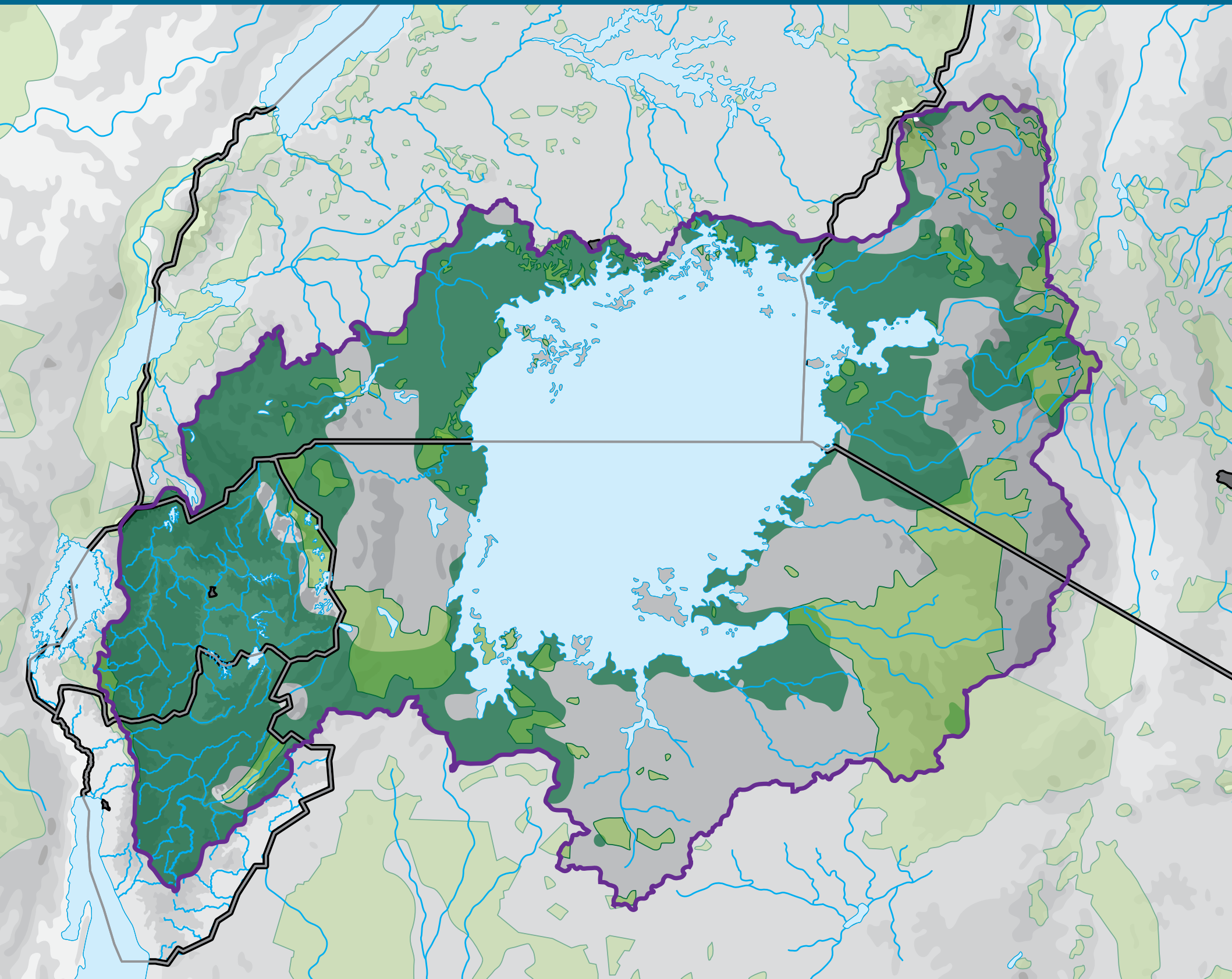




# LAKE VICTORIA BASIN

Atlas of Our Changing Environment





# LAKE VICTORIA BASIN

## Atlas of Our Changing Environment



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We regret any errors or omissions that may unwittingly have been made.

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# Foreword



The Lake Victoria Basin covers 194,000 square kilometres and its water resources comprise one of the world's greatest complexes of lakes, wetlands, and rivers. Lake Victoria itself with a surface area of 68,000 square kilometres is the largest freshwater lake in Africa. The lake basin plays major ecological, social and economic roles in the East African Community (EAC). It is the main source of water for domestic, industrial, and hydro power generation. It is a climate regulator, a reservoir of biodiversity and a medium for transport.

The basin contributes significantly to nutrition and food security through agricultural and fish production. The Nile River, which flows out of Lake Victoria, is an extremely important freshwater resource for downstream countries of Ethiopia, South Sudan, Sudan and Egypt. Of the estimated population of 150 million people in the EAC region, about 40 million reside within the Lake Victoria Basin. A large concentration of the basin's population lives along the lakeshore, including in towns such as Mwanza, Entebbe and Kisumu.

The grasslands, wetlands, mountains, rainforests and riverine areas are home to many species of plants and animals. The lake basin is also a land of unparalleled natural beauty. Its vast mineral and natural resources provide immense opportunities for economic development and human well-being. However, increasing population and rapidly changing land-use patterns are having profound effects on the local environment. Sustaining high economic growth rates needs to be matched with maintenance of the integrity of environmental and natural resources in the Lake Victoria Basin. It is therefore imperative to identify and understand environmental challenges in Lake Victoria and to provide decision- and policy-makers with a scientific basis to guide the sustainable use of the basin's resources.

The Lake Victoria Basin Commission, in collaboration with GRID-Arendal, developed this *Lake Victoria Basin: Atlas of Our Changing Environment* as part of

its mandate under the Protocol for the Sustainable Development of the Lake Victoria Basin. The atlas provides compelling evidence of the extent and severity of the dramatic changes over the past 30 years on the Lake Victoria Basin's environment due to both natural processes and human activities. The atlas is the first major publication to depict environmental change in Lake Victoria Basin using satellite imagery. By telling a vivid, visual story of the dramatic natural and human activities effects on the Basin's landscapes, it is a resource for remedial action at local, national, and regional levels. The satellite images show different types of environmental change, including conversion of forests and the loss or degradation of habitats, urban growth, altered hydrology, degraded shoreline areas, mining developments, and impacts of climate change.

The active participation of partner states and other stakeholders signifies the importance attached to this atlas, and their commitment to implement its recommendations. Therefore, there is a need to create more awareness and sensitize stakeholders at all levels on the importance of the findings of this atlas. Its content should be disseminated to a wide audience in the partner states and beyond to enable them to incorporate the findings into their activities, decisions and policies. In line with the Protocol for the Sustainable Development of the Lake Victoria Basin, the Lake Victoria Basin Commission supports the partner states to actively protect, conserve and where necessary rehabilitate the basin and its ecosystems.

On my own behalf and that of the Lake Victoria Basin Commission, I take this opportunity to thank GRID-Arendal, Lake Victoria Basin Commission staff and experts from the basin who spearheaded the writing of this atlas. I urge all players in the lake basin to support the implementation of the findings by taking the first steps to implement the atlas's recommendations.

Thank you



**Dr. Ally Said Matano**  
Executive Secretary  
Lake Victoria Basin Commission

# Preface

Lake Victoria Basin is one of East Africa's most prominent landmarks. This is in addition to the scenic mountain areas of the region from which the lake basin receives much of its water. The lake provides headwaters for the Nile, the longest river in the world. With a shoreline bordered by Kenya, Tanzania and Uganda, the lake basin also extends into Burundi and Rwanda. Lake Victoria Basin is central to the development and regional integration of the East Africa Community.

The Lake basin supports a population of 40 million by providing a variety of economic and development opportunities, including fisheries, tourism and transboundary conservation. The Lake is one of the most productive freshwater fisheries in the world, with an annual fish catch of as much as 800,000 tonnes. Although the lake basin population is largely rural, some of the prominent cities in East Africa are located in the basin including Eldoret, Entebbe, Kigali, Kisumu, Mbarara, Musoma and Mwanza. Large sections of Kampala also lie within the basin.

The *Lake Victoria Basin: Atlas of Our Changing Environment* aims to guide policy and decision-making within the lake basin while also showcasing the value of regional integration through the East Africa Community. The preparation of the atlas followed a rigorous environmental assessment process, which was intended to profile sustainable development in the Lake Victoria Basin.

The atlas underscores not only the significance of the environmental dimension of sustainable development by emphasizing the costs associated with water pollution, deforestation, land degradation and invasive

alien species, among others, but also demonstrates environmental, social and economic benefits of regional cooperation. Of note is the acknowledgement of the role that the lake provides in the safe and cheap transportation of goods and services among the basin countries as a means of boosting trade, tourism and cultural exchanges.

The in-depth assessment of the scale of change in the state of the environment in Lake Victoria basin – through both analysis and presentation of visually compelling maps and graphics – should not only aid decision and policy-making, but also raise awareness among the general public. The findings and policy messages outlined in this atlas should also enable the identification of opportunities for future research.

In as much as the final product is important, the process leading up to the production of this atlas is equally worth noting. The preparation and dissemination of the atlas clearly demonstrates the value of partnerships and engagement. GRID-Arendal used its capacity to communicate complex science in a more easily understandable way and to facilitate global outreach, while the Lake Victoria Basin Commission provided much of the information and data, as well as using its convening power to facilitate the selection and training of authors and gave the necessary political legitimacy to the process.

GRID-Arendal hopes that its partnership with river and lake commissions is not only strengthened, but also that such partnerships continue to identify and produce cutting edge scientific and evidence-based communication products that guide policy-making.



A handwritten signature in blue ink that reads "Peter T. Harris". The signature is fluid and cursive, with the first name "Peter" and the last name "Harris" clearly legible.

**Dr. Peter Harris**  
Managing Director  
GRID-Arendal

# Acknowledgements



The Lake Victoria Basin Commission acknowledges the work of many individuals and institutions that provided the content and analyses for the *Lake Victoria Basin: Atlas of Our Changing Environment*. The atlas is the first such publication for the Lake Victoria Basin, which is not only one of the largest single ecosystems in East Africa, but also a shared resource that has the potential to promote sustainable development and regional cooperation.

The Lake Victoria Basin Commission is thankful to its partners and individuals for their many contributions towards the preparation of the atlas. The East African Community (EAC), from which the Commission derives its mandate, supported the initiative, while the past Lake Victoria Basin Commission Executive Secretary, Dr. Cannissius Kanangire, provided guidance to the atlas production process. The Lake Victoria Basin Commission secretariat is acknowledged for having the fine mix of professional and people skills that were relevant to the production of the atlas.

The United Nations Environment Programme (UNEP), especially the Regional Office for Africa, provided access to some of its networks, including the Environmental Pulse Initiative, through which some satellite datasets were accessed. GRID-Arendal provided technical and training support, as well as coordinated the design and printing of the atlas. Norway's Ministry of Foreign Affairs contributed financially towards the production of the atlas.

The preparation of this atlas benefited from experiences from similar initiatives within and outside the Lake Victoria Basin. The Kenya Environment Management Agency, Zambia Environment Management Agency and Rwanda Environment Management Agency's experience in producing their national atlases provided valuable knowledge and guidance to the *Lake Victoria Basin: Atlas of Our Changing Environment*.

The preparation of the *Lake Victoria Basin: Atlas of Our Changing Environment* started in 2014 with the

formation of a consultative group from representatives of the Lake Victoria Basin partner states. Initial consultations that were jointly coordinated by the Lake Victoria Basin Commission and GRID-Arendal, resulted in an annotated outline for the atlas, as well as identified sites where significant environmental change had happened and could be visualized. Thereafter a training and drafting workshop was convened in Kigali, Rwanda, at which the draft copy was presented and reviewed. Guidance from this workshop, and peer reviews later on were useful in improving and updating the content of the atlas.

Design and printing of the atlas was done by GRID-Arendal in consultation with the Lake Victoria Basin Commission. Both GRID-Arendal and the Lake Victoria Basin Commission host the internet version of the atlas, which is available at [www.grida.no](http://www.grida.no) with links to <https://www.lvbcom.org>

The atlas was produced with technical backstopping from UNEP as well as from Environmental Pulse Initiative. The Lake Victoria Basin Commission thanks GRID-Arendal for their creativity in the production of visual materials such as maps and graphics, as well as for designing and printing the final product. To Dr. Ally-Said Matano and Mr. Telly Eugene Muramira, the Commission and GRID-Arendal acknowledge your spirit of partnership and shared vision for the Lake Victoria Basin as well as your personal commitment to the preparation of the atlas. Our gratitude also go to Dr. Peter Harris and his management team at GRID-Arendal for the enormous encouragement and oversight they had to the process.

There are many organisations and individuals who have contributed directly and indirectly to this process. While efforts have been made to acknowledge their input, it may be that not everyone has been credited by name. Please accept this acknowledgement of your role in this important publication.

**Eng. Omari Mwinjika,**  
Lake Victoria Basin Commission

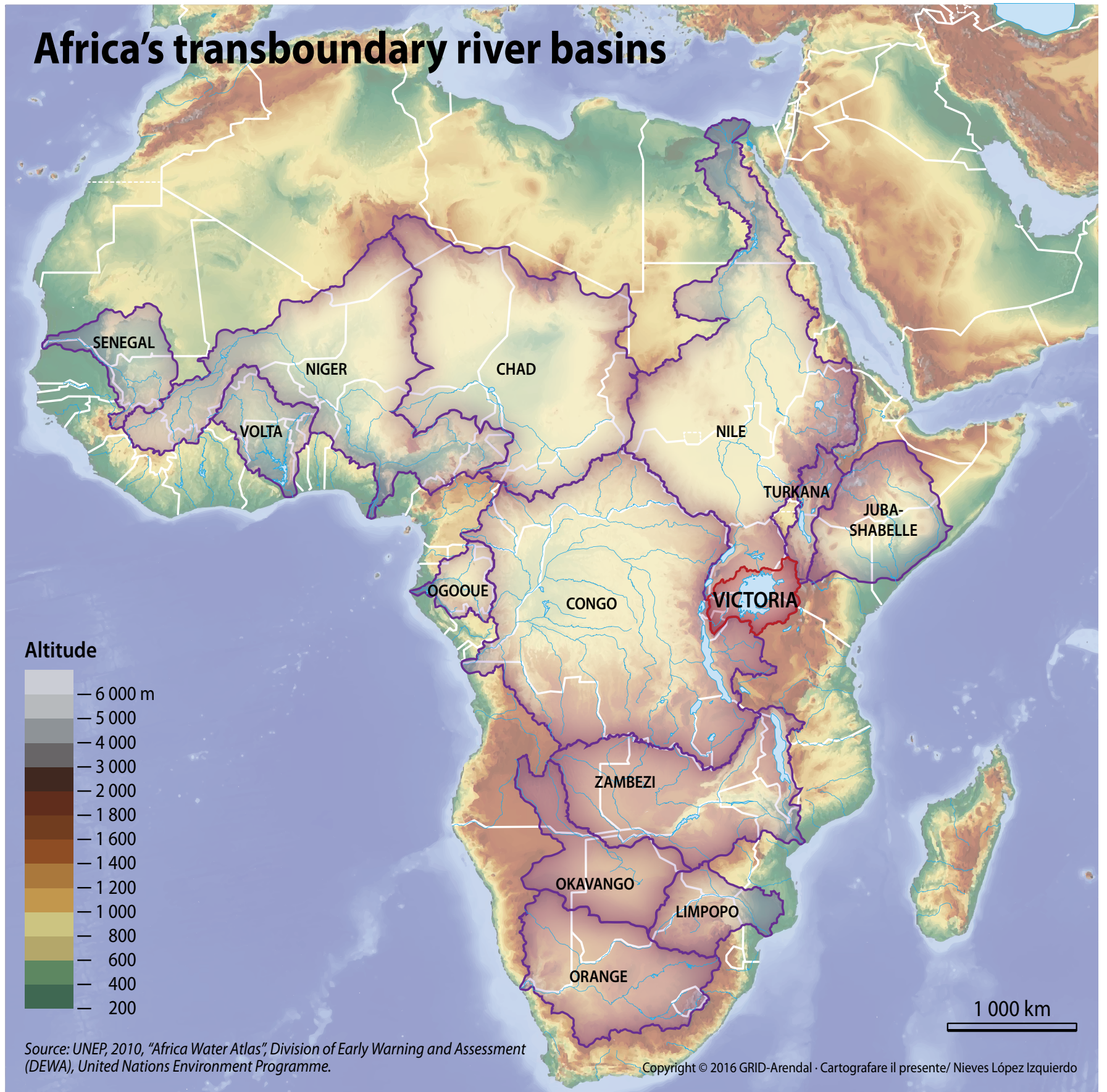


# Acronyms

AIDS	Acquired Immuno-deficiency Syndrome
BOD	Biochemical Oxygen Demand
COMESA	Common Market for Eastern and Southern Africa
EAC	East African Community
ENSO	El Nino/Southern Oscillation
ESA	Ecological Sensitive Areas
GDP	Gross Domestic Product
HIV	Human Immuno-deficiency Virus
IBA	International Bird Areas
IGAD	Inter-Governmental Authority on Development
ITCZ	Inter-Tropical Convergence Zone
IUCN	International Union for Conservation of Nature
LEVMP	Lake Victoria Environmental Management Project
LVB	Lake Victoria Basin
LVBC	Lake Victoria Basin Commission
MW	Mega Watt
PREPARED	Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development
QBO	Quasi-biennial Oscillation
REMA	Rwanda Environment Management Agency
SADC	Southern African Development Community
SLM	Sustainable Land Management
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization



# Africa's transboundary river basins



# 1

## LAKE VICTORIA BASIN

Draining an area of 194,200 km<sup>2</sup> (Lake Victoria Basin Commission 2007a), Lake Victoria Basin is one of East Africa's most prominent landmarks. It not only provides the headwaters of the White Nile but is also central to the development and regional integration of the East Africa Community. The Lake itself is shallow but in terms of surface area it is the second largest freshwater lake in the world, after Lake Superior in North America (Lake Victoria Basin Commission 2007a). Lake Victoria covers 68,800 km<sup>2</sup> (Lake Victoria Basin Commission 2007b; World Agroforestry Centre 2006), with a 3,460 km shoreline and is bordered by Kenya, Tanzania and Uganda; with Burundi and Rwanda also lying within the Lake Victoria Basin (Lake Victoria Basin Commission 2007a). A number of important rivers flow into Lake Victoria including the River Mara, Kagera, Yala, Nyando, Bukora and Katonga. The White Nile is the only river flowing out of the Lake (Lake Victoria Basin Commission 2007a). The Kagera (Akagera) River, which drains the mountains of Burundi and Rwanda and is the furthest and most remote headstream of the Nile River, is considered as the source of the Nile (Africa Facts 2016).

Supporting a population of 40 million (World Bank 2016), the Lake Basin provides a variety of economic and development opportunities, including fisheries, tourism and transboundary conservation. However, these opportunities are hindered by a number of threats that include eutrophication, over-fishing, introduced exotic species and the impacts of climate change.





# The basin

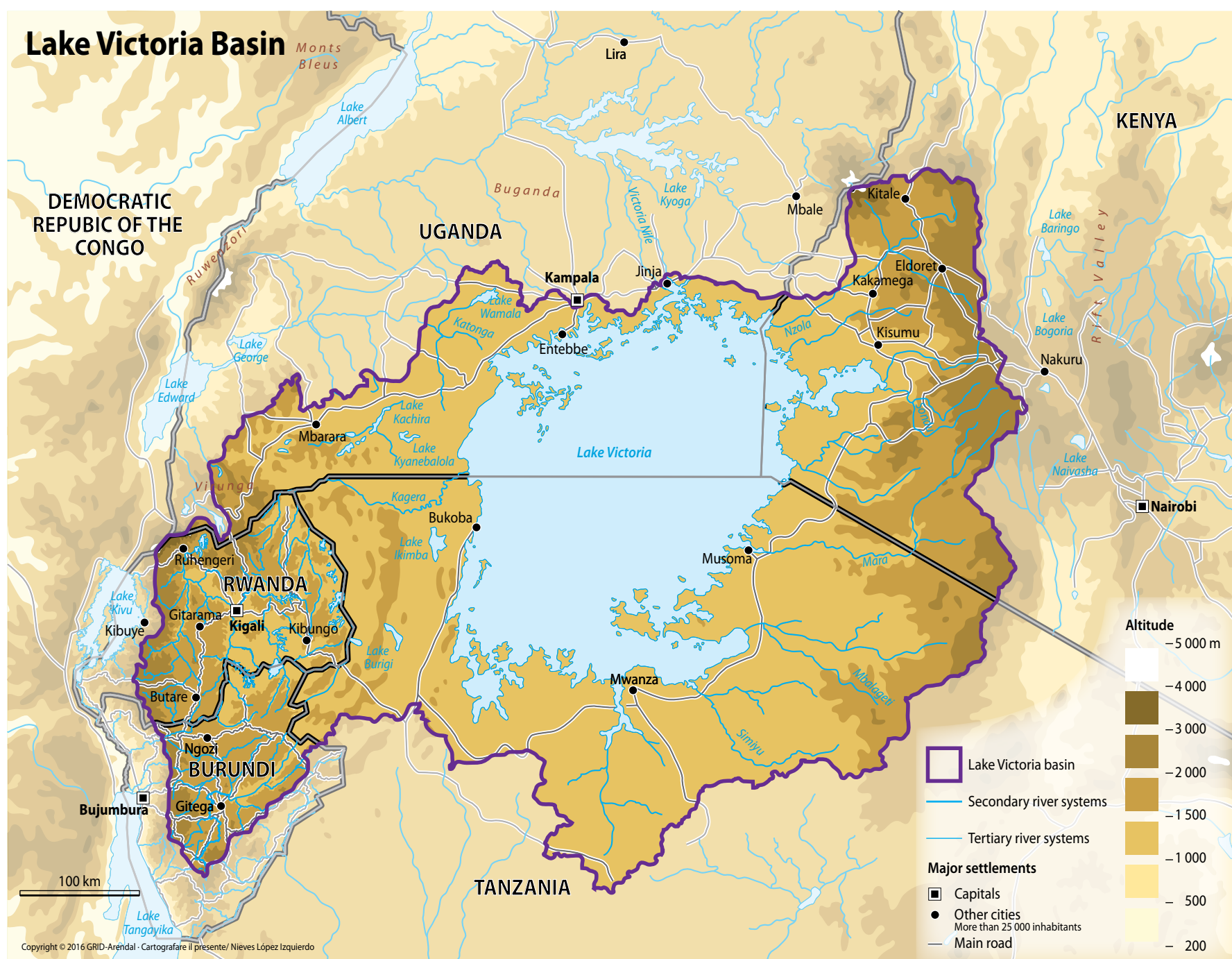
Lake Victoria is located in East Africa. The Lake drains areas within Burundi, Kenya, Rwanda, Uganda and Tanzania, as shown in Figure 1.1. The Basin is linked to the Nile River Basin through the White Nile (Abteu and Melesse 2014) and contributes much of the headwaters of Africa's longest River.

The largest portion of the Lake Victoria Basin (LVB) is in Tanzania – 44 per cent (85,448 km<sup>2</sup>) of the Basin's drainage area; while Kenya, Uganda, Rwanda and Burundi make up 22 per cent (42,724 km<sup>2</sup>), 16 per cent (31,072 km<sup>2</sup>), 11 per cent (21,362 km<sup>2</sup>) and 7 per cent (13,594 km<sup>2</sup>), respectively (Lake Victoria Basin Commission 2007a).

**Table 1.1: Lake Victoria surface area, catchment area and shoreline statistics**

Country	Lake surface area		Catchment area		Lake shoreline length	
	Km <sup>2</sup>	%	Km <sup>2</sup>	%	Km	%
Kenya	4,128	6	42,724	22	550	16
Uganda	29,584	43	31,072	16	1,750	51
Tanzania	35,088	51	85,448	44	1,150	33
Burundi	0	0	13,594	07	0	0
Rwanda	0	0	21,362	11	0	0
<b>Total</b>	<b>68,800</b>	<b>100</b>	<b>194,200</b>	<b>100</b>	<b>3,450</b>	<b>100</b>

Source: Lake Victoria Basin Commission 2002



**Figure 1.1: The Lake Victoria Basin**



Rapids on the Nile River, Uganda

Of the five countries within the Lake Victoria Basin, only three share its 3,460 km shoreline: Kenya, Uganda and Tanzania (See Table 1.1 and Figure 1.1).

The part of Lake Victoria that is regularly filled is 412 km from north to south and 355 km from east to west. Situated at an altitude of 1,134 m above sea level, the Lake is located between latitudes 0° 30' N and 34° 12' S, and longitudes 31° 37' E and 34° 53' E (Lake Victoria Basin Commission 2007a).

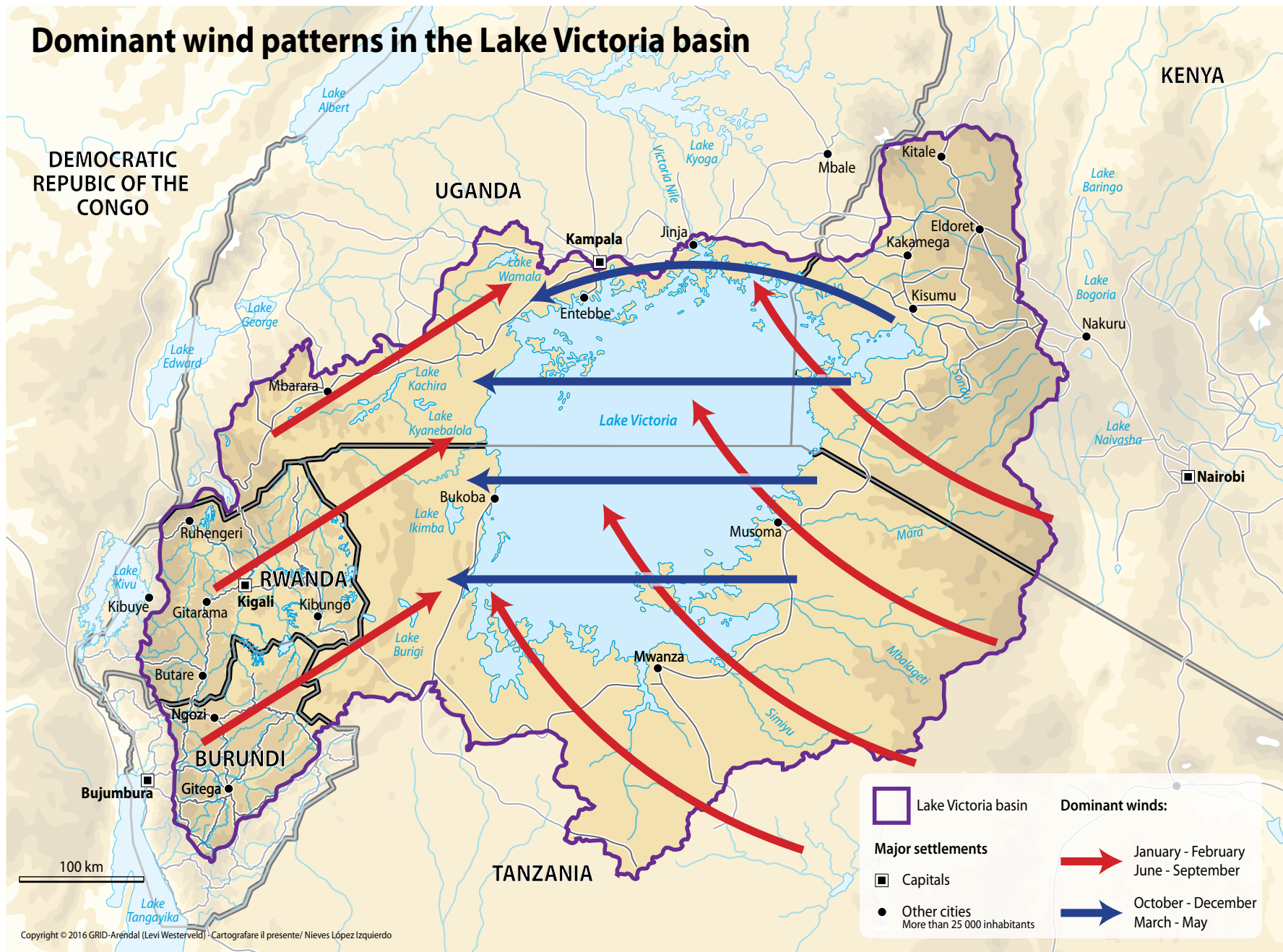
### Climate

The LVB has an equatorial, hot and humid climate with a biannual rainfall pattern – the long rains are experienced from March to May and short rains from October to December. Rainfall varies considerably from one part of the Basin to another (Williams and others 2014). The Ssesse Islands have the highest annual rainfall in Uganda, with an average of approximately 2,400 mm, while Tanzania and Kenya have between 1,350 and 2,400 mm annually. Burundi and Rwanda have an average rainfall of 1,800 mm annually. Rainfall amounts for Burundi and Rwanda increase from east to west from 600 to 2,800 mm annually, and the average for the year is 1,800 mm (Lake Victoria Basin Commission 2007a).

July is the coolest month of the year and the warmest month varies between October and February; in most of the Basin countries, temperatures reach their maximum in February, just before the March equinox, and range from 28.6°C to 28.7°C. Temperatures drop to their lowest in July following the height of the June equinox, during which time they vary between 14.7°C and 18.2°C. A comparison of temperature records for the period 1950–2000 and 2001–2005 show that current maximum temperatures have increased by an average of 1 °C (Lake Victoria Basin Commission 2007a). (See Chapter 2 for more details on climate change.)



Figure 1.2: The White Nile flows out of Lake Victoria into the Nile, Africa's longest river



**Figure 1.3: Seasonal wind patterns for the Lake Victoria Basin**

Source: Lake Victoria Basin Commission 2002

The hydrological processes of the Basin are influenced by seasonal winds, as depicted in Figure 1.3. During January and February and from June to September, the wind is predominantly from the east, blowing parallel to the equator. These relatively dry winds pick up moisture while crossing the Lake and deposit it in the western catchments, particularly the Bukora Catchment in Uganda. Between March and May and from October to December, the wind pattern changes towards the northern parts of the Lake (Lake Victoria Basin Commission 2002).

### Geology and Soils

The LVB is geologically relatively young, formed through tectonic forces over 400,000 years ago (Yisong et al. 2004; Johnson et al. 2000). Most of the Lake Basin is made up of Precambrian bedrock, with the exception of the Kavirondo Gulf in the north-eastern corner. Tertiary and recent alkali volcanic and sedimentary units dominate the terrain. The nature of the land drained upstream affects the physical chemistry of the water: the majority of the rocks (mentioned above) are rich in silicates, aluminium and iron (Yisong et al. 2004; Johnson et al. 2000).

The Basin is characterized by different types of soils suitable for a variety of crops, including maize, beans, cassava and sugarcane. Ferrosols – characterized by high acidity and low base saturation – are dominant within the lower parts of the Basin. Vertisols, which are also common, are dark-coloured clays that expand and contract markedly with changes in moisture content and develop deep drying cracks. The vertisols soils are extensively cultivated.

### Drainage

The LVB consists of rivers, streams and wetlands. The Kagera River provides the largest inflow into the Lake, contributing up to 33 per cent of surface water inflow. It originates in Rwanda and Burundi (as the River Akagera), as well as in parts of south-western Uganda, before passing through Tanzania. The other major rivers flowing into Lake Victoria are the Bukora and Katonga, which originate in Uganda; the Nzoia, Sio, Mara, Yala, Awach, Gucha, Migori and Sondu, which originate in Kenya; and the Mori, Simiyu, Grumeti, Mbalageti and Magogo-Moame, which originate in Tanzania (Lake Victoria Basin Commission 2007a) (Figure 1.4 and Table 1.2).

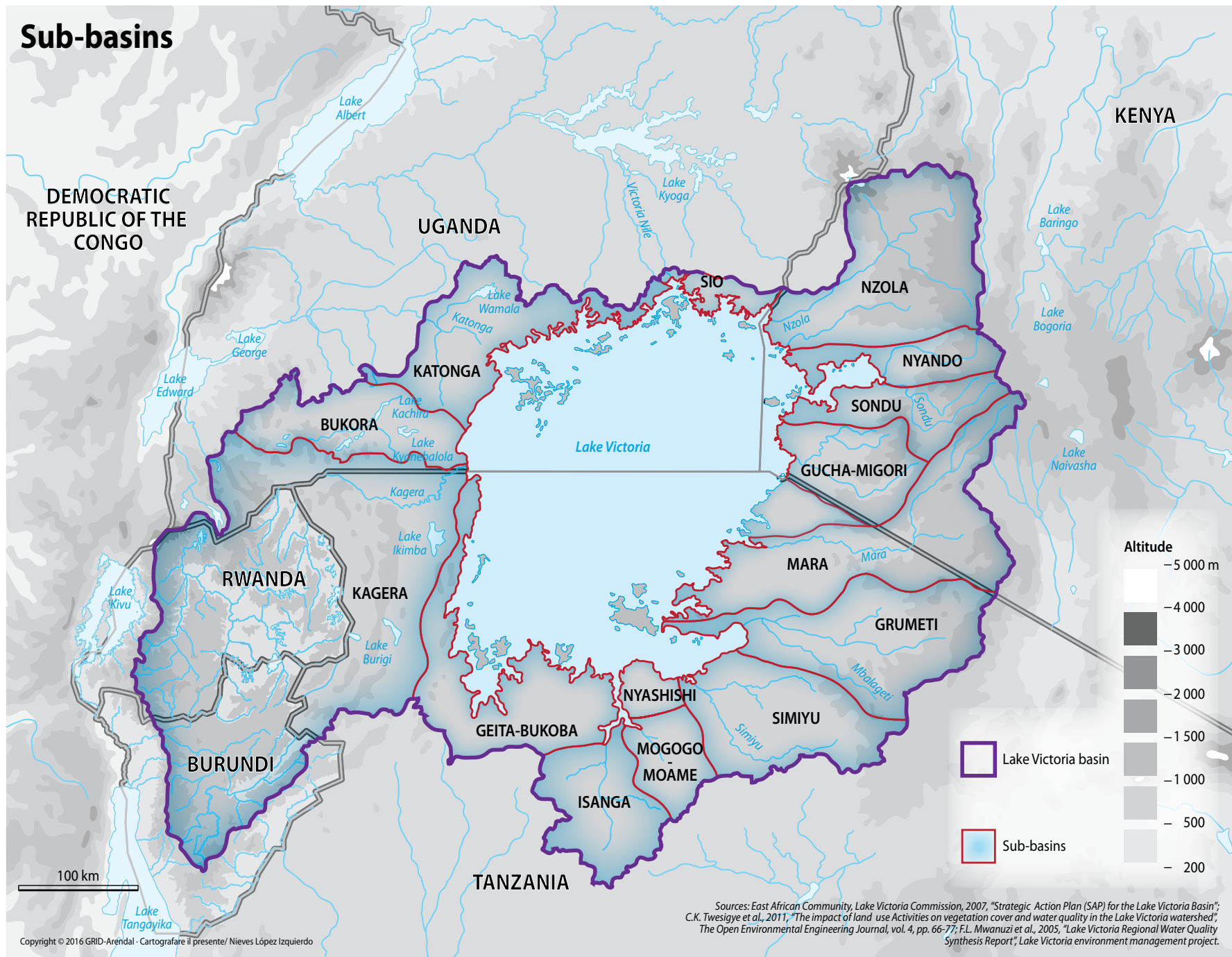




**Table 1.2: Drainage into the Lake Victoria Basin**

Country	River Basin	Flow in cu m	%	Flow in cumecs**	%	Flow in cumecs***	%
Kenya	Sio	11.4	1.4	9.8	1.4	11.3	1.4
	Nzoia	116.7	14.5	107.4	15.7	116.1	14.6
	Yala	37.7	4.7	47.9	7.0	38.4	4.8
	Nyando	18.5	2.3	41.9	6.1	20.3	2.6
	North Awach	3.8	0.5	3.3	0.5	3.7	0.5
	South Awach	5.9	0.7	5.5	0.8	5.9	0.7
	Sondu	42.2	5.2	43.9	6.4	42.4	5.3
	Gucha-Migori	58.0	7.2	39.9	5.8	56.6	7.1
Tanzania	Grumeti	11.5	1.4	4.6	0.7	11.0	1.4
	Mbalageti	4.3	0.5	3.5	0.5	4.2	0.5
	Eastern Shore Streams	18.6	2.3	11.3	1.6	18.1	2.3
	Simiyu	39.0	4.8	12.2	1.8	37.0	4.6
	Magogo-Maome	8.4	1.0	1.6	0.2	7.8	1.0
	Nyashishi	1.6	0.2	0.3	0.0	1.5	0.2
	Issanga	31.0	3.9	4.3	0.6	29.0	3.6
	Southern Shore Streams	25.7	3.2	3.5	0.5	24.1	3.0
	Biharamulo	17.8	2.2	18.3	2.7	17.9	2.2
	Western Shore Streams	20.7	2.6	18.9	2.7	20.6	2.6
Uganda	Bukora	3.1	0.4	2.0	0.3	3.0	0.4
	Katonga	5.1	0.6	2.1	0.3	4.9	0.6
	Nothern Shore Streams	25.6	3.2	28.2	4.1	25.8	3.2
Shared rivers	Kagera	261.1	32.4	252.5	36.8	260.5	32.7
	Mara	37.5	4.7	23.1	3.4	36.5	4.6
	<b>Total</b>	<b>805.3</b>	<b>100</b>	<b>686.2</b>	<b>100</b>	<b>796.6</b>	<b>100</b>

Source: Lake Victoria Basin Commission 2002



**Figure 1.4: Sub-basins of the Lake Victoria Basin**

There are several satellite lakes that are part of the LVB. These include (Lake Victoria Basin Commission 2007a):

- Lake Wamala (150-250 km<sup>2</sup>). This is in the Katonga sub-basin in Uganda and is completely surrounded by wetlands. It drains seasonally towards Lake Victoria. The Lake and its wetlands are closely associated with local cultural norms and beliefs and are of traditional and cultural significance to the people of Buganda.
- Lake Nabugabo (40 km<sup>2</sup>). This is about 20 km east of Masaka and 4 km west of Lake Victoria and is surrounded by wetlands (around 220 km<sup>2</sup>). It is a designated Ramsar site because of its unique flora and fauna.
- Lake Mburu (12 km<sup>2</sup>), Nakivali (31 km<sup>2</sup>), Kachira (40 km<sup>2</sup>) and Kijanebalola (42 km<sup>2</sup>). These form part of the Kijanebalola Swamp complex in the Bukora sub-basin in Uganda.
- Lakes Burera (5.5 km<sup>2</sup>) and Ruhondo (2.8 km<sup>2</sup>). These are located in the middle reaches of the Kagera sub-basin in Rwanda. They are connected and drain through the Mukungwa into the Nyabarongo River and into Lakes Muhazi (30 km<sup>2</sup>) and Mugesera (35 km<sup>2</sup>) to the east and south-east, respectively, of Kigali.
- Lake Rweru (102 km<sup>2</sup>) and Cyohoha South (78 km<sup>2</sup>) – also known as Cohoha. These are on the border between Rwanda and Burundi in the Nyabarongo sub-basin and flow towards the Nyabarongo River. Lake Cyohoha provides outflows during seasonal flood events and Lake Rweru is only recharged by the Nyabarongo River during flood events.
- Lake Ihema (9.1 km<sup>2</sup>). This is on the border between Rwanda and Tanzania in the middle reaches of the Kagera sub-basin and is part of the Kagera riverine wetlands system.
- Lake Kanyaboli (10.5 km<sup>2</sup>). This is fed by the Yala/Nzoia sub-basins in Kenya, as well as the Yala River waters via an artificial canal.



