LAKE VICTORIA BASIN ENVIRONMENT OUTLOOK

Environment for Development

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List of Abbreviations and Acronyms

AEO	Africa Environment Outlook
AMCEN	African Ministerial Conference on Environment
BMU	Beach Management Unit
CBD	Convention on Biodiversity
CBO	Community Based Organization
CBS	Central Bureau of Statistics
DEM	Digital Elevation Model
DEWA	Division of Early Warning and Assessment
EAC	East African Community
EADB	East African Development Bank
EDEWS	Environmental Degradation Early Warning System
EIA	Environmental Impact Assessment
EWS	Early Warning System
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEO	Global Environment Outlook
HIV/AIDS	Human Immunodeficiency Virus/Acquired Immune Deficiency Syndrome
HPI	Human Poverty Index
ICT	Information and Communication Technology
IFMP	Integrated Fisheries Management Project
IGAD	Intergovernmental Authority on Development
IPCC	Intergovernmental Panel on Climate Change
ITK	Indigenous Technical Knowledge
IUCN	International Union of Conservation Networks
IWRM	Integrated Water Resources Management
KAP	Knowledge, Attitude and Practice
KARI	Kenya Agriculture and Research Institute
KEFRI	Kenya Forestry Research Institute
KEMFRI	Kenya Marine and Fisheries Research Institute
LBDA	Lake Basin Development Authority
LVB	Lake Victoria basin
LVBEO	Lake Victoria Environment Outlook
LVDP	Lake Victoria Development Product
LVEMP	Lake Victoria Environmental Management Project
LVFO	Lake Victoria Fisheries Organization
LVRLAC	Lake Victoria Region Local Authorities Cooperation
MDG	Millennium Development Goals
MEA	Multilateral Environment Agreement
NALEP	National Agriculture and Livestock Extension
NBI	Nile Basin Initiative (NBI)
NEAP	National Environment Action Plan
NELSAP	Nile Equatorial Lakes Subsidiary Action Programme
NEMA	National Environment Management Authority
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
PASS	Pan African START Secretariat

PIC	Prior Informed Consent
POPS	Persistent Organic Pollutants
PPP	Polluter Pays Principle
PSRP	Poverty Reduction Strategy Paper
SARD	Sustainable Agriculture and Rural Development
SID	Society for International Development
SLM	Sustainable Land Management
SOE|	State of the Environment
START	System for Analysis, Research and Training
SWB	Satellite Water Bodies
UBS	Uganda Bureau of Statistics
UN	United Nations
UNCCD	United Nations Convention to Combat Desertification
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
USCCSP	United States Climate Change Science Program
USNSF	United States National Science Foundation
WMO	World Meteorological Organization

Foreword

Lake Victoria Environment Outlook report is the first ecosystem environment outlook report in Africa region. It has been produced in partnership with Pan African START Secretariat (PASS) and the University of Nairobi and many scientists in the riparian states. The report has been prepared within the framework of the Africa Environment Outlook (AEO) process.

The Lake Victoria basin supports a population of over 30 million people most of who are involved in farming or fishing and is one of the most important population centres in the Africa region. The livelihood of people in the basin is closely linked to the quality and integrity of the resource base such as the land and fisheries. The population growth in the Lake basin is higher than in the rest of Africa because of the wealth of natural resources and economic benefits the basin offers. The rapid population growth is putting a lot of pressure on the resources whose regeneration capacity cannot cope with the population increase. Both terrestrial and aquatic resources are undergoing a rapid degradation.

The process of environmental degradation is leading to increasing human vulnerability in the basin. The rural people, with limited livelihood options, have been particularly impacted. Poverty is generally on the increase, and there is a general decline in the populations' health and food security as a result of economic losses due to environmental degradation. Conflicts resulting from competitive access to natural resources are also becoming common.

Lake Victoria Basin Environment Outlook is set within the context of environment and development. In this context, the report explores the plight of people and their livelihoods. It also discusses the existing policy framework for improving these livelihoods and sustaining the environment. In keeping with its integrated nature, the report addresses social and economic issues and their interaction with the environment. The issues addressed include global trade and conflict. Against this background, the report discusses emerging environmental issues and explores the possible future scenarios and outlook for the environment. Such an analysis of the past, current and future opportunities, trends and vulnerabilities presents an opportunity for policy makers in the region to develop strategies for combating environmental degradation in the basin and improve livelihoods. The outlook aspect of the report is intended to stimulate discussions and focus attention for policy development on environment and livelihoods in the basin into the future.

The extensive consultation and the scientific assessments undertaken during the report preparation have concluded that improving environmental quality in the basin requires concerted effort by all stakeholders. The political goodwill demonstrated by the establishment of institutional frameworks for environmental management in all the basin countries needs to be complemented by a comprehensive capacity building process, particularly in the areas of enforcement and compliance. It is imperative to act now since the environmental resources are the fabric of socio-economic development in the basin and their continued degradation is a threat to human livelihood.

The outlook report is an important decision support tool for all stakeholders dealing with the pressing environmental issues in the basin. The information in it can contribute to a further elaboration of an integrated program for environmental management in the region for the Lake Victoria Commission as well as the riparian countries. I hope the report will be useful to all of us, who in one way or another, are in constant interaction with our environment in the basin, either as beneficiaries or managers.

Sekou Toure
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CHAPTER ONE

Social and Policy Framework: Context of People and Livelihoods

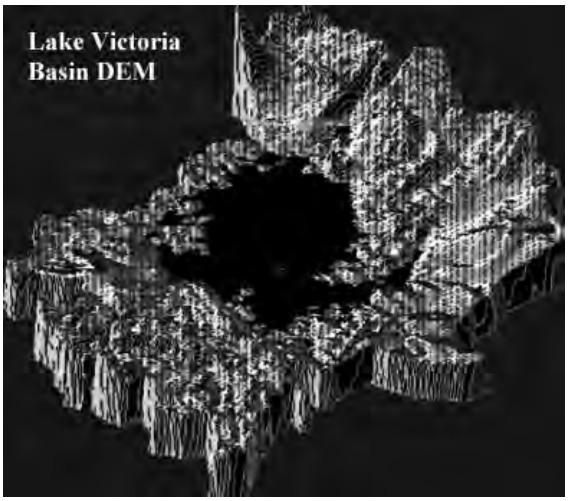
GEOGRAPHICAL SETTING

Lake Victoria basin (LVB) is located in the upper reaches of the Nile River basin and occupies an area of about 251,000km^2 of which 69,000km^2 is the lake area (URT 2001) and is shared by Kenya, Uganda, Tanzania, Rwanda and Burundi (see Tables 1.1, 1.5 and 1.6). The basin contains Lake Victoria, which is the largest freshwater lake in Africa and also the second largest freshwater lake of the world. Lake Victoria has three riparian countries: Kenya, Uganda and Tanzania and draws 20% its water from the Kagera, Mara, Simiyu, Gurumeti, Yala, Nyando, Migori and Sondu-Miriu rivers. The remaining 80% is from direct rainfall. Its catchment area is surrounded by mountains on all sides except for the north (Figure 1.1). The mean depth is about 40 m with a recorded maximum depth of 84 m and the volume of water stored is estimated at about 2,760 km^3. Figure 1.2 shows the drainage pattern in the basin.

Table 1.1: Lake Victoria surface area, shoreline and basin area per country (Shepherd and others 2000)

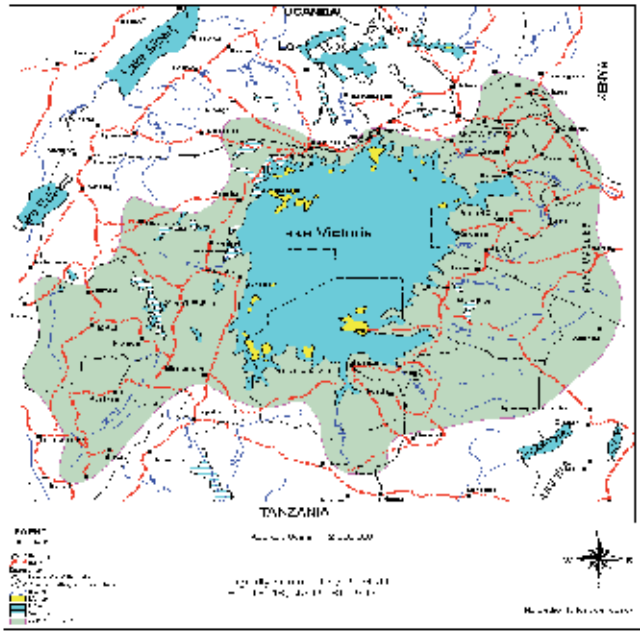
Country	Lake surface area		Shoreline		Tributary	
	km^2	%	km	%	km^2	%
Kenya	4,113	6	550	17	38,913	21.5
Tanzania	33,756	49	1150	33	79,570	44.0
Uganda	31,001	45	1750	50	28,857	15.9
Rwanda	0	0	0	0	20,550	11.4
Burundi	0	0	0	0	13,060	7.2
Total	**68,870**	**100**	**3450**	**100**	**180,950**	**100.0**

Figure 1.1: Lake Victoria basin Digital Elevation Model – DEM[1] (Source: FAO 2002)



1 The physical structure of the basin represented by this DEM determines the main socio-economic and biophysical processes that shape the level of development and environmental management in the riparian states. Opportunities for livelihood sustenance also abound from this DEM. These are, however, moderated by issues of governance.

Figure 1.2: The Lake Victoria basin



DEMOGRAPHIC AND ETHNIC COMPOSITION

The LVB supports one of the densest and poorest rural populations in the world, with densities of up to 1200 persons/km^2 in parts of Kenya (Hoekstra and Corbett 1995). The average population density in the entire basin is about 165 persons/km^2. This is due to its favourable conditions for agriculture, fishing and other economic activities. The average population density on the Kenyan, Tanzanian and Ugandan sides of the basin is 297 persons/km^2, 97 persons/km^2 and 635 persons/km^2 respectively. The growing population, with an average annual growth rate of 3%, exerts increasingly greater pressures on its natural resources. The utilization of these resources is heavily driven by livelihood needs of the inhabitants of the basin. Tables 1.2, 1.3 and 1.4 show some demographic characteristics of the lake basin districts in the three riparian countries.

Table 1.2: Population density of the Kenyan Districts around Lake Victoria

District	Males	Females	Total	Population Density People/km^2
Siaya	220,977	259,187	480,164	316
Bondo	113,583	125,197	238,780	242
Kisumu	248,735	255,624	504,359	549
Nyando	146,635	153,295	299,930	257
Rachuonyo	145,793	161,333	307,126	325
Homa Bay	136,728	151,812	288,540	249
Migori	247,131	267,766	514,897	257
Suba	75,167	80,499	155,666	147
Busia	174,368	196,240	370,608	330
Total	**1,509,117**	**1,650,953**	**3,160,070**	**296.90**

Source: *The Little Fact Book*, 2002

Table 1.3: Population Size and Growth on the Tanzanian side of the lake basin

Item	Mwanza Region	Mara Region	Kagera Region	Average
Land area Km^2	19,592	19,568	28388	22,516
Population	2,929,644	1,363,397	2,028,157	6,321,198
Population annual growth rate (%)	3.2	2.5	3.1	2.93
Sex ratio (males/females)	98	91	97.	95.3
Population % (0-14 years of age)	46.6	48.1	47.3	47.8
Population % (15-64 years of age)	50.1	48.1	48.8	49
Population % (> 64 years of age	3.2	3.8	3.9	3.6
Household size	5.9	5.5	5.2	5.5
Population density	150	70	71	97
Urban population	20.5	18.6	6.2	15.1

Source: National Bureau of Statistics, Tanzania (2001)

Table 1.4: Population Size and Growth on the Ugandan side of the Lake Region, by District

District	Population	Population Density (Persons/km^2)	Growth Rate Per Annum (%)
Rakai	456,400	99	3.0
Masaka	1,015,400	216	2.7
Kalangala	18,400	38	4.1
Kampala	878,600	4,581	4.0
Mpigi	1,121,000	202	2.7
Mukono	1,063,200	179	2.4
Jinja	397,300	428	1.8
Iganga	887,600	210	3.0
Bugiri	283,800	165	4.0
Busia	209,300	232	2.8
Total	**6,331,000**	**635**	**3.05**

Source: MoFPED (1998)

The socio-cultural and socio-economic image of the lake basin is closely intertwined with the livelihoods of the lake region communities, which have ethnic differentials as well as regional universalities. The ethnic composition of the indigenous people around the lake is diverse but they share similar livelihoods. In Tanzania they include: Wahaya, Wasukuma, Wakerewe, Wazinza, Wakara, Wajita, Waruri, Wakurya, Waluo, Wazanaki, Suba and Wamaasai. The main ethnic communities living in the Kenyan side include Luhya, Luo, Kisii, Kuria, Maasai, Suba, Kalenjin and Teso. In Uganda there are the Luhya, Luo, Baganda, Basoga, Teso and Kalenjin. Rwanda and Burundi are inhabited by the Hutu and Tutsi. In the urban centres around the lakeshores, we find a composition of settlers and indigenous people involved in commercial activities, trading and provision of social services. These settlers include Arabs, Asians (mainly Indians in Kenya), Nubians and other ethnic groupings from different parts of the region.

SOCIO-ECONOMIC INDICATORS OF WELL-BEING

The age distribution, which has important implications to labour force supply shows a favourable structure in the sense that the dependency ratio[2] is low with the lower end of the pyramid significantly favourable for future labour force. On the Tanzania side of the LVB the dependency ratio is 106% (Tanzania population census, URT 2002) while for Uganda it is 120% (Republic of Uganda 1994) and Kenya 125%. Livelihood standards of the area have deteriorated as noted by Aseto and others (2003), not just because of the consequences of the population increases, but also through a host of driving forces including agricultural and livestock production that lead to land degradation and declining productivity.

Table 1.5: Population, household and average household sizes of districts in different countries of the lake basin

Sub-Region	Population	Households	Average household size
Shinyanga	2,805.580	445,020	6.3
Kagera	2,033,888	394,128	5.2
Mwanza	2,942,148	495,400	5.9
Mara	1,368,602	246,600	5.5
Total/Average (Tanzania)	**9,150,218**	**1,581,148**	**5.725**
Central	6,200,944	1,290,977	4.8
Eastern	5,701,446	1,079,302	5.3
Western	5,442,399	966,7973	5.7
Total/Average (Uganda)	**17,344,789**	**3,337,072**	**5.3**
Nyanza	4,392,196	986,014	4.5
Rift Valley	6,987,036	1,494,984	4.6
Western	3,358,776	701,323	4.6
Total/Average (Kenya)	**14,738,008**	**3,164,321**	**4.6**

Source: URT, 2002, Population and Household Census; Republic of Kenya, 2001 CBS, 2004 and UBS, 2001

Table 1.6: Selected social indicators for the Lake Victoria basin[3]

Administrative Region	Education (those without formal education - %)	Health (mean distance to hospital - km)	Land ownership (acres)	Basic needs poverty line
Kagera	25	25.1	4.0	29
Mara	24	13.4	8.0	46
Mwanza	27	30.1	6.8	48
Shinyanga	40	18.9	14	42
National average	23	21.3	5.3	36
LVB (Tanzania) Average	29	21.9	8.2	41.3

2 Dependency ratio is used to refer to the proportion of the population supported by the economically active individuals.

3 [a] = Refers to income poverty in 2000. [b] = Refers to Human Poverty Index (HPI) in 2003. HPI measures human deprivation in basic dimensions of human poverty and is the proportion (%) of people left out of progress. HPI includes the adult literacy rate, the percentage of population expected to reach age 40 and overall economic provisioning. The latter is a composite of three indicators – percentage of people with access to safe water, percentage of people without access to health services and percentage of children under five years of age who are underweight.

Central	23	21.5	3.2	25
Eastern	41	34.1	3.4	36
Western	35	42.5	4.7	38
National Average (Uganda)	37	32.4	5.4	39
LVB (Uganda) Average	33	27.8	4.7	34
Nyanza	14.3	12.4	3.35	70.9[a] [42.8][b]
Rift Valley	25.7	18.4	5.9	56.4 [35.6]
Western	14.8	10.8	3.8	66.1 [38.5]
National Average (Kenya)	49.3	24.5	3.95	52.6 [34.1]
LVB (Kenya) Average	18.3	13.6	4.35	64.5 [39]

Source: CBS, 2004, Republic of Kenya, 2000; SID, 2004 and UBS, 2001

LIVELIHOODS, CULTURE AND NATURAL RESOURCES

Livelihoods

The concept of 'sustainable livelihoods' is increasingly pivotal to the debate about sustainable development, poverty reduction and environmental management (Scoones and others 2002). This chapter attempts to bring this new lexicon to the context of socio-economics and sustainable environmental management in the basin. An environmentally sustainable livelihood strategy must (1) create gainful employment for income, production and recognition (where employment provides recognition of food security for any population); (2) lead to poverty reduction; (3) improve the well-being and capabilities of people; (4) encourage livelihood adaptation and reduce vulnerability through resilience; and (5) promote natural resource base sustainability. The people of the Lake Victoria basin have become increasingly vulnerable to environmental change over the last two decades due to natural processes and inappropriate human actions (Birch-Thomsen and others 2001). This report considers sustainable environmental management as a requirement for sustainable livelihood and therefore treats the two as one and the same.

People and livelihoods are at the centre of concern for sustainable development. Human beings are entitled to a healthy and productive life in harmony with nature.

A livelihood comprises the capabilities, assets (including both material and social resources) and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets, while not undermining the natural resource base (Chambers and Conway 1992).

The people of Lake Victoria basin are involved in several activities in support of their livelihoods including fishing, farming, bee keeping, trading activities, quarrying and sand mining and mining of gold and other minerals. The perceptions and practices related to the exploitation of the natural resources are closely intertwined with livelihoods and culture. In Tanzania, for instance, all land belongs to the state and vested in the presidency but customary rights are recognized. Tanzanians may lease but not own land - their right of access and use are therefore insecure as the government may reallocate land to other users anytime. In Kenya, property rights to agricultural land are generally quite clear with most agricultural land being privately owned with clear title deeds. Land in the Ugandan part of Lake Victoria basin is held under a customary system, with patrilineal rules of inheritance.

Culture

The ethnic communities living within the basin have rich culture. The numerous cultural sites that dot the basin provide evidence of this. Cultural sites in the Kagera region in Tanzania include *Kyaya, Bunukangoma* in *Rwamishenye* Division. *Kyaya h*as special type of soil, "*inoni*" which resembles ash, and was used when chiefs were being enthroned. The Luo and Abasuba of Kenya have very many legendry cultural sites. These were places of significant historical phenomena or mythical incidents and rituals. Some of these sites are *Simbi Nyaima*, *Nyamgondho, Lwanda Magere, Kit Mikayi, Thim Iye Lich Ohinga* and legendary islands such as *Atego, Ringiti* and *Mbasa na Muole, Nyama ni Ware*. In Uganda, the sites include *Kabaka Tombs*, *Namirembe Cathedral, Uganda martyrs, Owen Falls* and *Budhaghali* at the source of River Nile. These sites can be explored for an integrated and environmentally friendly eco-tourism.

Cultural practices, beliefs and norms in the basin are closely linked to natural resources management in the basin. A number of socio-economic studies have shown that there are gender differences in utilization of natural resources (Nakijoba 1996; Nanjunya 2001; Ochola and others 2000; Yanda and others). Degradation of resources tends to affect men and women differently as evidenced, for example by the impact of reclamation of Nakivubo Wetlands in Kampala area. It has been observed that declining wetland resources affect women more adversely than men because they utilize wetlands more than men do for their households' food and medicinal resources (Nakijoba 1996). The types of households do have implications on cultural values and beliefs. Polygamy is considered to be a sign of wealth and high social status in some communities. It is also closely linked with poverty. Traditional way of livestock keeping is still practised, but with declining open spaces for grazing and pressure for land, there is a need to adopt "new" livestock rearing practices.

Natural Resources

The exploitation of the basins' resources, including water, fish, mining and agriculture, currently dictates the pace and direction of development as well as the vulnerability and overall wellbeing of the inhabitants (Aseto and Ong'ang'a 2003). The Lake catchment is mainly (80%) an agricultural catchment (Majaliwa and others 2000). The lake basin as a whole (lake and catchment) provides for the livelihood of about one third of the combined population of the three East Africa Community partner states, and about the same proportion of the combined gross domestic product. Subsistence agriculture, pastoralism and agro-pastoralism currently support about 21 million people in the basin, with average incomes in the range of US$90-270 per annum (World Bank 1996). Fishing is by far the most important economic activity for those living in the lakeshore areas. The aftermath of the introduction of Nile Perch and expansion of fish export market to Europe and Asia was a boom in this sector. This has turned the lake from a source of purely subsistence livelihood to a competitive commercialized activity in the riparian countries. The fisheries sector contributes about 3% to the GDP of Tanzania and Uganda and 0.5% to the GDP of the Kenyan economy (Bwathondi and others 2001; URT 2002). The estimated landings for the lake in the late 1980s and 1990s were about 500,000 metric tonnes per year (UNEP 2004). The annual gross economic product (GEP) of the Lake region is relatively low and in the order of US$ 3-4 billion (or 107–143 $US GEP per capita). This ranks the riparian countries in the lowest third of countries of the world on a per capita income basis.

Tourism is a potential major income earner but basin inhabitants do not reap the benefits of the income accruing from the industry. This has led to periodic conflicts in some game reserves such as Masai Mara in Kenya. There is substantial scope to expand the tourism potential and manage the basin's resources sustainably (Ehlin and others 1998). Box 1.1 illustrates the intricate link between the basin's environment and human activities that have continued to define the levels of poverty.

Box 1.1: Poverty and Environment

The relationships between human activity and the physical environment are complex. People everywhere consume water, food, energy and other natural resources in order to live. All economic activities are based on resources from nature. Any productive activity can deplete natural resources and cause environmental stress. On the other hand, environmental problems can prevent people from reaching an acceptable standard of living. This is particularly true for poor people, who tend to rely more directly on their environment for survival than the wealthy. However, all people, not just the poor, need to work for environmental protection to ensure our long-term survival and well-being.

Poverty causes people to put pressure on the environment:

- **Difficulty in meeting the family's needs leads to pressure on marginal lands, over-exploitation of soils, deforestation;**
- **Farming changes imposed on poor families can lead to loss of traditional knowledge about how to protect the environment;**
- **Poor people have limited access to adequate sanitary and waste disposal services.**

Environmental problems cause more suffering among the poor:

- **Soil erosion and salination cause declining crop yields;**
- **Shortages of wood for fuel and other uses make it more expensive to buy;**
- **Overcrowded and poorly serviced urban settlement areas increase the risk of disease;**
- **Environmental damage increases the impact of floods and other natural disasters.**

Other social, economic and political forces adversely affect the situation of both poor people and the environment:

- **The actions of people in developed countries can damage the environments on which poor people in developing countries depend (e.g. Demand for export fish in Europe leading to over-fishing and use of unorthodox fishing methods which harm lake biodiversity);**
- **War and political unrest threaten the environment in Lake Victoria and people's livelihoods, such as in the Great Lakes region of Africa;**
- **Changing land tenure systems means that common lands, once a "safety net" for the poor, disappear.**

It is no wonder that in LVB and indeed throughout the world, the poorest people are increasingly clustered in two types of areas: 1) remote and ecologically fragile rural areas; and 2) the edges of growing urban areas or in poorly serviced sprawling shanties. Poverty alleviation and poverty reduction efforts have in recent years constituted the expressed motivational core of policies of governments in the region.

