Credit: Laurent /UNEP/Topfoto

3.3 Water

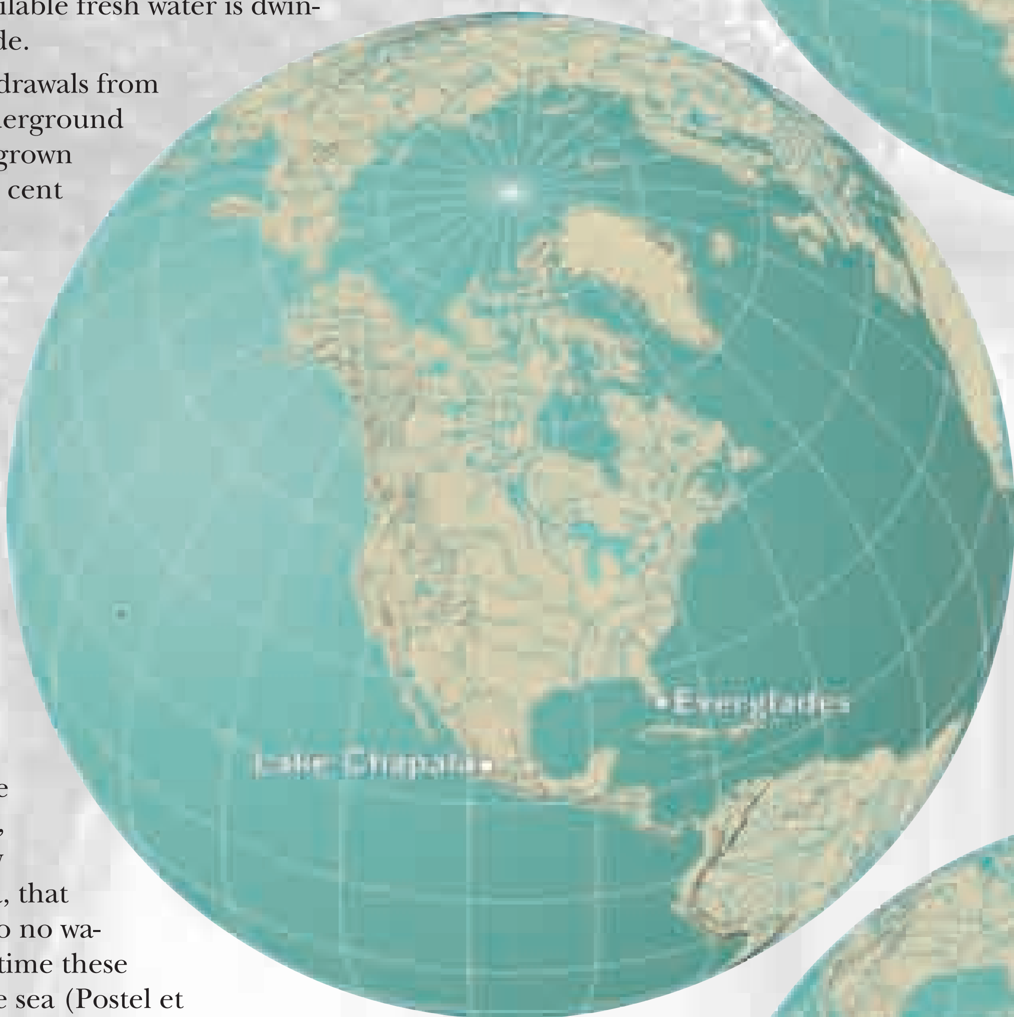
Water is fundamental to almost all living things on the Earth. Human health—and survival—depends on a clean and reliable supply of fresh drinking water, as well as water for crop irrigation and sanitation (UNESCO 2000). Fresh water is water that has a very low salt content—usually less than one per cent. Only about 2.5 per cent of all water on the planet is fresh. Of that amount, only about 0.5 per cent is surface water (found in lakes, rivers, wetlands) or accessible groundwater. Rainfall is also a source of fresh water. But rainfall is unpredictable and amounts vary dramatically from place to place and season to season around the world (UNFPA 2001).

During the past century, world population has tripled. Over roughly the same period of time (1900 to 1995) water use worldwide has increased six-fold. Experts predict that by 2025, global water needs will increase even more, with 40 per cent more water needed for cities and 20 per cent more water for growing crops (Paden 2000). Yet while needs increase, the amount of available fresh water is dwindling worldwide.

Water withdrawals from rivers and underground reserves have grown by 2.5 to 3 per cent annually since 1940, significantly ahead of population growth. So much water is withdrawn from several of the world's major rivers, including the Colorado River in the United States, the Nile River in Egypt, and the Yellow River in China, that there is little to no water left by the time these rivers meet the sea (Postel et al. 1996). Demands on groundwater are equally great; water tables are falling on every continent.

Over the next two decades, it is estimated that the average supply of water per person will drop by one-third. Annually, lack of clean drinking water can be linked to roughly 250 million cases of water-related disease and between 5 and 10 million deaths worldwide. Thus, water shortages indirectly condemn millions of people to an avoidable premature death each year.

Water shortages are also impacting global grain markets, as arid countries that rely on irrigation for crop production switch from growing grain to importing it (Harrison and Pearce 2001). Irrigation accounts for 70 per cent of direct water consumption worldwide. It has been estimated that practices such as drip irrigation and inexpensive moisture monitors could cut agricultural water use by as much as 40 per cent (Wall 2001).



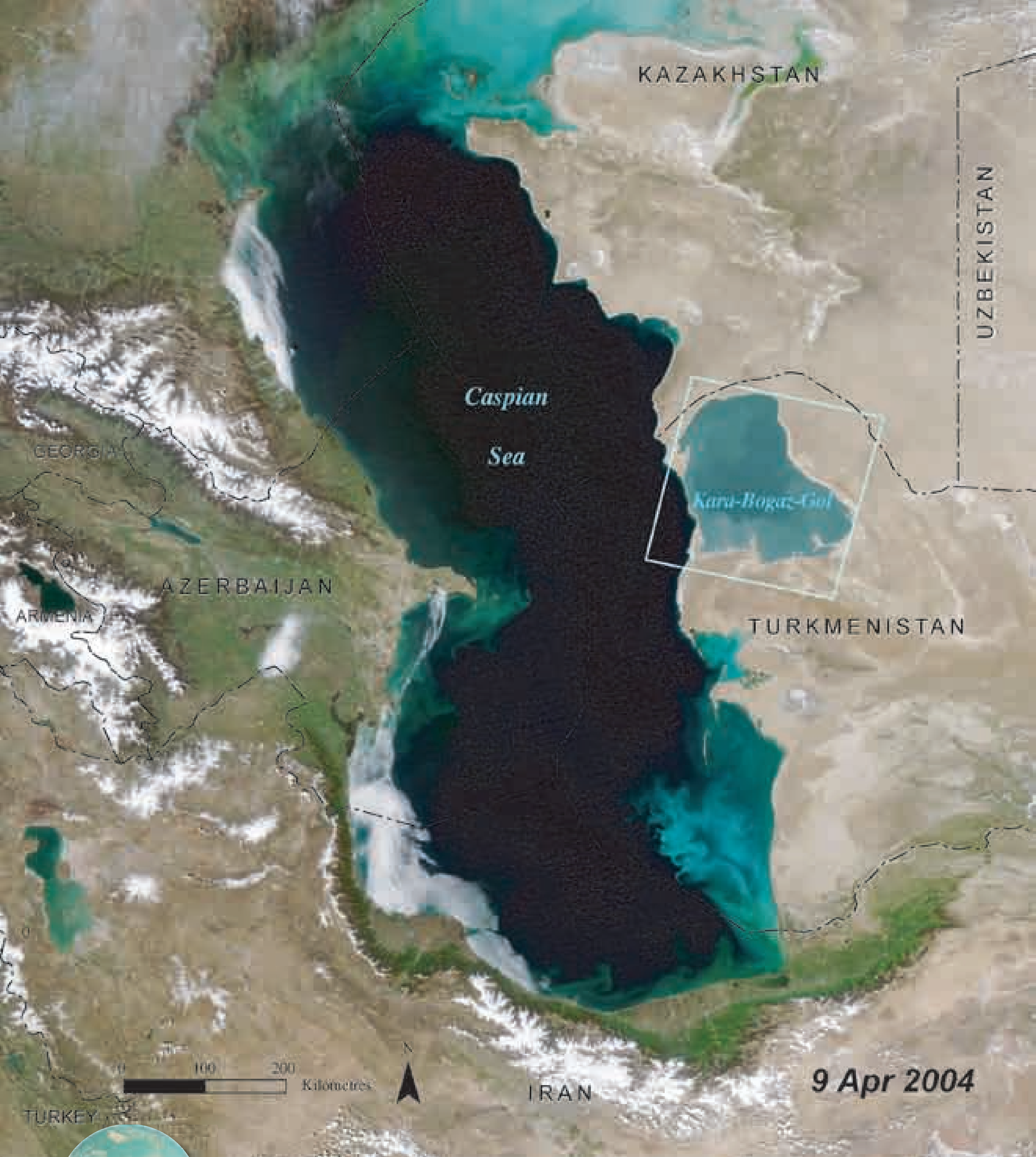
The exploitation of the world's water resources has occurred at no small cost to the environment. Worldwide, all major rivers have water works that change flow regimes to some extent and therefore impact riparian ecosystems. Many endemic riparian species are disappearing (Ramsar Convention Bureau 1998), and twenty per cent of all freshwater fish are currently endangered. Few aquatic ecosystems have been as severely impacted as wetlands, however. During the 20th century, half of the Earth's wetland ecosystems—such as marshes, fens, swamps, and estuaries—disappeared (UNESCO 2003). Approximately 40 000 hectares (98 842 acres) of wetlands are destroyed each year as the result of human activities (Center for Environmental Resource Management n.d.). Drainage for agricultural production is the principal cause of wetland loss.