Lake Burera in the Kagera sub-basin, Rwanda

# The people

The population of the LVB is estimated at 40 million (World Bank 2016) and constitutes 30 per cent of the total population of the five countries that share the Basin. The population is largely rural, with an average of 40 per cent living in urban areas (World Bank 2016). As Table 1.3 shows, the demography varies from country to country – as much as 94 per cent of Uganda’s Basin population live in urban areas, while only 5 per cent of Burundi’s Basin population live in urban areas (Lake Victoria Basin Commission 2007a).

Major urban centres in the LVB include Eldoret, Entebbe, Kigali, Kisumu, Mbarara, Musoma and Mwanza. Large sections of Kampala lie within the basin. Population density is highest in the Burundi portion of the Basin and lowest in Tanzania (Lake Victoria Basin Commission 2007a).



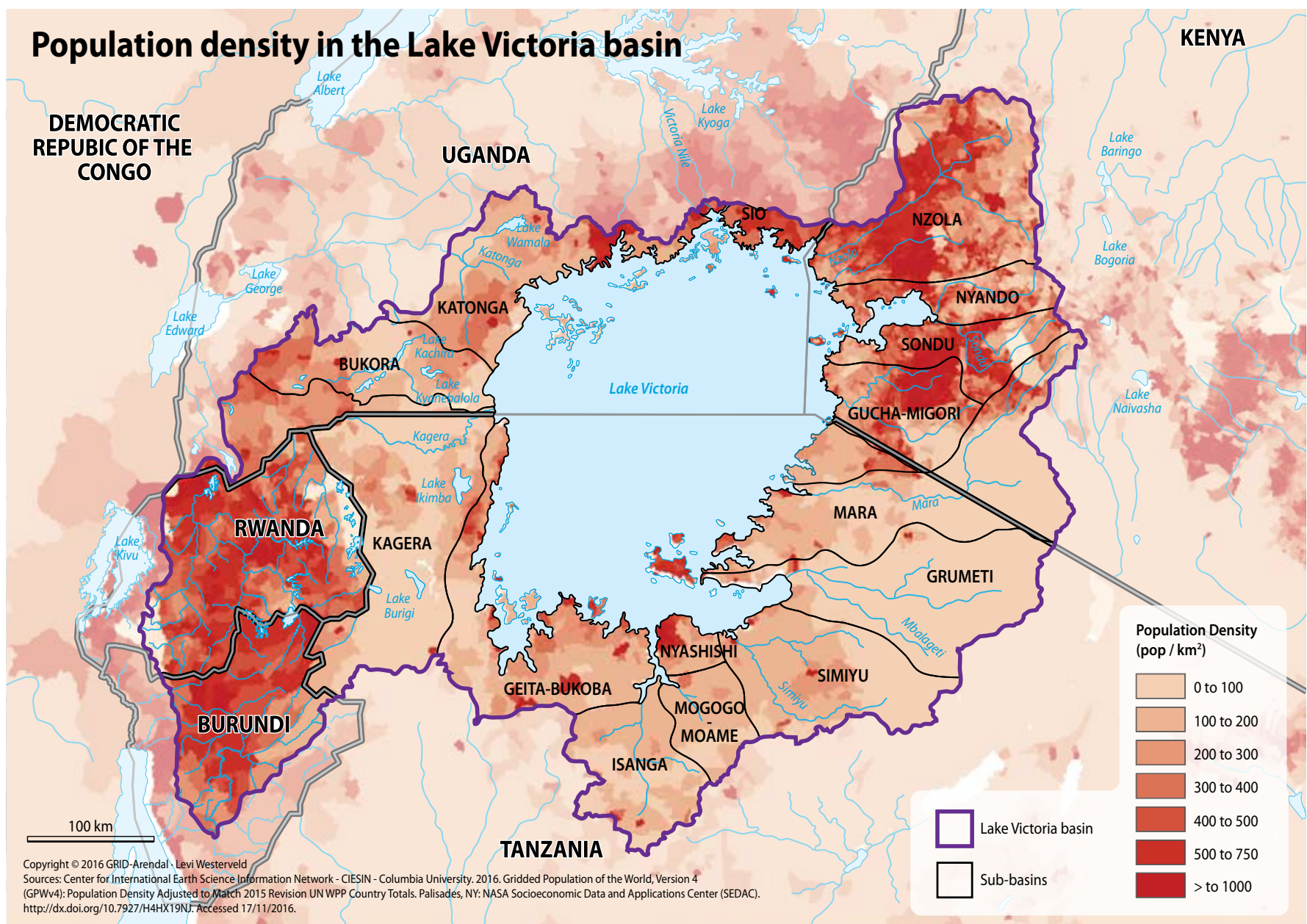
Traditional fishing

The majority of people living in the LVB have their livelihoods and economic activities rooted in the Bantu, Nilotic and Cushitic cultures (UNEP 2006). Most of these cultural groups are farmers and fishers.

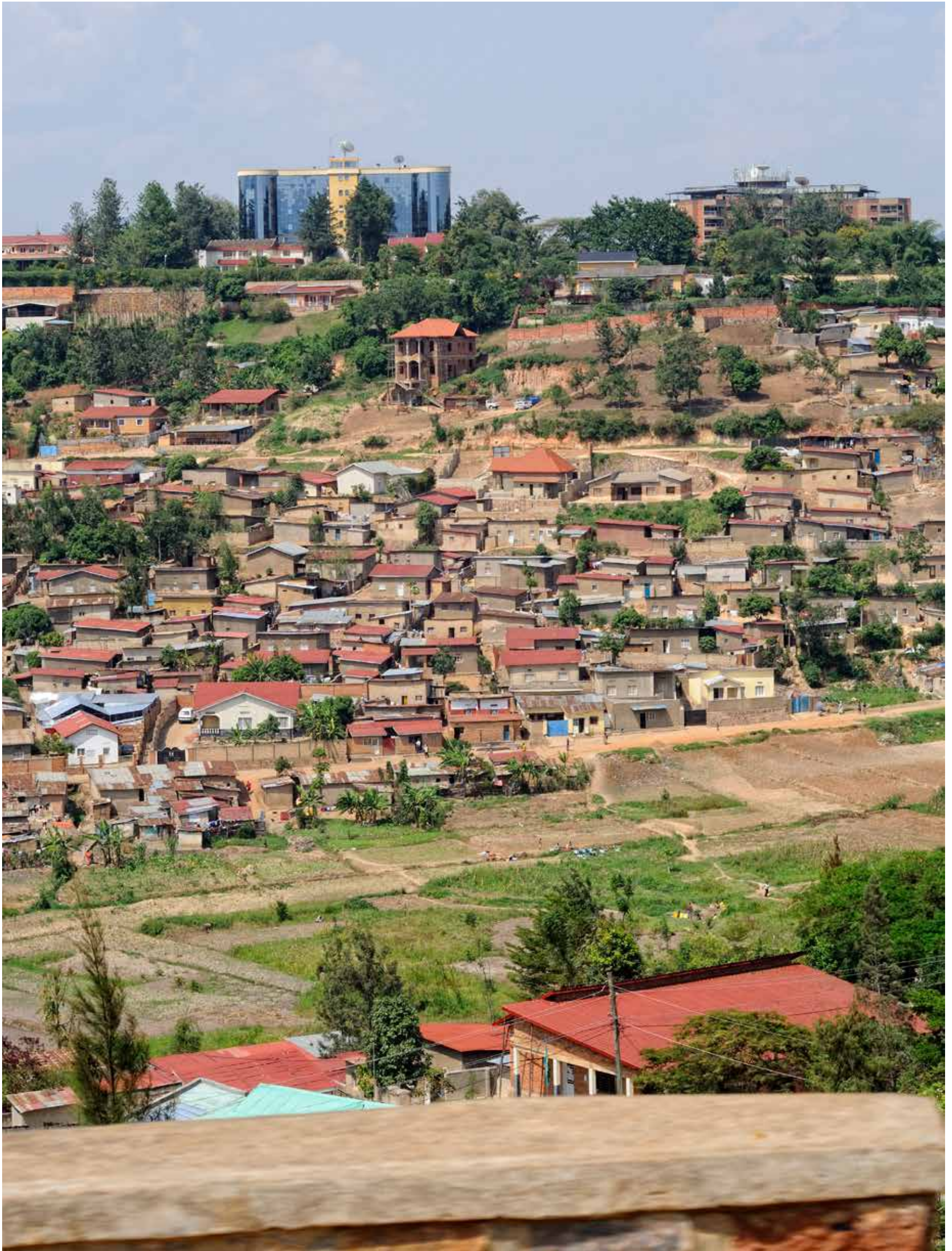
**Table 1.3: Population distribution in the Lake Victoria Basin**

Population	Burundi	Kenya	Rwanda	Tanzania	Uganda	LV Basin
Total population (Millions)	3.9	12.5	6.9	5.6	5.6	34.5
Rural population (%)	95	92	90	87	6	60
Urban population (%)	5	7.8	10	13	94	40
Population density (number of people per km <sup>2</sup> )	285	257	323	66	180	

Source: Lake Victoria Basin Commission 2007a



**Figure 1.5: Population density in the LVB**



Suburban housing in Kigali

# Economic Activities



The major economic activities in the LVB are agriculture, fisheries, wildlife conservation, tourism, mining and power generation (Lake Victoria Basin Commission 2007a). Other key sectors include the service industry, trade, forestry and telecommunications. There has been significant growth in many of these economic activities over recent years, which, in some cases, has resulted in environmental degradation, including water pollution, declining fish catches and soil erosion.

Expansion in regional trade has led to the emergence and expansion of urban centres along the shores of the Lake, resulting in an increase in point source pollution of the Lake waters. Some of the major urban centres on the shoreline of Lake Victoria include Entebbe, Kisumu and Mwanza.



## Fishery Resources

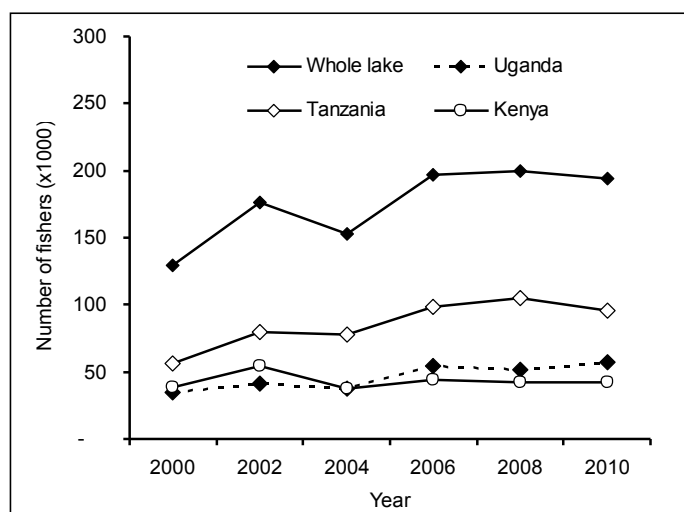
Lake Victoria is one of the most productive freshwater fisheries in the world, with annual fish yields of as much as 800,000 metric tonnes (Lake Victoria Fisheries Organization 2016). The Nile perch (*Lates niloticus*) and Nile tilapia (*Oreochromis niloticus*) are the most dominant species, and both were introduced into the Lake. The native cyprinid (*Ratrineobola argentea*) is also widely found in the Lake (Kayondo and Jorgensen 2005).

In the early 1960s, there were between 400 and 500 species of fish in Lake Victoria, comprising of 12 families and 27 genera, including over 100 identified species of the Haplochromis taxon (Greenwood 1965). However, 40 years after the introduction of the Nile perch, it is estimated that the number of fish species has been reduced to about 200; the rest having been decimated through predation by the Nile perch and competition from the introduced tillapines species (*Tilapia zillii*, *T. rendallii*, *Oreochromis niloticus*, *O. melanopleura* and *O. leucostictus*) (UNEP 2006). Over-fishing has also contributed to depletion of some fish species.

The Nile perch supports 30 fish-processing factories in the three countries that share the Lake's shoreline. The number of fishers operating on Lake Victoria has stabilized after fluctuating between 2000 and 2006: there was a drastic increase from 129,305 in 2000 to 175,890 in 2002 before decreasing to 153,066 in 2004 and then increasing to 196,426 in 2006. The numbers remained around the 2006 level in 2008, with an increase of only 1.4 per cent to 199,242 and a minimal decline of 2.5 per cent to 194,172 fishers in 2010 (Lake Victoria Basin Commission 2007a).

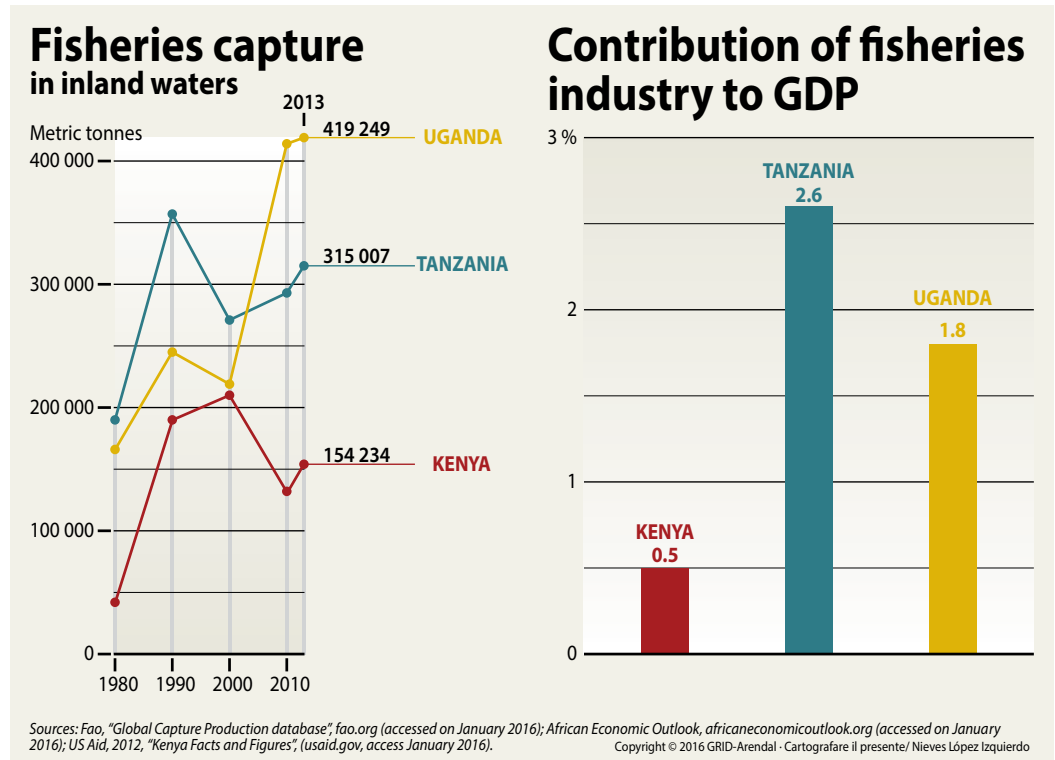
In 2006, 23 per cent of the fishers in Lake Victoria operated in Kenyan waters, 28 per cent in Ugandan waters and 49 per cent in Tanzanian waters. These proportions have remained fairly constant: 21 per cent, 26 per cent and 53 per cent, respectively, for 2008; and 22 per cent, 29 per cent and 49 per cent for 2010 (Figure. 1.6). (Lake Victoria Basin Commission 2007a).

The fishing industry contributes significantly to the Gross Domestic Product of Kenya, Tanzania and Uganda as shown in Figure 1.7.



**Figure 1.6: Distribution of fishers in Lake Victoria between 2000 and 2010**

Source: Lake Victoria Basin Commission 2007a



**Figure 1.7: Contribution of the inland fisheries sector to the GDP of Kenya, Tanzania and Uganda**



Woman pointing at Nile perch in a market in Kampala, Uganda

In the upper catchment areas of Burundi and Rwanda, satellite lakes have proven potential for commercial fisheries. These include Lake Rwhinda, Cohoha, Rweru, Kazingiri, Gaharwa, Kirumbi and Bugesera on the southern floodplain; Lake Ihema, Kivumba and Rwanyakizinga in Akagera National Park; and Lake Bulera and Ruhondo in Ruhengeri Province, close to the border with Uganda (Lake Victoria Basin Commission 2007a).



Potato farming in the Lake Victoria Basin, Kenya

### Agriculture

About 85 per cent of the LVB population depends on agriculture as their major economic and livelihood activity (Lake Victoria Basin Commission 2007a). Agricultural production is the mainstay of the Basin economy, particularly in terms of food security, income generation and employment. The main food crops grown in the Basin are maize, beans, rice, cassava, sweet potato, Irish potato, sorghum, wheat, millet, banana, pineapples, groundnuts, sesame cowpeas, green grams, soybean, yams, tomato and a wide variety of indigenous and exotic fruits.

Vegetables and other horticultural crops such as tea and coffee are also grown on a commercial-scale. Other main cash crops grown in the Basin are sugarcane, cotton, tobacco, sunflower, pyrethrum and vanilla. The proportion of land used for agriculture varies, depending on topography, soils, rainfall, population pressure and climate. The area of arable land in the

Basin is 33 per cent, 20 per cent and 28 per cent of the total land area for Kenya, Tanzania and Uganda, respectively (Bullock et al. 1995).

Small- to medium-scale irrigation schemes are common, especially in the lower part of the Basin where river water is harnessed for irrigation. Figure 1.8 shows the different kinds of cultivation systems in the LVB.

Mixed lowland smallholder subsistence rain-fed cultivation is the most common agricultural production system in the Basin and is characterized by small landholdings of less than one hectare, operated by single households and cultivated mainly by hand. There is a single growing season during the rainy period. There is minimal use of innovative farming techniques and many households maintain a small herd of livestock.

Mixed highland smallholder cultivation is also common and similar to the lowland system. There are, however, some differences: mixed highland smallholder cultivation is generally located at higher altitudes (above 1,700 metres above sea level [masl]); the landholdings are a little bigger, ranging between 2 and 10 ha; there is a mix of hand cultivation and some use of mechanized equipment; the farming system is semi-commercial, with cash crops prevalent in addition to food crops; and crop efficiency is higher, with two growing seasons a year. Small-scale irrigation is sometimes practised in these cultivation systems, and is used to provide water during the dry season and times of drought. Marshland irrigation is a particular type of technique practised in the Kagera sub-basin.

Large-scale cultivation systems involve landholdings as large as tens of thousands of hectares. The system is generally mechanized and cash (or industrial) crops are the main types of crop. They are characterized by large household landholdings and company-owned or government-owned estates. Commonly grown crops are coffee, tea, cotton, flowers, sugarcane and cereals. This type of farming system is characterized by the high use of fertilizers, pesticides and herbicides, as well as supplementary irrigation.

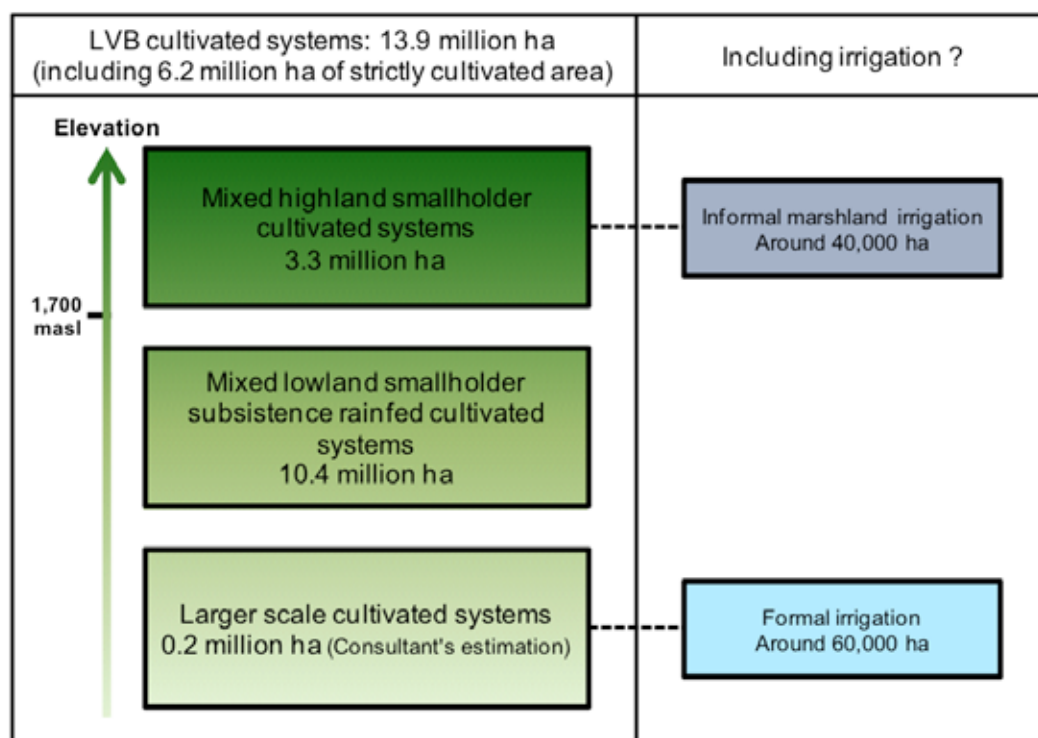


Figure 1.8: Main agricultural systems in the Lake Victoria Basin

Source: BRL Ingénierie 2014





Rural landscape, Uganda

## Forestry

Natural forest cover in the LVB consists of tropical forest, woodlands and savannah forest. About 80 per cent of rural households in the Basin depend on forest resources for basic energy and food. The forests provide a range of environmental services such as greenhouse gas mitigation, watershed protection, climate regulation, soil and water conservation and nutrient cycling. The forestry sector contributes an average of 6–10 per cent of partner states GDP and provides between 850,000 and one million jobs in the formal sector (Lake Victoria Basin Commission 2012). The majority of these jobs are in fuelwood and charcoal production.

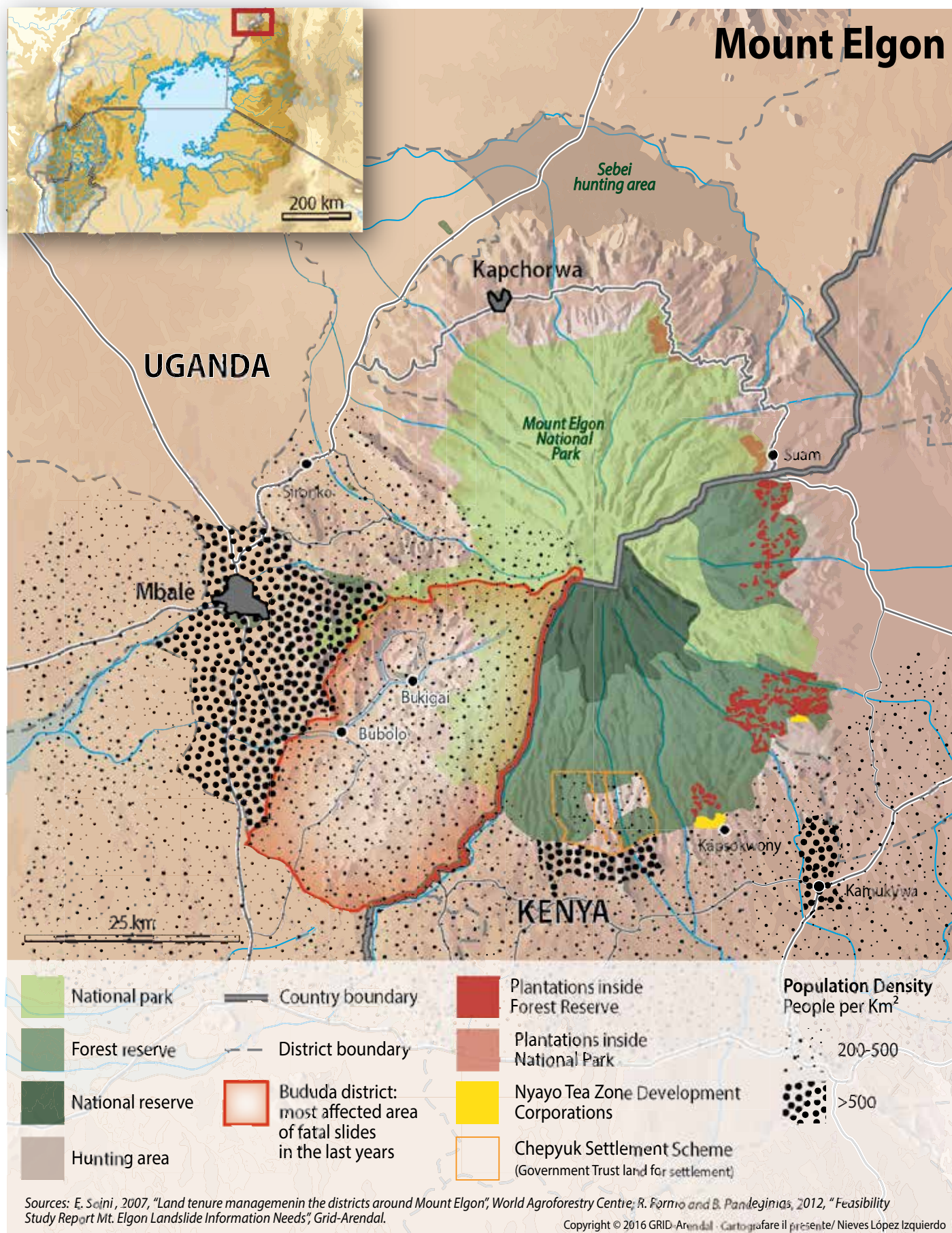
The diverse forest ecosystems in the LVB provide an array of habitats for multiple species of high global significance. These include species of megafauna in protected areas such as the Akagera National Park, Lake Mburo, the Burigi Game Reserve, the Maasai Mara National Park in Kenya and the Serengeti National

Park in Tanzania. The ecosystems also include natural forests such as Gishwati, Nyungwe, Kakamega, Nandi and Timborua and remnants of previously widespread riverine forests along the Kagera, Mara, Nzoia, Yala Nyando, Miriu and Simiyu Rivers. Many endemic plant and animal species such as *Ficus toningii*, *Markhamia lutea* and *Eritrina abbyssinica* species are valued for their medicinal properties and as sources of food (Lake Victoria Basin Commission 2012).

Extensive swampy forests and grasslands with dense tall grasses and papyrus are important ecological components of the LVB floodplain ecosystem. However, these continue to be cleared for commercial and subsistence agriculture, as well as for grazing during times of drought. This severely compromises the important function that swamps and wetlands play in regulating water flow, filtering nutrients such as excess nitrogen and phosphorous, capturing sediments and nurturing biodiversity and habitat for fauna and flora – upon which the health and productivity of the LVB depends.



Serengeti National Park, Tanzania



**Figure 1.9: Mount Elgon**

### Wildlife Conservation and Tourism

The LVB is endowed with some of the world's most pristine wildlife areas, offering a variety of sceneries and huge potential for nature-based conservation and ecotourism. Important sites for tourism include national parks, game reserves, lakeshore beaches, wetlands, forests and unique physical landscapes. The Kagera and Mara sub-basins, as well the Mount Elgon ecosystem, are examples of landscapes that have nature reserves rich in biodiversity. Other important areas include the Akagera National Park, the Maasai Mara and the Serengeti National Park – the latter being partly in the Basin.

Some sections of the Basin enjoy international recognition and special protection under the United Nations Educational, Scientific and Cultural Organization (UNESCO). The Basin has a high diversity of fish, birds, wild animals and plants. Some parts of the Basin with fragile ecosystems have been designated as Ramsar sites of wetlands of international importance. The Serengeti National Park in Tanzania, part of which is located in the Basin, and the Maasai Mara in Kenya are world famous. Seventy sites in the Basin have also been designated as Important Bird Areas (IBA) (Kimbowa 2013). Despite huge conservation efforts,

there are a number of endangered bird species in the Basin, including the papyrus yellow warbler (*Chrolopetta gracillostris*) and papyrus gonolek (*Laniarius mufumbiri*) (Kimbowwa 2013).

In Rwanda, there are three protected areas: the Nyungwe Forest National Park in the west, Akagera National Park in the east and the Volcano National Park in the north, all of which are situated in the LVB and are critical watersheds for the Basin (Lake Victoria Basin Commission 2007a). These ecosystems have unique physical and geographical characteristics that support a variety of different life forms spread over different altitudinal ranges. In addition to the economic returns from tourism, these parks provide habitats to some of the rarest species in the world, making them internationally important biodiversity sites. The parks in Rwanda are a major tourist attraction, contributing substantially to the economy through tourism revenue.

With its huge potential, the Basin could be fully developed as a major tourist destination. The development of an extensive transport network across the Lake, in particular, would help to boost tourism. The Ssesse Islands in Uganda and the Ukerewe Islands in Tanzania have beautiful sandy beaches with huge tourism potential but remain undeveloped, with few visitors. Tourist attractions include water sports, bird watching, angling and other natural attractions. In addition to contributions from governments, the private sector has also taken steps to develop facilities to support the tourism industry in the Basin. This includes hotel accommodation, the provision of travel and tour operations, professional tour guiding and tourism promotion.

## Mining

The mining industry in the LVB is a developing economic and land-use activity, making an annual contribution of about 2.3 per cent to the Basin's GDP (Lake Victoria Basin Commission 2007a). Artisanal mining is prevalent in the Burundian portion of the LVB, where the most common mined minerals are alluvial gold, cassiterite, columbo-tantalite and wolframite. These activities have, however, a negative impact on the environment because their solid loads cause river pollution and excessive silting of river floors, rendering them unsuitable for agriculture.

The Kenyan part of the Basin has minerals that include Kisii soapstone, phosphate, sulfur, wollastonite and nephelinite, manganese, tin, kaolin, clay, fluor spar, iron ore, graphite and diatomaceous soil. Industrial mining of limestone is carried out at Koru in Nyando District, while the extraction of building material such as granite, brick clay, sand, tuffs, murrum and material for ballast is widespread.

A range of minerals – cassiterite, coltan, wolfram and colombo tantalum – and other valuable materials such as sand, gravel and stones are extracted in various parts of the Basin in Rwanda. Mining sand and stones is largely unregulated and there are concerns about the destruction of other natural resources, particularly wetlands and fragile hillsides. Mining activities support a significant proportion of livelihoods and local economies but there are concerns that current mining activities in Rwanda are unsustainable (Lake Victoria Basin Commission 2007a). The Government of Rwanda has intervened by outlawing mining in some areas, but appropriate mechanisms are needed to ensure the delicate balance between the environment and livelihoods.



Diamond mining in Tanzania

The mining industry in Tanzania is an important land-use activity and currently contributes about 2.3 per cent of GDP (Lake Victoria Basin Commission 2007a). Diamonds are mined at Mwadui, in the Tanzanian part of the Basin. The main gold fields in this area are in the Lake Zone, south and east of Lake Victoria, extending up to the Kenyan border. The most active sites are Geita, Bulyanhulu (near Kahama), Iramba, Sekenke, Kilima Fedha, Serengeti, Nyambegena, Musoma and Tarime.

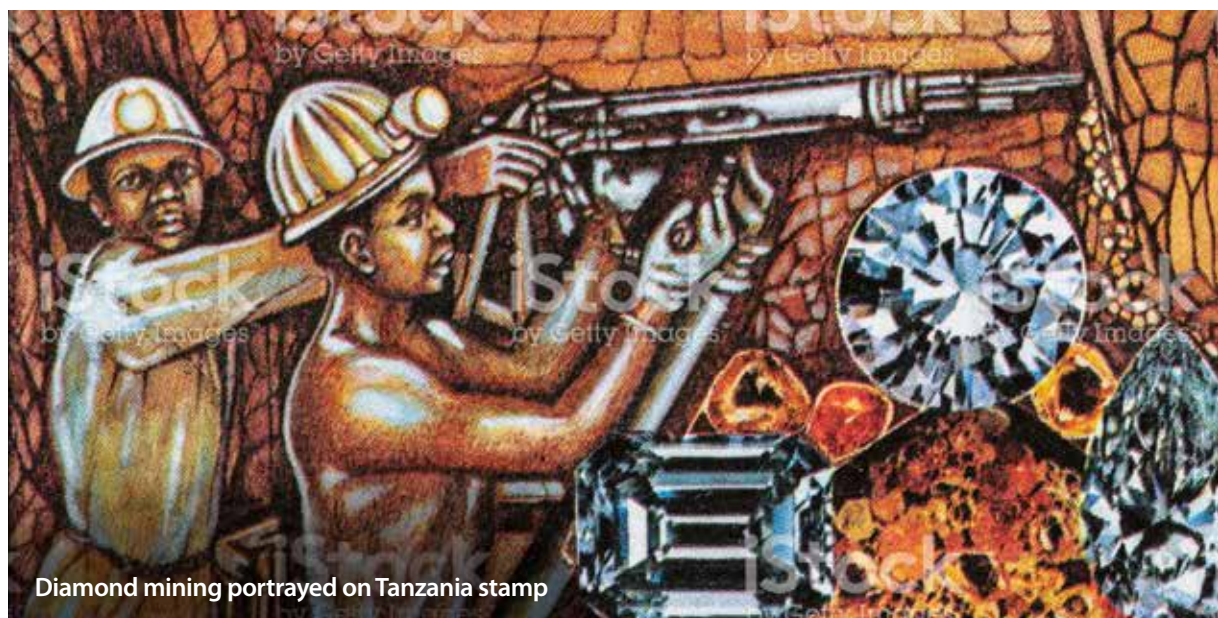
The mine waste dumps, mercury contamination from artisanal mining activities, and the continued pumping of saline wastewater from mines and quarries, threaten to pollute the lower part of the Basin.

## Energy

Woodfuel provides over 90 per cent of the energy requirements of the Basin countries (Lake Victoria Basin Commission 2007a). Other potential energy sources such as solar, geothermal and wind energy are not significantly developed. Wind power is used mainly to pump water, but only in a few areas. Hot springs are present in parts of the Basin, but these remain unexploited. Similarly, solar power generation is on a small-scale and usually off-grid.

In Burundi, there are many small hydroelectric dams such as Rwegura with an installed capacity of 18 MW, and the Kavuruga and Ndurumu both of which have a low power generating capacity of less than 1 MW. Some of the hydropower stations generate very little power during the dry season because of insufficient water supply.

In Kenya, fuelwood accounts for 70 per cent of the energy mix, while oil and electricity account for 20 per cent and 9 per cent, respectively (Lake Victoria Basin



Diamond mining portrayed on Tanzania stamp

Commission 2007a). The Kenyan part of the Basin has the potential for hydroelectric power generation: according to the Lake Basin Development Authority Master Plan (1987) the area could generate up to 563 MW of hydroelectric power: 159 MW from the Nzoia River, 114 MW from the Yala River, 14 MW from the Nyando River, 249 MW from the Sondu-Miriu River system and 27 MW from the Kuja–Migori River system. Currently, however, hydroelectric power generation is limited, but is set to expand once the Sondu-Miriu Hydropower project comes on stream (Lake Victoria Basin Commission 2007a).

In Tanzania around 90 per cent of national energy needs are met by woodfuel, while petroleum and electricity account for 8 per cent of total energy consumption; coal and other sources account for less than 1 per cent (Lake Victoria Basin Commission 2007a).





Maasai tribeswoman, Kenya

A large proportion of the rural population depends on forest resources to meet their firewood needs. In Mwanza, a study in 2000, showed that the city consumed about 438,102 m<sup>3</sup> of firewood and charcoal, resulting in the deforestation of 17,777 ha per year (Chamshama 2005). In Musoma, there is evidence that even protected forest reserves have been seriously degraded and the Kyanyari Forest Reserve is now devoid of trees (Chamshama 2005).

The greatest potential for hydroelectric power generation in the LVB is in Uganda. Uganda also has the largest developed hydropower energy sector in the Basin. The Owen Falls Dam at Jinja has installed capacity of 380 MW, although it currently only generates about 50 per cent of its potential; a further 250 MW is generated at Bujagali Falls. There are plans for the development of a 200 MW plant at Karuma. The 50 MW geothermal plants in Kampala and Jinja, as well as the 100 MW thermal plants further contribute to Uganda's energy mix (Adeyemi and Asere 2014).

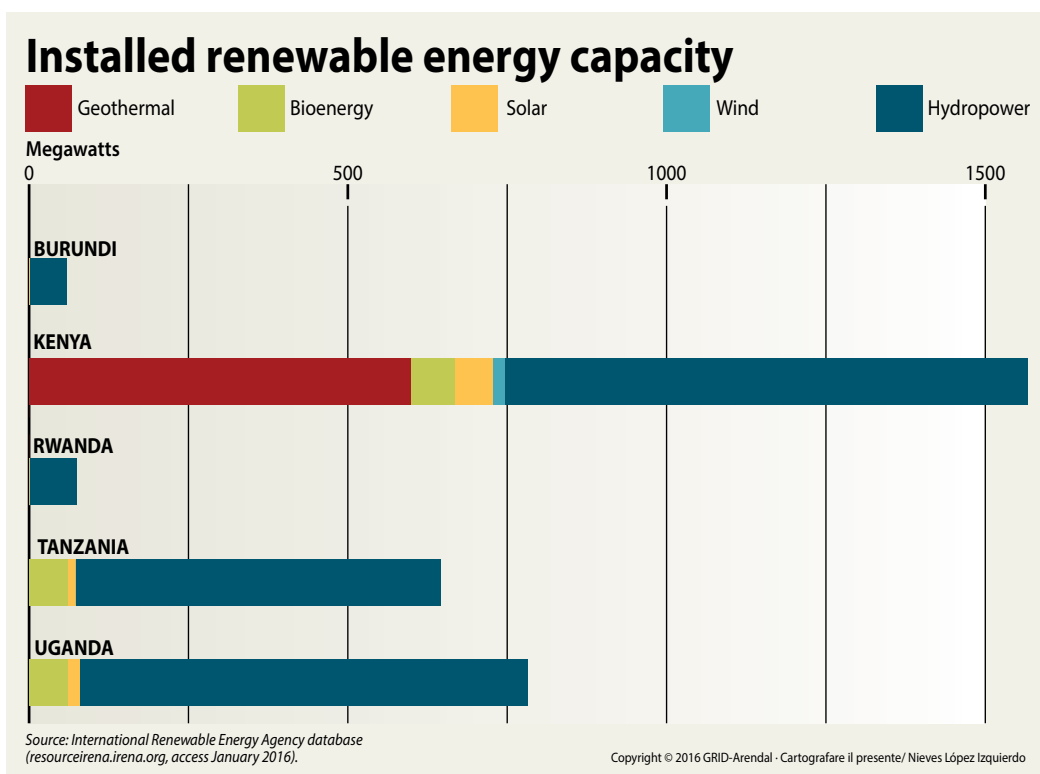


Figure 1.10: Installed renewable energy capacity for Lake Victoria Basin States

Rwanda generates 30 MW from power stations at Rusizi in the west and Ntaruka and Ruhondo in the north. In addition, the country generates 30 MW from thermal sources. Levels of connection to the electricity grid are low, with estimates indicating that there are only 67,000 energy subscribers in the country. Peat mined from wetlands is used as an alternative to fuelwood in industrial activities. Other sources of energy such as biogas, solar, thermal and methane gas, are also being explored (Lake Victoria Basin Commission 2007a).

There are growing efforts in the Basin countries to shift towards renewable forms of energy, with Kenya making some significant advances (as shown in Figure 1.10).

### Trade and Industry

Trade and industry are some of the fastest growing sectors in the LVB, with a high potential for improving incomes and employment. These sectors have been heavily promoted by the current regional integration process facilitated by the EAC Customs Union, which



promotes intra and interregional trade in the Basin (Okumu and Nyankori 2010). Most of the traded goods and services involve agricultural and livestock products, fish, household goods, wood and timber, textiles and construction materials. Trade between Kenya, Uganda and Tanzania has greatly increased since the initiation of the integration of EAC Partner States.