EXISTING POLICY FRAMEWORK FOR IMPROVEMENT OF LIVELIHOODS

The livelihood of the Lake Victoria basin (LVB) inhabitants who number around 30 million in the five (5) countries of Kenya, Uganda, Tanzania, Rwanda and Burundi is at the centre of the social and policy discussion. The Agenda 21, the Lake Victoria Development Vision and the Lake Victoria Fisheries Organisation (LVFO) all emphasize Sustainable Development (LVFO 2001). The newly revived East African Community's Lake Victoria Development Programme (LVDP) has developed a common vision of the LVB, which together with that of the LVFO are the main guiding institutions for the development and management of the LVB on behalf of the riparian states (EAC 2000). While the LVFO is specific to fisheries for the whole lake, LVDP is concerned with the general development and management matters of the LVB. The two institutions perform the all-important role of bringing together all the riparian partner states through policy harmonisation for LVB resources management and utilisation. Further to these two institutions, two more projects were initiated during the late 1990s, namely the Lake Victoria Environmental Management Project (LVEMP) financed by the World Bank and the Global Environmental Facility (GEF). The other established in 1997 was the Lake Victoria Fisheries Research Project (LVFRP), with the objective of encouraging sustainable development of the LVB

by assisting LVFO in the creation and implementation of a viable regional management of the lake fisheries (Odada and others 2004; LVEMP 2001 & 2003). These initiatives are in concert with collective and separate attempts towards the attainment of Millennium Development Goals (MDG), all of which have some direct or indirect link with the environment. Box 1.2 illustrates the relationship between each of the seven MDGs and environmental management in the lake basin while Box 1.3 summarizes some other initiatives that are relevant to the environmental management of the lake basin resources.

Box 1.2: Examples of the link between MDGs and environment in the LVB	
Eradicate extreme poverty and hunger	Livelihood strategies and food security of people often depend directly on healthy ecosystems and the diversity of goods and ecological services they provide.
Achieve universal primary education	Time spent collecting water and fuelwood by children, especially girls, can reduce time at school.
Promote gender equality and empower women	Women are especially exposed to indoor air pollution and the burden of collecting water and fuelwood, and have unequal access to land and other natural resources.
Reduce child mortality	Water-related diseases such as diarrhoea and cholera kill an estimated 3 million people a year in developing countries, the majority of which are children under the age of five.
Improve maternal health	Indoor air pollution and carrying heavy loads of water and fuelwood adversely affect women's health and can make women less fit for childbirth and at greater risk of complications during pregnancy.
Combat major diseases	A good proportion of total burden of diseases in the LVB may be associated with environmental risk factors. Preventive environmental health measures are as important and at times more cost-effective than health treatment.
Ensure environmental sustainability	Current trends in environmental degradation in the LVB must be reversed in order to sustain the health and productivity of the basin's ecosystem.

Box 1.3: International initiatives of relevance to Lake Victoria basin environmental management

- African Convention (formerly Algiers Convention)
- Initiatives under the East African Treaty
  - Customs Union
  - Protocol for sustainable development of Lake Victoria
  - Protocol on environmental and natural resources management
- Development of new strategy for implementation of IGAD mandate
- The vision and strategy framework for management of Lake Victoria basin
- The Nile Basin Initiative
- The Nairobi Convention (on marine and coastal resources)
- Jakarta Mandate
- African Monitoring of the Environment and Sustainable Development
- The World Bank GEF initiatives on water resources in East Africa

This chapter has highlighted some of the issues related to the socio-economic context of the Lake Victoria basin which have influenced development and shaped the pace and direction of environmental management and livelihoods in Lake Victoria basin, especially over the past two decades. The responses that have been instituted by individual communities, institutions and governments at sub-basin and basin scales have also been presented particularly as they have contributed to the basin's responses to the main environmental challenges. The following chapters discuss many of these issues in greater detail. Chapter 2, 'The State of the Environment and Opportunities for Development', provides more in-depth analysis of the states, trends, values, opportunities, demands and pressures of key assets of the basin that reflect the New Partnership for Africa's Development (NEPAD) programme areas of relevance. Chapter

3, 'Emerging Issues', presents the main environmental issues that have recently arisen as priority areas for the management of the basin's environment to achieve sustainable development. Chapter 4, 'The Outlook 2005-2025', explores plausible future environmental and development eventualities based on assumptions packaged into four different scenarios. Chapter 5, 'Options for Action', presents some of the policy responses needed to resolve some of the environmental and developmental challenges facing the basin.

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CHAPTER TWO

The State of the Environment and Opportunities for Development

INTRODUCTION

The main assets of the LVB lie in its human and environmental resources such as water, fish, minerals and agriculture. These resources are of significant bearing to the development of the basin, and the environmental vulnerability of the basin's inhabitants depends on the successes and failures to capitalize on the opportunities presented by these assets. An analysis of the past, current and future opportunities, trends and vulnerabilities is pivotal to engaging environmental resources in sustainable development in the basin.

> **The problems facing the Lake Victoria Basin are multi- faceted and to understand and solve them requires many different insights and contributions. Some of the factors contributing to the predicament of the basin are the consequence of decisions and policies made in far parts of the world, formerly by colonial powers and more recently by global economic structures. But other contributory factors are cultural, ecological and geographical and require detailed understanding of the lake basin in terms of its anthropology, biology, communities, demography, economy, geography, hydrography,... all the way to zoology (Fuggle 2002).**

As emphasized in Chapter 1, humans are at the centre of sustainable development. The increasing vulnerability of the people of the Lake Victoria basin to environmental change over the last two decades due to natural processes and inappropriate human actions need decisive and appropriate actions which primarily aim at adding value to and efficiently and sustainably utilizing existing resources. The current environmental threats can be turned into opportunities for development. The socio-economic context of the basin, characterized by diversity in demographic and ethnic composition, diversity in economic and occupational activities and institutional arrangements influence the state and trends of environmental assets in the riparian states to varying degrees. Policy responses and reforms can be basin-wide or localized to sub-basins or dependent on the region's socio-economic diversity.

This chapter presents a profile of the opportunities that exist for sustainable development and poverty alleviation through the utilization of the environmental assets of Lake Victoria basin. The assessment of the state and trends of these assets is based on NEPAD programme areas[4] which are relevant to various regional mandates and environment initiatives. The assessments focus on key thematic areas and a wide range of issues that have regional and sub-basin significance. The assessment includes a discussion of major issues for each theme in the lake basin; an overview of the state and trends of the resources with appropriate basin-wide and sub-basin examples; an exposition of the endowment value of various resources; levels of exploitation; and an analysis of the threats to attainment of opportunities linked to these resources for poverty alleviation and sustainable development based on the opportunities framework.

4 NEPAD programme areas include land, forests and woodlands, atmosphere, freshwater, wetlands, human settlements, biodiversity, coastal and marine, human health, energy, technology transfer, natural disasters and gender and environment.

Box 2.1: Environmental Resources of Lake Victoria basin

The lake has breathtaking sceneries and there are possibilities for yachting, steamboat leisure and entertainment, sports fishing and recreation that could be exploited for tourism. The lake is habitat for a great number and wide diversity of invertebrates: fish, reptiles, birds, and mammals.

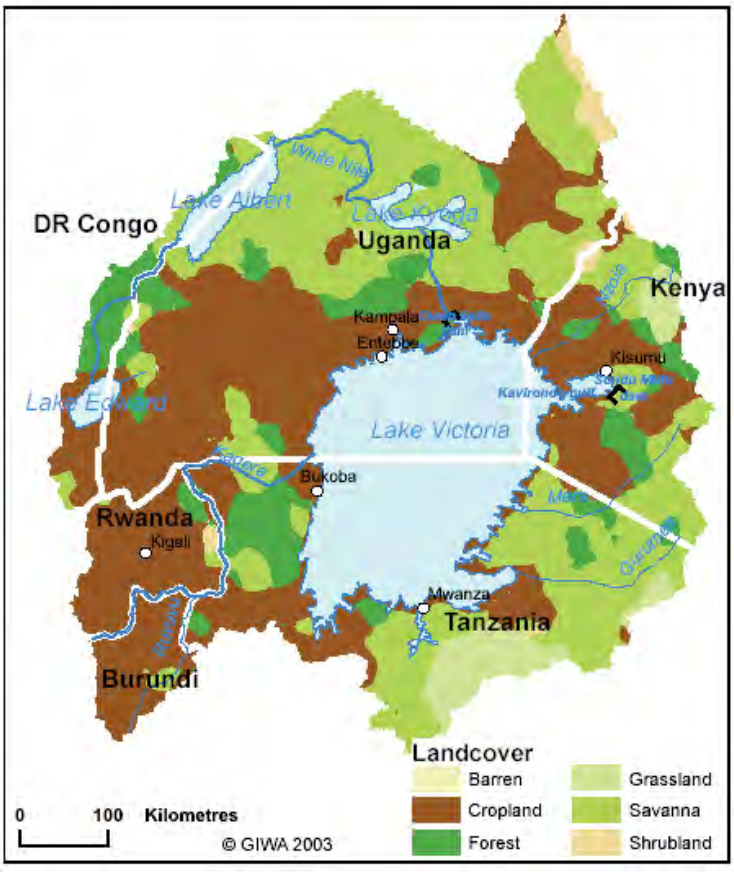
Lake Victoria is an excellent 'road network without pavement' linking three countries in trade and commerce. The precious minerals like gold and building stone deposits in the surrounding areas have become a major income earner for companies and individuals alike. The water resources of the lake basin are used for drinking, bathing, irrigation and electric power generation. The rivers and swamps could become major resources for food production. There is enormous potential for exploitation of all these resources.

LAND

Resource State and Trends

Lake Victoria basin area (land) is 210,000 km^2 (Figure 2.1) while the lake surface area is 69,000 km^2. The incremental loss of natural habitat has reduced vegetation cover exposing soils to both wind and water erosion. Water erosion is extensive in many parts of Lake Victoria basin with approximately 45 percent of the land prone to water erosion (Reich and others 2001). Siltation of dams and the increased risk of flooding in rivers and estuaries are the direct effects of soil erosion and other degradation forces in the basin. The near annual flash floods in Budalangi and Kano plains have been linked to such forces emanating from point and non-point processes (Gichuki 2003).

Figure 2.1: Map of the Lake Victoria basin forest cover and types (UNEP 2004)



The eutrophication of Lake Victoria is clearly linked to land use changes and rapid population growth in the catchment with impacts beginning to clearly affect the lake from about 1930 (Figure 2.2).

Figure 2.2: Principal events in the recent environmental history of Lake Victoria basin, in relation to human-population growth and agricultural production (Verschuren and others 2002)

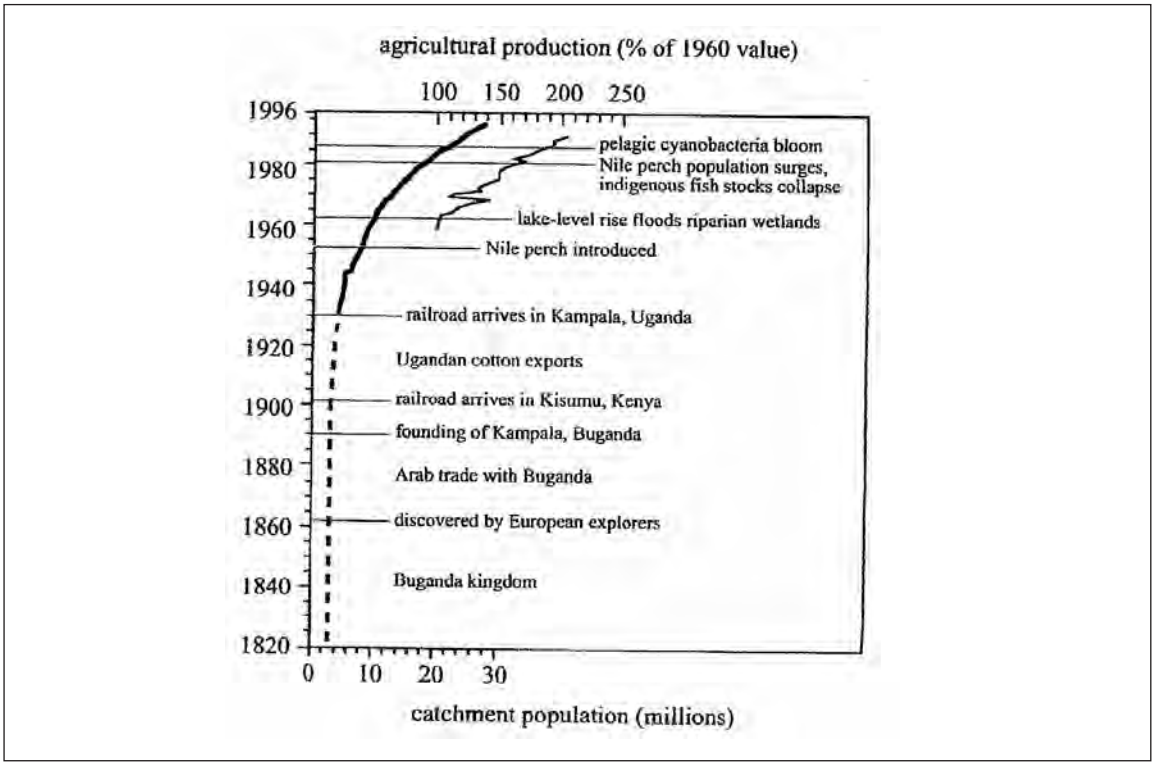
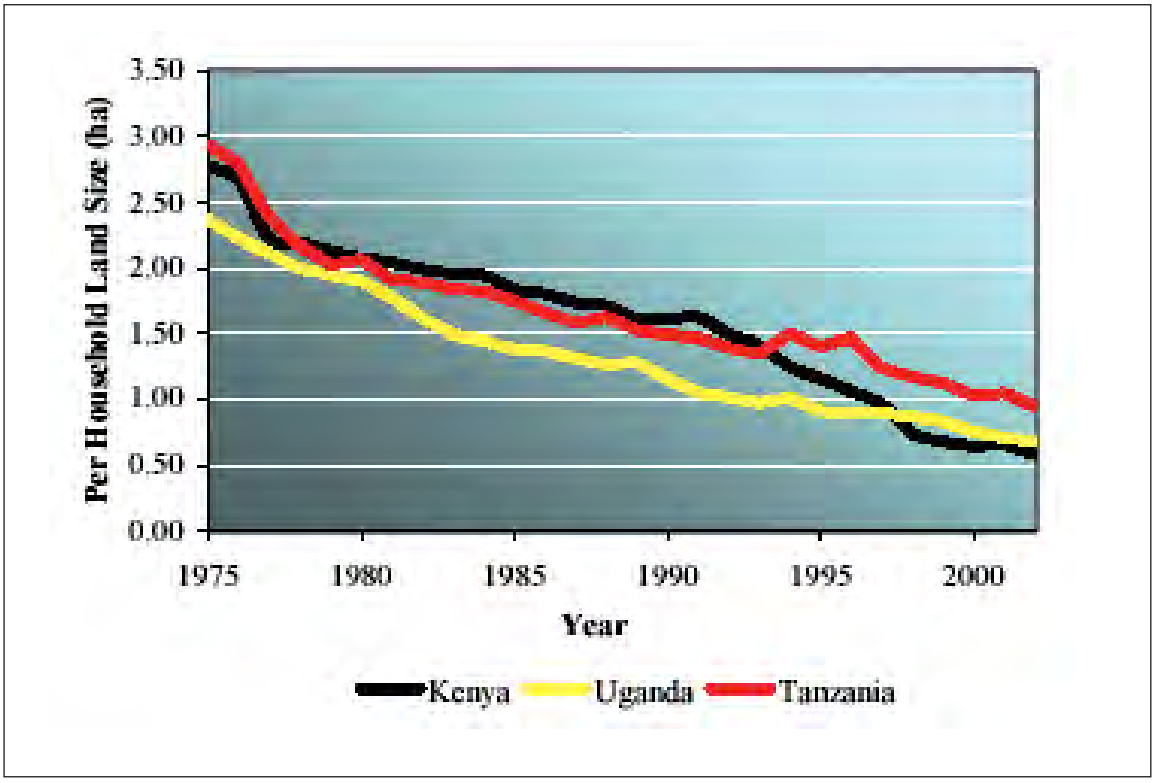


Figure 2.3: *Per capita* land holding of countries in the Lake Victoria basin (FAOSTAT 2004)



Reserves of potentially arable land are mainly the overpopulated pockets of the Lake Victoria basin. Only a small proportion of the basin's land area has favourable agro-ecological conditions for agriculture development. Most of the land has either fragile ecosystems that need to be protected, soils with low fertility and poor texture, biotic constraints such as tsetse fly, or is prone to natural disasters such as floods. Agricultural land is increasingly claimed for urbanization, and urban growth has reached unprecedented proportions in some districts.

Box 2.2: Some statistics about land …

- **Average regional *per capita* land holding is about 0.75 ha.**
- **Average regional per capita income is under 250 US$.**
- **Population increases at an annual rate of 3%.**
- **An estimated 150, 000 km² of land has been affected by soil degradation since 1980 including as much as 60% of agricultural land.**
- **About 75% of wetland area has been significantly affected by human activities and about 13% is severely degraded.**
- **Approximately 46% of the 3,516km² Nyando River basin (or 1,624km²) has experienced severe soil physical erosion.**
- **The efforts needed to meet land use needs for the additional 5 million people in the next 20 years will be immense.**
- **A two-fold reduction of degraded land is necessary in the next 20 years for the growing needs of the inhabitants.**

(Swallow and others 2001)

About 35% of the population had access to arable land during the period 1990-1999 (FAOSTAT 2004) although per capita land holding has been steadily declining in the past three decades to the current average of about 0.75 ha (Figure 2.3). This is expected to fall further to 0.35 ha in 2025. The continuous decline of per capita land size, cultivated land per person, declining soil productivity and worsening soil loss constitute threats to food security, especially where rural populations depend on local land resources for their livelihoods. The most degraded parts of the basin, both in terms of nutrient deficiencies and soil physical degradation, are areas currently used for open grazing and extraction of fuelwood. Areas currently used for subsistence agriculture are also characterized by both types of degradation but at lower prevalence rates than grazing areas (Swallow and others 2001). In the Mara, Mwanza and Kagera regions, clearing of forests has resulted into deforestation, a dominant feature in most parts of the area where land is left bare following the expansion of settlements, livestock keeping, and agriculture (Hongo 2001). Further research is, however, required to establish the linkages between land degradation, and biodiversity and ecosystem change in the lake, its Satellite Water Bodies (SWB) and rivers.

Values, Opportunities and Potential

Land offers vast resources for the lake basin development goals. Land is the most critical resource for the survival of the over 30 million inhabitants of the Lake Victoria basin. In all the riparian countries, agriculture contributes over 30% of the GDP and employs close to 60% of the labour force (World Bank 1998). The opportunities linked to land resources in the basin include production of crops and livestock products for food security, development of human settlements, reclamation of dry lands and marginal lands for expanded economic land use as well as other purposes like ecotourism, urban development and transport. The major factors that are critical to the optimization of these opportunities regard land tenure, land degradation (Box 2.3), land use planning (LUP), proliferation of environmentally sustainable agricultural practices and other land uses such as use of marginal lands, and prevention of loss of arable land.

Demands and Pressures

The urgent need to rapidly transform land use in Lake Victoria basin is underscored by the fact that region's population growth rate of about 3% per year is expected not only to reduce the availability of

land resources *per capita*, but also to accelerate the rate of their degradation. Land resources in the Lake Victoria basin present the inhabitants and their development partners with monumental paradoxes including:

- Enormous natural resource wealth with potentially high endowment value yet majority of the people live in abject poverty.
- It is the home of incredible land use diversity yet the ecosystems are fragile and easily degraded by unsustainable land use.

The continued poverty of the majority of the inhabitants of the Lake Victoria region is linked to the continued land degradation. The present land use and environmental courses of action are largely unsustainable and no longer constitute options to a sustainable future (Swallow and others 2001).

Poverty, in association with unsustainable livelihoods such as sand harvesting, put undue pressure on natural resources. This accentuates the vicious cycle of high population growth rate, poverty and environmental degradation.

Plate 2.1: Sand harvesting along River Awach (Photo by van der Kwast 2002)

Box 2.3: Causes of Land degradation in Lake Victoria basin

- Soil erosion and loss of soil fertility
- Overgrazing
- Unplanned infrastructure development
- Poor farming methods e.g. ploughing on steep slopes, indiscriminate use of inorganic fertilizers
- Cultivation in marginal areas
- Wanton destruction of forests
- Continuous mono-cropping
- Weak institutional collaboration and uncoordinated provision of extension services
- Increasing sedentary habit of pastoral communities

Extreme cases of land degradation caused by rill erosion (a), gulley erosion (b) and sheet erosion (c) in Kano plains.

Photos by: van der Kwast

FORESTS AND WOODLANDS

Resource State and Trends

Resource State

The existing forests and woodlands in the basin reduce soil erosion rate, impede surface run-off and control its release into rivers, lakes and wetlands within the basin. The forest and woodland resources have experienced large, rapid and adverse changes due to rapid population increase, commercialization of timber and fish processing industries, need for agricultural land, unsustainable agricultural practices, increased energy demand, introduction of terrestrial invasive species and lack of appropriate technologies for forests and woodland conservation.

Trends

In 2000, land under forest in the three East African countries were estimated at 30.0-49.9% for Kenya and Tanzania and 15.0-29.9% for Uganda out of their total land area respectively. The deforestation rate was estimated at 0.5-0.9% for Kenya, more than 1.0% for Uganda and less than 0.1-0.4% for Tanzania (Shepherd and others 2000). Woodland areas that used to be over 20% of land area have almost disappeared. Exotic trees have replaced the varieties of indigenous trees. Similarly, many of the original wildlife species that existed in the early 1930 to 1950s have undergone varying degrees of decline.

Value, Opportunities and Potential

A healthy resource base depends on the preservation of the existing forests and woodland reserves (UNEP 2002a). Forests and woodlands play important roles in livelihood strategies of the people of the Lake Victoria basin. They provide resources for use as energy, food, timber and non-timber products. They also sustain many cultural and religious values and the socio-economic development of local industries.

The main issues relating to forests and woodlands include deforestation and declining forest quality, incomplete inventory, monitoring and management, unsustainable governance with poor community involvement as well as unsustainable exploitation. Conservation of the forest reserves in the basin would provide opportunities for biodiversity conservation and economic returns through ecotourism, leisure activities for local communities, habitats, medicinal benefits, technological advancement and research, catchment protection against soil erosion and climate regulation.

Box 2.4: Environmental and socio-economic value of forests and woodlands in Lake Victoria basin

As ecosystems which support rich and diverse flora and fauna, forests and woodlands of the basin provide myriad resources and environmental goods and services. Forests and woodlands in the lake basin support an estimated 150,000 plant and animal species with invaluable economic value to the human populations in terms of shelter, food, energy needs (both industrial and domestic) from wood and charcoal. Because these ecologic benefits accrue not only to the inhabitants of the basin, it is impractical to estimate their economic value. Forests and woodland resource endowments include:

- Medicine
- Fruits
- Honey
- Wild meat
- Firewood
- Thatching grass
- Building materials
- Fodder
- Utensils
- Timber
- Materials for mats and baskets
- Soil fertility
- Water
- Erosion control
- Good air
- Shade and shelter
- Vegetables

Demands and Pressures

The great endowment value of Lake Victoria forest and woodland resources means that the high deforestation rates witnessed hitherto are a serious issue that must be immediately addressed. The combined impacts of the unsustainable use of forest and woodland resources have led to reduced cover of indigenous forests, increase in general vegetation loss, and loss in catchment endowment values such as soil erosion and sedimentation; enhanced climate variability; reduced surface water quantity; reduced groundwater quality and recharge; and loss of biodiversity.

The driving forces for the pressures causing this depletion of forests and woodlands value are complex and as diverse as the ecosystem and socio-economic set up of the basin. These forces are both natural and anthropogenic and lead to the current states and trends either directly or indirectly. They include commercial lumbering activities for timber industries in the region, clearing for agriculture and other land use types such as urban expansion, infrastructure and grazing. Population expansion, forest and environmental policies, laws and economic forces are the indirect pressures. According to FAO (2001), the demand for charcoal and other forms of fuel wood will increase by over 40% in the wider Eastern Africa region over the next 30 years. The situation is similar in the lake basin. The natural forces of forest depletion in the basin include fires, floods, landslides and changes in river courses such as in river Nyando as it enters Lake Victoria. The natural causes are more often than not precipitated by anthropogenic actions in the basin (Plate 2.2 and 2.3).

