating that the reservoir was at full capacity. The entire project is expected to cost US$8 000 million by the time of its completion in 2020 (South Africa Info 2004).

The Lesotho Highlands Water Project lies within the summer rainfall area of Southern Africa where more than 85 per cent of the annual rainfall occurs in the seven months from October to April. The Lesotho Highlands—with its high level of rainfall and high basalt surface area of the Maloti mountains—is an outstanding catchment area. Water originating in the mountains is characterised by good chemical quality and low sediment content. Estimates by the LHWP of the natural mean annual run-off at the sites of four dams are in Table 3.4. Although the mountain region of Lesotho constitutes only five per cent of the the total catchment of the Senqu / Orange river, it provides about 50 per cent of the total catchment run-off.

The project also aims to address the needs of South Africa's rapidly growing Gauteng province. Home to 40 per cent of South Africa's population, it generates almost 60 per cent of the country's industrial output and 80 per cent of its mining output. The region's main water source, the Vaal river, is not able to meet current demands. With the completion of the latest building phase many of Gauteng's water problems will be solved for the immediate future. The dam is expected to help rejuvenate the Vaal River.

Critics of the controversial project point to a number of problems that include the dramatic changes of the formerly remote mountain communities of the Lesotho Highlands; the moving of 20 000 people into the project region; the introduction of AIDS by the work force; and significant increases in prostitution and alcoholism. Environmental concerns include the prospective loss of thousands of hectares of arable or grazing land, downstream reductions in wetlands habitat, less water available downstream for people and wildlife, reductions in fisheries, and cessation of natural flooding (Byers 2002).

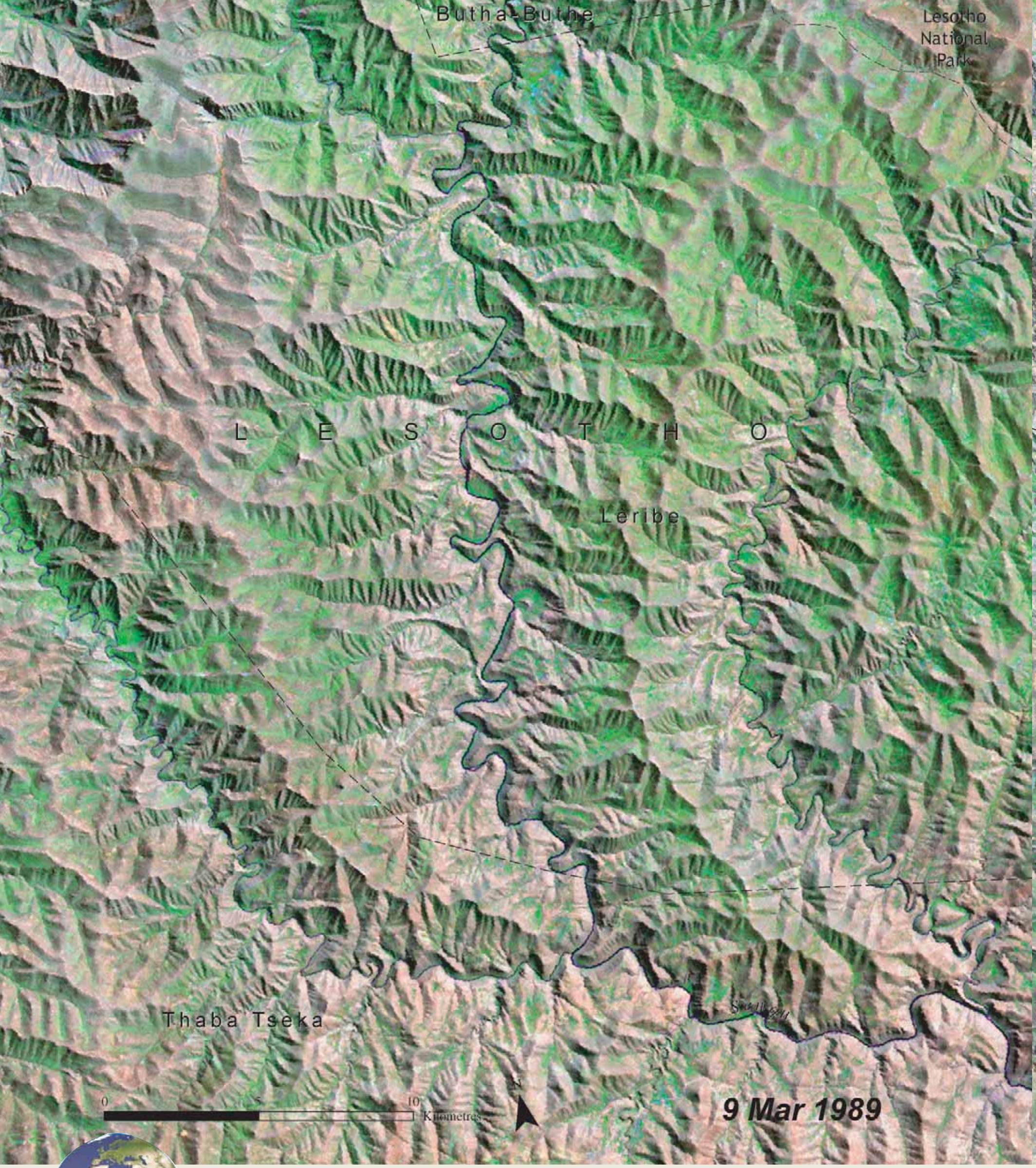
Table 3.4: Annual natural mean run-off at four dam sites