At the same time that global water supplies are declining, so is the quality of the water that remains. Water pollution is the presence of harmful and objectionable material—such as sewage, industrial wastes and chemicals, and run-off from land development or agriculture—in sufficient concentrations as to make water unfit for use (EEA 2004). Water pollution is a serious threat to the world's water supply. It is also a growing threat to the oceans that cover more than 70 per cent of the planet. People have long viewed these immense bodies of water as limitless dumping grounds for wastes. Over time, however, raw sewage, garbage, industrial wastes, and oil spills have begun to overwhelm the diluting capabilities of the oceans. Most coastal waters are now polluted, often severely (Revenga and Mock 2000, Revenga et al. 2000).

The 21st Century brings with it a global water crisis. Unless corrective and conservation measures are taken, it is estimated that by 2030 global demands for fresh water will exceed the supply (NSW EPA 2003, UNESCO 2000). Serious water and food security problems already exist in some developing countries and regions, and these demand urgent attention (FAO 2003).

Growing population in urban areas is exerting great pressure on water resources. Even if the world maintained the pace of the 1990s in water-supply development, this would not be enough to ensure that everyone had access to safe drinking water by the year 2025. The impacts of climate change—including changes in temperature, precipitation and sea levels—are expected to have varying consequences for the availability of freshwater around the world. Current indications are that if climate change occurs gradually, the impacts by 2025 may be minor, with some countries experiencing positive impacts while most experience negative ones. Climate change impacts are projected to become increasingly strong during the decades following 2025.

Credit: Mario Hernan Valencia/UNEP/Topfoto



Water
KBG, Turkmenistan

The Caspian Sea, seen in this 2004 image, is the largest inland body of water in the world, often categorized as a large salt lake. It is salty because rivers (especially the Volga) flow into it, but none flow out. Water leaves

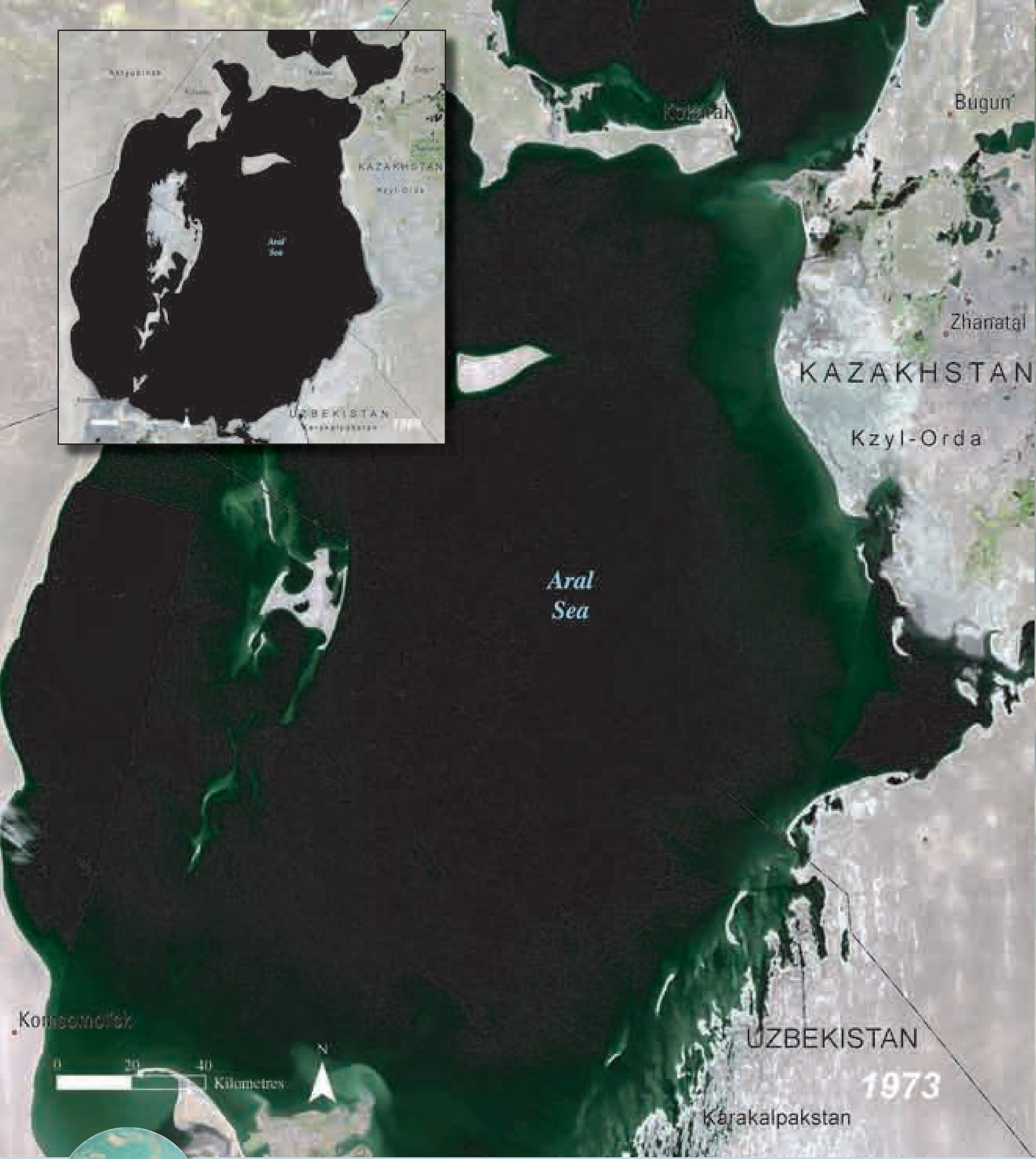
through evaporation, and the dissolved salts remain. Changes in water levels are common in the sea, resulting both from changing climatic factors and water diversion by humans. The 2004 image highlights the area of change—the Kara-Bogaz-Gol (KBG). KBG is a large, shallow lagoon of the Caspian Sea, normally about 18 200 km^2 (7 000 square miles) and a few metres deep. The Caspian's changing water level has been a concern since the 1970s. The KBG's water flows in from the Caspian Sea, and its fluctuations have affected the KBG dramatically.

In the 1980s, a dam blocked the KBG's inflow, resulting in the formation of a "salt bowl" that caused widespread problems of blowing salt,

In 1980, in response to the rapidly dropping sea level, a dam was constructed to prevent water from flowing into the shallow and restricted Kara-Bogaz-Gol basin, resulting in the drying up of the bay. The dam was partially opened a few years later, and completely opened in 1992 when Caspian water levels started to rise quickly. *Credit: NASA Johnson Space Center*

reportedly poisoning soil, and causing health problems for people living hundreds of kilometers downwind to the east. While the dam was in place, not only did the KBG's water level rapidly drop by 2 m (7 ft) or more, but the lagoon's shallow bottom also rose 0.5 m (2 ft), due to the accumulation of salts.