Plate 2.2: Wanton destruction of indigenous and exotic forest trees through clearing and burning causes loss of forest cover

Plate 2.3: Charcoal market at Jinja, reflecting deforestation on the islands in Lake Victoria (Photo - D. Verschuren)

FRESHWATER

Resource State and Trends

Resource State

Lake Victoria basin has vast fresh surface and groundwater resources (Table 2.1). Lake Victoria is the second largest freshwater lake in the world presenting the area with enormous aquatic resources. Surface water systems and groundwater aquifers constitute the main freshwater reservoirs in the basin. The groundwater aquifer systems in the basin constitute a relatively little understood but vital water reservoir especially in the hinterland. Lake Victoria receives 80% of its water from direct precipitation (Table 2.2). The remainder comes from rivers which drain the surrounding catchments. The most significant of these rivers, the Kagera, contributes roughly 7 percent of the total inflow, or one half of that from the rivers, over and above direct precipitation. Some 85 percent of the water leaving the lake does so through direct evaporation from its surface, and the remaining 15 percent largely by way of the Nile River outflow.

Table 2.1: Demographic and biophysical characterisation of the inlet drainage basins of Lake Victoria (from Shepherd and others 2000)

River basin name	Countries sharing basin	Est. basin size (km^2)	Ave. est. 2000 pop. Density (people/km^2)	Est. total pop. In 2000	Ave. annual rainfall (mm)	Ave. sediment transport capacity index*	Ave. % slope
Nzoia / Yala	Kenya	15,143	221 (±154)	3,346,000	1,306	0.14	2.3
Nyando	Kenya	3,517	174 (±127)	611,000	1,360	0.30	5.0
Sondu Miriu	Kenya	3,583	220 (±148)	788,000	1,415	0.14	2.3
Gucha	Kenya	6,612	224 (±183)	1,481,000	1,300	0.16	2.0
Mara	Kenya Tanzania	13,915	46 (±56)	640,000	1,040	0.15	2.0
Gurumeti	Tanzania	12,290	21 (±26)	258,000	879	0.12	1.6
Mbalaget	Tanzania	5,702	37 (±22)	211,000	766	0.05	0.6
Duma / Simiyu	Tanzania	9,702	50 (±26)	485,000	804	0.06	0.5
Magoga / Muame	Tanzania	5,104	88 (±47)	449,000	842	0.05	0.4

Table 2.1: (Contd.)

Isonga	Tanzania	8,972	48 (±22)	430,000	897	0.04	0.3
Kagera	Tanzania Uganda Rwanda Burundi	59,158	181 (±196)	10,711,000	1,051	0.24	3.0
Lake edge	Kenya Tanzania Uganda	40,682	133 (±175)	5,411,000	1,077	0.21	1.4

* Areas with high indices are those with higher risk of erosion.

Table 2.2: Lake Victoria annual water balance 1965 -1995 (World Bank 1996)

Water balance Component	Volume (km^3)	Lake level equivalent (m)
Lake rainfall	125	1.81
Lake evaporation	110	-1.6
Lake net rainfall	14,5	0.21
Catchments rainfall	293	n.a.
Catchments evaporation	270	n.a.
Inflow from catchments	23	0.34
Net basin supply	37,5	0.55
Outflow (Owen Falls)	38	-0.57

The main freshwater issues in the basin include water quality and quantity deterioration, water supply availability and accessibility, low technological investment, exploration and assessment of freshwater potential, rampant waterborne diseases and transboundary water management concerns. The lake is the final destination of factory effluent, oil and grease and sewage from the urban centres, and oil spillage from transportation.

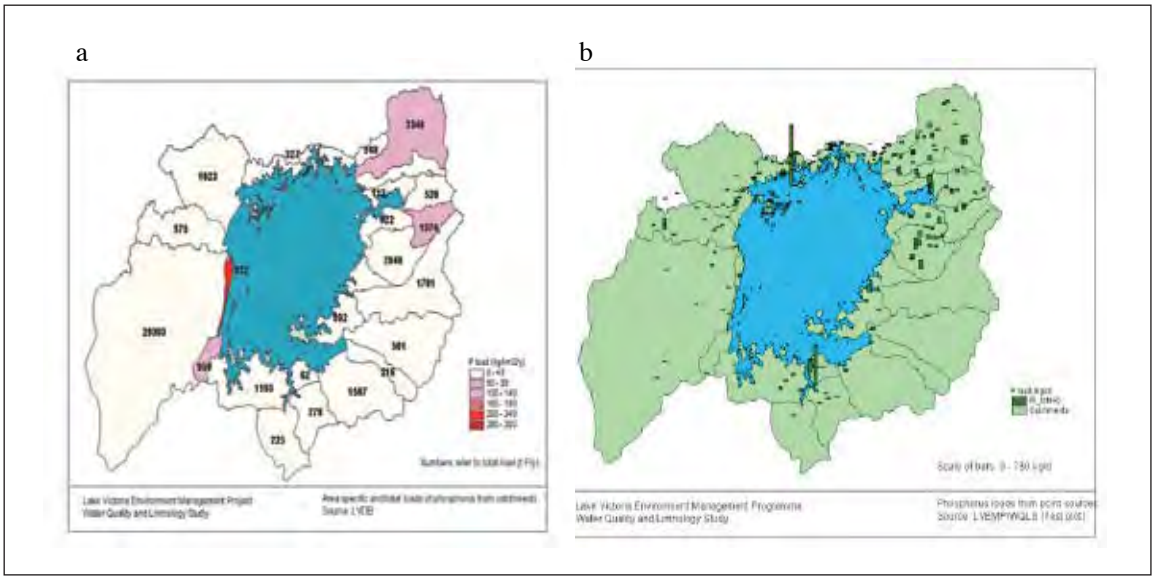
Box 2.5: Rivers in the Kenyan drainage basin

In 1940-60 the Lake Victoria water was clear and filled with life. Today it is murky, smelly and choking with algae. The water quality deterioration has been a result of poor planning, maintenance and inadequate investment in municipal wastewater treatment systems that have contributed to the increased untreated effluent discharge. Table 2.3 gives the number of urban centres with sewered and unsewered urban populations in the lake catchments. The combined nutrient loads from all sources has contributed to the loss of oxygen and build up of the total phosphorus and nitrogen content in the lake. Figure 2.4a shows that the phosphate load from in the catchments ranges from 62 to 29,363 t P/yr. Rivers that drain the areas transport the phosphate content to the lake due to high soil erosion in the catchments. Measurements of total phosphorus flux at point sources (Figure 2.4b) in the lake basin show concentrations ranging from 0-730 μg/d. These are high flux rates that have negative effect on the ecology of the lake.

Table 2.3: Number of sewered and unsewered urban populations in the catchments of Lake Victoria basin (Scheren and others 2000)

Country	Total population (1000 people)	Sewered Urban population (1000)	Unsewered Urban population (1000)	Number of towns
Kenya	10,200	390	630	18
Uganda	5,600	210	870	9
Tanzania	5,200	27	340	4
Rwanda	5,900	-	400	5
Burundi	2,800	-	140	4
Total	**29,700**	**627**	**2,380**	**40**

Figure 2.4: Extent of water pollution in Lake Victoria basin shown by (a) phosphate load in the catchments and (b) total phosphorus flux at point sources. (LVEMP 2002)



Other issues worsening the freshwater challenges are unsustainable population pressure, poorly planned industrialization and urbanization, water as a source of energy, outdated cultural practices such as superstition towards use of pit latrines, unsustainable agricultural practices, loss of freshwater biodiversity, over-exploitation of fisheries resources and introduction of aquatic invasive alien species.

Box 2.6: Water and health

The main water-borne diseases in the Lake Victoria region, which are influenced by scarcity of clean water include cholera, typhoid, dysentery, and certain intestinal parasites. Increased human contact and exposure to the lake water in the cities and the fishing villages occurs through fish landing, trading, transport, recreational swimming, bathing, collecting water and washing household items in the lake.

Box 2.7: Water hyacinth and health

Water hyacinth disrupted socio-economic activities especially fishing, water transport, and hydro-electricity generation, and led to increased water abstraction and treatment costs. Large stationary mats of hyacinth smothered fish nurseries and feeding grounds while the hypoxia and poisonous gases under the mats displaced biodiversity and fish. Narrow, sufficiently oxygenated mats of hyacinth provided nurseries for young fish, refugia for young and small fishes; and supported a range of biodiversity. Fish species tolerant to low oxygen concentrations such as the lungfish and catfish, flourished even in less hospitable zones of stationary water hyacinth mats particularly after the subsequent succession with hippograss.

Deforestation coupled with poor agricultural practices have led to an accelerated rate of river sediment transport and sedimentation in aquatic environments including Lake Victoria. The high sedimentation rate has been contributed mostly by Kenyan rivers and by Kagera River. The quality of Lake Victoria's water is further exacerbated by large discharges of untreated sewer and chemical wastes from urban centres as well as microbacterial and nutrient laden runoff from pastoral and agricultural land, shrub-lands, forests and municipal slums.

Pesticides have been introduced either directly by fishermen or indirectly through runoff from agricultural areas (Table 2.4). The levels detected are much lower than the WHO guidelines for daily intake of drinking water, however, they become significant considering magnification through the food chain (Madadi 2004).

Table 2.4: Comparison of pesticide residues in water from Rivers Sio, Nzoia and Lake Victoria (µg/l) (Madadi, 2004)

Pesticide	R. Sio (n=9)	R. Nzoia (n=9)	Sio Port Beach (n=9)	Marenga Beach (n=9)
_-HCH	0.02-0.03	0.01-0.04	0.01-0.05	0.01-0.3
_-HCH	0.01-0.05	0.01-0.06	0.01-0.05	0-0.10
_-HCH	0.04-0.11	0.04-0.06	0.05-0.09	0.03-0.07
p,p'-DDT	0.02-0.13	0.07-0.09	0.07-0.09	0.01-0.09
o,p'-DDE	0.08-0.16	0.02-0.15	0.02-0.09	0-0.09
p,p'-DDD	0.02-0.10	0.08-0.18	0.07-0.14	0.04-0.18
_-Endosulfan	0.12-0.23	0.05-0.11	0.02-0.15	0.06-0.13
Endosulfan sulphate	0-0.19	0.07-0.10	0.01-0.15	0.07-0.14
_-Endosulfan	0.09-0.18	0-0.14	0.03-0.09	0-0.09
Aldrin	0.17-0.34	0.03-0.20	0.07-0.14	0.05-0.10
Dieldrin	0.07-0.10	0.18-0.36	0.09-0.18	0.12-0.31
Endrin	0.03-0.17	0.05-0.22	0.08-0.11	0.04-0.09
Heptachlor	0.03-0.17	0.10-0.15	0.08-0.15	0.05-0.10
Heptachlore	0.03-0.15	0.06-0.12	0.08-0.15	0.05-0.11
Methoxychlor	0.02-0.86	0.02-0.08	0.04-0.07	0.02-0.14

Measurements of heavy metals like copper, zinc, manganese, iron, cadmium, lead and chromium have been carried out in various media of the lake by various researchers, and they find that, generally, sediments have higher trace metal concentrations than water and other living organisms in the lake (e.g. Wandiga and Onyari, 1987; Onyari and Wandiga, 1989). Recent evidence indicates that gold mining activities along the shoreline or upstream may be introducing toxic cyanide and mercury into the lake, for example, mercury presence has been documented in large Nile perch, weighing more than 5-10 kilograms (kg) with concentrations usually exceeding 200 ng/g in fish tissue (Campbell 2000).

Trends

The quality of the lake water has deteriorated in several respects (Hecky and Bugenyi, 1992), and has been associated with human activities in both the catchments and near shore areas. Historical monitoring data are scarce and hamper apportioning of responsibilities. Furthermore, the dynamic and complex nature of ecosystem changes have not been delineated to allow assessment of the impacts of catchment changes on the lake. What is apparent is that the onset of massive cyanobacteria blooms offshore took place at the same time the indigenous fish stock collapsed. The lake depth, bottom oxygen content and transparency (the Secchi index decreased from 5m in 1930 to less than 1m in 1990s) have decreased, while sediment and water phosphorus and nitrogen concentrations have increased (Hecky, 1993). Hence the lake bottom is eutrophicated during some seasons of the year. Increased nutrient flows into the lake coming mostly from agricultural land and forest areas have been estimated to range between 69×10^7 kg/yr to 1.98×10^{10} kg/yr (Verschuren and others 2002) with resultant plume expansion in the lake: the lake receives 2.3 mm per year of sediment load (silt, P, N and others) (Odada and others 2003; Verschuren and others 2002). Paleolimnological evidence show that most of the land changes and hence sediment deposits in the lake occurred after 1940 with the heaviest deposits occurring between 1970 and the early 1980s. The paleolimnological data established a strong chronological link between historical land use and algal production in the lake (Verschuren and others 2002). The dissolved oxygen concentration may be as low as <1 mg O_2/ l for up to ten months in a year in the deeper parts of the lake, while seasonal anoxia is observed in the shallow waters. From a few studies, it has been calculated that the year-round bottom oxygenation was adequate in the last 140 years before the 1960s. After this the deep-water anoxia started to deteriorate and reached its current spatial extent in the late 1970s

(Verschuren and others 2002). Therefore, the loss of oxygen in the lake has been a slow process that took several years to manifest. It has been occurring in the lake for the past 30 years and will take the lake much longer to recover to a life sustaining level if all the nutrient loads were stopped today.

Value, Opportunities and Potential

Water is a major factor of production and investment in agriculture, industry, fisheries and other sectors. Large water bodies such as Lake Victoria provide useful navigation and transport. Virtually all the features of Lake Victoria basin outlined in Chapter 1 and elsewhere in this chapter including vegetation cover, livestock, human population and all socio-economic livelihood activities are fundamentally influenced by availability of freshwater. In countries around Lake Victoria, fisheries contribute 3-5% of GDP (LVEMP 2005). Freshwater fisheries also contribute significantly to export earnings. In Uganda, for example, fish exports are among the two most important export sectors. Lake Victoria supports the most productive freshwater fishery in the world with annual fish yields in excess of 500,000 tons worth 600 million USD annually.

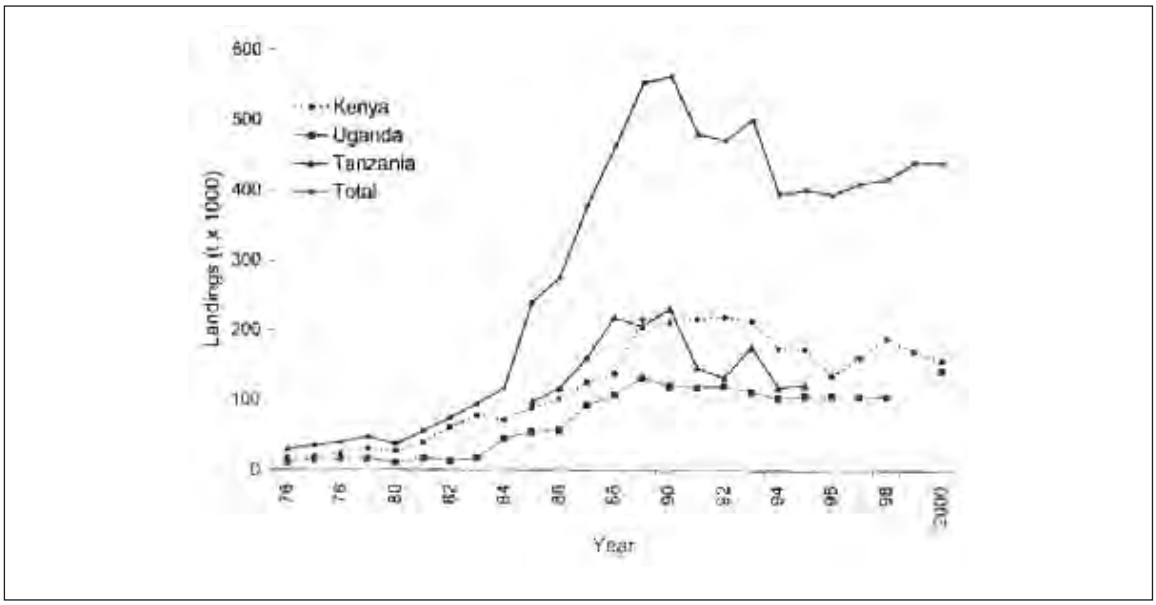
Plate 2.4: A beehive of activities in a beach on Lake Victoria (Photo: Obiero Ong'ang'a)

Demands and Pressures

Effluents from urban and rural settlements affect water quantity and quality. Millions of litres of untreated sewage sludge flow into the lake every day from major urban centres along the lake shore (Scheren and others. 2000). Faecal contamination is one of the commonest surface water quality problems. Unprotected wells and springs exposed to contaminated storm water are particularly vulnerable especially at the onset of the rainy season. Groundwater, in heavily settled areas where pit latrines are not properly sited relative to the water sources, is often contaminated with faecal coliform. Proper effluent treatment from such settlements is a necessary prerequisite to improvement of water quality, but such facilities are non-existent, obsolete or inadequate. Unsustainable farming practices especially in the hilly zones of the Lake Victoria basin generate serious soil erosion. Other sources of water contaminants include mining (associated with heavy metals), municipal sewage and industrial effluents (excess nutrients, faecal coliform, BOD, heavy metals).

Introduced predatory Nile perch has given rise to a booming, largely export-driven, commercial fishery. Nile perch has, however, also been linked to the decimation of about 300 species of haplochromines through predation. Most of the fishes were algal grazers and their decimation is believed to have contributed to the accumulation of algal biomass whose decay enhanced anoxia and nutrient recycling. Excessive fishing effort and destructive fishing practices, resulted in even further fish stock depletion (Figure 2.5).

Figure 2.5: Total landings (t) of fish in the three riparian countries of Lake Victoria (from Knaap and others 2002).



Changes in water resources, their impacts, responses and opportunities available

Deforestation coupled with poor agricultural practices have led to an accelerated rate of sedimentation. Increased sediment influx is mainly from Kenyan rivers and Kagera River. The quality of Lake Victoria's water further is further impacted by large discharges of untreated sewage and chemical wastes from urban centres as well as microbacterial and nutrient laden runoff from pastoral and agricultural land, shrub-lands, forests and municipal slums. Pesticides have largely been introduced into the lake through runoff from agricultural areas. Recent evidence indicates that mining activities along the shoreline or upstream may be introducing toxic cyanide and mercury into the lake.

As a result of the above mentioned ecological changes, the impacts on the lake have been eutrophication, declining water quantity, increase in water-borne diseases, emergent diseases, proliferation of invasive fauna and flora, loss of biodiversity, increasing floods and droughts frequency, proliferation of cyanobacteria and hypoxia in parts of the lake, reduced species habitats and diversity, and change in trophic diversity.

ATMOSPHERE

Resource State and Trends

Resource State

The Lake Victoria basin enjoys a relatively unpolluted atmospheric environment. This may not remain so for a long time if industrialization is embarked on as the means of development replacing the present preoccupation with agriculture as the major industry. A few industries such as the Webuye Paper Mills in Kenya are associated with localized air pollution problems (Plate 2.6). The main issues concerning the atmosphere would be climate change, climate variability and air quality and their impact on health, food security and human settlement. Most of the farming systems in the lake basin are associated with slash

and burn land management practices. Nutrient loads to the Lake are associated mainly with atmospheric deposition (natural and biomass burning) and land run-off (e.g. agriculture), and these together account for about 90% of phosphorus and 94% of nitrogen input to the Lake (Scheren and others 2000; UNEP 2004). Studies need to be carried out to quantify atmospheric and runoff contributions to the nutrient loads in the lake and its environs.

Human dependence on rainfall is basic to socio-economic development in the Lake Victoria basin where rain-fed agriculture is the main source of food and income. A direct empirical relationship exists between human population pressure and high rainfall reliability and intensity in various parts of the lake basin. Densely populated basin zones of Mt Elgon districts in Uganda and Kenya, the Kisii highland of Kenya and much of Rwanda receive relatively higher precipitation. Similarly, the extensive catchment forests on the slopes of Mt Elgon and some shores and islands of Lake Victoria are positively correlated with the high rainfall in those locations of the basin.

Plate 2.5: A beautiful sunset over L. Victoria (Photo: S.O. Wandiga)

Plate 2.6: Emissions from Webuye Paper Mills (Photo: Obiero Ong'ang'a)

Trends

Climate change, through the balance of temperature and rainfall will affect the hydrological cycle and hence freshwater systems in the region (IPCC 2001). Recent climate studies in Lake Victoria basin show general increase in temperature from the 1960s. For example, maximum temperatures in Kericho (Kenya) have increased by 3.48°C from 1978 to 1999 (Wandiga and others 2006). Less dramatic but equally significant temperature rises have been recorded in other parts of the basin (Wandiga and others 2006). Lake Victoria is now one-half a degree (°C) warmer than in the 1960s (Hecky and others 1994; Bugenyi and Magumba 1996), in harmony with changes in surface temperature at tropical elevations above 1000m worldwide. The strong El Niño's of the past decades have been associated with cholera and malaria epidemics in Lake Victoria basin. Generally higher temperatures may increase the risk of malaria in the highly vulnerable communities in the lake basin highlands.

The Lake Victoria basin has not been spared the effects of natural and climate change disasters. In the past few decades the region has experienced a number of severe droughts and floods that are probably linked to climate change (UNEP 2004). Serious droughts were witnessed in 1984, 1987, 1992 and 1999. There is evidence of increasing intensity of the drought incidences in the region. The rain failures associated with such droughts have had serious implications on the environment and livelihoods of the people including crop failures, severe water shortages and reductions in water quality and decline in energy generation capacities due to low reservoir levels. These have invariably affected food security, and forced the introduction of water and power rationing schemes, causing significant interruptions of economic activities in the basin. On the other hand, the strong El Niño years such as the 1982-3 and the 1997-8 events tended to rapidly raise the lake level and caused widespread flooding along the lakeshore and rivers (Birkett and others 1999; Conway 2002). For example, the El Niño phenomenon in 1997-1998 saw water level rise by 1.7 m (Lake Victoria), 2.1 m (Lake Tanganyika) and 1.8 m (Lake Malawi) (Birkett and others 1999). The widespread heavy rainfall and flooding produced adverse wide-ranging agricultural, hydrological, ecological and economic impacts in east Africa (Conway 2002).

Value, Opportunities and Potential

The opportunities that abound through the atmosphere include investment in new and renewable energy like wind and solar; strengthening of the existing atmospheric monitoring systems, source of water through untapped precipitation (e.g. rainwater harvesting), potential to support agriculture and tourism, strategic investment in air pollution control, adoption of cleaner technologies, adoption of the polluter pays principle (PPP) and development of early warning systems to monitor atmospheric and climatic changes and associated natural disasters as well as human vulnerabilities.

Demands and Pressures

Although there is relatively low level of industrialization and urbanization in the basin with resultant negligible green house gas emissions as compared to the global situation, impacts of climate change are however felt in the basin in terms of food security. This is through the already experienced unpredictable and spatial variations in rainfall, increased temperatures and increased evaporation. The frequent floods experienced in the flood plains of the basin may be loosely linked to such global climate change.

ENERGY

State and Trends

Energy resources available in the Lake Victoria basin include biomass, petroleum and other renewable sources of energy. Biomass energy sources in the basin are classified into two categories: (1) traditional biomass energy, that is, firewood, charcoal and agricultural residue; and (2) modern biomass energy, including bio-fuels (ethanol and bio-diesel), biogas and briquettes.

Traditional biomass energy is a major source of livelihood for the population in rural and urban areas in the Lake Victoria basin. Woody biomass is the preferred source, with others such as agricultural residue consumed only when woody biomass is in short supply. Increasingly, woody biomass is being converted to charcoal and contributes to environmental degradation through loss of biodiversity and soil erosion. The cottage industry sub-sector is a major consumer of biomass energy. Micro enterprises in the rural areas use biomass energy for brick making, tobacco curing, milk processing, in fishing and fish smoking, bakeries, restaurants and kiosks, to name but a few.
Modern biomass energy sources include the more convenient forms such as gases or liquids including power alcohol, cogeneration, municipal waste and biogas. Power alcohol was marketed in Kenya as a fuel blend with gasoline, known as gasohol, between 1983 and 1993 but was discontinued thereafter because of management and pricing problems due to high production cost.

Value, Opportunities and Potential

In the lake basin there exist opportunities for co-generation (combined heat and electricity generation). Kenya is among the riparian countries with some experience in co-generation using bagasse (a waste product from sugar processing) as a primary fuel since Kenya's lake basin is home to the bulk of domestic sugar factories. All the seven sugar companies in the region have been involved in one way or another in co-generation but only Mumias Sugar Company is self-sufficient in electricity from the use of bagasse and has a limited capacity for export to the national grid. Nevertheless, opportunities exist for increased co-generation, not only in Kenya, but also in other riparian countries, particularly Uganda.