Dam	River	Catchment Area km^2	Mean Annual hm^3	Run-Off m^3/s
Katse	Malibamats'o	1 860	656	20.8
Mohale	Senqunyane	938	367	11.6
Mashai	Senqu	7 977	1 569	49.7
Tsoelike	Senqu	10 375	1 891	59.9

Source: LHWP n.d.

Katse Dam, Lesotho

Unknown/UNEP/The Mountain Club of South Africa

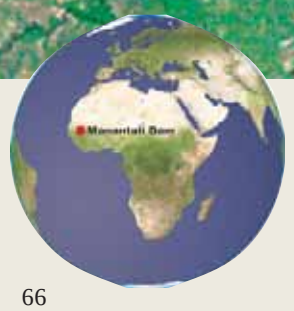


Lesotho Highlands

Lesotho

The Lesotho Highlands Water Project is one of the largest infrastructure projects ever undertaken on the African continent. The project is designed to divert water from Lesotho's

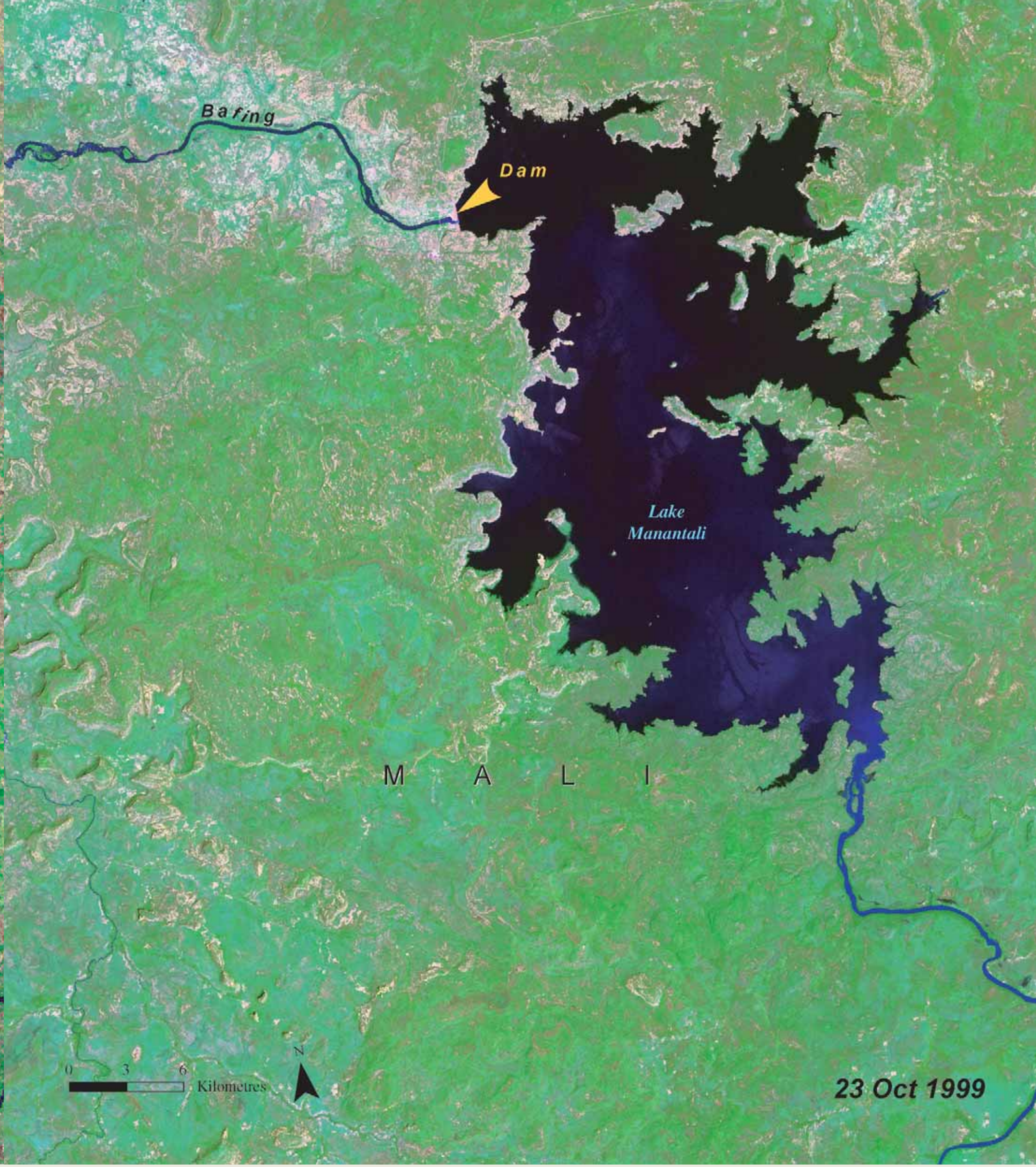
Maloti Mountains to South Africa's urban and industrial Gauteng Province, while providing impoverished Lesotho with hydroelectric power and profits from the sale of water. An 82 km (51 mile) water transfer-and-delivery system