The processing and packaging of coffee, cotton, rice, tobacco, sugarcane, dairy milk and oils dominate Burundi's industrial activities. The production of consumer goods, chemicals, textiles, wood, paper and building materials are also key industrial activities. About 70 per cent of the produced goods are transported by the nation's road network, which connects to Rwanda, Uganda, Kenya and Tanzania (Lake Victoria Basin Commission 2007a).

In Tanzania, industrial activities in the Lake Victoria region are characterized by small to medium-sized production units, based primarily on agriculture and fishing. These include fish processors, fishmeal mills, abattoirs, vegetable oil mills, animal feed mills, and coffee and tea processors (Lake Victoria Basin Commission 2007a).

Uganda has a number of important industries in various sectors of the economy, including mining and agriculture (coffee, tea, fish, milk, edible oil and fruits processing) (Lake Victoria Basin Commission 2007a).

### **Communication**

Communication infrastructure within the Basin includes the road and rail network, air transport, inland water

transport and telecommunications. Some of the transport routes inter-connect the riparian countries. While there is a well-developed road network across the Basin States, most rural roads are in poor condition, which makes it difficult to travel or transport goods to more remote parts of the Basin, particularly during the wet season.

In terms of telecommunications, the Basin is served with both fixed and mobile communication facilities. In the last five years, there has been a remarkable growth in mobile telephone subscription, with a tendency towards region-wide networks. The fixed telephone network has, however, lagged behind, affecting access to the Internet. Each of the riparian countries has a number of radio and TV stations, and newspapers.

Transboundary public road transport vehicles include buses and large trucks that transport goods, including oil tankers. Cross-border rail transport in the Basin is being revived with private sector involvement, to link Rwanda and Burundi. There are a number of small passenger and goods boats operating on Lake Victoria, as well as a few large regional cargo transport vessels. In Tanzania and Uganda, sizeable vessels serve the islands on the Lake.

International air transport is limited to the main international airports in Nairobi, Entebbe, Dar-es-Salaam, Kilimanjaro, Kigali and Bujumbura, with connections to inland airports within the Basin, such as Kisumu and Mwanza.

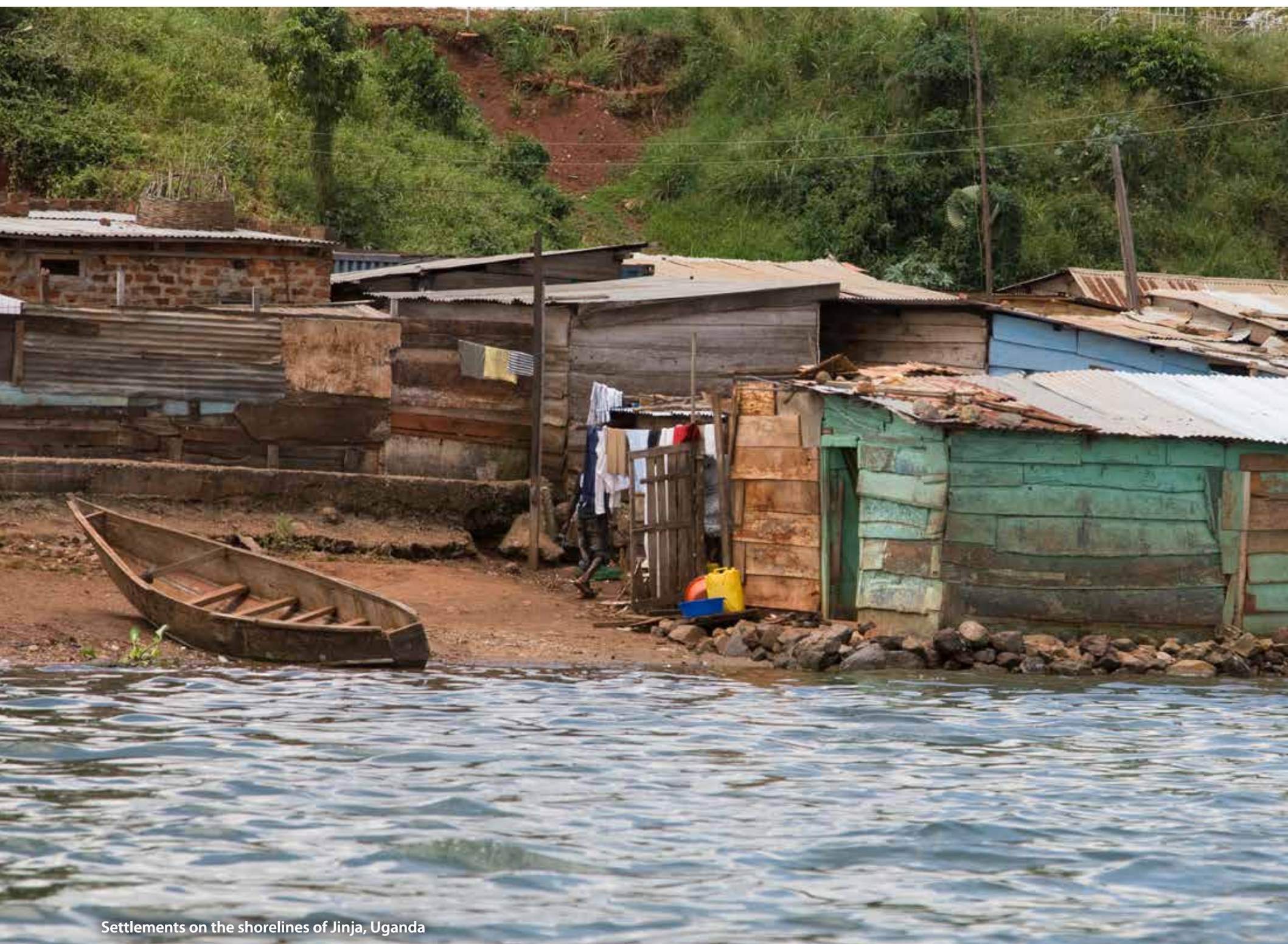
# Institutional Arrangements

As a resource that is not only shared by all partner states of the EAC, but also provides the headwaters to the Nile River Basin, management of the LVB requires a coordinated approach. Benefits can be realized equitably through coordination in the use and management of transboundary resources and services such as fisheries, inland transport, power generation, climate regulation, transboundary conservation and the management of international water towers.

The Lake Victoria Basin Commission (LVBC), a specialized institution of the EAC, coordinates all activities in the LVB, with the primary goal of ensuring coordinated and sustainable development. The establishment of the LVBC is provided for under article 114 of the 1999 Treaty establishing the EAC, in which the partner states designated the Lake Victoria and

its Basin as an economic growth zone that should be exploited in a coordinated manner. This is highlighted in the first East African Cooperation Development Strategy (1997-2000) (EAC 1999).

In order to fulfil the East African Cooperation Development Strategy, a study to determine the legal and institutional arrangements for managing the Basin was commissioned in 2000 by the EAC Secretariat. The study culminated in the establishment of the Lake Victoria Development Programme Unit (LVDP) in 2001, at the EAC Secretariat in Arusha. The Unit led the negotiations for the Protocol for the Sustainable Development of Lake Victoria Basin, which was concluded on 29 November, 2003, and ratified by the partner states in December 2004. The LVBC was formally established by the EAC Council of Ministers in



Settlements on the shorelines of Jinja, Uganda



July 2005 and became fully operational in April 2006, initially operating out of Arusha. In January 2007, the Commission relocated to its current headquarters in Kisumu, Kenya. The protocol establishing the LVBC was signed in 2003 (EAC 2003).

The broad mandate of the LVBC is provided for under article 33(2) of the Protocol for Sustainable Development of Lake Victoria Basin; namely to:

*"... promote equitable economic growth, promote measures aimed at eradicating poverty, promote sustainable utilization and management of natural resources, promote the protection of the environment within the Lake Victoria Basin, and promote compliance on safety of navigation."*

The vision of the LVBC is to have a prosperous population living in a healthy and sustainably managed environment providing equitable opportunities and benefits.

The mission of the LVBC is to promote, facilitate and coordinate activities of different actors towards sustainable development and poverty eradication of the Lake Victoria Basin.

The LVB is designated as an Economic Growth Zone for the EAC Partner States. The Basin offers opportunities for socioeconomic development and investment in a variety of diverse areas, including tourism development; lake transport and communication; trade and industry; water treatment, supply and sanitation; and fisheries.

Despite the vast opportunities in the Basin, there are a number of environmental, socioeconomic and management challenges. The environmental challenges include over-fishing, point and non-point source pollution, invasive weeds and the degradation of catchment areas. Socioeconomic challenges include high population densities, limited livelihood options, high levels of illiteracy, lack of skilled labour and high mortality rates resulting from HIV and AIDS, malaria, water-related diseases and malnutrition.

The main management challenges include the coordination of transboundary natural resources and the enforcement of laws governing the management of these resources. Currently, transboundary natural resources are managed in accordance with national institutional and legal frameworks. In order to sustainably exploit the existing and potential opportunities in the Basin, while simultaneously addressing the challenges, the EAC Council of Ministers has, over the last few years, approved and adopted a variety of legal and administrative instruments to guide the sustainable management of the LVB. These include the Protocol for Sustainable Development of Lake Victoria Basin (2003); the Vision and Strategy Framework for Management and

Development of the Lake Victoria Basin (2004); the EAC Development Strategies formulated every five years; and the LVBC Operational Strategy (2007-2010). These policy documents, particularly the Strategic Intervention Areas defined by the Lake Victoria Basin Commission in the fourth EAC Development Strategy (2011-2016), guided the development of the current LVBC Strategic Plan (2011- 2016) (Lake Victoria Basin Commission 2015).

In addition to the five-year strategic planning cycles, guidance for the management of the Basin is also provided through article 3 of the Protocol for Sustainable Development of the Lake Victoria Basin, which identifies 14 areas of cooperation (EAC 2003):

- sustainable development, management and equitable utilization of water resources
- sustainable development and management of fisheries resources
- promotion of sustainable agricultural and land-use practices including irrigation
- promotion of sustainable development and management of forestry resources
- promotion of development and management of wetlands
- promotion of trade, commerce and industrial development
- promotion of development of infrastructure and energy
- maintenance of navigational safety and maritime security
- improvement in public health with specific reference to sanitation
- promotion of research, capacity-building and information exchange
- environmental protection and management of the Basin
- promotion of public participation in planning and decision-making
- integration of gender concerns in all activities in the Basin
- promotion of wildlife conservation and sustainable tourism development

The five LVB riparian countries are Member States of the East African Community (EAC). While East Africa's major regional policy instrument for the management of the Basin is the Protocol for the Sustainable Development of the Lake Victoria Basin, membership of the EAC Partner States in other regional economic communities, including: the Southern Africa Development Community (SADC) of which Tanzania is a member; the Common Market for Eastern and Southern Africa (COMESA), which includes Burundi, Kenya and Rwanda; and the Intergovernmental Authority on Development (IGAD) of which Kenya and Uganda are members, means some basin states have also to deal with other environmental management instruments. For example, as a member of the SADC, Tanzania is also subject to the provisions of the revised SADC Protocol on Shared Watercourse Systems.

# 2

## CHANGING ENVIRONMENT

The Lake Victoria Basin ecosystem continues to undergo substantial changes as a result of pollution from industry and agriculture, the proliferation of waterweeds, over-fishing, the introduction of invasive alien species and land degradation. Algal blooms are prevalent in the Lake, to the extent that water transparency declined from five metres in the 1930s to less than one metre in the 1990s. The proliferation of the water hyacinth weed impedes the flow of water for irrigation, hinders navigation and interferes with hydropower schemes. The introduction of the Nile perch is blamed for the decline in the number of fish species from over 400 to about 200.





# Atmospheric and Climatic Conditions

The LVB climate is consistent with that of East Africa. Major climatic features that regulate the Basin include the El Nino Southern Oscillation, the Quasi-biennial Oscillation, the Inter-Tropical Convergence Zone and monsoon winds (Anyah and Semazzi 2004). Together with Lake Malawi and Lake Tanganyika, Lake Victoria has an influence on East Africa's climate (Song et al. 2004). The humid Congo air mass, which originates in the tropical Congo Rainforest, also affects the LVB climate (Anyah and Semazzi 2004).

Despite the sporadic dust-storms and the occasional haze from wood burning, the LVB enjoys a relatively unpolluted atmosphere.

## Temperature

Lake Victoria basin average temperatures reach a maximum of about 28.7° C in February just before the March equinox and reach their lowest in July after the June equinox maximum. Minimum temperatures vary from 14.7 to 18.2° C (Lake Victoria Basin Commission 2007). While there are wide differences between cold season and warm season temperatures, studies by Anyah and Semazzi (2004) show that average temperature in the lake varies only slightly from month to month.

Comparison of temperature records for the period 1950-2000 and 2001-2005 show that maximum temperatures have increased by an average of 1° C (Lake Victoria Basin Commission 2007). Anyah and Semazzi (2004) noted a significant jump in average temperatures in the basin since the 1990s. Air temperature on the Ugandan side of the lake was 0.5° C higher in the 1990s than in the 1960s (Anyah and Semazzi 2004).

While the interactions between lake surface temperature and rainfall amounts and distribution are complex, there are indications that higher lake temperatures are associated with increased rainfall, with models predicting that some areas of the LVB could receive double the current average rainfall when lake temperatures rise by 1.5° C (Anyah and Semazzi 2004). Such an impact of temperature increase would have significant impacts in shaping the East Africa's climate.

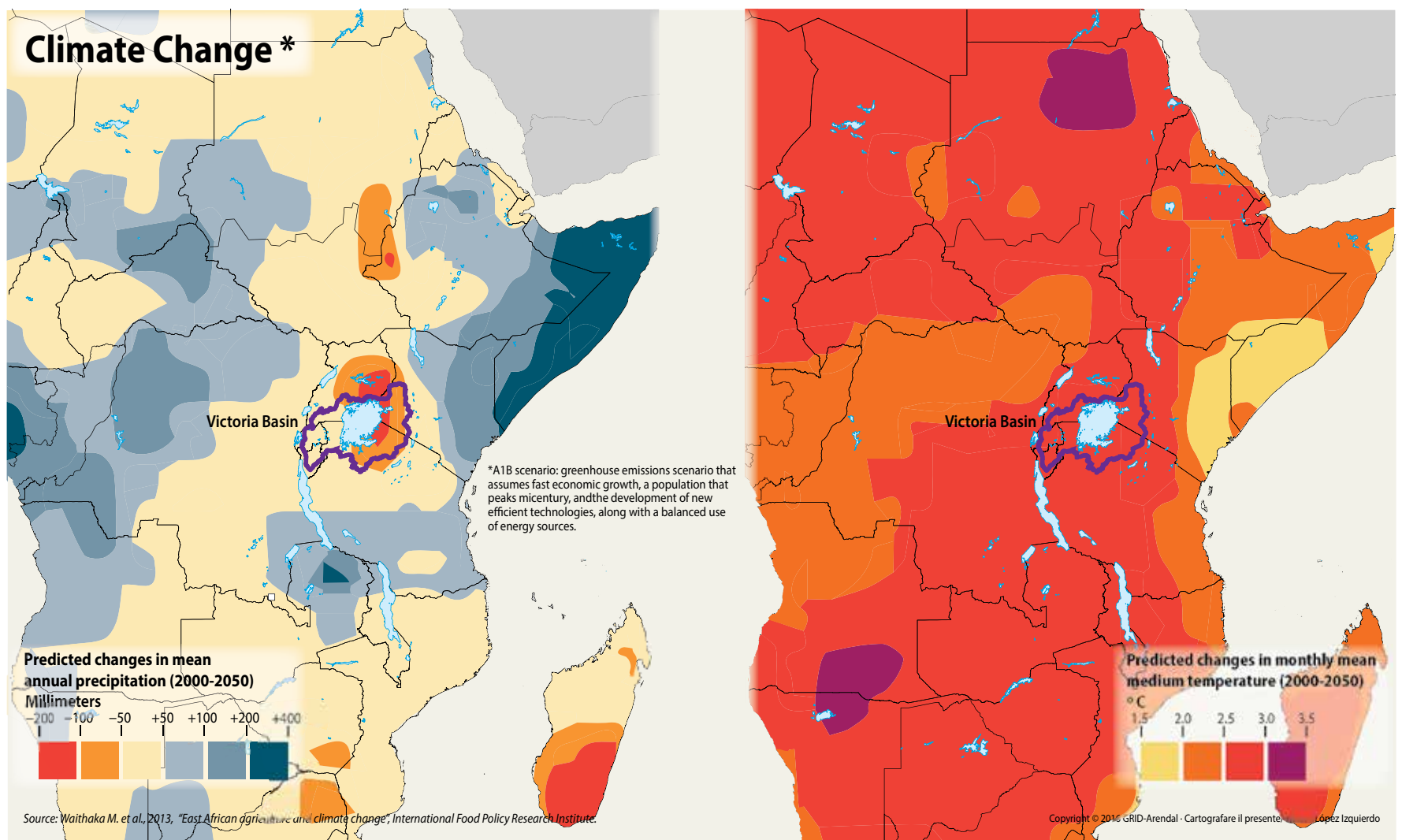
## Rainfall

Average annual rainfall in the Basin ranges from 400 to 2,736 mm (Kizza et al. 2009). The minimum rainfall amount was recorded at Ngudu while the maximum amount was recorded at Bukoba. Recorded rainfall averages show that received rainfall amounts are higher in the north to north-eastern parts of the basin than the amounts received in the southern portions of the basin (Kizza et al. 2009).



**Figure 2.1: Average rainfall trends for Lake Victoria Basin since 1903**

Source: Kizza et al. 2009



**Figure 2.2: Changes in temperature and rainfall in the Lake Victoria Basin region and beyond**



**Rain in Jinja, Uganda**



Rainy day at Lake Bunyonyi in Kabale, Uganda

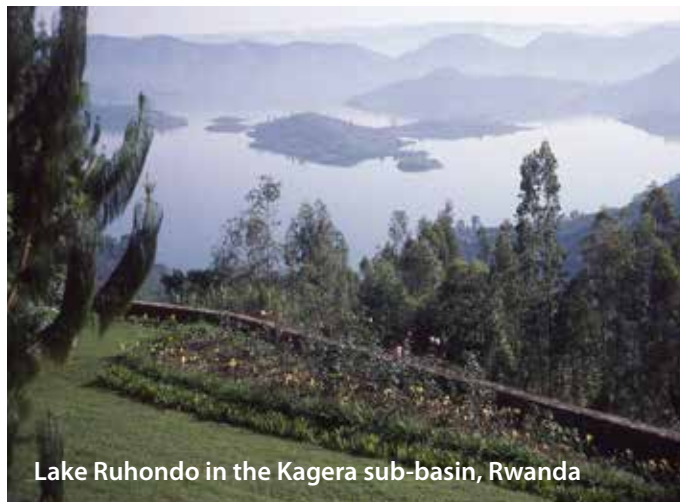
Rainfall is the primary source of water recharge for the LVB, contributing 80 per cent of the water entering the Lake (Awange et al. 2008). The main water reservoirs in the Basin include surface water in lakes, rivers, streams and wetlands, and groundwater in aquifers.

There is considerable variation in the intensity and spatial distribution of rainfall across the Basin. This is demonstrated by the study conducted in Kericho, Kabale and Bukoba (Kizza et al. 2009). The annual precipitation

cycle in Bukoba and Kabale, as much as the rest of the LVB, shows two distinct rainy seasons: the March to May rainy season, and the September to December rainy season. The rainy seasons are punctuated by two dry seasons between January and February, and between June and August (Kizza et al. 2009). The September to December period receives less rainfall than the March to May season.

The daily, seasonal and inter-annual variability of LVB's climate results from the interaction between the inter-tropical convergence zone (ITCZ), El Nino/Southern Oscillation (ENSO), Quasi- biennial Oscillation (QBO), large-scale monsoonal winds, meso-scale circulations and extra-tropical weather systems (Nicholson and Yin 2002). The seasonal north to south movement of the ITCZ results in the two rainfall seasons, while the inter-annual variability in received rainfall corresponds to the ENSO changes (Kizza et al. 2009).

The study by Kizza et al. (2009) further indicates an overall increase in the average rainfall amounts in the LVB. There is, however, some variation across the region: while there has been a general increase in the average annual rainfall in the western sections of the Basin, some stations in the eastern section recorded a decline.



Lake Ruhondo in the Kagera sub-basin, Rwanda



# Forest cover

**Table 2.2: Distribution of LVB ecosystems per sub-basin (Lake Victoria excluded)**

Name of the Forest Ecosystem	Forest Ecosystems		
	Lake Victoria forests (km <sup>2</sup> )	Tropical highland forests (km <sup>2</sup> )	Mountain forests (km <sup>2</sup> )
Biharamulo	32	501	0
Bukora	47	1	0
Gucha-Migori	0	21	0
Katonga	27	212	0
Lake Victoria Islands	1 177	0	0
Lower Kagera	281	475	0
Mara	0	227	456
Middle Kagera	0	110	0
North Awach	0	2	0
Northern shore streams	374	7	0
Nyabarongo	0	5	379
Nyando	0	386	408
Nzoia	0	597	654
Ruvubu	0	9	17
Simiyu	5	0	0
Sondu	0	347	406
South Awach	10	24	0
Southern shore streams	209	248	0
Western shore streams	2	0	0
Yala	0	640	119
<b>LVB</b>	<b>987</b>	<b>3812</b>	<b>2439</b>

Source: LVBC WRMP study by BRL Ingénierie 2014

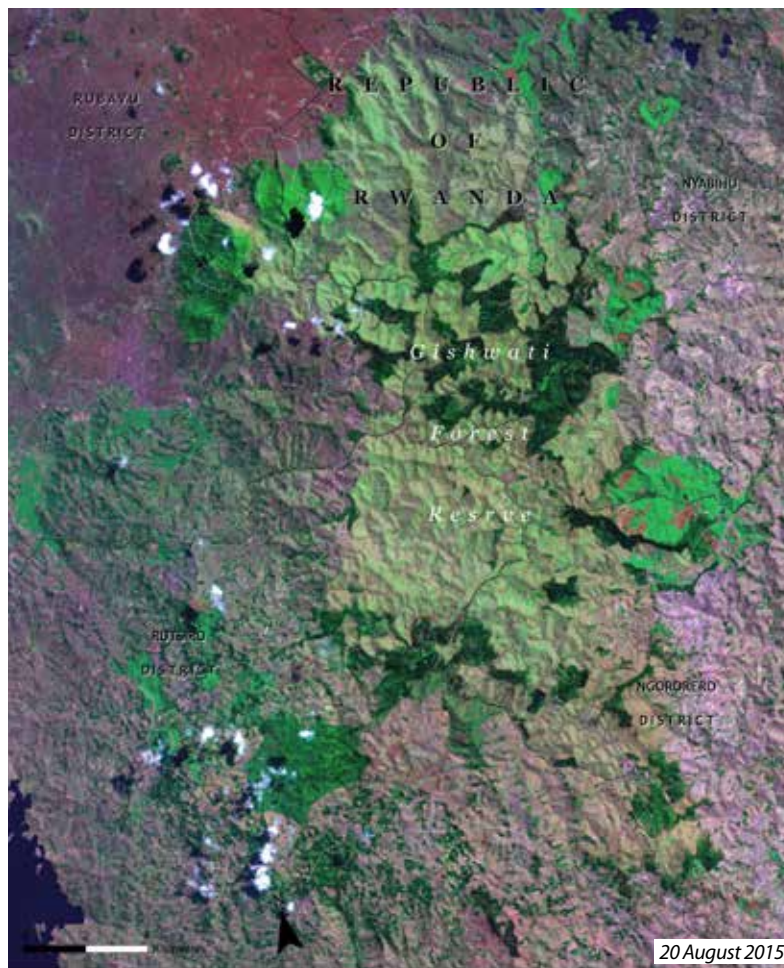
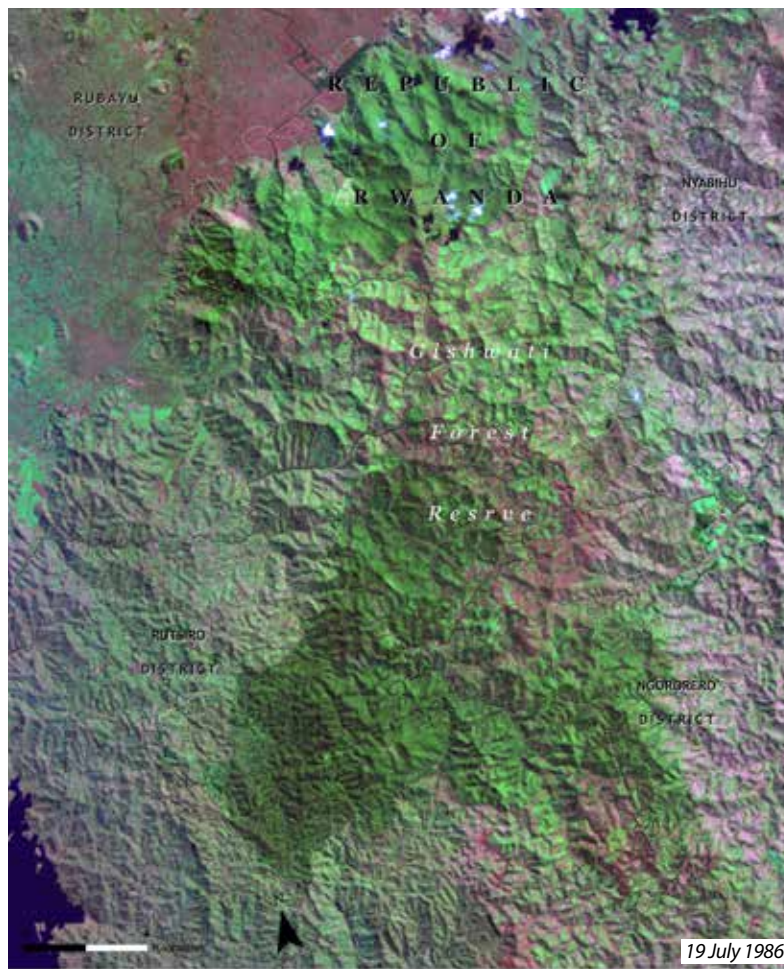
Lake Victoria consists of moist forest areas on the shores and fringes of the Lake, as well as on the islands in the Lake. According to the Lake Victoria Basin Commission (2012) – which has designated a number of Ecological Sensitive Areas (ESAs) – there are 222 forest units occupying an area of 1,120 km<sup>2</sup> on islands in Lake Victoria, as well as along and near the shoreline (3 km<sup>2</sup> in Kenya, 401 km<sup>2</sup> in Tanzania and 716 km<sup>2</sup> in Uganda). Indigenous trees dominate these forests, which influence, and in turn are strongly influenced by, the microclimate of the Lake. The wider LVB has about 7,200 km<sup>2</sup> of forest cover (as shown in Table 2.2).

Pockets of the LVB are losing significant amounts of forests due to the growing pressure for land for crops, grazing, settlement and firewood. In addition to large-scale deforestation, selective logging, debarking and charcoal burning are also responsible for the reduction in the extent of forests and in the diversity of plant species through loss of seedling species richness (Chazdon 2008).

Deforestation in the LVB is more acute outside of protected areas, and on forested private and public/communal lands that are not regulated or managed by government authorities. Communities living in these non-regulated forest lands depend on forest resources for firewood, building materials and medicinal plants, prompting over-exploitation. The deforestation rate in the Basin is estimated at 55,000 – 100,000 ha per year, equivalent to a forest loss ratio of 1.1 - 3.15 per cent per year (Lake Victoria Basin Commission 2007).







## Gishwati Forest

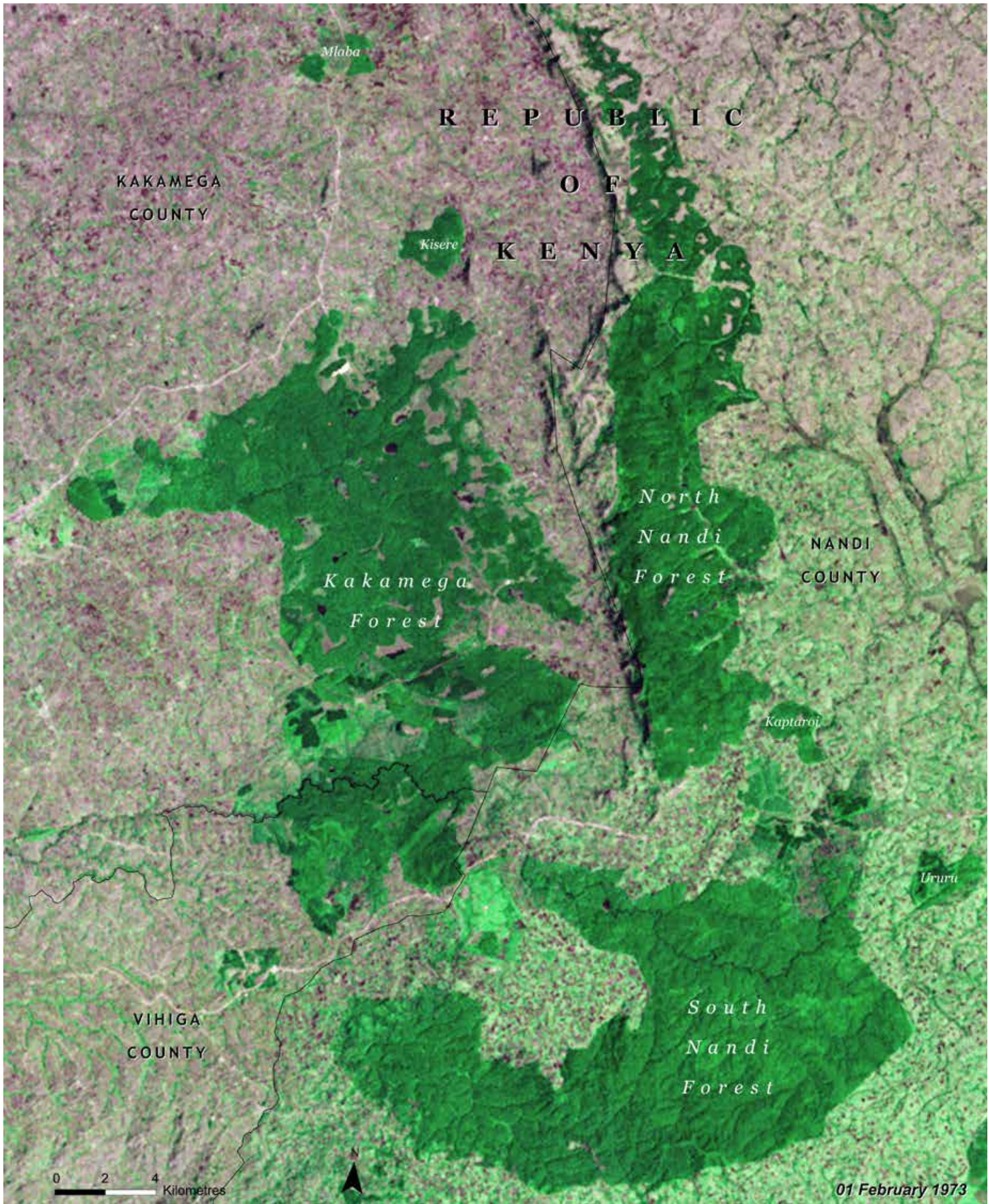
Once an intact forest extending for 70,000 ha in the 1930s, the Gishwati Forest in Rwanda was reduced to 28,000 ha during the 1970s due to clearance of the forest for large-scale cattle ranching, crop cultivation and settlement (Gatera 2001; Plumptre et al. 2001). A major pine plantation was created in the forest in 1986 and a further 3,000 ha

converted into a military zone. By 1995, more natural forest had been converted for agriculture following the demand for land for returning refugees and internally displaced persons at the end of the war (Kanyamibwa 1998). By the 1990s, only 8,800 ha of forest remained; this further declined to 600 ha in 2005. Since 2005, forest restoration work has been ongoing (Nyandwi and Mukashema 2011).

### Kakamega Forest

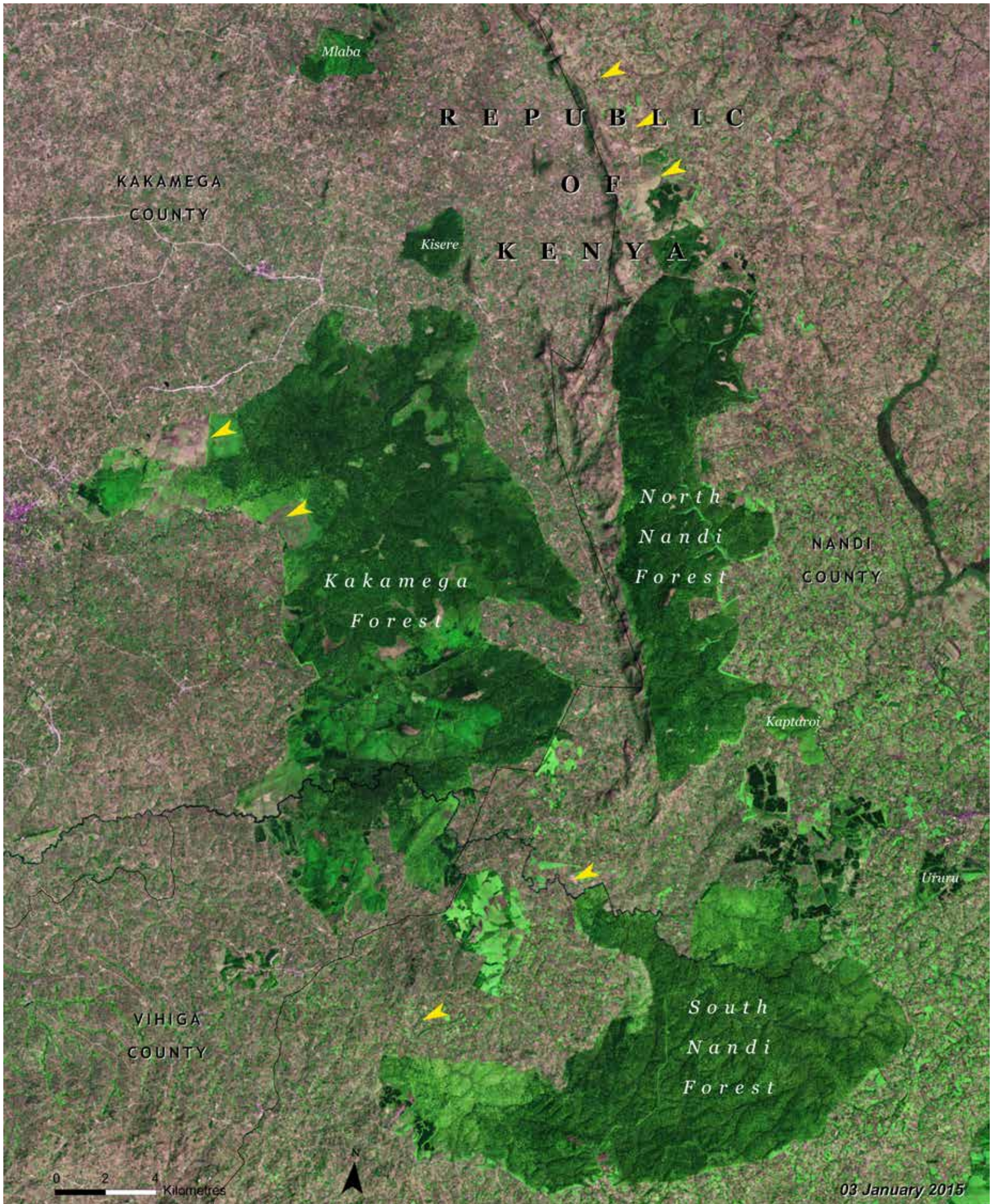
Kakamega forest is Kenya's only tropical rainforest, and the eastern-most remnant of the Guineo-Congolian tropical rainforests. Around 1913 the Kakamega forest

was contiguous with the North and South Nandi Forests. The forest is now heavily fragmented and degraded due to the high human population densities that surround the Forest (Vuyiya et al. 2014). The Forest is rich in



biodiversity that includes numerous bird species, some of which are globally and regionally threatened. The Kakamega Forest has been designated an Important Bird Area. Population pressure and the resultant conversion

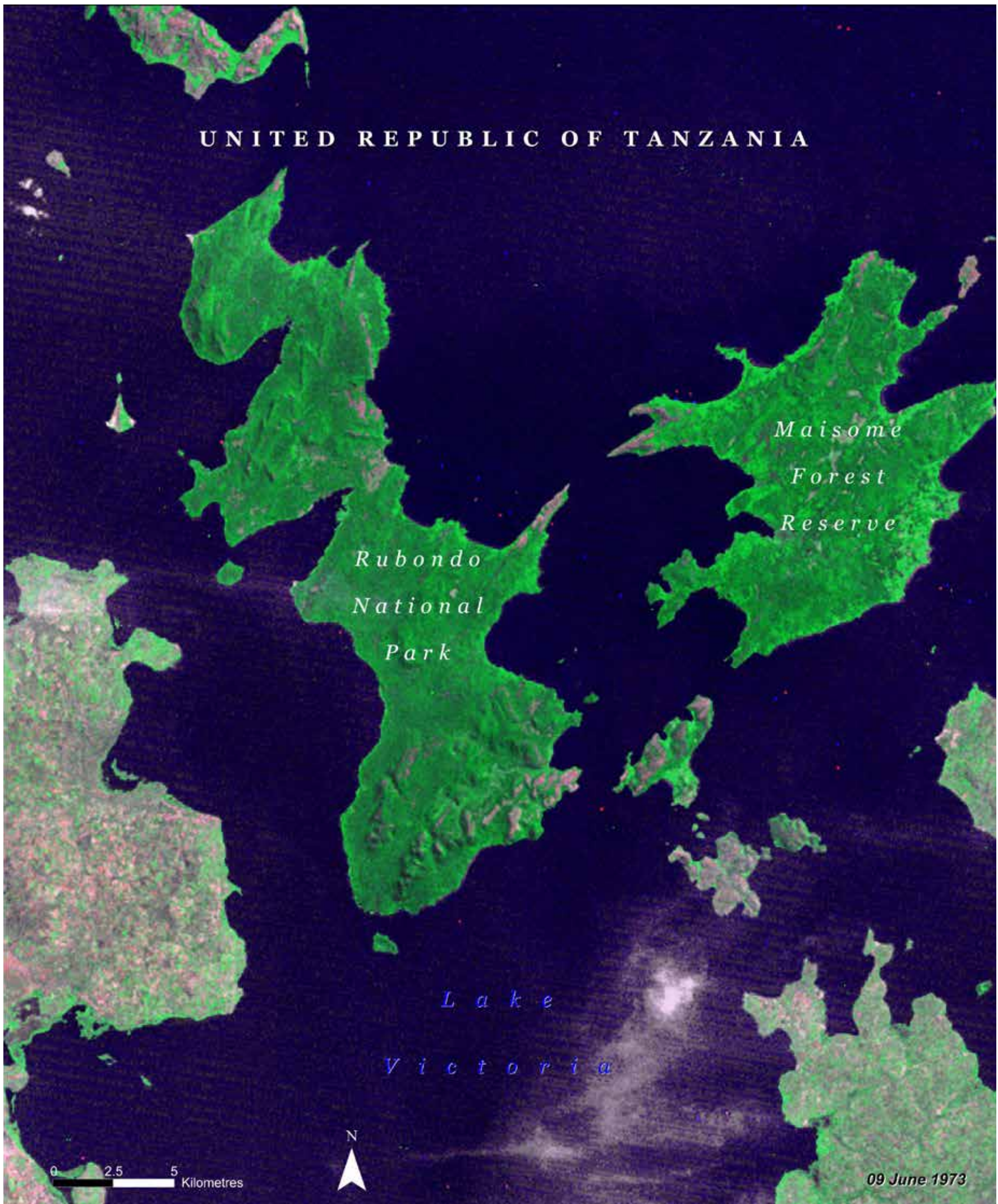
of forested areas to crop cultivation, has greatly diminished the area covered by these forests. Sections of the Forest continued to decline between 1973 and 2015 (as shown by the yellow arrows).