Other forms of energy like municipal waste, biogas and petroleum can be exploited within the basin. The transport sector accounts for the largest share of petroleum consumption. The industrial sector is also a major consumer of petroleum products. In addition, the residential sector consumes significant quantities of petroleum products in the form of kerosene and liquefied petroleum gas (LPG). Lake Victoria basin is well endowed with significant amounts of renewable energy sources, including biomass, hydropower, solar and wind. The contribution of renewable energy to total energy supply is currently very low, estimated at less than one per cent; these energy sources, however, have the potential to significantly improve access to improved energy services for majority of the population. Renewable energy sources can, in the long term, be harnessed to meet a significant portion of the basin's energy needs without impairing the ecosystem. Furthermore, with prudent management, these resources would contribute to the security of energy supply at increasingly competitive prices and to national development.

There is a huge hydroelectric resource potential from the major rivers flowing into Lake Victoria. Detailed resource assessments have only been done for a small number of sites in the whole region; there is, therefore, need to carry out comprehensive assessment of these resources. In addition, there is a large potential in the category of small-scale hydropower sites currently considered to be uneconomical to exploit. A variety of factors have constrained the exploitation of small-scale hydro resources. High costs, lack of awareness on the part of users and destruction of catchment areas are among the key factors contributing to the low level of exploitation. Shortage of data on hydrology and on comparative economics of these power sources as well as lack of infrastructure for local manufacture is a major drawback to the exploitation of the small hydro resources. Renewable energy sources have the potential to meet energy demand for various sectors of the economy and to substantially meet national social objectives.

Box 2.8: The challenges and opportunities of renewable energy in Lake Victoria basin

The potential for exploitation of renewable energy sources in Lake Victoria basin is limited by a number of factors including high costs and limited priority accorded them by policy- and decision- makers and planners. In order for these energy sources to play a significant role in meeting the energy demands in the various sectors of the economies of the riparian states, the following challenges must to be overcome:

- **high capital costs of most renewable energy sources;**
- **low priority given to renewable energy development in national development and planning;**
- **lack of appropriate credit and financing mechanisms for renewable development and technologies;**
- **lack of institutional, legal and regulatory frameworks or development of renewable sources of energy;**
- **lack of awareness and information on energy opportunities and economic benefits offered by renewable sources of energy;**
- **inadequate data on renewable sources of energy resource potential;**
- **high cost of undertaking feasibility studies and associated viability risks (small hydro, wind, solar/ thermal);**
- **limited local capability to manufacture and maintain renewable energy systems;**
- **inappropriate system standards, faulty installations and importation of poor and sub-standard systems which have led to erosion of consumer confidence;**
- **market barriers;**
- **lack of adequate information on potential environmental impacts arising from production and use of energy; and**
- **inadequate priority given to research and development on renewable energy sources.**

Demands and Pressures

The demand for energy is increasing in proportion to the increase in population. This demand is possibly one of the major factors in land, water and soil degradation due to deforestation. A second impact derived from use of low quality energy is the high rate of acute upper and lower respiratory diseases. The number of persons that are seen in hospitals as a result of respiratory diseases is third largest after malaria and HIV/AIDS.

Energy drives any environmental management and economic growth in the basin. Further growth in the lake basin economy will, therefore, result in increased needs for energy services with emphasis on:

- Facilitating the development of income generating opportunities;
- Improving living standards such as in health, and provision of educational services;
- Reducing poverty;
- Ensuring the protection of the environment.

As an asset in the Lake Victoria basin environment, energy is a driver for development through the existence of new and renewable energy resources.

BIODIVERSITY

Resource State and Trends

The lake basin is rich in biodiversity although the natural habitats are under threat from rapidly increasing human population. The main biodiversity of the lake basin consists of fish species, birds, and higher vertebrates like amphibians, reptiles and mammals as well as several plant species. A total of 31 amphibian, 28 reptilian and 44 mammalian species have been recorded from various sites in Lake Victoria basin. The inshore waters, satellite water bodies (SWB), and fringing wetlands support several species of reptiles, the commonest of which are the Nile crocodile (*Crocodylus niloticus* Laurent 1768), monitor lizard (*Varanus niloticus* Linnaeus 1766), and snakes such as African rock python (*Python sebae* Gmelin 1789), mambas and cobras (Chisara and others 2001).

The dominant terrestrial vegetation comprises dry forest and woodland in the southern parts (Tanzania) of the basin, deciduous bush land and thicket in the northern parts (Uganda) and dry, peripheral, semi-evergreen rainforest and scrub forest in the eastern parts (Kenya) of the basin. Several species are currently threatened, particularly those in fragile areas such as wetlands. Much of the lake margin is swampy and vegetated mainly by *Cyperus papyrus* (Hughes and Hughes 1992). The current phytoplankton community is dominated by the cyanobacteria *Cylindrospermopsis* and *Planktolyngbya*, and the diatom *Nitzchia* (Komarek and Kling 1991; Hecky 1993). Zooplanktons consist of abundant copepods and cladocerans (Branstrator and others 1996). As recently as the 1960s, Lake Victoria supported an endemic cichlid fish species flock of over 500 species (Seehausen 1996), but these have progressively disappeared from the catches to become poorly represented today. The losses are attributed to habitat degradation in the catchment, introduction of exotic species (particularly Nile perch) and heavy fishing pressure (Ogutu-Ohwayo 1990; Witte and others 1999).

The Nile perch, introduced in the Lake during the 1950s, exploded in numbers during the early 1980s (Ogutu-Ohwayo 1990) causing serious predatory impacts on the lake's fish species assemblages. According to Witte and others (1992), a huge proportion of the endemic species of haplochromine cichlids were almost approaching extinction in Lake Victoria in the 1980s. The timing and causes of these dramatic shifts in the lake's environmental conditions and biotic assemblages are quite interesting and subject to various scientific studies. Whether the answers can solely be attributed to the introduction of the Nile perch and subsequent changes in the trophic relationships in the ecosystem, or to environmental dynamics such as increased deforestation and agriculture in the lake basin associated with increased human population growth, and urbanisation around the lake, remain unclear.

Box 2.9: Fish communities of Lake Victoria

The Lake Victoria fish stocks and the fisheries have undergone remarkable changes in the past 20 years. Before the introduction and subsequent establishment of the Nile perch and the Nile tilapia, Lake Victoria had a multi-species fishery dominated by haplochromine cichlids (Kudhongania and Cordone 1974). The lake had a variety of habitats that harboured different fish species. Close to 70 non-haplochromines and over 300 (Greenwood, 1981) to 500 plus (Seehausen, 1996) haplochromines existed in the basin. As the stocks of Nile perch increased, the diversity of haplochromines decreased rapidly. Many of these species have been displaced from the lake through competition for space, predation and environmental degradation. It is estimated that over 60% of the haplochromines have greatly diminished in numbers or have been completely eliminated (UNEP 2002b). This loss of biodiversity has serious repercussions to the whole lake basin ecosystem. Although many endemic non-haplochromine fish species have reduced in numbers, none is extinct from the lake.

Lake Victoria experienced dramatic changes in the past century as a result of land use and land cover changes, industrialization, agricultural developments, introduction and invasion of alien species and intensive non-selective fishing. These, among other factors, have led to destruction of native and endemic biota of the Lake Victoria basin. Lake Victoria lost about 60% of its cichlid taxa in the last decade and faced deterioration in water quality, partly due to over-exploitation of the fishes and human impacts on the ecosystem (Hecky, 1993; Witte and others 1992; Kudhongania & Chitamwebwa, 1995; Gophen and others 1995; Ogutu-Ohwayo and others 1997). Other affected components of the aquatic ecosystem included algae, macrophytes, invertebrates, birds, amphibians and reptiles.

A number of endemic species of fish and birds in Lake Victoria basin face various threats from a variety of human activities (Table 2.5). In 1988, about one hundred native fish species endemic to Lake Victoria were entered in the World Conservation Union's Red Book of endangered species. A number of studies report remarkable post perch structural changes directly impacting on the niche composition at all levels of biodiversity (Mbahinzireki 1994; Mugidde 1993; Gichuki & Odhiambo 1994; Seehausen & Witte 1995; Chapman and others 2001). The wetland ecosystems in Lake Victoria basin are rich with vertebrates. Other than fish most of these are not well studied. It is reported that Kingfisher (*Ceryle rudis*) diet changed from haplochromines to dagaa (Omena) following the explosion in Nile perch population

(Goudswaard & Wanink 1994). The ecosystems are quite diverse and provide different ecological niches or habitats for different species. The rivers and their associated wetlands provide *refugia* for fish species endangered from Nile perch and other predators (Chapman and others 1996). Some species, thought to have disappeared following the perch introduction in the lake, have been found in satellite lakes and other *refugia*. Some of these species or populations could recover under effective ecosystem management.

Table 2.5: Main satellite water bodies (SWB) of the Lake Victoria basin and their species of biodiversity importance

Country	Drainage System	Lake	Species of Biodiversity Importance
Kenya	Yala System	Kanyaboli	*Oreochromis esculentus* and haplochromines
		Sare	*O. esculentus,* Haplochromines
		Namboyo	*O. esculentus, Haplochromines*
		Mauna Dam	*Oreochromis variabilis*
Tanzania	Mara System	Kubingena	*O. leucostictus, Claria garepinus, Protopterus*
		Kirumi	Haplochromines, *O. esculentus*
	Dam	Kyarano	*Labeo victorianus, O. niloticus*
	Kagera System	Katwe	*O. niloticus, C. gariepinus, O. leucostictus*
		Kalenge	Haplochromines, *O. esculentus*
		Rushwa	*O.s esculentus,* Haplochromines
		Mitoma	*O.s esculentus,* Haplochromines
		Lwakajungu	*O. niloticus, Claria,* Haplochromines
		Ngoma	*O. niloticus, O. esculentus, O. variabilis,* Haplochromines
Uganda	Koki System	Nakivali	*O. esculentus*
		Mburo	*O. esculentus*
		Kachera	*O. esculentus*
		Kijanebalola	*O. esculentus*
	Nabugabo System	Nabugabo	*Schilbe intermedius,* mormyrids, haplochromines
		Manywa	*O. esculentus,* Haplochromines
		Kayugi	*O. esculentus,* Haplochromines
		Kayanja	*O. esculentus,* Haplochromines

(Source: Wandera and others 2005)

Before the introduction of Nile Perch and the exotic cichlids in the 1950's, Lake Victoria beamed with a diverse fish population whose main components were: tilapiines, *Oreochromis esculentus* and *Oreochromis variabilis*; the lungfish *Protopterus aethiopicus*; catfish, *Bagrus docmak* and *Clarias gariepinus*; and the cyprinid, *Labeo victorianus*. Haplochromines were the most abundant group constituting about 80% of the demersal fish biomass (Kudhongania & Cordone 1974). There were over 300 haplochromine species, most of them (more than 99%) endemic to the lake (Witte and others 1992; cf. also Greenwood 1981 and Seehausen 1996 on estimated numbers of cichlid species).

The Lake Victoria fish stocks and the fisheries have undergone remarkable changes over the past 20 years. Signs of overfishing were reported as early as 1970 when catch rates of tilapia dropped from 100 fish per 50m long net (127 mm stretched mesh) to less than 5 fish (Ssentongo 1972). As the stocks of Nile perch increased, the diversity of haplochromines decreased rapidly. The contribution of haplochromines to fish biomass in the lake decreased from 80% to less than 1% within a decade of the 1970s and 1980s (Kudhongania & Cordone 1994). Following these drastic shifts in species composition and stocks

depletion, a number of management measures have been instituted on the lake. Notably among these measures are: the ban on the use beach seine nets and under-sized mesh nets (<127 mm stretched mesh) of 1994, the ban on trawlers in 1996, and the introduction (in 2002) of slot size of 50 – 84 cmTL for Nile perch.

Value, Opportunities and Potential

Biodiversity as an asset of Lake Victoria basin offers both social and economic uses in tourism, traditional medicine, food security and trade in traditional handicraft goods such as mats, baskets and other woven goods (UNEP 2004). There will be immense intergenerational benefits if today's biodiversity is preserved. The scientific value of biodiversity includes ecosystem and species studies, gene pool variability and maintenance of ecological integrity. Biodiversity can also be used as an indicator of environmental policy effectiveness. The main issues of concern in Lake Victoria basin's biodiversity are its rapid loss, lack of inventory, classification, valuation and mapping systems, low investment by governments, lack of domestication and implementation of international biodiversity conventions, governance issues regarding the exclusion of local communities in management of biodiversity resources, and the effects of invasive alien species.

Demands and Pressures

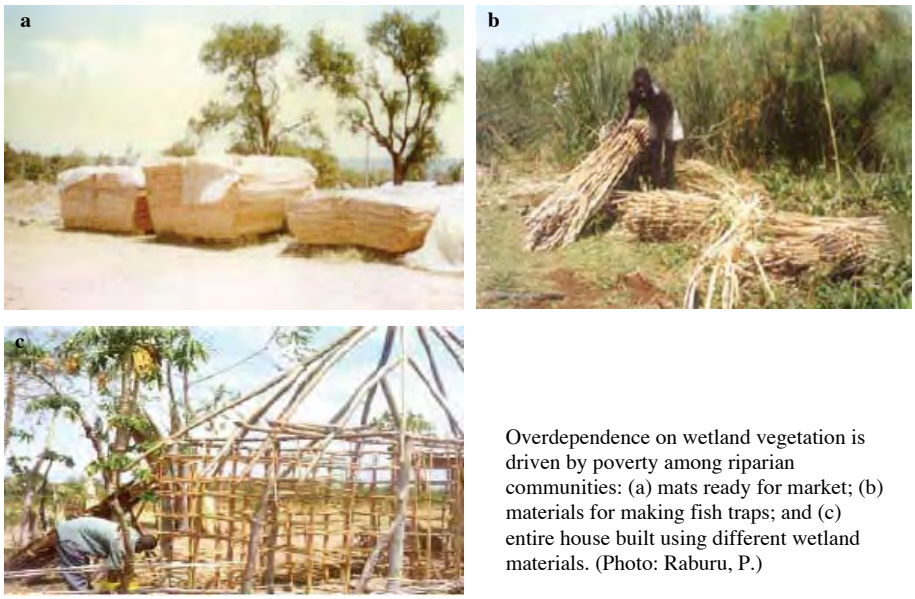
Lake Victoria is subject to dramatic changes (Beeton 2002; UNEP 200b), which have affected its biodiversity. The pressures on the lake which have also led to some degree of terrestrial biodiversity changes include invasive species (especially the Nile perch, *Lates niloticus*), overfishing and land use changes. Pressure on wetlands for grazing grounds, cultivation, and building materials competes with the need to prevent lakeshore erosion and to filter pollutants and sediments from rivers and runoff in the lake catchment. The rich wetlands biodiversity is threatened. There is, for example, large-scale draining of the Yala Swamp in Kenya to create land for agriculture and settlement. Clearing of riparian vegetation has led to erosion and loss of vegetation that acted as filters (Lowe-McConnell 1994). Indications are that the on-going and unregulated wetland conversion may contribute to a decline of floral and faunal diversity through loss of habitat, destruction of *refugia*, and floral/faunal mixing (UNEP 2004). The need for fuelwood and timber as well as land for settlements and other uses in terrestrial environments leads to changes in the ecosystem that accelerate the extinction of rare plants and animal species and traditional medicinal plants. Not all the species inhabiting the lake basin have been identified. The full potential of traditional knowledge systems on biodiversity has not been realised due to the non-recognition of its significance in biodiversity protection.

Various reasons have been advanced for the loss of fish species in L Victoria. Haplochromines, for example, were decimated by the introduced perch, overfishing, and environmental changes (Acere 1988; Ogutu-Ohwayo 1988). The native tilapiines i.e. *Oreochromis esculentus* and *O. variabilis* were displaced through inter-specific species competition for food, space, and mates by the introduced superior breeds of *O. niloticus, Tilapia zillii*, *T. rendallii* and *O. leucostictus* (Balirwa 1990). Deforestation as a result of fuelwood collection to process Nile perch increased sediment and nutrient flux into the lake. The nutrients have induced eutrophication and led to proliferation of water hyacinth. The decomposition of the algae and water hyacinth results into depletion of dissolved oxygen thus making much of the water column uninhabitable by cichlids and other aquatic life. Eutrophication has also disturbed traditional mating systems, hence contributing to the decline of cichlid and other fish species. Extensive cover of the inshore waters with water hyacinth and other macrophytes protected the settling of sediments and decaying plant material, thus encroaching on the nesting grounds for the cichlids. Apart from the aquatic biodiversity, terrestrial biodiversity of the lake basin is a significant indicator of biophysical changes in the ecosystems (e.g. Ramogi Hill, Box 2.10).

Box 2.10: The Biodiversity of Ramogi Hill

The Ramogi Hill forest is characterized mostly by lowland dry forest. The forest contains opportunistic and generalist animal species which are probably forest remnants of a once extensive biota. Rapid assessment of Ramogi Hill biodiversity carried out in July 1993 and June 1994 (Bagine 1998) recorded a total of twelve mammal species, four reptile species, three amphibian species and 64 bird species. Over 22 orders of invertebrates and over 100 species of plants were recorded. Species of birds in the Hill are forest-generalist and occur in other forest habitats. Two of the species, Ross's turaco, *Musophaga rossae*, and olive bellied sunbird, *Nectarinia chloropygia*, are generalists of Guineo-Congolian region and in Kenya they are confined to forests in the western part of the country. In Ramogi Hill, 53 species of butterflies, eight species of termites, eight species of Orthoptera and six species of Odonota (dragonflies) have been identified. Most of these invertebrate species, e.g. butterflies, dragonflies, snails, have been used by ecologists as indicators of environmental changes because of their high diversity, rapidity of generation turnover and their susceptibility to change. As the human population continues to grow, demand for arable farmland increases and this exerts great pressure on natural resources. Global and national threats to biodiversity are alarming and many species are now vulnerable to extinction. Ramogi Hill is an isolated forest shrine and an important cultural heritage for the surrounding communities and Kenya in general. Although it may not be of global or national significance in terms of its size and biological resources, the evolutionary events which shaped the biogeography and ecology of East African forests also affected Ramogi Hill and its biological resources. Ramogi Hill and its biota are greatly influenced by the surrounding human settlements, lakes, rivers and swamps. Consequently, it can be viewed as an island which represents a natural laboratory for the study of local evolution and dispersal of flora and fauna.

Plate 2.7: Diverse uses of wetland products



Overdependence on wetland vegetation is driven by poverty among riparian communities: (a) mats ready for market; (b) materials for making fish traps; and (c) entire house built using different wetland materials. (Photo: Raburu, P.)

Grasses mixed with papyrus, reeds and scattered or patches of swamp forest dominate wetlands biodiversity in the basin. Expansion of grasses, sedimentation and human activities such as clearing, burning and grazing have been linked to wetland plant succession (marked by disappearance of papyrus). Aquatic invertebrates constitute a significant component of wetlands biodiversity in the region.

CONCLUSION

The inhabitants of Lake Victoria basin are highly dependent on the land-based and aquatic resources for their livelihood. As a result, there has been intensive pressure on these resources, exacerbated by high and rapid population growth rates, rapid expansion of unplanned urban and rural settlements that lack in basic infrastructure, water and sanitation provision; lack of expert knowledge in sustainable

land and water resources management and practices at the local and sub-basin levels. Enveloping these intensive driving pressures is the abject poverty that is the lot of almost 70% of the basin inhabitants. The observed environmental degradation is therefore a logically predictable outcome.

Despite this bleak picture, there are several opportunities to turn around the land and water resources degradation and improve the livelihood of the basin inhabitants. Key to this is a mandatory paradigm shift in the way land and water based resources are turned into economic opportunities and gain for the collective good. As an example, the Nile Perch fishery generates 600 million USD in exports annually but only a very small percent of this goes to the fishers and associated workers at the harvesting end of the industry. Middlemen and exporters who may comprise of only a handful of firms and individuals take the largest share of the cake and tend to invest the economic gains outside the region. The fishers need to have, for example, share holding in secondary institutions such as marketing houses which would sell directly to buyers in the export countries. This will guarantee a large part of the population higher returns for their labour and also ensure that economic gains and investments are retained within the basin thus creating wealth in the region. Demonstrable economic and other benefits from sustainable utilisation of resources are a necessary prerequisite to turn around the lake basin's environmental degradation. To this end it is necessary to institute carefully thought out sustainable and expandable pilot programmes in the various interrelated sectors.

There has been some progress in land use reforms in Lake Victoria basin countries, which will create an enabling environment to mitigate the adverse effects of land use and land cover change on land resources. Stakeholder engagement, including communities' responses to land degradation is being addressed in the new land policies under redrafting in Kenya and other East African countries. Present economic gains have, however, not had significant impacts on livelihoods and the environment. One of the major threats to the uplifting of local livelihoods is declining health standards within the basin and the associated high economic costs of treatment. At present the lake basin communities have the heaviest burden of illnesses such as malaria, HIV/AIDS, upper and lower respiratory disease, diarrhoeal diseases, tuberculosis and others in relation to other parts of Eastern Africa. Some of these health challenges could be exacerbated by climate change. For example, highland malaria epidemics in the lake basin have increased due to increased positive anomalies in maximum temperature in the highlands. The highland communities have been exposed to malaria disease to which they have no immunity.

In addition to addressing the present state of the environment, there are emerging issues such as environmental conflicts and introduction of invasive alien species that are addressed in the next chapter. Some policies addressing these issues inclusive of their outlook are profiled in the last chapter of this report.

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CHAPTER THREE

Emerging Issues

This chapter highlights the key emerging issues that represent new environmental management issues or re-emerging old issues. The emerging issues can be grouped into those that impact upon the biophysical and socio-economic systems. The main emerging issues in Lake Victoria basin are shown in Box 3.1.

Box 3.1: Some emerging issues in the Lake Victoria basin

Biophysical
- Invasive alien species
- Loss of biodiversity
- Eutrophication
- Global climate change
- Deforestation
- Increased risk of natural hazards

Socio-economic
- Changing demography
- Conflict and environment
- Global trade
- Transboundary resource use (lake Victoria waters, ground water resources)
- Fish trade and the environment
- Vulnerability of small island communities
- Human vulnerability to extreme environmental events and natural disasters
- Emergence of new diseases and re-emergence of old ones

The anticipated future trends in population growth and corresponding increases in the demand for energy and other natural resources in the basin imply that prudent decisions need to be made to maintain and improve the quality of human life by reducing the vulnerability of the basin population to these emerging issues and challenges (improving resilience). The formulation of well-informed policy will depend on deriving answers to questions such as: What are the emerging issues and why? To what degree are these normal or natural variations? What are the economic and social consequences? How do they affect people's livelihoods? What are their trends and projections? Can effective response strategies be conceived to manage them and what are their costs? The priority emerging issues can be clustered into three categories: unforeseen events and scientific discoveries about environmental interactions; sudden, unexpected transformations of old issues; and already well-known issues to which the present response is inadequate.

BIOPHYSICAL SYSTEM

Invasive alien species

Nile Perch

The introduction in the 1950s and success of the predator Nile perch (*Lates niloticus)* has had a tremendous effect on indigenous fish species and their rapid disappearance. The establishment of introduced fish species in Lake Victoria was followed by rapid increases in fishery yield. Fish (mainly Nile perch and tilapia) catches lake-wide increased five fold from about 85,000 metric tonnes in 1975 to a peak of 554,000 metric tonnes in 1990 (UNEP 2004). This has made Lake Victoria the single most important source of freshwater fish in the world. The introduction of the Nile perch brought with it a complete change in the local fishing economy and distribution of wealth (Wilson and others 1999).

