Figure 1-1: A satellite composite image of Africa (Source: NASA)

Africa's Lakes
1 Introduction

Seen from space, the Earth appears as a largely blue planet, suggesting the presence of vast quantities of water. Although this is true, only about two per cent of the Earth's water is fresh, with the majority of this small fraction locked up in icebergs and glaciers, or located far underground beyond our easy reach. Lakes appear like blue diamond mosaics in the terrestrial mass. As a relative perspective, if all the water on Earth could be put into a four-litre bottle, the readily-available quantity for use by people would be about one tablespoon, or less than half of one per cent of the total. Nevertheless, even this small amount is deemed sufficient to meet all the present and foreseeable people's needs – if it were evenly distributed around the world and protected from degradation.

A lake is defined as a large body of water, usually fresh water, which is surrounded by land. Lakes are usually formed when natural depressions or basins in the land surface become filled with water over time. They can range from small ponds to water-bodies stretching hundreds of kilometres and containing vast quantities of water; large lakes are sometimes referred to as 'inland seas'. Some small seas are also often referred to as lakes (Wikipedia 2005). As definitions of what constitutes a lake also vary, the precise number of the world's lakes is difficult to determine.

In contrast to flowing streams and rivers, lakes provide a means for pooling or storing water for varying periods of time. Lakes are one of our most important natural resources, especially in the tropics, where they form highly productive biological systems. They provide water for consumption, fishing, irrigation, power generation, transportation, recreation, and a variety of other domestic, agricultural and industrial uses (Zinabu 1998).

Natural and human made lakes and wetlands provide significant storage of somewhat easily accessible global terrestrial water, which varies seasonally and annually according to climate variation and anthropogenic activities. There are approximately 50 000 natural lakes and 7 500 human made lakes in the world (Ryanzhin 2004). Despite the publication of several world lakes datasets and databases (Herdendorf 1982; Birkett, Mason 1995; ILEC 2002; Wetlands International 2002; Lehner, Döll 2004), most data on limnologically studied natural and human made lakes are dispersed over a wide range of literature.

Africa, with a total area of 30 244 050 km^2 (11 677 293 square miles), is the second largest and second most populous continent after Asia. It covers approximately 20.3 per cent of the total land area on Earth. With over 800 million people, it accounts for about one seventh of the world's population (Wikipedia 2005). It is also the largest of the three great southward projections from the main mass of the Earth's surface. It is estimated that Africa has about 30 000 km^3 (7 197 cubic miles) of water in large lakes (Anon 1978; WCMC n.d.), which is the largest volume of any continent.

Africa is endowed with hundreds of lakes, both natural and artificial (Table 1.1). For example, Lake Bosumtwi is a natural lake that was formed by a crater when a large meteoroid smashed into the continent. Lake Nasser, on the other hand, is a reservoir or artificial lake created behind the Aswan Dam in Egypt. Africa is also home to some of the largest lakes in the world, many of which are bordered by two or more countries. Lake Victoria is the largest of all African lakes and the second largest freshwater body in the world, with a surface area of about 68 800 km^2 (27 000 square miles). Its extensive surface is divided among three countries: the northern half to Uganda, the southern half to Tanzania, and part of the northeastern sector to Kenya.

According to the WORLDLAKE database, there are 677 lakes in Africa, with 88 of them listed as principal lakes (see Appendix). Although lakes are a source of livelihoods in most African societies, they are also a major source of natural disasters, tropical diseases and pandemics. It is important to note that Africa's lakes are also undergoing significant changes due to a combination of human activities and climate change, with potentially serious implications for people's livelihoods and aquatic biodiversity.

Figure 1.1: Distrubution of Africa's major lakes

UNEP/GRID–Sioux Falls

The Mankwe Dam in Pilanesberg National Park, South Africa.