### **Maisome Forest**

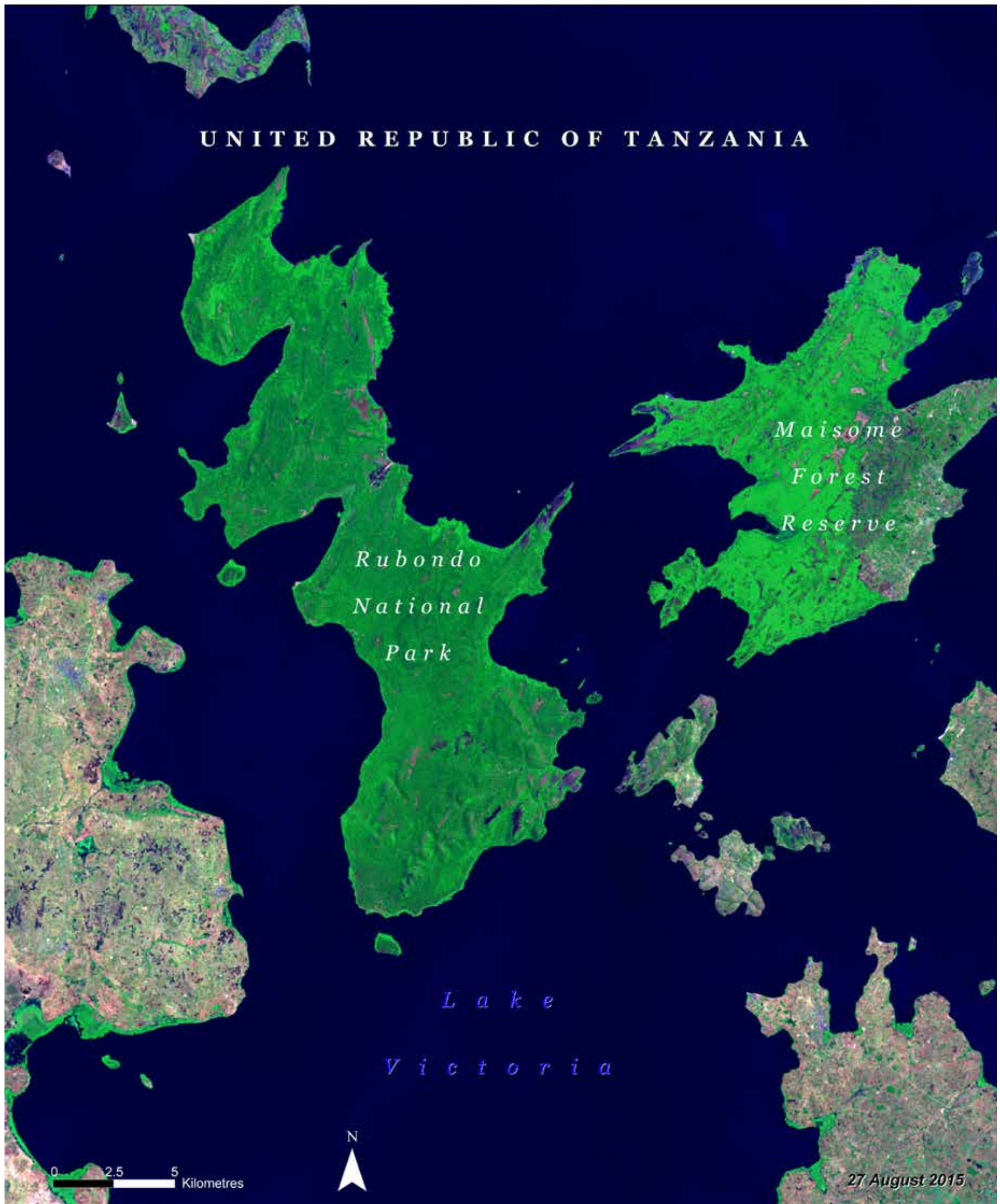
Maisome Forest reserve is found on Maisome Island in the southwest of Lake Victoria in Geita District, Tanzania. The island is separated from the slightly

larger Rubondo Island by about 10 km of open water. The island is densely populated with 188 people per km<sup>2</sup>. The nearest town of Mwanza is five hours by local boat transport. The lushly forested western half of



Maisome is currently designated as a protected forest reserve covering an area of 124 km<sup>2</sup>. Up until 1973, the protected reserve was almost entirely intact, with a closed canopy forest. By 2015, the forest area on the

island had changed from dense forest to savannah and open woodland, as a result of a high population density and the demand for agricultural land, settlements and fuelwood in the protected area (Stevens 2011).



# Land use change

With average land holdings estimated at 0.75 ha per capita and a population growing at a rate of 3 per cent per year (Lake Victoria Basin Commission 2007),

the LVB continues to undergo significant changes in land use. Huge sections of the Basin have been taken over by settlements and some areas have been inundated by water following the construction of dams, while others have been opened up for mining. Significant areas of the Basin have also been converted to farmland.

Vast tracts of wetlands have been converted to agriculture and settlements, among other uses. As much as 13 per cent of the wetlands in the LVB are said to be severely degraded (Lake Victoria Basin Commission 2007); this includes the densely populated Nakivubo Wetlands in Uganda and the Yala swamps in Kenya (Abila 2002). The wetlands that once engulfed the Mwanza Gulf have been converted into agricultural lands, primarily rice fields, while some sections have been taken over by human settlements. Sections of the Akaranya Wetland system in Rwanda are now used for subsistence farming.

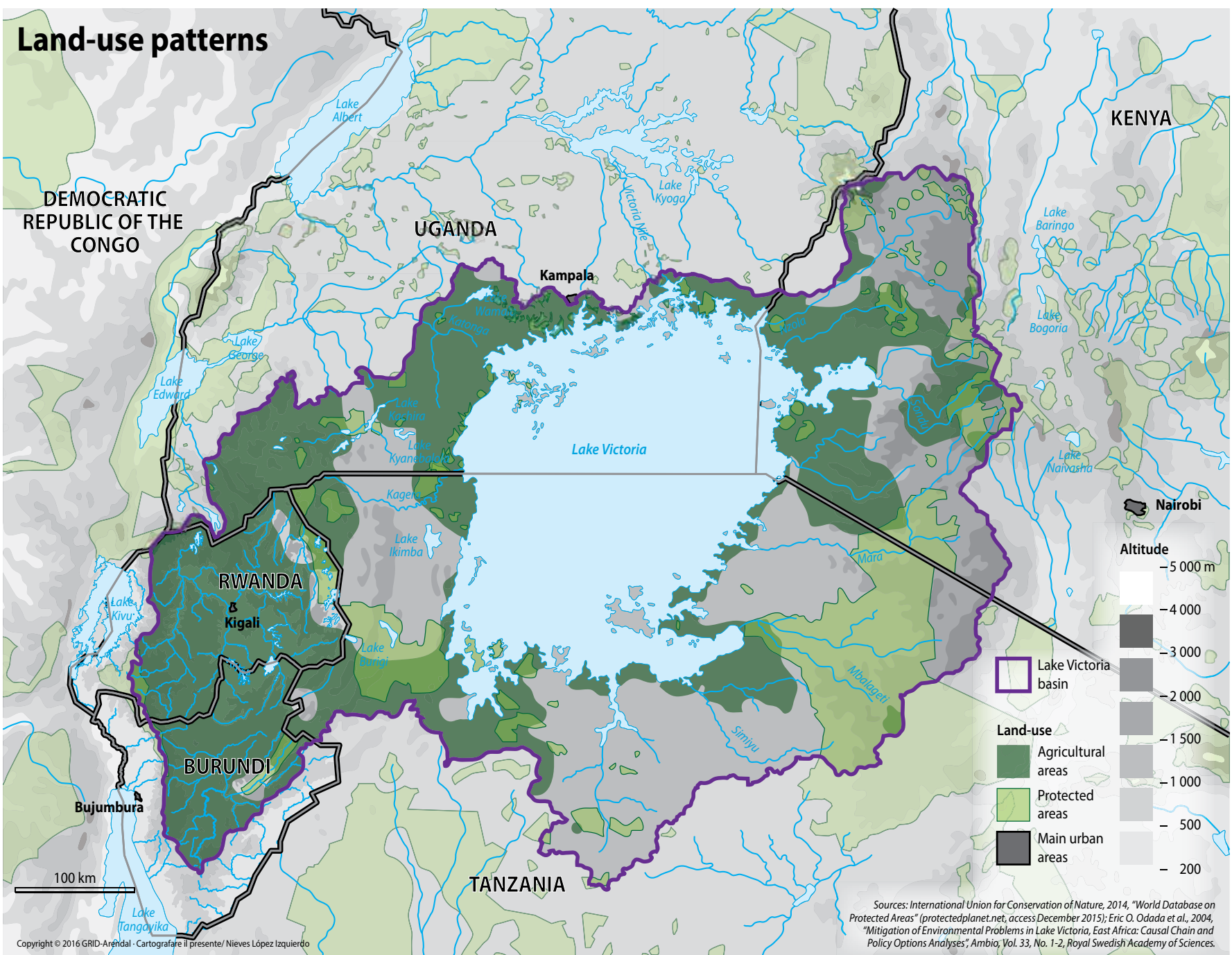
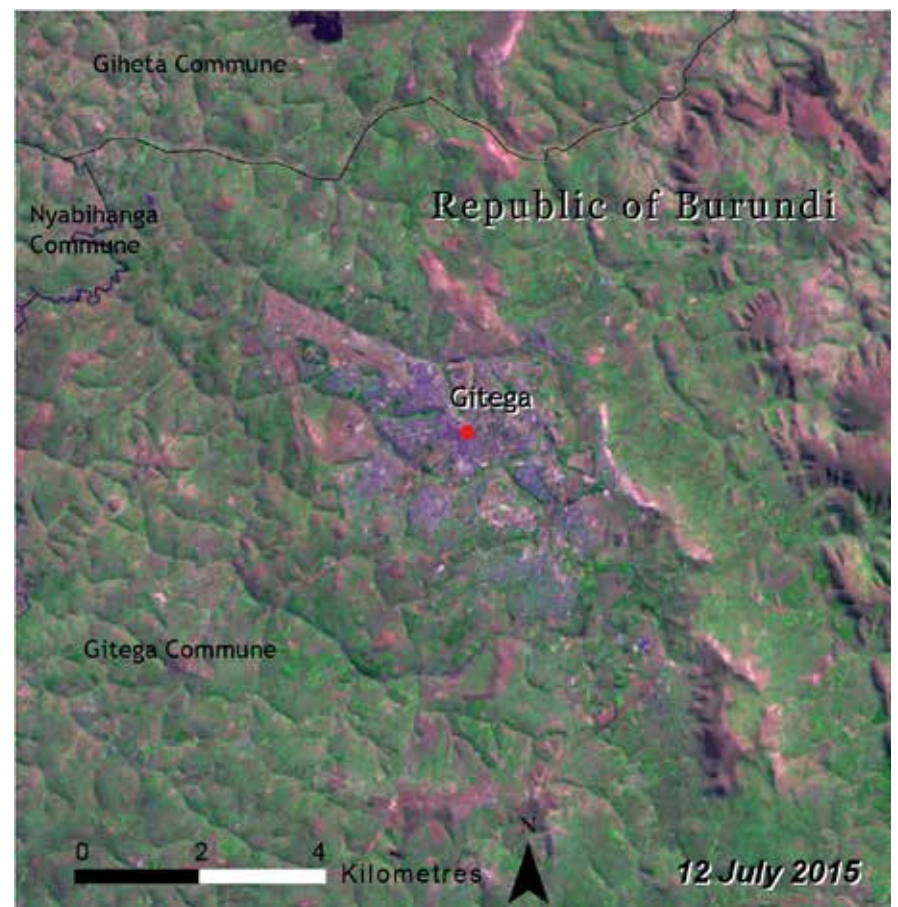
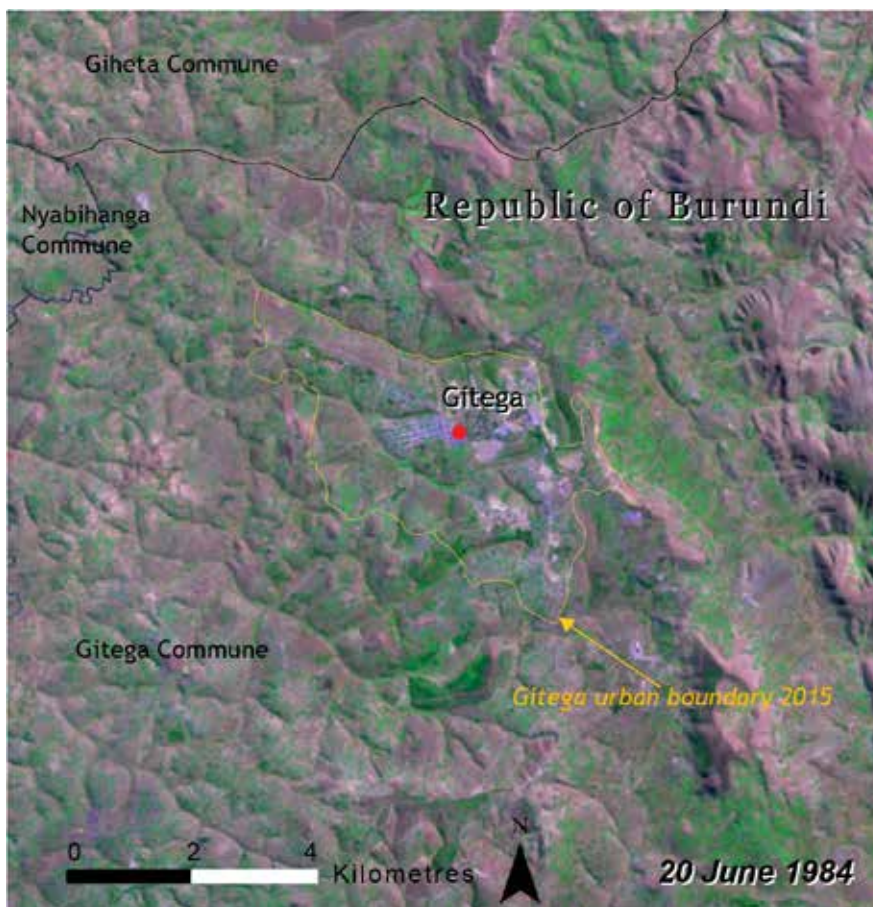


Figure 2.4: Land use patterns in the Lake Victoria Basin

## Urbanization



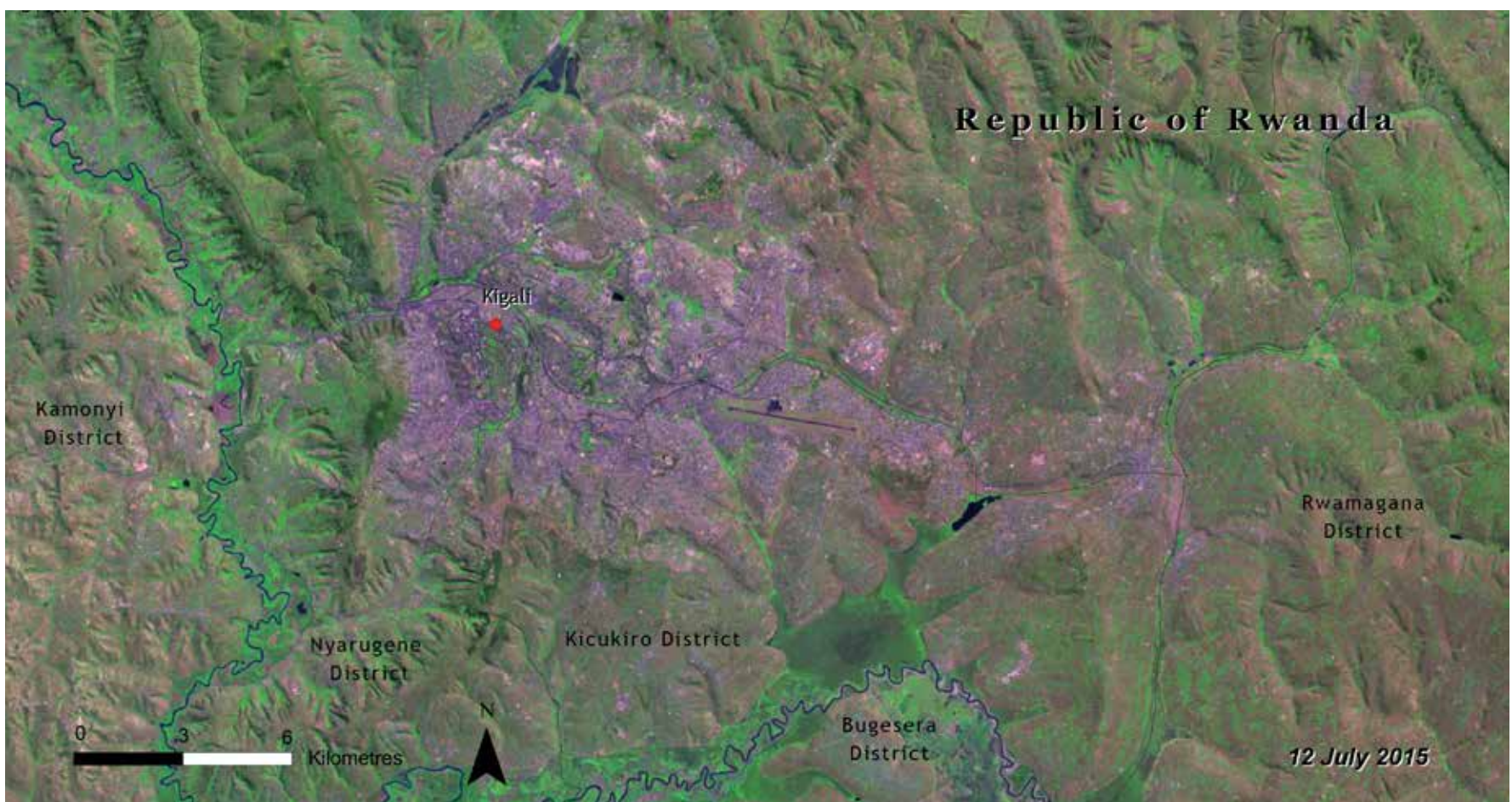
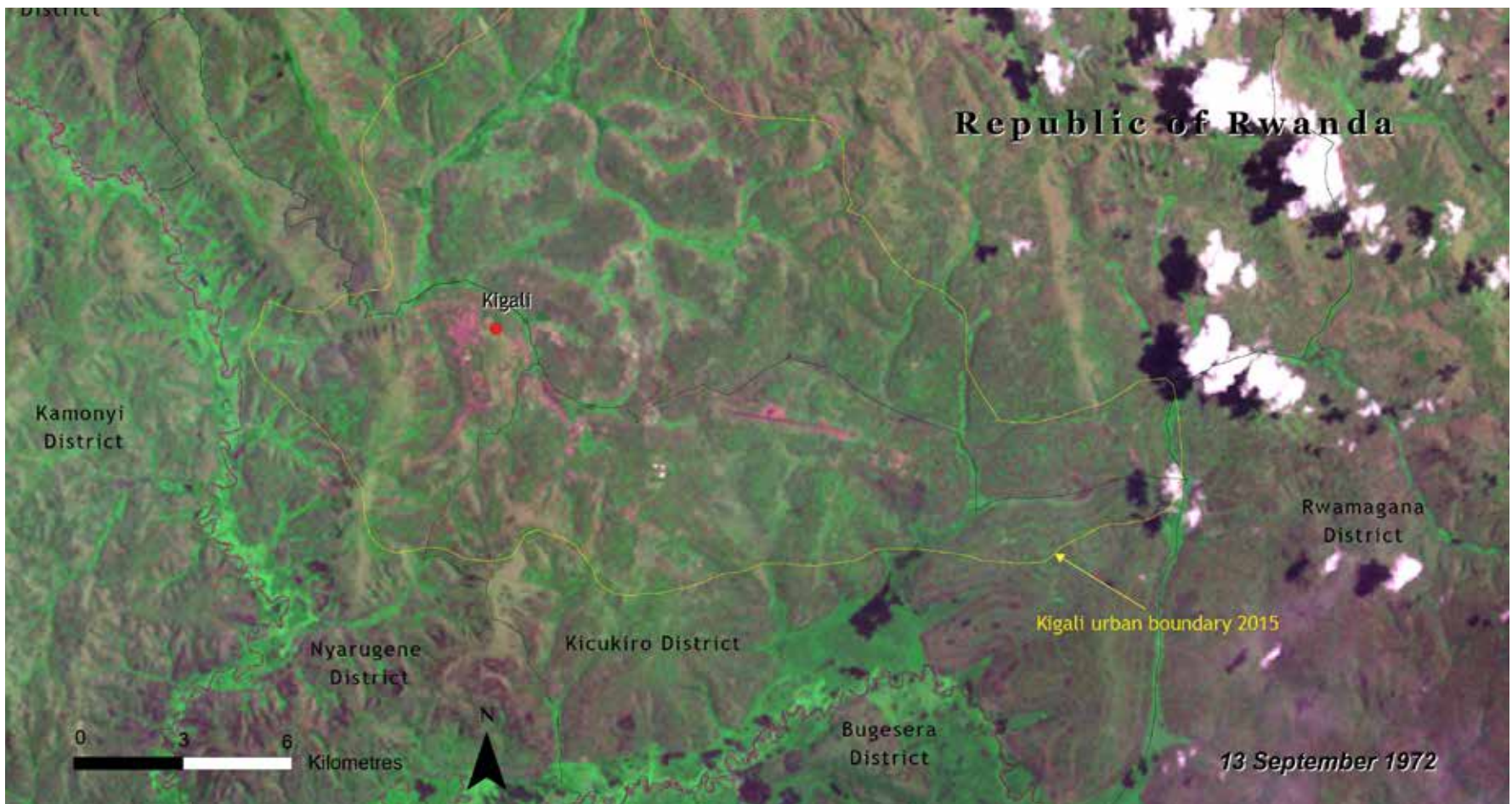
Gitega



### Gitega City, Burundi

Gitega, formerly known as Kitega, is a town located in central Burundi. The town lies 65 km east of the capital, Bujumbura, and is the capital of Gitega Province. The population of Gitega town was 50,000 in 2012. For centuries Gitega was the seat of the Burundian *Mwami* (king) and the capital of the kingdom of Burundi.

Even though 89 per cent of Burundi's population remains rural, urban areas are growing rapidly. The urban population increased from 200,000 in 1980 to 922,000 in 2010 (World Bank, 2015). Consequently, the country's major cities – such as Gitega – are expanding at a remarkable rate, encroaching onto adjacent farmland.



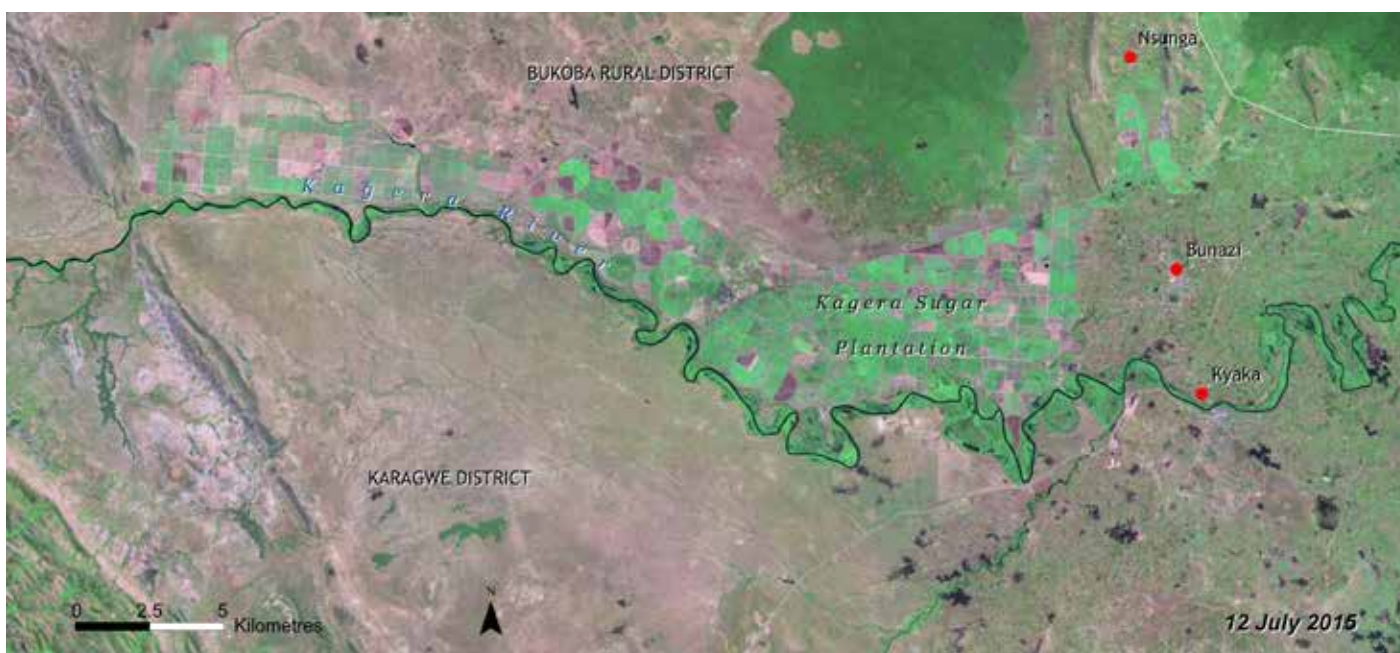
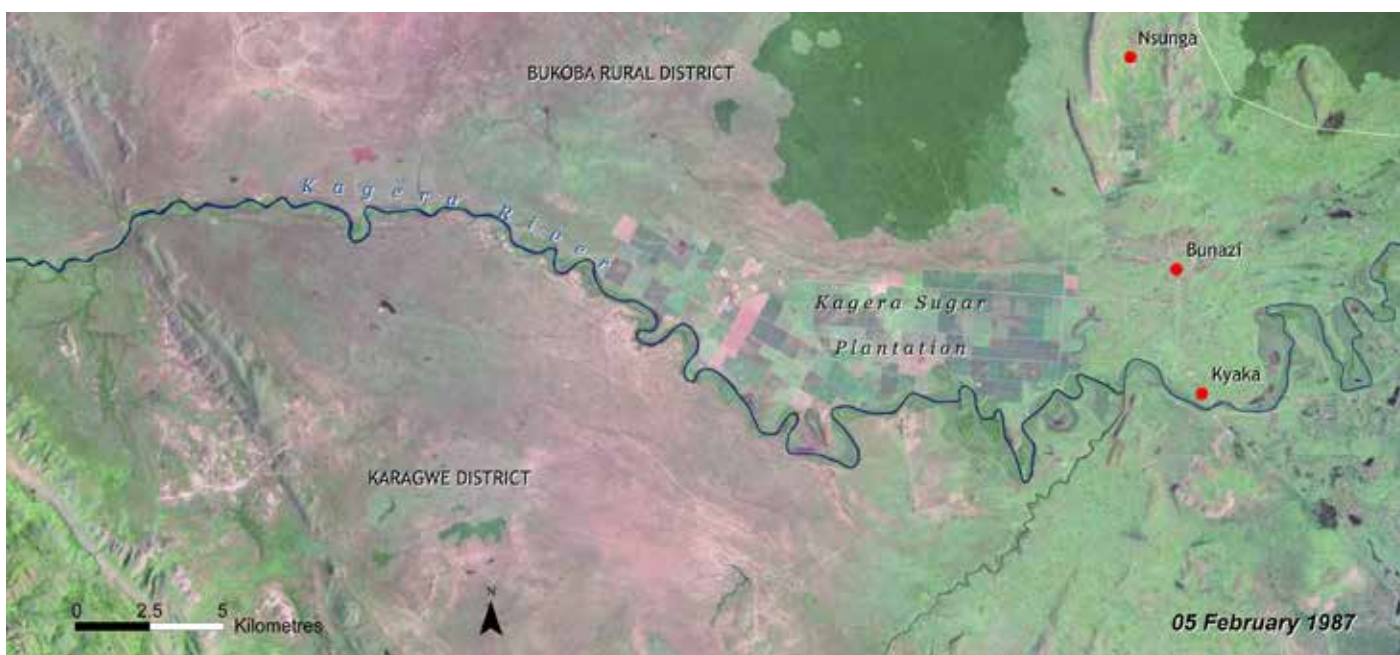
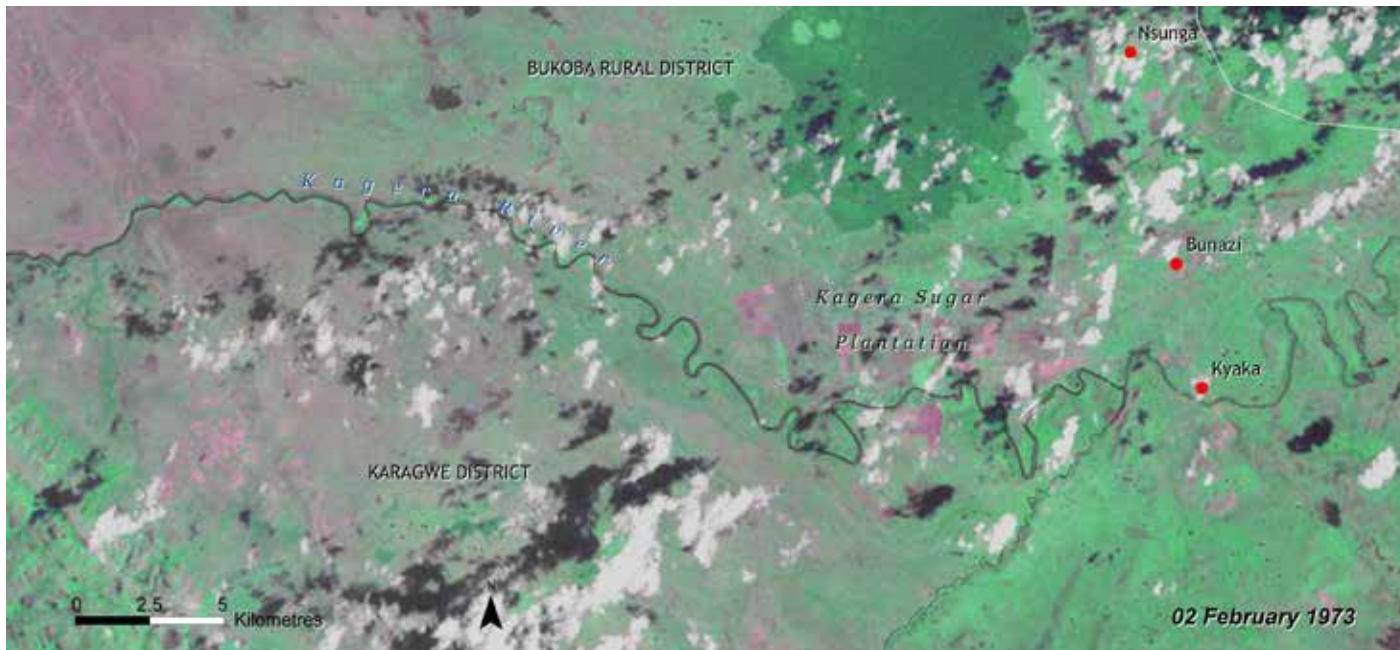
### **Kigali, Rwanda**

Located in Rwanda's heartland, Kigali City comprises of three districts: Gasabo, Kicukiro and Nyarugenge. Founded in 1907, the City of Kigali serves as the country's capital, business hub and the principal gateway to the rest of the country (REMA 2011; Kigali City Council 2013). The population of Kigali City grew from 34,319 in 1960 to close to 1.13 million in 2010 (REMA 2011; National Institute of Statistics Rwanda 2012).

Improvements to garbage collection, the enforcement of a ban on plastic bags, the upgrading of public transport and sewage systems and the beautification of Kigali's streets, has transformed the city into one of the cleanest in Africa (UN Habitat 2008). The Landsat images illustrate the rapid expansion of the built up area, as well as the growth in population density, between 1972 and 2015. The city has encroached on to land previously used for agriculture and forestry.



## Agriculture



### **The Kagera Sugar Plantation, Tanzania**

The Kagera sugar plantation is located in the northwest of Tanzania, close to the border with Uganda. The plantation comprises of a nucleus of 17,000 ha and an out-grower programme covering a further 1,150 ha (Lake Victoria Basin Commission 2007). The sugar plantation is located along the

Kagera River, which provides irrigation water, drawn through the use of centre-pivot irrigation systems, reel irrigators and overhead sprinklers. The Kagera sugar plantation has increased dramatically over time, from a few visible patches in the 1973 image to a much larger area spanning the length of the 2015 image.



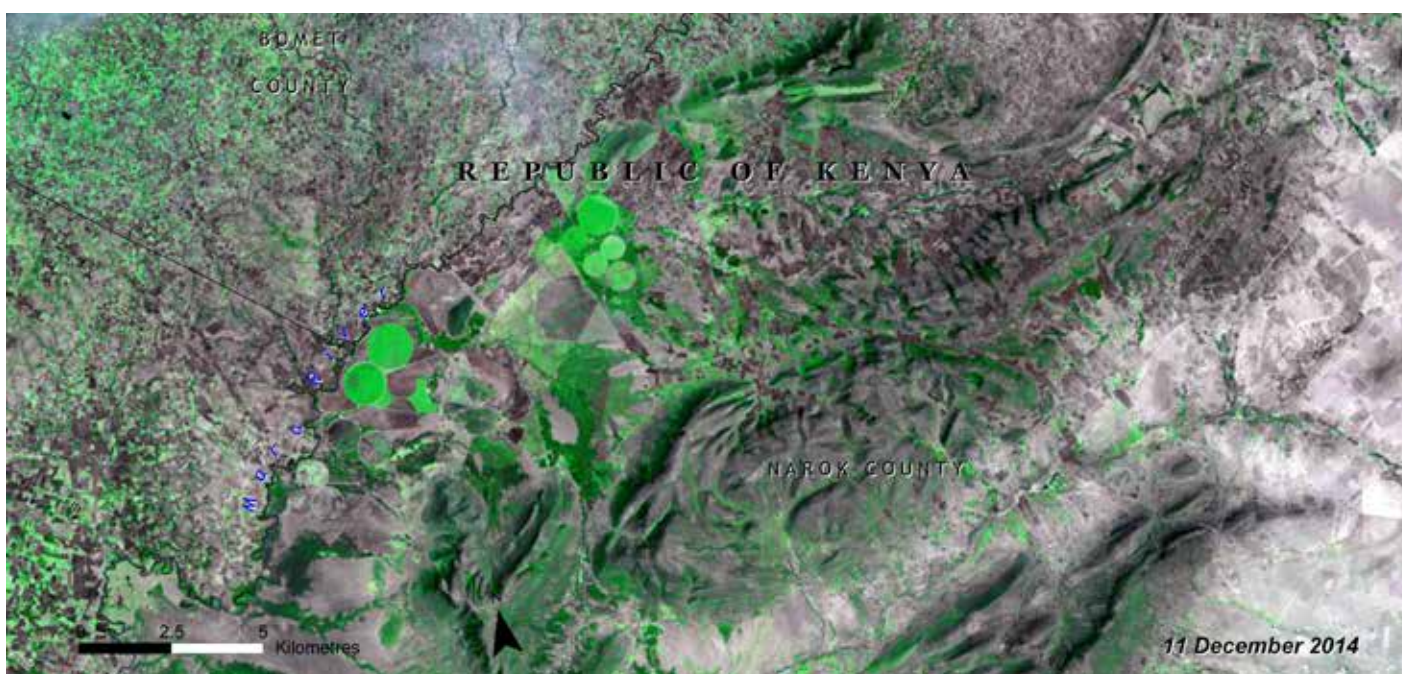
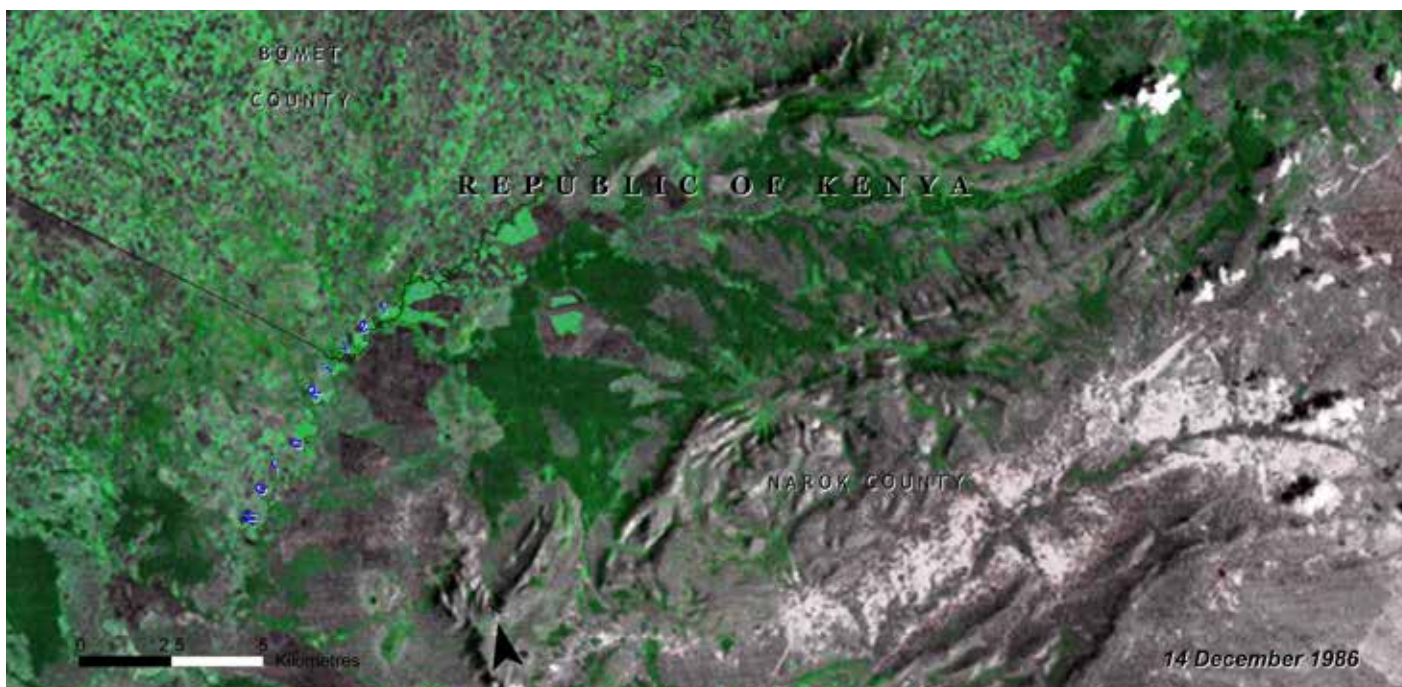
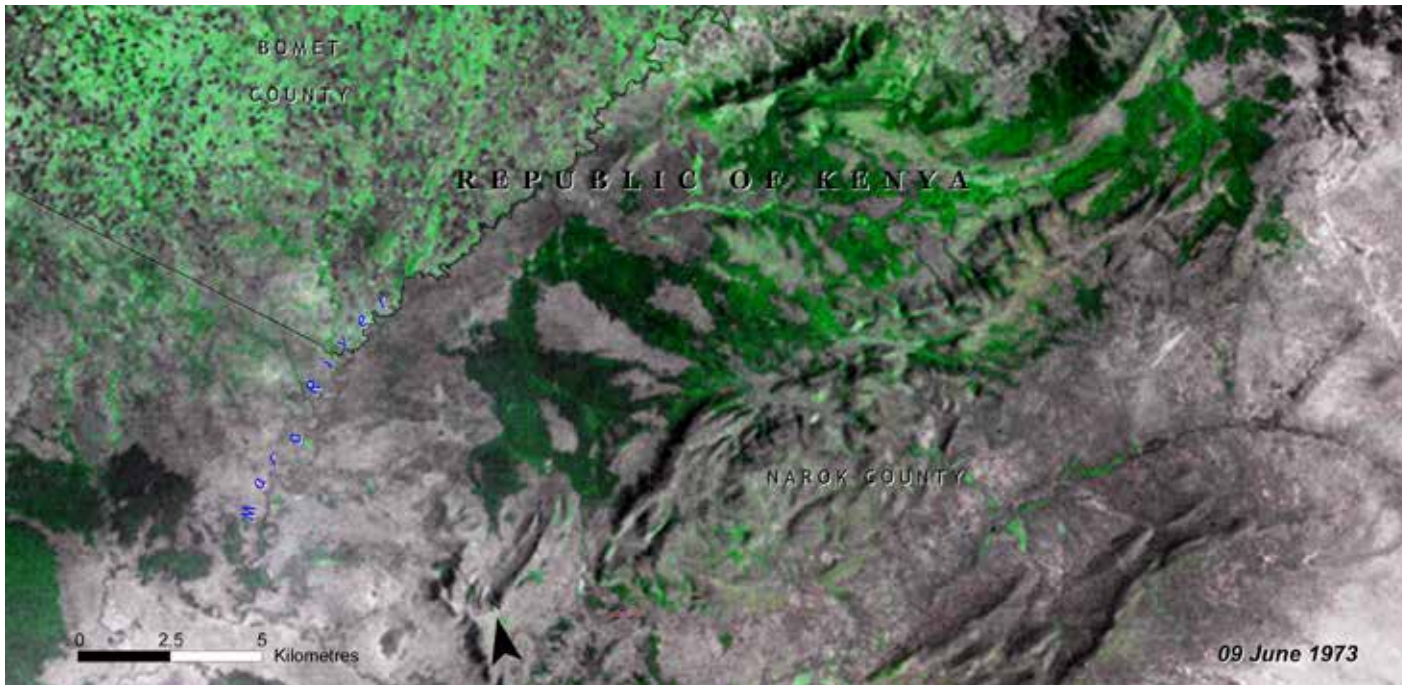
Mara River winding across the Serengeti Savanna, Tanzania

### **The Mara River Basin, Kenya and Tanzania**

Extraction of irrigation water along the Mara River poses a major threat to the Serengeti-Mara ecosystem. The Mara River Basin extends over 13,750 km<sup>2</sup>, of which 70 per cent lies within Narok County in Kenya, and 30 per cent within the Serengeti National Park in Tanzania (Lake Victoria Basin Commission 2007). The Mara River originates on the Mau escarpment in Kenya and has two major tributaries, the Nyangores and Amala River, which carry the headwaters to the more arid lands downstream and support pastoralists and a large population of wildlife. The rivers converge at the base of the escarpment to form the upper Mara River,

which flows along a gentle gradient through wooded grasslands used primarily for livestock grazing but also increasingly for small-scale and irrigated agriculture (Lake Victoria Basin Commission 2007).