Water Hyacinth

Lake Victoria is believed to have been invaded by water hyacinth (*Eichornia crassipes*) in the late 1980s (Freilink 1991), through the Kagera River (Twongo 1996), and since then a constant stream of the plant to cover three hectares a day have entered the lake. On entering the lake it found a fertile environment for its multiplication. The weed thrives in bays and inlets which are sheltered from strong offshore and along-shore winds; have flat or gently sloping, relatively shallow shores (rarely deeper than 6 m); and have a muddy bottom rich in organic matter (Twongo 1996). The floating masses form habitats suitable for infestation by secondary weed growth, Papyrus (*Cyperus papyrus*) and Hippograss (*Vossia cuspidator*) in particular, as well as habitat for mosquitoes, bilharzia snails, and snakes. Increased incidences of malaria, schistosomiasis and cholera have been attributed to the infestation. A study in Lake Victoria (Uganda) has shown that, in the vicinity of the water hyacinth, fish species number, biomass and diversity are reduced, the former two very significantly (Raytheon and others 2002; Willoughby and others 1996). It, however, provides a protective habitat for some of the endangered haplochromine species, hippopotamus, crocodiles, snakes, bilharziasis carrying snails and mosquitoes.

The proliferation of water hyacinth, the world's most prodigious water weed, wreaked havoc on trade and commercial activities on Lake Victoria in recent years. The spread of this water weed had clearly become an economic and social problem of epic proportions. Both long and short-term solutions to the lake's problems are being pursued and include the release of biological organisms (two weevil species - *Neochetina bruchi* and *Neochetina eichorniae*). Presently (2005), the weed is under control and no longer poses grave ecological and socio-economic threats to the livelihood of the people.

Plate 3.1: Water Hyacinth blocking the Kisumu ferry terminal and landing sites in Uganda

By the mid 1990's over 75% of Uganda's shoreline had a permanent fringe of water hyacinth. Normal lake activities were completely disrupted in many beaches. Fishing villages could neither launch canoes nor land catches. Fishing nets were destroyed by the floating masses of weed. The operations of ferries and lake steamers were severely hampered if not stopped completely. Ports in Uganda and Kenya were brought to a complete standstill as boats could not pass through the thick mats of weed. Industries and power generation plants had their water intakes clogged.

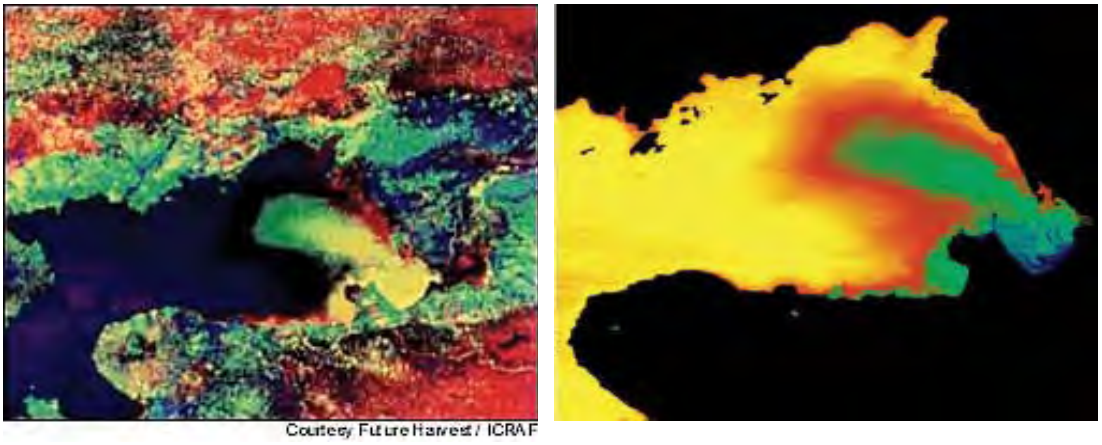
Water hyacinth blocking the Kisumu ferry terminal, December 1997 (http:edcintl.cr.usgs.gov/waterhyacinth.html)

Landing site heavily infested by Water Hyacinth, Lake Victoria, Uganda (www.fao.org/waicent/faoinfo/agricult/agp/agpp/ipm/weeds)

From satellite imagery (Plate 3.2), it has been observed that nutrient-rich sediment plumes originating from agricultural runoff and the low-lying, deforested riparian zones and other areas surrounding the lake are feeding the water hyacinth (Wilson and others 1999). Although proliferation of water hyacinth in Lake Victoria had a few positive attributes, on balance, the invasive weed was undesirable. Narrow fringes of well-oxygenated water hyacinth formed useful refugia for various biodiversity including small and young fish. Several types of adult fish fed in this weed belt (Willoughby and others 1996; Balirwa 1998). Fish species especially the lungfish and mudfish, which tolerate low oxygen levels, flourished in water hyacinth mats close to the more oxygenated zones. The habitat became particularly suitable for lungfish and mudfish when the succession with hippograss climaxed. The negative impacts due to the infestation, however, outweighed the above advantages by far. Water hyacinth inflicted detrimental

impacts on the environment and socio-economic interests in Lake Victoria. The infestation disrupted socio-economic activities especially fishing, water transport, hydro-electricity generation and water abstraction and hiked treatment costs. Infestation by resident water hyacinth mats along the shoreline seriously degraded near-shore wetlands. Macrophytes were smothered or shaded out together with the nurseries and feeding grounds of various fishes. Biodiversity was displaced due to anoxia and poisonous gases such as ammonia and hydrogen sulphide in the anoxic environment under the resident water hyacinth mats (Wanda and others 2001). Considering the estimated total weed cover of 12,000 ha (EAC 1999) and the highly migratory nature of the weed, the total environmental and socio-economic cost was huge.

Plate 3.2: Satellite images depicting plumes of nutrient rich sediment flowing into Lake Victoria



Other invasive species in the basin include *Lantana camara* (which is widely used for hedges but very difficult to eradicate), *Leptocybe invoisa* (a newly discovered insect pest that is attacking eucalyptus trees in the lake region), and the *striga* weed which has invaded farmlands in the lake region and colonizes many fallow fields, thereby causing biodiversity loss of indigenous herbaceous species and crops such as maize and sugarcane. This is endangering local livelihoods.

Loss of biodiversity

Loss of biodiversity is a major concern both in terrestrial and aquatic environments in the lake region. Cultivation practices, energy demands, commerce, land use practices and commercial farming constitute the major forces driving biodiversity loss in the lake region. This poses several environmental and livelihood concerns. Commercial timber demand has resulted in the loss of teak trees and oak trees in some forests in the lake region. Crop monocultures have caused reduction in staple and subsistence food crops. Over-fishing in the lake has caused the loss of some fish species in the lake. Forest clearing has caused biodiversity loss of endemic animal and plant species in the region. Cash agricultural economies with high chemical inputs have also had negative impact on indigenous food crops due to reduced above-ground and below-ground biodiversity. Lack of alternative uses of food crops such as cassava and others have also contributed to biodiversity loss of indigenous food crops.

Eutrophication

Eutrophication attributed primarily to landscape disturbance (see Chapter 2) is a serious threat to freshwater ecosystems of the basin. Nutrient loads to the lake are associated mainly with atmospheric deposition (natural and biomass burning) and land runoff, and these together account for about 90% of phosphorus and 94% of nitrogen input (Scheren and others 2000). This has affected water clarity

(Plate 3.3) and dissolved oxygen levels. Algal blooms have increased since the 1960's (Mugidde 1993). The filamentous and colonial blue green algae, known for causing hypoxia conditions that occasionally lead to fish kills is now very dominant in Lake Victoria.

Plate 3.3: Algal bloom (green colour) at Tanzanian Littoral station, December 2001 (Photo: John Okungu)

There is evidence that the domestic biological oxygen demand (BOD) exceeds industrial loads in all regions (Scheren and others 2000). The use of agrochemicals is increasing in the lake basin where there are large-scale farms of coffee, tea, cotton, rice maize, sugar and tobacco (Ntiba and others 2001). Consequently, nearly half of the lake floor currently experiences prolonged anoxia for several months of the year, compared to the 1960's when anoxia was localized and sporadic (Hecky 1993; LVEMP 2001). Algal concentrations are three to fivefold greater on the surface waters today than in the 1960's, reflecting higher rates of photosynthesis (Mugidde 1993). The situation has contributed to species decline with the major cause being attributed to land management whose control remains a significant remedy for saving the lake (Odada and others 2004).

Global climate change

Lake Victoria is sensitive to climate change as its water balance is dominated by rainfall on the lake and evaporation, with river inflow and outflow making minor contributions (UNEP 2004). Global warming will lead to higher temperatures estimated to be between 0.2 and 0.5 ºC per decade for Africa (Hulme and others 2001). The major effects of climate change on the basin's water systems are as a result of changes in the hydrological cycle, the balance of temperature, and rainfall. Lake Victoria is now 0.5°C warmer than in the 1960s (Hecky and others 1994; Bugenyi and Magumba 1996). Maximum temperatures in the region have been progressively increasing over the past two to three decades. It is also likely that extreme events such as El Niño are being experienced more frequently, and have become more intense (IPCC 2001) in the basin. The 1997 El Niño which saw Lake Victoria level rise by 2.4m (Birkett and others 1999) was the strongest in the region and caused wide-ranging agricultural, hydrological, ecological, economic and health impacts (Conway 2002).

Climate change in the lake basin is linked to local processes such as deforestation and burning of vegetation, reduced infiltration and topsoil depletion and soil erosion (Figure 3.1). It is also a driving force for a number of health problems including malaria epidemics in the basin (Githeko and Ndegwa

2001; Githeko and others 2000). The climate changes may also impact on other human activities in the lake basin including faming. Slight changes in temperatures and rainfall from the current levels that permit growing of coffee in most parts of Uganda may have a significant impact on the coffee-growing areas and on the whole economy. In the absence of appropriate technologies to mitigate the effects of climate variability, production and suitability can be greatly affected (Figure 3.2). There are opportunities to breed coffee cultivars that are able to withstand increasing temperatures and reductions in rain through biotechnology. This would bolster the resilience and ability of small-scale farmers to withstand the effects of climate change.

Figure 3.1: Drivers and impacts of global climate change

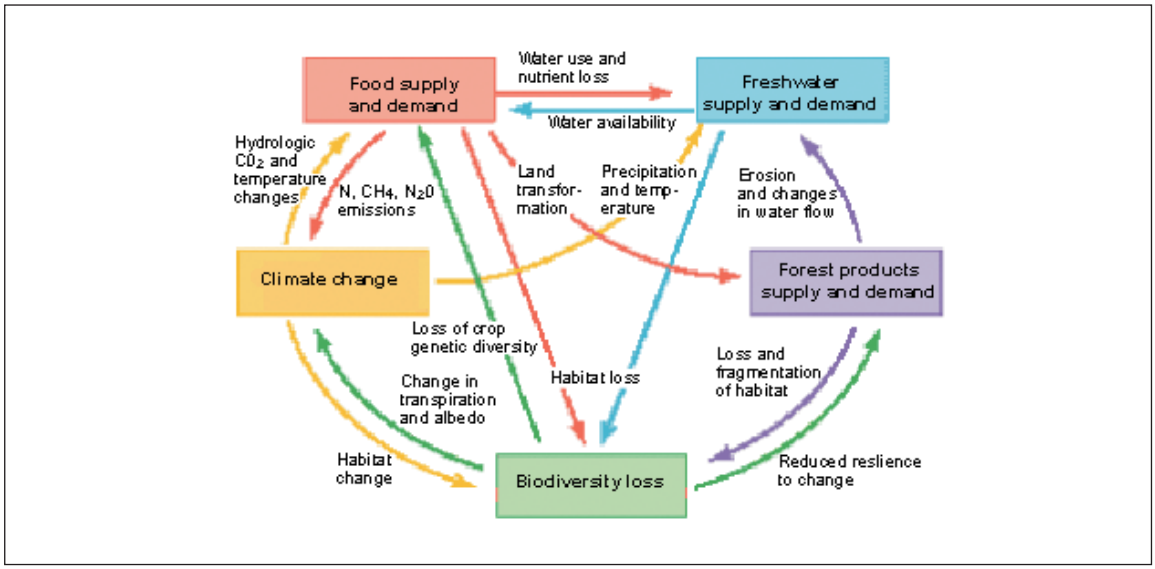
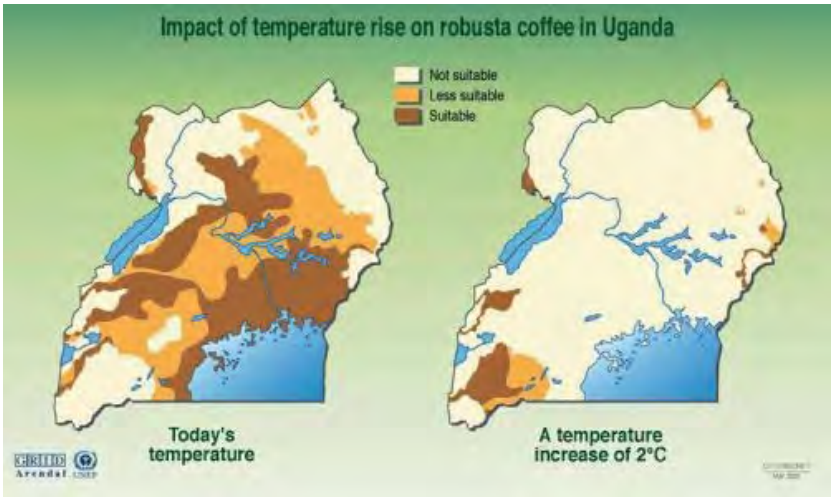


Figure 3.2: Simulated possible impact of temperature rise on robusta coffee growing in Uganda change



Source: Simonett 1989 in MFPED, 2004

SOCIO-ECONOMIC SYSTEM

Conflict and environment

The rapidly changing demography (Chapter 1) and intensive use of the transboundary resources of Lake Victoria (Chapter 2) are important drivers of environmental conflicts. In Lake Victoria basin, environmental conflicts arise from 'access to', 'use of', and 'use policy' of resources and occur between communities, states, humans, animals and sectors. The main conflict occurs over the transboundary utilisation of the lake fisheries, wetlands and land resources. Since 2001 there has been an upsurge of conflict over transboundary fishery of Lake Victoria and it is an issue that has become the most immediate obstacle to fisheries management on the lake. The conflicts arise among fishers and between fishers and law enforcement personnel primarily because of reducing fish CPUE (catch per unit effort), the migratory nature of fish shoals across the country lake borders and privatisation of fishing grounds. This is likely to get worse, particularly as the fisheries resource declines in productivity due to myriad pressures (Chapter 2).

Figure 3.3: The nature of transboundary interactions among the riparian communities

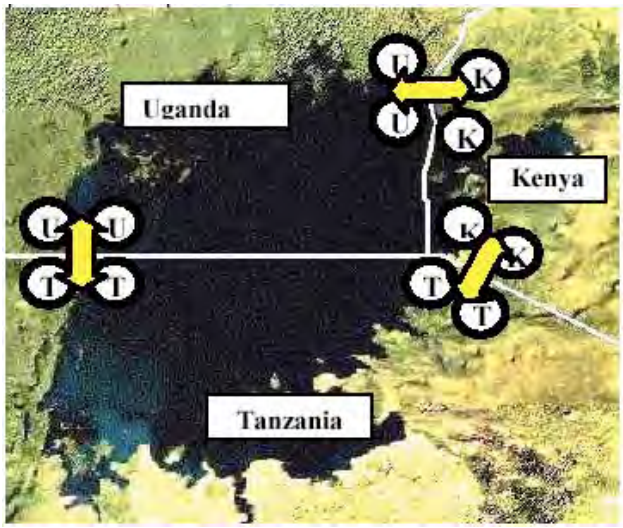


Plate 3.4: Small fishing boats competing for fishing waters

Whereas the political and legal responsibilities at all administrative levels in the three East African Community (EAC) partner states (Kenya, Uganda and Tanzania) are well understood and adhered to, and whereas cross-border co-operation in many aspects is strong, a mobile natural resource such as fish knows no man-made boundary and consequently migrates or moves between different jurisdictions (Heck and others 2004). Traditionally, this has presented few problems. In recent years however, following the commercialization of the Nile perch, its increased demand in the light of declining stock has led to conflicts or disagreements about access and control of better fishing grounds (LVFO 1999). The conflicts arise among fishers and between fishers and the enforcement authority as the authority tries to control cross border movement of fishers as they search for better fishing grounds and markets which they do without observing the relevant fisheries and immigration regulations of respective countries.

Box 3.2: Conflict over transboundary fishery resources

Causes of conflicts

- **Social and economic conflict over shared natural fishery resources**
- **Inequitable access to lake basin fishery resources**
- **Different rules and regulations of the three Partner States**
- **Lack of coordination between national enforcement authorities of the riparian countries**
- **Conflicting and less understood roles and responsibilities of different institutions**
- **Poor working relationship between fishers and enforcement institutions**

Strategy to address the conflict and manage transboundary fisheries

- **Recognition by governments of Beach Management Units (BMU) as mechanisms for community participation in national and regional management processes**
- **Establish customs and immigration posts on border islands**
- **Improved capacity of the cross-border institutions such as LVFO to effectively manage trans-boundary fishery management challenges;**
- **Improved cross-border relations among the fishing communities and between the fishers and law enforcement personnel;**
- **Enhanced information acquisition and sharing, transparent debate**
- **Harmonization of natural resource use strategies and laws**
- **Integrated ecosystems approach to transboundary resource management**

Other sources of conflict over the basin's resources include:

- **Fisheries and use of papyrus:** There is a conflict arising out of the restriction of papyrus harvesting for purposes of preserving fish breeding sites. The conflict arises between the women who make mats with the papyrus and the Fisheries officials who regulate the use of the lake resources, and environmentalists.
- **Grazing land:** The increase in land adjudication has reduced hitherto accessible and common communal grazing lands. This has resulted in conflict among neighbouring homes and communities when competing for these dwindling resources.
- **Land tenure and ownership:** The nature of land ownership perpetuates conflicts over land use. In Kenya this is characterized by weak regulation of public land use practices. Conflict is seen to arise between upstream and downstream users, where, for example, upstream deforestation leads to downstream flooding.
- **Lack of integrated watershed management:** Another type of conflict arises from lack of interaction between planners in different but bordering districts. For example, the lack of consultation between bordering district planners leads to lack of integrated environmental management plans. Conflict arises between neighbouring environmental management plans and land use practices. There is need for integrated natural resource management plans.

Managing a transboundary resource can be seen as any process of collaboration across boundaries that increase the effectiveness of attaining natural resource management goals' (van der Linde and others 2001). The major components and processes for the management of conflict over natural resources

in the Lake Victoria basin include effective stakeholder involvement, identification of roles and hierarchy within the management process, agreements committing parties to the process, and support to capacity and communication needs. The long-term strategy to address the conflicts over transboundary natural resources of Lake Victoria basin is to build the capacity of the cross border communities to participate in transboundary resource management and prepare partner states for a co-management regime. The implementation of capacity building strategies for transboundary natural resources conflict management, would include:

- Improved capacity of the cross-border community organizations including the Beach Management Units (BMU) to effectively handle trans-boundary natural resource management challenges;
- Improved cross-border relations among the fishers' communities and between the fishers and law enforcement personnel;
- Promoted culture of information acquisition and sharing, transparent debate, negotiations and consensus building;
- Recognition by governments of BMU and other local natural resource management institutions as mechanisms for community participation in national and regional management processes;
- Deepened cooperation among the EAC partner states; and
- The wise use of fisheries and other resources of the basin for improved livelihoods of the communities.

Managing a transboundary resource like Lake Victoria is complex and requires a long-term strategy that entails capacity building of the resource users, a partnership arrangement between the resource users and the governments, collaboration and networking among the resource users and between them and other agencies. The LVFO with the technical assistance from IUCN through the *Socio-economics of the Nile perch fishery project phase II* has investigated the conflict and developed a long-term strategy for its management.

Global trade

Free trade practices have led to expansion of external markets such as the European Union (EU) for some of the lake resources. Fish constitutes the major resource traded from the basin internationally. Regionally and locally, agricultural and other commercial goods and services are traded. The impact of free trade practices on the basin's socio-economic and environmental features are diverse. There are approximately 50 fish processing and export companies in Uganda, Tanzania and Kenya. Foreign actors own most of these factories and many are financed by international development banks and aid agencies from industrialized countries. There has been a rapid build up of fish processing and trade capacity around Lake Victoria. However, control over these processing plants has been minimal and effluent from processing plants has become problematic. Men rather than women are employed to deal with processing the large fish and men therefore gain control of money derived from the industry and the women no longer have equitable access to the fish harvest to meet family dietary requirements. Vulnerability of households that once relied for their livelihoods on the variety of small fish has escalated. Fish protein from Lake Victoria is exported to the markets of Europe and Asia while local communities go hungry. Continuous crop monocultures and timber felling creates biodiversity loss due to concentration on cash crops. Free trade encourages mining activities in the lake region with deleterious consequences.

Emerging and Re-emerging Diseases

One of the effects of El Niño-related flooding is widespread dispersal and elevated concentrations of biological contamination of water resources from surface runoff, domestic and municipal sewage wastes and other organic pollutants. This leads to sporadic higher incidences of water-borne diseases. Other social and community impacts associated with flooding include displacement of people from their villages, the disruption of normal day to day routine because of lack of exit and access to marooned areas, lack of shelter and food.

El Niño is a recurrent phenomenon in the region, but due to global change the frequency and perhaps the intensity of the event will increase. The current impacts that it has on the communities of the lake basin are basically as a result of lack of investment in flood control measures, and lack of disaster preparedness by the governments. The social, economic and health impacts of El Niño can be drastically reduced if the afore-mentioned measures are put in place. Malaria and cholera epidemics have occurred to varying degrees in the East African region in the last decade. It is critical to know what to expect in the future in terms of disease trends so that adaptive measures can be put in place. Equally it is important to establish the population's adaptive capacity in terms of the ability to prevent and treat climate related illnesses.

The quality of water available to the communities within the lake basin is unquestionably a contributing factor to the poor health rating of the region. The discharge of raw sewage and industrial waste directly into rivers and streams and into the lake has led to increased contamination of these waters which are important potable water sources. Continued microbial pollution of the water resources leads to diseases such as diarrhoea, cholera, typhoid, dysentery, schistosomiasis and worm infections. Improper management of floodwater and other stagnant water creates breeding ground for vectors. Malaria is the most important and widespread vector-borne disease in the region. High nitrate concentration in the lake waters may lead to *'blue babies'* in expectant mothers. Cyanide in the lake is poisonous to the fish and human beings, high concentrations of mercury can lead to risk of nervous breakdown. The sources of cyanide include artisanal mining of minerals, such as gold, around the lake. Surveys indicate that distance to health clinics, lack of money, ignorance, and poor roads and infrastructure contribute to the prevalence of some diseases. High poverty in the communities complicates efforts to improve health conditions in the lake basin. The prevalence of disease and the vulnerability of the inhabitants of the lake basin hinge on their poverty status and livelihood activities like car washing and sand scooping that predispose them to waterborne infections (Plate 3.5).

Box 3.3: Poverty and health in the lake basin

Poverty, which is linked to cash-income generating sources, is widespread in the Lake Victoria basin particularly among the rural communities. Causes of poverty are numerous and varied, ranging from diseases, conflicts, lack of education and skills, and poor infrastructure. The region's mean household poverty stands at 46.4% (LBDA 2004). This makes it difficult to improve health and nutrition conditions in the region. There is limited infrastructure to cope with the ever- increasing population, and available health facilities in the region are few and inaccessible to many people. An average of 42% of households in Kenya live within 4 kilometres of health facilities, but 21.7% of households in the Lake Victoria basin live at least 8 kilometres away from a health facility. Poverty frustrates efforts to control and manage the spread and effects of HIV/AIDS pandemic, which has affected the region more than any other part of Eastern Africa.

Plate 3.5: Residents of Kisumu City in Western Kenya washing buses and cars in the lake (Photos: D. Karanja and W. Ochola)

Car washing in Lake Victoria, Kisumu Kenya

Water contact by sand harvesters in Lake Victoria near Kisumu, Kenya

Box 3.4: HIV/AIDS situation

HIV/AIDS is a serious health problem, with great implications for the region's economy and a great contributor to poverty. The high rates observed in many areas are often linked to culture and changes in lifestyle. It is estimated that 21% of the total AIDS cases in Kenya are in Nyanza province within the Lake Victoria basin. AIDS drains both labour and capital from farming, seriously reducing harvest, and contributing to malnutrition. In 2003, it was declared a national disaster in Kenya. HIV/AIDS is most prevalent in the most productive age (15-49), and is particularly high (32.4%) among the lake basin inhabitants. Prevalence in Nyanza Province of the Lake Victoria basin in Kenya stands at 14%, compared with the national levels of 6.7% (KDHS 2003). Prevalence in a survey of men and women age 13-34 years in rural area bordering the lake was shown to be 15%. Constraints to AIDS control include socio-cultural habits and slow pace of behaviour change as well as poverty.