Unknown/UNEP/MorgueFile

Table 1.1: Africa's lakes by country

Country	# of Lakes	Percentage
Uganda	69	10%
Kenya	64	9.50%
Cameroon	59	8.70%
Tanzania	49	7.20%
Ethiopia	46	6.80%
South Africa	37	5.50%
Rwanda	29	4.30%
Ghana	29	4.30%
Morocco	26	3.80%
Madagascar	25	3.70%
Egypt	16	2.40%
Nigeria	16	2.40%
Mali	15	2.20%
Tunisia	15	2.20%
Zaire	15	2.20%
Malawi	13	1.90%
Botswana	12	1.80%
Gabon	8	1.20%
Others	134	<20%
Total	**677**	**100%**

Source: World Lakes Network (2004)

Africa, and particularly East Africa, has numerous lakes that support very important fisheries—providing a livelihood to millions of people, and contributing significantly to the food supply. In many of these lakes, however, fisheries are reaching a state of maturity and unsustainability. The fisheries of just 11 lakes in the 11 countries of eastern Africa employ close to half a million people, with perhaps three times as many engaged in secondary activities and related services—thus supporting about four per cent of the region's entire population (Petr 2005). This has also resulted in transboundary water conflicts, despite the creation of regional initiatives on integrated water management. Transboundary freshwater resources will clearly become a source of growing conflict in Africa without the development of—and adherence to—sound multilateral agreements for their shared management.

The degree of resource utilisation differs greatly from lake to lake, and according to the two main types of fisheries: demersal/onshore and pelagic/offshore. Currently, demersal/onshore resources are being more heavily exploited or overexploited. Africa's large lakes are receiving considerable biological attention through a number of international activities, with research focusing particularly on Lakes Victoria, Tanganyika and Malawi. However, governmental support for lakes remains low in many African countries, with little money allocated from national budgets for their conservation or development (Petr 2005).

Although Africa's lakes are limited and sensitive resources that call for proper care and management, they remain among the most abused of the continent's natural resources. The direct disposal of wastewater into lakes continues to have a damaging impact on their fragile ecological balances. Human impacts in lake basins and catchments also have devastating consequences for the lakes themselves, including: rapid siltation caused by accelerated soil erosion; irreversible uptake of water and/or salinisation due to irrigation; eutrophication; contamination with toxic chemicals and mine tailings; and acidification. Effective integrated watershed management requires not only strict soil conservation measures, but changes in the way that water moves through the agro-ecosystem.

In Africa, human factors, in combination with the natural conditions of climate and geology, may influence water quality to a large extent. Some African nations do

not have industries that flourish in developed countries, and pollutants are not produced in such large quantities. However, pollution resulting from land-use changes, environmental modification and other practices associated with rapid population increase, have caused or accelerated many changes in the continent's lakes (Zinabu 1998).

The main threats to water quality in Africa include eutrophication, pollution, and the proliferation of invasive aquatic plants such as the water hyacinth. Industrial wastes are still discharged without treatment into rivers and lakes in most African countries, posing a major and persistent health problem. Recurring droughts are also a major threat to, and cause of, water shortages (Ottichilo 2003).

Africa's freshwater supply, including its lakes, is threatened by certain natural phenomena and human factors. Among the greatest natural threats are:

- The multiplicity of transboundary water basins
- Extreme and temporal variability of climate and rainfall
- Growing water scarcity
- Shrinking of some water bodies
- Desertification

The major human threats include:

- The pursuit of inappropriate governance and institutional arrangements in managing national and transnational water basins
- The depletion of water resources through pollution, environmental degradation, and deforestation
- Failure to invest adequately in resource assessment, protection and development
- Unsustainable financing of investments in water supply and sanitation

These threats pose challenges in managing the continent's water resources and in meeting competing demands for basic water supplies (World Commission on Water for the 21st Century n.d.).

Water supplies are undoubtedly one of the most important resources for Africa's social, economic and environmental well-being. Currently, about two-thirds of the rural population and one-quarter of the urban population are without safe drinking water, and even higher proportions lack proper sanitation. Climate change will likely make the situation even worse. The greatest impact will continue to be felt by the poor, who have the most limited access to water resources (Watson et al. 1997).

Other threats to Africa's lakes include:

- Poisoning: Mercury poisoning is affecting at least three of Africa's Great Lakes: Turkana, Naivasha and Baringo (Campbell et al. 2003).
- Drought: Lake Chad, once one of the continent's largest freshwater bodies, has dramatically decreased in size due

A young boy near a waterfall.

CARF/UNEP/Flickr.com

to climate change and extraction. Once close in surface area to North America's Lake Erie, Lake Chad is now a ghost of its former self. According to a study by University of Wisconsin- Madison researchers, working with NASA's Earth Observing System programme, the lake is now one-twentieth of the size it was 35 years ago (NASA 2001).