The dam was partially opened in 1985, and completely opened in 1992 when Caspian Sea water levels started to rise quickly. Today, sea levels are more than 2.6 m (9 ft) higher than the 1978 levels and water flows freely into the salty waters of the Kara-Bogaz-Gol.



Water
Aral Sea, Kazakhstan

The name " Aral Sea " comes from the word "aral" meaning island. The sea's name reflects the fact that it is a vast basin that lies as an island among waterless deserts. The Aral Sea was once the world's fourth-largest inland sea. Its problems began in the 1960s and 1970s

with the diversion of the main rivers that feed it to provide for cotton cultivation in arid Soviet Central Asia. The surface of the Aral Sea once measured 66 100 km^2 (25 521 square miles). By 1987, about 60 per cent of the Aral Sea's volume had been lost, its depth had declined by 14 m (45 feet), and its salt concentration had doubled, killing the commercial fishing trade. Wind storms became toxic, carrying fine grains of clay and salts deposited on exposed sea floor. Life expectancies in the districts near the sea are significantly lower than in surrounding areas.

The sea is now a quarter of the size it was 50 years ago and has broken into two parts, the North Aral Sea and the South Aral Sea. Re-engineering along the Syr Darya River delta in the north will retain water in the North Aral Sea, thereby drying the South Aral Sea completely, perhaps within 15 years.

The power-generating station at the Atatürk Dam already provides 8.9 billion kilowatt hours of electricity—roughly 22 per cent of the electricity the country is expected to need by 2010.
Credit: Unknown/UNEP/USDA-FAS

WATER
ATATÜRK DAM, TURKEY

Built in 1990, the Atatürk Dam on the Euphrates River in southeastern Turkey is the centrepiece of the Southeastern Anatolia Project. The Atatürk Dam is the largest in a series of 22 dams and 19 hydroelectric stations built on the Euphrates and Tigris Rivers in order to provide irrigation water and electricity to this arid region

Main Harran canal
Credit: Unknown/UNEP/USDA-FAS

of the country. When the project's entire system of reservoirs, power generation stations, and irrigation channels is operational (projected to occur in 2010), the irrigation of approximately 1.7 million hectares (4.2 million acres) of land will be possible..

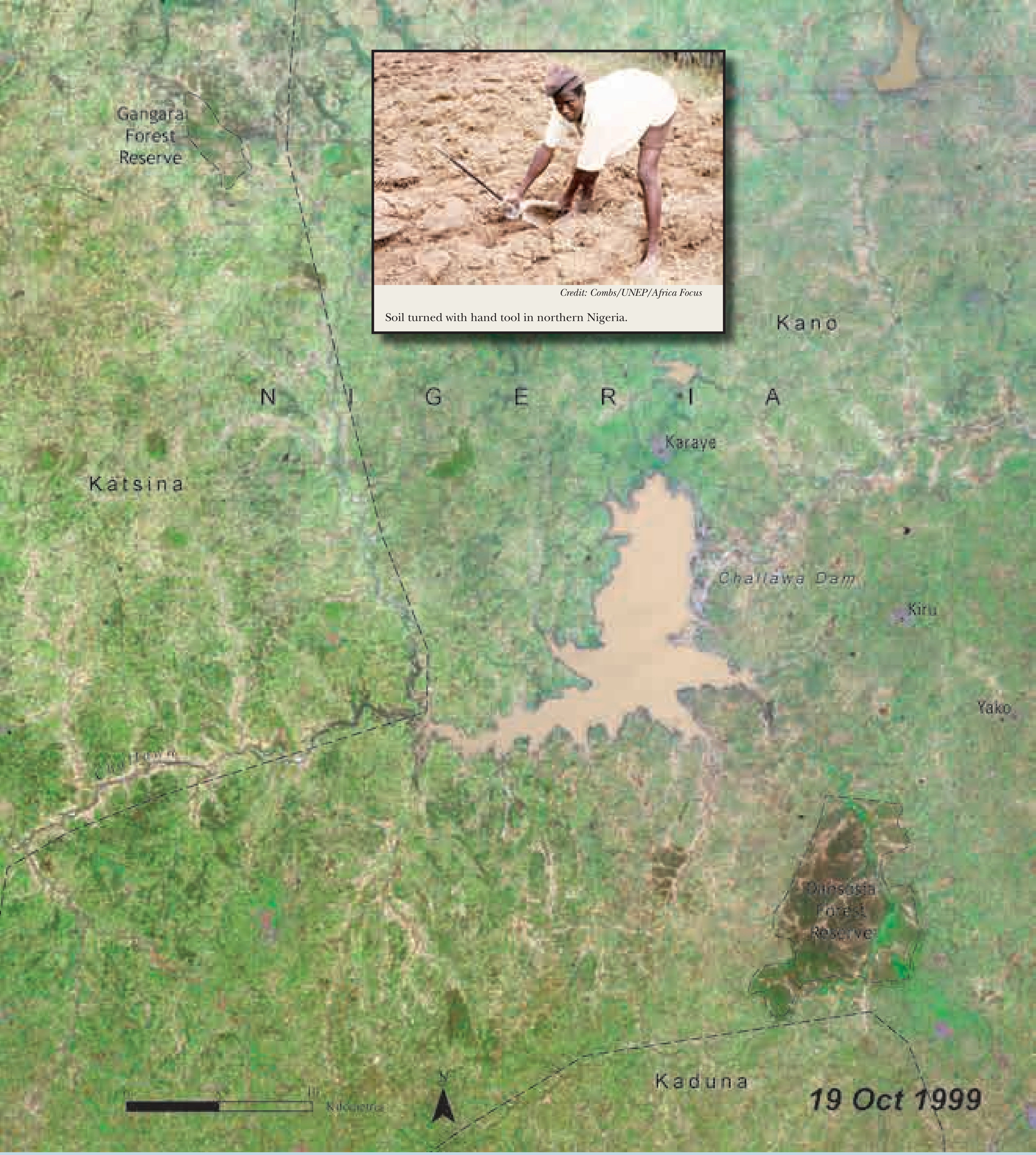
In these two Landsat images, acquired in 1976 and 1999, respectively, the transformation of the region around the dam is strikingly apparent. The dam's reservoir reached capacity in 1992 and has supplied sufficient water for irrigation to turn a once-arid landscape into a green one. This is especially obvious in the lower right-hand corner of the 1999 image, where irrigated fields completely surround the town of Harran. The development of the Harran region could not have occurred without the Atatürk Dam project, especially since the town is many kilometres from the river.

Credit: Combs/UNEP/Africa Focus

Vegetable crops of onions and sweet potatoes can grow in fields maintained by irrigation.

WATER
CHALLAWA GORGE DAM, NIGERIA

The Challawa Gorge Dam, completed in 1993 on the Challawa River, is the second-largest of the 23 dams along rivers in Nigeria's Hadejia-Jama'are River Basin. Though the dam has improved the water supply for irrigation, heavy rains cause the river to break its banks