Box 3.5: Management of Lake Victoria basin resources for improved health

It is imperative that proper management of resources of the Lake Victoria basin be undertaken to enhance agricultural productivity and improve nutritional and health potential for the riparian communities. Appropriate policies and legal frameworks should be developed to guide efficient management of available resources in a manner that will improve the health of the residents of the basin. Most countries have policies and legislation to regulate the utilisation of the Lake Victoria resources and deter environmental mismanagement. Enforcement regulations, however, tend to be weak or lacking, leading to ineffective implementation. The Lake Victoria Environmental Management Project (LVEMP) is an important initiative of the three riparian states to try and reverse the adverse impacts that have so far gone unchecked for so many years. This co-ordinated effort to curtail the current poor wetlands management encompasses management of fisheries and industrial and municipal wastes, control of water hyacinth, water quality monitoring, conservation of biodiversity, and sustainable land use. The Lake Victoria Development Programme (LVDP) has effected National Focal Points in the ministries of Partner States, which are responsible for Lake Victoria development (Odada and others 2004). Non-governmental organisations are also involved in implementing rural domestic water supply and sanitation programs.

Other health concerns relate to high child mortality, zoonosis, and other human diseases such as malaria and diarrhoeal diseases. The Lake has a direct influence on the health and nutritional status of the riparian populations, with much of the influence tending towards increased water-related diseases (UNEP 2004). Currently, capacity to cope is low, and the pressures on the environment and the lake, which result in compromised health status and food insecurity, continue to rise. Climate change and climate variability will probably exacerbate these effects as warming has been linked to increased outbreaks and epidemics of malaria in the highlands, and cholera in the lowlands (Githeko and others 2000; Wandiga and others 2006).

The common defence of regional health security requires a regional and global partnership. The aim should be to contain known infectious disease risks, to detect and respond to unexpected infectious disease risks and to improve preparedness and public health infrastructure. Reversal of the existing unacceptable socio-economic and environmental status of the lake basin region will require clear identification of opportunities available, in order to avoid or mitigate potentially adverse environmental impacts and to identify opportunities for beneficial impacts. Fortunately, the East African communities, which form the Lake Victoria basin and its catchment area realize the urgent need to set up systems that will encourage the management of the basin in a sustainable manner to their benefit. Community involvement and participation in health issues that affect them should be encouraged. With proper management incorporating all aspects of environmental flows, the perennial flows of the rivers and floods can be harnessed (alongside with rainwater) and treated to enhance agricultural productivity, and provide safe water supplies to the people of the region.

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CHAPTER FOUR

Outlook (2005 – 2025): The Future of Lake Victoria Basin Today

INTRODUCTION

There are a variety of ways in which Lake Victoria basin's environmental resources can be managed, each with different social, ecological and economic implications. The goal of sustainable environmental management is to select from these alternatives the strategy that best balances ecological sustainability with human uses. This chapter projects the outcomes of alternative environmental management scenarios, through narratives and scenario-building models.

Moving into the future means travelling into uncharted waters. Some of the way ahead is clear but there is much that cannot be mapped out, even with advanced technologies. As before, there will be challenges that can be prepared for but others that will seem to materialize from out of the blue (Raskin 2000).

For Lake Victoria basin, the scenarios consider a variety of outcomes with nested cross-cutting issues encompassing population, economics, land use, fisheries, technology transfer, policy and governance. Some of the issues have relevance either to the entire basin or sections of it. The presentation, therefore, integrates both basin-wide and sub-basin perspectives. Four scenarios are considered: *No Development* (Traditional Natural Resource Management), *Current Practices, Best Practices* and *Worst Case Scenario*. Some of the scenarios, although not possible to implement under the present socio-political dispensation, are important to be considered as "what if" scenarios. The main assumptions of these scenarios are summarized in Boxes 4.1.

Box 4.1: Assumptions and Descriptions of the Four Scenarios

No Development Scenario
Under this scenario all anthropogenic activities involving traditional use of environmental resources are assumed. Although this scenario is impractical due to its poor economic performance, it acts as a good point of reference when evaluating the ecological and socio-economic integrity achieved by other scenarios. It assumes the trajectory of traditional practices.

Current Practices
Under this scenario, current environmental exploitation practices persist through to the future assuming favourable environmental endowment value trajectories. This scenario assesses the implications of following current land and water use practices, policy and guidelines, acting as a good base-case when evaluating the performance of alternative scenarios.

Best Practices
Under this scenario, the best available technology is used to achieve socio-economic benefits of environmental exploitation with least possible ecological degradation. The utilization of environmental resources is ecologically based considering only pathways leading to intergenerational equity. Currently known, and new or improved best practices are used to minimize land degradation. Land water resources are protected and degraded areas restored. Agricultural and other land use strategies are intended to mimic ecosystems while natural resources including forests, woodlands, rangelands, water bodies and wetlands are well-managed to mitigate degradation. Traditional practices are only allowed when in tandem with social and economic goals that also encourage environmental conservation. The concept of the scenario is that by focusing on sustainable land and water use in the unprotected areas and minimising human activity in the protected areas, it may be possible to achieve positive economic gains while maintaining ecological integrity.

Worst Case Scenario
The scenario is represented by environmental management alternatives that lead to worst possible forms of ecological degradation. The practices under this scenario do not maintain ecosystem integrity and natural processes that are necessary to ensure sustainability; instead, they cause or lead to an adverse decline of ecological integrity.

The scenarios presented are based on the biophysical and socio-economic indicators shown in Box 4.2 as descriptors of the future pathways.

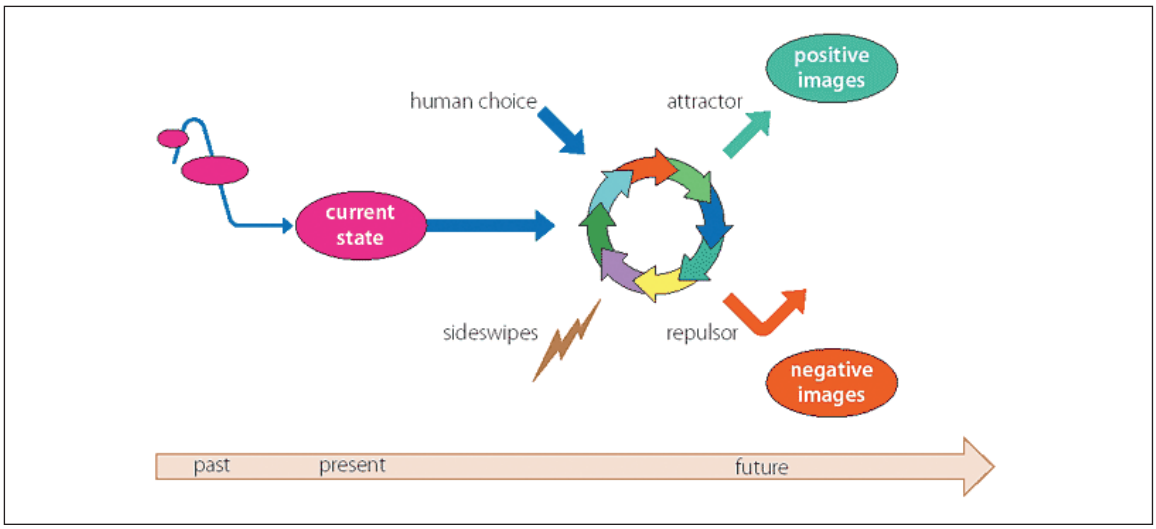
Box 4.2: Major indicators of future environmental management pathways in Lake Victoria basin

Biophysical Indicators	Socio-economic Indicators
• *Land use and Deforestation* – Area of gazetted forests encroached – *Per capita* land holding – Area of agricultural land – Area of other land use types • *Land degradation* – Soil loss – Area of degraded land – Land cover change • *Rivers and lake ecosystems* – Total dissolved solids (TDS) – Total suspended solids (TSS) – Nitrate and phosphates – Conductivity – Lake level – Rate of sedimentation – Trends and catch rates of fish stocks – Amount of chlorophyll in lake waters	• *Population statistics and demographic characteristics* – Total number and density of people – Demographic composition by gender and age-class categories • *Changes in literacy levels* • *Energy statistics (such as fuel demand)* • *Agricultural productivity* (yields/unit area) • *Land endowment value* • *Water quality indicators* – Chemical analysis indices – Water potability – Ground water quality and level – Boreholes per capita – Cumulative hydrological data – Water use conflicts • *Nutrition status* • *Per capita income* • *Poverty levels* • *Lake resource-based conflicts* • *Employment:* – Total workforce (number of people) associated with each of the major land uses – Full-time employees per unit flow of resources • *Human health and social condition:* – Human Development Index, which is a composite of life expectancy, education, and standard of living (income)

METHODOLOGY

The pathways that long-term environmental management outcomes may take in the future and their assessment are based on the current information base, sensitivity to initial conditions and human choices that drive the future (Anderberg 1989). Scenarios offer a means for examining the forces shaping the world, the uncertainties that lie ahead and the implications for tomorrow of today's actions (Kemp-Benedict 2001; UNEP 2002) and inactions. Various scenarios must offer a logical plot and narrative of alternative futures at designated points-in-time explaining clearly any possible future dispersions and taking into account the obvious systems complexity (Clark & Munn 1986; Toth 1989; Gallopin 1997). These complexities are represented by the common scenario dynamics (see Figure 4.1). The 'current state' of the environment is the outcome of a historical process, which is driven forward by a set of 'driving forces' (Ruskin 2000).

Figure 4.1: Scenario dynamics



Source: Ruskin and Kemp-Benedict (2002) in UNEP (2002)

A qualitative and integrated description of major assumptions and driving forces for each of these scenarios in the next 20 years, with both basin and sub-basin perspectives, is presented in the section below, i.e., 'The Lake Victoria basin futures'. This is followed by a detailed analysis of their biophysical and socio-economic implications through indicator suites that integrate specific environmental concerns.

THE LAKE VICTORIA BASIN FUTURES

Gallopin and others (1997) provide an overall basis for the scenario building work in this report which uses classes and variants to identify several scenarios which have been clustered into four broad scenarios. The resulting scenarios for the basin are illustrated below.

Scenario 1: No Development

The basic assumption of this scenario is a return to age-old traditional natural resource use practices under low human populations. In this scenario the basic goal of environmental management is subsistence with no commercial goals. The dominant land tenure systems that would prevail in the basin include communal grazing lands, communal farmland, settlement areas and special purpose areas. Energy would be solely from forests for firewood while building materials would be obtained from papyrus, forests, grasses and local shrubs, and earth. The scenario, through the obvious limited resource exploitation, would lead to a preservation of the basin's environmental pristine state. Traditionally communities would use indigenous technical knowledge (ITK) to develop an early warning system for short and long term environmental changes.

Natural disasters such as floods would continue to affect the basin especially in the vast flood plains. Communities would respond to this through traditional disaster mitigation and management mechanism including creation of riparian buffer zones to cushion settlements and farmlands. Traditional and customary regulations would form the main environmental management structures with reservations of sacred resources (like forests, trees, mountains such as Got Ramogi in Kenya, water bodies), taboos and customary regulations on resource use and establishment of 'councils of elders' to enforce environmental management including traditional governance on fishing, land use and conflicts. The main livelihood options would be pastoralism, farming, fishing and minimal barter trade on environmental products. Periodic conflicts would arise on resource use including use of common property resources like water bodies, pastures and forests. Traditional structures for conflict resolution would be institutionalized to resolve and manage the emerging conflicts while protective measures like establishment of vigilante groups would be common within communities.

Scenario 2: Current Practices

This scenario predicts a continuation of current environmental management practices. The main land tenure systems would continue to include government trust land and individual ownership. A breakdown of traditional community land use structures would continue to occur with majority of land owners having no title deeds. An increase in individual and state ownership of land would be witnessed although ecosystems and economic sustenance continue to be unmatched by land stewardship. The main energy sources would be wood fuel, hydro-power, cooking gas and limited clean energy sources like wind and solar. Afforestation would be carried out in some areas such as existing protected areas or through government and individual initiatives. This would, however, be haphazard, uncoordinated and not based on scientific assessment. This would be more conservation-targeted than for economic gains.

Environmental management would continue to be supported by ill-defined early warning systems. The present top-down systems driven by national rather than local goals with limited community involvement would prevail. Engineering and technical solutions to environmental problems would continue to encompass present soil and water management techniques like terracing, damming, buffer zoning, dykes, weirs, channels and drainage. Technology transfer would be limited to mainstream extension service delivery with low receptiveness for new knowledge on environmental management. This would constrain improvements in sustainable environmental management. Human settlement would continue to be in both rural and urban centres with increasing rates of rural-urban migration. Increasing trends in numbers and areas of poorly serviced and planned urban settlements would be witnessed. Cultural practices related to settlement in the rural and urban areas would continue, making conservation untenable in some parts of the lake basin. Incidences of sprawling beach settlements would increase.

Environmental legislation would remain disparate and conflicting between countries, with little capacity or will to implement the many acts related to land and water in the states of the region. Progress in land reforms would continue. Under this scenario, environmental degradation would persist due to unsustainable use. The National Environmental Management Authorities (NEMA) of riparian states and other institutions which are at their inception or infant stages would attempt to buffer the environmental degradation. Most of these implementing agencies would continue to be reactive rather than proactive to emerging environmental issues and concerns. Institutionalized management and resolution of resource-based conflicts would continue to be largely undeveloped with the local administrators acting as the main arbitrators.

Scenario 3: Best Practices

By assuming that environmental stewardship is at par with economic and social goals of environmental management, the *Best Practices* scenario assures pathways to a sustainable future. The driving forces such as population dynamics are at optimum levels that enhance sustainable use of the basin's resources. The status of rivers and lake ecosystems would consequently, marginally improve. Vulnerability of communities to natural disasters would be minimized and improvements in literacy levels and sustenance of agricultural and economic productivity of the lake basin assured. The other outcomes of the scenario are improved nutrition status, reduced poverty levels, reduced unemployment levels and minimal resource-based inter-community and cross-boundary conflicts.

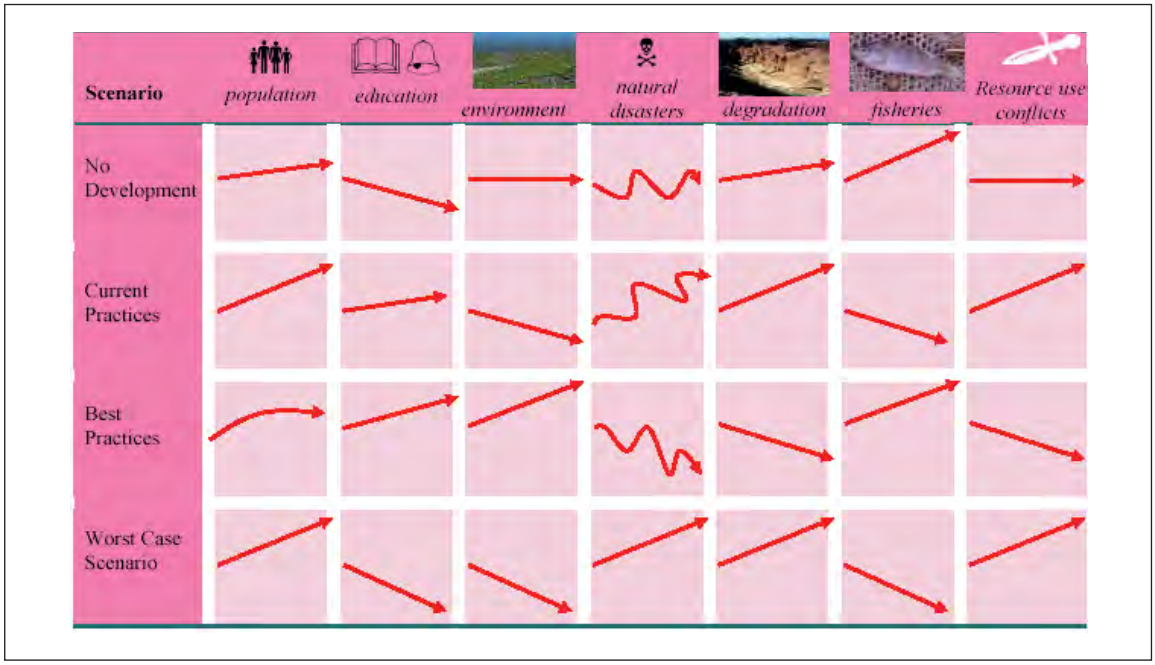
Scenario 4: Worst Case Scenario

As opposed to the *Best Practices* scenario, the *Worst Case Scenario* is pessimistic by assuming the extremes of unsustainable utilization of the basin's resource endowment. In this scenario, the rates of deforestation, land degradation, water pollution and destruction of rivers and lake ecosystems are highest. Population expands rapidly and is inversely related to economic growth leading to reduced quality of life. Cases of resource use conflicts are expected to escalate as a result of no or ineffective conflict resolution mechanisms and institutions. Poverty levels, nutrition status and per capita income are expected to

worsen. Other environmental performance outcomes like agricultural and economic productivity would be lowest in this scenario.

These outcomes and those of the other scenarios narrated in this outlook chapter are illustrated in Figure 4.2. The trends leading to the outcomes of each of these scenarios are presented and discussed in the subsequent section based on quantitative and figurative illustrations obtained from models and predictions using AEO-2 as the baseline.

Figure 4.2: Illustration of the predictive structure of outlook for selected issues in the Lake Victoria basin based on the four scenarios



THE DRIVING FORCES OF THE SCENARIOS

In this section, the driving forces that may change the state of the environment and trends discussed in Chapter 2 are described in terms of their influence on the social, economic and environmental changes in the state of the environment in the basin.

Driving forces are departure points for the future (Gallopin and others 1997).

Demographics

The Lake Victoria basin has witnessed high population growth rates of over 3 percent in the last three decades. Future growth rates will be lower largely because of HIV/AIDS with an estimated total population of about 35 million expected in 2025. Despite the slowing growth rates, serious challenges will be met in terms of key demographic characteristics namely actual population size, urban – rural balance and age structure. The challenges will affect essential social services including education, health, rural and urban sanitation, housing, employment and security (IIED 1997; World Bank 2000). The services will be most outstretched under the *Worst Case Scenario*.

Socio-economic issues

Social capital is a product of the interplay between the socio-cultural practices, economy and environmental management. Social issues of concern for the lake basin states include access to clean

water supplies, adult literacy, standards of living, poverty and other human development issues (Ochola and others 2000). Attempts by the governments of the Lake Victoria basin countries to provide basic services and utilities to their populations have been minimal but will nonetheless influence the social standards under the different scenarios. Social inequalities and indicators such as death and birth rates, levels of literacy and overall education improvements are compounded by poverty and can affect environmental degradation. Annual economic growth rates of over 7 percent are required for poverty levels in the basin to be reduced by at least half by 2025. This is not adequate to achieve the Millennium Development Goal of eradicating extreme poverty and hunger through halving, by 2015, the number of people living below the poverty line. The national and regional poverty reduction strategies are meant to focus social change by alleviating the challenges. Other challenges regard vulnerability and gender disparities with respect to socio-economic opportunities.

Because culture is dynamic, its influence on the environment will change due to consequences of "brain-drain", changes in consumption patterns, investment, livelihoods and other socio-economic patterns. The effects of these socio-cultural dynamics will become apparent on the ecosystem of the lake and its basin under different scenarios. Natural resource management within the basin (particularly on the Kenyan side inhabited mainly by the Luo) is bound by cultural practices (Ochola and others 2000).

Economics

The economies of the Lake Victoria basin contribute in various ways but significantly to the GDPs of the riparian states. The nature of the economies is largely extractive with livelihoods and trade based on agriculture and fisheries. Livelihoods are mainly subsistence and the economic sector is informal and so is highly vulnerable to national, regional and global changes. The fisheries of Lake Victoria dominate the export economy. The global share of fish exports is low and erratic with strict standards that have in the past lead to periodic ban of fish products from the basin in the European Union, the main market. This was due to unhygienic fishing and fish processing methods including use of toxic chemicals. The environmental consequences of emerging export oriented economies involving fish trade and small-scale mining is significant.

Land Use

The environment of Lake Victoria basin is a driving force for change only through its interaction with the other driving forces as seen in different land use types. There are severe environmental threats linked to land use in the basin such as fresh water scarcity, land degradation, loss of biodiversity, incremental loss of wetlands, degradation of coastal areas, water resource pollution, management of agricultural, industrial and domestic waste, emergence and re-emergence of diseases, the water hyacinth menace and natural disasters like floods. All these threats resonate with poverty. The ability of the lake basin environmental resources to sustain the livelihoods of the inhabitants depends on the abatement of these threats and the utilization of the resources in such ways to avoid the threats. Negative changes in the other driving forces like population, economy, culture and governance precipitate the threats. The on-going degradation of land and water resources through chemical pollution, siltation and erosion is compounded by environmental resource use conflicts which are both intra-state and of transboundary nature, and by the need for agriculture to meet the demands imposed by the ever increasing human population (FAO 1995).

Governance

Local, national and regional governance will play a significant role in environmental management of the lake basin. Good governance presupposes economic development and environmental sustainability. The legal and institutional arrangements in the lake basin dictate the pace of environmental change. The laws relating to land use, conservation and protected areas, tourism, pollution control, water resources and forestland are implemented by various institutions in the region. They are reflected in the various acts, treaties, agreements, articles, conventions and memoranda of understanding that have been adopted by the states (UNEP 2000). The establishment of LVEMP and LVFO are examples of

the products of such agreements. The re-institutionalization of the East African Community (EAC) is envisaged to reinvigorate cross-border environmental management through enactment of appropriate basin-wide legislation, laws and agreements.

Other driving forces

The driving forces discussed above will continue to occasion the realisation of the various scenario eventualities over the next 20 years in conjunction with other factors including energy consumption patterns, construction and infrastructure development, education, technology and innovation. The knowledge, attitudes and practices (KAP) of stakeholders are influenced by, among other factors, technology transfer. Appropriate technology availability and dissemination will determine the extent of minimization of land degradation in the lake basin. Other technological factors that would have an impact on the basin include the nascent information and communication technology (ICT), use of biotechnology in agriculture and integration of sophisticated early warning systems for environmental change monitoring.

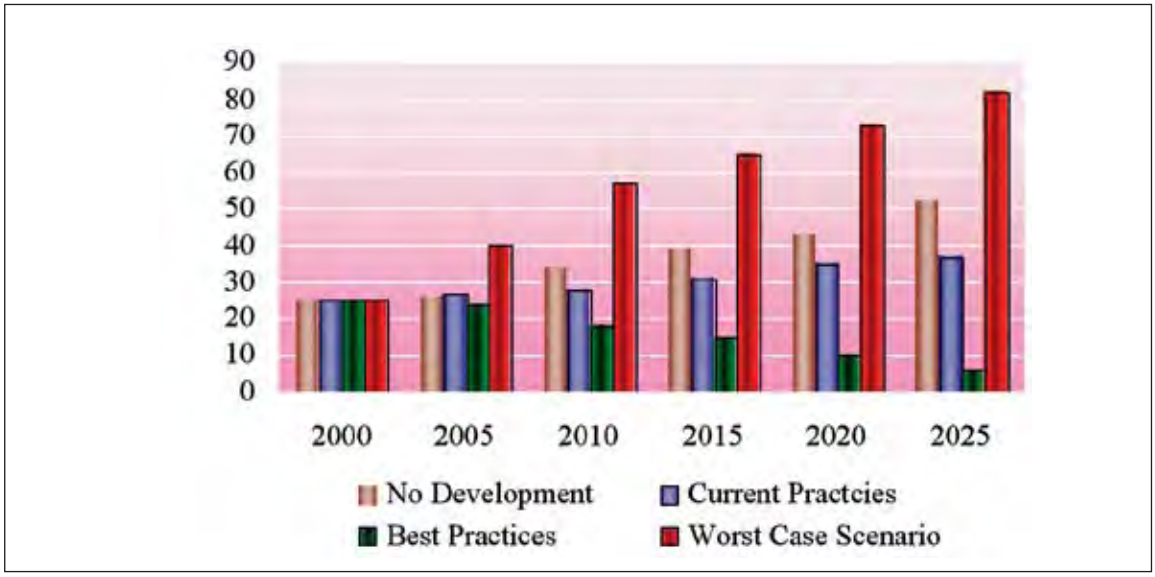
Energy consumption patterns affect environmental state. Extensive use of fuelwood leads to deforestation. The conflict between agriculture and fisheries over forest protection also escalates with increased use of fuelwood for fish processing along the lake's beaches. Diversionary policies that encourage the use of cheap, clean and renewable sources of energy would reduce environmental degradation. Intervening drivers like climate and changes in education will obviously moderate the effect of these driving forces on the future state of the lake basin environment.