is already in place, and four major dams are at various stages of completion in key locations. However, many questions remain unanswered about these dams' social and environmental impacts. The first, the Katse Dam on the Orange River, closed its gates in 1995, creating an enormous reservoir—along with serious social and environmental concerns. These two images provide a comparison of the area before and after the Katse Dam's completion, with its full extent and effects clearly visible in the 2001 image.



Lake Manantali

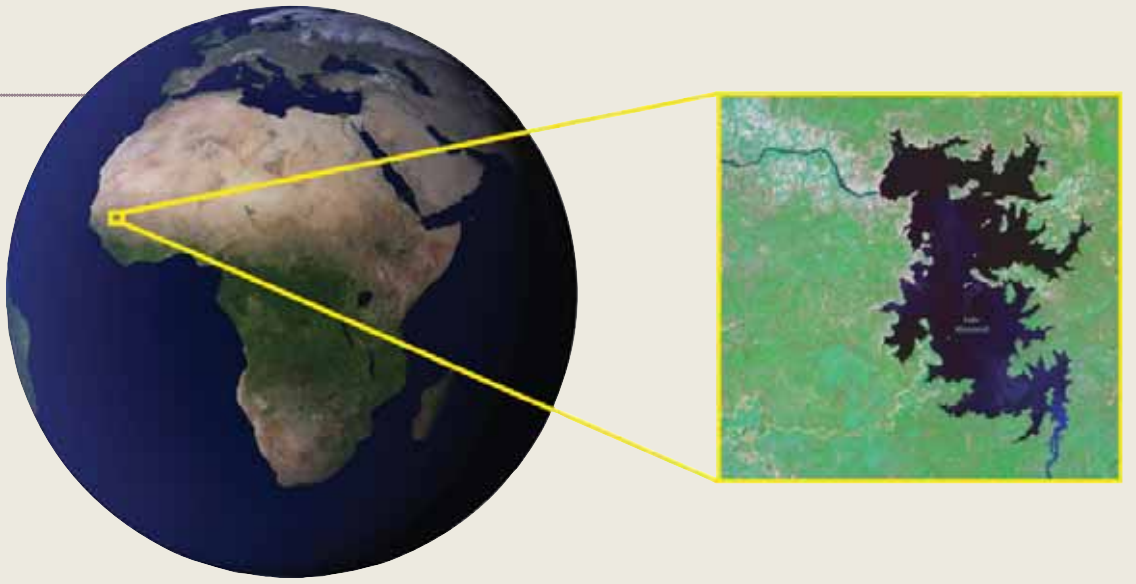
Mali

Lake Manantali on the Bafing River contributes to power generation and irrigation in the surrounding areas. These two images illustrate some of the physical changes that have occurred in the Bafing riverine system