Human activities within the Mara River Basin are negatively impacting the world's greatest annual wildlife migration across the East African plains. The annual migration of almost two million wildebeest and other wildlife across Tanzania's legendary Serengeti National Park and Kenya's renowned Maasai Mara National Reserve is a key tourist attraction, generating large annual incomes (UNEP 2009).



The use of Mara River Basin resources by humans is unavoidable, but the current nature and scale of utilization is unsustainable. Rapid land-use change has occurred since 1975, as evidenced in the satellite images. The development of irrigation farming along the Mara River has led to a loss of riverine forests, the fragmentation of wildlife habitats and

the extraction of water from the Mara River for agricultural purposes. In an attempt to curb the destruction of the Mara River ecosystem, many local and international stakeholders have been actively involved in a variety of conservation initiatives within the Basin in a bid to devolve the management of the Basin's resources to the grass roots levels.

Large-scale irrigation and industrial activities, such as mining along the sprawling Mara Basin, have led to high rates of water extraction. Increased forest clearance and cultivation in the upper catchment of the Mau uplands have progressively led to excessive sedimentation loads and altered the hydrography of the Mara River – the only source of drinking water for migratory wildlife during the dry season in August and September in the Serengeti-Mara ecosystem (UNEP 2009).

Seasonal floods and droughts have become more frequent and extreme, making the Mara River water flow more unpredictable over the past few years. The Mara River is not large enough to cope with the ever-increasing activities, which will severely degrade the riverine ecosystem and eventually disrupt the ecosystem services that support the local population, livestock and wildlife. This, in turn, will impact on the overall Basin economy. In the worst-case scenario, it could

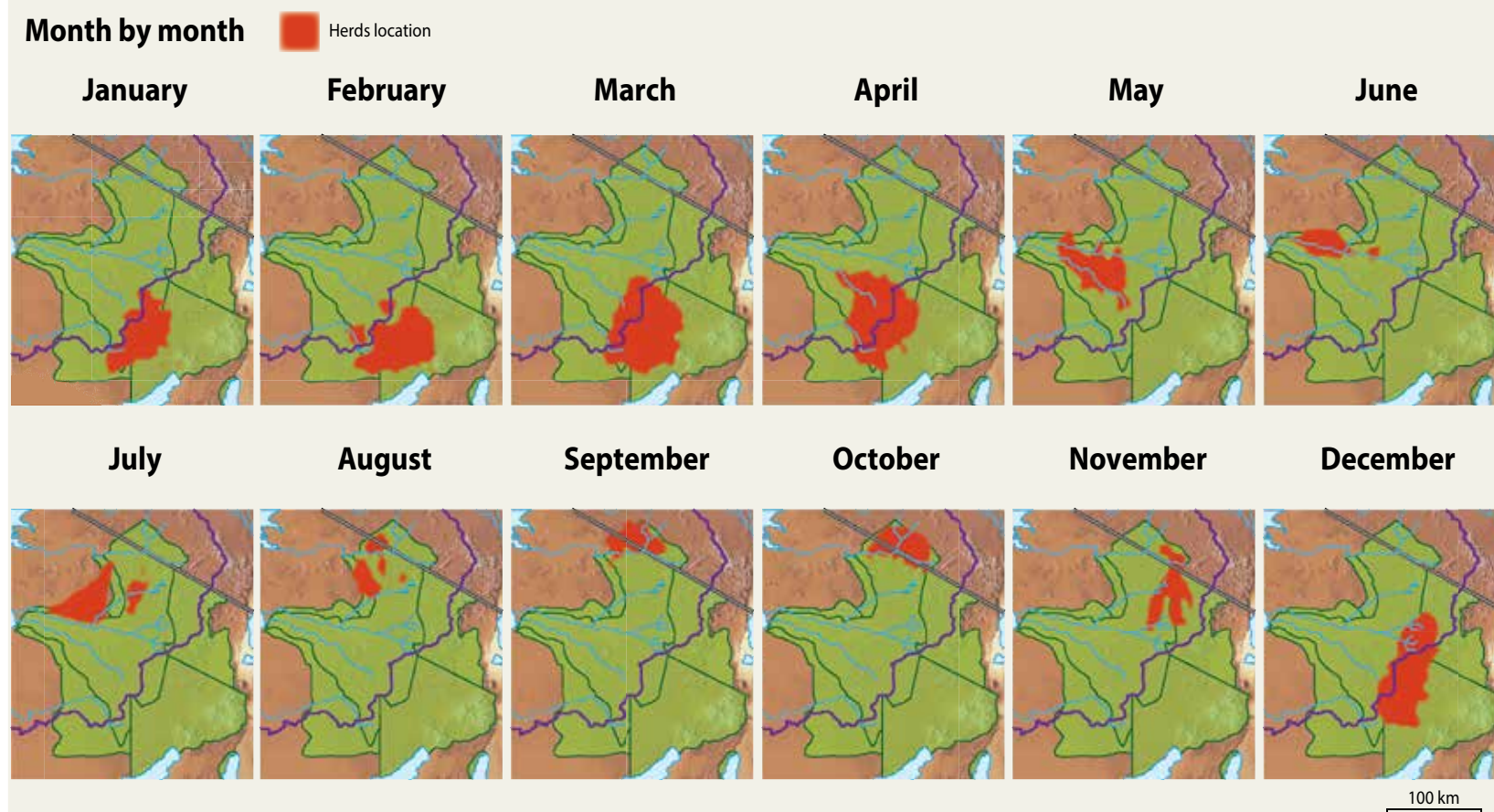
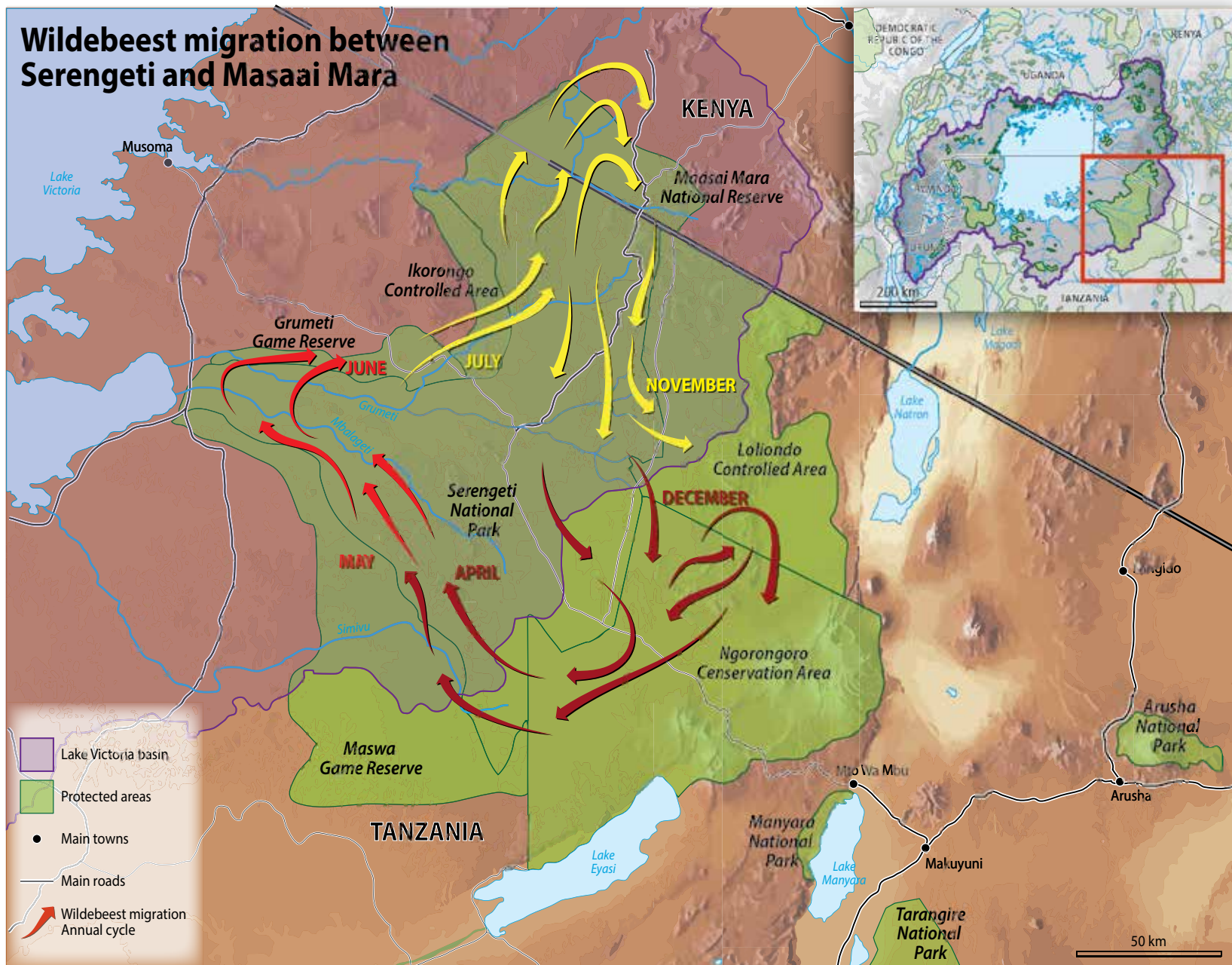


Blue wildebeest in the Serengeti

lead to the collapse of the wildebeest migration that sustains the Mara-Serengeti ecosystem, with devastating consequences for the tourism industry (UNEP 2009).



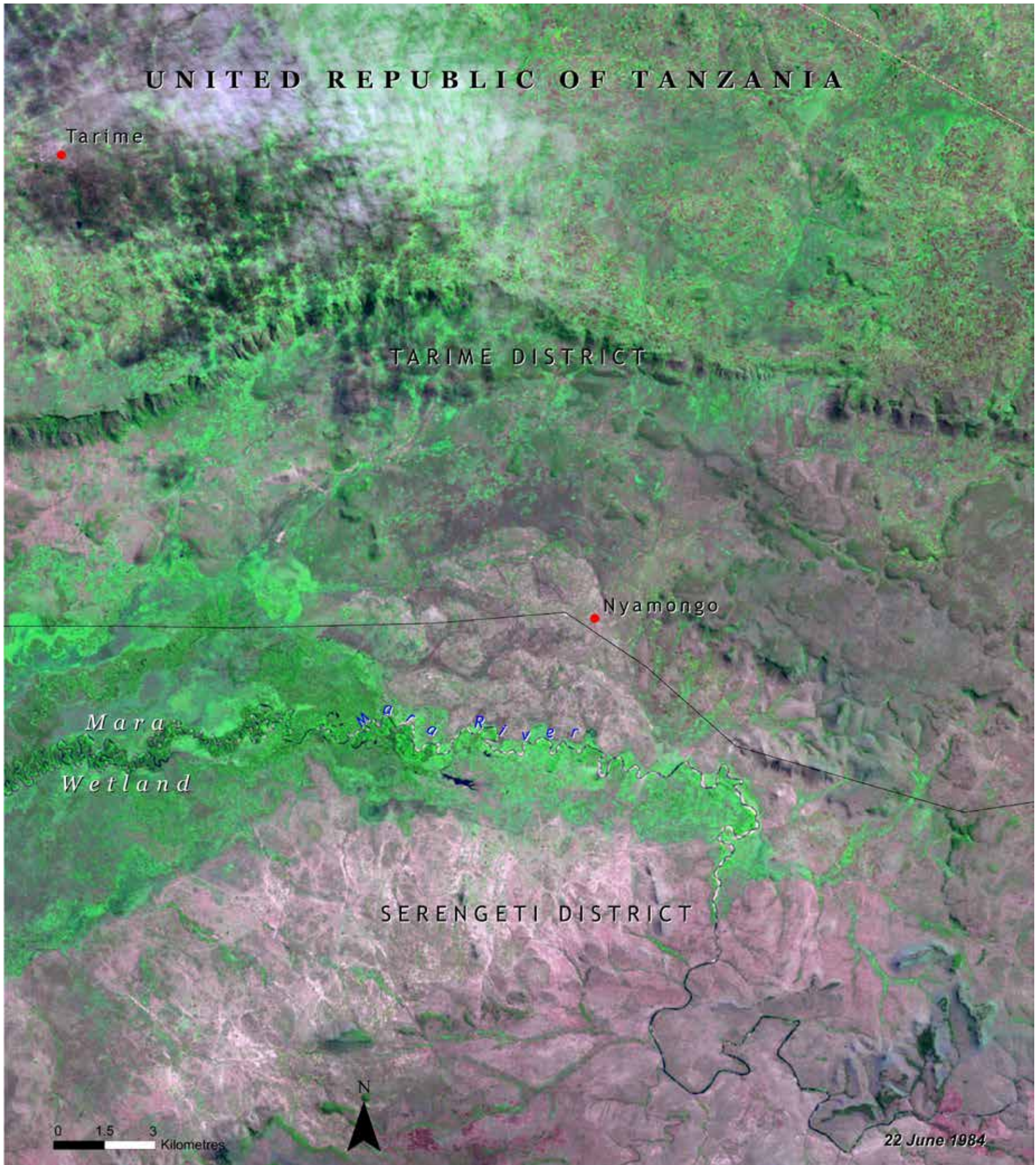
Great wildebeest migration, Serengeti National Park, Tanzania



Sources: International Union for Conservation of Nature, 2014, "World Database on Protected Areas" (protectedplanet.net, access December 2015); "Serengeti wildebeest migration", expertafrica.com, access January 2016; Frankfurt Zoological Society, 2014, "Serengeti's great migration", FZS Gorilla, N. 1, 2014. Copyright © 2016 GRID-Arendal · Cartografare il presente/ Nieves López Izquierdo

**Figure 2.5: East Africa's Wildebeest Migration**

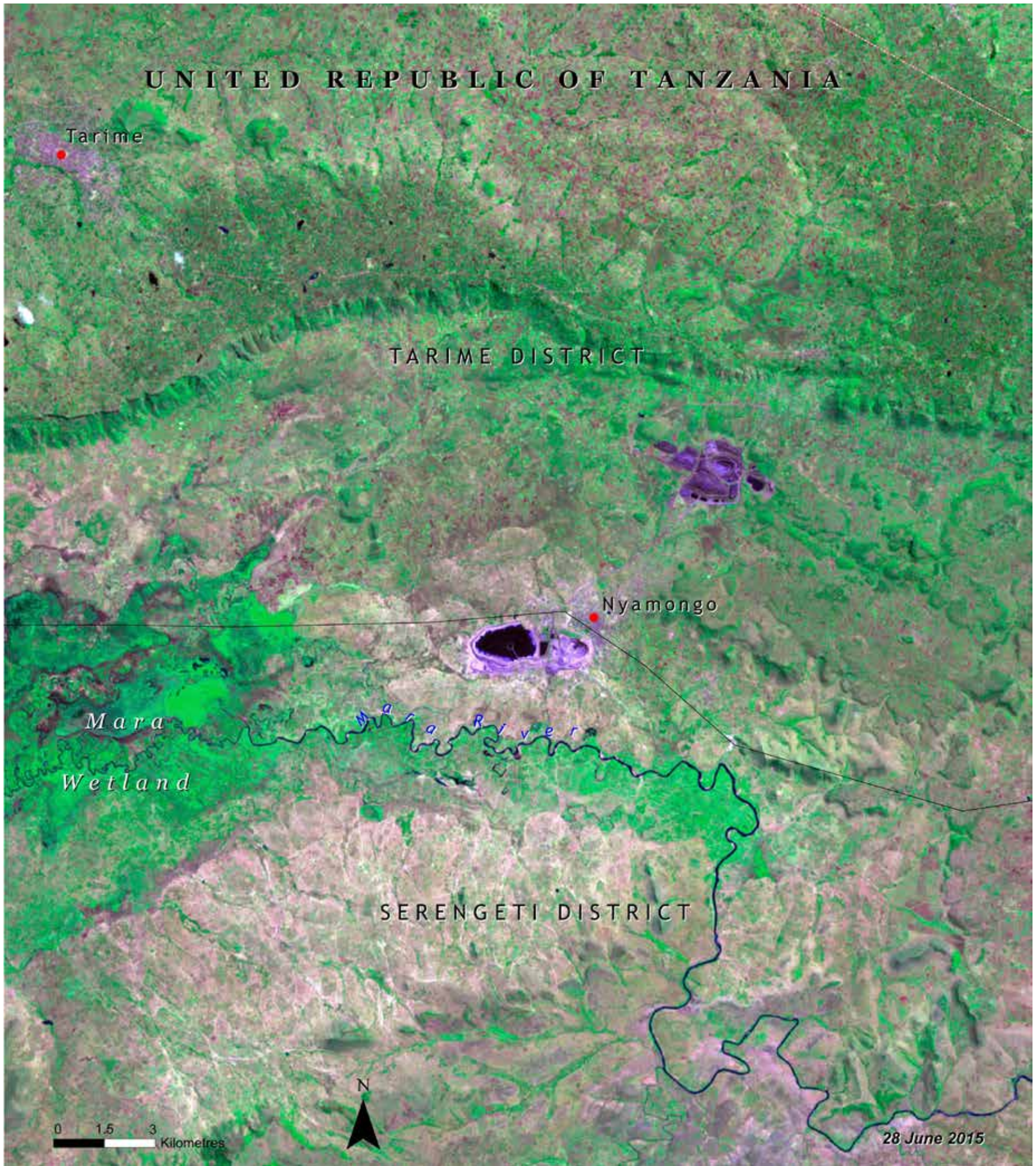
## Mining



### **The Nyamongo Gold Mine, Tanzania**

The Nyamongo Gold Mine is located in Tarime district in the Mara Region of northeast Tanzania. The mine is a combined open pit and underground operation from two deposits – Gokona (underground) and Nyabirama (open pit) – and has a plant that has the capacity

to process an average of 8,000 metric tonnes of ore per day. During the period prior to June 1984, the Nyamongo area had no large-scale mining activities. By June 2015, two major pits and a wastewater dam/pond had been created, resulting in extensive changes to the landscape (Tilumanywa 2014).



While mining in the Nyamongo mining area provides much-needed jobs and revenue for Tanzania, operations must safeguard the environment against disruptive activities that can cause long-term environmental degradation, including large open pits and water pollution, especially from mercury, which is

widely used by small-scale miners. In accordance with the Tanzania Mining Act 2010, miners must present an approved environment management plan, which demonstrates how they will manage and prevent pollution, and restore degraded land, before a licence is issued.

# Habitats and biodiversity

Despite its very rich biodiversity, the LVB's natural habitats are threatened by a rapidly increasing human population. The Basin's biodiversity consists of fish, birds and higher vertebrates such as amphibians, reptiles and mammals, as well as an abundance of plant species. These include 31 amphibian, 28 reptilian and 44 mammalian species recorded at various sites in the Basin. The inshore waters, satellite water bodies and fringe wetlands support many species of reptiles, including the Nile crocodile (*Crocodylus niloticus*), and snakes such as African rock pythons (*Python sebae*), mambas and cobras (Chisara et al. 2001). The most common terrestrial vegetation comprises of dry forest and woodland, primarily in the southern parts of the Basin in Tanzania; deciduous bush thickets in Uganda; and semi-evergreen rainforest and scrub forest in the eastern parts of the Basin in Kenya. Several species in the Basin are threatened, particularly those in fragile habitats such as wetlands.

In the 1960s, Lake Victoria supported over 400 species of endemic cichlid fish (Seehausen 1996), but these have progressively disappeared. The loss in fish species is due to habitat degradation, land-use changes, the introduction of exotic species such as the Nile perch and over-fishing. In 1998, about 100 native fish species endemic to the Lake were entered on to the IUCN Red List of Threatened Species (UN Habitat 2008).

The abundance of wildlife in the LVB, especially in the southern regions, led to the establishment of several

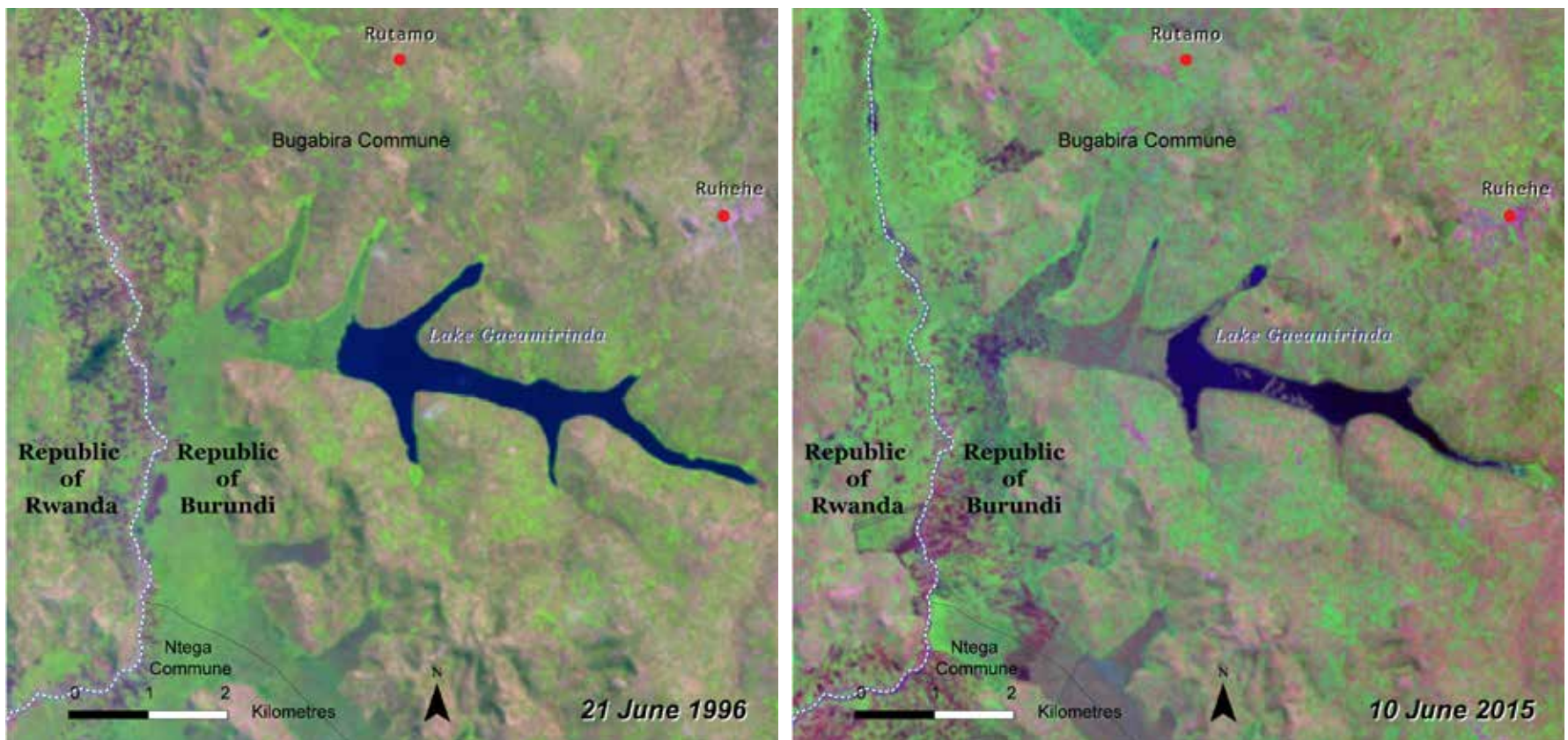
national parks and game reserves as part of efforts towards conservation. These include Rumanyika, Biharamulo, Burigi, Maswa and Saanane Game Reserves in Tanzania, and Kagera, Rubondo and Serengeti National Parks, also in Tanzania. Maasai Mara is the most prominent wildlife conservation area in the Kenyan part of the LVB, while in Burundi protected areas include Kibira, Ruvubu and Rusizi National Parks. Kibira National Park faces the threat of forest clearance for tea plantations and gold mining. Rwanda's Ibanda Game Reserve and Akagera National Park are the country's major conservation areas (Lake Victoria Basin Commission 2007).

Lake Victoria supports one of the world's most productive inland fishing industries, with a total catch of around 800,000 metric tonnes per year, of which 66.6 per cent is from the Tanzanian part of Lake, 18.6 per cent from Uganda and 14.8 per cent from Kenya (LVFO 2011). Commercial species include the Nile perch (*Lates niloticus*), Dagaa/Omena/Mukene (*Rastreneobola argentea*), tilapia and *Haplochromines* spp (fulu/furu/nkejje). The value of the catch at source is estimated at more than USD 500 million, with an export value of USD 260 million. The fishery sector contributes significantly to the GDP of the countries that share the Lake: 2 per cent for Kenya, 2.8 per cent for Tanzania and 3 per cent for Uganda (World Bank 2012). Lake Victoria is also very important to the wider economies of the EAC. It provides high protein food, employment, income, and water for domestic and industrial use.



Invasive *Parthenium hysterophorus*





Both aquatic and terrestrial biodiversity in the LVB is under serious threat from introduced exotic species. International trade and transport are blamed for the introduction of exotic trees in forests, gardens and water bodies. The tick berry (*Lantana camara*) is found in a number of protected areas and forests where it forms dense, bushy undergrowth that inhibits the growth of the natural vegetation. The velvet mesquite (*Prosopis juliflora*) is a serious problem to native plant species in several parts of the region. The most notable threat to

aquatic and wetland biodiversity is the water hyacinth (*Eichhornia crassipes*), which is often described as the world's worst aquatic weed. Water hyacinth infestation in Lake Victoria is a cause of concern for the local people who depend on the Lake for food, water, transportation and recreation. The water hyacinth is now present in most tributaries of the Lake, in many satellite lakes and in numerous wetlands. The red water fern (*Azolla filiculoides*) is also rampant in many wetlands across the LVB (Lake Victoria Basin Commission 2007).



Kisumu Port marooned by water hyacinth



Shoebill (*Balaeniceps rex*)

A number of alien or naturally occurring pathogens and parasites also threaten many species of plants and animals. They can become a problem as wildlife and people come into closer contact. The pandemic epizootic virus, Rinderpest, caused a continent-wide loss of wild ungulates after it was transmitted from cattle in the late 1800s. The canine distemper virus transmitted by dogs killed a third of the lions in Mara-Serengeti in the 1990s. Tuberculosis and anthrax periodically kill many native animals, including elephants and primates. Rift Valley fever, a highly fatal mosquito-borne viral zoonosis closely associated with prolonged episodes of rainfall and flooding, can also cause serious disease in both animals and humans (Lake Victoria Basin Commission 2007).

The variety of aquatic and terrestrial ecosystems found in the LVB, provide important habitats for a number of birds. Common bird species include cormorants, ducks, egrets, herons, plovers, jacanas, wagtails, waders, kingfishers, storks, pelicans, warblers, cranes, ibis, black-headed herons, lapwing, jacana and white pelican (Lake Victoria Basin Commission 2007).

Lutembe Bay on the northern shores of Lake Victoria, at the mouth of Murchison Bay between Entebbe and Kampala, is one of 30 Important Bird Areas (IBAs) in Uganda (Byaruhanga et al. 2001). The bay regularly supports 20,000–50,000 roosting and feeding water birds and seven globally threatened species: the papyrus yellow warbler (*Chloropeta gracilirostris*), the papyrus gonolek (*Laniarius mufumbiri*), the shoebill (*Balaeniceps rex*), the African skimmer (*Rhynchops flavirostris*), the pallid harrier (*Circus macrourus*), the great snipe (*Gallinago media*) and the Madagascar squacco heron (*Ardeola idea*). There are also 24 species of regional concern. As well as supporting a large diversity of African species, it is an important non-breeding area for huge congregations of palearctic migrants. Lutembe Bay regularly hosts over 70 per cent of the global population of white-winged black terns (*Chlidonias leucopterus*) (Byaruhanga 2003), as well as large numbers of grey-headed gulls (*Larus cirrocephalus*), black-headed gulls (*Larus ridibundus*) and gull-billed terns (*Sterna nilotica*).



African skimmer (*Rhynchops flavirostris*)

Bird species found around Lake Victoria, but rarely seen elsewhere in Kenya, include the blue-breasted bee-eater, the blue swallow, the swamp flycatcher, the greater swamp-warbler, the white-winged warbler, the papyrus yellow warbler, the carruthers' cisticola, the papyrus gonolek, the red-chested sunbird, the red-headed quelea, the slender-billed weaver, the yellow-backed weaver, the northern brown-throated weaver, the black-throated seedeater and the papyrus canary (Lake Victoria Basin Commission 2007).

The Akanyaru Wetlands, on the border between Rwanda and Burundi, is home to more than 100 bird species including threatened bird species such as the papyrus yellow warbler (*Chloropeta gracilirostris*) and the Madagascar pond heron (*Ardeola idea*) (Lake Victoria Basin Commission, 2007).

The Mpungwe Mountain Chain in Burundi, located near the Ruvubu National Park, is unprotected but ensures connectivity with the neighbouring Ruvubu National Park, an International Bird Area hosting endangered species such as the handsome francolin (*Francolinus nobilis*) (Lake Victoria Basin Commission 2007).



Blue-breasted bee-eater (*Merops variegatus*)



Pallid harrier (*Circus macrourus*)

# Water Resources

According to the Transboundary Diagnostic Analysis (Lake Victoria Basin Commission, 2007) of the LVB, Kagera River has the largest inflow into the Lake. The Kagera River originates from Rwanda and Burundi, as well as from parts of south-western Uganda. The river contributes up to 33 per cent of Lake Victoria's riverine inflow. The other rivers in the basin are the Bukora and Katonga which originate from Uganda; the Nzoia, Sio, Mara, Yala, North and South Awach, Gucha-Migori and Sondu which originate from Kenya; and the Mori and Simiyu, which originate from Tanzania.

Groundwater plays a significant part in the water balance of the sub-catchments of the LVB, and provides about 40 per cent of the baseflow during the dry season. The importance of groundwater is shown by the large areas of wetlands in the Lake Victoria Basin, which would not exist without baseflow. The decline in Lake Victoria water level of approximately two metres between 1999 and 2006 is closely linked to the drop

in groundwater levels. The partial rebound of Lake levels between 2006 and 2009 was partly due to higher precipitation, which also caused greater groundwater recharge (UNEP 2010).

The wetlands of the LVB cover a significant area, with those in Kenya and Uganda constituting approximately 37 per cent and 13 per cent, respectively, of the total surface area of wetlands in the two countries (Lake Victoria Basin Commission 2007). In Kenya, major wetlands include the Yala Swamp, covering an area of 17,500 ha; the Nyando Swamp; the Sondu-Miriu Wetlands at the mouth of the Sondu River; the Saiwa Swamp on the Nzoia River; and the Kimandi River Wetlands on the tributary of the Yala River (Lake Victoria Basin Commission 2007).

Tanzania's wetlands cover 422,000 ha, and are found in 28 sub-basins of the Tanzanian part of the Lake Victoria Basin. Of these, 14 per cent are permanent swamp

while 73 per cent are seasonal swamp. The largest wetlands are found in the Mara and Kagera River Basins (Lake Victoria Basin Commission 2007).

The wetlands in Uganda are categorized as swamp, swamp forest and zones with impeded drainage. They include areas of seasonally flooded grasslands and swamp forest such as Sango Bay; and permanently flooded papyrus, grass swamp and upland bog. Most wetlands in the country fall into two broad categories: those associated with lakes (lacustrine) – which are often permanently flooded – and those that lie along rivers. These include wetlands that border Berkeley (on the Kenya-Uganda border), Macdonald and Hannington Bay, and Napoleon Gulf; as well as Murchison, Waiya and Bunjako Bay. The Katonga Wetlands also cover a large area and the islands of Kalangala have extensive fringes of wetlands. Lacustrine wetlands are often permanently flooded (Lake Victoria Basin Commission 2007).



# Wetlands

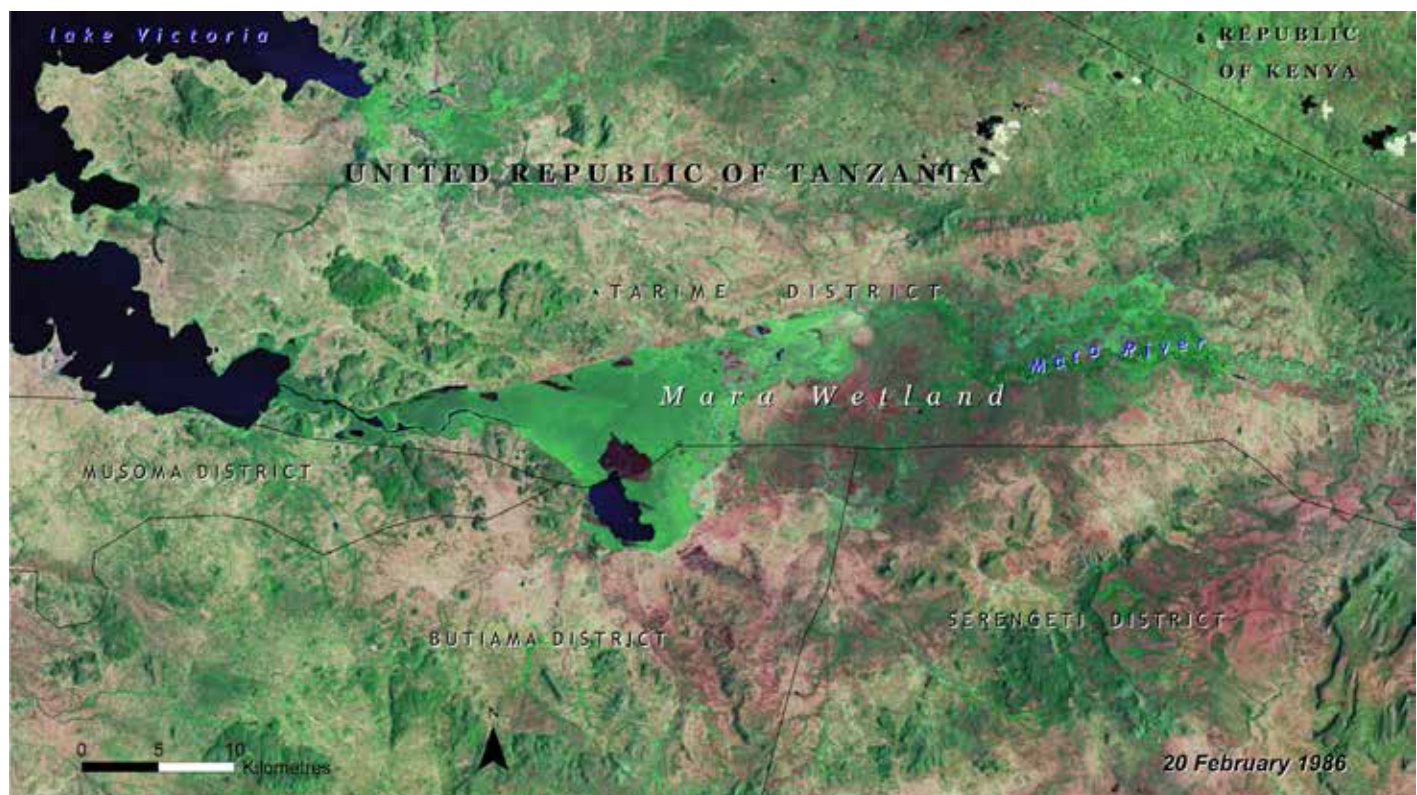
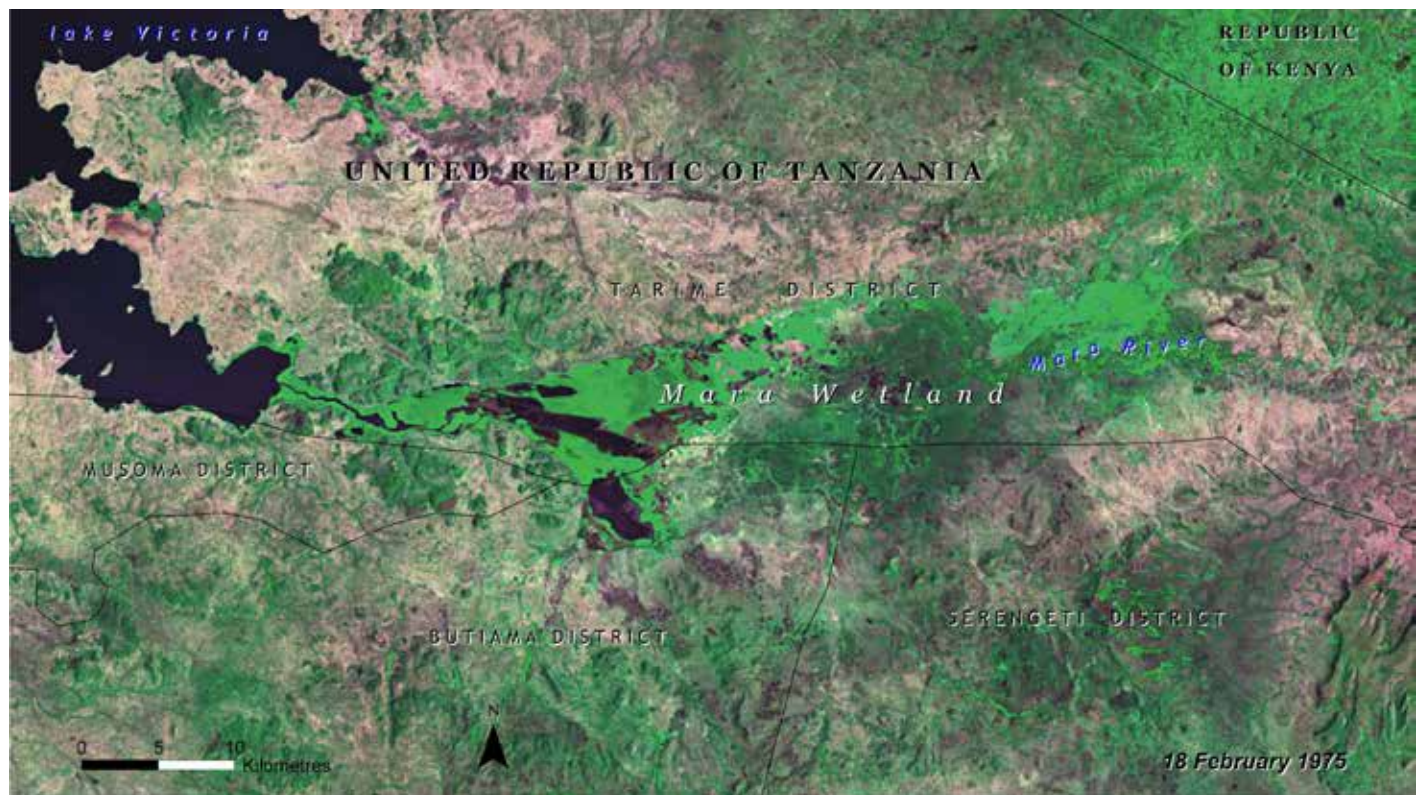
## Mara Wetlands, Tanzania

The Mara Wetlands are associated with the Mara River that originates in Masai Mara in Kenya. The river is 155 km long with a catchment area of 1.35 million ha. The river enters Tanzania through the Serengeti National Park in the Mara Region. It forms the border of Tarime and Serengeti districts as well as Tarime and Musoma districts. It enters Lake Victoria through Mara Bay. Pools and satellite lakes such as Lake Kubigena near Buswahili village are found in the Wetlands (Lake Victoria Basin Commission 2007).