TRACKING SELECTED ENVIRONMENTAL INDICATORS BASED ON THE SCENARIOS

Forests

The encroachment of forests grows sharply and steadily under the *Worst Case Scenario*. The collapse of environmental protection, disregard for environmental integrity and adverse changes in land tenure including reduction of protected status of gazetted forests explain this. Encroachment of forests is only expected to decline under the *Best Practices Scenario* characterised by positive land tenure reforms, increase of protected areas and environmental awareness and education. Even with current practices the encroachment of forest areas will increase due to disintegrated forest legislation and continued agricultural expansion. The *No Development Scenario* will see an escalation of encroachment higher than in the *Current Practices Scenario* but lower than in the *Worst Case Scenario* (Figure 4.3).

Figure 4.3 Total area of forests encroached in the various scenarios



Land Holdings

The per capita land holding changes are expected to be constant in the *Best Practices Scenario*. Despite the increase in population, land tenure reforms such as consolidation, actual land holding per capita remains constant or reduces at very low rates unlike in the other scenarios where continued subdivisions and high population growth rates will precipitate sharp reductions in per capita land holding (Figure 4.4). The key population changes (Figure 4.5) will be zero or minimal under *No Development Scenario* but highest growth rates will be experienced under the *Worst Case Scenario*. In this scenario, greater rural to urban migrations will occur coupled with increase of sprawling, poorly serviced small urban centres especially along the beaches.

Figure 4.4: Changes in per capita land holding under different scenarios

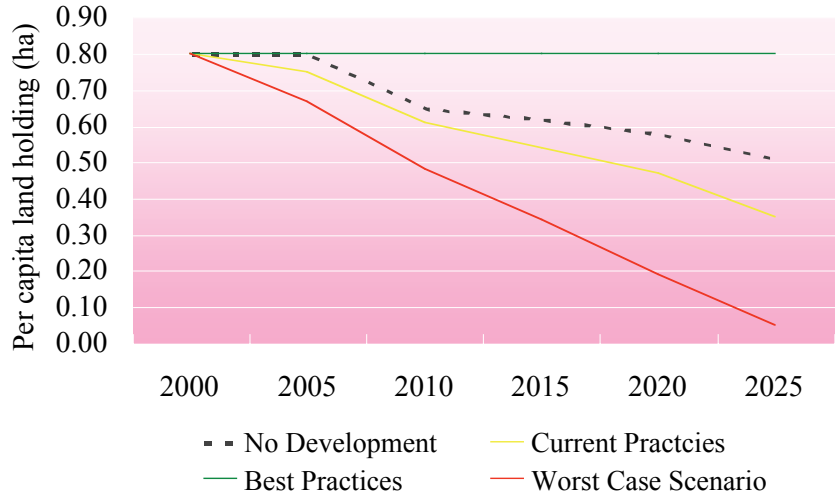
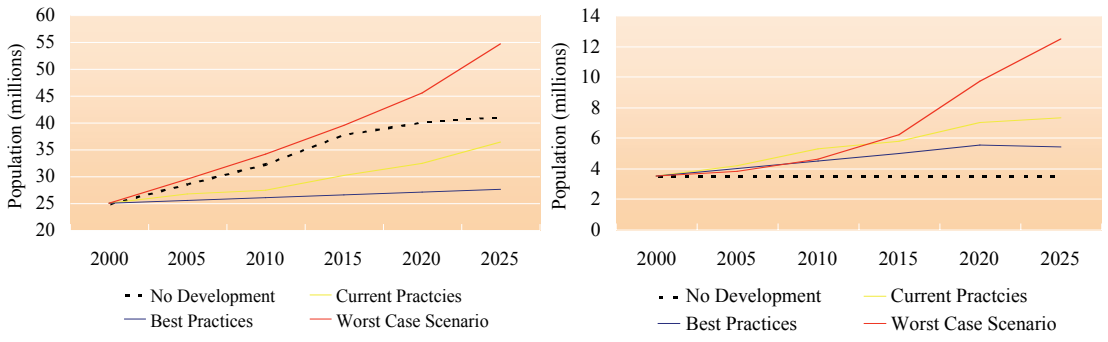


Figure 4.5: Population change under different scenarios

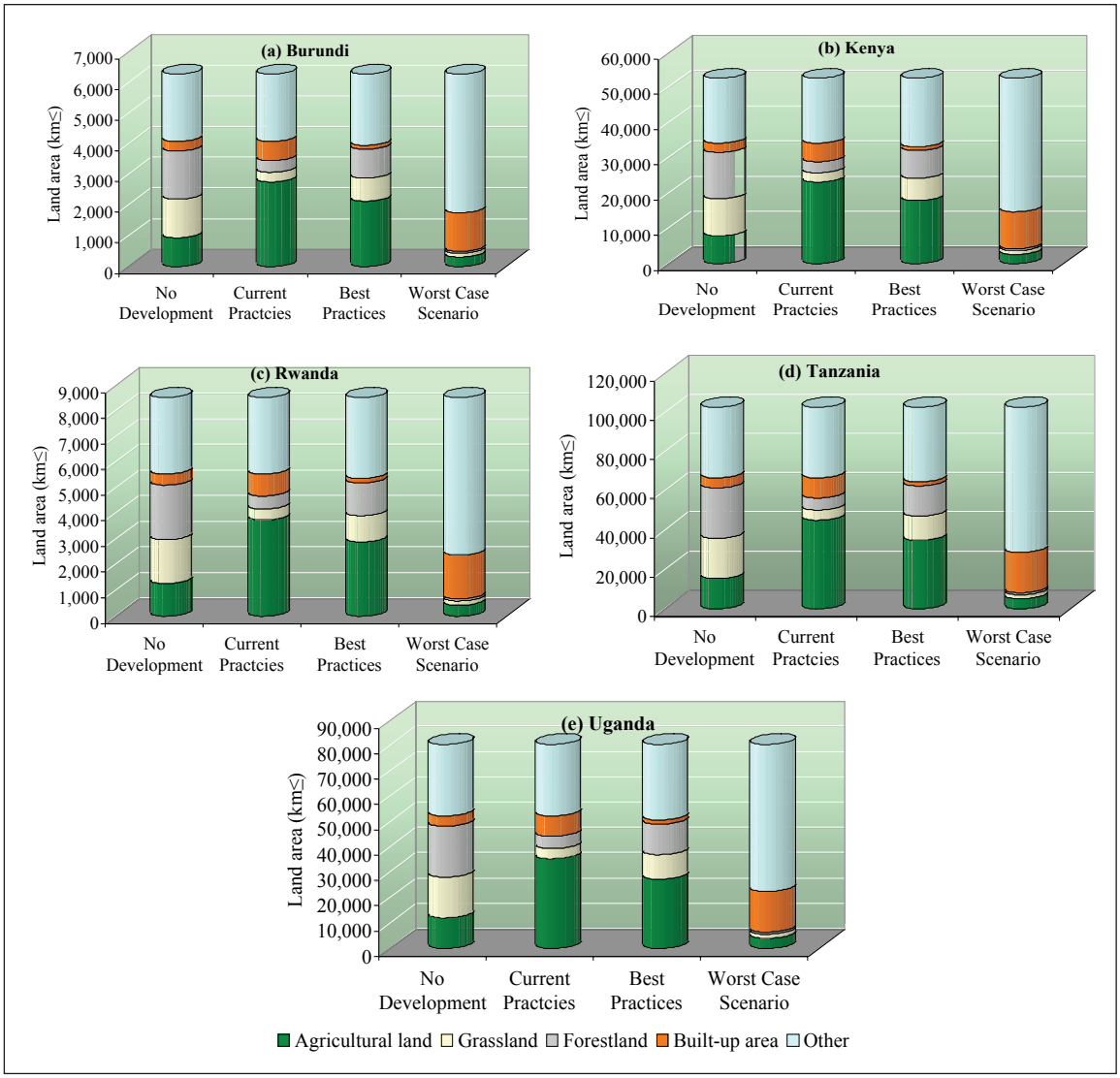


By 2025, land available for different land uses, including agriculture, grassland, forestland, infrastructure and others, will significantly differ under the separate scenarios (Figure 4.6). This is in comparison to the 2005 figures shown in Table 4.1. The largest area of agricultural land will be available under the *Current Practices Scenario* driven mainly by the existing agriculture-based economies of the riparian states. It will be lowest under the *Worst Case Scenario* due to land degradation associated with environmental neglect. The trends of land cover will directly mimic the changes in land area under different land use types (LUT).

Table 4.1: Land available for different land uses as of 2005 (Swallow and others 2002)

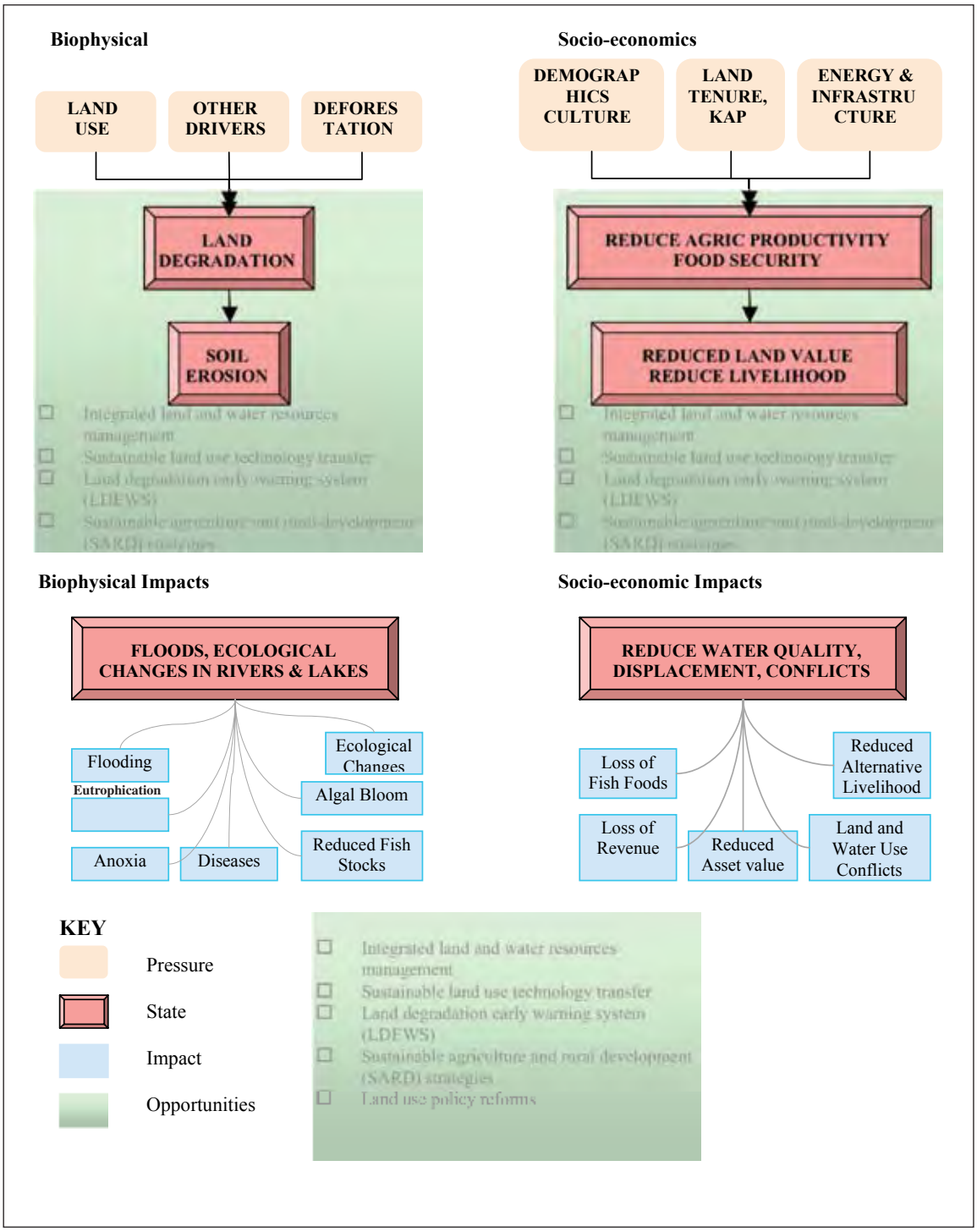
Country	Agriculture	Grassland	Forest land	Built up	Other
Kenya	7,900	10,500	13,050	2,630	18,350
Burundi	940	1,260	1,570	320	2,195
Rwanda	1,280	1,705	2,130	427	2,986
Tanzania	15,437	20,582	25,728	5,146	36,020
Uganda	12,086	16,114	20,143	41,029	28,200
Total	**37,643**	**50,161**	**50,921**	**12,552**	**8,775**

Figure 4.6: Land available for different land use types by 2025 under different scenarios



The future states of these main integrating environmental status issues were assessed with the central focus on land degradation using the Opportunities Framework (Figure 4.7).

Figure 4.7: Opportunities framework assessment of the outlook of Lake Victoria basin ecosystem



IMPLICATIONS OF THE SCENARIOS ON THE LAKE VICTORIA BASIN ECOSYSTEMS

No Development Scenario

The assumption that no development occurs in the basin under traditional environmental management would reflect a disintegration of several regional and global economic activities with impacts on the ecosystem. Although this scenario looks impractical, it offers a necessary reference point for the implications of current and future actions or inactions. Ecological changes and disasters like floods and drought are naturally driven. The atmosphere becomes cleaner as a result of reduction in

polluting activities like industrialization and chemical use in agriculture. The rivers and lakes of the basin continue to become less polluted and will witness an increase in biodiversity. Floods continue to displace vulnerable settlements regularly during rainy seasons. However the basin remains vulnerable to effects of climate change notably regular incidence of floods, drought and diseases. Because of reduced agricultural production, household food security is drastically decreased leading to over-dependence on food aid and influx of foods and other trade commodities from other regions. Livelihoods continue to be eroded. Land cover changes and land degradation worsen due to unplanned land use. Land is less economically utilized and pressure on land is worsened by disruption of land tenure structures. Communal land ownership becomes dominant, and ecologically responsible land investment becomes limited. There is no introduction of invasive or alien species into the lake.

Current Practices Scenario

Existing environmental management practices if left to continue unchecked will lead to serious ecological consequences in the future. Socio-economic and environmental (biophysical) stresses will continue with a resultant increase in extent and frequency of natural disasters like floods. Eutrophication, anoxia and changes in phytoplankton and zooplankton population in the lake will affect fish catches thereby severely depleting economic returns from fisheries. This will be the aftermath of associated poor upland farming practices, ineffective land and water use policies and pollution. Land degradation will worsen and land available for desirable land use types such as agriculture will dwindle. Despite the many environmental acts and laws, regional and local treaties and agreements, ecological stewardship will decline due to lack of local and national implementation capacity and will. Environmental acts and laws will continue to be ignored despite the creation of enforcement bodies like NEMA in the riparian states.

Predominant land tenure system will be individual ownership but due to population increases, per capita land holding decreases steadily. The desire to improve economic returns from land use leads to diversification of land uses. Pressure on land increases yet the steady rural-urban migration will not ease. The commercial and export oriented farming remains limited. Although land reforms will continue, their poor implementation will mean land owners and users will remain only accountable to themselves for the pollution and degradation their practices cause. The conservation efforts to improve biodiversity with increasing public and private involvement will remain increasingly uncoordinated. Alien species like water hyacinth and Nile perch continue to affect social and economic activities.

The lake water navigation remains largely hindered. Encroachment and destruction of forestland increase due to increasing demand for construction timber and extra land for agriculture and other land uses. Expansion of sprawling and poorly served urban centres along the beaches and adjoining hinterland continues. Poverty and vulnerability to disease and famine continue to be a major challenge. Fresh water supplies for domestic use remain a critical concern with evidence of high incidences of water-borne diseases like cholera. Within the scenario, the impact of demographic changes, environmental management, land use, technology transfer and other drivers are compounded leading to adverse ecological changes.

Best Practices Scenario

With environmental management and ecological stewardship in congruency, the scenario will lead to desirable ecosystems integrity in the lake basin. Water and land quality will be steadily improved as land degradation is mitigated. Reduction in the loss of wetlands is attained and biodiversity improves due to conservation efforts including enforcement of protected area status of selected ecosystems. Land use policy reforms will be better coordinated within states and between the states. The scenario offers the basin an opportunity to achieve the goals of environmental management and implement the NEPAD environment initiatives in all the programme areas namely: combating land degradation, drought and desertification; conserving wetlands; prevention, control and management of invasive alien species; conservation and sustainable use of marine coastal and freshwater resources; combating climate change;

and cross-border conservation or management of natural resources (freshwater, biodiversity, biosafety and genetic resources, and forests).

Air and water pollution remain under check. Public health and environmental policies converge in terms of strategies and implementation protocols with strict regulatory mechanisms. Domestication of international and regional conventions and treaties become the key avenues for implementation. Appropriate participatory and comprehensive land use policies adequately complement the land reform programmes. Land use changes in the area including large and small-scale land investments undergo comprehensive environmental impact assessments (EIAs) to isolate their negative environmental consequences. Pressure on land is reduced through sustainable population management. Urban migration reduces through incentives to stay in rural areas with deliberate policies that encourage employment creation in the rural areas.

Biodiversity continue to be one of the most significant ecological assets of the lake basin. Illegal resource extraction methods like improper fishing techniques will be eradicated and the capacity of institutions that encourage conservation, manage resource use conflicts and land stewardship is enhanced. Dependence on wood fuel will be reduced to levels that do not threaten forestland. Adequate legal frameworks will encourage and clarify local-level involvement in land use. Local populations will continue sustained participation in land planning, conservation of land, forests and water resources. Exploitation of the basin's land and water resources is done within a revamped legal, social and ecological framework. Forest cover improves to levels above the internationally desired level of 10% of the total basin terrestrial area. The economic and social endowment value of the basin's resources will be realized.

The upgrading of the region's freshwater resources and distribution networks is achieved. Integrated Water Resources Management (IWRM) strategies bring to bear efforts towards provision of domestic fresh water needs, urban and rural solid waste management, river and lake water pollution control, implementation of irrigation infrastructure and rain water harvesting systems. Vulnerability to water-borne diseases sharply declines for both rural and urban populations due to improved safe drinking water and sanitation.

The impacts of disasters like floods will be greatly reduced due to relevant and participatory disaster preparedness strategies and integrated early warning systems with wider communication reach. The escalation of poorly serviced sprawling towns will be replaced with well-planned urban expansion. Rural – urban migration will only occur when guided by appropriate land use planning (LUP) and population management policies with social services like education, access to clean water, employment and health balanced between urban and rural areas.

Worst Case Scenario

In this scenario the impacts on the environment are the result of the failure of the stakeholders to heed the quest for positive land and water use reforms leading to environmental protection complacency, with social and ecological concerns ignored largely due to trade-offs for economic gains. The lake basin's environmental conditions deteriorate with run away pollution, land degradation, loss of forest and other land cover. The development crisis that results is amplified by the undesirable interaction between poor population management, land use and government policies. Poverty rises steadily, while vulnerability to natural disasters, poor health, and local food insecurity increases. No significant social, economic, ecological and political progress is witnessed. The main challenges associated with this scenario include:

- Rapid uncontrolled population explosion.
- Vulnerability to both local and external environmental and economic shocks due to the changes occurring.
- Unprecedented spread of diseases such as HIV/AIDS and malaria with emergence of new diseases and re-emergence of old ones posing severe health concerns.
- Poverty escalates with more segments of the local population becoming absolutely poor.

The negative impacts on the basin's environment are also reflected in pollution of air and water. Air and water quality deteriorates with serious consequences on fisheries. Land degradation is rampant. Soil erosion continues to account for increasing loss of farmlands and land for other uses. Land reforms currently pursued are abandoned and expansionist land use tendencies threaten protected areas. Unsustainable use of fragile land such as rangelands, wetlands and steep slopes continues unabated. The increase in land degradation is accompanied by increase in resource use conflicts.

Destruction of habitats leads to extreme biodiversity that is worsened by breakdown of conservation frameworks and institutions. The invasion by alien and invasive species compounds the biodiversity loss and leads to widespread outbreaks of pests and diseases. The policing roles of national, regional and local environmental agencies are no longer strengthened.

CONCLUSION

The main objectives of sustainable environmental management in the Lake Victoria basin and elsewhere must remain to meet 'the needs of the present generation without compromising the ability of future generations to meet their own needs'. The needs are represented by livelihood strategies that are reflected in the economic, political, socio-cultural and ecological exploits of the inhabitants of the basin. The complex nature of the interactions and relationships within the basin's environment provides major challenges in harmonizing or trading off the often synergistic and antagonistic resource management priorities. The variations in environmental management perspectives, goals and outcomes demand an evaluation of the basins' environmental outlook in order to reflect on the different pathways and outcomes presented in this chapter as scenarios. The scenarios have been implicitly built based upon current conditions and driving forces; future images; and a logical story of inter-sectoral and ecological linkages leading to different future states. The four scenarios in this outlook chapter have been designed to inform debate, planning, action and monitoring of environmental progress. It is also possible for a combination of aspects of two or more of these scenarios to be experienced now and in the future within the basin or parts of it and its sectors.

The forces driving future environmental management in Lake Victoria basin include highly uncertain factors such as environmental policy and international and regional relations and resource use conflicts. Assessments of future environmental states require scenarios because of these uncertainties. The four scenarios presented here describe contrasting paths of possible and plausible developments. The probability of each scenario is a matter of discussion and depends on which of the major driving forces behind the scenarios are regarded as most likely from the current perspective. The incorporation of these eventualities and their effects in the plans, actions and policy reforms of governments and various regional and international mandates such as NEPAD, EAC, AMCEN and specific MEAs will determine the attainment of environmental sustainability in the Lake Victoria basin.

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CHAPTER FIVE

Options for Action

INTRODUCTION

In the previous chapters, this outlook report has (1) exposed the socio-economic context of Lake Victoria basin through a synthesis of the interactions between people and the environment by way of livelihood strategies; (2) profiled the state of the lake basin's environmental assets by assessing their states and trends, pressures and opportunities with respect to major resources reflecting the NEPAD priority areas; (3) reviewed key emerging issues with regard to environment and development in the basin that need prompt redress; and (4) presented different futures of the basin's state as affected by alternative resource utilization and livelihood strategies and policy directions. The current chapter discusses some priority options that would offer effective stewardship in the management of the basin's environment for sustainable development.

PRIORITY OPTIONS AND THEIR IMPLICATION

Some of the responses and coping strategies together with a number of opportunities for sustainable management of ecosystems resources of the lake basin can be packaged into alternative environmental management policies. The policies that would transform the direction of land and water use in the basin towards sustainable pathways represented by the best case scenario can be integrated in the on-going land use reforms which target land tenure systems.

Sustainable Land Management

For sustainable land management to be attained in the basin, the existing opportunities must be re-engineered. These opportunities regard efforts towards integrated land and water resources management (IWRM); management of wetland resources; sustainable agriculture and rural development (SARD); sustainable land use technology transfer; and early warning and assessment of land degradation. Some key opportunities in these aspects of sustainable land management are summarized in Box 5.1.