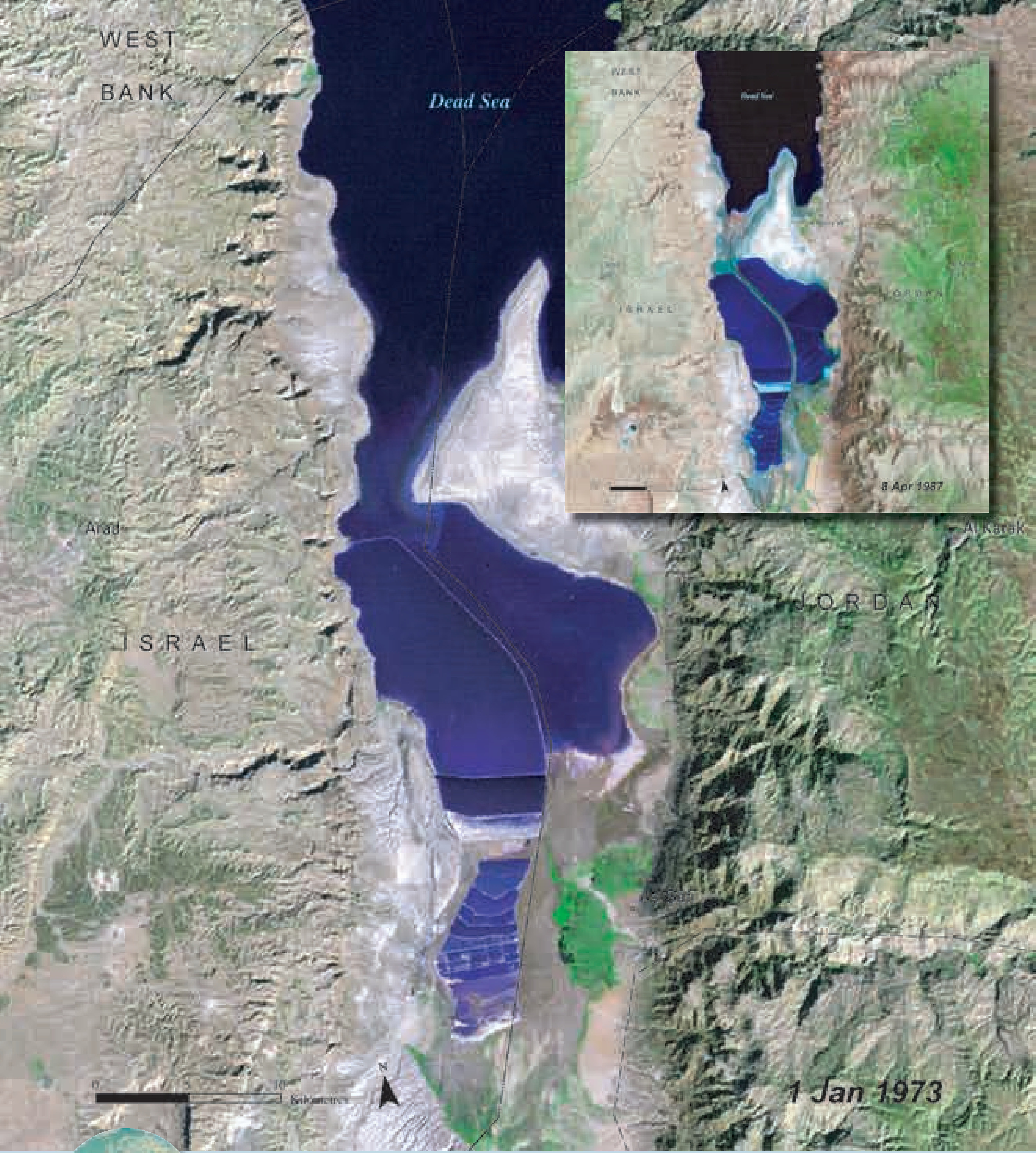


Credit: Combs/UNEP/Africa Focus

Soil turned with hand tool in northern Nigeria.

upstream from the dam; farmers are driven out as the rising water floods their farms and adjoining lands. Areas downstream from the dam, on the other hand, do not receive enough water to maintain the wetlands that border the river. Under these conditions, the soil dries out and overgrazing occurs, which in turn leads to wind erosion of the topsoil.

This satellite image pair gives a comparison of the area before and after construction of the dam. The 1999 image shows the degree to which flooding upstream from the dam impacts the landscape, and how the lack of water downstream negatively affects riverine wetlands and cropland. The colour of the water in the flooded area is also indicative of high-sediment content.



Water
Dead Sea, Jordan

For decades, heavy demands have been placed on the land-locked Dead Sea to meet the needs of growing populations in the countries that border it. Both Israel and Jordan draw water from rivers that flow into the Dead Sea, reducing the amount of water that would

naturally replenish it. The amount of area devoted to evaporation ponds for producing salt has greatly expanded over the past three decades. The creation of salt works tends to accelerate evaporation, further contributing to the reduction in water level. Currently, it is estimated that the water level of the Dead Sea is dropping at a rate of about one metre (3 feet) per year.

These two images, from 1973 and 2002, reveal dramatic changes in the Dead Sea over a period of about 30 years. Declining water levels, coupled with impoundments and land reclamation projects, have greatly increased the amount of exposed arid land along the coastline. The near-complete closing off of the southern part of the Sea by dry land (2002 image) reveals the severity of water level decline.

Aerial view of urban developement in the Everglades.
Credit: Unknown/UNEP/SFWMD

Water
Everglades, United States

These two Landsat images of southern Florida in the United States reveal some of the changes that have occurred in this region over the past 30 years. One of the most obvious is the growth of the Fort Lauderdale-Miami urban area. Urban expansion has led to the con-

The Florida panther.
Credit: Unknown/UNEP/SFWMD

version of what were once farmlands to cityscapes. The city of Miami has also expanded greatly to the southwest. The advance of urban areas westward across the peninsula threatens the continued existence of the vast wetlands area known as the Everglades. The Everglades ecosystem naturally filters groundwater and helps to recharge the Biscayne Aquifer. It is also home to a remarkable collection of plants and animals for which southern Florida is famous. As urban areas encroach upon the Everglades, water resources and wildlife habitat are placed at serious risk. Protecting the Everglades to maintain its essential water filtering capacity and remarkable biodiversity is part of the mission of the Federal "Smart Growth" Task Force, which is working to better manage urban sprawl and its negative consequences.

Former Danube river bottom exposed as water is redirected into the diversion canal. *Credit: Peter Bardo-Déak/UNEP/WWF-DCP*

Water

Gabcikova, Slovakia

The Gabcikova-Nagymoros hydraulic project on the Danube River was started in order to generate electric power, create an inland waterway, help manage water supplies, and aid in the region's economic development. The river was to be dammed and its water diverted into a canal. Four decades after it was initiated the

A dam on the Danube River
Credit: Peter Bardo-Déak/UNEP/WWF-DCP

Cunovo Dam began operation in Slovakia in October 1992. The dam diverted 80 to 90 per cent of Danube River water down a diversion canal to support a hydroelectric power station.

This pair of images from 1973 and 2000 reveal the striking changes the massive re-channeling of river water has brought to the region. The dam altered the hydraulic regime of the Danube River valley from a natural waterway to a controlled patchwork of channels and islands. The diversion of water by the dam brought an end to the natural, beneficial flooding that added moisture and nutrients to the soil. It also reduced the ability of wetlands and marshes to filter surface water and trap sediments. Consequently, water quality and soil nutrients levels in the region have declined. Generation of electricity has come with significant environmental cost.

WATER
LESOTHO HIGHLANDS WATER PROJECT

The Lesotho Highlands Water Project (LHWP) 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 South Africa is set to benefit from an increased supply of

much-needed water, Lesotho would gain through the generation of hydro-electric power and profits from the sale of water. An 82-km (51-mile) water transfer-and-delivery system is already in place for delivering water to South Africa. On completion of the full project, a total of four dams will be placed in key locations. However, many questions remain unanswered about the social and environmental impacts the completed dams will have. The first dam in the multi-dam scheme, called Katse, located on the Orange River, closed its gates in 1995, creating an enormous reservoir along with serious social and environmental concerns.