since the construction of the Manantali Dam, which began in 1981. The 1977 image shows the original meandering nature of the Bafing River, which annually deposited rich fluvial soils used by local people for growing sorghum and other crops on its flood-plains. The 1999 image shows the extent of irrigated agriculture in the surrounding area, which rapidly expanded after the dam was filled between 1986 and 1988. The increase in water quantity is also clearly visible in 1999 image.

Lake Manantali



Built in the early 1980s on the Bafing River, one of the three main tributaries of the Senegal River, the Manantali Dam was originally intended to power a 200 MW hydroelectric station, with 1 300 km (808 miles) of transmission lines serving the capital cities of Bamako (Mali), Nouakschott (Mauritania), and Dakar (Senegal). Measuring 1 460 m (4 790 ft) long and 65 m (213 ft) high, the dam created a reservoir with a storage capacity of 11.3 million million m^3 (14.8 million million cubic yards) and a surface area of 477 km^2 (184 square miles)(IRN 1997).

Built under the auspices of the Organization pour la Mise en Valeur du Fleuve Senegal (OMVS), the dam was designed to generate hydropower, to irrigate an area of 3 750 km^2 (1 448 square miles), and to expand navigation between the cities of St. Louis and Kayes. At US$25 000-40 000 per hectare, however, the construction of the irrigation networks fed by the reservoir proved to be more expensive than originally planned. Instead of 3 750 km^2 (1 448 square miles), only about 1 000 km^2 (386 square miles) of land has been brought under irrigation so far. With irrigation, the traditional sorghum crop has been replaced by rice. Even for the richer farmers, however, irrigation has proved to be more cumbersome and less productive than envisaged, with the lack of electric power necessitating the purchase of expensive diesel to run their pumps.

The Manantali Dam has not just affected local patterns of agriculture, but has led to violent conflicts at both national and regional levels. When the dam project opened new prospects of commercial agriculture, land legislation in Mauritania was rewritten in order to abrogate the land rights of black peasants who had lived along the riverbank for generations. In 1989, the killing of Senegalese farmers by Mauritanians triggered an outbreak of ethnic violence that saw hundreds of people killed and some 70 000 Mauritanian peasants expelled to Senegal. The two countries' militaries engaged in armed skirmishes, and nearly went to war over the conflict.

The impact of the Manantali Dam on traditional agriculture has been equally serious. For many centuries, the annual flood of the Senegal River has been the basis for flood-recession agriculture, fishing and cattle-grazing. Sorghum is still the staple food for more than 100 000 families in the floodplains. With the construction of the dam, however, the annual flood has been reduced to an artificial two-week flood. The new hydropower plant will compete with the artificial floods for agriculture, and will reduce the flooded area by another 20 000 ha (World Bank n.d.).

Traditionally, the Senegal River inundated about 150 000 ha on average and up to 350 000 ha in high-flow years. The World Bank reports that after hydropower construction, floods will still allow farming on at least 50 000 ha, except in very dry years. There is reason to doubt this statement. Critics argue that the World Bank's forecast is based on outdated hydrological data and does not reflect the reduced rainfall patterns that have prevailed since the 1970s. On the basis of actual recent flows, the average flood is more likely to extend to 30 000 ha, and every third year there will be insufficient water for any flood at all.

A field of rice.

UNEP/Morguefile.com

Lake Nakuru

Lake Nakuru National Park is the second most visited protected area in Kenya. It hosts the world's largest concentration of flamingos, as well much of the wildlife that makes Kenya a highly valued tourism destination, including lions, leopards, rhinos, and buffalo. In its total area of 18 800 hectares (46 456 acres), there are over 450 bird species and 56 mammal species. Recognized as a wetland of international importance, Lake Nakuru was declared a Ramsar Site in 1990.

One of the most pressing threats to the lake is the degradation of its catchment which is most likely to increase fluctuation in water flow and decrease water quality. On 16 February 2001, the Government of Kenya announced its intention of excising 35 301 hectares (87 231 acres) of forest in Eastern Mau Forest Reserve.