Box 5.1: Opportunities for Sustainable Land Management	
Integrated land and water resources management (ILWRM)	- Adopt a participatory approach to integrated land and water resources management, thus broadening considerably the scope of the interventions, putting people in the centre of the land management process in order to ensure its sustainability. - Ensuring win-win trade-offs and scenarios in which socio-economic development goes hand in hand with resource conservation. - Incorporation of indigenous environmental knowledge and technologies in ILWR co-management systems. - Mainstreaming gender perspectives in ILWRM systems.
Sustainable agriculture and rural development	- The application of appropriate technologies. - The allocation of land resources to competing land uses must be done while taking into account the inherent uncertainties of the future availability of resources while improving livelihoods of the people in cost-effective ways as indicated by 'land resource productivity', 'eco-efficiency', 'green accounting' as well as 'socio-economic parity' to alleviate poverty and increase food security. - Agricultural policy reforms aimed at slowing down or halting of the rampant *conversion of environmentally fragile rangelands or ecologically valuable land* to agricultural or other land uses.
Sustainable land use technology transfer	- The facilitation of appropriate research, information, advice, technology transfer including ITK and training to farmers and other stakeholders
Early warning and assessment for environmental degradation and natural disasters	- An environmental degradation early warning system (EDEWS) for Lake Victoria basin would provide data, information, and analyses for evaluating and anticipating the need for corrective interventions.

Sustainable forests and woodlands management

Various institutional arrangements exist as responses to the impacts of the forest depletion forces discussed in Chapter 2. Countries within Lake Victoria basin have put in place or are currently formulating appropriate forest policy and institutional reforms to conserve forest and woodlands resources. These reforms are largely based on reforestation schemes, protected area status of forestland and changes in land tenure systems and agroforestry technology transfer. Sub-basin specific action plans have been drawn in some countries and significant percentages of forests are being converted to protected areas. Specific actions must target

- Increased general afforestation
- Increase in on-farm forestry
- Increased investment opportunities in sustainable forestry activities as in Kenya
- 'Investment' in carbon sequestration program as in Uganda
- Diversification of forestry programs e.g. honey production
- Introduction of participatory programs with the private sector, community based organizations (CBOs), and non-governmental organizations (NGOs).

Freshwater Resources

Several coping strategies towards control of nutrient enrichment of the lake are in place. All riparian states have provisions aimed at proper management of nutrient sources in their national sectoral policies and institutional arrangements. The sectoral management effort is, however, basically inadequate and needs strengthening. The Treaty for the establishment of the East African Community (EAC) provides vital general principles on regional obligations towards sustainable management of natural resources. The Protocol for Sustainable Development of Lake Victoria basin, signed by the riparian states but yet to be ratified, sets a more specific and regionally binding agenda. Operationalising of this protocol would be vital while dealing with the international aspects of the problem. On the other hand, admission of Rwanda and Burundi to the EAC remains a condition to basin-wide compliance with the management guidelines.

Available coping strategies include revitalized fisheries policies to clearly stipulate strategies for sustainable fisheries resource utilization and preservation of the fisheries resource base, with active stakeholder participation for example in Uganda. Intensive regional dialogue and planning under the coordination of LVFO and funding through the Integrated Fisheries Management Project (IFMP) are underway. Supporting institutional arrangements are in place but the legal aspects need updating and strengthening to match new policy objectives and strategies. Funding mechanisms for monitoring, research, information dissemination need strengthening.

Opportunities exist in the lake basin for regional harmonization and co-operation in legal and institutional reforms that would improve management of the basin's freshwater resources; introduction of ecologically sound technologies for waste treatment and quality water supply; integrated water resources management; stakeholder involvement through mainstreaming of participatory approaches in the activities of institutions in the private sector, Non-Governmental Organizations and Community Based Organizations; enhancement of environmental impact assessment (EIA) process and disaster preparedness and institutional arrangements towards biodiversity restoration. Opportunities would include establishment of suitable environmental standards, assessment and monitoring of water quality, improved public education and awareness campaigns, participatory approach to biodiversity management; enhanced aesthetic value, development of ecotourism and recreational opportunities.

Atmosphere: Responses to climate change and variability

Although at national levels strategies exist for coping with effects of climate change and variability, there are limited strategies for action at the local levels in the basin. All the riparian states including Rwanda and Burundi have signed and ratified the UNCCD and through the Intergovernmental Authority on

Development (IGAD), they can institutionalize appropriate responses to climate change and variability. There are monitoring and early warning systems to improve this effort at national and regional levels. Reliance is still heavy on the World Meteorological Organization (WMO) for detailed regular information that triggers mitigatory action. Much of the action is still reactionary involving relief food distribution and little is in place for preparedness and management of climate change related disasters like floods and drought as in other developing countries (IPCC 2001).

The governments of East Africa have no disaster reduction, preparedness or management programs. There are no insurance schemes for the affected persons. Poverty is prevalent and suppresses the coping capacity of the persons in the area including coping with the impacts of HIV/AIDS (Allison and Selay 2004; ILO 2000). Lack of disaster preparedness in the Lake Victoria basin is one of the most important challenges facing the area. Economic opportunities exist in the region for commercial and industrial activities that would empower communities and eliminate or reduce poverty. Empowerment of persons will improve their adaptation to climate change and natural disasters (Hay and others 2000; Wandiga and others 2006). Other opportunities include development of policies towards disaster preparedness and management; entrenchment of disaster management and procedures, including education and awareness creation; appropriate land use planning to take into account flood control and management in prone areas; development of low head hydropower generation units; and conflict resolution.

Energy

The options for redressing energy challenges must consider the main issues associated with energy resources in the basin including appropriate economic frameworks for assessing the basin's energy options, availability, access and costs including start-up capital, efficiency in production, transmission and usage, vulnerability to natural disasters, appropriate technology, management and legislation as well as reduction of over-reliance on biomass which has the potential for environmental degradation.

Any strategy for energy resource development in the basin should entail (a) a more efficient production, conversion, distribution and use of energy; (b) increased development and use of environmentally sound renewable energy technologies; and (c) a shift towards environmentally sound, safe, efficient and cost-effective fossil fuel as well as other appropriate technologies. To this end, communities, governments, the private sector and non-governmental organisations should pursue the development, promotion and implementation of policies and programmes, as appropriate, designed to realize the goals of such a strategy. These should be the guiding principles for all countries when addressing questions on energy and sustainable development.

Enhanced availability, access to and usage of petroleum products in the basin should result in increased productivity in such areas as manufacturing and hence lead to improved economic development. Accessibility of modern forms of energy in the form of fuel for cooking positively impacts the basin's population through better health, especially in reducing prevalence of respiratory tract infections and effects of fuel wood smoke pollutants, not to mention improved utilization of time. There is scope for increasing electricity supplies in the Lake Victoria basin through, *inter alia,* harnessing hydroelectric resources from the rivers in the basin for electricity supplies. Electricity is the most versatile form of energy with high capacity for social transformation and contribution to national development; indeed there is a strong correlation between the per capita use of electricity and standard of living. Electricity is primarily used as a prime mover of economic growth in the industrial, commercial, service, and informal sectors, and provides, directly or indirectly, jobs to thousands in the region. Electricity also plays a crucial role in, for example, fish preservation (cooling), and processing, and for ice making.

Responses to and alternative options for action in the energy sector

A number of actions for improving access and availability of energy in the Lake Victoria basin exist. These include:

- Support for sustainable production and efficient utilization of biomass which continues to be the largest source of energy in the basin. This may involve (a) coordinating decision-making involving forests and woodlands management; (b) promoting fast maturing energy crops; (c) encouraging commercialisation of fuel-wood plantations; (d) carrying out biomass resource assessment; and (e) promoting modern biomass practices such as agro-forestry, the integration of tree crops in farming systems, woodlots establishment on rural people's land and other woodland resources.
- Increased development and use of renewable sources of energy in view of their considerable potential for providing environmentally sound energy to the domestic economy; and for ensuring diversity of supply options as well as increasing access to energy services to the majority of the population in the lake basin region.
- Improved information energy resource base and demand to improve understanding of the prevailing energy situation and in formulating an energy policy.
- Enhanced energy efficiency and conservation in its production, conversion and use which are crucial for socio-economic development and protection of the environment.
- Creation of an enabling environment that encourages broad participation of stakeholders, including public- private sector partnerships, non-governmental organisations (NGOs) and the donor community.
- Gender sensitivity as more than half of the population in Lake Victoria basin are women, who are affected, in one way or another, by the production, conversion, distribution, supply and use of energy.
- Promotion of research and development (R&D) in energy which plays a critical role in the development, conversion, transport and use of energy
- Provision of adequate energy services to rural areas as a pre-requisite to achieving desired socio-economic development goals, including poverty reduction and environmental protection.
- Establishment of suitable legal, regulatory and institutional framework for effective implementation of an energy policy covering exploration, production, conversion, transmission, distribution, marketing and use.
- International and regional co-operation in the development of environmentally sound, cost effective and affordable energy systems. Such co-operation is also essential for promoting energy efficiency improvement and conservation, the use of renewable energy sources and technologies, research and development, and dissemination of information on innovative technologies.
- Development of adequate national energy policy by each of the riparian countries consistent with the overall national development objectives and in tune with environmental conservation goals.

Responses to increased health and malnutrition vulnerability

Proper management of resources of the Lake Victoria basin would enhance agricultural productivity and improve health and nutrition amongst the riparian communities. This can be aided by the enactment of relevant policies and legal frameworks for the efficient management of available resources in a manner that will improve the health of the residents of the basin. All the countries in the region have policies and legislation to regulate the utilization of the Lake Victoria resources and deter environmental mismanagement. Enforcement regulations, however, tend to be weak or lacking, leading to ineffective implementation. The Lake Victoria Environmental Management Plan was initiated in Kenya, Uganda and Tanzania, in 1994 under the auspices of the Global Environment Facility (http://www.grida.no/climate/ipcc/regional/038.htm). The Lake Victoria Environmental Management Project (LVEMP) is an important initiative of the three riparian states to try and reverse the adverse impacts that have so far gone unchecked for so many years. This coordinated effort to curtail the current poor wetlands management encompasses management of fisheries and industrial and municipal wastes, control of water hyacinth, water quality monitoring,

conservation of biodiversity, and sustainable land use. The Lake Victoria Development Programme (LVDP) has effected National Focal Points in the ministries of Partner States, which are responsible for Lake Victoria development (Odada and others 2004). Non-governmental organizations are also involved in implementing rural domestic water supply and health and sanitation programs.

There have been various management activities implemented by the governments of Kenya, Tanzania, and Uganda, with support from international partners, to review, evaluate and develop a Regional Water Hyacinth Management Plan. Together with Rwanda, these countries have begun to coordinate management efforts through regional organizations or projects. Rwanda implemented a *Neochetina* weevil species rearing and release effort in 2000 (Agaba and others 2001). Despite all the negative impacts of water hyacinth some of the practical applications of the weed include water purification, fertilizers, animal fodder and fish feed.

Detection of disease in this region calls for major human and material resources, such as well-equipped health centres and qualified staff. For example, although malaria is curable if promptly diagnosed and adequately treated, it kills more people than any other communicable disease except tuberculosis. In Kenya, Uganda, and Tanzania, malaria accounts for one-third or more of outpatient morbidity in the population (De Savigny and others 2004). Most people, particularly children, affected by other diseases such as cholera and sleeping sickness, die before they can even be diagnosed. There are a number of disease surveillance centres that have come into operation, and which are strongly supplementing and strengthening the efforts of the national governments to monitor disease outbreaks. One such is the International Emerging Infections Program located in Kisumu, Western Kenya to deal with surveillance, investigating outbreaks, and intervening. Their quick mobilization during the recent outbreak of suspected leptospirosis in Western Kenya is an example of how the riparian states would benefit from strengthening disease outbreak policies.

Like many other regions in developing nations, the ability of lake basin's communities to construct and implement effective health policies is plagued with lack of adequate population health and vital events information. Dependable national data sources that would allow for evaluation of national or regional health and disease trends are lacking, and thus policies are sometimes based on inadequate and biased information.

HIV/AIDS support services have been developed in the Lake Victoria riparian states gradually over time (Beckmann & Raia 2004). Regional and national institutional frameworks also exist. Developing and promoting protective behaviors, adolescent health, and preventing and treating of Sexually Transmitted Infections can be a powerful tool in the fight against HIV/AIDS. For example the National HIV/AIDS Multisectoral Strategy Framework was recently formulated in line with the Tanzania National Policy on HIV/AIDS of 2001. Its objectives are to strengthen a multisectoral approach, ensure political and government commitment in the prevention of transmission, encourage voluntary HIV testing, increase care for persons living with HIV/AIDS and their families, enhance research efforts, and ensure the revision and creation of legislation on HIV/AIDS (Beckman and Raia, 2004). Other areas of HIV/AIDS prevention available are mother-to-child transmission (PMTCT), Voluntary counseling and testing (VCT), and reduction in number of sexual partners. Studies in Tanzania illustrate the significance of this strategy (Ng'weshemi and others 1996). Access to anti- retroviral drugs (ARVs), VCT, TB/HIV programme and service links also exists in the L. basin regions. Proper implementation and wider distribution of these services can also be a very powerful tool.

Malaria control involves a number of different approaches. These include protection against infection through prophylaxis, control of development of disease in infected individuals, personal protection through protective clothing, repellents, and bednets, community/population protection through insecticide spraying and environmental management. The effectiveness of insecticide-treated bednets in reducing morbidity and mortality from malaria has been documented (Choi and others 1995). This

can therefore be exploited in the fight against the disease. Drug resistance often impedes progress in the fight against diseases in the Lake Victoria basin. For example, high-grade chloroquine resistance is widespread in the lake region.

Cholera and other diarrhoeal diseases are highly preventable, the only requirement being proper sanitation and safe drinking water to significantly reduce their transmission in a community (Brooks and others 2003). Cholera epidemic control and preventive measures include hygienic disposal of human faeces, adequate supply of safe drinking water and good food hygiene. Although less than 10% of persons harbouring the cholera bacteria develop typical cholera with signs of moderate or severe dehydration, case-fatality rates, which can be limited to less than 1% in a community with well established diarrhoeal disease control programme, can rise to as high as 50% in an unprepared community (Birmingham and others 1997). In Kenya, the Ministry of Health has a National Cholera Task Force in collaboration with similar task forces set up at provincial and district levels (http://www.who.int/crs/don/1999_01_20/en/). Such task forces can, however, be greatly hampered by the poor infrastructure in the basin coupled with poor coping strategies within the impoverished communities. As in the case of malaria drug resistance, there are records of resistance to antibiotics by cholera bacteria (Shapiro and others 2001; Shapiro and others 1999).

There is great potential for fish farming even in the face of such an abundance of natural waters of the lake. Some groups are setting up precedence with this. In Kenya the Women in the Fishing Industry Project (WIFIP) is training women on the management of a Catfish propagation project. Apart from protecting the women from wading in disease and snake-infested waters, this is an income generating activity and conserves the wetlands.

Lessons can be learned from other regions in the world. The development of transgenic papaya saved the papaya industry in Hawaii from severe Papaya Ringspot Virus (PRSV). The same virus threatens the Lake Victoria basin papaya industry in Tanzania and Uganda with rates of incidence ranging from 51-100% (USAID, 2003). Continuing development of disease resistant crops such as papaya resistant to papaya ringspot virus can provide effective control of the disease and stem some of the malnutrition in the region. Due to pressure of population, irrigation has potential in the region to cover food deficits (Cohen and others 1996). However, this would have to be accompanied by strategies for prevention and control of water-borne diseases.

GOVERNANCE AND CAPACITY BUILDING FOR ENVIRONMENT AND DEVELOPMENT

The riparian states have individually enacted environmental laws consisting of legislation, standards, regulation, institutions and administration strategies to govern activities on environmental management. The countries are signatories to several multilateral environmental agreements (MEAs) that address several sectors of the environment including land, forests, woodlands, wetlands and water. Some of the MEAs ratified include the Convention on Biodiversity (CBD), UN Convention to Combat Desertification (UNCCD), the UN Framework Convention on Climate Change (UNFCCC), the Montreal Protocol on Substances that Deplete the Ozone Layer, Rotterdam Convention on Prior Informed Consent (PIC) and the Stockholm Convention on Persistent Organic Pollutants (POPS). In order to benefit from the MEAs, the states are also domesticating the New Partnership for African Development (NEPAD) initiative on combating desertification through the respective National Environmental Management Authorities (NEMA). Through these and other initiatives, opportunities exist for appropriate community governance and empowerment: better planned settlements – urban and rural; application and practice of sustainable agricultural methodologies; provision of better services such as sanitation, health, education and awareness; supply of power and transport system; and democratization and social harmony through cultural cohesion and integration.

Box 5.2: Legal and Institutional aspects and opportunities for the management of the environment

The laws that relate to the environment within the basin include: sectoral or functional laws regarding land use, protected areas and pollution control; and cross-cutting laws especially those creating regional and local arrangements and authorities. There is need to create a conducive framework for environmental laws. Aspects of the environment that are critical to the Lake Victoria basin to be considered in the laws include protection of rivers, lakes, wetlands, hill tops, hill sides, mountain areas, forests, energy conservation, conservation of biological diversity, and access to genetic resources of the basin, among others, The laws should consider the use of economic incentives to induce compliance with environmental law and penalties for non-compliance. NEMAs in all riparian countries (especially Kenya and Uganda) have been empowered to enforce existing and future laws.

There do exist regional institutions and instruments with legal frameworks and protocols focusing on specific aspects of the environment. The East African Act of 2002 in Kenya, for example, has specific articles covering several environmental concerns including prevention of environmental degradation, development of strategies for fragile terrestrial and aquatic ecosystems and control of noxious emissions and chemicals. In the EAC memorandum of understanding, the members states agreed to develop and harmonize standards and legislation applicable to environmental management with a view to preventing all sources of degradation by developing and strengthening institutional mechanisms at national and regional levels.

The Convention for the Establishment of the LVFO adopted by Kenya, Uganda and Tanzania will foster cooperation in the harmonisation measures for sustainable utilization of fishery resources. It is expected that LVFO will be empowered to deal directly with issues such as cross-border fishing that has tainted relations among the three countries. The Arusha protocol for sustainable development of Lake Victoria basin adopted in 2003 has provided an extra impetus to the process. The establishment of the Lake Victoria Commission as the apex body for this mission with the goal of promoting equitable economic growth but with enhanced sustainable utilization and management of natural resources and environmental protection is a welcome move. The commission has been mandated to initiate, coordinate and harmonize development of environmental laws at the regional level. It is the domestication and facilitation of stakeholder and public participation at the basin and local levels that will ensure that the benefits of such legal and institutional frameworks are realized in the basin.

RESPONSES AND POLICY REFORMS WITH REGARD TO FUTURE OUTLOOK

The knowledge of the future ecological state of Lake Victoria basin ecosystem as precipitated by the contribution of various driving forces can enhance avoidance of ecological crises and guide the push towards sustainable environmental management pathways. Current and future responses to the environmental impacts of the various scenarios (Chapter 4) constitute major challenges. The charting of a new course for the sustainable management of Lake Victoria basin's biophysical and socio-economic resources is the desire of ecologically sound policy reforms. The descriptions of the scenarios in Chapter 4 should assist in the recognition of the ecosystems vision, the identification of paths taken by the respective scenario indicators as well as in development of appropriate steps to be taken to redirect future ecosystems management pathways to the desirable goals.

The desire by AMCEN to develop regional outlooks such as this Lake Victoria Environment Outlook is a major stride in the basin's development efforts. The outlook provides minimum requirements for environmental stewardship in the basin. Reactions to future occurrences must be based on an appropriate balance of governance, resource extraction and conservation. The *Worst Case Scenario* is characterized by pessimism and apathy, neglect and lack of socio-economic and environment accountability that must be avoided at all costs. The *Best Practices Scenario*, on the other hand, is heralded by optimism, socio-economic and environmental responsiveness and a natural reaction towards seeking a balance between socio-economic development and environmental sustainability.

The driving forces for the various scenarios present the basin with major uncertainties that must be managed in such a way that their impacts on the ecosystem are considered in current and future policy and governance strategies. Targets set by AMCEN and the EAC and efforts towards adopting MEAs

and MDGs as also reflected in NEPAD's environment initiative and specific programme areas must consider the indicators, drivers, impacts and responses related to these scenarios. The Eastern Africa governments and local stakeholders in the basin are already aware of this and initial attempts are being made towards reorienting policies to be responsive to these environmental concerns. The management of future eventualities will depend on how local institutions, resource users, governments and other stakeholders integrate the following critical points of environmental sustainability:

- Land reforms.
- Alternative energy sources.
- Afforestation and protection of forestlands and rangelands.
- Establishment of early warning systems.
- Appropriate engineering solutions to selected environmental problems such as floods and other land degradation problems like soil erosion.
- Implementation and harmonization of relevant environment acts and legislation.
- Alternative livelihood options.
- Institutional arrangements for conflict management and stakeholder participation.

The responses will ensure a conscientious management of the basin's resources. Governments and their environment ministers must continue to appreciate the fact that current environmental policies and practices are grossly inadequate and cannot see us attain a sustainable future. Any review of policies and MEAs must address these concerns.

CONCLUSION

The review has clearly demonstrated that the Lake Victoria water and land resources have deteriorated to a point that they are no longer able to support livelihoods in the quantity and quality of the past 40 years. This can be attributed to the over-exploitation of resources, the outmoded cultural practices, ignorance or desperation for survival. However, the environmentally negative activities have injurious consequences on health, ecology and the lake itself. The major driving force behind resource depletion and degradation is population increase. Reorganization of the rural villages into self-supporting, well-serviced urban centres will free land for cultivation that can be properly planned and managed. A review of land tenure system in the catchments is an essential first step to the restoration activities in the lake and its catchment.

Deforestation, poor agricultural practices, over-stocking and grazing have all contributed to massive soil erosion. Enforcement of laws governing agriculture, forest, land and water conservation will lead to sediment and nutrient load reduction. There is a need to apply a mixture of command and control laws and regulations as well as market forces to effect change. Some market price adjustment for fertilizers and pesticides will introduce their conservative use.

The planning of urban and rural centres will lead to the provision of waste treatment plants, potable water, electricity, roads and other utilities. Once utilities are provided there should be sufficient financial resources to ensure operation and maintenance of installed infrastructures at all times. Most sub-Saharan African countries have very weak systems for operation and maintenance. The quality of the environment cannot be maintained if utilities are non-functioning. Hence sufficient resources need to be budgeted for each year for operations and maintenance. It is similarly critical that all municipal waste treatment plants that are in disrepair are made to function as soon as possible. Trained staff should be engaged to ensure their continued service. Market forces should be put in place to reward or penalize the offenders. Enforcement of the polluter pays principle (PPP) would spur the utilization of clean technologies, thus, industries and institutions would be encouraged to care for the environment through this policy.

Establishment of institutions that will encourage realistic stakeholder participation in conservation and management of resources at the village, local, national and regional levels is essential for the Lake Victoria resources utilization. Some of these institutions already exist. One such institution is the Lake

Victoria Fisheries Organization (LVFO). This institution, and similar fisheries research institutes should be strengthened to enable them mobilize communities and resources for the management of the lake and not only its fisheries resources. Similarly, the East African Community could play a stronger role in regional policy coordination. At the national levels the respective riparian governments should: show both political will and policy direction in establishing policies that engage the public (public awareness, voluntary groups, the mass media, others); enforce existing rules and regulations and where deficient making new ones; and establish policies that use existing markets (often use price signals) and create markets (often create price signals).

Owing to the realization that the Lake Victoria basin is endowed with largely untapped resources and that there is a potential threat posed by the degradation forces highlighted in various chapters of this report, the East African Community (EAC) and other development partners like the Governments of Sweden, France and Norway, the World Bank and the East African Development Bank (EADB) have entered into a long term partnership on the promotion of sustainable development of the basin. This was in response to the realization that the potential of the basin cannot be sustainably developed unless problems related to environmental degradation, deepening poverty and poor health standards are addressed in a broad and coordinated manner. The partnerships have seen the institutionalization of intergovernmental and international arrangements that largely focus on activities related to the sustainable development in the region including: the Lake Victoria Environment Management Project (LVEMP); the Nile Basin Initiative (NBI) and its sub-basin window, Nile Equatorial Lakes Subsidiary Action Program (NELSAP); the Lake Victoria Fisheries Organization (LVFO); the Lake Victoria Region Local Authorities Cooperation (LVRLAC); the Inter-University Council of East Africa; and ECOVIC, a consortium of Community-Based Organizations and Non-Governmental Organizations in the basin.

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