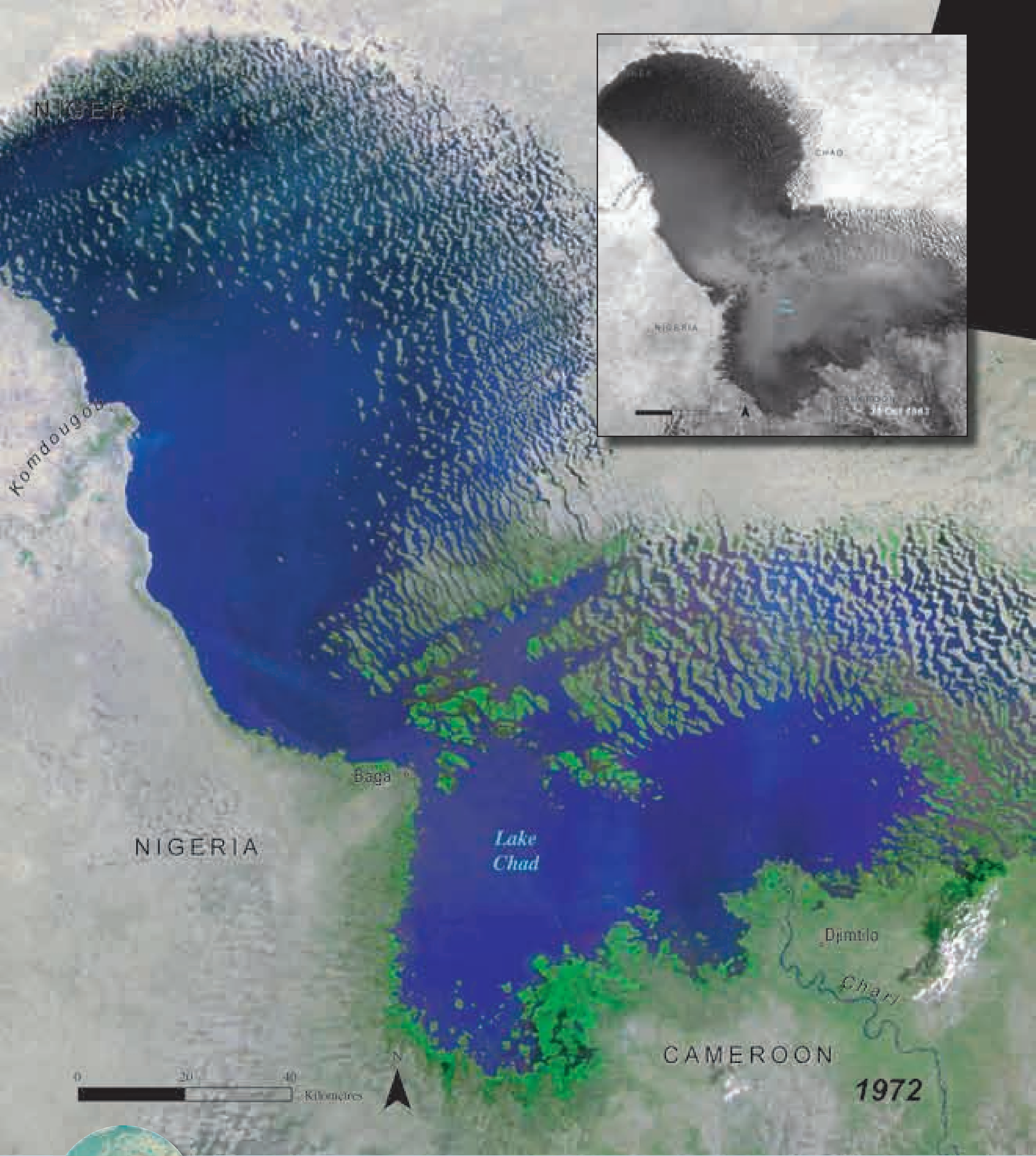
These two images provide a comparison of the area before and after completion of the Katse dam. The effects and extent of the Katse Dam can clearly be seen in the 2001 image.

Water
Lake Balkhash, Kazakhstan

Located in Kazakhstan, Central Asia, Lake Balkhash is replenished from the Ili River catchment area, most of which is located in northwestern China. The lake is a very important resource for the surrounding population. Water from the lake and its tributary rivers is used

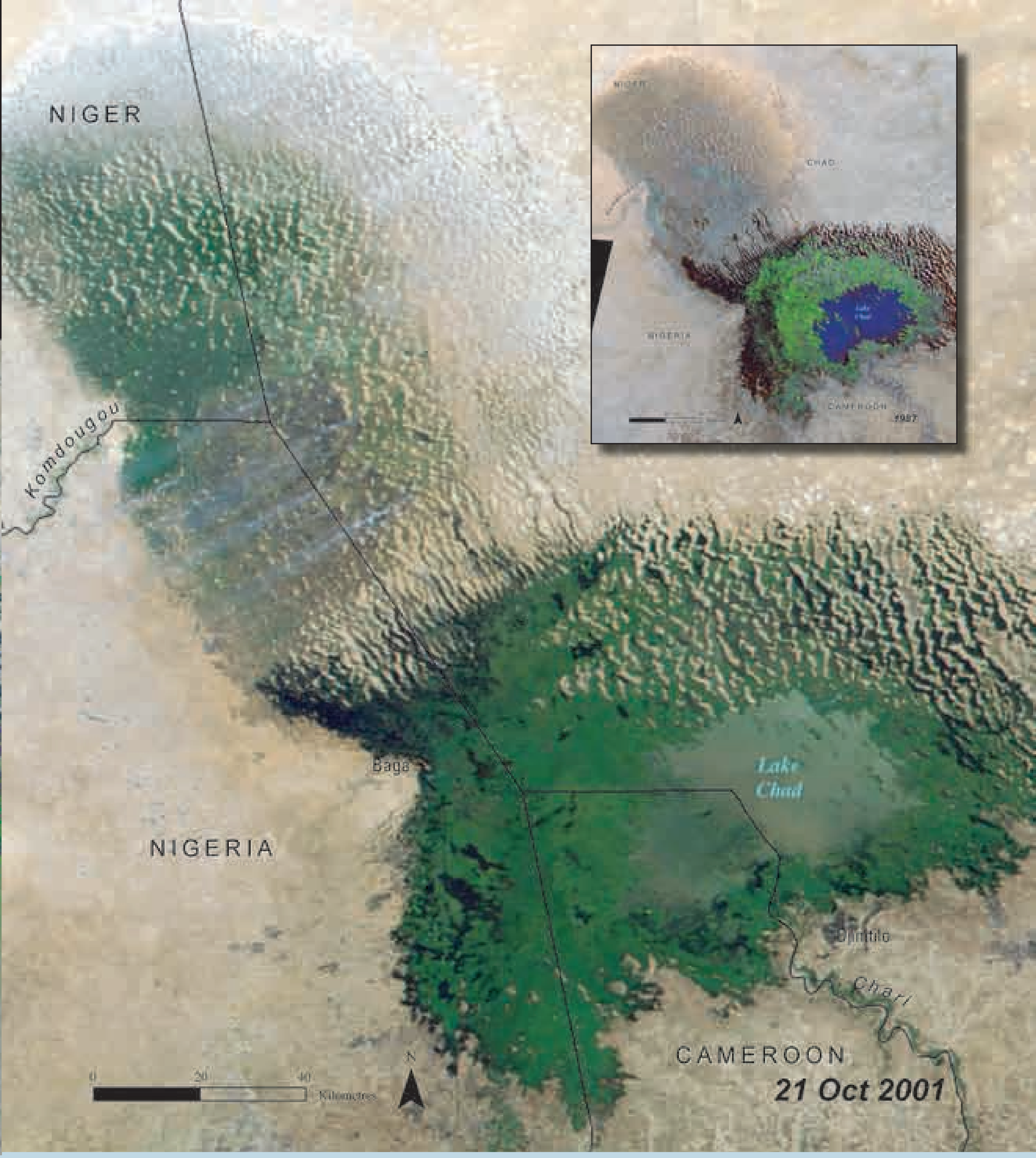
for irrigation and both municipal and industrial purposes, including supplying the water needs of the Balkhash Copper Melting Plant. Lake fish are also an important food source. However, artificially low water prices have encouraged excessive use and waste of lake water. The United Nations has warned that Lake Balkhash, which is the second largest lake in Central Asia after the Aral Sea, could dry up if current trends are not reversed.

These two satellite images reveal an alarming drop in the lake's water levels in just over twenty years. Smaller, neighboring lakes, to the southeast of Balkhash, have become detached from the main water body; they have dramatically decreased in size and appear to be drying up.



Water
Lake Chad, Africa

Lake Chad, located at the junction of Nigeria, Niger, Chad, and Cameroon was once the sixth-largest lake in the world. Persistent droughts have shrunk it to about a tenth of its former size. The lake has a large drainage basin—1.5 million km^2 (0.6 million square miles)—but almost no water flows in from the dry north. Ninety



per cent of lake's water flows in from the Chari River. The lakebed is flat and shallow; even before the drought, the lake was no more than 5-8 m (16-26 ft) deep. Considered a deep wetland, Lake Chad was once the second largest wetland in Africa, highly productive, and supporting a diversity of wildlife.

The lake is very responsive to changes in rainfall. When rains fail, the lake drops rapidly because annual inflow is 20-85 per cent of the lake's volume. Human diversion from the lake and from the Chari River may be significant at times of low flow, but rainfall is still the determining factor in lake level.