- Killer lakes: In August of 1986 Lake Nyos in Cameroon "exploded," releasing up to 1 km^3 (0.6 cubic miles) of CO_2 and killing about 1 700 people up to 26 km (16 miles) away. A smaller gas burst from Lake Monoun in August 1984 killed 37 people. Steps are being undertaken to reduce such risks in the future (Kling 2005).
- Flooding: In addition to drought, lakes may flood, posing threats to human populations living close by. An example is Lake Kyoga (Goulden 2005).
- Potential collapse of dams: The United Nations team of experts dispatched on 21 September 2005 to Lake Nyos, in Cameroon's Northwest province, to assess the stability of its natural dam warned of the risk of its potential collapse within the next five years, and called for urgent measures to prevent it.

The Africa Water Vision for 2025 (World Commission on Water for the 21st Century n.d.) calls for:

- Strengthening the governance of Africa's water resources
- Improving national and regional water wisdom
- Meeting the most urgent water needs
- Strengthening the financial base for a sustainable water future

This Atlas vividly illustrates some of the changes that people and nature have wrought on Africa's lakes – both good and bad – in recent decades, and presents an overview analysis of the situation of 24 major lakes (see Table 1.2). In doing so, it also serves as an early warning of the precarious environmental situation of many of Africa's lakes, and seeks to inform policymakers on the need to consciously assess and regularly monitor changes affecting lakes in their countries. An integrated approach will be taken in mapping out the changes in African lakes, including the main causes and effects of human activities. As water sustains life, the effective management of our water resources demands a holistic approach, linking social and economic development with the protection of natural ecosystems. Sustainable management must link land and water uses across entire catchment areas, as well as direct uses of lakes themselves, and should include the mainstreaming and crosscutting of population, health and climate changes in evaluating utilisation and management strategies. The analyses in this publication have been aided by the use of satellite imagery to map out demographic and environmental changes within Africa's lake ecosystems. The publication intends to provide a clear and practical basis for promoting more effective management and monitoring of Africa's lakes, for making informed policy decisions and encouraging individual actions to help sustain the livelihoods of the communities that live around them.

Table 1.2 Lakes, reservoirs and lagoons featured in this Atlas*

Name	Country	Surface area [km^2]	Maximum depth [m]
Alaotra, Lake	Madagascar	200	
Al Wahda, Lake	Morocco	123	
Challawa Gorge Reservoirs	Nigeria		
Cahora Basa Reservoirs	Mozambique	2739	157
Chad, Lake	Chad / Cameroon / Niger	1540	10.5
Djoudj, Lake	Senegal	160	
Ichkeul, Lake	Tunisia	120	
Kariba, Lake	Zambia / Zimbabwe	5400	78
Kivu, Lake	Rwanda, Zaire / Congo (DR), Rwanda	2220	480
Lesotho Highlands Reservoirs	Lesotho		
Malawi (Nyasa, Niassa)	Malawi, Mozambique, Tanzania	29500	706
Manantali, Lake	Mali	200	
Nakuru, Lake	Kenya	40	2.8
Monoum, Lake	Cameroon		
Nasser, Lake	Egypt	5248	130
Nyos, Lake	Cameroon		96
Sibaya, Lake	South Africa	78	43
Songor Lagoon	Ghana		
St. Lucia, Lake	South Africa	300	8
Tana, Lake	Ethiopia\Kenya	3600	14
Tanganyika, Lake	Tanzania / Zaire / Zambia / Burundi Burundi, Congo (DR), Tanzania, Zambia	32000	1471
Tonga, Lake	Algeria		
Toshka Project, Reservoirs	Egypt		
Victoria, Lake	Tanzania / Uganda / Kenya	68800	84