This excision took effect in October 2001 by Legal Notice 142 that appeared in the Kenya Gazette Supplement of 19 October 2001. With this excision, most of the forest cover in the upper catchment of the main rivers that feed Lake Nakuru will disappear.

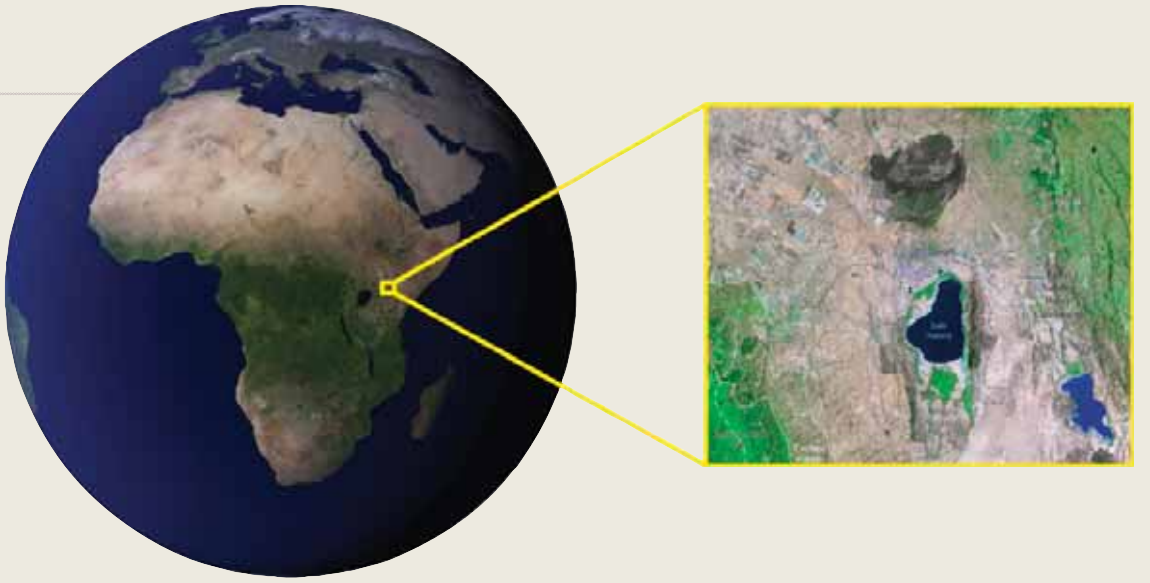


Table 3.5: Vegetation cover changes in the catchment of Lake Nakuru*

Forest Reserves	*1973 (ha)*	*2001 (ha)*	*Changes (%)*
Inside Forest Reserves			
Closed forest	33 230	15 925	-52%
Bush / open forest	5 441	5 665	4%
Outside Forest Reserves			
Closed forest	8 509	7 323	-14%
Bush / open forest	28 287	8 507	-70%
TOTAL	75 467	37 420	-50%
% of total catchment area	46%	23%	

* Changes are based on a preliminary interpretation of Landsat images.