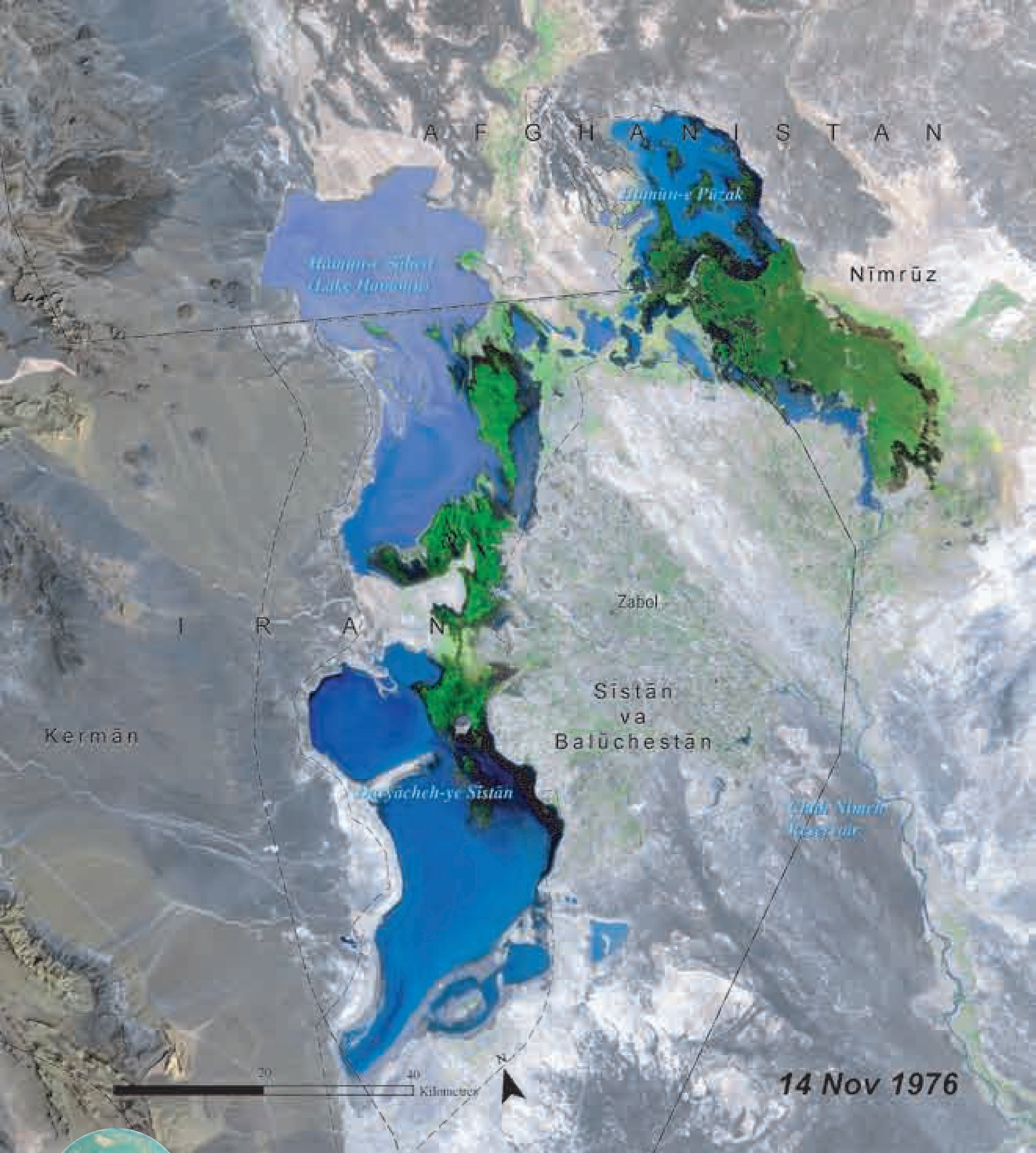
This image set displays a continued decline in lake surface area from 22 902 km^2 (8 843 square miles) in 1963 to a meager 304 km^2 (117 square miles) in 2001.

Water
Lake Chapala, Mexico

Mexico's Lake Chapala, lying in the heart of an extremely arid region, is the country's largest natural lake. The lake is one of the most important wetlands in the region and home to more than 70 endemic species. Since the 1950s, Lake Chapala has undergone many changes as a result of water abstraction for agricultural

use both inside and outside the region and for a rapidly growing population. The level of the lake has declined, and there have been noticeable decreases in surrounding wetland areas as well as changes in the hydrological system connecting various springs.

Some of these changes are visible in this pair of satellite images, including alterations in the contours of the shoreline, obvious extensions of land near various townships around the lake, and the appearance of remarkably large areas of reclaimed land at the lake's eastern end. Like all arid areas, the land around Lake Chapala is prone to salinization. If the lake continues to shrink, researchers predict both a decrease in water availability and an increase in the salt content of the region's soil.

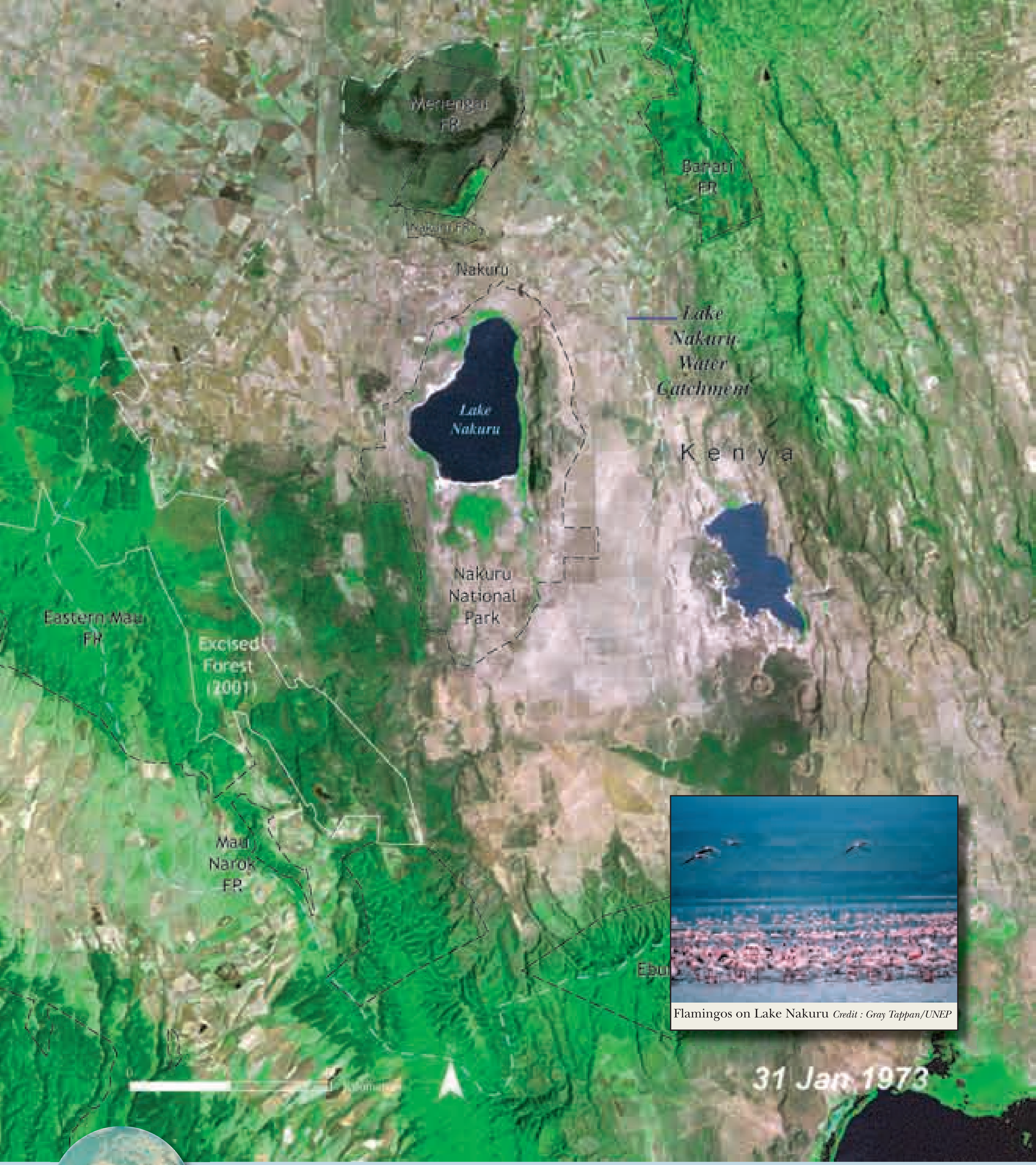


WATER
LAKE HAMOUN, IRAN

Iran's Lake Hamoun is fed primarily by water catchments in neighboring Afghanistan. In 1976, when rivers in Afghanistan were flowing regularly, the amount of water in the lake was relatively high. Between 1999 and

2001, however, the lake all but dried up and disappeared, as can be seen in the 2001 satellite image above.