Source: WorldLakes 2004

** See appendix for more statistics.*

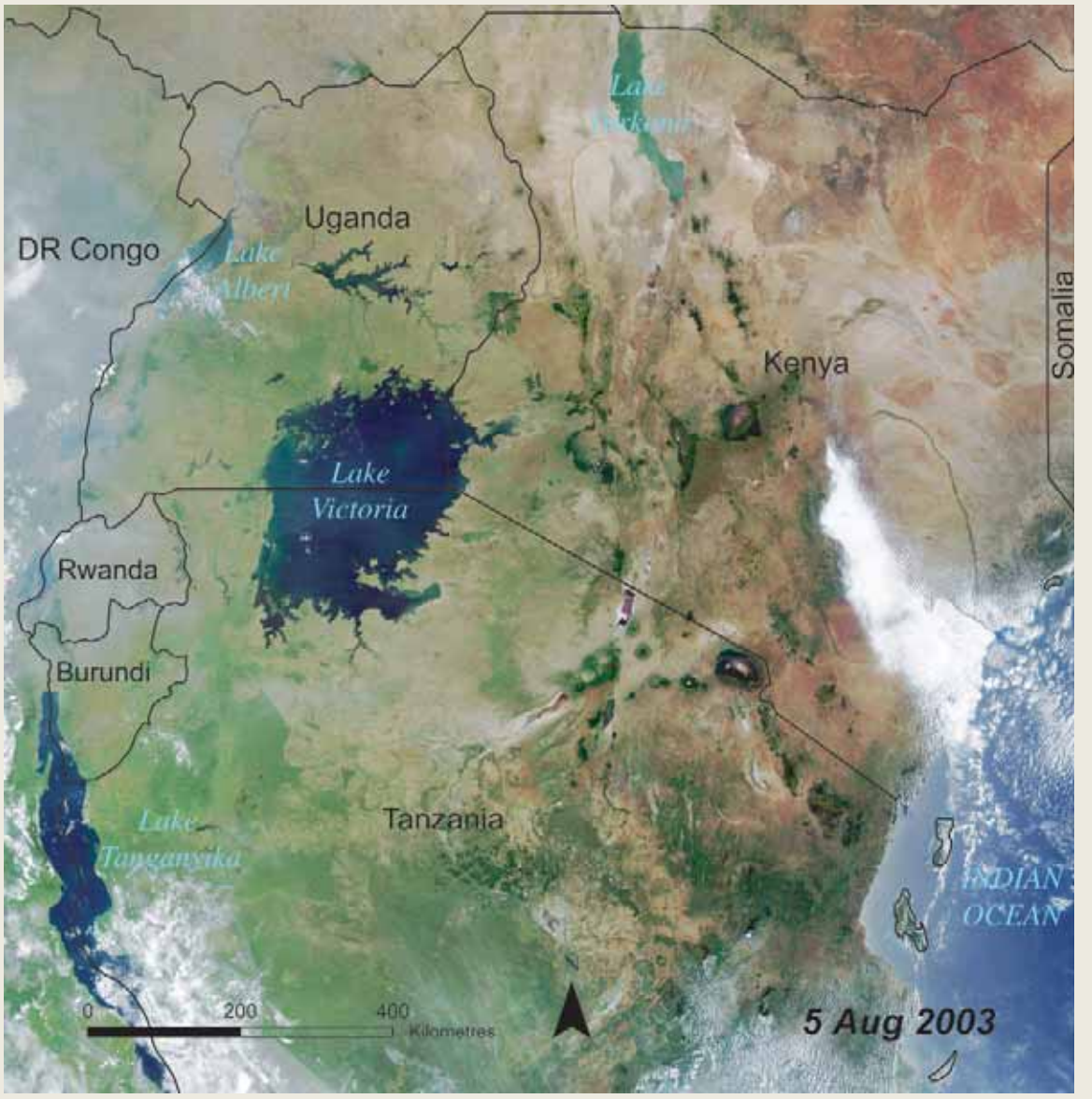

Figure 1.2: Satellite image showing the Great Lakes of Africa. This image vividly shows the major lakes of eastern Africa as they twist down the two arms of the Great Rift Valley in nine countries in East and Central Africa. The Great Lakes of Africa include some of the largest and most ecologically diverse freshwater systems on the planet. Eight of the 15 lakes in this region are ranked as 'Great Lakes' – a testimony to their size and depth. Lake Victoria is ranked as the second-largest freshwater lake in the world, and Lake Tanganyika as one of the deepest.

Source: NationMaster.com 2006

References

Anon (1978). World Water Balance and Water Resources of the Earth. UNESCO Press, Paris, France, 663p. USSR Committee for the International Hydrological Decade.

Birkett, C.M. and Mason, I.M. (1995). A new global lakes database for a remote sensing programme studying climatically sensitive large lakes. J. Gr. Lakes Res., 21 (3).