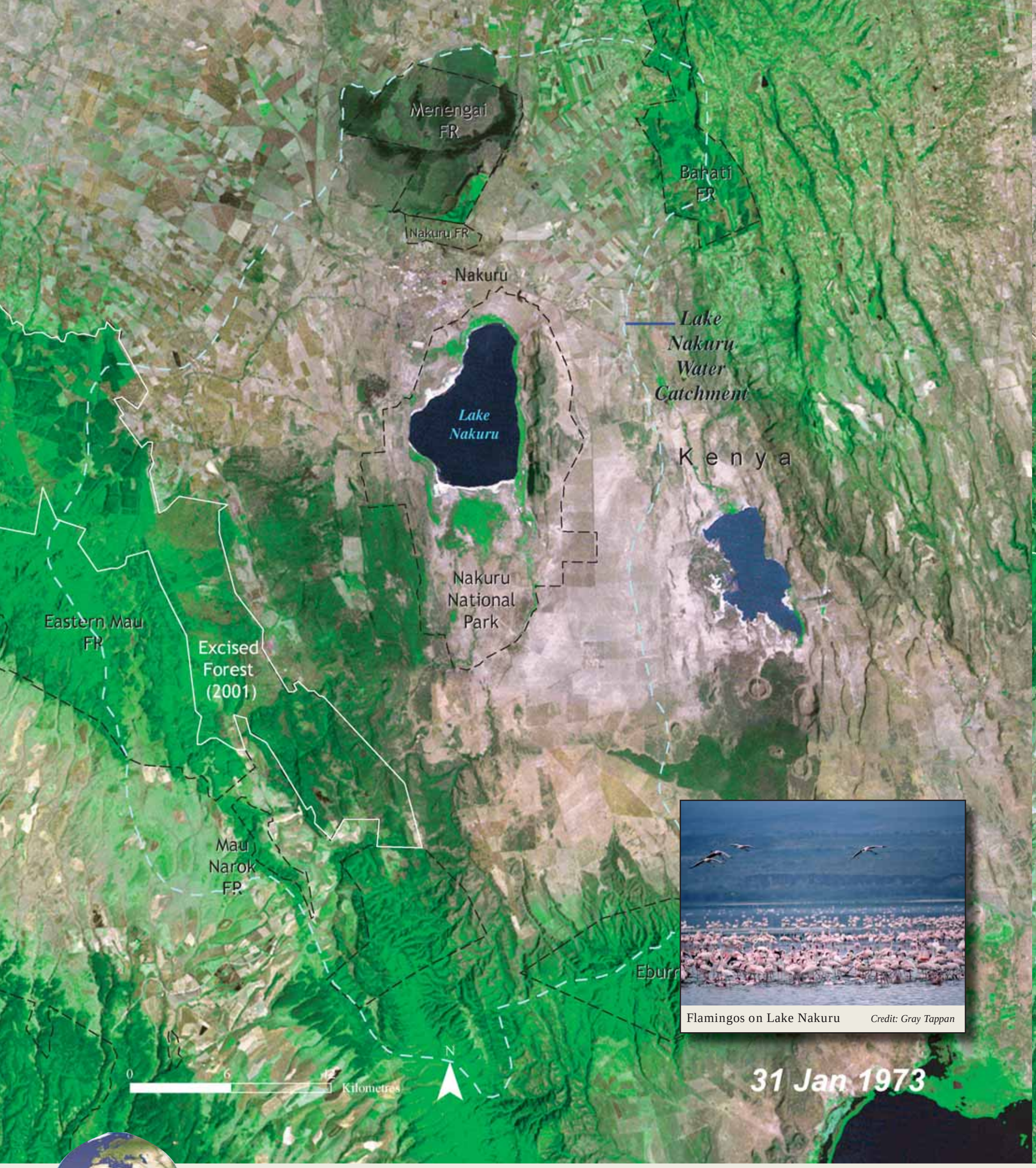
No ground truthing exercise has yet been undertaken.

Source: UNEP 2002.

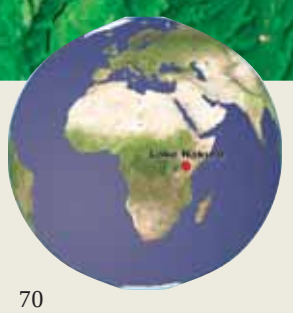
Christian Lambrechts/UNEP

Christian Lambrechts/UNEP

Gray Tappan/UNEP/USGS



Flamingos on Lake Nakuru *Credit: Gray Tappan*



Lake Nakuru

Kenya

Located in southwest Kenya's Great Rift Valley, Lake Nakuru is the centrepiece of Lake Nakuru National Park, the country's second most visited protected area. The lake hosts the world's largest concentration of flamin-

Vegetation around Lake Nakuru *Credit: Gray Tappan*

gos, as well as many of Kenya's more charismatic mammal species, including leopards and the rare black rhinoceros. Its 188 km^2 (73 square miles) are home to more than 450 bird and 56 mammal species. Despite its declaration as a Ramsar-protected wetland in 1990, the continuing degradation of land cover in Nakuru's populous catchment area is likely to increase flow fluctuations and decrease water quality in the lake. In 2001, the Kenyan Government announced its intention to excise 353 km^2 (136 square miles) of forest in the Eastern Mau Forest Reserve (ringed in white in the 2000 image)—a decision that could result in the disappearance of most of the forest cover in the upper catchment of the main rivers feeding Lake Nakuru.