The "dry phase" of Lake Hamoun is a striking example of how competition for scarce water resources can transform a landscape. When droughts occur in Afghanistan, or the water in watersheds that support Lake Hamoun is drawn down by other natural or human-induced reasons, the end result is a dry lakebed in Iran. In addition, when the lake is dry, seasonal winds blow fine sands off the exposed lakebed. The sand is swirled into huge dunes that may cover a hundred or more fishing villages along the former lakeshore. Wildlife around the lake is negatively impacted and fisheries are brought to a halt. Changes in water policies and substantial rains in the region saw a return of much of the water in Lake Hamoun by 2003.



Flamingos on Lake Nakuru *Credit : Gray Tappan/UNEP*

WATER
LAKE NAKURU, KENYA

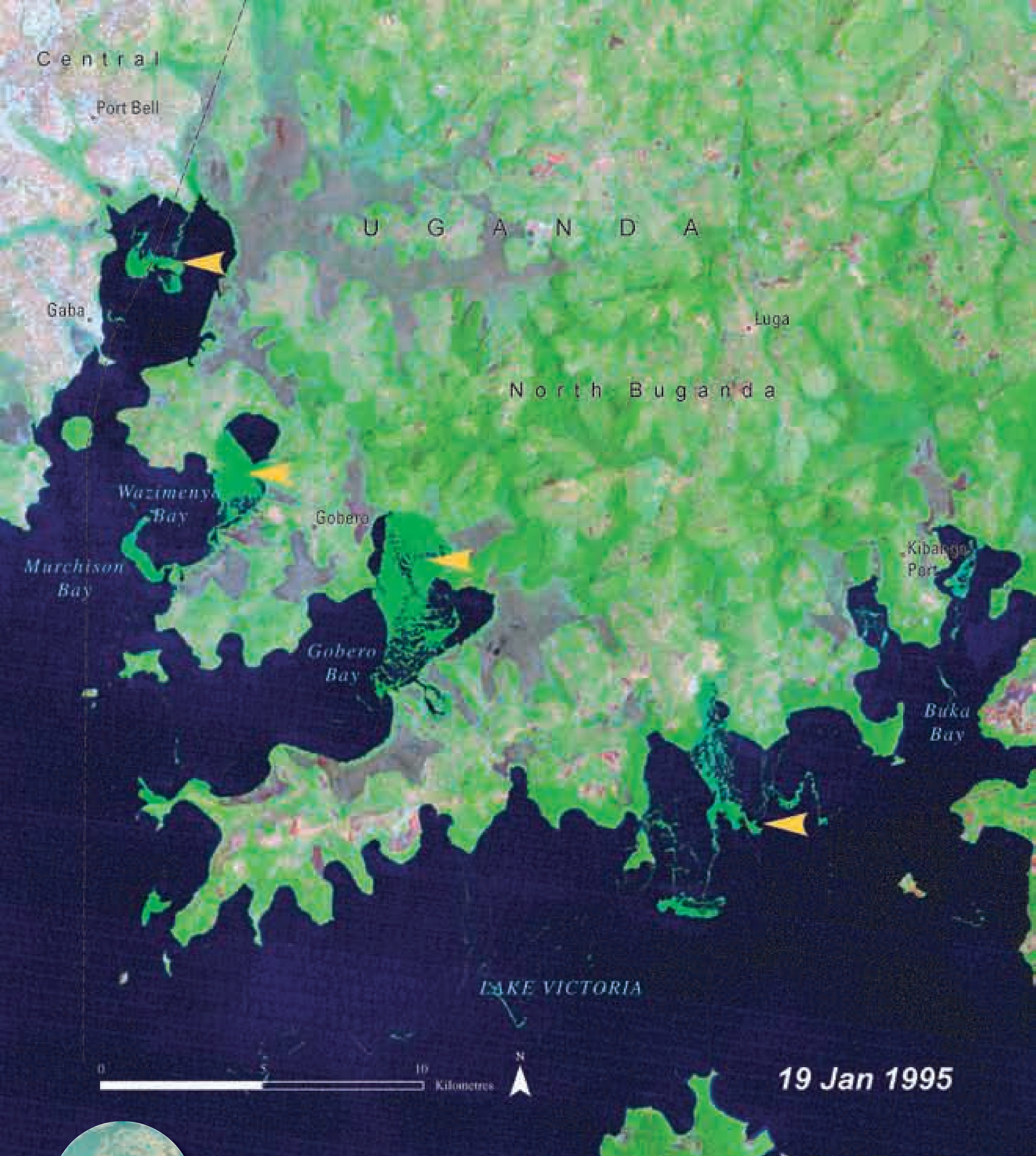
Lake Nakuru is located in the Eastern Rift Valley in southwest Kenya. Lake Nakuru National Park is the second most visited protected area in Kenya. It hosts the world's largest concentration of flamingos, as well as many of the animal species that make Kenya a highly valued tourism destination, including lions, leopards,

Vegetation around Lake Nakuru
Credit : Gray Tappan/UNEP

rhinoceros, and water buffalo. In its total area of 188 km^2 (73 square miles), 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.

The threat of land cover degradation in the catchments of the lake is likely to increase flow fluctuation and decrease water quality. These images show the land cover degradation in the lake's catchment between 1973 and 2000.

In 2001, the Government of Kenya announced its intention to excise 353 km^2 (136 square miles) of forest in the Eastern Mau Forest Reserve (area with white boundary in the 2000 image). As a result, most of the forest cover in the upper catchment of the main rivers that feed Lake Nakuru will disappear.