The area of permanent wetlands is dominated by heavy sedges (*Cyperus papyrus*) and bulrush (*Typha*). Reeds (*Phragmites* spp), sesbani, fig trees (*Ficus* spp) and grasses are also found in the Wetlands. Bulrushes are

expanding and displacing sedges. They are dominant in areas with salty soils.

The Wetlands support many species of animals. Common species include crocodiles (*Crocodillus niloticus*) and hippopotamuses (*Hippopotamus amphibius*), while sitatunga (*Tragelaphus spekei*) are an endangered species. Others include monitor lizards (*Varanus* spp), otters, turtles and snakes. The Mara Wetlands are an important breeding habitat for fish. Species found in the Wetlands include cichlids (*Oreochromis* spp and *Tilapia* spp), lungfish (*Protopterus aethiopicus*), catfishes (*Clarias* spp, *Schilbe* spp and *Synodontis* spp), and cyprinids (*Labeo* spp). (Lake Victoria Basin Commission 2007).

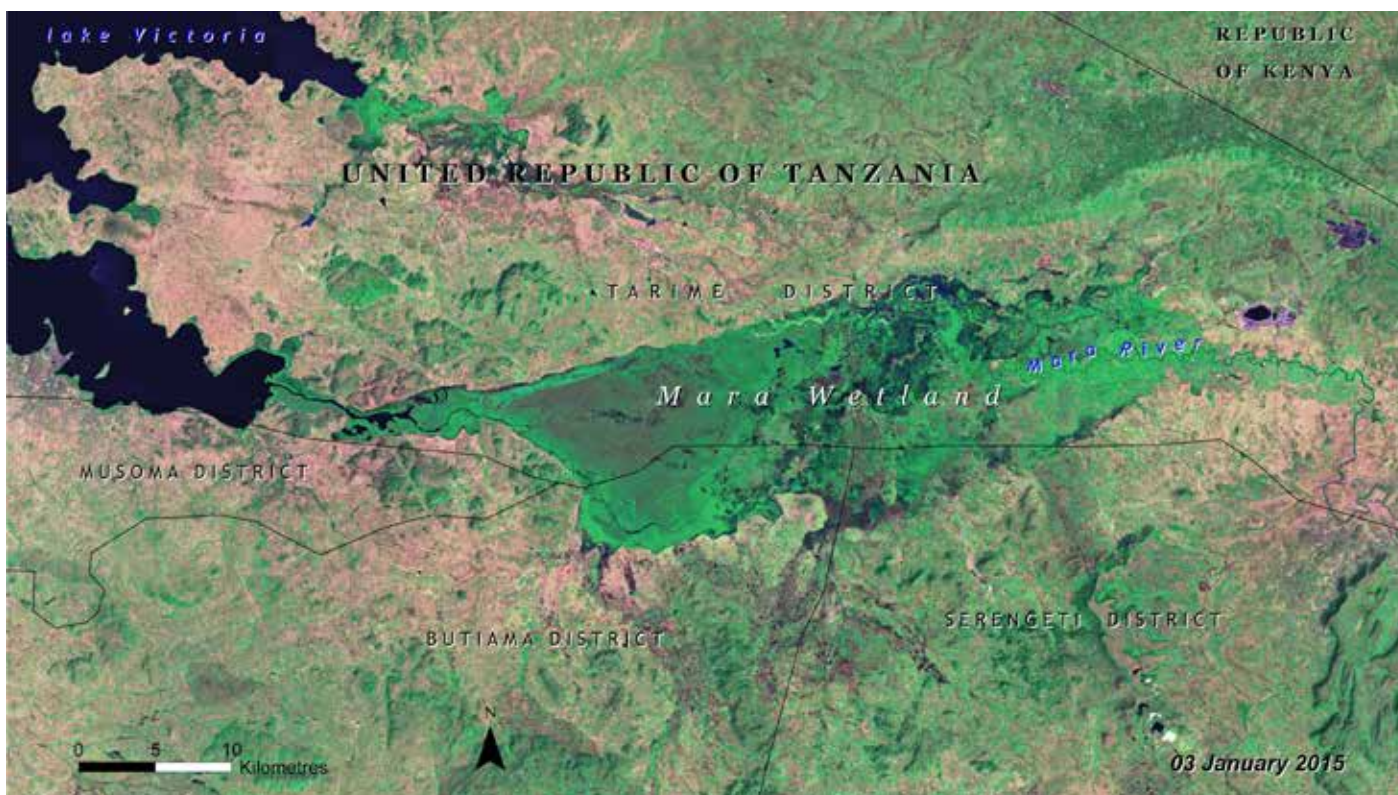
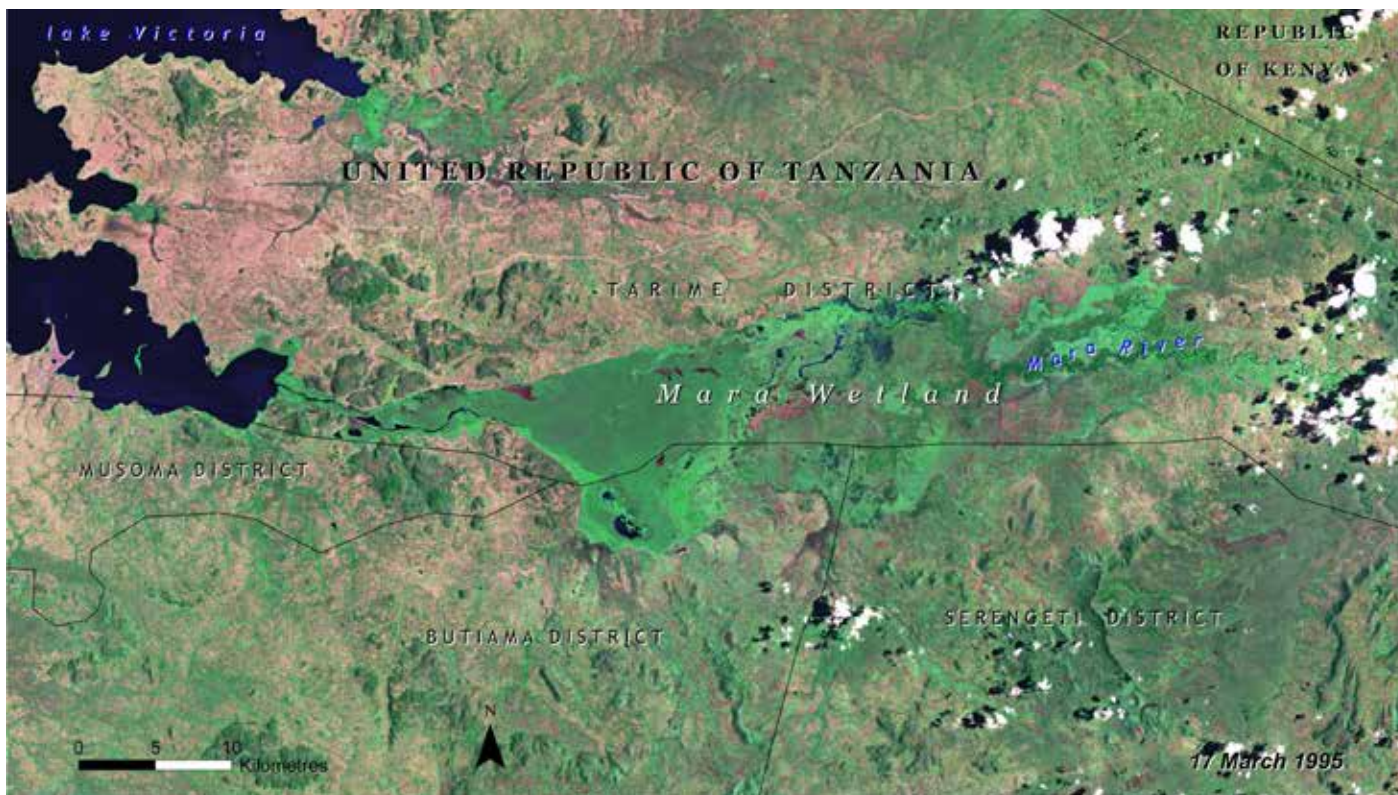


Birds that are commonly found in the Wetlands include the black crane (*Amaurornis flavirostra*), African jacana (*Actophilornis africana*), little egret (*Egretta garzetta*), white pelican (*Pelecanus onocrotarus*), spur-winged plover (*Vanellus spinosus*), wattled plover (*Vanellus senegalensis*), black-winged stilt (*Himantopus himantopus*), cattle egret (*Bulbulcus ibis*), fish eagle (*Haliaeetus vociferoides*), whiskered tern (*Chlidonias hybridus*), great white egret (*Casmerodius albus*), and white-faced tree duck (*Dendrocynia viduat*) (Lake Victoria Basin Commission 2007).

Crop cultivation, particularly maize, sorghum, cassava and sweet potatoes, is the main economic activity in the

Mara Wetlands. In addition, paddy rice and horticultural crops such as tomatoes, onions and cabbages are also cultivated. The Wetland soils are very fertile, and as such little or no fertilizer is used, except for horticultural crops that use urea. Blue copper and thiodan are used as pesticides in horticulture, while chemicals such as Supa Dip, Stelladone and Pour-on (*pyrethrum*) are used in livestock production – the second most important economic activity in the Basin. Commonly kept animals include cattle, goats and sheep.

Bulrush is used for thatching and making mats, while papyrus is also used for making mats. Many medicinal plants are also found in the swamp and floodplains.



## Rubana/Grumeti/Mbalageti Wetlands System, Tanzania

The combined wetlands system comprises of the Rubana riverine system and its tributary Grumeti and Mbalageti riverine systems. The Grumeti and Mbalageti rivers originate in the Serengeti National Park and discharge into Lake Victoria through the Speke Gulf. The Mbalageti River forms the border between Mara and Mwanza regions. The Rubana/Grumeti River is in Bunda district, Mara Region (Lake Victoria Basin Commission 2007).

The Rubana River is 210 km long and has a catchment area of about 1.3 million ha, while the Mbalageti is 224 km long with a catchment area of 331,100 ha. The area of permanent wetlands is located around the river mouths and is dominated by *Cyperus papyrus* and *Phragmites mauritianus*. The rest of the Wetlands are in the Serengeti National Park, which is dominated by grasses, shrubs and woodlands (Lake Victoria Basin Commission 2007).

The Rubana Wetlands contain the shallow waters of the Speke Gulf, an area of permanent swamp. The Wetlands widen in the middle of the Rubana Delta where papyrus dominates. Sesbania trees grow mainly along the shoreline. Grass (*Echinochloa* spp) and water hyacinth also grow at the river mouths (Lake Victoria Basin Commission 2007).

The permanent wetlands support many animals, including crocodiles, hippopotamuses, wild pigs, sitatungas and snakes. The crocodile population has increased significantly following the 1997 El Nino rains. It is believed that El Nino floods swept crocodiles downstream from the Serengeti National Park into the Lake.

Rubana is the main breeding habitat for many species of fish, especially cichlids, cyprinids and catfishes. The peak breeding season starts in January and ends in July each year.

Crop and livestock production are major economic activities in the Wetlands. Crops include paddy rice, maize, sorghum, millet, cassava, sweet potatoes, cotton and horticultural

crops such as tomatoes, onions and cabbages. Cattle, goats and sheep are the main types of livestock.

Few chemicals are used in food crops and horticultural crops because of the prohibitive prices and the levels of soil fertility. The limited use of chemical fertilizers includes Triple Superphosphate (TSP), Sulphate of Ammonia (SA) and Urea. Pesticides such as Blue Copper, Bulldock, Carete and Thiodan, are used in cotton and horticultural crop production. Stelladone, Bacdip and Supadip are used in livestock production.

Due to prolonged periods of drought, the flood plain is experiencing an influx of livestock from neighbouring districts.

Papyrus is harvested to make mats (majamvi), reeds are used in house construction, firewood and fishing weirs, while esbania trees are harvested to make floats, construct houses, and for firewood and medicine.

The Rubana Wetlands are an important breeding ground for many fish species. Consequently, the Wetlands have become an important area for many fishermen from surrounding areas. The main species caught include tilapias, cyprinids, catfishes and lungfish.

Other economic activities include brick making, hunting (of hippos in particular), and bird trapping (cormorants and pelicans)

Due to its importance as a fish breeding ground, the Rubana Wetlands (including the shallow waters of the Speke Gulf) was designated as a protected area in 1981. The area is closed for fishing activities from January to June, except for angling. The area between the main Mwanza-Musoma road and the lakeshore is a Speke Gulf Game Controlled Area (Lake Victoria Basin Commission 2007).

Concerted efforts have been made to rehabilitate the degraded floodplain by planting indigenous tree species.



The Rubana Wetlands community taking care of tree nurseries





Grumeti river



Crocodiles in the Grumeti river



Plank bridge across Grumeti river

## Yala Swamp, Kenya

Yala Swamp, the third largest of Kenya's wetlands, is situated on the deltaic sediments of the Nzoia and Yala Rivers, at the point at which they enter the northeastern corner of Lake Victoria. The wetlands cover an area of 17,500 ha and contain three freshwater lakes – Kanyaboli, Sare and Namboyo. The vegetation consists of papyrus (*Cyperus papyrus*), phragmites and typha, among others. The Wetlands are of national importance as one of the few habitats where the threatened sitatunga antelope (*Tragelaphus spekeii*) is found in Kenya. The lakes contain some critically endangered haplochromine fish species, some of which are no longer found in Lake Victoria. The area is also an important habitat for many birds (Lake Victoria Basin Commission 2007).

There is a lot of farming in and around the wetlands. The local communities harvest macrophytes for handicraft, building and fuel. It is an important area of grazing land and a source of water for livestock and domestic use. Fishing is also an important economic activity in the Swamp both for commercial and subsistence purposes.



Wetlands are drained and converted to agricultural land

The major threats to the Wetlands are drainage for crop cultivation, burning, water hyacinth infestation and pollution as a result of siltation.

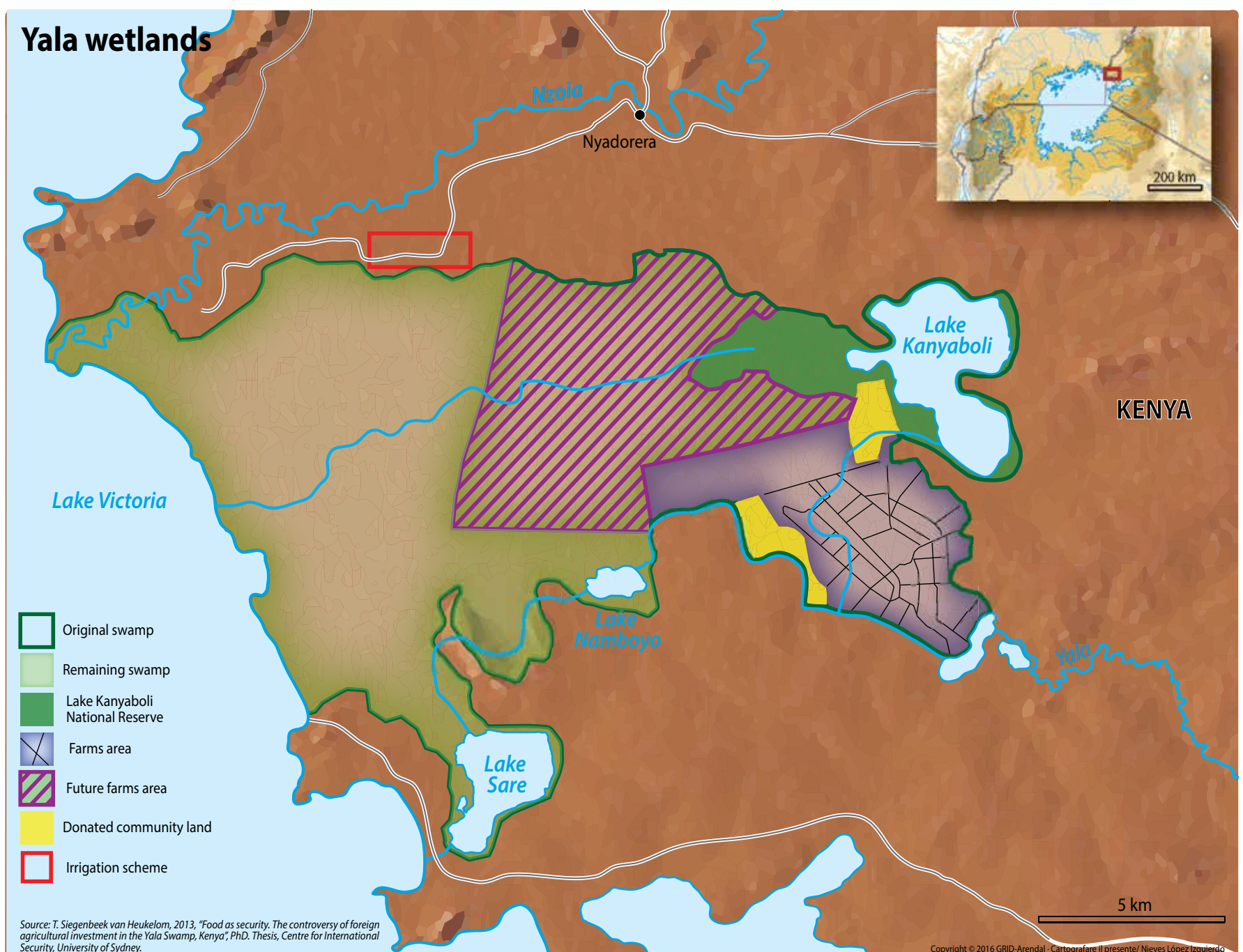
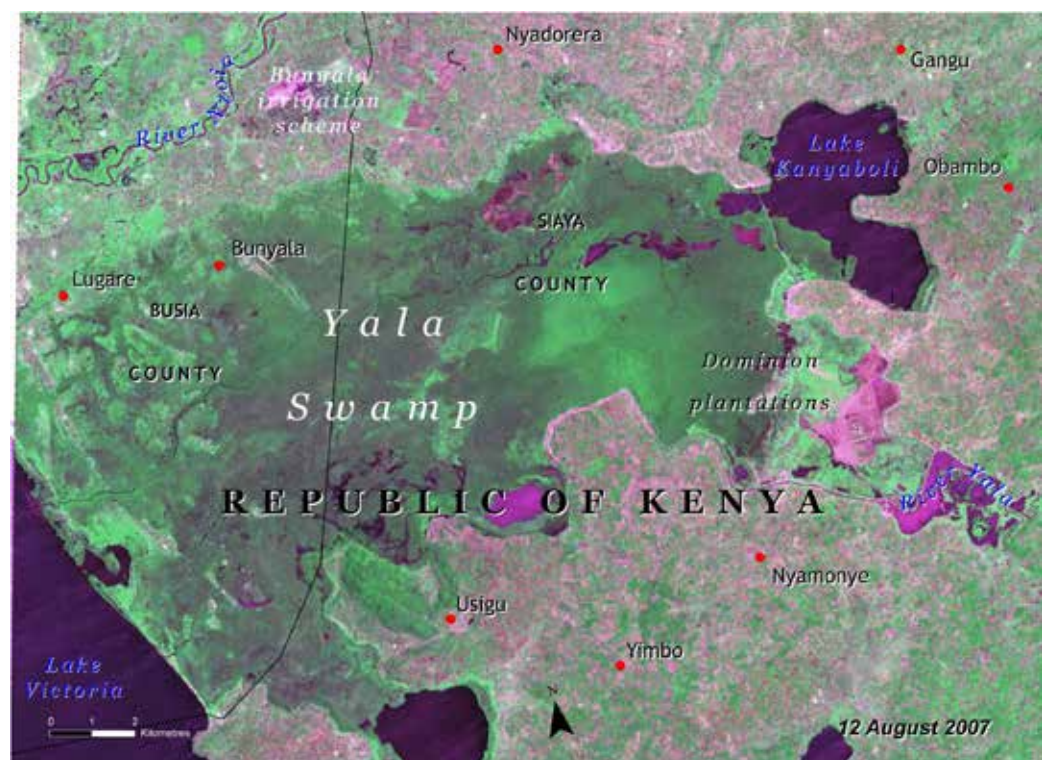
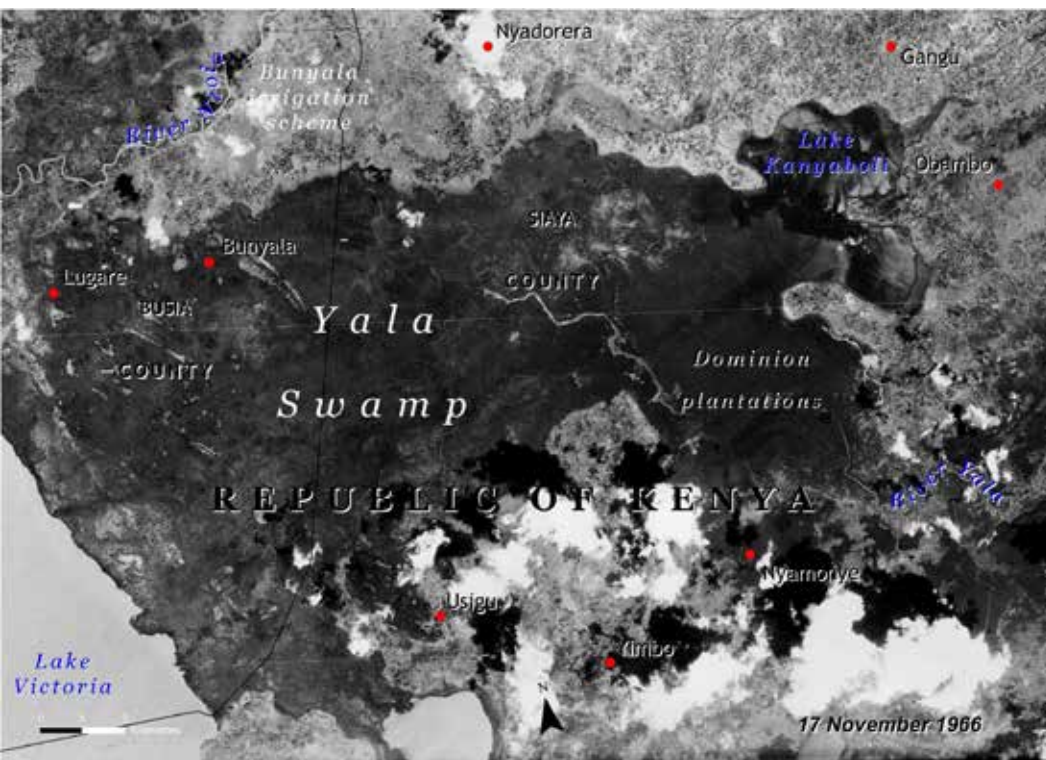


Figure 2.6: Land use changes around the Yala Wetlands



Around 1966, Yala Swamp was largely intact, with very little degradation, but by 1973 destruction of the Swamp had become more noticeable, particularly in the north and south-west (next to Lake Kanyaboli); this included some extensive burn scars, particularly in the southeast of the Swamp. By 2001, a large section of the Swamp had been converted to crop farming (as indicated by the yellow arrows).

## Dunga Wetlands, Kenya

Dunga Swamp is a small area of wetlands located at the tip of Kisumu Bay. The Swamp is in Kolwa, Kisumu District, Winam Division in Kisumu Municipality. The Swamp covers approximately 1,000 ha stretching southward from Nanga and Kibuye Point along the Lake's shoreline up to Nyamware. Dunga Swamp is a lacustrine wetland situated in the delta/estuary of Nyamasaria, Odesso, Wigwa and Luanda river systems (Lake Victoria Basin Commission 2007).

Dunga Swamp is dominated by papyrus. It is an important habitat for birds, including the papyrus gonolek. It is also an important fish breeding area. Other important animal species found in the Swamp include sitatunga, hippos, crocodiles and impalas.

Major economic activities around the Swamp include fishing, harvesting papyrus, handicraft production, wetland agriculture and ecotourism.

Major threats facing the Dunga Wetlands include encroachment by human settlements, reclamation for crop production, uncontrolled burning and sewage pollution from the town of Kisumu.

The wetlands are managed by the Dunga Ecotourism and Environmental Team, a community-based organization. The group promotes ecotourism and ensures the sustainable use of the Wetland resources.



Burning is common in wetlands



Sitatunga (swamp antelope)

## Sango Bay, Uganda

Sango Bay is located on the south-western shores of Lake Victoria. It is found in Rakai District, Uganda, on the border with Kagera Region, Tanzania. It is a low-lying area, dominated by plains and raised beaches. There are different types of wetlands in the bay, all rich in biodiversity. The wetlands are associated with three major drainage systems: the Lake Victoria Basin system (Kibale-Bukola Wetlands and Naludugavu Wetlands), the Kagera River Basin system (Lwemukunya Wetlands), and Lake Kijanebalola-Kacheera Basin systems (Lake Kacheera Wetlands, Lake Kijanebalola Wetlands, Kimanywa Wetlands, Kijonjo Wetlands) (Lake Victoria Basin Commission 2007).

The Kagera River system is associated with permanent wetlands dominated by papyrus. It is characterized by small hills and broad, low-gradient valleys; fluctuating water levels periodically flood the plains, creating seasonal wetlands, which are used mainly for grazing. Lake Kijanebalola and Kacheera are formed in two deep depressions and the edges of these two lakes and the surrounding valleys are covered by permanent swamps. These lakes eventually drain into Lake Victoria through the Kibaale/Bukola River/Wetlands system.

The plant ecosystems in the seasonal wetlands are made up of both of monoculture and mosaic stands. The monoculture stands are forming woodlands made up mainly of acacia species. The mosaic stands are comprised primarily of a mixture of grasses, albizia, acacia, euphorbia and *Carisa edulis*. Similarly, permanent wetlands have both monoculture and mosaic stands. The monoculture stands – papyrus, miscanthus, typha or vossia – merge into each other, forming mosaic plant communities.

Sango Bay is home to a range of animals such as antelopes, wild pigs, rabbits and birds (guinea fowls, partridges, crested cranes, ibis, herons and egrets).

Common fish species include lungfish, catfish, mudfish and tilapia, and these are found in the seasonal wetlands. The permanent wetlands provide a habitat for animals such as sitatungas and water bucks, as well as birds such as ibis, crested cranes, herons, kingfishers and hammerkops. There is commercial fishing of tilapia, catfish, lungfish, haplochromis and Nile perch in Sango Bay (Lake Victoria Basin Commission 2007).

Over 75 per cent of the soils in the bay are ferralitic – representing the final stages of weathering – with little or no mineral reserve remaining. Some heavy clay varieties have some fertility but sandy varieties are particularly poor. Common soil types include lithosols, alluvial and lacustrine sands and alluvial clays. Lithosols and humus loams are dominant in the uplands, while grey sandy soils derived from hill wash or river alluvium, grey clays of the valley bottoms and lacustrine sands dominate the lowlands and wetlands (Lake Victoria Basin Commission 2007).

The Sango Bay Wetlands are mainly used for crop cultivation, grazing and fishing. They also provide a variety of goods and services such as mulch grass, thatch grass, craft materials, poles, firewood, timber, charcoal and water for both livestock and human use.

The Sango Bay Wetlands supply water to the Rakai District's four urban councils: Rakai, Kyotera, Kalisizo and Lyantonde. The water supply for each town is drawn from Kijanebalola and Kasesa; Katango and Naludugavu; Bulimbale, Kacheera and Kikasa; and Bwasa, respectively. None of these urban areas has a waste treatment plant, so effluent enters directly into the Wetlands (Lake Victoria Basin Commission 2007).

Burning, drainage for settlement encroachment or conversion, overgrazing and urbanization are major threats to the Sango Bay Wetland system.



Kingfisher

## The Katonga Wetland System, Uganda

The Katonga Basin covers the districts of Kabarole, Kyenjojo, Mbarara, Mubende, Sembale and Mpigi and enters Lake Victoria through Nakinga Bay, Masaka district. The major wetlands within the Katonga catchment area are the Katonga, Nabajuzi, Kyojja and the shores of Lake Victoria. Parts of Masaka, Mubende Mbarara and Sembabule are generally flat with a few flat-crested hills with long, steep flanking slopes fluted by valleys and short pediments. The valleys are wide and some have rivers flowing through them. The wetlands are on the floodplains, along rivers and Lake margins (Lake Victoria Basin Commission 2007).

The Katonga wetlands are mainly supplied by water from surface flow from rivers, precipitation and groundwater. The wetlands are characterized by low rainfall as it is part of the Masaka-Ankole Dry Corridor. The main activity in this area is livestock (cattle) farming.

Dominant plants in the Katonga wetlands include freshwater reed species (*Cyperus papyrus*, *Loudetia* and *Miscanthus*), seasonally flooded herbaceous wetlands where species composition is variable, seasonally flooded wooded grassland, freshwater floating leaved but rooted vegetation, and freshwater rooted macrophytes.

Other dominant plant species in the Katonga wetland system are papyrus (*Cyperus papyrus*), *Loudetia* and *Miscanthus* species. These plants are tolerant to soils that are acidic and deficient in plant nutrients. The flood plains dominate the western catchment and are comprised mainly of wooded grasslands with acacia trees, which in certain instances form dense bushes. The grasslands are dominated by *Imperata* (spear grass), *Sporobolus* and *Hyparrhenia* species.

Sitatunga and otters are common animal species in the Katonga wetlands. Wetland fish, in particular catfish and lungfish, are also common. Common birds include cranes, ducks and ibis.

Papyrus is typically used for common local crafts (for example, baskets, trays and mats). Masaka district lies in the coffee and banana farming area and these crops need mulching to conserve water and soil. *Miscanthus* species are commonly used to mulch banana plantations.

The wetlands are a major source of food, mainly fish and game meat. They also provide water for domestic use and for watering livestock. Wetlands play a role in controlling floods, moderating the local climate and trapping sediment. The wetlands along rivers stabilize the riverbanks and lakeshores. Masaka Municipality receives its water supply from the Nabajuzi wetland and sewerage effluent is purified through the same system.

Only 12 km<sup>2</sup> of the wetland area in Masaka district has been converted – mainly for crop production. Little wetland conversion has taken place in the Katonga wetlands system because of the low fertility and acidic conditions of the soil.

Most of the wetlands and their surroundings come under the mailo land tenure system – a customary form of freehold practised in some parts of Uganda. The extensive and heavily waterlogged wetlands are public land, which includes the Nabajuzi, Kyogya and Katonga wetlands. A few wetlands in the Katonga system are partially or fully protected as part of the Forest Reserves; these include the Kanywa, Lwamunda and Namirembe wetlands.



Papyrus plants

## Rwanda's Marshlands

The marshlands are the most physically and chemically heterogeneous of all aquatic ecosystems in Rwanda. They are seasonal wetlands. The water table is near or above the lowest ground surface during the wet season and the floodplains are generally narrow (less than 200 m wide) or fairly short in length (REMA 2011). The most recent inventory of wetlands conducted in 2008 by the Rwanda Environment Management Authority, showed that Rwanda has 860 marshlands covering an area of 278,536 ha (10.6 per cent of the country's surface area) and 101 lakes covering a total of 149,487 ha (REMA 2011). The biggest marshlands are clustered around the rivers. The Rugezi and Kamiranzovu wetlands are high altitude wetlands; most of the others are at low altitude.

Over recent years, enormous pressure has been exerted on the water and wetland resources of Rwanda through a variety of emerging and increasing uses driven by the growing population. Some of these threats include agricultural intensification, pollution, invasive species, overuse and an inadequate institutional framework to manage the wetlands. Some of these threats have affected both the quantity and quality of the water supply. Climate change is also contributing to degradation of swamps. With decreasing amounts of rainfall, the hydrological regime of wetlands is increasingly under threat.



Bugesera marshes along the Nyabarongo River

## Burundi's Wetlands

The many wetlands and marshlands found in low-lying areas throughout Burundi are an important freshwater resource. A distinction can be made between the more permanent swamps or wetlands, and the seasonal, grassy areas or marshes (marais). These wetlands cover over 118,000 ha, or about 5 per cent of the country's territory. The wetlands and marshes serve several important ecological functions, including flood mitigation, erosion control, aquifer recharge, water quality enhancement through filtering, and habitat for various flora and fauna.

Historically, the seasonal marshes have been used as pasture for livestock, which helped to increase the marshes' fertility. As livestock numbers have decreased, and as the demand for cultivable land has grown, marshes and wetlands are increasingly being drained or used seasonally for agricultural production, particularly rice. Their high levels of organic matter and their ability to retain moisture during the dry season make them suitable for cultivation. Peat and clay extraction also threaten the integrity and ecological viability of the marais (Lake Victoria Basin Commission 2007).

The effective management of wetlands and marshes has been difficult in Burundi due to confusion over management authority and tenure rights. The 1986 *Code Foncier* established the wetlands under the management of the State and, therefore, eligible for exploitation through concessions. Some of the wetlands have also been conceded to the authority of the communes, as is the case in Kirundo, where private citizens are allowed cultivation rights. The Rural Development Department (Génie Rural) also supervises the technical management of wetlands, while the National Office for Peat Extraction (ONATOUR)



Goliath heron by the Ruzizi river, Bujumbura

has the authority to manage and extract from peat bogs. Additionally, since the early 1980s, the Ministry of Agriculture has reportedly targeted these resources for production, despite not having direct authority over the wetlands (Lake Victoria Basin Commission 2007).

An effort has been made to better regulate wetland use and conserve the remaining unexploited marshes through the drafting of a September 2000 Wetland Management Plan (Schema Directeur d'Aménagement et de Mise en Valeur des Marais). The Schema Directeur calls for a number of actions, including the creation of a sub-commission for the conservation of wetlands, mandatory Environmental Impact Assessments (EIA) prior to wetland exploitation, the increased use of organic fertilizers (green manure), community participation in wetland management, transboundary management agreements for cross-border wetlands, guidelines for peat extraction and the conservation of 2.8 per cent of wetlands (Lake Victoria Basin Commission 2007).



Gully running through agricultural landscape in Burundi





Ruzizi river

# 3

## HUMAN IMPACTS ON LAKE VICTORIA BASIN

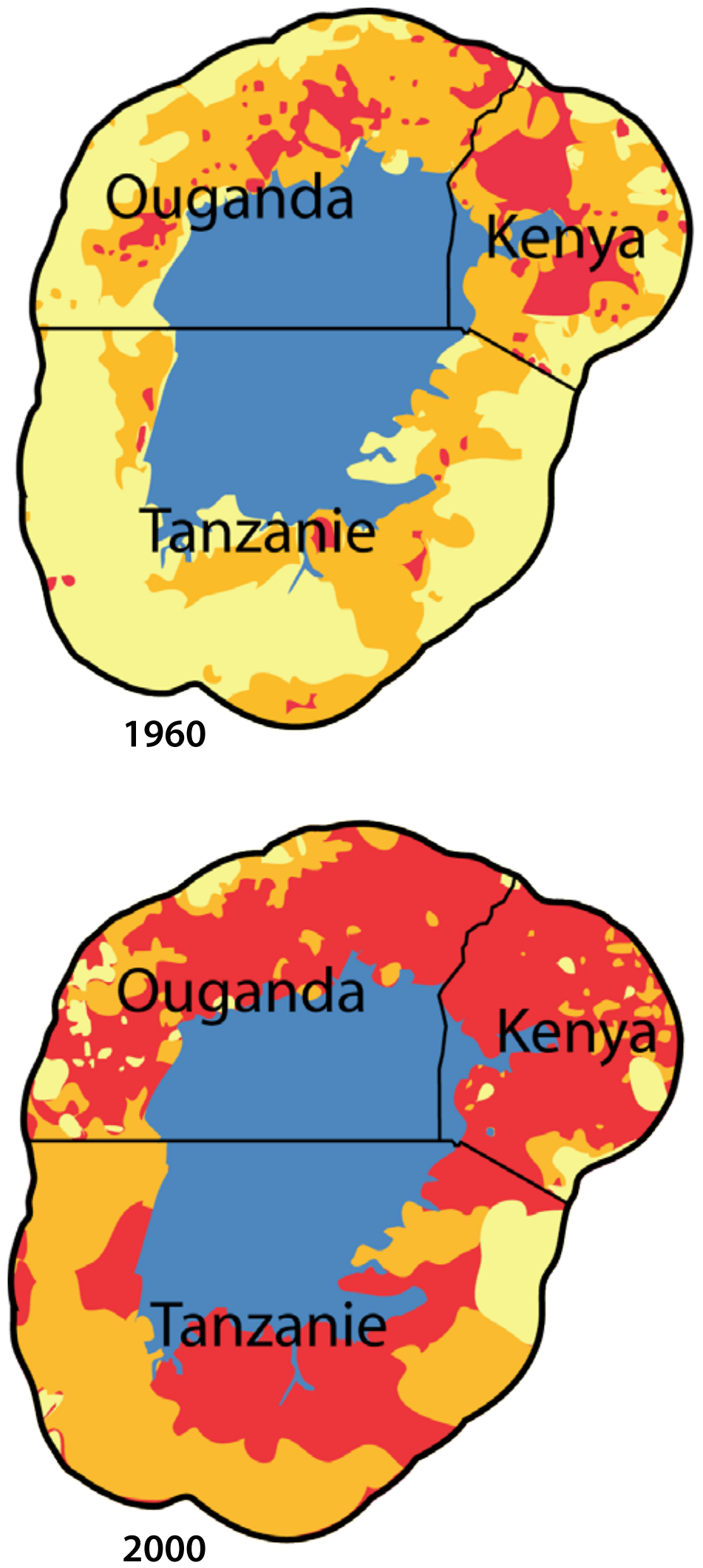
The Lake Victoria Basin's population of 40 million people represents 30 per cent of the total population of the five riparian countries (World Bank 2016). The Basin has a very high population density, with an average of 216 persons per km<sup>2</sup>. The high population density is more pronounced in the sections of the basin in Rwanda, Burundi, Kenya and Uganda (World Bank 2016).