Campbell, L.M., Osano, O., Hecky, R.E. and Dixon, D.G. (2003). Mercury in fish from three Rift Valley lakes (Turkana, Naivasha, Baringo), Kenya, East Africa. Environmental Pollution 125: 281–286. Available at http://biology.queensu.ca/~campbelm/CampbelletalEP2003.pdf.

Goulden, Marisa (2005). Adaptation to climate variability in East African lakes and wetlands: The role of social capital in promoting resilience. Human Security and Climate Change. International workshop, Asker, Sweden, 21-23 June 2005. 27 p. Available at http://www.cicero.uio.no/humsec/papers/Goulden.pdf.

Herdendorf, C.E. (1982). Large lakes of the world, J. Gr. Lakes Res., 8 (3).

ILEC (2002). Survey of the State of World Lakes: Online-database, Japan, Otsu: International Lake Environment Committee /United Nations Environment Progamme (ILEC/UNEP). Available at http://www.ilec.or.jp/database/database.html.

Kling, George (2005). Using Science to Solve Problems: The Killer Lakes of Cameroon. http://www.globalchange.umich.edu/globalchange1/current/lectures/kling/killer_lakes/killer_lakes.html.

Lehner, B. and Döll, P. (2004). Development and validation of a global database of lakes, reservoirs and wetlands, J. Hydrology, 296 (1-4).

NASA (2001). A Shadow of a Lake: Africa's Disappearing Lake Chad. National Aeronautics and Space Agency: Goddard Space Flight Center. Available at http://www.gsfc.nasa.gov/gsfc/earth/environ/lakechad/chad.htm.

NationMaster.com (2006). Africa's Great Lakes, Lake Victoria. Availiable at http://www.nationmaster.com/encyclopedia/Lake-Victoria.

Ottichilo, Wilber K. (2003). Use of Space Technology in Disaster Risk Assessment and Monitoring. 8 p. Available at www.ewc2.org/upload/downloads/Ottichilo2003AbstractEWC2.doc.

Petr, Tomi (2005). Inland Water Resources and Aquaculture Service. Available at http://www.oceansatlas.com/world_fisheries_and_aquaculture/html/ecosys/inland/nateco/lakes.htm.

Ryanzhin, S.V. (2004). Global statistics for surface area and water storage of natural world lakes. Verh. Internet. Verein. Limnol., vol. 29 (to be published).

UN Fact Sheet (2002). Implementing the Millennium Declaration: The Millennium Development Goals and the United Nations Role. Available at http://www.un.org/millenniumgoals/MDGs-FACTSHEET1.pdf.

UN (2005). UN Millennium Development Goals. Available at http://www.un.org/millenniumgoals/#.

UNEP (n.d.). The Watershed: Water from the Mountains into the Sea. Newsletter and Technical Publications. Lakes and Reservoirs vol. 2. Nairobi, Kenya: United Nations Environment Programme, Division of Technology, Industry, and Economics. Available at http://www.unep.or.jp/ietc/publications/short_series/lakereservoirs-2/6.asp.

Watson, Robert T., Zinyowera, Marufu C., Moss, Richard H. and Dokken, David J. eds. (1997). IPCC Special Report on the Regional Impacts of Climate Change – An Assessment of Vulnerability. 517 p. Available at http://www.grida.no/climate/ipcc/regional/index.htm.

WCMC (n.d.). Freshwater Biodiversity: a preliminary global assessment. WCMC Biodiversity Series No. 8. Cambridge, UK: World Conservation Monitoring Centre. Available at http://www.unep-wcmc.org/index.html?http://www.unep-wcmc.org/information_services/publications/freshwater/1.htm~main.

Wetlands International (2002). Ramsar Database (RDB). Wetlands International, Wageningen, The Netherlands. Available at http://www.wetlands.org/rdb.htm.

Wikipeda (2005). Africa - Wikipedia. Available at http://en.wikipedia.org/wiki/Africa.

World Commission on Water for the 21st Century (n.d.). The Africa Water Vision for 2025: Equitable and Sustainable Use of Water for Socioeconomic Development. 34 p. Available at http://www.worldwatercouncil.org/Vision/Documents/AfricaLatest.pdf.

World Lakes Network (2004). Protecting and reshaping the health of lakes throughout the world. Available at http://www.worldlakes.org/.

Zinabu, Gebre-Mariam (1998). Human Interactions and Water Quality in the Horn of Africa. Available at http://www.aaas.org/international/africa/ewmi/zinabu.htm.