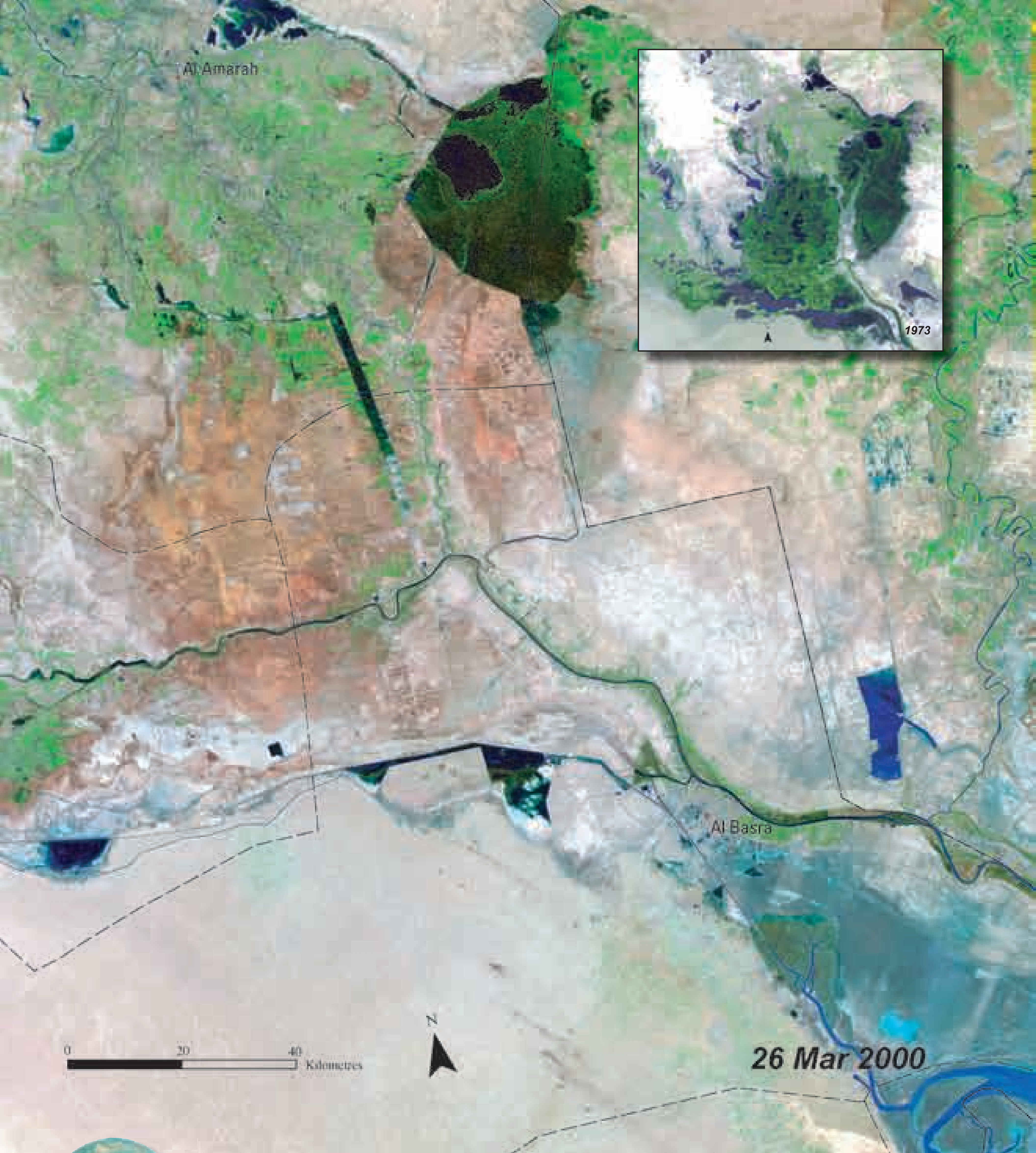
WATER
LAKE VICTORIA, UGANDA

Shared by Kenya, Tanzania, and Uganda, Lake Victoria is the second largest freshwater lake in the world. The infestation of Lake Victoria by water hyacinth in the 1990s disrupted transportation and fishing, clogged water intake pipes for municipal water, and created habitat for disease-causing mosquitoes and other

insects. This led to the initiation of the Lake Victoria Environmental Management Project in 1994. The focus of the Project was to combat hyacinth infestations on the lake, particularly the region bordered by Uganda, which was one of the most severely affected areas.

The 1995 image shows several water-hyacinth-choked bays: Murchison Bay near Gaba; large parts of Gobero and Wazimenya Bays; an area outside Buka Bay; and near Kibanga Port (yellow arrows).

Initially, water hyacinth was controlled by hand, with the plants being manually removed from the lake. But re-growth quickly occurred. A more recent control measure has been the careful introduction of natural insect predators of water hyacinth. As the 2001 image shows, this approach seems to have been successful, as the floating weeds have disappeared from all the locations noted above.



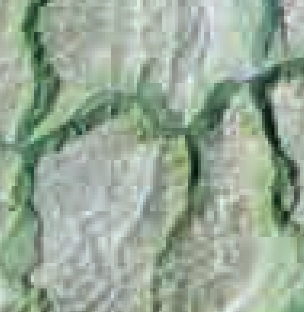
WATER

MESOPOTAMIA MARSHLANDS, IRAQ

Located at the confluence of the Tigris and Euphrates rivers, the Mesopotamian marshlands are one of the world's great wetlands covering an estimated original area of 15 000 - 20 000 km^2 (5 792 - 7 722 square miles) The marshlands are an important center of biodiversity, play a vital role in the intercontinental migration of birds, and have long supported unique human com-

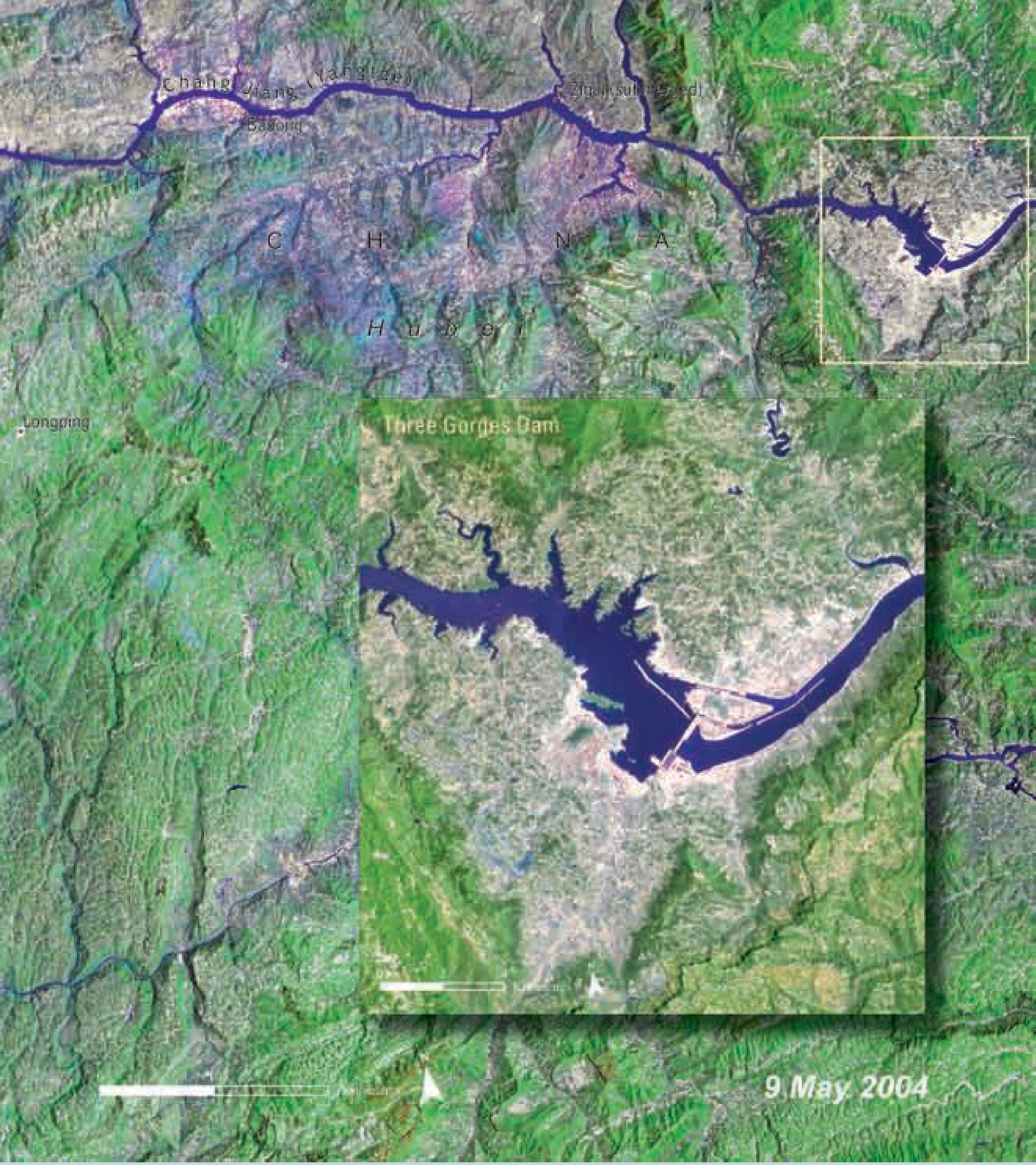
munities. Upstream damming as well as drainage activities in the marshlands themselves have significantly reduced the quantity of water entering the marshes. Together these factors have led to the collapse of the ecosystem. Restoration of the marshlands, mainly through reflooding by breaching of dykes and drainage canals has begun. As a result of these activities, vegetation and wildlife have returned to some parts of the marshes.

This set of images provides a synoptic illustration of the changes. While the 1973 image (inset left) shows the extent of the original marshlands, the 2000 image (inset right) reveals the area after being drained, with most of the wetlands having disappeared. On the other hand, the 2004 image illustrates recovery in progress with major portions in the central and western sections having been restored to some extent.



WATER
THREE GORGES DAM, CHINA

The Three Gorges Dam on the Chang Jiang (Yangtze) River in China is one of the largest single construction projects ever attempted on the planet. The dam was constructed to supply approximately one-ninth of China's electricity—as much power as could be gener-



ated by at least fifteen nuclear power plants. It is a relatively environmentally clean option compared to coal burning or nuclear power plants. It is also hoped that the dam will help control flooding on a river where seasonal floods during the past century has caused death of over one million people. However, the Three Gorges Dam project has also had negative environmental and social impacts as a result of the massive construction efforts and the submergence of land along the river above the dam. The former village of Zigui (top center of image) has already been submerged.

The 1987 image shows the nature of the river and surrounding landscape before work on the dam was begun. In the May 2004 image, the enormous Three Gorges Dam is clearly visible, as is the reservoir of impounded river water that has been created behind it.