The rising population in the Basin is often blamed for the increase in the degradation of natural resources. The increase also puts pressure on infrastructure (transport, education, health, water, power and telecommunications), increases food security concerns and leads to rural–urban migration, with the attendant problems of rapid urbanization.

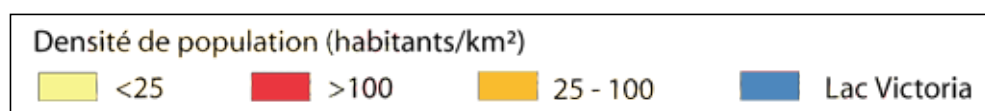
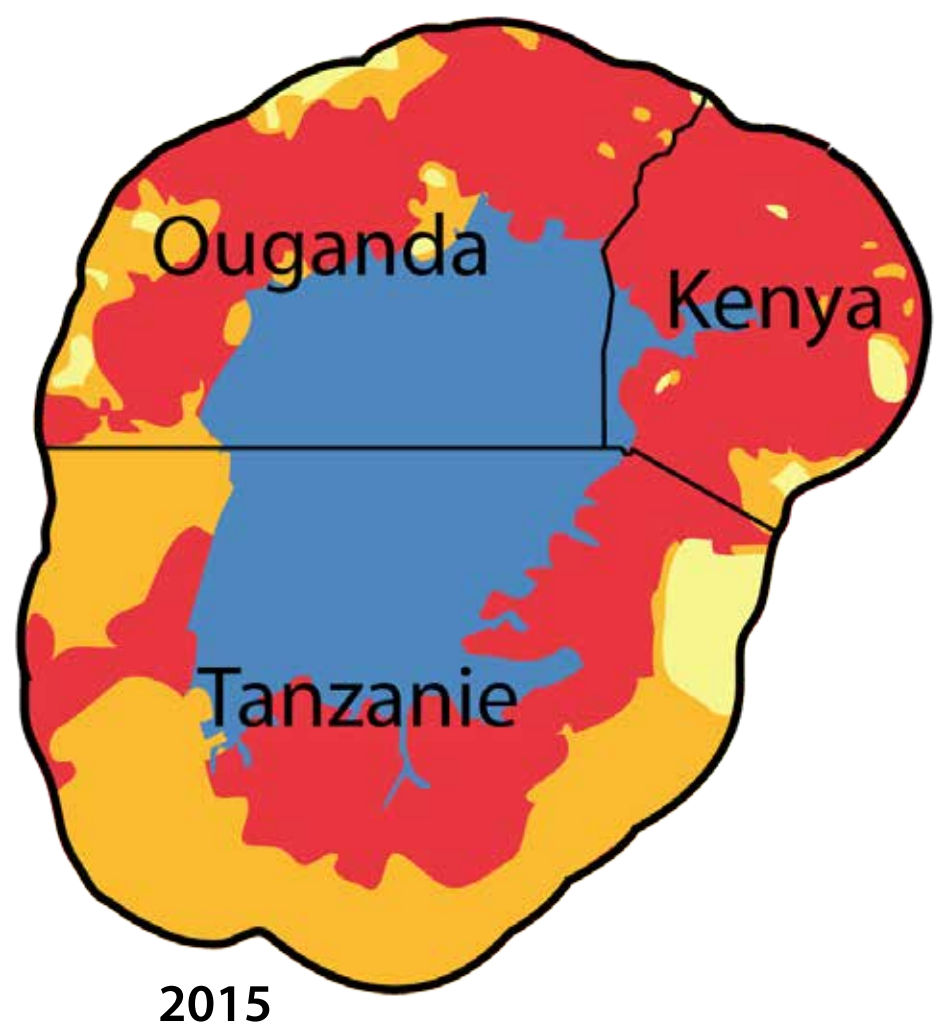
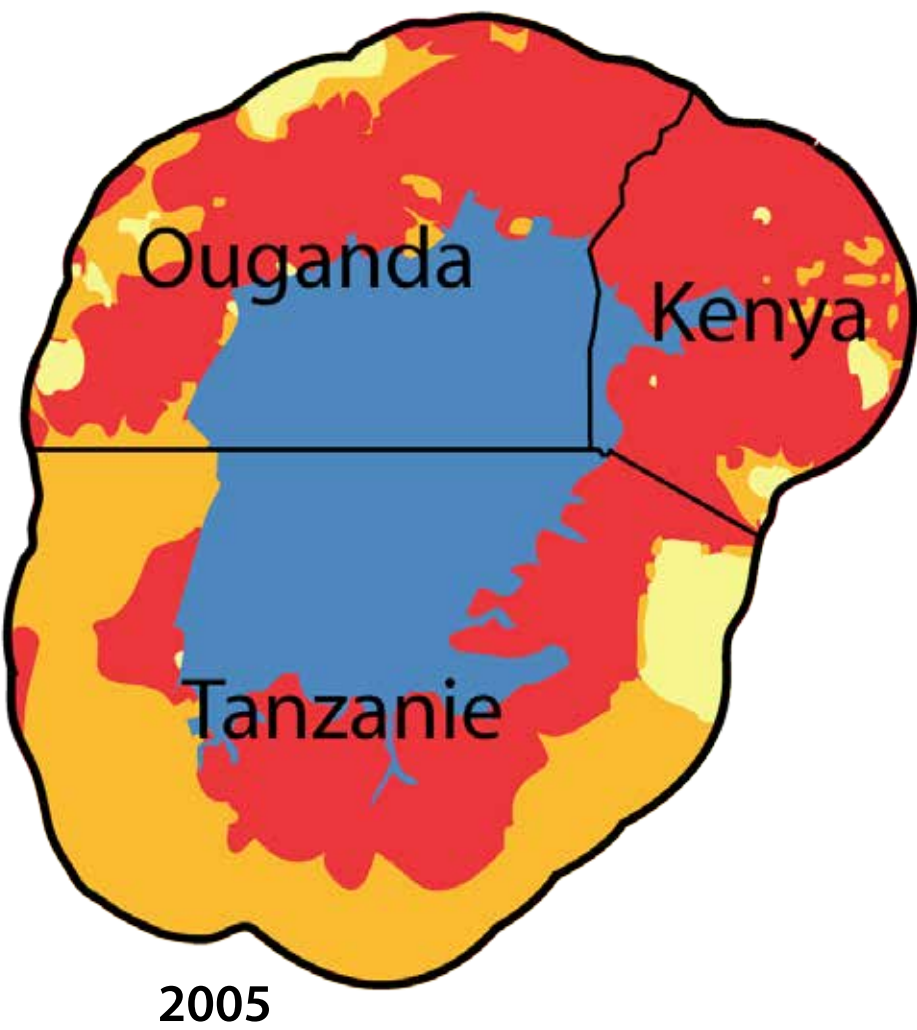
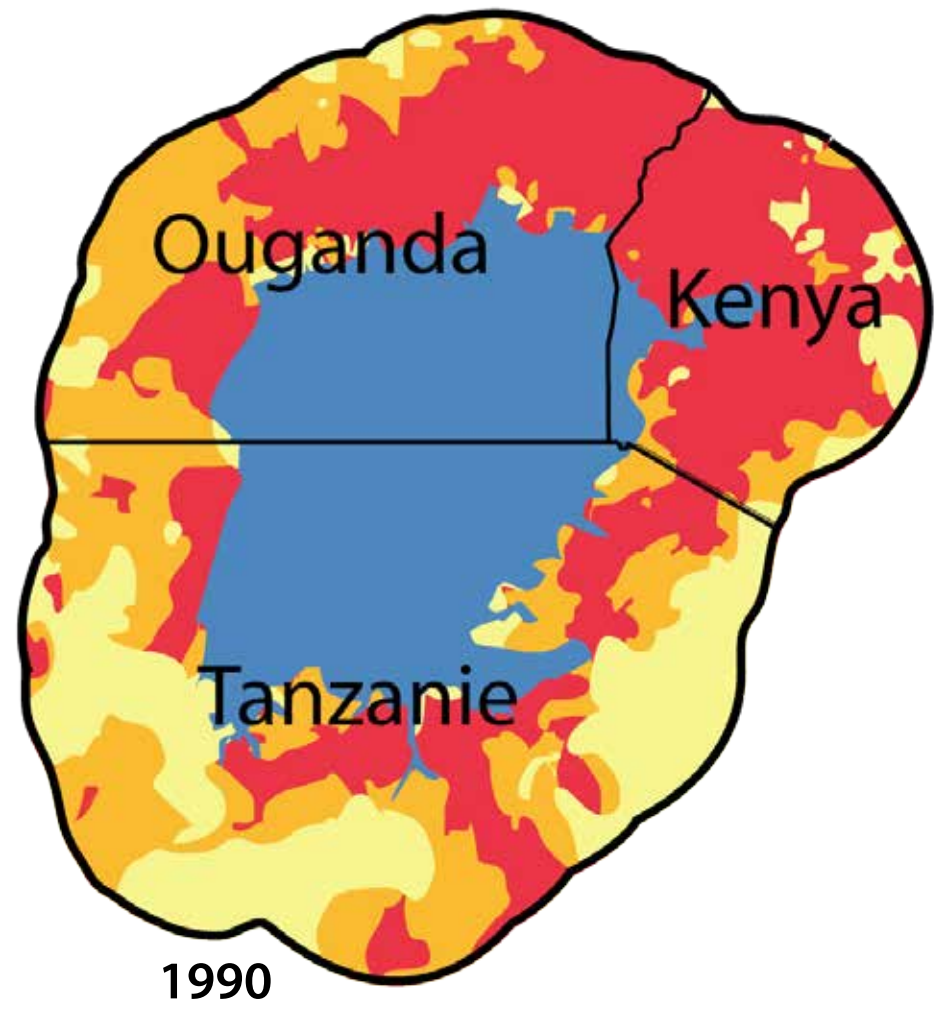
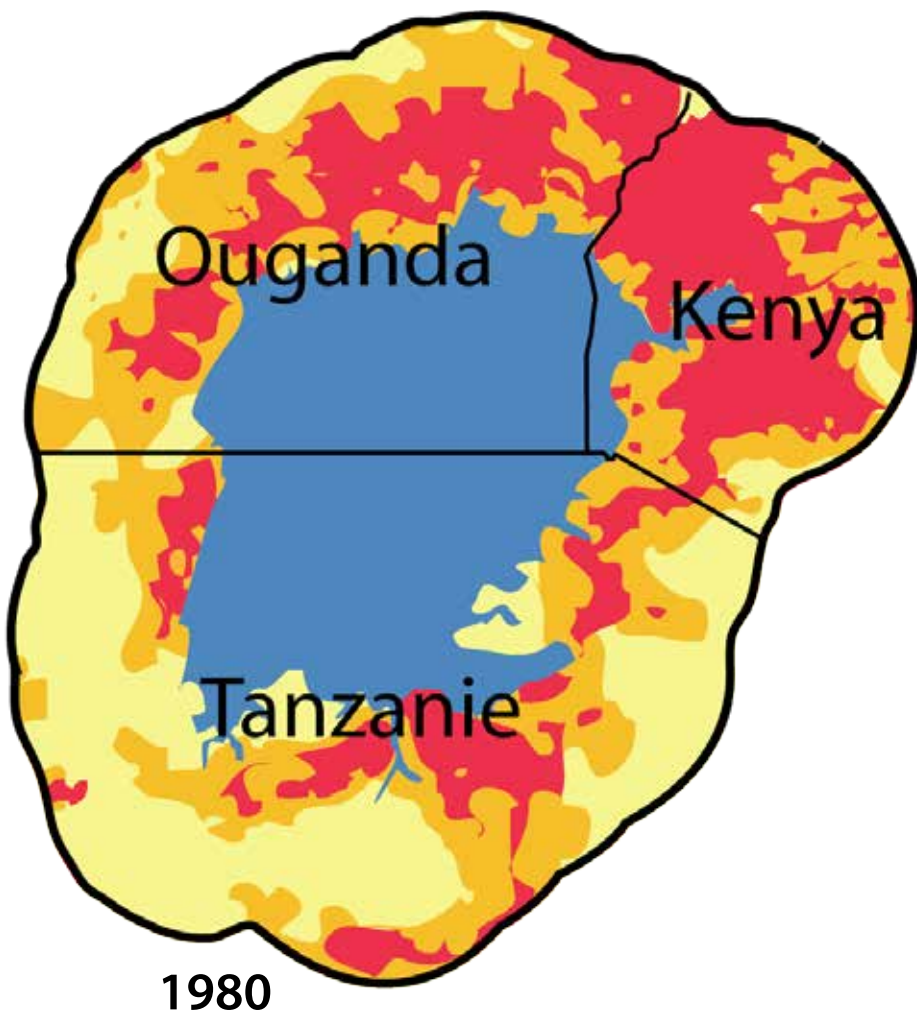


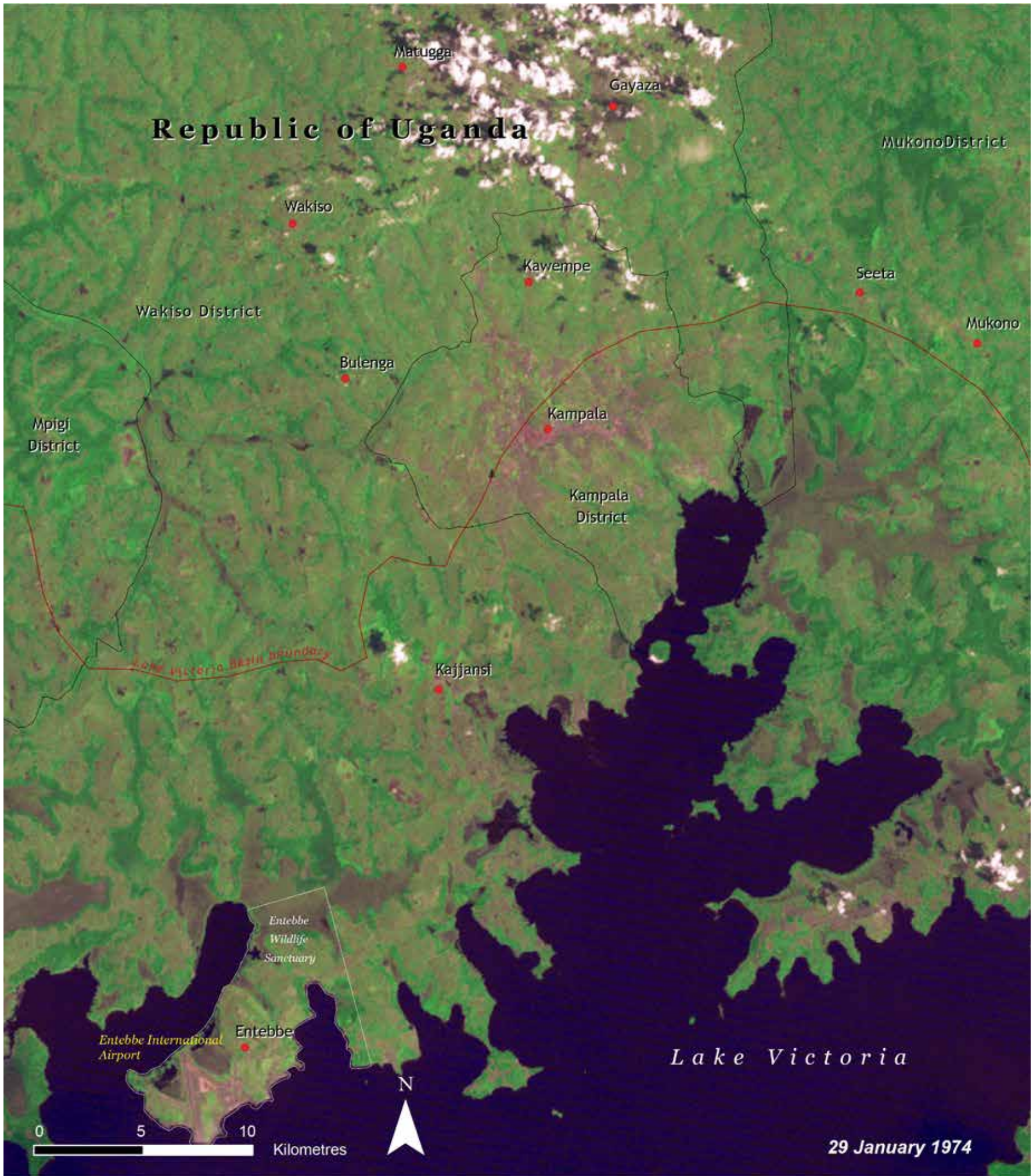


According to the Africa Water Atlas (UNEP 2010), the number of people living within 100 km of Lake Victoria's shoreline has been increasing much faster than the population of Africa as a whole since the 1960s. The Lake's resources support the livelihoods of the people living within and beyond the Lake Basin boundaries. The expanding population is blamed for the high rates of deforestation and land conversion, as well as pollution from agriculture, livestock and industry (Lehman 2009). The high population densities within the Lake Basin are due to the favourable conditions for agriculture and fishing. Since the turn of the century, the average population density on the shoreline of Lake Victoria has been high, and in some countries even higher than the present day average of 216 persons per km<sup>2</sup>. For example, on the Kenyan, Tanzanian and Ugandan sides of the Basin the population densities then were 297 persons per km<sup>2</sup>, 97 persons per km<sup>2</sup> and 635 persons per km<sup>2</sup>, respectively (UNEP 2006).



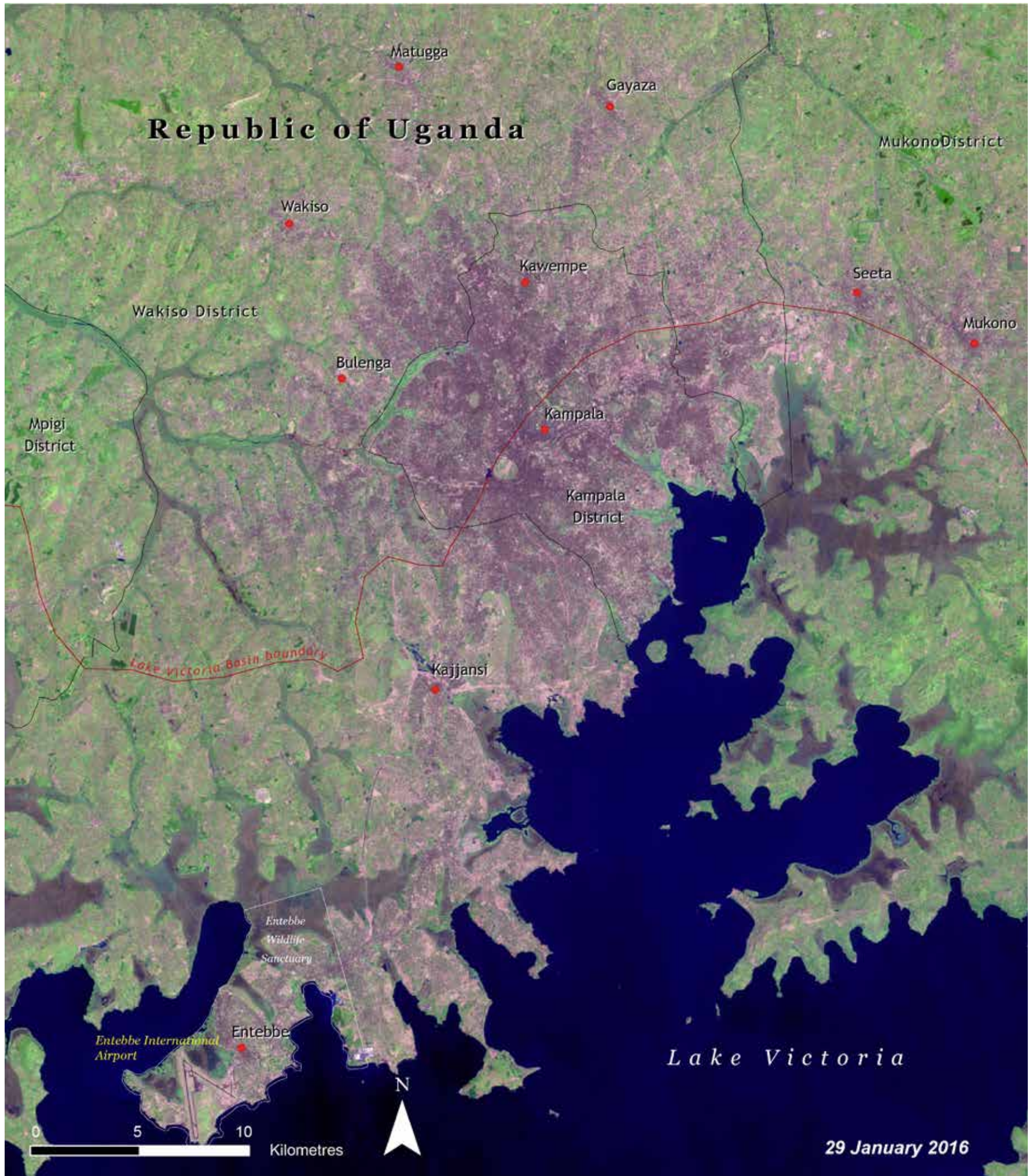
**Figure 3.1: Changes in population density in Uganda, Kenya and Tanzania**  
Source: UNEP 2006





According to an undated report by GEF et al. there are 87 urban settlements within the Lake Victoria Basin, of which the biggest are Mwanza, Bukoba, Musoma, Kampala, Jinja, Entebbe, Masaka, Kisumu, Homa Bay

and Kendu Bay. While Kampala largely lies outside the Lake Victoria Basin, the city has over the years been expanding into the Basin, forming a megacity with neighbouring Entebbe on the lake's shoreline.



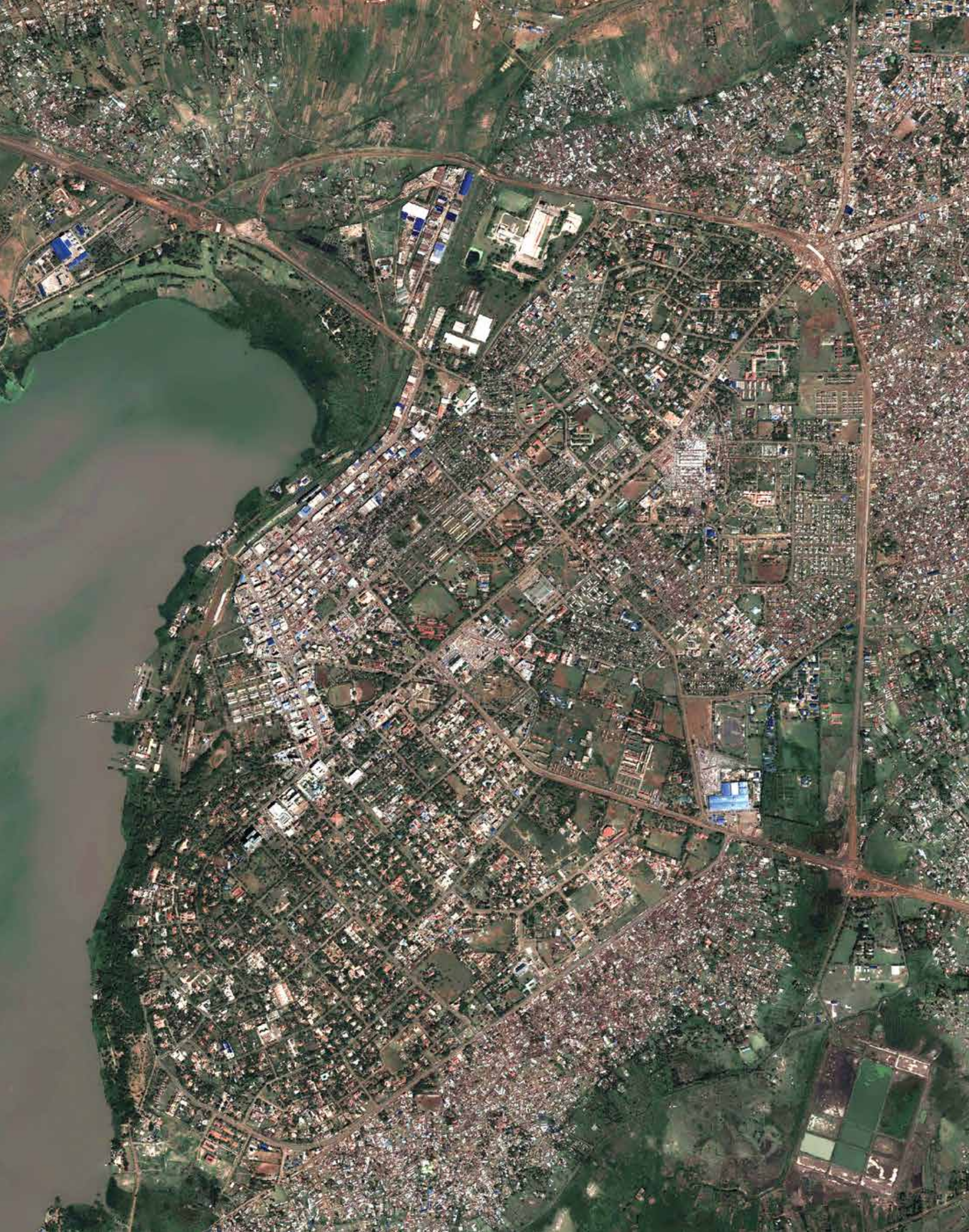


**Kisumu** is the main city of western Kenya, with direct access to Lake Victoria through the Winam Gulf. Formerly called Port Florence, Kisumu is accessible to the rest of the world through an international airport, as well by boat. The city has a population of half a million people.

Water pollution is a major environmental problem around the city. Sources of the pollution include industry, especially sugar processing. Car washing and domestic effluent are other sources of pollution into the Lake. About 10 per cent of households in Kisumu are connected to the sewer system, resulting in the discharge of raw sewage into the Lake.

The impact of the high levels of pollution around major settlements such as Kisumu includes eutrophication and the proliferation of water weeds such as the water hyacinth (Mdegela et al. 2014).

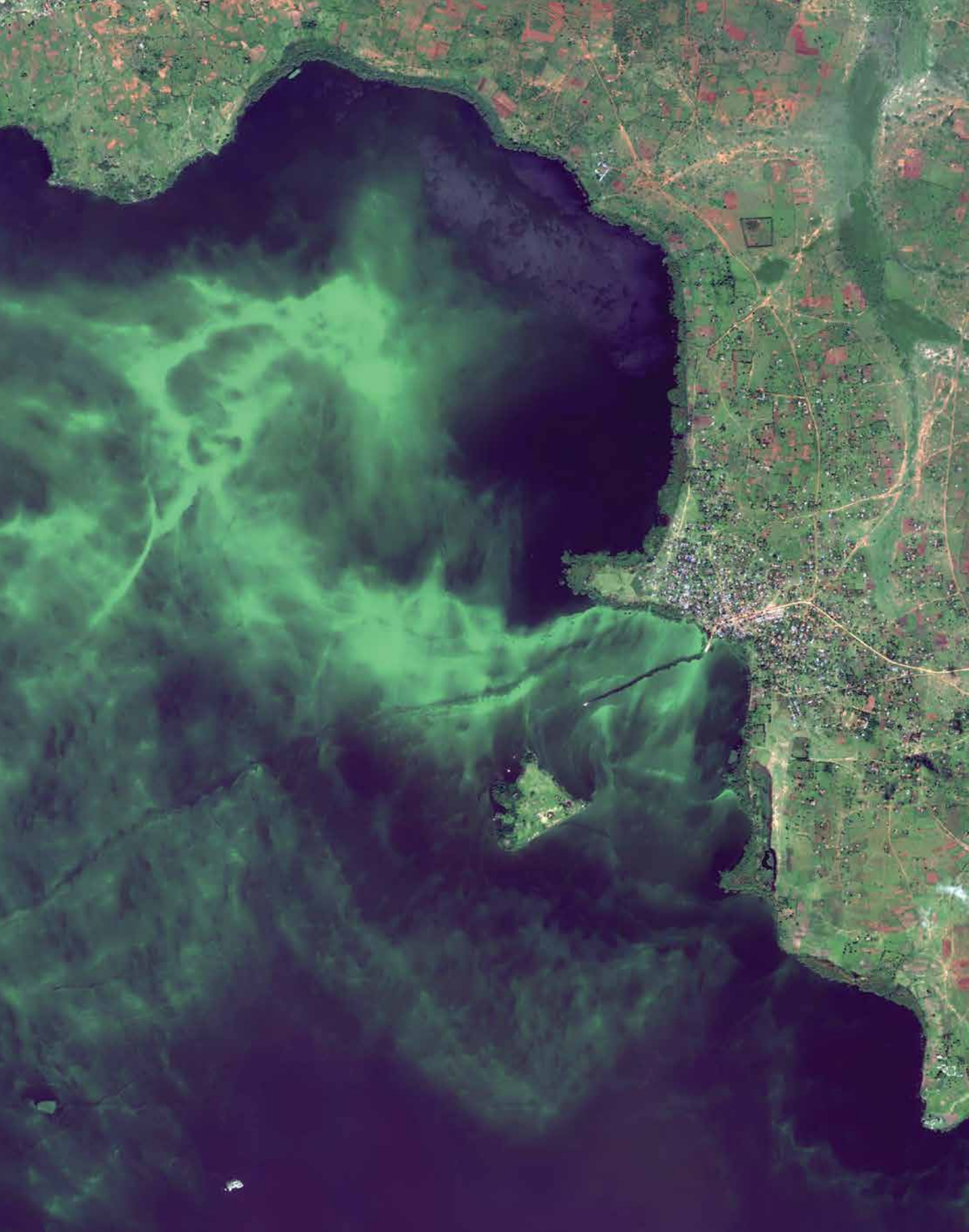




**Musoma** is the capital of the Mara region of Tanzania. The city is located on the eastern edge of Lake Victoria, and near the international borders of Tanzania with Kenya and Uganda.

According to the census of 2012, Musoma has a population of around 134,000. The people are largely engaged in fishing, while those living in the rural fringes of the city are engaged in pastoralism (National Bureau of Statistics (Tanzania) 2012).

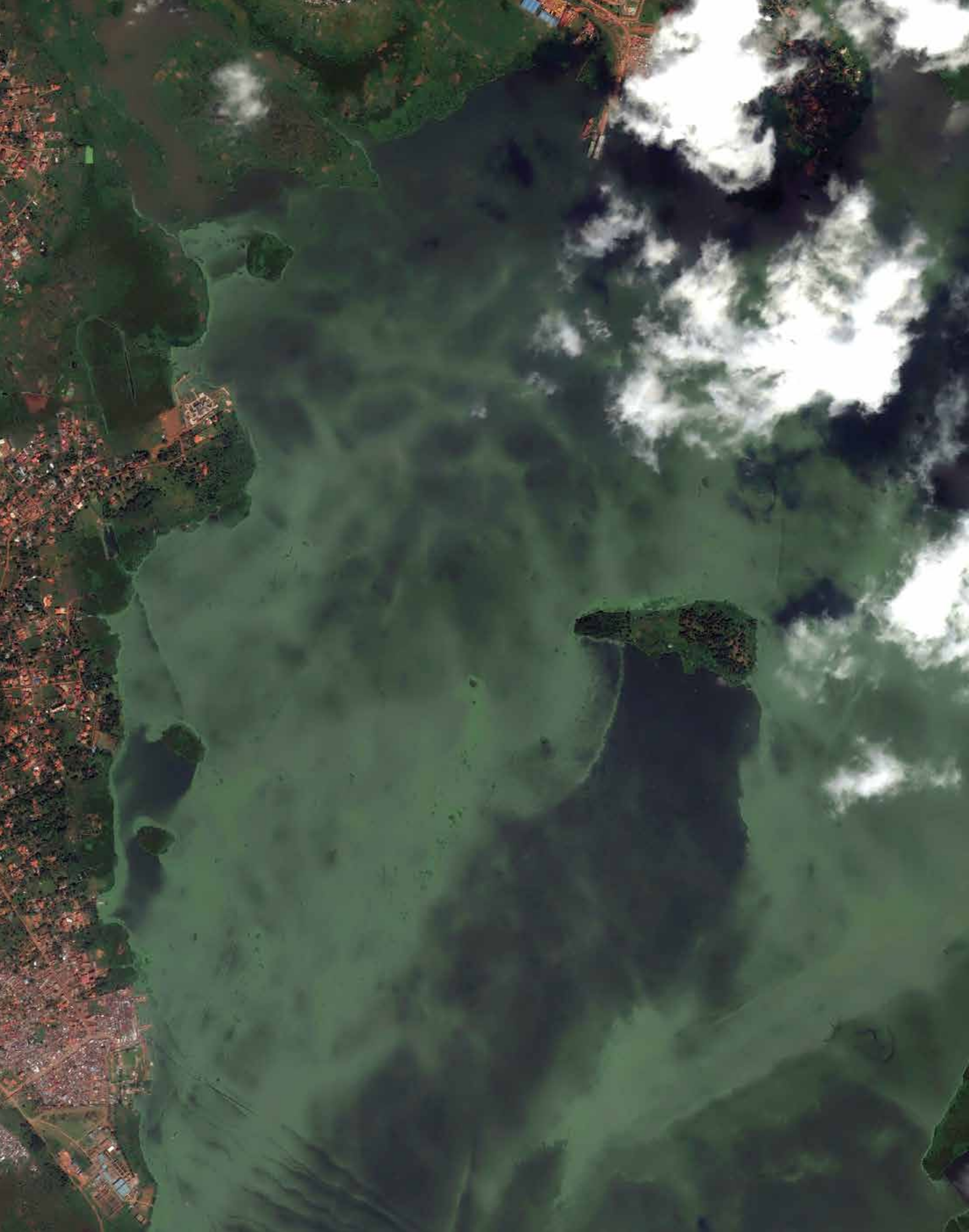






Rapid population growth, and increasing commercial and industrial activities around Kampala, continue to strain the provision of waste management services. There is an increase in the volume of waste that is generated, the bulk of which is disposed of into the local environment. The waste, which pollutes water, has in the past been subjected to natural purification by plants and microbes in the wetlands before it is discharged into the **Murchison Bay**. The efficiency of the wetlands system to treat wastewater has been lowered due to large scale draining for farmland and settlement (Kansiime and Van Bruggen 2001).

Wastewater entering Murchison Bay includes partially treated effluent from Bugolobi Sewerage Treatment Works as well as uncollected solid waste and wastewater discharged from slums, the Luzira prison complex and markets, 40 per cent of which have no pre-treatment facilities (Kizito 1986). The disposals of wastewater and industrial effluent into the wetlands or water systems are potential sources of heavy metal pollution, some of which ends up in the food chain system (Nyangababo et al. 2005). Besides the pollutants entering the food chain, drinking water sources for Kampala city, Mukono and Wakiso districts are also affected as these areas draw their water from Murchison Bay (NWSC 2004).



# Culture and Ethnicity

The population of the Basin is made up of different ethnic groups. Despite their diversity, these groups share similar lifestyles. Major ethnic groups in Tanzania include the Wahaya, Wasukuma, Wakerewe, Wazinza, Wakara, Wajita, Waruri, Wakurya, Waluo, Wazanaki, Suba and Wamaasai. The main ethnic communities on the Kenyan side are the Luhya, Luo, Kisii, Kuria, Maasai, Suba, Kalenjin and Teso, while in Uganda they include the Luhya, Luo, Baganda, Basoga, Teso and Kalenjin. Rwanda and Burundi are predominantly inhabited by the Hutu and Tutsi ethnic groups (UNEP 2006).



Masaai mother and child

The populations of the Lake Victoria Basin (LVB) depend on a variety of livelihoods, the most common of which are fishing, farming, bee keeping, trade, quarrying and the mining of sand, gold and other minerals. The exploitation of natural resources is closely defined by livelihood systems, cultural practices and property rights. Tanzania's land belongs to the state and customary rights are recognized, while in Kenya, agricultural land is largely privately owned with clear title deeds. In Uganda, land is held under a customary system, with patrilineal rules of inheritance (UNEP 2006).

The rich cultural heritage of the Basin is demonstrated by the many cultural sites that are spread throughout the Basin. These include Kyaya and Bunukangoma in Tanzania. A special type of soil, known as *inoni*, which resembles ash, is found in Kyaya and is used in the inauguration of chiefs. The Luo and Abasuba of Kenya have their own cultural sites, including Simbi Nyaima, Nyamgondho, Lwanda Magere, Kit Mikayi and Thim Iye Lich Ohinga. Islands such as Atego, Ringiti and Mbasana Muole, and Nyamani Ware are also revered cultural sites. Prominent cultural sites in Uganda include the Kabaka Tombs, Namirembe Cathedral, the Ugandan Martyrs Shrine, Owen Falls and Budhaghali at the source of River Nile (UNEP 2006).

The expanding fishing industry in the LVB is taking its toll, not only on fish stocks, but also on traditional ways of life. Women from nearby fishing communities, whose livelihoods once depended on buying native tilapia, labeo and haplochromines to dry in the sun and sell, have been forced to migrate to informal settlements near the Nile perch processing plants, where they buy fish carcasses after they have been filleted. The fleshy heads and tails are fried and sold from roadside pole stands. The carcasses are now the only fish most local people can afford (UNEP 2006).

Initially, official concern focused on the problems the Nile perch created for local communities: Fishers needed bigger fishing gear to deal with the larger Nile perch and local villagers did not know how to fillet or cook the big oily fish and were unable to dry it in the sun. There was no market for the introduced Nile perch, so the price dropped and most of the catch was left on the beach to rot. With United Nations funding, the Kenya Marine Fisheries Research Institute visited lakeside villages and hotels in Nairobi, demonstrating how to fillet, freeze, smoke and cook the fish. Development agencies and investors provided processing plants and refrigerated trucks (UNEP 2006).

Today, few people who live by the Lake can match the price paid by hotels and foreign customers for Nile perch. The LVB – which exported 238,500 metric tonnes of fish in 2005, an amount that dropped to 183,800 metric tonnes in 2011 (Golub and Varma 2014) – now suffers from local protein malnutrition.



Sukuma people



Wahaya girl



Kuria people

# Urbanization

As early as the thirteenth and fourteenth century, Lake Victoria was surrounded by organized and settled communities, with strong trade and cultural ties (UNEP 2006). The arrival of foreign settlers in the eighteenth century further strengthened the trade links. The earlier barter trading system became more developed as canoes and dhows began transporting goods around the Lake. Market centres developed and later small towns grew around the Lake ports. This was the origin of some of the Basin's major towns, including Entebbe and Jinja in Uganda; Kisumu and Homabay in Kenya; and Mwanza, Musoma and Bukoba in Tanzania (UNEP 2006).

More recently, many of these towns have seen a dramatic increase in population. Figure 3.2 shows population growth trends of some of the major urban settlements within and near the Lake Victoria Basin.

The population of the major urban settlements within the Lake Victoria Basin range from 0.2 to 2 million (World Bank 2016). A study conducted by the Lake Victoria Environment Management Project (LVEMP) indicates that there are 87 large towns in LVB, of which 51 are in Kenya, 30 in Tanzania and 6 in Uganda (Lake Victoria



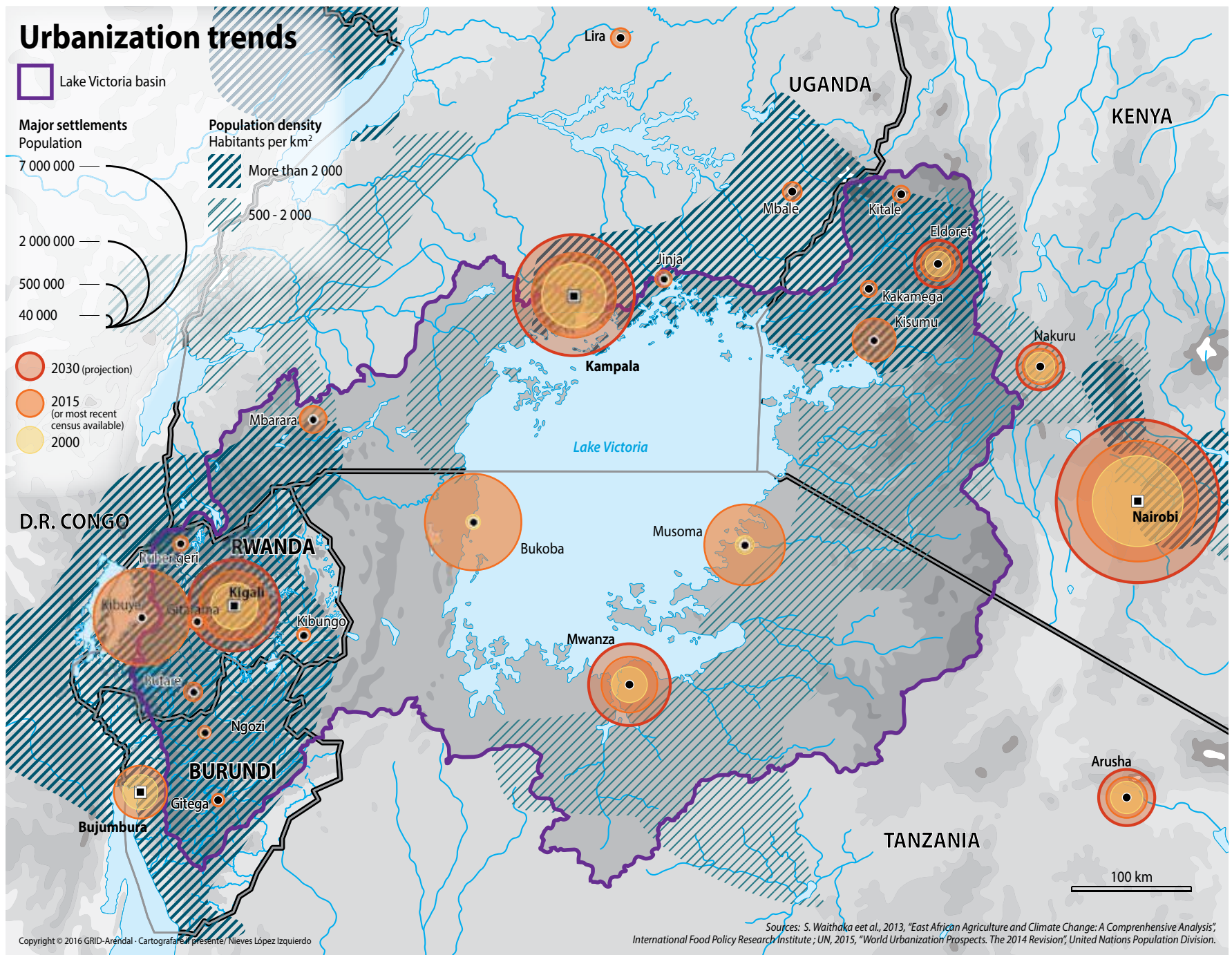
Informal settlements are a result of rapid urbanization

Basin Commission 2007). Urbanization in the LVB has led to a proliferation of informal 'squatter' settlements in some major towns. These settlements lack proper waste disposal and sanitary facilities. Less than 30 per cent of households in these towns are connected to a sewer system. Sewage treatment facilities in all the major towns are generally in poor condition. Raw sewage is discharged into small rivers and streams or directly into Lake Victoria, contributing significantly to water pollution and eutrophication, further exacerbating the water hyacinth threat (Lake Victoria Basin Commission 2007).



Kigali is one of the fast growing cities in East Africa





**Figure 3.2: Major urban settlements around Lake Victoria Basin**



# Trade, Industry and Energy

Trade and industry are some of the fastest growing sectors in the Basin with a high potential for contributing to improved incomes and employment. These sectors have been greatly encouraged by current regional integration efforts promoted by the East African Community (EAC) Customs Union. These efforts have facilitated intra and inter-regional trade in the Basin. As a designated economic growth zone, the Basin has an advantage over other regions in terms of attracting investments. Currently, there is little and dated data on the volume and value of transboundary trade within or across the Basin, but judging from the movement of goods within and out of the Basin, it is clear that trade plays a very important role in the local economy, as a source of

income, employment and food. Most of the trade within and across the Basin is based on agricultural crops, livestock products, fisheries, household goods, farm inputs, wood and timber products, textiles and construction materials.

Trade between Kenya, Uganda and Tanzania has greatly increased since the initiation of the integration of the EAC partner states. Exports to Tanzania from Kenya grew by 62 per cent from USD 0.16 billion in 2000 to USD 0.28 billion in 2005, while exports to Uganda from Kenya grew by 65 per cent from USD 0.35 billion in 2000 to USD 0.61 billion in 2005. Imports to Kenya from Tanzania also grew from USD 7.84 million in 2000 to USD 41.4 million in 2005. Ugandan imports to Kenya



during the same period grew by 49.2 per cent (Lake Victoria Basin Commission 2007).

In Burundi, industrial activities are dominated by agro-processing and food industries: coffee, cotton, rice, tobacco, sugarcane, dairy products, oil mills and breweries. Other important industrial activities relate to the production of consumer goods, chemicals, textiles, wood, paper and building materials. About 70 per cent of goods are transported by road, which connect Burundi to Rwanda, Uganda and Kenya and the principal transport corridor, which joins Burundi to Tanzania (Lake Victoria Basin Commission 2007).

In Tanzania, industrial activities in the Lake region are characterized by small or medium-sized production units based mainly on agriculture and fishing. These include fish processors, fishmeal mills, abattoirs, vegetable oil mills, animal feed mills, and coffee and

tea processors. In Uganda, investment is taking place in various sectors of the economy including mining and agriculture (coffee, tea, fish, milk, edible oils and fruit processing) (Lake Victoria Basin Commission 2007).

The major urban centres – Kampala, Entebbe, Masaka and Jinja in Uganda, Mwanza and Musoma in Tanzania, and Kisumu in Kenya – are the key point sources of pollution. In Rwanda, the manufacturing industries are concentrated in Kigali, which are also point sources of pollution. The industries in the Gikondo Valley in Kigali City are a source of chemical pollution for the Nyabarongo River that feeds the River Akagera. Most of the industrial facilities in the LVB have inadequate waste treatment facilities. Therefore, wastewater is discharged into storm water drains, which then finds its way, in some cases via wetlands, into the Lake. Those facilities that do have wastewater treatment plants are generally inefficient (Lake Victoria Basin Commission 2007).



## Technology and Communication

Technological advances have produced both positive and negative effects, especially on production and consumption patterns in the LVB. For instance, the Lake Victoria fisheries industry has become more commercialized following the increased use of more technologically-advanced, effective and expensive fishing equipment (Lake Victoria Basin Commission 2007). While this has resulted in bigger fish catches, the cost of running business has also risen above the level that many ordinary fishers can afford, forcing many of them to work as crew for those with adequate capital for investment.

The demand for fish exports, together with the use of advanced fishing gear, has resulted in destructive fishing methods. Commercial trawling, drift nets and beach seines methods have been directly linked to the increase in demand from the fish processing industry. The expansion of fish processing factories has been so rapid that the industry now has excess capacity within Lake Victoria (Lake Victoria Basin Commission 2007). Presently factories operate at less than half their capacity, largely owing to insufficient fish supplies.

## E-waste

Advances in information and communication technologies have seen an increase in computerization, as well as the use of mobile telecommunication devices. While these have improved the speed of business transactions in the Basin, they have also generated an excess of e-waste that has, in turn, led to an increase in heavy metal contamination and other pollutants in major water bodies. The shipment of electronic waste from other parts of the globe has presented further challenges to the Basin's efforts to manage e-waste. According to a study by Makerere University, Poly-brominated flame retardants, most likely resulting from poor electronic waste disposal practices (such as open burning), are polluting the environment in the LVB (Chemical Watch 2013). According to the study, the levels of poly-brominated diphenyl ethers (PBDEs) and 'novel' flame retardants – 1,2-bis (2,4,6-tribromophenoxy) ethane (BTBPE) and hexabromocyclododecane (HBCDD) – increased in both the air and precipitation in and around the Lake shore during the study period (2008-2010) (Chemical Watch 2013).



Scavenging through a pile of E-waste in Kisumu

## Hydroelectric Power

The demand for electricity has been increasing in the LVB and beyond, resulting in increased investment in hydropower generating capacity, among other modern forms of energy. Between 2000 and 2010, demand grew from 86,000 Gigawatt hours (GWh) to 180,000 GWh – an increase of over 100 per cent. This strong growth is expected to be sustained for several decades to come. Future energy scenarios show that a significant additional power-generation capacity is required to satisfy future electricity demand. In the Base Case Outlook for 2035, peak demand is forecast to increase by about 300 per cent in Uganda. For the other countries this figure is even higher, with demand predicted to double every five years after 2010. Kenya has the most ambitious projected demand increase – by a factor of 20 relative to 2010 levels. In the Enhanced Regional Cooperation Scenario, growth rates for 2035 are even higher. The projections predict the integrated system peak demand to equal the total hydropower potential in the region by 2030. The factors behind the steady growth in demand are multiple and include the success of regional efforts at economic reform, improvements in the investment climate, an increase in cross-border trade and a growing population (International Energy Agency 2014).

The increase in hydropower dams affects water release and abstraction from rivers and lakes in the Basin. The growth in investment in clean forms of energy in the LVB countries is driven by the huge energy gap, as shown in Figure 3.3, whereby a large section of the population does not have access to electricity.

Large investments in electricity generation capacity and transmission facilities are required to meet the projected demand. For the period 2010 to 2015, USD 13.3 billion was planned for new generation projects, with an additional USD 1.3 billion for new transmission lines. For the subsequent five years (2015 to 2020), USD 45 billion is required for new generation projects (International Energy Agency 2014). While EAC Member States are making good progress towards investments in renewable energy, not all the planned investments in the energy sector materialize.



Nalubaale Power Plant in Uganda

To raise the investments required for the energy sector, EAC member states need to quickly formulate a regional framework for resource mobilization that will target multiple funding sources, including the private sector. Concerted effort is also required to expedite the implementation of the transboundary interconnection to move energy from countries with a surplus to countries with a deficit, and curb the development of expensive thermal power stations by embracing peak power swapping. Failure to respond speedily will see power demand in the region continue to outstrip supply, with a consequent increase in construction of new thermal-based emergency power plants. This, in turn, will negatively impact on the unit cost of electricity, reduce the competitiveness of the region's products and slow down economic growth. The over-reliance on wood-based fuels by the basin states will not disappear overnight and the attendant problems of deforestation will continue to affect the region into the future (International Energy Agency 2014).

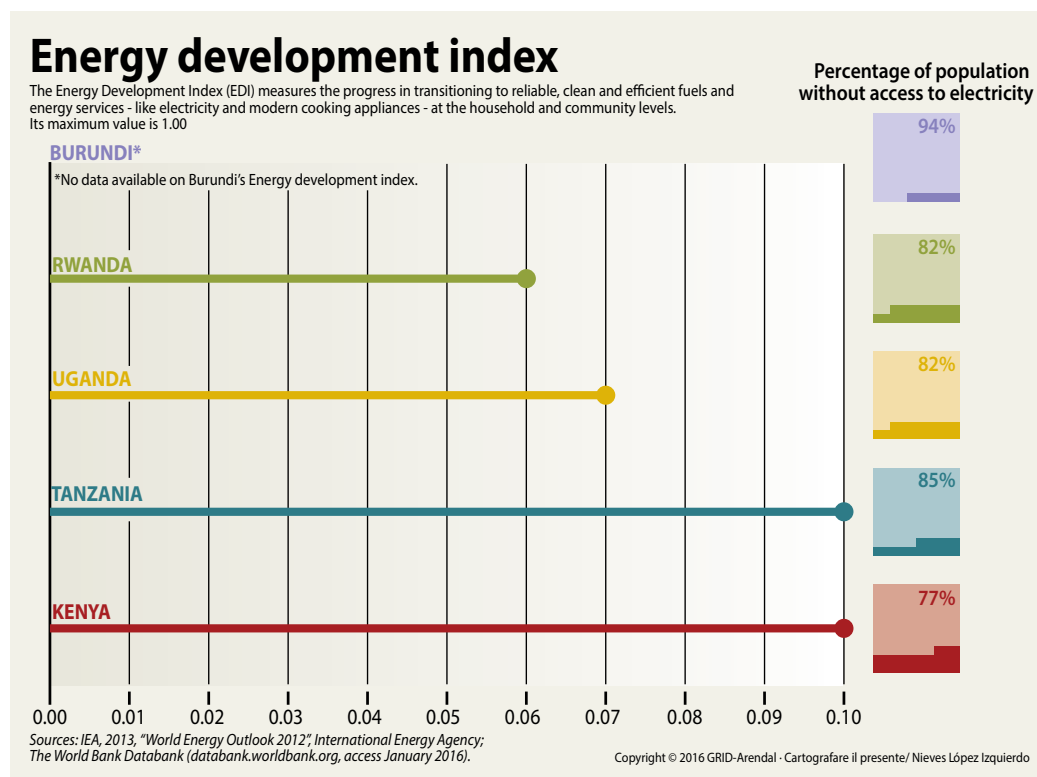


Figure 3.3: Energy Development Index for Lake Victoria Basin countries



Hydro generation plant between Lake Ruhondo and Lake Burera, Rwanda

# Infrastructure Development

The EAC in general, and the LVB in particular, are linked to the wider world via marine and air transport. The major coastal ports at Mombasa and Dar es Salaam are feeder ports supporting hubs on the main east-west shipping routes.

The regional hub for air transport is Nairobi, both for intraregional travel and for connecting the EAC with the rest of Africa and the World. As with other regional communities that are pursuing integration, East Africa's trade and regional integration efforts are being driven through economic development corridors as a means of organizing transport. While Lake Victoria is central to East Africa's trade and transportation systems, current efforts for economic development, as shown in Figure 3.4, extend beyond the boundaries of the Basin.

The LVB transport network is made up of road, rail, air, maritime and inland water transport systems. However, the transport infrastructure is generally poorly maintained. The EAC partner states are linked to one another mainly by road and air, and to a lesser extent, by rail, inland water and maritime services. More than half of the EAC countries are landlocked. Trade with global markets is conducted through transport corridors to and from seaports via neighbouring states. The existing transport systems in the region are designed to service overseas markets rather than link neighbouring states. As a consequence, there is a relatively low level of integration of physical transport networks within the Basin. The countries export mainly agricultural products, most with little added value.

Some Basin countries are continuing to discover or exploit major deposits of mineral resources such as oil, natural gas and precious stones. These are being exported through existing transport corridors. Road transport is

the fastest mode of surface transport in the region, and is most suited to short- to medium-distance hauls. Roads are flexible, providing a door-to-door service and interchange terminals for rail, water and air transport. Decades of under-investment, poor management and general neglect of the railways has meant that road transport has become the most dominant mode of motorized transport in the Basin. It currently accounts for 80 per cent of goods and 90 per cent of passenger traffic in the region (Golub and Varma 2014).

Commodities transported by road are mainly agricultural products and locally manufactured goods. They include cereals such as maize and flour, sugar, rice, beer, coffee, tea, tobacco, salt, gypsum, limestone, cement, petroleum oils, silicates and rolled iron. International traffic exports commodities such as coffee, hides and skins, fish, cotton, oil seeds, cereal flour, minerals and vegetable products. Imports into the EAC include petroleum products, cement, wheat, palm oil, iron and steel, clothing, sugar, ceramic tiles and motor vehicles (Golub and Varma 2014).

Haulage transport consists mainly of trailer trucks and road tankers (fuel trucks). The number of road accidents in the region is generally high. Other problems include damage to roads as a result of trucks exceeding axle-load limits and delays on transit corridors, mainly at seaports, weighbridges, border crossing points and inland terminal points – all of which increase transport costs (Lake Victoria Basin Commission 2007). Transporting bulk cargo by road is also more expensive than by inland water or rail transport for medium and long distances. Moreover, road transport has limited potential for achieving economies of scale and therefore hinders the industrialization and commercialization of agriculture. As such, freight costs in many parts of the Basin are very high. For instance,



Truck breakdown on a road in Kenya



Ferry loading terminal, Mwanza, Tanzania



Kisumu Railway line that will become Kisumu Revamp to connect major cities in the Basin

the cost of transport into the Lake Victoria Basin is about twice as much as transporting the same cargo to the coastal zone (Golub and Varma 2014). This reduces economic opportunities and slows down economic growth in the landlocked upper region of the Basin.

This situation is, however, projected to change with the ongoing development of regional transport corridors under the auspices of the EAC. Some of the proposed corridors transverse the LVB and will, therefore, be expected to improve trade, investment, agriculture and industrial production, as well as the exploration and exploitation of mineral resources – helping to boost the economy of the Basin.

## Oil Pipeline

Oil imports to the EAC and Lake Victoria Basin States are partly serviced through the pipeline in Kenya, which has two terminal depots at Kisumu and Eldoret. Transport of oil from these depots to western Kenya, Uganda, Rwanda, Burundi and Eastern Democratic Republic of Congo is by both road and water/marine transport. The EAC partner states are considering extending the oil pipeline to Kampala in Uganda, Kigali in Rwanda and to Bujumbura in Burundi in the future. The extension of the pipeline will further support the economic integration of countries in East Africa.

As a result of the developing oil industry in Uganda, there are plans to run a pipeline through the LVB into Tanzania and to the port in Dar es Salaam. The pipeline is expected to facilitate the export of oil through the port facilities in Tanzania.

## Air Transport

There are three international airports in the LVB: Entebbe in Uganda, Eldoret in Kenya and Kigali in Rwanda. There are plans to upgrade Kisumu Airport in Kenya and Mwanza Airport in Tanzania to international standards. The growing potential for trade and tourism, are likely to result in more air transport in the basin countries.

The Basin has various smaller landing facilities and airstrips: Homa Bay, Kisii and Kericho in Kenya, Mbarara in Uganda, and Bukoba and Musoma in Tanzania. These facilities allow regional and national connections that help enhance air travel between the major towns in the LVB and beyond. The airstrips are largely under-utilized and therefore, the Basin and the region at large need a more vibrant economy to make more efficient use of these facilities.



The Kisumu Airport terminal building

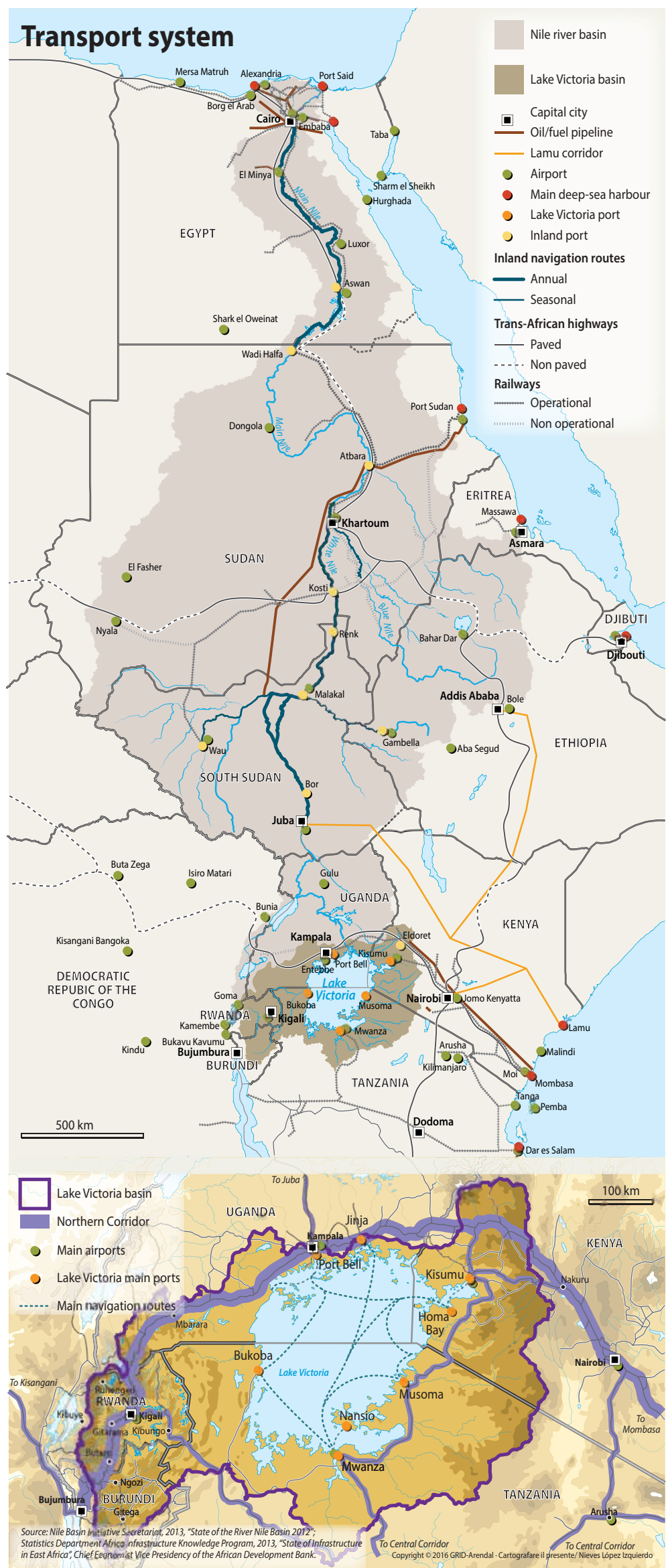


Figure 3.4: East Africa's transport corridors

# Governance

As a response to the various pressures on the socio-economic issues affecting the LVB, the EAC Member States Governments are working together to harmonize their laws, policies and regulatory frameworks to mitigate against environmental degradation, among other forms of degradation, in the Basin and the wider East Africa region. Some of the most prominent regional efforts include the enactment of the Lake Victoria Transport Act (2007), which is aimed at regulating transport on the Lake to avoid accidents, oil spills and toxic waste disposal. In addition, a hazardous and toxic chemical contingency plan is in place.

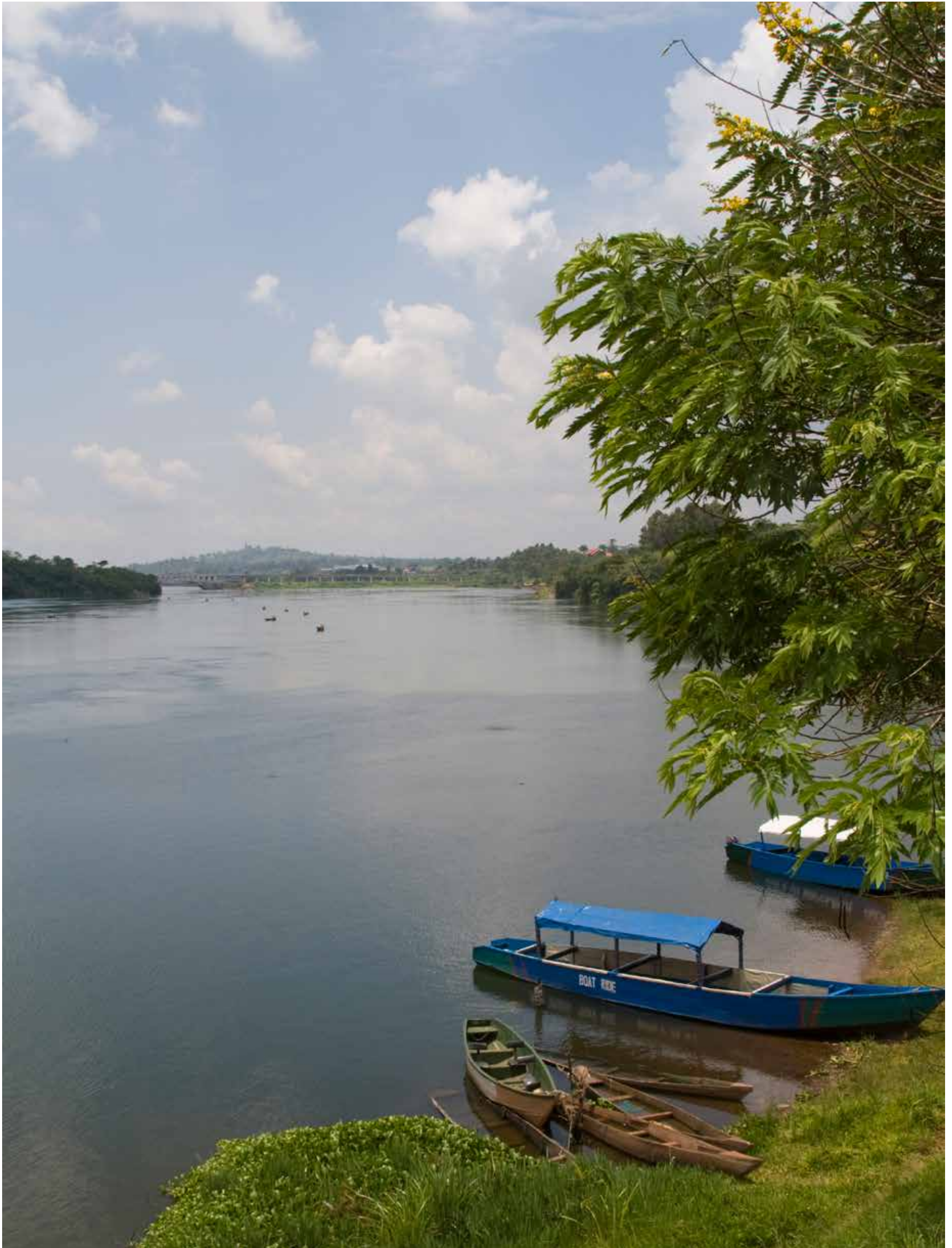
There are ongoing efforts to put in place an East Africa Community/Lake Victoria Basin Commission Act to govern the management of water resources in the LVB, as well as to complement the existing water release and abstraction policy for the LVB. The Lake Victoria Basin Commission, established under the Protocol for Sustainable Development of the Lake Victoria Basin, was set up to spearhead the sustainable management of the environment and natural resources in the Basin. The Protocol articulates 14 areas that the partner states have agreed to cooperate on:

- sustainable development, management and equitable utilization of water resources
- sustainable development and management of fisheries resources
- promotion of sustainable agricultural and land-use practices including irrigation
- promotion of sustainable development and management of forestry resources
- promotion of development and management of wetlands
- promotion of trade, commerce and industrial development
- promotion of development of infrastructure and energy
- maintenance of navigational safety and maritime security
- improvement in public health with specific reference to sanitation
- promotion of research, capacity-building and information exchange
- environmental protection and management of the Basin
- promotion of public participation in planning and decision-making
- integration of gender concerns in all activities in the Basin
- promotion of wildlife conservation and sustainable tourism development



Environmental protection is part of the mandate of the Lake Victoria Basin Commission





Lake Victoria's potential for maritime transport is not fully exploited

# 4

## CHALLENGES AND OPPORTUNITIES

The Lake Victoria Basin is central to the transformation of the East Africa Community into a formidable economic growth zone, offering opportunities for regional integration and sustainable development. Such opportunities and associated benefits can only be achieved through the joint management of the Lake Victoria Basin (LVB) as a single but shared ecosystem.

The need for inclusive regional cooperation in environmental management and social issues affecting the LVB has a long history, including the Convention on the Lake Victoria Fisheries Organization, which was signed in 1994 and came into force in 1996, and the revival of the East African Cooperation in the same year, as well as the establishment of the East Africa Community (EAC) in 1999. The EAC has had and continues to have a number of aims relating directly to the LVB (LVBC 2004), including:

- The designation of the Lake Basin as an economic growth zone and recognition of the economic potential therein
- The commissioning of studies on an institutional and legal framework for the management of the Lake Basin, which culminated in the establishment of the Lake Victoria Programme Unit at the EAC Secretariat
- Signature of the Treaty Establishing the East Africa Community in 1999 to provide the legal basis for the establishment of a body to manage the Lake Victoria Basin (article 114 of the Treaty)
- The commissioning of a study on the economic potential and constraints of the Lake Victoria Basin in 2000 to provide a conceptual basis for developing a strategy for the Basin
- The drafting of the Protocol for the Sustainable Management and Development of the Lake Victoria Basin in 2002.

While the LVB offers innumerable opportunities for socioeconomic development of the EAC, it is worth acknowledging that the Basin also faces significant challenges, most notably those relating to environmental degradation, population pressure, high poverty levels, poor transport infrastructure, and high mortality rates due to the prevalence of HIV and AIDS, and diseases such as tuberculosis and malaria (LVBC 2004).





# Challenges

Environmental stresses faced by the LVB which are highlighted in this report include:

- **Stresses within the Lake** such as over-fishing, oil spills, untreated liquid waste, invasive alien species (particularly water hyacinth) and over-abstraction of water from the Lake Basin;
- **Stresses on littoral zones** such as construction and farming on the shoreline, conversion of wetlands, and poor solid waste management;
- **Stresses on the wider Basin** such as land degradation, deforestation, proliferation of water weeds (particularly water hyacinth), pollution from agro-chemicals, sediment loads, and poor solid waste management; and
- **Stresses from outside the Basin** such as atmospheric nutrients including nitrogen and phosphorous that are transported into the Basin through the air.

If the water and land resources in the LVB continue to deteriorate, the Basin will reach a point when it will no longer be able to adequately support the livelihood demands of the growing population. The stresses on the Lake Basin, which manifest themselves through deteriorating water quality, fluctuating lake levels, the overexploitation of natural resources, the resurgence of water hyacinth, and climate change, are partly responsible for the lake's reduced capacity to provide some of its ecosystem goods and services.

The establishment of Lake Victoria Basin Commission in 2006 has provided a starting point for exploring solutions to the environmental challenges faced by the Basin. The LVBC has a mandate to coordinate, promote and facilitate conservation and sustainable utilization of resources in the Basin. It aims to encourage appropriate stakeholder participation in conservation and management of resources at various levels, including at village, local, national and regional levels.



Fisherman clears Lake Victoria of water hyacinth near Junga, Uganda



Deforestation in Rwanda



# Opportunities

## Food Security

There are various efforts aimed at improving household food security in the Basin, including the Sustainable Land Management (SLM) strategy, and the Mount Elgon Conservation Programme. The LVBC developed the SLM Strategy and Guidelines, with the primary aim of improving both food security and household incomes within the Basin. The SLM strategy and its guidelines have been implemented in all five partner states through the second phase of the Lake Victoria Basin Environmental Management Programme. The LVBC has also partnered with VI-Agroforestry Project, which aims at improving farming and cropping systems at the household level.

The LVBC has been instrumental in implementing the Mount Elgon Regional Ecosystem Conservation Programme with a view to providing a more secure and productive ecosystem by promoting effective transboundary natural resource management (between Kenya and Uganda) and participatory benefit sharing. The Mount Elgon Regional Ecosystem Conservation Programme aims to ensure the sustainable use of shared natural resources, benefiting livelihoods while mitigating against, and adapting to anticipated climate change impacts in the Mount Elgon transboundary ecosystem.

The second phase of the programme addresses the challenges of decreasing land productivity, increasing food insecurity and declining household incomes, while ensuring compliance with conservation measures in the protected areas of the Mount Elgon landscape. The 'landscape approach' – using private sector involvement and climate smart agriculture – is adopted to achieve the three main objectives: conservation, food security and improved household incomes.

## Investment and Infrastructure Development

The LVBC has initiated some projects which address investment, financing and infrastructure in the areas of maritime safety, transport corridors, water and sanitation, and energy. The second phase of the Lake Victoria Basin Environmental Management Programme, the Mount Elgon Regional Ecosystem Conservation Programme and the Lake Victoria Water and Sanitation (LVWTSAN) Programme, are some of the programmes through which the Lake Basin seeks to deliver on its infrastructure needs. The infrastructure development programmes complement those of the East Africa Community, whose main focus is on the improvement of roads and railways, ports, power pools and fuel pipelines, and other infrastructure services.



Woman tending to tomatoes in Kapersor Village, Kapchorwa, Uganda.

## Energy Security

The Lake Victoria Basin has modest potential for hydropower generation. According to Awang and Ong'ang'a (2006), significant potential for hydropower in the Basin is found in Uganda at the Owen Falls, which currently has an installed capacity of 180 MW but has the potential to generate 380 MW; Bujagali and Kalagala have a potential of 320 MW and 450 MW, respectively. Other sites with significant hydropower potential are Kamdini, Ayago and Murchison Falls. The total hydropower potential in Uganda between Lake Victoria and Lake Albert exceeds 2,700 MW. Rwanda has some hydropower potential on the Kagera River, while much of Tanzania's hydropower potential is on the Pangani River. Kenya has some potential on the Nzoia (60MW), Sondu (120MW) and Kuja Rivers (18MW).

The largely undeveloped potential for, not only hydropower, but also solar and geothermal power, is reflected in the lack of access to electricity in the Lake Victoria Basin. Access rates range from 12 per cent in Uganda (more than 27 million people without access), 14 per cent in Tanzania (nearly 38 million without access), and 18 per cent in Kenya (more than 32 million without access) (United Nations Economic Commission for Africa 2014).

In addition to the development of the hydropower sector, East Africa has plans to develop a regional pipeline for the transmission of crude oil. The crude oil pipeline is meant to facilitate the export of crude oil from landlocked Uganda. Over the years there have been plans to extend the Kenyan pipeline for refined petroleum products from the town of Eldoret to Kampala (Awang and Ong'ang'a 2006). Such an expansion would not only cheaply serve Uganda but also Rwanda and Burundi, as well as parts of the Democratic Republic of Congo and Tanzania. It would help ensure energy security for the East Africa Community Member States by securing access to refined petroleum products.

## Better Water and Land-Use Management

The implementation of the SLM strategy and guidelines will, in the long run, improve both food security and household incomes within the Lake Basin. The SLM initiatives in the Basin are particularly important given the large-scale conversion of forests to grass and cropland, causing declines in soil fertility and increased soil erosion. According to the World Agroforestry Centre (2006), areas dominated by grass and crops are 16 times more likely to be affected by severe erosion compared with forest and bushland, while crops grown on eroded soils have an 8 per cent higher chance of crop failure and a 30 to 40 per cent reduction in crop yields.

## Improved Valuation of Ecosystem Goods and Services

The LVBC's Planning for Resilience in East Africa through Policy, Adaptation, Research and Economic Development (PREPARED) Programme is conducting an economic valuation in nine selected Biologically Significant Areas to develop investment plans to improve these ecosystems. The programme is also

developing a framework for a 'Payment for Ecosystem Services' approach as a funding mechanism for natural resource management initiatives.

## Enhanced Adaptive Capacity for Climate Change

The PREPARED Programme is conducting Climate Change Vulnerability Impact Assessments, including mapping and developing climate change adaptation action plans that will address the effects of climate change in the Lake Victoria Basin. The activities under the plans include building the capacity of the EAC and Lake Victoria Basin Commission (LVBC) Secretariat for dealing with matters relating to climate change.

## Policy Enforcement

The Lake Victoria Environmental Management Programme's second phase also seeks to enhance the policy arrangements for the LVB by harmonizing policies on water, fisheries and effluent standards. Additionally, PREPARED Programme is helping to develop legal instruments and enforcement mechanisms for the management of transboundary resources.

## Institutional Capacity Development

Integrated water resources management is one of the key measures for improving the management of transboundary natural resources. In light of the challenges facing the LVB, a Lake Victoria Basin Water Resources Management Plan has been incorporated into the second phase of the Lake Victoria Environmental Management Project. The Plan aims to develop an integrated consideration of the different water uses in view of the availability of resources. It will work to define water allocation and management rules, along with ensuring that overall social and economic goals are achieved. This includes stimulating long-term interventions that promote sustainable economic development and biodiversity conservation in the LVB.

The PREPARED Programme also seeks to build the capacity of partner state institutions in managing transboundary resources.

## Lake Victoria Water Level Monitoring

A Basin Water Simulation Model is being developed through the Nile Basin Decision Support System to monitor Lake Victoria's water levels. Another initiative, soon to be developed, is the Water Release and Abstraction Policy and Monitoring Mechanism for Lake Victoria Basin. This will make it possible to simulate the water balance for the entire LVB based on different operational scenarios, and in the process, obtain a better understanding of the hydrological regime of the entire Basin, including the interaction between surface water bodies and aquifers. The initiative will also simulate chemical transport and nutrient run-off as a way of predicting the various impacts on water quality caused by point and non-point source pollution. The Water Release and Abstraction Policy and Monitoring Mechanism will also help to provide an accurate estimate of current water withdrawal rates and future water demands.





# Conclusion

The natural resource-rich Lake Victoria Basin is prone to small and large-scale, systemic environmental degradation, including, but not limited to, soil erosion, deforestation, water pollution and loss of biodiversity. The challenges affecting the Basin require basin-wide, coordinated management approaches, including land restoration initiatives and integrated water resources management.

Much of the current and planned interventions for the Lake Victoria Basin work at the interface between land and water management; this includes activities that focus on the monitoring of changes in water quality due to sediment and nutrient deposition, while also paying attention to the management of the whole catchment area. While acknowledging the need for basin-wide solutions, it is also important to note that some of the challenges faced by the Lake Victoria Basin are local, and therefore need local solutions. For example, heavy metal pollution, through copper, mercury, lead and cadmium contamination, is concentrated in sediments found in the Mwanza Gulf and, therefore, appropriate actions need to target these particular areas.

Wetlands, which are important for food production, hydrological stability and ecological productivity, continue to be degraded. Shallow wetlands are particularly vulnerable as they are used for the intensive

cultivation of crops such as sugarcane, sweet potatoes and yams; or excavated for sand and clay for brick moulding. Protection and reclamation efforts through national laws and designation as Ramsar sites are slow.

The water hyacinth is the most prominent waterweed in the Lake Victoria Basin; the weed is often blamed for hindering navigation and transport, hydropower schemes and fishing. Efforts to control the weed through mechanical and biological means have produced mixed results and, in many cases, the weed has been able to quickly re-establish itself.

The introduction of the Nile perch – while considered to be a commercial success as a result of a marked increase in export proceeds – is blamed for the loss of close to 200 fish species in Lake Victoria (Kayombo and Jorgensen 2006). It is also blamed for local protein malnutrition as the rising prices have meant that locals can no longer afford to buy.

The institutional arrangements for the management of Lake Victoria are now geared up for the sustainable management of the environmental resources of the Lake Basin through a range of programmes, including the Lake Victoria Environmental Management Programme. Both the Lake Victoria Basin Commission and the East African Community provide the basin-wide forum for the general management of the basin.



Small scale fishing provides the much needed protein to the local household food mix

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Draining an area of 194,200 km<sup>2</sup>, Lake Victoria Basin is one of East Africa's most prominent landmarks. It not only provides the headwaters of the White Nile but is also central to the development and regional integration of the East Africa Community. The Lake itself is shallow but in terms of surface area it is the second largest freshwater lake in the world. Supporting a population of 40 million, the Lake Basin provides a variety of economic and development opportunities, including fisheries, tourism and transboundary conservation. However, these opportunities are hindered by a number of threats that include eutrophication, over-fishing, introduced exotic species and the impacts of climate change.

